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**APT REPORT ON**

**DEVELOPMENT OF ENABLING POLICY AND REGULATORY ENVIRONMENTS, IN THE CONTEXT OF SATRC, TO EMBRACE THE NEW ECOSYSTEM BROUGHT BY 5G**

**Edition: October 2023**

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**EXECTIVE SUMMARY**

1. **Introduction & Background**
   1. Telecommunications sector has seen a tremendous growth in the recent past. Availability and affordability of smartphones and high-speed connectivity are the driving factors behind this. India already has one of the world’s largest and fastest growing bases of digital consumers and is digitizing faster than many mature and emerging economies. India was ranked fourth among ‘Break Out Economies’.[[1]](#footnote-1) Break out economies are the ones that are digitalizing very quickly and yet have a lot of room to grow before matching the developed economies such as those in Europe and in more developed Asian countries like Singapore, South Korea, and Hong Kong.
   2. Last few decades have witnessed several generations of mobile technologies (2G, 3G and 4G), each of them significantly contributing towards enhancing the digital connectivity and economic prosperity. 5G is not just yet another evolution of cellular technology enhancing mobile broadband capability, but it will act as an accelerator for digital transformation across industries. 5G provides ultra-reliable low latency communications, massive machine type connectivity and enhanced mobile broadband services. 5G network slicing features make the network service-oriented by allowing different use cases with varying network requirements to run flexibly and simultaneously on the same physical network.
   3. 5G technology holds the potential to enable unprecedented degrees of flexibility, productivity, and efficiency in industrial manufacturing. The potential of 5G, combined with artificial intelligence (AI), AR/VR, smart platforms and IoT, can deliver enormous value to consumers, organizations and the society at large. It will also pave the way for developing services for making smart cities, autonomous vehicles, smart factories, etc. Thus, 5G vision extends beyond mobile broadband connectivity and provides an opportunity to Telecom Service Providers (TSPs) to transform themselves into a Digital Service Provider.
   4. The core competency of TSPs today is in providing network connectivity. To realise the potential benefits of 5G, the network needs to transform into a digital platform and should be delivered as a service in the digital marketplace. Most of the implementations of 5G use cases will be brownfield implementations where the 5G solution needs to seamlessly integrate with existing business processes, IT systems and operational technologies. TSPs will need to adopt an ecosystem and build trusted and strategic partnerships with other ecosystem players, like
   5. Other infrastructure providers like electricity authorities, Railway and Road transport authorities.
   6. Device manufacturers
   7. Compute, storage, network vendors
   8. Software platform, API and application providers
   9. Cloud providers, Data, analytics and AI providers
   10. Domain-specific system integrators
   11. Open-source communities, Standard bodies and Regulators
   12. Hence, an ecosystem and collaboration-based approach will be key to faster and cost-effective deployment of 5G infrastructure as well as mass-scale adoption of 5G industry use cases. Keeping in view this fact, SATRC has come out with this report. The objective of this paper is to emphasize the need of such Cross-sector partnerships among the various players in the value chain, such as telecom and other infrastructure providers, media, manufacturing, health, education, government, and other sectors. It also dwells upon the challenges anticipated by the industry while building such partnerships and the possible regulatory approaches for South Asian region. It is expected that this report will pave the way for collaboration among various stakeholders of 5G ecosystem and accelerate the digital transformation across industries in the region.
2. **Scope & Objective**
   1. The scope of this report is to explore the possible policy and regulatory framework in areas such as
3. Spectrum Roadmap, Allocation, Sharing and Harmonization
4. 5G infrastructure deployment including small cell deployment, Fiber Backhaul/ Microwave Backhaul and infrastructure sharing

Pro-active tasks such as 5G testbeds, Experimentations and investment in R&D

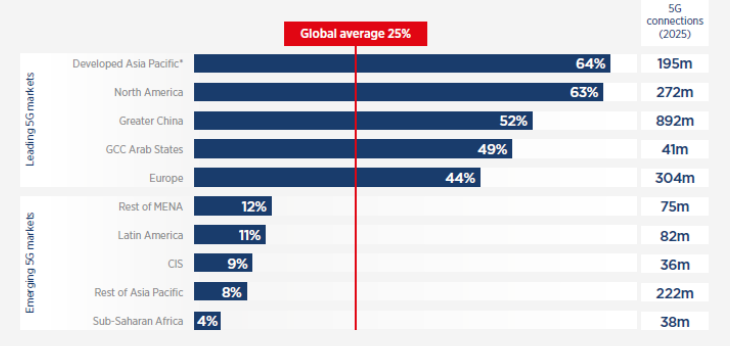
1. Cross sector collaboration for 5G infrastructure deployment
2. Cross sector collaboration for development and deployment of 5G use cases.
3. **Composition of the Report**
   1. This report is divided into four chapters. Chapter 1 discusses about the present deployment status of 5G. Chapter 2 deals with the policy and regulatory issues related to 5G spectrum and infrastructure deployment, global best practices and experience of India related to these issues. It also emphasizes the need of infrastructure sharing and radio frequency compliance issues regarding 5G small cell deployment scenario. Chapter 3 is about the cross-sector collaboration in 5G ecosystem for infrastructure deployment as well as development and deployment of 5G use cases. Chapter 4 includes recommendations for SATRC member countries on the subject matter. Annexure-I throws some light on the necessity of 5G for all depicting its likely socio-economic impact. Annexure-II contains the responses to the questionnaire received by all the SATRC countries.
4. **Methodology** 
   1. The study has been carried out in consultation with other experts from SATRC member countries on the subject. A questionnaire was prepared and circulated among the member nations. The questionnaire and responses are attached as Annexure-II. Based on the inputs and through the analysis of established literature and document, various policy and regulatory aspects for embracing 5G ecosystem has been presented and ways forward for the SATRC countries have been suggested.

# CHAPTER-1

# 5G DEPLOYMENT STATUS

1. **Status of 5G commercial launches and subscriptions worldwide**
   1. According to a recent report released by GSMA in January 2023,
2. 515 operators in 155 countries/territories have been investing in 5G networks in the form of tests, pilots, licence acquisitions, planned and actual deployments.
3. Of those, 243 operators in 96 countries/territories have launched commercial 3GPP-compatible 5G services (mobile or fixed wireless access)
4. 112 operators are identified as investing in 5G standalone for public networks (including those evaluating, testing, piloting, planning or deploying as well as those that have launched 5G standalone networks).
5. More than 1700 5G devices have been announced, out of which at least 1400 5G devices are commercially available.
6. 28 more countries and territories are planning 5G spectrum assignments by the end of 2023. This includes 112 operators that offer 5G fixed wireless access (FWA) services.
   1. 5G adoption is continuously rising. Momentum has been boosted by a number of factors, including the economic recovery from the pandemic, rising 5G handset sales, network coverage expansions and overall marketing efforts.

**Figure 1.5 : Global 5G connections by 2025**



Source: GSMA Intelligence

\*Australia, Japan, Singapore and South Korea

5G has become mainstream in many pioneer markets (notably China, South Korea and the US) and is making considerable progress in other countries as well. A new wave of 5G rollouts in large markets with modest income levels (such as Brazil, Indonesia and India) could further incentivise the mass production of more affordable 5G devices to cater to consumers in lower-income brackets. It could also drive the development of new 5G applications for consumers and enterprises in emerging markets. This is significant given that the majority of 5G applications and use cases to date have been focused on more advanced markets.

* 1. Operators around the world began their 5G deployment efforts with the non-standalone (NSA) version of the technology. However, after a slow start, 5G standalone (SA) deployments are beginning to ramp up. As per a GSA report[[2]](#footnote-2), 112 operators in 52 countries and territories are investing in standalone 5G for public networks in the form of trials, plans, paying for licences, deploying or operating networks. At least 37 operators in 22 countries and territories are now understood to have launched public standalone 5G networks, with several more expected to go live in the coming years. The added functionalities enabled by 5G SA are key to delivering on the 5G promise of fully supporting enhanced mobile broadband (eMBB), ultra-reliable low-latency communications (URLLC) and massive IoT use cases.
  2. Mobile operators are collaborating with vendors and enterprises across different verticals to explore the potential of 5G SA. For example, SoftBank and Honda are working together to test the effectiveness of using 5G SA and a cellular vehicle-to-everything (C-V2X) system to reduce collisions between pedestrians and vehicles. In Spain, Telefónica has announced plans to target three enterprise 5G use cases for its 5G SA network in 2022 - automated guided robot vehicles for use in places such as warehouses; remote maintenance systems using technology such as smart glasses; and drones for site surveillance.

1. **Status of 5G deployment in SATRC Countries**
   1. Nine nations that constitute SATRC, vary enormously in size and economic and technological power. It varies from the tiny landlocked kingdom of Bhutan, population less than 1 million and a GDP of US$2.54 billion[[3]](#footnote-3), to India with a population of 1.4 billion and a GDP of US$3.17 trillion. The 5G deployment status as reported by the respective nations at the end of 2022 are as follows:
2. **Afghanistan** has not made any decision or plan for 5G launch.
3. Commercial launching of 5G services are yet to begin in **Bangladesh**.[[4]](#footnote-4)
4. The 5G service has been commercially launched by the two Mobile operators i.e., Bhutan Telecom Limited and Tashi InfoComm Limited since December 2021 in **Bhutan**.
5. In **Iran** 5G services are commercially available as per Ookla 5G map. MTN Irancell has launched the country’s first commercial 5G service in 3 cities of Iran.
6. In **Maldives** 5G services were launched in the Maldives in 2019 and 2020 by the two mobile service providers. Both service providers cover the capital Male’ and whole of Greater Male’ region. 5G service is also available in two more populous islands one in the South and in the North with 5G service now available to about 45% of the population.
7. Spectrum has been provided to **Nepal** Telecom, free of cost, for 5G trial purpose. Non-standalone as well as standalone architecture is planned to be deployed for test purpose. This won’t be a commercial rollout, but limited subscribers will be able to use the services without any usage fees. This has been the initiative of NTA and Nepal Government, and they are in the process of incorporating other operators as well as frequency bands in the testing process. Such step is undertaken to test the coverage, ultra-fast speed, low latency, synchronization, handover, mobility, reliability, FWA features etc. of the 5G network.
8. Spectrum bands are identified for 5G launch in **Pakistan** in line with global practices and ITU standards.
9. In **SriLanka** 5G trials have been started three years back by many operators in the country under the guidance of the regulator. Assignment of spectrum for commercial 5G deployment has been planned in Q1 of 2024.
10. **5G deployment in India:**
    1. 5G services were first launched in India on October 1, 2022. At present, only Bharti Airtel and Reliance Jio are the two telecom operators offering 5G services in the country. Indian telecom operators have surpassed the three-year 5G network rollout target given to them within six months. They have set up more than 300,000 sites as of August 2023. It is expected that majority of the towns in the country will be covered by the end of this year.
    2. India is witnessing a digital revolution since last decade. Rising disposable income coupled with affordable data tariffs are encouraging the people to go digital. Growing smartphone penetration, significant rise in OTT consumption, digital payments, E-commerce are some of the major factors driving this digitization. These drivers enabled the ARPU in India to see a notable rise in the past 4 years, growing at a CAGR of ~13%. This is expected to further see a healthy rise going forward with the advent of 5G that makes data consumption seamless.
    3. With this revenue growth trajectory, telecom companies are investing heavily in 5G, fiber and coverage infrastructure across the country. 5G has significantly enhanced mobile internet speeds in the country. According to Ookla, the median download speed increased from 13.87 Mbps in September 2022 to 36.35 Mbps in April 2023. As a result, India’s position on the Speedtest Global Index improved by 58 places from 118th in September 2022 to 60th in April 2023.[[5]](#footnote-5)
    4. India has developed its indigenous 4G/5G technology stack, which is now ready, and the country is poised to emerge as a significant telecom technology exporter to the world in the coming three years. India is holding discussions with 18 countries[[6]](#footnote-6) that are planning to implement the 4G/5G technology stack, 5G based Private Networks have also started being deployed in India. Bharti Airtel has deployed Captive Private Network at Mahindra's Chakan Auto manufacturing facility in partnership with Tech-Mahindra.

**Government’s Initiative to facilitate the launch of 5G services**

* 1. The initiatives by the Government cover varied factors ranging from building 5G level infrastructure and bringing the ecosystem together for effective R&D to helping telcos to increase investments in 5G.

1. 5G HIGH LEVEL FORUM - This forum was formed to provide an action plan to realise the 5G vision. The forum released a report outlining the roadmap, suggesting policies, programs, standards and use cases for 5G.
2. BHARAT NET - It is government run project that aims to connect the rural India on the optical fibre network and provide it on non-discriminatory basis to all service providers.
3. 5G TEST BED - The government has offered indigenous 5G test bed at free of cost to start-ups and MSMEs and at nominal rates to other stakeholders to validate their use cases.
4. VEPP PROGRAM - 5G Vertical Engagement and Partnership Program (VEPP) program is an initiative to build strong collaboration partnerships across 5G Use-case ecosystem stakeholders with an exclusive emphasis to address User/Vertical Industry needs. In order to multiply the 5G opportunities across the usage verticals, an Inter-Ministerial Committee is constituted with representatives from various Ministries to facilitate collaborative efforts across stakeholders. VEPP will enable close collaboration between User verticals and 5G Tech stakeholders (Service providers, Solution providers & partner OEMs), which can trigger a multiplier effect to try & fine tune 5G digital solutions in respective economic verticals.
5. **Likely Impact of 5G on Economy of SATRC Countries**
6. **BANGLADESH –**
   1. Since 2019-2020, a high-level National Committee, led by BTRC, has been working to plan and formulate necessary policy guideline to launch 5G service in Bangladesh. The committee is comprised with representatives of BTRC, academia, government agencies, other regulatory bodies, mobile operators and other industry players. Under the supervision of this committee, primary spectrum identification, pricing of spectrum, formulation of regulatory guideline, auction guideline, Network architecture, service scope and modality, security aspects, etc. were outlined in a general manner. Moreover, BTRC has orchestrated many industry consultations, public consultations, vendor led trails, operator led trials and workshops which have helped illustrating the prospective socio-economic impact of 5G. These consultative approaches are key to reap the forthcoming 5G benefits for the individuals and industries of Bangladesh
7. **INDIA -** 
   1. 5G is expected to power up to 2% of India’s GDP, amounting to USD180 Billion by 2030[[7]](#footnote-7) , facilitated by increasing market penetration, strengthening economy and sectoral reforms. Sectors such as healthcare, energy & utilities, manufacturing, and retail are expected to benefit the most from large-scale 5G adoption. Effective collaboration between public and private players for creating a skilled workforce and cybersecurity infrastructure, reducing regulatory overlaps, and providing financial incentives, will be needed to ensure that the benefits of 5G are realized across sectors. 5G is expected to create new value through hyper-connectivity and become a catalyst for digital transformation across industries. 5G provides an opportunity for industries to augment the pace of digitization at the grassroots level and for consumers to gain with economies of scale.

**Figure 1.6 : 5G-enabled B2B Potential for select Industries in 2030**

**$ 180 Bn**

* 1. However, achieving this will require effective ecosystem collaboration between Telcos, OEMs, Infrastructure companies, and the Government to increase consumer adoption and market readiness to unlock large-scale benefits of 5G. Adequate infrastructure upgradation and fiberisation for 5G deployment, along with network densification need to be addressed to realize the full benefit of the technology across industries. 5G adoption will depend on factors such as dedicated R&D investments to develop India-specific use cases, enterprise penetration, device affordability, and consumer adoption.

1. **NEPAL -** 
   1. A study conducted for NTA included a topic “Socio-economic impact of 5G technologies and benefits of 5G”. The study focused more on literature review as well as analysis of international practices. The study concludes that 5G technology will provide the opportunity to reduce the digital divide in Nepal. The report also mentions that technology infrastructure and features of 5G will help Nepal to rapidly materialize the concept of smart cities and digital transformation.
2. **PAKISTAN -** 
   1. A study on “5G Readiness Plan for Pakistan” was conducted by Government of Pakistan, which was completed in 2021. The Report concluded that Pakistan can harness significant economic benefits if it facilitates the early deployment of 5G by a range of supporting policies and actions. In the long term the economic benefits to the Pakistan economy of 5G are very substantial. In contrast, stopping, delaying or other not releasing spectrum for 4G/5G services runs the risk that Pakistan and Pakistani citizens will be unable to be ‘digital ready’ and benefit from new innovative mobile technologies.

# CHAPTER- 2

# Identification of Policy & Regulatory Issues

1. **Spectrum for 5G**
2. **Spectrum band characteristics**
3. In general, radio frequencies differ widely in their capabilities to provide coverage and capacity. Lower frequency bands provide wider coverage because they can penetrate objects effectively and thus travel inside buildings. However, they tend to have relatively poor capacity capabilities because of limited supply. Higher frequency bands do not provide good coverage as these signals get attenuated by obstacles such as buildings and other objects. However, they tend to have greater capacity because there is a larger supply of high frequency spectrum making it easier to create broad frequency bands, allowing transfer of more user information. Therefore, waves that operate at very high frequency (e.g., mmWave bands) cannot get through obstacles but can carry lots of data. (Figure 2.1).

**Figure 2.1. Frequency bands vs. capacity and coverage**



source: GSMA

1. Because of their characteristics, lower frequency bands allow mobile operators to provide very wide coverage including in rural areas without requiring many base stations. However, these bands have a limited capacity to carry large amounts of data so operators tend to use higher frequency bands in busy areas such as cities and town centers where lots of people use mobile broadband services. Although this means lots of base stations are needed as the signals don’t travel far.
2. As a result, operators are looking to acquire more sub-1 GHz spectrum to extend mobile broadband into rural areas, especially in emerging markets. Simultaneously, they are also increasingly looking to higher frequency bands. That includes, spectrum bands above 3 GHz to accommodate busy urban areas. To provide higher aggregate bitrates in each cell it is also needed to have bigger width of the frequency carriers.
3. If the technology development at a given moment of time is limited by the maximum possible frequency carrier width (which increases with the time), then the tool to increase it on radio interface level is to aggregate different carriers below the network layer (i.e., below IP) and then the aggregated spectrum (consisted of different carriers, which may be located in different spectrum bands) can appear as a single pipe in a given cell from the networking and application point of view. So, the capacity in each cell is directly related to the available spectrum and possibility for aggregation of frequency carriers, and that directly influences the available speeds to the end users.
4. **Identification of Spectrum for 5G**
5. According to ITU, spectrum bands and spectrum management for deployment of 5G can be sub-divided in three macro categories: sub-1 GHz, 1-6 GHz and above 6 GHz as shown in Figure 2.2

**Figure 2.2 Capacity and coverage of 5G spectrum bands**



1. Sub-1 GHz bands are suitable to support mobile broadband coverage in suburban and rural areas as well as for various IoT services. This is because the propagation properties of the radio signals at these frequencies enable 5G to create very large coverage areas and deep in-building penetration.
2. The 1-6 GHz bands, such as the 3.5 GHz band, offer an optimal mix of coverage and capacity for 5G services. There is a reasonable amount of existing mobile broadband spectrum identified with this range which could be used for initial 5G deployments.
3. mm Wave bands, such as the 24 GHz and 28 GHz bands, are being used for 5G to deliver ultra-high-speed services and support high-density applications. These bands offer large amounts of bandwidth and are suitable for delivering high-speed services to small areas with high user density, such as urban centers and busy public spaces. The downside of using mm Wave bands is the much reduced coverage size of each cell and its susceptibility to blocking.
4. 3GPP has specified two frequency ranges (FRs) for 5G spectrum management, namely FR1 and FR2. The FR1 is sub-7 GHz range (410 - 7125 MHz) while FR2 is so-called mmWave range for 5G which exists above 24250 MHz, with two sub-ranges FR2-1 and FR2-2, as shown in Table 2.1.

**Table 2.1 Frequency ranges for 5G in 3GPP standards[[8]](#footnote-8)**

|  |  |  |
| --- | --- | --- |
| **Frequency range designation** | | **Corresponding frequency range** |
| **FR1** | | 410 MHz – 7125 MHz |
| **FR2** | **FR2-1** | 24250 MHz – 52600 MHz |
| **FR2-2** | 52600 MHz – 71000 MHz |

1. ITU WRC-19 has identified additional radio-frequency bands for International Mobile Telecommunications (IMT), which will facilitate the development of 5G mobile networks in the following several years. WRC-19 identified additional globally harmonized (millimeter wave) frequency bands for IMT, including IMT-2020 (i.e., 5G), facilitating diverse usage scenarios for enhanced mobile broadband, massive machine-type communications and ultra-reliable and low-latency communications. This will unlock a host of applications facilitating Intelligent Transport Systems, creating smart cities and making communities more sustainable while allowing for effective climate action, improved health care, sustainable agricultural practices, and greater energy efficiency.
2. 5G spectrum in mm wave bands above 24 GHz was the most important agenda item of WRC-19. So, WRC-19 has identified the mmWave frequency bands 24.25-27.5 GHz, 37-43.5 GHz, 45.5-47 GHz, 47.2-48.2 and 66- 71 GHz for the deployment of 5G networks. In total, 17.25 GHz of spectrum has been identified for IMT by the Conference. Out of this, 14.75 GHz of spectrum has been harmonized worldwide, reaching 85% of global harmonization.
3. In addition, WRC-19 has also defined a plan of studies to identify frequencies for new components of 5G. As an example, to facilitate mobile connectivity by High Altitude IMT Base Stations (HIBS) they may be used as a part of terrestrial IMT networks to provide mobile connectivity in underserved areas where it is difficult to be covered by ground-based IMT base stations at a reasonable cost. Moreover, additional frequency bands for High Altitude Platform Systems (HAPS) and the new Concept of HAPS 4G/5G base stations was approved, too. The Frequency bands 31-31.3 GHz, 38-39.5 GHz identified for worldwide use by HAPS. Existing bands in 40 GHz are also available for HAPS. So, HAPS can provide broadband connectivity with minimal ground network infrastructure. This can potentially enable lower-cost connectivity and faster deployment.
4. 5G will also need to provide Local Area Networks (LANs) services with improved capabilities to multiple market segments like residential, office, enterprise and factory etc. 3GPP has defined NR-U (New Radio in unlicensed bands) to enable the 5G system to offer 5G LAN-type services and virtual networks:
5. 5G LAN-type service: it is a service over the 5G system offering private communication using IP and/or non-IP type communications.
6. 5G LAN-virtual network: it is a virtual network capable of supporting 5G LAN-type service.
7. Targeted spectrum bands for NR-U are given in Table 2.2.

**Table 2.2 Spectrum Bands for 5G NR-U**

|  |  |  |  |
| --- | --- | --- | --- |
| **5G NR band** | **Uplink (UL) band** | **Downlink (DL) band** | **Duplex mode** |
| **n46** | 5150 MHz – 5925 MHz | 5150 MHz – 5925 MHz | **TDD** |
| **n96** | 5925 MHz – 7125 MHz | 5925 MHz – 7125 MHz | **TDD** |

3GPP Release 16 provides a single global solution framework for access to unlicensed spectrum which enables operation of NR in the 5 GHz and the 6 GHz (e.g., US 5925 – 7125 MHz, or European 5925 – 6425 MHz, or parts thereof) unlicensed bands taking into account regional regulatory requirements and reusing features of NR as much as possible.

