TRAI Consultation Paper on 37-37.5 GHz, 37.5-40 GHz, and 42.5-43.5 GHz bands

Contribution by:

Ayush Sharma
MBA (Digital & Telecom)
Symbiosis Institute of Digital and Telecom Management, Pune
Email ID: ayush.sharma2224@sidtm.edu.in

Yashwanth Vankadara
MBA (Digital & Telecom)
Symbiosis Institute of Digital and Telecom Management, Pune
Email ID: yashwanth.vankadara2224@sidtm.edu.in

Under the guidance of
Prof. Giri Gundu Hallur,
Associate Professor,
Symbiosis Institute of Digital and Telecom Management, Pune
Email ID: girihallur@sidtm.edu.in

About the Institute

SIDTM, in its 27th year of existence, is a constituent of Symbiosis International University, is the first institute to offer management training in digital, telecommunications, and information technology. It is a unique curriculum that combines Digital & Telecom Technology with Management, and it was founded in 1996; by the honorable Dr. S.B. Mujumdar sir (Chancellor of SIU), who took a bold stride forward. In the entire SAARC area, SIDTM is the premier institution for MBA in Digital and Telecom programs, with ranks of Best Telecom B-School in the specialty sector.

SIDTM is dedicated to training world-class ICT Business Leaders who can successfully manage the dynamic and ever-changing technical and business paradigms with ease and expertise. SIDTM helps attract brighter minds by providing them with opportunities for healthy growth throughout time, resulting in well-disciplined and optimistic Techno managers. Technology affects all business models, so SITDM is becoming more relevant and will become an institute of great importance in the future.

Acknowledgements

Symbiosis Institute of Digital and Telecom Management (SIDTM) would like to express sincere gratitude to the Telecom Regulatory Authority of India, for addressing the Auction of Frequency Spectrum in 37-37.5 GHz, 37.5-40 GHz, and 42.5-43.5 GHz bands Identified for IMT.

Combined with the young talent that SIDTM fosters, and the academic expertise held at the institute, we would like to put forth our comments on the matter at hand. The rest of the paper discusses the same.

Issues for Consultation

Q1. Whether the entire available spectrum in each of the frequency ranges (a) 37-37.5 GHz, (b) 37.5-40 GHz, and (c) 42.5-43.5 GHz should be put to auction for IMT? If no, please specify the quantum of spectrum in each frequency range to be put to auction. Kindly justify your response.

Response:

It is our recommendation that the entire bandwidth that aggregates to 4000MHz be auctioned for IMT deployment. With reference to Chapter 3, clause 5.149 of NFAP 2022, since the 42.5GHz to 43.5GHz band belongs also to the Radio Astronomy division, it is also advised that TRAI, along with SACFA should ensure clearance for radio allocation should be stringent and involves the implementation of appropriate isolation distance and field visits during survey procedures. There are 7-8 Radio Astronomy centers in India and all of them would need to ensure that proper radio isolation should be kept to ensure that interference effects between the systems is kept minimal.

Q2. In case you are of the opinion that any of the frequency ranges viz. 37-37.5 GHz, 37.5-40 GHz, and 42.5-43.5 GHz should be put to auction at a later date, what should be the timelines for auctioning of such frequency bands for IMT? Kindly justify your response.

Response:

It is our recommendation that the ideal timelines for the auction of the suggested spectrum be held in FY2025-26 or FY2026-27. Also, due to the upcoming auction, dated May 20, 2024, it will allow the telecom companies, to have a breathing space, and build up their equity capital requirements. This will allow for a healthier allocation of spectrum, without impacting capex requirements of the telcos and will also be in alignment with the objective of TRAI and DoT. Also, in accordance with Chapter 2, clause 17 of the consultation paper, the unavailability of the appropriate equipment in the n259 band, will deem it necessary to allow for the maturity of the ecosystem for creating equipment and suitable use cases.

