भारतीय दूरसंचार विनियामक प्राधिकरण

Telecom Regulatory Authority of India

Recommendations on
Assignment of the Microwave Spectrum in 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, 21 GHz Bands, E-Band, and V-Band

New Delhi, India

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Tower F, NBCC World Trade Centre, Nauroji Nagar, New Delhi-110029

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Chapter I: Introduction and Background

A. Introduction

1.1 Electromagnetic spectrum refers to the range of frequencies of electromagnetic radiations[1]. From the lowest to the highest frequencies, the full electromagnetic spectrum comprises radio waves, infrared light, visible light, ultra-violet light, x-rays, and gamma rays. Radio spectrum refers to that part of the electromagnetic spectrum which comprises radio waves – the waves with frequencies from 3 kHz to 3 THz.

1.2 In 1887, Heinrich Rudolf Hertz, a German physicist, was the first to prove the existence of electromagnetic waves. He showed that electromagnetic waves could be transmitted and received through free space. This discovery motivated scientists and innovators in many corners of the world to find new applications of electromagnetic waves.

1.3 Guglielmo Marconi is widely recognized as the inventor of radio[2]. At Signal Hill on December 12, 1901, Guglielmo Marconi and his assistant, George Kemp, confirmed the reception of the first transatlantic radio signals. With a telephone receiver and a wire antenna kept aloft by a kite, they heard Morse code for the letter "S" transmitted from Poldhu, Cornwall. Their experiments showed that radio signals extended far beyond the horizon, giving radio a new global dimension for communication in the twentieth century.[3] Marconi's achievement not only revolutionized telecommunications by demonstrating the possibility of transmitting

[1] Electromagnetic radiations are made up of waves of varying frequencies, which carry energy. Electromagnetic radiations travel at the speed of light in a vacuum and exhibit wave-particle duality, behaving both as waves and as discrete particles called photons.

[2]Source: https://spectrum.ieee.org/who-invented-radio-guglielmo-marconi-or-aleksandr-popov

[3] Source: https://ethw.org/Milestones:Reception_of_Transatlantic_Radio_Signals,_1901

information wirelessly over vast distances but also ushered in a new era of radio technology. The development of radio telegraphy led to numerous advancements in science, technology, and society.

1.4 While Guglielmo Marconi is often credited with demonstrating long-distance radio transmission, the contribution of Sir Jagadish Chandra Bose stands as a crucial but often underacknowledged chapter in the history of wireless communication.[4] Inspired by the electromagnetic theories of James Clerk Maxwell and the experiments of Heinrich Hertz, Bose began exploring the properties of radio waves. In November 1894, at the Town Hall in Kolkata, he publicly demonstrated the transmission of radio waves over a distance of 23 meters, successfully ringing a bell and igniting gunpowder — feats achieved using what he called "invisible light." Remarkably, radio waves even passed through intervening obstacles, including the body of the Lieutenant Governor of Bengal.[5]

1.5 International Telecommunication Union (ITU) has subdivided the radio spectrum[6] into the following nine frequency bands[7]:

[4] Source:
https://themarconifamily.pbworks.com/w/file/fetch/109978522/The%20Real%20Inventor%20of%20Marconi%27s%20Wireless%20Detector.pdf
Prasad, R., & Sridhar, V. (2015). The dynamics of spectrum management: legacy, technology, and economics. Management, 40(3), 388-391

[5]Source: https://m247.com/blog/forgotten-father-wireless-technology/
https://indianexpress.com/article/parenting/learning/jagdish-chandra-bose-invention-wireless-telecommunication-5573372/

also https://www.ieeefoundation.org/dr-mani-l-bhaumik-the-pioneer-behind-the-ieee-jagadish-chandra-bose-medal-in-wireless-communications/

[6] Though the radio frequencies have a range from 3 kHz to 3 THz, the present ITU's Radio Regulations (Edition of 2024) have allocations of radio frequencies only in the 8.3 KHz to 275 GHz range.
Source: ITU's Radio Regulations, Edition of 2024, accessible at the URL:
https://www.itu.int/hub/publication/r-reg-rr-2024/

[7] Source: Final Acts WRC-15 World Radiocommunication Conference Geneva, 2015
Accessible at the URL: https://www.itu.int/dms_pub/itu-r/opb/act/R-ACT-WRC.12-2015-PDF-E.pdf

Table 1.1: Radio Frequency Bands

Band Number[8]	Name	Symbols	Frequency Range	Corresponding Metric Sub-division
4	Very Low Frequency	VLF	3 to 30 kHz	Myriametric waves
5	Low Frequency	LF	30 to 300 kHz	Kilometric waves
6	Medium Frequency	MF	300 to 3,000 kHz	Hectometric waves
7	High Frequency	HF	3 to 30 MHz	Decametric waves
8	Very High Frequency	VHF	30 to 300 MHz	Metric waves
9	Ultra High Frequency	UHF	300 to 3,000 MHz	Decimetric waves
10	Super High Frequency	SHF	3 to 30 GHz	Centimetric waves
11	Extremely High Frequency	EHF	30 to 300 GHz	Millimetric waves
12			300 to 3,000 GHz	Decimillimetric waves

1.6 The earliest radio technologies depended mainly on lower frequencies (i.e., the frequencies upto 300 MHz) for two simple reasons - one relating to the state of the technological development at that time, and the other relating to propagation characteristics of lower frequencies. It was much simpler to design lower frequency communication systems with the then

[8] "Band N" (N = band number) extends from 0.3×10^N Hz to 3×10^N Hz.

available electronic communication technologies. Plus, lower frequencies can travel long distances (long propagation ranges); they are not subject to weather disruptions; they also penetrate most trees and even walls. However, as the demand for wireless telecommunications grew, the limitations of lower frequencies became apparent - lower frequencies lacked on the key aspect of 'bandwidth' and thereby 'information capacity'[9]. In general, the lower the frequency, the longer the propagation range but less bandwidth as the channel widths that are available are narrower. Moving higher in frequency means shorter propagation range but higher bandwidth.

1.7 The development of radar in the Second World War stimulated the expansion of communication technologies based on the microwave spectrum[10] i.e. the range of frequencies between 300 MHz to 300 GHz (the bands numbered 9, 10, and 11 in the Table 1.1 above). Microwave spectrum is, essentially, a sub-set of radio spectrum. The prefix "micro" in microwaves is not meant to suggest a wavelength in the micrometre range; rather, it indicates that microwaves are smaller (having shorter wavelengths), compared to the radio waves used in the earlier radio technologies. The development of microwave technologies led to the construction of several transcontinental microwave relay systems in North America and Europe after the Second World War. With the passage of time, advancements in solid state technologies[11] and digital signal

[9] "Bandwidth" of a signal is simply the range of frequencies that the signal contains. "Information capacity" of a channel is the amount of information that can be passed through a channel in a given time period.
In 1948, Claude Shannon developed a relationship between the information capacity of a channel to the channel's bandwidth and signal to noise ratio (SNR) as below:
$I=B \log_2 (1+SNR)$
Where I= Information capacity of the channel in bits per second
B= Bandwidth of the channel in Hz
SNR = Singal to Noise Ratio
Source: https://electronx.ca/education/communications/introduction-signals/bandwidth-information-capacity/#:~:text=The%20contributing%20factors%20to%20the,Bits%20Per%20Symbol)%5B/latex%5D

[10] Source: IEEE's article on 'Role of radar in microwaves' available at https://ieeexplore.ieee.org/document/989947

[11] Solid-state technology refers to electronic devices and systems built using semiconductors instead of traditional vacuum tubes or moving parts.

processing techniques[12] greatly enhanced the performance and lowered the cost of operating at microwave frequencies. These developments led to widespread usage of the microwave spectrum in wireless telecommunication systems worldwide.

B. Usage of the Microwave Spectrum in Cellular Mobile Networks

1.8 The microwave spectrum is the lifeblood of today's cellular mobile networks. It is used for providing both cellular mobile radio access, and radio backhaul. A brief description of these terms has been included in the following section. Conventionally, the microwave spectrum ranging from 400 MHz to 4 GHz was used for providing cellular mobile radio access, while the microwave spectrum ranging from 6 GHz to 24 GHz was used for providing radio backhaul. However, the recent introduction of the fifth generation (5G) radio access technology[13] in telecommunication networks and the consequent need for wider frequency channels have led to the use of frequencies above 24 GHz also - for cellular mobile radio access, and radio backhaul.

1.9 At the international level, ITU regulates the utilisation of radio frequencies, through Radio Regulations[14]. In the scheme of ITU's Radio Regulations, the cellular mobile radio access is a part of 'mobile service' while the radio backhaul is a part of 'fixed service'[15].

[12] Digital Signal Processing (DSP) is the manipulation of real-world signals within a digital computer, using mathematical techniques to enhance, change, or display the data in a specific way. It involves converting analog signals (such as audio or video) into digital form and performing various operations on them.
Source: https://www.sciencedirect.com/topics/physics-and-astronomy/digital-signal-processing#:~:text=Digital%20Signal%20Processing%20(DSP)%20is,%2C%20geophysics%2C%20and%20medical%20imaging

[13] 5G radio access technologies are based on the ITU's standard on International Mobile Technology (IMT)-2020.

[14] ITU's Radio Regulations, Edition of 2024 are accessible at the URL: https://www.itu.int/hub/publication/r-reg-rr-2024/. In India, the Radio Regulations (Edition of 2020) is the foundational text used for drawing up the National Frequency Allocation Plan-2022 (NFAP-2022).

[15] ITU's Radio Regulations define the terms 'mobile service' and 'fixed service as below:

C. Backhaul

1.10 A typical public telecommunication network consists of the following components:

(a) Access network;

(b) Core network; and

(c) Backhaul links.

1.11 'Access network' is the last mile connectivity to customer devices. 'Core network'[16] connects the access network to global public networks such as public internet, PLMN and PSTN. "Backhaul links" are used to connect the access network with the core network. The following figure depicts a typical public telecommunication network.

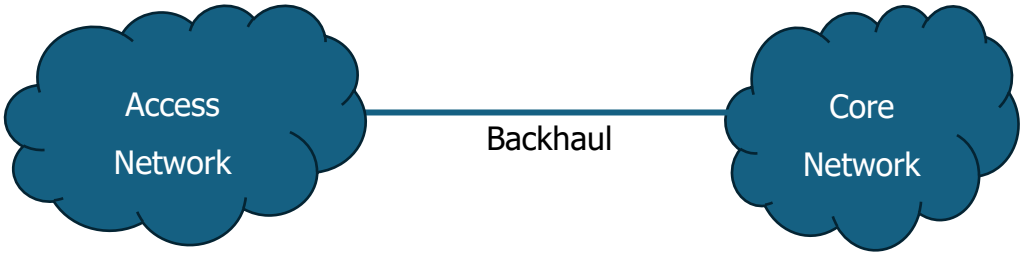

Figure 1.1: Architecture of a typical public telecommunication network

1.12 In cellular mobile networks[17], the last mile 'access' to consumer devices is provided by using microwave spectrum. For backhauling the

'mobile service': A radiocommunication service between mobile and land stations, or between mobile stations.
'fixed service': A radiocommunication service between specified fixed points.

[16] The core network carries out the switching and routing functions needed to connect a specific voice or data connection request to the correct paths.

[17] Mobile networks, as the name implies, provide the freedom of connectivity while on the move, virtually anywhere. This mobility is supported through the use of radio waves for the 'last mile of' connectivity – technically the 'air interface', between the mobiles and the base station. Although this last mile is a very fluid way for communication, a well-planned, rigid structure of radio cells needs to be in place to orchestrate this. The network of cells, activated by the base stations provide radio coverage throughout the span of the cell. In earlier cellular generations (up to 3G), there is a control node for the base stations – which decides on the attachment of a mobile to a certain base station, the process of switching the attachment (called handover) and the resource allocation to the mobiles for communication. In later standards (4G and

telecommunication traffic from the access network to the core network, traditionally, copper wires were used. However, as the cellular mobile networks gained popularity and the telecommunication traffic grew significantly, the "optical fibre cable" (OFC) emerged as the most desirable medium for backhauling because the OFC offers very high data capacity with the highest degree of reliability. In the last two decades, the country has witnessed a significant fiberization of the backhaul links connecting the access network with the core network. However, the OFC is, at times, not a 'practical' choice for backhauling the cellular mobile traffic. There could be practical difficulties in laying optical fiber cables in certain places such as tough terrains, hilly regions, water bodies, etc. The OFC may not be an economically viable option in places that are sparsely populated and where the cellular mobile traffic is not substantial. At certain places, there could be difficulties in getting permissions for laying optical fiber cables, or Right of Way (RoW) charges for laying optical fiber cables could be a matter of concern.

1.13 In essence, though the OFC is technically the most desirable medium for backhauling the cellular mobile traffic owing to its very high data capacity and the highest degree of reliability, it is sometimes time-consuming and costly to lay OFC upto the base stations[18] of cellular mobile networks. As deploying wireless links is both faster and more cost-effective, cellular mobile service providers generally prefer to deploy backhaul links using microwave spectrum in places where laying OFC is difficult and/ or economically unviable[19]. A backhaul link deployed by using microwave

5G), this node has disappeared, with its functionality absorbed mainly by the base stations. The interface that connects the base stations to the controller (and to the core in 4G/ 5G) is known as the backhaul links.
Source: Mythri Hunukumbure, Justin P. Coon, Ben Allen, and Tony Vernon (2022) The Technology and Business of Mobile Communications: An Introduction (Wiley IEEE Press)

[18] In cellular mobile networks, a base station is a fixed transceiver that is the main communication point for one or more mobile client devices. A base station serves as a central connection point for a mobile device to communicate.
Source: https://www.techtarget.com/whatis/definition/base-station

[19] Lately, telecom service providers have undertaken a significant densification of base stations, mainly because they have deployed higher frequency bands[19] particularly to cater to the massive increase in the mobile traffic in urban areas. At many of the new mobile base station sites in urban areas, laying OFC could be difficult and/ or economically unviable. The wireless backhaul becomes the preferred choice for telecom service providers to connect such mobile base stations.

spectrum is often referred to as 'microwave backhaul link', or simply 'microwave backhaul'. Microwave backhaul systems generally use directional antennas to create a wireless point-to-point (PTP) link, which enables data (information) to be transmitted over long distances.

1.14 Microwave spectrum is used not only in mobile backhaul links but also in the backbone networks[20]. In telecommunications, the backbone network is used to connect various nodes of the core network situated at different geographical locations. Though the OFC is arguably the preferred medium for connecting various nodes of the core network, telecom service providers tend to use the microwave spectrum of lower frequencies (typically less than 10 GHz)[21] to connect the nodes of the core network in case laying the OFC between such nodes is difficult and/ or economically unviable.

1.15 In the present recommendations, both backhaul links and backbone links built on microwave spectrum will collectively be referred to as "microwave backhaul", or "radio backhaul", or "wireless backhaul".

1.16 As per the report[22] by GSMA and ABI Research on 'Wireless Backhaul Evolution' (2021), the wireless backhaul will account for the majority of global backhaul links from 2021 to 2027 with around 65% market share; however, the continued use of the wireless backhaul will require an evolution toward higher frequency bands, which can support wider channels and have a greater total amount of spectrum available; the E-band (70/ 80 GHz) will be important for this purpose. In more developed markets, even higher frequency bands are likely to be important; the W-band (92 GHz to 114 GHz) and D-band (130 GHz to 175 GHz) are

[20] Source: DoT's web-page on microwave links, accessible at https://eservices.dot.gov.in/network-microwave-link

[21] Lower frequencies can support longer links. Therefore, lower microwave frequencies are preferred in backbone networks.

[22] https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2022/04/wireless-backhaul-spectrum.pdf

expected to start to gain global traction from 2025 onward. The report also mentions that traditional microwave bands would continue to play an important role as they can cover longer distances with fewer hops.

1.17 The following figure depicts the spectrum bands which are being used, or are being considered in the near future, for the microwave backhaul.

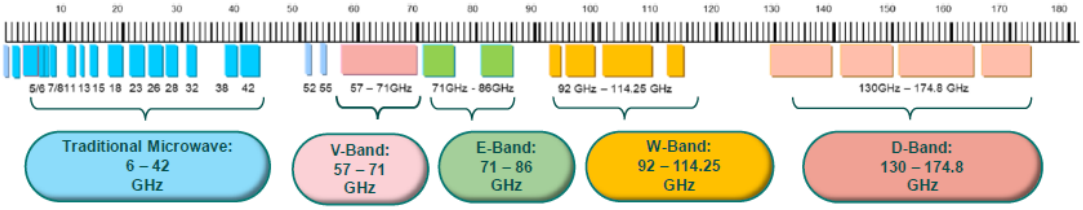

Figure 1.2: Spectrum bands being used, or under consideration, for the microwave backhaul, Source: ITU

1.18 Ericsson, in its report[23] on Microwave Outlook (2025), has mentioned that the global microwave backhaul market is growing on a steady trajectory and there are around 10.5 million transceivers installed for the microwave backhaul around the world. The following figure depicts the regional usage of the microwave spectrum, where the size of each circle represents the installed base and new deployment share per frequency range.

[23] Source: Ericsson Microwave Outlook, October 2025. The report is accessible at the following URL: https://www.ericsson.com/4a8a43/assets/local/reports-papers/microwave-outlook/2025/microwave-outlook-2025_report.pdf

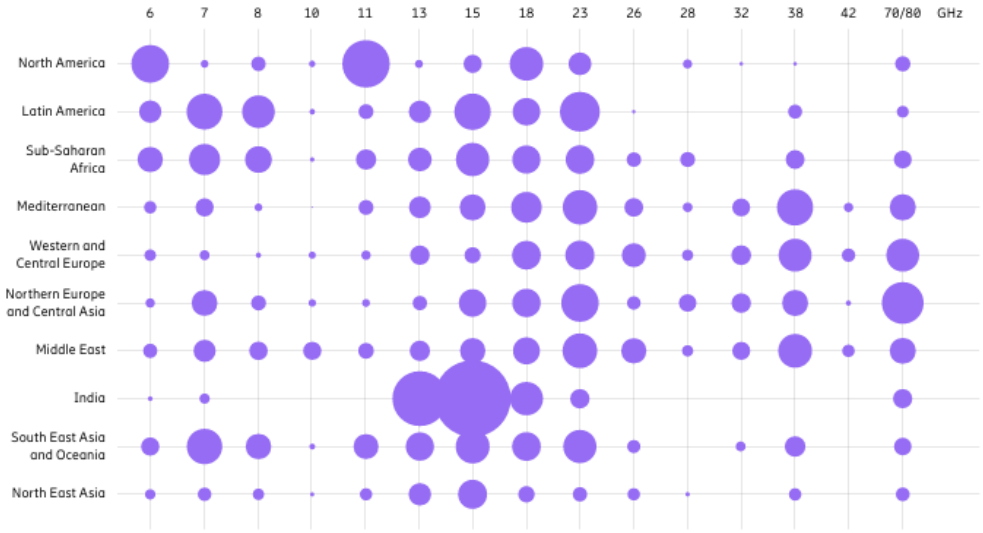

Figure 1.3: Regional usage of the microwave spectrum[24]

1.19 At present, a range of technologies (such as microwaves, optical fiber cable, copper cable, and satellite) are available for backhauling the cellular mobile traffic. Each of these technologies has its unique strengths and weaknesses. GSMA in its report on 'Mobile Backhaul Options' (2018) also provided a comparison of various means of backhaul technologies as below:

[24] Source: Ericsson Microwave Outlook, October 2025. The report is accessible at the following URL: https://www.ericsson.com/4a8a43/assets/local/reports-papers/microwave-outlook/2025/microwave-outlook-2025_report.pdf

Table 1.2: Mobile Backhaul Technologies[25]

Segment	Microwave (7–40 GHz)	V-Band (60 GHz)	E-Band (70/ 80 GHz)	Fiber-optic	Copper (Bonded)	Satellite
Future-Proof Available Bandwidth	Medium	High	High	High	Very Low	Low
Deployment Cost	Low	Low	Low	Medium	Medium/ High	High
Suitability for Heterogeneous Networks	Outdoor Cell- Site/ Access Network	Outdoor Cell- Site/ Access Network	Outdoor Cell-Site/ Access Network	Outdoor Cell-Site/ Access Network	Indoor Access Network	Rural only
Interference Immunity	Medium	High	High	Very High	Very High	Medium
Range (Km)	5~30	1~	~3	<80	<15	Unlimited
Time to Deploy	Weeks	Days	Days	Months	Months	Months

1.20 Amongst all the options for backhauling the telecommunication traffic, the OFC scores the most on all parameters except 'deployment cost' and 'time to deploy'. Importantly, the OFC is a future-proof technology. Considering the strengths of the OFC as a medium for backhauling, there has been a consistent endeavor on the part of both the Government and telecom service providers to enhance the fiberization of telecom towers. The National Broadband Mission[26] released by Department of Telecommunications (DoT), Ministry of Communications, Government of India, in December 2019, envisaged to increase by around two and half times the number of fiberized telecom towers in the country. The National Broadband Mission, 2019 had set the five-year target as below:

[25] Source: GSMA Report - 'Mobile backhaul options - Spectrum analysis and recommendations', September 2018 accessible at https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2019/04/Mobile-Backhaul-Options.pdf

[26] https://dot.gov.in/sites/default/files/National%20Broadband%20Mission%20-%20Booklet_0.pdf

Table 1.3: Target of Fiberization of Telecom Towers

	1-year	2-year	3-year	4-year	5-year
Fiberization of Telecom Towers (%) Cumulative	35	45	55	65	70

1.21 As per the press release dated 22.07.2022[27] issued by the Ministry of Communications on the progress of the National Broadband Mission, "*approximately 35.11% of Telecom Towers/ BTSs are fiberized as on June 2022. It is envisaged to be increased up to 70% by 2024-25.*"

1.22 In the recent past, the Government of India has taken many initiatives to facilitate the fiberization of telecom towers. For instance, the Government, in May 2022, launched the Gati Shakti Sanchar Portal for streamlining Right of Way (RoW) permissions for quick OFC laying and telecom tower setup, reducing the approval time. Besides, the Government, through the Telecommunications (Right of Way) Rules 2024, introduced uniform RoW charges nationwide for expediting telecom infrastructure deployment. Telecom service providers have also made significant investments to increase the fiberization of telecom towers. However, beginning from the year 2022, telecom service providers in India have started rolling out 5G mobile networks at a rapid pace (in addition to the regular expansion of the existing 4G and 2G mobile networks). The introduction of 5G mobile networks and the consequent use of higher frequency bands in radio access networks have led to a significant densification of cellular mobile base stations, particularly in urban areas. As the microwave backhaul is both faster to deploy and more cost effective, there has been a natural tendency amongst telecom service providers to connect new cellular mobile base stations (on many of them laying the OFC could be difficult, time-consuming, and economically

[27] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1843752

unviable) by using the microwave spectrum. As a result, while the total number of fiberized cellular mobile base stations in the country has increased with the passage of time, the percentage fiberization[28] of cellular mobile base stations has been able to reach only about 46%, demonstrating the continued need for the microwave backhaul in telecommunication networks.

D. Architecture of Backhaul in Cellular Mobile Networks

1.23 As indicated in the previous section, owing to techno-commercial considerations, the backhaul of cellular mobile networks in India contains a mix of OFC and microwave backhaul. The typical architecture of the backhaul in cellular mobile networks in the country can be visualized as a two-part system comprising of "pre-aggregation part"[29] and "aggregation part" as outlined below:

(a) Pre-aggregation part of the backhaul: It connects cellular mobile base station sites (also referred to as "cell sites") with the aggregation point.

(b) Aggregation part of the backhaul: It connects aggregation points to the core network. In effect, it carries the aggregated traffic from several cellular mobile base stations to the core network.

1.24 The following figure depicts a typical architecture of the backhaul in mobile networks in India:

[28] As of March 2025, 46.09% of BTSs (base stations) were fiberized. Source: DoT

[29] The pre-aggregation part of the backhaul is also referred to as "the last leg" of the backhaul.

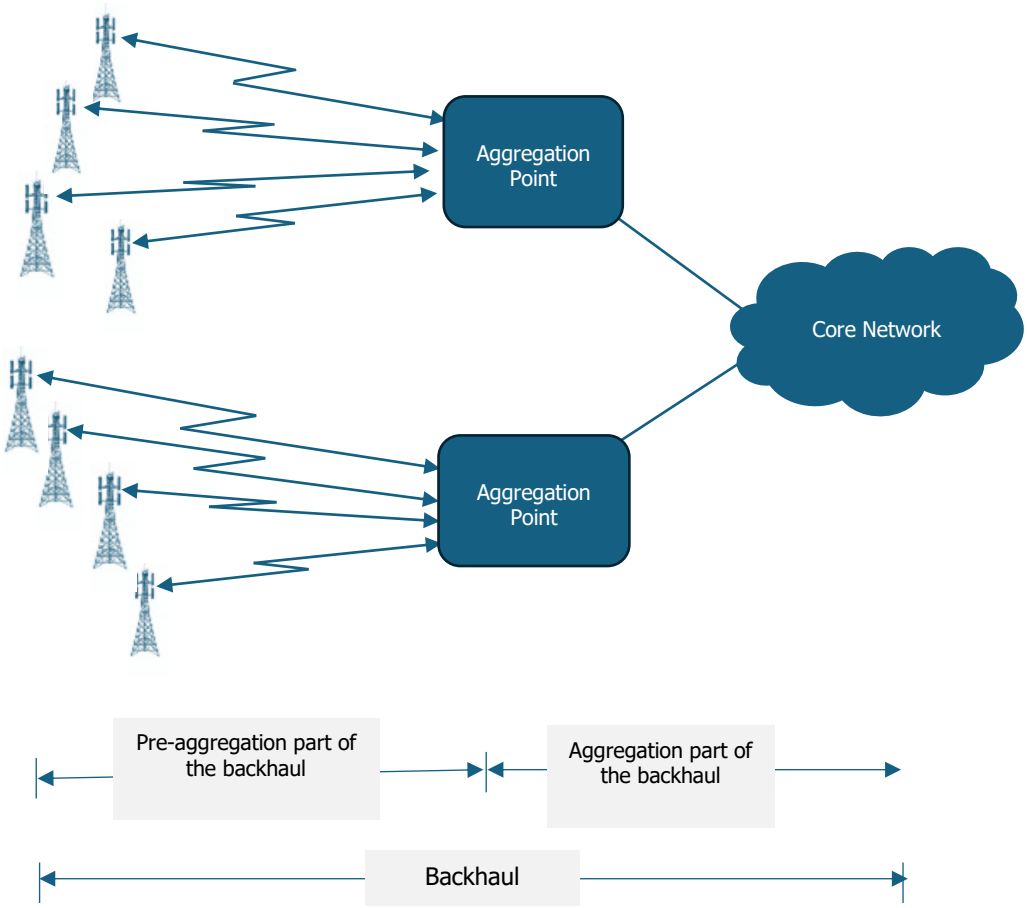

Figure 1.4: Typical architecture of the backhaul of cellular mobile networks

1.25 As the aggregation part of the backhaul requires high data capacity, it is, generally, built by using the OFC[30]. On the other hand, the pre-aggregation part of the backhaul is built by using the microwave backhaul, or OFC[31]. As mentioned earlier in this chapter, about 46% of cellular mobile base stations in the country have been fiberized; meaning thereby, about 54% of cellular mobile base stations are connected to aggregation points[32] through the microwave spectrum.

[30] The OFC has very high data capacity and the highest degree of reliability.

[31] In some cases, the satellite connectivity is also used, particularly to connect the cellular mobile base stations in remote and far-flung areas.

[32] In rare cases, cellular mobile base stations could be connected to the core network directly through the microwave spectrum.

E. Topology of backhaul networks and its evolution with the introduction of mobile broadband networks

1.26 The network topology of a typical mobile network shows that the microwave backhaul links and the optical fiber connectivity complement each other as the network expands. While the aggregation sites (i.e. the cell sites at aggregation points) and stand-alone cell sites carrying large traffic typically get optical fiber connectivity, the stand-alone cell sites with relatively lower traffic often are connected through the microwave backhaul.

1.27 With the increase in the traffic at a stand-alone cell site, the cellular mobile service providers, at a certain stage, may decide to lay an optical fiber cable to the stand-alone cell site, and sometimes convert the stand-alone cell site into an aggregation site and add additional cell sites nearby on microwave backhaul. This is how a typical cellular mobile network grows organically.

1.28 5G-based cellular mobile networks were introduced in the country in October 2022. Access service providers holding access spectrum (hereinafter, also referred to as "wireless access service providers") have deployed 5G mobile networks primarily in a newly acquired frequency band viz. 3500 MHz band. With the introduction of the 3500 MHz band in access networks in the country, the total amount of access spectrum deployed in wireless access networks has nearly doubled.[33] The increase in the quantum of access spectrum deployed in access networks coupled with the fact that 5G is a more efficient radio access technology, cellular

[33] Until the introduction of 5G mobile networks in India in 2022, the access spectrum holding of wireless access service providers in India was, generally, of the order of 60 to 80 MHz (in a mix of FDD and TDD bands) in each LSA. In the spectrum auction of 2022, many wireless access service providers obtained spectrum in the range of 60 to 100 MHz in the 3500 MHz band in each LSA.

mobile data traffic in the country has grown by 75% since the introduction of 5G in India in October 2022.[34]

1.29 With the introduction of 5G together with the introduction of the 3500 MHz band, the topology of backhaul networks has significantly evolved in the country. This aspect has also been highlighted by ITU-R, in its document[35] on "Evolution of Fixed Services for wireless backhaul of IMT 2020/ 5G" in the international context. In the said document, ITU-R has depicted the evolution of backhaul networks internationally through the following figures:

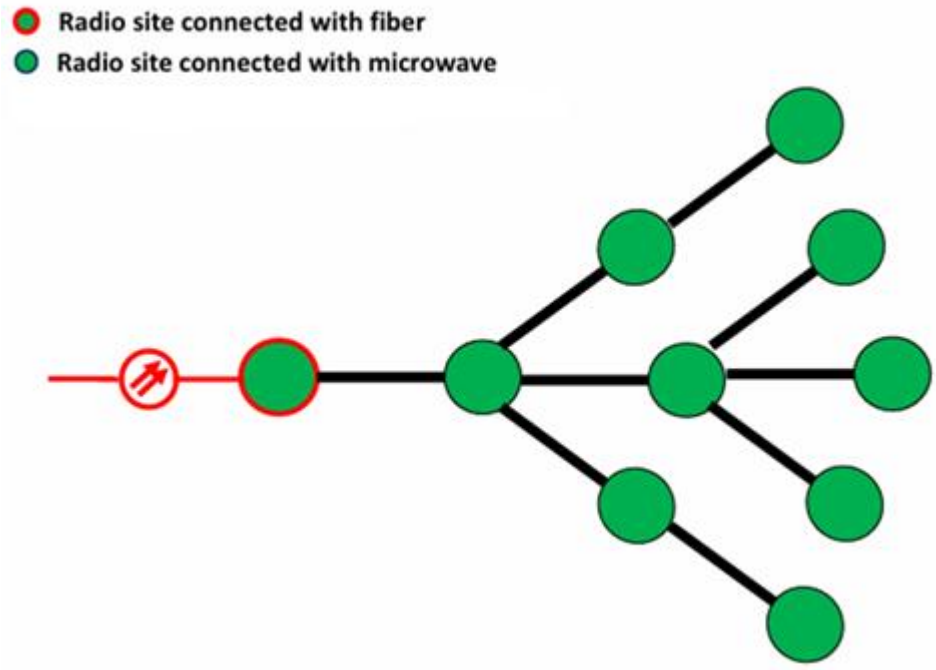

Figure 1.5: Typical topology of earlier backhaul networks[36]

[34] Based on the information provided by wireless access service providers to TRAI, the monthly wireless data usage in the month of September 2022 was 13,498,695 TB, which increased to 23,572,238 TB in September 2025, thereby registering a cumulative growth of 75%.

[35] Source: MW & mmW spectrum for 5G wireless backhaul

[36] Source: MW & mmW spectrum for 5G wireless backhaul

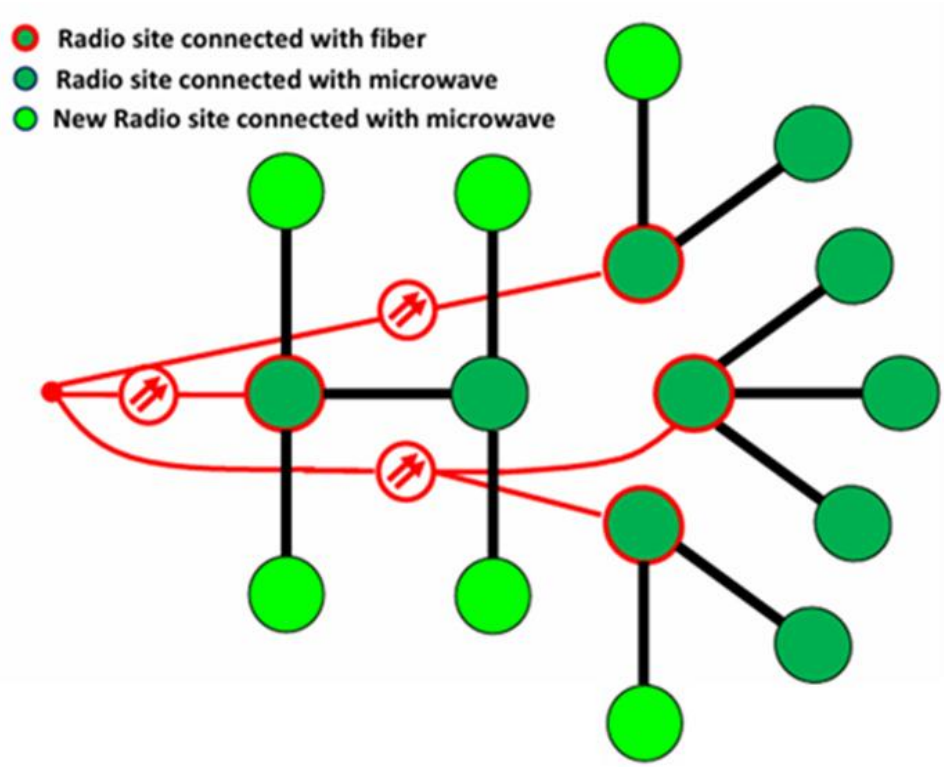

Figure 1.6: Typical topology of present backhaul networks[37]

1.30 While describing the evolution of backhaul networks, ITU-R, in the afore-mentioned document, has underscored the following changes which have taken place in backhaul networks with the introduction of 5G:

(a) Progressive fiber penetration from core to the edge;

(b) Shortening of microwave chains; and

(c) Star topologies from the fiber point-of-presence (aggregation point).

1.31 As may be seen in the preceding figure, as the cellular mobile data traffic has grown with the introduction of 5G, the number of cell sites connected through OFC have increased in most cellular mobile networks; however, the number of cell sites connected through microwave links have not decreased[38] because, in the interim, many new cell sites at the edge of

[37] Source: MW & mmW spectrum for 5G wireless backhaul

[38] In certain cellular mobile networks, the number of cell sites connected through microwave links might have increased also, if such cellular mobile networks are in an expansion phase.

cellular mobile networks have been introduced to cover hitherto unconnected geographical areas, or to increase the traffic carrying capacity of the network; often the new cell sites, which are introduced in telecom networks, are connected through microwave backhaul links.

1.32 Rural, suburban, urban, and dense urban are standard terms used in telecom network planning to classify different geographical areas based on their population density, building structures, and infrastructure. These classifications (also known as morphological clutter categories) are crucial for selecting appropriate telecom network architecture. ITU-R, in its document[39] on "Evolution of Fixed Services for wireless backhaul of IMT 2020/ 5G", has estimated the distribution of 5G cell sites, at the global level, in various morphological clutter categories viz. rural, sub-urban, urban and dense-urban. ITU-R has also estimated the distribution of wireless backhaul for connecting 5G cell sites. The following table depicts the distribution of 5G cell sites, and wireless backhaul to connect 5G cell sites, at the international level.

Table 1.4: Distribution of 5G cell sites, and wireless backhaul[40]

Clutter category	Rural	Sub-Urban	Urban	Dense-Urban
Percent 5G cell sites in the clutter category	>40%	>25%	>30%	5%
Percent 5G cell sites (within the clutter category) connected through wireless backhaul	>90%	>70%	>30%	Nearly 0%

[39] Source: MW & mmW spectrum for 5G wireless backhaul

[40] Extracted from the table titled "5G Access Sites Configurations and Network Segments" in the document- MW & mmW spectrum for 5G wireless backhaul

1.33 The above table demonstrates that globally, wireless backhaul would serve as a crucial pillar for the proliferation of 5G networks, particularly in rural and sub-urban areas.

1.34 In India, microwave backhaul is relevant and important not only in rural and sub-urban areas but also in urban and dense-urban areas because of sub-optimal level of fiberization even in dense-urban and urban areas. In certain dense urban and urban areas, rights-of-way (RoW), digging permissions, and relocation issues make new fiber routes slow, and expensive. As a result, telecom service providers sometimes prefer to keep using or expanding microwave links even in high-traffic zones.

1.35 In essence, in the future, the microwave backhaul would continue to play a complementary yet important role in the backhaul networks of wireless access service providers.

F. Traditional Microwave Backhaul Bands

1.36 In India, prior to the introduction of 5G mobile networks, only the spectrum in 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands were used for providing the microwave backhaul. These bands are often referred to as "the traditional microwave backhaul bands". DoT has classified the traditional microwave backhaul bands into two categories viz. Microwave Access (MWA) bands and Microwave Backbone (MWB)[41] bands. A brief description of MWA bands and MWB bands is given below:

(a) MWB bands: Lower 6 GHz (5.925-6.425 GHz) and 7 GHz (7.125-7.725 GHz) bands are collectively referred to as "MWB bands". Amongst all traditional microwave backhaul bands, MWB bands are least affected by rain, weather, and atmospheric absorption.

[41] Source: https://saralsanchar.gov.in/circular/licenses_issued/FAQ_ISP_MWA.pdf

Therefore, MWB bands are preferred for long backbone links in regions with intense seasonal rainfall. Generally, microwave links in these bands can support more than 15 km of link lengths.

(b) MWA bands: In India, 13 GHz band (12.75-13.25 GHz), 15 GHz band (14.5-15.5 GHz), 18 GHz band (17.7-19.7 GHz,) and 21 GHz band (21.2-23.6 GHz) are collectively referred to as "MWA bands". As these bands are more affected by weather, especially rain fade, the spectrum in MWA bands is used to carry traffic over relatively shorter distances.

G. E-Band and V-Band

1.37 E-band refers to the frequencies between 71-76 GHz and 81-86 GHz. Compared to MWA and MWB bands, E-band offers wider channels but lower range (typically 1-3 km), as signals are subject to attenuation due to atmospheric absorption, especially rain, oxygen, and CO_2. Worldwide, E-band is progressively gaining prominence for wireless backhaul in mobile broadband networks (4G, and 5G). At present, E-band is licensed for backhaul purposes in India. On 25.07.2022[42], prior to the start of the spectrum auction of 2022[43], DoT opened E-band for backhaul purposes of wireless access service providers.

1.38 V-band covers frequencies from 57 GHz up to 66 GHz. V-band is heavily affected by atmospheric attenuation, especially rain and oxygen absorption. Owing to severe atmospheric attenuation in V-band, only very small link lengths (often less than 1 km) can be supported in V-band, even with high power. For this reason, V-band is commonly used for ultra-

[42] Source: https://dot.gov.in/sites/default/files/Guidelines%20for%20allotment%20of%20E-band%20dated%2025%2007%202022%20signed.pdf

[43] In the year 2022, the Government conducted auction of Spectrum in 600 MHz, 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, 2500 MHz, 3300 MHz, and 26 GHz Bands. The spectrum auction started on 26.07.2022 and ended on 01.08.2022.

high-capacity, short-range links, ideal for small cell backhaul. V-band is yet to be opened for the licensed usage in India. In October 2018, DoT delicensed 500 MHz of spectrum (61-61.5 GHz range) in V-band for non-specific short range devices (SRDs).[44]

H. TRAI's Earlier Recommendations on 'Allocation and Pricing of Microwave Access (MWA) and Microwave Backbone (MWB) RF Carriers' Dated 29.08.2014

1.39 In the year 2012, Department of Telecommunications (DoT), Ministry of Communications, Government of India, through a reference dated 26.11.2012 under Section 11(1)(a) of the TRAI Act, 1997, had requested Telecom Regulatory Authority of India (hereinafter, also referred to as "TRAI", or "the Authority") to provide recommendations on the following aspects:

a) Methodology for Allocation and Pricing of MW Access and Backbone (MWA/ MWB) carriers for new service providers and the existing service providers for initial and additional allocations of MW Access and MW backbone carriers.

b) Criteria for withdrawal of excess allocation of MWA and MWB carriers from existing service providers.

c) Annual spectrum usage charges and criteria for pricing for different bands of MWA and MWB carriers including any upfront charges, along with date of applicability.

1.40 In response, TRAI, on 29.08.2014, sent its recommendations on 'Allocation and Pricing of Microwave Access (MWA) and Microwave Backbone (MWB) RF carriers' (hereinafter, also referred to as "the

[44] Source:https://dot.gov.in/sites/default/files/License%20Exemption%20for%20SRD%20Device%20G_S_R_1047%28E%29%20dated%2018th%20October%2C%202018_1.pdf

Recommendations dated 29.08.2014") to DoT. The Recommendations dated 29.08.2014 are reproduced below:

5.1 TSPs should be assigned MWA carriers as per their requirement. However, it will be subject to a ceiling on the number of MWA carriers that can be assigned to a TSP as given in Table 2.5 below.

Table 2.5 Maximum No. of MWA carriers that can be assigned to a TSP

Quantum of Access Spectrum that a Licensee has in a LSA	*Metro/ Cat 'A' Circles*	*Cat 'B' Circles*	*Cat 'C' Circles*
Less than 2.5 MHz	*3*	*2*	*2*
2.5 MHz or more but < 5 MHz	*4*	*3*	*2*
5 MHz or more but < 10 MHz	*5*	*4*	*3*
10 MHz or more but < 15 MHz	*6*	*5*	*4*
15 MHz or more but < 20 MHz	*7*	*6*	*5*
20 MHz or more but < 30 MHz	*8*	*7*	*6*
30 MHz or but <40 MHz	*9*	*8*	*7*
40 MHz or more	*10*	*9*	*8*

Note:

1. If any TSP requires carriers in addition to what have been recommended above, it may be examined by the DoT on a case-to-case basis.

2. It has been assumed that each carrier is of size 2x28 MHz. Carrier of 2x56 MHz and 2x112 MHz should be counted as 2 and 4 carries respectively when applying the above ceiling.

3. Access spectrum indicated in this table is a paired spectrum. Therefore, unpaired access spectrum shall be counted as half for the purpose of applying the above ceilings e.g. 20 MHz of unpaired spectrum in the 2300 MHz band shall be considered as equivalent to 10 MHz (paired).

4. The above ceilings may be reviewed periodically.

5.2 TSP should be assigned MW carriers as per their request as long as it is within the ceiling limit recommended in Para 2.22.

5.3 TSPs, holding MWA carriers in excess of the maximum number of carriers recommended by the Authority in Para 2.22, should be asked to surrender the excess MWA carriers in one year's time period with effect from the date the new guidelines come into force. However, in case TSP is left with excess MWA carriers as a result of trading of spectrum, it will have to surrender the excess MW carriers within three months of the effective date of trade. In case TSP wants to retain them, it should be permitted to do so, only if it is able to justify the need of additional carriers to the satisfaction of the DoT.

5.4 In future, no TSP should be assigned more than 4 MWA carriers in the 13/ 15 GHz band. In other bands too, there should be equitable distribution of carriers as far as possible. However, this would not have any impact on existing assignments. This is because of the fact that any re-arrangement of MWA carriers already assigned to TSPs will force them to redesign their network which will require them to incur significant costs.

5.5 The assignment of MWA carriers should be done on an exclusive basis for the various spectrum bands in 13-42 GHz range whereas the assignment of MWB carriers should be done on a link-to-link basis.

5.6 The assignment of MWA and MWB carriers should continue to be done administratively.

5.7 i. The assignment of MWA carriers should be done for the entire LSA. ii. Assignment of both access spectrum and MWA carriers should be done simultaneously within a period of one month from the date the TSP makes the payment for access spectrum, failing which TSP should be paid

compensation at the SBI PLR rate of the amount it had already paid to acquire the access spectrum.

iii. In case of delay in the assignment of MWA carriers for a new TSP in a LSA, the effective date of access spectrum assignment may be taken as the date of assignment of the first MWA carrier.

5.8 The higher frequency bands viz. 26 GHz, 28 GHz, 32 GHz, 38 GHz and 42 GHz should be earmarked for fixed point-to-point MW carriers and the channeling plan should be kept in line with the ITU-R recommendations. The Authority is also of the view that larger carriers of size 56 MHz (paired) and 112 MHz (paired) should also be assigned to the TSPs in these bands. As the number of assignments made in the 21 GHz band is quite small, the DoT may also examine the feasibility of assigning larger carrier sizes in this band.

5.9 a) The Central Government should take up the issue of RoW with the State Governments on top priority to emphasise the need to bring simplification and uniformity in the process of according RoW permissions and to bring the RoW charges to a realistic level.

b) The Central Government may mandate various agencies, responsible for making intra- and inter-city roads/ highways, to provide infrastructure utility ducts along the roads/ highways which can be used by companies providing utility services like telecom, power etc. for laying cables. (Para 3.9)

5.10 There should not be any upfront charges for the assignment of MWA and MWB carriers.

5.11 The AGR based spectrum charging mechanism for MWA carriers should be continued. However, for MWB carriers, the charging should be done on a link-to-link basis as is being done for all other terrestrial MW links.

5.12 The following spectrum charges for MWA carriers (28 MHz paired) should be made applicable for access service providers.

Table 3.7

No. of MWA carriers assigned to a TSP	*Applicable Percentage of AGR as spectrum charge for MWA carriers*			
	13/15 GHz	*18/21 GHz*	*26/28/32 GHz*	*38/42 GHz*
1	*0.17%*	*0.12%*	*0.10%*	*0.07%*
2	*0.34%*	*0.24%*	*0.20%*	*0.14%*
3	*0.51%*	*0.36%*	*0.30%*	*0.21%*
4	*0.68%*	*0.48%*	*0.40%*	*0.28%*
5	*0.85%*	*0.60%*	*0.50%*	*0.35%*

Note: For larger carrier sizes, spectrum charges shall increase proportionately. i.e. if the TSP has two carriers of 2x56 MHz of carriers in 18/21 GHz band, it shall be charged at 0.48% of AGR.

5.13 If a TSP, holding MWA carriers in excess of the maximum number of carriers recommended by the Authority in Para 2.22, fails to justify the retention of additional carriers to the DoT and does not surrender the excess MWA carriers within the specified time limits (i.e. either one year or three months as the case may be), it shall be liable to pay an additional 25% of total MWA spectrum charges that the TSP is otherwise liable to pay for the period in excess of permissible period.

5.14 Spectrum charges for MWB link shall be Rs. 13,900 per KM per annum.

5.15 Present spectrum charges for terrestrial Point-to-Point MW links (other than MWB links used in cellular network) should be rationalized and should be the same as have been recommended for MWB links.

5.16 In order to increase broadband penetration in India, the usage of high capacity backhaul E-band (71-76/ 81-86 GHz) and V-band (57-64 MHz) may be explored for allocation to the telecom service providers.

5.17 Both E-band and V-band should be opened with 'light touch regulation' and allotment should be on a 'link to link basis'. The responsibility for registration and database management should lie with WPC wing of DoT. For this purpose, WPC should make necessary arrangements for an online registration process by developing a suitable web portal. Responsibility for interference analysis should rest with the licensee, who needs to check the WPC link database prior to link registration (links should be protected on a "first come, first served" basis). WPC can also maintain a waiting list for the same spot.

5.18 (a) Channel bandwidth for E-band (71-76 GHz and 81-86 GHz) should be 250 MHz with a guard band of 125 MHz at the top and bottom of each 5 GHz band. More than one channel can be allowed and allocated for aggregation.
(b) Channel bandwidth for V-band (57-64 GHz) should be 50 MHz with a 100 MHz guard band at the beginning of the band. More than one channel can be allowed and allocated for aggregation.

5.19 (a) E-band carrier should be charged at Rs. 10,000/- (Rs. Ten Thousand) per annum per carrier of 250 MHz each. More than one channel can be allocated and allowed for aggregation. There should be initial promotional discount of 50% for three years from the date of allocation of first carrier in this band.

(b) In case of charging of V-band carriers since there are limitations in this band due to the factors enumerated in para 4.278, it should be charged for Rs. 1000 (Rs. One Thousand) per annum per carrier of 50 MHz each. More than one channel can be allocated and allowed for aggregation. There should be initial promotional discount of 50% for three years from the date of allocation of first carrier in this band.

(c) To avoid spectrum hoarding which may be possible by the low fee structure, a rollout obligation should be attached to the licenses and a 12 month time limit for achieving the rollout goal may be given to the licensee failing which the spectrum for that particular spot may be taken back and assigned to next in the waiting list.

(d) The prices mentioned for E-band and V-band has to be reviewed after 5 years based on deployment and usage of the links.

1.41 DoT, through the Reference dated 12.08.2022, outlined in a subsequent section of this Chapter, informed that "*it has been decided to seek fresh recommendation of TRAI… in view of technological changes which have taken place over the years…*" on the matter.

I. Extant Policy Regime for the Assignment of Backhaul Spectrum to Wireless Access Service Providers

(1) Extant Policy Regime for the Assignment of Traditional Microwave Backhaul bands

1.42 The Government of India, through DoT, has been assigning the spectrum in traditional microwave backhaul bands to wireless access service providers since 1995 when cellular mobile networks were established in the country for the first time. Through Order No. R-11014/4/87-LR (Pt) dated 20.07.1995, DoT stipulated royalty for microwave links for cellular mobile telephone service (CMTS) based on the following formula:

Annual Royalty R = M x W x C;

Where M = Constant multiplier,

W = Weighing factor,

C = Number of radio frequency (RF) channels used

1.43 In the year 2002, DoT decided to migrate the system for charging microwave spectrum to revenue-sharing basis. Through Order No. L-14047/01/2002-NTG dated 18.04.2002 (**Annexure-1.1**), DoT conveyed a package of microwave spectrum charging on a percentage revenue share basis to all cellular mobile service providers. The microwave spectrum charging package conveyed through the said order is given below:

Table 1.5: Microwave spectrum charging of 2002

Microwave spectrum type	**Metro**	**Circles other than Metro**	**Annual spectrum charges for microwave spectrum as a percentage of AGR**
Microwave Access (MWA) Spectrum	Upto 224 MHz	Upto 112 MHz	0.25%
	For every additional 56 MHz	For every additional 28 MHz	Additional 0.05%
Microwave Backbone (MWB) spectrum	Upto 56 MHz		0.10%
	For every additional 28 MHz		Additional 0.05%

1.44 The acceptance of the above offer was to be communicated within seven days of the date of issue of the letter. All cellular operators at that time accepted the said offer.

1.45 In the year 2006, in supersession of the DoT's Order of 2002 on Microwave Spectrum, and in partial modification of the DoT's Order of 1995 on Microwave Spectrum, DoT prescribed the spectrum charges for microwave spectrum in respect of both GSM and CDMA based telecom service providers through the order No. J-14025/200(11)/06-NT dated 03.11.2006 (**Annexure-1.2**).The following table provides the microwave spectrum charging prescribed by DoT in 2006:

Table 1.6: Microwave spectrum charging of 2006

Spectrum Bandwidth	**Spectrum Charge as a percentage of AGR**	**Cumulative spectrum charges as a percentage of AGR**
First carrier of 28 MHz (paired)	0.15%	0.15%
Second carrier of 28 MHz (paired)	0.20%	0.35%
Third carrier of 28 MHz (paired)	0.20%	0.55%
Fourth carrier of 28 MHz (paired)	0.25%	0.80%
Fifth carrier of 28 MHz (paired)	0.30%	1.10%
sixth carrier of 28 MHz (paired)	0.35%	1.45%

1.46 The above spectrum charges (as a percentage of AGR) were made applicable for both MWA carriers as well as MWB carriers.

1.47 In 2008, DoT issued an order dated 10.11.2008 (**Annexure-1.3**) in continuation of its earlier order dated 03.11.2006 regarding spectrum

charges for microwave access and backbone networks of GSM and CDMA based telecom services. Through the order dated 10.11.2008, DoT prescribed spectrum charges to be levied on microwave spectrum beyond the sixth carrier as below:

Table 1.7: Microwave spectrum charging beyond 6th carrier (addendum of 2008)

Microwave (MW) Spectrum Bandwidth	Spectrum Charge as a percentage of AGR effective from 03.11.2006	Cumulative spectrum charges as a percentage of AGR effective from 03.11.2006
Sevent carrier of 28 MHz (paired)	0.40%	1.85%
Eighth carrier of 28 MHz (paired)	0.45%	2.30%
Ninth carrier of 28 MHz (paired)	0.50%	2.80%
Tenth carrier of 28 MHz (paired)	0.55%	3.35%
Eleventh carrier of 28 MHz (paired)	0.60%	3.95%

1.48 In 2009, DoT issued an order dated 19.02.2009 in continuation of the earlier order dated 10.11.2008, Through the order dated 19.02.2009, DoT extended the deadline given to all telecom service providers using smaller microwave carrier bandwidths of 3.5 MHz/ 7 MHz/ 14 MHz in different 28 MHz carrier blocks to consolidate the same within one or two carriers of 28 MHz by 30.06.2009. In the said order, DoT also stated that "*after aggregation, the remaining small carriers (if any) shall be charged on pro*

rata basis using the incremental % rate of revenue share applicable to the relevant 28 MHz carrier if it is the seventh or higher carrier (of 28 MHz). In other words, the existing charging structure of half or full rate small carrier will continue to be applicable in case the aggregation of small carriers results in a balance within a carrier that is up to and including the 6th carrier."

1.49 In May/ June 2010, DoT conducted auctions of the spectrum in the 2100 MHz band and the 2300 MHz band for 3G and Broadband Wireless Access (BWA) respectively. Subsequently, DoT, through an order dated 16.03.2012, decided for the assignment of Microwave Access carriers for BWA services, as an interim measure, as below:

Table 1.8: Assignment of microwave carriers for BWA services (Order of 2012)

Service	Metro & A Circle	B Circle	C Circle	Remarks
BWA	4-6 Carriers	3-4 Carriers	3 Carriers	Requirement for a standalone BWA operator as well as for an operator having 2G and 3G services in a service area

1.50 Through the order dated 16.03.2012, DoT also stated that "*[i]nitially, a total of 4 MW Access Carriers in Metros & A circles and 3 in B & C circles respectively may be alloted to the new BWA operators as well as existing 2G/3G operators offering BWA services on their request. Additional MW Access spectrum beyond 4 MW Access Carriers in Metros & A circles and 3 in B circles may be considered by the Government after formulation of necessary criteria*."

1.51 Subsequently, DoT, through a reference dated 26.11.2012, sought the recommendations of TRAI on, *inter-alia*, (a) methodology for allocation of microwave spectrum, and (b) spectrum charges for microwave spectrum. In response, TRAI, after following a consultation with stakeholders, sent its recommendations dated 29.08.2014 on 'Allocation and Pricing of Microwave Access (MWA) and Microwave Backbone (MWB) RF Carriers' to DoT.

1.52 While TRAI's recommendations dated 29.08.2014 were under DoT's consideration, DoT, in view of the immediate requirement of MWA and MWB spectrum of telecom service providers, decided to allot MWA and MWB spectrum for the interim period provisionally pending the final decision in the matter by the Government. For this purpose, DoT issued guidelines on the matter through circular No. L-14035/19/2010-BWA (Pt) dated 16.10.2015 (**Annexure-1.4**). Hereinafter, these guidelines will also be referred to as "the Guidelines dated 16.10.2015". A relevant extract from the Guidelines dated 16.10.2015 is given below:

"Considering the immediate requirement of Microwave Access (MWA) and Microwave Backbone (MWB) spectrum of telecom service providers, it has been decided to allot such spectrum for the interim period provisionally, pending the final decision in the matter by the Government.

"2. The interim/ provisional allotment of MWA/ MWB carriers will be subject to following terms, conditions and criteria:

(i) TSPs would be allotted, including the present holding, a maximum of 4 carriers for Metro & Category A Service Area and 3 carriers for Category B and Category C Service Areas for MWA, subject to availability.

(ii) Microwave Backbone carrier allotment will be considered on link-to-link basis subject to availability.

(iii) Each Microwave carrier refers to 28 MHz paired bandwidth in 13, 15, 18 and 21 GHz bands for MWA and in sub 10 GHz band(s) for MWB.

(iv) For the interim period, the charging of MWA and MWB carriers will be done as per rates mentioned in Order no. J-14025/200(11)/06-NT Dated 3rd November' 2006 and its amendments of even no. Dated 10th November' 2008 and 19th February' 2009.

(v) The applicants (TSPs) are required to submit an undertaking and also enter into an Frequency Agreement (proforma enclosed herewith), duly filled in, before their request for the allotment of MWA/MWB carriers is considered.

(vi) All MWA/MWB carrier/spectrum allotted, as an interim measure, will be purely on temporary and provisional basis and all such allotees will have to participate in the allotment methodology as decided by the Government after considering the recommendations of TRAI on the subject.

(vii) In the event of decision of the Government to allot MWA carrier/ spectrum by auction, the carriers allocated as an interim measure, will stand reverted back to the Government after a period of three months from date of finalization of results of aforesaid auction, in case such allotees fail to participate and/ or win back the carriers/ spectrum provisionally allotted as an interim measure.

(viii) In the event of decision of the Government to allot MWA carrier/spectrum by a methodology other than the auction, the carriers allocated as an interim measure, will stand reverted back to the Government after a period of three months, in case such allotees fail to participate in the said process and/or not being able to get back the provisionally allotted carriers/spectrum, as per the methodology.

(ix) The licensees whose licenses have expired in November' 2014 or licenses expiring in future, will be allowed to hold the carriers allotted to them as per Clause. 8.4 of UL guidelines on a purely provisional basis till the ongoing process of TRAI consultation is completed and a final decision thereon is taken by the Government; thereafter, MWA/MWB carriers will be regulated in accordance with above Para (vii) and (viii) of this Guideline/OM.

(x) Due notice will be given to such allotees who have been provisionally allotted the carriers/spectrum as an interim measure and have not been able to get back the spectrum in full or in part.

(xi) During the said interim period, the present charging mechanism, as mentioned above, will continue subject to the condition that for the spectrum/carriers allotted during interim period, the TSPs will have to pay the charges with retrospective effect (i.e. from the date of issue of letter for allotment of carrier as interim measure) as finally determined through the auction process/market related process or any other methodology decided by the Government."

1.53 On 25.07.2022, prior to the start of spectrum auction of 2022, DoT issued an addendum[45] to the Guidelines dated 16.10.2015. The addendum dated 25.07.2022 is placed as **Annexure-1.5**. A relevant extract from the addendum dated 25.07.2022 is given below:

"In view of the increased requirement of backhaul on account of 5G, it has been decided to increase the limit of maximum number of Microwave Access Carriers that can be assigned to Telecom Service Providers with Access Service Authorization/ license on provisional basis vide Guidelines dated 16.10.2015, from existing 4 carriers (in Metro, Cat 'A' LSA)/ 3 carriers (Cat 'B' and Cat 'C' LSA) to 8 carriers (in Metro, Cat 'A' LSA)/ 6 carrier in (Cat 'B' and Cat 'C' LSA) w.e.f. the date of issue of this addendum."

(2) Regime for E-band (71-76 GHz/ 81-86 GHz)

1.54 On the day (25.07.2022) of issuing the addendum to the Guidelines dated 16.10.2015, DoT also issued the 'Guidelines for allotment of E-band (71-76/ 81-86 GHz) carriers to Telecom Service providers (TSPs) with Access

[45] Source: https://dot.gov.in/sites/default/files/addendum%20to%20MW%20guidelines%20dated%2025_07_2022%20signed.pdf

Service authorisation/ license and having Access Spectrum in IMT bands'[46] (**Annexure 1.6**). Hereinafter, these guidelines will also be referred to as "the Guidelines dated 25.07.2022 on E-band". A relevant extract from the Guidelines dated 25.07.2022 on E-band is given below:

"In view of the increased backhaul capacity requirements of TSPs with Access Service authorization/ license and having Access Spectrum in the IMT bands, especially on account of 5G, it has been decided to allot carriers in E-band spectrum for the purpose of backhaul on interim basis as per the following guidelines:

1. TSPs, based upon their application, would be allotted a maximum of 2 (two) carriers of 250 MHz each (paired) bandwidth in E-band (71-76/81-86) GHz for their backhaul purpose in the LSAs where they are holding Access Spectrum in IMT bands.

2. For each E band carrier of 250 MHz paired bandwidth, Spectrum Charges will be charged @ 0.15% Of AGR (Adjusted Gross Revenue) of the TSPs in the interim period, which will be adjusted/recalculated retrospectively (from date of provisional assignment) based upon the pricing decided finally. No interest shall be paid/ charged on the excess / shortfall amount, if any, while making such adjustment/recalculation. Final assignment of carriers will be decided accordingly.

3. Spectrum Charges shall be payable in four quarterly instalments during each financial year (FY). Quarterly instalments of Spectrum Charges for the first three quarters of a financial year shall be paid within 15 days of completion of the relevant quarter. However, for the last quarter of the financial year, the Licensee shall pay the Spectrum Charges by 25th March on the basis of expected revenue for the quarter, subject

[46] Source: https://dot.gov.in/sites/default/files/Guidelines%20for%20allotment%20of%20E-band%20dated%2025%2007%202022%20signed.pdf

to minimum payment equal to the revenue share paid for the previous quarter.

4. Any delay in payment of spectrum charges, payable, or any other dues payable under the License beyond the stipulated period will attract interest at a rate which will be 2% above the one-year Marginal Cost of Lending Rate (MCLR) of the State Bank of India existing as on the beginning of the Financial Year (namely 1st April) in respect of the spectrum charges pertaining to the said Financial Year. The interest shall be compounded annually. A part of the month shall be reckoned as a full month for the purpose of calculation of interest A month shall be reckoned as an English calendar month.

5. All E-band carriers assigned, as an interim measure, will be purely on temporary and provisional basis and all such assignees will have to participate in the auction and/or any other assignrnent methodology, as decided by the Government after considering the recommendations of the TRAI in this regard.

6. The E- band carriers, assigned as an interim measure, will stand reverted back to the Governrnent, after a period of three months from the date of finalization of results of aforesaid activity as detailed/stipulated in para 5 above in case such assignees fail to get back the carriers/ spectrum provisionally assigned as an interim measure.

7. WPC Wing reserves the right to change or modify frequencies assigned to licensee without any notice in the interest of public or for proper conduct of telegraphs and or for security considerations.

8. Equipments conforming to TEC/ITU and other international standards and National Frequency Allocation Plan (NFAP) shall be deployed.

9. Any misuse i.e. use of E-band carriers allotted under these guidelines for purpose(s) other than backhaul will lead to immediate withdrawal of these carriers and invocation of relevant terms and conditions of the UL/UASL-Access Service Authorization.

10. The applicants (TSPs) are required to submit an undertaking as per enclosed proforma. with their request for the assignment of E- band carriers.

11. These guidelines shall be effective from the date of its issue."

1.55 At present, there is no policy regime for the assignment of the spectrum in V-band on a licensed-basis.[47]

J. DoT's Reference dated 12.08.2022

1.56 Through the letter dated 12.08.2022 (**Annexure-1.7**), DoT sent a reference under Section 11(1)(a) of the TRAI Act, 1997 on the subject- "Seeking TRAI recommendations for assignment of E&V Bands; and Microwave Access (MWA) & Microwave Backbone (MWB) spectrum in existing frequency bands of 6/ 7/ 13/ 15/ 18/ 21 GHz" (hereinafter, also referred to as "the Reference dated 12.08.2022") to TRAI. An extract from the Reference dated 12.08.2022 is reproduced below:

"TRAI had provided its recommendations dated 29.08.2014 on "Allocation and Pricing of Microwave Access (MWA) and Microwave Backbone (MWB) RF carriers". In these recommendations, TRAI had also provided recommendations on allocation and pricing methodology for E band (71-76/ 81-86 GHz) and V bands (57-64 GHz) spectrum. Subsequent to DoT's

[47] DoT has delicensed 500 MHz spectrum in 61-61.5 GHz range for the use of non-specific short range radio frequency devices.

back reference dated 16.10.2015, TRAI's response/ letters dated 17.11.2015, 06.05.2016 and 15.07.2016 were also received by DoT.

2. The matter of E and V band spectrum assignment was deliberated in DoT, and it emerged that while the spectrum in E and V bands should be assigned through auction for provisioning of commercial telecom services; there may be certain non-TSP/ non-commercial usages like captive/ individual point to point/ multipoint usages, which also need spectrum in these bands and where auction may not be feasible.

2.1 In V band, the device/ chipset eco-system supporting various technologies for data transfer between consumer's devices such as smartphones, camera, laptops etc. has developed. The technologies used for such devices are designed for short-range, indoor, interference-tolerant applications. Therefore, while the V band spectrum can be assigned through auction for establishment of indoor/ outdoor telecom networks, allowing low power, indoor usages of V band on license-exempt basis for consumer device-to-consumer device data transfer may go a long way in serving greater public interest and realizing significant socio-economic gains.

3. With regard to assignments of MWA & MWB spectrum in frequency bands 6/ 7/ 13/ 15/ 18/ 21 GHz to TSPs, it has been decided to seek a fresh recommendation of TRAI on allocation methodology, quantum and pricing of MWA and MWB RF carriers, in view of technological changes which have taken place over the years as well as considering the existing assignments to TSPs.

4. In view of the above, TRAI is requested to provide its recommendations under the terms of clause 11(1) (a) of TRAI Act, 1997 as amended by TRAI Amendment Act 2000 on the following:

(a) applicable reserve price, band plan, block size, quantum of spectrum, duration of assignment, scope of services/ usages, spectrum cap, payment terms, eligibility conditions, methodology of auction and other associated conditions for auction of E band spectrum for establishment of terrestrial and/ or satellite-based telecom networks.

(b) applicable reserve price, band plan, block size, quantum of spectrum, duration of assignment, scope of services/ usages, spectrum cap, payment terms, eligibility conditions methodology of auction and other associated conditions for auction of V band spectrum for establishment of terrestrial and/ or satellite-based telecom networks.

(c) quantum of spectrum to be earmarked for non-commercial/ captive/ isolated use in E and V bands; and methodology of assignment, where auction is not feasible, and pricing for the same.

(d) feasibility, including technical parameters, for allowing low power, indoor, consumer device-to-consumer device usages on license-exempt basis, in parallel to use of the auction acquired spectrum by telecom service providers for establishment of terrestrial and/ or satellite-based telecom networks, in part or full V band.

(e) a fresh recommendation on allocation methodology, quantum and pricing of MWA and MWB RF carriers in 6/ 7/ 13/ 15/ 18/ 21 GHz bands, for establishment of terrestrial and/ or satellite-based telecom networks as well as for non-commercial/ captive/ isolated use.

(f) provide any other recommendations deemed fit for the purpose mentioned under (a) to (e) above in these frequency bands, including the regulatory/ technical requirements as enunciated in the relevant provisions of the latest ITU-R Radio Regulations."

1.57 In this regard, TRAI, through a letter dated 09.09.2022, sought certain additional information/ clarifications from DoT. In response, through a letter dated 11.10.2022 and email dated 16.11.2022, DoT provided the requisite information/ clarifications to TRAI.

1.58 With respect to the Reference dated 12.08.2022, TRAI issued a consultation paper on 'Assignment of Spectrum in E&V Bands, and Spectrum for Microwave Access (MWA) & Microwave Backbone (MWB)' dated 27.09.2023[48] (hereinafter, also referred to as, "the Consultation Paper dated 27.09.2023") for soliciting comments of stakeholders. In response to the Consultation Paper dated 27.09.2023, TRAI received comments from 23 stakeholders, and counter-comments from six stakeholders. The comments and counter-comments received from stakeholders in response to the Consultation Paper dated 27.09.2023 are available on TRAI's website[49].

1.59 In the meanwhile, in December 2023, the Indian Parliament enacted a new statute namely, 'the Telecommunications Act, 2023'[50]. The Act amends and consolidates the law relating to development, expansion and operation of telecommunication services and telecommunication networks, assignment of spectrum, and for matters connected therewith or incidental thereto. Section 4(4) of the Telecommunications Act, 2023 provides as below:

"The Central Government shall assign spectrum for telecommunication through auction except for entries listed in the First Schedule for which assignment shall be done by administrative process."

Explanation. – For the purposes of this sub-section,-

(a) "administrative process" means assignment of spectrum without holding an auction;

(b) "auction" means a bid process for assignment of spectrum."

[48] The Consultation Paper dated 27.09.2023 is available on the TRAI's website at the following URL: https://www.trai.gov.in/sites/default/files/2024-09/Consultation_Paper_27092023.pdf

[49] The comments and counter-comments may be accessed at the following URL: https://trai.gov.in/consultation-paper-assignment-spectrum-ev-bands-and-spectrum-microwave-access-mwa-microwave

[50] Source: https://egazette.gov.in/WriteReadData/2023/250880.pdf

1.60 The First Schedule of the Telecommunications Act, 2023 lists 19 items for the assignment of spectrum through administrative process. The relevant item of the First Schedule is reproduced below:

"12. Radio backhaul for telecommunication services.