1. The amount of spectrum needed for IMT mobile systems (IMT-2000 i.e. 3G, IMT-Advanced i.e. 4G and IMT-2020 i.e. 5G) has increased exponentially in the past three decades. The amount of spectrum identified for IMT in all ITU World Radiocommunication Conferences so far is about 19 GHz worldwide. Last spectrum allocation was done about 3 years ago, at WRC-19 concluded on 22 November 2019. The ITU-R has already consolidated the Agenda for WRC 2023, which includes different new candidate bands in different spectrum ranges.
2. **5G Spectrum assignment in SATRC Countries**
3. As reported by SATRC countries, the status of assignment of 5G spectrum is as follows:
4. **Afghanistan -** ATRA has not made any decision or plan for 5G spectrum auction or allocation yet.
5. **Bangladesh –** Spectrum bands that have been identified for 5G:

| **Band / GHz** | **Duplex Mode** | **Uplink / Downlink (MHz)** | **Assignment**  **(Amount)** |
| --- | --- | --- | --- |
| n40 / 2.3 | TDD | 2300 – 2400 | Partially Assigned in Auction  (70 MHz) |
| n41 / 2.6 | TDD | 2500 – 2690 | Partially Assigned in Auction  (120 MHz) |
| n78 / 3.5 | TDD | 3300 – 3800 | Temporary assignment for 5G trial (60 MHz) |

Spectrum auction for 2300 MHz and 2500 MHz bands has been done on 31st March 2022, where out of 220 MHz spectrum, 190 MHz was awarded in favor of 4 Mobile Network Operators.[[9]](#footnote-9)

Initially, these bands shall be used for enhancing existing 4G services throughout the country. Meanwhile, MNOs are directed to start the 5G trail in these bands by 30th September 2022. 5G is supposed to ride on the existing 4G infrastructure in its beginning phase. This NSA mode 5G will be eMBB only. MNOs shall be gathering trial experience and exploring vertical industry requirements before commercial launching. Upon issuance of necessary guidelines/licenses, MNOs may start providing commercial 5G services in Bangladesh.

1. **Bhutan** - 5G spectrum in the internationally harmonized mid band i.e. 3.5GHz has been assigned based on the administrative method. Both mobile operators have been allocated 100 MHz each i.e. 3.4-3.5 GHz and 3.5-3.6 GHz respectively. In Bhutan, 5G is used for mobile communication by the operators and the spectrum in mid-band is considered ideal for 5G eMBB with higher capacity than low-frequency bands and greater coverage (even indoors) than high-frequency bands.
2. **Iran** – The frequency bands assigned for 5G includes 3400-3600 MHz and the bands3600-3800 MHz and 24.25-27.5 GHz (26GHz) are considered for 5G.
3. **Maldives -** Both operators have been assigned with 100 MHz bandwidth each in 3.4 – 3.6 GHz. Additional 90 MHz in the 2.6 GHz band also allocated for 5G to each operator.
4. **Nepal** - All cellular bands have been made available for 5G deployment under technology neutrality regime. These bands are:

|  |  |
| --- | --- |
| Frequency Bands | Frequency Range |
|
| 700 MHz Band | 703-748 MHz paired with 758-803 MHz |
| 800 MHz Band | 852-862 MHz paired with 811-821 MHz |
| 850 MHz Band | 824-834 MHz paired with 869-879 MHz |
| 900 MHz Band | 880-915 MHz paired with 925-960 MHz |
| 1800 MHz Band | 1710-1785 MHz paired with 1805-1880 MHz |
| 2100 MHz Band | 1920-1980 paired with 2110-2170 MHz |
| 2300 MHz Band | 2300-2400 MHz |
| 2600 MHz Band | 2500 - 2570 paired with 2620 -2690 MHz |
| 2570-2620 MHz |
| 3500 MHz Band | 3300-3800 MHz |

NTA is in the process of allocating whole 2600 MHz Band in technology neutral regime. Additionally, studies are underway to allocate additional 5 MHz bandwidth in 800 MHz Band. Furthermore, 26 GHz (band n258: 24.25 to 27.50 GHz) is planned to be reserved and other mmWave bands shall be identified for mobile services in Nepal.

Among those bands, 2300 MHz and 2600 MHz bands will be considered as the primary bands for the introduction of newer services including 5G in Nepal as these bands provide better coverage than C-Band and have better compatibility with 4G. Also, 700 MHz and 800 MHz bands shall be considered as the primary 5G bands from the coverage perspective. However, these perspectives may change based on international market dynamics.

60 MHz in 2600 MHz Band (TDD) has been provided to an operator, free of cost, for 5G trial purpose.

1. **Pakistan** – Following spectrum bands are identified for 5G launch in Pakistan in line with global practices and ITU standards.

a. (B28/n28) 700 MHz, has been identified, however allocation is still pending.

b. (B40/n40) 2.3 GHz has been identified, however allocation is still pending

c. (B41/n41) 2.6 GHz has been identified; however, allocation is still pending.

d. (B42-43, B52/n78) 3.5 GHz - 3300 MHz - 3415MHz is available; 3415 – 3600 MHz be made available in 2024, however allocation is still pending

e. Available spectrum in (B3/n3) 1800 MHz and (B1/n1) 2100 MHz, however allocation is still pending

f. mmWave bands (n258 and n260) have been identified, however allocation is still pending

1. **Sri Lanka -** IMT Band 43 (3400-3600MHz) is identified for 5G for initial stage of the auctioning. This band was already cleared and ready for assignment. It is proposed to assign two chunks of 100MHz for two mobile operators.  In the later stage, 26GHz/28GHz band will be considered to cater the high-capacity requirements in 5G technology.
2. **5G Spectrum in India**
3. Government of India supports technology neutral spectrum. Telecom Service Providers can use any IMT technology in the bands identified for IMT. The foundation for ushering 5G services in India was laid with the 8th Spectrum Auction, held in July 2022. Government of India had put 72,098 MHz spectrum to auction, of which 51,236 MHz (71% of the total) has been sold with bid amounting to Rs. 1,50,173 cr. This is the highest-ever auction revenue proceeds received from a single auction. Further, in this auction highest number of bands i.e., 10 different bands across 22 LSAs (Licensed Service Areas) were simultaneously put to auction (i.e., 600 MHz, 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, 2500 MHz, 3300 MHz and 26 GHz).
4. The telecom reforms and clear policy direction led to spectrum auction of 2022 garnering highest ever bids. The recent reforms like zero spectrum usage charges on spectrum acquired from 8th auction onwards, doing away with mandatory up-front payments, ability to surrender spectrum after a minimum threshold period (10 years), easy payment options like increased number of annual installments (20 annual installments), option for moratorium on past dues etc. has contributed to successful spectrum auction. Spectrum is very critical for telecom connectivity and with better availability of spectrum to Telecom Service providers, the quality of services is also expected to improve.
5. **Indigenous 5G Test Bed**

Keeping in view India’s specific requirements and to take lead in 5G deployment, Department of Telecommunications (DOT) approved financial grant for multi-institute collaborative project to set up ‘Indigenous 5G Test Bed’ in at five locations viz. Integrated Test Bed at CEWiT/IIT Madras, IIT Delhi, IIT Hyderabad, IIT Kanpur and IISc Bangalore. The Indigenous 5G Test bed was dedicated to the nation by on May 17th 2022. Indian academia and industry can use the Indigenous 5G Test Bed to validate products, prototypes, algorithms, and services. As India becomes self-sufficient in 5G Technology, the development of this Indigenous Test Bed is a crucial step towards 5G Aatamnirbhar Bharat.

1. **Spectrum sharing**
2. Radio frequency spectrum is a scarce natural resource. With growing data usage, digitalization of services and uptake of video consumption over cellular network, demand for spectrum has increased significantly. Considering the growing demand for spectrum by not only the TSPs but also by other users such as Defence, Space, Railways, public sector undertakings (PSUs), captive users etc., it has become necessary for the Government to ensure efficient and optimal utilization of spectrum. Any amount of frequency spectrum, if not use optimally and efficiently, results not only in financial loss to the Government, but also hinders socio-economic development of the country. Spectrum sharing is one of the techniques, by using which, spectral efficiency can be increased.
3. The basic objective of spectrum sharing between TSPs is to enhance spectral efficiency by combining/ pooling the spectrum holding of two or more TSPs. If two TSPs pool their spectrum holdings, spectral efficiency increases nonlinearly. For illustration, data rates achievable with 10 MHz of spectrum is much higher than two times the data rate achievable with 5 MHz of spectrum. Spectrum sharing can provide additional network capacities in places where there is network congestion due to spectrum crunch. Spectrum sharing makes use of carrier aggregation to achieve higher data rates.
4. Spectrum sharing could be of the following types:

(a) Intra-Band Spectrum Sharing: The TSPs holding spectrum in a frequency band, pool their spectrum holdings in that frequency band and use intra-band carrier aggregation.

(b) Inter-Band Spectrum Sharing: The TSPs holding spectrum in two different frequency bands, pool their spectrum holdings and use inter-band carrier aggregation.

1. Internationally, spectrum sharing is generally treated as a part of active infrastructure sharing. As per the data available on ITU website[[10]](#footnote-10), spectrum sharing is permitted in 109 countries, including Australia, Canada, China, Finland, France, Germany, Hong Kong, Iran, Japan, Korea, New Zealand, Norway, Pakistan, Philippines, Saudi Arabia, Singapore, South Africa, Spain, Sweden, United Kingdom, United States. However, the information provides no distinction between the kind of spectrum sharing (intra-band sharing, or inter-band sharing) permitted in these countries.

*Authorised Shared Access (ASA) of Spectrum*:

1. Certain quantum of frequency spectrum in IMT identified bands is assigned to Government/ other users, the utilization of which, may not necessarily be optimum (entire spectrum, at all places, at all times may not be in use). To make available such frequency spectrum to the TSPs on secondary basis, some countries have permitted authorized shared access (ASA) of spectrum. ASA involves the concept of primary and secondary users, wherein a secondary user can use the same frequency spectrum when the primary user is not using it. In view of the growing data usage amongst consumers owing to increased digitalization and uptake of data hungry applications, and increasing proliferation of IoT based solutions, there could be a need to explore use of spectrum sharing using ASA in SATRC countries.
2. Some countries have already implemented spectrum sharing between different type of users, involving the concept of primary and secondary users, wherein secondary user can use the same frequency spectrum wherever and whenever the primary user is not using it. In Europe, such authorisation given to the mobile network operators is termed as Licensed Shared Access (LSA) and in USA, it is termed as Spectrum Access System (SAS).
3. **5G Spectrum regulatory aspects**
4. Spectrum management, regulations and pricing have a direct impact on 5G commercialization and service provision. High spectrum prices have been linked to lower investment in networks, worse quality and coverage, and lower consumer welfare. Because the spectrum cost is amortized over the annual costs of the mobile operator, as the number of bands required for the provision of mobile services increases, the total annual amortization of spectrum cost to operators also increases. The price of 5G spectrum should be affordable. Proportionate spectrum fees will allow operators to remain more focused on network investment, and it will drive down end user prices, bringing long-term socio-economic benefits through 5G connectivity.
5. Spectrum in most countries in the world is currently assigned by auction, and auction fees are expected to be paid by the operators within a specific time, or even as a lump sum. This greatly affects the financial status of operators in the initial stages of network deployment and hinders the progress of network rollout. To alleviate the negative effect brought about by lump-sum payments of spectrum auction fees, it would be preferable for the operators to be allowed to pay the auction fees in annual installments during the spectrum authorization period.
6. Moreover, in order to enable the retained funds to be effectively used in network construction, the regulator may stipulate appropriate network provisions in the form of rollout obligations. For example, to ensure that 5G users receive a high-quality service experience, it is necessary to set roll out obligations that are related to both population/ geographic coverage and network data rates (e.g. 100 Mbit/s in certain areas to meet the 5G average user-experienced data rate, as prescribed by IMT-2020 umbrella specification by ITU-R).
7. Spectrum assignments for specific mobile technologies (e.g. 2G, 3G and 4G), and in some countries for specific services (e.g. voice, data, broadband access), can no longer keep up with the speed of market demand for new network capabilities and for new services with enhanced performance. The principle of **technology neutrality** is a best practice that has been followed by many countries, including the most advanced markets. Such an approach has allowed operators to swiftly respond to the changes in market demands with tangible benefits for end users. Moreover, longer license durations protect the long-term investment plans of the operators. It is recommended that licenses are awarded for longer periods.
8. A harmonized frequency arrangement facilitates economies of scale resulting in the availability of affordable equipment. Therefore, it is essential to follow an internationally harmonized band plan in each of the frequency bands. To keep pace with the increasing demand of data services, it is essential that enough spectrum in globally harmonized bands is made available and auctioned at regular intervals. Further, it is equally important that at least a 5-year roadmap on spectrum likely to be made available for IMT in each year and likely date/month of auction is made public. Such a spectrum roadmap will provide certainty, enable the bidders to take informed decisions and may also encourage new entrants. Spectrum management authorities should also carry out harmonization exercise to ensure that frequencies assigned to the TSPs are in contiguous manner and any vacant spectrum is available towards the end of the spectrum band.
9. **Infrastructure Deployment Issues**
10. 5G networks are designed to keep up with the changing demands of citizens, industries, and cities. New age requirements are forcing the use of higher frequency bands to ensure support for ultra-high speeds. However, the use of higher frequency bands for 5G rollout poses the downside of shorter coverage and lower cell radii which in turn forces the need for densification of the network to ensure consistent coverage. Densification of the network means Telecom Service Providers (TSPs) must install a greater number of radio equipment and associated infrastructure. This poses a major economic and operational challenge for them. To handle this densification challenge, they need to have equipment that is small enough to be mounted on any structure, yet capable of supporting new age applications. Supplementing macro cells with a large number of small cells due to its portable and easy to deploy nature makes it a promising solution to achieve network densification.
11. **Small Cell Deployment**
12. Small cells are low-powered radio access nodes or base stations (BS) operating in licensed or unlicensed spectrum that have a coverage range from a few meters up to a few hundred meters[[11]](#footnote-11). The attributes of small cells (radio, antenna) are compressed such that they are portable and easy to deploy. Small cells intend to provide localized coverage in households and hotspot services especially in areas like city centres and transport hubs. Small cells provide coverage only for a very short distance and therefore they are installed in a dense or hyper dense manner, i.e., a very large number (even more than 200 per square kilometer) for good geographical coverage to provide highly reliable and high-capacity broadband. Due to its lower level of radiation, small cells require less stringent security and installation practices so easy to install and operate. Also, they can be mounted on any existing street furniture like poles, bus stands, traffic lights, buildings, etc. Despite being low on physical footprint these radio units provide huge data capacities to their users.
13. 5G networks in general and small cells in particular will play a pivotal role in Smart Cities development, due to its capacity to offer next generation solutions to meet the needs of Smart City dwellers. Many Smart City applications may run on next generation network-based Internet of Things (IOT). Intelligent Transport Management System, environment sensing, water and waste management smart networks are other key focus areas for Smart Cities. A 5G network with Small Cells can transport data from a massive number of small IoT devices embedded in roads and pavements to City Control Center which will result in better traffic management by reducing the idling time at traffic lights.
14. The Small Cell Forum (SCF), through its Market Forecast Report 2022[[12]](#footnote-12) predicts that there will be steady growth in small cell deployment between 2020 and 2027. Figure 2.3 represents the forecasted deployment growth of small cells in regional terms. The Asia-Pacific region is expected to become the chief deployment engine owing to the large-scale deployments in South Korea, Japan, China including India with its growing investment in 5G small cells.

**Figure 2.3 : Small Cells deployment in APAC Region from 2020-2027**

1. For densification of the 5G network infrastructure, making use of the wide variety of Street Furniture (publicly owned structures like utility poles, billboards, lamp posts, traffic signals, and public structures like gazebos, bus stops, etc.) to place small cell and aerial fiber equipment can act as the most economically feasible and sustainable mechanism for large-scale deployment of small cells. It can provide a win-win situation to the public and the authorities owning the street structures as they can benefit and gain from 5G use cases. On the other hand, TSPs can benefit from lower deployment costs.
2. To make street furniture suitable for small-cell networks, it must be able to accommodate power, antenna and associated fiber and other cabling equipment. In addition, good design and engineering is crucial for successful small-cell deployments on street furniture. Heat dissipation criteria, battery backup considerations and structural integrity concerns such as safe loading and wind resistance capacity are some of the other possible requirements for efficient deployment. A fast and cost-effective RoW permission process from controlling administrative authorities would be the first step, followed by ensuring presence of electricity and proper backhaul facilities at the street furniture. It is necessary to ensure that RoW permission process keeps pace with the new emerging requirement. Only then, the deployment of small cells on the public assets can be accomplished smoothly.
3. Access to street furniture in an orderly, non-discriminatory, and transparent manner is paramount for the success of 5G. “Evolving a proper regulatory framework to support the deployment of small cells will enable the industry and the Government to deliver the digital connectivity expectations of citizens and pave the way for 5G deployment. The policy/framework regarding the use of public places and street furniture should be fair, transparent, and effective, ensuring standardized guidelines for small cell size, power, space, quantity etc. are defined to make street furniture ready to deploy small cells.

*International Experience:*

1. Some of the International best practices for the use of street furniture for boosting 5G small cells are discussed below –
   * + 1. **United States** regulator Federal Communications Commission (FCC) has released a ‘Declaratory ruling and Third report and Order[[13]](#footnote-13)’ in September 2018 in the matter of ‘Accelerating Wireless Broadband Deployment by Removing Barriers to Infrastructure Investment’ and has arrived at far reaching decisions for all the States for removing restrictions to rollout of small cells required for 5G penetration in the States. The FCC has framed rules about the administration fee, timelines for approving permit applications (shot clocks) in this small cell order.
       2. In 2020, the **European Union** has adopted regulations[[14]](#footnote-14) to accelerate 5G installation by simplifying the deployment of small cell antennas that provide the last mile for 5G networks. The Regulations –
          - specifies the physical and technical characteristics of small cells;
          - facilitates a permit-exempt deployment regime;
          - provides national authorities to oversee deployment of small cells;
          - allows for broader national measures in support of straightforward small cell deployment and
          - foresees future amendments to incorporate the latest technological advances.
       3. **Singapore** regulator Infocomm Media Development Authority (IMDA) provides a Code of Practice for Info-communication Facilities in Buildings (COPIF) specifying the duties of building owners/ developers to provide adequate space, facilities, and access for telecom licensees to provide their services. COPIF[[15]](#footnote-15) allows ‘mobile installation spaces’ typically the rooftop spaces reserved for telecom equipment be provided to network operators by building developers and owners free of charge.
       4. The **Japanese** Government had approved 2,08,000 traffic signals to be used to deploy 5G small-cell architecture across the country, while the costs of using the traffic lights for 5G deployments be shared between operators and local administrations[[16]](#footnote-16).
       5. **United Kingdom**’s Electronic Communications Code facilitates operators’ access to macro and small cell infrastructure on public and private land. The Government in 2020 also proposed some changes to the law[[17]](#footnote-17) for speeding up 5G roll out and allowed the providers to put more equipment on masts, making it possible to share mobile masts.
       6. In Seoul of **South Korea**, 5G networks were established on subway lines being used as street furniture[[18]](#footnote-18).
       7. **Hong Kong** Government has issued guidelines[[19]](#footnote-19) on the use of street furniture such as sheltered bus stops, public payphone kiosks and smart lampposts for installation of 5G Radio Base Stations. The guidelines facilitated applications by mobile network operators and allowed them to conduct trials on that street furniture.
       8. The **Australian** Communications and Media Authority and the Department of Communications have put several policies to facilitate 5G infrastructure like reductions in planning requirements for small-cell deployments in the public space[[20]](#footnote-20).
       9. Small cell infrastructure has also been deployed in ‘smart lampposts’ which also serve as electric vehicle charging stations[[21]](#footnote-21) in city of Guimarães in **Portugal.**
       10. The Government of **Spain** has supported many private entities for deploying small cell infrastructure in public buildings such as in the city council of Barcelona[[22]](#footnote-22), to enable video transmissions of official proceedings.
2. There are four primary concerns in getting access to public places and street furniture for installation of small cells, namely,
3. Access to Rights of way
4. Backhaul and power supply
5. Aesthetics issues
6. Radiofrequency compliance
7. Significant challenges with regards to RoW access are acquiring permits, prolonged application process, different laws adopted by states and local bodies, bearing charges to deploy or rent the street furniture, and permissions needed for power supply under state electricity laws.
8. Unlike the 4G macro base stations, huge densification of small cell sites is required in case of 5G to achieve the same amount of coverage and capacity. This leads each individual operator to deploy their own small cell equipment over the street furniture to have complete control over its cell sites, differentiating on quality and depth of network coverage. Due to which there would be a situation of multiple number of small cell installations on the street furniture which may raise aesthetics issues, permission issues, power supply issues, etc. The aesthetics concern of small cells is also brought up in ITU’s 2018 paper[[23]](#footnote-23) on ‘Setting the Scene for 5G: Opportunities & Challenges’

***Experience of SATRC Countries (India):***

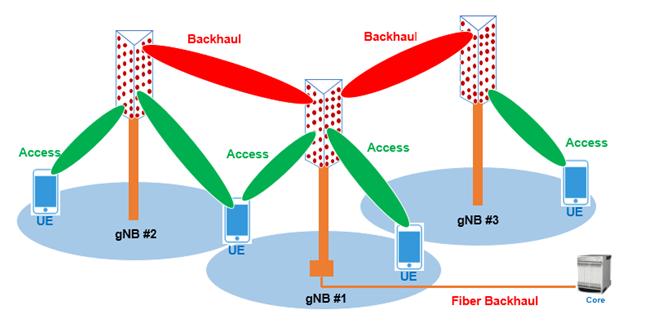
1. DoT has recently amended the Right of Way (ROW) Rules 2016 on 17.08.2022 and have incorporated provisions for faster processing of RoW permissions, predetermined charges for granting RoW permissions for installation of 5G small cells and optical fiber cable on street furniture, etc.
2. DoT has also launched a National RoW portal “GatiShakti Sanchar Portal” (https://sugamsanchar.gov.in/) in May 2022 for integrated development of 20 infrastructure services. This is a collaborative institutional mechanism between various stakeholders including Central and State/UT Government(s), Local bodies, and Service Providers to facilitate the Right of Way (RoW) Application Process through a single interface. This portal envisages bringing transparency, accountability and responsiveness to all stakeholders while processing the application.

