Consultation Paper No 1/2011

TELECOM REGULATORY AUTHORITY OF INDIA

Consultation Paper

On

Issues related to

Telecommunications Infrastructure policy

14th January, 2011

Mahanagar Doorsanchar Bhawan

Jawahar Lal Nehru Marg

New Delhi-110002

Preface

Modern lifestyle afforded by technological developments is enhancing demand for wireless voice and data services. Service providers are expected to expand their existing networks and also create new network infrastructure for 3G and Broadband Wireless Access. A robust telecom infrastructure is indispensable for providing reliable services to the consumers. Though India has seen growth in all the constituents of the telecom infrastructure – fixed, mobile and broadband, the path has not been without its share of problems. While many infrastructure related issues have been dealt with by TRAI in the past, there are issues related to design, standardisation, aesthetics, pollution, safety and sharing of telecom tower infrastructure that remain to be addressed.

In this context TRAI had issued a pre-consultation paper in February, 2010 and several issues have been identified. Based thereon, this consultation paper has been prepared raising specific issues for consideration of stakeholders, so as to enable the Authority to take further action.

Written comments on the issues raised in this consultation paper are invited from the stakeholders by 31st January, 2011 and counter-comments on the comments by 7th February, 2011. The comments and counter-comments may be sent, preferably in electronic form, to Mr Lav Gupta, Principal Advisor (TD) on the e-mail address: tdra@trai.gov.in or tdra.trai@gmail.com. The fax number of TRAI is 011-23230056. Comments and counter comments will be posted on the TRAI's website.

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Chairman, TRAI

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INTRODUCTION

1. Telecommunications has been recognised the world-over as an important tool for socio-economic development for a nation. It is one of the prime support services needed for rapid growth and modernization of various sectors of the economy. Apart from the direct contribution that the development of such infrastructure may have on an aggregate output, investments in these technologies are expected to have pervasive effects throughout the economy. Several authors (e.g. Saunders et al. 1983, 1994[1]; Leff, 1984[2]; Norton, 1992[3], Roller & Waverman 2001[4], Sridhar, Kala Seetharam and Varadarajan, Sridhar 2004[5]) have outlined the role of telecommunications in reducing transaction costs, improving the functioning of organizations and enhancing the efficiency of other factors of development. Communications is used not only for personal interactions and businesses but also in critical applications like public health, traffic control, electricity distribution and other public services where any breakdown of communication infrastructure could lead to catastrophic consequences. This calls for a robust and reliable telecommunications infrastructure to be in place.

2. It is argued by many that the development of a modern nation, to its full potential, in the contemporary world can never be attained without adequate telecommunications infrastructure. What telecom is to economy

[1] Saunders, R.J. Warford, J.J., Wellenius, B. (1994). Telecommunication and Economic Development. Johns Hopkins University Press, Baltimore

[2] Nathaniel H. Leff*, Social benefit-cost analysis and telecommunications investment in developing countries Columbia University, New York

[3] Norton. S. W (1992) "Transaction Costs, Telecommunications and the Microeconomics of Macro Economies Growth", Washington University

[4] Roller.,L. and L.Waverman 2001. Telecommunications Infrastructure and Economic Development: A simultaneous Approach. American Economic Review

[5] Sridhar, Kala Seetharam and Sridhar, Varadarajan.2004.Telecommunications Infrastructure and Economic Growth: Evidence from Developing Countries. http://ideas.repec.org/p/ind/nipfwp/14.html

telecom infrastructure is to telecom services. Adequate infrastructure becomes the bedrock for reliable telecom services. Telecom service providers have always faced the challenge of matching their technology and infrastructure to the customers' demand cycles. In the past, this was easier as the project lifecycles and the capital cycles of the telecom services was long and the corresponding services evolved over a long period of time. Now, the service demand cycles have shortened and long infrastructure cycles would result in missing of opportunities and loss of potential revenue. Data services such as video calling, mobile banking and mobile entertainment are expected to take off in a major way in the year 2011. Mobile operators, device makers, application developers and equipment vendors are all gearing up towards making the entire ecosystem ready to meet consumer expectations from the third generation (3G) and BWA technologies. Several countries are pledging investment in the new telecom infrastructure. In the US for example, the economic stimulus supported Broadband Technology Opportunities Program allocates a major share of its budget to fund broadband-related projects in unserved and underserved areas, including for the requisite infrastructure.

3. In the pre-reform monopoly era, the pace of network roll-out was slow. There were non-competitive equipment procurement procedures, sub-optimal quality of service delivery, weak infrastructure base and huge unmet demand. At that time, the teledensity was below 1%. It took 25 years after independence to reach the first one million mark; today, we add over 15 million phones a month. In the early decades of planned development of India, investment in telecommunications as a percentage of GDP was low. In the first six five-year Plans since 1950, investment hovered between 1.4 and 2.7 percent of the Gross Domestic Product (GDP). The total combined investment in all the six plans was less than Rs 4900 crore while in the VII plan (1985-90) alone, a little more than Rs. 8000 crore was allocated.

4. Along with the liberalisation of the Telecom sector, there has been a clear recognition at the Government level of the criticality of provision of world class telecommunications infrastructure not only for the development of the ICT industry but also has widespread ramifications on the entire economy of the country. The NTP-99, inter-alia, aims at creating "*a modern and efficient telecommunications infrastructure taking into account the convergence of IT, media, telecom and consumer electronics and thereby propel India into becoming an IT superpower*".

5. All the investment that has been made in the last decade for creating infrastructure has provided a forward momentum for growth. Though, for the last few years, the growth has been led by wireless telephony there has been all-round development in the telecommunications infrastructure. The switching capacity, the domestic and long distance network, Internet and Broadband Network, and the mobile network have all grown. In the fixed networks the total equipped switching capacity as on 31st Dec 2006 was about 58 million and in March 2010, 79 million. The mobile networks have experienced a dramatic growth since their inception in 1995. When the 4th licences for mobile services were given in September 2001, there were approximately 4.80 million mobile subscribers and the geographical coverage of mobile services at that time was low. The number of mobile subscribers grew by over 1000% during the period March 2005 to March 2010 (i.e. from 52.22 Million to 584.32 Million). The share of mobile phones out of total telephone connections has increased from 44.02% percent at the end of March 2004 to 95.23% at the end of October 2010. The wireless connections are growing at a compound annual growth rate (CAGR) of 60% per annum since 2000. This has resulted in increased infrastructure requirement as can be seen from the growing numbers of some of the important elements of the mobile network. The mobile switching centres (MSC) were 613 in March 2007 and have grown to 1234 by September 2010. The number of BTSs have shown considerable increase growing from 72,550

in March 2006 to 5,60,276 in September 2010. In the long distance network, the TAX capacity of BSNL was 6.9 million ports in December 2006 which increased to 9.14 million by September 2010. The Intelligent Services platforms for offering services like freephone, televoting and virtual calling cards have been installed by most service providers in the last 5 years. The backbone networks for carrying IP traffic of Internet, broadband and other data services have also come up in the last 5 years. In the ongoing XI five-year plan (2007 –2012), an investment of ~ Rs. 2,67,001 crore has been projected amounting to 13.2% sectoral share. About 68.7% of this investment is to come from the private sector.

6. The right type and amount of telecom infrastructure is necessary for providing a variety and quality of telecommunication services required and expected by the customers. Lack of infrastructure can cripple all efforts towards providing a reliable, high quality world-class telecom services to the citizens of the country. At the same time, concerns of the citizens as well as the service providers need to be factored in. Besides timely availability of affordable telecom services, there could be concerns about security of and safety afforded by the telecom infrastructure. In coping with demands for new services, the service providers would have concerns about mandatory clearances, certifications, right of way issues, funds for infrastructure creation and regulatory certainty. A sound telecommunications infrastructure development policy is therefore indispensable for all-round growth of any country.

7. This consultation paper has been issued by TRAI, *suo-motu,* to evolve a policy on all the infrastructure related issues including the unaddressed issues relating to tower infrastructure. Chapter I classifies the telecom infrastructure for ease of description and briefly describes the telecom infrastructure and narrates the related initiatives carried out by TRAI and

their current status. Chapter II covers the issue of setting up of Internet Exchange Points. Chapter III deals with the need for revised recommendations regarding Mobile Virtual Network Operators. Chapter IV Deals with various aspects of Telecom towers and Chapter V with issues relating migration to Rural Telephony, IPv6 and IPTV. Finally, Chapter VI gives the summary of the issues for consultation before the Authority makes appropriate recommendations to the Government.

CHAPTER I

OVERVIEW OF TELECOM INFRASTRUCTURE AND PAST REGULATORY INITIATIVES

1.1 In general terms, telecommunications infrastructure includes the organisations, personnel, procedures, facilities, and networks employed to transmit and receive information by electrical or electronic means[6]. We would focus in this consultation paper on telecommunications networks and facilities that include the public switched telephone network – fixed and mobile, copper and optical fibre cables, broadband network – access and backbone and the long distance network. There are many ways to classify the telecom infrastructure. One may use the traditional way of classifying the infrastructure into local area and long distance networks or wireless and wireline networks. Another way would be to study the infrastructure as being part of the access or the core network. Alternatively, considering the emergence of Internet Protocol based infrastructure, one can discuss Time Division Multiplexing (TDM) and Internet Protocol (IP) networks separately. Yet another way of doing it would be to look at narrowband and broadband networks. In our context, to be able to maintain a continuum with the work already carried out in the past and focus on issues that are relevant to the future growth of infrastructure, we would classify the infrastructure as follows:

[6] Institute for Telecommunications Sciences, NTIA, Boulder, Colorado, for the US Federal Standard 1037C

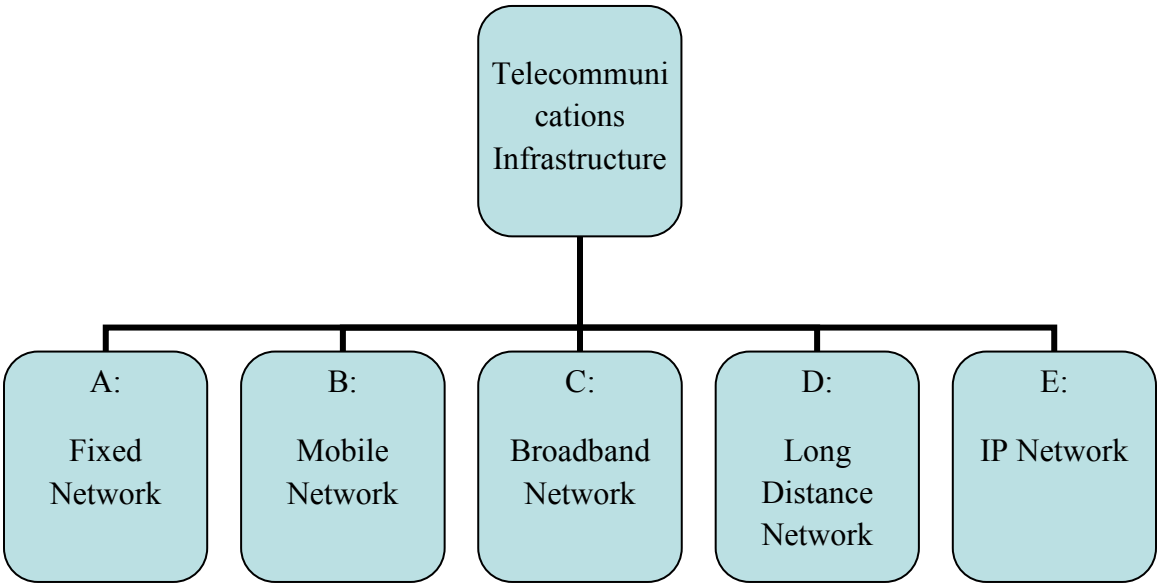


Figure 1.1 Telecommunications Infrastructure

1.2 In the past few years, several recommendations relating to infrastructure development have been made to the Government. Some of these recommendations have been accepted while others are still under consideration. These recommendations are briefly recounted along with the discussion of the corresponding infrastructure. Where recommendations need to be reconsidered because of change in the environment the stakeholders have been invited to give comments.

A - Fixed Network

1.3 The fixed telecommunications network primarily consists of the following:

(i) Switches
(ii) Transmission links
(iii) Access Network
(iv) Intelligent Network systems

A1 - Switches

1.4 Broadly, there are two types of switches or exchanges in the local network: The local telephone exchanges and the tandems. The local telephone exchanges are where the subscriber loops are terminated. Modern local switches are all digital electronic switches that allow subscribers not only to call each other but also supplementary services like dynamic call barring, call forwarding and conferencing. A digital switch works on time division switching of digitized signals using Common Channel Signalling #7 (CCS7) signalling. Switches are installed in buildings that are referred to as central offices or exchange buildings. The capacity of a switch could be from a few hundred to tens of thousands of lines. The central offices would also have a Main Distribution Frame (MDF) with terminal blocks on which the subscriber cables are terminated on one side and the exchange cables on the other. The MDF will also have devices to protect the switch from lightning, shorts with electric power lines, or other foreign voltages. As the telecom network would have a number of switches, inter-exchange junction cables would also be coming to the MDF. The local switches are also referred to as Class 5 switches. A digital electronic exchange also allows remote line units (RLUs) to be installed in remote locations and parented to it. The remote line units do not have the common control equipment and can be accommodated in smaller buildings.

1.5 The local loops are generally copper based which can carry voice signals in the base-band to a distance of about 5 kms. Metros and bigger cities would therefore have a number of local exchanges for coverage of the entire area. To enable any subscriber to call any other subscriber all these exchanges would be interconnected. If the number of exchanges are large, then interconnecting each exchange with the other, at a desired grade of service, becomes expensive. In such a situation, a switch

called tandem or transit could be installed to which the local switches could be connected. A tandem optimises the number of direct links between the local switches, streamlines the flow of traffic between exchanges and reduces the cost of the network. A pure transit switch would only have junctions from other exchanges and no subscriber loops. There could, however be a hybrid or a local cum transit switch which does both the functions.

A2 - Access Network

1.6 The access network consists of cables and equipment between the subscribers and the local exchange. Today the access network is predominantly made of copper cables and the flexibility points viz MDF, Cabinets, Pillars and Distribution Points. A small amount of fibre has also been laid in the access network by some service providers along with systems like passive optical network (PON) or fibre optic cabinets.

A3 – Transmission Links

1.7 In a multi exchange local area there would be links between the local exchanges and between local and transit exchange (if a transit is installed). These are called junctions (the term trunks would be used for inter-local area links). These links would be on copper or fibre using technologies like Pulse Code Modulation(PCM), Synchronous Digital Hierarchy (SDH) or microwave. The electronics may be installed on the street-side, poles or in the manholes.

1.8 For connecting one local area to another there would be trunk or long distance network consisting of trunk switches and links between them. Local exchanges and tandems would be connected to the trunk switches

for enabling subscribers to make long distance calls. The trunk switches would be two types, national trunk switch (also called trunk automatic exchange or TAX) for national calls and international gateway for international calls. These are discussed in Section D.

A4 – Intelligent Network (IN) Systems

1.9 IN systems are platforms used in the fixed network for providing services and features that are normally not available in the switches. Intelligence is placed in the computer nodes that may be placed anywhere in the network. This separation provides the network operator with the means to develop and control services more efficiently. New capabilities can be rapidly introduced into the network. Once introduced, services are easily customized to meet individual customer's needs. An IN infrastructure typically involves service logic on network platforms, CCS7 signalling system and IN-capable software in the network switch. Service like freephone, universal personal number, televoting and virtual calling cards are offered through these systems.

A5 – Policy Issues in Fixed Network

1.10 Fixed networks have been mainly deployed by the Basic Services Operators (BSO), the incumbent Public sector operators BSNL and MTNL, and some of the UAS licensees. For creating the switching and the transmission infrastructure, subject to the technical conditions specified in the licence, the service providers are free to decide the number, location, technology and types of switching and transmission equipment. According to the licence conditions, the technology should be based on standards issued by ITU/TEC or any other International Standards Organization/ bodies/Industry. Any digital technology having

been used for a customer base of one lakh or more for a continuous period of one year anywhere in the world, shall be permissible for use regardless of its changed versions. The service provider is also obliged to furnish complete technical details with all calculations for engineering, planning and dimensioning of the system/network, concerned relevant literature, drawings, and installation materials regarding the applicable system. The service provider also has to ensure the Quality of Service (QoS) as prescribed by the licensor or TRAI. All these steps go towards ensuring reliable standards based network.

1.11 There have been no specific recommendations on switching and transmission network. The Authority has made regulatory and policy interventions whenever considered necessary in the interest of growth and efficient use of the fixed network infrastructure. The relevant recommendations are summarised here:

- In August 2010, recommendations were made for efficient utilisation of numbering resources for orderly growth of fixed and mobile network and these recommendations are under consideration of the Government.
- A regulatory intervention was done in the area of leased circuits both physical and virtual. These are services that may be provided over facilities owned or operated by a service provider or over transmission capacity sold or leased by another service provider. It may use existing media copper, fibre or wireless and may be provided through passive, circuit switched or packet switched network. Leased circuit does not involve switching operations. These measures were included in the Domestic Leased Circuit regulation issued in Sept 2007. These regulations provide a framework to ensure transparency, predictability and reasonableness and allow provision of DLC/local

lead in a non-discriminatory manner. These regulations are available on the website www.trai.gov.in

- The Authority issued IN regulation in November 2006, requiring all eligible service providers to give option to their subscribers for using the Intelligent Network Services of other Service Providers. IN regulations are available on the TRAI website www.trai.gov.in.

No policy issue is being raised in this paper specifically for switching, transmission, access and IN infrastructure.

B – Cellular Mobile Networks

1.12 There are 12-14 mobile service providers in various service areas who are creating infrastructure on their own or through partnerships with equipment manufacturers. Mobile network services in India have seen considerable growth. India has now become the second largest and fastest growing mobile network with about 730 million mobile connections as of end of November 2010. In 2007-08, the growth was about 43% and the total revenue was Rs. 23,770 crore. In the last financial year, despite global financial meltdown, the wireless infrastructure industry grew by 40% with the total value of Rs. 33,261 crore[7]. With the addition of new players and service providers planning 3G deployments, the wireless infrastructure would receive further boost. Greenfield operators are in the process or building networks and rolling out services. Existing cellular operators would also have to install amount of overlay network. It is estimated that the industry would need Capex investment of $18-20 billion upto 2012[7].

[7] Voice and Data, V&D100 - 2009 VOL - I

1.13 The cellular mobile networks primarily consist of the following

(i) Network and Switching Subsystem(NSS)

(ii) Base Station Sub-system(BSS)

(iii) Tower and associated infrastructure

(iv) Transmission Network

(v) Spectrum

B1 - Network and Switching Subsystem

1.14 The Mobile Switching Centre (MSC) performs the switching functions required for the user equipment located in the associated geographical area. The MSC monitors the mobility of its subscribers and manages necessary resources required to handle and update the location registration procedures and to carry out the handoff functions. The MSC is involved in the interworking functions to communicate with other networks such as PSTN and ISDN. The call routing, call control and echo control functions are also performed by the MSC. The Home Location Register (HLR) is the functional unit used for management of mobile subscribers. Any changes in the subscriber data is carried out in the HLR. The HLR stores IMSI, MSISDN number, VLR address and subscriber data. The VLR is linked to one or more MSCs. It is a functional unit that stores subscriber information, such as location area, when the subscriber is located in the area covered by the VLR. In order to set up a call, the call is first routed to a gateway MSC (GMSC) which routes the call to the right MSC. The GMSC has interface with the external networks and also the CC7 signalling network. It also contains the facilities for the Authentication Centre, allowing mobiles onto the

network. In addition to this it will also contain the facilities to generate the billing information for the individual accounts.

