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IAFI

PROPOSED FURTHER UPDATES TO THE WORKING DOCUMENT TOWARDS A DRAFT NEW APT REPORT ON DEPLOYMENT APPROACHES AND SOLUTIONS FOR IMT-2020/5G USE CASE

1. Background

This Report provide national approaches and knowledge gained by some APT countries in the use/deployment or planning of International Mobile Telecommunications 2020 (IMT-2020) in frequency bands that are allocated to the mobile service and identified for IMT, including regulatory, technical and operational aspects. The case studies in this report include information of IMT networks from the planning stages to actual deployments of IMT radio stations.

2. Discussion

it is proposed to clarify the >>>>>

2. Proposal

IAFI proposes some modifications to the working document, as contained in Attachment. The proposed revisions are highlighted in turquoise

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[Editor's note: To be discussed further between two texts
INP-91(IAFI)
INP-98(GSA)]

[Editor's note: Numbering of table, figure and reference will be adjusted after contents become stable.]

Contact: Email:

WORKING DOCUMENT TOWARDS A DRAFT NEW APT REPORT ON DEPLOYMENT APPROACHES AND SOLUTIONS FOR IMT-2020/5G USE CASE

1. Introduction

This Report provide national approaches and knowledge gained by some APT countries in the use/deployment or planning of International Mobile Telecommunications 2020 (IMT-2020) in frequency bands that are allocated to the mobile service and identified for IMT, including regulatory, technical and operational aspects. The case studies in this report include information of IMT networks from the planning stages to actual deployments of IMT radio stations.

The presentation of the results of technical operation of networks, deployment scenarios and other technical information are useful parts of national approaches and included where available. This Report is not linked to any specific frequency band and may be applied to any frequency band identified for IMT. Each case study reflects the viewpoint of the contributing APT member.

or

Mobile network operators require access to spectrum in various frequency bands, i.e., low, mid, and high bands, in order to establish cost-effective networks and ensure the availability and speed of 5G services.

Lower frequency bands are essential for facilitating rapid and extensive deployment of mobile broadband, particularly in rural regions where the digital divide is most pronounced. Mid-band spectrum has been the primary driving force behind the launch of 5G, and it is anticipated that this spectrum range will continue to play a crucial role in unlocking the majority of 5G benefits over the next decade. mmWave spectrum is needed for deployment in the most densely populated urban areas, i.e., 5G hotspots. This spectrum range is vital in ensuring the reliability and low-latency performance of networks in various settings, including public transport hubs, factories, music and sports venues, among others.

The success of 5G deployment heavily relies on the presence of strong licensing frameworks and timely provision of spectrum. Once these conditions are met, 5G has the potential to revolutionize digital economies worldwide, bridge the digital divide, and foster digital inclusivity.

2. Scope

The scope of the report is to provide information on global trends on 5G deployments and national approaches in APT countries for implementation of terrestrial component of IMT in frequency bands that are identified for IMT in the Radio Regulations.

The focus of this report is to introduce/update the implementation of IMT-2020/5G; which has the capabilities to deliver various usage scenarios like eMBB, mMTC and URLLC in both sub-6GHz band as well as in frequency ranges above 24GHz. This report also includes aspects like spectrum utilisation, throughput delivered, usage scenarios realized etc in various environments such as dense urban, hotspots, indoor etc. The report also includes technical and operational solutions being used for deploying IMT-2020/5G in various APT countries including Infrastructure Sharing, RAN sharing, multi-RAT, dual carrier, stand alone and non-stand alone, carrier aggregation, Multi-layer solutions, Wireless backhaul links (complementary to optical fiber) and Coverage Extensions

or

Scope of this document is to explore technical, operational and regulatory solutions for IMT 2020/5G use cases. Different frequency bands (Low bands, Midbands, mmWave bands) have different propagation characteristics and as a consequence have different coverage and cell radius for different bands. Coverage and capacity offered by specific bands could be more suitable for specific use cases and applications. Use case specific technology components, spectrum, operational and regulatory solutions is necessary to leverage full capability of 5G use cases. Further, deployment challenges often needs administration to design regulatory solutions which involves various administration bodies and operators to work together for successful deployment.

This document also facilitate administrations to share experiences and solutions adopted by various administration globally.

3. Vocabulary of terms

4. Global trends on 5G deployments

– Global status and forecast

– General deployment challenges

5. Technical and operational solutions on IMT-2020/5G deployment

[Editor Note: This section covers various technical and operational solutions being used for deploying IMT-2020/5G in various countries.]

Infrastructure Sharing

[Editor Note: This section covers the solutions related to cell site procurement and deployment solutions related to infra sharing and use of street furniture.]

Multi-layer solutions

[Editor Note: This section deals with the solutions related to deployment of cells in private or public local areas.]

Hierarchical deployment

Ubiquitous coverage in a given area would call for the availability of adequate cell sites. As mentioned above that procuring cell sites in a city is challenging; compounded to that, deployment of cell sites inside apartment buildings, office campus, and heritage sites, often face challenges, due to overlapping plans of agencies maintaining the premises. It becomes challenging for an operator to find a good and available site to deploy wireless nodes in a local premises.

Agencies maintaining the local area are better equipped to identify sites for wireless nodes and also entitle for possible modifications to make the best site available for deployment of wireless nodes. Agencies governing local areas could be leveraged by the operator for the deployment and maintenance of wireless nodes in local premises.

Aforementioned hierarchical deployment would demand a policy framework for operators leasing deployment and maintenance of nodes inside the local campus.

Figure- 4: Hierarchical deployment

Observation: Deployment of wireless nodes in local area within a city generally find challenges by private owners or government agencies. It's often hard for an operator to find suitable area within premises from coverage perspective. Local agencies could be leveraged for deployment and maintenance of wireless nodes in a local area.

Wireless backhaul links (complementary to optical fiber)

[Editor Note: This section indicates the importance of wireless backhaul link as complementary solution to optical fiber considering deployment issues in urban and rural areas.]