Explanation.—The term "radio backhaul" shall mean the use of radio frequency only to interconnect telecommunication equipment, other than the customer equipment in telecommunication networks."

1.61 In view of the afore-mentioned provision of the Telecommunications Act, 2023, TRAI, through a letter dated 20.02.2024, conveyed to DoT that *"the DoT's Reference dated 12.08.2022, requesting TRAI to provide its recommendations for (a) methodology of auction of E&V band spectrum and (b) allocation methodology of MWA and MWB RF carriers in 6/7/13/15/18/21 GHz bands, may require a review by DoT. Therefore, DoT is requested to provide the specific issues on which TRAI's recommendations are now required on the subject."*

K. DoT's Instant Reference Dated 13.09.2024

1.62 In response to TRAI's letter dated 20.02.2024, DoT sent a letter dated 13.09.2024 (**Annexure 1.8**) to TRAI. Through the letter dated 13.09.2024, DoT provided a clarification to TRAI's query and requested TRAI to provide its recommendations under Section 11(1)(a) of the TRAI Act, 1997 on certain aspects. Hereinafter, the DoT's letter dated 13.09.2024 will be referred to as "the Reference dated 13.09.2024". The relevant extract of the Reference dated 13.09.2204 is reproduced below:

"… TRAI, quoting the provisions of Section 4(4) and the First Schedule of the Telecommunications Act, 2023, has mentioned that DoT's reference dated 12-08-2022 may require review in respect of the item (a) and (b) of the reference i.e., methodology of allocation (auction) and requested

to provide specific issues on which their recommendations would now be required.

2. While agreeing to the TRAI's observation that Backhaul spectrum is part of First Schedule of the Act, for which the assignment method would be administrative, it is to state that DoT's letter dated 12-08-2022 on the 6/7/13/15/18/21 GHz bands was based upon techno-regulatory state at that point of time. Meanwhile, apart from passing of the Telecommunications Act, international regulatory landscape has seen some changes at the World Radiocommunications Conference (WRC) 2023. The Telecom Service Providers (TSPs) have also demanded amended usage of some of these bands. Without going into the merit of these demands, these are mentioned in the developments below:

2.1 6 GHz: While the upper 6 GHz band (not part of this reference) i.e., 6.425-7.125 GHz has been identified for IMT in other parts of the world, the lower 6 GHz band i.e. 5.925 to 6.425 GHz continues to be used as backhaul.

2.2 7/ 13/ 15/ 18/ 21 GHz: The spectrum band 7.125 to 8.400 GHz (7 GHz) & 14.8-15.35 GHz (15 GHz) are being considered for IMT i.e., Access, under agenda items 1.7 of WRC-2027. One of commercial telecom service providers holding Unified License with Access service authorisation and providing wireline services has requested for spectrum in the 6/ 7/ 13 GHz bands for establishing links for last mile connectivity solutions in certain Licensed Service Areas.

2.3 Requirement of captive users: Point to point connectivity requirements of certain captive users is required to be met from one or more of these bands i.e. 6/ 7/ 13/ 15/ 18/ 21 GHz bands. Such requirements are generally localised and mostly limited to few links only. In case, some carriers are specifically earmarked for such use, they can be re-used among multiple users with geographical separation.

It may be noted that current use of 6 GHz (lower)/ 7/ 13/ 15/ 18/ 21 GHz for backhaul purposes continues to be covered under the First Schedule of the Act.

3. The Developments related to V- band and E- band are described below:
3.1 The V-band (57-64/ 66 GHz) is a part of the band n263 of 3GPP (57 GHz to 71 GHz), which is also referred to as 60 GHz band. That is to say that the complete 57-71 GHz band has been planned by 3GPP as IMT/ Access band. Point to point (backhaul) solutions are also available in the V band. Further, a part of this band, i.e., 66-71 GHz, has already been identified by ITU globally for IMT based Access services in WRC-19.

3.2 The E-Band (71-76 GHz/ 81-86 GHz) has already been assigned LSA-wise for Backhaul purpose to TSPs on provisional basis, during 2022. One of the commercial telecom service providers, holding UL with Access service authorisation, has sought permission for using this band for Access Services, in addition to the Backhaul purposes. i.e. as IAB (Integrated Access & Backhaul). In addition, another service provider, holding UL with Internet service authorisation (ISP) has sought E/ V band spectrum for last mile connectivity purpose.

4. In view of above, TRAI, considering the relevant clauses of section 4 of the Telecommunications Act, 2023, is requested to provide its recommendations under section 11(1) (a) of the TRAI Act on the following:
(a) Demand assessment and scope of service/ usage for (i) 57-64/ 66 GHz (V-band) and (ii) 71-76 GHz/ 81-86 GHz (E-band) and accordingly methodology of assignment of spectrum and associated terms & conditions, in line with the determination of scope of services/ usages by TRAI i.e. "Access" or "Backhaul" or "Integrated Access & Backhaul (IAB)".
(b) Spectrum charges and related terms & conditions such as spectrum cap, carrier aggregation, etc. for assignment of spectrum in 6 (lower)/ 7/

15/ 13/ 18/ 21 GHz bands for backhaul purposes of commercial telecom services.

(c) Any need for review in respect of use of 7/ 15 GHz bands in view of consideration of these bands for Access using IMT after WRC - 2027.

(d) Quantum/ band(s) of spectrum to be earmarked for last mile connectivity (Fixed Wireless Access) of commercial telecom services and methodology of assignment of spectrum and associated terms & conditions in non-IMT bands as referred to in Para 2.2 above.

(e) Quantum/ band(s) of spectrum to be earmarked for Backhaul purposes for noncommercial/ captive use and associated terms & conditions including charges as referred to in Para 2.3 above.

(f) Feasibility & technical parameters, for allowing low power, indoor, consumer device-to-consumer device usage on license-exempt basis in V-band as referred to in Para 4(d) of reference dated 12-08-2022.

(g) Provide any other recommendations deemed fit for the purposes mentioned under (a) to (f) above."

1.63 In this regard, TRAI, through a letter dated 07.04.2025, sought additional information/ clarification from DoT. In response, DoT, through a letter dated 08.05.2025, provided the requisite information on the frequency assignments to various telecom service providers and other entities in the frequency bands under consideration. Through the letter dated 08.05.2025, DoT also informed that it "*has decided to de-license the lower 6 GHz band (5925-6425 MHz) for low power applications. Relevant rules are under consideration in the Department for notification*."

1.64 Upon careful perusal, the Authority noted that the scope of the Reference dated 13.09.2024 is quite different from the Reference dated 12.08.2022, necessitating a fresh consultation with stakeholders.

L. TRAI's Consultation Paper dated 28.05.2025

1.65 In this regard, the Authority issued a consultation paper on 'Assignment of the Microwave Spectrum in 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, 21 GHz Bands, E-Band, and V-Band' dated 28.05.2025 (hereinafter, also referred to as, "the Consultation Paper dated 28.05.2025") to solicit comments of stakeholders on specific issues. Initially, the last dates for furnishing comments and counter-comments were kept as 25.06.2025 and 09.07.2025, respectively. However, upon requests from some stakeholders, the last dates for furnishing comments and counter-comments were extended up to 02.07.2025 and 16.07.2025, respectively.

1.66 In response to the Consultation Paper dated 28.05.2025, the Authority received comments from 24 stakeholders and counter-comments from eight stakeholders. The comments and counter-comments received from stakeholders were placed on the TRAI's website.[51] An Open House Discussion (OHD) on the Consultation Paper dated 28.05.2025 was held on 11.08.2025 via online mode.

M. The Present Recommendations

1.67 Based on the inputs received from stakeholders and further analysis, the Authority has arrived at the present recommendations. The recommendations comprise four chapters. This chapter provides an introduction and background to the subject. In Chapter II, the Authority has examined the issues related to the assignment of the spectrum in traditional microwave backhaul bands viz. 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, 21 GHz bands keeping in view stakeholders' comments, and has provided recommendations thereupon. In Chapter III, the

[51] The comments and counter-comments received from stakeholders are accessible at the following URL: https://trai.gov.in/consultation-paper-assignment-microwave-spectrum-6-ghz-lower-7-ghz-13-ghz-15-ghz-18-ghz-21-ghz

Authority has examined the issues related to the assignment of the spectrum in E-band and V-band keeping in view stakeholders' comments and has provided recommendations thereupon. Chapter IV provides analysis and recommendations on the issues related to spectrum charging mechanism. Chapter V provides a summary of the recommendations.

Chapter II: Assignment of the Spectrum in Traditional Microwave Backhaul Bands

2.1 This chapter examines the issues related to the assignment of the spectrum in traditional microwave backhaul bands viz. 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz Bands.

2.2 Through the Reference dated 13.09.2024, DoT provided, *inter-alia*, the following information to TRAI with respect to the traditional microwave backhaul bands:

"2.1 6 GHz: While the upper 6 GHz band (not part of this reference) i.e., 6.425-7.125 GHz has been identified for IMT in other parts of the world, the lower 6 GHz band i.e. 5.925 to 6.425 GHz continues to be used as backhaul.

2.2 7/ 13/ 15/ 18/ 21 GHz: The spectrum band 7.125 to 8.400 GHz (7 GHz) & 14.8-15.35 GHz (15 GHz) are being considered for IMT i.e., Access, under agenda items 1.7 of WRC-2027. One of commercial telecom service providers holding Unified License with Access service authorisation and providing wireline services has requested for spectrum in the 6/ 7/ 13 GHz bands for establishing links for last mile connectivity solutions in certain Licensed Service Areas.

2.3 Requirement of captive users: Point to point connectivity requirements of certain captive users is required to be met from one or more of these bands i.e. 6/ 7/ 13/ 15/ 18/ 21 GHz bands. Such requirements are generally localised and mostly limited to few links only. In case, some carriers are specifically earmarked for such use, they can be re-used among multiple users with geographical separation.

It may be noted that current use of 6 GHz (lower)/ 7/ 13/ 15/ 18/ 21 GHz for backhaul purposes continues to be covered under the First Schedule of the Act.

2.3 After providing the above information, DoT, through the Reference dated 13.09.2024, DoT requested TRAI to provide recommendations on the following aspects related to the spectrum in traditional microwave backhaul bands:

"(b) Spectrum charges and related terms & conditions such as spectrum cap, carrier aggregation, etc. for assignment of spectrum in 6 (lower)/ 7/ 15/ 13/ 18/ 21 GHz bands for backhaul purposes of commercial telecom services.

(c) Any need for review in respect of use of 7/ 15 GHz bands in view of consideration of these bands for Access using IMT after WRC - 2027.

(d) Quantum/ band(s) of spectrum to be earmarked for last mile connectivity (Fixed Wireless Access) of commercial telecom services and methodology of assignment of spectrum and associated terms & conditions in non-IMT bands ...

(e) Quantum/ band(s) of spectrum to be earmarked for Backhaul purposes for noncommercial/ captive use and associated terms & conditions including charges …

…

(g) Provide any other recommendations deemed fit for the purposes mentioned … above."

2.4 In this regard, the Authority examined the extant regime for the assignment of spectrum in traditional microwave backhaul bands and the recent developments in the usage of these bands internationally. Based on the examination, the Authority, through the Consultation Paper dated 28.05.2025, solicited comments from stakeholders through Q1 to Q17. In response, a wide range of comments have been received from stakeholders. Section-A of this chapter presents a summary of comments

received from stakeholders on Q1 to Q17. In Section-B, the Authority has given its recommendations on the matter after conducting a comprehensive analysis of the issues and the comments of stakeholders.

A. Summary of comments received from stakeholders on Q1 to Q17

(1) Summary of comments on Q1

2.5 Q1 is reproduced below:

"Q1. What is the level of demand of the spectrum in the traditional microwave backhaul bands [viz. 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands] for radio backhaul purposes? Kindly provide a detailed response with justifications."

2.6 A broad summary of the comments of stakeholders in response to Q1 is given below:

(a) Since the early 2000s, the per-site backhaul capacity requirement has grown exponentially, driven initially by 4G and now by the rapid deployment of 5G. With the increasing rollout of 5G in both mid-band and millimeter wave (mmWave) frequencies, and assuming optimal utilization of access spectrum, backhaul demand is projected to grow by a factor of 3 to 5 over the next 5 years across most licensed service areas (LSAs).

(b) The current backhaul requirements are largely driven by limited traffic volumes and partial utilization of access spectrum. However, with the anticipated scale-up in 5G services and increased utilization of the 26 GHz band, the backhaul demand per site is projected to rise substantially—potentially reaching up to 4 Gbps per site.

(c) While India is advancing in fiberization, around 54% of base stations are still connected via wireless backhaul. The traditional microwave

bands thus remain indispensable, especially in geographies where optical fiber rollout is impractical due to cost, terrain, or administrative constraints.

(d) The demand for traditional microwave backhaul bands will persist due to (i) rapid urbanization and densification requirements, (ii) increased cellular traffic from 5G and future network technologies, and (iii) necessity for resilient and cost-effective backhaul solutions, especially in geographies challenging for fiber deployment.

(2) <u>Summary of comments on Q2</u>

2.7 Q2 is reproduced below:

"Q2. For which commercial telecommunication services should the spectrum in traditional microwave backhaul bands be assigned for radio backhaul purposes? Kindly provide a detailed response with justifications."

2.8 A broad summary of the comments of stakeholders in response to Q2 is given below:

(a) <u>View#1</u>: Considering increasing traffic and densification requirements, the existing spectrum in traditional microwave bands should be made fully available to telecom service providers with Access Service Authorisation. Permitting non-access entities or low-capacity services risks congesting available bandwidth in the traditional microwave bands and undermining quality of service (QoS) benchmarks.

(b) <u>View#2</u>: Spectrum in traditional microwave bands is also required by TSPs other than Access Service Providers (ASPs) and other non-TSP entities for non-commercial/ captive/ isolated use. The following

commercial telecommunications services should also be assigned spectrum in traditional microwave bands for radio X-haul purposes:

(i) Fixed Wireless Access (FWA)
(ii) Enterprise connectivity (dedicated access)
(iii) Remote site connectivity
(iv) Redundant network paths in hybrid networks (fiber + wireless)
(v) Support for emerging enterprise use cases such as SD-WAN, IoT, and smart infrastructure
(vi) Private Network traffic backhauling

(c) View#3: The microwave backhaul spectrum is required to provide connectivity for delivering commercial enterprise services. The last mile connectivity to end customer may be extended on fiber/ ethernet/ copper.

2.9 One of the stakeholders opined that all traditional microwave backhaul bands should be assigned through auction in a technology and service agnostic manner, and the spectrum can be used in both access and backhaul network.

(3) Summary of comments on Q3

2.10 Q3 is reproduced below:

"Q3. Which of the following methods should be used for the assignment of the spectrum in traditional microwave backhaul bands for radio backhaul purposes for various commercial telecommunication services:
(a) Block-basis in LSA,
(b) Point-to-point link-basis, or
(c) Any other?
Please provide a detailed response with justifications in respect of the relevant commercial telecommunication services."

2.11 In response to Q3, mixed comments have been received from stakeholders. Most stakeholders have opined that the spectrum in traditional microwave backhaul bands should be assigned – (i) on a block-basis for entire LSA to access service providers, and (ii) on a point-to-point (P2P) link-basis to the TSPs other than access service providers and non-TSPs. On the other hand, a few stakeholders have stated that the spectrum in the traditional backhaul bands should be assigned on a point-to-point link-basis.

2.12 The stakeholders favouring the block-based assignment of the spectrum in traditional microwave backhaul bands to access service providers have provided the following arguments in support of their contention:

(a) Given the scale of mobile networks in India - with tens of thousands of sites per operator in each LSA - the operational and logistical complexity of point-to-point (P2P) link-based coordination is not sustainable. Any attempt to assign MWA on P2P link-basis will be both cumbersome and impractical due to the requirement of effective co-ordination for huge numbers of MWA links that are deployed by access service providers.

(b) A block-based assignment enables operators to autonomously plan, deploy and optimize large microwave networks, which is essential for meeting growing demand in a cost- efficient and timely manner.

2.13 The stakeholders favouring the link-based assignment of the spectrum in traditional microwave backhaul bands have provided the following arguments in support of their contention:

(a) P2P links allow precise, need-based deployment, encourage spectrum reuse, and minimize underutilization, especially where operators require only a selective deployment rather than contiguous coverage.

(b) The P2P link-based assignment is the most efficient and scalable approach for non-access service license holders (such as ISPs and NLDOs) given their national license scope.

(c) The point-to-point link-based assignment is preferable in frequency bands shared with fixed satellite service (FSS) such as 13 GHz, 15 GHz and 17 GHz to ensure granular control over interference and coexistence. In the frequency bands with minimal satellite presence, a hybrid model could be considered. A block assignment model is not suitable for shared bands, as it risks uncontrolled deployment of high-density terrestrial systems that may exceed acceptable interference thresholds for satellite services.

(4) <u>Summary of comments on Q4</u>

2.14 Q4 is reproduced below:

"Q4. In case it is decided to use different methods (block-based, link based, or any other) for the assignment of the spectrum in traditional microwave backhaul bands for radio backhaul purposes for different types of commercial telecommunication services, what quantum of spectrum, and in which of 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands should be earmarked for point-to-point link-based assignments? Kindly provide a detailed response with justifications."

2.15 In response to Q4, mixed comments have been received from stakeholders. A broad summary of comments from stakeholders is given below:

(a) <u>View#1</u>: The spectrum in traditional microwave backhaul bands should be assigned to access service providers only. To address the needs of smaller or niche players for the spectrum, spectrum leasing would serve as an optimum mode.

(b) <u>View#2</u>: Out of the various MWA Bands, the 15 GHz band is almost saturated and has very little bandwidth to offer. Another most

utilized band is the 13 GHz band with almost 50% utilization. Both 13 GHz and 15 GHz bands should be exclusively assigned to the TSPs having access service authorisation. Point-to-point link requirement must be fulfilled from 18 GHz and 21 GHz bands. As such, 25% of carriers in 18 GHz and 21 GHz bands can be reserved for allocation to captive/ non-telecom/ non-access service requirements on PTP link-basis allocations. Similarly, 25% of carriers in 6/ 7 GHz bands can be reserved for exclusive use of non- telecom/ captive uses.

(c) View#3: Backhaul throughput requirements are increasing year-on-year, driven by growing data consumption, enterprise connectivity demands, and the expansion of high-speed broadband services to newer areas or locations which are non-feasible due to commercial or any other reason not in control of TSP. The minimum allocation for backhaul should support at least 1 Gbps full duplex throughput, with provisions to scale upward as demand grows. To meet such requirements, it is suggested to allocate two contiguous carriers of 28 MHz each in all the six bands.

(5) Summary of comments on Q5

2.16 Q5 is reproduced below:

"Q5. What should be the terms and conditions for the assignment of spectrum in traditional microwave backhaul bands for radio backhaul purposes of various commercial telecommunication services, such as -

(a) Carrier size;

(b) Carrier aggregation;

(c) Validity period of the assignment;

(d) Renewal mechanism;

(e) Roll-out obligations; and

(f) Surrender of spectrum etc.?

Kindly provide a detailed response with justifications. along with the international scenario on the matter."

2.17 A broad summary of the comments of stakeholders in response to Q5 is given below:

Carrier Size

2.18 Regarding the carrier size in traditional microwave backhaul bands for radio backhaul purposes, while most stakeholders have favoured a carrier size of 28 MHz (paired), a few others have provided differing views.

2.19 The stakeholders favouring a carrier size of 28 MHz (paired) have provided the following arguments in support of their contention:

(a) The carrier size of 28 MHz (paired) provides adequate flexibility. In case any telecom service provider needs more bandwidth to meet the need of growing traffic then, they may obtain multiple carriers of 28 MHz.

(b) The carrier size of 28 MHz (paired) should be continued with as the radios currently in operation are already compatible with the carrier size of 28 MHz. In case the size is altered, it may render the existing radios unusable.

2.20 A broad summary of the comments of stakeholders, who have suggested other carrier sizes, is given below:

(a) Carrier sizes should be aligned to meet the requirements of new technologies and provide wider channel sizes to support data technologies such as 5G and beyond, as is also evident from the GSMA's report referred to by the Authority. 56 MHz carrier size is optimum for traditional microwave backhaul bands.

(b) A range of standard carrier sizes (7 MHz, 14 MHz, 28 MHz, 56 MHz, 112 MHz) should be available, with the actual assigned carrier size

determined by the operator's specific capacity requirements for each point-to-point link.

Carrier Aggregation

2.21 In their comments, stakeholders have unanimously supported carrier aggregation in traditional microwave backhaul bands. A broad summary of the comments of stakeholders with respect to carrier aggregation is given below:

(a) Carrier aggregation is permitted under the extant regime. It enhances equipment and operational efficiency, leads to energy savings, as well as reduces tower loading. Thus, it should not only be continued with, but also actively encouraged.

(b) Carrier aggregation is a technology related feature and need not be regulated. Further, there is no global precedence of regulating carrier aggregation.

(c) Carrier aggregation should be fully permitted without any regulatory restrictions or preconditions. Telecom service providers (TSPs) should be permitted to aggregate carriers without any need for approvals or coordination beyond the initial assignment.

Validity Period

2.22 A broad summary of the comments of stakeholders in respect of the validity period of assignment of spectrum in the traditional microwave backhaul bands is given below:

(a) The validity period should provide sufficient timeframe to allow licensees to make the necessary investments, innovations and optimize networks.

(b) The validity period should be reasonably long, ideally 10 to 15 years, aligned with the typical investment cycles for network infrastructure. A longer validity period provides operators with the necessary

regulatory certainty to make significant investments in the microwave equipment.

(c) Validity period should be 20 years or till the TSP is providing access service, whichever is later.

Renewal Mechanism

2.23 A broad summary of the comments of stakeholders with respect to the mechanism for the renewal of the spectrum assignment in the traditional microwave backhaul bands is given below:

(a) Under the extant regime, the validity period of microwave backhaul carriers assigned to a TSP is co-terminus with its license. At the time of the renewal of its license, the TSP has to submit a request to DoT for revalidation/ renewal of its microwave carriers as well. This process has worked well in the past. It is aligned with the policy of assigning microwave backhaul carriers on an administrative basis and with the validity period of microwave backhaul carriers being co-terminus with the license. The same should be continued.

(b) A clear, transparent, and predictable renewal mechanism should be in place. Renewal should generally be granted provided the licensee has complied with the original terms and conditions.

(c) There should be annual self-declaration-based renewal with usage review and option to surrender.

Rollout Obligations

2.24 Regarding rollout obligations, most stakeholders have opined that there should be no rollout obligations associated with the backhaul spectrum. In support of their viewpoint, they have provided the following arguments:

(a) TSPs holding access spectrum are already subject to rollout obligations specific to access services. These rollout obligations are

designed to ensure that TSPs extend their network coverage to provide services to end-users within a defined timeframe and geographic area. Backhaul spectrum, on the other hand, is not meant to provide coverage at the access level; rather, its primary purpose is to establish high-capacity data links among various network elements. It only plays a supporting role in the telecommunications ecosystem by facilitating the efficient transport of network traffic between cell towers and the core network. Hence, there is no logical reason for prescribing separate roll out obligations for microwave backhaul carriers.

(b) There has been no precedent of mandating roll-out obligations for backhaul spectrum.

2.25 On the other hand, a couple of stakeholders have suggested certain roll-out obligations for microwave backhaul spectrum. While one stakeholder has suggested that the deployment of 100 hops in the LSA in 12 months may be kept as a roll-out obligation for microwave backhaul spectrum. Another stakeholder has suggested that the assigned links must be activated within a specified timeframe (e.g., 6-12 months) from the date of assignment; the enterprise should be required to submit proof of installation and operationalization of the links; non-compliance with rollout obligations should lead to forfeiture of the assigned spectrum and potential penalties.

Surrender of Spectrum

2.26 Regarding the surrender of spectrum in the traditional microwave backhaul bands, most stakeholders have opined that there should be no lock-in period for the surrender of spectrum in the traditional microwave backhaul bands, and the process of voluntary surrender of the spectrum in traditional microwave backhaul bands should be smooth and time-

bound. A broad summary of the comments of such stakeholders is given below:

(a) An enabling regime for the surrender of spectrum encourages TSPs to keep on optimizing the backhaul infrastructure as well as to adopt more efficient technologies and spectrum bands. Further, the technology shift on radio backhaul spectrum could be more dynamic than for access spectrum. Therefore, TSPs should be permitted to surrender the spectrum in the traditional microwave backhaul bands without any lock-in period.

(b) A clear and streamlined process for voluntary surrender of spectrum assignments for individual backhaul links should be established. Operators should be allowed to surrender links when they are no longer needed (e.g., due to fiber deployment, network optimization, or technology upgrade). This process should ideally involve no penalty for surrender.

(c) As per the extant guidelines, a TSP may surrender an MWA/MWB carrier assigned to it by serving an advance notice of 30 days to DoT. This process has worked well in the past. Option to surrender is critical to ensure efficient spectrum utilization; and a simplified mechanism of surrender enables ease of doing business. Thus, the same should be continued with.

2.27 On the other hand, one stakeholder has stated that the surrender of microwave spectrum should be permissible post-5 years.

(6) <u>Summary of comments on Q6</u>

2.28 Q6 is reproduced below:

"Q6. Is there a need to prescribe ceilings on the number of carriers that can be assigned to a commercial telecommunication service provider in each frequency band [6 GHz (lower)/ 7 GHz/ 13 GHz/ 15 GHz/ 18 GHz/

21 GHz] or in a group of frequency bands for radio backhaul purposes? Kindly provide a detailed response with justifications."

2.29 In response to Q6, broadly two types of views have been received from stakeholders. Many stakeholders have favoured the prescription of a ceiling on the number of carriers. However, a few others have suggested that there should be no ceiling on the number of carriers.

2.30 A broad summary of the comments of stakeholders favouring the prescription of a ceiling on the number of carriers is given below:

(a) There is a clear need to prescribe ceilings on the number of microwave carriers that can be assigned to a TSP holding spectrum under access service authorisation. Existing ceilings have proven effective for the last two decades. Therefore, it will be proper to maintain continuity with the same policy.

(b) The overall ceiling in the MWA bands should be linked to the total access spectrum allocated to a TSP. While the current ceiling is generally adequate in light of the existing traffic levels on 4G and 5G networks, a significant increase in traffic load is anticipated over the next 3 to 5 years. Accordingly, it is recommended that the ceiling be subject to a periodic review, preferably every three years, to ensure it remains aligned with evolving network demands and technological advancements.

(c) For TSPs having access service authorisation, further assignment in the new bands should be done only after the usage validation of their existing allocated carriers.

2.31 A broad summary of the comments of stakeholders opposing the prescription of a ceiling on the number of carriers is given below:

(a) The role of the ceiling on the number of carriers is to ensure and maintain sufficient competition in the market and prevent monopolization of valuable national resources. Monopolization is not

possible when large amount of spectrum remains unassigned. Thus, there is no case for a ceiling on the number of carriers. However, in case ceiling is to be recommended, then the overall ceiling should be 40%.

(b) There should be no ceiling on number of microwave carriers that can be held by a licensee as this spectrum will be shared across the LSA by multiple number of users and there will not be any exclusive assignment of the same.

(7) Summary of comments on Q7

2.32 Q7 is reproduced below:

"Q7. In case it is decided to prescribe ceilings on the number of carriers that can be assigned to a commercial telecommunication service provider (TSP) for each frequency band or each group of frequency bands, -

(a) Should there be any criterion for the ceiling on the number of carriers that may be assigned to a TSP? If yes, what should be the criteria?

(b) In case of group of frequency bands, how should the bands be grouped?

(c) What should be the respective ceilings for each frequency band, or each group of frequency band(s)?

(d) Should there be any provision for assignment of spectrum above the ceiling limit on a case-by-case basis? If yes, what criterion should be prescribed, based on which, additional spectrum above the ceiling limit may be assigned to a telecom service provider?

Kindly provide a detailed response with justifications."

2.33 A broad summary of the comments of stakeholders in response to Q7 is given below:

Criterion for the ceiling on the number of carriers

2.34 A couple of stakeholders have suggested that there should be different ceilings based on service area categories, i.e., Metro, Category-A circles, Category-B circles, and Category-C circles. Another stakeholder has suggested that the type of LSA and the quantum of access spectrum held by the TSP should together be used as criteria for the ceiling on the number of carriers that may be assigned to a TSP.

Ceiling on the number of carriers in each frequency band, or a group of frequency bands

2.35 Stakeholders have provided quite divergent views on the aspect related to a ceiling on the number of carriers for each frequency band or a group of frequency bands as outlined below:

(a) View#1: There is no need to prescribe a separate ceiling for each of the traditional microwave backhaul bands. In this way, a TSP will be empowered to get their radio backhaul holdings harmonized in one of the spectrum bands across the LSA and the country. With such harmonization, carrier aggregation would be possible and easier with 'n' number of contiguous 28 MHz spots into one carrier and help achieve higher capacities and optimum utilization of radio backhaul spectrum. Any imposition of an individual band-wise ceiling would effectively result in the operator forfeiting its current spectrum holdings, thereby causing a complete disruption of services.

(b) View#2: For prescribing overall ceilings, the bands should be grouped based on the usage. MWA bands (13/ 15/ 18/ 21 GHz) should form one group, and MWB bands (6/ 7 GHz) should form another group. In case of MWA carriers, the current ceiling of 8 carriers in each of Metro/ Category-A circles and 6 carriers in each of the Category-B and Category-C circles is sufficient to meet the

demand both at present and in the near future. A ceiling of two MWB carriers per LSA in all categories of LSAs should be sufficient.

(c) View#3: In case ceiling is proposed, it should be group-wise ceiling of 40%. The first group of the 6 GHz and 7 GHz, and the second group of the 13/ 15/ 18/ 21 GHz.

(d) View#4: Any TSP should not hold more than 40% of the available carriers in any band.

2.36 Apart from the above, a stakeholder has suggested that the carriers in 13 GHz and 15 GHz bands should be assigned to TSPs only. In the 18 GHz and 21 GHz bands, 25% carriers can be reserved for non-TSP/ captive users.

Provision for the assignment of spectrum above the ceiling limit

2.37 On the aspect related to the provision for the assignment of spectrum above the ceiling limit on a case-by-case basis, a stakeholder has opined that the spectrum ceilings should be periodically reviewed and revised to accommodate growing demands, while ensuring that the ceilings remain sacrosanct and are not exceeded.

(8) Summary of comments on Q8

2.38 Q8 is reproduced below:

"Q8. In the new policy regime for the assignment of spectrum, whether there is a need to grant an option to telecom service providers already holding carriers in traditional microwave backhaul bands to retain the existing carriers with them? Kindly provide a detailed response with justifications."

2.39 In response to Q8, most stakeholders have opined that in the proposed new policy regime, telecom service providers should be granted an option

to retain the carriers held by them in traditional microwave backhaul bands. On the other hand, a stakeholder has suggested that the option to retain the carriers is unnecessary.

2.40 A broad summary of the comments of stakeholders, who have opined that telecom service providers should be granted an option to retain the carriers held by them in traditional microwave backhaul bands, is given below:

(a) Indian telecom networks have evolved over a long period of time on the basis of administratively assigned microwave backhaul spectrum. The legacy equipment deployed in telecom networks does not support the entire range of frequencies available in a particular microwave backhaul band. Therefore, changing the frequency carriers assigned to a telecom service provider would compromise the operational integrity of the entire telecom network, potentially leading to widespread outages, degraded quality of service (QoS), and customer dissatisfaction.

(b) In India, presently, in the existing backhaul bands, a vast number of microwave hops, estimated to be around 5 lakh links, are already deployed. The legacy backhaul equipment has inherent limitations related to 'occupied bandwidth' ("OBW") and 'instantaneous bandwidth' ("IBW"). The designs of these systems are optimized for performance within specific frequency bands and sub-bands. Attempting any modifications to these systems could render existing backhaul equipment obsolete, necessitating a complete overhaul of the backhaul network. Therefore, practically, there is no flexibility to change the currently assigned spots.

(c) If telecom service providers are not granted an option to retain their existing carriers, it would cause humungous change in network design and planning, service disruption and capex requirements, because, with change in band, there would also be change in propagation characteristics of different bands besides equipment

not being compatible. For hundreds of millions of subscribers, which are dependent on these legacy networks, such disruptions could lead to significant inconvenience, ranging from dropped calls and slower data speeds to limited access to essential digital services. These impacts would be particularly severe for users in underserved or remote areas where alternative connectivity options are limited. Any interruption in service continuity not only affects daily communication and productivity but also undermines customer confidence and satisfaction. Therefore, it is imperative that continuity and stability in frequency usage be maintained to safeguard the user experience and uphold public trust in digital infrastructure.

2.41 However, one stakeholder has not supported the proposed option to retain the existing carriers in traditional microwave backhaul bands. In support of its contention, it has stated as below:

(a) DoT has already made it amply clear that the assignment of MWA/MWB carriers is temporary in nature, the assignees would have contingency plans in place to prevent disruption of services. Therefore, principally, we do not support the proposal to ensure that the newly assigned frequency carriers to a TSP are supported by the existing equipment of the TSP. However, if it is decided to provide an option to telecom service providers already holding carriers in traditional microwave backhaul bands to retain the existing carriers, then there should be no permission to add new links.

(b) Additionally, the TSPs should be permitted to swap their assignment basis mutual agreement. Further, in case serious service disruption is envisaged, the Government may provide a three-month timeline to recalibrate or replace the equipment for new frequencies before effecting the change in assignment for existing users.

(9) Summary of comments on Q9

2.42 Q9 is reproduced below:

"Q9. As the 7125-8400 MHz range in the 7 GHz band and the 14.8-15.35 GHz range in the 15 GHz band are being considered for IMT in WRC-27, whether there is a need to review the usage of 7 GHz and 15 GHz microwave backhaul bands at this stage itself, or should the review be undertaken after considering the outcome of WRC-27? Kindly provide a detailed response with justifications."

2.43 A broad summary of the comments of stakeholders in response to Q9 is given below:

Review of the usage of 7 GHz band

2.44 Most of the stakeholders have opined that the review of the usage of the 7 GHz microwave backhaul band in the country should be conducted after the conclusion of WRC-27. On the other hand, a few stakeholders have indicated that the 7 GHz band may be set aside for future IMT applications prior to WRC-27 itself.

2.45 A summary of the inputs of the stakeholders, who have opined that the review of the usage of the 7 GHz band in the country should be conducted on the conclusion of WRC-27, is given below:

(a) Presently, the frequency range 7125-8400 MHz is used for communication between the earth stations and space stations of the Earth Exploration Satellite Service (EESS), Fixed Satellite Service (FSS), Meteorological Satellite Service (MetSat), Mobile Satellite Service (MSS) and Space Research Radio Service (SRS). This band is heavily used by Satcom with downlink in the range of 7250-7750 MHz and uplink in the range of 7900-8400 MHz to support many applications. Particularly, the uplink band 7900-8400 MHz could

have sharing characteristics similar to the upper 6 GHz band (FS military point-to-point, audio-visual transport and FSS uplink). The protection of space stations in this band would however be much more critical than in the upper 6 GHz band. Therefore, the 7 GHz band as well as the adjacent bands should not be identified for IMT unless the continued operation of current and future usage of incumbent services is adequately guaranteed by the ongoing compatibility studies at ITU-R level.

(b) The outcome of WRC-27 will determine global harmonization of the 7 GHz band for IMT, influencing equipment standards, interference thresholds, and coexistence frameworks. Hence, any major regulatory review of the 7 GHz band should be deferred until the conclusion of WRC-27 considering the fact that the microwave backhaul networks remain critical for rural and remote connectivity.

(c) A review after WRC-27 will ensure that any changes to backhaul allocations are informed by final international regulatory decisions, enable harmonized spectrum use, and avoid premature reassignments that could limit flexibility.

2.46 A summary of the inputs of the stakeholders, who have indicated that the 7 GHz band may be set aside for future IMT applications even prior to WRC-27, is given below:

(a) The strategic value of the 7 GHz band for future IMT deployment, particularly for 6G, cannot be overstated. Its global harmonization potential, mid-band propagation advantages, and ability to support wide bandwidths make it an essential asset in India's long-term spectrum roadmap. Hence, the 7 GHz band should be reserved for IMT, while ensuring that near-term backhaul requirements are accommodated within the other microwave backhaul bands.

(b) The review of the 7 GHz band can be carried out in a couple of years. Principally, in so far, the existing holdings in the 7 GHz band being used for radio backhaul are protected, no issue is foreseen in

the allocation of non-overlapping channels for IMT. For the spots which are currently being utilized, a review can be carried out after 3 to 5 years.

Review of the usage of 15 GHz band

2.47 With respect to the review of the usage of 15 GHz band, a few stakeholders have submitted that the review of the usage of this band should be undertaken upon the conclusion of the WRC-27. On the other hand, many stakeholders have opined that there is no need to review the usage of the 15 GHz band even after WRC-27.

2.48 A broad summary of the comments of the stakeholders, who have opined that there is no need to review the usage of the 15 GHz band even after WRC-27, is given below:

(a) India is experiencing an unabated exponential rise in mobile data traffic, driven by increased smartphone penetration, video consumption, cloud-based services, and digital inclusion initiatives. As IMT bands are progressively deployed for access services, including mid-band and mmWave for 5G, the requirement for proportionate and high capacity backhaul spectrum becomes even more critical. Without sufficient microwave backhaul capacity, the utility of the newly allocated access spectrum will remain suboptimal. At present, the 15 GHz band serves as a key pillar for the backhaul infrastructure across the telecom industry in India. Its technical characteristics, such as suitable bandwidth availability, favorable propagation, and mature equipment ecosystem, make it highly efficient and cost-effective for medium-to-long distance point-to-point backhaul links.

(b) The 15 GHz band is vital for backhauling. The widespread use of 15 GHz band marks the band as the "lifeline" of India’s mobile backhaul network. A significant proportion of existing links are deployed in

this band, supporting tens of thousands of cell sites across the country. Therefore, the 15 GHz band is imperative for backhaul usage to ensure the resilience, scalability, and continuity of India's mobile and broadband infrastructure in the face of rising data demand and incomplete fiber coverage.

(c) Any consideration of re-allocating the 15 GHz band from backhaul to IMT under WRC-27 would have serious adverse consequences, including disruption of existing infrastructure, service degradation and investment risk.

2.49 A broad summary of the comments of the stakeholders, who have submitted that the review of the usage of the 15 GHz band should be undertaken upon the conclusion of WRC-27, is given below:

(a) The 15 GHz band (14.8-15.35 GHz) is allocated to Space Research Service (SRS). WRC-23 upgraded the SRS use in this band to the primary status. Several space agencies operate current and future missions, including manned missions (currently ISRO is also involved) in this frequency band. Therefore, the 15 GHz band should not be identified for IMT unless the continued operation of current and future usage of incumbent services is adequately guaranteed by the ongoing compatibility studies at ITU-R level.

(b) Until WRC-27 decisions are finalized and harmonized globally, making changes in the national policy would be speculative and could result in regulatory misalignment

(10) <u>Summary of comments on Q10</u>

2.50 Q10 is reproduced below:

"Q10. In case it is decided to review the usage of 7 GHz and 15 GHz bands at this stage itself, what should be the policy framework for the assignment of the spectrum in 7 GHz and 15 GHz microwave backhaul

bands to take care the possible outcomes of AI 1.7 of the WRC-27? Kindly provide a detailed response with justifications."

2.51 In response to Q10, most of the stakeholders have opined that a cautionary approach should be followed with respect to the usage of 7 GHz and 15 GHz bands at this stage. A summary of the comments of stakeholders in response to Q10 is given below:

(a) Any regulatory decision to re-farm the 7 GHz band for IMT will only follow WRC-27 deliberations. As such, there remains a window of approximately 2 to 3 years before any potential reallocation takes effect. In the interim, the existing backhaul deployments in the 7 GHz band may continue to operate. Migration of such links, if required, should be pursued on a voluntary basis, or alternatively, the 7 GHz band may continue to be allocated exclusively for the operators' backhaul use until it is formally transitioned to IMT.

(b) If the 7 GHz band (specifically 7.125–7.75 GHz) is considered for review, TRAI should identify sub-bands not shared with FSS as potential candidates for flexible future use, while reserving FSS-co-primary bands for fixed link and satellite coexistence only.

(c) It is expected that the 7 GHz and 15 GHz bands will be identified for IMT in WRC-27. Therefore, it will not be appropriate to allow further assignments of fixed links in these bands.

(d) As a precaution, no new assignments should be given in these bands.

(11) <u>Summary of comments on Q11</u>

2.52 Q11 is reproduced below:

"Q11. Whether there is a need to earmark certain quantum of spectrum in traditional microwave backhaul bands for the last-mile connectivity (Fixed Wireless Access) to the customer equipment of commercial

telecommunication services? Please provide a detailed response with justifications."

2.53 In response to Q11, most of the stakeholders have contended that no spectrum in traditional microwave backhaul bands should be earmarked for the last-mile connectivity (Fixed Wireless Access) to the customer equipment of commercial telecommunication services. On the other hand, a few stakeholders have opined in favour of it.

2.54 A summary of the comments of the stakeholders, who have opposed the earmarking of any spectrum in traditional microwave backhaul bands for the last-mile connectivity (Fixed Wireless Access) to the customer equipment of commercial telecommunication services, is given below:

(a) Traditional microwave backhaul bands serve a critical role in the transport layer of telecommunication networks, facilitating the movement of aggregated traffic between cell sites, aggregation nodes, and core networks. As India scales its 5G infrastructure and prepares for the transition to 6G, protecting and optimizing traditional microwave backhaul spectrum is of national strategic importance. The high throughput and low-latency requirements of next-generation networks will place significant demands on the backhaul layer.

(b) Diverting spectrum from its core function of backhaul would undermine the performance, coverage, and scalability of mobile networks.

(c) India's regulatory and policy framework clearly defines customer connectivity as part of "access services", which must be delivered using access spectrum. The availability of mid-band and mmWave access spectrum provides ample opportunity for operators to deploy high-speed FWA without the need to divert scarce and valuable backhaul spectrum from its primary function.

(d) No portion of traditional microwave backhaul bands should be earmarked for Fixed Wireless Access (FWA) to customer premises. These bands are primarily designated for point-to-point fixed services and are co-allocated on a primary basis to FSS under the ITU-RR. Traditional microwave bands should be preserved exclusively for backhaul purposes, while encouraging last-mile FWA to be deployed in more appropriate bands designed for that purpose. This approach will protect satellite operations, ensure spectral harmony, and support both terrestrial and satellite connectivity goals.

(e) There is no regulatory barrier preventing the deployment of Fixed Wireless Access (FWA) solutions today. TSPs are already empowered to use their access spectrum holdings to provide broadband connectivity, including FWA, to customer premises using licensed access bands such as 2.3 GHz, 2.5 GHz, 3.3–3.6 GHz, and mmWave spectrum. The availability of mid-band and mmWave access spectrum provides ample opportunity for operators to deploy high-speed FWA without the need to divert scarce and valuable backhaul spectrum from its primary function.

(f) The use of backhaul links as transport for FWA is already permitted within the current framework, where microwave links connect the wireless access node to the core network. However, the actual last-mile delivery to customer equipment must occur via access spectrum, as per regulatory and technical norms.

(g) There are many access licensed bands as well as unlicensed bands, which can help address last mile challenges like large frequency blocks in mmWave spectrum with existing TSPs or existing unlicensed band and upcoming unlicensed band in the lower 6 GHz band.

(h) For enterprise customers, these carriers will be used between one point-of-presence (POP) of TSP to another POP of TSP; the last mile of the customer will be extended on fiber/ ethernet/ copper

therefore there is no requirement to earmark any spectrum for FWA in these bands.

2.55 A summary of the comments of the stakeholders, who have favoured the earmarking of certain spectrum in traditional microwave bands for the last-mile connectivity (Fixed Wireless Access) to the customer equipment of commercial telecommunication services, is given below:

(a) Traditional microwave bands (e.g., 7 GHz, 15 GHz) offer lower propagation loss compared to E/V bands, making them ideal for FWA in non-line-of-sight scenarios.

(b) The non-access service providers lack administrative allocation of spectrum for X-haul disadvantaging them against access service providers who hold spectrum and can further obtain, trade and share. Earmarking spectrum for FWA would enable ISPs to serve enterprise customers with reliable, SLA-compliant connectivity and prevent the customer churn due to QoS degradation from suboptimal unlicensed-band solutions e.g., unlicensed band radio (UBR).

(12) Summary of comments on Q12

2.56 Q12 is reproduced below:

"Q12. In case it is decided to earmark certain quantum of spectrum in traditional microwave backhaul bands for the last-mile connectivity (Fixed Wireless Access) to the customer equipment of commercial telecommunication services, -

(a) What quantum of spectrum, and in which of 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands should be earmarked for such purposes?

(b) What should be the eligibility conditions to obtain the spectrum in traditional microwave backhaul bands for such purposes?

(c) What should be the terms and conditions for the assignment of spectrum in traditional microwave backhaul bands for such purposes through auction such as-

(i) Block size;

(ii) Minimum quantity for bidding;

(iii) Spectrum cap;

(iv) Validity period of the assignment;

(v) Roll-out obligations;

(vi) Surrender of spectrum etc.?

(d) Whether flexible use i.e., both backhaul connectivity, and last mile connectivity (fixed wireless access) to the customer equipment should be permitted in the frequency ranges earmarked for such purposes? If yes, should the terms and conditions of the auction of spectrum be the same as those applicable for the "access spectrum"?

Kindly provide a detailed response with justification and international practice."

2.57 In response to Q12, a stakeholder has suggested the following aspects with respect to the assignment of the spectrum in traditional microwave backhaul bands for the last mile connectivity:

(a) 50-100 MHz spectrum per operator (access and non-access service provider) should be reserved in sub-15 GHz bands (prioritizing 7 GHz, and 13 GHz bands) for FWA and the allocation of the same should be done administratively.

(b) All licensed service providers should be eligible to obtain the spectrum in traditional microwave bands for X-haul purposes.

(c) There should not be any rollout obligation for deployment of such spectrum for enterprise use cases.

(13) Summary of comments on Q13

2.58 Q13 is reproduced below:

"Q13. Should a certain quantum of the spectrum in traditional microwave backhaul bands be earmarked for fulfilling point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users? If yes -

(a) What quantum of spectrum, and in which of 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands should be earmarked for such purposes?

(b) What should be the terms and conditions for the assignment of spectrum for such purposes, such as-

(i) Carrier size;

(ii) Carrier aggregation;

(iii) Ceiling on the number of carriers;

(iv) Validity period of the assignment;

(v) Renewal mechanism;

(vi) Criteria for the assignment of additional spectrum above the ceiling limit;

(vii) Roll out obligations; and

(viii) Surrender of the spectrum, etc.?

Kindly provide a detailed response with justifications."

2.59 In response to Q13, many stakeholders have opined in favour of earmarking certain quantum of spectrum in traditional microwave backhaul bands for fulfilling point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users. On the other hand, many other stakeholders have opposed it.

2.60 A summary of the comments of the stakeholders, who have contended that no spectrum in traditional microwave backhaul bands should be

earmarked for fulfilling point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users, is given below:

(a) Given the importance of radio backhaul to access telecom networks, no quantum of spectrum should be removed from the traditional microwave radio backhaul bands for earmarking for the point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users.

(b) Any earmarking of spectrum for captive users will create fragmentation issues, arbitrage as well as complicate pricing.

(c) Any de-licensing/ reservation of spectrum for the industrial use or for the establishment of private networks would not only cause huge loss to the exchequer but will also lead to sub-optimal utilization of this scarce resource.

(d) A substantial amount of spectrum in the unlicensed band is available and can help serve the demand of such captive (non-commercial/ non-TSP) users. Besides, the Government is also looking at providing more unlicensed spectrum in the lower 6 GHz band.

2.61 A summary of the comments of the stakeholders, who have opined in favour of earmarking certain quantum of spectrum in traditional microwave backhaul bands for fulfilling point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users, is given below:

(a) The Telecommunications Act, 2023 acknowledges the need for captive networks to foster Industry 4.0, IoT, and enterprise digital transformation. Point-to-point microwave links are crucial for these networks to connect various sites within a campus, industrial complex, or specific geographical area where laying fiber is impractical or too costly.

(b) A certain quantum of spectrum in traditional microwave backhaul bands should be earmarked for captive (non-commercial/non-TSP) users, with clear policy, eligibility, and assignment mechanisms. This

should be done via administrative assignment, with periodic review and robust monitoring to ensure optimal and equitable use of this valuable resource.

(c) Captive (non-commercial/ non-TSP) users may be assigned microwave spectrum provided that such usage remains limited to point-to-point applications and does not interfere with co-primary FSS operations. Spectrum earmarking for captive usage should be carefully constrained, especially in sensitive bands like 12.75–13.25 GHz.

2.62 A few stakeholders, who have opined in support of earmarking certain quantum of spectrum in traditional microwave backhaul bands for fulfilling point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users, have also provided inputs with respect to the quantum of spectrum to be earmarked and various terms and conditions for the assignment of spectrum. A summary of their inputs is given below:

Quantum of spectrum to be earmarked

2.63 A stakeholder has opined that a small quantum should be earmarked across a few suitable bands, rather than a large chunk from any single band; this would ensure that the primary use of these bands for TSP backhaul is not significantly impacted; 18 GHz and 21 GHz bands have shorter propagation distances and higher capacities, making them ideal for intra-campus or short-to-medium distance point-to-point links; they are also less congested for long-haul backhaul compared to lower bands; potentially 1 pair of 28 MHz carrier in each of these bands should be assigned on a per-link basis; this provides sufficient capacity for most enterprise backhaul needs without excessive earmarking; the frequency bands 13 GHz and 15 GHz bands offer a good balance of capacity and propagation characteristics; they could be considered for slightly longer links within a campus or connecting nearby facilities; a very limited

amount, perhaps 1 paired 28 MHz carrier in each of the 13 GHz and 15 GHz bands should be considered as a secondary option if 18/ 21 GHz bands are insufficient or technically unsuitable for a specific link.

2.64 Another stakeholder has suggested that at a minimum, two numbers of 28 MHz FDD paired channels in MWA and MWB bands should be earmarked on a pan-India basis for TSPs other than access service licensees and certain other user categories.

Carrier size

2.65 A stakeholder has suggested that the standard carrier sizes viz. 28 MHz and 56 MHz (paired), which are used in the respective bands for point-to-point microwave backhaul should be prescribed; this would ensure compatibility with existing equipment and technical standards, leading to a mature ecosystem and lower equipment costs. Another stakeholder has opined that the carrier size for the captive users should be 7 MHz and its multiples.

Ceiling on the number of carriers

2.66 A stakeholder has suggested that for captive/ non-TSP users, there should be a ceiling of 1 paired carrier per link. Another stakeholder has opined that a maximum of 8 carriers of 7 MHz should be allowed to captive users.

Validity period of assignment

2.67 A stakeholder has suggested that the validity period of assignment of spectrum to captive users should be long enough to provide sufficient ability for enterprises to plan and amortize their network investments.

Renewal Mechanism

2.68 A stakeholder has suggested the renewal of spectrum assignment should not be automatic, and there should be a formal process to re-evaluate the necessity. The assignment of spectrum should be renewed based on satisfactory performance and continued need.

Assignment of additional spectrum above the ceiling limit

2.69 A stakeholder has suggested that additional spectrum above the ceiling limits should be assigned only in exceptional cases with rigorous justification.

Roll-out obligations

2.70 A stakeholder has suggested that the assigned links must be activated within a specific timeframe (for example 6-12 months) from the date of assignment. Another stakeholder has opined that the user should commence the link within six months. Yet another stakeholder has contended that there should be no roll-out obligations considering point-to-point link.

Surrender of spectrum

2.71 A stakeholder has suggested that enterprises should be allowed to voluntarily surrender the assigned spectrum at any time without penalty.

(14) Summary of comments on Q14

2.72 Q14 is reproduced below:

"Q14. In case your response to Q13 is 'no', in what manner should the point-to-point connectivity requirements of captive (noncommercial/

non-TSP) users be fulfilled? Kindly provide a detailed response with justifications."

2.73 Many stakeholders, who are not in favour of earmarking of any spectrum for captive (non-commercial/ non-TSP) users, have suggested methods for fulfilling the point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users. A summary of their comments is given below:

(a) Fiber connectivity should be the primary mode of backhaul, given its reliability and scalability. In case laying fiber is not feasible, the users may procure services from licensed TSPs, who can offer managed microwave or fiber backhaul. Such a practice would help avoid fragmented and inefficient spectrum occupation and ensure better QoS and regulatory compliance in return. Captive non-TSP users can also opt to use unlicensed bands to fulfil their needs.

(b) The connectivity requirements of captive users should be addressed through a well-regulated spectrum leasing framework, wherein licensed TSPs are allowed to lease their spectrum to such entities.

(15) <u>Summary of comments on Q15</u>

2.74 Q15 is reproduced below:

"Q15. In case it is decided to assign the spectrum in traditional microwave backhaul bands on a point-to-point link basis to cater to point-to point connectivity requirements of commercial telecommunication service providers as well as captive (non-commercial/ non-TSP) users, whether there is a need to prescribe minimum link lengths (path lengths) in these bands? If yes, what should be the minimum link length for each of the traditional microwave backhaul bands?

Kindly provide a detailed response with justifications."

2.75 In response to Q15, a few stakeholders have suggested that minimum link lengths (path lengths) in traditional microwave backhaul bands should be prescribed. A few other stakeholders have opposed it.

2.76 A broad summary of the comments from stakeholders, who have supported the prescription of the minimum link lengths (path lengths) in traditional microwave backhaul bands, is given below:

(a) Prescribing minimum link lengths in traditional microwave backhaul bands is necessary to ensure efficient spectrum use, minimize interference, and harmonize spectrum policy for both commercial TSPs and captive users. Recommended minimum distances range from 0.3 km in very high-frequency short-range bands (V- Band) up to 5 km in lower-frequency long-range bands (e.g., 21 GHz), reflecting propagation characteristics and typical use cases.

(b) Minimum link lengths can help prevent the hoarding of spectrum by non-users, ensuring that it is used efficiently. Knowing the minimum required link lengths can help in efficient planning of network infrastructure and placement of devices. Minimum link lengths can provide a level playing field for all users, ensuring that no one is unfairly disadvantaged due to their location or specific needs.

(c) There is a strong need to prescribe minimum link lengths. The minimum link lengths should be based on a balance of technical feasibility, international best practices (where applicable), and efficient spectrum use within the Indian context, considering both TSP and CNPN needs. For 13 GHz and 15 GHz Bands, the minimum link length should be 3 km. For 18 GHz and 21 GHz Bands, the minimum link length should be 1 km. These are higher MWA bands, with increased sensitivity to rain fade and higher free-space path loss compared to lower bands. They are ideal for short-haul, high-capacity links, typically within dense urban areas or large industrial campuses.

2.77 A broad summary of the comments from stakeholders, who have opposed the prescription of the minimum link lengths (path lengths) in traditional microwave backhaul bands, is given below:

(a) The introduction of minimum link length (path length) requirements for microwave backhaul bands would be counterproductive. Any such mandate would artificially constrain network architecture, limiting operators' ability to design optimal link topologies based on real-world deployment conditions. The operators may be forced to choose longer or indirect routing paths, even when more efficient, shorter links are both technically feasible and preferable. Any such practice would delay network rollouts, as operators would be required to revisit and re-engineer backhaul designs to conform to arbitrary regulatory thresholds, thereby impeding timely infrastructure expansion.

(b) The prescription of a minimum link distance for a particular frequency band may not be appropriate, as it could unnecessarily restrict deployment flexibility. Service providers should be allowed to choose the most suitable equipment and network design based not only on distance, but also on factors such as capacity requirements, interference environment, path profile, and customer-specific needs. Allowing flexibility in link distance enables optimal use of advanced radio technologies and ensures that spectrum is efficiently utilized across a variety of deployment scenarios, including dense urban areas, short-hop links, and capacity-sensitive environments.

(c) Mandating minimum link lengths may hinder network flexibility and usage of spectrum particularly for dense enterprise environments.

(16) <u>Summary of comments on Q16</u>

2.78 Q16 is reproduced below:

"Q16. Considering that the Government has decided to delicense the 6 GHz (lower) band (5.925-6.425 GHz) for low power applications, whether there is any need to prescribe certain measures to provide necessary protection to incumbent users such as Fixed Microwave (backhaul) Services, Fixed Satellite Service (FSS) etc. operating in the 6 GHz (lower) band? If yes, which specific measures should be prescribed for this purpose? Kindly provide a detailed response with justifications."

2.79 In response to Q16, many stakeholders have opined that there is no need to prescribe any measures to provide necessary protection to incumbent users in the 6 GHz (lower) band. On the other hand, a few stakeholders have contended that there is a need to prescribe measures to provide necessary protection to incumbent users in the 6 GHz (lower) band.

2.80 A broad summary of the comments of the stakeholders, who have opined that there is no need to prescribe any measures to provide necessary protection to incumbent users in the 6 GHz (lower) band, is given below:

(a) Extensive studies in CEPT as reported in ECC Report 302 and ECC Report 316 demonstrate that low-power indoor (LPI) and very low power (VLP) portable WAS/RLAN (Wi-Fi) deployments can coexist with incumbent FS and FSS systems without causing harmful interference when basic coexistence measures are observed. These findings are likely directly applicable to India, where similar incumbent usage conditions apply.

(b) The Draft Rules Notified by the Government for the lower 6 GHz band already have factored in the WiFi/ RLAN applications to be deployed primarily indoors with usage of low power /very low power. This is based on the best international practices and also takes into account the findings of spectrum sharing studies - both locally as

well as globally. Hence no additional protection for incumbent users is required.

2.81 A broad summary of the comments from the stakeholders, who have contended that there is a need to prescribe measures to provide necessary protection to incumbent users in the 6 GHz (lower) band, is given below:

(a) Geographical exclusion or protection zones around incumbent FSS earth stations should be established to prevent interference in sensitive areas.

(b) RLAN (Wi-Fi) systems should not be granted any protection from satellite earth station transmitters because such systems are limited to 'low power indoor' and 'very low power' applications.

2.82 Many other stakeholders have opined that DoT in its draft Rules has recommended the outdoor power limit of 14 dBm (25 mW) which is highly restrictive and will significantly constrain the ability to fully leverage the transformative potential of the 6 GHz (lower) band, especially in the context of next-generation Wi-Fi technologies such as Wi-Fi 6E and Wi-Fi 7; therefore, to unlock the full potential of the 6 GHz band for enterprises, addressing spectrum scarcity, interference, and coverage challenges, while ensuring responsible spectrum sharing, power limits should be in line with global norms and leveraging Automated Frequency Coordination (AFC) technology and in alignment with power permitted in 5 GHz band.

(17) Summary of comments on Q17

2.83 Q17 is reproduced below:

"Q17. Any other suggestions relevant to the assignment of spectrum in 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands may kindly be provided with detailed justifications."

2.84 A broad summary of comments from stakeholders in response to Q17 is given below:

(a) A real time spectrum management system should be implemented to facilitate dynamic assignment and coordination of P2P links at a national level.

(b) India should consider adopting a regulatory framework for the 6 GHz band (5925–7125 MHz) that closely aligns with the successful model implemented by the U.S. Federal Communications Commission (FCC). The FCC framework authorizes licence-exempt use of the entire 6 GHz band for licence-exempt devices, such as Wi-Fi 6E, while ensuring protection for incumbent services through appropriate technical rules.

(c) India may also consider the band split for the upper 6 GHz. Before proceeding with the allocation of the Upper 6 GHz band for mobile (IMT).

B. Analysis of the issues related to traditional microwave backhaul bands

(1) Which type of services should be permitted to be provided in traditional microwave backhaul bands

2.85 Section 4(4) of the Telecommunications Act, 2023 states that *the Central Government shall assign spectrum for telecommunication through auction except for entries listed in the First Schedule for which assignment shall be done by administrative process*. The First Schedule of the Telecommunications Act, 2023 lists 19 items for the assignment of spectrum through the administrative process. The item at Serial No. 12 of the First Schedule is "*Radio backhaul for telecommunication services".* Meaning thereby, the spectrum for radio backhaul purposes shall be

assigned through the administrative process.[52] Notably, in the explanation under the item at Serial No. 12, the term 'radio backhaul' has been defined as "*the use of radio frequency only to interconnect telecommunication equipment, other than the customer equipment in telecommunication networks".*

2.86 At present, DoT assigns the spectrum in traditional microwave backhaul bands for wireless backhaul purposes in a carrier size of 28 MHz (paired)[53]. Based on the TRAI's request, DoT, through a letter dated 11.10.2022, provided details of carriers in 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands (**Annexure-2.1)**. The following table presents the frequency ranges and number of carriers available in the traditional microwave backhaul bands:

Table 2.1: Details of Traditional Microwave Backhaul Bands

MWA/ MWB	Band	Frequency range	No. of carriers
MWB	6 GHz (lower)	5925-6425 MHz	8
	7 GHz	7125-7425 MHz	5
		7425-7725 MHz	5
MWA	13 GHz	12.75-13.25 GHz	8
	15 GHz	14.5-15.5 GHz	15
	18 GHz	17.7-19.7 GHz	32
	21 GHz	21.2-23.6 GHz	40

[52] DoT, through the Reference dated 13.09.2024 has agreed with the TRAI's observation that the backhaul spectrum is part of the First Schedule of the Act, for which the assignment method would be administrative.

[53] The unit of assignment for the spectrum in traditional microwave backhaul bands is generally 28 MHz (FDD) i.e. 28 MHz (uplink) + 28 MHz (downlink). However, DoT has assigned carriers in traditional microwave backhaul bands to captive users and NLD service providers in paired blocks of sizes 3 MHz, 3.5 MHz, 6 MHz, 7 MHz, 14 MHz and 35 MHz also. However, such assignments are very few in number. Source: DoT's letter dated 08.05.2025
The term "FDD" is an acronym of "Frequency Division Duplexing". FDD technique allows uplink and downlink transmission at the same time, but over different frequency bands.

2.87 DoT has classified traditional microwave backhaul bands (6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands) into two categories viz. Microwave Access (MWA) bands and Microwave Backbone (MWB)[54] bands, as given below:

(a) MWA bands: 13 GHz band (12.75-13.25 GHz), 15 GHz band (14.5-15.5 GHz), 18 GHz band (17.7-19.7 GHz,) and 21 GHz band (21.2-23.6 GHz) are collectively referred to as "MWA bands". The spectrum in MWA bands is used to carry traffic over relatively shorter distances.

(b) MWB bands: Lower 6 GHz band (5.925-6.425 GHz) and 7 GHz band (7.125-7.725 GHz) bands are collectively referred to as "MWB bands". The spectrum in MWB bands is used to carry traffic over relatively longer distances.

2.88 As per the information provided by DoT through the letter dated 08.05.2025, DoT has assigned the spectrum in traditional microwave backhaul bands mainly to wireless access service providers (i.e. access service providers holding access spectrum) for radio backhauling. DoT has also assigned the spectrum in these bands to non-TSP isolated captive users and other types of telecom service providers for establishing point-to-point links on the need basis. In other words, under the extant regime, DoT has assigned the spectrum in traditional microwave backhaul bands to commercial telecom services and non-commercial captive use for interconnecting telecommunication equipment (other than customer equipment) i.e. radio backhaul. This spectrum has not been assigned for last mile connectivity (Fixed Wireless Access) of commercial telecom services.

[54] As per DoT, both MWA and MWB are part of the mobile backhaul network. Mobile backhaul is that portion of network infrastructure that provides interconnectivity between the access and core network.
Source: https://saralsanchar.gov.in/circular/licenses_issued/FAQ_ISP_MWA.pdf

2.89 In this context, the Authority, through Q1, Q11 and Q12 of the Consultation Paper dated 28.05.2025, solicited comments from stakeholders on the following aspects:

(a) Q1 regarding the level of demand of the spectrum in the traditional microwave backhaul bands for radio backhaul purposes; and

(b) Q11 and Q12 regarding the need to earmark certain quantum of spectrum in traditional microwave backhaul bands for the last mile connectivity (Fixed Wireless Access) to the customer equipment of commercial telecommunication services, and the terms and conditions for the assignment of spectrum for the last mile connectivity

2.90 In response to Q1, most of the stakeholders have submitted that there is a huge demand of the spectrum in traditional microwave backhaul bands for backhaul purposes due to rapid urbanization and consequent densification of access networks, increased cellular traffic from 5G and future network technologies, and necessity for resilient and cost-effective backhaul solutions.

2.91 In response to Q11, most of the stakeholders have submitted that no spectrum in traditional microwave backhaul bands should be earmarked for the last mile connectivity (Fixed Wireless Access) to the customer equipment of commercial telecommunication services. In support of their contention, they have submitted mainly the following arguments:

(a) Under the current framework, the operators have sufficient avenues to provide last mile connectivity (fixed wireless access) to customer equipment. They can obtain access spectrum in numerous frequency bands including 2.3 GHz, 2.5 GHz, 3.5 GHz and mmWave bands for providing the last mile connectivity (fixed wireless access) to customer equipment.

(b) There is a substantial demand for traditional microwave backhaul bands for radio backhaul purposes and this demand would grow in

the future as India scales its 5G infrastructure and prepares for the transition to 6G. Therefore, traditional microwave backhaul bands should be preserved exclusively for backhaul purposes.

2.92 While analyzing the issue of earmarking certain quantum of spectrum in traditional microwave backhaul bands for the last mile connectivity (Fixed Wireless Access) to customer equipment of commercial telecommunication services, the Authority has taken note of the following aspects related to the use of licensed spectrum for wireless access and wireless backhaul:

(a) Wireless Access: For providing wireless access service including fixed wireless access, telecom service providers in India mainly use the spectrum in IMT bands (also referred to as "access spectrum")[55]. At present, for providing fixed wireless access, access service providers in India are mainly using the IMT spectrum in 3300-3670 MHz range. It is expected that in the future, the access spectrum in the 26 GHz band would also be used for providing fixed wireless access. Apart from these bands, the spectrum in upper 6 GHz band and 37-37.5 GHz and 37.5-40 GHz ranges are also being considered for IMT, which may potentially be used for providing fixed wireless access.[56]

(b) Wireless Backhaul: For wireless backhaul, the telecom service providers in India mainly use the spectrum in traditional microwave backhaul bands. Lately, the Government of India has also granted the spectrum in E-band to wireless access service providers for wireless backhaul. However, due to the shorter propagation range of the spectrum in the E-band, the extent of usage of the E-band

[55] Access Service Providers have acquired access spectrum in the following IMT bands from the Central Government: 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, 2500 MHz, 3300 MHz, and 26 GHz bands.

[56] Lately, telecom service providers have started using the spectrum in unlicensed bands (such as 5 GHz and 2.6 GHz bands) also for providing fixed wireless access.

for wireless backhaul in India so far has been lower than the usage of the spectrum in traditional microwave backhaul bands.

2.93 Considering the above, the Authority is of the following view:

(a) In India, the spectrum in traditional microwave backhaul bands has played a pivotal role in backhaul networks of wireless access service providers. A successful scale up of mobile broadband networks such as 4G, 5G and beyond in the country will heavily hinge on the availability of adequate amount of spectrum in traditional microwave backhaul bands for backhauling the mobile traffic to core networks, particularly in the geographies where laying optical fiber cables is difficult and/ or unviable.

(b) The last mile connectivity (fixed wireless access) directly to the customer equipment is a part of access service, for which sufficient access spectrum has already been made available in India in globally harmonized frequency bands.

(c) In the extant framework, there is a clear distinction between the licensed spectrum used for wireless access service and the licensed spectrum used for wireless backhauling.

2.94 The Authority notes that the Telecommunications Act, 2023 also maintains the distinction between access spectrum and backhaul spectrum - it provides different mechanisms for the assignment of spectrum for access service (auction) and radio backhaul (administrative).

2.95 In light of the above, the Authority is of the view that, at this stage, there is no need to earmark any spectrum in traditional microwave backhaul bands for the last-mile connectivity (fixed wireless access) to customer equipment and the spectrum in traditional microwave backhaul bands should continue to be assigned for backhaul purposes only.

2.96 Considering the foregoing discussion, **the Authority recommends that at this stage -**

(a) The spectrum in traditional microwave backhaul bands viz. 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands should be assigned for radio backhaul purposes only.

(b) No spectrum in traditional microwave backhaul bands should be earmarked for the last-mile connectivity (fixed wireless access) to customer equipment.

(2) <u>To which type of entities should the spectrum in traditional microwave backhaul bands be assigned</u>

2.97 While examining the issue as to which type of entities should the spectrum in traditional microwave backhaul bands be assigned for radio backhaul purposes, the Authority has taken note of the following aspects:

(a) As per the information provided by DoT through the letter dated 08.05.2025, DoT has assigned the spectrum in traditional microwave backhaul bands to not only wireless access service providers but also to several captive users and a National Long Distance Operator (NLDO) for establishing point-to-point fixed links.

(b) In response to Q2 of the Consultation Paper dated 28.05.2025, many access service providers have opined that the spectrum in traditional microwave backhaul bands should be assigned only to the wireless access service providers to ensure that the backhaul spectrum does not become a limiting factor for mobile network performance or expansion. On the other hand, many other stakeholders have contended that the spectrum in traditional microwave backhaul bands should also be assigned to other types of TSPs as they also require this spectrum for establishing radio backhaul links.