B2 – Base Station Sub-system (BSS)

1.15 The BSS provides all the components and the transmission facilities for the radio part of the network. It consists of the Base Transceiver Stations (BTSs), Base Station Controllers (BSCs) and Transcoder Rate Adaptation Units (TRAU). The main function of the BSS is to connect the subscriber mobile stations to the network through connections to the MSC. The BSS takes care of the mobility management including handover. The BTS provides the radio interface directly to the mobile. The BTS infrastructure is usually large and spread out in the service area. BTS configurations are used to divide the cell into sectors using directional antennae to achieve adequate radio capacity. The BTS performs radio transmission and reception for MSs, coordinates cell and resource management with BSC, broadcasts information for mobiles for recognising the network as well as coordinates access, performs encryption and decryption, channel coding and signal strength calculation. The BSC controls the BTSs and provides direction and coordination for allocating resources and coordinating the access by multiple Mobile Stations (MSs). BSC coordinates the frequencies to be used in every cell. It is the BSC that determines when mobile should perform handover and to which cell. In general, any transaction required between the MSC and the mobile for any communication or resource allocation are coordinated through the BSC. TRAU acts as an interface between MSC and BSC for data rate conversion from 64kbps to 13/12.2/5.6 kbps and vice-versa depending on the encoding method used so that multiple calls can be transported in a single 64kbps time slot.

B3 – The Tower Infrastructure

This is considered in detail in Chapter 4.

B4 – The Transmission Network

1.16 The links between the BTS and the BSC may use either land lines/OFC or microwave links. The BSC is often co-located with a BTS. The BSC interfaces with the MSC. This makes more widespread choices about the routing of calls and interfaces to the land line based PSTN as well as the HLR and VLR.

B5 – Spectrum

1.17 Besides the voice communication requirements, the new technologies have made possible communication of data and video. Besides the 2G, 2.5G, EDGE and GPRS, now service providers have started deploying 3G, WiFi and WiMax networks. Increasing requirement of high data rates may see operators deploying HSPA and LTE networks. Wireless devices are making possible man to machine and machine to machine communication. None of these networks can be deployed if suitable spectrum is not available.

1.18 In May 2010, the Authority made certain recommendations to the Government on Spectrum Management and Licensing framework. These covered issues relating to assignment of spectrum, its pricing, rollout obligations, consolidation of spectrum etc. These recommendations which are under consideration of the Government are available on the TRAI website www.trai.gov.in. The present consultation process does not envisage any issues relating to Spectrum. A separate consultation will be initiated in respect of the spectrum for 4G technologies

Policy Issues in the Mobile Networks

1.19 The Licence conditions require the service providers to furnish details of the technology proposed to be deployed for operation of the service. It stipulates that the technology should be based on the standards issued by ITU/TEC or any other International Standards Organization/ bodies/Industry. Any digital technology having been used for a customer base of one lakh or more for a continuous period of one year anywhere in the world, shall be permissible for use regardless of its changed versions. The service provider has to follow the national fundamental plans including numbering plan, routing, transmission plan etc. To ensure rollout of network and facility based competition the UASL licence conditions state that*"The LICENSEE shall be responsible for, and is authorized to own, install, test and commission all the Applicable system for providing the Unified Access Services under this Licence agreement."*

1.20 The Authority has made regulatory and policy interventions whenever considered necessary in the interest of growth and efficient use of the mobile network infrastructure. The important interventions are described here:

- Detailed recommendations were made for Spectrum Management in May 2010
- For development of rural infrastructure, TRAI had earlier made recommendations in 2005 and 2009. In the changed context some of these recommendations may have lost relevance while others may need reconsideration. These modifications are being discussed in Chapter 5. In its more recent recommendations on 'Spectrum management and Licensing Framework' of May, 2010 TRAI made a number of recommendations for improving rural coverage. The roll-out obligations, coverage by intra-service area roaming, incentives

for rollout, monitoring of roll-out, linking incremental spectrum with rollout obligations, moving towards uniform licence fee and utilisation of USOF for villages with population less than 500 for mobile and more than 1000 for broadband have all been dealt with.

- As regards the numbering plan, recommendations made in August 2010 TRAI suggested ways to have a large numbering space for mobile services in order to have unstinted growth. These include implementing an integrated numbering scheme for fixed and mobile so that the unused numbering space locked up for fixed network can be used for the mobile network. These recommendations are available on TRAI website www.trai.gov.in.

- In August 2008, TRAI issued its recommendations on need, timing and terms and conditions of the licence for MVNO. The recommendations dwelt upon the definition and other issues like need and timing, regulatory model, regulatory and licensing issues like license service area, eligibility conditions, scope of service, service obligations, entry fees, annual licence fees, allocation of numbers and interconnection. Issues like roll out obligations, mergers, substantial equity, FDI, Bank guarantees to be paid by MVNO were also covered in these recommendations. The recommendations are available on TRAI website www.trai.gov.in. Some of these recommendations may require reconsideration in the context of changed environment. These are considered in detail in Chapter III of this consultation paper.

C - Broadband Network

1.21 The Broadband infrastructure is now considered indispensable to economic and social growth. It is therefore natural that countries are concerned about creating a robust broadband infrastructure that would sustain high growth of broadband services. The US, Japan, Australia, Canada, Portugal, South Korea, Germany, Singapore and Finland have already developed national plans for creating nationwide broadband network reaching the unconnected areas. The Governments of these countries have also allocated suitable financial resources for creating countrywide high speed broadband network. Studies worldwide suggest positive returns from investment in the broadband infrastructure

1.22 The broadband infrastructure can be envisioned in two parts:

(i) The broadband core network
(ii) Broadband Access Network

C1 – The broadband core network

1.23 Broadband backbone consists of carrier grade routers connected with high speed links. The routers in the core network, also called provider routers, typically range from hundreds of Gbps to a few terabits switching capacity. The links between the routers could be STM-16, STM-64 or higher on fibre optic cable. The backbone network also has edge routers which provide connection points to the second part of the network or directly to the customers' networks.

C2 – The Access Aggregation and Access Network

1.24 The access aggregation network aggregates traffic from a number of sources and funnels them to the backbone network. This part of the network may contain Ethernet and/or RPR switches connected through high speed Ethernet over fibre links. The broadband access networks that may consist of equipment that work on copper or fibre e.g. DLSAM, GPON, GEPON, MSAN etc. These are the equipment to which subscribers are connected.

Policy Issues in the Broadband Network

1.25 The Authority made a recommendation on "Accelerating Growth of Internet and Broadband Penetration" in April 2004 after which the Government issued Broadband Policy in December 2004 laying down the targets for broadband connections. It was estimated that the broadband connections would grow to 9 million by the end of year 2007 and 20 million connections by the end of year 2010 in India. However, the growth fell far short of the requirements.

1.26 Growth of broadband services has so far been through variants of DSL technology on copper network. Availability of copper network in the country is limited and is not likely to improve as there is progressive decline in the demand for fixed connections for which the copper network is primarily laid. Future growth is expected through wireless technologies and on fibre. The sharing of copper loop through unbundling or bit stream sharing which was at one time considered important for increasing broadband penetration has lost relevance especially for rural areas. It is now increasingly becoming evident that in the short wireless

broadband technologies would be key to growth of broadband while in the longer term fibre based technologies would be right option.

1.27 Concerned about continuous inability of the country to accelerate proliferation of broadband, the Authority, after detailed consultations with all stakeholders, released recommendations on "The National Broadband Plan" on 8th December 2010. The main thrust of the recommended plan is to create a robust fibre based broadband infrastructure for proliferation of broadband related services in urban and rural areas. The National Broadband Plan envisages provision of 75 million broadband connections (17 million DSL, 30 Million cable and 28 million wireless broadband) by the year 2012 and 160 million broadband connections (22 million DSL, 78 million cable and 60 million wireless broadband) by the year 2014. The plan involves setting up of an open access fibre optic network connecting all Gram Panchayats by the year 2012 and all habitations with population of 500 and above by the year 2013. For urban areas, the plan is to provide fibre to the home (FTTH) in 63 cities covered under JNURM and fibre to the Kerb (FTTK) in all other cities. The network would be financed by USO fund and loans given or guaranteed by Central Government. The Network will provide easy access to high speed data and information to citizens, promoting thereby the efforts in the field of education, health etc. The National Broadband Plan is available at the website of TRAI www.trai.gov.in. Since this Plan has been proposed only in December 2010, after discussion with all stakeholders, this paper does not attempt to deal with this issue further.

D - Long Distance Communication Infrastructure

1.28 The long distance communication infrastructure has elements that enable subscribers to make national and international calls. This primarily consists of the following:

(i) National and International trunk switches
(ii) Transmission Network
(iii) Submarine Cable Landing Stations

D1 – Trunk Switches

1.29 The trunk switches or class 4 switches do not terminate subscriber loops but the local switches are connected to these switches. A number of trunk switches are interconnected to make a long distance network. When a subscriber calls a national or an international number, the call can be routed through one or more trunk switch to the destination within or outside the country. The international trunk switches are also known as international gateways. The international network consists of International Gateways, Cable landing stations with associated equipment and the international submarine cable terminating on the cable landing stations.

D2 – Transmission Network

1.30 The transmission network connecting the trunk exchanges to each other and local to trunk exchanges is predominantly of SDH technology. Both the fixed and mobile networks use the same infrastructure for voice and low rate data traffic. In many cases, IP backbone networks have been established as multi-service, multi-protocol networks for long distance

communication. The Internet traffic would also use the IP backbone. In this section, we consider the traditional long distance network while the IP backbone is taken up in Section E.

D3 – Cable Landing Stations

1.31 A submarine cable landing station has the following infrastructure to which other eligible service providers will need access:

- Fibre Distribution Frame
- Equipment Room
- Network Operation Centre (NOC)
- Digital Distribution Frame
- Backhaul Termination
- Landing Facilities

1.32 The service provider seeking to use submarine cable landing facilities need to collocate their equipment in the owner's premises and for this they need facilities including building space, power, environment services, security and site maintenance.

Policy Issues in the Long Distance Network

1.33 The following issues have been handled by TRAI in relation to long distance networks

- The National Long Distance Service was opened for private participation, without any restriction on the number of operators, from 13th August 2000. As per the original provisions of NLD licence, the combined net worth requirement of the company for NLD licence was Rs 2500 crore and Paid up Capital of Rs 250 crore was required. The entry fee was fixed as Rs 100 crore and the annual licence fee was fixed as 15% of AGR. NLD licences stipulated a mandatory

provision of setting up of one or more points of interconnection of sufficient capacity in each Long Distance Charging Area. NLD service providers were not allowed to access the subscriber directly for provision of leased circuits/closed user groups. From 1st January 2006, these provisions were relaxed and as per the present provisions of the licence, the licensee is required to pay one-time non refundable Entry Fee of Rs 2.5 crore only before the signing of the Licence and an annual licence fee of 6% of AGR. The net worth requirement and paid up capital requirement of the company was also reduced to Rs 2.5 crore. The Licensee can access the subscribers directly only for provision of Leased Circuits/Close User Groups (CUGs) and also for provision of national long distance voice service only through Calling Cards.

- The International Long Distance Service was opened for private participation from 1st April 2002. As per the original provisions of ILD licence, the combined Net worth requirement of the company for ILD licence was Rs 25 crore. The entry fee was fixed as Rs. 25 crore and the annual licence fee was fixed as 15% of AGR. From 1st January, 2006 these provisions were relaxed and as per the present provisions, the licensee is required to pay one time entry fee of Rs 2.50 crore and an annual licence fee of 6% of AGR. There is no mandatory roll out obligation for ILD service licensees except for having at least one switch in India. Net worth and Paid up Capital of the company for ILD service licence is Rs. 2.5 crore. ILD service providers are permitted to offer international bandwidth on lease to other operators. ILD service providers are allowed to access the subscribers directly only for providing International Long Distance voice service through Calling Cards. They are also permitted to provide international bandwidth on lease to Resellers who are issued licence for 'Resale of IPLC'. The minimum network rollout requirement is to establish at least one

International Gateway switch having interconnection with at least one NLD licensee within 3 years of date of licence agreement.

- A Submarine Cable Landing Station has been a `bottleneck facility' and the fact that access to International connectivity would be severely affected by monopolistic position of the incumbent ILD operator. Regulatory measures are required to ensure level playing field and fair competition. In order to enhance competition in International connectivity segment, TRAI made recommendations to DOT on measures to promote competition in International Private Leased Circuits (IPLC) in India on December 16, 2005. These recommendations were accepted by the Government. After this TRAI issues regulation on "Access to Essential Facilities at Cable Landing Stations (CLS). These regulations are available on the TRAI website www.trai.gov.in. The regulation mandated cable landing station owners to publish approved RIO and charges on their websites and facilitate use of submarine cable capacity on fair and non-discriminatory terms and conditions by eligible Indian International Telecommunication entities.

- International Private Leased Circuit (IPLC) is one of the significant elements of international connectivity for Internet, Broadband and IT Enabled Services (ITES). The Authority had given detailed terms and conditions for the resale of IPLC which were accepted by the Government.

The issues relating to long distance networks are supported by regulations. This consultation paper does not attempt to deal with these matters. However, cable landing stations being infrastructure elements that are important to promote competition in international bandwidth

the Authority invites comments from the stakeholders on the methods of encouraging more ILDOs to set up cable landing stations.

E - Internet Protocol Networks

1.34 The backbone network referred to in Section C is normally based on Internet Protocol. This makes it agnostic to the source of data as long as the data can be packetized. The same backbone can be used for voice, data and video traffic from fixed as well as mobile networks. A number of integrated service providers have created their backbone networks. These networks could be connected with each other through an Internet Exchange. To be able to address all these components it would be appropriate to discuss the IP network as a separate category. The following infrastructural components are discussed below:

(i) IP Backbone
(ii) IP Access Network
(iii) IP Address Space
(iv) Internet Exchange

E1 - IP Backbone

1.35 The backbone network is a bearer network usually architectured as a multi-level distributed network providing traffic channels for the rest of the network. It may consist of routers, route-reflectors, packet shapers, load balancers and fibre-optic links between them. The network has a network management system that is used for configuration, diagnostics and accounting. The backbone networks must be very reliable with alternate routes for traffic. The core part of the network must have high traffic carrying capacity and route redundancy. The traffic is usually distributed and 'bursty' and packet switching is used to take advantage

of the traffic pattern. Integrated service providers having a large footprint have all created their IP backbone network. The contemporary IP backbones are multi-protocol multi-service networks that can cater to voice, data and video traffic. The same backbone could be used for high speed Internet access, Virtual Private Networks (VPNs), hosting services and Video based services like IPTV.

E2 – IP Access Network

1.36 Not long ago dialup was the main method to access the Internet. Remote Access Servers were installed in the Central Office along with the voice switch as an interface between the voice and IP worlds. The subscriber could use his telephone line to dial into this server and get connected to the Internet cloud. Now there are various ways to implement end-to-end IP networks. DSL equipment at the central office end has native IP interface to connect to the IP aggregation network or the IP backbone. The fibre-to-the-home (FTTH) and Ethernet switches are also being increasingly deployed. With the growing diversification of access methods IP access systems have become a major part of our infrastructure. It is important to have scalable architecture in terms of services that can be offered and bandwidth that can be provided. The basic access features include PPP termination, general encapsulation (L2TP etc), header search (Layer 2, Layer 3) etc and the advanced feature like IPSec. To provide a virtual private network (VPN) for users, the access system must be able to handle a pair of layer-2 and layer-3 addresses. Thus, by providing these switching features covering multiple layers in the access system, telecommunication carriers are able to provide various services for end users.

E3 - IP Address Space

1.37 An IP address is a unique address allocated to computers and other devices on a network so that they can identify and communicate with one another. Each device in the network must have its own unique address. Users of the Internet are allocated IP addresses by their ISPs either permanently (Static IP) or at the time of creating a session (dynamic IP). The IP addresses of users browsing the World Wide Web are used to enable communications with the server of the web site.

1.38 The predominant standard protocol for the Internet is IPv4 in which each IP addresses is of 32 bits, giving over 4 billion addresses. While a number of measures have been taken to conserve the limited existing IPv4 address space (such as the use of Private Addresses and Network Address Translation), the number of 32-bit IP addresses is not sufficient to accommodate the long-term growth of the devices that can connect to the Internet. For this reason it is considered necessary to migrate to the 128-bit IPv6 addressing scheme which will provide about $3.4x10^{38}$ addresses that should suffice for the foreseeable future. This protocol also offers advanced features like security, quality of service, better multimedia support that could play a catalytic role in the growth of IP network infrastructure in the country.

E4 - Internet Exchange

1.39 Internet offers access to content and users anywhere in the world. The ISPs have to secure network connections to all potential senders and recipients of content. Reciprocal interconnection makes it possible for an ISP to access the entire global Internet "cloud" for its subscribers. The Tier-1 ISPs can dictate interconnections terms and conditions. Smaller ISPs in remote areas must meet the entire cost of accessing large Tier-1 ISPs using expensive international bandwidth. In countries where there

is no local facility for exchange of Internet traffic, the ISPs must pay for international transit facilities to deliver local traffic. An important way to reduce cost of Internet traffic for the ISPs is through development of Internet Exchange Points (IXPs). IXPs offer traffic switching and routing flexibility. By using an IXP, ISPs can individually and collectively reduce their bandwidth and line transmission costs, provide more reliable service with lower latency, and operate more efficiently. This arrangement improves quality of service by reducing the transmission time, number of routers and distance traffic must travel. It provides a neutral, universally supported "clearing house" for the exchange of traffic, making it possible to keep local traffic local.

1.40 On the basis of recommendations made by TRAI in Sept 2002, National Internet Exchange of India (NIXI) was set up by the Department of Information Technology (DIT) in 2003. Utilisation of NIXI has not been optimal. By April 2007 only 27 ISPs out of 135 operational ISPs connected to NIXI nodes. The Authority made fresh recommendations for improvement of NIXI.

1.41 Internet Exchange Point and related issues are discussed in detail in Chapter 2.

Policy Issues in IP Networks

1.42 Internet Service Providers can set up ISP nodes according to the guidelines issued by the Licensor. Addressing scheme for Internet Telephony shall only conform to IP addressing Scheme of Internet Assigned Numbers Authority (IANA). IP addresses can have up to 128 bit binary address or higher. An ISP can set up International Gateway Station using satellite medium for Internet with prior approval of the Licensor. An ISP is permitted to set up, maintain and operate submarine

cable landing station for international gateway for Internet with the prior approval of the Licensor. The Landing Station for International Gateway for Internet shall be used only for carrying Internet traffic.

1.43 TRAI had, in January 2006, sent its recommendations on "Issues Relating to Transition from IPv4 to IPv6 in India" the main points of which were:

- Definition of IP address mentioned in ISP licence to be amended to enable 128 bits to be used as needed for IPv6 based addressing.
- Encourage migration by mandating use of IPv6 in Government projects.
- Raise awareness through seminars and workshops.
- Establish National Internet Registry (NIR) in the country.
- Improve test bed facilities

1.44 DOT vide its letter dated 22nd April 2009 had sought modification to the effect that DOT should establish the NIR. TRAI, in its reply on 6th May, 2009, had indicated that it is important to create NIR immediately and the Ministry of Communications and IT could decide who should create it. The recommendations, DOT's letter and TRAI's reply are available on the TRAI website www.trai.gov.in.