Shrinking of inter site distance (ISD) either due to capacity limits in dense urban area or due to high propagation/penetration losses, would result in increasing the number of wireless nodes in a given area to ensure desired quality of service (QoS). Increasing the number of wireless nodes would also demand backhaul links as shown in Figure-2, thereby, creating stress on the number of backhaul links among wireless nodes.

Urban and rural terrains find different challenges to providing backhaul links; for example, in urban areas the deployment of optical cables require digging through existing civil infrastructure, which often finds resistance from private owners or government agencies, since excavation requires very specific permission in certain areas of the city. In the rural areas, it's rather easy to deploy optical cables among wireless nodes due to limited civil infrastructure, however, maintaining optical cables in the rural area demands additional cost due to fleet and availability of resources in rural areas.

Administrations could explore more high capacity wireless backhaul links to support growing deployment on need basis replacement of optical fiber backhaul link.

Observation: Deployment of wireless nodes with small ISD either due to capacity or coverage limitation will bring additional stress on the backhaul links, therefore administration may explore high-capacity wireless backhaul and consider opening up higher frequency bands, such as E-band (71-76 GHz & 81-86 GHz) to satisfy the high-capacity backhaul requirements to complement optical fiber.

Coverage Extensions

[Editor Note: This section deals with solutions related to coverage extensions and coverage issues due to obstacles in dense urban environments specific to mmWave 5G.]

mmWave suffers from high penetration loss and such losses can be compensated by increasing base stations transmission power and/or implementing large antenna arrays using massive

MIMO technology. Higher array gain offered by large antenna arrays is leveraged to compensate penetration loss in mmWave deployment. However, practical mmWave deployment is still experiencing occasional coverage holes and operators are addressing different solutions to fill such gaps. One could observe that it's not always easy to keep adding number of wireless infra nodes to fill coverage holes, since additional wireless infra nodes will increase inter-cell interference and thereby reducing cell capacity.

Coverage is a fundamental aspect of cellular network deployments. Mobile operators continuously explore different types of network nodes to offer blanket coverage in their deployments.

One of the type of network node is the *RF repeater*. **RF repeaters** have been used in 2G, 3G and 4G deployments to supplement the coverage provided by regular cells. They constitute the simplest and most cost-effective way to improve network coverage. The main advantages of RF repeaters are their low-cost, their ease of deployment and the fact that they do not increase latency. Within RF repeaters, there are different categories depending on the power characteristics and the amount of spectrum that they are configured to amplify. RF repeaters are non-regenerative type of relay nodes and they simply amplify-and-forward everything that they receive. RF repeaters typically do not differentiate between UL and DL from transmission or reception standpoint.

As we moves to higher frequencies (to mmWave (FR2) band) propagation conditions degrade compared to lower frequencies exacerbating the coverage challenges. As a result, further densification of cells may be necessary. Multi-antenna techniques consisting of massive MIMO and analog beamforming for FR2 assist in coping with the more challenging propagation conditions of these higher frequencies.

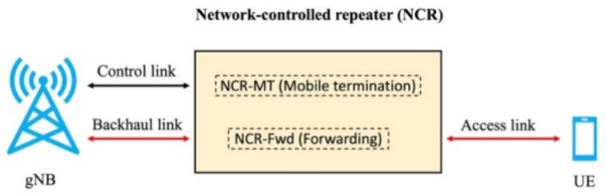
Note that all the frequency bands defined at this higher frequency regime are TDD and use of multi-beam operation with associated beam management.

Two important observation could be made (a) Many planned NR deployments are TDD and therefore simultaneous, bi-directional amplify-and-forward may not be necessary. (b) Beamformed transmissions to individual users is fundamental to coverage esp. in FR2 bands. A simple RF repeater that the network is agnostic to may be unable to achieve the requisite beamforming gain.

Given background of RF repeaters, another type of network node "Smart repeaters" was needed, to make use of some side control information and enable a more intelligent amplify-and-forward operation in a system with TDD access and multi-beam operation.

A network-controlled repeater (NCR) is an enhancement over conventional RF repeaters with the capability to receive and process side control information from the network. "Side control information" could allow a network-controlled repeater to perform its amplify-and-forward operation in a more efficient manner. Potential benefits are mitigation of unnecessary noise amplification, transmissions and receptions leveraging spatial information, and simplified network integration.

3GPP NR has considered smart repeaters as **Network controlled repeaters (NCR) [**7]-[9]. In simple words, NCR is a repeater with beamforming capabilities that can receive and process side control information from the network. Such side control information could allow an NCR to perform its amplify-and forward operation in an efficient manner. In general, the NCR can be considered as a network-controlled "beam bender" relative to the gNB.



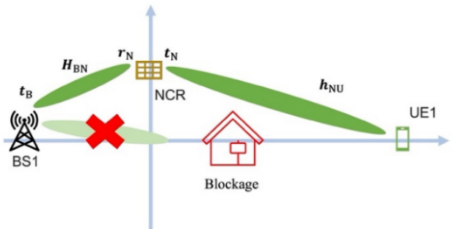


Figure-6a: Network controlled repeaters   Figure-6b: NCR-assisted DL system

In this way, NCR is logically part of the gNB for all management purposes, i.e., it can be assumed that the NCR is deployed and under the control of the operator. NCR is based on amplify-and-forward relaying scheme.

Current 3GPP NR based NCR [8] makes the following assumptions,

- NCRs are in-band RF repeaters used for extension of network coverage on FR1 and FR2 bands based on the NCR model as shown in figure [6a][6b].
- For only single hop stationary NCRs.
- NCR can maintain the gNB-repeater link and repeater UE link simultaneously.