**Figure 2.4: Provisions in the GatiShakti Sanchar portal**



1. Currently the “GatiShakti Sanchar Portal” does not have a provision for power related applications and permissions. Considering this, TRAI has recommended to expand the scope of this portal to grant RoW permissions from utility providers like water, electricity, gas etc. More specifically, it has stressed on the inclusion of power sector since most of the street furniture are under its control.
2. In the recent RoW amendments, the process for granting permission to use street furniture for installation of small cells and telegraph linehas been simplified. Having learnt from the international experience, TRAI has recommended for adding a provision for bulk approval and bulk processing for small cell applications and issuing single permission for multiple sitesto further simplify the process for permission for establishment of small cells in large numbers.
3. Uninterrupted power is must for the small cells deployed on the street furniture to function. As there will be hundreds of thousands of small cells to be deployed on the available street furniture during initial stages of 5G in the country, ensuring power supply to the installed equipment in a cost-effective manner will be the most challenging part. Sharing of nearby power sources and generation units would solve the problem of ensuring sufficient power supply to the small cell sites. TRAI has recently taken an initiative for cross-sector collaboration between the Telecom and Power sectors. A Forum of Indian Regulators (FOIR) working group was created which has representation from TRAI, Central Electricity Regulatory Commission (CERC), State Electricity Regulatory Commissions (SERCs), DISCOMs, Infrastructure Providers and has a provision to co-opt experts from other organizations as well. The collaborative framework is expected to help in the 5G technology rollout in the country. Thus, this issue of power at site for 5G small cells could be worked out in collaboration with the electricity authorities with the model framework for aerial fiber rollout along the electricity/dedicated poles.
4. Issuance of individual permissions for small cells at the state, regional or local level can make it difficult for Service Providers to keep track of the variety of rules and processes that will be followed by each authority. To deal with the humongous volume of small cell installation permissions continuing with the existing process may become difficult not only for TSPs but also for permission processing authorities. Process complexity and resource bottlenecks will result in delays as the number of applications increases. Introducing a much simplified or permit-exempt regime can help in minimizing such delays and will help in quick modernization and upgradation of the networks. It will help in ease of doing business for service providers thus resulting in quicker rollout of the next generation network. Simultaneously, there is a need to keep in mind that public health is protected, and visual landscape remains coherent. Therefore, it is important to specify the requirements carefully to maintain a balance among the interests of various stakeholders. It will generate public acceptance as well as simplify the permission processes for network rollout significantly.
5. **Strengthening the Backhaul**
6. Small cell based 5G networks which support higher speeds will necessarily require high capacity backhaul. Unfortunately, the fiber penetration in India is still not adequate and most of the existing macro sites are still not having fiber backhaul connectivity. According to estimates, fiberization of macro sites itself is hovering around 30% in India. Use of alternate means of data connectivity like Microwave, FSO (Free Space Optics), satellite etc. for backhaul will limit the capabilities of small cells as these mediums can support limited bandwidths. There is a need to have fiber backhaul support not only to effectively deploy small cells, but also to increase current fiberization levels of macro cell sites.
7. Without strengthening the backhaul the full potential of 5G cannot be exploited. Fibre is often considered to be the most suitable type of backhaul by mobile operators due to its longevity, high reliability and ability to support very high-capacity traffic. Compared to wireless backhaul, fiber backhaul always have a benefit of more stable connection speeds since network interference is less of an issue. Additionally, the speed of a system built on fiber is considerably faster than what can be achieved on a wireless network. Policy changes that facilitate the rollout of new fibre backhaul and encourage sharing of facilities and costs, can help to reduce the overall costs of backhaul.
8. Governments are looking at the arrival of 5G as an opportunity to promote fibre infrastructure. In the UK, for example, regulators in 2018 granted “Relief from Non-Domestic [Tax] Rates” (i.e., lower business tax rates) for fiber rollouts in England and Wales, aiming to “support and incentivize the rollout of broadband and 5G services.” Regulators of SATRC nations may consider removing tax burdens to reduce investment cost associated with fibre in order to facilitate the deployment of 5G networks.
9. As laying underground fiber is costly and time consuming, there is a need to find a deployment model which is light on Capital expenditure (CAPEX) as well as operational expenditure (OPEX) requirement. Developed countries like Japan and Europe have rolled out aerial fibers as part of their broadband plans due to its relatively quick and easy installation characteristics. In SATRC countries also aerial fiber deployed on street furniture can be a viable solution for quickly providing reliable high-speed fiber backhaul to small and macro sites.
10. Fiber is the preferred connectivity choice, however, as we move towards a denser network specially with mmWave spectrum in the RAN, a wireless solution also makes sense. High-capacity links operating in the E-Band spectrum (70/80GHz) can today deliver 10Gbps of capacity and with low latency over a single channel. The industry is looking to opening new spectrum in mmWave, specifically in the W band (75-110GHz) and D band(110-170GHz) that will enable delivery of wireless links in the order of 100Gbps.
11. Network densification using street-site deployments comes with new challenges. Typically, mmWave deployments require high density with an inter-site distance between base stations of 200-250 meters. This leads to higher costs, with a significant portion coming from the high rate (around 10 Gbps) backhaul connections required for the new access points. And in many regions, the availability of high-speed backhaul, such as optical fiber, is scarce, expensive and not readily available. Usually, fiber trenching and Right of way permissions can be time-consuming exercises. This calls for a new type of wireless backhaul that is fully integrated with 5G New Radio (NR) access.
12. The allowed space and weight for equipment is limited. The installation, integration and operation must be simplified with a high degree of automation to achieve cost-efficient deployment of RAN and transport. This is where integrated access backhaul (IAB) enters the frame. IAB is an important Rel-16 feature in 5G New Radio (NR) that enables rapid and cost-effective millimeter wave (mmWave) deployments through self-backhauling in the same spectrum. Wireless self-backhauling uses the same wireless channel for coverage and backhaul connectivity to other base stations, which leads to greater performance, more efficient use of spectrum resources and lowers equipment costs, while also reducing the reliance on the availability of wired backhaul at each access node location. In other words, IAB is a multi-hop approach to network deployment and allows deployment of mmWave base stations with or without fiber backhaul transport.

**Figure 2.5 : Integrated Access and Backhaul**

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1. It works by having a fraction of the deployed BSs act as donor nodes, using a fiber/wired connection. The remainder without a wired connection are called IAB nodes. Both types of BSs generate an equivalent cellular coverage area and appear identical to user equipment (UE) in its coverage area. IAB allows operators to leverage their existing mmWave spectrum licenses and have the freedom to deploy separate backhaul where needed.
2. IAB can provide flexible and scalable multi-hop backhauling, using the same or different frequency bands for access and backhaul. IAB could serve as a versatile backhaul option for street sites in urban and suburban areas, using small-scale star and tree backhaul topologies. It could also be useful for temporary deployments for special events or emergency situations. Point-to-point microwave backhaul will remain an essential complement to fiber for 5G transport for traditional macro sites, while IAB is a promising advanced concept that may become as important for wireless backhaul of street sites.
3. **Infrastructure Sharing**
4. Infrastructure sharing is a common practice in almost every telecom market in the world. According to a Mckinsey report[[24]](#footnote-24), Operators have been able to reduce the total cost of ownership by up to 30 percent while improving network quality through sharing a variety of both active and passive equipment. Sharing of the passive infrastructure happens quite often, even on an ad hoc basis with regular infrastructure wholesale agreements. Active network sharing became popular with the advent of 4G rollout in the decade after 2010.
5. The advent of 5G has triggered a new wave of interest in network sharing in markets and operators that have not yet been involved in such ventures. 5G demands high investment in the radio access network and transmission network, due to the following:
6. High spectrum costs in several new bands (700-800 MHz, 3.5-3.7 GHz, 20-26 GHz).
7. Densification of radio access networks for C-band (3.5-3.7 GHz) of 1.6-1.8 times more sites and up to 10 times more small cell sites than macro/microsites for mmWave bands (20-26 GHz).
8. Fiber optic backhaul to most sites (70-80 percent) for adequate transport capacity.
9. 5G sites with active antenna units (AAUs) and massive MIMO (e.g., 64x64 in urban areas).
10. Hence, the cost savings potential for network sharing is even stronger with 5G. Here, the rationale for sharing extends beyond cost, as it could solve many practical roadblocks of 5G deployment in urban areas, such as the potential for urban disruption and aesthetics issues arising from the installation of excessive equipment and fiber. Infrastructure sharing is critical for 5G small cell networks due to the required density of deployment[[25]](#footnote-25).
11. 5G deployments will build on existing sharing models from the prior generations, i.e., Multi-operator Radio Access Network (MORAN) and Multi-operator Core network (MOCN) architecture. However, these sharing models will also be supplemented with new features like Network Slicing, which allows dynamic resource allocation to specific traffic or use cases. Another possibility is sharing of Street Furniture (SF). SF sharing practices will help SATRC countries’ small cell deployment scenario by enabling economies of scale and affordability. This type of sharing will result in significant reduction in deployment costs, especially by sharing expensive 5G base station equipment. A growing number of regulators are taking steps to permit and even encourage shared deployment, especially for small cells, recognising that network operators need the flexibility to share infrastructure assets. The adoption of Open-RAN (Radio Access Network) standards that support interoperation between vendors’ equipment and offer network flexibility at a lower cost can further help the case of sharing.

**International Experience**

1. Regulators are becoming increasingly open to the idea that expanding a nationwide cost-efficient 5G networks will require sharing of some sort, such as active network sharing and spectrum sharing. In 5G spectrum auctions in Europe, multiple regulators have indicated the possibility of active network sharing under certain conditions, including by non-telco entities. For example,
2. In a 2019 3.5 GHz spectrum auction, the **Austrian** Regulatory Authority for Broadcasting and Telecommunications indicated that active network sharing, including spectrum sharing could be permitted under certain conditions. In general, sharing could be potentially permitted everywhere except in the three largest cities. However, explicit regulatory permission would be required before implementing an active network-sharing agreement.
3. German regulator Bundesnetzagentur also allows active network sharing under certain conditions (regional/rural sharing) but does not yet allow spectrum pooling.
4. Some other markets like Denmark and Sweden allow active network sharing with spectrum pooling on a national level, as long as it does not distort retail market competition.
5. On the other hand, competition agencies are taking tougher positions when the incumbent operator is involved in network sharing.
6. In 2019, Proximus and Orange Belgium announced a MORAN all-technology network-sharing agreement, which was under regulatory review by the Belgian Competition Authority, with work towards the agreement resumed as of 18 March 2020.[[26]](#footnote-26)
7. The European Commission is also investigating the network sharing agreement between O2/CETIN and T-Mobile in the Czech Republic to ensure competition is not restricted. In all these cases, the main argument brought forward by the competition agencies is that the sharing covered more than 70-80 percent of the population coverage and harms the competitiveness of the market, as it leaves the third player out of the network-sharing arrangement.
8. Many 5G network-sharing agreements specifically mention that the focus will be on rural network sharing, and the dense urban cities will be left out of the arrangement. For example, an active network-sharing deal between TIM and Vodafone Italy announced[[27]](#footnote-27) in 2019 mentions that it only covers cities and towns with a population less than 100,000 inhabitants.
9. In a pilot study conducted at Amsterdam, a TSP collaborated with a global leading company which owns over 100,000 street furniture assets in the Netherlands. The SF owning company had existing agreements with the local authorities, with contracts of 10-20 years already in place. By leveraging these existing permits, the said TSP and other operators were able to significantly speed up their small cell rollouts. The street furniture used included facilities for powering the small cells and terminating fibres that were laid on the street, thus eliminating or reducing the need for additional civil works and providing future-proofed high-speed backhauling capable of supporting upgrades to 5G. One additional major benefit of the same was that it enabled multi-operator passive sharing by accommodating up to four separate small cells within the same street furniture asset. This is an example of how street furniture sharing can speed up the small cell deployment.
10. Some countries like UK, Singapore, US have already provisioned for such sharing or access to street furniture structures through state laws/codes. The German Telecommunications Act[[28]](#footnote-28) entitles operators of public telecom to use trafficways free of charge. Further, under the Act, the owner of a property cannot prohibit the setting up, operation and renewal of telecommunications lines on his property subject to certain conditions. Japan Government has allowed its service providers to set up 5G base stations on traffic signals, hoping to reduce the cost and time it takes to roll out the ultrafast networks9. Roughly 200,000 traffic signals administered by local governments can be used. For incentivizing the local authorities, they have been allowed to use the networks for self-driving vehicle projects and emergency communications in natural disasters. It is also expected that the cost of

***Experience of SATRC Countries (India):***

1. In India, active infrastructure sharing is already permitted for Access and ISP authorizations under the UL and UL-VNO licenses. Sharing of Active infrastructure amongst Service Providers based on the mutual agreements entered amongst them is permitted. Active infrastructure sharing will be limited to antenna, feeder cable, Node B, Radio Access Network (RAN) and transmission system only. Sharing of infrastructure related to Wi-Fi equipment such as Wi-Fi router, Access Point etc. is allowed. Sharing of backhaul is also permitted.
2. **Radio Frequency Compliance**
3. 5G networks are specifically designed to minimize transmitter power, even more than existing 4G networks. 5G networks use a new advanced radio and core architecture that is very efficient and minimizes transmissions, which results in lower EMF levels. Some deployments of 5G also use "massive" multiple input, multiple output (MIMO) antennas that have multiple elements or connections to send and receive more data simultaneously. The smart antennas use beamforming, which has the benefit of reducing network interference and electromagnetic emission in unintended directions by focusing antenna beams in desired directions.
4. Small cells are well suited for coverage extent, as well as capacity issues. Their proximity to users enables them to provide better quality and reduced power radiated to and from mobile phones. This is a good point in terms of exposure for mobile users. By reducing the distance between receivers and transmitters, small cells enable the reduction of the power emitted by mobiles phones and total EMF exposure.
5. Radio frequency EMF exposure limits differ across countries, and in some cases are unduly restrictive. Policies regarding power density limits should be evidence based and harmonised in line with recommendations by expert bodies such as the World Health Organization (WHO) and the International Telecommunication Union (ITU). Both these organisations recommend the human exposure guidelines developed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP), which are designed to provide protection against all established health hazards.
6. The guidelines developed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) are widely adopted by national authorities around the world. In terms of providing protection for 5G technologies, the latest ICNIRP guidelines in 2020 for limiting exposure to Electromagnetic fields (100 kHz to 300 GHz) has made several changes to ensure that new technologies such as 5G will not be able to cause harm, regardless of our current expectations. Reference levels have been derived to provide an equivalent degree of protection to the basic restrictions, and thus an exposure is taken to be compliant with the guidelines if it is shown to be below either the relevant basic restrictions or relevant reference levels.

**International Experience**

1. Some countries have adopted criteria like the height of the installed antenna and the Effective Isotropic Radiation Power (EIRP) metric for frequency exposure certification exemption and simplification of approval process for permission. Several countries across the world have a regime for small cells focused on ensuring aesthetical visual appearance and sufficiently low emission power for building public acceptance and ensuring safety of the public. The current global landscape witness diversity in parameters and the limits used to qualify sites for exemptions.
2. Some countries have used location as the criteria to give exemption. In Cyprus, if the base station is outside the boundary of urban development then site permits are not needed when the antenna mast is less than 25 meters tall. Transmitters inside buildings in Lithuania and in privately owned buildings of Spain are granted exemption from permits.
3. Few other countries have provided exemptions based on EIRP. In Belgium, no environmental permit is needed for transmitters with ERP of 2 W or less. In Estonia, no permits are needed for base stations with EIRP ≤100W. For France, no declaration or ANFR (French Regulatory agency for spectrum management) authorization is needed for stations radiating less than 1 W EIRP. Any station operating on an assigned frequency at 1-5 W EIRP, which is their de facto definition of small cells, must notify ANFR and the local governing authority about the station’s technical characteristics. In Germany, radio stations with EIRP of 100 mW or less do not need site certificates. BNetzA (Federal Network Agency) must be notified two weeks in advance about the commissioning of new or substantially modified stations whose EIRP is greater than 100 mW, but less than 10 W and civic authorities must be informed at the same time. In certain parts of Italy, for base stations <10 W and surface area <0.5 m2 the local planning authority requires notification but does not have to decide on a permit.[[29]](#footnote-29)
4. There are diverse practices adopted by countries for exempting different types of permits based on the location and power parameters used. Some other parameters such as mounting, total size of equipment, mast height, appearance, etc. have also been adopted. Considering that one of the primary factors for exemption adopted commonly by most countries is the EIRP of the small cell equipment, exempting certain categories of small cells at all places through use of EIRP as an exemption criterion is an approach that can be adopted in the context of SATRC Nations also.

**Experience of SATRC Countries (INDIA)**

1. In August 2021, DoT has recently issued special EMF compliance dispensation for Small Cells. All base stations with EIRP between > 2 and ≤ 100 Watts are considered as normally compliant and >100 Watts EIRP are considered as provisionally compliant. As a result of normal installation practices and the typical use of these sources for communication purposes, the exceedance zone of these sources is not accessible to people under ordinary conditions. Examples include small cells with low transmit power (with EIRP ≤ 100 Watts) and antennas mounted on sufficiently tall towers. So, a Small Cell was defined as equipment radiating EIRP<=100 W.
2. Subsequently, in May 2022 DOT issued instructions for “Simplification of SACFA siting clearance guidelines- procedure for clearance of Low Power BTS/ small cells i.e., Micro, Pico and Femto cells on existing street furniture/infrastructure and the cases of additional antenna”. The requirement for a formal application for SACFA processing is done away with for such Low Power BTSs (EIRP <=100W).
3. TRAI has recently carried out four pilots with an objective to lighten the regulatory regime for deployment of small cells and aerial fiber on street furniture. It was observed that most of the small cells used by TSPs had maximum EIRP between 52 dBm to 57.5 dBm (say up to 600 watts). Based on these recommendations, TRAI has therefore recommended recently that Low Power Base Transceiver Stations (LPBTS) should be defined as those BTS that radiate EIRP<=600W. Such equipment/small cells should be exempted from seeking any kind of permission from any Authority except from the Street Furniture/building owning Agency at all places.

**CHAPTER-3**

**Cross sector Collaboration for 5G Ecosystem**

**Introduction**

1. In Ecosystem strategy multiple stakeholders join hands for development of some technology or service. They are interdependent on other players and work in a coherent manner for providing solutions to users and customers. 5G promises to empower digitalization of many verticals, and for the sake of making it a success for all its stakeholders, applying ecosystem thinking can be a very powerful means. A telecom service provider can provide 5G service which co-exists with Information Technology (IT) service, system integration, software, and cloud services. When entering the industry verticals’ domain, providers of 5G services could collaborate with domain specific providers.
2. Hence, the cross sector collaboration in a 5G ecosystem will be (a) for 5G network provisioning and (b) for deployment of 5G use cases in different industry verticals. The 5G network provisioning ecosystem includes all necessary providers, operators and suppliers needed to deliver 5G services to the customers. Similarly, the 5G use case ecosystems are composed of other actors that assume roles necessary to adopt 5G use cases. Manufacturing, Healthcare, Automotive sectors are some of the industry verticals of 5G use cases ecosystem. Both these ecosystems and the associated challenges have been discussed in detail in the following sections.
3. **Cross Sector Collaboration for 5G Infrastructure Deployment**
4. As discussed earlier, 5G is not just expected to enhance the mobile broadband capacity but will improve reliability and latency in the network giving rise to innovative use cases in the long term. In traditional telecom markets, the network and service provisioning roles have been performed by the TSPs being those Mobile and/or Fixed-network Infrastructure Providers. While established TSPs undoubtedly can play a role of a key actor in the 5G provisioning business at initial stages, the assumption of the complete end-to-end (E2E) 5G provisioning solely by them may not be practical to be followed throughout all stages of 5G deployment. At that point 5G provisioning ecosystems can emerge in various formulations, expectedly with the TSPs maintaining the core actor position in them and sharing of some activities and roles with additional, possibly new stakeholders. In fact, 5G provisioning needs an ecosystem view, rather than working in siloes, where TSPs need to partner with other industry stakeholders. Examples of such partnerships or collaborations along with practices being followed in the global marketplace and way forward are discussed in the following sections.
5. Cross-sector collaboration for infrastructure creation could either be in the beginning of the infrastructure development itself or at later stage by leveraging the existing assets of other sectors such as Power, cable TV, Road transport authorities, Railways, Metro Rail etc., which will provide improved connectivity, affordability, and sustainability. A clear roadmap is required for cross-sector infrastructure sharing along with setting up of an institutional framework to build synergies among the sectors.
6. In the telecom sector, collaboration is not a new phenomenon. It has proven its worth when there was need of more towers to provide 3G services and the TSPs started collaborating within the sector for infrastructure co-creation and sharing. Independent infrastructure providers created towers and ducts that were shared and used by multiple TSPs. Now the outlook needs to shift from within the sector to collaboration with cross-sectoral partners like Smart Cities, City Municipalities, Airport/Port owners, DISCOMs etc. to use their street furniture for network deployment.
7. High RoW charges levied for the street furniture will make the rollout of 5G small cells un-viable and hence will become the biggest roadblock in early deployment of 5G in any country, if not resolved timely. Uninterrupted power is must for the small cells deployed on the street furniture to function. Collaboration models involving state, local bodies and private sector is necessary for provisioning infrastructure in municipalities, rural areas and national highways for speedy rollout of 5G access and backhaul networks.
8. As there will be hundreds of thousands of small cells to be deployed on the available street furniture, ensuring power supply to the installed equipment in a cost-effective manner will be another challenging task. In addition to this, the administrative difficulty in applying for permission for individual street furniture is also an area of concern. To address this a mechanism for simplified bulk approval is required to be developed. Most of the street furniture are established and owned by the electricity authorities only and therefore the rental, RoW charges and approval of permission for using street furniture shall fall in their jurisdiction. Cross-sector collaboration between the Telecom and Power sectors will be required with representation from Telecom Regulator and Electricity Regulator to resolve this issue of power supply at site for 5G small cells.

**International Experience**

1. Co-deployment of new infrastructure by two or more individual utility providers is the most effective way of optimizing costs. Fiber cables when co-deployed along highways, railways, power transmission, gas pipelines etc. leads to the development of high-speed infrastructure networks providing cost-effective access to information and socio-economic services to un-served and under-served groups. The following table describes the co deployment of infrastructure across various countries:

**Table 3.1: Collaboration for Co-Deployment of infrastructure[[30]](#footnote-30)**

| **Infrastructure** | **Country** | **Initiative** |
| --- | --- | --- |
| Roads and Highways | Korea | Korea Expressway Corp. (KEC) permitted Korea Telecom to lay OFC and was leasing its network facilities to meet internal High-speed Communication requirements, respond to new communication needs and to diversify KEC’s business areas.  KEC presently operates 4,700 Kms of Backbone Network along the Expressway and another 7,700 Kms of along the major Arterial Highway and Urban Roads. |
| Russia | Rostelecom owns an extensive backbone digital network running to a length of 500,000 kms of widespread intercity roads, consisting of trunk communication lines connected via international and intercity transit nodes with national and foreign networks. |
| Bangladesh[[31]](#footnote-31) | Roads and Highways Dept. Bangladesh permitted several Government organizations, such as the ICT Division and the Bangladesh Telecom Company Ltd. (BTCL), as well as some private companies (e.g., Grameenphone, Banglalink, and Fibre Bangladesh), to install OFCs along highways after their construction. |
| Thailand | Co-deployment/Co-habitation of OFC is done along RoW running in parallel with Roads and Highway Routes under the control of the Transportation Ministry of Thailand. |
| Railways | Korea | Korean National Railroad and Korea Electrical & Telecom Corporation signed the agreement on Co-deployment of Trackside OFC in 1986.  The OFC network continues to be expanded under the Mid/Long Term Railway Optical Network Plan formulated and implemented by Korea Rail Network Authority. |
| Bangladesh | Bangladesh Railway has about 2,300 km out of the total 2,877km of railway route co-deployed with OFCs, part of which have been leased out to private companies Grameenphone Ltd and Robi Axiata Ltd, now operating commercially. |
| Thailand | National policy and plans for OFC are finalized by the Ministry of Transport to be deployed along highway, railway, and aeronautical, maritime transportation and by the Ministry of Digital Economy and Social for national broadband network.  Multiple public-sector entities are involved in co-deployment projects, State Railway of Thailand (SRT) along with TOT Public Company has experience in Co-deployment of OFC along Railways under the Com-link Project. |
| Telegraph Posts | Thailand | Overhead OFC lines are laid by the operators who acquire type three licenses from National Broadcasting and Telecom Commission along the existing 7,500 telegraph poles along the railway network owned and maintained by SRT. |
| Power Transmission[[32]](#footnote-32) | Kenya | KETRACO (Kenya Electricity Transmission Company) was granted network provider license in 2017 by the Communications Authority of Kenya to lease excess fiber to licensed operators in Kenya and East Africa.  KETRACO has partnered with Liquid Telecom company to co-deploy OFC to meet the rising demand for high- bandwidth, video and internet services for businesses and individual consumers. |
| Tanzania | TANESCO (Tanzania Electric Supply Company) deployed OFC network serving 10 regions of Tanzania covering 2,050 kilometers as Phase 1 of a broader fiber rollout plan. |
| Zimbabwe | The public data network operator ‘Powertel Communications’ - subsidiary of ZESA (Zimbabwe Electricity Supply Authority) is fully licensed by the Postal and Telecom Regulatory Authority of Zimbabwe (POTRAZ) to provide data communications services. |