1.45 The aspect of migration from IPv4 to IPv6 is important for the growth of IP networks in the country. The Authority, therefore invites the views of the stakeholders on what should be the time frame for migration. This issue is discussed further in Chapter VI.

Infrastructure Sharing

1.46 As per the terms and conditions of the CMTS/UAS Licences, the access service providers were initially permitted sharing of "passive" infrastructure viz., building, tower, dark fibre etc. only. However, in April, 2008, in order to ensure an optimum utilization of the available resources and to bring down the cost of providing service, the Government issued 'Guidelines on Infrastructure sharing among the Service Providers and Infrastructure Providers'. As per these guidelines, the service providers were permitted to share the active infrastructures limited to antenna, feeder cable, Node B, Radio Access Network (RAN) and transmission system only.

1.47 The DoT, vide its letter dated 9th March 2009 clarified that the scope of IP-I category providers, which was at that time limited to passive infrastructure, has been enhanced to cover the active infrastructure if this active infrastructure is provided on behalf of the licensees, i.e. they can create active infrastructure limited to antenna, feeder cable, Node B, Radio Access Network (RAN) and transmission system only for/on behalf of UASL/CMSP licensees.

1.48 In the May 2010 recommendations on "Spectrum Management and Licensing Framework" the Authority noted that the IP-I registration was opened to the private sector with effect from 13.08.2000 to encourage growth in infrastructure and bandwidth capacity. At the time of release of recommendations there were 219 IP-I companies who had registered with Department of Telecommunications for Infrastructure provision. As per research estimation, the average growth of towers was expected to be 17% in next 4-5 years. In view of the increasing role of IP-1 in the sector, the Authority was of the opinion that there were enough reasons to bring them under the ambit of the licensing regime. This will also facilitate the following:

(i) By licensing them, they can also be permitted to provide both passive and active infrastructure, independent of the service providers. This will facilitate faster roll out and reduction in the capital expenditure on the part of the service providers.

(ii) Tower providers were facing restrictions from different local bodies and were being subjected to local regulations which were not uniform. Bringing them under the licensing regime would facilitate a more orderly development.

(iii) The scope for arbitrage will be significantly reduced

1.49 Infrastructure sharing has been discussed in detail in Chapter 4

From the above discussion, the following issue emerge for consultation:

1. **Do you agree with the classification of infrastructure elements described in this chapter? Please indicate additions/modifications, if any, particularly where you feel that policy interventions are required.**
2. **What measures can be taken to encourage more ILDOs and ISPs to set up cable landing stations?**

CHAPTER II

INTERNET EXCHANGE POINT

A - Necessity of Internet Exchange Point

2.1 An Internet Exchange (IXP) is a facility to which Internet Service Providers (ISPs) can connect and exchange IP traffic among themselves. In the absence of an IXP the Indian ISPs have either directly interconnect with each other or exchange even their domestic traffic through an IXP abroad. In addition, in the absence of a national IXP the ISPs would have to connect with international ISPs for accessing the global Internet cloud. An IXP can aggregate requirement of Indian ISPs and exchange International traffic at lower negotiated rates. Presence of one or more IXPs in the country would therefore ensure that domestic traffic does not use International bandwidth and thereby reduces the requirement of and expense on such bandwidth. Also by aggregating the International bandwidth requirement for accessing Internet "cloud" the Indian ISPs are jointly in a better position to negotiate better rates for such bandwidth. Presence of IXP not only reduces cost but also with the facility of switching and routing at the IXP the quality of service also improves because of reduction in transmission time, number of routers and distance the traffic must travel.

B - Early Efforts at establishing IXPs

2.2 The requirement of creating Internet exchange point for peering of the ISPs was felt as early as 2002 when TRAI set up a Task Force involving experts from DIT, IIT Delhi, IIM Ahmedabad, C-DOT, TEC and ISPAI with an objective to prepare an action plan to achieve faster growth of Internet

in the Country. The Task force recommended establishment of Internet Exchange Points (IXP) for exchange of Internet traffic within the country. Recommendations included setting up of an Internet Exchange Points called NIXI (National Internet Exchange of India) in the country under the umbrella of an Industry representative not-for-profit, neutral body. The Task Force also recommended that DIT should facilitate this through a one-time grant for capital requirement and also the provision of space at their associate offices at nominal rent, to begin with, in four metros. The Task force emphasized that this will result in cost saving on International connectivity, lower Internet usage prices for the consumers and also better quality of service.

2.3 TRAI forwarded the recommendation of the task force to the Government in August 2002. Government accepted the recommendations for setting up of NIXI. The initial capital for the project (Approximately Rs 4 crore) was provided as a grant by Department of Information Technology. It was envisaged that the project would become financially self-sustaining from the Second year of operations and all surplus income would be used to meet the objectives of NIXI.

C - Present Status of NIXI[8]

2.4 NIXI is managed by a limited liability company by the name National Internet Exchange of India, registered as a Section 25 company under the Companies Act of India. It is managed by a Board of Directors drawn from the Department of Information Technology, eminent academicians, ISPAI, and from among the peering ISPs.

[8] www.nixi.in

2.5 Initially, four nodes of NIXI were made operational at Noida, Mumbai, Chennai and Kolkata, which were physically hosted at the premises of Software Technology Parks of India at these locations. Presently NIXI has 7 nodes, one each at New Delhi (Noida), Mumbai, Chennai, Kolkata, Bangalore, Hyderabad and Ahmedabad. These nodes are hosted at the premises of Software Technology Parks of India except Ahmedabad. At present 36 ISPs have 85 connections to these nodes. Two more nodes at Lucknow and Mohali (Chandigarh) have also been established, but ISPs are yet to start peering at these nodes.

2.6 The general principles adopted by NIXI are:

- NIXI is not an ISP and will not provide Internet connections or Transit services. Members should have full Internet connectivity independent of NIXI facilities.
- NIXI is carrier neutral.
- NIXI is the neutral meeting point of the ISPs in India with forced, multi-lateral peering model at present. Members can connect to NIXI at any NIXI Node(s).
- NIXI will not assign or provide for IP addresses, AS numbers, etc. Peering ISP will make his own arrangements with APNIC for this.
- Connectivity to the NIXI will be through dedicated leased lines of sufficient capacity based on which NIXI charges will be billed. Payments to carriers for the leased link will be made directly by the concerned ISP and NIXI will not be a party to it, except for ensuring technical compatibility. Members shall make arrangement for backhaul (routers, convertors and cabling) to their networks.

- Members must either collocate router within the appropriate NIXI Node, or connect via direct, un-switched, Ethernet circuit from Participant's router to the NIXI Node.
- Peering ISPs will not be allowed to have NIXI facilities as a default route. Further no ISP should use NIXI to carry traffic between its own two or more routers.
- Members ISP at any NIXI node must at a minimum announce all its regional routes to the NIXI router at that location.
- Members will ensure that their use of NIXI facilities is not detrimental to other members in any way and that all usage is compliant with the applicable internet standards of IETF.
- NIXI reserves the right to temporarily disconnect any member for security reasons or preserving the stability of NIXI infrastructure.

Basic Routing Policy followed by NIXI

2.7 An ISP at any NIXI node must, at a minimum, announce all its regional routes to the NIXI router at that NIXI location. All ISPs connecting to that NIXI node are entitled to receive these routes using a single Border Gateway Protocol (BGP) session with the NIXI router. This will guarantee the exchange of regional traffic within a NIXI node. This is referred to as forced regional multi-lateral peering under the policy.

2.8 In the event, one NIXI member is already providing transit to another NIXI member, the exchange of regional routes may also happen using a separate private connection between the ISPs.

2.9 ISPs should announce only those routes that belong to their AS (Autonomous System), i.e. their own network, and their customer routes at the NIXI. An ISP in any region can aggregate traffic from other ISPs in the region and connect to the NIXI through a single connection.

2.10 The NIXI router will only exchange information but not carry any transit traffic.

2.11 All NIXI members must ensure that they suitably and proactively upgrade capacity from time-to-time so that they do not end up dropping traffic that other peers are exchanging with them. An ISP must upgrade its port capacity or take additional port if 95th percentile of its OUT or IN traffic in a month crosses 70% of its port capacity, for 3 months.

Tariff Policy of NIXI

2.12 For traffic exchange at a NIXI node between ISP A and ISP B, B will pay to A (through NIXI) an amount equal to Rs. 25 per Gbyte x [traffic from A to B - traffic from B to A]. Here, the prevalent concept is "Requester Pays" to promote domestic content. It is currently proposed that the settlement of this be done by paying this money to the NIXI and the NIXI pays the net of all such settlements to the respective ISP. The tariff of Rs. 25 per GB can be reviewed from time to time by NIXI based on the prevailing bandwidth prices.

2.13 In the case of a NIXI member providing transit to another NIXI member, where they agree to adhere to the NIXI routing policy using a separate link between them, the above "X-Y" calculation will be done by both the members and settlement will be done amongst themselves; However, in the event of a dispute, the NIXI will have the right to intervene and NIXI's decision in the matter will be binding on both parties.

2.14 To prevent unfair advantage to stand alone Data Centers, there will be an additional factor (P) introduced in the calculation of payment for interconnect between the ISPs. The factor will have a value of 0 if it is

determined that the ISP is primarily a Data Center (outgoing traffic is 5 times incoming traffic). It will be 1 for other ISPs.

2.15 In order to simplify measurement, the NIXI will do the settlement between the ISPs accordingly. Thus, the ISPs will pay the NIXI the following accordingly:

C x P x (X - Y)

Where C is currently Rs. 25 per Giga Bytes and P has a value of 0 or 1 respectively if the ISP is a standalone Data Center (i.e his outgoing traffic is 5 times his incoming traffic), or is otherwise ISP. This amount will be rounded off to nearest hundred rupees.

Other Charges prescribed by NIXI

2.16 For becoming the member of NIXI, one time joining charges of Rs 1000/- (per NIXI PoP) are to be paid in addition to a membership fee of Rs. 1000/- per annum on all India basis.

2.17 Connectivity Charges

Port Capacity	**Charges in Rs. per annum**
2 Mbps	24000
10 Mbps	100000
100 Mbps	200000
1000 Mbps	300000
10 Gbps	1000000

2.18 Rack space including electricity: 2U rack space would be provided free of charge but ISPs have to pay additional Rs 2500 per U rack space requirement per year.

D – Issues for consultation

2.19 It was observed in year 2006 that despite NIXI's infrastructure having been established in 2003, only 27 ISPs out of 135 operational ISPs had joined NIXI nodes at four locations and the total number of connections to NIXI from these ISPs was only 54 by October 2006. The total traffic exchanged per week at all the four locations was merely 1.9 Gbps. This was a clear indication that a lot of domestic traffic was not routed through NIXI defeating the very purpose of setting up of NIXI. The NIXI infrastructure was, therefore, sub-optimally utilized. A strong need was felt to address the functional weaknesses to improve the effectiveness of NIXI. A consultation process was initiated in November 2006, through a consultation paper "Improvement in the Effectiveness of National Internet Exchange of India (NIXI)".

2.20 Various reasons like high cost of leased line to connect to NIXI node, non availability of NIXI nodes at all state capitals, high cost to obtain Autonomous System (AS) number were indicated by the stakeholders for not joining NIXI. It was also observed that though an ISP was connected by the bandwidth of the connection was inadequate to cater to the expected Internet traffic. Often ISPs connected at NIXI were neither announcing nor accepting all the routes. Since data traffic flow is one way, hop by hop, routed by analyzing the destination addresses based on the routes learnt, announcement and acceptance of all routes becomes crucial for effective exchange of the domestic Internet traffic. Considering these issues impacting effectiveness of NIXI, the Authority made the

recommendations on "Improvement in the Effectiveness of National Internet Exchange of India (NIXI)" to DIT and DoT, *suo motu*, in April 2007 for effective utilization of NIXI.

2.21 Major recommendations were:

- All the ISPs or their upstream providers (ISP who is carrying the traffic to International Internet Bandwidth providers or NIXI) either connect to NIXI or with International Internet bandwidth providers through direct peering link.
- Compulsory announcement and acceptance of all the routes at NIXI nodes to facilitate effective exchange of domestic Internet traffic at NIXI without requiring direct connectivity of ISPs.
- Quality of Service parameters of NIXI nodes were prescribed to ensure effective functioning of the NIXI.

2.22 These recommendations were accepted by DoT in June 2009. Some of the recommendations regarding announcement of routes by ISPs, connection by regional ISPs to NIXI through upstream ISP over a single link and upgradation of ISP link to NIXI were also implemented by NIXI. NIXI has also reduced various charges including connectivity charges.

2.23 Despite all the efforts optimal utilization of NIXI's infrastructure has not been achieved. As on 12th January 2011 only 36 of the total 167 operational ISPs were connected to NIXI. The data available on NIXI website on this date indicates that the weekly traffic exchanged at all the seven nodes is approx 23 Gbps, which is merely 5% of the total national bandwidth of 483 Gbps reported by ISPs at the end of September 2010.

2.24 The above discussions bring out the disturbing fact that NIXI has not been effective as Internet Exchange Point despite various efforts made

from time to time. Presently NIXI is not a telecom licensee and therefore is not under the purview of TRAI & DoT. There is clear resistance of the service providers to join NIXI which cannot be mandated as NIXI is not a service provider. NIXI being independent agency cannot be regulated in terms of QoS, tariffs and infrastructure.

2.25 The IP traffic has increased manifold since 2002 when recommendations were given by the task force for setting up of NIXI. Increasing digitization of content, convergence, support of various services and application on IP platform, adoption of IP backbone and migration towards NGN has brought a paradigm change. As per a CISCO forecast, IP traffic is growing at a compounded rate of 46 % per year. A number of services are either real-time or otherwise time sensitive and require strict control of latency, packet loss and jitter. In such a scenario, there is a need to have a well structured framework for establishment of the Internet Exchange Points.

2.26 TRAI in its recommendations on "Spectrum Management and Licensing Framework" sent to DoT on 11th May 2010 has recommended for grant of Unified license without spectrum covering all the telecom services. One of the options could be to enhance the scope of the Unified license to setup Internet Exchange Points in the Country. In order to ensure impartial behavior of such Unified Licensees who wish to provide Internet Exchange points in the country, adequate safeguards can be provided while permitting such services under the Unified License. Comments of the stakeholders are invited on the framework to establish impartial Internet exchange points in India.

2.27 The following issues emerge for consultation:

3. Do you perceive the need for effective Internet exchange point(s) in the country to efficiently route domestic IP traffic?

4. If your answer to issue #4 is in affirmative, please comment on the licensing framework of the entities for setting up Internet Exchange Points in India.

5. Will it be desirable to permit those Unified licencees to setup IP exchange points in the country who have no vested interest in routing of the IP traffic?

CHAPTER III

MOBILE VIRTUAL NETWORK OPERATOR (MVNO)

3.1 Mobile Virtual Network Operators (MVNOs) can provide mobile services to the end-users by using the radio spectrum of a licencee who owns radio spectrum (MNO). In addition an MVNO may build, buy or lease network capacity from a Mobile Network Operator (MNO) to obtain essentially the same possibilities to offer mobile services to end-users as an MNO.

A - Benefits of MVNO

3.2 MVNOs potentially help in widening and deepening MNOs services. They offer the customer additional choices. Depending on the technical approach chosen and commercial agreements made between the MVNO and the existing mobile networks, the MVNO may be able to offer different packages of services and tariffs from those available today from service providers. Due to their lower overheads, MVNOs may be able to go into areas which MNOs did not consider viable. MVNOs may be able to tie up with small application and content developers to offer innovative services. The introduction of MVNO is seen as a contributor to efficient use of existing telecommunication infrastructure and also to development of new infrastructure.

B- Policy framework affecting MVNOs

3.3 The Department of Telecommunications (DoT) vide its letter dated 20th March, 2008 had sought TRAI's recommendations on the need and timing for introduction of MVNO as well as terms and conditions of the license to be granted to such operators. TRAI sent its recommendations on the need and timing for introduction of MVNO as well as terms and conditions of the license to be granted to such operators to DoT on 6th August 2008. A list of the recommendations is attached as Annexure II. In its D.O. letter no. 800-18/2009-VAS.III/5 dated 24th February 2009 DOT sought reconsideration of the recommendations which were mostly related to procedural matters, and were accepted by the Authority. Only on DOT's suggestion that one MVNO should be able to get attached to a maximum of two MNOs the Authority reiterated that for the time being, one MVNO may be restricted to get parented to one MNO. The Government is yet to notify the guidelines for MVNO in the country.

3.4 There have been further developments in the sector that may warrant reconsideration of a number of recommendations that were earlier given by the Authority. One of the major developments has been the release of recommendations on 'Spectrum Management and Licensing Framework' by the Authority in May 2010 which covered in a comprehensive manner, all the aspects of licensing for provision of access services. A framework for issue of future licenses is also a part of the recommendations. The recommendations relevant for MVNO guidelines are mentioned in the following paragraphs:

(i) Considering the spectrum demand and supply position, development of technologies in different spectrum bands and the

possibilities of offering applications on wireline and fibre networks, the Authority recommended that no more UAS licence linked with spectrum should be awarded. At the same time, keeping in view the possibility of some service providers wanting to launch access services without spectrum, the Authority recommended that future licences must be unified licences, not linked to spectrum. A Unified licensee shall be permitted to offer any/all services covered under 'Class licence' and 'Licensing through Authorization' but not vice-versa. Such a licensing regime will be service and technology neutral and shall permit a unified license holder to offer any or all telecom services. Spectrum, if required, is to be obtained separately. The Authority had also recommended two types of unified licences – national and service area specific. The national unified licensees would be allowed NLD/ILD services.

(ii) The Authority noted that major telecom companies are forming IP-I companies and hiving off their existing telecom tower assets to such IP-I companies, prime motive being reduction of attendant incidence of licence fee on revenues earned from sharing of their telecom infrastructure. To ensure certain minimum conditions like transparency, separation of accounts and non-discriminatory treatment provisions the Authority recommended introduction of licensing regime for infrastructure providers. The Authority was of the opinion that this would facilitate provision of both passive and active infrastructure, independent of the service providers, faster roll out, reduction in the capital expenditure and more orderly development.

(iii) The Authority also expressed the opinion that the existing roll out obligations, of covering at least 10% of the District Headquarters (DHQs) in the first year and 50% of the District Headquarters within three years of effective date of very lenient and are urban centric as a result even 15 years after the introduction of mobile service in the country, the rural teledensity is still below 25. The Authority stressed upon the importance of telecommunications in the development of rural areas in the context of the objective of the Government to bridge urban-rural divide. The Authority therefore recommended imposing an obligation of coverage of Habitations having a population of more than 2000 in a phased manner. It shall be incumbent on every service provider to provide connectivity through its own network in all habitations with a population of more than 5000 persons. A licensee would however be allowed to cover the habitations having a population between 2000-5000 through intra service area roaming, subject to the condition that at least one-third of the habitations shall be covered by its own network. The Authority has also proposed a system of discouraging non-fulfilment of roll-out objectives in terms of higher spectrum usage charges. For habitations with a population of 500 to 2000 persons, the Authority proposed incentives for roll out of services in terms of reduction in annual licence fee.