Observation: mmWave generally suffers from high path losses and 5G Massive MIMO technology can compensate these losses. In addition, smart repeaters play an important role in the industry's mmWave deployment strategy by striking a balance between performance and cost. They facilitate faster and more efficient deployments, thus, continuous evolution of smart repeaters is very relevant to support the industry's needs effectively

High-Band Uplink Transmission Optimized for Coverage

Coverage stands as one of the key considerations for operators when rolling out cellular networks, given its direct influence on service quality and operational costs. In particular for mmWave bands, uplink (UL) performance can be a bottleneck, especially with the emergence of vertical use cases characterized by heavy UL traffic, such as video uploading. Poor uplink signal quality in mmWave poses significant challenges, including signal degradation due to attenuation and blockage. This leads to reduced throughput, increased latency, and potential service disruptions [5].

The 5G uplink utilizes two waveforms: precoded (DFT-S-) and non-precoded (CP-) OFDM. DFT-S-OFDM. The latter offers a relatively lower peak-to-average power ratio (PAPR), allowing the UE to operate its power amplifier closer to its maximum output power compared to CP-OFDM. This higher output power can enhance coverage, particularly for higher modulation orders. Moreover, it facilitates more efficient power amplifier operation, resulting in reduced power consumption for the UE.

UL waveform switching is supported in current mobile networks standards [6]. This functionality facilitates dynamic switching of waveforms in the uplink, thus improving cell coverage. The selection of the uplink waveform is dictated by measurements of uplink signal strength and is triggered when the UE is in poor coverage areas for a long period of time.

Observation: UL waveform switching provides better coverage for UEs on the cell edge in mmWave bands.

6. Regulatory and policy measures to facilitate IMT-2020/5G deployment

[Editor Note: This section includes some of the regulatory and policy measures in APT countries to accelerate 5G deployments. Inputs from various Administrations/Operators are invited.]

Cost of service and price elasticity

[Editor Note: This section deals with the solutions related to relaxation in policy framework, which allows operators to assess the cost of 5G services.]

As cited in the GSMA report [1], 5G deployment would encounter new challenges concerning to identify the "cost of providing new 5G services". We have noticed that 5G has transformed traditional broadband services into new use cases based on enhanced mobile broadband (eMBB), ultra-reliable low latency communications (URLLC), and enhanced machine-type communication (eMTC). Volume of applications envisaged to leverage new capabilities offered by 5G. eMBB is one of the traditional broadband services but the extremely high data rate offered by 5G has given rise to new applications and like augmented reality (AR), virtual reality (VR), 4K video. eMTC and URLLC has created a new ecosystem for Smart agriculture, Robotic industry, Smart cities, vehicle-to-vehicle (V2V), vehicle-to-everything (V2X), and Industry 4.0.

One of the important observation to make here is that, operators and users are still en route to find cost of 5G services. New infra would need new investments and operators would like to see returns on their investments. Users has to experience new services in order to find value and be ready to pay the extra subscription fees. Administration may seek to review deployment conditions and help operators for faster adoption of 5G.

Observation: For mid-bands, administrations could allow continuous 80-100MHz bandwidth in a timely manner for each operator in order to enjoy the full capability of 5G. Administrations could relax policies and allow operators to calibrate 5G services for making users ready to embrace new 5G services and let operators identify possible prices for new services. From a policy perspective, the government could allow some “warm-up time” (e.g., relax operators’ roll out obligations) for 5G services, where operators can explore, assess, and stabilize new 5G services.

6.1. Republic of Korea

IMT-2020/5G, which was commercialized in Korea in 2019, is a fifth-generation mobile communication technology featuring ultra-high speed (eMBB), ultra-low latency (URLLC), and ultra-connectivity (MMTC). The ultimate goal of 5G is to connect and integrate all devices and industries with 5G, bringing about digital transformation across industries. Not only does 5G surpass Wi-Fi in terms of data speed, capacity, and latency, but it also ensures security and mobility. Consequently, it offers the advantage of implementing diverse use cases that are unattainable with existing Wi-Fi networks. Local/private 5G networks are inherently more stable as they restrict unauthorized access from public network users. Moreover, unlike public networks that provide universal services, Local/private 5G networks can optimize the number of users and traffic profiles according to use cases, enabling much more effective and flexible network operation. On October 28, 2021, the MSIT (Ministry of Science and ICT) started offering local/private frequencies (100MHz@4.7GHz, 600MHz@28GHz) to deploy local/private 5G network called ‘e-Um 5G’, a crucial infrastructure for enterprises digital transformation, across a variety of industries in Korea. ‘e-Um 5G’ stands for the characteristic of 5G (eMBB (enhanced Mobile Broadband), URLLC (Ultra Reliable and Low Latency Communication), MMTC (massive Machine Type Communication)) and also means 'connection' among human or things in Korean language. In 2022, the use of e-Um 5G began in 26 sites across 9 sectors including manufacturing, healthcare, and logistics. By 2023, the utilization expanded to 54 sites spanning 14 sectors such as automotive, shipbuilding, steel manufacturing, and education, indicating a widespread adoption across various vertical domains.

Spectrum and Regulation Policy

Spectrum for e-Um 5G network can be allowed to use over local area (e.g. terrestrial area/building) for special purpose use. Frequencies of 100MHz (4.72-4.82GHz) in the 4.7GHz band and 600MHz width (28.9~29.5GHz) in the 28GHz band are provided. The 4.7GHz band is allocated up to 10 blocks of 10MHz wide block, and the 28GHz band is allocated up to 12 blocks of 50MHz wide block. Frequency assignment applicants can apply for appropriate bandwidth according to their demand. The frequency applicant is allowed to choose the frequency use period of 2 to 5 years, and in order to prevent retention of frequencies without use, it is obliged to build a radio station within 1 year after frequency assignment.