**Experience of SATRC Countries**

1. All the SATRC nations agree that cross-sectoral) plan or framework is key, to address the immense challenges of 5G roll out. **Bangladesh** has opined thatJoint workshops among government bodies, different organizations, associations, institutions need to be held for dialogue session and to share knowledge. It is essential that all government stakeholders of 5G along with their officials have full knowledge on the scope and capability of 5G before planning on the services that they can provide. We need collaboration among all the relevant stakeholders to structure the policy to introduce 5G in Bangladesh.
2. Similarly, **BICMA, Bhutan** is of the opinion that the smooth rollout of 5G depends on the support and facilitation from many cross-sector. For example, the handset manufacturer is an important sector to enable 5G success. Besides, the agencies responsible for granting the right of way to telcos in installing the access networks for 5G services. The 5G will need the installation of multiple access sites compared to the previous generation of mobile services. Therefore, the operators should be facilitated with the right of way access to build and install the access network sites.
3. **Sri Lanka** thinks that a framework to minimize the roll-out cost would be ideal. However, in a hyper-competitive market like Sri Lanka a strong 5-10 year framework is required to be worked out based on a Public-Private-Partnership between the relevant Government Ministries and the Telco Operators to make a smooth roll-out a reality. A suitable device strategy also needs to be included with the network roll out. Because, for industries such as Health and Education, handheld mobile phone might not be the most suitable.
4. Some examples of co-deployment in **India** include:
   1. Concrete Utility Duct provided by NHAI as part of the Delhi - Meerut Highway has been included in the Composite Contract for Construction of the Highway for a length of 27 kms. The utility duct is constructed in RCC and is 2M X 2M.
   2. Indian Railways laid 53,655 Kms of OFC till May 2018 along its RoW of Railway Tracks. Substantial portion of the OFC Network is taken over by RailTel for its Maintenance, Upgradation and Commercial Usage. In FY 2018-19, to ensure complete coverage, OFC work has been sanctioned in the remaining sections. In addition to this, all New Railway Line Sections are commissioned along with fiber by Zonal Railways as matter of policy.
   3. PGCIL has about 48,500 kms of OFC network across the country by 2018; it has used OPGW technology to roll out its fibre on a live-line environment on the existing transmission lines. PGCIL is also part of the BharatNet project in Telangana, Himachal Pradesh, Jharkhand and Odisha, covering about 35,791 GPs on deposit work basis.
   4. Utility Ducts provided by Tamil Nadu Road Development Company limited (TNRDC) along the Rajiv Gandhi Salai Road includes construction of service Trenches/Ducts for carrying utility lines including Electrical, Telephony and Optic Fibre Cables/Wires so as to avoid re-digging in future.
   5. Gujarat International Finance Tec-City (GIFT-City) near Gandhinagar developed the vision of “Digging Free City” for placing utilities in a Tunnel so that there is no need to excavate the roads in future for any utility.
   6. New Raipur Smart City has planned Utility Ducts covering the entire City in different phases for various utilities. No Digging Policy is being enforced.
5. In **India**, TRAI has initiated pilot projects at Bhopal Smart City, GMR International Airport New Delhi, Deendayal Port Kandla and Namma Metro Bengaluru on use of street furniture for Small Cells and aerial fiber deployment. All major Telecom Service Providers and Infrastructure Providers are participating in these Pilots at different locations. The objective of these pilot projects was to ensure complete synergy among all stakeholders. Significant progress has been achieved in these Pilots in a short time with the active support from various authorities. These pilots were designed to explore challenges in using brownfield infrastructure created by entities belonging to sectors other than telecom like electricity poles owned by DISCOMs, traffic lights owned by municipal corporations, etc. Success of these pilots are suggestive of the cross-sector participative framework particularly for the use of street furniture for deployment of small cells on it.
6. TRAI has also taken an initiative for cross-sectoral collaboration between the Telecom and Power sectors realising that power being the lifeline on which telecom network runs. At the behest of TRAI, Forum of India Regulators (FOIR) had constituted a working group on Cross Sector Collaborative Regulation between the Telecom Regulators and Electricity Regulators. The working group had representation from TRAI, Central Electricity Regulatory Commission (CERC), State Electricity Regulatory Commissions (SERCs), DISCOMs, Infrastructure Providers and has a provision to co-opt experts from other organizations as well. It had identified certain issues and made its recommendations to FOIR. These are Development of a centralized portal & GIS Mapping of Assets, Monetizing assets of power utility companies, Placement of telecom antennas and associated equipment on the transmission towers, Utilizing transmission assets such as electric substation lands & buildings, Deployment of small cells and aerial fiber on electric poles.
7. Governments of SATRC countries should actively encourage the cross-sector infrastructure initiative. The possibilities for cross-sector infrastructure development and sharing could be:
   1. Partnership with Power Distribution Sector – Transmission Line network entities (electricity lines, power ducts, conduits, towers, and poles)
   2. Partnership with Public works departments – Civil Road and Highways (Land corridors, access shafts and manholes in or along the roads)
   3. Synergies with Railways, Metros, State Fiber Grids and Bridges.
   4. Inside the pipes of water, sewer, or gas transport.
   5. Excess dark fiber in internal networks installed by utilities.
8. **Cross Sector Collaboration for 5G use cases**
9. 5G technology holds the potential to enable unprecedented degrees of flexibility, productivity, and efficiency in various industry verticals. The potential of 5G, combined with artificial intelligence (AI), AR/VR, smart platforms and IoT, can deliver enormous value to consumers, organizations and the society at large. It will also pave the way for developing services for making smart cities, autonomous vehicles, smart factories, etc. Thus, 5G vision extends beyond mobile broadband connectivity and provides an opportunity to Telecom Service Providers (TSPs) to transform themselves into a Digital Service Provider. Telecom industry has been transitioning from different generations of mobile technologies since last few decades and has been pivoting from voice to content to commerce and industrial applications. However, to realise the true potential of 5G beyond the eMBB use cases, the ICT industry must come together as an ecosystem for development and deployment of mature use cases.
10. The core competency of TSPs today is in providing network connectivity. To realise the potential benefits of 5G, the network needs to transform into a digital platform and be delivered as a service in the digital marketplace. Most of the implementations of 5G use cases will be brownfield implementations where the 5G solution needs to seamlessly integrate with existing business processes, IT systems and operational technologies. TSPs will need to adopt an ecosystem and build trusted and strategic partnerships with other ecosystem players for faster and mass-scale adoption of 5G use cases. Mobile operators are collaborating with vendors and enterprises across different verticals to develop and deploy 5G use cases for industry. Some such collaborations happening across the globe are discussed below.

**International Experience:**

1. Mobile operators are collaborating with vendors and enterprises across different verticals to explore the potential of 5G stand-alone (SA) network. For example, SoftBank and Honda are working together to test the effectiveness of using 5G SA and a cellular vehicle-to-everything (C-V2X) system to reduce collisions between pedestrians and vehicles. In Spain, Telefónica has announced plans to target three enterprise 5G use cases for its 5G SA network. They are automated guided robot vehicles for use in places such as warehouses; remote maintenance systems using technology such as smart glasses; and drones for site surveillance.[[33]](#footnote-33)
2. **South Korea**'s 5G ecosystem brought together government ministries, legislative bodies, carriers, private sector vendors, research institutes and other stakeholders such as trade unions, civil society groups at the very early stages of the 5G buildout. This led to an environment of cooperation and tremendous technology breakthroughs and cost benefits. Future technologies were tested in an evolved beta market, technology standards were established and a strong market adoption strategy was created well in advance of the commercialisation. Subsequently, telecom operators in **South Korea** introduced 5G-powered services and each operator offered unique content and experience use cases. Some of them included:
3. South Korean Telecom's TReal and eSpace platforms where baseball fans can access real-time data and stats by pointing their smartphone camera at a baseball player. They can point a VR headset at the field and watch the game from eight different angles.
4. LG U+ Idol Live that allows K-Pop fans to enjoy a concert as they would do in a real theatre.
5. South Korean Telecom's 5G-AI Machine Vision, a smart factory solution that uploads high-resolution, multi-angle photos to a cloud server via a 5G router, instantly identifying defective products on a conveyor belt.

Applications like these have spiked the data consumption in the country and led to increased average revenue per user (ARPU).

1. **Singapore** has become the first country in the world to be fully covered by standalone 5G. The island nation now has achieved over 95% of 5G nationwide coverage. It has managed to achieve these three years ahead of scheduled target, which was by the end of 2025.[[34]](#footnote-34) As part of its earlier 5G innovation efforts, IMDA supported seven 5G innovation use-cases in strategic areas such as cloud gaming, urban mobility, smart estates, industry 4.0 and maritime operations. In 2019, IMDA has partnered with the Maritime & Port Authority of Singapore (“MPA”) and PSA Singapore, to test and commercialize maritime 5G use cases, starting with the remote pilotage of vessels that are entering the port of Singapore. This will significantly enhance service efficiency, improve resource utilisation and transform the role of a harbour pilot from a physically demanding job to remote operations while enhancing safety. Other maritime 5G use cases include shore-to-ship delivery, where drones can send critical components to vessels out at sea instead of having ships dock at the berth for urgent inspections and repairs.[[35]](#footnote-35)
2. In **Hong Kong,** HKT, one of the leading telecom operators in the country, is working with enterprises to integrate different technologies like 5G, AI and cloud computing to help them transform their operations. For example:
3. HKT is working on a wide range of smart campus and smart building projects. These require not only 5G connectivity for tenants but also for the physical facilities, allowing a building to be equipped with sensors to detect and regulate temperature, humidity, lighting, appliances and air quality and also AI-based energy saving algorithms can help buildings minimise energy usage.
4. HKT provides end-to-end services to accelerate enterprise digital transformation – from consulting and solution design to project implementation and delivery.  Their Enterprise Managed Services also offer multi-skilled supports catering IT operations and end user support requests.
5. HKT is also maintaining a strong partnership with an OEM across many technology domains, including fibre networks, 4G and 5G networks, and for enterprise services such as cloud, storage, networking and Wi-Fi. They are working together to co-create products and services like a 5G solution integrated with Wi-Fi, Bluetooth and an IoT connectivity platform.
6. **Australia** is a global leader in 5G rollout. By the end of 2021, Australia’s Mobile Network Operators (MNOs) had installed around 4,000 operational 5G base stations across the country. 5G innovation has accelerated in Australia due to collaborations and co-investments between companies and across industries. Telstra recently collaborated with Ericsson and Microsoft to begin 5G-enabled edge compute trials earlier this year.[[36]](#footnote-36) Similarly, Australian technology companies M2M Connectivity and ARQ Group formed a partnership to deliver digital twin technology for mining companies looking to use 5G to increase production efficiency and lower operational costs.[[37]](#footnote-37)
7. There are several such examples of telecom operators showcasing and developing the 5G use cases for industries[[38]](#footnote-38), like
8. one such 5G use case is the “Alba Iulia Smart City”, which has been developed in collaboration with Orange, and has seen congestion monitoring, parking sensors, and smart waste management introduced in the Romanian city.
9. O2 has also now announced a project to trial driverless cars in London using its 5G network. The UK's second-biggest phone network has partnered with the Smart Mobility Living Lab - a research organisation comprised of experts from the Transport Research Laboratory (TRL), DG Cities, Cisco, and Loughborough University - to develop what it claims to be the ‘most advanced driverless testbed in the world’.
10. At the Consumer Electronics Show in January 2020, Samsung and BMW showcased the companies' efforts in connected cars, revealing the 5G TCU (Telematics Control Unit). The TCU will be included in the BMW iNext.
11. Huawei, in partnership with Thailand National Broadcasting and Telecommunication Commission (NBTC) and Siriraj Hospital, has launched a new project to use 5G-powered self-driving vehicles to deliver medical supplies.
12. Fox Sports has trialed 5G at golf’s US Open with Intel, AT&T, and Ericsson allowing its team to cover more of the course, while 5G was used to capture some events at the 2018 Winter Olympics. Verizon and Sony have joined hands to demonstrate how 5G can enhance live sports broadcasts.
13. Irish startup Manna has partnered with Cubic Telecom to fly 5G-connected delivery drones in Ireland and England.
14. In the US, mobile network Verizon has partnered with specialist glass maker Corning, the maker of Corning Gorilla Glass, to investigate how 5G can improve the factory environment.
15. 5G has even made its way into the operation theatre, when Telefónica, with the help of a hospital in Malaga, already presented the first assistance system for surgery that runs entirely on 5G technology. The showcase took place at the IV Advanced Digestive Endoscopy Conference, where Telefónica broadcasted medical training sessions live, and in 4K quality. It achieved this with “almost no latency”.
16. Centrica Storage and Vodafone have entered a partnership that will build the “gas plant of the future” at their Easington site, providing a 5G-ready mobile private network (MPN) for the facility, which will be the first of its kind in the UK’s oil and gas sector.
17. Hyperbat, one of the UK’s largest independent vehicle battery manufacturers, has partnered with BT, Ericsson and NVIDIA to create ‘digital twins’ of products. It will enable remote teams to connect, collaborate, and interact using a virtual 3D engineering model. This digital twin project will be a world-first, which will allow design and engineering teams to walk around, and interact with, a 3D life-size model in real time.
18. AeroFarms, a global leader in indoor vertical farming and Nokia Bell Labs have partnered to combine their expertise and expand their joint capabilities in cutting-edge networking, autonomous systems, and integrated machine vision and machine learning technologies. This partnership is expected to further enhance its capabilities as an industry-leading operator of world-class, fully connected smart vertical farms that grow the highest quality plants all year round.

**India’s Experience[[39]](#footnote-39)**

1. Government of India is setting up test labs in collaboration with 14 other ministries and departments to explore 5G use cases for the respective industry verticals leveraging communication technologies such as 5G/4G-Adv and IoT (Internet of Things). The 14 ministries taking part in the 5G use case test labs are: Ministry of Mines, Ministry of Power, Ministry of Agriculture, Ministry of Education, Ministry of Urban Development, Ministry of Railways, Ministry of Road Transport and Highways, Department of Water, Ministry of Tourism, Ministry of Heavy Industries, Ministry of Health and Family Welfare, Ministry of Housing and Urban Administration, Ministry Electronics and IT, and the Department of Science and Technology. The following use cases have been identified for time-being:
2. For Ministry of Housing & Urban Affairs, where the role of ICT will be explored in the smart cities mission;
3. For Ministry of Power, where use cases of smart grids and smart metering will be explored for the National Smart Grid Mission;
4. For Ministry of Education the role of ICTs to further expand the New Education Policy will be discussed;
5. For Ministry of Jal Shakthi (water resources), use cases for water conservation, augmentation & preservation, smart water & sewage management will be looked at; and
6. For Ministry of Railways- Rail-Track Safety, Trackside Systems -video analytics, Intelligent Transport, Collision avoidance, Freight Management/Asset tracking will be explored.
7. The expected outcomes of this initiative are going to be possible collaborations among stakeholders (solution providers, user agencies, OEMs) to conduct pilots for reasonably matured use cases. The ministries in collaboration with the Ministry of Communications will work on ideas, technologies, prototyping, fine-tuning of use cases identified by the Vertical Ministry.

**CHAPTER-4**

**Conclusion and Recommendations**

1. **5G: Essential for all SATRC Nations**
2. 5G has the potential to radically transform the lives of citizens of SATRC countries by enabling high-speed internet connectivity for the masses. It will help in minimising the digital divide, especially in rural areas through new avenues of economic growth, increased access to online markets and e-commerce platforms. 5G promises to provide quality education and expected to take virtual learning to the next level by eliminating some of the bandwidth constraints currently faced by students. 5G offers an economically feasible way to enhance broadband connectivity and help students to seamlessly connect to e-learning platforms and virtual classrooms.
3. 5G has the potential to address some of the basic challenges of healthcare sector through remote patient monitoring and diagnosis opportunities for the people living in the rural areas. Currently, bandwidth limitations prevent using high quality video consultation. Remote diagnosis centres enabled by 5G will lead to a more decentralized patient treatment using technology and relieve some of the pressure from urban healthcare facilities. Consumers will have access to variety of immersive content related services, made more real with the help of Virtual and Augmented reality.
4. 5G will advance societies, enhance experiences, transform industries, and pave the way for smart agriculture, smart manufacturing, smart healthcare, and in turn, smart cities across the SATRC countries. The transition to 5G will unlock a new wave of opportunities and is expected to open-up new use cases and revenue streams. Hence, seizing the 5G opportunity is critical and all stakeholders must take initiatives for its early commercialization across the SATRC countries.
5. **Key takeaways and Recommendations**
6. In view of the discussions and deliberations in the previous chapters, the key takeaways and recommendations for the regulators and policy makers across the SATRC countries are as follows:
7. The policymakers or regulators, who have not yet done the spectrum assignment or allocation may consider allocating or assigning globally harmonized 5G spectrum bands at the earliest. Spectrum management authorities should also carry out harmonization exercise to ensure that frequencies assigned to the TSPs are in contiguous manner and any vacant spectrum is available towards the end of the spectrum band.
8. Policy-makers may consider financial grants for projects to set up 5G Test Bed in collaboration with academia and industry, which can be used to validate products, prototypes, algorithms, and country-specific 5G use cases. This will enable the SATRC countries in becoming self-sufficient in 5G Technology.
9. In view of the growing data usage amongst consumers owing to increased digitalization and uptake of data hungry applications, and increasing proliferation of IoT based solutions, intra-band and inter-band spectrum sharing among TSPs may be encouraged. there Spectrum sharing using authorized shared access (ASA) also may be explored.
10. Policymakers and regulators may develop a framework for access to public places and street furniture in an orderly, non-discriminatory, and transparent manner to support the deployment of small cells and pave the way for 5G deployment. Provisions should also be made for faster processing of RoW permissions at predetermined charges for granting RoW permissions for installation of 5G small cells and optical fiber cable on street furniture. The policy framework should also have a provision for bulk approval and bulk processing for small cell applications and issuing single permission for multiple sitesto further simplify the process for permission for establishment of small cells in large numbers.
11. Collaboration with electricity authorities may be considered for ensuring uninterrupted power supply for small cells at subsidized cost.
12. Policymakers may consider removing any tax burdens associated with deploying fibre networks to reduce the associated costs. Policymakers may agree upon standardized wayleave agreements to reduce cost and time to deploy fibre and wireless networks.
13. Sharing of common ducts for affordable fibre deployments should be ensured.
14. A portfolio of wireless technologies for 5G backhaul in addition to fibre, including point-to-multipoint (PMP), microwave and millimeter wave (mmWave) radio links and satellites may be considered.
15. Sharing of radio access networks and backhaul among multiple service providers may be encouraged for cost-effective and aesthetic deployment.
16. Policies regarding EMF exposure limits should not be unduly restrictive and harmonized with ITU and WHO recommendations.
17. Cross-sector collaboration may be encouraged for leveraging the existing assets of other sectors such as Power, cable TV, Road transport authorities, Railways, Metro Rail etc. It will provide improved connectivity, affordability, and sustainability. A clear roadmap may be developed for cross-sector infrastructure sharing along with setting up of an institutional framework to build synergies among the sectors.
18. Cross-sector collaboration should also be encouraged among service providers, academia, Government ministries, vendors and enterprises across various industry verticals for development and successful deployment of country-specific 5G use cases. It will enable the integration of different industries, technologies, and infrastructure, leading to improved outcomes, increased innovation, reduced costs, and improved speed of deployment.

**ANNEXURE- I**

**5G - THE NECESSITY FOR ALL**

1. **Significance of Fast and Reliable mobile Internet Connectivity**
   1. The Internet has become ingrained into the tasks that people across the world perform each day. From obtaining information on markets or health, to making mobile payments, the Internet has made each task much easier. The internet has become an essential requirement for businesses as well as the daily lives of the general population. India is home to the world’s largest pool of internet users, with almost 800 million users, and each mobile data user consumes almost 17 GB of data each month on average. The dependency on the internet became even more profound in a post-COVID world as it became an integral part of our daily lives. In 2020, the Supreme Court of India identified access to information via the internet as a fundamental right under the Indian constitution.
   2. With the onset of COVID-19, the way we interact with the world on a day-to-day basis has changed completely. The virtual world today has become more real than we ever expected. Virtual education, remote work, digital payments, online grocery and the foundation of the meta-verse was laid in 2020 with the acceleration of digitalization becoming the new normal. The pandemic highlighted the power of fast and reliable internet connectivity in supporting individuals, businesses, governments, and societies.
   3. In fact, digital services, underpinned by high speed and high-performance internet, are set to become more integral to society in a post-pandemic world. The unconnected populations will be at greater risk of exclusion from many life-enhancing online services. The mobile industry has been instrumental in extending internet connectivity to people around the world. In 2021, the number of mobile internet subscribers reached 4.32 billion[[40]](#footnote-40) globally. Mobile ownership and internet usage are expected to keep growing in the future, as mobile technologies are becoming more affordable and available than ever. This upward trend in mobile internet adoption is particularly visible in developing digital markets where mobile networks are the primary means of internet access. Today, mobile internet traffic accounts for almost 55 percent of total web traffic.
   4. The year 2021 and beyond is witnessing a new era, where working from anywhere has gained significant traction. Almost every industry is embracing accelerated digital transformation. Organisations have very quickly adapted to the new ways of operating remotely and in a hybrid model. Mainstream use of AI, IoT, AR and VR technologies in sectors such as education, healthcare, e-commerce has brought up a need of high speed and high bandwidth internet. 5G has the potential to fulfil these requirements.
   5. 5G has the potential to transform our economy through a more enhanced and robust mobile broadband landscape. It will enable wireless broadband services to be provided at gigabit speeds. It also offers low latency and high reliability to support new types of applications, connecting devices and objects through the internet of thing (IoT). It will fuel the development of innovative business models across multiple sectors ranging from transport, health, and manufacturing to logistics, energy, and media and entertainment. Some exclusive features of 5G are covered in more detail in the next section.
2. **5G Evolution** 
   1. The evolution of mobile generations has been driven by the continuous "chase" for higher data rates, higher capacity, lower delay, better spectrum efficiency and flexibility, high level of QoS provisioning, diversified mobile speed and greater coverage over cellular. It resulted in GPRS/EDGE (2.5/2.75G) evolving to UMTS (3G) to HSPA (3.5G) to HSPA+ (3.75G), then to 4G LTE, LTE-Advanced and LTE-Advanced Pro, finally evolving to 5G NR, and continuing further to 5G-Advanced and later (around 2030) to 6G. From 3G, the ITU makes umbrella specifications, called IMT.

**Figure 5.1 IMT-Family and naming conventions (source: ITU)**

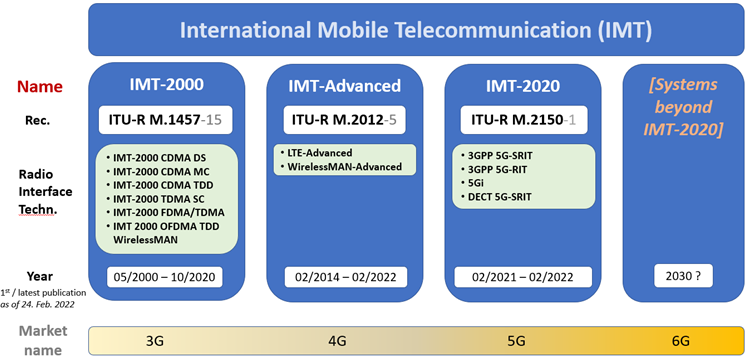
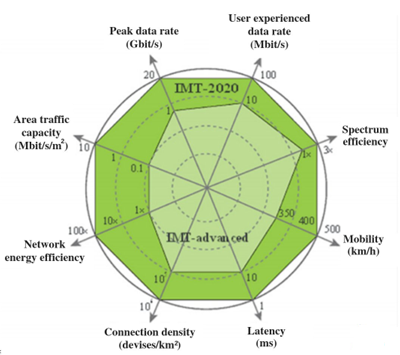


Figure 5.1 shows ITU umbrella specifications for 3G (IMT-2000), 4G (IMT-Advanced) and 5G (IMT-2020), and technologies that were accepted by the ITU under each such umbrella. Each such umbrella included stricter requirements than the previous, thus ensuring continuous progress in mobile systems.

* 1. The enhancements in key capabilities from IMT-Advanced to IMT-2020 is shown in figure 5.2. For example, **IMT-2020 is capable of delivering minimum peak bitrate of 20 Gbit/s** in **downlink,** and **10 Gbit/s** in **uplink.** Bitrates experienced by **individual** mobile users to be **100 Mbit/s** or higher. Also, **connection density** in IMT-2020 is increased ten times compared to IMT-Advanced, which is set to support of minimum 1 million connections per square kilometer in 5G systems. This includes smartphones, IoT devices, and all other IMT-2020/5G devices. Another important enhancement is support for **user plane latency** as low as 1 ms, which is needed for the envisioned critical services in IMT-2020 (i.e., 5G) systems.