Q3. Do you agree that TDD-based duplexing configuration should be adopted in the country for the frequency ranges under consideration viz. (a) 37 - 37.5 GHz, (b) 37.5 - 40 GHz, and (c) 42.5 - 43.5 GHz, for IMT? If yes, considering that there is an overlap of frequencies in the band plans n260 (37-40 GHz) and n259 (39.5-43.5 GHz), how should the band plan(s) along with its frequency range be adopted? Kindly justify your response

Response:

In our opinion, yes, TDD-based duplexing configuration should be adopted for the frequency bands under consideration. By using a similar NR slot format being used in 5G, the adoption of

dynamic TDD with various numerologies, will boost the ecosystem that is needed to develop products and services that can leverage the frequency bands under consideration. To ensure that the probability of overlap of frequencies is minimal, it is advised to consider enabling contiguous block allocation of frequencies, similar to the enablement during the auction of 2022, where band swapping was allowed by TRAI and DoT. This will also boost the consideration for contiguous block allocation between the telecom service providers so that they can reduce the overheads caused due to the deployment of guard bands and/or guard spaces. To ensure the isolation of frequencies with Radio Astronomy services, the appropriate isolation recommendations as mentioned in ITU-R sharing studies and IMT-2020 standardization, protection from Radio Astronomy would be a separation distance of 9-70kms for Base Stations, and 5-27kms for User Equipment [1].

Footnote:

[1] Nikolai Vassiliev, ITU-R sharing studies and IMT-2020 standardization the 26-28 GHz India 5G Spectrum Workshop 28 September 2018, New Delhi, India.

Q4. Whether the spectrum in the frequency ranges under consideration viz. (a) 37-37.5 GHz, (b) 37.5-40 GHz, and (c) 42.5-43.5 GHz should be assigned for a validity period of 20 years, as prevalent in the existing frequency bands, or for a shorter validity period? In case you are of the opinion that a shorter validity period should be adopted, please suggest the validity period? Kindly provide your response with detailed justifications.

Response:

It is our recommendation that, due to the current maturity of the ecosystem and trends expected in the near future, we consider a validity period of 10 years or 15 years. By recommending a 10-year initial validity period, it will be possible to achieve accelerated maturity of the ecosystem, with more use cases being created and experimented with. Post-completion of the initial validity period, a follow-up procedure can be devised, where the maturity of the technology is evaluated and validated against the need for the spectrum. This will then facilitate a follow-up auction, with more spectrum bands being available for auction. One such method to achieve healthy participation is to auction the total available spectrum, with the constraints being the following

- Roll Out Obligations would be eased due to the assumption that the spectrum range under consideration, will not be majorly for commercial roll-out of services, but rather captive networks.
- For the initial allocation period, TSPs would be encouraged to boost the maturity of the ecosystem, where the corresponding products and services would be developed and experimented with.
- Accurate monetization models would be created so as to ensure, the ecosystem would not be capex or opex intensive, since it would convert into tariff hike for consumers

Q5. Whether the spectrum in (a) 37-37.5 GHz, (b) 37.5-40 GHz, and (c) 42.5-43.5 GHz frequency ranges should be assigned for the existing licensed service areas (LSAs) for Access Service (i.e. Telecom Circles/ Metros), or it should be assigned for smaller service areas? In case you are of the opinion that the spectrum in these bands should be assigned for smaller service areas, please suggest the criteria for defining such service areas? Kindly provide your response with detailed justifications.

Response:

It is our opinion that, if the roll-out obligations would be relaxed for the deployment of technology involving the spectrum under consideration, the current LSA parameters, would still be applicable and there would be no need to design smaller service areas. Since the spectrum under consideration will mostly be deployed for captive private networks, that enable hyperlocal automation and relevant use cases, commercial deployment of services across the LSA would be capex and opex intensive and without proper monetization models, it will be difficult for the ecosystem to flourish. In correspondence with the propagation characteristics of the spectrum under consideration, it would compel the TSPs to invest in greater capex where proper business use cases would be counter-productive to the industry. Instead, roll-out obligations should consider regions where deployment is practical and appealed for, based on which the roll-out obligations would consider only those regions, and devise a roll-out plan for minimum roll-out obligation criteria based on these newly obtained parameters.

If we wish to consider smaller service areas, as an option for spectrum auction, then the following parameters should be considered:

- Existing LSAs should be further broken down into Hotspot Zones, and only for these hotspot zones deployments of technology be permitted and eventually restricted to
- Integration of requirements with government initiatives of smart cities, identified across the country, where pilot tests can be done for commercial deployment, following the results of which, a full-fledged deployment on a massive scale can be designed
- Fastrack lane for approvals for deployment of this technology for SEZs, ports, railway stations, airports, etc.

Q6. What should be the block size, and the minimum quantity for bidding in (a) 37-37.5 GHz, (b) 37.5-40 GHz, and (c) 42.5- 43.5 GHz frequency ranges? Kindly justify your response

Response:

The total quantum of spectrum available for auction is around 4000MHz. Since the number of participants in the auction would be low, it is our recommendation that a block size of 100MHz be considered. This will allow for better allocation of spectrum, which in turn can create more sub-channels, using the appropriate subchannel spacing, can result in delivering high precision and highly effective services that are dependent on good bandwidth requirements.