(iv) It was mentioned that encouraging Mobile Virtual Network Operators (MVNOs) would be a way of sharing spectrum. MVNOs operate through commercial arrangements with licensed service providers and buy bulk minutes of traffic and resell them to their own subscribers in their own brand. Permitting spectrum

sharing is one of the mechanisms for increasing efficiency in spectrum utilization and temporarily fulfilling the demand for spectrum. The Authority, inter-alia, recommended sharing of spectrum among licencees each of whom does not have more than 4.4 MHz/2.5 MHz (GSM/CDMA) spectrum for a maximum period of 5 years.

C – Recommended framework for MVNOs

3.5 Taking into account the developments that have taken place, the framework recommended for MVNOs through TRAI's recommendations of 6th August 2008 needs reconsideration. In view of the fact that MVNOs can assist MNOs in extending coverage to rural and remote areas, the MNOs should be allowed to cover habitations having populations between 2000-5000 through MVNOs in addition to the intra service area roaming option recommended in the May 2011 "Spectrum Management and Licencing Framework" recommendations. In the light of the same recommendations, there may not be any need for a separate MVNO licence but a Unified licencee may be allowed to work as an MVNO, share the spectrum of the MNO and setup or lease the required infrastructure for providing service in the contracted areas. In the process the spectrum already held by the MNO gets more effectively utilised. **In view of what has been said above the stakeholders may give their opinion on the following modifications to the TRAI's 6th August 2008 recommendations(given in Annexure II for reference):**

- A Unified licencee who does not possess spectrum may be allowed to work as an MVNO in any service area. The Unified licencee ceases to be an MVNO if he gets his own spectrum.

- An MVNO should fulfill all the obligations of the Unified Licencee.
- An MVNO may be allowed to use the spectrum of an MNO and also to set up infrastructure including Radio Access Network(RAN)/Base Station Subsystem, if required.
- There should not be any limit to the number of MVNOs attached to an MNO. However, an MVNO cannot get attached to more than one MNO in the same service area. Additionally, the MNO should ensure that there is only one MVNO in one revenue district.
- MVNO should pay spectrum charges as per the slab applicable to the parent MNO.
- For counting the roll out obligations, the MNO can take into account the roll out done by the MVNOs attached to it.

CHAPTER IV

TELECOM TOWER INFRASTRUCTURE

A - Present Status of Towers

4.1 In the past few years, there has been a considerable investment in the wireless network in India. This follows the need for increasing coverage and meeting the traffic demands generated by voice and non-voice services. By and large, the telecom service providers create their own infrastructure or partner with manufacturer-suppliers in building the required network. Whatever be the case, much of the network is service provider specific and not shared. A large part of the ongoing investment goes into creating these infrastructural facilities. There are elements of the infrastructure, like towers and associated auxiliary equipment that can be shared by more than one service provider. As seen in the last chapter, not only the CMTS/UAS licence permits sharing of passive infrastructure but there is a category of providers called Infrastructure Provider category I (IP-I) who install towers and associated equipment for use by the service providers. To make the cost model more attractive, these infrastructure elements are allowed to be shared by more than one service provider. The attractiveness of the tower infrastructure business has caused many tower companies to come up. Looking at the potential of this sector, several service providers have hived off their tower businesses into separate subsidiaries. All this has gone to effectively making creation of tower infrastructure a separate industry.

4.2 India had around 3,10,000 telecom towers at the end of February 2010. Out of these, about 80% of the towers belong to IP-I companies and 20% to telecom service providers. As per the revenue collection for the year 2009-10, the total revenue of the major IP-I companies will be around Rs. 22,000 crore. As per research estimation, there will be an average annual growth of 17% in number of towers in next 4-5 years. As reported by the industry, total revenue from tower business was Rs 13626 crore in 2009-10. The existing 310,000 towers cater to 481,333 Base Transceivers Stations (BTS) as of March 2010. This gives an average tenancy ratio of approximately 1.55. These BTSs served 584.32 million wireless subscribers as on March 2010(Figure 4.1) indicating an average of 1214 subscribers per BTS (Annexure –I)

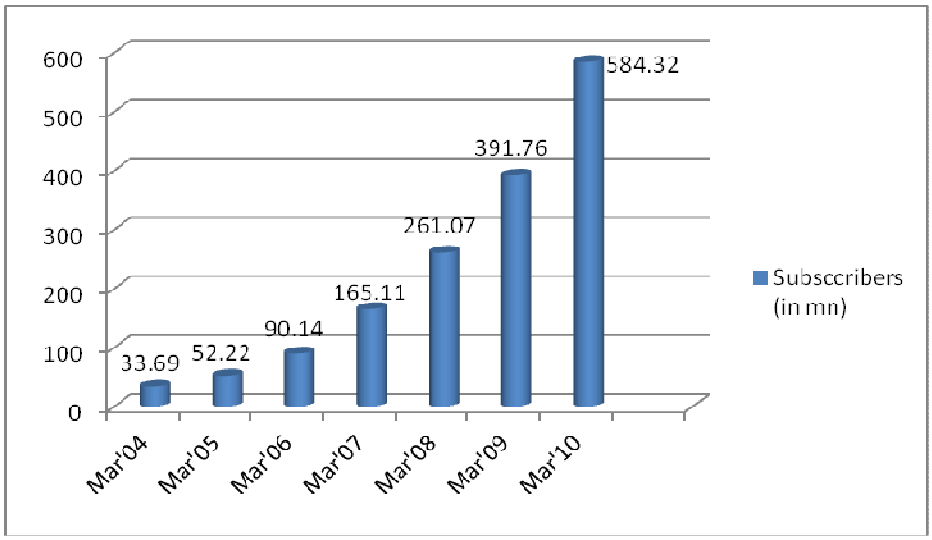
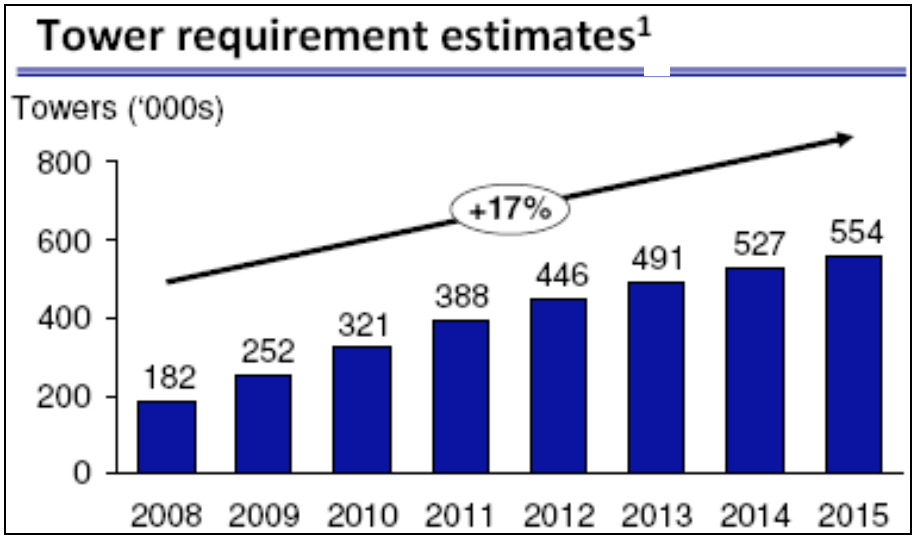


Figure 4.1: Growth of Wireless Subscribers

4.3 At the current growth rate, it is estimated that the subscriber base would reach 1 billion by the year 2014. In order to serve additional 415 million wireless subscribers and additionally to meet expected spurt in wireless data services, approximately 346,000 more BTS will be required. Considering current average tenancy ratio of 1.55, approximately

2,21,000 new towers will be required by 2014. However, considering increased tower sharing in future if we take a higher tenancy ratio of 2.5, this number can be reduced to about 1,36,000 new towers by 2014. A report on Indian Telecom sector by Industrial Development Bank of India projects a similar estimate for requirement of towers (Figure 4.2).



[1]Source: IDBI Bank

Figure 4.2: Estimated Growth of Towers

4.4 Table 4.1 gives total expenditure required for erecting additional number of towers required by 2014 with different tenancy ratios considering an average expenditure of about Rs 25,00,000.

Average Tenancy Ratio	Additional number of towers required by 2014	Total expenditure required (in billion rupees)
1	346,000	865
1.5	230,000	575
2	173,000	433
2.5	140,000	350

Table 4.1: Cost of constructing Mobile Towers

4.5 In view of impending rollout of 3G and BWA services, the requirement indicated above is expected to be even more in near future. This clearly indicates the growing need for investment in towers and related infrastructure. Considering the size of tower industry and considerable importance of towers in expanding the wireless networks, a careful analysis of the technology, current issues and future possibilities is important to ensure that the growth of the wireless sector is not compromised.

B - Issues relevant to tower infrastructure

The following issues are important and would be discussed in the succeeding paragraphs:

1. Methods to reduce dependence on towers
2. Standard design of towers
3. Reducing visual impact
4. Clearances
5. Alternate sources of energy
6. Infrastructure Sharing

1 - Methods to Reduce Dependence on Towers

4.6 Given a large number of service providers in every service area and expanding wireless networks, the need for increase in the number of towers is constantly felt. The situation is reaching alarming levels in business districts and densely populated areas of metros where the average distance between two towers of the same service provider has come down to less than 500 meters. If we take into account all the service providers in any area then the result is a big urban eyesore.

4.7 Aesthetics apart, towers involve huge cost and time and are a strain on service providers' financial resources. Although, sharing of towers reduces the burden to some extent but still the estimated requirement of 1,40,000 shared towers at a cost of Rs 350 billion is large by any standards. Thankfully, there is some hope in developments that allow coverage without installing conventional towers.

4.8 Some new technologies allow mounting of antennas on alternative structures like electric poles, lamp posts, street furniture etc. However, providing connectivity to these antennae becomes a problem due to complex procedures for granting Right of Way(ROW) permissions. The Authority has recently released recommendations on the National Broadband Plan. If these are adopted, in the form indicated, then all 63 Jawaharlal Nehru Urban Renewal Mission (JNNURM) cities [7 Category A (above 4 million population), 28 Category B(1-4 million population) and 28 Category C(less than 1 million population) cities] and the remaining 4315 towns would have fibre to the home or curb by 2013. All villages with population of 500 and above will also have fibre. This fibre infrastructure can be leveraged to induct alternative for telecom towers

and make at least the city areas free of these structures. We shall discuss here some methods of reducing the number of towers:

(i) In Building Solution (IBS)

4.9 Traditional wireless macro networks do not provide seamless and uniformly good quality service in whole of the coverage area. Signals often fade inside buildings, basements, parking garages or subways. With the growing dependency on wireless services for voice and data, subscribers expect seamless wireless coverage everywhere. As about 70% of calls are made or received within buildings, adequate in-building coverage is necessary for providing good quality of service. Moreover, spectrum is not optimally utilised when wireless coverage is provided from outside the building by increasing the power of the signal. This may improve the reception to some extent, but strength of the signal varies a lot with the location resulting in poor quality of speech and call drops.

4.10 In-Building Solutions (IBS), are solutions that provides mobile coverage inside buildings, where the coverage, capacity or quality otherwise would not had been satisfactory. IBS can include cellular standards such as GSM, WCDMA and CDMA2000.

4.11 An in-building solution may be offered in many different ways. There is always a trade-off between quality and cost. The implementation of dedicated in-building coverage enables new traffic for the mobile operators in areas that previously were “black holes” and offloads the macro system in areas with overlapping in-building and macro network coverage, thereby increasing overall system coverage and capacity. Coverage given by IBS may attract new subscribers due to the enhanced mobile network quality and accessibility to mobile Internet and other value added services.

4.12 For mobile operators, in-building solutions off-load the macro network, and thus permit increased mobile traffic. The IBS may attract new subscribers due to the enhanced mobile network quality and accessibility to mobile Internet applications and other offered services.

4.13 The primary reason for limited use of IBS in India is said to be lack of adequate connectivity with existing mobile networks through suitable media like optical fibre. Such connectivity requires permission to lay cable into a building which is the bottleneck. Complicated RoW procedures with associated high cost limit use of in-building solutions. Incidences have also come to the notice where permission to install in-building solutions have been given to one or few selected telecom service providers by the builders or the resident welfare associations forcing all the users in such dwelling units to use telecom services from the selected telecom service providers, throttling the competition. There is a need to look into these issues.

The following issues emerge for consultation:

6. **What methods would you propose for reduction of the number of towers?**
7. **In what ways do you think that IBS can be encouraged for better in-building coverage, better QoS and reduction in level of radiated power from Macro cell sites?**
8. **How can sharing of IBS among service providers be encouraged? Does TRAI need to issue any guidelines in this regard?**

(ii) Distributed Antenna System(DAS)

4.14 One way of implementing a Distributed Antenna System is to mount low powered BTSs on lamp-posts or street furniture which are connected to the mobile operators' networks via copper wires or optical fibres. As lamp-posts are available at short distances a large number of such BTSs can be planned each with a small coverage area. Optical fibre connectivity would be preferable over other traditional methods like microwave and satellite from the point of view of cost-performance benefits. Figure 4.3 shows a DAS installation in which antennae along with radio nodes are mounted on electric poles and buildings along the road. All the radio nodes are connected using suitable supporting network usually having optical fibre.

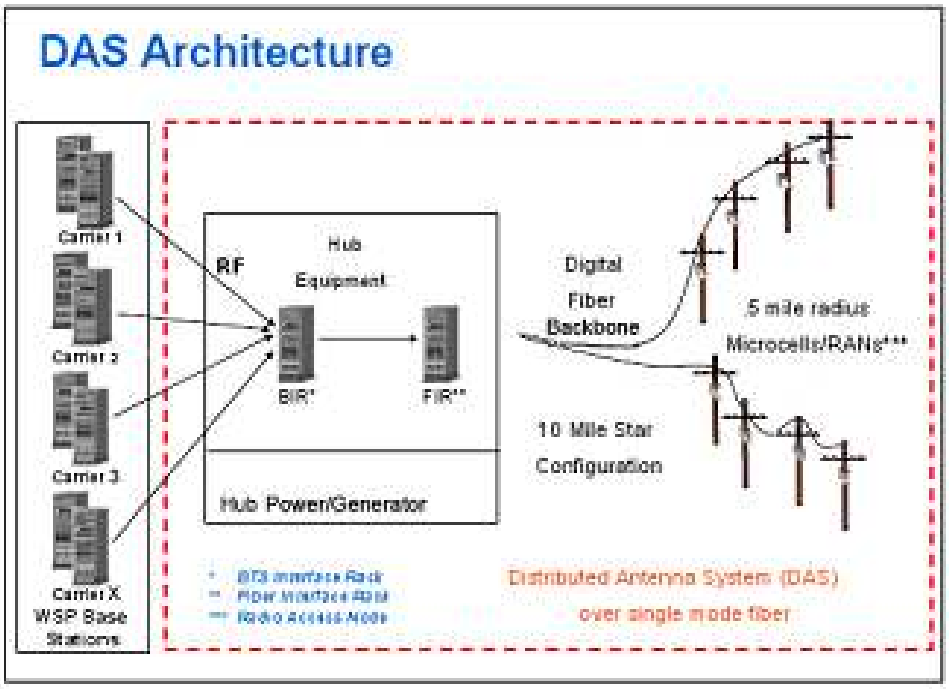


Figure 4.3: DAS Architecture

4.15 DAS systems can serve many telecom service providers simultaneously. The output ports of the BTSs are connected to one or several antennas and an antenna system with several antennas is usually named

Distributed Antenna System (DAS). The DASs can consist of either passive or active components. When both active and passive components are used in a DAS, it is often referred to as a hybrid solution.

4.16 The commonly deployed DASs consist of coaxial feeder cables and components such as antennas, power tappers and power splitters. Radiating feeders work as a combined feeder cable and antenna. They are often used in tunnels and culverts. The DASs can support one or several mobile operators and one or several bands or wireless standards. Wireless Service Providers use Shared Distributed Antenna Systems (DAS) for both in-building and outdoor RF coverage to help alleviate many challenges associated with the traditional Macro/Micro Cell architecture. Figure 4.4 shows a shared DAS implementation.

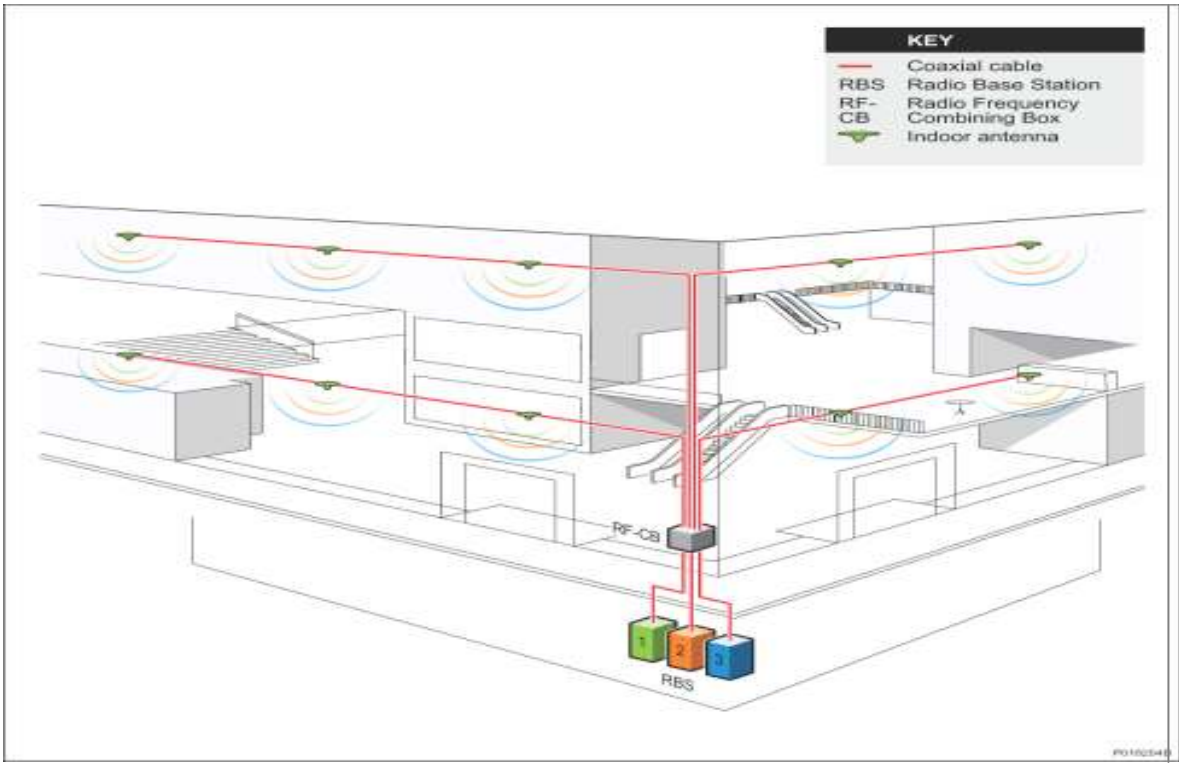


Fig 4.4 An Implementation of DAS for multiple operators

4.17 Sharing a single DAS between several operators/bands will reduce cost and minimize any disturbance to the building and tenants compared to the scenario where a multitude of DASs were deployed in the same building. Distributed Antenna Systems that are designed and available for use by multiple service providers are commonly referred to as neutral host systems. If a DAS system is designed and deployed properly, common coverage and capacity benefits to more than one provider via a single distribution backbone can be achieved without the need to add a series of independent systems. Each carrier needs to provide only the head end equipment, via a dedicated base station or a donor antenna/amplifier, to connect their macro network to the DAS system. A donor site is one that is not exclusively used for the DAS system but also provides service to areas outside of the DAS.