2.98 As this stage, for the purpose of understanding, it would be worthwhile to make a classification of telecommunication traffic[57] as below:

(a) Wireless access network traffic i.e. the telecommunication traffic originating from, or terminating to wireless access networks of access service providers holding access spectrum
(b) Telecommunication traffic other than wireless access network traffic

2.99 Both the above two types of telecommunication traffic may require radio backhaul for the carriage of traffic to the respective core networks. The Authority notes that the requirement of radio backhauling in case of wireless access network traffic is substantial as wireless access service providers (i.e. access service providers holding access spectrum) have to connect thousands of cellular mobile base stations with their core networks. On the other hand, the requirement of radio backhaul for the telecommunication traffic other than wireless access network traffic is relatively less. Many commercial service providers (such as long-distance service providers, internet service providers, wireline access service providers etc.) as well as many non-commercial captive users may require radio backhaul for interconnecting network elements (other than the customer equipment) in their telecommunication networks; however, the requirement of such service providers for backhaul spectrum is much less than wireless access service providers - owing to the size, and diversity of their networks.

2.100 Based on the information provided by DoT through its letter dated 08.05.2025, the Authority has noted that the following assignments have been made to authorised entities, including captive users, for the purpose of backhauling telecommunication traffic other than wireless access network traffic:

[57] The load carried on a telecommunication network is called traffic.
Source: https://www.worldscientific.com/doi/10.1142/9789811200267_0013

(a) 6 GHz (lower) band: The spectrum in the 6 GHz (lower) band has been assigned on a link basis to a state-owned National Long Distance Operator (NLDO) in five LSAs (viz. Assam, Himachal Pradesh, Kolkata, North East and West Bengal) and a captive user in Orissa LSA.

(b) 7 GHz band: The spectrum in the 7 GHz band has been assigned on a link-basis to seven captive users. Amongst these, four captive users have obtained spectrum in Gujarat LSA, two captive users have obtained spectrum in Delhi LSA, while one captive user has obtained spectrum in Mumbai LSA.

(c) 13 GHz band: The spectrum in the 13 GHz band has been assigned on a link-basis to one captive user in Delhi LSA.

(d) 15 GHz band: The spectrum in the 15 GHz band has been assigned on a link-basis to one captive user in Mumbai LSA.

2.101 Considering the above, the Authority has taken note of the following aspects with respect to the assignment of backhaul spectrum in traditional microwave backhaul bands for backhauling the telecommunication traffic other than wireless access network traffic:

(a) If one leaves aside the assignments given to wireless access service providers in 6 GHz (lower) and 7 GHz on link-basis for MWB purposes, only a handful of spectrum assignments have been given in 6 GHz (lower), 7 GHz, 13 GHz, and 15 GHz bands to government organizations or public sector entities on a link-basis for backhauling the telecommunication traffic other than wireless access network traffic.

(b) At present, there are no spectrum assignments in 18 GHz and 21 GHz bands to any entity on a point-to-point link basis for backhauling the telecommunication traffic other than wireless access network traffic.

(c) In the present consultation process, many stakeholders have contended that many types of authorised entities require the

backhaul spectrum for connecting their network elements for delivering a range of services to their users; an enabling framework for this purpose is urgently required else the growth of national telecom infrastructure would be hindered.

(d) As far as captive users are concerned, on 10.09.2025, DoT has issued draft rules under the Telecommunications Act, 2023 for public consultation by the name "the Telecommunications (Authorisation for Captive Telecommunication Services) Rules, 2025". Under the captive telecommunication service authorisation category, DoT has proposed four authorisations viz. captive mobile radio trunking service (CMRTS) authorisation, captive VSAT service authorisation, captive non-public network (CNPN) authorisation, and captive general service authorisation. Under the eligibility criteria for grant of these authorisations, DoT has proposed that "*[a]n applicant seeking authorisation under these rules shall be a company incorporated under the Companies Act, or a Ministry or Department of the Central or State Government, the Parliament of India, Legislative Assembly of a State of India, any Court of law, or any agency or autonomous organisation of the Central or State Government*." DoT has proposed the definition of captive non-public network (CNPN) as "*a terrestrial wireless telecommunication network established for captive use within a specified geographical area, which cannot be used for providing commercial or public telecommunication services to users*." In respect of the scope of Captive General Service Authorisation, DoT has proposed that "*[t]he scope of captive general service authorisation comprises establishing, operating, maintaining, or expanding captive telecommunication network including wireline and wireless telecommunication networks for captive use*." It is expected that many captive service authorisation holders, particularly CNPN Service authorisation holders and Captive General Service

authorisation holders would require backhaul spectrum in traditional microwave backhaul bands for connecting their network elements.

2.102 In light of the above, the Authority is of the view that an enabling, inclusive and rule-based policy framework for assigning the backhaul spectrum in traditional microwave backhaul bands is indeed required so that all types of authorised entities including captive users may gainfully utilize the backhaul spectrum in these bands. The Authority is of the view that a forward-looking policy framework for the assignment of backhaul spectrum to all types of authorised entities would drive national telecom infrastructure growth and service improvements.

2.103 Considering the above, the Authority is of the opinion that the spectrum in traditional microwave backhaul bands should be assigned to all types of authorised entities which may require to establish point-to-point links for interconnecting telecommunication equipment (other than the customer equipment) in their telecommunication networks. [The aspects related to assignment of spectrum, i.e., which traditional microwave backhaul band(s) can be assigned to which type of authorised entity, have been discussed in a subsequent section.]

2.104 The Authority has also taken note of the following aspects:

(c) In the Telecommunications Act, 2023, the term "radio backhaul" has been defined as "*the use of radio frequency only to interconnect telecommunication equipment, other than the customer equipment in telecommunication networks*." From the definition of radio backhaul provided in the Telecommunications Act, 2023, it may be seen that the use of radio backhaul is envisaged to interconnect telecommunication equipment (other than the customer equipment) within the telecommunication network of the spectrum assignee.

(d) Through these recommendations, the Authority is recommending a comprehensive framework for assignment of backhaul spectrum to

all kinds of authorised entities, including captive users. Meaning thereby, any authorised entity, which requires spectrum for radio backhaul purposes, can obtain backhaul spectrum directly from the Central Government.

2.105 Considering the above, it would be proper to include a provision in the terms of assignment of backhaul spectrum that the backhaul spectrum can be used for self-use only.

2.106 In view of the above, **the Authority recommends that-**

(a) Any authorised entity, including captive users, which may require spectrum for radio backhaul purposes [i.e. for deploying point-to-point links to interconnect telecommunication equipment (other than the customer equipment) in its telecommunication network] should be made eligible to obtain spectrum in traditional microwave backhaul bands.

(b) It should be included in the terms of assignment of backhaul spectrum in traditional microwave backhaul bands that the assigned backhaul spectrum can be used for self-use only.

(3) <u>What should be the unit of assignment (carrier size)</u>

2.107 In the context of microwave backhaul, a "carrier" signifies a fixed bandwidth slice of spectrum allocated for radio transmission between two fixed points in the wireless backhaul network. Carriers are the fundamental unit of spectrum assignment and usage in microwave backhaul systems, allowing operators to efficiently manage, plan, and scale their backhaul transmission capabilities. In traditional microwave

backhaul bands, a carrier typically has a standardized bandwidth, commonly 28 MHz (paired).

2.108 The Government has been assigning the spectrum in traditional microwave backhaul bands to access service providers since 1995 when cellular mobile networks were established in the country for the first time. In the early stage of growth of cellular mobile networks in India, the spectrum in traditional microwave backhaul bands was assigned to access service providers in the paired blocks of 3.5 MHz, 7 MHz, and 14 MHz bandwidth. However, as the demand for the radio backhaul increased with the growth in cellular mobile traffic in the country, the paired block size was increased to 28 MHz. At present, the Government generally assigns the spectrum in traditional microwave backhaul bands in a carrier size of 28 MHz (paired)[58]. In other words, the unit of assignment for the spectrum in traditional microwave backhaul bands is generally 28 MHz (FDD)[59] i.e. 28 MHz (uplink) + 28 MHz (downlink). If the carriers assigned to an entity are contiguous, it can aggregate multiple carriers to form larger spectrum blocks such as 56 MHz, and 112 MHz for establishing higher capacity links.

2.109 On the issue related to the size of the carrier in traditional microwave backhaul bands, the Authority has taken note of the following aspects:

(a) The ITU-R Recommendation F.758[60] specifies carrier sizes suitable for fixed service microwave links in traditional microwave backhaul bands such as 6 GHz, 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz. In the said recommendation, carrier sizes typically include 7 MHz,

[58] While the paired block size of 28 MHz is generally used, DoT has assigned carriers in traditional microwave backhaul bands to captive users and NLD service providers in paired blocks of sizes 3 MHz, 3.5 MHz, 6 MHz, 7 MHz, 14 MHz and 35 MHz also. However, such assignments are very few in number. Source: DoT's letter dated 08.05.2025

[59] The term "FDD" is an acronym of "Frequency Division Duplexing". FDD technique allows uplink and downlink transmission at the same time, but over different frequency bands.
Source: https://www.sciencedirect.com/topics/engineering/frequency-division-duplexing

[60] Source: Recommendation ITU-R F.758-8 (02/2025) - System parameters and considerations in the development of criteria for sharing or compatibility between digital fixed wireless systems in the fixed service and systems in other services and other sources of interference

14 MHz, 28 MHz, 56 MHz, 112 MHz, and 224 MHz. The most referenced carrier size in the traditional microwave backhaul bands is 28 MHz.

(b) Under the extant policy regime, DoT, generally, assigns the spectrum in traditional microwave backhaul bands in a carrier size of 28 MHz (paired)[61]. It is worth noting that DoT has assigned carriers in traditional microwave backhaul bands to captive users and NLD service providers in paired blocks of sizes 3 MHz, 3.5 MHz, 6 MHz, 7 MHz, 14 MHz, and 35 MHz also. However, such assignments are very few.

(c) In the consultation process, most stakeholders have opined that the current carrier size of 28 MHz (paired) in the traditional microwave backhaul bands should be continued as this carrier size is compatible with the radio equipment already deployed in the wireless access service providers' backhaul networks; besides the carrier size of 28 MHz (paired) provides sufficient flexibility; in case any telecom service provider needs more bandwidth to cater to the growing traffic, it can obtain multiple carriers of 28 MHz (paired). On the other hand, a stakeholder has suggested that the carrier size in traditional microwave backhaul bands should be increased to 56 MHz (paired) to meet the requirement of new radio access technologies such as 5G and beyond. Another stakeholder has opined that a range of standard carrier sizes (7 MHz, 14 MHz, 28 MHz, 56 MHz, 112 MHz) should be made available to service providers so that they can make a choice to meet the specific capacity requirements for each point-to-point microwave link. Further, one of the stakeholders has mentioned that there should be the flexibility of usage in an aggregated (or split) manner without any requirement of approval or intimation to the Government.

[61] 28 MHz (paired) means 28 MHz (uplink) *plus* 28 MHz (downlink)

2.110 The Authority has examined the stakeholders' suggestion for increasing the carrier size in the traditional microwave backhaul bands from the existing 28 MHz (paired) to 56 MHz (paired). In this regard, the Authority has taken note of the following aspects:

(a) More than 550,000 microwave point-to-point links using the carriers of 28 MHz (paired) in traditional microwave backhaul bands are operational in the wireless access service providers' networks.

(b) In case, the carrier size is increased from 28 MHz (paired) to 56 MHz (paired), it would mean that a service provider would have to acquire a higher-sized carrier even if it does not necessarily require to deploy a higher capacity link. Importantly, increasing the carrier size from 28 MHz to 56 MHz would have significant implications for existing deployments as it may prevent current assignees from retaining their microwave backhaul carriers, an outcome that may not be in the larger public interest. Further, it is understood that a sizable number of legacy radio equipment deployed in backhaul networks in India can support carriers of only 28 MHz (paired) size.

(c) In case a telecom service provider requires to deploy higher capacity point-to-point links, it can obtain two or more contiguous microwave carriers and aggregate such carriers using carrier aggregation technique to cater to the requirement of higher capacity links.[62]

2.111 Considering the above, the Authority is of the following opinion:

(a) The carrier size in traditional microwave backhaul bands should be 28 MHz (paired).

(b) If an authorised entity seeks more than one carrier in a frequency band, DoT should, to the extent feasible, ensure that the entire spectrum assigned to it is in contiguous form.

[62] In the present consultation process, stakeholders have unanimously supported carrier aggregation in traditional microwave backhaul bands. They have stated that carrier aggregation should be permitted without any regulatory restrictions or conditions; telecom service providers should be permitted to aggregate carriers without any need for regulatory approvals.

(c) For better spectrum efficiency, the spectrum assignees should be allowed to split or aggregate their assigned backhaul spectrum carriers without prior approval from the Central Government.

2.112 In view of the above, **the Authority recommends that with respect to the assignment of spectrum in traditional microwave backhaul bands, -**

(a) The carrier size should be 28 MHz (paired).

(b) If an entity applies for more than one carrier in any traditional microwave backhaul band and seeks contiguous carriers, DoT should, to the extent feasible, ensure that the carriers are assigned in a contiguous manner.

(c) Spectrum assignees should be allowed to split or aggregate carriers assigned to them without prior approval from the Central Government.

(4) Need for a review of the usage of 7 GHz and 15 GHz bands

2.113 The Resolution 256[63] of WRC-23 on "Sharing and compatibility studies and development of technical conditions for the use of International Mobile Telecommunications (IMT)[64] in the frequency bands 4400-4800 MHz, 7125-8400 MHz (or parts thereof), and 14.8-15.35 GHz for the terrestrial component of IMT", *inter-alia*, resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference –

[63]Source: https://www.itu.int/dms_pub/itu-r/oth/0c/0a/R0C0A0000100007PDFE.pdf

[64] The term "international mobile telecommunication (IMT)" encompasses IMT-2000, IMT-Advanced and IMT-2020 collectively based on Resolution ITU-R 56.
Source: https://www.itu.int/dms_pub/itu-r/opb/hdb/R-HDB-62-2022-PDF-E.pdf

"1. the appropriate studies of technical, operational and regulatory issues pertaining to the possible use of the terrestrial component of IMT in the frequency bands listed in 2, taking into account:

- *evolving needs to meet emerging demand for IMT;*
- *technical and operational characteristics of terrestrial IMT systems that would operate in these specific frequency bands, including the evolution of IMT through advances in technology and spectrally efficient techniques;*
- *the deployment scenarios envisaged for IMT systems and the related requirements of balanced coverage and capacity;*
- *the needs of developing countries; and*
- *the time-frame in which spectrum would be needed;*

2. sharing and compatibility studies, with a view to ensuring the protection of services to which the frequency band is allocated on a primary basis, including protection of stations operating in international waters or airspace which cannot be registered in the MIFR, without imposing additional regulatory or technical constraints on those services, and also on services in adjacent bands, for the frequency bands:

- *4400 - 4800 MHz;*
- *7125 - 8400 MHz; and*
- *14.8 - 15.35 GHz,*

invites administrations to participate actively in the studies and provide the information required for the studies listed under resolves to invite the ITU Radiocommunication Sector to complete in time for the 2027 world radiocommunication conference by submitting contributions to ITU-R,

invites the 2027 world radiocommunication conference to consider, based on results of studies, the identification of frequency band(s):

– 4 400-4 800 MHz, or parts thereof, in Region 1 and Region 3;

– 7 125-8 400 MHz, or parts thereof, in Region 2 and Region 3;

– 7 125-7 250 MHz and 7 750-8 400 MHz, or parts thereof, in Region 1;

– 14.8-15.35 GHz, for the terrestrial component of IMT."

2.114 With respect to Resolution 256 of WRC-23, an agenda item viz. Agenda Item 1.7 (AI 1.7) of WRC-27 has been created. AI 1.7 of WRC-27 is *to consider studies on sharing and compatibility and develop technical conditions for the use of International Mobile Telecommunications (IMT) in the frequency bands 4400 – 4800 MHz, 7125 – 8400 MHz (or parts thereof), and 14.8 – 15.35 GHz taking into account existing primary services operating in these, and adjacent, frequency bands, in accordance with Resolution 256 (WRC-23).*

2.115 In India, the frequency range 7125-7725 MHz (under the 7 GHz band) and the frequency range 14.5-15.5 GHz (under the 15 GHz band) are being used for microwave backhauling. Under AI 1.7, the entire frequency range of 7125-7725 MHz in the 7 GHz microwave backhaul band is under study for the use of International Mobile Telecommunications (IMT), while out of the 14.5-15.5 GHz range in the 15 GHz microwave backhaul band, the frequency range 14.8-15.35 GHz is under study for the use of IMT. The following figure depicts the frequency ranges for microwave backhaul vis-à-vis frequency ranges being considered for IMT in WRC- 2027 in 7 GHz and 15 GHz bands.

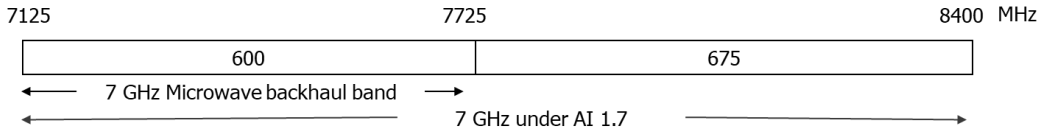

Figure 2.1: Frequency ranges in the 7 GHz band

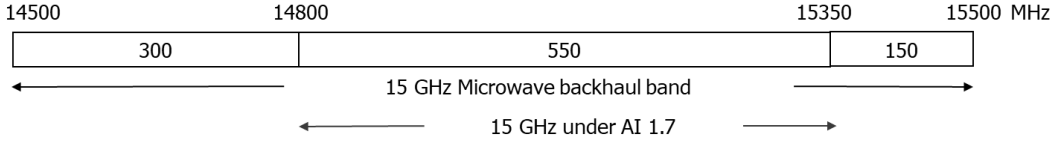

Figure 2.2: Frequency ranges in the 15 GHz band

2.116 The list of present carriers in the 15 GHz microwave backhaul band, as provided by DoT, is given below:

Table 2.2: Carriers in the 15 GHz band

Channel	Uplink frequency (GHz)	Downlink frequency (GHz)
F1/ F1′	14515	14935
F2/ F2′	14543	14963
F3/ F3′	14571	14991
F4/ F4′	14599	15091
F5/ F5′	14627	15047
F6/ F6′	14655	15075
F7/ F7′	14683	15103
F8/ F8′	14711	15131
F9/ F9′	14739	15159
F10/ F10′	14767	15187
F11/ F11′	14795	15215
F12/ F12′	14823	15243
F13/ F13′	14851	15271
F14/ F14′	14879	15299
F15/ F15′	14907	15327

2.117 As listed in the above table, all carriers in the 15 GHz microwave band will have either the uplink or the downlink falling in the 14.8-15.35 GHz range, which is under study for the use of IMT in the AI 1.7 of WRC-27. In case eventually it is decided to adopt 14.8-15.35 GHz range or IMT, there would no longer be any carriers available for microwave backhaul purposes in the 15 GHz microwave band.

2.118 Through the Reference dated 13.09.2024, DoT requested TRAI to provide recommendations on *any need for review in respect of use of 7/15 GHz*

bands in view of consideration of these bands for Access using IMT after WRC-2027.

2.119 In this context, the Authority, through Q9 and Q10 of the Consultation Paper dated 28.05.2025, solicited comments from stakeholders on the following aspects:

(a) Q9 regarding the need to review the usage of 7 GHz and 15 GHz bands at this stage itself or should the review be undertaken after considering the outcome of WRC-27; and

(b) Q10 regarding the policy framework for the assignment of the spectrum in 7 GHz and 15 GHz bands to take care of the possible outcomes of AI 1.7 of WRC-27.

Review of the usage of the 7 GHz band

2.120 The Authority has taken note of the following aspects with respect to the 7 GHz band:

(a) There are 10 carriers in the 7 GHz band microwave backhaul band (7.125-7.725 GHz range). At present, DoT assigns the spectrum in the 7 GHz band (7.125-7.725 GHz range) for radio backhauling purposes on a point-to-point link basis for a minimum link length of 15 km in plain regions; in the hilly terrains (including Assam, North East, Himachal Pradesh, and Jammu & Kasmir LSAs), the carriers in the 7 GHz band are assigned for a minimum link length of 10 km.

(b) Based on the information provided by DoT in respect of the assignment of spectrum in the 7 GHz band to wireless access service providers, through the letter dated 08.05.2025, the following may be inferred:

(i) In the 7125-7425 MHz range (the first half of the 7 GHz band), in which five carriers of 28 MHz (paired) are available, no carrier has been assigned in 11 LSAs. In the remaining 11 LSAs, only one carrier out of five carriers has been assigned to

access service providers. Thus, at present, the first half of the 7 GHz band is largely unutilized.

(ii) In the 7425-7725 MHz frequency range (the second half of the 7 GHz band), in which five carriers are available, no carrier has been assigned in 8 LSAs. In 6 LSAs, only one carrier out of five carriers has been assigned. In the remaining 8 LSAs, two to four carriers have been assigned. Thus, at present, the second half of the 7 GHz band is being utilized scantily.

(iii) Overall, the utilization of the 7 GHz band for microwave backhaul in the country is meagre.

(c) In response to the Consultation Paper dated 28.05.2025, a few stakeholders have opined that the frequency range of 7.125 - 8.4 GHz has emerged as a key candidate for future IMT (6G) services owing to its propagation qualities, its ability to accommodate large contiguous channels, and the significant potential for achieving global harmonization of spectrum allocations. They have also suggested that the 7 GHz band should be reserved for IMT at this stage itself, and the near-term backhaul requirements should be accommodated within the other microwave backhaul bands. On the other hand, many stakeholders have expressed their concerns against reserving the 7 GHz band for IMT services at this stage. They have suggested that no changes should be made in the regulatory framework or usage policies for the 7 GHz band prior to the conclusion of the WRC-27. In general, most stakeholders have opined that the existing assignments in the 7 GHz band should not be affected until the outcome of WRC-27; however, as a pre-caution, no new assignments should be given in this band.

2.121 Considering the above, the Authority is of the view that it would be proper that the usage of the 7 GHz band is reviewed only after considering the outcome of the WRC-27. As it would be difficult to predict the exact timeline by which the 7 GHz band may get repurposed, the Authority is

of the view that until the Government takes a decision to repurpose the 7 GHz band, the existing point-to-point radio backhaul links in the 7 GHz band may be permitted to operate with an annual renewal mechanism. This would help in reducing the time between the decision for repurposing the band, and its implementation.

2.122 With respect to permitting new point-to-point radio backhaul links in the 7 GHz band, the Authority has taken note of the following aspects:

(a) Many stakeholders in the consultation process have alluded that there is a fair likelihood of identification of at least a part of the spectrum in the 7 GHz band for IMT service based on the outcome of WRC-27.

(b) In general, the useful life of the electronic equipment deployed in telecommunication networks is 10 years or more. In case the Government continues to assign the spectrum in the 7 GHz band for establishing new point-to-point radio backhaul links, and eventually, based on the outcome of WRC-27, full or a part of the 7 GHz band is identified for IMT services, it is likely that the radio equipment deployed on such new point-to-point links would go waste - much before the end of their useful life. The Authority is of the opinion that such a situation is avoidable given the fact that sufficient backhaul spectrum is available in the neighboring 6 GHz (lower) band.

2.123 Considering the above, the Authority is of the view that no new assignments for point-to-point backhaul links should be given in the 7 GHz band until a decision is taken with respect to the usage of the 7 GHz band based on the outcome of the WRC-27.

2.124 In view of the above, **the Authority recommends that –**

(a) The usage of the 7 GHz band should be reviewed after considering the outcome of the WRC-2027.

(b) Until the Government takes a decision with respect to the usage of the 7 GHz band based on the outcome of the WRC-27, -

(i) The existing point-to-point links in the 7 GHz band should be permitted to operate with an annual renewal mechanism. In other words, the period of reassignment (renewal) of the spectrum in the 7 GHz band on the point-to-point links, which are already in operation, should be one year with an option for further renewal.

(ii) The spectrum in the 7 GHz band should not be assigned for establishing new point-to-point links.

(c) In case the Government, based on the outcome of WRC-27, decides to continue to use the 7 GHz band for backhaul purposes, the spectrum in the 7 GHz band should be assigned for backhaul purposes, in a manner similar to that recommended for the 6 GHz (lower) band.

Review of the usage of the 15 GHz band

2.125 With respect to the 15 GHz band, the Authority has taken note of the following aspects:

(a) There are 15 carriers in the 15 GHz band (14.5-15.5 GHz range). As per the extant policy regime, the carriers in the 15 GHz band are assigned to wireless access service providers on a block-basis in the licensed service area. The following table depicts the number of carriers already assigned to wireless access service providers in the 15 GHz band for radio backhauling:

Table 2.3: Number of carriers assigned to wireless access service providers in the 15 GHz band

LSA	No. of carriers already assigned to wireless access service providers in the 15 GHz band
	(Total no. of carriers = 15)
Andhra Pradesh	11
Assam	11
Bihar	13
Delhi	10
Gujarat	14
Haryana	10
Himachal Pradesh	11
Jammu and Kashmir	8
Karnataka	15
Kerala	12
Kolkata	14
Madhya Pradesh	14
Mumbai	7
Maharashtra	12
North East	9
Odisha	11
Punjab	14
Rajasthan	13
Tamil Nadu	12
Uttar Pradesh (East)	10

LSA	No. of carriers already assigned to wireless access service providers in the 15 GHz band
	(Total no. of carriers = 15)
Uttar Pradesh (West)	13
West Bengal	12

(b) Out of 330 carriers (cumulatively available in the 15 GHz band across the 22 LSAs in the country), 256 carriers have already been assigned to wireless access service providers. Meaning thereby, the average utilization of the 15 GHz band is 78%, which is significantly higher than all other microwave backhaul bands.

(c) In response to the Consultation Paper dated 28.05.2025, a few stakeholders have suggested that the review of the usage of the 15 GHz band should be undertaken upon the conclusion of the WRC-27. On the other hand, many stakeholders have opined that there is no need to review the usage of the 15 GHz band even after WRC-27. Such stakeholders have alluded that the widespread usage of the 15 GHz band marks it as the lifeline of the India's mobile backhaul network; they have also cautioned that any consideration of re-allocating the 15 GHz band from backhaul to IMT under WRC-27 would have serious adverse consequences including disruption of the existing network infrastructure, and service degradation.

2.126 Considering the above, the Authority is of the view that it would be proper that the usage of the 15 GHz band is reviewed only after considering the outcome of the WRC-27.

2.127 On the aspect of assigning new carrier(s) to the existing wireless access service providers, which already hold carriers in the 15 GHz band, the Authority has taken note of the following aspects:

(a) Many stakeholders in the consultation process have alluded that, owing to the widespread usage of the 15 GHz band by wireless

access service providers for mobile backhauling in the country, the likelihood of the identification of the spectrum in the 15 GHz band for IMT services is less as compared to the spectrum in the 7 GHz band.

(b) Under the extant policy regime, the carriers in the 15 GHz band have been assigned on a block-basis (in the LSA) to wireless access service providers. It means, a wireless access service provider, by using a carrier assigned to it in an LSA, can deploy as many backhaul links as required and feasible in the LSA. When the telecom traffic catered by a mobile base station increases due to an increase in the subscribers and/ or the telecom usage per subscriber, the capacity of the backhaul link also requires to be enhanced. To address such a situation, wireless access service providers aggregate the microwave carriers assigned to them. The aggregation of carriers can be achieved on a single radio equipment easily if the carriers are occupying contiguous frequencies. In case an existing wireless access service provider seeks the assignment of new microwave carriers in the 15 GHz band in an LSA, where it already holds a few microwave carriers in the 15 GHz band, it can well make use of the existing radio equipment to aggregate the existing carrier(s) with the new carrier(s) and enhance the capacity of the backhaul links. Therefore, it would be proper that any wireless access service providers, already holding microwave carrier(s) in the 15 GHz band in an LSA, is not denied the assignment of new carriers in the 15 GHz band in that LSA until a decision for repurposing the band is taken based on the outcome of the WRC-2027.

2.128 The Authority has also examined the appropriateness of assigning new carriers in the 15 GHz band in an LSA to any wireless access service provider, which is not holding microwave carriers in the 15 GHz band in that LSA before a decision is taken based on the outcome of the WRC-2027. As mentioned in the preceding paragraphs, in general, the useful

life of the electronic equipment deployed in telecommunication networks is 10 years or more. In case the Government assigns the spectrum in the 15 GHz band in an LSA to any wireless access service provider, which is not holding microwave carriers in the 15 GHz band in that LSA, and eventually, based on the outcome of WRC-27, full or a part of the 15 GHz band is identified for IMT services, it is likely that the radio equipment deployed on such new point-to-point links would go waste, much before the end of their useful life. Accordingly, it would not be proper to assign carriers in the 15 GHz band in an LSA to any wireless access service provider, which is not already holding any microwave carrier in the 15 GHz band in that LSA.

2.129 In light of the foregoing discussion**, the Authority recommends that-**

(a) The usage of the 15 GHz band should be reviewed only after considering the outcome of the WRC-27.

(b) Until the Government takes a decision for repurposing the 15 GHz band, -

(i) The existing microwave carriers in the 15 GHz band should be permitted to operate.

(ii) New microwave carriers in the 15 GHz band in an LSA may be assigned to any wireless access service provider if it already holds microwave carrier(s) in the 15 GHz band in that LSA.

(c) In case the Government, based on the outcome of WRC-27, decides to continue to use the 15 GHz band for backhaul purposes, the restriction recommended in (b)(ii) above should not apply, i.e., new carriers in the 15 GHz band may be assigned to wireless access service providers, subject to the applicable ceiling on the number of carriers.

(5) Spectrum assignment in the 6 GHz (lower) band for backhaul purposes

2.130 As per the National Frequency Allocation Plan (NFAP) 2022, the 6 GHz (lower) band is allocated to three services on a primary basis viz. Fixed Service, Fixed Satellite Service (Earth-to-space), and Mobile Service. As per the information provided by DoT through the letter dated 08.05.2025, spectrum in this band has been assigned not only for radio backhaul purposes (Fixed Service) but also to numerous teleport providers, digital satellite new gathering (DSNG) service providers, headend-in-the-sky (HITS) service providers, and captive Very Small Aperture Terminal (VSAT) service providers in India.

2.131 Through the Reference dated 08.05.2025, DoT has informed that "*it has decided to de-license the lower 6 GHz band (5925-6425 MHz) for low power applications. Relevant rules are under consideration in the Department for notification*." In this regard, DoT, on 16.05.2025, has circulated draft rules for public consultation by the name (draft) "Use of Low Power and Very Low Power Wireless Access System including Radio Local Area Network in Lower 6 GHz band (Exemption from Licensing Requirement) Rules, 2025". Through the draft rules, DoT has proposed that no authorization or frequency assignment shall be required to establish, maintain, work, possess or deal in any wireless equipment for the purpose of low power indoor and very low power outdoor wireless access systems, including radio local area networks operating in the frequency band 5925-6425 MHz on non-interference, non-protection and shared (non-exclusive) basis, and complying with the following technical parameters:

Device Type	Max. PSD e.i.r.p for in-band emissions	Max. e.i.r.p for in band emissions	Max. Emission Bandwidth	Out of band emissions (Max e.i.r.p density)
Low Power Indoor	5 dBm/MHz	30 dBm	320 MHz	-27 dBm/MHz
Very Low Power Outdoor	-5 dBm/MHz	14 dBm	320 MHz	-27 dBm/MHz

2.132 Considering that the Government has decided to delicense the 6 GHz (lower) band [5.925-6.425 GHz] for low power indoor and very low power outdoor wireless access systems, the Authority, through Q16, solicited comments from stakeholders as to whether there is any need to prescribe measures to provide protection to incumbent users such as Fixed Microwave (backhaul) Services, Fixed Satellite Service (FSS) etc. operating in the 6 GHz (lower) band.

2.133 In this regard, the Authority has taken note of the following aspects:

(a) In response to Q16 of the Consultation Paper dated 28.05.2025, most of the stakeholders have opined that there is no need to prescribe any measures to protect the incumbent users. They have suggested that extensive studies in CEPT[65] and ECC[66] demonstrate that low-power indoor and very low power portable wireless access systems can coexist with incumbent FS and FSS systems without causing harmful interference. They have also opined that the draft rules notified by the Government for the lower 6 GHz band are based on the best international practices; the draft rules have taken into

[65] CEPT stands for European Conference of Postal and Telecommunications Administrations.

[66] ECC stands for the Electronic Communications Committee (ECC), which is a body within the European Conference of Postal and Telecommunications Administrations (CEPT).

account the findings of spectrum sharing studies; hence no additional protection for incumbent users is required.

(b) In 2020, Ofcom in United Kingdom made available the lower 6 GHz band for Wi-Fi and other radio local area network (RLAN) devices on a license exempt-basis, enabling indoor and very low power outdoor use.[67] With respect to the possibility of a harmful interference to fixed services owing to such delicensing, Ofcom noted that "*Our technical analysis shows that no harmful interference to fixed links is likely to be caused by our decisions. We do not consider that there is a need for further analysis, noting that our analysis took into account fixed links with a variety of topologies and also included critical infrastructure links. Furthermore, in case of harmful interference caused by non-compliant devices, we will consider taking enforcement action where appropriate*."

(c) In 2021, the European Commission (EC) implemented a decision[68] for delicensing the lower 6 GHz band for Low Power Indoor and Very Low Power wireless access systems including RLAN on a non-exclusive, non-interference and non-protected basis.[69]

[67] Ofcom decided a maximum EIRP of 250mW for indoor use and a maximum EIRP of 25mW for outdoor use. Aeronautical mobile use is not permitted. Airborne use of the relevant equipment is permitted within an aircraft only to establish a connection with a station or apparatus within the same aircraft.
Source: Ofcom: Improving spectrum access for Wi-Fi Spectrum use in the 5 GHz and 6 GHz bands, accessible at the following URL: https://www.ofcom.org.uk/spectrum/frequencies/improving-spectrum-access-for-wi-fi

[68] Decision (EU) 2021/1067 (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021D1067)
While taking this decision, the European Commission noted that the studies carried out by CEPT[68] indicate that the coexistence of delicensed devices with terrestrial fixed service deployments (fixed links) and FSS Earth stations in the 5945-6425 MHz range is feasible, subject to certain conditions to ensure adequate protection of existing usages in and adjacent to the 5945-6425 MHz range from harmful interference originating from WAS/ RLAN equipment.

[69] The European Commission prescribed the following technical conditions on the delicensed use of the 6 GHz band:

Low power indoor (LPI) WAS/RLANs devices

Parameter	Technical conditions
Permissible operation	Restricted to indoor use, including in trains. Outdoor use, including in road vehicles, is not permitted.
EIRP $_{Max\ mean}$	23 dBm
EIRP $_{Max\ mean}$ density	10 dBm/MHz

Very Low Power (VLP) WAS/RLAN devices

Parameter	Technical conditions
Permissible operation	Indoors and outdoors. Use on Unmanned Aircraft Systems (UAS) is not permitted.
EIRP $_{Max\ mean}$ for in-band emissions	14 dBm

(d) In 2022, the Australian Communications and Media Authority (ACMA) allowed low power indoor and very low power devices to operate in the lower 6 GHz band (5925-6425 MHz) with differing operating restrictions.[70]

2.134 Based on the comments of stakeholders on Q16 and international practices on the matter, it may be inferred that radio backhaul links in the 6 GHz (lower) band can well co-exist with delicensed low power indoor and very low power outdoor wireless access systems in the band.

2.135 In the previous section of these recommendations, the Authority has recommended that until a decision is taken based on the outcome of WRC-27, the existing point-to-point links in the 7 GHz band should be permitted to operate; however, the spectrum in the 7 GHz band should not be assigned for establishing new point-to-point links. In the event of the identification of the 7 GHz band for IMT service based on the outcome of WRC-27, the backhaul links currently operating in the 7 GHz band would require to be shifted to the 6 GHz (lower) band. Therefore, it becomes important that the 6 GHz (lower) band remains available for all types of authorised entities, including captive users to meet their requirements for deploying longer backhaul links.

2.136 There are only eight carriers of 28 MHz (paired) bandwidth in the 6 GHz (lower) band. With a view to ensuring that the spectrum in the 6 GHz

[70] ACMA prescribed the following power limits and restrictions specific to LPI devices and VLP devices:

Restriction criteria	**For LPI devices**	**VLP devices**
Maximum power	24 dBm EIRP	14 dBm EIRP
Maximum power density	11 dBm/MHz EIRP	1 dBm/MHz EIRP
Operation	Indoor	Any location

Regarding the coexistence with incumbent fixed services, ACMA in the October 2021 consultation paper stated that "*the outcomes of previous studies conducted in jurisdictions where arrangements for RLANs in the 6 GHz band have been made, along with a lack of feedback in submissions to the April 2021 consultation, we are comfortable that the LPI and VLP devices proposed can co-exist with existing and future fixed point-to-links in the band.*"

Source: ACMA's consultation paper on Proposed updates to the LIPD Class Licence for 6 GHz RLANs, October 2021 Accessible at the following URL: https://www.acma.gov.au/sites/default/files/2021-10/Proposed%20changes%20to%20LIPD%20class%20licence%20for%206GHz%20RLAN_consultation%20paper.docx

(lower) band can be made available for all types of authorised entities, including captive users, to meet their requirements for deploying longer backhaul links, it would be proper to continue with the point-to-point link-based spectrum assignment in the 6 GHz (lower) band. Further, any entity may be assigned not more than two carriers of 28 MHz (paired) bandwidth per point-to-point link to allow multiple entities to obtain the spectrum in the 6 GHz (lower) band in the same geographical area without causing harmful interference to other entities.

2.137 In view of the above, **the Authority recommends that the spectrum in the 6 GHz (lower) band should be assigned for radio backhaul purposes to all types of authorised entities, including captive users, on a point-to-point link basis with a ceiling of two carriers of 28 MHz (paired) bandwidth per link.**

(6) Mechanism for Spectrum Assignment in 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands

2.138 As indicated above, DoT, in its policy documents, refers to the 13 GHz, 15 GHz, 18 GHz and 21 GHz bands collectively as "Microwave Access (MWA) bands". MWA bands are the most widely used frequency bands amongst all the frequency bands which are currently earmarked for radio backhaul purposes in India. As per the information provided by wireless access service providers to TRAI, about 575 thousand (5.75 lakh) radio backhaul links are currently operational in cellular mobile networks in India, of which, more than 5.5 lakh radio backhaul links have been established by using the spectrum in MWA bands. The popularity of these frequency bands for backhaul purposes may be attributed to their favorable propagation characteristics, availability of sufficient spectrum [5.9 GHz spectrum within which 95 carriers of 28 MHz (paired) have been earmarked], and availability of an excellent radio device eco-system

owing to global use of these bands for backhauling. Considering that backhaul spectrum in 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands is vital for radio backhauling, it would be important to put in place an enabling mechanism for spectrum assignment in these bands under the proposed new policy regime for backhaul spectrum.

Method of assignment of spectrum in MWA bands

2.139 The most important aspect related to the spectrum assignment is the method of assignment of spectrum. Globally, over a period, mainly two methods have evolved for the assignment of backhaul spectrum viz. (a) block-based assignment, and (b) link-based assignment. As indicated earlier, in case a carrier of backhaul spectrum is assigned to any entity on a block-basis in a service area, the entity can establish any number of backhaul links using that carrier in the service area. On the other, if a carrier of backhaul spectrum is assigned to an entity on a link-basis between two designated points, only one link between the designated points can be established; the entity cannot establish backhaul links elsewhere using that carrier without obtaining prior permission from DoT.

2.140 With respect to the method of assignment of the spectrum in the 13 GHz, 15 GHz, 18 GHz and 21 GHz bands for wireless access service providers, the Authority has taken note of the following aspects:

(a) At present, DoT uses the following methods for assigning the spectrum in 13 GHz, 15 GHz, 18 GHz and 21 GHz bands to various types of entities:

(i) Block-based assignment for backhauling wireless access network traffic: The carriers in 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands are assigned on a block-basis[71] in an LSA to

[71] Meaning thereby, if a carrier in the 13 GHz, 15 GHz, 18 GHz or 21 GHz bands is assigned to an access service provider in an LSA, the access service provider can use that carrier on any number of radio backhaul links within the LSA.

wireless access service providers for backhauling wireless access network traffic.

(ii) Link-based assignment for backhauling telecommunication traffic other than wireless access network traffic: The spectrum in 13 GHz, 15 GHz, 18 GHz, or 21 GHz bands is assigned to authorised entities including captive users on a point-to-point link-basis for the purpose of backhauling telecommunication traffic other than wireless access network traffic.

(b) In the consultation process, stakeholders have generally opined that the current practice of (i) the block-based assignment of the spectrum in the 13 GHz, 15 GHz, 18 GHz, or 21 GHz bands for backhauling wireless access network traffic, and (ii) the point-to-point link-based assignment for backhauling any other telecommunication traffic should be continued.

(c) In support of the block-based assignment of the spectrum in these bands for backhauling the wireless access network traffic, stakeholders have opined that the block-based assignment enables wireless access service providers to autonomously plan, deploy and optimize large microwave backhaul networks; the link-based assignment is both cumbersome and impractical due to the requirements of effective coordination for huge number of backhaul links that are deployed by wireless access service providers.

(d) In support of the link-based assignment of the backhaul spectrum in these bands for backhauling any other telecommunication traffic, stakeholders have opined that for the operators which require only selective deployment rather than contiguous coverage, link-based assignment is preferable as it allows precise and need-based

deployment, encourages spectrum re-use, and minimizes spectrum underutilization.

2.141 Considering the above, the Authority is of the view that at a broad level, there is no need for departing from the current method of assignment of spectrum in MWA bands for backhaul purposes. The spectrum in MWA bands may be assigned as below:

(a) Assignment of spectrum in MWA bands on a block-basis to access service providers holding access spectrum for backhauling their wireless access network traffic, and

(b) Assignment of spectrum in MWA bands on a link-basis to authorised entities, including captive users, for backhauling their telecommunication traffic other than wireless access network traffic.

Explanation: If any access service providers holding access spectrum is also providing other types of services such as wireline telephony service and internet access services, it can obtain (i) MWA spectrum on a block-basis for backhauling its wireless access network traffic, and (ii) MWA spectrum on a point-to-point link-basis for backhauling its wireline telephony network traffic and internet traffic. It is worth noting that (i) the MWA spectrum obtained on a block-basis can only be used for backhauling wireless access network traffic and not for any other purposes, and (ii) the MWA spectrum obtained on a point-to-point link-basis cannot be used for backhauling wireless access network traffic.

A few examples of authorised entities, including captive users, which might require microwave spectrum for backhauling telecommunication traffic other than wireless access network traffic could be wireline access service providers, internet access service providers, long distance service providers, and captive non-public network service providers.

Ceiling on the number of carriers in MWA bands for wireless access service providers

2.142 Another important aspect related to the spectrum assignment is the spectrum cap. Spectrum caps or spectrum limits are regulatory measures implemented to restrict the amount of radio frequency spectrum that an entity can acquire or hold in a particular frequency band or a group of frequency bands and/ or geographical area. The purpose of spectrum caps is to promote competition, prevent spectrum concentration, and ensure efficient spectrum utilization. In case of backhaul spectrum, spectrum caps are generally implemented in terms of number of carriers.

2.143 With respect to the ceiling on the number of carriers in the 13 GHz, 15 GHz, 18 GHz and 21 GHz bands for wireless access service providers, the Authority has taken note of the following aspects:

(a) As per the extant policy regime in the country, there is a ceiling/ limit on the number of carriers (each carrier of 28 MHz paired bandwidth), which may be assigned to an access service provider in MWA bands in a service area. For Metro and Category-A service areas, the ceiling is of eight carriers. For Category-B and Category-C service areas, the ceiling is of six carriers.

(b) Based on the information provided by DoT through its letter dated 08.05.2025, wireless access service providers have generally obtained four to five carriers in MWA bands (13 GHz, 15 GHz, 18 GHz, and 21 GHz bands together) in each LSA.

(c) In the present consultation process, stakeholders have generally favored the prescription of a ceiling on the number of carriers in backhaul frequency bands. They have suggested that the MWA bands (13 GHz, 15 GHz, 18 GHz and 21 GHz bands) should be

grouped for prescribing the spectrum ceiling. They have also alluded that the current ceiling of eight carriers in each of Metro/ Category-A circles and six carriers in each of Category-B/ Category-C circle are sufficient for the near to medium term; the ceilings may require to be revised upwards in about three to five years.

2.144 With a view to examine the need for a separate ceiling on the number of backhaul carriers in MWA bands based on the circle category, the Authority perused the information on licensed service area-wise monthly wireless data usage, as gathered from wireless access service providers. The following table presents the licensed service area-wise wireless data usage for the month of August 2025:

Table 2.4: LSA-wise wireless data usage (August 2025)

Circle Category	Circle	Total Wireless Data Usage in the month of August 2025 (in Tera Byte)
Metro	Delhi	9,44,788
Metro	Kolkata	4,50,879
Metro	Mumbai	5,81,221
A	Andhra Pradesh	15,45,102
A	Gujarat	17,54,617
A	Karnataka	13,77,912
A	Maharashtra	21,50,335
A	Tamil Nadu	14,93,758
B	Haryana	5,04,712
B	Kerala	6,85,524
B	Madhya Pradesh	**15,82,581**
B	Punjab	6,51,092

B	Rajasthan	**14,51,252**
B	Uttar Pradesh (East)	**20,09,434**
B	Uttar Pradesh (West)	**13,71,191**
B	West Bengal	11,75,110
C	Assam	5,64,403
C	Bihar	**21,48,329**
C	Himachal Pradesh	1,87,124
C	Jammu & Kashmir	2,58,638
C	North East	2,70,513
C	Orissa	6,76,201

2.145 The Authority notes that the monthly wireless data usage in many circles of category B and C [such as Bihar, Madhya Pradesh, Rajasthan, UP (East), and UP (West) circle] is greater than the monthly wireless data usage in many Category A circles and metro areas. Accordingly, the Authority is of the view that in the proposed new policy regime, it would not be logical to prescribe different ceilings on the number of carriers in MWA bands based on circle category. Instead, it would be proper to keep a uniform ceiling across the circle categories on the number of carriers in MWA bands.

2.146 Considering the foregoing discussion, the Authority is of the view that it would be suitable to keep a ceiling of eight carriers which may be assigned to a wireless access service provider on a block-basis in a licensed service area in MWA bands (13 GHz, 15 GHz, 18 GHz, and 21 GHz bands together) for the purpose of backhauling wireless access network traffic.

Need for earmarking spectrum in MWA bands for link-based assignments

2.147 Through Q4 of the Consultation Paper dated 28.05.2025, the Authority solicited inputs of stakeholders on the aspect of earmarking certain quantum of spectrum for link-based assignments. In this regard, a few stakeholders opined that the 13 GHz and 15 GHz bands are being used heavily for cellular mobile backhauling and therefore, the spectrum in these bands should be assigned only to wireless access service providers; the spectrum requirement of the other types of entities for establishing point-to-point radio backhaul links should be fulfilled from the 18 GHz and 21 GHz bands.

2.148 Through the Reference dated 13.09.2024, DoT has informed that *"point to point connectivity requirements of certain captive users is required to be met from one or more of these bands i.e. 6/ 7/ 13/ 15/ 18/ 21 GHz bands. Such requirements are generally localised and mostly limited to few links only. In case, some carriers are specifically earmarked for such use, they can be re-used among multiple users with geographical separation".* In this regard, DoT has requested TRAI to provide recommendations on "*quantum/ band(s) of spectrum to be earmarked for backhaul purposes for non-commercial/ captive use and associated terms & conditions including charges*".

2.149 As mentioned earlier, at present, DoT assigns the microwave spectrum for backhaul purposes in traditional microwave backhaul bands to not only telecom service providers but also non-TSP entities for their non-commercial/ captive usages. As per the information provided by DoT on 08.05.2025, many entities including government organizations and public sector units (PSUs) have obtained carriers in traditional microwave backhaul bands from DoT for their captive usages. However, at present, the extent of usage is rather low. Spectrum charges for such microwave

links are governed by the DoT's order dated 11.12.2023[72] on the spectrum charges for the assignment of frequencies to captive users for different types of radiocommunication services and applications.

2.150 The Authority has also perused the information on frequency-wise spectrum assigned for backhaul purposes to wireless access service providers provided by DoT through its letter dated 08.05.2025. Based on the information, a summary of the number of MWA carriers assigned to wireless access service providers on a block-basis in various LSAs is given below:

Table 2.5: LSA-wise Number of MWA Carriers Assigned to Wireless Access Service Providers

LSA	13 GHz Band	15 GHz Band	18 GHz Band	21 GHz Band
	Total 8 carriers	Total 15 carriers	Total 32 carriers	Total 40 carriers
Andhra Pradesh	4	11	5	1
Assam	3	11	3	1
Bihar	3	13	2	-
Delhi	4	10	8	4
Gujarat	5	14	3	-
Haryana	3	10	3	-
Himachal Pradesh	5	11	-	-
Jammu and Kashmir	3	8	4	1
Karnataka	4	15	5	2
Kerala	3	12	5	3
Kolkata	-	14	10	1
Madhya Pradesh	3	14	2	-

[72] https://dot.gov.in/sites/default/files/Spectrum%20usage%20charges.pdf

LSA	13 GHz Band	15 GHz Band	18 GHz Band	21 GHz Band
	Total 8 carriers	Total 15 carriers	Total 32 carriers	Total 40 carriers
Mumbai	4	7	10	7
Maharashtra	2	12	6	-
North East	3	9	3	1
Odisha	3	11	4	-
Punjab	3	14	3	1
Rajasthan	3	13	5	-
Tamil Nadu	4	12	5	2
Uttar Pradesh (East)	5	10	4	-
Uttar Pradesh (West)	5	13	5	-
West Bengal	3	12	5	-

2.151 As may be seen from the above table, most assignments of carriers to wireless access service providers fall under the 13 GHz, 15 GHz, and 18 GHz bands; the number of assignments in the 21 GHz band are much fewer in number. While the average utilization of the carriers in the 13 GHz, 15 GHz and 18 GHz bands together is about 36%, the average utilization of the carriers in the 21 GHz band is only 3%.

2.152 The Authority notes that 55 carriers are available in 13 GHz, 15 GHz, and 18 GHz bands together. In the preceding paragraphs, the Authority has already arrived at a conclusion that at most eight carriers in MWA bands may be assigned to a wireless access service provider on a block-basis in an LSA for the purpose of backhauling wireless access network traffic. At present, only four entities (viz. M/s Bharti Airtel Limited, M/s BSNL/ MTNL, M/s Reliance Jio Infocomm Limited, and M/s Vodafone Idea Limited) are actively providing wireless access services across all LSAs. In case one or two more entities enter into the wireless access service market in the near

future, the demand for microwave carriers for radio backhauling of all wireless access service providers can be fully met within the 13 GHz, 15 GHz, and 18 GHz bands.

2.153 The Authority notes that in the present consultation process, many stakeholders have opined that certain quantum of spectrum in traditional microwave backhaul bands should be earmarked for fulfilling point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users and TSPs other than wireless access service providers. They have contended that point-to-point microwave links are crucial for such entities to connect various sites within a campus, industrial complex, or specific geographical areas in which laying optical fiber cables is impractical or too costly.

2.154 In view of the above, the Authority is of the opinion that it would be proper to earmark the backhaul spectrum in 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands, at a broad level, as below:

(a) The spectrum in 13 GHz, 15 GHz, and 18 GHz bands may be earmarked for block-based assignments to access service providers holding access spectrum for the purpose of backhauling their wireless access network traffic.

(b) The spectrum in the 21 GHz band may be earmarked for link-based assignments to all types of authorised entities, including captive users, for the purpose of backhauling their telecommunication traffic other than wireless access network traffic.

[The matter related to permitting wireless access service providers (i.e. access service providers holding access spectrum) to retain their existing carriers in the 21 GHz band assigned on a block-basis for the purpose of backhauling their wireless access network traffic, and permitting the authorised entities including captive users to retain their existing carriers in 13 GHz, 15 GHz and 18 GHz bands

assigned on a point-to-point link basis for the purpose of backhauling their telecommunication traffic other than wireless access network traffic has been dealt in subsequent paragraphs.]

2.155 As the Authority has already arrived at a conclusion that the backhaul spectrum in 13 GHz, 15 GHz, and 18 GHz bands should be earmarked for block-based assignments to access service providers holding access spectrum for backhauling their wireless access network traffic, the entire requirement of point-to-point link-based assignments of carriers of all types of authorised entities for backhauling telecommunication traffic other than wireless access network traffic (i.e. any telecommunication traffic other than wireless access network traffic) would have to be fulfilled within the spectrum available in the 21 GHz band. The Authority notes that 40 carriers are available in the 21 GHz band (21.2-23.6 GHz range). Accordingly, the Authority is of the view that it would be proper to prescribe a ceiling of four carriers i.e. 112 MHz (paired) capacity on the point-to-point link-based assignment in the 21 GHz band.

<u>Provision for the assignment of spectrum in MWA bands above the ceiling limit</u>

2.156 In the present consultation process, the stakeholders are generally of the view that a ceiling of eight carriers in each LSA would be sufficient at this stage; the ceiling may be revised periodically while ensuring that the ceiling remains sacrosanct and is not exceeded.

2.157 Through these recommendations, the Authority is proposing an enabling framework for the assignment of backhaul spectrum in four frequency band groups viz. MWB bands [6 GHz (lower), and 7 GHz bands], MWA bands [13 GHz, 15 GHz, 18 GHz, 21 GHz bands], V-band (57-66 GHz band) and E-band (71-76 GHz band paired with 81-86 GHz band). Each of the four band groups possesses unique strengths in terms of

propagation distance and transmission capacity. Meaning thereby, under the proposed policy regime for the assignment of backhaul spectrum, sufficient amount of spectrum in various frequency bands would be at the disposal of access service providers holding access spectrum to meet their specific backhaul needs.

2.158 Considering the above, the Authority is of the view that instead of laying down an *ad-hoc* mechanism for the assignment of backhaul spectrum, it would be proper to stipulate a rule-based policy framework for such purposes. Accordingly, the Authority is of the view that there is no need to permit wireless access service providers to obtain carriers in MWA bands above the ceiling limit under the proposed policy regime.

Retention of the carriers already assigned to wireless access service providers

2.159 Wireless access service providers have established over 5.5 lakh backhaul links by using the spectrum in the MWA bands (13 GHz, 15 GHz, 18 GHz and 21 GHz bands) in the country. When an access service provider obtains the right to use a carrier in a particular MWA band in a licensed service area, it deploys that carrier for building a large number of radio backhaul links across the licensed service area. In the network of a typical access service provider, there could be thousands of microwave backhaul links operating on a particular carrier of a traditional microwave backhaul band in a licensed service area. Often the radio equipment available in the market for establishing point-to-point links in any traditional microwave backhaul band do not support the entire frequency band but only a portion of the frequency band (also referred to as a 'sub-band').

2.160 Through Q8 of the Consultation Paper dated 28.05.2025, the Authority solicited inputs from stakeholders on the need for granting an option to telecom service providers to retain the carriers already held by them in

traditional microwave backhaul bands. In response, stakeholders are generally of the view that in the proposed new policy regime, telecom service providers should be granted an option to retain the carriers held by them in traditional microwave backhaul bands. In support of their view, stakeholders have contended that the legacy backhaul equipment deployed in the Indian telecom network are optimized to operate within specific frequency bands and sometimes within a sub-band of the frequency band; in case, under the proposed policy regime, the telecom service providers are not granted an option to retain their existing backhaul carriers, and they are instead assigned carriers in altogether different frequency bands/ sub-bands, it would cause humongous changes in network design and planning, resulting in avoidable capital expenditure on radio equipment and possibility of deterioration/ disruption in the service.

2.161 The Authority notes that the radio equipment, which have been deployed by wireless access service providers for establishing backhaul links using the spectrum in MWA bands, are often "sub-band" specific. In case, a carrier of a particular sub-band of an MWA band, held by a wireless access service provider in a licensed service area, is taken away, and a new carrier is assigned to it in some other sub-band of that MWA band or any other MWA band, it would require the wireless access service provider to replace the radio equipment deployed in each of its backhaul link on which the previous carrier was used in the licensed service area. The replacement of the radio equipment on the scale of a license service area would not only have significant cost implications for the wireless access service provider but may also result in a temporary disruption of services, or deterioration of quality of service to the users of the wireless access service provider during the process of replacement of the radio equipment.

2.162 Considering the comments of stakeholders and its analysis, the Authority is of the view that, at a broad level, the entities holding spectrum in MWA bands should be granted an option to retain their existing carriers.

2.163 In this Chapter, the Authority has already arrived at a conclusion that 13 GHz, 15 GHz, and 18 GHz bands should be earmarked for block-based assignments to wireless access service providers for backhauling their wireless access network traffic, whereas the 21 GHz band should be earmarked for link-based assignments to authorised entities, including captive users, on a point-to-point link basis for backhauling their telecommunication traffic other than wireless access network traffic. In this regard, the Authority notes that under the extant policy regime, DoT has granted a few spectrum assignments in the 21 GHz band to wireless access service providers on a block-basis for radio backhaul purposes; DoT has also granted a couple of spectrum assignments in 13 GHz and 15 GHz bands to captive users in Delhi and Mumbai service areas on a point-to-point link-basis. As outlined above, in case such spectrum assignments are not protected and the entities are forced to migrate to any other backhaul frequency bands, it may lead to avoidable capital expenditure and service disruption on account of the change in the radio equipment. Accordingly, the Authority is of the view that in the proposed new policy regime, it would be prudent to permit the spectrum assignments granted to wireless access service providers on a block-basis in the 21 GHz band, as well as the spectrum assignments granted to captive users on a link-basis in the 13 GHz, 15 GHz, and 18 GHz bands to continue to operate. The Authority would like to add that in case any wireless access service provider intends to retain the carriers assigned to it on a block-basis in the 21 GHz band, such carriers should be counted for the purpose of the ceiling on carriers for the sake of parity.

2.164 Further, with respect to permitting the assignments given to authorised entities, including captive users, on a link-basis in 13 GHz, 15 GHz, and

18 GHz bands for backhauling their telecommunication traffic other than wireless access network traffic to continue to operate, the Authority is of the view that the period of reassignment of the spectrum in 13 GHz, 15 GHz, and 18 GHz bands to authorised entities, including captive users, on the point-to-point links, which are already in operation, should be one year with an option for renewal. Further the Central Government should encourage the entities holding backhaul spectrum in 13 GHz, 15 GHz, and 18 GHz bands on point-to-point link basis to migrate their microwave links to the 21 GHz band so that 13 GHz, 15 GHz, and 18 GHz bands can be earmarked exclusively for wireless access service providers on a block-basis for backhauling their wireless access network traffic.

2.165 In view of the foregoing discussion, **the Authority recommends that in the proposed new policy regime, -**

(a) The spectrum in 13 GHz, 15 GHz, and 18 GHz bands should be assigned to wireless access service providers on a block-basis in a licensed service area (LSA) for backhauling their wireless access network traffic. In these recommendations, the term "wireless access service provider" means 'an access service provider holding access spectrum'.

<u>Explanation</u>: If an access service provider, which holds access spectrum in an LSA but also provides other types of services such as wireline telephony service and internet access service in the LSA, obtains the spectrum in 13 GHz, 15 GHz, and 18 GHz bands on a block-basis in the LSA, it can use such spectrum for backhauling its wireless access network traffic only and not for any other purposes.

(b) Henceforth, no fresh assignment of microwave spectrum should be made in 13 GHz, 15 GHz, and 18 GHz bands on a point-to-point link basis. However, in case any authorised entity, including captive users, is already holding spectrum in 13 GHz, 15 GHz, and 18 GHz bands on a point-to-point

link-basis for backhauling telecommunication traffic other than wireless access network traffic, it should be permitted to retain such spectrum for backhauling telecommunication traffic other than wireless access network traffic on an annual renewal basis. Further, the Government should encourage such entities to migrate their point-to-point links to the 21 GHz band.

(c) The spectrum in the 21 GHz band should be assigned to authorised entities, including captive users, on a point-to-point link basis in an LSA for backhauling any telecommunication traffic other than wireless access network traffic.

Explanation: If any access service provider holding access spectrum is also providing other types of services such as wireline telephony service and internet access service, it can obtain the spectrum in the 21 GHz band on a point-to-point link-basis for backhauling the wireline telephony traffic and internet traffic. The spectrum in the 21 GHz band assigned on a point-to-point link-basis cannot be used for backhauling wireless access network traffic.

(d) There should be a ceiling of four carriers, each of 28 MHz (paired) bandwidth per link, for the point-to-point link-based assignment in the 21 GHz band.

(e) Henceforth, the spectrum in the 21 GHz band should not be assigned to wireless access service providers on a block-basis for backhauling wireless access network traffic. However, wireless access service providers should be permitted to retain the carriers already assigned to them in the 21 GHz band in any LSA for backhauling their wireless access network traffic. In case any wireless access service provider intends to retain the carriers assigned to it in the 21 GHz band in any LSA, such carriers should be counted for

the purpose of the ceiling on the carriers in 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands in the LSA for radio backhaul purposes.

(f) There should be a combined ceiling of eight carriers, each of 28 MHz (paired) bandwidth, which may be assigned to a wireless access service provider on a block-basis in any LSA in 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands together for backhauling wireless access network traffic.

(g) In general, any entity already holding carriers in 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands for radio backhaul purposes should be permitted to retain such carriers for radio backhaul purposes subject to the prescribed ceiling.

(h) The backhaul spectrum in 13 GHz, 15 GHz, 18 GHz and 21 GHz bands obtained by any wireless access service provider on a block-basis can only be used for backhauling wireless access network traffic and not for any other purposes.

Need for stipulating minimum link length for point-to-point link

2.166 While evaluating the need for stipulating minimum link length for point-to-point backhaul links in traditional microwave backhaul bands, the Authority has taken note of the following aspects:

(a) Under the extant policy regime, MWB carriers are assigned for a minimum link length of 15 km in plain regions. In the hilly terrains (includes Assam, North East, Himachal Pradesh, and Jammu & Kasmir LSAs), MWB carriers are assigned for a minimum link length of 10 km. There is no restriction on the link length for MWA carriers.

(b) In the present consultation process, many stakeholders have opined that prescribing the minimum link length in traditional microwave backhaul bands is necessary to ensure efficient spectrum use and to minimize interference, many other stakeholders have opined that

the introduction of minimum link lengths for microwave backhaul bands would be counterproductive as it would artificially constrain network architecture, limiting operators' ability to design optimal network topologies based on real-world deployment conditions; the operators may be forced to choose longer or indirect routing paths, even when more efficient shorter links are both technically feasible and preferable.

2.167 The Authority notes that the frequencies of the 6 GHz (lower) band are the lowest amongst all the frequency bands which are currently used for radio backhauling. As the lower frequencies can travel longer distances, the spectrum in the 6 GHz (lower) band is used for providing connectivity over longer distances. In case the 7 GHz band is identified for IMT after WRC-27, only the 6 GHz (lower) band would be available for establishing radio backhaul links of longer lengths. With a view to avoid congestion of the 6 GHz (lower) band in that scenario, it would be necessary to restrict the usage of the 6 GHz (band) for establishing long distance links only. Accordingly, the Authority is of the view that it would be proper to continue with the minimum link lengths currently applicable for the 6 GHz (lower) band.

2.168 As far as the backhaul spectrum in 7 GHz, 13 GHz, 15 GHz, and 18 GHz bands is concerned, the Authority has already arrived at a conclusion that there should be no fresh spectrum assignments in these bands on a point-to-point link-basis under the proposed new policy regime. [The entities holding spectrum assignments in 7 GHz, 13 GHz, 15 GHz, and 18 GHz bands on point-to-point link-basis should be permitted to retain such spectrum assignments.] As there would be no fresh assignments in 7 GHz, 13 GHz, 15 GHz, and 18 GHz bands on point-to-point link basis, there is no need for stipulating minimum link length in case of point-to-point link-based assignments in 7 GHz, 13 GHz, 15 GHz, and 18 GHz bands. Accordingly, the Authority proceeds to examine the need for stipulating

minimum link length in case of point-to-point link-based assignments in the 21 GHz band.

2.169 With respect to the spectrum in the 21 GHz band, the Authority has taken note of the following aspects:

(a) The climate of India includes a wide range of weather conditions. It is influenced by the vast geographic scale and varied topography. India encompasses a diverse array of climatic subtypes. India's rainfall zones vary from extreme to scanty due to its monsoon and terrain diversity. Regions include the wettest zones along the Western Ghats and Northeast, heavy rainfall in eastern states, moderate rainfall across central and peninsular areas, and arid zones in Rajasthan, Ladakh, and northwestern India with minimal precipitation. Most parts of India receive ample monsoon rains.

(b) The frequencies of the 21 GHz band are the highest amongst all the traditional microwave backhaul bands. In such high frequencies, using shorter hops increases system availability and is standard practice in tropical zones with moderate to high-intensity rainfall.

(c) Under the extant policy regime, there is no stipulation of the link length for MWA carriers.

2.170 Considering the above, the Authority is of the view that it would not be prudent to stipulate the minimum link length for point-to-point links in the 21 GHz band in the country.

2.171 In light of the above, **the Authority recommends as below with respect to link-based assignments in 6 GHz (lower) band, and 21 GHz band:**

(a) The minimum link length for a point-to-point link in the 6 GHz (lower) band should be 15 km for plain regions, and 10 km for hilly terrains (including Assam, North East, Himachal Pradesh, and Jammu & Kashmir LSAs).

(b) There should be no requirement for a minimum link length for the point-to-point links in the 21 GHz band.

Surrender of backhaul spectrum in traditional microwave backhaul bands

2.172 Surrender of spectrum refers to the process by which an entity voluntarily relinquishes the rights to use a portion or all the spectrum it has previously been assigned. This can happen for various reasons, such as lack of business necessity, strategic realignment, or financial difficulties. An enabling framework for the surrender of spectrum is necessary to ensure efficient, transparent, and fair management of a scarce public resource, while also supporting market flexibility.

2.173 With respect to the surrender of spectrum in traditional microwave backhaul bands, the Authority has taken note of the following aspects:

(a) As per the extant policy regime[73], any entity holding spectrum in traditional microwave backhaul bands can submit the request for surrender not before 60 days prior and not later than 30 days prior, to the proposed date of surrender. Along with the request for surrender, wireless access service providers have to also submit a certified proof of payment from the concerned office regarding payment of spectrum charges upto the previous quarter of application.

[73] Through the letter No. L-14042/01/2022-IMT dated 10.11.2022, DoT issued 'Guidelines for Surrender of administratively assigned spectrum for Telecom Service Providers (TSPs) with Access Service Authorisation". The relevant extracts from these guidelines are given below:

"1. Applicant shall submit the request for surrender of administratively assigned frequency carriers (GSM/ CDMA/ MW Access and MW Backbone) to DoT, not before 60 days prior and not later than 30 days prior, to the proposed date of surrender …

2. Applicant shall submit a certified proof of payment from the office of Pr. CCA/ CCA of concerned LSA (where surrender is proposed) regarding payment of Spectrum Charges/ Spectrum Usage Charges (SUC) upto the previous quarter of date of application either on provisional/ final assessment basis or self assessment basis as the case may be. Charges which are sub-judice may be excluded w.r.t proof of payment. An undertaking as per Annexure-I should also be enclosed with the application.

…

4. WPC Wing shall issue the necessary letter to the applicant regarding taking surrender on record within 30 calendar days from receipt of application …"

(b) In the present consultation process, stakeholders are generally of the view that the existing provisions for the surrender of spectrum are adequate. They have opined that there should be no lock-in period for the surrender of spectrum in the traditional microwave backhaul bands; the process of voluntary surrender of the spectrum in the traditional microwave backhaul bands should be smooth and time-bound.

2.174 The Authority is of the opinion that for promoting ease of doing business, there should be an enabling framework under which entities can easily surrender the backhaul spectrum when they no longer need it, for example, due to fiber deployment, network optimization, or technology upgrade. The Authority is also of the view that the administrative process for the surrender of the backhaul spectrum should be time bound.

2.175 Considering the comments of stakeholders and its own analysis, **the Authority recommends that-**

(a) Any entity holding spectrum in traditional microwave backhaul bands should be permitted to surrender its microwave carriers after giving prior notice of at least 30 calendar days through the Central Government's online portal. In case a wireless access service provider desires to surrender any backhaul spectrum assigned to it on a block-basis, it should be required to submit certified proof of payment regarding payment of spectrum charges up to the previous quarter of the date of application.

(b) DoT should issue the letter to the applicant entity regarding taking the surrender of spectrum on record within 30 calendar days from the date of the application.

Need for stipulating roll-out obligations for the spectrum in traditional microwave backhaul bands

2.176 A roll-out obligation for spectrum is a regulatory requirement imposed on telecom operators to ensure timely deployment and operationalization of network services using the spectrum they have been assigned or acquired. It typically mandates operators to cover a minimum geographic area or population within a specified timeframe, ensuring that the spectrum resource is actively utilized to provide telecom services and not left idle. In India, while assigning access spectrum to telecom service providers, the Central Government imposes milestone-based roll-out obligations on them.