Total Available Spectrum = 4000MHz
Block Size = 100MHz
SCS = 120KHz or 240KHz
Total Blocks available = 4000MHz / 200MHz = 40 blocks
Recommended spectrum cap = 40%
Maximum applicable blocks per telecom service provider = 16 blocks
Total number of players = 4
Maximum possible blocks per player = 10
Proposed minimum blocks = 2 blocks, i.e., 400MHz
Usable bandwidth (per block) = 100MHz
Sub-Carrier Spacing Channel = 2 scenarios
Scenario - 1: 120KHz
Available subcarriers = (usable-bandwidth)/(subcarrier spacing)
Usable bandwidth = 90% of available bandwidth considering 10% in guard space = 90MHz
Available subcarriers = 90MHz / 120KHz
Available subcarriers = 750 (approximately)
Scenario - 2: 240KHz
Available subcarriers = 90MHz / 240KHz
Available subcarriers = 375 (approximately)

Since one block of 100MHz can produce this much number of subcarriers, when 2 blocks are taken, the number of subcarriers approximately doubles in value, each with a good bitrate as per the modulation scheme. This allows the creation of multiple use cases and services that cater to the requirements of QoS.

Since this spectrum band under consideration is being auctioned for the first time, by definition mentioned in NIA 2024, all participants in the auction would be considered New Entrants. Taking this into account, it is our recommendation that for Existing Licensee and New Entrants, a minimum bidding quantity of 2 blocks of 100MHz quantity for auction bidding.

A Cap of 40% on the total spectrum holding in the spectrum band under consideration band including existing spectrum holding of TSPs

Q7. What provisions with respect to the spectrum cap per service provider in a licensed service area (LSA) should be made applicable for the frequency ranges under consideration viz. (i) 37-37.5 GHz, (ii) 37.5-40 GHz, and (iii) 42.5-43.5 GHz for IMT? Specifically, - (a) Whether there is a case for a combined spectrum cap for the 26 GHz band (24.25-27.5 GHz) and the frequency ranges under consideration? If yes, what should be the spectrum cap? Kindly justify your response. (b) In case your response to (a) above is in the negative, whether spectrum cap should be prescribed separately for each frequency range viz. (i) 37-37.5 GHz, (ii) 37.5- 40 GHz, and (iii) 42.5-43.5 GHz or these frequency ranges should be combined for applicability of spectrum cap? What should be the spectrum cap(s)? Kindly justify your response

Response

A Cap of 40% on the total spectrum holding in the spectrum band under consideration including existing spectrum holding of TSPs.

Q8. What should be the roll-out obligations for the assignment of spectrum in (a) 37-37.5 GHz, (b) 37.5-40 GHz, and (c) 42.5-43.5 GHz frequency bands for IMT? Kindly justify your response.

Response:

The roll-out obligations for the spectrum under consideration should be similar to that of 26GHz, as recommended by NIA 2023-2024, provided the definition of licensed service areas is not changed. But, due to the nature of the spectrum under consideration, it is possible to be deployed majorly to create captive networks, to enable use cases such as hyper-automation. Due to this, commercial deployment of this technology across the LSA would be far-fetched. Instead, it is advisable to relax the roll-out obligations for the deployment of this technology to a considerable extent, so as to ensure no capex and opex burden on the TSPs. One such methodology is described below

- Identify the regions where the spectrum would be deployed
- Calculate the number of sites needed to cover the region/area
- Declare this zone as a hotspot zone
- Roll-out obligations would be designed for these sites alone
- Audit for the conformity to the roll-out obligation can be either through self-declaration or though drive tests.

Q9. Whether the eligibility conditions and associated eligibility conditions for participation in the auction for 37-37.5 GHz, 37.5-40 GHz, and 42.5-43.5 GHz should be kept analogous to the eligibility conditions and associated eligibility conditions for participation in the auction for spectrum for IMT, as defined in NIA 2024? In case your response is in the negative, suggestions may kindly be made with detailed justification.

Response:

It is our recommendation that the current eligibility criteria and associated eligibility criteria that exist for current LSAs and bands, can be extended for the spectrum under consideration, which the conditionality that roll-out obligations would be relaxed. In correspondence with NIA 2024, the eligibility criteria mention granting of a Unified License for various LSA and the definition of new entrants is clear. The same eligibility criteria can be used for the auction of the spectrum under consideration.