4.18 Single-operator DASs are typically owned by the mobile operator, while multi-operator DASs tend to be owned by other players in the market, such as neutral host providers, building owners, government authorities and enterprises.

4.19 Wireless Service Providers (WSP) can realize a 15-40% reduction in both Capital and Operating Expenditures annually by migrating to a DAS architecture. The DAS architecture provides radio efficiencies that are impossible to achieve with the current deployments. WSPs spend far more with current methods to deploy new cell site infrastructure for coverage, quality and capacity.

4.20 These current RF design methods are nearly 20 years old. Tremendous capital savings can be realized by utilizing new RF Distribution via fibre in metro core areas, in-building, difficult to zone cities, rural highways/corridors and extension of existing sites. Further capital

savings can be achieved through the Shared DAS infrastructure. Through implementation of DAS, the indoor and also outdoor solutions, depending upon the design configuration, the basic objectives of the efficient utilizations of spectrum and limiting the number of towers, be achieved to a great extent. Some important benefits of DAS are summarized here:

Technical Benefits

(i) Increased spectrum efficiency.

(ii) Specific coverage solution and enhanced quality

(iii) Ability to add or direct capacity at the Base Station.

(iv) Specific coverage to address existing RF holes in the network

(v) Reduction in day-to-day management practices.

(vi) Reduced dependence on high power telecom towers and reduction in the EMF levels in the populated areas

(vii) Protection of skyline of cities

Economic and operational benefits

(i) Decrease in overall operating cost

(ii) Efficient use of technical personnel for operations & maintenance.

(iii) Reduction in utility and service providers' management requirements and costs.

(iv) Easier to troubleshooting of network problems.

(v) All radio resource capacity enhancements and maintenance is implemented at the base station.

(vi) Increased spectrum efficiency, a significant increase in reuse.

(vii) Reduced cost of ownership

(viii) Opportunity to re-deploy some of the recovered BTS equipment and expand coverage in other areas.

(ix) Elimination of a majority of administrative and legal costs associated with the ongoing management of site leases, utility, service providers' infrastructure.

(x) No site acquisition and multiple site construction costs and reduced base station infrastructure deployment costs.

4.21 Now in most of the urban areas of the country the big shopping malls, the hospitals, commercial buildings, the big office space and even the big residential building have become common. The metropolitan cities are now coming up with their under/over ground mass rapid transport systems which also require the mobile connectivity for the public at large. The majority of calls (around 70-80%) are generated from within these indoor spaces. To cover these vital indoor spaces the wireless access architecture based on macro cell towers will be sheer waste of resources, which are going to increase the costs, the EMF radiations to the public and the requisite wireless access connectivity may not be up to the mark.

4.22 Though the DAS solution is cost effective and reduces dependency on conventional towers, they require connectivity of antennas through cables. In the case of CBDs and densely populated areas, difficulties in getting ROW and high cost have become hurdles in laying cables in such areas and therefore hinders implementation of DAS systems. The fibre optic network proposed in the National Broadband Plan recommendations would solve the problem of backhaul to a large extent.

4.23 Given the above detailed discussion, there is a lot of scope in setting up shared IBS & DAS in the urban scenario. Presently such activities are taking place without any laid down norms or regulatory guidelines. Such norms or guidelines are expected to provide impetus to this vital activity.

The following issues in DAS require comments of the stakeholders:

9. **Do you agree that innovative technologies such as 'Distributed Antenna System' (DAS) can be effectively utilised to reduce number of towers and migrate towards tower-less cities?**
10. **What are the impediments in adoption of new technologies such as DAS and how can these be removed?**

2 - Standardisation of tower design

4.24 Towers are designed by taking into consideration several factors like size, weight, height & orientation of antenna and wind velocity at the site. Site survey and soil investigation are also carried out while designing and installing a tower. Technological evolution further facilitates better tower design to suit present requirements. The following paragraphs focus on various factors related to tower structure, design, standardization and other important issues.

(a) Types of Towers

4.25 Several types of towers are used in mobile networks depending on the applicability, antenna load and terrain of the installation site. Some of the popular types of telecom tower structures are given below:

(i) **Steel Lattice structure:** Steel lattice structures are modular in construction and are made up of latticed steel elements. Such structures are usually triangular or square in cross-section. Steel lattice constructions are very widely used since they offer the advantage of minimum wind resistance and easy maintenance. These towers have good strength, low cost and can be erected very

quickly. Most of the power transmission, telecommunication and broadcasting towers are of this type.

(ii) **Tubular Steel structure (Monopole):** Tubular steel structures offer high load bearing capacity. These towers are made up of elements with tubular section joined together to get great strength. The sections of tubular towers have their own advantages, but offer low durability especially at places with high corrosive environment, like a coastal area or an industrial zone.

(iii) **Reinforced concrete towers:** These towers are among the most expensive to construct. However, reinforced concrete towers provide maximum rigidity against high wind-loads. These towers can house within it, a control centre to monitor and control operations of the tower and associated equipment.

(iv) **Fibre glass towers:** These towers are used for very niche and limited applications such as low power non-directional beacons and medium wave transmission. Good quality fibreglass can have its own advantages as far as durability is concerned. But its load bearing capacity is lower than that of its steel counterparts, and hence is used for very limited requirements.

4.26 Based on the installation type, mobile towers are further classified as Ground Based Towers(GBT) or Roof Top Towers(RTT).

(i) Ground based towers

4.27 These towers are erected on natural ground with suitable foundations. Height of these towers can vary from 30–200 meters; however most of the telecom towers are of 40 meters in height. The approximate cost of setting up a ground based tower is Rs 25 lakh to Rs 30 lakh depending upon the height of the tower. These towers have high load bearing

capacity and are suitable for sharing. As per Telecommunication Engineering Centre (TEC) generic requirement GR/TWR-11/01.Dec 2004, a four legged 30/40 meter tower can support upto 12 number of panel antennas and 3 number of 0.6m diameter microwave solid dish antennas.

(ii) Roof Top Towers

4.28 These types of towers are erected on top of the roofs of existing buildings with raised columns and tie beams. Height of these towers can vary from 9-30 meters. The capital expenditure for setting up a roof top tower is Rs 15 to 20 lakh. Load bearing capacity of the building on which such towers is erected becomes important. Service Providers have to carefully evaluate the strength of roof top before taking a decision to erect roof top towers. As per TEC generic requirement GR/TWR-09/01.feb 2004, a 20/25/30 meter roof top tower with square base can support upto 12 number of panel antennas and 3 number of 0.6m dia microwave solid dish antennas. Whereas a 15/10 meter roof top tower with square base can support upto 6 number of panel antennas and 3 number of 0.6m diameter microwave solid dish antennas.

(b) Factors affecting the Tower Design

4.29 A thorough study is done before any telecom service provider decides to erect a telecom tower in a particular location. Some of the factors that are taken into consideration for designing towers are:

- Population and geographical conditions within the area served
- Aerial height requirement for each system
- Directions for the directional antennas

- Wind drag on each element of the array
- Size, weight and disposition of all feeders and cables
- Permitted angular rotations in azimuth and elevation of each aerial
- Need for all-weather access
- Possible future extension
- Atmospheric ice formation on the structure and aerials and its likelihood to occur with high wind
- Wind drag with ice
- Degree of security required
- Available ground area and access to the site
- Overall cost of land, foundations and structure
- Cost of future maintenance
- Any special planning considerations imposed by statutory bodies
- Aesthetic appearance of the structure

The above list is not exhaustive. Any of the factors mentioned can singly but often in combination, influence the choice of the optimum structure.

4.30 After taking into account all the important factors, a tower is designed and erected. Broadly, any new tower is expected to accomplish one or more of following three objectives:

(i) Coverage: A new tower provides coverage over areas that do not currently have coverage.

(ii) Capacity: A new tower provides additional capacity for handling more calls in areas where existing towers are overloaded.

(iii) Quality: A new tower can provide better coverage over an area where call drops are high or quality of calls is poor.

4.31 Coverage area (cell) of a tower depends on various factors. The cells are smaller in high-density population areas and larger in case of low density population areas. (Figure 4.5)

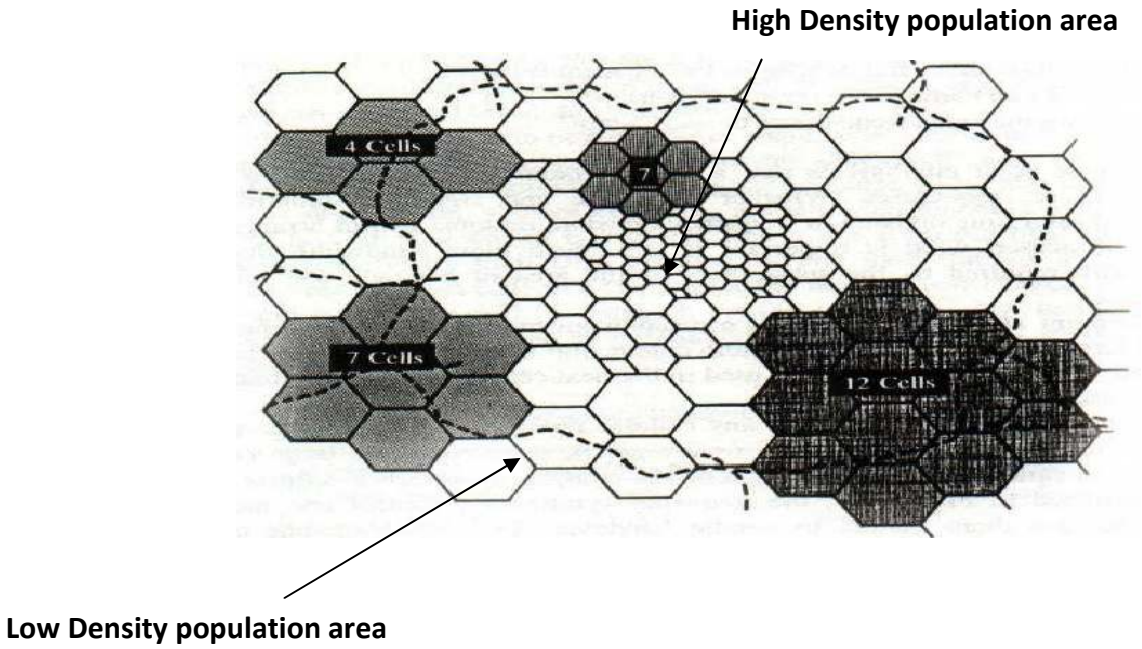


Figure 4.5: Cell Area Vs Population Density

4.32 Location and density of telecom towers in a service area are important factors bearing direct relation to the capacity and quality of service. Service providers split bigger cells into smaller cells by installing more BTSs, and consequently more towers, to increase the capacity for catering to the increased voice traffic.

4.33 The strength and rigidity of a tower is important to ensure safety of people and property near the towers. Telecom Engineering Centre (TEC) has issued Generic Requirements (GR) for both ground-based as well as roof-top mobile towers including technical specifications and safety

requirements. However, UAS license neither provides for any condition related to tower specification or standards, nor it has suggested any single body for tower design certification making adherence to TEC specifications optional for the service providers. Service providers and Infrastructure providers are of the view that TEC's GR are not suitable to meet their requirement particularly in the fast evolving industry. As there are no mandatory design specifications for towers, every service provider and infrastructure provider has adopted tower designs that suit their convenience. Service providers and infrastructure providers have taken approval for design of these towers from organisations such as Structural Engineering Research Centre (SERC), Central Power Research Institute (CPRI), educational institutes like IITs, State Electricity Regulatory Commissions and the like. Due to non availability of any uniform design specification and lack of a designated approving body, cities and towns are cluttered with towers of various designs which make the skyline aesthetically unattractive. Safety of such towers is also questioned by different agencies including Resident Welfare Associations (RWA) of residential colonies. There appears to be a need to explore uniform designs and specifications for towers and a single approval or certification body. This will be helpful for standardization of tower design and reducing the cost of manufacturing.

4.34 The current design practices draw reference primarily from Indian code of practice for transmission line towers and from multiple codes of practices for steel structures, wind load, seismic load, snow load, manufacturing codes etc. From the information on their website www.bis.org.in it appears that Bureau of Indian Standards is working on the development of Indian Codes of practice for telecom towers. Telecom Engineering Centre has prescribed certain specifications but they are not being followed in many of the cases. There is a need for a comprehensive

set of standards to be in place early so that the large number of towers that are expected to be built in future adhere to these standards. In the next few paragraphs we shall see what other countries have done in this regard.

4.35 The US and a few European Countries have developed dedicated and comprehensive codes for telecom towers which cover all the essential aspects of telecom towers from planning, design, manufacturing, soil investigation parameters, assembly & construction in field, safety requirements including grounding protection system and aviation obstruction requirements, periodic maintenance, condition assessment and reverse engineering for existing towers to ascertain the load carrying capacity of towers for enhanced antenna loading. The US also mandates to all the operators and Infrastructure companies to comply with American Code of Practices for telecom towers as per ANSI - TIA - 222G.

4.36 The guidelines issued by Telecommunications Regulatory Commission of Sri Lanka in July, 2009 on "National Policy on Antenna Structures" prescribe standards and procedures for construction of antennas on ground and installation of antennas on buildings. It lays down that all antenna structures on the building with a total height exceeding 30 m above ground level should be designed to withstand any disaster.

4.37 Malaysian Communications and Multimedia Commission (MCMC) has technical standards giving general requirements on rooftop sites, tower sites, mobile/portable BTS sites, operations & maintenance, design requirements for construction, structural, mechanical & electrical (C&S and M&E) of equipment cabins, antenna mounting structures, towers and power supply are elaborated. Many sample drawings and pictures are included to enhance visualization of the various structures. Towers

having aesthetic look are encouraged. Some of the suggested aesthetic structures are Monopole / Monopole Tree, Multipurpose Structures, Bill board, Minaret and Lamp Poles.

4.38 In Canada design and construction of antenna sites are subject to the National Building Code. To ensure the safety of air navigation, antenna proponents must comply with Transport Canada's antenna structure clearance rules and procedures.

4.39 Nigeria has issued detailed 'Guidelines on Technical Specifications on for the Installation of Telecommunications Masts and Towers' on 9th of April, 2009. These guidelines provide standards to be adhered to by telecommunications services providers/operators, designers, fabricators and installers of telecommunications towers towards ensuring environmental safety and sound engineering practices. All towers and masts shall be erected and operated in compliance with the guidelines. Non-compliance with the mandatory provisions of these guidelines shall be deemed to be an offence punishable under relevant provisions of the Nigerian Communications Act 2003 (the Act); the Nigerian Communications (Enforcement Processes, etc.) Regulations 2005 and other applicable laws

4.40 Australian Communications Authority (ACA) registered the "Deployment of Mobile Phone Network Infrastructure Industry Code" in April, 2005 with an objective to regulate radio communication infrastructure. The objectives of this code are:

- to apply a precautionary approach to the deployment of radiocommunications infrastructure;
- to ensure relevant stakeholders are informed and consulted before radiocommunications infrastructure is constructed;

- to specify standards for consultation, information availability and presentation;
- to ensure Council and community views are incorporated into the radiocommunications infrastructure site selection.

The following are issues for consultation on standardisation of tower design:

11. Would you agree that the design of towers can and should be standardised?

12. If yes, how many different types of towers need to be standardised?

13. What are the important specifications that need to be included in these standards?

14. Which is the best Agency to standardise the tower design?

3 – Reducing Visual Impact of Towers

4.41 Various ways of reducing the visual impact of mobile towers have been tried in many countries. These include use of alternative support structures to hide the towers and camouflaging of towers. Local administrations in many countries have set standards for the installation of mobile towers in order to minimize the adverse visual effects. International experience indicates that local civic authorities are concerned about the skyline of cities and encourage various techniques like camouflaging, integration of towers with surrounding structures for reducing the visual impact of towers. However, for implementing such techniques additional expenditure is required. Some of the techniques used are:

a. Camouflaging

4.42 Mobile towers can be made very pleasant looking by hiding them inside artificial trees, Church steeples, Chimney or structures that look like sculptures. In Sri Lankan capital Colombo, mobile towers have been camouflaged as palm trees. Some examples of camouflaging of towers are shown in Figure 4.6:

Figure 4.6: Camouflaging of towers with structures

Integration with surrounding Structures

4.43 In European countries, mobile towers are often integrated with existing structures like clock towers, flag pole etc. Some such examples are

depicted in Figure 4.7. Landscaping or other suitable screening around the towers is also used for making them virtually invisible from major roads.

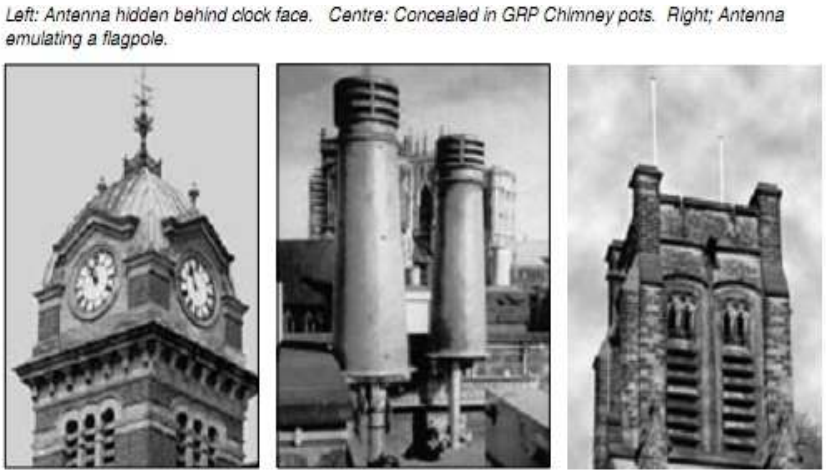


Figure 4.7: Towers Integrated with surrounding Structure

4.44 The local civic authorities of different Indian States are mainly focused on location of towers, land use type, structural safety, one time application fee, periodic license fee, radiation and clearance from other agencies such as pollution, fire etc while granting permission for erection of telecom towers. Service providers erect towers as per their requirement. Every city has its own characteristics and looks, therefore, different cities will require different aesthetic look depending upon surrounding location, historical values and local sentimental factors. These requirements can suitably be assessed by local bodies. However, giving the aesthetic look to tower may have cost implications on service providers. A balanced approach will be necessary.

15. What is the likely cost of camouflaging the towers?

16. Can camouflaging be made mandatory? If so, can this be made part of the design standards of the towers?

4 – Clearances from local authorities

4.45 The service providers are currently required to seek permission from the local civic authorities before erecting a tower in any area. They need to fulfil the conditions as stipulated in the guidelines prescribed by the local Authorities for this purpose. In the initial stages of introduction of mobile telephony, conditions were lenient and restrictions on location of towers were less. Service providers were able to erect towers according to their coverage requirement. With rapid growth in the subscriber base, a large number of towers have sprung up especially in metros and big cities and towns. This has made civic authorities concerned about the many fallouts viz. aesthetics, safety of people and property, air pollution and hazardous effects of RF radiations. In addition to the civic authorities, the resident welfare associations (RWA), non-government organizations and general public have been voicing concern and even filed public interest litigations in various courts.