**Figure 5.2: Enhancements from IMT-Advanced to IMT-2020**

Source : ITU

* 1. To have a much better understanding, these enhancements are also presented in tabular form.

**Table 5.1 IMT-2020 vs. IMT-Advanced by ITU (source: ITU)**

|  |  |  |
| --- | --- | --- |
|  | **IMT-Advanced** | **IMT-2020** |
| Minimum peak bitrate | Downlink: 1 Gbit/s  Uplink: 0.05 Gbit/s | Downlink: 20 Gbit/s  Uplink: 10 Gbit/s |
| Bitrate experienced by  individual mobile device | 10 Mbit/s | 100 Mbit/s |
| Peak spectral efficiency | Downlink:15bit/s/Hz  Uplink: 6.75 bit/s/Hz | Downlink:30bit/s/Hz  Uplink: 15 bit/s/Hz |
| Mobility | 350 km/h | 500 km/h |
| User plane latency | 10 msec | 1 msec |
| Connection density | 100 thousand devices per square kilometer | 1million devices per square kilometer |
| Traffic capacity | 0.1 Mbit/s/sq. m. | 10 Mbit/s/sq. m. in hot spots |

* 1. The deployment of 5G is happening in two modes, i.e.  **5G Non-Stand-Alone (NSA)** architecture and 5G Stand-Alone architecture. According to the 3GPP, the **5G NSA** architecture will have the 5G RAN, 5G New Radio, and 4G LTE access and network core. On the other side, the **5G SA** architecture is characterized by dedicated 5G RAN base stations, small cell base stations, and a 5G core network. While the NSA architecture only supports LTE services but has improved 5G capabilities such as lower latency as well as higher bitrates. **SA architecture** can take **full advantage of 5G** end-to-end network capabilities supported by NR and 5GC, providing customized service, especially to **vertical industry**, in an effective and efficient way. New features, including service-based architecture, end-to-end network slicing, and MEC (Multi-access Edge Computing), can be enabled according to specific requirement of each service, providing customized superior 5G user experience. These features are discussed in detail in the following section.

1. **5G Special Features**
   1. The ITU has defined three standard 5G service profiles – Massive Machine to Machine-Type Communications (mMTC), Ultra-Reliable Low-Latency Communications (uRLLC) and Enhanced Mobile Broadband (eMBB). These profiles are expected to meet the requirements of most industrial applications and are driving the adoption of 5G for industrial use cases.
2. Massive Machine to Machine-Type Communications (mMTC): Providing connectivity to IoT devices and machines on a large scale with connection density of 1 million devices per square km. mMTC supports extremely high connection densities, enabling industrial-scale IoT. With it, 5G will be able to connect up to a million IoT sensors and devices per square kilometer.
3. Ultra-reliable low-latency communication (uRLLC): With uRLLC, 5G will be able to connect controllers, switches, sensors, and actuators at latency and reliability levels equivalent to those of a wired connection. 5G’s URLLC service profile addresses several critical applications in different industries and scenarios, such as for manufacturing, automation, and autonomous equipment or vehicle operation.
4. Enhanced Mobile Broadband (eMBB): Very High Speed broadband on Cellular Network with data rates of the order of 20 bps.The special features that enable 5G to meet the requirement of these service profiles are discussed below :
5. **Service Based Architecture**
   1. Compared to previous generations the 3GPP **5G system architecture is service based.** That means wherever suitable the architectural elements are defined as network functions that offer their services via interfaces of a common framework to any network functions that are permitted to make use of these provided services. This architectural model, which further adopts principles like modularity, reusability and self-containment of network functions, is chosen to enable deployments to take advantage of the latest virtualization and software technologies.
   2. The service-based architecture provides Capability exposure, i.e. makes 5G Core Network functionalities available to third parties such as service providers and vertical industries outside the operator’s domain. This feature is provided by the **Network Exposure Function (NEF)**. The interface provided by the NEF to third parties can be regarded as one of the essential membranes through which 5G communicates more closely towards **vertical industries** than mobile networks of earlier generations did. 5G service exposure by the NEF is based on so-called **RESTful APIs.**
   3. The Network Functions (NFs) forming the SBA communicates with each other via **Service Based Interfaces (SBI)**. So, this way the **5G Core** Network internal communication obeys the same principles as the **functional exposure**, thus allowing a harmonized and holistic technological approach of the complete 5G system, fully in-line with the progressive paradigms which are at the heart of a **wide range of services** used by end-customers as well as for the automation of whole industries.
6. **Multi-access Edge Computing** 
   1. Multiaccess edge computing (MEC) enables telecom operators and third-party service provider’s content and functions to be hosted close to User Equipment's (UE) access point of attachment. MEC brings significant reduction in end-to-end latency and load on transport network. Unified MEC in IMT-2020 FMC networks is required to provide Platform As A Service (PAAS) functions to ensure the quick integration of storage, computing, network and security capabilities, and to build up an ecosystem for operator's and third-party's services and applications. An **MEC application** runs on top of the virtualization infrastructure and can interact with the MEC platform to provide and deploy MEC services.
   2. The **5G** network will enable a variety of services, including enhanced mobile broadband (**eMBB**) based services, massive machine type communications (**mMTC**) based services and ultra-reliable low latency communications (**URLLC**) based services. Therefore, **mobile edge cloud** in **5G** network is required to be a more efficient, personalized, intelligent, reliable and flexible network.
7. **Network Slicing**
   1. 5G network will enable a variety of services, including enhanced Mobile Broadband (eMBB) services, massive Machine Type Communications (mMTC) based services and Ultra-Reliable Low Latency Communications (URLLC), on the same infrastructure of network and computing resources. Network operators have traditionally provisioned multiple different networks to cope with different requirements in terms of service characteristics, functionalities, and performance. Network slicing enables 5G network operators to create logically partitioned networks providing customized solutions for different market and business scenarios.
   2. According to the ITU’s definition - network slice is a logical network that provides specific network capabilities and network characteristics. Network slices enable the creation of customized networks to provide flexible solutions for different market scenarios which have diverse requirements, with respect to functionalities, performance and resource allocation. The behavior of a network slice is realized via Network Slice Instance(s) (NSIs). A Network Slice Instance (NSI) is composed of a set of Network Function Instances (NFIs) running over the allocated resources. An NSI constitutes a logical network that provides specific network capabilities and characteristics. The underlying physical infrastructure is abstracted as network, storage, or computing resources with the help of network virtualization based on SDN, NFV, and cloud computing technologies.
   3. There are different possible uses of network slicing in 5G. For example, one network slice can be allocated for mobile Internet traffic from an operator’s own subscriber (via eMBB network slice) and another network slice can be allocated for the similar traffic (i.e., mobile Internet access) for a virtual mobile operator which is using the same 5G network infrastructure. For 5G services that require very low latencies and high reliability, a separate network slice (or slices) can be allocated (e.g., URLLC slices), where different slices can be created for different end customers (e.g., one slice for one enterprise, another network slice for other enterprise, and so on).
   4. SDN, NFV and network slicing further to extend the possibilities for offering customized services with different requirements on QoS. During the 5G era, network slicing will allow mobile operators to create virtual data pipelines for each data service. This means that QoS will be assured for every service. It may be noted that this approach is NOT jeopardizing the Internet network neutrality, which is also valid in mobile networks, but it is more targeted to extension of mobile services portfolio to other verticals, such as mission critical services (as one often used example), such as connected cars, industry automation, etc. Ultimately, the technology allows mobile operators to develop unprecedented business models.
8. **Socio-economic impact of 5G**
   1. From 2010 onwards, mobile broadband spread throughout the world, building on existing cellular networks, and then expanding and upgrading to new generations of networks. A generalized decline in service prices during 2010–2020 caused an increase in mobile broadband penetration. Various studies show that mobile infrastructure continues to have a stable impact on the world economy. The economic dividend of mobile broadband continues to be greater in countries with lower levels of economic development.
   2. 5G’s faster speed, lower latency, and ability to connect to huge numbers of devices than previous generations of mobile technology will certainly result in a more efficient and productive society. There are numerous innovative and promising use cases of the technology for various sectors, e.g., hospitals equipped with 5G devices that enable remote patient monitoring, and smart ambulances that communicate with doctors in real time; digital wallets that connect phones, wearables, cars and other devices to create seamless financial transactions; and 5G-enabled factories in which connections can be maintained among more sensors than ever before.
   3. Moreover, when 5G is used along with AI, extended reality (XR), edge computing and the Internet of Things (IoT), it will enable business and society to realise the full benefits of these other technological advances. According to a whitepaper released by World Economic Forum (WEF), *5G will be a catalyst for socio-economic growth in the Fourth Industrial Revolution with an estimated $13.2 trillion of global economic value reached by 2035. (See Fig 1.3).* For the next few years, the contribution of 5G to economic growth will be fairly modest, as telecom operators will focus on infrastructure construction and rollout. But by middle of the decade, these investments will have an increasingly energising effect on the global economy, as 5G-enabled applications become more widespread.

**Figure 1.3 : Economic and social value of 5G[[41]](#footnote-41)**

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* 1. 5G alone is expected to benefit the global economy by more than $960 billion in 2030 *(See Fig 1.4)*, mostly in developed regions, including East Asia and the Pacific, North America and Europe. Towards the end of the decade, other regions will also start benefiting from 5G, thanks to network deployments. 5G is expected to benefit all economic sectors of the global economy, although some industries will benefit more than others due to their ability to incorporate 5G use cases in their business.

**Figure 1.4 : Annual global 5G contribution by industry, 2020–2030**

 Source: GSMA Intelligence

A more elaborate analysis of sector-wise socio-economic impact of 5G has been presented below.

1. **Healthcare**
   1. 5G boosted by advances in robotics, IoT and AI—will enable the emergence of a new, connected healthcare ecosystem. This ecosystem will use 5G connectivity to meet patient and provider needs accurately, conveniently, cost-effectively and at a massive scale. According to PwC study 5G-powered healthcare applications will add US$530bn to global GDP by 2030. 5G could enhance healthcare applications in the following ways:
2. 5G will enable continuous and real time communication among doctors and patients both within and outside hospitals. This will produce better patient outcomes and reduce the length of hospital stays.
3. Mobile health platforms powered by 5G will enable faster and more accurate collection and sharing of health information between healthcare providers and patients. It may also enable doctors to use surgical robots or scanners controlled remotely over 5G to help them treat patients.
4. Healthcare providers will also be able to remotely monitor data from a large base of patients in real time, often through 5G-connected wearable devices and complemented by cloud analysis and processing.

Thus, 5G will expand the reach and effectiveness of remote health monitoring and telemedicine programmes in far-flung and rural areas also, which don’t have easy access to hospitals.

1. **Industrial Manufacturing**
   1. 5G technologies provide the network characteristics like low latency and high reliability that are key for addressing manufacturing use cases. It has the potential to address the key challenges in digitalization for industrial manufacturing. 5G networks offer manufacturers and telecom operators the chance to build smart factories and truly take advantage of technologies such as automation, artificial intelligence, augmented reality for troubleshooting, and the Internet of Things (IoT).
   2. Modern factories have advanced machines and robots equipped with a wide array of sensors connected to high-powered analytics engines in the cloud. They help in accomplishing tasks such as assess performance, manage production schedules, maintain supplies and orchestrate all the activities on the factory floor. 5G will eliminate the need of wired connectivity and supplement the high-speed manufacturing environment with a far greater degree of flexibility. 5G-enabled factory will have the capacity to maintain connections among far greater number of sensors than either wired or previous wireless facilities.
2. **Digital Financial services**
   1. 5G technology has the potential to greatly impact the financial sector by providing faster, more secure, and innovative financial services. Financial institutions are already exploring and investing in 5G technology to stay ahead of the competition and deliver better services to their customers. Following are some of the key benefits that 5G can offer to the financial industry:
3. With 5G, financial institutions can process transactions at high speeds, reducing latency and improving efficiency. This enables real-time processing of payments and instant transfer of funds. It will enable consumers to solve their queries in real time and help financial institutions greater ability to scale service provision even while downsizing branches.
4. 5G technology offers improved security features such as network slicing, which allows for the creation of secure and isolated virtual networks for sensitive financial transactions. This reduces the risk of cyberattacks and improves overall security.
5. 5G's high speeds and low latency, combined with its ability to support new technologies such as virtual and augmented reality, will open up new opportunities for the creation of innovative financial products and services. For example, virtual reality experiences could be used to provide financial advice or investment simulations, while augmented reality could be used to assist with the analysis of financial data.
6. 5G's high speeds and low latency will greatly improve mobile banking services, enabling customers to access financial services from anywhere, at any time. This will result in increased convenience for customers, as well as increased opportunities for financial institutions to reach new markets.
7. **Automotive Sector**
   1. 5G technology has the potential to transform the automotive sector and revolutionize the way we drive and interact with our vehicles. Some of the key benefits and applications of 5G in the automotive sector include:
8. Enhanced Connectivity: 5G technology will provide vehicles with high-speed and low-latency connectivity, enabling real-time communication and data transfer between vehicles, road infrastructure, and cloud-based systems. This will enable advanced features such as improved traffic management, predictive maintenance, and advanced driver assistance systems.
9. Improved Autonomous Driving: 5G will enable vehicles to receive real-time information about their surroundings, including traffic conditions, road hazards, and other vehicles, allowing for enhanced autonomous driving capabilities. This will improve the safety and efficiency of autonomous vehicles and help accelerate their widespread deployment.
10. Remote Vehicle Management: 5G technology will enable remote vehicle management, allowing automakers and dealers to remotely diagnose, troubleshoot, and update vehicles, reducing the need for costly maintenance visits.
11. New Business Models: 5G technology will enable the creation of new business models and services, such as connected car insurance, in-car entertainment and commerce, and location-based advertising.
12. Improved Energy Efficiency: 5G will enable real-time communication and data transfer between vehicles and the grid, allowing for improved energy management and more efficient charging of electric vehicles.

However, to fully realize the potential of 5G in the automotive sector, it is important to carefully manage the associated risks and challenges, including cybersecurity, privacy, and regulatory issues.

1. **Smart utilities** 
   1. The integration of 5G technology has the potential to revolutionize the way that smart utilities, such as electric and water companies, operate. Some of the key benefits and applications of 5G in the smart utilities sector include:
      * 1. Improved Network Connectivity: 5G technology will provide smart utilities with high-speed and low-latency connectivity, enabling real-time communication and data transfer between grid assets, such as sensors, meters, and substations. This will improve the efficiency and reliability of the energy and water networks, reducing downtime and costs.
        2. Advanced Analytics and Predictive Maintenance: 5G technology will enable smart utilities to collect and analyze large amounts of data from grid assets, allowing for the use of advanced analytics and machine learning to improve operations and prevent failures. This will enable predictive maintenance, reducing the need for costly repairs and downtime.
        3. Enhanced Grid Management: 5G technology will enable smart utilities to manage their grids more efficiently, improving the integration of renewable energy sources, such as wind and solar, and enabling the creation of microgrids and other flexible energy solutions.
        4. Improved Customer Engagement: 5G technology will enable smart utilities to provide customers with more information and control over their energy and water consumption, improving customer engagement and satisfaction.
        5. New Business Models: 5G technology will enable the creation of new business models and services, such as demand response, time-of-use pricing, and virtual power plants, which can help improve the efficiency and reliability of the energy grid while reducing costs.

However, to fully realize the potential of 5G in the smart utilities sector, it is important to carefully manage the associated risks and challenges, including cybersecurity, privacy, and regulatory issues.

1. **Agriculture Sector**
   1. 5G will revolutionise the agriculture sector by realising precision agriculture, achieving best cost realisation, optimising utilisation of crop and livestock resources, smart management and ensuring best price for the end users. 5G enabled drones can be deployed for remote sensing of farms and spraying fertilizers/ pesticides/insecticides. The goals are profitability, safeguarding the environment and sustainability.Precision agriculture is a strategy for enhancing productivity. This strategy increases accuracy, precision and throughput at all levels with reduced cost and labour through automation, remote sensing, data analytics and utilising disruptive innovations like 5G. With the help of 5G enabled IOT devices, data from numerous sources is collected, updated frequently and sent to the cloud in real time. In the cloud, data is analysed using AI/ ML algorithms to present actionable insights to the farmers. The sources may be soil moisture, weather, seed genetics, crop condition, plant health, historical yields, soil pH level, crop prices collected from the market etc. The actionable insights can be regarding crop to be planted, type of seed to be sown, timing of plantation, type of fertilizer, quantity and timing of fertilizer application, pests infecting the field, type and amount of crop protection products to apply, Irrigation, harvesting and selling of crops.
   2. 5G enabled drones, equipped with multispectral sensors, can be used to analyse the nutrient status of crops by Digital soil Mapping. This data is integrated with weather and other agronomic information for applying an optimal quantity of fertilizer precisely at a specified area. Drones scan and detect pests, diseases and weeds and apply pesticides at target areas after the data is analysed by an AI algorithm. 20 per cent of global GHG (GreenHouse Gases) emissions are contributed by agriculture. Soil nutrients are lost due to excessive usage of chemicals. Usage of chemicals can be reduced by 15 per cent, without impacting the yield, by deploying 5G powered drones as described above. Drones can collect and deliver information about field status and crop stage. As 5G supports high bandwidth, the 5G enabled drones can collect high resolution quality video data and relay it faster. The drone operation experts sitting at remote places operate these drones and the farmers can derive the benefits.
   3. Autonomous agricultural vehicles are another use case in agriculture. Farmers can monitor tractor's status from their cell phone which provides images and live data of the tractor. Tractors can be fitted with 5G enabled devices which allow operators to adjust remotely tractor's speed, depth of soil penetration and distance between seed rows. Driverless farm equipment will provide more flexibility and efficiency and save labour cost.
   4. Another use case in farming can be Livestock monitoring and management. India has more than 30 crore cattle and is the country with the largest consumption of dairy products. But our cattle productivity is less. Daily milk yield per cattle is 4 to 6 litres whereas the same is 30 to 40 litres in Israel. Technology can help in increasing the productivity of the cattle. Each year farmers lose significant amounts of money due to animal illness. Using 5G enabled sensor devices, farmers can monitor pests and diseases in farm animals and take action. These sensor devices can be fixed to the ear of the animal and farmers can find out remotely whether the animal is in heat stage or sick. Sensor devices can be fixed on its stomach to find out how good its digestive system is. Animal's behaviour, health, feeding patterns, food and water quality, hygiene levels can be monitored. Their location in the farm can be tracked and traced. Livestock reproductive cycles and the calving process can be tracked for safer and successful deliveries.

**ANNEXURE-II**

[**RESPONSE TO QUESTIONNAIRE FROM SATRC**](#_3as4poj) **COUNTRIES**

1. **Afghanistan**

Q1. What are the key points of spectrum auction and the status of spectrum allocation in your country for 5G?

A1. ATRA has not made any decision or plan for 5G spectrum auction or allocation yet.

Q2. Which spectrum bands have been identified and auctioned/ are being considered for auction? What are the broad considerations for selecting these bands? Have potential use cases been a part of the criteria for the selection of these bands? Please elaborate.

A2. ATRA has not yet planned to hold an auction for the 5G spectrum.Q3. Is there a spectrum roadmap prepared by the regulator concerning potential use cases and their rollout plan?

A3. No.

Q4. Are the spectrums allocated harmonized with global standards? Has your country examined the allocation of the spectrum regarding licensed and unlicensed spectrum bands? What are the conclusions?

A4. Yes, the allocation of licensed spectrum bands in Afghanistan is harmonized with global standards. However, for unlicensed bands, there are currently no specific regulations in place.

Q5. Is there a study conducted for your country regarding how 5G would affect the social and economic aspects? If yes, what have been the key parameters kept under consideration in the study, and what were the key findings?

A5. No.

Q6. Do you feel that a mechanism or framework is required for addressing cross-sectoral aspects, to enable the smooth rollout of 5G technology in different sectors? Please provide your detailed suggestions, if any, in this regard.

A6. Yes, different aspects of 5G application should be considered for different sectors. Like the need for 5G in every sector should be consider and so more.

Q7. Has your country mapped the backhaul and front haul connectivity currently available and are there any measures under consideration to review/ strengthen them for 5G?

A7. Afghanistan have mapped the backhaul and front haul connectivity for 3G and somewhere for 4G but for 5G the upgradation is necessary.

Q8. Are there 5G testbeds being established in your country? Are such initiatives taken up by the government or by the industry or a PPP type of approach is being followed. Please elaborate on the underlying reasons for the same.

A8. No, testbeds are not established.

Q9. What are the key collaborations with industry partners for the deployment of 5G? Are 5G use cases being identified with short-term and long-term maturity plans?

* A9. In Afghanistan the 5G use cases and maturity plans have not been formally identified or developed at this point due to certain challenges including: Infrastructure Constraints and limited resources like lack of electricity and funding availability
* Lagacy Network: The mobile and technology market remains relatively small, with 2G/3G/4G connectivity
* Regulatory and policy gaps: No policies and regulations has exist regarding the 4G yet.
* Shortage Skills: Specialized 5G skills like network planning, IT, programming are lacking locally.
* Rural Connectivity: Providing high bandwidth 5G to remote mountainous villages will require innovative solutions like satellite integration due to difficult terrain conditions.

Q10. Has the government/ regulator introduced or is considering specific plans to enable industries to develop/ adoption of 5G use cases? What is the institutional mechanism to coordinate and collaborate with all the economic verticals to identify, develop and deploy 5G use cases in every vertical?

A10.NO

Q11. What is the framework in your country for addressing issues such as cybersecurity and data privacy? Are there specific regulations in place? How is the country planning to adopt the existing framework/ regulations for 5G? What are your views on the security aspect concerning 5G? There any review under consideration in this regard with reference to 5G rollout?

A11. For addressing issues and for data privacy, the MCIT apply the 27001 and 27000 ISO framework.

Q12. How is your country planning to address the digital divide, if present in your country? Please elaborate including, but not limited to measures planned via 5G.

A12. In Afghanistan, we have a comprehensive plan to address the digital divide and increase accessibility to high-quality internet services.

Recently, we have conducted thorough assessment on the broadband situation in Afghanistan and have developed Fiber Optic Extension and relevant infrastructure sharing policies to connect remote areas of the country. Our goal is to increase accessibility to affordable, high-quality internet services throughout the country.

Currently, we have successfully connected 25 provinces through Fiber Optic, and we have plans to connect the remaining 9 provinces in the coming years. Additionally, we have connected major schools and hospitals in most provinces and districts through fiber optics. To ensure that citizens have access to essential digital skills, we have established training centers in all provinces of Afghanistan.

By implementing these initiatives, we aim to bridge the digital divide and ensure that all citizens have access to reliable and high-speed internet services everywhere.

Q13. What are the challenges your country is anticipating/ facing in 5G rollout or building the 5G ecosystem?

A13.

In reality, Afghanistan has only experienced 3G/4G technologies, and the ATRA has not yet established regulations for the implementation of 5G technology. As a result, we have not yet conducted a study to identify the challenges associated with the implementation of 5G technology in Afghanistan.

Q14. What are the current rollout obligations as per the extant guidelines in your country?

A14. As mentioned above, Afghanistan has not yet established regulations or obligations for the implementation of 5G mobile technology.

Q15. Does your organization think that cross-sectoral policy development is required keeping in view the use cases for 5G? What types of policy should be developed or revised? Have you undertaken any such policy?

A.15: Afghanistan is currently not yet ready for the implementation of 5G technology. However, we are committed to exploring the possibilities for future implementation of 5G technology and will study and decide about the cross-sectoral policy as needed.

1. **Bangladesh**

Q1. What are the key points of spectrum auction and the status of spectrum allocation in your country for 5G?