Additionally, it is equally important to address the second player in the digital communication space, i.e., satellite communication service providers, aka, SatComm players. As of today, for spectrum allocation, for mobile and terrestrial networks, spectrum is disbursed through an auction process, whereas for SatComm it is through administrative allocation. But, with the recent developments to use Low Earth Orbit for terrestrial and satellite networks, spectrum allocation would reach an impasse. It would need special provisions that need to be included in the way Unified License would be granted to the corresponding stakeholders thereby increasing the number of players. It would also need to consider TSPs that have a SatComm division, such as Bharti Airtel, TSP, owns OneWeb, a SatComm provider.

Q10. To mitigate inter-operator interference due to TDD-based configuration, whether the approach adopted for 3300- 3670 MHz and 26 GHz bands should also be made applicable for the frequency ranges under consideration viz. 37-37.5 GHz, 37.5-40 GHz, and 42.5-43.5 GHz, or some other provisions need to be created? In case you are of the opinion that some other provisions are required to be created, suggestions may be made with detailed justification.

Response:

We resonate with the findings of ‘Auction of spectrum in frequency bands identified for IMT/5G’ dated 11.04.222, which mentions contiguous block allocation and implementing dynamic TDD frame structure, similar to the NR frame structure under various numerologies.

Dynamic TDD would be more effective for indoor network deployment, where there is sufficient frequency isolation due to the four walls where the technology would be deployed. For isolation in outdoor networks, it would need stronger and effective guard bands and synchronizing of internetwork border frequencies, a comparatively difficult task. One method to ensure that the probability of adjacent frequencies of different TSPs doesn't cause destructive interference is to assign weights to the frequencies allocated in alpha, beta, and gamma of the gNB. If the

distance between the operating frequencies is significantly higher than each other, then the burden of adjacent frequencies will be minimized.

Q11. Whether there could be any challenges in sharing of 37.5- 40 GHz and 42.5-43.5 GHz spectrum frequency ranges between IMT and Satellite Gateway links? If yes, what challenges do you foresee and what measures could be adopted to mitigate such challenges? Kindly justify your response.

Response:

Yes, there are challenges regarding the sharing of spectrum under consideration between IMT and Satellite Gateway Links. With regard to satellite gateway links, to ensure the isolation of frequencies with Radio Astronomy services, the appropriate isolation recommendations as mentioned in ITU-R sharing studies and IMT-2020 standardization, protection from Radio Astronomy would be a separation distance of 9-70kms for Base Stations, and 5-27kms for User Equipment. This input is taken from a presentation given by Nikolai Vassiliev, ITU-R sharing studies and IMT-2020 standardization The 26-28 GHz India 5G Spectrum Workshop 28 September 2018, New Delhi, India. Keeping this consideration as primary justification, it is recommended that, in the vicinity of such Fixed Satellite Service Earth Stations, it would be more logical to make use of FWA mode of delivery, combined with the transportation capability of Optic Fiber for information exchange. This allows for the creation of equipment, namely routers, that cater to the higher frequency range, and since they will be deployed indoors, it is subject to attenuation, due to the inherent nature of the surroundings, the probability of interference with the uplink/downlink satellite is thus reduced and it gives scope for implementation of use cases with the spectrum under consideration. Another restriction could be to use mobile devices that are to be configured up to the frequencies of the lower band of 5G, where the interference ratio is subjectively lower, and already has solutions in place to ensure no distortion between the two technologies.

Q12. In case it is decided to share (i) 37.5-40 GHz, and (ii) 42.5- 43.5 GHz spectrum frequency ranges between IMT and Satellite Gateway links, - (i) Whether there is a need to prescribe a protection/ keep-off distance between IMT stations and Satellite Earth Station Gateways? If yes, what should be the protection distance? (ii) What other parameters should be prescribed for the coexistence of IMT and Satellite Gateway links? Suggestions may kindly be made with detailed justification.

Response:

In case of such an event, where there is a frequency sharing between IMT and Satellite Gateway Links, it is recommended that the isolation distance should be as prescribed by ITU-R sharing studies and IMT-2020 standardization, protection from Radio Astronomy would be a separation distance of 9-70kms for Base Stations, and 5-27kms for User Equipment[1]. This input is taken from a presentation given by This can be recalibrated to calculate the minimum safe distance for the spectrum under consideration since the above values are made with the

assumption of up to 27.5GHz. It is also advised that in such regions, IMT advances in Optic Fiber-based communication and extends the technology of FTTx, combined with FWA.