4.46 The service providers are equally concerned about their inability to install towers in residential areas and its detrimental effect on coverage and quality of mobile services. There are instances where even the existing towers have been declared illegal for not meeting the new guideline norms and were sealed by the local authorities causing distress to the service providers and consumers.

4.47 In view of the increasing concerns, civic authorities have prescribed stringent conditions for granting permissions for erecting towers. In many cases, clearance from the respective RWAs has been made mandatory. In some cities, civic authorities have put a blanket ban on erecting new towers in residential areas.

4.48 Different State and local bodies have adopted different guidelines for granting permission for installation of telecom towers. In many cases, the process may be complicated and time consuming. The main issues are high charges for grant of permission, complicated approval procedure and clearance required from multiple agencies resulting in delays. Some of the clearances required for erecting a mobile tower are detailed below:

- Clearance from Urban Art Commission
- Building completion certificate
- Structural safety certificate
- Permission from Resident Welfare Associations
- Permission from the fire safety authority
- Clearance from pollution control board
- Permission from Airports Authority of India
- Permission from Archaeological Survey of India (ASI)

4.49 Almost all the civic authorities prescribe a one-time registration charge on installation of each tower. Initially, the registration fee was token in nature but lately, the infrastructure providers feel that it has become substantial bordering on exorbitant in many jurisdictions. In some cases, these charges are as high as Rs. 5 lakh per tower while in some others the charges are Rs. 10000/- per meter based on tower height. In addition, some civic authorities demand monthly or yearly fee for each tower. Another complaint is that while, on one hand, most of the civic authorities profess encouragement to sharing of towers and even mention this in their guidelines, they also demand additional fee of up to Rs. 1 lakh for each BTS on the same tower, posing a deterrent to sharing of towers.

4.50 In addition to the registration charges, some authorities prescribe land conversion charges from residential or agricultural land use to commercial land use for installing towers. The whole property where a tower is installed is considered commercial for various tax purposes. Telecom service providers need to have electric connections at commercial rates, which are the highest tariff rates. It has been argued that telecom services being a public utility service may be treated at least at par with industrial establishments and power tariff applicable to industrial category should be levied.

4.51 The safety concerns of the RWAs and general public in respect of Telecom towers need to be understood. For the ground based towers, there is no provision for certification of telecom tower structural design taking into account important factors such as soil type, wind load, proposed antennae load etc. For roof top towers, which are estimated to be about 70% of all towers, no formal strength analysis of the roofs is done before they are erected. While telecom service providers argue that most of their tower designs are certified by expert bodies like IITs, yet it is also a fact that there is no identified certification body. There is a need to prescribe well defined procedure of structure design certification. Such certifications must be accepted by all civic authorities to avoid any duplication of work and delay in giving permission to erect towers.

4.52 Concern about pollution caused by the equipment associated with the towers has had adverse publicity in recent times. There are two types of pollution that cause concern to the general public. Firstly, the diesel generator sets used for un-interrupted supply of the equipment cause noise and air pollution. There are greener alternatives like solar and wind energy but they are currently expensive. Various Government agencies

are involved in making these solutions affordable. In the meanwhile, it has been suggested that some framework can be developed to streamline the approval procedures to reduce time required for such clearance of generator sets. There only are a finite number of generator models used by the service provider so clearance of each type of generator rather than each site may make the approval process faster. The RF emission related issues are also very important and are being studied by many agencies. TRAI proposes to conduct a separate study on the subject.

4.53 From the above discussion, it appears that there are many roadblocks to creating tower infrastructure for growth of telecom services. Service providers contend that the location of the mobile tower is determined based on the radio frequency planning for a given area and restrictions imposed by the civic agencies will create serious operational problems giving rise to QoS issues. Therefore, there is a need to develop a framework that would facilitate smooth growth of the telecom sector while simultaneously addressing the concerns of the civic bodies, RWAs and the public. From the service providers' viewpoint, there is a need to simplify the procedure and define the time frame for granting permission for erecting towers.

Right of Way (RoW)

4.54 The BTSs installed on the towers are required to be connected to the rest of the mobile network through some kind of a telecom link called backhaul. Presently point to point microwave links are used for this purpose. Considering the ever increasing voice traffic and also possibility of higher data traffic, optical fibre seems to be more suitable for

backhaul. Innovative solutions like IBS & DAS also need optical fibre to connect them to the mobile network. The procedure for grant of ROW for laying optical fibre cable is presently complicated, time consuming and expensive. Both connectivity through towers and through tower-less solutions require that these procedures are simplified.

4.55 In US, FCC follows a notification system, as a part of the approval process, for towers being built on historical and other restricted sites. While the notification system is voluntary, the tower review process is still required before any tower or antenna can be built. All the towers which are more than 200 feet in height or if the tower is located next to an airport need to be registered with FCC.

4.56 In Canada, the prohibition, restriction or regulation of land for its use as a wireless telecommunications facility does not rest with the Land-Use Authority so that zoning and other laws do not interfere with federal undertaking such as cellular networks. Nonetheless, Industry Canada requires anyone who is planning to install or modify an antenna system that doesn't meet certain criteria to consult with the local land-use authority and/or local public where appropriate. Industry Canada generally considers that once a participating land-use authority is contacted, the consultation process should be concluded within 120 days.

Safety Issues

4.57 In Central Business Districts and densely populated areas of large cities, usually adequate space is not available for ground based towers and therefore towers are erected on roof top of the buildings. It has been mentioned before that, according to the industry data, approximately

70% of the towers are roof top towers. This raises concerns regarding structural and fire safety. Some of these buildings may be structurally weak and may develop cracks or collapse due to weight of the towers or vibration of DG sets endangering the lives of the people living in and around such installations. Delhi being within Zone-IV with MSK seismic intensity VIII i.e. high earthquake prone area according to Indian Code IS: 1893–2002, there is a special need to ensure structural safety of the buildings in case of roof top towers. Different civic authorities require the service providers to submit structural safety certificates from different agencies. There are no uniform standards prescribed across the country.

4.58 DoT has issued guidelines on Disaster Resistant Telecom Buildings and Towers vide their letter no. 800-4/2001-VAS dated 24.10.2005. According to these guideline "To ensure safety of tower during such disaster, it may be made mandatory for all telecom operator to design the towers by incorporating the provisions of latest BIS codes of practice governing the design. A structural safety certificate may be obtained from a qualified structural engineer and submitted to a designated central unit of DOT which shall be authorised to check any design. And if any design is found deficient in examination appropriate action may be taken against the concerned operator".

4.59 The Indonesian government requires that the construction of telecommunication towers should be earthquake-resistant to prevent the repeated breakage of telecommunication service soon after a disaster. All the telecommunication operators who have installed BTSs on buildings have been cautioned to take into account the condition of the buildings while installing infrastructure. BTSs are allowed to be installed only on earthquake-resistant buildings.

4.60 Air and noise pollution from the diesel generator sets used for un-interrupted supply of power to the equipment with the towers is has been cited as an area of concern. It is estimated that all the towers use about 2 billion litres of diesel and produce about 60 tonnes of CO_2 per BTS every year. Alternate energy sources like solar, wind, biogas and fuel cells are becoming available but they are currently expensive.

4.61 The following issues therefore deserve consideration:

17. Do you consider that the existing framework of different civic authorities to grant permission for telecom towers is adequate and supportive for growth of telecom infrastructure?

18. Is there a need to set-up a single agency for approval and certification of towers? Is there an existing agency that can do this work? If a new agency is proposed, what should be its composition and framework?

19. Is it feasible to have a uniform framework of guidelines including registration charges, time frame, single window clearance etc for granting permission for installation of telecom towers and laying of optical fibre cables? If so, can it be prescribed by the Licensor or the Regulator?

20. What can be an appropriate time frame for grant of permission for erection of towers?

21. How can a level playing field be ensured for telecom service providers vis-à-vis other utility service providers especially in reference to tower erection?

22. Which agency is best suited to inspect the buildings and certify the structural strength of the buildings in case of roof based towers?

Electro-magnetic Radiation from towers.

4.62 Concerns have also been raised that continuous exposure to RF radiation emanating from telecom towers cause harmful thermal and non-thermal health effects. The ill-effects of exposure to radio frequency radiation has created an active scientific debate among the research agencies across the globe. However, till now there is no conclusive report on the adverse effects by exposure to RF radiation. Further, there remains a lack of consensus among the experts about whether and at what levels electric/magnetic fields and electromagnetic radiation can result in adverse effects on human beings. Most current safety standards are based on the thermal effects. In order to assess the scientific evidence of possible health effects of EMR in the frequency range from 0 to 300 GHz, World Health Organization (WHO) established the International EMF Project in 1996. WHO also released a fact sheet on "Electromagnetic fields radiation and public health: Base stations and wireless technologies[9] in May 2006 wherein it has held that "*Considering the very low exposure levels and research results collected to date, there is no convincing scientific evidence that the weak RF signals from base stations and wireless networks cause adverse health effects."*

4.63 Some reports that point to adverse effect of radiation from mobile towers/mobile phones are given below:

- The Telegraph (16.10.2008): Study by the International Agency for Research on Cancer, part of the World Health Organization (WHO) discovered that the chances of developing a malignant tumour are

[9]http://www.who.int/mediacentre/factsheets/fs304/en/

"significantly increased" for people who use cell phones for ten years.

- The Independent (21.09.2008): Research from Sweden reports that children and teenagers are five times more likely to get brain cancer, if they use mobile phones.

- Among people living closer than 300 m away from the base station, a French study found an increased incidence of tiredness within 300m, of headache, sleep disturbance, discomfort, etc. within 200 m, and of irritability, depression, loss of memory, dizziness, libido decrease, etc. within 100 m. Women were found to complain significantly more often than men of headache, nausea, loss of appetite, sleep disturbance, depression, discomfort and visual perturbations. This study, based on the symptoms experienced by people living in vicinity of base stations recommend that the minimal distance of people from cellular phone base stations should not be < 300 m. (Santini R, et al 2002)

- An Austrian research confirms health effects of base station radiation. Another study where tests were done on subjects living within 20-600 meters from Mobile Phone Base stations were found to have sleeping problems and effect on cognitive performance. (Hutter et al 2006)

- The Australian, UK (5.13.2006) After a seventh case of brain tumor observed among workers in the top floors of a Melbourne office building, the top floors were closed down and 100 people were evacuated. The mobile phone towers on the roof of the 17-storey RMIT University building were thought to be linked to the recurrent cancer cluster.

- JJ Hospital in Mumbai, India said no to installation of mobile towers inside the premises. VVIPs in JJ Hospital had complained of poor network inside main building, but experts said electromagnetic signals would adversely affect medical equipment and powerful antenna tower inside the campus could be hazardous too.

However, further studies and research are being promoted by WHO to determine whether there are any health consequences from the higher RF exposures.

4.64 DoT amended the Licenses of Unified Access Services Providers and Cellular Mobile Service Providers on 4th November 2008 by introducing the clause 43.6A stipulating limits of radiations. The clause is reproduced below:

" Licensee shall conduct audit and provide self certificates annually as per procedure prescribed by Telecommunication Engineering Centre (TEC) / or any other agency authorized by Licensor from time to time for confirming to limits/levels for antennae (Base station emissions) for general public exposure as prescribed by International Commission on Non- Ionizing Radiation Protection (ICNIRP) from time to time. The present limits/levels are reproduced as detailed below:

Freq- Range	**E-field strength (Volt/Meter (V/m))**	**H-Field strength (Amp/Meter (A/m))**	**Power Density (Watt/Sq.Meter (W/Sq.m))**
400 MHz to 2000 MHz	$1.375f^{1/2}$	$0.0037f^{1/2}$	f/200
2GHz to 300 GHz	61	0.16	10

(f = frequency in MHz)

Table 4.2 Acceptable EMR levels

4.65 The RF emission related issues being very important, and there being several studies indicating the presence or absence of a risk to human beings from RF radiation, TRAI proposes to engage itself in gathering this data and making suitable recommendations / regulations in this regard separately.

5 - Alternate sources of energy

4.66 A large number of towers have been installed in areas where there is no power supply or supply is available only for a short time every day. The pre-dominant use of diesel generators as alternate source of power is a big source of carbon emission. This would only increase if greener alternatives are not worked out. Solar power initiative has the advantage of cutting down on noise and air pollution but is found to be expensive today. The operating expenses are low but the initial cost of a solar panel is high. Agencies are working on other alternatives like wind energy and fuel cells. There have been reports that the concerned ministries are working out subsidies to promote use of solar power.

4.67 TRAI issued a pre-consultation paper on 'Green Telecommunications' in May 2010 and is soon coming up with a detailed consultation paper. Use of alternate energy sources for telecom towers will also be deliberated in that consultation paper.

6 - Infrastructure sharing

4.68 It was discussed in paragraphs 4.3 and 4.4 that a large number of towers will be required to meet the infrastructural requirements of the projected telecom growth. Installation of a large number of additional towers would

mean higher investment and more environmental issues. Generally, infrastructure creation is desirable but inefficient use of the same leads to unnecessary cost to the service provider. The capital that is invested in creating excessive infrastructure has an opportunity cost and can better be utilised for other capital investments. In this context, the concept of infrastructure sharing between mobile operators assumes importance, as it allows operators to leverage and ride on existing infrastructure.

4.69 With the introduction of 5-6 new service providers in each of the service area, reduction in the overall tariffs and restrictions placed by various local bodies on installation of mobile towers, infrastructure sharing amongst service providers and IP-Is has become a necessity. In the wireless network setup, presently the IP-I is only allowed to install and maintain the passive infrastructure at site i.e. tower structure, electrical supply and power backup systems, air-conditioning, secure cabins, safety of the site etc. The active infrastructure, namely, BSC, BTS, RF amplifiers switches & cables, access antennae and microwave antennae, along with associated setup, etc. belongs to the service providers. The IP-I is not permitted to own and accordingly cannot import these active infrastructure components. As per the licensing conditions and regulation the MSCs cannot be shared among service providers and to be setup by the service provider for their use.

4.70 According to the Indian telegraph Act, 1885, Central Government Authorisation, i.e. a telegraph/ telecommunication licence, is necessary for establishing, maintaining and working telegraphs in the country. Therefore, a proper authorisation in the form of a licence from the Government is necessary for IP-I to establish and maintain telegraph. Thereafter, Wireless Telegraphy (WT) licence is also required by any telecom operator to provide wireless based telecom services.

4.71 According to the Indian Wireless Telegraphy Act, 1933 Government authorisation/licence is required even to deal and/or possess any wireless telegraphy/telecommunication equipment/apparatus etc. As the IP-I is not a licensee, it is not permitted to possess, install and maintain the wireless transmitter & receiver equipment/setup.

4.72 It has been observed in the May 2010 recommendations on Spectrum Management that according to the terms and conditions of the CMTS/UASL, the access service providers were initially permitted sharing of "passive" infrastructure viz., building, tower, dark fibre etc. only. However in April, 2008, in order to ensure an optimum utilization of the available resources and to bring down the cost of providing service, the Government issued 'Guidelines on Infrastructure sharing among the Service Providers and Infrastructure Providers'. As per these guidelines, the service providers were permitted to share the active infrastructures limited to antenna, feeder cable, Node B, Radio Access Network (RAN) and transmission system only. The DoT, vide its letter dated 9th March 2009 has clarified that the scope of IP-I category providers, which is presently limited to passive infrastructure, has been enhanced to cover the active infrastructure if this active infrastructure is provided on behalf of the licensees, i.e. they can create active infrastructure limited to antenna, feeder cable, Node B, Radio Access Network (RAN) and transmission system only for/on behalf of UASL/CMSP licensees. Therefore, the Authority recommended that in view of increasing role of IP-1 in the sector, there are enough reasons to bring them under the ambit of licensing regime and permitting them to provide both passive and active infrastructure, independent of the service providers. This will facilitate faster roll out and reduction in the capital expenditure on the part of the service providers.

4.73 For infrastructure sharing, some of the other issues which need to be considered are - load bearing capacity of the antenna, azimuth angle of different operator, tilt of the antenna and height of the antenna. While new infrastructure can be built taking into consideration the ultimate load bearing capacity required, the existing towers may not be designed to cater for more load resulting in unsuitability of such towers for sharing of infrastructure. In case of roof top mounted antennas, load bearing capacity of the building/foundation also becomes very important and may limit the possibility of sharing. Microwave antennae required for backhaul are also mounted on the same towers increasing the load. If optical fibre is used for providing backhaul connectivity, microwave antennas can be avoided. This will not only increase the number of tenants on a tower but will also enable the service providers to carry enhanced volume of voice and data traffic using the same tower. Future infrastructure has to be designed keeping in view the ultimate requirement of sharing. The National broadband plan recommendations given by TRAI in August 2010 have proposed extensive fibre optic network in the access and backhaul networks. Once this fibre is in place providing backhaul connectivity for the BTSs of multiple service providers would be possible on this fibre.

4.74 International experience in Infrastructure Sharing is described below:

- Australia has permitted passive infrastructure. Commercially negotiated 3G site and RAN sharing is also allowed.
- In Brazil ANATEL has allowed passive sharing (mast, towers, and site equipment) in all areas and sharing of active network elements (Antennas, transmission system, RNCs) in rural areas. Spectrum sharing is also allowed.

- In China, both active and passive infrastructure sharing are allowed. In 2008, China's Ministry of Industry and Information Technology (MIIT) had published new rules which encouraged the mobile operators to share their network infrastructure wherever possible.
- France allows both passive and active infrastructure sharing. However, sharing of spectrum is not allowed.
- The Malaysian Communications and Multimedia Commission(MCMC) has identified infrastructure sharing as one of the criteria for issuing licences for 3G mobile spectrum. It has asked applicants to demonstrate their capacity of sharing of network capacity and capabilities (traffic volume and access conditions).
- In Pakistan, both Active and Passive infrastructure sharing are allowed. The main rationale behind encouraging infrastructure sharing, especially amongst the mobile cellular operators, is due to environment issues related to mast and towers. The Infrastructure sharing would include the requirement to lease out facilities on a principle of neutrality, non-discrimination, equal access to other service providers and such facilities includes, space, electrical power, air conditioning, security, cable ducts, space on antenna masts or towers, room etc. Infrastructure sharing also includes co-location.
- In Norway physical sharing of Node B, RNC and transmission routes is allowed as long as the operator retains logical control over their own base stations, network and spectrum. In France shring of Node B, BSC(RNC), MSC and Routers are allowed as long as the logical control is with the owner and frequencies are not shared.
- Sweden has allowed both active and passive infrastructure sharing
- In UK operators share masts whenever they can. The regulator has allowed sharing of RAN as well.
- In USA, both Active and Passive infrastructure sharing are allowed.

The following issues emerge for consultation:

23. Should sharing of mobile towers be mandated?

24. Should sharing of active infrastructure, created by themselves or infrastructure providers, be allowed?

CHAPTER V

MISCELLANEOUS ISSUES RELATING TO INFRASTRUCTURE

5.1 There are other areas in which it is important to create a conducive environment for growth of infrastructure. Three such areas in which TRAI has issued recommendations in the past and need reconsideration are Rural Telephony, migration from IPv4 to IPv6 and IPTV. These are discussed in the following sections.