Ans: Recently, on 31st march 2022, BTRC Assigned 70 MHz Spectrum from 2.3 GHz Band & 120 MHz Spectrum from 2.6 GHz Band. These bands are compatible with both 4G and 5G. The spectrum was sold at the rate of 6.5 Million USD/ MHz/ 15 Years, which gives a total of more than 1.2 Billion Doller revenue. BTRC has shown great flexibility in setting auction instructions this time around which has reflected Bangladesh’s promise regarding ease of doing business. Some of the key points:

1. Spectrum acquisition price for 2100 MHz band was around 30 mUSD which was reduced by around 80% for 5G compatible bands.
2. Payment of fees:
   * 10 installments to pay the total fee.
   * 3 months’ time allowed to pay the 1st installment
3. Spectrum Activation: 9 months’ time allowed for activating the spectrum.
4. 5G network/ spectrum rollout obligation: No specific rollout obligation to date. 5G trial to start by 30 September 2022.
5. Sharing of facilities in 5G scenario: Traditional cell, tower, and fiber, scenarios are expected to face drastic change. Yet to finalize the responsibility regarding facility sharing amongst operators.

Q2. Which spectrum bands have been identified and auctioned/ are being considered for auction? What are the broad considerations for selecting these bands? Have potential use cases been a part of the criteria for the selection of these bands? Please elaborate.

Ans: Spectrum bands that have been identified for 5G:

| **Band / GHz** | **Duplex Mode** | **Uplink / Downlink (MHz)** | **Assignment**  **(Amount)** |
| --- | --- | --- | --- |
| n40 / 2.3 | TDD | 2300 – 2400 | Partially Assigned in Auction  (70 MHz) |
| n41 / 2.6 | TDD | 2500 – 2690 | Partially Assigned in Auction  (120 MHz) |
| n78 / 3.5 | TDD | 3300 – 3800 | Temporary assignment for 5G trial (60 MHz) |

Considerations: These are the globally harmonized bands for 5G. Among these bands, n40 and n41 are compatible with both 4G and 5G. Auction-2022 was done in these two bands only. Initially, these bands shall be used for enhancing existing 4G services throughout the country.

Meanwhile, MNOs are directed to start the 5G trail in these bands by 30th September 2022. 5G is supposed to ride on the existing 4G infrastructure in its beginning phase. This NSA mode 5G will be eMBB only. MNOs shall be gathering trial experience and exploring vertical industry requirements before commercial launching. Upon issuance of necessary guidelines/licenses, MNOs may start providing commercial 5G services in Bangladesh.

Q3. Is there a spectrum roadmap prepared by the regulator concerning potential use cases and their rollout plan?

Ans: Someof the MNOs already asked for additional spectrum from 2.3 GHz/ 2.6 GHz Band. Considering MNOs demand and need from the vertical industries, the unassigned spectrum from 2.3 GHz, 2.6 GHz and 3.5 GHz bands shall be auctionedfirst, tentatively by end of the year 2023. BTRC is in the process of identifying millimeter waves aligning with international allocation for region 3.

Q4. Are the spectrums allocated harmonized with global standards? Has your country examined the allocation of the spectrum regarding licensed and unlicensed spectrum bands? What are the conclusions?

Ans: Yes. The spectrums that are allocated for 5G are harmonized with global standards.  
These are licensed allocations. Bangladesh has identified 2 bands for unlicensed use for ISM applications/ data offloading; namely; 2.4 GHz (83.5 MHz) and 5.7 GHz (150 MHz) Bands. Allocating more unlicensed spectrum, for new emerging services are under consideration.

Q5. Is there a study conducted for your country regarding how 5G would affect the social and economic aspects? If yes, what have been the key parameters kept under consideration in the study, and what were the key findings?

Ans: Since 2019-2020, a high-level National Committee, led by BTRC, has been working to plan and formulate necessary policy guideline to launch 5G service in Bangladesh. The committee is comprised with representatives of BTRC, academia, government agencies, other regulatory bodies, mobile operators and other industry players. Under the supervision of this committee, primary spectrum identification, pricing of spectrum, formulation of regulatory guideline, auction guideline, Network architecture, service scope and modality, security aspects, etc. were outlined in a general manner. Moreover, BTRC has orchestrated many industry consultations, public consultations, vendor led trails, operator led trials and workshops which have helped illustrating the prospective socio-economic impact of 5G. These consultative approaches are key to reap the forthcoming 5G benefits for the individuals and industries of Bangladesh.

Q6. Do you feel that a mechanism or framework is required for addressing cross-sectoral aspects, to enable the smooth rollout of 5G technology in different sectors? Please provide your detailed suggestions, if any, in this regard.

Ans: Ans: A national level (cross-sectoral) plan or framework is key, to address the immense challenges of 5G roll out.

Joint workshops among government bodies, different organizations, associations, institutions need to be held for dialogue session and to share knowledge. It is essential that all government stakeholders of 5G along with their officials have full knowledge on the scope and capability of 5G before planning on the services that they can provide. We need collaboration among all the relevant stakeholders to structure the policy to introduce 5G in Bangladesh.

Q7. Has your country mapped the backhaul and fronthaul connectivity currently available and are there any measures under consideration to review/ strengthen them for 5G?

Ans: Yes, the available backhaul connectivity are been mapped in detail. BTRC had issued NTTN license back on 2008 for backhaul fiber connectivity to Access Network Providers. Presently, there are more than 1,45,000 KM fiber which has been laid down by the operators throughout the country. Under new use cases for 5G and beyond, fronthaul, any-haul, etc. are being evaluated by the regulator and industry.

As backhaul connectivity is of immense importance, BTRC is planning to propose the following for the ANS:

If the ANS requires fiber connectivity to any tower, it shall request to an  
NTTN Operator first to provide such connectivity and shall notify BTRC of the same. If  
the NTTN Operator cannot lay the fiber within 45 (forty five) days which will be reviewed  
by the Commission from time to time, the Licensee shall have the right to lay its own fiber  
to connect the tower with the nearest transmission POP. In such case, the Licensee cannot  
rent or lease out the fiber to any other operator except NTTN operator.

Q8. Are there 5G testbeds being established in your country? Are such initiatives taken up by the government or by the industry or a PPP type of approach is being followed. Please elaborate on the underlying reasons for the same.

Ans: 5G testbeds are yet to be established in Bangladesh, however BTRC has coordinated 5G trials. On 25 July 2018, a leading vendor had conducted such trial. Spectrum auction for 2300 MHz and 2500 MHz bands has been done this year (on 31st March 2022) where out of 220 MHz spectrum, 190 MHz was awarded in favor of 4 MNOs. MNOs are directed to start 5G trail by 30th September 2022. Initially, these bands shall be used for enhancing existing 4G services throughout the country. Meanwhile, in December 2021, state-owned MNO, Teletalk, has been given administrative permission to trail 5G in 3500 MHz band (3740-3800 MHz) and they have already deployed a few 5G sites in some major locations of our country. Upon issuance of necessary guidelines/licenses, MNOs may start providing commercial 5G services in Bangladesh.

Q9. What are the key collaborations with industry partners for the deployment of 5G? Are 5G use cases being identified with short-term and long-term maturity plans?

Ans: Industry partners, to be precise, the MNOs are requesting not to impose any rollout target for 5G. BTRC is planning to impose a soft and high-level rollout obligation which may look like the following:

In order to materialize Governments plan to build Smart Bangladesh and to make ‘Vision  
2041’ a reality during the first year after the issuance of the License under these  
Guidelines the Licensee shall establish its cellular mobile network including provisions of  
telecom services based on the demand from the customers i.e. government, enterprises and citizens. However, from the second year onwards the Licensee must have the capability to provide identified services (mentioned below), including mission critical services like smart city, smart home, intelligent transportation systems, smart grid, or any other useful new applications using eMBB, uRLLC, mMTC, IoT and any new  
telecommunication services based on important use cases and demand from the public and private sector of Bangladesh.

The Licensee is authorized to provide Cellular Mobile Services including the following services through its Telecommunication systems:

* Cellular Mobile Services which include 2G/3G/4G/5G or IMT for 2020 and beyond technologies.
* Intra-Operator Domestic Voice and Video Calls.
* Inter-Operator Domestic Voice and Video Calls.
* International Long- Distance Voice and Video Calls.
* International Roaming Services.
* Domestic and International SMS/ EMS/VMS services.
* Internet of Things (IoT), Machine to Machine (M2M) and B2B services.
* Mobile Broadband/Internet.
* Fixed Wireless Access Service.
* enhanced Mobile Broadband Service (eMBB).
* massive Machine Type Communication services (mMTC).
* ultra-Reliable and Low Latency Communications (uRLLC) service.
* Value Added Services (compatible with 2G, 3G, 4G/LTE, 5G and beyond) as per Regulatory Guidelines for Issuance of Registration Certificate for Providing Telecommunication Value Added Services (TVAS) in Bangladesh.
* Any other compatible services related to the license as approved by the Commission.

Considering the service scope, network development and overall advancement of the use  
cases, BTRC may issue directives/ instructions containing roll-out target in consultation  
with the licensees for the utilization of particular frequency band, deployment of new  
services and technologies as and when required along with Performance Bank Guarantee,  
if required. The terms and conditions of any such directive/instruction shall be treated as  
an integral part of these Guidelines and Licenses.

Q10. Has the government/ regulator introduced or is considering specific plans to enable industries to develop/ adoption of 5G use cases? What is the institutional mechanism to coordinate and collaborate with all the economic verticals to identify, develop and deploy 5G use cases in every vertical?

Ans: From the different use cases of 5G we have seen that there is need of development in all sectors like health, roads and highways, power, agriculture, education, etc. to get the full potential out of this technological advancement. Industry stakeholders have identified several potential use cases for 5G networks, and the ITU-R has defined three important categories:

* Enhanced mobile broadband (eMBB) – enhanced indoor and outdoor broadband, enterprise collaboration, augmented and virtual reality;
* Massive machine-type communications (mMTC) – IoT, asset tracking, smart agriculture, smart cities, energy monitoring, smart home, remote monitoring; and
* Ultra-reliable and low-latency communications (URLLC) – autonomous vehicles, smart grids, remote patient monitoring and telehealth, industrial automation.

Collaborative Regulation has been steadily gaining momentum, reflecting a data-driven world where the demarcation between the ICT and Telecom sectors and other industry verticals has increasingly blurred. Regulators and policymakers should work with investors, including operators, to create the conditions that encourage the investment that will meet the needs of the unconnected, providing more connectivity but also more security, better digital skills, and improved affordability of 5G services.

Q11. What is the framework in your country for addressing issues such as cybersecurity and data privacy? Are there specific regulations in place? How is the country planning to adopt the existing framework/ regulations for 5G? What are your views on the security aspect concerning 5G?

Ans: Bangladesh has faced a number of cyber-attack incidents in the form of web defacement, information damage, information theft, distributed denial of service, etc, due to lack of information protection procedure, weak and unmanaged security controls and lack of expertise because of under skilled personnel. For protecting right of the citizens and enterprises across the country and beyond specific regulations relating to cybersecurity, data privacy, etc. are important.

The 2nd objective of National ICT Policy 2018 is Digital security which covers the ICT security policy issues. Here 9 Specific strategies were delineated. They are:

* Standard/ Quality software and hardware
* Safe and Secure use of the Internet
* Maintain the privacy of personal information
* Secure women and children online
* Preventive measure/ Pecuniary punishment for Digital crime/ cybercrime incidents.
* Standard procedure to follow to Store/ Manage/ Use/ secure information etc
* Secure ICT to ensure safe financial transactions online.
* Digital Transaction log to be securely stored for forensic investigation and dispute resolution.
* Digital Signature implementation and onshore storage of all Governmental information

Prevailing ICT Security Policy/Guideline/Strategy in Bangladesh are as follows:

* Information Security Policy Guideline 2014
* National Cybersecurity Strategy 2014
* Guideline on ICT Security for Banks and Non-Bank Financial Institutions, 2015
* National Digital Commerce Policy 2018
* Government E-mail Policy 2018
* Draft ‘Regulation for Digital, Social Media and OTT Platforms, 2021’
* Draft ‘Data Protection Act, 2022’
* ‘Bangladesh Computer Security Incident Response’ (BD-CSIRT)’ Supervised by BTRC.

All these Policies/Guidelines/Strategies in place shall be adopted for upcoming technologies including 5G.

Q12. How is your country planning to address the digital divide, if present in your country? Please elaborate including, but not limited to measures planned via 5G.

Ans: Digital exclusion now means exclusion from employment, education, essential information, and even from the chance to stay close to friends and family. Therefore, Bangladesh is putting significant effort to provide affordable access to relevant telecom, ICT, multimedia & digital services to the enterprises and people. Adequate policy help, necessary spectrum availability at an affordable price for the operators, infrastructure readiness, necessary backhaul network provisioning (microwave, optical fiber, satellite, etc.), availability of smart device (phone/IoT products/SIM based CPEs/etc.), and strict quality of service monitoring have played key role in this regard. We all know, 5G is the next step in our journey to connect all societies to a better future. Building upon and working with harmonized 4G, 5G will deliver more than just faster downloads with lower lag. It promises to have a deeper impact on our lives than any previous mobile generation. In order to materialize 100% digital inclusion Bangladesh is looking forward to timely adoption of newer technologies, system and services.

Q13. What are the challenges your country is anticipating/ facing in 5G rollout or building the 5G ecosystem?

Ans:

|  |  |  |
| --- | --- | --- |
| **Spectrum** | **Network, Systems & Services** | **Rollout and other** |
| * vailability (Legacy Service/Contiguous/High-Mid-Low) * Auction Design (Transparent/Fair) * Fee (Acquisition/ Usage/ Affordable/ Grace period) * Sharing (Active) * Technology (Neutral) * Guard Band | * Cost (New radio/ Acquisition/ Software/ Hardware) * Service tariff (Home/ Corporate/ Diversity of use cases) * Sharing of facilities (Active/ passive/ accessing public infrastructure) * Front-haul Fiber to small cell. * 5G RAN (Cell planning in diversified use cases) * 5G Core (Network Functions Virtualization Infrastructure; Management and Orchestration) * Offshore infrastructure or platform (Cloud-based storage, backup and recovery management, analytic and high-performance computing, web hosting, software and applications through API, etc.) * Radiation/Monitoring/Security/Privacy | * Setting Obligation/ No Obligation debate * Addressing End user Diversity/ Integration/ Service creation * Infrastructure deployment responsibility * Device penetration * Co-existence with 4G/WiFi/Satellite * Power/ CO2 emission * Tax/Vat/other applicable levies |

Q14. (a) What are the current rollout obligations as per the extant guidelines in your country? (b) Is there any review under consideration in this regard with reference to 5G rollout?

Ans: (a) The rollout obligation for 4G services in Bangladesh are comprised of following 3 phases:

|  |  |  |
| --- | --- | --- |
| **Phase** | **Description/Responsibility** | **Duration/Criteria** |
| 1st phase | Services in all Divisional Headquarters | 9 Months/15 Months |
| 2nd phase | Services in another 30% of district Headquarters | 18 Months/24 Months |
| 3rd phase | Services in all District Headquarters | 36 Months |
| Other obligation | Services in major cities/ locations | As per direction from Commission |
| Services in Upazila/ National Highway /railway track | Upon fulfillment of 3rd phase work |
| Services in all over the country | Upon fulfillment of 3rd phase work |

*\*Divisions are the first-level administrative unit in Bangladesh. There are 8 Divisions, 64 Districts and 492 Upazilas in Bangladesh.*

(b) Necessary guidelines with network and service rollout obligation are to be published soon.

Q15. Does your organization think that cross-sectoral policy development is required keeping in view the use cases for 5G? What types of policy should be developed or revised? Have you undertaken any such policy?

Ans: To reap the optimum potential of 5G, BTRC thinks cross-sectoral policy development is of significant importance.

MNO led 5G trail has commenced in 2022 and 5G commercial launching is nearing. Now, it is essential that all private/government stakeholders of 5G should have adequate knowledge on the scope and capability of 5G before planning on the services that they can avail and provide.

Aligning with the national policy; joint workshops and dialogues among government bodies, academia, different organizations, etc. are currently underway regarding cross-sectoral 5G service provisioning in Bangladesh. In this connection, necessary guidelines with network and service rollout obligation are to be published soon.

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1. **Bhutan**

Q1. What are the key points of spectrum auction and the status of spectrum allocation in your country for 5G?

Ans. The 5G service has been commercially launched by the two Mobile operators (Bhutan Telecom Limited and Tashi InfoComm Limited) since December 2021 in Bhutan. The spectrum in the mid 3.5GHz band (3.4GHz - 3.6GHz) has been issued based on the administrative method and not through the auction method.

Q2. Which spectrum bands have been identified and auctioned/ are being considered for auction? What are the broad considerations for selecting these bands? Have potential use cases been a part of the criteria for the selection of these bands? Please elaborate.

Ans. No spectrum band has been auctioned or is being considered for auction. We have assigned the 5G spectrum in the mid 3.5GHz band based on the administrative method. The mid 3.5GHz band has been considered for 5G since the band being internationally harmonized and recommended by the GSMA.

In Bhutan, 5G is used for mobile communication by the operators and the spectrum in mid-band is considered ideal for 5G eMBB with higher capacity than low-frequency bands and greater coverage (even indoors) than high-frequency bands.

Q3. Is there a spectrum roadmap prepared by the regulator concerning potential use cases and their rollout plan?

Ans. Yes, there are certain roadmaps prepared by the regulator such as the roadmap for 5G rollout plan which identified certain frequency bands for deployment of 5G

Q4. Are the spectrums allocated harmonized with global standards? Has your country examined the allocation of the spectrum regarding licensed and unlicensed spectrum bands? What are the conclusions?

Ans. Yes, they are harmonized with global standards according to recommendations from ITU and GSMA. The 3.5GHz mid band has been globally recommended for the implementation of 5G services. The BICMA is also reviewing to allocate the mmWave bands for high capacity 5G services as an addition to the mid 3.5GHz band.

Q5. Is there a study conducted for your country regarding how 5G would affect the social and economic aspects? If yes, what have been the key parameters kept under consideration in the study, and what were the key findings?

Ans. No study has been done on the effect that 5G would have on social and economic aspects.

Q6. Do you feel that a mechanism or framework is required for addressing cross-sectoral aspects, to enable the smooth rollout of 5G technology in different sectors? Please provide your detailed suggestions, if any, in this regard.

Ans. Yes. The smooth rollout of 5G depends on the support and facilitation from many cross-sector. For instance, the 5G rollout is also dependent on the availability of the consumer mobile handsets which should be compatible to the frequencies deployed as well as network ecosystems. Without compatible mobile handsets, the 5G services provided by the operators will not be realized. Therefore the handset manufacturer is also an important sector to enable 5G success.

Besides, the agencies responsible for granting the right of way to telcos in installing the access networks for 5G services. The 5G will need the installation of multiple access sites compared to the previous generation of mobile services. Therefore, the operators should be facilitated with the right of way access to build and install the access network sites.

Q7. Has your country mapped the backhaul and fronthaul connectivity currently available and are there any measures under consideration to review/ strengthen them for 5G?

Ans. Currently, the backhaul and fronthaul connectivity for 5G are done through the existing microwave links and fiber connectivity. We are also planning to provide the fronthaul and backhaul connectivity through the high capacity microwave links through higher frequencies.

Q8. Are there 5G testbeds being established in your country? Are such initiatives taken up by the government or by the industry or a PPP type of approach is being followed. Please elaborate on the underlying reasons for the same.

Ans. No. We do not have the testbeds established at the moment.

Q9. What are the key collaborations with industry partners for the deployment of 5G? Are 5G use cases being identified with short-term and long-term maturity plans?

Ans. The operators are coordinating with the mobile handset manufacturers for allowing the network compatibility with the handsets.

Q10. Has the government/ regulator introduced or is considering specific plans to enable industries to develop/ adopt 5G use cases? What is the institutional mechanism to coordinate and collaborate with all the economic verticals to identify, develop and deploy 5G use cases in every vertical?

Ans. No. The study is yet to be carried out.

Q11. What is the framework in your country for addressing issues such as cybersecurity and data privacy? Are there specific regulations in place? How is the country planning to adopt the existing framework/ regulations for 5G? What are your views on the security aspect concerning 5G?

Ans. This is being taken care of by the different agencies who look after the cybersecurity in the country.

Q12. How is your country planning to address the digital divide, if present in your country? Please elaborate including, but not limited to measures planned via 5G.

Ans. All the remote areas which are not commercially viable are being connected with the mobile voice and data services through the Rural Communication Project funded by the Government of Bhutan. In future the country may also look into the feasibility of providing 5G services in the remote rural areas through such projects.

Q13. What are the challenges your country is anticipating/ facing in 5G rollout or building the 5G ecosystem?

Ans. The challenges are:

1. Site acquisition and right of way
2. Handset availability
3. Awareness and advocacy
4. Affordability
5. Investment for operators

Q14. What are the current rollout obligations as per the extant guidelines in your country? Is there any review under consideration in this regard with reference to 5G rollout?

Ans. No obligations

Q15. Does your organization think that cross-sectoral policy development is required keeping in view the use cases for 5G? What types of policy should be developed or revised? Have you undertaken any such policy?

Ans. Yes. The broadband policy needs to be revised and moreover there is a critical need for comprehensive digital policy.

1. **India**

Q1. What are the key points of spectrum auction and the status of spectrum allocation in your country for 5G?

and

Q2. Which spectrum bands have been identified and auctioned/ are being considered for auction? What are the broad considerations for selecting these bands? Have potential use cases been a part of the criteria for the selection of these bands? Please elaborate.

In India, the IMT spectrum is assigned through auction and is technology neutral.

Telecom Regulatory Authority of India (TRAI) in April 2022 has given its recommendations on ‘Auction of Spectrum in frequency bands identified for IMT/5G’ to the Department of Telecommunications. Based on these recommendations, the Government has released Notice Inviting Applications for Auction of Spectrum in 600 MHz, 700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz, 2500 MHz, 3300 MHz, and 26 GHz Bands in June 2022 and the auction of spectrum is scheduled for July 2022. In total of 72097.85 MHz of spectrum is being put to auction and the auction will be a Simultaneous Multiple Round Ascending (SMRA) e-auction.

Spectrum in in all three requisite globally harmonized spectrum bands for 5G – Low (600 MHz, 700 MHz), Mid (3300 MHz), and High (26 GHz band) bands, is being auctioned.

In India, the Wireless Planning and Coordination (WPC) Wing of the Ministry of Communications, is responsible for Frequency Spectrum Management, including identification of spectrum bands for IMT.

Q3. Is there a spectrum roadmap prepared by the regulator concerning potential use cases and their rollout plan?

and

Q4. Are the spectrums allocated harmonized with global standards? Has your country examined the allocation of the spectrum regarding licensed and unlicensed spectrum bands? What are the conclusions?

As WPC wing of DoT is responsible for Frequency Spectrum Management.

Q5. Is there a study conducted for your country regarding how 5G would affect the social and economic aspects? If yes, what have been the key parameters kept under consideration in the study, and what were the key findings?

The Government of India set up a 5G High-Level Forum in September 2017 to articulate the Vision for 5G in India and to recommend policy initiatives and action plans to realize this vision. The 5G High-Level Forum approved the 5G Vision for India in December 2017. The High-Level Forum released its Report on ‘Making India 5G ready’ in August 2018[1] and suggested measures in areas such as Spectrum Policy, Regulatory Policy, Education and Awareness Promotion Program, Application & Use Case Labs, Development of Application Layer Standards, Major Trials and Technology Demonstration and Participation in International Standards. It also recognized the importance of swift clearances and rights of approval for infrastructure densification.

In 2018, Government launched National Digital Communication Policy (NDCP)[2] with an objective to lead India to a realm of new 'Digital First' world and aims to facilitate the implementation of technologies such 5G, IoT, M2M, etc. to achieve the goal of digital empowerment and improved well-being of the people, NDCP 2018 seeks to unlock the transformative power of digital communications networks.

As such TRAI has not conducted any study regarding how 5G would affect the social and economic aspects. However, there are number of reports, published by different agencies, which are in the public domain.