Interference happens when two signals, operating at the same frequency, distort each other when they are in different directions, or not at quadrature with each other. FSS communication, by inherent structure, needs a lot of air interface, which eventually defines the Satellite Earth Station Gateways. Due to the latest and efficient advancements in Terrestrial and Mobile Networks, a convergence between the two networks already exists and is implemented in various use cases. Around the vicinity of the Earth Station Gateways, if IMT networks adopt FTTx technology, and reduce the radius of air interface to indoor networks alone, then, there would be effective spectrum sharing between the two players. Under the assumption that the spectrum under consideration would be majorly used for captive indoor networks, it would be logical to deduce that, if FWA transceivers would deploy such frequency within the four walls where it is needed, and from there, the rest of the communication through optic fiber would be, effective to ensure proper radio isolation.

Footnote:

[1] Nikolai Vassiliev, ITU-R sharing studies and IMT-2020 standardization The 26-28 GHz India 5G Spectrum Workshop 28 September 2018, New Delhi, India.

Q13. Whether the value of spectrum in 37–37.5 GHz, 37.5–40 GHz and 42.5–43.5 GHz spectrum bands be derived by relating it to the auction determined price/value of spectrum in any other band by using spectral efficiency factor? If yes, with which spectrum band, should these bands be related and what efficiency factor or formula should be used? Please justify your suggestions.

Q14. Should international spectrum prices i.e. the auction determined price/ reserve price of other countries in 37 – 37.5 GHz, 37.5 – 40 GHz and 42.5 – 43.5 GHz spectrum bands serve as a basis for the purpose of valuation of these bands? If yes, what methodology can be followed in this regard? Please provide detailed information.

Q18. What ratio should be adopted between the reserve price for the auction and the valuation of the spectrum in these spectrum bands and why? Please support your answer with detailed justification.

Response:

Peak spectral efficiency is determined by the highest throughput a technology can deliver in a given amount of spectrum, occurring with the highest-order modulation scheme available and the least amount of coding. [1] . Given the propagation characteristics of high C-band frequencies such as 37-42 GHz, the most efficient use of cellular spectrum would be to deploy small cells everywhere, but the cost of doing so becomes extremely high since each small cell needs a physical location with mounting, power, and most significantly, backhaul to the core network [3]. Hence, a need to include the cost of deployment as one of the factors. This factor was the basis of the FCC’s recommendation of bps/Hz/sq.km. as the metric for Personal

Communications Systems, which takes into account both spectral efficiency (bps/Hz) and deployment density,

The value of 37–37.5 GHz, 37.5–40 GHz, and 42.5–43.5 GHz can be compared to 26-28 GHz as the propagation characteristics and availability of equipment are more or less similar. Most of the developed countries have auctioned 26 GHz but except for the USA, none have auctioned the 37-42 GHz range of spectrum and hence cross-comparative analysis of 2GHz vs 37-42 GHz cannot be done.

The following table shows the final auction prices in terms of $ per MHz-POP for the USA

$ per MHz-POP- 28 GHz	$ per MHz-POP-24 GHz	$ per MHz-POP-37.6–38.6 GHz, 38.6–40 GHz) and 47.2–48.2 GHz	Ratio of 37-42 GHz to 28 GHz	Ratio of 37 GHz to 24 GHz
0.0113	0.009112	0.00711	0.62920354	0.780289728

So, it can be seen that the auction price realized for 37-42 GHz was 38% and 22% lower as compared to 28GHz and 24 GHz respectively. It is also important to note that the number of bidders also was 35 and eventually 28 bidders won licenses. The US telecom market is an active secondary spectrum trading one and hence offers a chance for bidders to exit the market through the secondary sale of spectrum which explains the competitive bidding by bidders. Moreover, UK's Ofcom issued a consultation paper in November 2023 in which they have provisionally considered that reserve prices of £1m for a 100 MHz lot in 26 GHz (both 26 GHz lower and 26 GHz upper) and £0.5m for a 100 MHz lot in 40 GHz would be appropriate, adding that the lower reserve price for 40 GHz lots reflects the less developed ecosystem compared to 26 GHz.

In the case of India, although we have allowed Spectrum Trading, the secondary trading market is not as active as that of the US. DoT has sent show-cause notices to two of the four private players for non-fulfillment of the roll-out obligations for 26 GHz. This shows that deployment of 26 GHz has also not been done in a comprehensive way. This may create a subdued demand for 37-42 GHz.