2.177 While evaluating the need for imposing roll-out obligations in respect of the backhaul spectrum in traditional microwave backhaul bands, the Authority has taken note of the following aspects:

(a) Under the extant policy regime, DoT has not specified any roll-out obligations in respect of the backhaul spectrum.

(b) In the present consultation process, most of the stakeholders have opined that there should not be any roll-out obligations associated with the backhaul spectrum. In support of their contention, they have stated that access service providers holding access spectrum are already subjected to roll-out obligations; the purpose of roll-out obligations is to ensure that access service providers extend their network coverage to provide services to end users within a defined timeframe and geographical area; on the other hand, backhaul spectrum is not meant to provide coverage at the access level; rather its primary purpose is to establish connectivity among various network elements; backhaul spectrum only plays a supporting role; hence, there is no logical reason for prescribing separate roll-out obligations for backhaul spectrum.

2.178 The Authority notes that backhaul spectrum is used for network transport connectivity i.e. for linking access nodes such as cell sites to the core network; it is not used for direct service delivery to end users. In general, roll-out obligations are prescribed to ensure active service coverage and quality for consumers by requiring operators to deploy radio access networks in licensed areas. However, backhaul spectrum serves the role of a supporting infrastructure that is essential yet not consumer-facing.

2.179 Considering the above aspects, the Authority is of the view that rollout obligations for the backhaul spectrum in traditional microwave backhaul bands would not serve any useful purpose**.** Accordingly, **the Authority recommends that there should be no roll-out obligations associated with the assignment of backhaul spectrum in traditional microwave backhaul bands.**

The validity period of the proposed new regime for the assignment of spectrum in traditional microwave backhaul bands

2.180 Based on the comments of stakeholders in the consultation process, it may be inferred that, at present, there is a robust demand-supply dynamic for the backhaul spectrum in traditional microwave backhaul bands in the country. However, in the future, the demand and supply of the backhaul spectrum in traditional microwave backhaul bands may undergo a change due to various technological, commercial, and regulatory developments. For illustration, a few developments, which might influence the demand and supply of the backhaul spectrum in traditional microwave backhaul bands, are outlined below:

(a) Demand side: At present, several technological developments are shaping the backhaul segment worldwide. These developments include the adoption of E-band and V-band for radio backhauling;

satellite backhaul integration; and the use of Software-Defined Networking (SDN) and Network Function Virtualization (NFV) in the backhaul networks. The technological developments in the backhaul segments, which would keep occurring in future as well, are likely to influence the demand of the traditional microwave backhaul bands. Besides, the Central Government has "*proposed to provide connectivity through Optical Fiber Cable (OFC) to all the Gram Panchayat villages and all other villages on demand*." [74] In case an affordable and good quality OFC-based connectivity becomes available in rural areas, it might affect the demand of the traditional microwave backhaul bands in the country.

(b) Supply side: Another development in the traditional microwave backhaul bands is happening at the regulatory level. As discussed above, the 7 GHz band and a part of the 15 GHz band are being considered for IMT in WRC-27. These developments, and many other such developments which might occur henceforward, are likely to influence the supply of the spectrum in traditional microwave backhaul bands in the future.

2.181 Considering the above, the Authority is of the view that the validity period of the proposed regime for the assignment of backhaul spectrum in traditional microwave backhaul bands should be such that it may provide adequate regulatory certainty to operators as well as sufficient flexibility to the Central Government to make necessary amendments in the policy regime in line with the market developments and international scenario. Accordingly, the Authority is of the opinion that it would be proper to keep the validity period of the proposed new policy regime for the assignment of spectrum in traditional microwave backhaul bands as five years. The

[74] Source: https://eservices.dot.gov.in/sites/default/files/user-mannual/NBM%202-0%20Vision%20Document_Final_RoW-compressed.pdf

Government may, if deemed necessary, extend the policy regime by a period of upto two years.

2.182 In light of the foregoing discussion, **the Authority recommends that the terms and conditions for the assignment of spectrum in traditional microwave backhaul bands including spectrum pricing, recommended through these recommendations, should remain valid for a period of five years from the date of notification of the proposed new policy regime for the assignment of backhaul spectrum by the Central Government, further extendable by a period of upto two years.**

Maximum period for which spectrum in traditional microwave backhaul bands should be assigned

2.183 Worldwide, most of the regulators assign frequency spectrum for a limited period of validity. While fixing the validity period of spectrum assignment, regulators generally aim to balance efficient use of spectrum, adaptation to technological changes, and protection of investment on network infrastructure.

2.184 In the report[75] on 'Wireless Backhaul Evolution' (2021), GSMA and ABI Research have presented the findings of a survey on the license duration for the microwave spectrum in 40 countries. The following figure depicts the license durations adopted by the countries surveyed by GSMA and ABI Research in the year 2020:

[75] https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2022/04/wireless-backhaul-spectrum.pdf

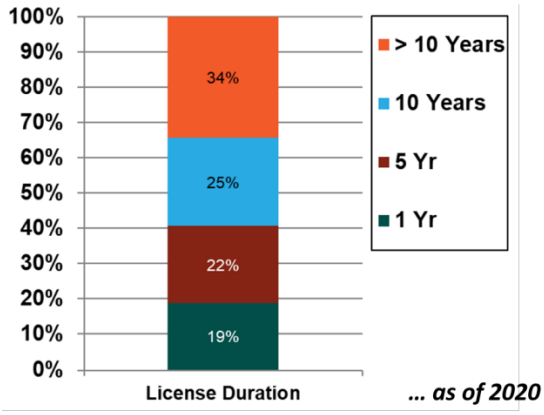

Figure 2.3: Summary of License Durations in the Surveyed Countries[76]

2.185 The afore-mentioned report of GSMA and ABI Research presents the following analysis on the license duration:

"10- or >10-Year licenses are the most common license duration types across the surveyed countries in 2020; accounting for 59% of the licenses surveyed. These licenses are typically sold to operators with ongoing renewals to protect their capital investment in their respective network infrastructure and to ensure consistent revenue generation for regulators. However, the long durations give incumbents extended monopolies over important portions of spectrum. This would give them undue leverage on a share of returns from new use cases, which could serve as an obstacle to innovation.

In contrast, license durations that last for 1 year, accounting for 19% of licenses surveyed, is the least preferred license duration among the countries surveyed. The shorter duration does not protect revenue generation (from the regulators' perspective) and does not ensure technological continuity (from the perspective of the licensee). Conversely, having short, yearly license durations gives operators more adaptability in evolving spectrum developments. Short licenses allow operators more flexibility in their network planning, as they are not tied down to frequency bands for a long time; this allows for quicker network

[76] ibid

development, as they can quickly move their links to different bands that have more available spectrum."

2.186 While evaluating the matter related to the maximum period for which spectrum in traditional microwave backhaul bands may be assigned, the Authority has taken note of the following aspects:

(a) Generally, when the spectrum in traditional microwave backhaul bands is assigned to a wireless access service provider, it continues to use the spectrum within the ceiling until the expiry of its access service license or the expiry of its access spectrum assignment, whichever is earlier. At present, the assignment and charging of MWA and MWB carriers in India are governed through the Guidelines dated 16.10.2015 (as amended).[77]

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[77] As mentioned in Chapter I of these recommendations, DoT, in 2015, decided to assign MWA and MWB spectrum, for the interim period provisionally pending the final decision in the matter by the Government. For this purpose, DoT issued guidelines on the matter through circular No. L-14035/19/2010-BWA (Pt) dated 16.10.2015. A relevant extract from the Guidelines dated 16.10.2015 is given below:

"Considering the immediate requirement of Microwave Access (MWA) and Microwave Backbone (MWB) spectrum of telecom service providers, it has been decided to allot such spectrum for the interim period provisionally, pending the final decision in the matter by the Government.

"2. The interim/ provisional allotment of MWA/ MWB carriers will be subject to following terms, conditions and criteria:

(i) TSPs would be allotted, including the present holding, a maximum of 4 carriers for Metro & Category A Service Area and 3 carriers for Category B and Category C Service Areas for MWA, subject to availability.

(ii) Microwave Backbone carrier allotment will be considered on link-to-link basis subject to availability.

(iii) Each Microwave carrier refers to 28 MHz paired bandwidth in 13, 15, 18 and 21 GHz bands for MWA and in sub 10 GHz band(s) for MWB.

(iv) For the interim period, the charging of MWA and MWB carriers will be done as per rates mentioned in Order no. J-14025/200(11)/06-NT Dated 3rd November' 2006 and its amendments of even no. Dated 10th November' 2008 and 19th February' 2009.

(v) The applicants (TSPs) are required to submit an undertaking and also enter into an Frequency Agreement (proforma enclosed herewith), duly filled in, before their request for the allotment of MWA/MWB carriers is considered.

(vi) All MWA/MWB carrier/spectrum allotted, as an interim measure, will be purely on temporary and provisional basis and all such allotees will have to participate in the allotment methodology as decided by the Government after considering the recommendations of TRAI on the subject.

(vii) In the event of decision of the Government to allot MWA carrier/ spectrum by auction, the carriers allocated as an interim measure, will stand reverted back to the Government after a period of three months from date of finalization of results of aforesaid auction, in case such allotees fail to participate and/ or win back the carriers/ spectrum provisionally allotted as an interim measure.

(viii) In the event of decision of the Government to allot MWA carrier/spectrum by a methodology other than the auction, the carriers allocated as an interim measure, will stand reverted back to the Government after a period of three months, in case such allotees fail to participate in the said process and/or not being able to get back the provisionally allotted carriers/spectrum, as per the methodology.

(ix) The licensees whose licenses have expired in November' 2014 or licenses expiring in future, will be allowed to hold the carriers allotted to them as per Clause. 8.4 of UL guidelines on a purely provisional basis till the ongoing process of TRAI consultation is completed and a final decision thereon is taken by the Government; thereafter, MWA/MWB carriers will be regulated in accordance with above Para (vii) and (viii) of this Guideline/OM.

(x) Due notice will be given to such allotees who have been provisionally allotted the carriers/spectrum as an interim measure and have not been able to get back the spectrum in full or in part.

(xi) During the said interim period, the present charging mechanism, as mentioned above, will continue subject to the condition that for the spectrum/carriers allotted during interim period, the TSPs will have to pay the charges with retrospective effect (i.e. from the date of issue of letter for allotment of carrier as interim measure) as finally determined through the auction process/market related process or any other methodology decided by the Government."

(b) Generally, the spectrum is assigned to captive users on an annual basis. Upon the expiry of the validity period, captive users may again apply for the renewal of the existing spectrum assignment. At present, the assignment and charging of spectrum to captive users (being charged on formula basis) for different types of radiocommunication services and applications are governed through DoT's order No. P-11014/34/2009-PP dated 11.12.2023.[78]

(c) In the consultation process, most of the stakeholders have expressed a view that the validity period of assignment of spectrum in traditional microwave backhaul bands should be reasonably long, aligned with the typical investment cycles for network infrastructure.

2.187 The Authority is of the view that the backhaul spectrum in traditional microwave backhaul bands is vital for the business continuity of wireless access service providers. The Authority, in the previous sub-section, has

[78] The relevant extract from the DoT's order No. P-11014/34/2009-PP dated 11.12.2023 on the subject- "Spectrum Charges for Assignment of Frequencies to Captive Users (being charged on formula basis) for different types of Radiocommunication services and applications is given below:

"In pursuance of the powers conferred under section 4 of the Indian Telegraph Act, 1885 (13 of 1885) and in supersession of this Ministry's Orders Nos. P-11014/34/2009-PP (I), (II), (III) & (IV) each dated 22.03.2012, the Central Government has decided that assignment of radio frequency spectrum to all users to whom radio frequency assignment is made through administrative process and spectrum charges are calculated based on a formulae, shall be made as per the methodology defined in this order.

2 Upon successful processing of application for assignment of radio frequency, a Letter of Intent (LoI) will be issued to the applicant which include, among others, information about the license fee and royalty charge (collectively called spectrum charges) required to be paid. Spectrum charges shall be informed for the full period of the assignment requested. If the request for assignment is for a period more than one year, the applicant can opt to pay the license fee and royalty annually, in advance
for each year.

3 Immediately thereafter, but in any case not later than sixty (60) days from the date of issue of the LoI, the applicant shall pay the spectrum charges for issue of Decision Letter (DL), if otherwise permissible.

3.1 If the payment is not received within 60 days from the date of LoI, the application shall be treated as cancelled and the frequency shall be freed for assignment to other applicants. The applicant will have to submit a fresh application if they still want the frequency assignment.

4. A Construction Period of three months is permitted for the purpose of import of the equipment, site preparedness, deployment, etc. and spectrum charges be levied, after three months" period from the 1st day of the month of date of issue of LoI.

4.1 Three months' construction period shall not be applicable for temporary frequency assignment (assignment issued for the period less than one year). In such cases, spectrum charges shall be applicable from the 1st day of the month of date of issue of LoI.

5. Initially, DL shall be issued with a validity of 15 months (one year plus three months of construction period) from the 1st day of the month of date of issue of LoI that can be further extended for a period of another one year subject to payment of annual spectrum charges, in advance. For example: If date of issue of initial LoI is 20th August 2023, the spectrum charges will be levied from 1st November 2023 and the initial DL will be valid upto 31st October 2024. Further extension of one year will be expired on 31st October 2025.

5.1 In no case DL be renewed further, however, extension of another one year may be considered for Government users under certain circumstances subject to payment of annual spectrum charges, in advance."

Source: https://eservices.dot.gov.in/sites/default/files/circular-notifications/Spectrum%20Charges%20for%20Assignment%20of%20Frequencies%20to%20Captive%20_Users.pdf

arrived at a conclusion that the proposed new policy regime for the assignment of spectrum in traditional microwave backhaul bands should remain valid for a period of five years, further extendable by a period of upto two years. For protecting the investments in backhaul network infrastructure made by wireless access service providers, it would be proper that any backhaul spectrum in traditional microwave backhaul bands, once assigned to wireless access service providers on a block-basis for backhauling wireless access network traffic, is not ordinarily withdrawn from them under the proposed policy regime if they continue to provide wireless access services. Accordingly, the Authority is of the view that any backhaul spectrum in 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands, once assigned (including the renewal cases) on a block-basis to a wireless access service provider in an LSA for backhauling its wireless access network traffic under the policy regime for the assignment of backhaul spectrum recommended through these recommendations (hereinafter, also referred to as "the proposed policy regime"), should remain assigned under the proposed policy regime, if the wireless access service provider continues to hold the authorisation for providing access service as well as access spectrum in the LSA, and the wireless access service provider does not surrender the assigned backhaul spectrum.

2.188 The Authority also examined the issue related to the maximum period of validity of backhaul spectrum in traditional microwave backhaul bands assigned to authorised entities, including captive users, on a point-to-point link-basis under the proposed policy regime. In this regard, the Authority has already arrived at the conclusion that if any entity holds any spectrum in 7 GHz band, 13 GHz, 15 GHz, and 18 GHz bands on a point-to-point link-basis, it should be permitted to retain such spectrum assignment on an annual renewal basis. Thus, the maximum validity period of assignment of backhaul spectrum on a point-to-point link basis in only two bands viz. 6 GHz (lower) band, and 21 GHz band remains to be decided.

2.189 At this stage, it is worthwhile to mention that, through these recommendations, the Authority has already arrived at the conclusion that fresh assignments of backhaul spectrum on a point-to-point link-basis should be given in only 6 GHz (lower) band, and 21 GHz band (amongst all traditional microwave backhaul bands). It is expected that in 6 GHz (lower), and 21 GHz bands, a substantial number of point-to-point link-based assignments would be sought by authorised entities, including captive users, under the proposed policy regime. In response to the present consultation process, a few stakeholders have opined that the spectrum assignments to all types of authorised entities, including captive users, should be given for sufficiently long periods so that the spectrum assignees get sufficient time to make the necessary investments, innovations, and optimization of their networks. The Authority concurs with this viewpoint. Accordingly, the Authority is of the opinion that under the proposed policy regime, the spectrum assignments given in 6 GHz (lower) and 21 GHz bands on a point-to-point link basis should remain valid for the period of assignment applied for by the authorised entity under the proposed policy regime provided that the authorised entity continues to hold the authorisation under Section 3 of the Telecommunications Act, 2023 under which the backhaul spectrum has been assigned, and the authorised entity does not surrender the assigned backhaul spectrum.

2.190 Further, the Authority is of the view that any revision in the terms and conditions of the assignment of backhaul spectrum in traditional microwave backhaul bands, notified by the Central Government after five years, should become applicable to all authorised entities, including the existing spectrum assignees. While assigning the backhaul spectrum in traditional microwave backhaul bands under the policy regime recommended through these recommendations, a condition should be included in the terms of assignment of backhaul spectrum stating that

whenever the policy regime is revised after five years, the existing backhaul spectrum assignments at that time shall have to conform to the revised policy regime. It is noted that the Central Government may, under the revised policy regime (as notified after five years), decide to repurpose any traditional microwave backhaul band (or a part of it) and earmark it for another service in public interest; in a situation like this, the carriers assigned to authorised entities for backhaul purposes in such a frequency band may be required to be withdrawn.

2.191 In view of the above, **the Authority recommends that –**

(a) Under the policy regime for the assignment of backhaul spectrum recommended through these recommendations (hereinafter, referred to as "the proposed policy regime"), the maximum period of assignment of the backhaul spectrum in traditional microwave backhaul bands should be as below:

(i) <u>For block-based assignments (including renewal) in 13 GHz, 15 GHz, 18 GHz and 21 GHz bands</u>:

The spectrum should remain assigned under the proposed policy regime, if the wireless access service provider continues to hold the authorisation for providing access service as well as access spectrum in the LSA, <u>AND</u> the wireless access service provider does not surrender the assigned backhaul spectrum.

(ii) <u>For point-to-point link-based assignments (including renewal) in 6 GHz (lower) and 21 GHz bands</u>:

The spectrum assignment should remain valid for the period of assignment applied for by the authorised entity under the proposed policy regime *provided* that:

the authorised entity continues to hold the authorisation under Section 3 of the Telecommunications Act, 2023 under which the backhaul spectrum has been assigned, <u>AND</u> the authorised entity does not surrender the assigned backhaul spectrum.

(iii) <u>Renewal of point-to-point link-based assignments to authorised entities, including captive users in the 7 GHz, 13 GHz, 15 GHz, and 18 GHz bands</u>:

The spectrum should be renewed for a maximum period of one year under the proposed policy regime.

(b) Any revision in the terms and conditions of the assignment (including renewal) of the backhaul spectrum in traditional microwave backhaul bands including spectrum pricing notified by the Central Government after a period of five years from the date of notification of the policy regime, recommended through these recommendations, should become applicable to all authorised entities, including the existing spectrum assignees.

(c) While assigning (including renewal) the backhaul spectrum in traditional microwave backhaul bands under the policy regime recommended through these recommendations, a condition should be included in the terms of assignment of backhaul spectrum stating that whenever the policy regime is revised after five years, the existing backhaul spectrum assignees at that time shall have to conform to the revised policy regime, including any changes in the backhaul spectrum pricing.

(d) It should be explicitly conveyed to the spectrum assignees that the Central Government may withdraw the assigned backhaul spectrum at the stage of the revision of the policy regime after five years in case:

(i) The authorised entity does not accept the terms and conditions under the revised policy regime, or

(ii) The Central Government decides to repurpose the usage of traditional microwave backhaul bands.

(7) Procedure for the assignment of spectrum in traditional microwave backhaul bands frequency bands for backhaul purposes

2.192 Apart from stipulating an enabling policy framework for the assignment of the backhaul spectrum in traditional microwave backhaul bands, it would be desirable to establish a smooth and efficient procedure for the assignment of the backhaul spectrum. The Authority is of the view that the process for application and assignment of the backhaul spectrum in traditional microwave backhaul bands should be online. DoT may open a monthly window for seeking online applications from the entities desirous of assignment and renewal of the backhaul spectrum. This window may be kept as the first week of the month. After examining the applications received in the first week of the month, DoT may issue the assignment letters to the applicant entities by the end of the month in an online mode.

2.193 As the Authority has recommended two separate methods viz. block-basis and link-basis for the assignment of spectrum in traditional microwave backhaul bands, it would be desirable to establish two separate procedures, one for the assignment on a block-basis, and the other for the assignment on a link-basis.

Procedure for the assignment on a block-basis

2.194 In the previous sub-section, the Authority has arrived at a conclusion that the backhaul spectrum in 13 GHz, 15 GHz and 18 GHz should be assigned to wireless access service providers on a block-basis in a licensed service area for backhauling their wireless access network traffic. Wireless access service providers should also be permitted to retain the carriers already held by them in the 21 GHz band on a block-basis. The Authority is of the view that for the assignment and renewal of carriers to wireless access service providers on a block-basis, the process of application, evaluation of applications and assignment of spectrum could involve the following steps:

(a) Interested wireless access service providers may submit their applications specifying the number of carriers, and the preference for carriers in a frequency band for each LSA in the first week (i.e. by the seventh day) of any month.

(b) DoT may evaluate the applications received from wireless access service providers in the first week of the month and assign carriers within the stipulated ceiling of carriers in the LSA by the last day of the month.

(c) In case more than one applicant entity has applied for the same carrier in any LSA (hereinafter, referred to as "the candidate carrier"), the following tests may be used for according priority for the assignment of the candidate carrier:

(i) First test: Whether it is a case of retention of the candidate carrier for any applicant entity?

An applicant entity seeking the retention of the candidate carrier should be accorded priority.

[Reason: As discussed above, needless capital expenditure and service disruption due to the change of radio equipment can be avoided by permitting wireless access service providers to retain carriers already held by them.]

(ii) Second test: In case it is not a case of the retention of the candidate carrier for any applicant entity, whether any applicant entity, which has applied for the fresh assignment of the candidate carrier, already holds one or more carriers in the LSA in the frequency band containing the candidate carrier?

The applicant entity already holding one or more carriers in the LSA in the frequency band containing the candidate carrier should be accorded priority.

[Reason: Wireless access service providers may prefer to obtain all backhaul carriers within a single frequency band so that they have to procure and keep inventory for backhaul radio equipment of a singular type of equipment. Apparently, this helps them in reducing their capital and operating expenditure.]

(iii) Third test: Which applicant entity amongst the applicants for the candidate carrier has the most AGR in the LSA?

In case the conflict cannot be resolved through the above two tests, the applicant entity having the highest adjusted gross revenue (AGR) for wireless access services in the LSA should be accorded priority. For this purpose, the AGR for the latest year for which audited information is available should be used.

[Reason: More AGR would, generally, mean more telecommunication traffic to be catered.]

2.195 In view of the above, **the Authority recommends that –**

(a) DoT should invite applications from the wireless access service providers desirous of assignment and renewal of the backhaul spectrum on a block basis by the 7th day of every month through an online portal.

(b) Interested wireless access service providers may submit their applications specifying the number of carriers, and the

preference for carriers in a frequency band for each LSA, in the first week (i.e. by the seventh day) of any month.

(c) DoT should evaluate the applications received from wireless access service providers in the first week of the month and assign carriers within the stipulated ceiling of carriers in the LSA. In case more than one application has been received for a particular carrier in an LSA (hereinafter, referred to as "the candidate carrier"), certain predefined guidelines, as illustrated below, should be framed for the assignment of the candidate carrier:

(i) If any applicant entity is seeking the retention of the candidate carrier, it should be accorded priority.

(ii) If no applicant entity is seeking the retention of the candidate carrier, the applicant entity already holding one or more carriers in the LSA in the frequency band containing the candidate carrier should be accorded priority.

(iii) If the contention cannot be resolved by using the above two criteria, the applicant entity having the highest AGR for wireless access services in the LSA for the preceding completed financial year should be accorded priority.

(d) After examining the applications received from the wireless access service providers, DoT should issue the assignment/ rejection letters to the applicant entities by the end of the month through its online portal.

Procedure for the assignment on a link-basis

2.196 The Authority is of the view that while assigning the spectrum in traditional microwave backhaul bands on a point-to-point link-basis, it should be ensured that the assigned spectrum would be utilized only for

radio backhauling and no other purposes. In this regard, the authorised entities which apply for the assignment of spectrum in traditional microwave backhaul bands on a point-to-point link-basis should be required to provide justification in support of their requirements.

2.197 The Authority is of the view that for the assignment (and renewal) of carriers to authorised entities on a link-basis, the process of application, evaluation of applications and assignment of spectrum could involve the following steps:

(a) Interested applicant entities may submit their applications specifying the details of the backhaul link (coordinates of the two ends of the link, height of the antennas, etc.), frequency band in which the backhaul spectrum is required, and preferred carriers (or spectrum range) in the frequency band.

(b) DoT may assign the spectrum for establishing the backhaul link within the stipulated ceiling of carriers per link after conducting an analysis of the applications received from applicant entities on the basis of justification in support of their requirement and availability of spectrum, after taking into consideration the spectrum requirement of other entities and conducting an analysis of harmful interference to the existing users. Any applicant entity seeking retention of the backhaul spectrum on an existing point-to-point link should be accorded priority.

2.198 In view of the above, **the Authority recommends the following procedure for the assignment of the backhaul spectrum on a point-to-point link basis:**

(a) DoT should invite applications from the authorised entities desirous of assignment and renewal of the backhaul spectrum on a point-to-point link basis by the 7th of every month through an online portal.

(b) Interested authorised entities, including captive users, may submit their applications specifying the details of the proposed backhaul link including coordinates of the two ends of the link, heights of the antennas at the two ends, frequency band in which the backhaul spectrum is required, and preferred carriers (or spectrum range) in the frequency band, period of assignment, etc. with full justification in support of the requirement.

(c) DoT should analyze the applications received from applicant entities on the basis of justification in support of their requirement and availability of spectrum, after taking into consideration the spectrum requirement of other entities and conducting an analysis of harmful interference to the existing users. Any applicant entity seeking retention of the backhaul spectrum on an existing point-to-point link should be accorded priority.

(d) After examining the applications received from the authorised entities, DoT should issue the assignment/ rejection letters to the applicant entities by the end of the month through its online portal.

(8) Need for a comprehensive online portal for the assignment of backhaul spectrum

2.199 In response to the Consultation Paper dated 28.05.2025, a stakeholder has opined that a real-time spectrum management system should be implemented to facilitate dynamic assignment and coordination of point-to-point links at a national level.

2.200 In this regard, in the previous sub-section, the Authority has already recommended that the entire process of submitting applications for

backhaul spectrum as well as issuing letters for the assignment of backhaul spectrum should be through an online portal. The Authority is of the view that the online portal for the assignment of backhaul spectrum should also store complete and updated database of LSA-wise carriers assigned on a block-basis and point-to-point link basis. This database should be made available to eligible entities in a secure manner. Such a database would not only help the new applicant entities in planning their point-to-point links but also aid DoT in carrying out interference studies.

2.201 The online portal should also capture the details about the point-to-point links established by wireless access service providers using the microwave carriers assigned to them on a block-basis. For this purpose, all the backhaul spectrum assignees should be mandated to upload information about the point-to-point links established by them on the online portal within seven days of the establishment of such links. This information will also serve as an important input while reviewing the policy regime for the assignment of backhaul spectrum after five years.

2.202 Further, it is noted that certain frequency bands being used for backhaul links or Fixed Services are also earmarked for Fixed Satellite Services (FSS). The database of operational fixed point-to-point links will also be useful in interference management between terrestrial backhaul and FSS.

2.203 In view of the above, **the Authority recommends that –**

(a) DoT should establish an online portal for the assignment of backhaul spectrum. The online portal should store a complete and updated database of LSA-wise carriers assigned on a block-basis as well as carriers assigned on a point-to-point link basis. The database should be made available to eligible entities in a secure manner.

(b) The online portal should also capture the details about point-to-point links established by wireless access service

providers using the microwave carriers assigned to them on a block-basis.

(c) All the backhaul spectrum assignees should be mandated to upload details about each point-to-point link established by them, such as coordinates of the two ends of the link, link length in km, height of the antenna, carriers deployed on the link, etc., on the online portal within seven days of the establishment of such links.

2.204 The following chapter examines the issues related to the assignment of the spectrum in E-band and V-band.

Chapter III: Assignment of the Spectrum in E-Band and V-Band

3.1 This chapter examines the issues related to the assignment of the spectrum in E-band and V-band.

3.2 Through the Reference dated 13.09.2024, DoT provided, *inter-alia*, the following information to TRAI with respect to the developments related to V-band and E-band:

"3. The Developments related to V- band and E- band are described below:

3.1 The V-band (57-64/ 66 GHz) is a part of the band n263 of 3GPP (57 GHz to 71 GHz), which is also referred to as 60 GHz band. That is to say that the complete 57-71 GHz band has been planned by 3GPP as IMT/ Access band. Point to point (backhaul) solutions are also available in the V band. Further, a part of this band, i.e., 66-71 GHz, has already been identified by ITU globally for IMT based Access services in WRC-19.

3.2 The E-Band (71-76 GHz/ 81-86 GHz) has already been assigned LSA-wise for Backhaul purpose to TSPs on provisional basis, during 2022. One of the commercial telecom service providers, holding UL with Access service authorisation, has sought permission for using this band for Access Services, in addition to the Backhaul purposes. i.e. as IAB (Integrated Access & Backhaul). In addition, another service provider, holding UL with Internet service authorisation (ISP) has sought E/ V band spectrum for last mile connectivity purpose.

3.3 After providing the above information, DoT, through the Reference dated 13.09.2024, DoT requested TRAI to provide recommendations on the following aspects related to the spectrum in V-band and E-band:

"(a) Demand assessment and scope of service/ usage for (i) 57-64/ 66 GHz (V-band) and (ii) 71-76 GHz/ 81-86 GHz (E-band) and accordingly methodology of assignment of spectrum and associated

terms & conditions, in line with the determination of scope of services/ usages by TRAI i.e. "Access" or "Backhaul" or "Integrated Access & Backhaul (IAB)".

…

(f) Feasibility & technical parameters, for allowing low power, indoor, consumer device-to-consumer device usage on license-exempt basis in V-band ….

(g) Provide any other recommendations deemed fit for the purposes mentioned under (a) to (f) above."

3.4 In this regard, the Authority, through the Consultation Paper dated 28.05.2025, solicited comments from stakeholders through Q18 to Q34. In response, stakeholders have provided a wide range of comments. Section-A of this chapter presents a summary of comments received from stakeholders on Q18 to Q34. In Section-B, the Authority has given its recommendations based on the comments of stakeholders and its own analysis of the matter.

A. Summary of comments received from stakeholders on Q18 to Q34

(9) Summary of comments on Q18

3.5 Q18 is reproduced below:

"Q18. What is the level of demand of the spectrum in the E-band (71-76 GHz, and 81-86 GHz) for each of the service/ usage viz. "Backhaul", "Access" and "Integrated Access & Backhaul (IAB)"? Kindly provide a detailed response in respect of each service/ usage with justification including availability of technical standards and ecosystem."

3.6 In response to Q18, most of the stakeholders have opined that E-band should be designated exclusively for backhaul purposes to avoid

destabilizing existing networks and to ensure sufficient capacity for evolving 5G requirements; deploying the E-band for non-backhaul purposes could impact network stability and degrade service quality; the device ecosystem, technical standards, and operational track record decisively support exclusive backhaul use in the current context; allowing for usages beyond backhaul, especially before a device ecosystem matures for access or IAB, may hinder network efficiency and reliability. A stakeholder has mentioned that the present level of fiberization in the country is quite less, and the situation is not about to change materially in the near future; most telecom service providers are largely dependent on backhaul spectrum as they expand their fiber networks; in such a scenario, any proposal to expand the usage of E-band and to use it for access and IAB would disrupt the telecom ecosystem; due to Line-of-Sight (LoS) propagation requirements in the E-band, the spectrum in this band is more suitable for backhaul; consequently, 3GPP has not specified a band plan for E-band; allowing access services in E-band will result in the wastage of scarce resources that are crucially required for constructing the high capacity backhaul for 5G and mitigating the challenges associated with fiber deployment.

3.7 With respect to the demand for E-band in "Access", many stakeholders have opined that E-band's propagation characteristics, requiring strict line-of-sight and being highly sensitive to blockage, make it unsuitable for broad mobile access. They have also said that there is a lack of a developed device ecosystem and relevant technical standards for direct user access in this band; thus, any consequential demand for access services in E-band is not anticipated. With respect to the demand for IAB, many stakeholders have alluded that global standards for IAB in E-band are yet to evolve.

3.8 A stakeholder opined that demand studies for spectrum is not required, as requirement will inevitably grow with evolving technologies and shorter

technology cycles; to ensure optimal utilization and foster innovation, regardless of current demand, all available spectrum - across access, backhaul and new bands such as E band - should be auctioned in a technology and service-neutral manner.

(10) <u>Summary of comments on Q19</u>

3.9 Q19 is reproduced below:

"What is the level of demand of the spectrum in the V-band (57–64/66 GHz) for each of the service/usage viz. Backhaul, Access and IAB? Kindly provide a detailed response in respect of each service/usage with justification including availability of technical standards and eco-system."

3.10 In response to Q19, stakeholders have expressed a high level of interest in V-band, recognizing its potential for supporting high-capacity wireless backhaul and short-range broadband access, especially in dense urban and enterprise environments. However, opinions differed regarding the demand of V-band for Access, and IAB, mainly based on ecosystem maturity and deployment economics. Notably, many stakeholders have expressed that V-band should be delicensed for low power applications.

3.11 A broad summary of the comments from stakeholders on the level of demand of the spectrum in V-band (57–64/66 GHz) for Backhaul, Access and IAB is given below:

(a) Most stakeholders have opined that the primary demand in V-band currently exists for short-hop, high-throughput backhaul links, particularly for 5G small-cell densification; due to its shorter propagation characteristics, the spectrum in V-band can help connect the street furniture, which is an essential part of 5G urban infrastructure; global deployments demonstrate successful use of V-band for wireless backhaul due to its large contiguous bandwidth and inherent frequency reuse potential.

(b) A few stakeholders have alluded that some demand for Access and IAB might emerge in the future in V-band. On the other hand, many stakeholders have opined that the excessive rain attenuation and the absence of device eco-system in V-band suggest that V-band is unsuitable for Access; there is a very limited spectrum available in V band; sharing it for IAB will further lead to reduction of spectrum for backhaul purposes. A stakeholder has stated that the demand for V-band for backhaul purposes will continue to grow significantly in urban and semi-urban zones for dense 5G and small cell architectures; permitting access applications in V-band in parallel with backhaul use could lead to interference, congestion, and inefficient utilization of this valuable spectrum, especially in such dense deployment environments.

3.12 In response to Q19, a stakeholder has noted comparatively lower demand for V-band than E-band and has suggested exploring its parallel use for low-power indoor applications. On the other hand, another stakeholder has contended that demand studies for spectrum is not required, as the requirement will inevitably grow with evolving technologies and shorter technology cycles; to ensure optimal utilization and foster innovation, regardless of current demand, all available spectrum - across access, backhaul and new bands such as V band - should be auctioned in a technology-neutral or service-neutral manner.

(11) Summary of Comments on Q20

3.13 Q20 is reproduced below:

"For which commercial telecommunication services should the spectrum in E-band and V-band be assigned for radio backhaul purposes? Responses with detailed justifications may kindly be provided for E-band and V-band separately."

3.14 In response to Q20, most stakeholders have emphasized the importance of both E-band (71–76 GHz and 81–86 GHz) and V-band (57–64/66 GHz) spectrum in meeting the growing backhaul requirements of 5G and beyond, particularly as small-cell and dense urban deployments increase. However, distinct use cases have been proposed for each band based on their propagation characteristics, available capacity, and ecosystem readiness.

3.15 A broad summary of the comments of stakeholders regarding E-band is given below:

(a) Most stakeholders have opined that the spectrum in E-band should be primarily assigned for high-capacity wireless backhaul to support 5G in dense urban and suburban areas; this band offers multi-gigabit throughput, making it particularly suitable for macro cell aggregation, transport networks, and core interconnects. A few stakeholders have emphasized that the spectrum in E-band should be assigned to telecom service providers with Access Service authorisation for radio backhaul purposes only.

(b) A few stakeholders have suggested that a portion of E-band should be reserved for commercial enterprise services and ISPs so that they can use this spectrum as a substitute for fiber backhaul. The spectrum in E-band should be assigned on a point-to-point link basis for such applications.

(c) One of the stakeholders has opined that E-band is suitable for high capacity backhaul for 4G, 5G, and future 6G mobile networks and also suitable as access spectrum for delivering broadband services to end users; it can be used for connecting enterprise buildings with high-capacity links with the use of outdoor customer premises equipment (CPE); it is already identified as backhaul for 5G and is also deemed useful for IAB under 5G.

3.16 A broad summary of the comments of stakeholders regarding V-band is as follows:

(a) Many stakeholders have opined that V-band should be used primarily for short-range, high-capacity wireless backhaul for small cells and campus networks, and for access connectivity in certain cases; due to its high attenuation and limited range, V-band is suitable for short-hop links within a few hundred meters, ideal for 5G densification, hotspots, and metro backhaul.

(b) One of the stakeholders has opined that V-band is suitable as high capacity backhaul spectrum for mobile networks and also as access spectrum both for 5G and Wi-Fi; V-band can also be used for connecting enterprise buildings with high-capacity access links.

(c) Many other stakeholders have contended that V-band is not a priority band for IMT (Mobile Service) or backhaul (Fixed Service). Worldwide it is expected to be used by unlicensed services, both indoor and outdoor, as short range devices. For V-band, a license-exempt approach is appropriate.

(d) Several stakeholders have suggested the use of V-band in both licensed and unlicensed segments through "light licensing" or shared-access frameworks to promote flexible utilization and rapid rollout.

3.17 Difference of opinion among stakeholders exists primarily regarding the licensing regime in these bands. While many stakeholders have favored a regulated, coordinated assignment model for both E-band and V-band to ensure interference control and QoS assurance, many other stakeholders have suggested simplified administrative processes, including self-coordination and database-driven access, particularly for V-band.

(12) Summary of Comments on Q21

3.18 Q21 of the Consultation Paper dated 28.05.2025 is reproduced below: *"Which of the following methods should be used for the assignment of the spectrum in E-band and V-band for radio backhaul purposes for various commercial telecommunication services:*
(a) Block-basis in LSA;
(b) Point-to-point link-basis; or
(c) Any other?
Responses with detailed justifications may kindly be provided for E-band and V-band separately in respect of the relevant commercial telecommunication services."

3.19 In response to Q21, E-band has been generally favored for block-based assignment to support high-capacity backhaul. For V-band, apart from block-based assignment, shared-access models have been suggested due to its short-range propagation and dense reuse capability.

3.20 A broad summary of the comments of stakeholders regarding E-band assignment is given below:

(a) Many stakeholders have supported a block-based assignment of E-band spectrum to wireless access service providers. They have opined that the assignment of E-band spectrum on a link-basis will be both cumbersome and impractical due to the requirement of effective coordination for huge numbers of links that would be deployed by wireless access service providers in this band; E-band's block-based assignment in LSA will ensure speed, operational agility, and a lower regulatory burden, all of which are necessary for meeting 5G rollout timelines and high-capacity service levels.

(b) Another stakeholder has suggested that two paired carriers of 250 MHz in E-band should be earmarked for enterprise backhaul

purposes. The spectrum in E-band should be assigned on a point-to-point link basis.

(c) Another stakeholder has opined that E-band spectrum should be assigned on a point-to-point link basis. In support of its view, it has stated that E-band links are inherently highly directional, line-of-sight (LOS) point-to-point connections; they use narrow beams and are typically planned meticulously between two specific points.

3.21 A broad summary of the comments of stakeholders regarding V-band assignment is as follows:

(a) A few stakeholders have contended that V-band spectrum should be assigned exclusively to wireless access service providers; it should be assigned to them on a block-basis in licensed service area.

(b) A few other stakeholders have supported shared access for V-band assignments due to its limited range, high attenuation, and dense frequency reuse potential in localized environments. They have opined that a self-coordination mechanism similar to Wi-Fi usage would be adequate for urban hotspots and small cell backhaul link in V-band.

(13) Summary of Comments on Q22

3.22 Q22 of the Consultation Paper dated 28.05.2025 is reproduced below: *"In case it is decided to use different methods (block-based, link-based, or any other) for the assignment of the spectrum in E-band and/or V-band for radio backhaul purposes for different types of commercial telecommunication services, how much spectrum in E-band and V-band should be earmarked for the point-to-point link-based assignment for radio backhaul purposes for commercial telecommunication services? Responses with justifications may kindly be provided for E-band and V-band separately."*

3.23 With respect to E-band, a stakeholder has opined that a minimum of two carriers of 250 MHz FDD in E-band should be earmarked on pan-India basis for enterprise backhaul purpose.

3.24 With respect to V-band, a few stakeholders have suggested that the entire V-band should be given on a shared access basis.

3.25 A few other stakeholders have contended that no quantity of spectrum in E-band and V-band should be earmarked for point-to-point link-based assignments.

(14) Summary of Comments on Q23

3.26 Q23 of the Consultation Paper dated 28.05.2025 is reproduced below:

"Q23. What should be the terms and conditions for the assignment of the spectrum in the E-band for radio backhaul purposes of commercial telecom services such as-

(i) Band plan;

(ii) Carrier size;

(iii) Carrier aggregation;

(iv) Validity period of the assignment;

(v) Renewal mechanism;

(vi) Surrender of the spectrum;

(vii) Ceiling on the number of carriers (spectrum cap);

(viii) Criteria for the assignment of additional spectrum above the ceiling limit; and

(ix) Roll-out obligations etc.?

Kindly provide a detailed response with justifications."

3.27 A broad summary of the comments of stakeholders regarding the terms and conditions for E-band spectrum assignment is as follows:

(a) Band Plan: Most of the stakeholders have endorsed adherence to the internationally harmonized FDD band plan in accordance with ITU-R F.2006, maintaining 71-76 GHz for uplink and 81-86 GHz for downlink with a 10 GHz duplex gap. They have opined that this approach will ensure international alignment, robust equipment availability, and operational efficiency.

(b) Carrier Size: Most stakeholders have suggested a standardized carrier size of 250 MHz paired, as per the prevailing regime and global practice. Many stakeholders have opined that maintaining uniformity in channel size avoids unnecessary technical complexity and supports multi-gigabit data rates essential for next-generation backhaul.

(c) Carrier Aggregation: Most stakeholders have supported full flexibility for the aggregation of assigned carriers by telecom service providers, without regulatory or operational restrictions in order to maximize spectral efficiency and cater to evolving capacity requirements as data traffic surges, especially with the onset of 5G. One of the stakeholders has also contended that splitting of carriers should also be permitted without any regulatory approval.

(d) Validity Period of Assignment: Most stakeholders have opined that the validity period of assignment of E-band spectrum should be long enough to provide certainty to telecom operators for sustained investment and network planning. Several stakeholders have advocated for a period co-terminus with the operator's license or up to 20 years.

(e) Renewal Mechanism: Most stakeholders have favored streamlined spectrum renewal processes, either mirroring those for traditional microwave bands or via self-certification.

(f) Surrender of Spectrum: Most stakeholders suggested the continuation of existing surrender guidelines, notably a process allowing surrender by serving advance notice of 30 days to DoT, without mandatory lock-in or penalty period, promoting efficient spectrum utilization.

(g) Ceiling on the Number of Carriers (Spectrum Cap): Given increased traffic growth projections, most stakeholders have advocated increasing the current cap from two to four carriers of 250 MHz (paired) per LSA. Some stakeholders have recommended periodic review of the carrier ceiling to reflect evolving network requirements.

(h) Criteria for Assignment of Additional Spectrum above Ceiling: A few stakeholders have opined that the ceiling should remain sacrosanct and should not be exceeded. One stakeholder has suggested that the assignment above ceiling limits should be permitted only if justified by link congestion, density, or performance metrics, and reviewed on case to case.

(i) Roll-out Obligations: Most stakeholders have opined that no roll-out obligations should be imposed for E-band spectrum, as backhaul does not directly serve customers but instead supports network infrastructure. Most stakeholders have regarded rollout obligations unnecessary and potentially burdensome for operators.

(15) Summary of Comments on Q24

3.28 Q24 is reproduced below:

"What frequency range (57-64 GHz, or 57-66 GHz) in the V-band should be adopted for radio backhaul purposes? In case you are of the opinion that the 57-66 GHz range should be adopted for radio backhaul purposes,

considering that the 66-71 GHz range is already identified for IMT, whether there is a need for provisioning a guard band between the 57-66 GHz range (for the backhaul purposes) and the 66-71 GHz range (for IMT)? If yes, what should be the guard band? Kindly provide a detailed response with justifications."

3.29 In response to Q24, many stakeholders have supported adopting the entire 57-66 GHz range of the V-band for radio backhaul purposes, noting its alignment with international practices and technical standards. A few other stakeholders have preferred the 57-64 GHz range, highlighting its better ecosystem support and existing harmonization in global regulations. With respect to the need for provisioning a guard band between the 57-66 GHz range (for the backhaul purposes) and the 66-71 GHz range (for IMT), a stakeholder has opined that the current international recommendation ITU-R F.1497-2 already incorporates a guard band of 50 MHz within the 57-66 GHz allocation to prevent interference and ensure coexistence. Another stakeholder has suggested a guard band of 100 MHz. One of the stakeholders which has favored the 57-64 GHz range for backhaul purposes, has suggested that a guard band of at least 1 GHz, possibly extending from 64 GHz to 66 GHz, should be provisioned.

(16) <u>Summary of Comments on Q25</u>

3.30 Q25 of the Consultation Paper dated 28.05.2025 is reproduced below: *"What should be the terms and conditions for the assignment of the spectrum in the V-band for radio backhaul purposes of commercial telecom services including the following aspects:*

(i) Band plan;

(ii) Carrier size;

(iii) Carrier aggregation;

(iv) Validity period of the assignment;

(v) Renewal mechanism;

(vi) Surrender of the spectrum;

(vii) Ceiling on the number of carriers (spectrum cap);

(viii) Criteria for the assignment of additional spectrum above the ceiling limit; and

(ix) Roll-out obligations etc.?

Kindly provide a detailed response with justifications."

3.31 A broad summary of the comments of stakeholders regarding terms and conditions for the assignment of spectrum in V-band is given below:

(i) Band Plan: Many stakeholders have suggested that the ITU-R Recommendation F.1497-2 for TDD-based radio frequency channel arrangements in the 55-66 GHz band should be followed. A few other stakeholders have opined that the 57-64 GHz range should be used for radio backhauling.

(ii) Carrier Size: Many stakeholders have favored a carrier size of 50 MHz, aligned with earlier TRAI recommendations of 2014 and global practices. A few other stakeholders have further opined that channel size should be flexible and should not be mandated.

(iii) Carrier Aggregation: Most stakeholders have opined that operators should have the freedom to aggregate multiple carriers within the V-band without regulatory restrictions. One of the stakeholders has also contended that the splitting of carriers should also be permitted without any regulatory approval.

(iv) Validity Period: Most stakeholders have suggested the validity period for V-band spectrum assignments be co-terminus with the operator's license, providing continuity and certainty for network investments. Some stakeholders have recommended a validity

period of 10 to 20 years to reflect the long-term nature of backhaul infrastructure.

(v) Renewal Mechanism: Most stakeholders have supported a light-touch renewal mechanism. They have recommended renewal by self-declaration or automatic renewal, emphasizing ease and predictability.

(vi) Surrender of Spectrum: Most stakeholders have supported a straightforward mechanism permitting voluntary surrender of V-band spectrum by providing advance notice of 30 days.

(vii) Ceiling on Number of Carriers (Spectrum Cap): A stakeholder has suggested a ceiling of 40 carriers of 50 MHz per Licensed Service Area (LSA) with a view to balance spectrum availability and competition. Another stakeholder has suggested a lower cap of 10 carriers reflecting anticipated demand over the next few years. Another stakeholder has indicated that there should be a 40% in-band ceiling.

(viii) Criteria for Assignment Above Ceiling: Many stakeholders have emphasized that there should be no allocation beyond prescribed ceilings as it defeats the terms and conditions, brings in non-transparency, and defeats certainty in regulatory norms. One of the stakeholders has opined that assignments above the prescribed ceiling should be considered on a case-by-case basis, grounded in genuine operational need, network congestion, and clear performance metrics. A few stakeholders have also suggested that spectrum caps should be reviewed periodically to accommodate evolving demand.

(ix) Roll-out Obligations: Most stakeholders have opined that no specific roll-out obligations should be imposed on V-band spectrum assignments as this spectrum would be used for radio backhauling and would support network infrastructure rather than providing direct consumer service. However, a few stakeholders have suggested to consider roll-out deadlines aligned with ecosystem maturity or license conditions in limited scenarios.

(17) Summary of Comments on Q26

3.32 Q26 is reproduced below:

"In case it is decided to earmark a few carriers in E-band and/or V-band for services/usages as 'Access' and/or 'Integrated Access & Backhaul (IAB)', –

(a) What quantum of spectrum in E-band and V-band should be earmarked for such services/usages?

(b) What should be the eligibility conditions to obtain the spectrum in E-band and V-band for such services/usages?

(c) What should be the terms and conditions for the assignment of spectrum in E-band and V-band through auction such as:

(i) Block size;

(ii) Minimum quantity for bidding;

(iii) Spectrum cap;

(iv) Validity period of the assignment;

(v) Roll-out obligations; and

(vi) Surrender of spectrum etc.?

(d) Should flexible use [i.e., radio backhaul, and last-mile connectivity (fixed wireless access) to the customer equipment] be permitted in frequency ranges earmarked in E-band and/or V-band for such services/usages? If yes, should the terms and conditions of the auction of spectrum be the same as those applicable for 'access spectrum'?

Responses with detailed justifications and international practices may kindly be provided for E-band and V-band separately."

3.33 In respect of E-band, most of the stakeholders have opined that this band should be totally focused on high-capacity backhaul, and no spectrum in the E-band should be earmarked for "Access" or "IAB".

3.34 In respect of V-band, many stakeholders have suggested that this band should be used for radio backhaul purposes only, while many others have suggested that it should be delicensed. One of the stakeholders has submitted that there should be no usage or technology-wise fragmentation of the spectrum in E-band and V-band, and all spectrum should be put to auction, and the successful bidder should be given the option to use the spectrum as per its requirements.

(18) <u>Summary of Comments on Q27 and Q28</u>

3.35 Q27 and Q28 are reproduced below:

"Q27. Whether there is a need for earmarking certain quantum of spectrum in E-band and V-band for point-to-point connectivity requirements of captive (non-commercial/non-TSP) users? If yes,

(a) What quantum of spectrum in E-band and V-band should be earmarked for such purposes?

(b) What should be the terms and conditions for the assignment of spectrum such as:

(i) Carrier size;

(ii) Carrier aggregation;

(iii) Ceiling on the number of carriers;

(iv) Validity period of the assignment;

(v) Renewal mechanism;

(vi) Criteria for the assignment of additional spectrum above the ceiling limit;

(vii) Roll out obligations; and
(viii) Surrender of the spectrum etc.?"
Responses with detailed justifications may kindly be provided for E-band and V-band separately.

Q28. In case your response to Q27 is 'no', in what manner should the point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users be fulfilled? Kindly provide a detailed response with justifications."

3.36 In response to Q27, stakeholders have expressed mixed opinions regarding the need to earmark a portion of the E-band and V-band spectrum for captive or non-commercial users.

3.37 A broad summary of the comments of stakeholders with respect to earmarking certain quantum of E-band spectrum for captive users is given below:

(a) Many stakeholders have opined that E-band spectrum should be available for assignment to all categories of service providers, including those setting up captive networks. They have suggested that 2x250 MHz (paired) should be earmarked for such applications; the minimum validity period of the assignment to such users should be 10 to 20 years; the renewal of spectrum should be straightforward if the efficient use persists and surrender of spectrum should be voluntary.

(b) Many other stakeholders have contended that the E-band spectrum is essential for national 5G transport and backhaul; hence, if any quantum of the E-band spectrum is dedicated for non-commercial users, it would lead to its inefficient use.

3.38 A broad summary of the comments from stakeholders with respect to earmarking certain quantum of the V-band spectrum for captive users is given below:

(a) Many stakeholders have supported dedicating a certain quantum of spectrum in V-band for point-to-point connectivity requirements of captive users.

(b) Many other stakeholders have contended that any fragmentation or diversion of this critical spectrum towards non-commercial use would compromise its optimal utility and undermine ongoing and future efforts to expand and strengthen telecom networks.

3.39 A broad summary of the comments from stakeholders in response to Q28, who are not in favour of earmarking certain quantum of spectrum for point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users in E-band and V-band for point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users, is as below:

(a) The connectivity requirements of captive users in E and V bands can be effectively addressed through bandwidth services offered by telecom service providers, either through business-to-business, or through business-to-consumer arrangements.

(b) The demand of captive (non-commercial/ non-TSP) users can be met through spectrum leasing by access service providers. For this purpose, the policy framework should allow spectrum leasing by access service provider on point-to-point links basis.

(19) Summary of Comments on Q29

3.40 Q29 is reproduced below:

"Whether it is feasible to allow low power indoor consumer device-to-consumer device usages on a license-exempt basis in the V-band in parallel to the use of the spectrum by telecom service providers for the

establishment of terrestrial networks in a part or full V-band? Kindly provide a detailed response with justification and international scenario."

3.41 In response to Q29, many stakeholders have acknowledged the growing importance of enabling low power, indoor license-exempt applications in V-band, given its technical characteristics and international precedents. While many stakeholders have agreed that such usage could coexist with licensed or light-licensed terrestrial deployments, a few others have raised concerns over potential interference management and coordination challenges.

3.42 A broad summary of the comments of stakeholders, who have supported permitting low power indoor license-exempt usage in the V-band, is given below:

(a) V-band offers high propagation loss and oxygen absorption characteristics, naturally confining signals to short distances. This makes it technically suited for indoor consumer device applications such as high-speed data sharing, augmented reality, and uncompressed video transmission. Coexistence is feasible since low power indoor devices pose negligible risk of interference to licensed operations.

(b) Allowing license-exempt usage would promote widespread consumer adoption of advanced devices, support digital inclusion, and drive domestic manufacturing ecosystems for millimeter-wave equipment under open technological frameworks.

(c) Many stakeholders have suggested mandatory adherence to emission masks to ensure interference-free coexistence between user and operator segments.

3.43 A broad summary of the comments of stakeholders, who have raised concerns against the low power indoor license-exempt usage in the V-band, is as follows:

(a) In case the low power indoor license-exempt usage is permitted in the V-band, there will be interference-related issues that will undermine quality of service (QoS) of both sets of services.

(b) Permitting extensive license-exempt usage could complicate frequency planning for 5G backhaul or enterprise-grade fixed wireless deployments operating in the same band.

(c) Device proliferation - even at low power - might result in aggregate interference, particularly in densely populated cityscapes with overlapping user nodes.

(20) <u>Summary of Comments on Q30</u>

3.44 Q30 is reproduced below:

"In case it is decided to allow low power indoor consumer device-to-device usages on a license-exempt basis in the V-band (57–64/66 GHz), -

(a) Should it be permitted in the entire V-band or only in a portion of the V-band? If it should be permitted only in a portion of the V-band, please specify the frequency range.

(b) In case it is decided to permit low power indoor consumer device-to-device usages on a license-exempt basis in the entire V-band, whether the 57–64 GHz range, or the 57–66 GHz range should be considered for such usages?

(c) What should be the carrier size/channel bandwidth?

(d) What should be the definition of indoor usages?

(e) What technical parameters should be prescribed, including EIRP limits for low power indoor consumer device-to-device usages? Kindly provide a detailed response with justifications and international scenario."

3.45 In response to Q30, many stakeholders have supported allowing low power indoor consumer device-to-device communication on a license-

exempt basis in the V-band, citing its technical suitability for short-range applications and alignment with global spectrum policies. However, they expressed different opinions regarding the portion of V-band to be opened for such usage and the associated technical parameters.

3.46 A broad summary of comments from stakeholders who have favoured the 57-66 GHz frequency range of the V-band for low power indoor consumer device-to-device usages on a license-exempt basis, is given below:

(a) The license-exempt range should be extended up to 66 GHz to harmonize with various global jurisdictions, thus ensuring wider ecosystem compatibility and equipment interoperability.

(b) The license-exempt usage of the 57-66 GHz range will allow usage of a wide range of applications including low-power, short-range wireless communications.

3.47 The stakeholders, who have favored the 57-64 GHz range of the V-band for low power indoor consumer device-to-device usages on a license-exempt basis, have opined that the 57-64 GHz range of V-band is the most globally harmonized and widely used segment for license-exempt, short-range, high-speed consumer applications; a mature ecosystem of chipsets, modules, and end-user devices already exists, leading to cost-effectiveness and ready availability.

3.48 A broad summary of comments from stakeholders with respect to the carrier size in V-band for low power indoor consumer device-to-device usages on a license-exempt basis, is given below:

(a) Some stakeholders have opined that the carrier sizes in the V-band should be dictated by the applications utilized under a license-exempt regime on a technology-neutral basis and do not need to be mandated in regulation.

(b) A few stakeholders have submitted that the carrier size should align with IEEE 802.11ad/ay standards; these typically include: 2.16 GHz

(for 802.11ad) as a base channel and channel bonding in multiple 2.16 GHz channels to achieve wider bandwidths (e.g., 4.32 GHz, 8.64 GHz) for 802.11ay.

3.49 A broad summary of comments from stakeholders with respect to the definition of indoor usages in V-band for low power indoor consumer device-to-device usages on a license-exempt basis, is given below:

(a) "Indoor usage" from a regulatory perspective primarily refers to the conditions and activities within enclosed built environments.

(b) To qualify as "indoor usage", the devices must be physically placed within the building and not in the open air.

3.50 A few stakeholders have contended that there is no need to define "indoor-use" for license-exempt deployments in V-band, as "indoor-use" restriction would greatly limit the types of innovative devices allowed on the market and restrict growth.

3.51 A broad summary of comments from stakeholders on technical parameters for the delicensed use in V-band is given below:

(a) A few stakeholders have proposed EIRP limits consistent with global regulatory benchmarks - typically up to 40 dBm peak EIRP for fixed indoor devices and 27 dBm for portable low-power applications - with antenna gains capped at 10–12 dBi.

(b) A few other stakeholders have suggested technical emission masks, and duty cycle controls to prevent unintended outdoor operations.

(21) Summary of Comments on Q31

3.52 Q31 is reproduced below:

"Whether there is a need for permitting 'outdoor' usages of V-band on a license-exempt basis? Kindly provide a detailed response with justification and international scenario."

3.53 Stakeholders have expressed diverse views on permitting the outdoor usage of V-band on a license-exempt basis. While a section of stakeholders has supported a controlled outdoor usage citing its potential for short-range connectivity, others have opposed it citing the issues related to the interference management and coordination with existing and planned telecom backhaul operations in the band.

3.54 A broad summary of the comments of stakeholders who have supported 'outdoor' usages of V-band on a license-exempt basis is given below:

(a) Globally, most regulatory regimes permit license-exempt usage of V-band for outdoor applications. Allowing outdoor usage on license-exempt basis in India would enable 60 GHz devices and networks to benefit from economies of scale already seen globally, encouraging cost-effective domestic manufacturing of fixed wireless equipment. Several important "outdoor" usages of V-band on a license exempt basis are gesture control for vehicle access, robotics obstacle detection, smart city parking spot detection, inventory management, human presence detection etc.

(b) Allowing outdoor use on license-exempt basis would help startups, businesses, and local ISPs to roll out services faster and innovate more easily.

3.55 A broad summary of the comments of stakeholders, who have opposed the "outdoor" usage of V-band on a license-exempt basis, is given below:

(a) V-Band should not be permitted on a license-exempt basis for the outdoor usage due to the potential for interference to licensed services.

(b) Wide and indiscriminate adoption of delicensed spectrum will cause serious interference issues, thus rendering these bands technically unusable for 5G.

(22) Summary of Comments on Q32

3.56 Q32 of the Consultation Paper dated 28.05.2025 is reproduced below: *"If the response to the Q31 is in the affirmative, whether it is feasible to allow outdoor usages on a license-exempt basis in the V-band in parallel to the use of the spectrum by telecom service providers for the establishment of terrestrial networks in a part or full V-band? Kindly provide a detailed response with justification and international scenario."*

3.57 In response to Q32, stakeholders have provided mixed opinions on the feasibility of permitting outdoor license-exempt usage in the V-band alongside licensed operations. While several stakeholders have acknowledged technical feasibility with appropriate mitigation measures, a few others have opposed such usages for protecting planned and existing backhaul deployments from interference.

3.58 A broad summary of the comments from stakeholders, who have supported allowing such parallel usages, is given below:

(a) Many stakeholders have opined that the high oxygen absorption and limited propagation range of V-band signals inherently restrict interference possibilities, enabling shared operation between outdoor unlicensed and licensed uses.

(b) A few stakeholders have cited international practices, including the United States, where the FCC authorizes outdoor operations between 57–71 GHz under Part 15 rules with specified power and beamforming limits, coexisting effectively with licensed link deployments.

(c) A few stakeholders have stated that allowing parallel usage would help accelerate innovation; in turn, it would benefit users through higher bandwidth applications and improved digital inclusion.

3.59 A broad summary of the comments from stakeholders, who have opposed such parallel operations, is as follows:

(a) Telecom networks require clean, interference-free spectrum for high-reliability backhaul. Allowing uncontrolled and license-exempt operation of consumer devices or outdoor use may result in mushrooming of uncoordinated, high-density deployments Such unlicensed deployments would interfere with planned and licensed telecom backhaul links, especially when multiple networks share the same infrastructure. This would lead to degraded spectrum hygiene, eventually rendering the spectrum noisy and unclean for backhaul use of licensed telecom service providers. This would undermine network reliability, especially in urban deployments where V-band is crucial for dense 5G small cell backhaul.

(b) Even though propagation is limited, dense deployments in urban areas could result in cumulative interference, particularly in high-elevation or line-of-sight locations.

(c) Wide and indiscriminate adoption of delicensed spectrum will cause serious interference issues thus rendering these bands technically unusable for 5G.

(23) <u>Summary of Comments on Q33</u>

3.60 Q33 is reproduced below:

"In case it is decided to allow outdoor usages on a license-exempt basis in the V-band (57–64/66 GHz),

(a) Should it be permitted in the entire V-band or only in a portion of the V-band? If it should be permitted only in a portion of the V-band, please specify the frequency range.

(b) In case it is decided to permit outdoor usages on a license-exempt basis in the entire V-band, whether the 57–64 GHz range, or the 57–66 GHz range should be considered for such usages?

(c) What should be the carrier size/channel bandwidth?
(d) What technical parameters should be prescribed, including EIRP limits for low power indoor consumer device-to-device usages?
Kindly provide a detailed response with justifications and international scenario."

3.61 In response to Q33, stakeholders have expressed diverse views regarding outdoor license-exempt usage of the V-band, reflecting differing priorities between promoting unlicensed broadband innovation and protecting carrier-grade backhaul systems. While a set of stakeholders have supported the outdoor usage aligned with internationally prevalent frameworks, others have favored restricting unlicensed operation strictly to indoor environments or only selective V-band sub-ranges. A few other stakeholders have contended that no portion of V-band should be delicensed.

3.62 A broad summary of the comments from stakeholders, who have supported outdoor license-exempt usage in the V-band, is given below:

(a) Many stakeholders have proposed authorizing outdoor operation in the 57–64 GHz range as this portion offers mature device ecosystems conforming to IEEE 802.11ad/ay (WiGig) protocols. A few other stakeholders have suggested allowing operations up to 66 GHz, harmonizing with international practices.

(b) Many stakeholders have suggested flexible channel bandwidths of 100 MHz to 2.16 GHz, aligning with WiGig and 5G NR-U standards, allowing flexibility for both short-range data transfer and short-hop fixed wireless backhaul uses.

(c) Many stakeholders have suggested to adopt already developed international standards for outdoor usages on a license-exempt basis in V-band.

(24) Summary of Comments on Q34

3.63 Q34 is reproduced below:

"Any other suggestions relevant to the assignment of the spectrum in E-band (71–76/81–86 GHz) and V-band (57–64/66 GHz) may kindly be made with detailed justifications."

3.64 In response to Q34, the feedback reflected a demand for balanced regulation that supports investment certainty for operators while simultaneously encouraging innovation through flexible spectrum access for emerging technologies. A broad summary of the suggestions provided by stakeholders is given below:

(a) Stakeholders have emphasized the need for early, transparent release of spectrum in both E-band and V-band to accelerate high-capacity backhaul for 5G rollouts and to prepare for 6G transport readiness. Many stakeholders have called for timely issuance of comprehensive guidelines to maintain regulatory predictability.

(b) Several stakeholders have recommended adopting a hybrid licensing framework combining administrative light-licensing for E-band and uncoordinated/ shared licensing for V-band to ensure optimal use of these bands.

(c) Many stakeholders have suggested clear co-existence rules should be defined between licensed and unlicensed uses in the V-band, including emission masks, and power thresholds.

B. Analysis of the issues related to E-band and V-band

(1) Scope of services/ usages in E-band

3.65 As outlined in Chapter-I of these recommendations, E-band spectrum refers to the line-of-sight radio waves in the frequency range of 71 GHz

to 76 GHz paired with 81 GHz to 86 GHz. These frequencies correspond to wavelengths between about 3.3 mm and 5 mm, fitting within the millimeter wave range. E-band frequencies generally require line-of-sight (LOS) conditions for effective communication. This is due to their high frequency which results in limited diffraction and greater susceptibility to blockage by physical objects such as buildings, trees, and even atmospheric factors like rain and moisture.

3.66 With the introduction of mobile broadband technologies (such as 4G and 5G), cellular mobile data traffic has witnessed a remarkable growth. The following figure depicts annual mobile data usage in India in the last 11 years.

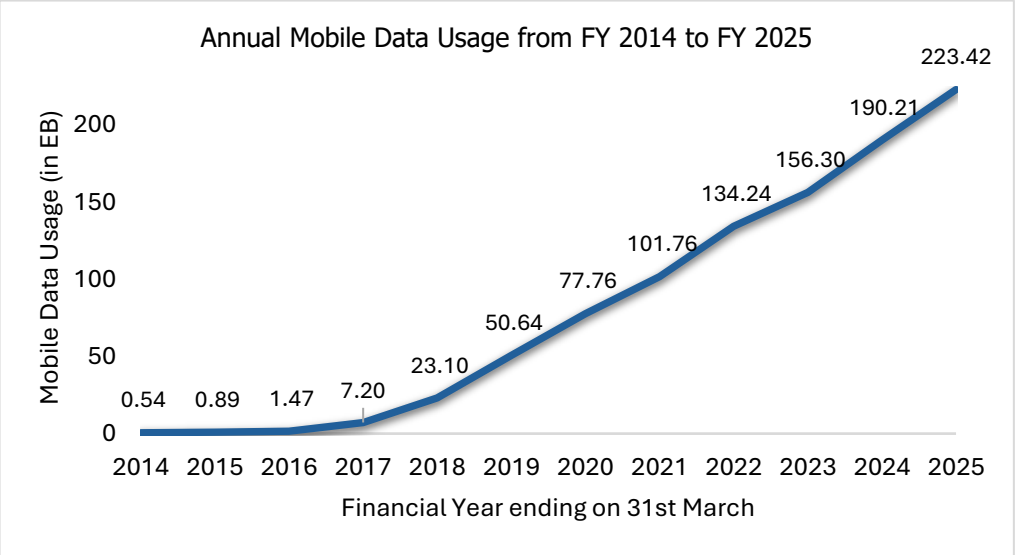


Figure 3.1: Annual Mobile Data Usage in the Past 11 Years in India

3.67 As may be seen from the above, the mobile data traffic has followed a "hockey stick curve" depicting sudden and extremely rapid growth after a significant period of tepid growth. With the consistent rise in the adoption of 5G, the mobile data traffic in the country is set to grow substantially in the future.

3.68 Worldwide, until mobile broadband technologies (such as 4G and 5G) became prominent, only traditional microwave backhaul bands (the frequencies of these bands are below 24 GHz) were used for radio backhauling - mainly due to their favorable propagation characteristics. However, with the steady growth of mobile data traffic, the cellular mobile service providers started experiencing constraints in backhauling their mobile data traffic with their existing carriers in traditional microwave backhaul bands. They started looking for "high capacity" wireless backhaul systems. Eventually, this pursuit led to the identification of E-band as a new backhaul band for backhauling mobile broadband traffic.[79]

3.69 In India, the spectrum in E-band started being used for radio backhauling by wireless access service providers since July 2022. DoT has assigned upto two carriers of 250 MHz (paired) bandwidth in E-band to wireless access service providers as an interim measure for backhaul use on a provisional basis[80].

3.70 Through the Reference dated 13.09.2024, DoT requested TRAI to, *inter-alia*, determine the scope of service/ usage of E-band and to provide recommendations on the *methodology of the assignment of spectrum and associated terms and conditions in line with the determination of scope*

[79] Even after the introduction of E-band for radio backhauling, traditional microwave backhaul bands continue to remain important for mobile backhauling as they can cater to much longer backhaul links than E-band.