Q6. Do you feel that a mechanism or framework is required for addressing cross-sectoral aspects, to enable the smooth rollout of 5G technology in different sectors? Please provide your detailed suggestions, if any, in this regard.

Since, 5G technology will also enable a massive expansion of digital products and services across industrial, commercial, education, healthcare, agriculture, financial, and social sectors, therefore, to identify, develop and proliferate telecom-driven use cases across different sectors, TRAI in its recommendation on ‘Auction of Spectrum in frequency bands identified for IMT/5G[3]’ dated 11 April 2022, recommended for establishment of an ‘Inter-Ministerial Working Group (IMWG)’ for better coordination and complementing each other’s efforts to realize the benefits of 5G technology for achieving overall economic growth of the Country.

While making recommendations, TRAI also emphasized that the Micro, Small and Medium Enterprises (MSMEs) may need Government’s hand holding and there would be a need to assess the degree of intention and inclination among the MSMEs, both in formal and informal sectors, towards automation and digital transformation. It was also mentioned that timely intervention and hand holding of MSME sector would also help India to increase its share in the international value chain system and play a significant role in the Indian and global digital economy.

 Q7. Has your country mapped the backhaul and fronthaul connectivity currently available and are there any measures under consideration to review/ strengthen them for 5G?

As per the Press Information Bureau (PIB) press release dated 15th June 2022, the Cabinet has decided to provisionally allocate up to two carriers of 250 MHz each in the E-Band and the Cabinet has also decided to double the number of carriers in existing Microwave bands in 13/15/18/21 GHz bands However, Guidelines regarding the same will be issued separately by the Government.

Q8. Are there 5G testbeds being established in your country? Are such initiatives taken up by the government or by the industry or a PPP type of approach is being followed. Please elaborate on the underlying reasons for the same.

Keeping in view India’s specific requirements and to take lead in 5G deployment, DoT also started work on setting up an ‘Indigenous 5G Test Bed’ in India in March 2018 in collaboration with premier academic institutes. The testbed is likely to enhance national capability in telecom technology, development of indigenous Intellectual Property (IP), and give a fillip to Indian telecom manufacturers. It is likely to pave the way for end-to-end testing of 5G User and network equipment by 5G stakeholders developing 5G Products/Services/Use cases. The indigenous 5G test bed, a technology development project initiated in telecom space, will enable development, testing and proliferation of 5G technology system components, cross-sectoral use cases, besides setting up foundation for the development of “6G Technology landscape” in the country. This has recently been made available to the Public by the Hon’ble Prime Minister of India during the Silver Jubilee Celebration of TRAI on World Telecommunication and Information Society Day 2022.

DoT is working with different Ministries/Departments for setting up of India specific Use Case labs in Education, Health care, Agriculture, Public safety, FinTech etc.

Q9. What are the key collaborations with industry partners for the deployment of 5G? Are 5G use cases being identified with short-term and long-term maturity plans?

And

Q10. Has the government/ regulator introduced or is considering specific plans to enable industries to develop/ adoption of 5G use cases? What is the institutional mechanism to coordinate and collaborate with all the economic verticals to identify, develop and deploy 5G use cases in every vertical?

The Department of Telecommunications launched “5G Hackathon” in collaboration with MeitY, NITI Aayog, Start-up India and other stakeholders to identify and promote applications, relevant to India in different categories like Healthcare, Education, Governance, Banking, Finance, Insurance, Cyber Security, Enterprise transformation, Industry 4.0, Agritech, Livestock, Smart Cities & Infrastructure etc. in the 5G realm that will be developed into workable products and services. The main objective of the “5G Hackathon” was to bring all the players together in the ecosystem such as tech companies, mobile operators, manufacturers, developers to work together and convert their ideas into workable products and services. During phase 1 of 5G Hackathon, 100 best ideas have been selected in different sectors mentioned above. These 100 selected applicants were awarded with prize money of Rs. 1.0 Lakh each. Thereafter the 5G Hackathon entered into phase 2, wherein these ideas converted into workable products and services under the mentorship of Industry and academia and 30 best products have been selected and awarded in Phase 2 on which the further progress is being made.

Further, TRAI in its recent recommendations on ‘Auction of spectrum in frequency bands identified for 5G/IMT’, has recommended that:

a.            A 5G-dedicated Inter-Ministerial Working Group (IMWG), under the Chairmanship of Member (Technology), DoT  should be formed comprising Ministry of Electronics and Information Technology, Department for Promotion of Industry and Internal Trade, Ministry of Information and Broadcasting, Department of Space, Ministry of Finance, Ministry of Education, Department of Science & Technology, Ministry of Micro, Small and Medium Enterprises (MSME) and Niti Ayog as members, which should be represented by JS Level officers.

b.            The IMWG may co-opt officers from other concerned Ministry(ies) / Department(s) as per requirement.

c.            The concerned Ministries/Departments shall establish a special dedicated Digital Cell, headed by the JS Level officer nominated as member in IMWG, with dedicated technical manpower to formulate the use of digital technologies like 5G, IoT, M2M, AI etc. and development of relevant and affordable use cases involving start-up companies, entrepreneurs, application providers etc. The scope of the Digital Cell shall include, but not limited to, involving the relevant stakeholders in discussions, framing and monitoring short-term (annual), medium-term (5-year), and long-term (10-year) plans with quantitative targets in respect of sector specific 5G use cases, providing platform and promoting 5G use cases. The Digital Cell may also need to focus on issues relating to digital literacy, connectivity and affordable user devices for their sector.

d.           The Ministries/Departments should take up short-term (annual), medium-term (5-year), and long-term (10-year) plans with quantitative targets in respect of sector specific 5G use cases and the same can be considered by IMWG for consistent and coordinated development of use cases and start-up ecosystems to align issues such as connectivity, privacy, data security etc. in the country.

DoT is working with different Ministries/Departments for setting up of India specific Use Case labs in Education, Health care, Agriculture, Public safety, FinTech etc.

Q11. What is the framework in your country for addressing issues such as cybersecurity and data privacy? Are there specific regulations in place? How is the country planning to adopt the existing framework/ regulations for 5G? What are your views on the security aspect concerning 5G?

With increasing digitalization, the issue of the protection of the personal data and of the telecom service users is a matter of deep concern for everyone. Since a large portion of data flows through the telecom networks, it is necessary to ensure the security of telecom networks.

To ensure the security of telecom networks, especially with 5G services, the Government of India has launched a 'trusted telecom' portal in June 2021, signaling the coming into effect of the National Security Directive on Telecommunication Sector (NSDTS). Consequently, with effect from 15th June 2021 the Telecom Service Providers are mandatorily required to connect their networks only those new devices which are designated as ‘Trusted Products’ from ‘Trusted Sources’. The present Directive does not envisage mandatory replacement of the existing equipment already inducted in the networks of the TSPs. The National Cyber Security Coordinator (NCSC) is the designated authority for the determination of the inclusion of a vendor/telecom product as a Trusted Source/Product.

On the issue of the legal framework for data protection, TRAI issued its recommendations on ‘Privacy, Security and Ownership of the Data in the Telecom Sector’ dated 16th July 2018, covering aspects such as adequate protection to sensitive personal information, adoption of globally accepted data protection principles, and provisions governing the cross-border transfer of data.

Q12. How is your country planning to address the digital divide, if present in your country? Please elaborate including, but not limited to measures planned via 5G.

The Government of India is taking significant steps towards acquiring competence in information and technology to cope with India’s Digital Divide.

1.Digital India Initiatives by Government to improve internet access in the country are –

* In 2011, the BharatNet project was launched to connect 0.25 million panchayats through an optical fibre (100 MBPS) and connect India’s villages.
* In 2014, the government launched the National Digital Literacy Mission and the Digital Saksharta Abhiyan.
* In 2015, the government launched several schemes under its Digital India campaign to connect the entire country.
* PM Gramin Digital Saksharta Abhiyan, launched in 2017, to usher in digital literacy in rural India by covering 60 million households.

2. Seeing the importance of digital literacy, the Supreme Court of India has declared the right to access to the Internet as a fundamental right, making it a part of the right to privacy and the right to education that comes under Article 21 of the Constitution.

3. National Education Policy, 2020 aims at making “India a global knowledge superpower” by introducing several changes from the school to college level in the Indian education system with special emphasis on digital education.

4. Internet Saathi Program – The Internet Saathi Program was launched in 2015 by Google India and Tata Trusts. The aim of this project is to facilitate digital literacy among rural Indian women.

5. DIKSHA (Digital Infrastructure for Knowledge Sharing) platform- DIKSHA is the national platform for school education available for all states and the central government for grades 1 to 12 and was launched in September 2017. As part of PM eVidya announced under the Atma Nirbhar Bharat programme, DIKSHA is the ‘one nation; one digital platform’ for school education in India.

Q13. What are the challenges your country is anticipating/ facing in 5G rollout or building the 5G ecosystem?

Some of the challenges facing 5G rollout or building 5G ecosystem in India are as under:

1. Cross-sector collaboration for infrastructure creation and sharing,
2. RoW permissions for erection of telecom infrastructure,
3. Investment in 5G network by the Service Providers
4. Technology upgradation from 4G to 5G handsets.

Q14. What are the current rollout obligations as per the extant guidelines in your country? Is there any review under consideration in this regard with reference to 5G rollout?

TRAI has recently given its recommendations on ‘Auction of Spectrum in frequency bands identified for IMT/5G’ in April 2022. Based on these recommendations, in the NIA 2022, the Government has laid down roll-out conditions. For 600 MHz, 700 MHz, 800 MHz, 900 MHz, 1800MHz, 2100MHZ, 2300MHz & 2500MHz bands, roll-out obligations are coverage based whereas for 3300 MHz and 26 GHz band spectrum, roll-out obligations are based on service based / number of sites to be deployed. For further details, kindly refer to the recent NIA[4] for auction of Spectrum.

Q15. Does your organization think that cross-sectoral policy development is required keeping in view the use cases for 5G? What types of policy should be developed or revised? Have you undertaken any such policy?

Inputs to Q9 & 10 may kindly be referred.

[1] https://dot.gov.in/sites/default/files/5G%20Steering%20Committee%20report%20v%2026.pdf

[2] https://dot.gov.in/sites/default/files/Final%20NDCP-2018\_0.pdf

[3] https://www.trai.gov.in/sites/default/files/Recommendations\_11042022.pdf

[4] https://dot.gov.in/sites/default/files/NIA\_Version\_Dated\_15\_06\_2022.pdf

1. **Iran**

Q1. What are the key points of spectrum auction and the status of spectrum allocation in your country for 5G?

**Answer:**

* Bandwidth Continuity
* Assigned the best amount of bandwidth
* Fairness of competition
* The price is right
* Avoiding increase unwanted of the basic fee in the auction

Q2. Which spectrum bands have been identified and auctioned/ are being considered for auction? What are the broad considerations for selecting these bands? Have potential use cases been a part of the criteria for the selection of these bands? Please elaborate.

**Answer:**

**A:** The frequency bands have been assigned for developing 5G tech. are including:

- 3400-3800 MHz (3500 MHz)

- 24.25-27.5 GHz (26GHz)

B: These bands are selected according to:

* National allocation table
* Release of band
* ICT sector demand

C: According to the many use cases which run in worldwide and, the abundance of equipment in the market, these are effective factors in the selection mentioned frequency bands.

Q3. Is there a spectrum roadmap prepared by the regulator concerning potential use cases and their rollout plan?

**Answer:** Yes, the regulator prepared spectrum roadmap.

Q4. Are the spectrums allocated harmonized with global standards? Has your country examined the allocation of the spectrum regarding licensed and unlicensed spectrum bands? What are the conclusions?

**Answer:** the spectrums are allocated is harmonized with global standards.

Due to the fact that the 3500 MHz frequency band in the 5G network is used as a pilot in our country, it is in accordance with international standards and has a license.

Q5. Is there a study conducted for your country regarding how 5G would affect the social and economic aspects? If yes, what have been the key parameters kept under consideration in the study, and what were the key findings?

Q6. Do you feel that a mechanism or framework is required for addressing cross-sectoral aspects, to enable the smooth rollout of 5G technology in different sectors? Please provide your detailed suggestions, if any, in this regard.

Q7. Has your country mapped the backhaul and fronthaul connectivity currently available and are there any measures under consideration to review/ strengthen them for 5G?

**Answer:** The radio links of the E-band type are considered for 5G communication, however the main priority is the use of optical fiber.

Q8. Are there 5G testbeds being established in your country? Are such initiatives taken up by the government or by the industry or a PPP type of approach is being followed. Please elaborate on the underlying reasons for the same.

Developing FTTx network for preparing 5G infrastructure is ongoing

Q9. What are the key collaborations with industry partners for the deployment of 5G? Are 5G use cases being identified with short-term and long-term maturity plans?

5G use cases are being identified with long-term maturity plans by some industries such as car industry

Q10. Has the government/ regulator introduced or is considering specific plans to enable industries to develop/ adoption of 5G use cases? What is the institutional mechanism to coordinate and collaborate with all the economic verticals to identify, develop and deploy 5G use cases in every vertical?

Q11. What is the framework in your country for addressing issues such as cybersecurity and data privacy? Are there specific regulations in place? How is the country planning to adopt the existing framework/ regulations for 5G? What are your views on the security aspect concerning 5G?

Q12. How is your country planning to address the digital divide, if present in your country? Please elaborate including, but not limited to measures planned via 5G.

Q13. What are the challenges your country is anticipating/ facing in 5G rollout or building the 5G ecosystem?

Q14. What are the current rollout obligations as per the extant guidelines in your country? Is there any review under consideration in this regard with reference to 5G rollout?

Q15. Does your organization think that cross-sectoral policy development is required keeping in view the use cases for 5G? What types of policy should be developed or revised? Have you undertaken any such policy?

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1. **Maldives**

Q1. What are the key points of spectrum auction and the status of spectrum allocation in your country for 5G?

* Spectrum is not auctioned but allocated as part of licence requirement on needs basis.
* No current plans for auction.

Q2. Which spectrum bands have been identified and auctioned/ are being considered for auction? What are the broad considerations for selecting these bands? Have potential use cases been a part of the criteria for the selection of these bands? Please elaborate.

* Both operators assigned with 100 MHz bandwidth each in 3.4 – 3.6 GHz
* Additional 90 MHz in the 2.6 GHz band also allocated for 5G to each operator.
* Criteria considered – Equipment availability, Current allocation and use, & potential interference
* Initially caused interference to satellite downlink services by local cable TV operator during 5G Testing in 3.6 – 3.8 GHz band. Bands Reassigned as above. Limited cable operator downlink bandwidth to 3.8 – 4.2 GHz. Operators had to replace equipment.

Q3. Is there a spectrum roadmap prepared by the regulator concerning potential use cases and their rollout plan?

* No specific roadmap, but to follow global trends

Q4. Are the spectrums allocated harmonized with global standards? Has your country examined the allocation of the spectrum regarding licensed and unlicensed spectrum bands? What are the conclusions?

* Yes, harmonized. The current 5G assignments are those standardized by ITU and 3GPP
* Not considered unlicensed spectrum bands.

Q5. Is there a study conducted for your country regarding how 5G would affect the social and economic aspects? If yes, what have been the key parameters kept under consideration in the study, and what were the key findings?

* No

Q6. Do you feel that a mechanism or framework is required for addressing cross-sectoral aspects, to enable the smooth rollout of 5G technology in different sectors? Please provide your detailed suggestions, if any, in this regard.

* Yes

Q7. Has your country mapped the backhaul and fronthaul connectivity currently available and are there any measures under consideration to review/ strengthen them for 5G?

* Yes we have mapped the current backhaul and fronthaul.
* Not specifically for 5G, however works in progress for expanding backhaul capacity for both international as well as domestic.

Q8. Are there 5G testbeds being established in your country? Are such initiatives taken up by the government or by the industry or a PPP type of approach is being followed. Please elaborate on the underlying reasons for the same.

* Not yet. Some pilot testbeds were used by service providers.

Q9. What are the key collaborations with industry partners for the deployment of 5G? Are 5G use cases being identified with short-term and long-term maturity plans?

* No collaborations as such were made, but through the competitive environment both service providers have deployed 5G.

Q10. Has the government/ regulator introduced or is considering specific plans to enable industries to develop/ adoption of 5G use cases? What is the institutional mechanism to coordinate and collaborate with all the economic verticals to identify, develop and deploy 5G use cases in every vertical?

* 5G services are currently limited to fixed wireless and mobile broadband services. More use-cases are being explored in line with regional and global trends.

Q11. What is the framework in your country for addressing issues such as cybersecurity and data privacy? Are there specific regulations in place? How is the country planning to adopt the existing framework/ regulations for 5G? What are your views on the security aspect concerning 5G?

* A full-fledged cybersecurity law has not been enacted yet. A number of cybersecurity and data privacy laws are being drafted with the objective of finalizing them in the next one to 2 years. No specific 5G related cybersecurity measures have been considered yet.

Q12. How is your country planning to address the digital divide, if present in your country? Please elaborate including, but not limited to measures planned via 5G.

* The digital divide in the country is significantly narrower than most other countries in the region. 4G Broadband coverage is available in all islands nationwide. Fixed Broadband via Fibre connectivity is available to about 80% of the population with more islands being covered every month.

Q13. What are the challenges your country is anticipating/ facing in 5G rollout or building the 5G ecosystem?

* Installation of the many number of masts required maybe be challenging.
* People’s perception on the potential safety hazards by 5G.
* Slow growth of realistic use cases.

Q14. What are the current rollout obligations as per the extant guidelines in your country? Is there any review under consideration in this regard with reference to 5G rollout?

* No rollout obligation as such but government policies and development roadmaps strongly encourage and provide incentives towards the introduction and rollout of new technologies such as 5G. Furthermore, the prevailing competitive environment drives both service providers to continuously increase coverage with about a third of the population already covered by 5G.

Q15. Does your organization think that cross-sectoral policy development is required keeping in view the use cases for 5G? What types of policy should be developed or revised? Have you

undertaken any such policy?

* The current policy framework is sufficient for the development of 5G as well.

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1. **Nepal**

Q1. What are the key points of spectrum auction and the status of spectrum allocation in your country for 5G?

A1: The 4G ecosystem in the Country is gradually maturing, and Service Providers are planning 5G trial. As of now, 60 MHz in 2600 MHz Band (TDD) has been assigned, free of cost, for 5G trial purpose and test network is being assembled.

NTA has done its homework, and spectrum auction, specifically for 5G, will be done as soon as market demands it. The auction will assign spectrum in technology neutrality basis, include rollout obligations, and existing operators as well as new entrants can take part in the bidding process.

Q2. Which spectrum bands have been identified and auctioned/ are being considered for auction? What are the broad considerations for selecting these bands? Have potential use cases been a part of the criteria for the selection of these bands? Please elaborate.

A2: All cellular bands have been made available for 5G deployment under technology neutrality regime. These bands are:

|  |  |
| --- | --- |
| Frequency Bands | Frequency Range |
|
| 700 MHz Band | 703-748 MHz paired with 758-803 MHz |
| 800 MHz Band | 852-862 MHz paired with 811-821 MHz |
| 850 MHz Band | 824-834 MHz paired with 869-879 MHz |
| 900 MHz Band | 880-915 MHz paired with 925-960 MHz |
| 1800 MHz Band | 1710-1785 MHz paired with 1805-1880 MHz |
| 2100 MHz Band | 1920-1980 paired with 2110-2170 MHz |
| 2300 MHz Band | 2300-2400 MHz |
| 2600 MHz Band | 2500 - 2570 paired with 2620 -2690 MHz |
| 2570-2620 MHz |
| 3500 MHz Band | 3300-3800 MHz |

NTA is in the process of allocating whole 2600 MHz Band in technology neutral regime. Additionally, studies are underway to allocate additional 5 MHz bandwidth in 800 MHz Band. Furthermore, 26 GHz (band n258: 24.25 to 27.50 GHz) is planned to be reserved and other mmWave bands shall be identified for mobile services in Nepal

Among those bands, 2300 MHz and 2600 MHz bands will be considered as the primary bands for the introduction of newer services including 5G in Nepal as these bands provide better coverage than C-Band and have better compatibility with 4G. Also, 700 MHz and 800 MHz bands shall be considered as the primary 5G bands from the coverage prospective. However, these perspectives may change based on international market dynamics.

60 MHz in 2600 MHz Band (TDD) has been provided to an operator, free of cost, for 5G trial purpose.

Primary use case is expected to be eMBB for the time being, while the demand for mMTC will be generated imminently and uRLLC is anticipated to grow gradually.

Q3. Is there a spectrum roadmap prepared by the regulator concerning potential use cases and their rollout plan?

A3: Draft of the spectrum roadmap is prepared by NTA, but has not been published yet. Spectrum assignment generally match with the provisions stipulated in the draft roadmap.

Q4. Are the spectrums allocated harmonized with global standards? Has your country examined the allocation of the spectrum regarding licensed and unlicensed spectrum bands? What are the conclusions?

A4: All the spectrum is allocated as per the Radio Regulations of ITU and are globally harmonized. But 800 MHz Band (852-862 MHz paired with 811-821 MHz) and EGSM portion of 900 MHz Band (880-890 MHz paired with 925-935 MHz) lacks regional harmonization. Present allocation of unlicensed spectrum bands includes traditional 2.4 GHz and 5 GHz. Discussions regarding unlicensed spectrum bands for new technologies are underway and have not reached a concrete conclusion.

Q5. Is there a study conducted for your country regarding how 5G would affect the social and economic aspects? If yes, what have been the key parameters kept under consideration in the study, and what were the key findings?

A5: Yes. A study conducted for NTA included a topic “Socio-economic impact of 5G technologies and benefits of 5G”. The study focused more on literature review as well as analysis of international practices. The study concludes that 5G technology will provide the opportunity to reduce the digital divide in Nepal. The report also mentions that technology infrastructure and features of 5G will help Nepal to rapidly materialize the concept of smart cities and digital transformation.

Q6. Do you feel that a mechanism or framework is required for addressing cross-sectoral aspects, to enable the smooth rollout of 5G technology in different sectors? Please provide your detailed suggestions, if any, in this regard.

A6: 5G networks are emerging not only as the foundation for advanced communication services, but also as the infrastructure supporting socio-economic development and driving industrial digital transformation. In this regard, it is necessary to encourage other sectors to maximize the use of 5G technology in order to increase their productivity and reduce the cost. This in turn increases the viability and sustainability of the 5G service providers. NTA is in the process of preparing “Master Action Plan for Implementation and Promotion of 5G in Vertical Sectors”.

Q7. Has your country mapped the backhaul and fronthaul connectivity currently available and are there any measures under consideration to review/ strengthen them for 5G?

A7: No formal assessment of the backhaul and fronthaul connectivity currently available in the Country has been studies. However, Service providers as well as the Regulator (by utilizing USO Fund) are investing heavily on the Nationwide Information Superhighway (based on optical fiber). Furthermore, numerous microwave links are also installed where it is difficult to lay optical fibers or as a backup to the optical fibers. Hence, the backhaul and fronthaul connectivity currently available are expected to meet the initial demand that is likely to be created by 5G services.

Q8. Are there 5G testbeds being established in your country? Are such initiatives taken up by the government or by the industry or a PPP type of approach is being followed. Please elaborate on the underlying reasons for the same.

A8: 60 MHz in 2600 MHz Band (TDD) has been provided to Nepal Telecom, free of cost, for 5G trial purpose. Non-standalone as well as standalone architecture is planned to be deployed for test purpose. This won’t be a commercial rollout, but limited subscribers will be able to use the services without any usage fees. This has been the initiative of NTA and Nepal Government, and we are in the process of incorporating other operators as well as frequency bands in the testing process. Such step is undertaken in order to test the coverage, ultra-fast speed, low latency, synchronization, handover, mobility, reliability, FWA features etc. of the 5G network.

Q9. What are the key collaborations with industry partners for the deployment of 5G? Are 5G use cases being identified with short-term and long-term maturity plans?