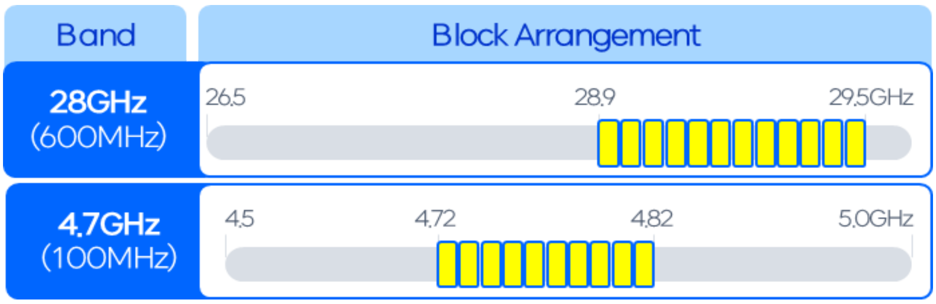


Fig. X. e-Um 5G frequency Arrangement in Korea

There are 3 types of e-Um 5G deployment according to service provider and service user.

Type	Service Provider	Service User	Business Registration	Spectrum Licensing
Type 1	Private Organization	Private Organization User(e.g. enterprise)	Private network builder	Freq. designation (Radio Station License)
Type 2	Private Organization	Private Organization (including visitors) and Public user (e.g. enterprise)	Telecommunication Operator	Freq.. Assignment (Spectrum License)
Type 3	Third party Operator			

Table X. Types of e-Um 5G Introduction in Korea

Type 1: e-Um 5G frequencies are designated by the MSIT to user equipment (e.g. terminal, base station) in order to install and to use 5G private networks on their own. Typically, enterprises purchase 5G network equipment (base stations, cores, MECs) from SIs or vendors, and the equipment is the property of the company (purchase type).

Enterprises can only use the private 5G network for their own employees and not for other enterprises.

Type 2: Approved by the MSIT, and assigned Local 5G frequencies to provide e-Um 5G services to enterprise customers (excluding operators providing IMT services using assigned IMT frequencies).

Type 3: e-Um 5G operators build their 5G networks for enterprise customers and charge a fee for the service. Typically, 5G equipment is provided free of charge or at a minimal cost, and a monthly subscription fee may be charged to keep upfront costs down.

Below diagram shows e-Um 5G market structure example for type 1 and type 3 in Korea. The case of type 2 is very similar to type 1 other than the way of frequency licensing. In particular, MNOs having IMT spectrum are not allowed to be an e-Um 5G operator in order to facilitate 5G B2B service market competition.

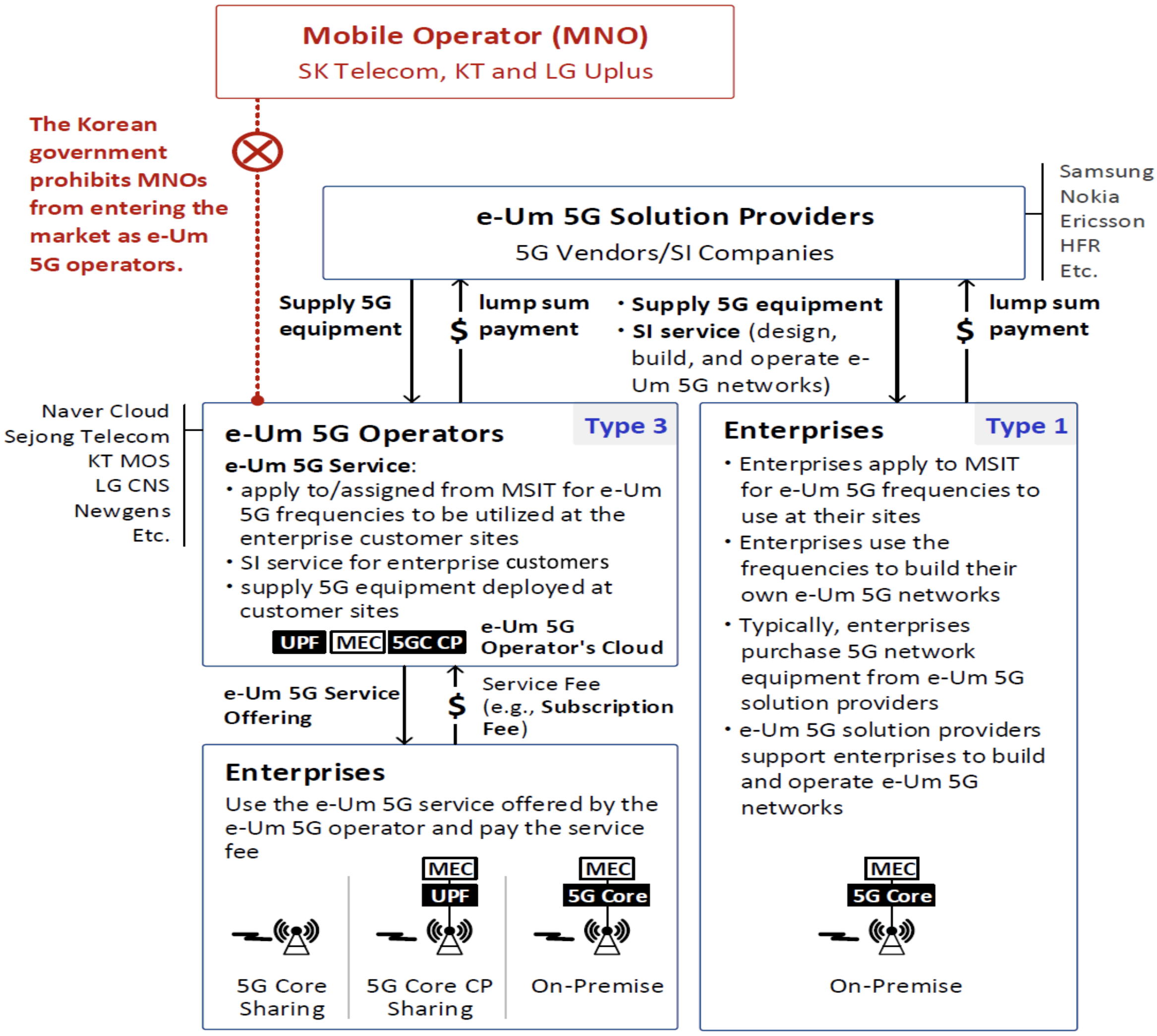


Fig. X. e-Um 5G Market structure example for Type 1 and 3

Frequency Assignment Fee

Considering that e-Um 5G frequency is used in confined area so competitive demand for frequencies is limited, frequency assignment fee for e-Um 5G frequency is charged according to government-calculated method rather than auction. e-Um 5G frequency assignment fee is calculated according to service area, period and bandwidth as follows:

Assignment Fee = Base Cost x (5a1+a2+1) x Period x Number of Block, where, Base Cost: ₩100,000/10MHz for 4.7GHz, ₩50,000/50MHz,

a1: service area (km^2) of metropolitan area (city over 500,000),

a2: service area (km^2) other than metropolitan area

Period: frequency use period (year).