[80] On 25.07.2022, DoT issued "the Guidelines for allotment of E-band (71-76/81-86 GHz) carriers to Telecom Service Providers (TSPs) with Access Service authorization/ license and having Access Spectrum in IMT bands" . A relevant extract from these guidelines is given below:

"*1. TSPs, based upon their application, would be allotted a maximum of two carriers of 250 MHz each (paired) bandwidth in E-band (71-76/81-86) GHz for their backhaul purpose in the LSAs where they are holding Access Spectrum in IMT bands.*

…

5. All E-band carriers assigned, as an interim measure, will be purely on temporary and provisional basis and all such assignees will have to participate in the auction and/or any other assignment methodology, as decided by the Government after considering the recommendations of the TRAI in this regard.

6. The E- band carriers, assigned as an interim measure, will stand reverted back to the Government, after a period of three months from the date of finalization of results of aforesaid activity as detailed/stipulated in para 5 above in case such assignees fail to get back the carriers/ spectrum provisionally assigned as an interim measure."

Source: https://dot.gov.in/sites/default/files/Guidelines%20for%20allotment%20of%20E-band%20dated%2025%2007%202022%20signed.pdf

of services/ usages by TRAI i.e., Access, or Backhaul, or Integrated Access & Backhaul (IAB).

3.71 As mentioned in Chapter I of these recommendations, "Access" is the last mile connectivity to consumer devices, and "Backhaul" is the link connecting the access network with the core network[81]. "Integrated Access and Backhaul (IAB)" is a new concept[82] which was introduced by 3GPP in Release 16. A brief description of IAB is given below.

3.72 IAB standardized by 3GPP in Release 16 is aimed to enhance 5G New Radio (NR) capabilities by permitting the wireless backhaul to share the same spectrum as access links. The architecture of an IAB network, as defined by 3GPP Release 16, is depicted in the following figure. The network nodes in an IAB network are either 'IAB donors' or 'IAB nodes'. The IAB donors connect to the core network with OFC and can provide wireless access services to mobile users as well as wireless backhauling to IAB nodes. The IAB nodes provide wireless access services to mobile users and wireless backhauling to other IAB nodes as well.[83]

[81] ITU, in the 'Terms and Definitions for Network 2030'[81], has defined "access network" as the last mile connectivity to the consumer device. It may be mobile radio, copper, fibre, satellite or terrestrial floating network. The backhaul may be considered as a hand-off layer between access and transport/core network.
Source: https://www.itu.int/en/ITU-T/focusgroups/net2030/Documents/Network_2030_Terms_and_Definitions.pdf

[82] ITU, in its Report on 'Future technology trends of terrestrial International Mobile Telecommunications systems towards 2030 and beyond', has noted that in future, IAB should be considered as a critical axis of ultra-dense radio access networks; IAB can facilitate replacing fibre optics with wireless, and could reduce both capital expenditures and operating expenses of backhaul links. Source: https://www.itu.int/dms_pub/itu-r/opb/rep/R-REP-M.2516-2022-PDF-E.pdf

[83] Source: https://www.mdpi.com/2078-2489/15/1/19

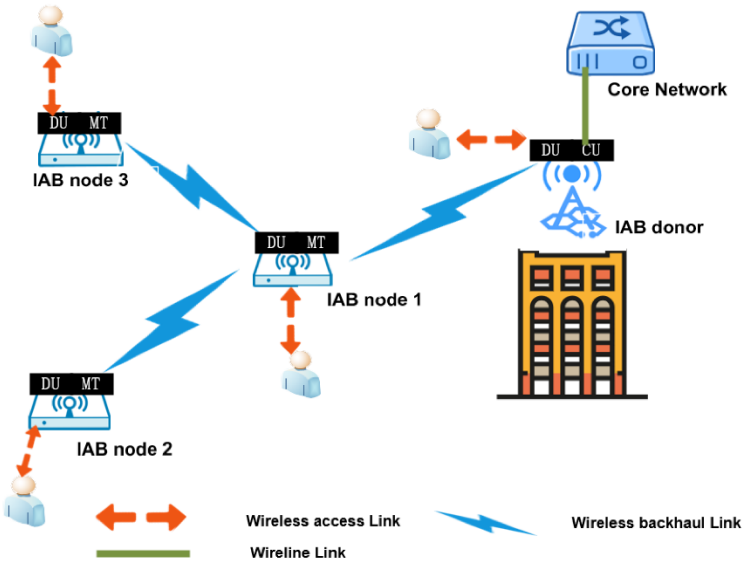


Figure 3.2: Architecture of Integrated Access and Backhaul (IAB)[84]

3.73 According to 3GPP, the frequency range designation in which 5G new radio (NR) can operate are as below:

(a) FR1 (410 MHz – 7125 MHz),

(b) FR2-1 (24250 MHz – 52600 MHz), and

(c) FR2-2 (52600 MHz – 71000 MHz).

3.74 Further, 5G NR IAB is designed to operate in the following bands:

(a) n41 (2496-2690 MHz), n77 (3300-4200 MHz), n78 (3300-3800 MHz), and n79 (4400-5000 MHz) of FR1, and

(b) entire FR2-1[85].

3.75 From the frequency range designations of 3GPP for 5G NR and 5G NR IAB, it may be seen that E-band is neither designated for 5G NR nor for 5G IAB.

[84] Source: https://www.mdpi.com/2078-2489/15/1/19

[85] Source: https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3665

3.76 In this context, the Authority, through Q18 and Q26 of the Consultation Paper dated 28.05.2025, solicited comments from stakeholders on the following aspects:

(a) Q18 regarding the level of demand of the spectrum in E-band for backhaul, access, and IAB separately.

(b) Q26 regarding the terms and conditions of the assignment of spectrum in E-band in case it is decided to earmark a few carriers in E-band for access and/ or IAB.

3.77 In response to Q18, most of the stakeholders have opined that E-band should be designated exclusively for backhaul purposes to avoid destabilizing existing networks and to ensure sufficient capacity for evolving 5G requirements. In support of their contention, they have made mainly the following arguments:

(a) Deploying the E-band for non-backhaul purposes could impact network stability and degrade service quality.

(b) The device ecosystem, technical standards, and operational track record decisively support exclusive backhaul use in the current context.

(c) Allowing for usages beyond backhaul, especially before a device ecosystem matures for access or IAB, may hinder network efficiency and reliability.

3.78 In response to Q26, most of the stakeholders have opined that E-band should be totally focused on high-capacity backhaul, and no spectrum in the E-band should be earmarked for "Access" or "IAB". One of the stakeholders is of the view that there should be no usage or technology-wise fragmentation of spectrum, and all spectrum should be put to auction, and the successful bidder will have the option to use it as per its requirements.

3.79 The Authority has taken note of the following aspects with respect to E band:

(a) E-band radios operate with very narrow, high-gain pencil beams. Wireless backhaul systems in E-band frequencies can transmit highly focused, point-to-point "pencil beam" signals and require essentially line-of-sight or near-line-of-sight as signals attenuate rapidly when they encounter obstructions. This makes frequency coordination, interference mitigation, and path planning much simpler in the E-band.

(b) E-band offers large contiguous blocks of 5 GHz (paired), which can enable carriers of larger bandwidth to offer high-capacity data links required for high-capacity backhaul. These characteristics make E-band highly suitable for high-capacity backhaul.

(c) Commercial E-band equipment is widely available and standardized for point-to-point backhaul; meaning thereby, mature products and a deployment ecosystem are available for backhaul purposes in E-band. E-band has not been identified for IMT by ITU. Further, E-band is neither designated for 5G NR nor for 5G IAB, by 3GPP. Therefore, the eco-system for access and IAB in E-band has not yet developed.

(d) As per Ericsson's Microwave Outlook Report 2024[86], E-band has been on a remarkable journey over the last decade and is now extensively used as a 5G backhaul band. As per the ETSI White Paper[87] on E-Band (2020), the E-band can cover the most popular 5G uses cases, requiring high capacity over relatively short hops up to 2 km. As per the report[88] of GSMA and ABI Research on

[86] Source: https://www.ericsson.com/4a7bec/assets/local/reports-papers/microwave-outlook/2024/ericsson-microwave-outlook-report-2024.pdf

[87] Source:https://www.etsi.org/images/files/ETSIWhitePapers/etsi-WP-37-E-Band-survey-on-Status-of-Worldwide-Regulation.pdf

[88] Source: https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2022/04/wireless-backhaul-spectrum.pdf

'Wireless Backhaul Evolution' (2021), E-band will be important across all regions and is expected to enjoy an exceptional growth of 11.6% CAGR from 2021 to 2027. According to ABI Research[89], E-band links are expected to grow to over 2.5 million by the year 2027 making up 33% of total wireless backhaul links.

(e) E-band is highly suitable for backhaul purposes and access service providers have already deployed this band significantly, after its provisional assignment in the year 2022. There has been a significant uptake of E-band in urban areas particularly for backhauling the mobile broadband traffic.

3.80 Considering the above, the Authority is of the following view:

(a) The spectrum in traditional microwave backhaul bands is not sufficient for catering to high-capacity backhaul links required in the modern mobile broadband networks (4G and 5G). Today, the use of E-band for backhauling has become imperative to meet the growing need of high-capacity backhaul. A successful scale up of mobile broadband services will depend highly upon the availability of E-band spectrum for backhauling the mobile traffic.

(b) E-band has not been identified for IMT, nor is it designated for 5G IAB; Thus, the eco-system for access and IAB in E-band has not yet developed. Therefore, it would be pre-mature to allocate E-band for licensed "Access" or "IAB" at this stage. In any case, sufficient spectrum has been made available for access service in a variety of globally harmonized frequency spectrum bands.

3.81 Considering the above, the Authority is of the opinion that, at this stage, there is no need to earmark any spectrum in E-band for access, or IAB purposes, and the entire spectrum in E-band should be assigned for backhaul purposes only.

[89] Source: https://www.rcrwireless.com/20230807/5g/the-use-of-e-band-for-backhaul-a-key-ingredient-for-successful-5g-beyond-analyst-angle

3.82 In light of the foregoing discussion, **the Authority recommends that -**

(a) The spectrum in E-band (71-76 GHz, paired with 81-86 GHz) should be assigned for "Backhaul" purposes only.

(b) No spectrum in E-band should be assigned for "Access" or "Integrated Access and Backhaul (IAB)".

(2) Scope of services/ usages in V-band

3.83 V-band is also called "the 60 GHz band". There are two distinct band designations for V-band viz. (a) 57-64 GHz, and (b) 57-66 GHz[90]. At present, in India, the spectrum in V-band has not been assigned for any licensed use. However, DoT has delicensed 500 MHz spectrum in 61-61.5 GHz range for the use of non-specific short range radio frequency devices[91].

3.84 Through the Reference dated 13.09.2024, DoT requested TRAI to, *inter-alia*, determine the scope of service/ usage of V-band (57-64/66 GHz) and to provide recommendations on the *methodology of the assignment of spectrum and associated terms and conditions in line with the determination of scope of services/ usages by TRAI i.e., Access, or Backhaul, or Integrated Access & Backhaul (IAB)*.

[90] In the Reference dated 13.09.2024, DoT mentioned that "*[t]he V-band is generally referred to as 57-64 GHz. The extended V-band is considered to be from 57 to 66 GHz range*."

[91] DoT has delicensed, *inter-alia*, the 61-61.5 GHz range through the 'Use of Low Power and Very Low Power Short Range Radio Frequency Devices (Exemption from Licensing Requirement) Rules, 2018' dated 18.10.2018. The transmit power limit for such devices is 100 mW eirp. The devices are required to comply with EN 305 550 standard for effective use of spectrum and to avoid harmful interference.

Source: DoT's G.S.R. 1047(E) dated 18.10.2018, accessible at the following URL: https://dot.gov.in/sites/default/files/License%20Exemption%20for%20SRD%20Device%20G_S_R_1047%28E%29%20dated%2018th%20October%2C%202018_1.pdf?download=1

3.85 In this context, the Authority, through Q19 and Q26 of the Consultation Paper dated 28.05.2025, solicited comments from stakeholders on the following aspects:

(a) Q19 regarding the level of demand of the spectrum in V-band for backhaul, access, and IAB separately.

(b) Q26 regarding the terms and conditions of the assignment of spectrum in V-band in case it is decided to earmark a few carriers in V-band for access and/ or IAB.

3.86 In response to Q19, most of the stakeholders have opined that V-band is suited for short-range, high-capacity backhaul, particularly for connecting dense 5G small cells where laying fiber is not feasible. They have provided the following arguments in support of their contention:

(a) Due to its shorter propagation characteristics, V-band can help connect the street furniture, which are essential part of the 5G urban infrastructure.

(b) Global deployments demonstrate successful use of V-band for wireless backhaul due to its large contiguous bandwidth and inherent frequency reuse potential.

3.87 Notably, many stakeholders, in response to Q19, have expressed that the V-band should be delicensed for low power applications.

3.88 The Authority has noted that a defining feature of V-band is the strong absorption of radio signals by atmospheric oxygen (O_2), peaking around 60 GHz as depicted in the following figure:

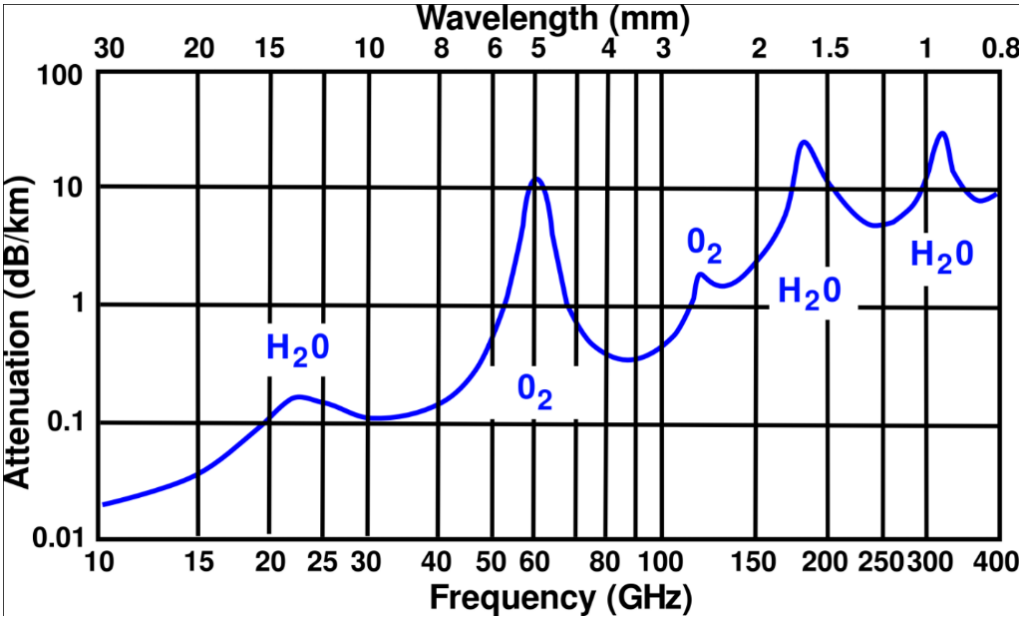


Figure 3.3: Attenuation of signals due to atmospheric absorption[92]

3.89 As may be seen from the above figure, the attenuation of signals due to oxygen absorption in V-band is of the order of 15 dB/ km. As a result, radiations in the V-band are quickly reduced. Though it limits the distances that a V-band link can cover, it also makes a V-band link highly immune to interference from other V-band links. V-band antennas are highly directional and together with the propagation limitations, wireless systems operating at V-band frequencies can transmit highly focused, point-to-point "pencil beam" signals allowing a much higher reuse of the same frequency in a given area. These propagation characteristics together with the fact that a large bandwidth of 9 GHz is available in the band make the spectrum in the V-band a good candidate for short-hop high-capacity backhauling. The applications could include radio backhaul solutions for 5G small cells.

[92] https://www.slideserve.com/ednaa/wigig-technologies-ieee-802-11ad-ay-powerpoint-ppt-presentation

3.90 The Authority has also noted the following aspects with respect to the V-band:

(a) ITU has identified the 66-71 GHz range for IMT, but not the 57-66 GHz range (V-band).

(b) 3GPP has designated the 57-71 GHz range as 5G NR band n263. In its technical specification No. 3GPP TS 38.101-2 V19.2.0 (2025-09)[93], 3GPP has stated that "*[t]he band n263 is for unlicensed operation and subject to regional and/or country specific regulatory requirements.*"

(c) V-band is not covered in the frequency ranges designated by 3GPP for 5G NR IAB.

3.91 Based on the comments of stakeholders and its analysis, the Authority notes that V-band has emerged as a potential band for "Backhaul" in 5G small cells. The spectrum in V-band might also be used in the networks of other types of telecom service providers such as wireline access service providers and Internet service providers for providing short-hop backhaul links. As far as the potential usage of V-band for licensed "Access" or "IAB" is concerned, the Authority notes that there is no clear demand for licensed "Access" or "IAB" for V-band. The device eco-system and standards for licensed "Access" or "IAB" for V-band have not yet developed. Therefore, it would be pre-mature to allocate V-band for licensed "Access" or "IAB" at this stage. In any case, sufficient spectrum has been made available for access service in a variety of globally harmonized frequency spectrum bands.

3.92 Considering the above, the Authority is of the opinion that, at this stage, there is no need to earmark any spectrum in V-band for licensed "Access", or "IAB" purposes, and the entire spectrum in V-band should be assigned for "Backhaul" purposes only.

[93] Source: https://www.3gpp.org/ftp/Specs/archive/38_series/38.101-2/

3.93 In light of the foregoing discussion, **the Authority recommends that-**

(a) The spectrum in V-band should be assigned for "Backhaul" purposes only.

(b) No spectrum in V-band should be assigned for "Access" or "Integrated Access and Backhaul (IAB)".

(3) Eligibility for assignment of spectrum in E-band and V-band for radio backhaul purposes

3.94 As per the guidelines dated 25.07.2022 for the provisional allotment of E-band carriers, the carriers in the E-band spectrum have been assigned only to wireless access service providers. In this context, the Authority, through Q20, Q27 and Q28 of the Consultation Paper dated 28.05.2025, solicited comments from stakeholders on the following aspects:

(a) Q20 regarding commercial telecommunication services for which the spectrum in E-band and V-band should be assigned for radio backhaul purposes

(b) Q27 and Q28 regarding the need for E-band and V-band for captive users

3.95 In response to the consultation process, a few stakeholders opined that the spectrum in E-band and V-band should be assigned to wireless access service providers only for backhaul purposes. On the other hand, many stakeholders contended that the spectrum in E-band and V-band spectrum should be assigned for backhaul purposes to all categories of service providers, including captive users.

3.96 The Authority notes that the issue as to which types of entities should be eligible to obtain backhaul spectrum has also come in the matter of the assignment of spectrum in traditional microwave backhaul bands. This issue has been dealt with in Chapter II of these recommendations. At that

stage, the Authority had noted that the requirement of wireless access service providers for the backhaul spectrum is quite high as they have to connect thousands of cellular base stations with their core network elements; however, other types of telecom service providers such as long-distance operators, internet service providers, wireline access service providers etc. and non-commercial captive users also require backhaul spectrum for interconnecting network elements (other than the customer equipment) in their telecommunication networks; though the requirement of such telecom service providers for backhaul spectrum is relatively less than wireless access service providers (owing to the size, and diversity of the network). In this regard, the Authority, after a comprehensive analysis, arrived at the conclusion that the spectrum in traditional microwave backhaul bands should be assigned to all types of authorised entities which may require to establish point-to-point links for interconnecting telecommunication equipment (other than the customer equipment) in their telecommunication networks.

3.97 The Authority notes that to meet the need for high capacity backhaul, the spectrum in E-band and V-band would be useful for not only wireless access service providers but also other types of telecom service providers (such as ISPs, wireline access service providers and long-distance service providers) and captive service providers.

3.98 Considering the above, the Authority is of the opinion that the spectrum in E-band and V-band should be assigned to all types of authorised entities which may require to establish point-to-point links for interconnecting telecommunication equipment (other than the customer equipment) in their telecommunication networks. Similar to the recommendations given in Chapter II in respect of the assignment of backhaul spectrum in traditional microwave backhaul bands, it would be proper to include a provision in the terms of assignment of backhaul spectrum in E-band and V-band, that the backhaul spectrum can be used for self-use only.

3.99 In view of the above, **the Authority recommends that –**

(a) Any authorised entity, including captive users, which may require spectrum for radio backhaul purposes [i.e. for deploying point-to-point links to interconnect telecommunication equipment (other than the customer equipment) in its telecommunication network] should be made eligible to obtain spectrum in E-band and V-band.

(b) It should be included in the terms of assignment of backhaul spectrum in E-band and V-band that the assigned backhaul spectrum can be used for self-use only.

(4) Band plan and carrier size in E-band and V-band for backhaul purposes

3.100 In the year 2012, ITU issued its recommendation ITU-R F.2006 on 'Radio Frequency Channel and block arrangements for fixed wireless systems operating in the 71-76 and 81-86 GHz bands'[94]. Through the recommendation, ITU recommended several radio frequency channel arrangements in the E-band with a guard band of 125 MHz at the top and bottom of each 5 GHz range (i.e. 71-76 GHz range, and 81-86 GHz range). In the first arrangement, there are 19 FDD channels of 250 MHz each with a duplex separation of 10 GHz between them. In the second arrangement, there are 19 FDD channels of 250 MHz each with a duplex separation of 2.5 GHz between them. In the third arrangement, there is a flexibility to decide about deployment in TDD, FDD, or their mixed use of the band. In short, the ITU recommendation permits both FDD and TDD duplexing and allows several channel arrangements.

[94] https://www.itu.int/dms_pubrec/itu-r/rec/f/R-REC-F.2006-0-201203-I!!PDF-E.pdf

3.101 DoT, while making provisional assignments of the spectrum in the E-band to access service providers has adopted the ITU's first channel arrangement viz. 19 FDD channels of 250 MHz each with a duplex separation of 10 GHz between them. This channel arrangement may be depicted as below:

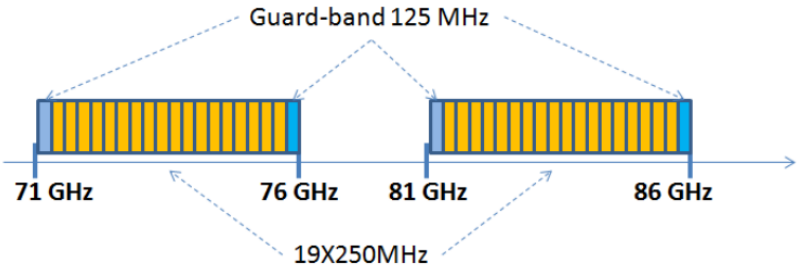


Figure 3.4: The channel plan adopted by India for the provisional assignment of the spectrum in E-band

3.102 In the year 2014, ITU issued its recommendation ITU-R F.1497-2 on 'Radio-frequency channel arrangements for fixed wireless systems operating in the band 55.78-66 GHz[95]. The recommendation permits both FDD and TDD duplexing scheme in the 57-66 GHz range. In respect of the FDD duplex separation, ITU has stated that the FDD duplex separation is not specifically identified; it may be either left free or defined at national level according to the needs.

3.103 In the afore-mentioned recommendation, ITU has divided the 57-64 GHz range into 140 channels of 50 MHz size. ITU has said that channels n=1,2 may be considered as guard band towards the lower band 55.78-57 GHz possibly subject to different coordination conditions; in this case they should only be used for temporary purposes or equipment alignment and propagation tests; in the upper band edge, there is no need for a guard band because the same system might appropriately operate also in the adjacent band.

[95] RECOMMENDATION ITU-R F.1497-2 - Radio-frequency channel arrangements for fixed wireless systems operating in the band 55.78-66 GHz

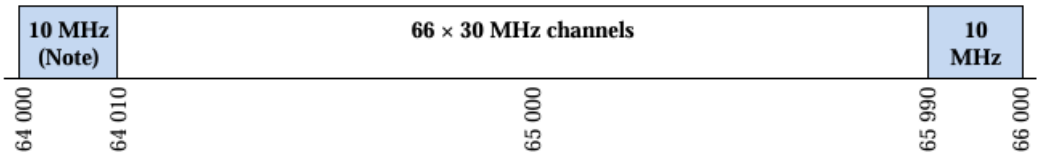
3.104 In effect, as per the ITU's recommendation, 138 channels of 50 MHz size are available in V-band for the carriage of traffic. The following figure depicts the channel arrangement in 57-64 GHz range.

Bands limits (GHz) →	57-59							59-63					63-64		
50 MHz Slot number	1	2	3	4	.....	39	40	41	42	.....	119	120	121	.....	140
	Guard Band				.....					.....				.....	

Figure 3.5: Channel Arrangement for the 57-64 GHz range[96]

3.105 In the 64-66 GHz range, ITU has given flexibility of two channel sizes viz. 30 MHz and 50 MHz. With the channel size of 30 MHz and 50 MHz, the TDD-based channel arrangements in the 64-66 GHz range are given below:

Basic 30 MHz channel TDD arrangement 64-66 GHz



NOTE – When used in conjunction with a contiguous lower band (from 57-64 GHz range in Annex 2 of this Recommendation), this guard band may also be used.

Basic 50 MHz channel arrangement 64-66 GHz
(used in conjunction with arrangement in lower band)

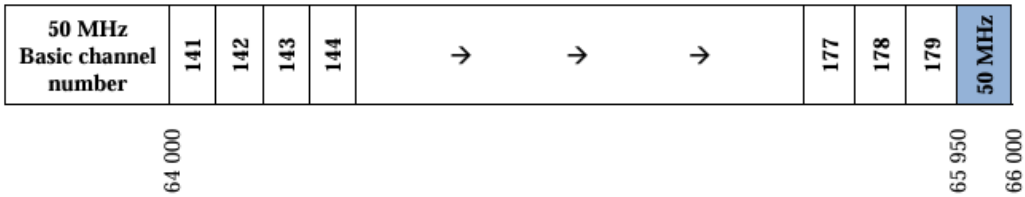


Figure 3.6: TDD-based Channel Arrangements for the 64-66 GHz range[97]

[96] RECOMMENDATION ITU-R F.1497-2 - Radio-frequency channel arrangements for fixed wireless systems operating in the band 55.78-66 GHz

[97] RECOMMENDATION ITU-R F.1497-2 - Radio-frequency channel arrangements for fixed wireless systems operating in the band 55.78-66 GHz

3.106 It is worth mentioning that TRAI, through the Recommendations dated 29.08.2014, had recommended as below in respect of band plan, carrier size and carrier aggregation in E-band and V-band:

"Channel bandwidth for E-band (71-76 GHz and 81-86 GHz) should be 250 MHz with a guard band of 125 MHz at the top and bottom of each 5 GHz band. More than one channel can be allowed and allocated for aggregation.

Channel bandwidth for V-band (57-64 GHz) should be 50 MHz with a 100 MHz guard band at the beginning of the band. More than one channel can be allowed and allocated for aggregation. "

3.107 In this context, the Authority, through Q23 and Q25 of the Consultation Paper dated 28.05.2025 solicited comments from stakeholders on, *inter-alia*, band plan, carrier size and carrier aggregation in E-band and V-band for radio backhaul purposes of commercial telecom services. Further, through Q24, the Authority solicited comments from stakeholders as to which frequency range (57-64 GHz, or 57-66 GHz) in V-band should be adopted for radio backhaul purposes.

3.108 With respect to the band plan for E-band, most of the stakeholders have suggested that the internationally harmonized FDD band plan in accordance with ITU-R F.2006 should be followed. The Authority notes that this band plan has already been followed by DoT while granting provisional assignments of carriers in E-band as per the guidelines of July 2022. The Authority agrees with the views of stakeholders of using FDD duplexing scheme for E-band, aligning with international standards (ITU-R F.2006), with a 10 GHz duplex gap between 71–76 GHz and 81–86 GHz.

3.109 With respect to the carrier size in E-band, most of the stakeholders have suggested a standardized carrier size of 250 MHz paired, as per the prevailing policy regime and global practice. The Authority notes that 250

MHz carrier size aligns with global vendor ecosystems. Adopting a carrier size of 250 MHz would be practical and equipment-friendly, which would also enable scalable throughput by combining carriers. Operationally, using a uniform 250 MHz carrier size ensures regulatory simplicity and continuity with operator's current practice, avoiding churn or costly equipment redesigns. Accordingly, the Authority concurs with the views of stakeholders on the carrier size of 250 MHz (paired) for E-band.

3.110 About the frequency range (57-64/ 66 GHz) in V-band that should be adopted for radio backhaul purposes, most of the stakeholders have opined that the entire frequency range (57-66 GHz) should be adopted for this purpose, noting its alignment with international practices and technical standards. Regarding the guard band requirement between the adjacent band identified for IMT, i.e., 66-71 GHz, a few stakeholders have submitted that the channel arrangements specified in ITU-R F.1497-2 already incorporate a final 50 MHz guard band, reserved specifically to prevent interference. The Authority concurs with these views of stakeholders.

3.111 With respect to the band plan for V-band, most stakeholders have suggested that the ITU-R Recommendation F.1497-2 for radio frequency channel arrangements in the 57-66 GHz band should be followed. The Authority concurs with this view of stakeholders on the band plan for V-band.

3.112 With respect to the carrier size in V-band, many stakeholders have favored a carrier size of 50 MHz, aligned with earlier TRAI recommendations and global practices. The Authority concurs with the view of stakeholders on the carrier size of 50 MHz in V-band.

3.113 With respect to permitting carrier aggregation in E-band and V-band, stakeholders are unanimously of the view that the spectrum assignees

should be permitted to aggregate the spectrum carriers assigned to them. A few stakeholders have also contended that the splitting of carriers should also be permitted without any regulatory approval. The Authority concurs with these views of stakeholders on carrier aggregation and carrier splitting. Further, the Authority is of the view that if an entity takes more than one carrier in a frequency band, DoT should, to the extent feasible, ensure that the entire spectrum assigned to it is in contiguous form.

3.114 In view of the above, with respect to E-band and V-band, **the Authority recommends that –**

(a) For assignment of spectrum in E-band, the Frequency Division Duplexing (FDD) based configuration (71-76 GHz, paired with 81-86 GHz), with carrier size of 250 MHz (paired) and guard bands of 125 MHz at the top and bottom of each 5 GHz band, should be adopted.

(b) For assignment of spectrum in the V-band, the Time Division Duplexing (TDD) based configuration (57-66 GHz), with a carrier size of 50 MHz, with a 100 MHz guard band at the beginning and a 50 MHz guard band at the end, should be adopted.

(c) The spectrum assignee should be permitted to aggregate or split the carriers assigned to it without any approval from the Central Government.

(d) If an entity is assigned more than one carrier within a band, DoT should, to the extent feasible, ensure that the entire spectrum assigned to it is in contiguous form.

(5) Mechanism for the assignment of spectrum in E-band and V-band for backhaul purposes

3.115 As per a report on "Backhaul Media for 5G and beyond" published in Ericsson Microwave Outlook (October 2025)[98], today, microwave backhaul is used in 75 percent of the live 5G networks worldwide. Huawei, in its white paper on Microwave Industry (2022)[99] has mentioned that E-band is the leading choice for 5G backhaul in urban and sub-urban areas. V-band, on the other hand, has emerged as good candidate for backhauling the traffic from 5G small cells. Considering that E-band and V-band are important bands for radio backhauling the cellular mobile traffic in 5G and beyond, it would be important to put in place an enabling mechanism for spectrum assignment in these bands under the proposed new policy regime for backhaul spectrum.

Method of assignment of spectrum in E-band and V-band

3.116 As mentioned in Chapter II of these recommendations, globally, over a period of time, mainly two methods have evolved for the assignment of backhaul spectrum viz. (a) block-based assignment, and (b) link-based assignment. In case a carrier of backhaul spectrum is assigned to any entity on a block-basis in a licensed service area, the entity can establish any number of backhaul links using that carrier in the licensed service area. On the other, if a carrier of backhaul spectrum is assigned to an entity on a link-basis between two designated points, only one link between the designated points can be established; the entity cannot establish backhaul links elsewhere using that carrier without obtaining prior permission from DoT.

[98] Source: https://www.ericsson.com/4a8a43/assets/local/reports-papers/microwave-outlook/2025/microwave-outlook-2025_report.pdf

[99] Source: https://www-file.huawei.com/admin/asset/v1/pro/view/e1e2b7a3a7934ef9a07b9c0f630256af.pdf

3.117 The Authority, through Q21 of the Consultation Paper dated 28.05.2025, solicited comments from stakeholders on the method of assignment of spectrum in E-band and V-band. In response to Q21, stakeholders have generally supported a block-based assignment to wireless access service providers citing that the link-based assignment would be cumbersome as a huge number of links would be deployed by wireless access service providers. A stakeholder has suggested that two carriers [250 MHz (paired)] should be earmarked in E-band for backhauling enterprise traffic; these carriers should be assigned on a point-to-point link basis. For V-band, many stakeholders have suggested that the spectrum in V-band should be given on a shared access basis.

3.118 With respect to the method of assignment of the spectrum in E-band, the Authority has taken note of the following aspects:

(a) As per the existing practice for the provisional spectrum assignment in E-band, the spectrum in E-band is assigned to wireless access service providers on a block-basis in a licensed service area. At present, there is no provision for assignment of E-band spectrum to other types of telecom service providers or captive users.

(b) In the last three years since 2022 when E-band carriers started being assigned in the country, wireless access service providers in India have established thousands of point-to-point links using the E-band carriers assigned to them. Considering the steady year-on-year growth in the demand for the broadband mobile traffic in the country, wireless access service providers are likely to densify 5G radio access networks in the future to cater to the increasing demand, particularly in urban and sub-urban areas. As 5G radios are added on more base station sites, the throughput on such base station sites will grow, necessitating the addition of E-band carriers in the backhaul network.

3.119 Considering the above, the Authority agrees with the view of stakeholders that in the future, with thousands of point-to-points links established using E-band carriers in each LSA, the assignment of E-band carriers on a link-to-link basis would become cumbersome and impractical; on the other hand, block-based assignment would ensure speed, operational agility, and a lower regulatory burden. Accordingly, the Authority is of the view that the assignment of E-band carriers to wireless access service providers should be done on a block-basis in a licensed service area for backhauling wireless access network traffic.

3.120 With respect to the assignment of E-band carriers for backhauling the telecommunication traffic other than wireless access network traffic, the Authority is of the view that unlike the massive deployment of backhaul links by wireless access service providers for backhauling their wireless access network traffic, the deployment of backhaul links by authorised entities, including captive users, for backhauling their telecommunication traffic other than wireless access network traffic would generally be selective and much less spread out geographically. Therefore, link-based assignment would be preferable for such usages as it would allow precise and need-based deployment, encourage the reuse of spectrum, and minimize under-utilization of spectrum. Accordingly, the Authority is of the view that the assignment of E-band carriers to authorised entities, including captive users, for backhauling their telecommunication traffic other than wireless access network traffic should be done on a point-to-point link-basis.

3.121 With respect to the assignment of the spectrum in V-band, the Authority has taken note of the following aspects:

(a) Though V-band has emerged as a potential radio backhaul band for 5G small cells, this band has yet to be opened for radio backhaul purposes in many countries. The eco-system and deployment

scenarios of V-band devices are still in an infant stage. Most of the countries have already permitted the delicensed usage of this band.

(b) Given the propagation characteristics of V-band, including the significant absorption of radio waves by oxygen, V-band backhaul links may find their use only in limited cases. Therefore, the use of the V-band spectrum for radio backhaul purposes is not likely to be across the length and breadth of an LSA. The spectrum in V-band is likely to be deployed mostly in dense-urban areas, and sometimes in urban areas.

(c) Considering the deployment scenario of the spectrum in V-band, TRAI, through the Recommendations dated 29.08.2014, had recommended that the spectrum in V-band should be assigned on a link-basis.

3.122 Considering the above, the Authority is of the view that the spectrum in V-band should be assigned to all types of authorised entities on a point-to-point link basis.

3.123 In light of the foregoing discussion, **the Authority recommends that –**

(a) E-band carriers should be assigned on a block-basis in a Licensed Service Area to wireless access service providers for backhauling their wireless access network traffic.

(b) E-band carriers should be assigned on a point-to-point link basis to authorised entities, including captive users, for backhauling their telecommunication traffic other than wireless access network traffic.

(c) V-band carriers should be assigned on a point-to-point link basis to all types of authorised entities, including captive users, for radio backhaul purposes.

Ceiling on the number of carriers (spectrum cap) in E-band

3.124 As per the guidelines of July 2022, at most two E-band carriers of 250 MHz (paired) bandwidth may be assigned to a wireless access service provider in an LSA. In response to the present consultation process, most stakeholders have advocated increasing the current cap from two to four carriers of 250 MHz (paired) per LSA considering the future projections for mobile data usage in the country. Some stakeholders have recommended a periodic review of the ceiling on carriers to reflect evolving network requirements. The Authority notes that many stakeholders have suggested that two carriers of 250 MHz (paired) bandwidth should be earmarked for authorised entities other than wireless access service providers, including captive users for radio backhaul purposes.

3.125 At present, in India, four wireless access service providers are actively providing wireless access services in each LSA. In case a ceiling of four carriers per wireless access service provider is prescribed, as suggested by a few stakeholders, it will amount to a total of 16 carriers. Further, considering that there are 19 carriers in E-band, out of which, two carriers would be required for the link-based assignment to meet the requirements of other authorised entities and captive users, only one carrier will be left for any new player in the wireless access service segment.

3.126 Considering the above, the Authority is of the view that for E-band, the present ceiling of two carriers per wireless access service provider should be increased to three carriers per wireless access service provider, and two carriers should be earmarked for other authorised entities and captive users for the link-based assignment.

3.127 Further, it is noted that the E-band equipment generally supports the entire band; however, for the sake of convenience, the Authority is of the view that the wireless access service providers currently holding E-band carriers

should be given an option to retain their existing carriers, and the same should be counted for the purpose of the ceiling on the number of carriers.

3.128 In view of the above, **the Authority recommends that for E-band-**

(a) There should be a ceiling of three carriers, each of 250 MHz (paired) bandwidth, which may be assigned to a wireless access service provider on a block-basis in any LSA in E-band.

(b) The wireless access service providers currently holding E-band carriers in any LSA should be given an option to retain their existing carriers in the LSA, and the same should be counted for the purpose of the ceiling on the number of carriers in the LSA.

(c) Two carriers in E-band should be earmarked for the assignment on a point-to-point link basis to authorised entities, including captive users, for backhauling their telecommunication traffic other than wireless access network traffic.

Ceiling on the number of carriers (spectrum cap) in V-band

3.129 The V-band (57-66 GHz range) has a total of 9 GHz of unpaired spectrum. Considering the carrier size of 50 MHz, with a 100 MHz guard band at the beginning and a 50 MHz guard band at the end, as recommended in an earlier sub-section, a total of 177 carriers of 50 MHz each are available for assignment for radio backhaul purposes.

3.130 In the present consultation process, a stakeholder has suggested a ceiling of 40 carriers of 50 MHz per LSA with a view to balance spectrum availability and competition. Another stakeholder has suggested a lower cap of 10 carriers reflecting anticipated demand over the next few years.

3.131 The Authority is of the view that since V-band will be opened for radio backhaul for the first time and E-band is already available for radio backhaul, a ceiling of 20 carriers, i.e. 1 GHz unpaired spectrum per link would be sufficient for all practical purposes.

3.132 In view of the above, **the Authority recommends that there should be a ceiling of 20 carriers each of 50 MHz (unpaired) bandwidth per link for the point-to-point link-based assignment in V-band.**

Need for stipulating rollout obligations for the backhaul spectrum in E-band and V-band

3.133 The Authority has examined the issue of stipulating rollout obligations for the backhaul spectrum in traditional microwave backhaul bands in Chapter II of these recommendations. The Authority is of the view that the provisions for rollout obligations associated with backhaul spectrum in E-band and V-band for radio backhaul should be similar to those recommended for traditional microwave backhaul bands.

3.134 In view of the above, **the Authority recommends that there should be no roll-out obligations associated with the assignment of backhaul spectrum in E-band and V-band.**

Validity Period of the proposed new regime for the assignment of spectrum in E-band and V-band for backhaul purposes

3.135 In Chapter II of these recommendations, the Authority, based on the comments of stakeholders and a comprehensive analysis on the matter, arrived at the conclusion that the validity period of the proposed regime for the assignment of backhaul spectrum in traditional microwave backhaul bands should be such that it may provide adequate regulatory certainty to operators as well as sufficient flexibility to the Central Government to make

necessary amendments in the policy regime in line with the market developments and international scenario. Accordingly, the Authority has recommended that the terms and conditions for the assignment of spectrum in traditional microwave backhaul bands including spectrum pricing, recommended through these recommendations, should remain valid for a period of five years from the date of notification of the proposed new policy regime for the assignment of backhaul spectrum by the Central Government, further extendable by a period of upto two years.

3.136 The Authority is of the view that the necessity to provide adequate regulatory certainty to operators as well as sufficient flexibility to the Central Government to make necessary amendments in the policy regime in line with the market developments and international scenario applies to E-band and V-band as well. Accordingly, the Authority is of the view that it would be proper to keep the validity period of the proposed new regime for the assignment of spectrum in E-band and V-band as five years. The Government may, if deemed necessary, extend the policy regime by a period of upto two years.

3.137 In view of the above, **the Authority recommends that the terms and conditions for the assignment of spectrum in E-band and V-band including spectrum pricing, recommended through these recommendations, should remain valid for a period of five years from the date of notification of the proposed new policy regime for the assignment of backhaul spectrum by the Central Government, further extendable by a period of upto two years.**

Maximum period for which spectrum in E-band and V-band should be assigned for radio backhaul purposes

3.138 In the present consultation process, many stakeholders have opined that the validity period for the assignment of spectrum in E-band and V-band

should be reasonably long to provide sufficient certainty for telecom service providers to plan their investments in network infrastructure (towers, equipment, deployment). The validity period suggested by stakeholders ranges between 10 to 20 years.

3.139 In Chapter II of these recommendations, the Authority, based on the comments of stakeholders and a comprehensive analysis on the matter, has arrived at the conclusion that the backhaul spectrum in 6 GHz (lower), 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands is vital for business continuity of wireless access service providers; therefore, it would be proper that any backhaul spectrum in these bands, once assigned to wireless access service providers, is not ordinarily withdrawn from them until they continue to provide wireless access services.

3.140 In this regard, the Authority is of the view that the spectrum in E-band also plays an important role in mobile broadband networks such as 4G and 5G. Further, the spectrum in V-band is likely to play a key role in 5G small cells. Accordingly, it would be proper that any backhaul spectrum in E-band and V-band, once assigned to wireless access service providers for backhauling wireless access network traffic, is not ordinarily withdrawn from them until they continue to provide wireless access services.

3.141 Considering the above, the Authority is of the view that provisions in respect of the maximum period of assignment of spectrum in E-band and V-band should be similar to the provisions in respect of the maximum period of assignment of spectrum in traditional microwave backhaul bands.

3.142 Accordingly, **the Authority recommends that –**

(a) Under the policy regime for the assignment of backhaul spectrum recommended through these recommendations (hereinafter, referred to as "the proposed policy regime"),

the maximum period of assignment of the backhaul spectrum in E-band and V-band should be as below:

(i) <u>For block-based assignments (including renewal) in E-band</u>:

The spectrum should remain assigned under the proposed policy regime, if the wireless access service provider continues to hold the authorisation for providing access service as well as access spectrum in the LSA, <u>AND</u> the wireless access service provider does not surrender the assigned backhaul spectrum in E-band.

(ii) <u>For point-to-point link-based assignments in E-band and V-band</u>:

The spectrum assignment should remain valid for the period of assignment applied for by the authorised entity under the proposed policy regime *provided* that:

the authorised entity continues to hold the authorisation under Section 3 of the Telecommunications Act, 2023 under which the backhaul spectrum has been assigned, <u>AND</u> the authorised entity does not surrender the assigned backhaul spectrum.

(b) Any revision in the terms and conditions of the assignment (including renewal) of backhaul spectrum in E-band and V-band including spectrum pricing notified by the Central Government after a period of five years from the date of notification of the policy regime recommended through these recommendations, should become applicable to all authorised entities, including the existing spectrum assignees.

(c) While assigning (including renewal) the backhaul spectrum in E-band and V-band under the policy regime

recommended through these recommendations, a condition should be included in the terms of assignment of backhaul spectrum stating that whenever the policy regime is revised after five years, the existing backhaul spectrum assignments at that time shall have to conform to the revised policy regime, including any changes in the backhaul spectrum pricing.

(d) It should be explicitly conveyed to the spectrum assignees that the Central Government may withdraw the assigned backhaul spectrum at the stage of the revision of the policy regime in case:

(i) The authorised entity does not accept the terms and conditions under the revised policy regime, or

(ii) The Central Government decides to repurpose the usage of E-band and/ or V-band.

Surrender of backhaul spectrum in E-band and V-band before expiry of the validity period

3.143 The issue of surrender of backhaul spectrum in traditional microwave bands has been examined in Chapter II of these recommendations. The Authority is of the view that the provision for surrender of backhaul spectrum for the spectrum in E-band and V-band for radio backhaul purposes should be similar to that recommended for traditional microwave bands. Accordingly, **the Authority recommends that-**

(a) Any entity holding spectrum in E-band or V-band should be permitted to surrender its microwave carriers after giving prior notice of at least 30 calendar days through the Central Government's online portal. In case a wireless access service provider desires to surrender backhaul spectrum in E-band assigned to it on a block-basis, it should also be required to submit certified proof of payment regarding

payment of spectrum charges up to the previous quarter of the date of application.

(b) DoT should issue the letter to the applicant entity regarding taking the surrender of spectrum on record within 30 calendar days from the date of the application.

Procedure for the assignment of the backhaul spectrum in E-band and V-band, and the need for a comprehensive online portal for the assignment of backhaul spectrum

3.144 In Chapter II of these recommendations, the Authority has formulated comprehensive recommendations for the procedure to be followed by DoT for assignment and renewal of the backhaul spectrum, and the need for a comprehensive online portal for the assignment of backhaul spectrum. Those recommendations will also apply on all frequency bands of backhaul spectrum including E-band and V-band. Accordingly, the Authority is not making any separate recommendations for the procedure for the assignment of the backhaul spectrum in E-band and V-band.

(6) License-exempt usage of V-band

3.145 DoT, through the Reference dated 12.08.2022, had informed that *"[i]n the V-band, the device/ chipset eco-system supporting various technologies for data transfer between consumers' devices, such as smartphones, cameras, laptops, etc., has developed. The technologies used for such devices are designed for short-range, indoor, interference-tolerant applications. Therefore, while the V-band spectrum can be assigned for the establishment of indoor/ outdoor telecom networks, allowing low-power, indoor usages of V-band on a license-exempt basis for consumer device-to-consumer device data transfer may go a long way in serving greater public interest and realizing significant socio-economic gains."* In this regard, through the Reference dated 13.09.2024, DoT

requested TRAI to provide recommendations on *"[f]easibility & technical parameters, for allowing low power, indoor, consumer device-to-consumer device usage on license-exempt basis in V-band …"*

3.146 In this context, the Authority, through Q29 to Q33 of the Consultation Paper dated 28.05.2025, solicited comments from stakeholders on the following aspects:

(a) Q29 regarding the feasibility for allowing low power indoor consumer device-to-consumer device usages on a license exempt basis in V-band in parallel to the licensed use

(b) Q30 regarding the frequency range within V-band within which low power indoor consumer device-to-consumer device usages should be permitted on a license exempt basis and technical parameters for such usages

(c) Q31 regarding the need for permitting "outdoor" usage of V-band on a license-exempt basis

(d) Q32 regarding the feasibility for allowing outdoor usages on a license exempt basis in V-band in parallel to the licensed use

(e) Q33 regarding the frequency range within V-band within which outdoor usages should be permitted on a license exempt basis and technical parameters for such usages

3.147 In response to Q29, many stakeholders have opined in favour of allowing low power indoor consumer device-to-consumer device usages on a license exempt basis in V-band in parallel to the licensed use. In support of their contention, they have opined that owing to high propagation loss and oxygen absorption characteristics, coexistence is feasible since low power indoor devices pose negligible risk of interference to licensed operations. On the other hand, a few other stakeholders have raised concerns over potential interference-related issues citing that the proliferation of unlicensed devices -even at low power - might result in

aggregate interference, particularly in densely populated cityscapes with overlapping user nodes.

3.148 In response to Q30, while some stakeholders have suggested that low power indoor consumer device-to-consumer device usages should be permitted on a license exempt basis in the 57-64 GHz range, some other stakeholders have suggested that such usage should be permitted in the entire 57-66 GHz range. The stakeholders have generally favored that the technical parameters should align with global standards to ensure wider ecosystem compatibility and equipment interoperability.

3.149 In response to Q31, some stakeholders have supported controlled outdoor usages in V-band. In support of their contention, they have cited its potential for short-range connectivity and have stated that globally most regulatory regimes permit outdoor on license-exempt V-band usage. On the other hand, some stakeholders have opposed the "outdoor" usage of V-band on a license-exempt basis due to potential for interference to licensed services.

3.150 In response to Q32, several stakeholders have acknowledged technical feasibility of outdoor usages on a license exempt basis in V-band in parallel to the licensed use, with appropriate mitigation measures. On the other hand, a few other stakeholders have opposed such usages for protecting planned and existing backhaul deployments from interference.

3.151 In response to Q33, many stakeholders have supported limited outdoor usage aligned with international spectrum frameworks in the entire V-band. On the other hand, a few stakeholders have favored restricting unlicensed operation strictly to indoor environments or only selective V-band sub-ranges.

3.152 In this context, the Authority has perused the developments in V-band at international level and has observed that ITU has issued recommendations for short-range communication in V-band. The Authority has also perused the prevalent regulatory regimes with respect to the delicensed usage of the V-band. A brief description of such developments is given below:

ITU Recommendation on MGWS in V-band

3.153 In 2018, ITU issued its recommendation[100] on 'Multiple Gigabit Wireless Systems in frequencies around 60 GHz'. Multiple Gigabit Wireless Systems (MGWS) radiocommunication networks can be used in short-range, line-of-sight (LOS) and non-line-of-sight (NLOS) circumstances with traditional wireless local area network (WLAN) topologies. MGWS systems can also be used in very short-range high-rate proximity communications where the radio range is a few centimeters with devices pairing point-to-point in proximity to each other. Salient points of the ITU's recommendation are given below:

(a) WLAN: For WLAN, multiple gigabit performance is typically expected at ranges around 10 m for in-room use when devices typically possess a few (≤ 3) dozen antenna elements, to a few hundred meters for outdoor use when devices can be equipped with several (≥ 6) dozen antenna elements.

(b) WPAN: For proximity communication, performance up to 100 Gbps is expected with a range of 10 cm or less (devices nearly touching) with transient connections (rapid setup and teardown). In some applications, nomadic devices connect with stationary devices (i.e. kiosk, doorway, turnstile, vending machine) for a very short duration to transfer large amounts of data, e.g. download two hours of HD

[100] Source: https://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.2003-2-201801-I!!PDF-E.pdf

video content in 250 milliseconds while passing through an entry turnstile at a train station or airport.

3.154 The key points of the ITU's recommendation with respect to the use of spectrum in the V-band for MWGS are given below:

(a) To satisfy the requirements of MWGS, a minimum of 7 GHz contiguous spectrum in the 57-71 GHz is needed.

(b) A channel bandwidth of 2.16 GHz is required for single channels. Bonding of single channels is allowed.

(c) Centre frequencies for single channels are recommended to be at 58.32 GHz, 60.48 GHz, 62.64 GHz, 64.80 GHz, 66.96 GHz, and 69.12 GHz.

3.155 A brief description of the practices being followed in a few countries with respect to the delicensed usage of the V-band is given below:

United States of America (USA)

3.156 In USA, the Part 15 rules[101] permit low-power intentional radiators (popularly known as "unlicensed devices") to operate without an individual license where such use is not anticipated to cause harmful interference to authorized users of the radio spectrum[102]; unlicensed devices in the 57-71 GHz band generally include indoor/ outdoor communication devices such as WiGig[103] wireless local area networking (WLAN) devices, outdoor fixed point-to-point communication links, and

[101] The term "Part 15 rules" refers to Part 15 (Radio Frequency Devices) of subchapter-A (General) of Chapter I (Federal Communications Commission) of Title 47 (Telecommunications) of the Code of Federal Regulations of USA.

[102] The fundamental operating conditions under Part 15 are that the operator of a Part 15 device has no vested right to continued use of any given frequency, must accept interference that may be caused by the operations of authorized users or other unlicensed devices, and must not cause harmful interference it causes. Should harmful interference occur, the operator is required to immediately correct the interference problem, even if correction of the problem requires ceasing operation of the part 15 equipment causing interference.

[103] WiGig, alternatively known as 60 GHz Wi-Fi, refers to a set of 60 GHz wireless network protocols. It includes the current Institute of Electrical and Electronics Engineers (IEEE) IEEE 802.11ad standard and also the IEEE 802.11ay standard. The name WiGig comes from Wireless Gigabit Alliance, the original association being formed to promote the adoption of IEEE 802.11ad. However, it is now certified by Wi-Fi Alliance.

field disturbance sensors (FDS) – which includes radar operations. Section 15.255 (Operation within the band 57-71 GHz) of the Part 15 rules mandates that within the 57-71 GHz band, emission levels shall not exceed the following equivalent EIRP[104]:

Device Type	Power Limits
Devices other than field disturbance sensors	(i) The average power of any emission shall not exceed 40 dBm and the peak power of any emission shall not exceed 43 dBm; or (ii) For fixed point-to-point transmitters located outdoors, the average power of any emission shall not exceed 82 dBm, and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi. The peak power of any emission shall not exceed 85 dBm, and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi.
Field disturbance sensors/ radars	Shall not exceed −10 dBm peak conducted output power and 10 dBm peak EIRP except that field disturbance sensors/ radars that limit their operation to all or part of the specified frequency band may operate without being subject to a transmitter conducted output power limit if they operate in specific frequencies, for which separate EIRP levels have been defined.

3.157 Unlicensed device users must account for the operations of authorized Federal and non-Federal users in the band, who operate under a variety of co-primary allocations. These allocations, which vary by band segment, consist of the Mobile, Fixed, Inter-Satellite, Earth-Exploration Satellite

[104] Source: https://www.ecfr.gov/current/title-47/chapter-I/subchapter-A/part-15/subpart-C/subject-group-ECFR2f2e5828339709e/section-15.255

Service (EESS), Space Research, Mobile-Satellite, Radiolocation, Radionavigation, and Radionavigation-Satellite services.[105]

United Kingdom (UK)

3.158 In UK, the 57-71 GHz band can be used to provide wireless access solutions (e.g. small base stations fixed to a lamppost) or to provide wireless backhaul (e.g. point to point links). These can be used to provide broadband services or help to connect a variety of other technologies such as Internet of Things (IoT) or Machine-to-Machine (M2M) networks. The authorisation needed to use the 57–71 GHz band varies depending on the equipment being used as outlined below:

(a) Licence-exempt low power indoor use- No license is required for the usage of the spectrum in the 57-71 GHz range at or below 40 dBm EIRP.[106]

(b) Licensed outdoor use- The "Spectrum Access: EHF license" is required for the outdoor usage of the spectrum in the 57-71 GHz range above 40 dBm EIRP upto 55 dBm EIRP.[107]

Australia

3.159 Australian Communications and Media Authority (ACMA) through Radiocommunications (Low Interference Potential Devices) Class Licence 2015[108] has authorised use of Low Interference Potential Devices (LIPDs) on shared frequencies, *inter-alia*, in the frequency ranges 57–71 GHz for

[105] Source: https://docs.fcc.gov/public/attachments/DOC-373482A1.pdf

[106] For Wideband Data Transmission System (WBDTS), Equipment must not form part of a fixed outdoor installation. Equipment may be used airborne. Source: Ofcom's IR 2030 – UK Interface Requirements 2030- Licence Exempt Short Range Devices (SRDs), accessible at https://www.ofcom.org.uk/siteassets/resources/documents/spectrum/interface-requirements/ir-2030.pdf?v=335258

[107] Power limits on outdoor use: 55 dBm EIRP, 38 dBm/MHz EIRP density and a transmit antenna gain ≥ 30 dBi Source: Spectrum Access: EHF Licence- Licensing guidance document, accessible at https://www.ofcom.org.uk/siteassets/resources/documents/manage-your-licence/spectrum-access-ehf/spectrum-access-ehf-licence-guidance.pdf?v=325307

[108] https://www.legislation.gov.au/F2015L01438/2023-03-02/text

which there is no need to apply for a licence or pay any fees. The technical conditions on various transmitters permitted in the 57-71 GHz range are given below:

Class of transmitter	Frequency band (MHz)	Maximum EIRP	Main technical conditions
All transmitters	57000-71000	100 mW	(a) The maximum transmitter power must not exceed 10 mW. (b)The maximum radiated power spectral density must not exceed 13dBm per 1 MHz.
Data communications transmitters	57000-71000	20 W	The transmitter must comply with FCC Rules Title 47 Part 15 Section 255[109].
Data communications transmitters used outdoors	59000–63000	150 W	(a) The transmitter must not be operated on board an aircraft. (b) The maximum transmitter power must not exceed 20 mW. (c) The transmitter must not cause spurious emissions outside the band at or greater than –30 dBm/MHz. (d) The transmitter must only be used outdoors.
Fixed point-to-point links used outdoors	57000-71000		The transmitter must comply with FCC Rules Title 47 Part 15 Section 255.

[109] https://www.ecfr.gov/current/title-47/section-15.255

New Zealand

3.160 In New Zealand, the government has allowed the following two general user licenses in the 57-71 GHz range:

(a) General User Radio Licence for Fixed Radio Link Devices (GURL-FRLD)[110]

(b) General User Radio Licence for Short Range Devices (SRDs)[111]

3.161 A general user licence lets people use particular types of radio transmitters without needing a licence of their own. General user licences are free of charge.[112]

3.162 Under the afore-mentioned general use licenses, the frequency use is on a shared basis. Any person using frequencies in the 57-71 GHz range must not cause intentional harmful interference to licensed services operating in the 57-71 GHz range.

[110] Any person may transmit radio waves in the 57-71 GHz range using Fixed Radio Link Devices, including those known as U-NII devices, using digital modulation techniques to typically provide high data rate fixed point-to-point communications. However, point-to-multipoint systems, omni-directional applications and multiple co-located transmitters transmitting the same information are not permitted.
The power limit under General User Radio Licence for Fixed Radio Link Devices is 55 dBm with the following conditions:
(a) Transmitter peak power must not exceed –3 dBW (500 mW) and the power spectral density must not exceed –10 dBm/MHz. For emission bandwidths less than 100 MHz, the transmitter peak power of –3 dBW (500 mW) must be prorated by (bandwidth (MHz) / 100 (MHz)).
(b) The peak power of any emission must not exceed 55 dBW e.i.r.p., or minus 2 dB for every dB that the antenna gain is less than 51 dBi. The average power of any emission shall not exceed 52 dBW e.i.r.p., or minus 2 dB for every dB that the antenna gain is less than 51 dBi.
Source: https://gazette.govt.nz/notice/id/2022-go3099

[111] Any person may transmit radio waves in the 57-71 GHz range using Short Range Devices (SRDs), also known as Restricted Radiation Devices (RRDs), Low Interference Potential Devices (LIPDs), or Spread Spectrum Devices (SSDs).
The power limit under General User Radio Licence for Short Range Devices (SRDs) is 13 mW e.i.r.p. A higher power upto 25 dBm is permitted with the following conditions:
(a) For devices transmitting at 10 dBW e.i.r.p. or less, the power spectral density must not exceed -7 dBW/MHz e.i.r.p. and the maximum transmit power must not exceed -3 dBW at the antenna port or ports.
(b) For devices transmitting greater than 10 dBW e.i.r.p., the power spectral density shall not exceed 8 dBW/MHz e.i.r.p and antennas with a gain greater than 30 dBi shall be used.
Source: https://gazette.govt.nz/notice/id/2022-go3100

[112] Source: https://www.rsm.govt.nz/about/our-work/general-user-licences

Singapore

3.163 In March 2011, The Infocomm Development Authority (IDA), Singapore issued a Decision outlining the regulatory framework for the 60 GHz frequency band[113]. Through the said decision, IDA mandated that the 60 GHz band will be available under two categories of licensing framework as follows:

(a) Licence-exempt (low power devices with EIRP <=40 dBm)

(b) Licenced (high power devices with EIRP >40 dBm)

3.164 A summary of frequency allocations and regulatory framework of IDA, Singapore in respect of the V-band is given below:

Applications	**Authorised Frequency Band**	**RF Output Power**	**Key Requirements**
MGWS WPAN/ WLAN	57-66 GHz	Not to exceed 40 dBm EIRP	• Indoor use is restricted to a maximum mean EIRP density limit of 13 dBm/MHz • Outdoor use is restricted to a maximum EIRP of 25 dBm and a maximum EIRP power spectral density of -2 dBm/MHz
Point-to-Point fixed wireless systems including fixed LAN	57.1-62.9 GHz[115]	Not to exceed 55 dBm EIRP	• Equipment is not allowed on aircraft or satellites • Minimum antenna gain of +30 dBi and maximum

[113] https://www.imda.gov.sg/regulations-and-licences/regulations/consultations/consultation-papers/2016/consultation-on-proposed-regulatory-framework-for-60-ghz-frequency-band

[115] Excluding guard bands of 100 MHz at each end of the spectrum

extension (FLANE) applications[114]			transmitter output power of +10 dBm • Maximum transmit output power density is limited to -10dBm/MHz

3.165 IDA, Singapore in its decision also mentioned that *"[w]here these devices are used to form a wide area network for service provisioning to third parties, applications shall have to apply for FBO or SBO licenses."*[116]

3.166 From the above, it can be inferred that many countries, such as the USA, UK, Canada, New Zealand, Australia, and Singapore permit the usage of V-band spectrum for low-power short-range devices (with specified power limits) on a license-exempt basis. In addition to the delicensed usage, the UK and Singapore have a licensed regime for wireless systems operating with higher power (EIRP between 40 dBm and 55 dBm) in the V-band.

3.167 On the issue related to the delicensed usage of V-band in parallel to licensed usage, the Authority has taken note of the following aspects:

(a) In the consultation process, many stakeholders have supported allowing low power indoor, as well as outdoor usage on licensed-exempt basis in V-band with technical parameters aligned with global standards, in parallel to the licensed usage.

(b) Allowing low-power indoor applications on a license-exempt basis supports a wide array of consumer and industrial innovations. Key examples include wireless docking stations, ultra-fast data transfer between devices, streaming, radar-based gesture control, presence and motion detection, in-vehicle safety sensors, home automation, and healthcare monitoring. These use cases require extremely high

[114] In the decision, IDA mentioned that high radiation equipment (>40 dBm EIRP) may be permitted only in the 57-63 GHz frequency band in view of future Intelligent Transport System ("ITS") deployed in the 63-64 GHz band.

[116] FBO and SBO are acronyms of "Facilities-Based Operators" and "Service-Based Operators" respectively.

bandwidth but only over short distances. The combination of a wide contiguous spectrum, small cell size, and limited propagation ensures that these indoor uses do not impact outdoor telecom operations.

(c) Similarly, very low-power outdoor use, for example, vehicle radar, smart parking, robotics obstacle detection, and smart city sensors, can be safely accommodated through EIRP caps. Outdoor SRDs and radar sensors operate at short ranges (typically a few meters) and use spread spectrum or ultra-wideband waveforms, producing minimal interference potential. As mentioned by a few stakeholders, a modest-power transmitter in V-band experiences over 70 dB free-space loss within the first meter, and more loss due to atmospheric absorption and rain-fade beyond that, ensuring that outdoor SRDs cannot harmfully affect licensed backhaul links located on towers with directional high-gain antennas.

(d) Globally, many countries have either completely de-licensed V-band for low power applications or have permitted the delicensed usage of V-band in both indoor and outdoor in parallel to the licensed usage in the band.

3.168 The Authority also notes that DoT, through a letter dated 08.05.2025, has informed that it "*has decided to de-license the lower 6 GHz band (5925-6425 MHz) for low power applications. Relevant rules are under consideration in the Department for notification*." In this regard, DoT, on 16.05.2025, has circulated draft rules for public consultation by the name (draft) "Use of Low Power and Very Low Power Wireless Access System including Radio Local Area Network in Lower 6 GHz band (Exemption from Licensing Requirement) Rules, 2025". The draft rules provide, *inter-alia*, as below:

"4. Exemption. — No Authorization or Frequency Assignment shall be required to establish, maintain, work, possess or deal in any wireless

equipment for the purpose of Lower Power Indoor and Very Low Power outdoor wireless access systems, including radio local area networks operating in the frequency band 5925-6425 MHz on noninterference, non-protection and shared (nonexclusive) basis, and complying with the following technical parameters; namely:

Table

Low power indoor and Very Low Power Outdoor WAS/ RLAN Access Points and devices

Device Type	*Max. PSD e.i.r.p for in-band emissions*	*Max. e.i.r.p for in band emissions*	*Max. Emission Bandwidth*	*Out of band emissions (Max e.i.r.p density)*
Low Power Indoor	*5 dBm/MHz*	*30 dBm*	*320 MHz*	*-27 dBm/MHz*
Very Low Power Outdoor	*-5 dBm/MHz*	*14 dBm*	*320 MHz*	*-27 dBm/MHz*

…"

3.169 As may be seen from the above table, DoT has proposed that low power indoor and very low power outdoor wireless access systems, including radio local area networks operating in the frequency band 5925-6425 MHz can be permitted to operate on noninterference, non-protection and shared (nonexclusive) basis with the following maximum EIRP:

(a) 30dBm (1Watt) for low power indoor wireless access systems, including RLAN

(b) 14 dBm (25 milli Watt) for very low power outdoor wireless access systems, including RLAN

3.170 The Authority notes that as per the information provided by DoT through the letter dated 08.05.2025, the spectrum in 5925-6425 MHz range [6

GHz (lower)] has been assigned not only for radio backhaul purposes (Fixed Service) but also to numerous teleport providers, digital satellite new gathering (DSNG) service providers, headend-in-the-sky (HITS) service providers, and captive Very Small Aperture Terminal (VSAT) service providers in India. In Chapter II of these recommendations, the Authority, based on the comments of stakeholders and international practice on the matter, has already arrived at the conclusion that radio backhaul links in the 6 GHz (lower) band can well co-exist with delicensed low power indoor and very low power outdoor wireless access systems in the band.

3.171 In this sub-section, the feasibility of the delicensed usage of low power indoor and very low power outdoor applications in V-band in parallel with licensed microwave backhaul operations in the band is being examined. This is quite similar to the proposed delicensed usage of the 6 GHz (lower) band in parallel to the licensed use.

3.172 In light of the above, it can be inferred that permitting low-power indoor and very low-power outdoor license-exempt operation in V-band alongside licensed fixed services (radio backhaul) is technically feasible, globally harmonized, and economically advantageous. By adopting a non-interference, non-protection regime with well-defined limits for EIRP, power spectral density (PSD), and out-of-band-emission (OOBE), full potential of this spectrum for next-generation short-range communication and sensing applications can be unlocked to stimulate innovation; at the same time harmful interference-free operation of licensed radio backhaul links can be enabled.

3.173 Therefore, the Authority is of the view that, in parallel to the licensed fixed services (radio backhaul), license-exempt usage should be permitted in V-band for both low-power indoor and very low-power outdoor usage for applications such as Multi Gigabit Wireless System (MGWS), Wireless

Access System (WAS), Radio Local Area Network (RLAN), Wireless Personal Area Network (WPAN), Short-Range Devices (SRDs), sensing applications (including radar, and IoT functions) etc. on a non-interference, non-protection, and shared (non-exclusive) basis.

Whether entire V-band or a portion of V-band should be permitted for license-exempt operation

3.174 Through the Consultation Paper dated 28.05.2025, the Authority solicited inputs from stakeholders through Q30 and Q33 as to whether the low power indoor and very low power outdoor applications should be permitted on a license-exempt basis in the entire V-band (57-66 GHz) or only a portion of the V-band. In response to Q30 and Q33, many stakeholders have opined that such usages should be permitted in the entire V-band.

3.175 The Authority notes that globally, in many countries such as USA, UK, Australia, New Zealand and Singapore, the license exempt operation is permitted in the entire V-band (57-66 GHz). The Authority also notes that in the 57-66 GHz frequency range, the following four channels of 2.16 GHz (as recommended by ITU in its recommendations on MGWS) may be considered for MWGS:

Table 3.1: Frequency channels in 57-66 GHz range for MGWS

Channel	Start Frequency (GHz)	Centre Frequency (GHz)	End Frequency (GHz)
1.	57.24	58.32	59.40
2.	59.4	60.48	61.56
3.	61.56	62.64	63.72
4.	63.72	64.80	65.88

3.176 Based on the comments of stakeholders and its analysis on the matter, the Authority is of the view that the entire V-band (57-66 GHz range) should be permitted for both license-exempt usages alongside licensed fixed backhaul services, as technical conditions and international experience confirm that coexistence is feasible. The V-band's high oxygen absorption and strong propagation loss naturally confine low-power emissions to short ranges, preventing interference with high-power directional backhaul links. Globally, regulators already allow unlicensed use in this range under non-interference, non-protection rules, supporting widespread consumer and industrial applications like WiGig (IEEE 802.11ad/ay), SRD, radar sensors, AR/VR streaming, etc. Allowing 57–66 GHz in India would harmonize with the global norms, leverage the mature device ecosystem, and spur domestic innovation.