A9: The key sectors acknowledged by the Digital Nepal Framework (<https://mocit.gov.np/application/resources/admin/uploads/source/Digital%20Nepal%20Framework%20-%20Final%20Submission%20-%2024%2012%202018%20v2.6.2.pdf>) are digital foundation, agriculture, health, education, urban infrastructure, energy, tourism and finance. Specific use cases for short-term and long-term maturity is expected to be included in the “Master Action Plan for Implementation and Promotion of 5G in Vertical Sectors”.

Q10. Has the government/ regulator introduced or is considering specific plans to enable industries to develop/ adoption of 5G use cases? What is the institutional mechanism to coordinate and collaborate with all the economic verticals to identify, develop and deploy 5G use cases in every vertical?

A10: Digital Nepal Framework recognizes Internet as the backbone of Digital Nepal initiative and connectivity for all is critical for the success of Digital Nepal program. It has recommended to take a lead in 5G, rather than be a follower to put Nepal at the forefront of ongoing digital transformation. “Master Action Plan for Implementation and Promotion of 5G in Vertical Sectors” being prepared by NTA is expected to include specific plans for vertical sectors to identify, develop and deploy 5G use cases*.*

Q11. What is the framework in your country for addressing issues such as cybersecurity and data privacy? Are there specific regulations in place? How is the country planning to adopt the existing framework/ regulations for 5G? What are your views on the security aspect concerning 5G?

A11: The current legal framework for addressing issues such as cybersecurity and data privacy in Nepal is Electronic Transaction Act *(*[*http://www.tepc.gov.np/uploads/files/12the-electronic-transaction-act55.pdf*](http://www.tepc.gov.np/uploads/files/12the-electronic-transaction-act55.pdf)*).*

Furthermore, Cyber Security Bylaw *(*[*https://nta.gov.np/wp-content/uploads/2020/08/Cyber-Security-Bylaw-2077-2020.pdf*](https://nta.gov.np/wp-content/uploads/2020/08/Cyber-Security-Bylaw-2077-2020.pdf)*)* has been issued by NTA for the implementation of cyber security standards and best practices so as to protect ICT Infrastructure and Information Systems of Telecommunication Service Providers of Nepal from various malicious attacks and threats; and build trust and confidence of users towards using ICT technology and services.

Q12. How is your country planning to address the digital divide, if present in your country? Please elaborate including, but not limited to measures planned via 5G.

A12: National ICT Policy *(*<https://nta.gov.np/wp-content/uploads/2012/05/ICT-Policy-2072.pdf> (in Nepali)) seeks to enhance the vision of transforming Nepali society into knowledge and information-based society by harnessing rapid advances in the information and communication technology sector. Similarly, National Broadband Policy *(*[*https://nta.gov.np/wp-content/uploads/2012/06/Broadband-Policy-2071.pdf(in*](https://nta.gov.np/wp-content/uploads/2012/06/Broadband-Policy-2071.pdf(in)Nepali)) puts forth a framework for stimulating broadband access and availability across the country. Among others, policy emphasis that has been placed on effectively leveraging Universal Service Access Funds as a means of bridging digital divide will provide a strong mechanism for expanding broadband access to communities beyond urban areas if implemented effectively.

Digital Nepal Framework recognizes that Internet and mobile connectivity form the backbone of economic growth and employment generation, and create an enabling environment for socioeconomic transformation by improving income levels, empowering underprivileged communities, and bridging the digital divide. The Digital Nepal program is designed to enable Nepal to harness its growth potential by leveraging disruptive technologies and driving socioeconomic growth.

Q13. What are the challenges your country is anticipating/ facing in 5G rollout or building the 5G ecosystem?

A13: Service providers in Nepal are still expanding 4G network, and it is likely to take some time for them to become ready of 5G.

Given the geography and socioeconomic status of the Country, mMTC and uRLLC may not be massively implemented immediately. Thus, standalone 5G network may not be economical viable for now.

However, maturity of the 4G network as well as backbone and backhaul infrastructure (optical fibers, microwave links, satellite links etc.) will be advantageous for 5G rollout.

Q14. What are the current rollout obligations as per the extant guidelines in your country? Is there any review under consideration in this regard with reference to 5G rollout?

*A14:* Clause 30 of Telecommunications Act *(*[*https://nta.gov.np/wp-content/uploads/2012/06/Telecom%20Act%20Upto%20date%20Eng.pdf*](https://nta.gov.np/wp-content/uploads/2012/06/Telecom%20Act%20Upto%20date%20Eng.pdf)*)* specifies obligations of the Licensee to develop, expand and operate the telecommunications service in the directed areas. According to the Clause, the Licensee shall invest the prescribed percent of his total investment for the development, extension and operation of the Telecommunications Service in the rural area. NTA has created a fund for the development, extension and operation of the Telecommunications Service in the rural area and the Licensees deposit such amount, every year, out of the annual income received by him as specified by the NTA. NTA designates Licensees for developing extending or operating the Telecommunications Service by using the aforementioned fund.

Additional conditions to be met by the Service Providers, as stipulated in the License are:

Quality of Service shall be as specified by NTA (as mentioned in the QoS Bylaw: [*https://nta.gov.np/wp-content/uploads/2018/03/qos\_bylaw\_2073.pdf*](https://nta.gov.np/wp-content/uploads/2018/03/qos_bylaw_2073.pdf) *(in* Nepali)).

Privacy of the User Data and Activities.

Tariff to be approved by NTA.

Billing Statements to be provided to the user.

Interconnection.

End User Agreement.

Similarly, key rollout obligation specified while assigning 4G frequencies are:

The operator shall ensure that it shall provide National 4G coverage (in all 7 provinces and 77 district headquarters) within a specified duration.

4G coverage in urban area shall be 95% (by population) within a specified duration.

* 4G coverage in rural areas of municipalities and rural municipalities shall be 90% (by population) within a specified duration.
* 4G coverage in Tourist Areas/Specified National Parks/High Way shall be 95% within a specified duration.
* All installed 4G sites shall be of LTE advance standard.
* User Experience (Download Speed) shall be of minimum of 20 Mbps in Urban and 10 Mbps in rural areas.
* In order to ensure that the coverage & capacity requirements in urban and rural areas are met as prescribed above, the Operator shall deploy additional 3,000 new 4G sites within a specified duration.

Rollout obligations may be reviewed while assigning 5G spectrum and approving 5G rollout plan.

Q15. Does your organization think that cross-sectoral policy development is required keeping in view the use cases for 5G? What types of policy should be developed or revised? Have you undertaken any such policy?

A15: As 5G is a cross-sectoral technology, cross-sectoral policy development is required keeping in view the use cases for 5G. Policies related to agriculture, health, education, urban infrastructure, energy, tourism, finance etc. should be revised with a view to deliver services in these sectors via Internet and 5G technology. Digital Nepal Framework includes 80 digital initiatives (working plans) in 8 sectors to propel socioeconomic growth. Additionally, we are working to make necessary provisions on policies or having a new policy to capitalize the possible benefits provided by the 5G.

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1. **Pakistan**

Q1. What are the key points of spectrum auction and the status of spectrum allocation in your country for 5G?

Ans: Key points of spectrum auction are as follows;

1. Socioeconomic development of Pakistan
2. Broadband proliferation and promote effective utilization of Spectrum
3. Promote consumer welfare (user experience, affordability, etc.)
4. Enhance digital inclusion and E-Governance
5. Promote innovation entrepreneurship and Startups in ICT sector
6. Economic growth in the ICT sector

Spectrum bands for 5G have been allocated along with respective appropriate Bandwidths

Q2. Which spectrum bands have been identified and auctioned/ are being considered for auction? What are the broad considerations for selecting these bands? Have potential use cases been a part of the criteria for the selection of these bands? Please elaborate.

Ans. Following spectrum bands are identified for 5G launch in Pakistan in line with global practices and ITU standards.

1. (B28/n28) 700 MHz, has been identified, however allocation is still pending.
2. (B40/n40) 2.3 GHz
3. (B41/n41) 2.6 GHz has been identified, however allocation is still pending.
4. (B42-43, B52/n78) 3.5 GHz - 3300 MHz - 3415MHz is available; 3415 – 3600 MHz be made available in 2024
5. Available spectrum in (B3/n3) 1800 MHz and (B1/n1) 2100 MHz
6. mmWave bands n258 and n260) have been allocated.

Q3. Is there a spectrum roadmap prepared by the regulator concerning potential use cases and their rollout plan?

Ans. Yes spectrum roadmap has been prepared and shared with all stakeholders, which is available on:

https://www.pta.gov.pk/assets/media/pak\_rolling\_spec\_strategy\_03112020.pdf

Q4. Are the spectrums allocated harmonized with global standards? Has your country examined the allocation of the spectrum regarding licensed and unlicensed spectrum bands? What are the conclusions?

Ans: Yes the assigned Spectrum is harmonized with the Global standards. The unlicensed spectrum in 6GHz is under consideration and discussion, as it is principally been allocated to the space agency of Pakistan for space program.

Q5. Is there a study conducted for your country regarding how 5G would affect the social and economic aspects? If yes, what have been the key parameters kept under consideration in the study, and what were the key findings?

Ans. A study on “5G Readiness Plan for Pakistan” was conducted by Government of Pakistan, which was completed in 2021. The Report concluded that Pakistan can harness significant economic benefits if it facilitates the early deployment of 5G by a range of supporting policies and actions. In the long term the economic benefits to the Pakistan economy of 5G are very substantial. In contrast, stopping, delaying or other not releasing spectrum for 4G/5G services runs the risk that Pakistan and Pakistani citizens will be unable to be ‘digital ready’ and benefit from new innovative mobile technologies. The study is available at:  [5G READINESS PLAN FOR PAKISTAN-WORLD BANK FINAL DRAFT](https://moitt.gov.pk/SiteImage/Misc/files/World%20Bank-%20TA%20Advisory-%205G%20Readiness%20Plan%20for%20Pakistan.pdf)

Q6. Do you feel that a mechanism or framework is required for addressing cross-sectoral aspects, to enable the smooth rollout of 5G technology in different sectors? Please provide your detailed suggestions, if any, in this regard.

Ans: A national level (cross-sectoral) plan or framework is key, to address the immense challenges of 5G roll out. To enable smooth 5G rollout, Government of Pakistan is in process of finalizing 5G strategic plan and policy guidelines. The draft 5G rollout plan is available at  [5G STRATEGIC PLAN & POLICY GUIDLINES-CONSULTATION DRAFT](https://moitt.gov.pk/SiteImage/Misc/files/5G%20Policy%20Guidelines%20_Final_15%20Dec%2021.pdf)

Q7. Has your country mapped the backhaul and fronthaul connectivity currently available and are there any measures under consideration to review/ strengthen them for 5G?

Ans: Yes, the available backhaul and fronthaul connectivity has been analyzed in detail in the form of report. The gaps have been identified in the light of the minimum requirement for smooth delivery of 5G networks. The measures have been identified to be taken for strengthening the infrastructure prior to launch of 5G.

Q8. Are there 5G testbeds being established in your country? Are such initiatives taken up by the government or by the industry or a PPP type of approach is being followed. Please elaborate on the underlying reasons for the same.

Ans: No test beds have been established as of today, however Trials have been done by the cellular operators in the last quarter of 2017. The policy of the Federal Government for tests and trials is available at [policy\_directive\_281217.pdf (pta.gov.pk)](https://pta.gov.pk/assets/media/policy_directive_281217.pdf).

Q9. What are the key collaborations with industry partners for the deployment of 5G? Are 5G use cases being identified with short-term and long-term maturity plans?

Ans. The Government of Pakistan has been in consultation with the industry. Several potential use cases for 5G Networks have been identified by industry and GoP. However, enhanced mobile broadband (eMBB) and FWA are being identified as potential use cases for Pakistan. Detailed use cases, their feasibility in the incumbent environment and also their implementation plan has been discussed in detail in the study report available at:  [5G READINESS PLAN FOR PAKISTAN-WORLD BANK FINAL DRAFT](https://moitt.gov.pk/SiteImage/Misc/files/World%20Bank-%20TA%20Advisory-%205G%20Readiness%20Plan%20for%20Pakistan.pdf)

Q10. Has the government/ regulator introduced or is considering specific plans to enable industries to develop/ adoption of 5G use cases? What is the institutional mechanism to coordinate and collaborate with all the economic verticals to identify, develop and deploy 5G use cases in every vertical?

Ans: Industry stakeholders have identified several potential use cases for 5G networks, and the ITU-R has defined three important categories.

1. Enhanced mobile broadband (eMBB) – enhanced indoor and outdoor broadband, enterprise collaboration, augmented and virtual reality;

2. Massive machine-type communications (mMTC) – IoT, asset tracking, smart agriculture, smart cities, energy monitoring, smart home, remote monitoring; and

3. Ultra-reliable and low-latency communications (URLLC) – autonomous vehicles, smart grids, remote patient monitoring and telehealth, industrial automation.

A report on 5G Readiness Plan, concluded that the most significant ways that 5G will contribute to industrial advances are by enabling faster and effective inspections through predictive intelligence; improving workplace and worker safety; and enhancing operational effectiveness.

In practical terms, the above outcomes will be enabled by the key 5G use cases that are likely to be the most relevant based on their potential and anticipated socio-economic benefits on the economy. For example, high-speed broadband in the home and office has many potential applications that are enabled by the provision of high-speed broadband. In the field of education, it is expected to increase access to and quality of education, especially in cases where online learning opportunities are necessary.

Additionally, 5G enables the use of remote operation of different types of devices that can enable the remote control of equipment and vehicles. This is expected to increase safety by preventing human workers from operating machinery in risky situations. 5G also enables the use of next-generation transport connectivity. That is, intelligent transportation systems using data from connected vehicles and smart infrastructure could improve commute times and reduce pollution by optimizing pedestrian routes and public transportation. A strategy shall be made to promote 5G in these sectors as a primary step.

Q11. What is the framework in your country for addressing issues such as cybersecurity and data privacy? Are there specific regulations in place? How is the country planning to adopt the existing framework/ regulations for 5G? What are your views on the security aspect concerning 5G?

Ans: In order to ensure the online safety of the citizens of Pakistan and to ensure the security of the digital systems, various initiatives are already in place by different federal & provincial bodies and sectoral regulators under the enactments such as the Electronic Transaction Ordinance, 2002 (covering only electronic financial transactions and records), Investigation for Fair Trial Act (IFTA) – 2013, Pakistan Telecommunication (Re-Organization) Act - 1996 and Prevention of Electronic Crime Act (PECA) 2016 which cover some but not all aspects of information and Cyber Security.

In addition, there is a National Cybersecurity Policy 2021 supported by an overarching framework that also addresses data protection and privacy. This policy is designed to be a framework with which all public and private organizations would be obligated to attain—and maintain—compliance. The same is available at [National CYBER SECURITY POLICY 2021 (moitt.gov.pk)](https://moitt.gov.pk/SiteImage/Misc/files/National%20Cyber%20Security%20Policy%202021%20Final.pdf).

In addition, the State Bank of Pakistan (SBP) issues guidelines on Cyber Security for the financial sector, and the PTA has notified the Telecom Computer Emergency Response Team (CERT). However, the inter-departmental coordination and holistic approach to address the Cyber Security challenges and their emerging trends requires a special focus on a national level. With regards to setups responsible for Cyber Security in the country, only the selective Cyber Security Incident Response Teams (CSIRTs) are operational at the organizational level in the public, private, and defense sectors. However, there is a need to enhance existing legislative and institutional frameworks, and strengthen the principal, organization, mandated for national Cyber Security. The legal framework, structures, and processes related to Cyber Security need to be constantly monitored, assessed, and improved.

The framework in place shall be adopted for upcoming technologies including 5G.

Q12. How is your country planning to address the digital divide, if present in your country? Please elaborate including, but not limited to measures planned via 5G.

Ans: PTA is committed to ensure access to all and improve digital divide in ICTs in Pakistan. It is striving to develop a digital strategy that brings together key stakeholders of gender mainstreaming in Pakistan. Also the unserved and underserved areas are being identified by Universal Service Fund and aggressively working on the development of fiber or wireless backbone to such areas for the provision of the digital services to those areas.

Q13. What are the challenges your country is anticipating/ facing in 5G rollout or building the 5G ecosystem?

Ans: Transitioning to 5G would be challenging, as major challenges in improvement of the physical layer and radio hardware needs, in order to cope with faster speeds i.e. the necessary telecommunications infrastructure for 5G such as a robust optical fibre network, spectrum bandwidth and other factors have not been fully addressed. The issues of increased energy consumption and data processing are also a challenge in 5G deployment.

Q14. What are the current rollout obligations as per the extant guidelines in your country? Is there any review under consideration in this regard with reference to 5G rollout?

Ans: The in-place Network Rollout obligations in terms of percentage population coverage are as under and they increase each year in each province:

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Note: (i) The Licensee has to meet/exceed the QoS targets mentioned in Appendix 3 in the areas claimed to be covered as ‘X’ and ‘Y’ above.

(ii) Population Coverage increase to be undertaken with the distribution of 70% in urban and 30% in rural areas.

(iii) Rollout Obligations will be analyzed by the Authority in accordance with existing population coverage statistics along with RF coverage / maps (provided by the licensee on effective date) submitted by the Licensee on an annual basis.

(iv) Rollout Obligations could be fulfilled by the frequencies stated in Appendix 2 or by any other frequencies for mobile communications the Licensee is entitled to use.

(v) Further to the population coverage obligations set out in the table above, the Licensee also needs to meet within these coverage areas the Quality of Service parameters set out in Appendix 3 below. - 25 –

(vi) Rollout Obligations can also be fulfilled through National Roaming, Universal Service Funding, Active Sharing, Spectrum Trading and Sharing as per Authority approved frameworks.

(vii) A wholesome review at National level will be carried out after 6 x years and future rollout targets will be set, if required.

b) Yes, the roll out obligations are under review, for 5G rollout.

Q15. Does your organization think that cross-sectoral policy development is required keeping in view the use cases for 5G? What types of policy should be developed or revised? Have you undertaken any such policy?

Ans: Yes, our organization is convinced that the cross sectoral policy shall be required for digitalization on the overall country. In this regard, the cross sectors are mutually signing Memorandum of Understanding (MoUs) to assist and adopt the policies of digitalization of the relevant sectors for leapfrog jumps in developments of the latest technologies. Adoption of the use cases of 5G is one major contributor to this concept.

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1. **Sri Lanka**

Q1. What are the key points of spectrum auction and the status of spectrum allocation in your country for 5G?

Mainly TRCSL assigns frequencies in Administrative basis including frequencies for access technologies. We are planning to assign frequencies for 5G though an auction most probably in next year. Presently, TRCSL is preparing necessary rules to conduct such auctions in line with Sri Lanka Telecommunications Act No 25 of 1991 as amended.

Q2. Which spectrum bands have been identified and auctioned/ are being considered for auction? What are the broad considerations for selecting these bands? Have potential use cases been a part of the criteria for the selection of these bands? Please elaborate.

IMT Band 43 (3400-3600MHz) is identified for 5G for initial stage of the auctioning. This band was already cleared and ready for assignment. It is proposed to assign two chunks of 100MHz for two mobile operators. In the latter stage, 26GHz/28GHz band will be considered to cater the high-capacity requirements in 5G technology.

Q3. Is there a spectrum roadmap prepared by the regulator concerning potential use cases and their rollout plan?

Yes. The draft spectrum roadmap was prepared with a consultation of ITU.

Q4. Are the spectrums allocated harmonized with global standards? Has your country examined the allocation of the spectrum regarding licensed and unlicensed spectrum bands? What are the conclusions?

Yes. TRCSL assigned frequencies in harmonized manner with ITU standard. TRCSL has been monitoring the utilization of licensed as well as unlicensed frequency bands for interference investigations and occupancy measurements.

Q5. Is there a study conducted for your country regarding how 5G would affect the social and economic aspects? If yes, what have been the key parameters kept under consideration in the study, and what were the key findings?

Not yet.

Q6. Do you feel that a mechanism or framework is required for addressing cross-sectoral aspects, to enable the smooth rollout of 5G technology in different sectors? Please provide your detailed suggestions, if any, in this regard.

A framework to minimize the roll-out cost would be ideal. However, in a hyper-competitive market like Sri Lanka where customers are extremely price sensitive, this may not be implementable in the short-term. However, if a strong 5-10 year framework is worked out based on a Public-Private-Partnership between the relevant Government Ministries and the Telco Operators, a smooth roll-out could definitely become a reality.

The Public-Private-Partnership could be framed according to the following:

1. 5G spectrum to be provided to the operators with a proven track record of investing and running Telco networks.

2. A strict Universal Service Obligation to be imposed on the Telco operators.

3. A suitable device strategy to be included with the network roll out.

E.g.: For industries such as Health and Education, handheld mobile phone might not be the most suitable.

Q7. Has your country mapped the backhaul and fronthaul connectivity currently available and are there any measures under consideration to review/ strengthen them for 5G?

Backhaul and fronthaul connectivity is currently available in the country to cater 4G requirements. With the introduction of 5G, this connectivity must be improved high capacity and low latency 5G applications specially with the introduction of 5G in SA mode.

Q8. Are there 5G testbeds being established in your country? Are such initiatives taken up by the government or by the industry or a PPP type of approach is being followed. Please elaborate on the underlying reasons for the same.

5G trials were started two years back by many operators in the country with the guidance of the regulator. The investment for 5G testing is mainly funded by the operators themselves.

Q9. What are the key collaborations with industry partners for the deployment of 5G? Are 5G use cases being identified with short-term and long-term maturity plans?

Commercial deployment is not started.

Q10. Has the government/ regulator introduced or is considering specific plans to enable industries to develop/ adoption of 5G use cases? What is the institutional mechanism to coordinate and collaborate with all the economic verticals to identify, develop and deploy 5G use cases in every vertical?

Possible 5G user cases of 5G in Sri Lanka are as follows.

* Smart Cities and Smart Home applications
* Automated port activities
* Industrial Automation
* Traffic Management
* VR and AR applications
* Smart Transportation

Q11. What is the framework in your country for addressing issues such as cybersecurity and data privacy? Are there specific regulations in place? How is the country planning to adopt the existing framework/ regulations for 5G? What are your views on the security aspect concerning 5G?

Specific laws are in place to deal with general cybersecurity issues. However, as 5G is not commercially available in the country, this will decide in future.

Q12. How is your country planning to address the digital divide, if present in your country? Please elaborate including, but not limited to measures planned via 5G.

The first recommendation is to provide more quality online Sinhala- and Tamil-language content. According to UNICEF’s global report on children in a digital world released 2017, “56 percent of all websites are in English, and many children cannot find content they understand or that is culturally relevant.”

Other recommendations followed, such as enacting legislation to ensure the safe use of the internet by children, establishing a self-regulatory body of telecommunications and IT industry partners, encouraging internet service providers to introduce network-level parental controls to customers and developing age-specific educational and training material into the IT curriculums in schools.

Further, enabling the availability of mobile broadband and allowing for low prices will contribute to Sri Lanka’s success in connecting its citizenry to the world via mobile broadband. Further, the fact that the demand for broadband services increased in the past years shows that Internet access is not a luxury but a necessity. It is apparent that those who cannot afford broadband connections are increasingly left behind in the accelerated pace of digitalization. Government/ Regulator and operators are in the process of taking steps to increase broadband capacity and improve affordability.

Further with the guidance and concessions of the regulator, operators are implementing several rural deployment projects and actively contributing for providing services to remote areas with less broadband facilities to ensure the availability of digital accessibility.

Q13. What are the challenges your country is anticipating/ facing in 5G rollout or building the 5G ecosystem?

* Spectrum scarcity
* High cost of network equipment
* Installation of huge no of antenna structures
* High cost of handsets
* Radio frequency interference
* Ensuring Cybersecurity

Q14. What are the current rollout obligations as per the extant guidelines in your country? Is there any review under consideration in this regard with reference to 5G rollout?

Not yet defined.

Q15. Does your organization think that cross-sectoral policy development is required keeping in view the use cases for 5G? What types of policy should be developed or revised? Have you undertaken any such policy?

Same answer of Q6.

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