In densely populated areas such as metropolitan cities, the demand for frequencies is high, and it is expected that more profits can be generated through the use of frequencies, so a regional coefficient (metropolitan area: other than metropolitan area = 5:1) is applied.

In particular, the assignment fee for the 28 GHz band was calculated as low as 1/10 of the 4.7 GHz band under the condition of using the same bandwidth, taking into account frequency characteristics, equipment and terminal ecosystem conditions, etc.

7. Case studies for IMT-2020/5G use cases in some countries

7.1. Republic of Korea

e-Um 5G is a telecommunications network that utilizes the advantages of fifth-generation (5G) mobile communication, such as ultra-high speed, ultra-low latency, and ultra-connectivity, by deploying it in specific areas such as land and buildings. In December 2021, Naver Cloud announced the introduction of services as the first domestic operator to be allocated frequencies. In 2022, it began to be used in 26 sites across 9 sectors including manufacturing, healthcare, and logistics. By 2023, its utilization expanded to 54 sites across 14 sectors including automotive, shipbuilding, steel, and education, spreading its application scope to all industrial sectors. To promote the spread of e-Um 5G, the MSIT has streamlined the submission documents and application procedures for e-Um 5G, as well as improved regulations by excluding restrictions on foreign ownership stakes when registering for telecommunications businesses. Additionally, to provide comprehensive information on the latest domestic and international deployment cases, equipment, and terminal supply status, they have opened a website (eum5gportal.kr) and organized seminars. They have also provided year-round pre-consultation (consulting) for frequency application procedures and technical support. To enable the utilization of e-Um 5G in various fields, they have presented reference standards through 15 demonstration projects and pursued various policies to enhance e-Um 5G activation, including completing the development of technology to improve the speed of e-Um 5G small cells up to 3Gbps.

< Medical and Healthcare cases >

The surgeon's operation room is captured utilizing high-definition immersive video such as AR glasses, an endoscope, and a 360-degree camera, and then streamed to a medical education platform through e-Um 5G network. In the professor's office, a specialist watches the video and guides the surgery (remote cooperative surgery). Students in the seminar room can see the live surgical video while also learning from the specialist's guidance (real-time remote surgical training).

- Customized surgical AR guide for each patient using augmented 3D reality
- Scanning and modeling of the patient's body
- Real-time non-face-to-face collaboration service: Sharing of medical
- Images in the limited operating room space to medical staff in the hospital

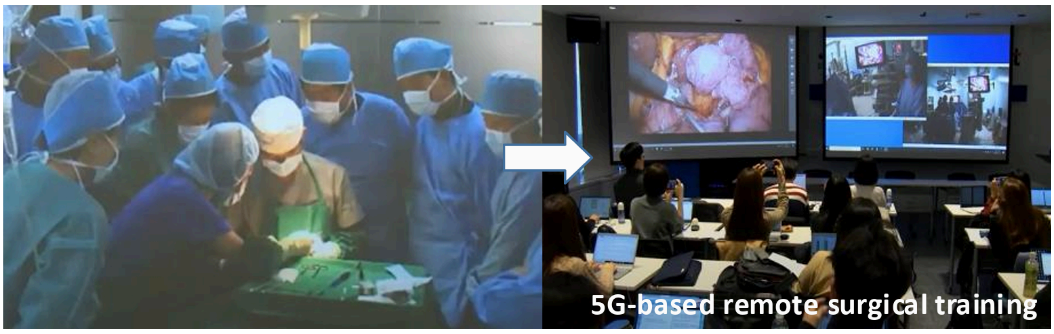


Fig. X. e-Um 5G case of 5G-based remote surgical training in Samsung Medical Center

Autonomous self-driving electric wheelchair, AMR (unmanned transport of medical materials/drugs/linen), and Smart simulation (3D camera) were implemented. To ensure the safe transportation of patients, enhanced autonomous wheelchair systems were developed, equipped with safety features. These wheelchairs are capable of self-navigation, both when called to the patient and when returning autonomously to their designated positions. Additionally, a wheelchair control platform and a management app for summoning and overseeing wheelchairs were implemented.