Carrier Size

3.177 About the carrier size, the stakeholders were generally of the view that carrier sizes in the V-band should be dictated by the applications utilized under a license-exempt regime and should not be mandated through regulation. The Authority concurs with the views of the stakeholders that the channel bandwidth or carrier size should not be specified, and there should be flexibility with the stakeholders to decide the channel bandwidth based on the technology/ application being deployed.

Power limits

3.178 Regarding the power limits for the license-exempt low power indoor operation in V-band, a few stakeholders have proposed EIRP limits consistent with global regulatory benchmarks - typically up to 40 dBm peak EIRP for fixed indoor devices. With respect to the license-exempt very low power outdoor operation in the V-band, a few stakeholders have suggested to follow internationally prevalent technical parameters; a few

of them have proposed to keep the peak EIRP for outdoor devices at about 20 dBm.

3.179 In this regard, the Authority has perused the technical parameters prescribed by various regulatory authorities which have permitted low power indoor applications as well as very low power outdoor applications on a license-exempt basis in parallel to licensed radio backhaul operations. The Authority notes that the Infocomm Development Authority (IDA) Singapore has, through its decision on the regulatory framework for 60 GHz frequency band dated 30.03.2011[117], permitted license-exempt usage of MGWS/ WPAN/ WLAN in parallel to licensed operations with the following EIRP limits:

(a) Maximum EIRP of 40 dBm (10 Watt) for indoor use

(b) Maximum EIRP of 25 dBm (316 milli Watt) for outdoor use

3.180 The Authority is of the view that DoT, in consultation with the Telecommunication Engineering Centre (TEC), should examine and prescribe power limits and other technical conditions for license-exempt use in V-band (57-66 GHz) for both low power indoor and very low power outdoor usage for applications such as Multi Gigabit Wireless System (MGWS), Wireless Access System (WAS), Radio Local Area Network (RLAN), Wireless Personal Area Network (WPAN), Short-Range Devices (SRDs), sensing applications (including radar, and IoT functions) etc. on a no-interference, no-protection, and shared (non-exclusive) basis. In the interim, license-exempt usages in V-band should be permitted with the power limits as prescribed by IDA, Singapore, i.e., 40 dBm maximum EIRP for low power indoor use and 25 dBm maximum EIRP for very low power outdoor use and other technical conditions mentioned therein.

[117] The decision of IDA may be accessed at the following URL: https://www.imda.gov.sg/-/media/imda/files/inner/pcdg/consultations/20100219_framework60ghzfreqband/60ghzemp.pdf

3.181 In view of the above, **the Authority recommends that –**

(a) In parallel to the licensed fixed services (radio backhaul) in V-band, the license-exempt usage should also be permitted in V-band (57-66 GHz) for both low-power indoor and very low-power outdoor usage for applications such as Multi Gigabit Wireless System (MGWS), Wireless Access System (WAS), Radio Local Area Network (RLAN), Wireless Personal Area Network (WPAN), Short-Range Devices (SRDs), sensing applications (including radar, and IoT functions) etc., on a non-interference, non-protection, and shared (non-exclusive) basis.

(b) For license-exempt usages in V-band, there should be flexibility to decide the channel bandwidth based on the technology/ application being deployed.

(c) DoT, in consultation with the Telecommunication Engineering Centre (TEC), should examine and prescribe power limits and other technical conditions for the recommended license-exempt use in V-band (57-66 GHz) for both low power indoor and very low power outdoor usage. In the interim, license-exempt usages in V-band should be permitted with the power limits as prescribed by IDA, Singapore, i.e., 40 dBm maximum EIRP for low power indoor use and 25 dBm maximum EIRP for very low power outdoor use and other technical conditions mentioned therein.

3.182 The following chapter examines the issues relating to spectrum charges and valuation of the microwave backhaul spectrum.

Chapter IV: Spectrum Charges and Valuation of microwave spectrum in 6 (lower) GHz, 7 GHz, 13 GHz, 15 GHz, 18 GHz, 21 GHz bands, E-band and V-band

Part-I

Spectrum Charging of traditional microwave backhaul bands (6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, 21 GHz bands)

A. Introduction

4.1 A well-designed spectrum charging framework can induce optimum and effective deployment of backhaul spectrum, promote investments in backhaul infrastructure and maintain affordability for telecom operators, with potential enhancements in overall quality of service for consumers. The policy views contained in GSMA report[118] on "Spectrum for Wireless Backhaul" highlight the following:

"Regulators need to carefully consider the most effective backhaul licensing term, approaches, terms and conditions. High backhaul spectrum prices present a barrier to mobile network evolution, improved coverage and more spectrum efficient backhaul technologies. Regulators should, in consultation with the industry, ensure the timely availability of a sufficient amount of affordable backhaul spectrum under reasonable licensing approaches, terms and conditions".

4.2 It is important to note that fiber continues to be the gold standard for backhaul, owing to its high data capacity. Wired access backhaul offers several other advantages over wireless alternatives, including lower latency, greater reliability, and enhanced security. However, it has been

[118] https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2021/02/wireless-backhaul-spectrum-positions.pdf

noted that extent of fiberisation deployed in the network by various operators is an outcome of multiple factors including technical factors such as level of data usage and throughput requirements, geographical factors such as difficulty and remoteness of terrain, demographic factors such as population density and feasibility of laying fiber in built-up area as well as processes related to RoW charges and clearances. Hence, terrestrial wireless backhaul will continue to play a vital role, as fiber deployment is either commercially not viable or not a feasible option at numerous sites/ requirements.

4.3 Microwave bands form a critical component of modern telecom backhaul networks, providing wireless connectivity where fiber deployment is limited or unfeasible. The adequate availability and affordability of backhaul spectrum, in terms of both coverage and capacity, is important for achieving high quality of service delivery. This is especially true with the rise of 5G networks which require increasingly higher data throughput. Keeping in view the important role of the backhaul spectrum, it is generally not put to market auction and is instead administratively assigned across the world, with different models of licensing, ranging from exclusive basis (per point-to-point link or per block) to lightly licensed and also unlicensed basis. In the case of India, as already noted in Chapter I, the radio backhaul for telecommunication services has been incorporated as Item 12 in the First Schedule of the Telecommunication Act, 2023, thus stipulating the assignment of backhaul spectrum through administrative process.

4.4 The pricing of these bands should follow from the important role of the backhaul spectrum and should be in consonance with the mode of assignment, whether on block or point-to-point link basis. Further, the pricing of backhaul spectrum should encourage service providers to acquire and utilize the available spectrum in these bands.

B. DoT's reference dated 13.09.2024: Spectrum Charging/Pricing in 6 (lower)/7/13/15/18/21 GHz bands

4.5 Through the letter dated 13.09.2024, DoT requested TRAI to provide its recommendations under Section 11(1)(a) of the TRAI Act, 1997 on certain aspects. The relevant extract of the Reference dated 13.09.2024 regarding 6 (lower) / 7/ 13/ 15/ 18/ 21 GHz bands is reproduced below:

…b) Spectrum charges and related terms & conditions such as spectrum cap, carrier aggregation, etc. for assignment of spectrum in 6 (lower)/7/13/15/18/21 GHz bands for backhaul purposes of commercial telecom services.

……..

(d) Quantum/ band(s) of spectrum to be earmarked for last mile connectivity (Fixed Wireless Access) of commercial telecom services and methodology of assignment of spectrum and associated terms & conditions in non-IMT bands as referred to in Para 2.2 above.

(e) Quantum/ band(s) of spectrum to be earmarked for Backhaul purposes for non- commercial/ captive use and associated terms & conditions including charges as referred to in Para 2.3 above….

C. Summary of recommendations regarding assignment in 6(lower)/7 GHz & 13/15/18/21 GHz for backhaul use by all Authorised entities

4.6 Analysis and recommendations on various technical and other aspects related to the assignment of 6 (lower)/7/13/15/18/21 GHz bands for backhaul of all Authorised Entities, including non-commercial/ captive users, have already been provided in Chapter II. Salient points are noted below:

a) For 6 GHz (lower) band, it has been recommended that spectrum should be assigned for backhaul purposes to all types of Authorised entities, including non-commercial/ captive users, on a point-to-point link basis, with a ceiling of two carriers of 28 MHz (paired) bandwidth per link.

b) For 7 GHz band, it has been recommended that existing point to point links in the 7 GHz band should be permitted to operate with an annual renewal mechanism until the Government takes a decision with respect to the usage of the 7 GHz band based on the outcome of the WRC-27. The spectrum in the 7 GHz band should not be assigned for establishing new point-to-point links for any category of operators/ services.

c) For 13/15/18 GHz band, it has been recommended that spectrum should be assigned *exclusively* to Access Service Providers on a block basis in a licensed service area (LSA) for backhaul of wireless access network traffic *only.* Further, henceforth, the spectrum in 13 GHz, 15 GHz, and 18 GHz bands should not be assigned for any purpose except backhaul of wireless access network traffic by Access service providers.

However, if any entity other than Access Service providers is already holding spectrum in 13 GHz, 15 GHz, and 18 GHz bands on a point-to-point link-basis, it should be permitted to retain such spectrum in that LSA on a point-to-point link basis.

In the case of 15 GHz band specifically, it has also been recommended that the future usage of the 15 GHz band should be reviewed only after considering the outcome of the WRC-2027. Further, the existing microwave carriers in the 15 GHz band should be permitted to operate. Also, new microwave carriers in the 15 GHz band may be assigned to Access service providers in an LSA, for backhaul of wireless access network traffic, if they already hold microwave carriers in the 15 GHz band in the LSA.

d) For 21 GHz band, it has been recommended that this band should henceforth only be assigned on point-to-point link basis for backhaul of telecom traffic, other than wireless access network traffic, by all Authorised entities. Thus, henceforth, the spectrum in the 21 GHz band should not be assigned to Access service providers on a block basis for backhaul of wireless access network traffic.

However, Access service providers should be permitted to retain the carriers already assigned to them on block basis in the 21 GHz band in any LSA for backhaul of wireless access network traffic, with no further assignments henceforth.

4.7 In the light of the present DoT reference dated 13.09.2024 and aforesaid recommendations on assignment of traditional microwave backhaul bands, as mentioned above, the next sections (D), (E) & (F) deal with spectrum charging of 6(lower)/7/13/15/18/21 GHz bands, wherein (D) deals with the issue of spectrum charging for backhaul by Access service providers, (E) deals with the issue of spectrum charging for last mile connectivity (Fixed Wireless Access) of commercial telecom services, and (F) deals with the issue of spectrum charging for all Authorised entities, including non-commercial/ captive users, for backhauling telecom traffic other than wireless access network traffic.

(D) Spectrum Charges for traditional microwave backhaul bands (6 (lower)/7/13/15/18/21 GHz) for backhaul use by Access Service providers

4.8 With a view to determine spectrum charges for Access Service Providers being assigned 6 (lower)/7/13/15/18/21 GHz bands for radio backhaul, it is necessary to examine the stakeholders' comments on questions raised in the Consultation Paper dated 28.05.2025 and prevailing spectrum

charging framework for above mentioned bands, along with other relevant factors.

4.9 In this context, the following questions were raised in the Consultation Paper:

Q35. In case the 6 (lower)/7/13/15/18/21 GHz bands for radio backhaul of various commercial telecom services are assigned on a Point-to-Point (P2P) Link basis, should the spectrum charges be levied:

i. As a percentage of Adjusted Gross Revenue (AGR), or

ii. On a per carrier/link basis, or

iii. Through any alternative mechanism (please specify)?

Kindly provide a detailed justification for the approach considered most suitable, along with the suggested percentage of AGR or the applicable per point-to-point link/per carrier charge.

Q36. In case the 6 (lower)/7/13/15/18/21 GHz bands for radio backhaul of various commercial telecom services are assigned on a block basis for the entire Licensed Service Area (LSA), should the spectrum charges be levied:

i. As a percentage of Adjusted Gross Revenue (AGR), or

ii. On a per MHz or per carrier basis, or

iii. Through any alternative mechanism (please specify)?

Kindly provide a detailed justification for the approach considered most suitable, along with the suggested percentage of AGR or the applicable per carrier/ MHz charge.

Stakeholders Comments

4.10 A majority of stakeholders, including all Access Service Providers, have supported the continued use of the existing AGR-based charging methodology for the traditional backhaul bands, which should be assigned on a block basis for the entire LSA, while emphasizing the need for significant rationalization of the current rates. It has been argued that the existing AGR percentages are disproportionately high with a significant portion of spectrum usage charges payouts attributed to backhaul spectrum. The high proportion of Backhaul spectrum charges vis-à-vis Access spectrum charges does not seem justified as backhaul does not generate direct revenue but serves as critical supporting infrastructure for access networks. The emphasis has been on role of backhaul spectrum as a public utility resource and core enabler of telecom services whose affordability benefits both Digital India mission and government exchequer. It was highlighted that rationalizing AGR-based charges for backhaul spectrum would reduce network rollout costs especially in underserved and fiber deficient areas, promote faster deployment of 4G and 5G infrastructure, and enhance network reach and service quality, aligning with national digital connectivity goals. Thus, rationalisation of charges was articulated as serving national interest, as it would enhance rural connectivity and enable cost efficient service delivery across geographies, facilitating inclusive digital growth and equitable access to telecom services.

4.11 It was also stated that in current era of 5G, where traffic volumes are growing rapidly while fiber coverage remains incomplete, backhaul spectrum is indispensable for network scalability. The progressive escalation matrix for spectrum charge, it was emphasised, results in a disproportionately high financial burden, especially considering that microwave backhaul is a non-revenue-generating, enabling infrastructure that merely supports the delivery of services through access spectrum. It

has been suggested that a simplified, linear charging structure, such as a constant rate of 0.05% or 0.10% of AGR per carrier, would better reflect the non-revenue-generating nature of backhaul spectrum and encourage efficient network planning without penalizing operators for requiring additional capacity. This approach, it was stated, would support cost-effective deployment of high-capacity links crucial for 5G and beyond, while maintaining fairness and transparency in spectrum pricing. It was also stated that the present link-wise allocation of MWB spectrum is technically inefficient and at the same time, the charges are required to be paid based on AGR for entire LSA, and this anomaly needs to be corrected. In this light, rationalizing or revising the pricing toward a fixed, nominal, or non-escalating fee model, consistent with the utility function of backhaul spectrum, was held as essential by stakeholders.

4.12 A few stakeholders recommended adopting a per-link charging mechanism for traditional backhaul, as it promotes efficient and need based spectrum utilisation. It was suggested that spectrum should be assigned as one or more carrier city wise and charged with a formula-based model, rather than AGR based model.

4.13 One stakeholder highlighted that valuation methodologies linking pricing of backhaul to access spectrum prices, based on auction-determined prices for IMT/5G bands, or by applying spectral efficiency-based valuation models extrapolated from access bands, are flawed due to fundamental differences in technical functions, regulatory classifications and economic roles. It was urged that comparative or derivative valuation methodologies would lead to distorted cost structures, discourage efficient deployment of backhaul capacity, and ultimately hamper the expansion of high-quality mobile networks. An independent framework that recognizes the essential, non-commercial enabling nature of backhaul without comparisons to IMT bands was advocated.

Present charging methodology

4.14 It is noted that, historically, prior to 2002, the annual royalty charges for all MW links for cellular mobile systems were calculated on a link-to-link basis and were based on a formula accounting for the number of radio frequency channels used, adjacent channel separation etc.

In April 2002, WPC changed the calculation methodology for spectrum charges for MWA and MWB networks of GSM based cellular networks from point-to-point link basis to an AGR based regime as explained below:

For MW Access networks (normally in the frequency band 10 GHz and beyond):

- *For spectrum bandwidth up to 112 MHz in any of the circles, or 224 MHz in any of the 4 metros, spectrum charges shall be levied @ 0.25% of AGR per annum; and*
- *For every additional 28 MHz or part thereof (if justified and assigned) in circles or 56 MHz or part thereof in any of 4 metro areas, additional spectrum charges shall be levied @ 0.05% of AGR per annum.*
- *These would also include the royalty charges for spectrum usages and license fee for the fixed stations in the MW access links.*

For MW backbone networks (generally below 10GHz frequency band):

- *For spectrum bandwidth up to 56 MHz, spectrum charges shall be levied @ 0.10% of AGR per annum; and*
- *For every additional 28 MHz or part thereof (if justified and assigned), additional spectrum charges shall be levied @ 0.05% of AGR per annum.*
- *These will include the royalty charges for spectrum usages and license fee for the fixed stations in the MW backbone links.*

4.15 Further, through its order of 03.11.2006 and its subsequent amendments dated 10.11.2008 and 19.02.2009, WPC amended the AGR based charges for MWA and MWB carriers of GSM & CDMA based cellular networks. As

per above said DoT order, the following revenue share percentage(s) is levied for assignment of microwave networks of telecom service providers.

Spectrum Bandwidth	Spectrum charges as percentage of AGR	Cumulative spectrum charge as % of AGR
First carrier of 28 MHz (paired)	0.15%	0.15%
2nd carrier of 28 MHz (paired)	0.20%	0.35%
3rd carrier of 28 MHz (paired)	0.20%	0.55%
4th carrier of 28 MHz (paired)	0.25%	0.80%
5th carrier of 28 MHz (paired)	0.30%	1.10%
6th carrier of 28 MHz (paired)	0.35%	1.45%
7th carrier of 28 MHz (paired)	0.40%	1.85%
8th carrier of 28 MHz (paired)	0.45%	2.30%
9th carrier of 28 MHz (paired)	0.50%	2.80%
10th carrier of 28 MHz (paired)	0.55%	3.35%
11th carrier of 28 MHz (paired)	0.60%	3.95%

4.16 The subsequent developments regarding assignment and charging of backhaul spectrum for Access service providers, following the 2006 & 2008 DoT orders, have been captured in Chapter I. These include Amendment dated 19.02.2009 in continuation of the 2008 order, as well as DoT Guidelines dated 16.10.2015 & its Addendum dated 25.07.2022. As per the

2015 Guidelines, purely temporary and provisional allotment of 04 carriers in Metro/ Category A service area and 03 carriers in Category B/C service area, for MWA carriers was permitted, while link-to-link allotment in MWB carriers was continued. Also, charging regime as per 2006/2008 Orders was to continue. In the addendum to the 2015 Guidelines, the maximum number of Microwave Access (MWA) Carriers that can be assigned to TSPs with Access service authorizations/ licensees on provisional basis, was increased from existing 4 carriers (in Metro, Cat 'A' LSA)/ 3 carriers (Cat 'B' and Cat 'C' LSA) to 8 carriers (in Metro, Cat 'A' LSA)/ 6 carriers in (Cat 'B' and Cat 'C' LSA). The charging methodology as per 2006/2008 orders was continued.

Analysis

4.17 For the purposes of the analysis, the Authority has examined pre-2002 link based charging methodology, AGR based charging methodology in DoT order of 2002, extant DoT orders of 2006/ 2008, the Guidelines of 2015 and its addendum of 2022, the relevant TRAI recommendations of 2014, the relevant stakeholders' comments as well as other relevant factors, including, inter-alia, the objective of achieving an affordable backhaul spectrum regime to increase acquisition and utilization of backhaul spectrum, potentially leading to improvements in quality of services.

4.18 In line with the recommended methodology of assignment of traditional microwave backhaul bands to Access Service providers in the current recommendations, as discussed in Para 4.6, the analysis related to determination of spectrum charges for Access Service providers is in the sub-sections as given below:

(i) Analysis related to spectrum charges for fresh and renewal block assignments in 13/15/18 GHz band and for renewal (only) block assignments in 21GHz band for backhaul of wireless access network traffic by Access Service providers is discussed in sub-section D(i)

(ii) Analysis related to spectrum charges for fresh point-to-point link assignment for backhaul of telecom traffic, other than wireless access network traffic, by Access Service providers in 21 GHz is discussed in sub-section D(ii)

(iii) Analysis related to spectrum charges for fresh point-to-point link assignment to Access Service providers in 6 (lower) GHz and for renewal (only) point-to-point link assignment to Access service providers in 6(lower)/7 GHz is discussed in sub-section D(iii)

D(i) Analysis related to Spectrum charges for fresh and renewal block basis assignments in 13/15/18 GHz and renewal block basis assignments in 21 GHz band for backhaul of wireless access services by Access service providers

4.19 As mentioned above, prior to 2002, the pricing for all types of MW RF links was being done on per point-to-point link basis. In 2002, the pricing mechanism for MWA (13/15/18/21 GHz) and MWB (6/7GHz) carriers used in Access networks was modified to AGR based charging, whereas for MW links for non-commercial/ captive users, per point-to-point link charging is continuing till date.

4.20 Based on study of international jurisdictions, it is seen that most countries have adopted charging mechanism based on per point-to-point link basis, which is in consonance with the per point-to-point link assignment process being followed in these countries.

4.21 The Authority in its 2014 recommendations on the issue of pricing on per link vis-à-vis AGR basis had observed

"…*charging on a link basis may lead to better utilisation of MW spectrum. With link basis assignment and charging, the TSPs are expected to use the carrier frequencies judiciously because they have to pay based on the number of links. However, it will add to complexity in the sense that*

charges for each and every link will need to be determined. Also, since the charges payable are dependent on the number of links, the manner in which the new links are accounted for will change dynamically. This will create a potential bone of contention between the licensor and the licensee.

The present pricing methodology is simple and has in-built elasticity for future revenues on the basis of growth in AGR. The current charging of MW carriers on an AGR basis, which increases with the increase in number of carriers, incentivizes operators to opt for the least number of MW carriers that are required for running the network. Huge rollouts have been carried out by TSPs on the basis of allocated carriers. Any change in charging methodology from the present AGR basis per carrier to a link-to-link basis will pose operational and administrative difficulties and will be a challenge both for the TSP as well as the WPC. Moreover, as the Authority has recommended that the assignment of MWA carriers be done on exclusive basis for the entire LSA, charging on the basis of AGR for the entire LSA seems logical."

4.22 As per data regarding carriers and links analysed for the present exercise, placed at Annexure-4.2, it is seen that the MWA bands viz. 13/15/18/21 GHz indeed have a dense network of links, approximately 5.2 lakh links, deployed by Access service providers in the acquired carriers, for which charges are being paid on percentage of AGR per carrier for entire LSA. As mentioned in 2014 Recommendations, a change in charging methodology from current percentage of AGR per carrier to per point-to-point link basis is likely to pose operational and administrative challenges both for TSPs and DoT. It will be complex to implement especially due to large number of links already deployed in these bands in the utilised carriers, as each link will have to be accounted for. This could create a potential bone of contention between licensor and licensee, as held in the 2014 Recommendations.

4.23 Moreover, it is prudent to have the basis of assignment and the method of charging to be in consonance with each other. Accordingly, a block basis of assignment should have carrier-based charging for entire LSA, which provides autonomy for the Access service providers to deploy links using the acquired carriers as per their requirements. Further, charging for the carriers on percentage AGR basis, rather than a fixed cost, is reflective of the revenue generated for the entire LSA and considers the users' capacity to pay. Also, a majority of stakeholders, including all major Access Operators, have also supported AGR based charging approach along with the rationalization of the AGR percentage. Thus, continuity of AGR based charging methodology is considered appropriate, as was also held in the 2014 recommendations, and further, is in line with the present method of charging and the recommended mode of assignment.

4.24 Regarding the option of pricing per unit (i.e. KHz or MHz) rather than carrier as a whole, it is noted that the MW bands, which are used for backhaul purposes and not for last-mile connectivity, do not generate revenue on their own. Consequently, financial and other market-related data indicating the market valuation of these bands is not available. Thus, their precise valuation on per MHz basis is difficult to be derived through arithmetic valuation models.

4.25 Accordingly, **the Authority recommends that spectrum charges for fresh and renewal block basis assignments in 13/15/18 GHz bands and renewal block basis assignments in 21 GHz band for backhaul of wireless access service by Access service providers should be levied on a percentage of Adjusted Gross Revenue (AGR) basis.**

4.26 As mentioned at Para 4.15-4.16, presently, spectrum charges for microwave bands are levied on a percentage of AGR basis. To decide whether the existing AGR percentage slabs should be rationalized/ revised,

or the charges should be continued to be levied as per the present AGR slabs, it is necessary to analyze the historical and present spectrum charging orders for these bands, as well as the stakeholders' comments and TRAI recommendations of 2014 regarding AGR based charging for these bands.

4.27 As per DoT 2002 charging orders, discussed above, spectrum charges *for spectrum bandwidth up to 112 MHz in any of the circles, or 224 MHz in any of the 4 metros, spectrum charges shall be levied @ 0.25% of AGR per annum; and for every additional 28 MHz or part thereof (if justified and assigned) in circles or 56 MHz or part thereof in any of 4 metro areas, shall be levied @ 0.05% of AGR per annum*. Thus, the charges were constant for a certain number of carriers and thereafter increased in a linear manner.

4.28 As per the 2006/2008 charging orders, discussed in para 4.16, the spectrum charge for the first carrier of microwave spectrum in 13/15/18/21GHz band, is 0.15% of AGR, while for next two carriers, it is 0.20% of AGR per carrier and subsequently charge per carrier increases by additional 0.05% for each carrier. Thus, the charge per carrier is increased progressively, reaching a charge of 0.60% for the 11th carrier. Spectrum charges are levied on a cumulative basis, leading to a *non-linear increase in cumulative percentage of AGR rate from the second carrier itself*, reaching 3.95% if an operator has 11 carriers in any LSA. However, it is observed that no operator has more than 06 carriers in any of the circle/ LSAs, which is presently charged at 1.45% of AGR as per DoT's 2006 order.

4.29 The Authority examined the reasons for fixing the charge for first carrier at 0.15% in the 2006/2008 charging orders as well as the increasing per carrier charge and non-linear charging scheme in the 2006/2008 orders and sought information from DoT on the same as well. However, no significant information regarding the basis for adopting this charge could be obtained.

4.30 Regarding the present charging structure, the following excerpts from the 2014 Recommendations are relevant:

"*The access service providers can only roll-out their network if they have MWA carriers. Now, access spectrum can only be acquired through spectrum auction/trading. Having paid the market price, there seems to be no justification for high annual spectrum charges for the assignment and subsequent use of MW carriers.*

…. the Authority is not in favour of substantially higher spectrum charges for the use of MWA carriers. However, it is of the view that as assignments are to be made administratively, the applicable percentage of AGR needs to be hiked with the assignments of additional carriers to ensure that TSPs make optimal and efficient use of MW carriers and seek assignment of additional MWA carriers only when it is essential for them.

As per the rates notified by the DoT in 2002, for the first two MWA carriers in non-metro LSAs and four MWA carriers in metro LSAs, the same percentage of AGR was applicable as spectrum charges. Subsequently, there was a provision of uniform increase in the spectrum charges as percentage of AGR with the increase in the number of MWA carriers assigned. As per the modified rates of 2006, there is a non-linear increase in slab rates with the assignment of each carrier. The Authority is of the view that the non-uniform and substantial hike in the applicable percentage with the assignment of each MW carrier is simply not justified. The Authority is of the view that there should be a uniform and reasonable increase in the applicable slab with the assignment of each MW carrier."

4.31 There have been stakeholder submissions that the slab rates of AGR as prescribed by the DoT in 2006/ 2008 charging orders are quite high and do not consider the fact that MWA/MWB carriers are only a supporting infrastructure for access backhaul. Further, it has been submitted that backhaul should be made available at as reasonable rates as possible to facilitate cost-effective roll-out of services, in line with its role as a public

utility resource and a core enabler of telecom services. There is unanimous submission by all stakeholders that current escalating spectrum charge matrix is undesirable and rationalization of percentage AGR charges would ultimately support better network reach as well as quality of services, thus enabling digital growth. A few TSPs have also submitted specific suggestions regarding slabs, mentioning constant per carrier charge at 0.10% or 0.05%, and simple cumulation for number of carriers. The stakeholders have also submitted that since 2010, all Access spectrum can only be acquired through auction at auction determined prices or through trading at market prices. It is argued that since the operators have already paid the market price for access spectrum, hence in view of the complementary nature of backhaul spectrum, rates for backhaul spectrum must be rationalised

4.32 It is noted from the views of stakeholders that backhaul spectrum is an enabler of mobile networks rather than a direct revenue-generating resource and should be priced reasonably. The rationalization of current prices, as highlighted by stakeholders, would likely help reduce network rollout costs, faster deployment of advanced technologies as well as facilitate densification of networks, which is especially required in the 5G era. The rationalisation would support uptake of optimal number of carriers by the service providers. The Authority understands that quality of service is likely to improve with usage of more carriers for backhaul of wireless access services. Thus, it is acknowledged that the availability and affordability of backhaul spectrum is important for quality of service, especially with increasing data requirements of 5G and beyond.

4.33 A review of the 2006/2008 Charging Orders, in light of stakeholders' comments and TRAI's 2014 Recommendations, indicates that the 2006/2008 Orders substantially increased the applicable spectrum charges vis-à-vis the 2002 orders, by introducing a non-linearly increasing charging structure.

4.34 A factor to be considered while recommending rationalization of AGR slabs is the policy goal of increasing fiberisation vis-à-vis use of wireless backhaul. The same has been dealt with in previous chapters. As discussed before, the extent of fiberisation deployed in the network by various operators is an outcome of multiple factors including technical factors such as levels of data usage and throughput requirements, geographical factors such as difficulty of terrain, demographic factors such as population density and feasibility of laying fiber in built up area as well as processes related to RoW charges and clearances. It is reasonable to expect that terrestrial wireless backhaul will continue to play an important role, since at numerous sites, fiber deployment is either commercially not viable or not a feasible option. As such, backhaul spectrum needs to be priced at an appropriate and reasonable level to support quality of service in the access network.

4.35 It is also important to note that, as mentioned in Chapter II, the average utilization of the carriers in the 13 GHz, 15 GHz and 18 GHz bands together is about 36% while the average utilization of the carriers in the 21 GHz band is only 3%. Thus, though these bands generally have a dense network of links utilising the acquired carriers, overall, a significant portion of available carriers are unused. As per the Addendum of 2022, to the 2015 DoT Guidelines, regarding maximum carriers which can be acquired, the limit was increased to 08 for Metro/Category A service area and 06 for Category B/Category C service area. However, currently, in most of the circles, the TSPs on an average have 4-5 carriers. As noted above, the Authority believes that the uptake of backhaul spectrum could be enhanced by a rationalised charging structure for backhaul spectrum and is likely to lead to improvements in quality of service and densification of networks.

4.36 Considering the above factors including stakeholders' comments, the logic articulated in the 2014 TRAI Recommendations regarding need for revision of the non-linear charging schema, the level of uptake of backhaul carriers

across the country and the various positive effects of having affordable backhaul spectrum regime as highlighted at Para 4.32 & 4.33, the Authority is of the view that there is a clear case for rationalisation of percentage AGR charges for backhaul spectrum.

4.37 The next step in the present exercise is recommending the charges for the 13/15/18/21 GHz bands for backhaul of wireless access services. For this, there are three inherent decision points:

i. First is the base rate for one carrier of the 13/15/18/21 GHz bands
ii. Second is whether there should be any differential pricing between the 13/15/18/21 GHz bands inter-se
iii. Third is the increment in rates per increasing carrier

Base rate for first carrier:

4.38 The Authority, in its 2014 Recommendations, had recommended a spectrum charge of 0.12% of AGR for one carrier in the 18 GHz/ 21 GHz bands and there on derived the charges of 0.17% of AGR for one carrier in the 13GHz/15GHz bands based on the concept of frequency band factors. The detailed rationale for arriving at the rate of 0.12% was provided in Para 3.32 to 3.40 of the said Recommendations. For reference, the key considerations are summarized at Para 4.30 above, with another relevant excerpt stated below:

"*…..Keeping in view the stakeholders' comments, the WPC orders of 2002 and the policy that charges for MW links should be reasonable, the Authority has concluded that a uniform rate of 0.12% of AGR per carrier of 28 MHz bandwidth (paired) can be prescribed for MWA carriers in the 18 GHz/21 GHz bands both for metro as well as for non-metro LSAs.*"

4.39 As mentioned before, in the present exercise, the Authority aims to recommend spectrum charges for backhaul in a manner that recognizes the role of backhaul spectrum as an important enabler of mobile networks,

rather than a direct revenue-generating resource for either the service providers or the Government. The Authority is of the view that optimally structured spectrum charges can enhance cost efficiency to encourage network densification and expansion, promote investments in backhaul infrastructure, maintain affordability for access service providers as well as ensure the long-term reliability and sustainability of wireless services. Thus, in the present exercise, the determination of spectrum charges is based on broadly similar concerns as followed in the 2014 Recommendations. Hence, for the purpose of arriving at the rationalized spectrum charges in the present exercise, it may be reasonable to use the 0.12% of AGR for first carrier of 18/21 GHz (i.e., percentage recommended in 2014) as a reference point.

4.40 Further, the backhaul spectrum charge of 0.12% of AGR per carrier of 18/ 21 GHz as recommended in 2014 needs to be reviewed, in the context of changes in the revenue of the sector and cost inflation across the years, so that the cost to the operators per carrier remains approximately the same vis-à-vis the cost created by 0.12% of AGR recommended in 2014, in real terms. For this purpose, it would be relevant to consider the change in the AGR of the sector in F.Y. 2024-25 (the year preceding the present recommendations) vis-à-vis F.Y. 2013-14 (the year preceding the 2014 recommendations). Likewise, it would be relevant to examine the cost inflation in F.Y. 2024-25 vis-a-vis F.Y. 2013-14.

4.41 There are two approaches which could be adopted for the aforesaid adjusting of the growth in revenue (AGR)/ costs (Spectrum Charges) for inflation i.e. converting the nominal growth to real growth. The Marginal Cost of Funds Based Lending Rate (MCLR) can be used as an index for adjusting revenues/ costs/ prices across years for inflation. However, MCLR is not a direct measure of inflation, but indirectly linked to inflation through the monetary policy. On the other hand, the Cost of Inflation index (CII), notified by the CBDT and used for adjusting the price of long-term capital

assets for inflation, is better suited to adjust the AGR and related spectrum charges across the years for inflation.

4.42 For the purposes of the calculations, the AGR of Access Service Licenses (AGR(Access)) only has been considered, as they are the relevant group for the calculations. Further, the base year, for which both AGR & CII data has been considered, has been taken as 2013-14, and the current year has been taken as FY 2024-25.

4.43 Accordingly, the below mentioned steps have been followed, to arrive at a revised spectrum charge per carrier taking into account the changes in revenue of the sector and cost inflation:

a. In FY 2013-14, the AGR (Access) was Rs 1,24,174 crore and hence the approximate cost per carrier of 28 MHz (paired) in 18/21 GHz band, as per 2014 recommended rate of 0.12%, was 0.12%*1,24,174 = Rs 149.01 crore.
b. Adjusting this cost for inflation across FY 2013-14 & FY 2024-25 (using CII of 220 in 2013-14 & 363 in FY 2024-25), the cost in FY 2024-25 would approximately be 149*363/220 = Rs 245.85 crore.
c. This cost of one carrier of backhaul spectrum in 18/21 GHz i.e. Rs 245.85 cr is then divided by AGR (Access) of FY 2024-25 i.e. Rs 2,53,649 crore, yielding a percentage cost of 0.096% of AGR per carrier. For practical purposes, this can be rounded off to 0.10% of AGR for one carrier of 18/21 GHz.

4.44 It is noted that the above calculation is only an indicative exercise, based on an approximation of cost to business on account of backhaul spectrum charges per carrier in 18/21 GHz band. This cost to business has been defined for purposes of deriving a suitable percentage AGR charge for one carrier, which is relevant in the current financial state of the sector.

4.45 Accordingly, the Authority is of the view that it is appropriate to price the first carrier of 18/21 GHz at 0.10% of AGR. The next part examines whether the price all four bands viz. 13/15/18/21 GHz should be same or there is a case for inter-se differential pricing based on band factors.

Need for differential pricing inter-se 13/15/18/21 GHz:

4.46 It is noted that the percentage of 0.12% recommended in 2014 was for one carrier of 18/21 GHz, while the percentage for one carrier of 13/15 GHz was derived at 0.17% of AGR using frequency/ band factors. As a concept, band factors are used to differentiate between low and high frequency bands based on characteristics such as propagation distance and carrying capacity, as well as on level of usage/ congestion in different areas, related level of spectrum availability/scarcity, exclusive/ non-exclusive nature of assignment etc.

4.47 For the present exercise, the feasibility and suitability of prescribing different rates inter-se 13/15/18/21 GHz, using band factors, has been examined in the following paragraphs. For the same, the band factors used in TRAI Recommendations of 2014 as well as present international regimes have been examined, and the present assignment and usage of 13/15/18/21 GHz bands in India has been studied in light of these.

4.48 The examination of band factors and differential pricing across international regimes, which are relevant in inter se pricing of 13/15/18/21 GHz bands, is placed at Annexure-4.4. It is noted that the pricing in all examined jurisdictions is usually on per point-to-point link basis, in line with point-to-point link assignment followed in the countries. Generally, the pricing relies on a unit rate/ base rate per MHz or KHz, multiplied by channel size bandwidth, and further modulated for factors such as availability of spectrum, path length, location-specific usage density etc.

Also, the treatment or categorisation of the four bands varies across the countries.

Overall, it is seen that band factors have generally been used for differential pricing of 13/15/18/21 GHz bands inter se, in most regimes studied for the purpose of this exercise. Usually, 13/15 GHz have been treated as a single category different from 18/21GHZ, with a factor ranging from 1.3-2.0. In one case, 13GHz is treated as a separate category with a factor of 1.5 over 15/18/21 GHz which are treated as a single category, while in another, 13/15/18 GHz bands are treated as a single category with a factor of 2 over 21 GHz.

4.49 Going forward, examining the TRAI Recommendations of 2014, it is noted that the remit of recommendations was much broader and included the 13/15/18/21 GHz bands as well as 26/28/32 GHz bands and 38/42 GHz bands. TRAI in 2014 had classified the frequency bands in 13-42 GHz range in four band groups as below:

(a) Band Group#1: 13 GHz, and 15 GHz bands
(b) Band Group#2: 18 GHz, and 21 GHz bands
(c) Band Group#3: 26 GHz, 28 GHz, and 32 GHz bands
(d) Band Group#4: 38 GHz, and 42 GHz bands

Since 2014, three of the aforesaid bands viz. 26 GHz band, 38 GHz and 42 GHz bands have already been identified for IMT in India. The 28GHz had been identified for IMT in NFAP 2022, however, later it was decided by government to earmark this band for FSS. The present DoT reference also does not seek recommendations on 28 GHz & 32GHz for backhaul purposes. Thus, the present recommendations relate to a narrower frequency range (13-21 GHz range) than the frequency range (13-42 GHz range) for which recommendations were made in 2014.

The Authority in its 2014 recommendations had noted that:

" *….. propagation characteristics of frequency bands need to be incorporated in the charging mechanism being framed for MWA charges.*

It would discourage TSPs from hoarding lower frequency MWA carriers and would encourage them to opt for higher frequency MWA carriers to reduce spectrum charges. It may also result in vacation of a few lower frequency MWA carriers that may be assigned to TSPs who do not have any MWA carrier in the 13 GHz/15 GHz range. Therefore, it would also help in achieving the objective of equitable assignment of MWA carriers."

Accordingly, TRAI had in 2014 decided to apply the band factors specified by two regulators viz. ICASA, South Africa and OFCOM, United Kingdom, to differentiate between spectrum charges of higher and lower frequency bands. The band factors used for final calculations in 2014 TRAI recommendations are tabulated below:

Sl. No.	Frequency band	Frequency Factor
1.	13/ 15 GHz	1.4
2.	18/ 21 GHz	1
3.	26/ 28/ 32 GHz	0.8
4.	38/ 42 GHz	0.6

It is important to note that in the Recommendations of 2014, TRAI had taken 18/ 21 GHz band as the "base" band and had applied band factors on other bands vis-à-vis the propagation characteristics of 18/21 GHz bands. The spectrum charges of 0.12% had been recommended for one carrier of 18/21GHz and the charges for other bands were derived from this using appropriate band factors. Accordingly, charges for 13/15GHz were derived at 0.17% of AGR for one carrier of 28MHz across LSA for backhaul use by Access Service providers.

4.50 After examining the international regimes as well as TRAI recommendations of 2014 regarding applicability of band factor inter se 13/15/18/21 GHz, the current assignment, charging and deployments of links in these bands have been studied. In this regard, following points are relevant:

a. The current charging regime for 13/15/18/21GHz bands assigned to Access service providers as per 2006/2008 orders has the same charges for all the four bands. It does not use band factors inter-se 13/15/18/21GHz bands for accounting for varying propagation characteristics in the pricing scheme.
b. Further, the average link length deployed in these bands by different Access service providers across LSAs has been studied. It is observed that the differences in propagation characteristics as captured in band factor formulations are not uniformly and commensurately borne out in link lengths of deployed links. The real-world deployments appear to be more driven by availability & assignment of carrier in particular band to a service provider in a LSA as well as network design, commercial, demographic and geographical factors, such as rural/ urban agglomeration, population density, demand for data etc., rather than the theoretical propagation distances of bands.
c. Generally, assignments of carriers by DoT have not been made with specific considerations of variation of propagation characteristics amongst the 13/15/18/21 GHz bands.
d. Further, in present exercise, the Authority has recommended that any entity holding carriers in 13 GHz, 15 GHz, 18 GHz and 21 GHz bands for backhaul purposes should be permitted to retain such carriers for backhaul purposes subject to the prescribed ceiling. Hence, in future as well, the decision to obtain a particular carrier in the proposed new regime would likely be based on the consideration of retaining the existing carriers, and not as much on the propagation characteristics of the individual frequency bands.

Thus, it is noted that there is significant legacy constraint in differential pricing inter se 13/15/18/21 GHz bands through the application of band factors. Presently more than 5 lakh links have already been deployed in these bands, which are being allocated on block basis and charged on percentage of AGR per carrier.

4.51 Considering the above, the Authority is of the view that it would not be necessary or appropriate to depart from the extant practice of levying the same spectrum charges across all MWA bands viz. 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands. In other words, it would not be proper to apply band factor for differential pricing of 13/ 15 GHz bands with respect to 18/ 21 GHz band. Accordingly, the calculation of separate charges for 13/15 GHz vis-à-vis 18/21 GHz, as was done in 2014 recommendations, is not deemed appropriate in the current scenario.

4.52 Considering the stakeholders' comments regarding rationalisation of AGR based charging as well as the espoused objectives of the present exercise including increasing uptake of backhaul carriers by Access service providers, a uniform charge of 0.10% for first carrier for both fresh assignments in 13/15/18 GHz and for renewal assignments in 13/15/18/21 GHz for backhaul of wireless access services by Access service providers is considered appropriate.

Increment structure with increasing carriers:

4.53 As has been noted in Paras 4.15-4.16, in the 2002 Orders, there is a linear increase in the cumulative AGR percentage charge with increasing number of carriers, while in the 2006/2008 order, the cumulative AGR percentage charge is increasing non-linearly with increase in number of carriers. As discussed before, the present charging structure, involving a non-linear increase, has been held to be unjustified in the 2014 recommendations as well. Further, there have been unanimous stakeholder submissions to rationalise the charges towards a linear structure.

4.54 It is also observed that in the 13/15/18/21 GHz bands, TSPs on an average have 4-5 carriers, and the number of carriers does not exceed 6 for any Access service provider in any LSA. As has been stated in Chapter II, the average utilization of the carriers in the 13 GHz, 15 GHz and 18 GHz bands

together is about 36% while the average utilization of the carriers in the 21 GHz band is only 3%, with significant number of available carriers still unutilized. As stated in above sections, increasing the utilisation of carriers in the 13/15/18/21 GHz bands by Access service providers for wireless access services would have many positive effects, including enhancements in quality of service, and is a desirable objective of the present exercise.

4.55 Hence, it is felt that spectrum charges as percentage of AGR should increase with increasing number of carriers, to ensure that the carriers are acquired by service providers only when required and there is efficient utilisation of the carriers. However, the charges should not increase in a non-linear manner, as it would increase the prices to an extent so as to dilute the principle of providing affordable backhaul and increasing the uptake of backhaul carriers. This balance is also in line with the stakeholders' comments as well as the TRAI 2014 recommendations.

4.56 Thus, the Authority is of the opinion that a uniform per carrier charge with increase in number of carriers and a linear increase in cumulative percent of AGR charge would be most appropriate for the purposes of this present exercise.

4.57 Accordingly, **the Authority recommends a uniform spectrum charge of 0.10% of AGR for all the eight carriers in each of the 13/15/18 & 21 GHz bands, with no differential pricing of carriers *inter se* these bands. Accordingly, the following percentage of AGR is recommended as spectrum charge for fresh and renewal block basis assignments of 28 MHz (paired) carriers in 13/15/18 GHz bands and renewal block basis assignments of 28 MHz (paired) carriers in 21 GHz for backhaul of wireless access network traffic by Access service providers:**

28 MHz (paired) carrier	AGR %	Cumulative AGR %
First	**0.10%**	**0.10%**
Second	**0.10%**	**0.20%**
Third	**0.10%**	**0.30%**
Fourth	**0.10%**	**0.40%**
Fifth	**0.10%**	**0.50%**
Sixth	**0.10%**	**0.60%**
Seventh	**0.10%**	**0.70%**
Eighth	**0.10%**	**0.80%**

For the purpose of the above charges, only AGR from wireless access services should be considered.

D (ii) Analysis related to spectrum charges for fresh point to point link assignment for backhaul of telecom traffic, other than wireless access network traffic, by Access service providers in 21 GHz

4.58 The first point of decision for fresh point to point link assignment for backhaul of telecom traffic, other than wireless access network traffic, by Access service providers in 21GHz would be whether to charge on per point-to-point link basis or per carrier/block basis for entire LSA. It has been held that the method of charging should generally be in consonance with mode of assignment. Further, the fresh assignments in 21 GHz are for purposes other than backhaul of wireless access traffic, which would include wireline telephony and internet access traffic. It is expected that the number of links deployed for these purposes would be fewer compared to those deployed for wireless access traffic. In this case, point-to-point link based charging would provide flexibility to service providers to acquire & deploy links on need basis, while a per carrier charging for entire LSA based on AGR is likely to deter the service providers from acquiring such links due to resultant high cost per link.

4.59 Considering the above, **the Authority recommends that charging for fresh point-to-point link assignment, for backhaul of telecom traffic other than wireless access traffic by Access Service providers in 21 GHz band, should be on per point-to-point link basis.**

4.60 For arriving at the per point-to-point link charges for fresh assignments in 21 GHz band for backhaul of telecom traffic other than wireless access traffic by Access service providers, the Authority examined the extant order/ directions for the same as well as the TRAI recommendations of 2014. It is found that there is no existing order/ methodology available for per point-to-point link based charging applicable for link based assignments to Access Service Providers. Currently, charging for Access service providers for all backhaul bands, whether in 6 (lower)/7GHz or 13/15/18/21 GHz or E-Band, is on AGR basis.

4.61 However, prior to migration to AGR based charging in 2002, the charging for microwave backhaul carriers, was on per point-to-point link basis based on the M*C*W formula, as described below:

Annual Royalty (R) = M x C x W, where.

i. M (Basic Royalty) = 4800 for GSM Standard CMTS MW Networks within a city/town/service area and point-to multipoint network.

   M= 4800 for point-to-point MW link(s) with end-to-end distance less than or equal to 60 Km.

   M= 9000 for point-to-point MW link(s) with end-to-end distance greater than 60 Km but less than or equal to 120 Km.

   M= 15000 for point-to-point MW link(s) with end-to-end distance greater than 120Km but less than or equal to 500 Km.

   M= 20000 for point-to-point MW link(s) with end-to-end distance greater than or equal to 500 Km.

ii. W (Weighing or Bandwidth Factor) which is decided by the adjacent channel separation of the R.F channelling plan deployed where:

W = 30 for adjacent channel separation up to 2 MHz.

W = 60 for adjacent channel separation greater than 2 MHz but less than or equal to 7 MHz.

W = 120 for adjacent separation greater than 7 MHz but less than or equal to 28 MHz.

W = 0.15 X Number of equivalent voice channels that can be accommodated within the adjacent channel separation greater than 28 MHz.

iii. Number of frequency carriers represented by 'C'.

It is noted that the same formula was carried forward for point-to-point link based charging for captive users, albeit with revised values for the M, C & W factors in DoT OM dated 22.03.2012 & further revised in DoT O.M 11.12.2023. Both these orders are applicable for the spectrum charges for *captive users* for different types of radiocommunication services and not for Access Service providers.

If the M x C x W formula, with factor values as per extant 2023 order, were to be applied for charging of per point-to-point links in 13/15/18/21 GHz, the charges per point-to-point link with M-factor of 1500 (for link length of 2-5 kms), C-factor of 2 (all are FDD bands with paired carriers) and W-factor of 120 (carrier sizes in all bands are of 28MHz), would be as below:

Point-to-point link charges for a link of 2-5 kms in 13/15/18/21 GHz bands	
M - Factor	1500 (for distance of 2-5 kms)
W - Factor	120 (for carrier size of 28MHz)
C - factor	2 (for FDD bands)
Annual spectrum charge (Rs)	**Rs 3,60,000**

4.62 In order to understand the formula as well as rationale for assigning values to the M, C & W parameters, the Authority sought information from DoT.

However, no significant information regarding the reason for assigning values is available.

4.63 Going further, the TRAI recommendations of 2014 were examined regarding the matter. However, it is noted that TRAI in 2014 did not recommend point-to-point link assignments in the 21 GHz band for Access service providers, and accordingly, no charging methodology was prescribed for backhaul use by Access service providers.

4.64 Across international regimes, it is seen that the methodology for charging of microwave point-to-point links usually follows a combination of factors as per an indicative formula, mentioned at Annexure-4.4. It is noted that the initial point for considering these factors, across most jurisdictions, is the unit price (U) per MHz or KHz of spectrum. The methodology for arriving at the per unit price in different countries is not readily available. As has been mentioned earlier, it is noted that the MW bands, which are used for backhauling purposes and not for last-mile connectivity, do not generate revenue on their own. Consequently, financial and other market-related data indicating the market valuation of these bands is also not available. Thus, their precise valuation on a per unit (MHz/ KHz) basis is difficult to be derived through arithmetic valuation models. Accordingly, it has not been feasible to consider the combination of factors as captured at Para 1 of Annexure-4.4 for pricing of point-to-point links.

4.65 In view of above, the Authority has explored an alternative methodology for pricing of the links, based on actual spectrum charges payout for links deployed across bands. It has been considered reasonable to approximate the per point-to-point link charges against the actual present spectrum charges payout by the Access service providers per link. The approximation would be valid for bands, such as 13/15/18/21 GHz, having a dense network of deployed links, reflecting optimal and mature utilisation of the acquired carriers.

The spectrum charges payout per point-to-point link is essentially the cost paid to the government for each deployed point-to-point link by the service providers. The basic premise for using this cost to approximate and recommend per link charges, in case of per point-to-point link assignment, is that the cost per link should remain largely the same, whether in case of AGR based charging or per link charging. It is only rational that there is an equivalence in the cost or charges paid per link, since the same resource is being assigned. Point-to-point link charges, at par with link costs under a AGR charging regime, would allow for cost-effective and optimal deployment of links by the service providers, especially for areas and purposes which would not have very high deployment of links, such as low-density areas, remote areas etc.

4.66 Accordingly, in line with the methodology proposed above, the data for deployed links in all bands (6/7/13/15/18/21/E-Band) from the three major TSPs for each LSA has been considered. From a study of the data (refer Annexure 4.1 & 4.2), it is noted that the 13/15/18/21 GHz bands represent the most used bands for backhaul with a dense network of links in the acquired carriers. Although, as mentioned earlier, a large number of carriers are unutilised even in these bands, the number of links deployed using the assigned carriers is high at approximately 5.20 lakh links, reflecting a mature market. Further, as has been brought out above in Para 4.46-4.52 above, inter-se differentiation between these four bands is not appropriate under the present deployment scenario. Accordingly, the Authority has considered all these four bands together for purposes of approximating the per point-to-point link charges based on the spectrum charges payout for these bands.

4.67 Thus, the following formula has been applied for calculation of per point-to-point link charges in 13/15/18/21 GHz bands, to arrive at spectrum charge payout per point-to-point link, adjusted to the proposed spectrum charge rates arrived at in the present exercise:

$$S_i = \frac{(Recommended\ AGR\%) * AGRi}{TLi}$$

Where:

- S_i is per point-to-point link spectrum charges in LSA_i
- Recommended AGR% as per recommendations at Para 4.55 depending on number of carriers in each LSA
- AGRi is the AGR in LSAi for 2024-25
- TLi is total number of links deployed in 13/15/18/21 GHz in LSAi

For application of above formula, the following data has been used:

- AGR 2024-25 as submitted by TSPs to TRAI for Financial Data report
- Carriers and Link data submitted by TSPs in response to email dated 10.09.2025

4.68 The data regarding assigned carriers & links in each band/LSA combination was also obtained from DoT. However, it was seen that consolidated data on number of links is not available with DoT. Therefore, to ensure a uniform data source, carrier and links data as submitted by TSPs has been used.

It is also mentioned that, for the purpose of calculating per-link charges using the above formula, the Authority has considered the number of carriers and links of the three major wireless access service providers in the 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands. Also, for calculation of the above charges, a point-to-point link refers to a point-to-point connection without the deployment of any repeaters, and is generally, co-terminus with a hop.

4.69 The step-by-step methodology used for calculating the per point-to-point link charges in 13/15/18/21 GHz is given below:

a) Step I: By inserting the values of AGR, the recommended AGR percentage (as per slabs recommended at Para 4.55 above), and the number of links into the above formula, the per-link charge is calculated for a particular service provider (e.g., TSP 1) for one Licensed Service Area (LSA).

b) Step II: The same calculation is carried out for all 22 LSAs of TSP 1, resulting in per-link charges for each LSA.
c) Step III: The per-link charges across all 22 LSAs are averaged to obtain the average per-link charge for TSP 1.
d) Step IV: The above steps are repeated for the remaining service providers (TSP 2 and TSP 3) to arrive at their respective average per-link charges.
e) Step V: The final per-link charge is determined by taking the average of the per-link charges across all three service providers (TSP 1, TSP 2, and TSP 3).

4.70 Using the above methodology, the spectrum charge has been calculated as Rs. 25,000 per annum (rounded off) per annum per carrier for any point-to-point link in 13/15/18/21 GHz bands.

4.71 Accordingly, **the Authority recommends spectrum charges of Rs 25,000 per carrier per annum for each fresh point-to-point link assignment in 21 GHz band for backhaul of telecommunication traffic, other than wireless access network traffic, by Access Service providers.**

D(iii) Analysis related to spectrum charges for fresh point-to-point link assignment in 6 (lower) GHz and for renewal of point-to-point link assignment in 6(lower)/ 7 GHz for backhaul by Access service providers in 6(lower)/7 GHz band.

4.72 As has been mentioned in Section D(ii), prior to 2002, all MW RF links were priced on a per point-to-point basis, as per the 1995 DoT order. In 2002, AGR-based charging was introduced for MWA (13/15/18/21 GHz) and MWB (6/7 GHz) carriers used in access networks, while per-link charging for

other terrestrial MW links used by non-commercial/ captive users continues to date.

4.73 It has been examined whether the charging for the 6(lower)/7 GHz bands should be continued on AGR basis or should be changed to a per point-to-point link basis, based on the assignment methodology recommended in earlier chapters, present deployments in the 6(lower)/& GHz bands by Access service providers, stakeholders' comments and previous TRAI recommendations of 2014.

4.74 In the 2014 Recommendations as well, the following is mentioned:

"In contrast, MW backbones, which mainly cater inter-city traffic, are limited in number. Therefore, adoption of charging on a link-to-link basis for MWB carriers is relatively easier.

Moreover, the assignment of MWB carriers is not done on an exclusive basis. Therefore, charging MWB carriers on the basis of AGR of the entire LSA does not seem justified."

Thus, in 2014, based on multiple considerations, TRAI had recommended for charging on per point-to-point link basis for 6/ 7 GHz (MWB) carriers.

4.75 As has been stated before, it is prudent to have the basis of assignment and the method of charging to be in consonance with each other. Presently, the provisional assignment of these carriers is done on per point-to-point link basis, while charging is on AGR basis. Thus, there is a mismatch between assignment method and charging basis for Access service providers in 6 (lower)/7 GHz bands, where they are currently assigned on per point-to-point link basis, but charged on block AGR basis. The resulting high cost per link appears to be a deterrent for utilisation of these bands, in view of the very low number of links found to be deployed in these bands.

4.76 Based on a study of present deployments by three major Access Service providers, it is clear that number of links deployed by the operators in 6(lower)/ 7 GHz carriers are very low compared to number of deployments in 13/15/18/21 GHz carriers. Of the major Access operators, one of them has only 926 links across the country in only 07 LSAs, the other has only 428 links across 16 LSAs, while the third has only 28 links across 03 LSAs, at the time of this study. Comparatively, the number of links are at approximately 5.20 lakhs across the country in 13/15/18/21 GHz carriers. Therefore, as held in 2014 Recommendations, it is noted that assignment and charging for 6 (lower)/ 7 GHz backhaul on link basis is relatively easier. Further, based on industry consultations, it is learnt that presently as well as in future, it is likely that these links are going to be deployed in low density and commercially less lucrative area and for long distances, rather than in dense urban areas, with the number of links not likely to reach as high as that in 13/15/18/21 GHz bands. In such cases, point-to-point link based assignment and charging would continue to be manageable and would also provide flexibility to service providers to acquire & deploy links on need basis.

4.77 Accordingly, **the Authority recommends that, in line with the method of assignment, the charging for fresh assignments in 6 GHz (lower) band and the renewal assignments in 6 (lower)/7 GHz bands, should be on per point-to-point link basis, for backhaul use by Access service providers.**

4.78 For arriving at the per point-to-point link charges for fresh assignments in 6 (lower)GHz band and renewal assignments in 6(lower)/7 GHz band for backhaul of Access service providers, the Authority examined the extant orders/ directions, international practices as well as the TRAI recommendations of 2014.

4.79 Here, it is found that there is no existing order/ methodology available for per point-to-point link based charging applicable for assignments to Access Service Providers. Currently, charging for Access service providers for all backhaul bands, whether in 6 (lower)/7GHz or 13/15/18/21 GHz or E-Band, is on AGR basis.

However, prior to migration to AGR based charging in 2002, the charging for microwave backhaul carriers was on per point-to-point link basis based on the M x C x W formula, as has been described above in Section D(ii). The same has not been used for present exercise for reasons mentioned in Section D(ii) above.

4.80 The broad charging methodology for per point-to-point link across international regimes has been placed at Para 1 of Annexure-4.4 and described in Section D(ii) at Para 4.64. The relevance and appropriateness of these for the present Indian context has also been analyzed therein.

4.81 Going forward, the TRAI recommendations of 2014 were examined regarding the matter. The Authority in 2014 had also examined the rationale for assigning values to the three parameters—M, W and C—in the M × C × W formula. However, based on the available information, the reasons for assigning specific values to these parameters were not found. Therefore, the Authority had decided to use the cost of laying or leasing OFC for backhaul as a proxy for determining spectrum charges. Relevant excerpt is quoted below:

"In view of the above, the Authority has decided to use the cost of laying/leasing a fiber for the backhaul as a proxy for arriving at the spectrum charges which a TSP should pay for a microwave link. Through its Telecom Tariff (57th Amendment) Order dated 14th July 2014, TRAI has notified revised ceiling tariffs for domestic leased circuits for E1 (2Mbps), DS-2 (45 Mbps), STM-1 (155 Mbps) and STM-4 (622 Mbps) capacities. It is proposed to determine the link charges for MWB carriers

using the ceiling tariffs for domestic leased circuits for STM-1 (155 Mbps) as TSPs, generally, are deploying STM-1 systems on the 2x28 MHz MWB carrier.

…… The Authority is of the view that in this overall context, it would be reasonable to allow a decrement of about 50% on the corresponding OFC costs for arriving at the MWB costs. Therefore, the Authority considers that a factor of 0.5 may be used on the ceiling tariff of DLC to compensate for above advantages of fiber over microwave and also to account for Return on Capital (RoC) and Licence Fee of the DLC providers. Therefore, the Authority has decided to apply the factor of 0.5 to the ceiling tariff. Thereafter, the annualized capital cost and O&M charges, that a TSP will have to incur, have been deducted to determine spectrum charges for MW link.

……It has been assumed that a MW backbone link would be typically of 30 KM length without the need of a repeater. Therefore, ceiling tariffs for 30 KM distance have been used to calculate the MW link charges.

In the TTO (57th amendment), the first slab for ceiling tariffs notified by TRAI is for a distance< 50km. Using the formulation used by TRAI to arrive at the cost, tariff has been determined for slabs of distance 30 KM, which comes out to be Rs. 1,057,262 per annum

After applying the factor of 0.5 to the ceiling tariff and adjusting the annualized capital cost (Capital Cost taken as Rs. 3 lakh for terminal both the ends. Applying 15% ROCE and 12.5% of depreciation, annualized capital cost comes out to be Rs. 82500) and O&M charges (10% of terminal cost, i.e., Rs 30,000), remaining amount has been considered as the spectrum charges for 30 KM MWB link which comes out to be Rs. 4,16,131 only as detailed in Table 3.8 below:

Table 3.8

Item	Amount
(A) Ceiling Tariff (per annum) for 30 KM distance	Rs, 1,057,262
(B) After applying factor of 0.5	Rs. 528,631
(C) Terminal costs and O&M charges	Rs. 112,500
(D) Spectrum Charge for 30 KM MWB link (B-C) per annum	Rs. 416,131

The above charges are for 30 KM MWB link which implies that spectrum charges using MWB carrier will be Rs. 13871 per annum i.e. Rs. 13,900 per KM per annum (after rounding off).”

4.82 Thus, the prescribed charges had been calculated using prescribed DLC tariffs as per TTO (57th amendments) issued in 2014 and also the prevailing capital and O&M costs at that time. Hence, the recommended charges would require a re-examination. The Authority, as stated in 2014 Recommendations, had also recognized that it is not easy to quantify the relationship between OFC costs and the corresponding MWB costs. Further, since 2014, several technological developments have taken place in the DLC market — such as the shift from distance-based pricing to distance-neutral offerings, shifts in demand from SDH-based systems to IP/Ethernet technologies, and increasing demand for higher capacities. In view of the passage of time and multiple changes in technologies and costs, the DLC ceiling tariffs prescribed in 2014 is no longer considered an appropriate reference for the present exercise.

4.83 In line with the proposed methodology above, the data for deployed links in all bands (6/7/13/15/18/21/E-Band) from the three major TSPs for each LSA has been considered. As mentioned earlier, it is seen that 6 (lower)/7 GHz bands are presently being very sparingly used by operators for backhaul purpose, with very few carriers and links, and the existing links are further increasingly being surrendered by Access service providers. As such, approximating per link charges directly based on the spectrum

charges payout for the 6(lower)/7 GHz bands would not be appropriate or representative, due to the low utilisation of the bands.

4.84 The 13/15/18/21 GHz bands represent the most used bands for backhaul with a dense network of links in the acquired carriers, nearing 5.20 lakh links across India, and hence the methodology had been directly applied to these bands, as can be seen in Section D(ii) above. Accordingly, the per point-to-point link charge has been calculated as Rs. 25,000 per annum (rounded off) per point-to-point link of 21 GHz band using the methodology at Para 4.67 to 4.73 in Section D(ii) above.
Going forward, the point-to-point link charges for 6(lower)/ 7 GHZ bands shall be derived from these charges.

4.85 It is to be noted that the Authority has not relied on the DLC ceiling tariffs used in the 2014 recommendations or the M x C x W formula for recommending per point-to-point link charges of 6(lower)/7 GHz bands for backhaul by Access service providers. It was noted that since the 2014 pricing recommendations had used DLC ceiling tariffs for leasing OFC— which were distance-based— as a proxy for MWB spectrum, the spectrum charges of MWB links were also determined on a per-kilometer basis. Further, the M x C x W formula also considers the operational distance through the M factor. Though not directly prescribing per km rates, but the rates are calculated for slabs of distances as per M x C x W formula.

4.86 Regarding distance-based pricing, it is observed in all international regimes studied for the purpose of present study, placed at Annexure-4.4, the charging formula does not have distance of link or link length as a variable. The prices for links are derived by multiplying a base unit rate with the total channel bandwidth, and moderated further as per frequency band, density of area, spectrum congestion/ availability etc. Consequently, spectrum charges per link are not prescribed per kilometre or on distance basis in any of the jurisdictions studied. In fact, in a few regimes, notably

UK & South Africa, the charges are higher by a path-length factor, if the deployed link is shorter than the mean path length for that frequency stipulated by the regulator.

It is also noted that the length of microwave links deployed in remote, rural, difficult and hilly areas tends to be longer than in urban settings. An important objective in the current context is to promote investment in backhaul infrastructure, particularly in such difficult areas, to enhance the coverage and quality of service in these regions. It is noted that determining spectrum charges for point-to-point links on a per-kilometre basis would result in higher overall backhaul costs in these areas without commensurate return on investment due to sparse population/development. This could undermine the objective of strengthening and expanding backhaul infrastructure in geographically remote regions.

Further, in the absence of specific reasons for including distance in M x C x W formula, it is surmised that one of the primary reasons of charging for a link on per km basis or pricing distance into the charging formula could be that the bands with better propagation characteristics and efficiency should be charged more. There seems to be lack of other clear grounds for charging for links on distance basis.

In the current recommendations, rather than using distance-based pricing for differentiating the bands, the differences in propagation characteristics between 6 (lower)/7 GHz bands vis-à-vis the 13/15/18/21 GHz bands can be reflected in differential pricing by using the concept of band factors between these two groups of bands, as given below.

4.87 It is noted that differential pricing of inter se 13/15/18/21 GHz bands, using band factors, has not been recommended, for reasons mentioned at Para 4.48-4.53 in Section D (i) above. However, now, the case for differentiating the 13/15/18/21 GHz bands as a category vis-à-vis the 6(lower)/7 GHz bands needs to be examined, to see whether point-to-point link pricing of 6(lower)/7 needs to be adjusted accordingly.

It is observed from data on average link length of deployed links as well as study of technical reports that there is substantial difference in average link length and propagation characteristics between the 6 (lower)/7 GHz bands and the 13/15/18/21 GHz bands. As per data of deployed links collected from the Access service providers, the average link length of the few links deployed in 6 (lower)/7 GHz is 17.20 kms, as compared to 3.50 kms of the average link length in the 13/15/18/21 GHz bands. Internationally, as well, there are multiple international regimes using band factors and differential pricing between these two categories, as can be seen at Annexure-4.4.

Based on the above, there is a case for differential pricing of links in 6(lower)/7 GHz vis-à-vis links in 13/15/18/21 GHz. This is justified more so, as it has been recommended in Chapter II that fresh assignment of links in 6(lower) GHz can generally only be for a distance of 15 kms (10 kms in hilly states) or more, while the assigned links in 21 GHz bands can be deployed for any distance, which is likely to be much lesser owing to the propagation characteristics.

4.88 For arriving at appropriate band factors for differentiating 6 (lower)/ 7GHZ vis-à-vis 13/15/18/21 GHz, the existing M x C x W formula, the practical carrier/ link deployment data for India, TRAI Recommendations of 2014 as well as other international jurisdictions have been studied.

a. The average link length of the approximately 1500 point-to-point links (refer Annexure-4.1), deployed across India in 6(lower)/7 GHz band by the three major access service providers, is approximately 17.20 kms. Further, in the current recommendations, the links in 6(lower)/ 7 GHz bands are to be generally assigned above 15 kms (10kms in hilly states). Also, as per data published by ICASA & OFCOM as part of their pricing regulations, it is learnt that the mean path length applicable for links in these bands is near about 15-16 kms. Hence, the derived average link length of 17.50 is considered a reasonable basis for this analysis.

On the other hand, the average length of links deployed in 13/15/18/21 GHz bands, using the same weighted average methodology, is approximately 3.50 kms. Rather than differences in propagation characteristics *inter se* the 13,15,18 & 21 GHz bands, the real-world deployments appear to be driven by availability & assignment of carrier in particular band to a service provider. However, the overall weighted average link length of 3.5kms can be considered fairly representative of the ground reality, as nearly 5.2 links have been deployed.

With the carrier size of 28 MHz (paired) being same across these bands, a factor of approximately 4.9 for 6(lower)/7 GHz bands vis-à-vis 13/15/18/21 GHz bands, based on the deployed link lengths of 17.20 kms & 3.5 kms respectively, can be observed from the practical deployment data.

b. The Authority in its 2014 recommendations had used frequency band factors as specified by the South African Regulator ICASA and UK regulator OFCOM. For an updated examination of international practices, the pricing methodologies and frequency band factors as specified by these regulators as well as other international jurisdictions have also been studied and are placed at Annexure-4.4.