A - Rural Telephony

5.2 TRAI in its recommendations on 'An Approach to Rural Telephony – Suggested Measures for an Accelerated Growth' dated 19th March 2009, inter-alia, made the following recommendations related to Universal Service Obligation Fund (USOF) in paragraphs 4.1 to 4.10:

i. In regard to revitalisation of USOF:
   - USOF should be reorganized and revamped with wide ranging but specific powers.
   - It is extremely important that the USOF Administrator is empowered effectively in terms of administrative and financial powers and ultimate decision making.
   - It needs to be separated from Department of Telecom and a framework on the lines of National Highway Authority should be considered.
   - It is important that the present USO Fund Act/ Rules should be so amended that the funds accruing to USOF through levy is directly managed by the organization and is not routed through the budgetary process of the Union Government. As it may take some

time to restructure the USOF as recommended above, therefore, in the interim, it is suggested that the government may ensure that the fund requirements of USOF are met, in totality, without any delay as and when requested by the USOF Administrator.

ii. For expediting the infrastructure support for the mobile and broad band services in rural areas:

- The USOF should follow the bidding process only where it is necessary.
- It should concentrate primarily on planning and monitoring of the implementation of the scheme.
- In view of the need to proliferate ICT applications in the rural areas and the fact that broadband is practically non existent in most of the rural areas, the identification of SDCAs should be revisited, and scope for the payment of subsidy may be broadened so as to cover majority of the geographical area designated as rural as per the last census.

iii. Based on the experience of Phase-I, the Authority recommends that USOF should determine the subsidy support for setting up towers in different regions and any IP-I/CMTS/UASL operator, who sets up the tower in the designated SDCAs and share it, should be paid subsidy depending on the number of operators sharing the tower. It is further recommended that 80% of the bid amount determined by the USOF in phase-I of a rural cluster may be considered as an incentive to the existing IP-I / access service providers having mobile towers in the designated SDCAs. For this purpose, upto three service providers may be encouraged for sharing of existing towers. (e.g., if rupees "X" per annum for five years is the bid amount for a certain cluster under phase-I, then any IP-I/existing service provider having mobile tower,

that falls within the designated SDCA, shall be eligible for 40% of Rs. "X" subsidy per annum for five years in case the tower is shared by two service providers and shall get subsidy of 80% of Rs. "X" in case of sharing by three service providers). In case the designated SDCA is not one of the identified in phase-I then the rates finalized for the nearest identified cluster may be taken.

iv. The Authority reiterates its earlier recommendations of charging a reduced USO levy of 3% on covering 75% of the development blocks including villages in a licensed service area.

v. The USOF may devise a scheme to call expression of Interest from IP-I/NLD/UAS licensees to provide fibre from the USOF subsidized towers to nearest block headquarter. USOF shall give subsidy @ maximum one lakh per KM per sharing (to be distributed over a period of three years) provided it shares it with at least one access service provider. The subsidy will be restricted up to two sharings with those telecom service providers who are having USOF subsidized sites. The OFC owner will be free to lease the remaining fibre to the other service providers but the subsidy will be given for only two sharings. The subsidy will be given only after certification of usage by the concerned access service providers.

vi. In order to curtail the delay in USOF subsidy disbursement, the payments for subsidy claims shall be made in a certain time frame based on the self certifications of the service providers. In case any discrepancy is found after verification, the recovery, if any, shall be made from the service provider.

vii. In order to improve broadband infrastructure, the Authority recommends that USOF may device a scheme / agreement with state governments in which broadband connection are facilitated by USOF while state Government would assure fixed number of broadband connections for Government offices/ public places such as hospitals /schools etc.

viii. The development of local content needs to be area specific and should address the local and immediate needs of the people.

ix. The USOF supported activities should be synergized and coordinated with the State Government activities and efforts.

x. (I) The delay in obtaining the right of way can be considerably reduced if amendment is made in section 10 of the Indian Telegraph Act, 1885. Accordingly the Authority suggests the following amendments in the said Act:

In section 10 after Clause (c), the following clause may be inserted as 10(ca) -

"The local authority will grant permission within such reasonable time as it thinks fit, but not exceeding 90 days from the date of receipt of requests for such permissions from the telegraph authority."

(II) DoT, in consultation with state governments, should invoke the provision under section 15 of the Indian Telegraph Act, 1885 and shall appoint, in general, the District Magistrate as an officer for redressal of such disputes.

(III) The installation of towers and related equipment in rural areas serves the purpose of local population and to some extent

business organizations. Hence the requirement for land conversion (around 400 Square metre of land) for setting up tower in rural areas by the telecom service providers should be dispensed with.

(IV) State electricity boards should provide power supply to rural BTSs on priority basis.

(V) DoT shall again issue a broad framework to help state governments to form their state specific telecom policy."

5.3 However subsequently, in its recommendations on "Spectrum management and licensing framework" of May 2010 and 'National Broadband Plan' of December 2010, the Authority has revisited the issue of need to have a faster penetration of mobile services and broadband in the rural areas.

5.4 In the "Spectrum management and licensing framework" recommendations of May 2010 the Authority has made the following observations and recommendations:

- In its recommendations of May 2010, the Authority has observed that the present roll out obligations are very lenient and are urban centric. The service providers are mandated to provide coverage only in the district headquarters or major towns. As a result even 15 years after the introduction of mobile service in the country, the rural teledensity is still below 25%.
- The importance of telecommunications in the development of rural areas needs no reiteration. Providing telecommunications to the rural areas and bridging the urban-rural divide has been the objective of the Government for long. The Authority would ideally like to see all the villages/habitations with a population of 500 and above to be covered within the next three years. Since earlier

efforts in this direction have met with limited success, the Authority would like to adopt a two-fold approach to this challenge. One segment of this approach is to impose a full service obligation on the service providers. The Authority is in favour of imposing an obligation of coverage of Habitations having a population of more than 2000 in a phased manner, as follows:

Roll out obligations

Time	Habitation >10000	Habitation 5000-10000	Habitation 2000-5000
2 years from effective date	100%	50%	-
3 years from effective date	100%	100%	50%
4 years from effective date	100%	100%	100%

In the above roll out obligations, coverage of 90% or above habitations will be taken as compliance of the obligation.

- In order to ensure that the smaller habitations are also covered, the Authority also recommended that those licensees who have covered 50% of the habitations with a population of 500-2000 be given a reduction of 0.5% in the annual licence fee and those licensees who have covered 100% (90% & above to be treated as 100%) of the habitations with a population of 500-2000 should be given a 2% discount in the annual licence fee.

- On the use of USO fund, the Authority recommended that the Universal Service Obligation Fund be utilised by the government for provision of telecommunications facilities in habitations having a population of less than 500 and to provide broadband to all the villages having a population of more than 1000 to start with and later

extend the same to all habitations having a population of 500 and above.

5.5 In the recommendation on "National Broadband Plan" issued in December 2010, the following were the main points relating to rural coverage:

- The Authority has emphasized that the primary objective of the USO fund should be to lay optical fibre cable from Block Head Quarters(BHQ) to villages so as to fulfil the backhaul bandwidth requirement for provision of broadband and facilitate broadband growth in the rural areas. Accordingly, the Authority recommended for formation of National Optical Fibre Agency(NOFA) and State Optical Fibre Agency(SOFA) and stated that this network would require a fund of Rs 60,000 Crore, which may be financed by USO Fund and the loan given/ guaranteed by Central Government.

- The issue of 'Right of Way' has been a major constraint in proliferation of optical fibre network in the country, therefore in its recommendations of December,2010, the Authority has again discussed this issue and has recommended that "the Government may fix and notify the charges for Right of Way in consultation with the State Governments on priority basis and ensure time bound availability of RoW to telecom service providers after due intimation to the agency concern."

- On the issue of local content for the rural areas, the Authority has discussed various applications like e-Health, e-Banking, e-Commerce, e-Education, e-Governance, e-Entertainment etc.

which are required to develop and customized for the local needs. On the issue of developing content in local languages the Authority in the same recommendations observed that websites that currently exist in local languages are insufficient to cater to the needs of the users. The content that is available today on the Internet is largely in English and is not customized to local needs. The task is to make this content available in Indian languages. Further, there is also a need for a higher proliferation of vernacular user interface (keyboards, software etc) to facilitate usage of local language content.

5.6 In view of the above the Authority proposes that no action be taken on the recommendations made on "An Approach to Rural Telephony – Suggested Measures for an Accelerated Growth" dated 19th March, 2009 which are yet to be accepted by the Government. **Stakeholders' comments are invited on this proposal.**

B – Migration to IPv6 (Internet Protocol version 6)

5.7 The current generation of IP version 4 (IPv4) uses a 32 bit addressing and allows for approximately 4.3 billion unique IP addresses. Use of IPv4 started in 1983 and at present only 6% unallocated IPv4 address blocks are left in IANA (Internet Assigned Numbers Authority), the body responsible for the global coordination of the IP addressing. With the limited addressing resources and rapidly growing demand of IP addresses, unallocated address pool with IANA is projected to be exhausted by February 2011 and that with Regional Internet Registries (RIRs) by November 2011. As per the OECD report "Economic

Considerations in the Management of IPv4 and in the Deployment of IPv6" the IPv4 will run out of address space in July 2011.

5.8 In order to find a long term solution for shortage of IP addresses, a new 128-bit IP standard has been defined by the Internet Engineering Task Force (IETF) in 2000, called IPv6. Given the larger size of IPv6 addresses, the entire address space can theoretically support $3.4x10^{15}$ unique addresses. Besides larger address space, IPv6 also offers advantages of better quality of service, better security features and support for multi-media services.

5.9 IPv6 is being adopted progressively around the world. The biggest push for IPv6 comes from the Asia Pacific region, which faces the most serious shortage of allocated IPv4 addresses. In India some steps have been taken by the Government towards deployment of IPv6. An IPv6 Implementation Group (IPIG) has been formed under the aegis of DIT to work out the roadmap for migration to IPv6. ERNET established an IPv6 test-bed in the year 2005 connecting various educational and research institutes. TRAI made its recommendations on 'Issues relating to Transition from IPv4 to IPv6" in January 2006 the main points of which were:

- Change in IP address definition in ISP license to facilitate use of any version of internet protocol including IPv6.
- Creation of National Internet Registry (NIR) for IPv6 on priority basis.
- Encouragement by Government for IPv6 migration:
    - Govt. should mandate usage of IPv6 in the platforms/applications pertaining to e-governance, and IPv6

compatibility in its own procurement of IT systems and networks.

- Organize workshops and seminars to bring awareness about IPv6 and its benefits for service providers and end-users community.
- Setting up IPv6 Test bed.

5.10 These recommendations were accepted by DoT in June 2009. The Government also formed an IPv6 Task Force in July 2010 for smooth transition from IPv4 to IPv6. The Task Force has been entrusted with the task of taking up activities in the following key areas for speedy deployment of IPv6:

(i) Raise awareness on the exhaustion of IPv4 and impact of IPv6 on proliferation on Internet and broadband in the country.
(ii) Encourage all stakeholders to begin the initial phases of IPv6 readiness.
(iii) Develop transition plans in subsequent phases to support a smooth and wide transition to IPv6.
(iv) Undertake series of impact assessments/business cases
(v) International cooperation in IPv6 related areas

5.11 The Government has modified the definition of the IP addresses in the ISP license in October 2007 and made provision for the use of IPv6 address space. TEC (Telecommunication Engineering Centre) has organised several workshops on awareness and technical issues related to migration to IPv6. However, no notification has been issued by the Government regarding usage of IPv6 in the platforms/applications pertaining to e-governance, and IPv6 compatibility in its own procurement of IT systems and networks.

5.12 In line with the recommendations of TRAI, the application for setting up of National Internet Registry (NIR) was submitted by National Internet Exchange of India (NIXI) to APNIC (Asia Pacific Network Information Centre) in August 2008. A National Internet Registry (NIR) is a national resource allocation agency that obtains numeric Internet address resources (IP addresses, AS number) from regional Internet registry (RIR) and allocates these resources to the service providers of the country. APNIC has given its in-principle approval for setting up of NIR in India by NIXI. However, final approval is still awaited.

5.13 IPv6 deployment in India is very slow at present. Till now only 76 entities (ISPs, Educational institutes and other organizations) have obtained IPv6 addresses from APNIC, out of which only 16 have deployed and announced their IPv6 routes. The major hurdle in IPv6 deployment seems to be unavailability of IPv6 content and applications leading to lack of interest from the consumers. In addition, migration from IPv4 to IPv6 may require hardware and software upgrades, in the operator's network as well as in the applications and programs used at the user's end. Needless to say that this would have financial repercussions which would be weighed against the benefits obtained from migration.

5.14 With increasing adoption of wireless devices that can connect to the Internet, machine to machine communication, growth of broadband, cloud computing a large number of IP addresses will be required in India in the near future. As already mentioned above, the existing IPv4 address pool with RIRs is likely to exhaust by November 2011. Several mechanisms like Classless Inter-Domain Routing (CIDR) Addressing, Network Address Translation (NAT) have been used in order to solve the problem of address scarcity, but these add a level of complexity in the implementation of peer-to-peer applications and are blamed as mechanisms used by network operators to retain control over the end

users. The methodologies that have been tried can only delay the IPv4 address exhaustion for sometime but cannot provide a long term solution. In such a scenario, migration to IPv6 may have to be treated with urgency so that shortage of addresses does not hamper growth of telecom services in India.

5.15 A lot discussion has taken place on the issue but commensurate action, for adoption of IPv6 in India, is lacking. The service providers foresee a major upgradation of the backbone and access aggregation network for being able to actually implement IPv6. Enterprises would also need to upgrade their LANs and applications in order to make them IPv6 compatible. The users hesitate to demand IPv6 compliant content, applications and hardware as it may mean more expenditure. However, it is important to see that the time is not far away when there would be no more IPv4 addresses and then the service providers, the infrastructure providers, the corporate users, content and application developers would all have to take emergency action which may mean sub-optimal development and higher cost.

5.16 The following issues emerge for consultation:

27. What measures are required to encourage the deployment and adoption of IPv6 in the country?

28. In your opinion, what should be the timeframe for migration to IPv6 in the country?

C - IPTV (Internet Protocol Television)

5.17 IPTV is provision of television and other value added services using IP protocol. It is a new method of delivering and viewing television program using high speed IP networks. IPTV is one of the examples of convergence of broadcasting and telecom networks that is rapidly transforming the

market. It has become a very popular value added service in many countries and the service providers' networks are being upgraded to be able to offer such services.

5.18 Due to the advantages that IP offers, more and more telecom service providers are adopting IPTV technology. The service provisioning by Telecom service providers is done in accordance with the licensing conditions of the various licenses. However, broadcasting of TV channels is governed under provisions of Cable Television Networks (Regulation) Act, 1995. In order to examine the applicability of Cable Television Networks (Regulation) Act, 1995 to telecom service providers for providing IPTV services, TRAI issued a position paper on "Provisioning of IPTV Services" in September 2007.

5.19 TRAI sent its recommendations on "Provision of IPTV Service" to Department of Telecommunications and Ministry of Information & Broadcasting Government simultaneously on 4th January 2008. The main recommendations are summarized below:

(i) Telecom service providers (UASL and CMTS) having license to provide triple play services and ISPs with net worth more than Rs. 100 crore and having permission from the licensor to provide IPTV can provide IPTV service under their licenses without requiring any further registration. DoT, as a licensor, can permit any other telecom licensee to provide IPTV services. Similarly cable TV operators registered under Cable Television Network (Regulation) Act 1995 can provide IPTV services without requiring any further license.

(ii) Any breach of the provisions of Act/ License/ Registration/ Permission by telecom service provider/ cable operator/ Broadcasters shall be dealt with by designated agencies which are

responsible for administering such Acts/ License/ Registration/ Permissions.

(iii) BIS would look into standardization of IPTV Set Top Box specifications.

(iv) Compliance of Content regulations by respective ministries.

(v) Amendment in the up linking / down linking guidelines to enable the broadcasters to provide signals to all distributors of TV channels such as cable operators, multi-system operators, DTH operators, HITS operators, IPTV service providers.

5.20 These recommendations were accepted by the Government and the Ministry of Information & Broadcasting (MIB) issued guidelines for operating IPTV services in September 2008. MIB also amended the up linking/down linking guidelines in September 2008 enabling the broadcasters to provide signals to all distributors of TV channels such as cable operators, multi-system operators, DTH operators, and IPTV service providers. Subsequently Department of Telecommunications also amended ISP licenses in February 2009 enabling them to provide IPTV services after taking prior permission if they have networth of Rs 100 crores. This enabled provisioning of IPTV services by telecomm service providers as well as by cable TV operators.

5.21 ISPs complain that restrictions in providing various value added services are impacting their business model and are hindrance in the growth of broadband. ISPAI (Internet Service Providers Association of India) has also raised the issue of level playing field and wanted that ISPs may also be permitted to provide IPTV services without having restrictions on their networth. The core network required to provide IPTV services can be shared and hence limiting ISPs to provide IPTV services is restrictive in nature and not desirable.

5.22 The growth of IPTV services is slow but has huge potential. The flexibility to ISPs to provide various services will boost broadband penetration and will contribute in development telecom infrastructure. Comments of the stakeholders are invited as to how we can encourage different service providers to enhance provision of IPTV services.

5.23 Issues for Consultation

29. What measures do you suggest to enhance provision of IPTV services by various service providers?

30. Should there be any restriction on ISPs for providing IPTV services in this competitive environment?

CHAPTER VI

ISSUES FOR CONSULTATION

Overview of Telecom Infrastructure

6.1 Do you agree with the classification of infrastructure elements described in this chapter? Please indicate additions/modifications, if any, particularly where you feel that policy interventions are required.

6.2 What measures can be taken to encourage more ILDOs and ISPs to set up cable landing stations?

Internet Exchange Point

6.3 Do you perceive the need for effective Internet exchange point(s) in the country to efficiently route domestic IP traffic?

6.4 If your answer to issue in 6.3 is in affirmative, please comment on the licensing framework of the entities for setting up Internet Exchange Points in India.

6.5 Will it be desirable to permit those Unified licencees to setup IP exchange points in the country who have no vested interest in routing of the IP traffic?

Mobile Virtual Network Operator

6.6 Please give your comments on the changes proposed in para 3.5 of Section C of Chapter 3.

In- Building Solutions

6.7 What methods would you propose for reduction of the number of towers?

6.8 In what ways do you think that IBS can be encouraged for better in-building coverage, better QoS and reduction in level of radiated power from Macro cell sites?

6.9 How can sharing of IBS among service providers be encouraged? Does TRAI need to issue any guidelines in this regard?

Distributed Antennae Systems

6.10 Do you agree that innovative technologies such as 'Distributed Antenna System' (DAS) can be effectively utilised to reduce number of towers and migrate towards tower-less cities?

6.11 What are the impediments in adoption of new technologies such as DAS and how can these be removed?

Standardization of Tower Design

6.12 Would you agree that the design of towers can and should be standardised?

6.13 If yes, how many different types of towers need to be standardised?

6.14 What are the important specifications that need to be included in these standards?

6.15 Which is the best Agency to standardise the tower design?

Reducing Visual Impact of Towers

6.16 What is the likely cost of camouflaging the towers?

6.17 Can camouflaging be made mandatory? If so, can this be made part of the design standards of the towers?

Clearances From Local Authorities

6.18 Do you consider that the existing framework of different civic authorities to grant permission for telecom towers is adequate and supportive for growth of telecom infrastructure?

6.19 Is there a need to set-up a single agency for approval and certification of towers? Is there an existing agency that can do this work? If a new agency is proposed, what should be its composition and framework?

6.20 Is it feasible to have a uniform framework of guidelines including registration charges, time frame, single window clearance etc for granting permission for installation of telecom towers and laying of optical fibre cables? If so, can it be prescribed by the Licensor or the Regulator?