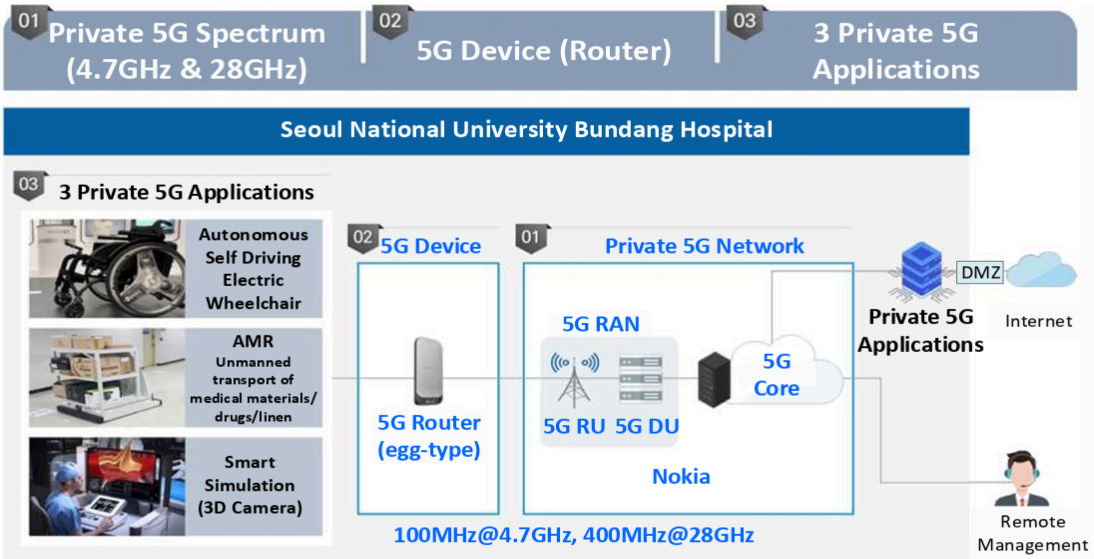


Fig. X. e-Um 5G case of Seoul National University Bundang Hospital

< Entertainment cases >

In the Lotte World Atlantis attraction, an immersive and realistic virtual experience attraction were implemented using 28 GHz band 5G technology, which was previously impossible with conventional Wi-Fi. Real-time transmission of large-capacity videos (4k: uplink 40Mbps, 8k: 200Mbps) and motion data from the rides is enabled to indoor motion simulators, providing customers with an immersive experience identical to being on-site.

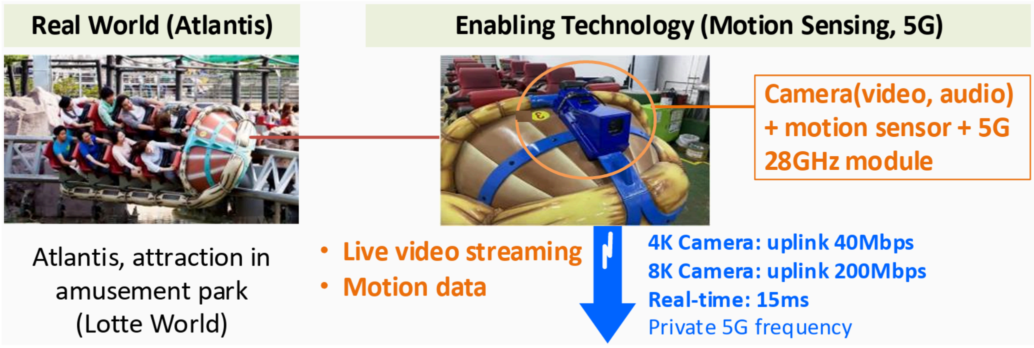


Fig. X. e-Um 5G case of Lotte World's Amusement Park

Atlantis is immersive parallel reality experience services enabling technology equipped with a 28GHz band 5G transmission module with built-in camera and motion sensor. The transmission module sends video and motion data to the motion simulator through e-Um 5G network. Visitors seated in the motion simulator can virtually experience the realistic attraction. The elderly, who were previously unable to enjoy offline attractions, can now ride, and children can ride without height restrictions.

< Energy Industry cases >

Transformers and gas-insulated switchgear in substations are the core facilities of the power grid, and in the event of a breakdown or failure, large-scale power outages occur, causing national damage. KEPCO deployed private 5G in substations, and based on this, introduced wireless IoT sensors, quadruped robots, wireless CCTV, and AI servers to build a smart facility management system that monitors facilities in real time and predicts and prevents failures through AI analysis.

- IoT-based predictive maintenance (wired sensors -> wireless sensors)
- Maintenance inspection based on quadruped robot (human -> unmanned)
- Safety & access control through wireless CCTV and AI real-time analysis

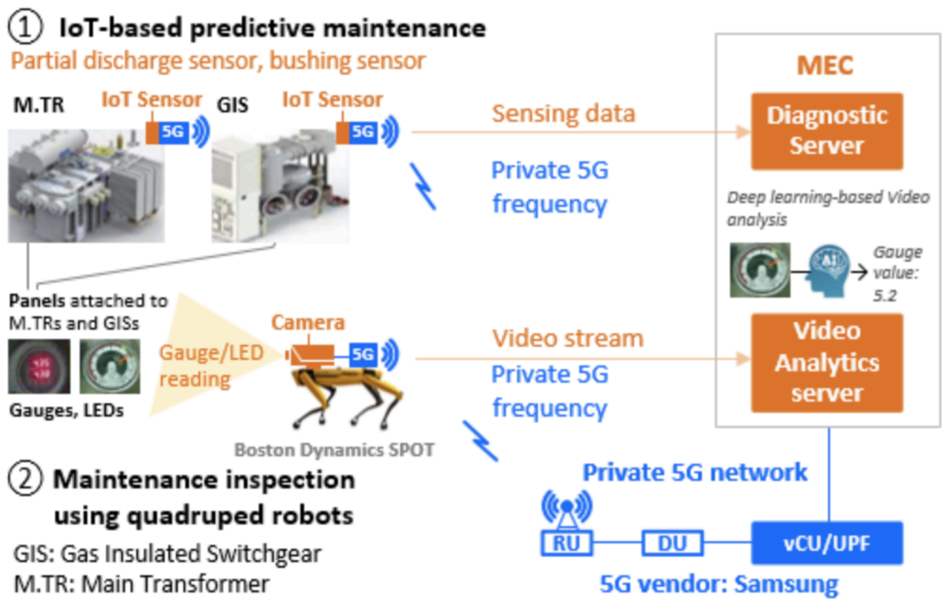


Fig. X. e-Um 5G case of Korea Electric Power Corporation (KEPCO)

7.2. India

Introduction

In India, spectrum allocations at present are technology neutral. The spectrum bands or parts thereof for IMT services namely 700 MHz; 800 MHz; 900 MHz, 1 800 MHz; 2 100 MHz; 2 300 MHz, 2 500-2 690 MHz, 3 300-3 400 MHz and 3 400-3 600 MHz bands[1] are available for telecom services in India. To pave the way for 5G services in India, the Department of Telecommunications allocated spectrum in August 2022, to the three TSPs through auction, across a range of bands, including 600MHz, 700 MHz, 800 MHz, 900 MHz, 1 800 MHz, 2 100 MHz, 2 500-2 690 MHz, 3 300-3 670 MHz, and the 26 GHz band.