It is observed that, across most regimes, lower frequency bands (6(lower)/7 GHz) command higher pricing factors than higher frequency backhaul bands (13/15/18/21 GHz). The relative pricing factor of 6 (lower)/7 GHz vis-à-vis 18/21 GHz in various countries, as derived from study of pricing in international jurisdictions at Annexure-4.4, is tabulated below:

S.no.	Sources	Relative pricing factor of 6/7 GHz vis-a-vis 13/15/18/21GHz
1	OFCOM, UK	2.10
2	Communications Regulator, Ireland	1.35
3	ICASA, South Africa	1.75
4	CST, Saudi Arabia	2.50
5	ISED, Canada	1.75
6	TDRA, UAE	1.38

Across international jurisdictions, a factor ranging from 1.35 - 2.50 between 6(lower)/7 GHz & 13/15/18/21 GHz can be observed.

c. As per the M x C x W formula for charging of point-to-point links in the extant DoT order dated 13.11.2023, the 'M' factor for a link length (operational distance) of less than 2 kms is 750, for a link length between 2 to 5 kms is 1500 and between 5 to 25 kms is 3000. As discussed at sub para (a) above, the average link length for 13/15/18/21 GHz is approximately 3.50 kms, which will have a M factor of 1500, whereas, the average link length for 6 (lower)/7 GHz band is approximately 17.20 kms which will have a M factor of 3000. Thus, the relative band factor between these two categories, as per extant M x C x W formula, would be 2**.**

4.89 In order to arrive at suitable pricing factor between 6(lower)/7 GHz & 13/15/18/21 GHz, it is observed from the analysis at Para 4.88 above that, practical link deployments in India show a factor of 4.9 between the average link lengths, whereas international comparisons yield a price factor

of 1.35-2.10, and the DoT's M x C x W formula shows a factor of 2 between relevant M values.

Another important factor, while deciding relative price factor between 6(lower)/7 GHz vis-à-vis 13/15/18/21 GHz bands, is that industry inputs and observations in Chapter II & III show that a significant number of links utilising 6(lower)/ 7 GHz are deployed in geographically difficult and low-density areas, which are also commercially less lucrative. It is a stated objective to price backhaul in a manner as to encourage the deployment of links, which can enhance expansion of networks and quality of services. Hence, rates for point-to-point links in 6(lower)/ 7 GHz should support enhanced deployment of links and network roll outs, especially in difficult terrains and low-density areas.

Thus, to encourage utilization of full potential of hitherto underutilized 6(lower)/ 7 GHz bands, in expansion of networks in geographically difficult terrains and low-density areas, the pricing factor should be less than the factor that would be indicated by the present ratio of link lengths prevailing in India between (lower)/7 GHz vis-à-vis 13/15/18/21 GHz bands. The Authority is of the view that the reasonable factor should be between the factor based on link lengths deployed in India, internationally prevailing price factors and the factor as per the extant provisional DoT M x C x W formula. On a balance of considerations, a pricing factor of 3 between 6(lower)/7 GHz and 13/15/18/21 GHz is considered reasonable.

Accordingly, the calculations are mentioned below:

i. Spectrum charge per point-to-point link for 21 GHz = Rs 25,000 per annum
   (as calculated in Section D(ii) above)
ii. Applying pricing factor of 3.0, yields a spectrum charge of 25000*3.0 = Rs 75,000 (rounded off) per annum per point-to-point link for 6 (lower)/7 GHz bands.

4.90 Accordingly, **the Authority recommends spectrum charges of Rs 75,000 per carrier per annum for each fresh or renewal point-to-**

point link assignment in 6 GHz (lower) band and renewal of point-to-point link assignment in 6 GHz (lower)/7 GHz band for backhaul by Access Service providers.

E. Spectrum charging of traditional microwave backhaul bands viz. 6 (lower)/7/13/15/18/21 GHz bands for last-mile connectivity (Fixed Wireless Access) of commercial telecom services

4.91 Through the reference dated 13.09.2024, DoT has informed that "*One of commercial telecom service providers holding Unified License with Access service authorization and providing wireline services has requested for spectrum in the 6/ 7/ 13 GHz bands for establishing links for last mile connectivity solutions in certain Licensed Service Areas*". Accordingly, TRAI's recommendations have been sought on "*quantum/ band(s) of spectrum to be earmarked for last mile connectivity (Fixed Wireless Access) of commercial telecom services and methodology of assignment of spectrum and associated terms & conditions in non-IMT bands*."

4.92 In the Consultation paper dated 28.05.2025, it was stated that if it is decided that some frequency spectrum in any one or more of the 6 (lower)/7/13/15/18/21 GHz bands is earmarked for last-mile connectivity i.e. Fixed Wireless Access (FWA) then it would become necessary to determine the appropriate spectrum valuation and reserve price for these bands.

4.93 The Authority has already dealt the issue of assignment of traditional microwave backhaul bands for last mile connectivity (FWA) in Chapter II and held that the traditional microwave frequency bands viz. 6(lower)/7/13/15/18/21GHz, should continue to be assigned for backhaul purposes only. As these bands have not been recommended for last mile connectivity (FWA), the question of their pricing or method of assignment

for this purpose does not arise. Therefore, no further analysis is required to determine appropriate spectrum valuation and reserve price for these bands for last-mile connectivity i.e. Fixed Wireless Access (FWA).

4.94 Accordingly, the questions 37-39 in the Consultation Paper stated below do not require further analysis:

Q37. In case it is decided to assign some frequency spectrum in 6 (lower)/7/13/15/18/21 GHz spectrum bands for last mile connectivity (Fixed Wireless Access) of commercial telecom services through auction, then:

i.Should the auction determined price of other bands by using spectral efficiency factor serve as a basis of valuation for the above bands? If yes, which spectrum bands be related, what efficiency factor or formula should be used and what is the basis for the same? Please justify your suggestions.

ii. If response to question (i) above is no, what other methodology may be used. Please justify your suggestions.

Q38. In case it is decided to assign some frequency spectrum in 6 (lower)/7/13/15/18/21 GHz spectrum bands for last mile connectivity (Fixed Wireless Access) of commercial telecom services through auction, then:

i. Should the auction determined price of other countries in 6/7/13/15/18/21 GHz spectrum bands for last mile connectivity and/or IMT services serve as a basis of valuation of microwave bands for last mile connectivity? What methodology should be followed for using this auction determined price as a basis for valuation? Support your suggestions with justifications and country-wise auction data.

ii. If the above approach is considered appropriate, should the international auction-determined prices be normalized to account for cross-country differences such as population, GDP, purchasing power parity (PPP), subscriber base, and other relevant factors? If so, should normalization be carried out by using the ratio of auction prices of

spectrum bands within the same country to neutralize the impact of cross-country differences? Alternatively, please suggest any other suitable normalization methodology that may be adopted in this context.

iii. Apart from the approaches highlighted above which other valuation approaches may be adopted for the valuation of 6 (lower)/7//13/15/18/21 GHz spectrum bands? Please provide detailed information.

Q39. What valuation methodology should be followed if it is decided to assign frequency spectrum in traditional microwave backhaul bands for flexible use (i.e. both backhaul connectivity and last mile connectivity) of commercial telecom services through auction? Please provide detailed justification.

F. Spectrum charges for fresh assignments in 6 (lower)GHz & 21 GHz and renewal assignments in 6 (lower)/7/13/15/18/21 GHz on point-to-point link basis to all Authorised entities, including non-commercial/ captive users, for backhauling telecom traffic other than wireless access network traffic

4.95 DoT through its reference dated 13.09.2024, has informed that:

"*point to point connectivity requirements of certain captive users is required to be met from one or more of these bands i.e. 6(lower)/ 7/ 13/ 15/ 18/ 21 GHz bands. Such requirements are generally localized and mostly limited to few links only. In case, some carriers are specifically earmarked for such use, they can be re-used among multiple users with geographical separation*".

Accordingly, recommendations have been sought on quantum/ band(s) of spectrum to be earmarked for backhaul purposes for non-commercial/ captive use and associated terms and conditions including charges.

4.96 Analysis and recommendations on various technical and other aspects related to the use of 6(lower)/7/13/15/18/21 GHz bands by all Authorised

entities, including non-commercial/ captive users, for backhauling telecom traffic other than wireless access network traffic have already been provided in Chapter II and summarised at Section C above. In line with recommended assignments, this section deals with the analysis and recommendations related to spectrum charges for fresh assignments in 6 (lower)/ 21 GHz or renewal assignments in 6 (lower)/7/13/15/18/21 GHz on link basis to all Authorised entities, including non-commercial/ captive users, for backhauling telecom traffic other than wireless access network traffic.

With a view to recommending appropriate spectrum charges, it is necessary to examine the stakeholders' comments on questions raised in the Consultation Paper dated 28.05.2025 and prevailing spectrum charging framework for above mentioned bands, along with other relevant factors.

4.97 In this context, the following questions were raised in the Consultation paper dated 28.05.2025:

Q40*. Should the spectrum charges for 6 (lower)/ 7/ 13/ 15/ 18/ 21 GHz bands for non-commercial/ captive backhaul use continue to be levied as per the M x C x W formula specified in the DoT's order No. P-11014/34/2009-PP dated 11.12.2023? Is there a need to revise this formula by inclusion of additional factors, modifying slab/factor values etc.? If yes, please specify which additional factors should be included and what should be the revised slab/factor values? Please provide detail of the same along with justification.*

Q41. If the answer to above question is no, whether an alternative charging mechanism should be adopted for levying spectrum charges for 6 (lower)/ 7/ 13/ 15/ 18/ 21 GHz bands for non-commercial/ captive backhaul use? Please provide detailed justification.

Stakeholders Comments

4.98 A few stakeholders submitted that captive demands can be met through existing unlicensed bands or spectrum leasing from access providers on a P2P basis, suggesting this market-driven approach should be prioritized over direct administrative assignments to captive operators, to avoid inefficiencies and ensure level playing fields.

4.99 Several stakeholders advocated that the M x C x W formula specified in the DoT OM under reference should be reviewed for non-commercial or captive backhaul use, pointing out that the current rates are excessively high and do not account for increased data demands or promote efficient utilization. It was submitted that the M x C x W formula and similar approaches result in excessively expensive charges, even for administrative assignments, defeating the purpose of optimal utilization for public good. A significant rationalization of the formula was recommended, due to the current high costs, which do not reflect the non-revenue-generating nature of backhaul. Modifications to slabs, such as merging distance slabs and adjusting the bandwidth slabs, to better reflect modern consumption patterns were suggested. In this vein, it was suggested that for captive use, spectrum on per point-to-point link basis, should be given at a much-reduced rate - at a discount of 50% from the rates for commercial purposes

4.100 Some stakeholders recommended that entirely new charging mechanisms. which avoid overvaluation and facilitate increased deployments, could be explored, emphasizing the need for rationalized, nominal, or fixed fees that align with utility of backhaul spectrum as a public resource supporting digital inclusion. It was argued that uniform rates without progressive escalation would be appropriate to facilitate high-capacity deployments. This would encourage investment in underserved areas, while ensuring that the uniform charges do not exceed current effective payouts in utilized bands, to avoid discouraging adoption.

4.101 Another stakeholder proposed replacing the administrative assignment and charging formula entirely with a market-driven charging mechanism like auction for fairness and revenue optimization.

Present Charging methodology:

4.102 Presently, the spectrum charges are being levied as per DoT's OM no. No. P-11014/34/2009-PP dated 11.12.2023, which deals with spectrum charges for assignment of frequencies to *captive users* for different types of radiocommunication services and applications on a provisional basis for the interim period. As mentioned in Chapter II, DoT has assigned point-to-point links for commercial non-Access services such as NLD/ ISP as well, apart from non-commercial/ captive users, which are also charged as per this OM itself.

4.103 The existing DoT order of 2023 determines spectrum charges based on various factors, including the basic royalty (captured by the M-factor), the bandwidth assigned (captured by the W-factor), and the number of frequency carriers allocated (captured by the C-factor), as given below:

Annual Royalty Charges (Rs) = M × C × W

Where:

i. M – Factor (Basic Royalty) depends on the maximum operational distance of the network.

Table: M -Factor

Distance Category	Maximum Distance (Km)	Value of M Factor
I	<= 2	750
II	> 2 <= 5	1500
III	> 5 <= 25	3000
IV	> 25 <= 60	6000

V	> 60 <= 120	11000
VI	> 120 <= 500	18750
VII	> 500	25000

ii. Number of carriers represented by 'C'

iii. Weighing Factor 'W' which is decided by the adjacent channel separation of the R.F channelling plan deployed, where

Table: Bandwidth factor(W)

Slabs of Adjacent Channel Separation (BW), in MHz	**Value of W factor**
More than 375 kHz and including 2 MHz	30
More than 2 but <= 3.5	40
More than 3.5 but <= 7	60
More than 7 but <= 14	90
More than 14 but <= 28	120
More than 28 but <= 56	150
More than 56 but <= 112	180
More than 112 but <= 256	210
More than 256 but <= 512	240
> 512	240 + 30 × (Excess bandwidth / 256)

4.104 Based on the M x C x W formula, the charge per point-to-point link assignment for the 6 (lower) & 7GHz band, assuming a link length of 5-25 kms, with C-factor of 2 (both are FDD bands with paired carriers) and W-factor of 120 (carrier sizes in both bands are of 28MHz), is tabulated below:

Point-to-point link charges for 6 (lower)/7GHz bands for a link of 5-25 kms	
M - Factor	3000 (for distance of 5-25 kms)
W - Factor	120 (for carrier size of 28MHz)
C - factor	2 (for FDD bands)
Annual spectrum charge (Rs)	**Rs 7,20,000**

For point-to-point links in 13/15/18/21 GHz, with a link length of 2-5 kms, C-factor of 2 (all are FDD bands with paired carriers) and W-factor of 120 (carrier sizes in all bands are of 28MHz), the charges would be as below:

Point-to-point link charges for a link of 2-5 kms in 13/15/18/21 GHz bands	
M - Factor	1500 (for distance of 2-5 kms)
W - Factor	120 (for carrier size of 28MHz)
C - factor	2 (for FDD bands)
Annual spectrum charge (Rs)	**Rs 3,60,000**

4.105 It is necessary to analyse whether spectrum charges for the 6 (lower)/7/13/15/18/21 GHz bands, when used by Authorised entities, including non-commercial/ captive users, for backhauling telecom traffic other than wireless access network traffic, should continue to be levied in accordance with the M x C x W formula as specified in above described provisional order of 2023, or need to be revised.

Analysis

4.106 For the purposes of the analysis, the Authority has examined the current charging mechanism, the relevant TRAI recommendations of 2014, the stakeholders' comments as well as other relevant factors.

4.107 It has earlier been observed that basis of assignment and methodology for charging should generally be in consonance with each other. In line with the same principle, and keeping in view the mode of assignment, **the Authority recommends that the spectrum charges, for fresh assignments in 6 GHz (lower) & 21 GHz bands and for renewal assignments in 6 (lower)/7/13/15/18/21 GHz bands, of point-to-point links to Authorised entities, including non-commercial/ captive users, for backhauling telecom traffic other than wireless access network traffic should be on per point-to-point link basis.**

4.108 Regarding the charging methodology to be recommended, the Authority has also noted the stakeholders' comments highlighting the high charges imposed per link by the extant M x C x W charging formula. There is need for significant rationalization of slabs in M x C x W formula to arrive at revised charges or exploration of alternative charging methods, in view of rationalization of backhaul spectrum prices for access services and to align with utility of backhaul as an enabler of telecommunication services. The case for rationalization also appears necessary, considering the low utilization of microwave links by captive users across India, where high prices could be one of the factors for the same.

4.109 In order to understand the M x C x W formula as well as rationale for assigning values to the M, C & W parameters as per 2023 order, the Authority sought information from DoT. However, as mentioned earlier, no significant information regarding the assigned values is available.

4.110 Further, the point-to-point link charges have been calculated for backhaul of telecom traffic, other than wireless access network traffic, in 21 GHz by Access service providers in Section D. (ii) above and for backhaul of access traffic in 6(lower)/7 GHz in Section D. (iii) above. For the exercise, the Authority has not relied on the DLC ceiling tariffs as was done in 2014 recommendations or the M x C x W formula as per historical or extant orders, for reasons elaborated in Section D. (ii). Instead, per point-to-point link charges have been calculated for 13/15/18/21 GHz, by converting the present AGR based spectrum charges being recommended presently for block basis assignments to spectrum charge payout per point-to-point link. The per point-to-point link charges for 6 (lower)/7 GHz have been derived from the charges for 13/15/18/21 GHz based on appropriate band factors. The methodology is detailed in Section D(iii) above.

4.111 Thus, per point-to-point link charge of Rs 25,000 per annum per point-to-point link in 13/15/18/21 GHz bands has been calculated in Section D(ii) above. Further, applying a band factor of 3 to these charges, per point-to-point link charge of Rs 75,000 per annum was arrived at for 6(lower)/7GHz bands, as detailed in Section D(iii) above.

4.112 The Authority is of the view that the same charges, which have already been rationalised in comparison to existing charges based on M x C x W formula, should be extended for backhaul use by Authorised entities, including non-commercial/ captive users, for backhauling telecom traffic other than wireless access network traffic, for parity of backhaul costs across categories of services and service providers, as well as rationalisation of backhaul costs, with backhaul being an enabler of telecom services.

4.113 Accordingly, **the Authority recommends spectrum charges of Rs 25,000 per carrier per annum for each fresh or renewal point-to-point link assignment in 21GHz band to all Authorised entities,**

including non-commercial/ captive users, for backhauling telecom traffic other than wireless access network traffic. The same charges are recommended for renewal of point-to-point link assignments in 13/15/18 GHz bands to all Authorised entities, including non-commercial/ captive users, for backhauling telecom traffic other than wireless access network traffic.

Further, the Authority recommends spectrum charges of Rs 75,000 per carrier per annum for each fresh or renewal point-to-point link assignment in 6 GHz (lower) band to all Authorised entities, including non-commercial/ captive users, for backhaul purposes. The same charges are recommended for renewal of point-to-point link assignments in 7 GHz band to all Authorised entities, including non-commercial/ captive users, for backhaul purposes.

Part-II
Spectrum Charges for E-band (71-76 GHz / 81-86 GHz) and V-band (57-64 / 66 GHz)

A. Introduction

4.114 The previous Part (I) of this chapter dealt with spectrum charging of traditional microwave backhaul bands viz. 6 (lower)/7/13/15/18/21 GHz bands for backhaul purposes by various Authorised entities for Access services, commercial non-Access services as well as non-commercial/ captive use. This part of the Chapter deals with analysis and recommendations related to spectrum charging of E-band (71-76 GHz / 81-86 GHz) and V-band (57-64 / 66 GHz).

4.115 The rising utility of E and V Bands in Access Backhaul has been brought out in the GSMA report of 2021 on "Spectrum for Wireless Backhaul":

"Over the 5G era, mobile operators will need to continually upgrade their backhaul networks to support growing adoption of the technology and increased usage. Technology upgrades alone will not be able to scale capacity to meet expected demand. This means it will be necessary for regulators to make available additional backhaul bands – especially in higher frequency ranges such as E-band and V-band.

There are a variety of approaches for licensing backhaul bands, especially with the emergence of higher frequency bands and dense small cell networks. Regulators should carefully consider how they can encourage spectrum efficiency and facilitate rapid deployments. Making sure the process can be efficiently managed by all parties is also key. To support the rapid expansion of 5G, it is crucial to have an effective pricing strategy for spectrum in these bands, which are essential for backhaul networks. A well-balanced pricing approach may enable operators to invest in high-speed networks while promoting fair competition and maximizing the efficient use of available spectrum".[119]

B. DoT's reference dated 13.09.2024: Spectrum Charging/Pricing in E-band and V-band

4.116 DoT in the said reference has requested TRAI under Section 11(1)(a) of the TRAI Act, 1997 to provide recommendations *inter alia*, on the following matters:

(a) Demand assessment and scope of service/usage for (i) 57-64/66 GHz (V-band) and (ii) 71-76 GHz/ 81-86 GHz (E-band) and accordingly methodology of assignment of spectrum and associated terms & conditions, in line with the determination of scope of services/ usages by TRAI i.e. "Access" or "Backhaul" or "Integrated Access & Backhaul (IAB)".

[119] https://www.gsma.com/connectivity-for-good/spectrum/wp-content/uploads/2021/02/wireless-backhaul-spectrum-positions.pdf

C. Summary of recommendations regarding assignment of E & V band for backhaul use by all Authorised entities

4.117 Analysis and recommendations on various technical and other aspects related to the assignment of E&V bands to Authorised entities, including non-commercial/ captive users, have already been provided in Chapter III. Salient points are noted below:

(a) E-band carriers should be assigned on a block-basis in a Licensed Service Area (LSA) to Access service providers for backhauling their wireless access network traffic, subject to a maximum of 03 carriers per LSA. The Access service providers currently holding E-band carriers in any LSA should be given an option to retain their existing carriers in the LSA, and the same should be counted for the purpose of the ceiling on the number of carriers in the LSA

(b) E-band carriers should be assigned on a point-to-point link basis to all Authorised entities, including non-commercial/ captive users, for backhauling their telecom traffic other than wireless access network traffic. Two carriers in E-band should be earmarked for the assignment on a point-to-point link basis

(c) V-band carriers should be assigned on per point-to-point link basis to all types of authorised entities, including non-commercial/ captive users, for backhaul purposes.

4.118 In context of the present DoT reference dated 13.09.2024 and in line with the present recommendations on assignment of E-band (71-76 GHz/ 81-86 GHz) and V-band (57-64/66 GHz) as mentioned above, the next sections *viz.* (D), (E) & (F) deal with spectrum charging of E & V band, wherein (D) deals with the issue of spectrum charging of E Band for backhaul of wireless access services by Access service providers, (E) deals with the issue of spectrum charging of E & V band for Access (last-mile connectivity) and/or Integrated Access Backhaul of commercial telecom services, and (F) deals

with the issue of spectrum charging of E & V band for backhaul purpose by Authorised entities, including non-commercial/ captive users, for backhauling telecom traffic other than wireless access network traffic.

D. Spectrum Charges for E-band (71-76 GHz/81-86 GHz) and V-band (57-64/66 GHz) for backhaul use by Access service providers

4.119 For determining spectrum charges for Access Service Providers being assigned E band (71-76 GHz/81-86 GHz) and V-band (57-64/66 GHz) for backhaul, it is necessary to examine the stakeholders comments on questions raised in Consultation paper dated 28.05.2025 on "Assignment of the Microwave Spectrum in 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, 21 GHz Bands, E-Band, and V-Band" and prevailing spectrum charging framework for above mentioned bands, along with other relevant factors.

4.120 In this context, the following questions were raised in the Consultation paper:

Q42. In case the E-band (71-76/ 81-86 GHz) is assigned for Radio backhaul purpose for various commercial telecommunication services and on a Point-to-Point (P2P) link basis, should the spectrum charges be levied:

i. As a percentage of Adjusted Gross Revenue (AGR), or

ii. On a per carrier/link basis, or

iii. Through any alternative mechanism (please specify)?

Kindly provide a detailed justification for the approach considered most suitable, along with the suggested percentage of AGR or the applicable per carrier/link charge.

Q43. In case the E-band (71-76/ 81-86 GHz) is assigned for Radio backhaul purpose for various commercial telecommunication services and on a block basis for the entire Licensed Service Area (LSA), should the spectrum charges be levied:

i.As a percentage of Adjusted Gross Revenue (AGR), or

ii.On a per MHz or per carrier basis, or

iii.Through any alternative mechanism (please specify)?

Kindly provide a detailed justification for the approach considered most suitable, along with the suggested percentage of AGR or the applicable per MHz/per carrier charge.

Q44. In case the V-band (57-64/66 GHz) is assigned for Radio backhaul purpose for various commercial telecommunication services and on a Point-to-Point (P2P) link basis, should the spectrum charges be levied:

i.As a percentage of Adjusted Gross Revenue (AGR), or

ii.On a per carrier/link basis, or

iii.Through any alternative mechanism (please specify)?

Kindly provide a detailed justification for the approach considered most suitable, along with the suggested percentage of AGR or the applicable per carrier/ link charge.

Q45. In case the V-band (57-64/66 GHz) is assigned for Radio backhaul purpose for various commercial telecommunication services and on a block basis for the entire Licensed Service Area (LSA), should the spectrum charges be levied:

i.As a percentage of Adjusted Gross Revenue (AGR), or

ii.On a per MHz or per carrier basis, or

iii.Through any alternative mechanism (please specify)?

Kindly provide a detailed justification for the approach considered most suitable, along with the suggested percentage of AGR or the applicable per MHz/per carrier charge.

Stakeholders Comments

4.121 Some stakeholders have advocated for administrative assignment of the E-band and V-band exclusively for backhaul purposes on a block basis for the

entire LSA, emphasizing that this approach avoids disruptions to existing networks and aligns with global best practices. It was argued that backhaul spectrum does not generate direct revenue but acts as critical supporting infrastructure, and subjecting it to auctions could create artificial scarcity, competitive imbalances, and jeopardize service continuity for operators reliant on wireless backhaul. These stakeholders recommended levying spectrum charges as a percentage of AGR, but with significant rationalization to reflect its non-revenue-generating nature, suggesting uniform rates such as 0.05% per carrier without escalation to promote efficient deployment and digital connectivity goals.

4.122 A few stakeholders proposed bundling a predetermined number of E-band/ V-band carriers with Access spectrum acquired through auctions, such as linking carriers to mid-band holdings like 3300 MHz, to meet standard backhaul needs without additional charges. It was suggested that beyond bundled carriers, charges should be applied on a per-carrier basis as a low percentage of AGR, around 0.05%, to rationalize costs and encourage high-capacity links for 5G and beyond, while maintaining LSA-wide exclusivity. This method, it was noted, ensures uniformity in pricing, aligns with LSA-based network planning, and avoids the inefficiencies of point-to-point allocation.

4.123 Another stakeholder suggested specific AGR-based slabs for E-band on block basis, such as 0.075% per carrier for the first two and 0.15% thereafter up to four carriers, with rollout obligations like minimum hops to ensure utilization and prevent hoarding. They highlighted the need for rationalized charges to address the disproportionate spectrum charges payouts for backhaul, which constitute the majority of spectrum usage charges, despite its complementary role, urging a shift to fixed or nominal models to support network scalability in fiber-deficient areas.

4.124 One stakeholder opposed administrative assignment for E-band and V-band, insisting on auctions for full License Service Area to ensure fairness and compliance with legal principles, arguing that these bands have versatile uses including Access and IAB, with competition from various service providers.

4.125 Several stakeholders recommended delicensing the V-band or parts thereof due to its limited propagation characteristics, in line with international practices in countries like Europe and the US, to facilitate low-power applications, without any spectrum charges, while lightly licensing E-band with nominal per-carrier fees based on global benchmarks.

Present charging methodology

4.126 Presently, spectrum charges for E-band are levied as per DoT's provisional orders issued as "Guidelines for allotment of E-band (71-76/81-86 GHz) carriers to Telecom Service Providers (TSPs) with Access Service authorization/license and having Access Spectrum in IMT bands" dated 27.07.2022. As per the order, all E-Band carriers are assigned as an interim measure, on purely provisional and temporary basis, and all such assignees will have to participate in an auction or any other assignment methodology, as decided by Government after considering the recommendations of TRAI in this regard. Subject to above conditions, spectrum charges for each E-band carrier of 250 MHz paired bandwidth are levied @ 0.15% of Adjusted Gross Revenue of the TSPs for a maximum of 02 carriers in each LSA, which will be adjusted/recalculated retrospectively (from the date of provisional assignment) based upon the pricing decided finally.

4.127 Further, V-band has not been assigned in India currently to any entity for any purpose whatsoever, hence there is no charging order applicable presently.

Analysis

4.128 For the purposes of the analysis, the Authority has explored the current charging mechanism, international practices, the relevant TRAI recommendations of 2014, the stakeholders' comments as well as other relevant factors, including, inter-alia, the objective of achieving an affordable backhaul spectrum regime to optimize utilization of backhaul spectrum, including promoting the adoption of E & V Bands, potentially leading to improvements in quality of services.

4.129 In line with the recommended methodology of assignment of E&V bands for backhaul by Access Service providers, the analysis related to determination of spectrum charges to be recommended for Access Service providers is in the sub-sections as given below:

a. Analysis related to spectrum charges for fresh and renewal block basis assignments in E-band for backhaul of wireless access network traffic by Access Service providers is discussed in sub-section D(i)

b. Analysis related to spectrum charges for fresh point-to-point link assignments in E-band for backhaul of telecom traffic, other than wireless access network traffic, by Access Service providers is discussed in sub-section D(ii)

c. Analysis related to spectrum charges for fresh point-to-point link assignments in V-band for backhaul by Access service providers is discussed in sub-section D(iii)

D(i) Spectrum charges for fresh and renewal block basis assignments in E band for backhaul of wireless access network traffic by Access Service providers

4.130 The Authority has observed that basis of assignment and methodology for charging should generally be in consonance with each other. In Section D

(i) of Part I, the Authority has considered certain reasons supporting the view that, given the block-based assignment of spectrum in the traditional backhaul bands for backhauling wireless access traffic by Access service providers, the adoption of an AGR-based charging mechanism for the same may be appropriate. The following reasons, as also observed earlier, are noted below:

a) AGR based charging is a simple and progressive approach aligning the charges with the benefits or revenue generated from spectrum use and considers the users' ability to pay, as well as provides autonomy to deploy required number of links utilizing the acquired carrier.

b) Presently, Access service providers are already paying charges for E-band as a percentage of their AGR, and continuity of the same would ensure a consistent and stable framework.

c) E-band is a capacity band for covering short distances and is used world over for dense urban areas. Its usage is expected to increase in India with increasing data usage in the 5G era. Block basis assignment and AGR based charging would be administratively and operationally more convenient for both Government and the access service providers.

d) Majority of stakeholders have supported this approach along with rationalization of the AGR percentage.

4.131 In the TRAI recommendations of 2014, in case of E-band and V-band pricing, the Authority had observed:

"…. Authority is inclined to agree with one of the stakeholder's suggestions that the current pricing model (based on AGR) cannot be applied to these bands considering the quantum of available spectrum and the different characteristics of these bands."

Thus, TRAI in 2014 recommendations had not supported block basis assignment and AGR based charging for E-bands. However, it is noted that E-band assignments are being done since 2022, on block basis to the Access service providers, who are paying for the same on AGR basis. Continuing the same would ensure stability and consistency of charging

framework. The reasons stated above support AGR based charging for block basis assignment in E band and justify reconsideration of approach recommended in TRAI recommendations of 2014.

Also, traditional backhaul bands and E-band, when assigned in similar manner and used for similar purposes, which in this case would be for backhaul of wireless Access traffic by Access service providers, should have similar basis of charging. This would create consistency across the entire backhaul charging framework as well.

4.132 Regarding the option of pricing per unit (i.e. KHz or MHz) rather than carrier as a whole, it is noted that E Bands, primarily used for backhaul purposes, do not generate revenue on their own. Consequently, financial and other market-related data indicating the market value is not available. Hence, their precise valuation is difficult to be derived through arithmetic models.

4.133 Accordingly, **the Authority recommends that spectrum charges for fresh and renewal block basis assignments in E-band for backhaul of wireless access network traffic by Access service providers should be levied on a percentage of Adjusted Gross Revenue (AGR) basis per carrier.**

4.134 Going forward, the appropriate percentage of AGR for levying spectrum charges for E-band needs to be decided and whether the extant spectrum charges for E-band shall continue or there is a need to revise this percentage.

For this purpose, it is necessary to analyse the present spectrum charges for E-band, the stakeholders' comments, TRAI Recommendations of 2014, international practices as well as the charging recommendations for traditional backhaul bands.

4.135 Presently, as per DoT's charging order dated 27.07.2022, interim spectrum charges for each E-band carrier of 250 MHz paired bandwidth are levied @

0.15% of AGR, which will be adjusted/recalculated retrospectively (from the date of provisional assignment) based upon the pricing decided finally.

It is noted that the aforesaid guidelines do not specify the rationale or basis for determining the interim spectrum charge of 0.15% of AGR for the E-band. Accordingly, the Authority had sought information from DoT regarding the rationale, basis, and methodology adopted in prescribing this rate. In response, DoT has stated that:

"The provisional spectrum charges @ 0.15% of AGR (Adjusted Gross Revenue) of the TSPs in the interim period for E band are in line with the spectrum charges applicable for Microwave Access (MWA)/Microwave Backhaul (MWB) spectrum since the final decision on spectrum assignment methodology and pricing for E-band spectrum assignment is pending."

Thus, it has been clarified by DoT, that the existing 0.15% AGR rate for E-band is aligned with the prevailing rates for first carrier of traditional backhaul (MWA/MWB) spectrum. It is noted that the rates for the traditional backhaul bands have been recommended for rationalisation in the present exercise.

4.136 There is also stakeholders' demand for significant rationalization, to reflect the non-revenue-generating nature of backhaul bands. The suggestions include uniform rates such as 0.05% per carrier without escalation, or a graded charging structure with 0.075% per carrier for the first two and 0.15% thereafter up to four carriers.

4.137 It is pertinent to note that in Section D of Part I, the Authority has recommended rationalized spectrum charges for 13/15/18/21 GHz band for backhaul by Access service providers, based on a number of considerations, including the objective to optimise the uptake and utilisation of large number of carriers lying unutilised, which is likely to boost quality of service.

The principles of making backhaul affordable and optimising its utilisation would apply in the context of charging of E-band as well.

4.138 Further, the TRAI Recommendations of 2014 also contained the following observations & recommendations regarding pricing of E-Band:

"*Based on the study of international trends, the usefulness of the bands in accelerating the growth of mobile data segment, and overall growth in ICT and in view of the fact that it is almost a greenfield area for short distance backhaul, the Authority has reached the conclusion that the price of carriers in E-band and V-band should be kept low so as to leverage technology.*

In case of E-band and V-band pricing, the Authority is inclined to agree with one of the stakeholder's suggestions that the current pricing model (based on AGR) cannot be applied to these bands considering the quantum of available spectrum and the different characteristics of these bands.

For India, we may put a price of Rs. 10000/- (Rs. Ten Thousand) per annum per carrier of 250MHz each in E-band. In order to promote this band an initial promotional discount of 50% for three years from the date of allocation of first carrier in this band can be given."

It can be seen that the charges then recommended were fixed at Rs 10,000 annually per carrier for each point-to-point link. However, since both assignment and charging for E-band has been recommended to be on block/ AGR basis, the charges need to be determined afresh.

4.139 The Authority has recommended a uniform spectrum charge of 0.10% of AGR per carrier in 13/15/18/21GHz band for backhaul of wireless access network traffic by Access service providers. Since both traditional and E-bands are recommended to be assigned on block basis for same purpose here viz. backhaul of wireless access services, the revised spectrum charges for the E-band can be determined through a comparative assessment of E-band vis-à-vis the 13/15/18/21 GHz bands. The recommended charge of 0.10% of AGR for the 13/15/18/21 GHz bands can be taken as a benchmark to assess whether the charge for the E-band

should be lower, same, or higher than 0.10% of AGR. For benchmarking with recommended charges for 13/15/18/21 GHz, international comparisons, M x C x W formula, current charging method, practical link deployments in India as well as other relevant factors have been studied.

4.140 As per study of international practices, placed at Annexure-4.4, it is seen that the charges for E-Band are generally very low. As with all backhaul spectrum, charging for E-band in various international regimes is also on per point-to-point link basis only. The charges are either derived through the same formula as traditional backhaul in a few countries or treated separately with flat fees.

The comparison of charges for E-band links utilising 250 MHz(paired) carriers vis-à-vis links in 13/15/18/21 GHz utilising 28 MHz (paired) across countries, based on calculations at Annexure-4.4, is summarised below:

a. In UK, the charging formula for traditional backhaul bands does not apply directly to E & V bands. The prescribed charges are flat £50 per link per year for links under light licensing regime, while for frequency coordinated links, additional one-time charge of around £200 apply. For comparison purposes, the charges are approx. 0.06 times of links in 13/15/18/21 GHz bands.
b. In USA, there is no charging formula for E-band assignments. E-band links are charged at $75 for a 10-year allotment term.
c. In Ireland, the charging formula for traditional backhaul bands does not apply directly to E & V bands. The charges are flat €100 per link of E-band, which is approximately 0.07 times of charges for 13/15/18/21 GHz links.
d. In South Africa, the charging formula for traditional backhaul bands does not apply directly to E & V bands. E-band links are charged at flat fee of R196, which is approx. 0.01 times for 13/15/18/21 GHz links.
e. In Saudi Arabia, E-band links are charged at approx. 0.20 times of charges for 13/15/18/21 GHz links, as per same formula as traditional backhaul bands.

f. In Canada, E-band links are charged at approx. 0.20 times of charges for 13/15/18/21 GHz bands, as per same formula as traditional backhaul bands.

g. In UAE, E-band links are charged at approx. 0.59 times of 13/15/18/21 GHz links, as per same formula as traditional backhaul bands.

Thus, internationally, charges for E-band links are significantly lower than that of links in traditional backhaul bands, with a factor ranging from 0.01 to 0.59 times of price of links in 13/15/18/21 GHz bands.

The data is examined further to arrive at the range of factors which can be considered for present purposes of price comparison between E-band and 13/15/18/21 GHz bands. Accordingly, two categories of comparative data can be seen:

- In many countries, E-band pricing is placed outside the charging formula, charged at a fixed nominal charge per link, such as in UK, USA, Ireland and South Africa.
- In countries such as Saudi Arabia, Canada and UAE, E-band charges are derived using the same formula as traditional backhaul bands. Here, it is observed that the charges for E-band link utilizing 250MHz (paired) ranges from a factor of approx. 0.23 - 0.59 of charges for link utilizing 28 MHz (paired) in the 13/15/18/21 GHz bands. Here, charging for both is based on same formula with consideration of band factor as well as channel bandwidth.

The Authority noted that after the issue of DoT's provisional charging orders for E-band dated 27.07.2022, there is rapid uptake of this spectrum, and the Access service providers have deployed nearly 22,000 links (refer Annexure – 4.3) in a period of about three years. This indicates evolution of maturity in E-band backhaul technology. Further, with the rollout of 5G services, data consumption is rapidly growing, which has significantly improved utility of E-band in backhaul for 5G. Thus, the Authority, at this stage does not support nominal charging of E-band spectrum and prefers a rational percentage of AGR commensurate with growing utility of this band.

4.141 Based on study of practical deployments as per data provided by Access service providers, the weighted average link length for the nearly 5.2 lakh links in 13/15/18/21 GHz bands have been calculated in above sections to be approx. 3.50 kms. As has been stated earlier in Section D(iii) of Part-I, as an overall weighted average of link length, the figure of 3.5kms can be considered fairly representative of the ground reality, as nearly 5.2 lakh links have been deployed in these bands over last four decades.

Regarding deployments in E-band, at the time of present study, the total number of links in E-band is nearly 22,000 across the country (refer Annexure – 4.3), with a weighted average link length of approx. 1.48 kms. Here, it is noted that the number of links is likely to grow substantially in future, since E-band is one of the primary capacity bands for backhaul use in dense urban areas in the 5G era. This would likely have a significant impact on the weighted average link lengths as well. Therefore, for comparative assessment between 13/15/18/21 GHz and E band, the factor of weighted average of practical deployment link lengths is not appropriate.

4.142 It is noted that presently, E-band is assigned on block basis, with charging on AGR basis, and there are no E-band links being assigned and charged on point-to-point link basis. However, a hypothetical comparison of point-to-point link charges can be done by using the M x C x W formula to see comparative assessment and pricing factor between 13/15/18/21 GHz bands and E band as per this formula. Based on pricing of links as per M x C x W formula, applied to links in 13/15/18/21 GHz and E band, the price would be Rs 3,60,000 for a 28MHz(paired) link in 13/15/18/21 GHz of 2-5 kms and Rs 3,15,000 for a 250MHz (paired) link in E-band of 0-2 kms. As per these link charges based on M x C x W formula, a factor of 0.88 is observed between prices of 250 MHz paired link in E-band with distance of 0-2 kms vis-à-vis prices of 28 MHz paired link in 13/15/18/21 GHz with distance of 2-5 kms.

4.143 Thus, based on international comparisons, it is observed that E-band links utilising 250 MHz (paired) carrier are priced lower, at a factor of 0.23-0.59, than links in 13/15/18/21 GHz bands utilising 28 MHz (paired) carrier. As per M x C x W formula, the pricing factor arrived at is 0.88 for the same.

For determining appropriate spectrum charges for the E-band, certain other important factors also merit consideration. One is the continually increasing importance of E band for high-capacity deployments in 5G era, especially in high density urban areas. The deployments are bound to grow significantly with increasing 5G roll outs and number of 5G users. Second, the uptake of E-band, since its allocation began in 2022, has been rapid, as one Access operators has acquired the limit of two carriers in each LSA, while the other has acquired the limit of two carriers in most of the LSAs (refer Annexure – 4.3). It can be inferred that the current charges for E-band, which has been kept at 0.15% of AGR per carrier, aligning with the 13/15/18/21 GHz bands, has not been a serious deterrent for acquisition of backhaul spectrum in E band. Further, for the present exercise, the charges for 13/15/18/21 GHz have also been recommended for rationalisation, with lower per carrier charges and a linearly increasing charging structure.

4.144 Accordingly, **the Authority recommends that spectrum charges, for fresh and renewal block basis assignment of 250 MHz (paired) carrier in the E-band, for backhaul of wireless access network traffic by Access service providers, should be levied at uniform rate of 0.10% of AGR per carrier per annum in each LSA, limited to three carriers per LSA. Accordingly, the following is recommended as spectrum charge for fresh and renewal block basis assignment of 250 MHz (paired) carrier in the E-band for backhaul of wireless access network traffic by Access service providers:**

250 MHz (paired) carrier	AGR %	Cumulative AGR %
First	**0.10%**	**0.10%**
Second	**0.10%**	**0.20%**
Third	**0.10%**	**0.30%**

Also, for the purpose of the above charges, only AGR from wireless access services should be considered.

D(ii) Spectrum charges for fresh point to point link assignment for backhaul of telecommunication traffic, other than wireless access network traffic, by Access service providers in E band

4.145 To calculate the per point-to-point link charges for fresh assignments in E band for backhaul of telecommunication traffic, other than wireless access network traffic, by Access service providers, the Authority found that there is no existing order/ methodology available from the DoT for per point-to-point link based charging applicable for assignments of E band to Access Service Providers.

4.146 The charging methods and rates for E links were explored across countries. It is seen that these per point-to-point link charges are generally low, with overall licensing regime being either exclusive per point-to-point link assignment or light licensing basis. The gist of international charging regimes for E band are given at Annexure-4.4 and Para 4.140 above.

4.147 As mentioned at Section D(ii) in Part I above, the Authority has adopted an alternative methodology, based on comparison with spectrum cost per point-to-point link in a AGR based charging regime, for pricing per point-to-point links deployed in the traditional backhaul bands. A similar basis by working out the per point-to-point link cost from the AGR based charging regime can be adopted here.

4.148 As has been observed earlier, the E-band carriers have been recently assigned to the service providers and link deployments in E-band are limited. Regarding deployments in E-band at the time of present study, the total number of links in E-band is nearly 22,000 across the country (refer Annexure – 4.3). As noted above, the number of links is likely to grow substantially in future, since E-band is one of the primary capacity bands for backhaul use in dense urban areas in the 5G era. This would have a significant impact on the derived spectrum charges per link. Therefore, approximating per point-to-point link charge for E-Band, by calculating the spectrum charges payouts per link for the present number of links, will yield an unreliable and unrepresentative estimate of the price.

4.149 Considering the above, the Authority is of the view that per point-to-point link charges for the E-band can be determined with reference to the point-to-point link charges for the 13/15/18/21 GHz bands, as was done for pricing of links in 6(lower)/ 7 GHz bands in Section D(iii) of Part I above. The comparative assessment of pricing of E-band vis-à-vis 13/15/18/21 GHz bands, as discussed at D(i) above for determining AGR-based charges, can also be applied here. The combined influence of factors such as current charging mechanism, international practice and growing importance of E-band in 5G era, justify aligning E-band spectrum charges with those applicable for the 13/15/18/21 GHz bands. The same reasoning applies in case of point-to-point links as well. Therefore, it is reasonable that the per point-to-point link charge of Rs 25,000 as recommended for 13/15/18/21 GHz bands shall be applicable for E-band as well.

4.150 Accordingly**, the Authority recommends that Spectrum charges for fresh point-to-point link assignments in E-band, for backhaul of telecommunication traffic other than wireless access network traffic, by Access service providers should be levied at Rs 25,000**

per 250 MHz (paired) carrier for each point-to-point link per annum.

D(iii) <u>Spectrum charges for fresh point to point link assignment for backhaul by Access service providers in V band</u>

4.151 Currently, V-band carriers have not been assigned to service providers, and therefore, no link deployment has taken place. Hence, there is no extant charging mechanism in place. Also, consequently, since there is no deployment and charging, the methodology based on spectrum cost per link in AGR based charging regime cannot be applied to determine per-link spectrum charges for the V-band. Accordingly, international pricing methodologies as well as TRAI recommendations of 2014 have been studied for this purpose.

4.152 The Authority is of the view that the per point-to-point link charges for the V-band can also be determined through a comparative assessment vis-à-vis the E-band, wherein international pricing has been duly considered. The recommended per-link spectrum charge of Rs. 25,000 for the E-band can therefore serve as a benchmark for this purpose.

4.153 As noted above, the carrier size of the E-band is 2*250 MHz, which is ten times larger than that of the V bands (50 MHz), which is a TDD band with unpaired blocks. The larger carrier size, by a magnitude of 10, enables the E-band to deliver significantly higher capacities compared to the V-band.

4.154 Internationally, it is seen that V-band prices are kept at a range from one tenth to equal of E-band prices, as is cited at Annexure-4.4. V-band is exempt from any fees in few of the international jurisdictions studied.

4.155 As per TRAI recommendations of 2014, following was observed:

"*4.28 Though there is a demand for keeping V-band as unlicensed band, however, there are two factors which require considerations:*

- *The effects of atmospheric attenuation (rain and oxygen absorption) are severe in this band, and rain or humidity can cause a significant reduction in signal strength even over short distances.*
- *The license-exempt approach may not provide operators with the reliability they require for their backhaul networks. While the high atmospheric absorption that typifies the band mitigates the risk of interference from other users, the possibility of interference between co-channels, co-located systems cannot be eliminated.*

Further, in case the band is kept as unlicensed it would be difficult to administer (if needed) it at a later stage in case of interference.

4.48 For India, we may put a price of Rs. 10000/- (Rs. Ten Thousand) per annum per carrier of 250MHz each in E-band. In order to promote this band an initial promotional discount of 50% for three years from the date of allocation of first carrier in this band can be given. Similarly, in case of V-band since there are limitations in this band due to the factors enumerated in Para 4.28 (above), it can be charged at Rs. 1000 (Rs. One Thousand) per annum per carrier of 50MHz each….."

It is noted that, as per TRAI recommendations of 2014, point-to-point links in V-band were recommended to be priced at 1/10th of links in E-band. This is also broadly in alignment with international practices and the price factor observed between the two bands in a few international jurisdictions.

4.156 Considering the above, the Authority is of the view that the per point-to-point link spectrum charges for V-band should be approximately 1/10 of that of E-band, which works out to be approximately Rs 2500 per carrier for each point-to-point link per year.

4.157 Accordingly**, the Authority recommends that spectrum charges for fresh link assignments in V-band for backhaul use by Access**

Service providers should be levied at Rs 2,500 per 50MHz carrier for each point-to-point link per annum.

E. Spectrum Charging of E-band (71-76 GHz/81-86 GHz) and V-band (57-64/66 GHz) for Access (last-mile connectivity) and/or Integrated Access Backhaul of commercial telecom services

4.158 In the Consultation paper dated 28.05.2025, it was stated that if it is decided that some frequency spectrum in any one or more of the E-band (71–76/81–86 GHz) and/or V-band (57–64/66 GHz) is earmarked for Access (last-mile connectivity) and/or Integrated Access Backhaul, then, it would become necessary to determine the appropriate spectrum valuation and reserve price for these bands.

4.159 The Authority has dealt with the issue of assignment E &V bands for Access (last-mile connectivity) and/or Integrated Access Backhaul in Chapter III and held that the E-band (71–76/81–86 GHz) and/or V-band (57–64/66 GHz), should continue to be assigned for backhaul purposes only. As these bands have not been recommended for Access (last-mile connectivity) and/or Integrated Access Backhaul, the question of their pricing or method of assignment for this purpose does not arise. Therefore, no further analysis is required to determine appropriate spectrum valuation and reserve price for these bands for Access (last-mile connectivity) and/or Integrated Access Backhaul.

4.160 Accordingly, the questions 46-47 in the Consultation Paper stated below do not require further analysis:

Q46. In case it is decided to assign some frequency spectrum in E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz) for Access (last mile connectivity)/ Integrated Access Backhaul (IAB) through auction, then:

(i) *Should the auction determined price of other bands serve as a basis of valuation for the above bands using spectral efficiency factor? If yes, which spectrum bands be related, what efficiency factor or formula should be used and what should be the basis for the same? Please justify your suggestions.*

(ii) *If response to question (i) above is no, what other methodology may be used? Please justify your suggestions.*

Q47. In case it is decided to assign some frequency spectrum in E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz) for Access (last mile connectivity)/ Integrated Access Backhaul (IAB) through auction, then:

i. Should the auction determined price of other countries in E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz) serve as a basis of valuation of these bands? If yes, what methodology should be followed for using this auction determined price as a basis for valuation? Support your suggestions with justifications and country-wise auction data

ii. If the above approach is considered appropriate, should the international auction-determined prices be normalized to account for cross-country differences such as population, GDP, purchasing power parity (PPP), subscriber base, and other relevant factors? If so, should normalization be carried out by using the ratio of auction prices of spectrum bands within the same country to neutralize the impact of cross country differences? Alternatively, please suggest any other suitable normalization methodology that may be adopted in this context.

iii. Apart from the approaches highlighted above which other valuation approaches should be adopted for the valuation of E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz)? Please provide detailed information.

F. Spectrum charging for fresh point-to-point link assignments in E-band (71-76 GHz/81-86 GHz) and V-band (57-64/66 GHz) to Authorised entities, including non-commercial/ captive users, for backhauling telecom traffic other than wireless access network traffic:

4.161 In the Consultation paper dated 28.05.2025, it was stated, in case after due analysis/deliberations it is considered that some frequency spectrum in E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz) should be earmarked for point-to-point connectivity requirements of non-commercial/ Captive users, then it would be necessary to determine the appropriate spectrum charges for these bands.

4.162 Analysis and recommendations on various technical and other aspects related to the use of E & V bands for assignments to all Authorised entities, including non-commercial/ captive users, for backhauling telecom traffic other than wireless access network traffic, have already been dealt in Chapter III. It has been recommended that assignment of E-band (71-76 GHz/81-86 GHz) and V-band (57-64/66 GHz) for all such Authorised entities including captive users should be on a point-to-point link basis. In line with recommended assignments, per-link spectrum charges for these bands needs to be determined. This section deals with determination of spectrum charges for fresh link assignments in E&V bands to Authorised entities, including non-commercial/ captive users, for backhauling telecom traffic other than wireless access network traffic.

4.163 It is necessary to assess whether these spectrum charges for E&V band should be levied in accordance with the M x C x W formula as specified in the DoT's order of 2023, or some other criteria. In this context, the following questions were raised in the Consultation paper:

Q48. In case it is decided to assign some frequency spectrum in E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz) for point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users, then:

(i) *Should the spectrum charges for E-band (71-76/ 81-86 GHz) and/or V-band (57-64/66 GHz) for point-to-point connectivity requirements of captive (non-commercial/ non-TSP) users may be levied as per the M x C x W formula as specified in the DoT's order No. P-11014/34/2009-PP dated 11.12.2023? Is there a need to revise this formula by inclusion of additional factors, modifying slab/factor values etc.? If yes, please specify which additional factors should be included and what should be the revised slab/factor values. Please provide detail of the same along with justification.*

(ii) *If the answer to above question is no, whether an alternative charging mechanism such as link to link charges as recommended in 2014 for levying spectrum charges for E and V bands for non-commercial/ captive backhaul use, should be adopted? Please provide detailed justification.*

Stakeholders Comments

4.164 A few stakeholders have opposed assigning spectrum in the E-band and V-band for point-to-point connectivity of captive users, arguing that no quantum should be earmarked as it could fragment resources and complicate pricing without detailed opportunity cost analysis. They emphasized that captive demands can be met through existing unlicensed bands or spectrum leasing from access providers on a P2P basis, suggesting this market-driven approach should be prioritized over direct administrative assignments to avoid inefficiencies and ensure level playing fields.

4.165 Some stakeholders recommended continuing the M x C x W formula for charges in these bands for captive use but highlighted the need for significant rationalization due to its current high costs, which do not reflect the non-revenue-generating nature of backhaul. Modifications such as including discounts for captive purposes or adopting the link-to-link charging mechanism from the 2014 recommendations were proposed as an alternative.

4.166 One stakeholder submitted that the M x C x W formula and similar approaches result in excessively expensive charges, even for administrative assignments, defeating the purpose of optimal utilization for public good. They argued for exploring entirely new mechanisms that balance government revenue with national connectivity goals, while avoiding overvaluation that could hinder deployments.

4.167 Another stakeholder advocated for delicensing the V-band entirely, citing its limited propagation and alignment with international norms in regions like Europe and the US for license-exempt operations, which would eliminate charges and support innovation in high-capacity wireless systems without the need for formulas or auctions.

Present Charging methodology:

4.168 Presently, the spectrum charges are being levied for link-to-link assignments to Captive users as per DoT's OM no. No. P-11014/34/2009-PP dated 11.12.2023 which at Section D (iii) of Part I above. However, it is noted that presently E-Band has only been assigned to Access service providers since 2022 who are being charged on AGR basis for the same. Hence presently, there are no entities utilising and paying for E-band spectrum on point-to-point link basis.

Analysis

4.169 It is noted that presently there are no prescribed point-to-point link charges for E-band, since E-band has only been presently assigned for backhaul use by Access service providers who are being charged on percentage AGR per carrier basis.

4.170 Basis the observation recurring throughout this exercise viz. keeping the method of assignment and charging in consonance with each other, the spectrum charges for fresh assignments on point-to-point link in E & V bands are recommended to be on point-to-point link basis for Authorised entities, including non-commercial/ captive users, for backhauling telecom traffic other than wireless access network traffic.

4.171 If the M x C x W formula is used for charging of E-band links, the charges per point to point link assignment for the E-band would be as under for a link deployment of 0-2 km, with the M-factor of 750 (link length in the slab of 0-2km), the C-factor of 2 (FDD band with paired carriers) and the W-factor of 210 (carrier size of 250MHz). The per point-to-point link charges for a link of 0-2 km is tabulated below:

Point-to-point link charges for a link of 0-2 kms in E-band	
Carrier Size (MHz)	250
W-Factor	210
C- factor	2
Annual spectrum charges (Rs)	**Rs 3,15,000**

4.172 The Authority has noted the stakeholders' comments highlighting the current high charges calculated per link by the existing formula, which does not reflect the non-revenue-generating nature of backhaul and the need for its significant rationalization. However, it is noted that these comments do not directly relate to charging for point-to-point link assignments in E & V bands but are instead general comments stated across multiple questions

of the consultation paper. As such, regarding pricing for point-to-point links, there is a recurring suggestion that M x C x W formula or similar approaches, if applied, would lead to excessively expensive charges, even for administrative assignments, defeating the purpose of optimal utilization for public good. Hence, new approach needs to be arrived at, which avoid overvaluations. Regarding V band links, it is noted that one stakeholder has submitted for complete delicensing with no applicable charges.

As stated at Chapter III, E & V-bands are recommended to be assigned on point-to-point link basis for captive users. Accordingly, this section has examined the applicable charges, keeping in mind the stakeholders' comments, as well as other relevant factors.

4.173 For purposes of charging, point-to-point link charges of E & V bands have already been calculated for backhaul of wireline telephony & internet access services by Access Service providers in Section D(ii). The point-to-point link charges for E band have been determined through a comparative assessment of its carrier size and link lengths vis-à-vis the 13/15/18/21 GHz. Further, the per point-to-point link charges for the V-band have also been determined through a comparative assessment of its carrier size and link lengths vis-à-vis the E-band. The methodology is detailed at Para 4.142 – 4.151 in Section D. (ii) above.

4.174 Thus, per point-to-point link charge of Rs 25,000 per annum per point-to-point link in E band has been calculated for backhaul of wireline telephony & internet access services by Access Service providers. Further, through a comparative assessment of carrier size as well as study of international comparisons of V band vis-à-vis the E band, per point-to-point link charge of Rs 2500 per annum has been arrived at for V band.

4.175 The Authority is of the view that the same charges, which have already been rationalised in comparison to existing charges based on M x C x W formula, can be extended for use by Authorised entities, including non-

commercial/ captive users, for backhauling telecom traffic other than wireless access network traffic. This would maintain parity in backhaul spectrum pricing across categories of services and service providers.

4.176 Accordingly, **the Authority recommends**

i. **Spectrum charges of Rs 25,000 per carrier per annum for each fresh point-to-point link assignment in E-band to all Authorised entities, including non-commercial/ captive users, for backhauling telecom traffic other than wireless access network traffic, and**

ii. **Spectrum charges of Rs 2,500 per carrier per annum for each fresh point-to-point link assignment in V-band to all Authorised entities, including non-commercial/ captive users, for backhaul purposes.**

4.177 The following chapter provides a summary of recommendations.

Chapter V: Summary of Recommendations

5.1 The Authority recommends that at this stage -

(a) The spectrum in traditional microwave backhaul bands viz. 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands should be assigned for radio backhaul purposes only.

(b) No spectrum in traditional microwave backhaul bands should be earmarked for the last-mile connectivity (fixed wireless access) to customer equipment.

[Para 2.96]

5.2 The Authority recommends that-

(a) Any authorised entity, including captive users, which may require spectrum for radio backhaul purposes [i.e. for deploying point-to-point links to interconnect telecommunication equipment (other than the customer equipment) in its telecommunication network] should be made eligible to obtain spectrum in traditional microwave backhaul bands.

(b) It should be included in the terms of assignment of backhaul spectrum in traditional microwave backhaul bands that the assigned backhaul spectrum can be used for self-use only.

[Para 2.106]

5.3 The Authority recommends that with respect to the assignment of spectrum in traditional microwave backhaul bands, -

(a) The carrier size should be 28 MHz (paired).

(b) If an entity applies for more than one carrier in any traditional microwave backhaul band and seeks contiguous

carriers, DoT should, to the extent feasible, ensure that the carriers are assigned in a contiguous manner.

(c) Spectrum assignees should be allowed to split or aggregate carriers assigned to them without prior approval from the Central Government.

[Para 2.112]

5.4 The Authority recommends that –

(a) The usage of the 7 GHz band should be reviewed after considering the outcome of the WRC-2027.

(b) Until the Government takes a decision with respect to the usage of the 7 GHz band based on the outcome of the WRC-27, -

(i) The existing point-to-point links in the 7 GHz band should be permitted to operate with an annual renewal mechanism. In other words, the period of reassignment (renewal) of the spectrum in the 7 GHz band on the point-to-point links, which are already in operation, should be one year with an option for further renewal.

(ii) The spectrum in the 7 GHz band should not be assigned for establishing new point-to-point links.

(c) In case the Government, based on the outcome of WRC-27, decides to continue to use the 7 GHz band for backhaul purposes, the spectrum in the 7 GHz band should be assigned for backhaul purposes, in a manner similar to that recommended for the 6 GHz (lower) band.

[Para 2.124]

5.5 The Authority recommends that-

(a) The usage of the 15 GHz band should be reviewed only after considering the outcome of the WRC-27.

(b) Until the Government takes a decision for repurposing the 15 GHz band, -

(i) The existing microwave carriers in the 15 GHz band should be permitted to operate.

(ii) New microwave carriers in the 15 GHz band in an LSA may be assigned to any wireless access service provider, if it already holds microwave carrier(s) in the 15 GHz band in that LSA.

(c) In case the Government, based on the outcome of WRC-27, decides to continue to use the 15 GHz band for backhaul purposes, the restriction recommended in (b)(ii) above should not apply, i.e., new carriers in the 15 GHz band may be assigned to wireless access service providers, subject to the applicable ceiling on the number of carriers.

[Para 2.129]

5.6 The Authority recommends that the spectrum in the 6 GHz (lower) band should be assigned for radio backhaul purposes to all types of authorised entities, including captive users, on a point-to-point link basis with a ceiling of two carriers of 28 MHz (paired) bandwidth per link.

[Para 2.137]

5.7 The Authority recommends that in the proposed new policy regime, -

(a) The spectrum in 13 GHz, 15 GHz, and 18 GHz bands should be assigned to wireless access service providers on a block-basis in a licensed service area (LSA) for backhauling their wireless access network traffic. In these recommendations, the term "wireless access service provider" means 'an access service provider holding access spectrum'.

Explanation: If an access service provider, which holds access spectrum in an LSA but also provides other types of services such as wireline telephony service and internet access service in the LSA, obtains the spectrum in 13 GHz, 15 GHz, and 18 GHz bands on a block-basis in the LSA, it can use such spectrum for backhauling its wireless access network traffic only and not for any other purposes.

(b) Henceforth, no fresh assignment of microwave spectrum should be made in 13 GHz, 15 GHz, and 18 GHz bands on a point-to-point link basis. However, in case any authorised entity, including captive users, is already holding spectrum in 13 GHz, 15 GHz, and 18 GHz bands on a point-to-point link-basis for backhauling telecommunication traffic other than wireless access network traffic, it should be permitted to retain such spectrum for backhauling telecommunication traffic other than wireless access network traffic on an annual renewal basis. Further, the Government should encourage such entities to migrate their point-to-point links to the 21 GHz band.

(c) The spectrum in the 21 GHz band should be assigned to authorised entities, including captive users, on a point-to-point link basis in an LSA for backhauling any telecommunication traffic other than wireless access network traffic.

Explanation: If any access service provider holding access spectrum is also providing other types of services such as wireline telephony service and internet access service, it can obtain the spectrum in the 21 GHz band on a point-to-point link-basis for backhauling the wireline telephony traffic and internet traffic. The spectrum in the 21 GHz band assigned on a point-to-point link-basis cannot be used for backhauling wireless access network traffic.

(d) There should be a ceiling of four carriers, each of 28 MHz (paired) bandwidth per link, for the point-to-point link-based assignment in the 21 GHz band.

(e) Henceforth, the spectrum in the 21 GHz band should not be assigned to wireless access service providers on a block-basis for backhauling wireless access network traffic. However, wireless access service providers should be permitted to retain the carriers already assigned to them in the 21 GHz band in any LSA for backhauling their wireless access network traffic. In case any wireless access service provider intends to retain the carriers assigned to it in the 21 GHz band in any LSA, such carriers should be counted for the purpose of the ceiling on the carriers in 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands in the LSA for radio backhaul purposes.

(f) There should be a combined ceiling of eight carriers, each of 28 MHz (paired) bandwidth, which may be assigned to a wireless access service provider on a block-basis in any LSA in 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands together for backhauling wireless access network traffic.

(g) In general, any entity already holding carriers in 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands for radio backhaul purposes should be permitted to retain such carriers for radio backhaul purposes subject to the prescribed ceiling.

(h) The backhaul spectrum in 13 GHz, 15 GHz, 18 GHz and 21 GHz bands obtained by any wireless access service provider on a block-basis can only be used for backhauling wireless access network traffic and not for any other purposes.

[Para 2.165]

5.8 The Authority recommends as below with respect to link-based assignments in 6 GHz (lower) band, and 21 GHz band:

(a) **The minimum link length for a point-to-point link in the 6 GHz (lower) band should be 15 km for plain regions, and 10 km for hilly terrains (including Assam, North East, Himachal Pradesh, and Jammu & Kashmir LSAs).**

(b) **There should be no requirement for a minimum link length for the point-to-point links in the 21 GHz band.**

[Para 2.171]

5.9 The Authority recommends that-

(a) **Any entity holding spectrum in traditional microwave backhaul bands should be permitted to surrender its microwave carriers after giving prior notice of at least 30 calendar days through the Central Government's online portal. In case a wireless access service provider desires to surrender any backhaul spectrum assigned to it on a block-basis, it should be required to submit certified proof of payment regarding payment of spectrum charges up to the previous quarter of the date of application.**

(b) **DoT should issue the letter to the applicant entity regarding taking the surrender of spectrum on record within 30 calendar days from the date of the application.**

[Para 2.175]

5.10 The Authority recommends that there should be no roll-out obligations associated with the assignment of backhaul spectrum in traditional microwave backhaul bands.

[Para 2.179]

5.11 The Authority recommends that the terms and conditions for the assignment of spectrum in traditional microwave backhaul bands including spectrum pricing, recommended through these recommendations, should remain valid for a period of five years

from the date of notification of the proposed new policy regime for the assignment of backhaul spectrum by the Central Government, further extendable by a period of upto two years.

[Para 2.182]

5.12 The Authority recommends that –

(a) Under the policy regime for the assignment of backhaul spectrum recommended through these recommendations (hereinafter, referred to as "the proposed policy regime"), the maximum period of assignment of the backhaul spectrum in traditional microwave backhaul bands should be as below:

(i) <u>For block-based assignments (including renewal) in 13 GHz, 15 GHz, 18 GHz and 21 GHz bands</u>:

The spectrum should remain assigned under the proposed policy regime, if the wireless access service provider continues to hold the authorisation for providing access service as well as access spectrum in the LSA, <u>AND</u> the wireless access service provider does not surrender the assigned backhaul spectrum.

(ii) <u>For point-to-point link-based assignments (including renewal) in 6 GHz (lower) and 21 GHz bands</u>:

The spectrum assignment should remain valid for the period of assignment applied for by the authorised entity under the proposed policy regime *provided* that:

the authorised entity continues to hold the authorisation under Section 3 of the Telecommunications Act, 2023 under which the backhaul spectrum has been assigned, <u>AND</u> the authorised entity does not surrender the assigned backhaul spectrum.

(iii) <u>Renewal of point-to-point link-based assignments to authorised entities, including captive users in the 7 GHz, 13 GHz, 15 GHz, and 18 GHz bands</u>:

The spectrum should be renewed for a maximum period of one year under the proposed policy regime.

(b) Any revision in the terms and conditions of the assignment (including renewal) of the backhaul spectrum in traditional microwave backhaul bands including spectrum pricing notified by the Central Government after a period of five years from the date of notification of the policy regime, recommended through these recommendations, should become applicable to all authorised entities, including the existing spectrum assignees.

(c) While assigning (including renewal) the backhaul spectrum in traditional microwave backhaul bands under the policy regime recommended through these recommendations, a condition should be included in the terms of assignment of backhaul spectrum stating that whenever the policy regime is revised after five years, the existing backhaul spectrum assignees at that time shall have to conform to the revised policy regime, including any changes in the backhaul spectrum pricing.

(d) It should be explicitly conveyed to the spectrum assignees that the Central Government may withdraw the assigned backhaul spectrum at the stage of the revision of the policy regime after five years in case:

(i) The authorised entity does not accept the terms and conditions under the revised policy regime, or

(ii) The Central Government decides to repurpose the usage of traditional microwave backhaul bands.

[Para 2.191]

5.13 The Authority recommends that –

(a) DoT should invite applications from the wireless access service providers desirous of assignment and renewal of the backhaul spectrum on a block basis by the 7th day of every month through an online portal.

(b) Interested wireless access service providers may submit their applications specifying the number of carriers, and the preference for carriers in a frequency band for each LSA, in the first week (i.e. by the seventh day) of any month.

(c) DoT should evaluate the applications received from wireless access service providers in the first week of the month and assign carriers within the stipulated ceiling of carriers in the LSA. In case more than one application has been received for a particular carrier in an LSA (hereinafter, referred to as "the candidate carrier"), certain predefined guidelines, as illustrated below, should be framed for the assignment of the candidate carrier:

(i) If any applicant entity is seeking the retention of the candidate carrier, it should be accorded priority.

(ii) If no applicant entity is seeking the retention of the candidate carrier, the applicant entity already holding one or more carriers in the LSA in the frequency band containing the candidate carrier should be accorded priority.

(iii) If the contention cannot be resolved by using the above two criteria, the applicant entity having the highest AGR for wireless access services in the LSA for the preceding completed financial year should be accorded priority.

(d) After examining the applications received from the wireless access service providers, DoT should issue the assignment/

rejection letters to the applicant entities by the end of the month through its online portal.

[Para 2.195]

5.14 The Authority recommends the following procedure for the assignment of the backhaul spectrum on a point-to-point link basis:

(a) DoT should invite applications from the authorised entities desirous of assignment and renewal of the backhaul spectrum on a point-to-point link basis by the 7th of every month through an online portal.

(b) Interested authorised entities, including captive users, may submit their applications specifying the details of the proposed backhaul link including coordinates of the two ends of the link, heights of the antennas at the two ends, frequency band in which the backhaul spectrum is required, and preferred carriers (or spectrum range) in the frequency band, period of assignment, etc. with full justification in support of the requirement.

(c) DoT should analyze the applications received from applicant entities on the basis of justification in support of their requirement and availability of spectrum, after taking into consideration the spectrum requirement of other entities and conducting an analysis of harmful interference to the existing users. Any applicant entity seeking retention of the backhaul spectrum on an existing point-to-point link should be accorded priority.

(d) After examining the applications received from the authorised entities, DoT should issue the assignment/ rejection letters to the applicant entities by the end of the month through its online portal.

[Para 2.198]

5.15 The Authority recommends that –

(a) DoT should establish an online portal for the assignment of backhaul spectrum. The online portal should store a complete and updated database of LSA-wise carriers assigned on a block-basis as well as carriers assigned on a point-to-point link basis. The database should be made available to eligible entities in a secure manner.

(b) The online portal should also capture the details about the point-to-point links established by wireless access service providers using the microwave carriers assigned to them on a block-basis.