6.21 What can be an appropriate time frame for grant of permission for erection of towers?

6.22 How can a level playing field be ensured for telecom service providers vis-à-vis other utility service providers especially in reference to tower erection?

6.23 Which agency is best suited to inspect the buildings and certify the structural strength of the buildings in case of roof based towers?

Infrastructure sharing

6.24 Should sharing of mobile towers be mandated?

6.25 Should sharing of active infrastructure, created by themselves or infrastructure providers, be allowed?

Use of USO for rural areas

6.26 Please comment on the issues raised in paragraph 5.6 of Section A of Chapter 5.

IPV6

6.27 What measures are required to encourage the deployment and adoption of IPv6 in the country?

6.28 In your opinion, what should be the timeframe for migration to IPv6 in the country?

IPTV

6.29 What measures do you suggest to enhance provision of IPTV services by various service providers?

6.30 Should there be any restriction on ISPs for providing IPTV services?

General

6.31 Please give your comments on any related matter not covered above.

LIST OF ACRONYMS

Sl No.	Acronyms	Expansion
1	3G	3RD GENERATION
2	3GPP	THIRD GENERATION PARTNERSHIP PROJECT
3	4G	FORTH GENERATION
4	AAS	ADAPTIVE ANTENNA SYSTEMS
5	ADSL	ASYMMETRIC DIGITAL SUBSCRIBER LINE
6	APON	ATM PASSIVE OPTICAL NETWORK
7	BGP	BORDER GATEWAY PROTOCOL
8	BPL	BROADBAND OVER POWER LINE
9	BPON	BROADBAND PASSIVE OPTICAL NETWORK
10	BPSK	BINARY PHASE SHIFT KEYING
11	BQS	BROADBAND QUALITY SCORE
12	BSC	BASE STATION CONTROLLER
13	BSO	BASIC SERVICE OPERATOR
15	BSS	BASE STATION SUBSYSTEM
16	BTS	BASE TRANSCEIVER STATION
17	BWA	BROADBAND WIRELESS ACCESS
18	CAGR	COMPOUND ANNUAL GROWTH RATE
19	Capex	CAPITAL EXPENDITURE
20	CCS7	COMMON CHANNEL SIGNALLING 7
21	CDMA	CODE DIVISION MULTIPLE ACCESS
22	CLS	CABLE LANDING STATION
23	CPE	CUSTOMER PREMISES EQUIPMENT
24	CSC	COMMON SERVICE CENTER
25	CUG	CLOSED USER GROUP
26	DAS	DISTRIBUTED ANTENNAE SYSTEM
27	DECT	DIGITAL ENHANCED CORDLESS TELECOMMUNICATIONS
28	DIT	DEPARTMENT OF INFORMATION TECHNOLOGY

29	DMT	DISCRETE MULTI TONE
30	DOT	DEPARTMENT OF TELECOM
31	DSL	DIGITAL SUBSCRIBER LINE
32	DSLAM	DIGITAL SUBSCRIBER LINE ACCESS MULTIPLEXER
33	EDGE	ENHANCED DATA RATE FOR GSM EVOLUTION
34	ETSI	EUROPEAN TELECOMMUNICATIONS STANDARDS INSTITUTE
35	EV-DO	EVOLUTION DATA OPTIMIZATION
36	FDD	FREQUENCY DIVISION DUPLEX
37	FTTB/C	FIBRE TO THE BUILDING/CURB
38	FTTH	FIBRE TO THE HOME
39	GDP	GROSS DOMESTIC PRODUCTS
40	GEPON	GIGIABIT ETHERNET PASSIVE OPTICAL NETWORK
41	GMSC	GATEWAY MOBILE SWITCHING CENTRE
42	GPON	GIGABIT PASSIVE OPTICAL NETWORK
43	GPRS	GENERAL PACKET RADIO SERVICE
44	GSM	GLOBAL STANDARD FOR MOBILE
45	HDSL	HIGH BIT RATE DIGITAL SUBSCRIBE LINE
46	HFC	HYBRID FIBRE COAXIAL
47	HLR	HOME LOCATION REGISTER
48	HSPA	HIGH SPEED PACKET ACCESS
49	HSUPA	HIGH-SPEED UPLINK PACKET ACCESS
50	IBS	IN BUILDING SOLUTIONS
51	ICT	INFORMATION AND COMMUNICATION TECHNOLOGY
52	IEEE	INSTITUTE OF ELECTRIC AND ELECTRONICS ENGINEERS
53	ILD	INTERNATIONAL LONG DISTANCE
54	IMSI	INTERNATIONAL MOBILE SUBSCRIBER IDENTITY
55	IMT-2000	INTERNATIONAL MOBILE TELECOMMUNICATION GLOBAL STANDARD
56	IP	INTERNET PROTOCOL
57	IPLC	INTERNATIONAL PRIVATE LEASED CIRCUITS

58	IPTV	INTERNET PROTOCOL TELEVISION
59	IPv4	INTERNET PROTOCOL VERSION 4
60	IPv6	INTERNET PROTOCOL VERSION 6
61	ISDN	INTEGRATED SERVICE DIGITAL NETWORK
62	ISP	INTERNET SERVICE PROVIDERS
63	IT	INFORMATION TECHNOLOGY
64	ITU	INTERNATIONAL TELECOMMUNICATION UNION
65	IXP	INTERNET EXCHANGE POINT
66	LAN	LOCAL AREA NETWORK
67	LTE	LONG TERM EVOLUTION
68	MDF	MAIN DISTRIBUTION FRAME
69	MNO	MOBILE NETWORK OPERATOR
70	MS	MOBILE STATION
71	MSAN	MULTI SERVICE ACCESS NETWORK
72	MSC	MOBILE SWITCHING CENTRE
73	MSISDN	MOBILE STATION INTEGRATED SERVICES DIGITAL NETWORK
74	MVNO	MOBILE VIRTUAL NETWORK OPERATOR
75	NGN	NEXT GENERATION NETWORK
76	NG-PON	NEXT GENERATION PASSIVE OPTICAL NETWORK
77	NIXI	NATIONAL INTERNET EXCHANGE OF INDIA
78	NLD	NATIONAL LONG DISTANCE
79	NLOS	NON LINE OF SIGHT
80	NOC	NETWORK OPERATION CENTRE
81	OAN	OPTICAL ACCESS NETWORK
82	ODN	OPTICAL DISTRIBUTION NETWORK
83	OFC	OPTICAL FIBRE CABLE
84	OFDM	ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING
85	OFDMA	ORTHOGONAL FREQUENCY DIVISION MULTIPLE ACCESS
86	OLT	OPTICAL LINE TERMINATION
87	ONU	OPTICAL NETWORK UNIT

88	Opex	OPERATING EXPENSE
89	OSA	OPEN SERVICE ARCHITECTURE
90	PC	PERSONAL COMPUTER
91	PCM	PULSE CODE MODULATION
92	PLC	POWER LINE COMMUNICATION
93	PLMN	PUBLIC LAND MOBILE NETWORK
94	PON	PASSIVE OPTICAL NETWORK
95	PSK	PHASE SHIFT KEYING
96	PSTN	PUBLIC SWITCH TELEPHONE NETWORK
97	QoS	QUALITY OF SERVICE
98	QPSK	QUADRATURE PHASE-SHIFT KEYING
99	RAN	RADIO ACCESS NETWORK
100	RAN	RADIO ACCESS NETWORK
101	RAT	RADIO ACCESS TECHNOLOGIES
102	RLU	REMOTE LINE UNIT
103	ROW	RIGHT OF WAY
104	RPR	RESILIENT PACKET RING
105	SDH	SYNCHRONOUS DIGITAL HIERARCHY
106	TAX	TRUNK AUTOMATIC EXCHANGE
107	TDD	TIME DIVISION DUPLEX
108	TDM	TIME DIVISION MULTIPLEXING
109	TDM	TIME DIVISION MULTIPLEXING
110	TEC	TELECOM ENGINEERING CENTER
111	TRAI	TELECOM REGULATORY AUTHORITY OF INDIA
112	TRAU	TRANSCODER RATE ADAPTATION UNIT
113	TV	TELEVISION
114	UASL	UNIFIED ACCESS SERVICE LICENCE
115	UE	USER EQUIPMENT
116	UMB	ULTRA MOBILE BROADBAND
117	UMTS	UNIVERSAL MOBILE TELECOMMUNICATIONS SYSTEM

118	USOF	UNIVERSAL SERVICE OBLIGATION FUND
119	VDSL	VERY HIGH DATA RATE DIGITAL SUBSCRIBER LINE
120	VLR	VIRTUAL LOCATION REGISTER
121	VoIP	VOICE OVER INTERNET PROTOCOL
122	VPN	VIRTUAL PRIVATE NETWORK
123	VSAT	VERY SMALL APERTURE TERMINAL
124	WCDMA	WIDEBAND CODE DIVISION MULTIPLE ACCESS
125	WDM	WAVE DIVISION MULTIPLEXING
126	Wi-Fi	WIRELESS FIDELITY
127	WiMAX	WORLDWIDE INTEROPERABILITY FOR MICROWAVE ACCESS

ANNEXURE –I

Circle wise number of wireless subscribers and BTS

(March 2010)

S.No.	Area	No.of BTS as on March 2010	No.of Wireless Subscribers (in millions)	Average No.of Subscribers per BTS
METROS				
	Delhi	**20024**	**28.3**	**1413**
	Mumbai	**16194**	**26.48**	**1635**
	Kolkata	**110069**	**16.4**	**1482**
CIRCLE- 'A'				
	Maharashtra	**35480**	**43.52**	**1226**
	Gujarat	**25801**	**32.35**	**1254**
	Andhra Pradesh	**37392**	**45.62**	**1220**
	Karnataka	**32407**	**37.13**	**1146**
	Tamil Nadu (incl.Chennai)	**43918**	**53.68**	**1222**
CIRCLE- 'B'				
	Kerala	**23157**	**24.19**	**1045**
	Punjab	**17378**	**20.1**	**1156**
	Haryana	**11927**	**14.13**	**1185**
	UP (W+E)	**61160**	**74.68**	**1221**
	Rajasthan	**27030**	**33.74**	**1248**
	MP	**25992**	**31.98**	**1230**
	West Bengal	**20603**	**25.17**	**1221**
CIRCLE- 'C'				
	HP	**5149**	**4.99**	**968**
	Bihar	**30931**	**36.97**	**1195**
	Orissa	**15851**	**15.27**	**963**
	Assam	**8758**	**8.76**	**1000**
	North East	**4321**	**5.31**	**1229**
	J&K	**6791**	**5.55**	**817**

ANNEXURE-II

List of Recommendations on MVNO dated 6th August 2008

1. Definition

"MVNO is a licensee in any service area that does not have spectrum of its own for access service, but can provide wireless (mobile) access services to its own customers through an agreement with the licensed access provider, UAS/CMTS Licensee"

2. Need and timing for introduction of MVNO

The Authority recommends that MVNO should be introduced in the Indian telecom network as a distinct service provider with its own licensing and enabling light touch regulatory framework.

3. Types of MVNO

Authority recommends that MVNO should be free to choose its business model. However MVNO shall not set up its own Radio Access Network (RAN)/ Base Station Subsystem (BSS).

4. Regulatory Models

Considering the international scenario and the stakeholders comments and keeping in view the Indian scenario as described above and discussed elsewhere in this recommendation, the Authority recommends that the commercial model covering the nature of relationship including the arrangement/ agreement between MNO and MVNO be left to the market forces. Besides commercial and other points, the points that has to be part of the agreement are given in chapter 4. A copy of the agreement is to be filed with the Licensor. The Authority reserves the right to intervene.

5. Issue of licence

The Authority recommends that MVNO should be issued a license under section 4 of the Indian Telegraph Act, for providing the services. The terms and conditions of the license have been outlined in these recommendations.

6. Licensed Service area

Considering all the technical and regulatory aspects, the Authority recommends that the licensed service area (circle) of MVNO should be same as that of parent MNO. However, the MVNO could offer service anywhere within the licensed service area (circle) of the parent MNO as specified in the mutual agreement between MNO and MVNO. Separate licence for each service area shall be required.

7. Duration of Licence

Authority recommends that the duration of license for MVNO should be 20 years and renewable. However the validity of MVNO licence shall be co-terminus with the validity of licence of the parent MNO i.e MVNO licence would automatically get terminated if the license of parent MNO is terminated or ceases to exist.

8. Eligibility conditions

The Authority recommends that an Indian company, which fulfills licence conditions such as FDI & substantial equity and the following conditions of networth and paid up capital shall be eligible for issue of MVNO license in a service area.

a) Networth: 10% of the networth specified for the MNO for the service area i.e. Rs.10 Crores for Metros/'A' Category, Rs. 5 Crores for 'B' Category, Rs. 3 Crores for 'C' Category
b) Paid up Capital: 10% of the prescribed networth for the MVNO.

The procedure for issue of license to MVNOs, shall be as follows:

i. LOI shall be issued to the eligible MVNO by the licensor.
ii. Entry fee and Bank guarantees to be submitted by the MVNO within a month from the date of grant of LOI by the licensor. The MVNO shall also enter into an agreement with MNO and submit the same to the Licensor, within this period of one month from the date of LOI.
iii. License shall be issued after the above conditions are fulfilled.
iv. The mandatory points that must be covered in the agreement between MNO and MVNO are listed in Chapter 4. TRAI would have power to intervene on any clause in the agreement. None of the

clause should violate any of the license conditions or the regulations in force. The Regulations / Directions / Orders of TRAI in this regard would be binding on MNO and MVNO.

v. If due to some reason, agreement between MVNO & MNO is terminated, the license of the MVNO would also be terminated. Fresh licence will have to be obtained by the MVNO if new agreement is being signed by the MVNO with another MNO.

9. Scope of Service of MVNO

The Authority recommends that the scope of service of MVNO would be within the scope of service of MNO, i.e. the MVNO can offer any or all of the services that the MNO can offer subject to the agreement between MNO and MVNO.

10. Number of MVNOs

The Authority recommends that there should not be any limit to the number of MVNOs attached to a MNO. However a MVNO cannot get attached to more than one MNO in the same service area.

11. Commercial Model

The Authority recommends that-.

(i) Commercial model between MVNO and MNO to be left to mutual agreement between the two. However this would be subject to the License Conditions and Regulations/ Directions/ Orders of TRAI.

(ii) MNO should pay spectrum charges also on the revenue of MVNO(s) or all the payments made by MVNO(s) to MNO, whichever is higher. In case it is difficult to operationalise this, any other scheme where the spectrum charges are accrued to the Government on the revenues of both MNO and MVNO(s), will serve the purpose.

(iii)The subscribers of MVNO(s) should be counted towards parent MNO for the purpose of spectrum allotment in bands where subscriber based criterion is applicable for spectrum allotment.

12. Service Obligations of MVNO

The Authority recommends that the service obligations may be dependent on the type of model chosen by MVNO. At the minimum level MVNO should handle obligations such as customer grievances, tariff and billing and at the maximum level the obligations would be same as that of MNO, except rollout obligations.

MVNO would however be directly responsible for –

i. Customers acquisition, management and grievance handling.

ii. Achieving QoS parameters as prescribed by TRAI from time to time.

iii. Complying with Billing and metering requirements as prescribed by TRAI including audit / surveys.

13. Entry Fees

The Authority recommends that the entry fee imposed on MVNO should be nominal. It may be 10% of MNO's entry fee as prevailing on date in that service area subject to a maximum of Rs. 5 crores for Metros and Category 'A', Rs. 3 crores for Category 'B' and Rs. 1 crore for Category 'C'.

14. Annual licence fee and AGR

The Authority recommends that the rate of annual licence fee as well as definition of AGR for MVNO shall be on similar lines as defined in the Access Service Providers' licence to whom the MVNO is parented.

15. Allocation of numbers, number portability, interconnection with other service providers and roaming

The Authority recommends that the allocation of numbers, number portability, interconnection with other service providers and roaming be provided to MVNO by the parent MNO. For allocating new block of numbers to MNO the subscribers of MVNO(s) should also be counted. On request, Mobile Network Code (MNC) should be allotted to MVNO by the licensor.

A suitable condition may be inserted in the licence for both MVNO and MNO to the effect that the Authority would intervene in case the hosting conditions of the network operators are not conducive enough for competition in the market for the MVNOs.

16. Failure of agreement between MVNO and MNO

The Authority recommends that:

a) In case of a dispute between MVNO & MNO, the procedure for resolution of dispute would be same as that being followed for disputes between MNOs.

b) In case MVNO wants to exit the business:

(i) MVNO to give six months' notice to customers, MNO, Licensor and the Authority before stopping the services.

(ii) MNO would offer its services to the subscribers of MVNO to migrate to any of the tariff plan of MNO without any extra charges such as upfront/ activation charges. In the case of lifetime subscribers, they should be offered life time plan of MNO. The subscriber should be allowed to retain the same number.

(iii) The MVNO that exits the business, would be disqualified to get a fresh license in that service area.

(iv) If the MVNO exits business, the PBG shall be forfeited. FBG shall be returned after adjusting the dues payable.

17. Roll out Obligations

The Authority recommends that

i. No roll out obligation be prescribed for MVNOs and

ii. MNO has to fulfill its roll out obligations independently i.e. the roll out done by the MVNO shall not be counted towards roll out of the parent MNO.

18. Mergers

The Authority recommends that in a service area, Merger of a MVNO with the parent MNO or another MVNO parented to the same MNO

may be permitted. Merger of MVNOs parented to different MNOs in a service area is not permitted as in a service area one MVNO can only get parented to one MNO.

19. Substantial Equity

The Authority recommends that in any service area, an equity holder, having 10% or more equity in a MVNO cannot hold 10% or more equity in another MVNO. In a service area, an equity holder having 10% or more equity in an MNO cannot hold 10% or more equity in a MVNO.

20. Foreign Direct Investment

The Authority recommends that to harmonize the FDI limit for various services in telecom sector, level of FDI upto 74% may be permitted in MVNO. As in the case of MNO up to 49% FDI through automatic route and beyond 49% up to 74% with prior FIPB approval may be prescribed. All the other conditions related to FDI applicable to MNO would be applicable to MVNO also.

21. Bank Guarantees

The Authority recommends that FBG should be equivalent to two quarters' license fee. As it may not be possible to estimate two quarters' licence fees initially, the amount of FBG for the first year may be fixed as 5% of FBG of MNO of that service area.

The PBG for MVNO to be 5% of MNO i.e. Rs. 1 Crore for Circle A, Rs. 50 Lakhs for Circle B and Rs. 10 Lakhs for Circle C.

22. Quality of Service

The Authority recommends that responsibility of the Quality of Service to its subscribers would remain with the MVNO. The Regulations/ Direction/ Orders of TRAI in this regard would be binding on MVNO.

23. Tariff

Authority recommends that MVNO being directly responsible for the tariff related matters, MVNOs should independently comply with the applicable Telecom Tariff Orders (TTOs) and tariff related requirements as prescribed by TRAI.

24. Customer acquisition

The Authority recommends that MVNO should comply with the requirements of customer acquisition including subscriber verification.

25. Technical standards

The Authority recommends that the facility based MVNOs who set up their own infrastructure has to ensure that the equipment that they use confirms to the prescribed standards.

26. National Security

The Authority recommends that MVNO should comply with all the requirement of National Security.

27. Reporting requirements

The Authority recommends that MVNO should comply with all the reporting requirements of the licensor and the Authority.