Approach

Cellular telephony was opened up in 1992 with a Duopoly regime, GSM as the mandated technology (900 MHz band), Receiving Party Pays (RPP) system and with a 10-year license. The entire country was divided into 22 licensed service areas.

Enhancing spectrum availability for IMT systems in India

Since 2010 onward, spectrum auctions have been regularly held for offering spectrum in a transparent manner through market related process. In the year 2010, spectrum in 2 100 MHz band (for 3G services) and 2 300 MHz band (for BWA services) were put to auction in 22 Licensed Service areas. Thereafter, spectrum auction for providing commercial telecom services have been held at least once each year during 2012-2016. During this period, the spectrum in bands 700 MHz; 800 MHz, 900 MHz, 1 800 MHz, 2 100 MHz, 2 300 MHz and 2500 MHz bands had been put to auction.

In August 2022, spectrum in700 MHz, 800 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2500 MHz, 3500 MHz, and the 26 GHz bands was auctioned with focus on 3500 MHz and 26 GHz bands for deployment of 5G services.

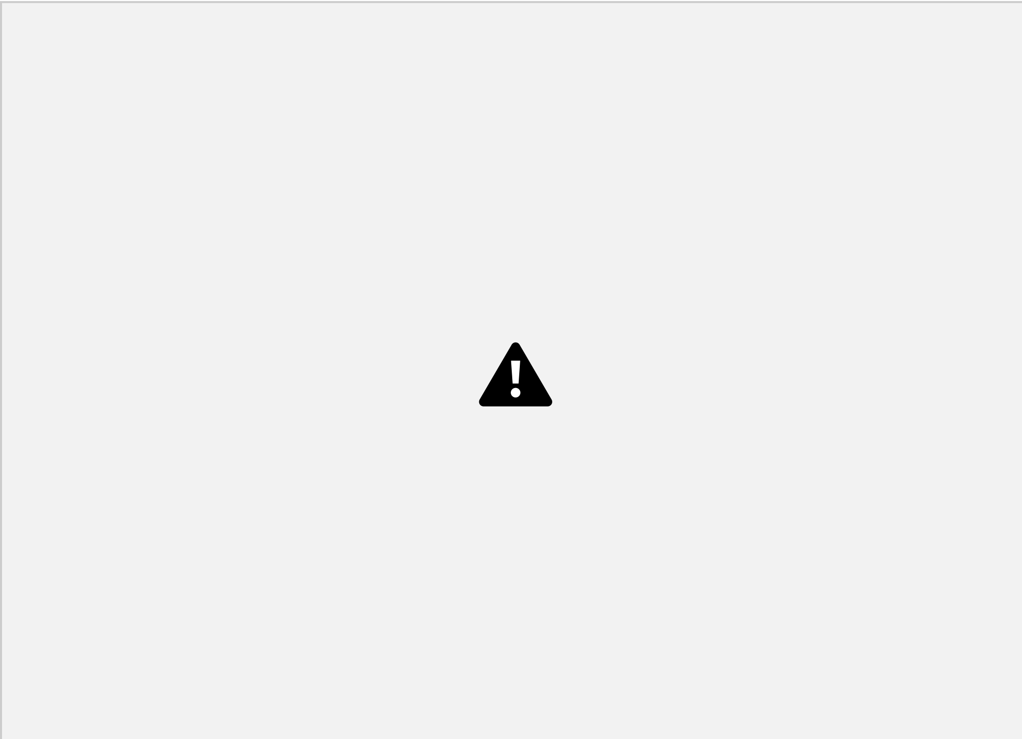
Subscriber base

The country witnessed exponential growth in subscriber base (wireless + wireline) since the onset of 3G and LTE services from 2010. The rate of Subscriber growth in India in the period of 2011 to December 2023 is as shown below.

[1]

FIGURE

Subscribers base in India[2]



Roll-out of 5G Network

India launched 5G services on 01st October, 2022. Due to aggressive rolling out of the 5G network by the Telecom Service Providers, across the length and breadth of the country, India became as one of the fastest 5G rollouts in the world with the latest telecom technology. Within 15 months of time, 5G BTS deployments has crossed the 0.4 million mark, reaching 738 districts and more than 100 million users. Now, most of cities and towns are covered with 5G network.

Now the India has moved from the 5G rollout stage to 5G reach out stage.

State/UT-wise 5G BTS Status[3]