(c) All the backhaul spectrum assignees should be mandated to upload details about each point-to-point link established by them, such as coordinates of the two ends of the link, link length in km, height of the antenna, carriers deployed on the link, etc., on the online portal within seven days of the establishment of such links.

[Para 2.203]

5.16 The Authority recommends that -

(a) The spectrum in E-band (71-76 GHz, paired with 81-86 GHz) should be assigned for "Backhaul" purposes only.

(b) No spectrum in E-band should be assigned for "Access" or "Integrated Access and Backhaul (IAB)".

[Para 3.82]

5.17 the Authority recommends that-

(a) The spectrum in V-band should be assigned for "Backhaul" purposes only.

(b) No spectrum in V-band should be assigned for "Access" or "Integrated Access and Backhaul (IAB)".

[Para 3.93]

5.18 The Authority recommends that –

(a) Any authorised entity, including captive users, which may require spectrum for radio backhaul purposes [i.e. for deploying point-to-point links to interconnect telecommunication equipment (other than the customer equipment) in its telecommunication network] should be made eligible to obtain spectrum in E-band and V-band.

(b) It should be included in the terms of assignment of backhaul spectrum in E-band and V-band that the assigned backhaul spectrum can be used for self-use only.

[Para 3.99]

5.19 The Authority recommends that –

(a) For assignment of spectrum in E-band, the Frequency Division Duplexing (FDD) based configuration (71-76 GHz, paired with 81-86 GHz), with carrier size of 250 MHz (paired) and guard bands of 125 MHz at the top and bottom of each 5 GHz band, should be adopted.

(b) For assignment of spectrum in the V-band, the Time Division Duplexing (TDD) based configuration (57-66 GHz), with a carrier size of 50 MHz, with a 100 MHz guard band at the beginning and a 50 MHz guard band at the end, should be adopted.

(c) The spectrum assignee should be permitted to aggregate or split the carriers assigned to it without any approval from the Central Government.

(d) If an entity is assigned more than one carrier within a band, DoT should, to the extent feasible, ensure that the entire spectrum assigned to it is in contiguous form.

[Para 3.114]

5.20 The Authority recommends that –

(a) E-band carriers should be assigned on a block-basis in a Licensed Service Area to wireless access service providers for backhauling their wireless access network traffic.

(b) E-band carriers should be assigned on a point-to-point link basis to authorised entities, including captive users, for backhauling their telecommunication traffic other than wireless access network traffic.

(c) V-band carriers should be assigned on a point-to-point link basis to all types of authorised entities, including captive users, for radio backhaul purposes.

[Para 3.123]

5.21 The Authority recommends that for E-band-

(a) There should be a ceiling of three carriers, each of 250 MHz (paired) bandwidth, which may be assigned to a wireless access service provider on a block-basis in any LSA in E-band.

(b) The wireless access service providers currently holding E-band carriers in any LSA should be given an option to retain their existing carriers in the LSA, and the same should be counted for the purpose of the ceiling on the number of carriers in the LSA.

(c) Two carriers in E-band should be earmarked for the assignment on a point-to-point link basis to authorised entities, including captive users, for backhauling their telecommunication traffic other than wireless access network traffic.

[Para 3.128]

5.22 The Authority recommends that there should be a ceiling of 20 carriers each of 50 MHz (unpaired) bandwidth per link for the point-to-point link-based assignment in V-band.

[Para 3.132]

5.23 The Authority recommends that there should be no roll-out obligations associated with the assignment of backhaul spectrum in E-band and V-band

[Para 3.134]

5.24 The Authority recommends that the terms and conditions for the assignment of spectrum in E-band and V-band including spectrum pricing, recommended through these recommendations, should remain valid for a period of five years from the date of notification of the proposed new policy regime for the assignment of backhaul spectrum by the Central Government, further extendable by a period of upto two years.

[Para 3.137]

5.25 The Authority recommends that –

(a) Under the policy regime for the assignment of backhaul spectrum recommended through these recommendations (hereinafter, referred to as "the proposed policy regime"), the maximum period of assignment of the backhaul spectrum in E-band and V-band should be as below:

(i) <u>For block-based assignments (including renewal) in E-band</u>:

The spectrum should remain assigned under the proposed policy regime, if the wireless access service provider continues to hold the authorisation for providing access service as well as access spectrum in the LSA, <u>AND</u> the wireless access service provider does

not surrender the assigned backhaul spectrum in E-band.

(ii) <u>For point-to-point link-based assignments in E-band and V-band</u>:

The spectrum assignment should remain valid for the period of assignment applied for by the authorised entity under the proposed policy regime *provided* that:

the authorised entity continues to hold the authorisation under Section 3 of the Telecommunications Act, 2023 under which the backhaul spectrum has been assigned, <u>AND</u> the authorised entity does not surrender the assigned backhaul spectrum.

(b) Any revision in the terms and conditions of the assignment (including renewal) of backhaul spectrum in E-band and V-band including spectrum pricing notified by the Central Government after a period of five years from the date of notification of the policy regime recommended through these recommendations, should become applicable to all authorised entities, including the existing spectrum assignees.

(c) While assigning (including renewal) the backhaul spectrum in E-band and V-band under the policy regime recommended through these recommendations, a condition should be included in the terms of assignment of backhaul spectrum stating that whenever the policy regime is revised after five years, the existing backhaul spectrum assignments at that time shall have to conform to the revised policy regime, including any changes in the backhaul spectrum pricing.

(d) It should be explicitly conveyed to the spectrum assignees that the Central Government may withdraw the assigned

backhaul spectrum at the stage of the revision of the policy regime in case:

(i) The authorised entity does not accept the terms and conditions under the revised policy regime, or

(ii) The Central Government decides to repurpose the usage of E-band and/ or V-band.

[Para 3.142]

5.26 The Authority recommends that-

(a) Any entity holding spectrum in E-band or V-band should be permitted to surrender its microwave carriers after giving prior notice of at least 30 calendar days through the Central Government's online portal. In case a wireless access service provider desires to surrender backhaul spectrum in E-band assigned to it on a block-basis, it should also be required to submit certified proof of payment regarding payment of spectrum charges up to the previous quarter of the date of application.

(b) DoT should issue the letter to the applicant entity regarding taking the surrender of spectrum on record within 30 calendar days from the date of the application.

[Para 3.143]

5.27 The Authority recommends that –

(a) In parallel to the licensed fixed services (radio backhaul) in V-band, the license-exempt usage should also be permitted in V-band (57-66 GHz) for both low-power indoor and very low-power outdoor usage for applications such as Multi Gigabit Wireless System (MGWS), Wireless Access System (WAS), Radio Local Area Network (RLAN), Wireless Personal Area Network (WPAN), Short-Range Devices (SRDs), sensing applications (including radar, and

IoT functions) etc., on a non-interference, non-protection, and shared (non-exclusive) basis.

(b) For license-exempt usages in V-band, there should be flexibility to decide the channel bandwidth based on the technology/ application being deployed.

(c) DoT, in consultation with the Telecommunication Engineering Centre (TEC), should examine and prescribe power limits and other technical conditions for the recommended license-exempt use in V-band (57-66 GHz) for both low power indoor and very low power outdoor usage. In the interim, license-exempt usages in V-band should be permitted with the power limits as prescribed by IDA, Singapore, i.e., 40 dBm maximum EIRP for low power indoor use and 25 dBm maximum EIRP for very low power outdoor use and other technical conditions mentioned therein.

[Para 3.181]

5.28 The Authority recommends that spectrum charges for fresh and renewal block basis assignments in 13/15/18 GHz bands and renewal block basis assignments in 21 GHz band for backhaul of wireless access service by Access service providers should be levied on a percentage of Adjusted Gross Revenue (AGR) basis.

[Para 4.25]

5.29 The Authority recommends a uniform spectrum charge of 0.10% of AGR for all the eight carriers in each of the 13/15/18 & 21 GHz bands, with no differential pricing of carriers *inter se* these bands. Accordingly, the following percentage of AGR is recommended as spectrum charge for fresh and renewal block basis assignments of 28 MHz (paired) carriers in 13/15/18 GHz bands and renewal block basis assignments of 28 MHz (paired) carriers in 21 GHz for

backhaul of wireless access network traffic by Access service providers:

28 MHz (paired) carrier	AGR %	Cumulative AGR %
First	0.10%	0.10%
Second	0.10%	0.20%
Third	0.10%	0.30%
Fourth	0.10%	0.40%
Fifth	0.10%	0.50%
Sixth	0.10%	0.60%
Seventh	0.10%	0.70%
Eighth	0.10%	0.80%

For the purpose of the above charges, only AGR from wireless access services should be considered.

[Para 4.57]

5.30 The Authority recommends that charging for fresh point-to-point link assignment, for backhaul of telecom traffic other than wireless access traffic by Access Service providers in 21 GHz band, should be on per point-to-point link basis.

[Para 4.59]

5.31 The Authority recommends spectrum charges of Rs 25,000 per carrier per annum for each fresh point-to-point link assignment in 21 GHz band for backhaul of telecommunication traffic, other than wireless access network traffic, by Access Service providers.

[Para 4.71]

5.32 The Authority recommends that, in line with the method of assignment, the charging for fresh assignments in 6 GHz (lower) band and the renewal assignments in 6 (lower)/7 GHz bands,

should be on per point-to-point link basis, for backhaul use by Access service providers.

[Para 4.77]

5.33 The Authority recommends spectrum charges of Rs 75,000 per carrier per annum for each fresh or renewal point-to-point link assignment in 6 GHz (lower) band and renewal of point-to-point link assignment in 6 GHz (lower)/7 GHz band for backhaul by Access Service providers.

[Para 4.90]

5.34 The Authority recommends that the spectrum charges, for fresh assignments in 6 GHz (lower) & 21 GHz bands and for renewal assignments in 6 (lower)/7/13/15/18/21 GHz bands, of point-to-point links to Authorised entities, including non-commercial/ captive users, for backhauling telecom traffic other than wireless access network traffic should be on per point-to-point link basis.

[Para 4.107]

5.35 The Authority recommends spectrum charges of Rs 25,000 per carrier per annum for each fresh or renewal point-to-point link assignment in 21 GHz band to all Authorised entities, including non-commercial/ captive users, for backhauling telecom traffic other than wireless access network traffic. The same charges are recommended for renewal of point-to-point link assignments in 13/15/18 GHz bands to all Authorised entities, including non-commercial/ captive users, for backhauling telecom traffic other than wireless access network traffic.

Further, the Authority recommends spectrum charges of Rs 75,000 per carrier per annum for each fresh or renewal point-to-

point link assignment in 6 GHz (lower) band to all Authorised entities, including non-commercial/ captive users, for backhaul purposes. The same charges are recommended for renewal of point-to-point link assignments in 7 GHz band to all Authorised entities, including non-commercial/ captive users, for backhaul purposes.

[Para 4.113]

5.36 The Authority recommends that spectrum charges for fresh and renewal block basis assignments in E-band for backhaul of wireless access network traffic by Access service providers should be levied on a percentage of Adjusted Gross Revenue (AGR) basis per carrier.

[Para 4.133]

5.37 The Authority recommends that spectrum charges, for fresh and renewal block basis assignment of 250 MHz (paired) carrier in the E-band, for backhaul of wireless access network traffic by Access service providers, should be levied at uniform rate of 0.10% of AGR per carrier per annum in each LSA, limited to three carriers per LSA. Accordingly, the following is recommended as spectrum charge for fresh and renewal block basis assignment of 250 MHz (paired) carrier in the E-band for backhaul of wireless access network traffic by Access service providers:

250 MHz (paired) carrier	AGR %	Cumulative AGR %
First	0.10%	0.10%
Second	0.10%	0.20%
Third	0.10%	0.30%

Also, for the purpose of the above charges, only AGR from wireless access services should be considered.

[Para 4.144]

5.38 The Authority recommends that Spectrum charges for fresh point-to-point link assignments in E-band, for backhaul of telecommunication traffic other than wireless access network traffic, by Access service providers should be levied at Rs 25,000 per 250 MHz (paired) carrier for each point-to-point link per annum.

[Para 4.150]

5.39 The Authority recommends that spectrum charges for fresh link assignments in V-band for backhaul use by Access Service providers should be levied at Rs 2,500 per 50 MHz carrier for each point-to-point link per annum.

[Para 4.157]

5.40 The Authority recommends

i. Spectrum charges of Rs 25,000 per carrier per annum for each fresh point-to-point link assignment in E-band to all Authorised entities, including non-commercial/ captive users, for backhauling telecom traffic other than wireless access network traffic, and

ii. Spectrum charges of Rs 2,500 per carrier per annum for each fresh point-to-point link assignment in V-band to all Authorised entities, including non-commercial/ captive users, for backhaul purposes.

[Para 4.176]

Annexures

Annexure 1.1: DoT's Order Dated 18.04.2002

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12

File No. L-14047/01/2002-NTG
Government of India
Ministry of Communications and Information Technology
Department of Telecommunications
Wireless Planning & Coordination (WPC) Wing
****

Dated: April 18, 2002

ORDER

Subject: **Spectrum charges for MW access and backbone networks of cellular networks.**

This is in continuation to the Government of India Order Nos. L14041/06/2000-NTG dated 22.9.2001 and 1 February, 2002 specifying spectrum charges for GSM frequencies in 900/1800 MHz band.

2. Assignment of frequencies for MW access and MW backbone networks for cellular operations, would continue to be considered on the basis of full justification of the requirements and availability of the spectrum, on case-to-case and link-to-link basis, after taking into consideration the interest of the other users with a view to ensuring electromagnetic compatibility etc. The complete technical analysis and all related aspects of frequency assignments, including efficient use of spectrum, will apply before assigning frequencies for various MW access backbone links. There will be no obligation on the part of the Government to assign frequencies for such purposes. Migration to revenue sharing concept is basically to simplify the system for charging of spectrum and in no way it should be linked to the grant of frequency spectrum.

3. Subject to the above conditions, the spectrum charges for microwave access networks (normally in the frequency band 10 GHz and beyond) would be as given below:

- for spectrum bandwidth upto 112 MHz in any of the circles, or 224 MHz in any of the 4 metros, spectrum charges shall be levied @ 0.25% of AGR per annum; and
- for every additional 28 MHz or part thereof (if justified and assigned) in circles or 56 MHz or part thereof in any of 4 metros areas, additional spectrum charges shall be levied @ 0.05% of AGR per annum.

3.1 These will include the royalty charges for spectrum usages and licence fee for the fixed stations in the MW access links.

4. Further, the spectrum charges for MW backbone networks to provide connectivity in the circle including spur routes, (generally below 10 GHz frequency band) would be as given below:

- for spectrum bandwidth upto 56 MHz, spectrum charges shall be levied @ 0.10% of AGR per annum; and
- for every additional 28 MHz or part thereof (if justified and assigned), additional spectrum charges shall be levied @ 0.05% of AGR per annum.

Contd-2

4.1 These will include the royalty charges for spectrum usages and licence fee for the fixed stations in the MW backbone links.

5. The assignments of MW access and backbone frequencies shall not be exclusive for any service provider and will be shared with other services/users.

6. In addition, the charges for GSM spectrum (900/ 1800 MHz band) will continue to be levied in accordance with Government of India orders No. L-14041/06/2000-NTG dated 22.9.2001 and 01.02.2002.

7. The above package, of spectrum charging on percentage revenue share will be available to the cellular operators on the premise that it is accepted in its entirety and simultaneously all legal proceedings, with regard to spectrum charging, instituted by them or COAI against the Government in Courts and Tribunals (TDSAT) etc shall be withdrawn. The cellular operators without prejudice should make payments of all outstanding dues of spectrum charges in accordance with the applicable Government of India orders within a month from the date of issue of this order.

8. This Order will come into force from the date of issue.

9. Acceptance of the above shall be communicated to this Ministry within seven days from the date of issue of this Order.

18/1/02

(K.R. MAHENDRA KUMAR)
Assistant Wireless Adviser to the Government of India

To:

1. Cellular Operators Association of India, New Delhi. This refers to their Letter No. TVR/COAI/013 dated 16.01.2002.
2. All Cellular Operators, including BSNL, and MTNL

Annexure 1.2: DoT's Order Dated 03.11.2006

Government of India
Ministry of Communications & IT
Department of Telecommunications
WPC Wing

Sanchar Bhavan, 20 Ashoka Road,
New Delhi – 110 001

No. J-14025/200(11)/06-NT

Dated the 3rd November 2006

ORDER

Sub: Spectrum charges for Microwave (MW) Access and MW Backbone Networks of GSM and CDMA based telecom service providers

In pursuance of the powers conferred by Section 4 of the Indian Telegraph Act, 1885 (13 of 1885) and in supersession of the Order No. L-14047/01/2002-NTG dated 18th April 2002 and in partial modification of Order No. R-11014/4/87-LR(Pt) dated 20th July 1995 and Corrigendum No. R-11014/26/2002-LR dated 1st April 2003, the central government hereby prescribes the following royalty charges (based on revenue share) for Microwave (MW) Access (normally in the frequency band 10 GHz and beyond) and MW Backbone networks (generally below 10 GHz frequency band) of GSM and CDMA based telecom service providers:

2.1 The following revenue share percentage(s) shall be levied for assignment of Microwave networks of GSM and CDMA based telecom service providers

Spectrum Bandwidth	Spectrum charges as percentage of AGR	Cumulative spectrum charges as percentage of AGR
First carrier of 28 MHz (paired)	0.15 %	0.15%
Second carrier of 28 MHz (paired)	0.20%	0.35%
Third carrier of 28 MHz (paired)	0.20 %	0.55 %
Fourth carrier of 28 MHz (paired)	0.25 %	0.80 %
Fifth carrier of 28 MHz (paired)	0.30 %	1.10 %
Sixth carrier of 28 MHz (paired)	0.35 %	1.45 %

2.2 The above spectrum charges (as percentage of AGR) are applicable for both for MW access carriers (in Metros and other telecom service areas) as well as the MW backbone carriers separately.

2.3 While the first microwave access carrier can be allotted for the complete service area, subsequent carriers shall be allotted based on justification and for the cities/ districts where it is found to be essential.

2.4 However, the revenue share would be based on the AGR for complete service area for simplicity of calculations, which is one of the main features of the revenue share regime.

Contd... 2/-

3/11/06

2.5 Assignment of frequencies for MW access and MW backbone networks fc GSM and CDMA based telecom networks would continue to be considered on the basis of full justification of the requirements and availability of the spectrum, o case-to-case and link-to-link basis, after taking into consideration the spectrun requirement of the other users with a view to ensuring electromagnetic compatibility etc. The complete technical analysis and all related aspects of frequency assignments, including efficient use of spectrum, will apply before assigning frequencies for various MW access and MW backbone links. There will be nc obligation on the part of the Government to assign frequencies for such purposes.

2.6 These charges include the royalty charges for spectrum usages and licence fee for the fixed stations in the MW access and MW backbone links.

2.7 The assignment of MW access and MW backbone frequencies shall not be exclusive for any service provider and will be shared with other services / users.

2.8 In addition, the charges for GSM spectrum (in 900 / 1800 MHz band) and CDMA spectrum (in 800 MHz band) will continue to be levied in accordance with the existing orders on the subject.

3. These orders shall come into force from the date of issue.

(Sukhpal Singh)
Assistant Wireless Adviser to the Government of India

Copy to:

1. All Concerned.
2. COAI.
3. AUSPI
4. All GSM based Operators.
5. All CDMA based operators.
6. Monitoring Organisation
7. Wireless Finance Division

Annexure 1.3: DoT's Order Dated 10.11.2008

Government of India
Ministry of Communications & IT
Department of Telecommunications
(WPC WING)
Sanchar Bhawan, 20-Ashoka Road,
New Delhi-110001

Dated the 10th November 2008

No. J-14025/200(11)/06-NT

ORDER

Subject: Spectrum Charges for Microwave Access and Backbone Networks of GSM and CDMA based telecom services.

1. In continuation of this office Order No. J-14025/200(11)/06-NT dated 03-11-2006 regarding the Spectrum charges for Microwave Access and Backbone networks of GSM and CDMA based telecom services, the Central Government prescribes the spectrum charges (licence fee plus royalty) beyond the 6th (sixth) carrier as under:

Microwave (MW) Spectrum Bandwidth	Spectrum charges as percentage of AGR effective from 03-11-2006	Cumulative spectrum charges as percentage of AGR effective from 03-11-2006
Seventh carrier of 28 MHz (paired)	0.40	1.85
Eighth carrier of 28 MHz (paired)	0.45	2.30
Ninth carrier of 28 MHz (paired)	0.50	2.80
Tenth carrier of 28 MHz (paired)	0.55	3.35
Eleventh carrier of 28 MHz (paired)	0.60	3.95

2. All telecom service providers, presently using MW bandwidths of 3.5MHz /7MHz/ 14MHz, in different 28 MHz carrier (bands) shall take immediate steps and consolidate the same within one or two carriers of 28 MHz by 31-12-2008. From 03-11-2006 till 31-12-2008, the aggregate of such small carriers shall be charged at *full* rate if their total quantum is more than or equal to 14 MHz bandwidth in a Service Area. On the other hand, if the quantum of such small carrier's aggregate is *less* than 14 MHz bandwidth in the Service Area, the same shall be charged at *half* the rate applicable to the specific 28 MHz (Paired) bandwidth carrier.

3. With effect from 1st January 2009, one or more small carriers of 3.5MHz /7MHz/ 14MHz, falling within a specific 28 MHz (Paired) bandwidth carrier in a Service Area, shall be charged at the rate applicable to the *full* carrier of 28 MHz (paired) bandwidth.

4. All other terms and conditions as mentioned in the Order No. J-14025/200(11)/06-NT dated 03-11-2006 remain unchanged.

5. This issues with the concurrence of Member (Finance), telecom Commission vide Dy. No.1321-M (F)/08 dated 03-11-2006

(P.Chandrasekharan)
Deputy Wireless Adviser to the Government of India

Copy to
1. All concerned.
2. COAI and AUSPI
3. All GSM and CDMA based Service Providers/Operators.
4. Monitoring Organization, Pusnpa Bhawan, New Delhi.
5. Wireless Finance Division, DOT

Annexure 1.4: DoT's Guidelines Dated 16.10.2015

No. L-14035/19/2010-BWA (Pt)
Ministry of Communication & Information Technology
Department of Telecommunication
Wireless Planning and Coordination Wing

New Delhi dated, the 16th October, 2015

GUIDELINES

Considering the immediate requirement of Microwave Access (MWA) and Microwave Backbone (MWB) spectrum of telecom service providers, it has been decided to allot such spectrum for the interim period provisionally, pending the final decision in the matter by the Government.

2. The interim/ provisional allotment of MWA/ MWB carriers will be subject to following terms, conditions and criteria:

i) TSPs would be allotted, including the present holdings, a maximum of 4 carriers for Metro & Category A Service Area, 3 carriers for Category B and Category C Service Areas for MWA, subject to availability.

ii) Microwave Backbone carrier allotment will be considered on link to link basis subject to availability.

iii) Each Microwave carrier refers to 28 MHz paired bandwidth in 13, 15, 18 and 21 GHz bands for MWA and in sub 10 GHz band (s) for MWB.

iv) For the interim period, the charging of MWA and MWB carriers will be done as per rates mentioned in Order no. J-14025/200(11)/ 06-NT Dated 3rd November' 2006 and its amendments of even no. dated 10th November' 2008 and 19th February' 2009.

v) The applicants (TSPs) are required to submit an *undertaking* and also enter into an *Frequency Agreement* (proformas enclosed herewith), dully filled in, before their request for the allotment of MWA/ MWB carriers is considered.

vi) All MWA/ MWB carrier/spectrum allotted, as an interim measure, will be purely on temporary and provisional basis and all such allottees will have to participate in the allotment methodology as decided by the Government after considering the recommendations of TRAI on the subject.

vii) In the event of decision of the Government to allot MWA carrier/ spectrum by auction, the carriers allocated as an interim measure, will stand reverted back to the Government after a period of three months from date of finalisation of results of aforesaid auction, in case such allottees fail to participate and/or win back the carriers/spectrum provisionally allotted as an interim measure.

viii) In the event of decision of the Government to allot MWA carrier/ spectrum by a methodology other than the auction, the carriers allocated as an interim measure, will stand reverted back to the Government after a period of three months, in case such allottees fail to participate in the said process and/or not being able to get back the provisionally allotted carriers/spectrum, as per the methodology.

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ix) The licensees whose licenses have expired in November' 2014 or licenses expiring in future, will be allowed to hold the carriers allotted to them as per Clause 8.4 of UL guidelines on a purely provisional basis till the ongoing process of TRAI consultation is completed and a final decision thereon is taken by the Government; thereafter, MWA/ MWB carriers may be regulated in accordance with above Para (vii) and (viii) of this Guideline/ OM.

x) Due notice will be given to such allottees who have been provisionally allotted the carriers/spectrum as an interim measure and have not been able to get back the spectrum in full or in part.

xi) During the said interim period, the present charging mechanism, as mentioned above, will continue subject to the condition that for the spectrum/carriers allotted during interim period, the TSPs will have to pay the charges with retrospective effect (i.e. from the date of issue of letter for allotment of carriers as interim measure) as finally determined through the auction process/ market related process or any other methodology decided by the Government.

Encls: As above
(Undertaking and Frequency Agreement Proforma)

16.10.2015
(Bhagirath)
Deputy Wireless Adviser

Copy to:
i) All concerned
ii) Sr. DWA (ASMS), WPC Wing, DoT for uploading on the WPC Wing website
iii) Director (IT), DoT, for uploading on the DoT website

Annexure 1.5: Addendum to DoT's Guidelines dated 16.10.2015 Issued on 25.07.2022

No. L-14035/19/2010-BWA (Pt-II)
Ministry of Communications
Department of Telecommunications
Wireless Planning and Coordination Wing

New Delhi dated 25th July, 2022

Subject: Addendum to the Guidelines dated 16.10.2015 regarding allotment of MWA/MWB carriers to TSPs with Access Service authorization/license.

In view of the increased requirements of backhaul on account of 5G, it has been decided to increase the limit of maximum number of Microwave Access carriers that can be assigned to a Telecom Service Provider with Access Service authorization/license on provisional basis vide Guidelines dated 16.10.2015, from existing 4 carriers (in Metro, Cat 'A' LSA) /3 carriers (in Cat 'B' & Cat 'C' LSA) to 8 carriers (in Metro, Cat 'A' LSA) / 6 carriers (in Cat 'B' & Cat 'C' LSA) w.e.f. the date of issue of this addendum.

2. A separate O.M shall be issued for modifying the Frequency Agreement, attached with the Guidelines dated 16.10.2015.

3. Other terms and conditions of the Guidelines dated 16.10.2015 will remain same.

AVNEESH KUMAR

Digitally signed by AVNEESH KUMAR
Date: 2022.07.25 19:56:18 +05'30'

(Avneesh Kumar)
Assistant Wireless Adviser to the Govt. of India

Copy To:

i. All Concerned
ii. Sr. DWA (ASMS), WPC Wing, DoT for uploading on the WPC Wing's website.
iii. Director (IT), DoT, for uploading on the DoT website.

Annexure 1.6: DoT's Guidelines dated 25.07.2022 for allotment of E-band carriers to Access Service Providers

No. L-14035/19/2010-BWA (Pt-II)
Ministry of Communications
Department of Telecommunications
Wireless Planning and Coordination Wing

New Delhi dated 25th July, 2022

Subject: Guidelines for allotment of E-band (71-76/81-86 GHz) carriers to Telecom Service Providers (TSPs) with Access Service authorization/license and having Access Spectrum in IMT bands.

In view of the increased backhaul capacity requirements of TSPs with Access Service authorization/license and having Access Spectrum in the IMT bands, especially on account of 5G, it has been decided to allot carriers in E-band spectrum for the purpose of backhaul on interim basis as per the following guidelines:

1. TSPs, based upon their application, would be allotted a maximum of 2 (two) carriers of 250 MHz each (paired) bandwidth in E-band (71-76/81-86) GHz for their backhaul purpose in the LSAs where they are holding Access Spectrum in IMT bands.

2. For each E band carrier of 250 MHz paired bandwidth, Spectrum Charges will be charged @ 0.15% of AGR (Adjusted Gross Revenue) of the TSPs in the interim period, which will be adjusted/recalculated retrospectively (from date of provisional assignment) based upon the pricing decided finally. No interest shall be paid/ charged on the excess / shortfall amount, if any, while making such adjustment/recalculation. Final assignment of carriers will be decided accordingly.

3. Spectrum Charges shall be payable in four quarterly instalments during each financial year (FY). Quarterly instalments of Spectrum Charges for the first three quarters of a financial year shall be paid within 15 days of the completion of the relevant quarter. However, for the last quarter of the financial year, the Licensee shall pay the Spectrum Charges by 25th March on the basis of expected revenue for the quarter, subject to minimum payment equal to the revenue share paid for the previous quarter.

4. Any delay in payment of spectrum charges, payable, or any other dues payable under the License beyond the stipulated period will attract interest at a rate which will be 2% above the one-year Marginal Cost of Lending Rate (MCLR) of the State Bank of India existing as on the beginning of the Financial Year (namely 1st April) in respect of the spectrum charges pertaining to the said Financial Year. The interest shall be compounded

annually. A part of the month shall be reckoned as a full month for the purpose of calculation of interest. A month shall be reckoned as an English calendar month.

5. All E-band carriers assigned, as an interim measure, will be purely on temporary and provisional basis and all such assignees will have to participate in the auction and/or any other assignment methodology, as decided by the Government after considering the recommendations of the TRAI in this regard.

6. The E- band carriers, assigned as an interim measure, will stand reverted back to the Government, after a period of three months from the date of finalization of results of aforesaid activity as detailed/stipulated in para 5 above in case such assignees fail to get back the carriers/ spectrum provisionally assigned as an interim measure.

7. WPC Wing reserves the right to change or modify frequencies assigned to licensee without any notice in the interest of public or for proper conduct of telegraphs and or for security considerations.

8. Equipments conforming to TEC/ITU and other international standards and National Frequency Allocation Plan (NFAP) shall be deployed.

9. Any misuse i.e. use of E-band carriers allotted under these guidelines for purpose(s) other than backhaul will lead to immediate withdrawal of these carriers and invocation of relevant terms and conditions of the UL/UASL-Access Service Authorization.

10. The applicants (TSPs) are required to submit an undertaking as per enclosed proforma, with their request for the assignment of E- band carriers.

11. These guidelines shall be effective from the date of its issue.

Encl: Proforma of Undertaking

AVNEESH KUMAR

Digitally signed by AVNEESH KUMAR
Date: 2022.07.25 19:49:40 +05'30'

(Avneesh Kumar)
Assistant Wireless Adviser to the Govt. of India

Copy To:

i. All Concerned

ii. Sr. DWA (ASMS), WPC Wing, DoT for uploading on the WPC Wing's website.

iii. Director (IT), DoT, for uploading on the DoT website.

Undertaking for Interim/Provisional allotment of E-band (71-76/81-86 GHz) carriers

I/We.....on behalf of M/s..... hereby undertake to agree for the assignment of frequencies against our application vide letter No.....dated.....with the following conditions:

(i) The allotment of spectrum is provisional and subject to Government's final decision on allotment & pricing of E-band spectrum;

(ii) In the event of final decision to allot spectrum through auction process or any other methodology as finally decided by the Govt., I/We shall follow the process accordingly; failing which the spectrum shall be withdrawn by the Govt.

(iii) In case the provisional allotment of spectrum is withdrawn, payment made towards spectrum charges or part thereof shall not be refunded;

(iv) In case the provisional allotment of spectrum is withdrawn, I/We would obtain Non-Dealer Possession License (NDPL) for possessing the wireless equipment or return the equipment to a DPL holder or shall dispose off the same as per procedure;

(v) The revised spectrum charges, as finally determined through market related mechanism or otherwise, as may be applicable, shall be paid by us from the date of issue of Letter for provisional allotment of spectrum.

(vi) The carriers allotted thus would only be used for backhaul purpose in the network.

(vii) I/We hereby agree and unequivocally undertake to fully comply with all the terms and conditions stipulated in the Guidelines dated.....for allotment of E-band (71-76/81-86 GHz) carriers without any deviations or reservations.

Place.....

Date.....

Signature of Authorized Signatory*

Name.....

Designation.....

*The document in support of being the authorized signatory (i.e. Board Resolution and POA) to be attached.

AVNEESH KUMAR

Digitally signed by AVNEESH KUMAR
Date: 2022.07.25 19:50:10 +05'30'

Annexure 1.7: DoT's Reference Dated 12.08.2022

Government of India
Ministry of Communications
Department of Telecommunications
Wireless Planning & Coordination (WPC) Wing
6th Floor, Sanchar Bhawan, 20, Ashoka Road, New Delhi

No: L-14035/10/2022-BWA **Date: 12-08-2022**

To,

The Secretary
Telecom Regulatory Authority of India
Mahanagar Doorsanchar Bhawan
Jawahar Lal Nehru Marg (Old Minto Road)
New Delhi-110002.

Subject: Seeking TRAI recommendations for assignment of E&V Bands; and Microwave Access (MWA) & Microwave Backbone (MWB) spectrum in existing frequency bands of 6/7/ 13/15/18/21 GHz.

Sir,

TRAI had provided its recommendations dated 29.08.2014 on "Allocation and Pricing of Microwave Access (MWA) and Microwave Backbone (MWB) RF carriers". In these recommendations, TRAI had also provided recommendations on allocation and pricing methodology for E band (71-76/81-86 GHz) and V bands (57-64 GHz) spectrum. Subsequent to DoT's back reference dated 16.10.2015, TRAI's response/letters dated 17.11.2015, 06.05.2016 and 15.07.2016 were also received by DoT.

2. The matter of E and V band spectrum assignment was deliberated in DoT and it emerged that while the spectrum in E and V bands should be assigned through auction for provisioning of commercial telecom services; there may be certain non-TSP/ non-commercial usages like captive/individual point to point/multipoint usages, which also need spectrum in these bands and where auction may not feasible.

2.1 In V band, the device/chipset eco-system supporting various technologies for data transfer between consumer's devices such as smartphones, camera, laptops etc, has developed. The technologies used for such devices are designed for short-range, indoor, interference-tolerant applications. Therefore, while the V band spectrum can be assigned through auction for establishment of indoor/outdoor telecom networks, allowing low power, indoor usages of V band on license-exempt basis for consumer device-to- consumer device data transfer may go a long way in serving greater public interest and realizing significant socio-economic gains.

3. With regard to assignments of MWA & MWB spectrum in frequency bands 6/7/ 13/15/18/21 GHz to TSPs, it has been decided to seek a fresh recommendation of TRAI on allocation methodology, quantum and pricing of MWA and MWB RF carriers, in view of technological changes which have taken place over the years as well as considering the existing assignments to TSPs.

4. In view of the above, TRAI is requested to provide its recommendations under the terms of clause 11(1) (a) of TRAI Act, 1997 as amended by TRAI Amendment Act 2000 on the following:

(a) applicable reserve price, band plan, block size, quantum of spectrum, duration of assignment, scope of services/usages, spectrum cap, payment terms, eligibility conditions, methodology of auction and other associated conditions for auction of E band spectrum for establishment of terrestrial and/ or satellite based telecom networks.

(b) applicable reserve price, band plan, block size, quantum of spectrum, duration of assignment, scope of services/usages, spectrum cap, payment terms, eligibility conditions methodology of auction and other associated conditions for auction of V band spectrum for establishment of terrestrial and/ or satellite based telecom networks.

(c) quantum of spectrum to be earmarked for non-commercial/ captive/ isolated use in E and V bands; and methodology of assignment, where auction is not feasible and pricing for the same.

(d) feasibility, including technical parameters, for allowing low power, indoor, consumer device-to-consumer device usages on license-exempt basis, in parallel to use of the auction-acquired spectrum by telecom service providers for establishment of terrestrial and/ or satellite based telecom networks, in part or full V band.

(e) a fresh recommendation on allocation methodology, quantum and pricing of MWA and MWB RF carriers in 6/7/ 13/15/18/21 GHz bands, for establishment of terrestrial and/ or satellite based telecom networks as well as for non-commercial/ captive/ isolated use.

(f) provide any other recommendations deemed fit for the purpose mentioned under (a) to (e) above in these frequency bands, including the regulatory/technical requirements as enunciated in the relevant provisions of the latest ITU-R Radio Regulations.

This issues with the approval of the competent authority.

(Gulab Chand)
Joint Wireless Adviser
Email: gulab.chand@nic.in
011-23372183

Annexure 1.8: DoT's Reference Dated 13.09.2024

Government of India
Ministry of Communications
Department of Telecommunications
Wireless Planning & Coordination (WPC) Wing
6th floor, Sanchar Bhawan,
20, Ashoka Road, New Delhi – 110001

No.: L-14035/10/2022-BWA

Date: 13.09.2024

To,

The Secretary
Telecom Regulatory Authority of India,
New Delhi.

Subject: Clarification/ information sought by TRAI regarding DoT's reference on assignment of E&V bands; and MWA & MWB spectrum- reg.

Reference: DoT's letter dated 12-08-2022 seeking TRAI's recommendations for assignment of E&V bands; and Microwave Access (MWA) and Microwave Backbone (MWB) spectrum in existing frequency bands of 6/7/13/15/18/21 GHz bands[1].

Sir,

I am directed to refer to the TRAI's letter no. C-15/2/ (1)/2022-NSL-II dated 20-02-2024 in response to DoT letter cited under *Reference* above. TRAI, quoting the provisions of Section 4(4) and the First Schedule of the Telecommunications Act, 2023, has mentioned that DoT's reference dated 12-08-2022 may require review in respect of the item (a) and (b) of the reference i.e., methodology of allocation (auction) and requested to provide specific issues on which their recommendations would now be required.

2. While agreeing to the TRAI's observation that *Backhaul* spectrum is part of First Schedule of the Act, for which the assignment method would be administrative, it is to state that DoT's letter dated 12-08-2022 on the 6/7/13/15/18/21 GHz bands was based upon techno-regulatory state at that point of time. Meanwhile, apart from passing of the Telecommunications Act, international regulatory landscape has seen some changes at the *World Radiocommunications Conference (WRC) 2023*. The Telecom Service Providers (TSPs) have also demanded amended usage of some of these bands. Without going into the merit of these demands, these are mentioned in the developments below:

2.1 6 GHz: While the upper 6 GHz band (not part of this reference) i.e., 6.425-7.125 GHz has been identified for IMT in other parts of the world, the lower 6 GHz band i.e. 5.925 to 6.425 GHz continues to be used as backhaul.

2.2 7/13/15/18/21 GHz: The spectrum band 7.125 to 8.400 GHz (7 GHz) & 14.8-15.35 GHz (15 GHz) are being considered for IMT i.e., *Access*, under agenda items 1.7 of WRC-2027. One of commercial telecom service providers holding Unified License with Access service authorisation and providing wireline services has requested for spectrum in the 6/7/13 GHz bands for establishing links for last mile connectivity solutions in certain Licensed Service Areas.

2.3 Requirement of captive users: Point to point connectivity requirements of certain captive users is required to be met from one or more of these bands i.e. 6/7/13/15/18/21 GHz bands. Such requirements are generally localised and mostly limited to few links only. In case, some carriers are specifically earmarked for such use, they can be re-used among multiple users with geographical separation.

It may be noted that current use of 6 GHz (lower)/7/13/15/18/21 for backhaul purposes continues to be covered under the First Schedule of the Act.

3. The Developments related to V - band and E - band are described below:

3.1 The **V-band** (57-64/66 GHz)[2] is a part of the band *n263* of 3GPP (57 GHz to 71 GHz), which is also referred to as 60 *GHz band*. That is to say that the complete 57-71 GHz band has been planned by 3GPP as IMT/ Access band. Point to point (backhaul) solutions are also available in the V band. Further, a part of this band, i.e., 66-71 GHz, has already been identified by ITU globally for IMT based Access services in WRC-19.

3.2 The **E-Band** (71-76 GHz/ 81-86 GHz) has already been assigned LSA-wise for *Backhaul* purpose to TSPs on provisional basis, during 2022. One of the commercial telecom service providers, holding UL with Access service authorisation, has sought permission for using this band for *Access Services*, in addition to the *Backhaul* purposes. i.e. as *IAB* (*Integrated Access & Backhaul*). In addition, another service provider, holding UL with Internet service authorisation (ISP) has sought E/V band spectrum for last mile connectivity purpose.

4. In view of above, TRAI, considering the relevant clauses of section 4 of the Telecommunications Act, 2023, is requested to provide its recommendations under section 11(1) (a) of the TRAI Act on the following:

(a) Demand assessment and scope of service/usage for (i) 57-64/66 GHz (V-band) and (ii) 71-76 GHz/ 81-86 GHz (E-band) and accordingly methodology of assignment of spectrum and associated terms & conditions, in line with the determination of scope of services/ usages by TRAI i.e. "Access" or "Backhaul" or "Integrated Access & Backhaul (IAB)".

(b) Spectrum charges and related terms & conditions such as spectrum cap, carrier aggregation, etc. for assignment of spectrum in 6 (lower)/7/15/13/18/21 GHz bands for backhaul purposes of commercial telecom services.

(c) Any need for review in respect of use of 7/15 GHz bands in view of consideration of these bands for Access using IMT after WRC – 2027.

(d) Quantum/ band(s) of spectrum to be earmarked for last mile connectivity (Fixed Wireless Access) of commercial telecom services and methodology of assignment of spectrum and associated terms & conditions in non-IMT bands as referred to in Para 2.2 above.

(e) Quantum/ band(s) of spectrum to be earmarked for Backhaul purposes for non-commercial/captive use and associated terms & conditions including charges as referred to in Para 2.3 above.

(f) Feasibility & technical parameters, for allowing low power, indoor, consumer device- to-consumer device usage on license-exempt basis in V-band as referred to in Para 4(d) of reference dated 12-08-2022.

(g) Provide any other recommendations deemed fit for the purposes mentioned under (a) to (f) above.

This issues with the approval of Competent Authority.

(M. Revathi)
Joint Wireless Adviser
to the Government of India
Email: m.revathi@nic.in
Phone: 011 2303 6534

[1] The exact frequency ranges of 6/7/13/15/18/21 GHz MWA/MWB bands are 5.925-6.425 GHz, 7.125-7.725 GHz, 12.75-13.25 GHz, 14.5-15.5 GHz, 17.7-19.7 GHz and 21.2-23.6 GHz respectively.

[2] The V band is generally referred to be as 57-64 GHz. The extended V band is considered to be from 57 to 66 GHz range.

Annexure-2.1: Details of the frequency carriers in 6 GHz (lower), 7 GHz, 13 GHz, 15 GHz, 18 GHz, and 21 GHz bands

Band	6 GHz		7 GHz		7 GHz		13 GHz		15 GHz		18 GHz		21 GHz	
No. of carriers	8		5		5		8		15		32		40	
Frequency range	5925-6425 MHz		7125-7425 MHz		7425-7725 MHz		12.750-13.250 GHz		14.5-15.5 GHz		17.7-19.7 GHz		21.2-23.6 GHz	
Tx-Rx separation	252.04 Mhz		161 Mhz		154 Mhz		266 Mhz		420 Mhz		1010 Mhz		1232 Mhz	
Adjacent Channel separation	29.65 MHz		28 MHz		28 MHz		28 MHz		28 MHz		27.5 MHz*		28 MHz	
Channels	Uplink	Downlink	Uplink	Downlink	Uplink	Downlink	Uplink	Downlink	Uplink	Downlink	Uplink	Downlink	Uplink	Downlink
F1/F1'	5945.20	6197.24	7138.5	7299.5	7442	7596	12765	13031	14515	14935	17727.5	18737.5	21238	22470
F2/F2'	5974.85	6226.89	7166.5	7327.5	7470	7624	12793	13059	14543	14963	17755.0	18765.0	21266	22498
F3/F3'	6004.50	6256.54	7194.5	7355.5	7498	7652	12821	13087	14571	14991	17782.5	18792.5	21294	22526
F4/F4'	6034.15	6286.19	7222.5	7383.5	7526	7680	12849	13115	14599	15019	17810.0	18820.0	21322	22554
F5/F5'	6063.80	6315.84	7250.5	7411.5	7554	7708	12877	13143	14627	15047	17837.5	18847.5	21350	22582
F6/F6'	6093.45	6345.49					12905	13171	14655	15075	17865.0	18875.0	21378	22610
F7/F7'	6123.10	6375.14					12933	13199	14683	15103	17892.5	18902.5	21406	22638
F8/F8'	6152.75	6404.79					12961	13227	14711	15131	17920.0	18930.0	21434	22666
F9/F9'									14739	15159	17947.5	18957.5	21462	22694
F10/F10'									14767	15187	17975.0	18985.0	21490	22722
F11/F11'									14795	15215	18002.5	19012.5	21518	22750
F12/F12'									14823	15243	18030.0	19040.0	21546	22778
F13/F13'									14851	15271	18057.5	19067.5	21574	22806
F14/F14'									14879	15299	18085.0	19095.0	21602	22834
F15/F15'									14907	15327	18112.5	19122.5	21630	22862
F16/F16'											18140.0	19150.0	21658	22890
F17/F17'											18167.5	19177.5	21686	22918
F18/F18'											18195.0	19205.0	21714	22946
F19/F19'											18222.5	19232.5	21742	22974
F20/F20'											18250.0	19260.0	21770	23002
F21/F21'											18277.5	19287.5	21798	23030
F22/F22'											18305.0	19315.0	21826	23058
F23/F23'											18332.5	19342.5	21854	23086
F24/F24'											18360.0	19370.0	21882	23114
F25/F25'											18387.5	19397.5	21910	23142
F26/F26'											18415.0	19425.0	21938	23170
F27/F27'											18442.5	19452.5	21966	23198
F28/F28'											18470.0	19480.0	21994	23226
F29/F29'											18497.5	19507.5	22022	23254
F30/F30'											18525.0	19535.0	22050	23282
F31/F31'											18552.5	19562.5	22078	23310
F32/F32'											18580.0	19590.0	22106	23338
F33/F33'													22134	23366
F34/F34'													22162	23394
F35/F35'													22190	23422
F36/F36'													22218	23450
F37/F37'													22246	23478
F38/F38'													22274	23506
F39/F39'													22302	23534
F40/F40'													22330	23562

Annexure 4.1 - LSA wise carriers and backhaul links in 6/7 GHz bands

LSA	Total no. of carriers in 6/7 GHz	Total no. of backhaul Links in 6/7 GHz
Andhra Pradesh	1	24
Assam	2	310
Bihar	2	118
Delhi	0	0
Gujarat	1	6
Haryana	0	0
Himachal Pradesh	2	21
Jammu & Kashmir	2	20
Karnataka	2	17
Kerala	1	25
Kolkata	0	0
Madhya Pradesh	2	43
Maharashtra	1	57
Mumbai	0	0
North-East	2	358
Odisha	1	2
Punjab	0	0
Rajasthan	3	286
Tamil Nadu	2	45
UP East	0	0
UP West	1	40
West Bengal	1	10
Total	**26**	**1382**

Annexure 4.2 – LSA wise carriers and backhaul links in 13/15/18/21 GHz bands

LSA	Total no. of carriers in 13/15/18/21 GHz	Total no. of backhaul Links in 13/15/18/21 GHz
Andhra Pradesh	14	35,141
Assam	11	13,932
Bihar	11	38,537
Delhi	14	13,819
Gujarat	15	30,236
Haryana	12	12,704
Himachal Pradesh	11	5,930
Jammu & Kashmir	10	6,553
Karnataka	14	32,996
Kerala	12	21,921
Kolkata	14	7,257
Madhya Pradesh	13	37,953
Maharashtra	16	46,035
Mumbai	14	8,505
North- East	11	8,676
Odisha	10	16,803
Punjab	13	17,438
Rajasthan	12	32,175
Tamil Nadu	13	37,139
UP East	12	39,757
UP West	12	29,933
West Bengal	10	26,481
Total	**274**	**519921**

Annexure 4.3 - LSA-wise carriers and backhaul links in E-band

LSA	Total no. of Carriers in E-band	Total no. of backhaul links in E-band
Andhra Pradesh	4	1272
Assam	4	421
Bihar	5	2585
Delhi	5	1019
Gujarat	4	1901
Haryana	4	632
Himachal Pradesh	2	25
Jammu & Kashmir	2	76
Karnataka	4	2050
Kerala	4	1639
Kolkata	4	486
Madhya Pradesh	4	662
Maharashtra	4	1921
Mumbai	5	1532
North-East	2	78
Odisha	2	200
Punjab	4	1022
Rajasthan	4	1061
Tamil Nadu	4	1986
UP East	4	1242
UP West	2	588
West Bengal	2	240
Total	**79**	**22638**

Annexure 4.4 - International pricing regimes for point-to-point links in Traditional Microwave and E and V bands

1. The methodology for charging of point-to-point links in international regimes usually follows a combination of factors. There is different combination of factors applied by different countries. The list of factors usually considered across regimes can be represented by the indicative formula:

Annual Spectrum Fees (per link) = U x BW x FBF x AF x EF x PLF

Where:

- U = Unit price per MHz or KHz (set at a level reflecting the economic status and goals of a country, set to recover a target level of revenue – usually including at minimum the administrative costs)
- BW = Bandwidth assigned in MHz
- FBF = Frequency Band Factor (reflecting levels of higher utility and limited availability of bands, usually of lower frequency bands vis-à-vis higher bands)
- AF = Geographic area factor (reflecting usage in high-density cities, rural or remote areas, with desirable frequencies in high usage and congestion areas taking a higher value)
- EF = Exclusivity factor (reflecting whether assignment is shared or exclusive basis in a region or country, with denial of right to use by other operators in the region/ country)
- PLF = Path Length factor (reflecting whether link length is in line with mean path length defined by regulator)

2. Backhaul charging in traditional microwave as well as E/V bands for point-to-point links have also been studied individually. A summary is placed below:

i. <u>Office of Communications (OFCOM), UK:</u>

The Wireless Telegraphy (Licence Charges) Regulations 2020 defines a link charging formula, *which does not cover allotments in E & V Band*:

AS = Sp × Bwf × Bf × Plf × Avf

where:

- AS is Appropriate Sum
- Sp (Spectrum price) is a fixed £88 per 2×1 MHz of bandwidth.
- Bwf (Bandwidth factor) scales with the licensed bandwidth in MHz (e.g. 28 MHz ≈ factor 28).
- Bf (Band factor) depends on the frequency range (different ranges cover 6 GHz, 13 GHz, 18 GHz etc., with higher bands generally having lower factors).
- Plf (Path-length factor) is derived from the ratio of actual path length (PL) to a band-specific minimum path length (MPL), with penal factor for shorter than MPL link lengths
- Avf (Availability factor) increases fees for links with higher availability targets (lower downtime tolerance)
- One-way fixed links are charged at 75% of the two-way coordinated link fee

As per *Wireless Telegraphy (Licence Charges) Regulations 2020*, the band factors used by OFCOM are stated below:

S.no.	Frequency Ranges (in GHz)		Band Factor
1	From	To	
2	1.35	2.69	1.0
3	3.60	4.20	1.0
4	5.92	7.13	0.74
5	7.42	8.50	0.74
6	10.70	11.70	0.43
7	12.75	15.35	0.43
8	17.30	19.70	0.30
9	21.20	23.60	0.30
10	24.50	29.06	0.26
11	31.00	31.80	0.26

12	31.80	33.40	0.26
13	37.00	39.50	0.26
14	49.20	57.00	0.17

It can be seen that OFCOM treats 13/15 GHz as a single category, at 1.43 times of 18/21 GHz

Using above factors, the base prices for a 28MHZ paired carrier in 6/17/13/15/18/21 GHz bands, 250 MHz paired carrier in E band and 50 MHz unpaired carrier in V-band is tabulated below:

S.no.	Point-to-point link in band	Price/ year
1	6/ 7 GHz	£ 1820
2	13/ 15 GHz	£ 1060
3	18/ 21 GHz	£ 739
4	E band*	£ 50
5	V- band*	£ 50

*Rates are for lightly licensed links. For frequency coordinated links, one-time charges of 150-200 pounds apply

As can be seen:

- 6/7 GHz band is priced at approx. 1.72-2.46 times of 13/15/18/21 GHz bands, an average of which can be a factor of 2.10.
- 13/15/18/21 GHz is priced at approx. 18 times of E-band.
- V- band is priced same as E-band, and both bands are not covered by the charging formula

ii. Federal Communications Commission (FCC), USA

As per FCC, the following formula is applicable for backhaul:

Annual Fee (USD) = $5 per MHz × Bandwidth (MHz)

Using above factors, the price for a 28MHZ paired carrier in 6/17/13/15/18/21 GHz bands, 250 MHz paired carrier in E band and 50 MHz unpaired carrier in V-band, CF=100 (city wide operation), is tabulated below:

S.no.	Point-to-point link in band	Price/ year
1	6/ 7 GHz	$140
2	13/ 15 GHz	$140
3	18/ 21 GHz	$140
4	E band	$7.50
5	V- band	NIL

As can be seen:

- There is no use of band factors, either inter se the traditional backhaul bands or otherwise.
- All bands are charged at fixed fee.
- V-band is exempt from all fees.

iii. <u>Communications Regulator, Ireland</u>

As per Fixed Radio Links Licensing Guidelines of 2023, Communications Regulator of Ireland also charges per link based on distinct bands inter-se 13/15/18/21 GHz. The range of charges, depending on high usage path or congested area, (for assigned bandwidth of 20 MHz to 40MHz) is given below:

S.no.	Point-to-point link in band	Price/ year
1	1 GHz < F < 17 GHz	EUR 1,200 - 1,440
2	17 GHz < F < 37 GHz	EUR 900 - 1080

3	37 GHz < F ≤ 39.5 GHz	EUR 660-792
4	F > 39.5 GHz	EUR 150-180

Here, Communications Regulator of Ireland treats 13/15 GHz as one category at 1.33 times of 18/21 GHz

The charges are to be updated from October 1, 2026, which are stated separately in the 2023 Regulations. As per the new charges, the price for a 28MHZ paired carrier in 6/17/13/15/18/21 GHz bands, 250 MHz paired carrier in E band and 50 MHz unpaired carrier in V-band, without any consideration of high usage path or congestion area, is tabulated below:

S.no.	Point-to-point link in band	Price/ year
1	6/ 7 GHz	EUR 1736
2	13/ 15 GHz	EUR 1461
3	18/ 21 GHz	EUR 1166
4	E band	EUR 100
5	V- band*	EUR 100*

*On the basis that it lies in F>39.5 GHz as per current pricing table, price is given as 100Euros. However, in the charges applicable from 2026, pricing for V-band was not found separately.

As can be seen:

- 6/7 GHz band is priced at approx. 1.2-1.5 times of 13/15/18/21 GHz bands, an average of which can be a factor of 1.35
- 13/15/18/21 GHz is priced at nearly 12-15 times of E-band, an average of which can be a factor of 13.5

- Since E & V band fall in same category of F>39.5 GHz, both have been assumed to be having same price. However, in the charges applicable from 2026, the category for V-band was not found.

iv. Independent Communications Authority of South Africa (ICASA), South Africa

The formula used by ICASA, South Africa is stated below:

Fee = UNIT × FREQ × BW × CG × GEO × SHR × HOPMINI × UNI × SEC

Where:

- UNIT - Base Unit Price (R3,263 per MHz as of April 2025)
- FREQ - Frequency Band Factor (0.05 to 1.0)
- BW - Bandwidth in MHz
- CG - Congestion/ Spectrum availability Factor (1.0 or 1.5)
- GEO - Geographic/ Density Factor (0.1 or 1.0)
- SHR - Sharing Factor (1.0 or 0.5)
- HOPMINI - Minimum Hop Length Factor (~0.7 to 1.0) (same as Path Length Factor (PLF) in OFCOM formula)
- UNI - Unidirectional Factor (1.0 for bidirectional FDD link or 0.75 for unidirectional TDD link)
- SEC - Security Factor (1.0 or 0.2)

The (FREQ) frequency band factors suggested by ICASA are tabulated below:

S.no.	From	To	Frequency factor
1	1 kHz	174 MHz	1
2	174 MHz	880 MHz	0.75
3	880 MHz	1.8 GHz	0.5
4	1.8 GHz	5 GHz	0.4
5	5 GHz	10 GHz	0.3
6	10 GHz	17 GHz	0.2
7	17 GHz	23 GHz	0.15
8	23 GHz	30 GHz	0.1
9	30 GHz	50 GHz	0.05

Here too, it is seen that 13/15 GHz are treated as a single category, with a factor of 1.33 over 18/21 GHz.

For E-band, radio spectrum fee is levied as the "minimum fees" per annum per link per hop based on 2 x250 MHz channel or multiples thereof, which is 196 ZAR per year from April 1, 2025.

Using above information, the price for a 28MHZ paired carrier in 6/17/13/15/18/21 GHz bands, 250 MHz paired carrier in E band and 50 MHz unpaired carrier in V-band, for high density metro without congestion, is tabulated below:

S.no.	Point-to-point link in band	Price/ year
1	6/ 7 GHz	R27,409
2	13/ 15 GHz	R18,273
3	18/ 21 GHz	R13,704
4	E band	R196 (minimum fixed fee)
5	V- band	License exempt low power usage

As can be seen:

- 6/7 GHz band is priced at approx. 1.5-2 times of 13/15/18/21 GHz bands, an average of which can be a factor of 1.75
- 13/15/18/21 GHz is priced at approx. 70 – 93 times of E-band, an average of which can be a factor of 82
- V- band is license exempt

v. Communications, Space and Technology Commission (CST), Saudi Arabia

The Saudi Arabia Communications, Space and Technology Commission (CST) uses the following official formula for microwave backhaul spectrum licensing fees (Council of Ministers Decision No. 632, dated 14 June 2022):

$$\textbf{Fee} = C \times B \times F \times S \times E$$

Where:

- C = 200 SAR (fixed management cost component)
- B = Bandwidth in MHz (transmitter frequency bandwidth)
- F = Frequency Band Factor (varies by frequency range)
- S = Frequency spectrum Service Factor (varies by amount of bandwidth and coverage area)
- E = Efficiency Factor = 1 (standard case)

As per the Guidelines for the Implementation of Frequency Licensing Fees Regulations 2023, the frequency band factors (F) are tabulated below:

S.no.	Frequency Band	Frequency Band Factor Value
1	Up to (230) MHz	250
2	Greater than (230) MHz up to (400) MHz	450
3	Greater than (400) MHz up to (470) MHz	600
4	Greater than (470) MHz up to (694) MHz	125
5	Greater than (694) MHz up to (960) MHz	30
6	Greater than (960) MHz up to (2200) MHz	15
7	Greater than (2,200) MHz up to (5,925) MHz	4
8	Greater than (5925) MHz up to (10000) MHz	2
9	Greater than (10) GHz up to (19.7) GHz	1
10	Greater than (19.7) GHz up to (30) GHz	0.5
11	Greater than (30) GHz up to (40) GHz	0.25
12	Greater than (40) GHz	0.1

As can be seen, 13/15/18 GHz bands are treated as a single category at a factor of 2 times of 21 GHz band.

The frequency spectrum service factor (S), dependent upon amount of total bandwidth used, is tabulated below:

S.no.	Bandwidth	BW Factor
1	Less than 50 MHz	0.4
2	>=50 MHz to < 100 MHz	0.25
3	>=100 MHz to < 200 MHz	0.15
4	>=200 MHz to < 500 MHz	0.1
5	>=500 MHz to <1000 MHz	0.05
6	>=1000 MHz to <2000 MHz	0.035
7	>=2000 MHz	0.02

Using above factors, the price for a 28MHZ paired carrier in 6/17/13/15/18/21 GHz bands, 250 MHz paired carrier in E band and 50 MHz unpaired carrier in V-band is tabulated below, for pan national (KSA) licenses:

S.no.	Point-to-point link in band	Price/ year
1	6/ 7Ghz	SAR 5600
2	13/ 15 GHz	SAR 2800
3	18 GHz	SAR 2800
4	21 GHz	SAR 1400
5	E band	SAR 500
6	V- band	SAR 250

As can be seen:

- 6/7 GHz band is priced at 2 - 4 times of 13/15/18/21 GHz bands, an average of which can be a factor of 2.5
- 13/15/18/21 GHz is priced at 2.8 - 5.6 times of E-band, an average of which can be a factor of 4.9
- V- band is priced at 0.5 times of E-band

vi. Innovation, Science and Economic Development (ISED), Canada:

As per Regulations of 2025, a simple formula is used for calculations:

Annual Fee (Duplex) = (Bandwidth × Base Rate) × 2

The base rates/ MHz, modulated for urban, rural and remote areas, are tabulated below:

S.no.	Frequency ranges and base rates for fixed point-to-point links			
	Frequency Range	Urban base rate ($/MHz)	Rural base rate ($/MHz)	Remote base rate ($/MHz)
1	890 MHz	2,750	2,200	1,375
2	>890 and 960 MHz	138	110.40	69.00
3	>960 and 4200 MHz	45	36.00	22.50
4	>4.2 and 8.5 GHz	32.75	27.20	17.00
5	>8.5 and 15.35 GHz	23.12	19.20	12.00
6	>15.35 and 24.25 GHz	15.42	12.80	8.00
7	>24.25 and 52.6 GHz	9.63	8.00	5.00
8	>52.6 and 92 GHz	0.50	0.40	0.25
9	>92	0.50	0.40	0.25

As can be seen, 13/15 GHz bands are treated as a single category priced at 1.6 times of 18/21 GHz, which are treated as a separate category. The ratio remains the same across the different types of areas viz. urban, rural and remote.

Using above factors, the price for a 28MHZ paired carrier in 6/17/13/15/18/21 GHz bands, 250 MHz paired carrier in E band and 50 MHz unpaired carrier in V-band, for urban deployments, is tabulated below:

S.no.	Point-to-point link in band	Price/ year
1	6/ 7 GHz	CAD 1834
2	13/ 15 GHz	CAD 1295

3	18/ 21 GHz	CAD 864
4	E band	CAD 250
5	V- band	CAD 25

As can be seen:

- 6/7 GHz band is priced at approx. 1.4-2.1 times of 13/15/18/21 GHz bands, an average of which can be a factor of 1.75
- 13/15/18/21 GHz is priced at approx. 3.45-5.18 times of E-band, an average of which can be a factor of 4.32.
- V- band is priced at 0.1 times of E-band

vii. Telecommunications and Digital Government Regulatory Authority (TDRA), UAE

As per Frequency Spectrum Fees Regulations Version 4.0 (Effective 1 January 2021), the following formula is applicable:

Frequency Fee (AED)= 1600 x FF x BW

Where:

- 1600 = Fixed multiplier constant
- FF = Frequency Factor (0.5 to 5 depending on frequency)
- BW = Bandwidth Factor (1 to 4 depending on total bandwidth)

As per above regulations, TDRA used frequency band factors for categories as given below:

S.no.	Point-to-point link in band	Frequency Factor
1	>= 0.03 GHz to <=3 GHz	5
2	>3 GHz to <=14 GHz	3
3	>14 GHz to <=48 GHz	2
4	>48 GHz to <=66 GHz	0.5
5	Above 66 GHz	1

Thus, TRDA treats 13 GHz band as a separate category, charging it at 1.5 times of 15/18/21 GHz

The bandwidth factor (BW) for different total bandwidths is tabulated below:

S.no.	Bandwidth	BW Factor
1	Less than 28 MHz	1
2	>=28 MHz to < 56 MHz	2
3	>=56 MHz to <= 112 MHz	3
4	More than 112 MHz	4

Using both frequency and bandwidth factors, the price for a 28MHZ paired carrier in 6/17/13/15/18/21 GHz bands, 250 MHz paired carrier in E band and 50 MHz unpaired carrier in V-band is tabulated below:

S.no.	Point-to-point link in band	Price/ year
1	6/ 7 GHz	AED 14,400
2	13 GHz	AED 14,400
3	15/ 18/ 21 GHz	AED 9600
4	E band	AED 6400
5	V- band	AED 1600

As can be seen:

- 6/7 GHz band is priced at approx. 1-1.5 times of 13/15/18/21 GHz bands, an average of which can be a factor of 1.38
- 13/15/18/21 GHz is priced approx. 1.5-2.25 times of E band, an average of which can be a factor of 1.69
- V- band is priced at 0.25 times of E-band

List of Acronyms

2G	Second Generation
3G	Third Generation
3GPP	3rd Generation Partnership Project
4G	Fourth Generation
5G	Fifth Generation
6G	Sixth Generation
ACMA	Australian Communications and Media Authority
AFC	Automated Frequency Coordination
AGR	Adjusted Gross Revenue
AI	Agenda Item
ASP	Access Service Provider
BSNL	Bharat Sanchar Nigam Limited
BTS	Base Transceiver Station
BWA	Broadband Wireless Access
CBDT	Central Board of Direct Taxes
CCA	Controller of Communication Accounts
CDMA	Code Division Multiple Access
CEPT	European Conference of Postal and Telecommunications Administrations
CII	Cost of Inflation index
CMTS	Cellular Mobile Telephone Service
CNPN	Captive Non-Public Network
CPE	Customer Premises Equipment
CST	Communications, Space & Technology Commission
dB	Decibel
dBi	Decibels relative to Isotropic
dBm	Decibel-milliwatts
DLC	Domestic Leased Circuit
DoT	Department of Telecommunications

DSNG	Digital Satellite News Gathering
EC	European Commission
ECC	Electronic Communications Committee
EESS	Earth-Exploration Satellite Service
EHF	Extremely High Frequency
EIRP	Effective Isotropic Radiated Power
ETSI	European Telecommunications Standards Institute
FBO	Facilities Based Operator
FCC	Federal Communications Commission
FDD	Frequency Division Duplexing
FDS	Field Disturbance Sensor
FLANE	Fixed Wireless Systems including Fixed LAN Extension
FSS	Fixed Satellite Service
FWA	Fixed Wireless Access
FY	Financial Year
Gbps	Gigabits per second
GHz	Giga Hertz
GSM	Global System for Mobile
GSMA	Global System for Mobile Communications Association
GURL-FRLD	General User Radio Licence for Fixed Radio Link Devices
HF	High Frequency
HITS	Headend In The Sky
IAB	Integrated Access & Backhaul
IBW	Instantaneous Bandwidth
ICASA	Independent Communications Authority of South Africa
ICT	Information and Communication Technology
IDA	Infocomm Development Authority
IEEE	Institute of Electrical and Electronics Engineers
IMT	International Mobile Telecommunications
IoT	Internet of Things
IP	Internet Protocol

ISED	Innovation, Science and Economic Development
ISP	Internet Service Provider
ISRO	Indian Space Research Organisation
ITS	Intelligent Transport System
ITU	International Telecommunication Union
ITU-R	ITU - Radiocommunication
ITU-RR	ITU - Radio Regulations
KHz	Kilo Hertz
KM	Kilometer
LF	Low Frequency
LIPD	Low Interference Potential Devices
LoS	Line of Sight
LPI	Low Power Indoor
LSA	Licensed Service Area
M2M	Machine to Machine
MCLR	Marginal Cost of Lending Rate
MetSat	Meteorological Satellite Service
MF	Medium Frequency
MGWS	Multiple Gigabit Wireless System
MHz	Mega Hertz
mmWave	Millimeter Wave
MSS	Mobile Satellite Service
MTNL	Mahanagar Telephone Nigam Limited
MW	Microwave
MWA	Microwave Access
MWB	Microwave Backbone
NFAP	National Frequency Allocation Plan
NFV	Network Function Virtualization
NLD	National Long Distance
NLDO	National Long Distance Operator
NLOS	Non Line of Sight

NR	New Radio
OBW	Occupied Bandwidth
OFC	Optical Fiber Cable
OFCOM	Office of Communications
OHD	Open House Discussion
OM	Office Memorandum
OOBE	Out Of Band Emission
O&M	Operation & Maintenance
POP	Point of Presence
PSD	Power Spectral Density
PSU	Public Sector Undertaking
PTP	Point to Point
QoS	Quality of Service
RF	Radio Frequency
RLAN	Radio Local Area Networks
RoC	Return on Capital
ROCE	Return on Capital Employed
RoW	Right of Way
SBI PLR	State Bank of India - Prime Lending Rate
SBO	Services Based Operator
SDH	Synchronous Digital Hierarchy
SDN	Software-Defined Networking
SD-WAN	Software-Defined Wide Area Network
SHF	Super High Frequency
SLA	Service Level Agreement
SRD	Short Range Device
SRS	Space Research Service
STM-1	Synchronous Transport Module level-1
STM-4	Synchronous Transport Module level-4
SUC	Spectrum Usage Charge
TDD	Time Division Duplexing

TDRA	Telecommunications and Digital Government Regulatory Authority
TEC	Telecommunication Engineering Centre
THz	Terra Hertz
TRAI	Telecom Regulatory Authority of India
TSP	Telecom Service Provider
TTO	Telecommunication Tariff Order
UAE	United Arab Emirates
UASL	Unified Access Service License
UBR	Unlicensed Band Radio
UHF	Ultra High Frequency
UK	United Kingdom
UL	Unified License
USA	United States of America
VHF	Very High Frequency
VLF	Very Low Frequency
VLP	Very Low Power
VSAT	Very Small Aperture Terminal
WAS	Wireless Access System
Wi-Fi	Wireless Fidelity
WiGig	Wireless Gigabit
WLAN	Wireless Local Area Network
WPAN	Wireless Personal Area Network
WPC	Wireless Planning & Coordination
WRC	World Radiocommunication Conference