Considering all these factors, we suggest the reserve price/block of 37-42 GHz can be estimated to be 50% of that of the reserve price/block of 26 GHz spectrum auction in the 2022 auction.

Footnote:

[2] P. Rysavy, "Challenges and Considerations in Defining Spectrum Efficiency," in *Proceedings of the IEEE*, vol. 102, no. 3, pp. 386-392, March 2014, doi: 10.1109/JPROC.2014.2301637. keywords: {Radio spectrum management;Modulation;Wireless communication;TV;Encoding;FCC;Throughput;Efficient use of spectrum;spectral efficiency;spectrum},

[3] Federal Communications Commission Technological Advisory Council, Sharing Work Group, "Spectrum Efficiency Metrics," Sep. 2011 .

Q15. Apart from the approaches highlighted above, which other valuation approaches should be adopted for the valuation of 37 – 37.5 GHz, 37.5 – 40 GHz and 42.5 – 43.5 GHz spectrum bands? Please support your suggestions with detailed methodology, related assumptions and other relevant factors, etc.
Q16. Whether the value arrived at by using any single valuation approach for a particular spectrum band should be taken as the appropriate value of that band? If yes, please suggest which single approach/ method should be used. Please support your answer with detailed justification.

Response:

The review of valuation methods used by FCC and OfCom shows that the valuation of the 37-42 GHz spectrum has been derived as a proportion of the valuation of the 26GHz band. The TRAI in its recommendations submitted to DoT before the 2022 auction had presented a detailed valuation process after which the reserve prices were finalized. So, we suggest that the valuation of the 37-42 GHz band can be set at a proportion of that of 26GHz.

Q17. In case your response to the above question is negative, will it be appropriate to take the average valuation (simple mean) of the valuations obtained through the different approaches attempted for valuation of a particular spectrum band, or some other approach like taking weighted mean etc. should be followed? Please support your answer with detailed justification.
Response: NA

Q19. What should the payment terms and associated conditions for the assignment of 37 – 37.5 GHz, 37.5 – 40 GHz and 42.5 – 43.5 GHz spectrum bands relating to: i. Upfront payment ii. Moratorium period iii. Total number of installments to recover deferred payments iv. Rate of discount in respect of deferred payment and prepayment Please support your answer with detailed justification.

Response:

The payment terms should be in line with the ones mentioned in the NIA for Spectrum Auction 2023-24. In the case, that the licensing period changes for the spectrum bands under consideration, then the payment terms suggested in NIA 2023-24 should be revised accordingly.

Q20. Any other suggestion relevant to the subject may be submitted with detailed justification.

Response:

Under the current circumstances and the maturity of Terrestrial and Mobile Networks, it is significant to understand the nuances that arise due to the potential use cases for IMT and Satellite Networks, especially in the emerging Low Earth Orbit. Due to the characteristics of the orbit, it provides numerous use cases that can be deployed either by TSPs or by SatComm players in the country. Some aspects to consider are

- Frequency allocation
- Radio Isolation
- Licensing requirements

Frequency Allocation: It is already established that frequency overlap is a potential threat, between TSPs and SatComm players. As of today, Frequency allocation to TSP is given via auction procedure, where as to SatComm players, it is through Administrative Allocation. It could raise a conflict of interest where the same frequency has multiple modes of allocation.

Radio Isolation: To ensure that signal distortion is minimal between the two technologies, it is important to determine and implement proper radio isolation between the two. Interference happens when two signals, operating at the same frequency, distort each other when they are in different directions, or not at quadrature with each other. FSS communication, by inherent structure, needs a lot of air interface, which eventually defines the Satellite Earth Station Gateways. Due to the latest and efficient advancements in Terrestrial and Mobile Networks, a convergence between the two networks already exists and is implemented in various use cases. Around the vicinity of the Earth Station Gateways, if IMT networks adopt FTTx technology, and reduce the radius of air interface to indoor networks alone, then, there would be effective spectrum sharing between the two players. Under the assumption that the spectrum under consideration would be majorly used for captive indoor networks, it would be logical to deduce that, if FWA transceivers would deploy such frequency within the four walls where it is needed, and from there, the rest of the communication through optic fiber would be, effective to ensure proper radio isolation.

Licensing Requirements: If spectrum sharing is considered, then the way licensing is given for TSPs and SatComm will be impacted as well. It is advised to streamline the definition of a Unified License and who is eligible for such licenses.