2

3

SN	State/UT	BTS as on													
		05.01.23	16.02.23	05.03.23	02.04.23	14.05.23	19.06.23	02.07.23	30.07.23	28.08.23	31.10.23	30.11.23	31.12.23	31.12.23	31.01.24
1	Andaman & Nicobar	-	-	-	33	87	89	89	89	90	98	112	115	115	115
2	Andhra Pradesh	522	1908	2194	4858	5374	10435	11890	13562	14520	16140	16712	17270	17270	17505
3	Arunachal Pradesh	407	21	29	70	155	286	313	341	360	443	471	492	492	515
4	Assam	-	749	1103	1729	2886	4801	5235	5979	6535	7103	7274	7504	7504	7692
5	Bihar	1121	1992	2583	3527	5788	8795	9847	11809	13960	18863	19549	20118	20118	20522
6	Chandigarh (UT)	290	352	411	529	588	608	610	627	637	659	672	689	689	711
7	Chhattisgarh	158	915	1138	1702	2858	4161	4482	4901	5473	5763	8511	6092	6092	6232
8	UT of Dadra and Nagar Haveli and Daman and Diu		14	14	125	191	255	261	282	305	344	353	364	364	373
9	Delhi	5718	6767	7843	9073	10063	10421	10491	10617	10693	10813	10869	11012	11012	11093
10	Goa	3	121	184	335	520	720	751	766	807	892	908	936	936	955
10	Gujarat	5179	7041	8358	10957	14489	17865	18566	20263	22676	25963	27600	28359	28359	28715
12	Haryana	2374	3594	4429	5986	7816	10526	11423	12188	12936	14104	14319	14824	14824	15110
13	Himachal Pradesh	61	283	433	750	1042	1507	1742	1908	2206	3141	3392	3724	3724	3827
14	Jammu & Kashmir (UT)	149	275	362	1627	2081	2534	3725	4434	4996	5851	6123	6281	6281	6476
15	Jharkhand	391	1428	2004	2911	3830	5280	5717	6602	7553	8404	8593	8835	8835	8975
16	Karnataka	3929	5559	7255	9995	14283	17954	19332	21056	22043	23996	25506	26681	26681	27530
17	Kerala	1001	2090	3096	5050	8322	12129	13405	16315	17503	18082	18378	18619	18619	18730
18	Laddakh	-	-	-	-	35	53	88	121	133	210	220	224	224	225
	Lakshadweep (UT)	-	-	-	-	-	-	-	-	-	2	2	2	2	2
19	Madhya Pradesh	932	2277	2987	4205	6433	9074	10276	11820	13745	16714	17090	17911	17911	18295
20	Maharashtra	9682	13993	15394	18907	23333	26726	29160	31737	34779	40694	42000	43391	43391	43881
21	Manipur	57	199	322	454	619	619	619	619	619	619	619	641	641	787
22	Meghalaya	8	47	64	101	156	306	326	413	442	500	538	597	597	622
23	Mizoram	-	39	67	119	166	237	257	309	341	366	375	391	391	402
24	Nagaland	-	99	137	212	272	393	431	485	504	560	603	639	639	663
25	Odisha	624	1342	1798	2919	4581	6655	7443	8932	9709	10568	10953	11264	11264	11501
26	Puducherry (UT)	10	85	107	193	291	350	369	387	406	439	450	476	476	514
27	Punjab	570	1842	2778	3742	5724	8108	8803	10343	11513	13568	13945	14437	14437	14644
28	Rajasthan	2223	4116	4685	5894	8777	12331	13598	15183	17993	22105	22875	23915	23915	24418
29	Sikkim	-	-	3	43	46	80	94	110	132	232	262	290	290	296
30	Tamil Nadu	5411	7354	8791	12730	18308	22661	25138	27292	28307	30230	30810	31739	31739	32276
31	Telangana	3691	4596	5046	7589	9758	12382	13300	14132	14725	15554	15839	16133	16133	16337
32	Tripura	-	137	195	316	459	642	700	881	909	977	1022	1068	1068	1093
33	Uttar Pradesh	3770	8083	10360	13829	17900	25488	27122	31637	35916	42688	43388	45746	45746	46704
34	Uttarakhand	111	661	957	1703	2053	2786	3185	3615	4145	4768	4876	5202	5202	5258
35	West Bengal	5198	6367	7053	8497	11820	15358	16468	18711	20961	24435	25414	26233	26233	26855
Grand Total		**53590**	**84346**	**102215**	**140710**	**191104**	**252615**	**275256**	**308466**	**338572**	**385888**	**397923**	**412214**	**412214**	**419845**

Department of Telecommunications of India proactively allocated the spectrum in August 2022 to roll-out 5G services, to ensures that ample bandwidth for high-speed data transmission and diverse applications is available.

New Initiative to launch one hundred 5G Use-cases Labs

For enhancing the 5G Use cases, a new initiative has been taken to launch100 '5G Use Case Labs' for educational institutions. This move aims to drive development of 5G applications tailored to local and global requirements.

7.3. China

China published "5G application "sail" action plan" in 2021 which set up the targets for 5G deployment, including 5G subscriber rate, 5G applicability in industry, etc.

By the end of 2023, all the targets were met and even beyond. China had built 3.377 million 5G base stations. The 5G deployment is continuing to deepen the coverage in cities and urban areas, and gradually extended to the rural areas as needed. The continuous growth of 5G mobile phone users and the rapid increase of 5G traffic consumption have promoted the vigorous development of naked-eye 3D, cloud mobile phones and other emerging services, and effectively expanded the development space of the mobile communication market. The number of 5G subscriber reached 805 million, accounting for 47% of mobile subscriber.

By the end of 2023, 5G industrial applications have been integrated into 71 national economic categories, with more than 94000 application cases and more than 29000 virtual private networks in 5G industry. The application of 5G is deeply promoted in industry, mining, electric power, port, medical and other industries. For example, in the medical industry, 5G applications have extended from remote diagnosis to remote precision treatment; 5G applications in the electric power field have changed from unmanned inspection of "transmission" to "generation, transmission, transformation, distribution and use".

https://www.miit.gov.cn/xwdt/gxdt/ldhd/art/2024/art_fb1ca760af7c40578600f3a62cfcab22.html

More than 8000 "5G + Industrial Internet" projects have been invested and built across the country, creating a number of 5G fully connected factories. A list of "5G factories of 2023" was released in the end of 2023, covering 24 different categories.

- 5G is widely used in mining, in which product capability was increased 11.7%;
- 5G is widely used in manufacturing, in which product capability was increased 24%;
- 5G is widely used in production and supply of electricity/heat/gas/water, in which product capability was increased 10.3%, and reduce the operating costs 18%;
- 5G is widely used in construction industry, in which product capability was increased 10%, and reduce the operating costs 20%;
- 5G is widely used in transportation, in which product capability was increased 20%, and reduce the operating costs 21.9%.

5G also contributed to increase the energy efficiency, and reduce the carbon emission at different level in different use cases.

https://www.miit.gov.cn/zwgk/zcjd/art/2023/art_1741388b2be2476b819199c8b1127b5e.html

https://ythxxfb.miit.gov.cn/ythzxfwpt/hlwmh/tzgg/xzxk/dxhhlwyw/art/2023/art_616e8f0c55574d2bb190921add57ce4a.html

8. Summary

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