ASIA-PACIFIC TELECOMMUNITY
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15 March 2021

ITU – APT FOUNDATION OF INDIA (IAFI) [1]

WORKING DOCUMENT TOWARDS A PRELIMINARY DRAFT NEW APT REPORT ON CURRENT STATUS AND FUTURE PLAN OF IMPLEMENTATION AND DEPLOYMENT OF IMT-2020 (5G) IN ASIA-PACIFIC REGION

1. Introduction

APT Wireless Group (AWG) is working on a draft new APT report on IMT-2020 systems (**AWG-26-TMP-24_WD_Current_status_and_future_plan_of_IMT-20205G**). The last update was provided in this working document during the 26th Meeting of AWG. Some of the information provided in the draft report is required to be updated to give the current status.

2. Proposal

IAFI proposes changes (in track change mode and highlighted) in the report regarding the information related to India in various sections of this draft report from Section 3 and 4 in the annexure 1 enclosed. This information is compiled from publicly available sources in India.

[1] ITU-APT Foundation of India (IAFI) is a new Affiliate Member of APT. Further details of IAFI can be seen at www.itu-apt.org/

Contact: Email:

ANNEXURE 1

3. Questionnaire and Responses

3.1. Questionnaire

Questionnaire sent out to each of the APT Member Administration is shown below.

3.1.1. Current status of 4G in your country

Question 1: Is there any information on penetration rate and/or number of subscriptions of 4G technologies, such as LTE/LTE-Advanced, in your country?

If yes, please describe.

3.1.2 Future plan of implementation of IMT-2020 (5G) in your country

Question 2**:** Is there any spectrum allocation plan for IMT-2020 (5G) in your country?

If yes, please describe the information including expected timeline, target frequency bands, etc.

Question 3**:** Is there any current status for IMT-2020 (5G) trial/demonstration services in your country?

If yes, please describe the information including applied 5G services (eMBB, URLLC, mMTC), frequency bands, technical overview, test environments, main location and responsible organizations.

Question 4**:** Is there any roadmap for commercialization of IMT-2020 (5G) in your country?

If yes, please describe.

Question 5**:** Is there any other information for 5G preparations in your country?

If yes, please describe.

3.2. APT Member countries that submitted responses to APT during the development of this Report

The following member countries provided their responses to the Questionnaire.

1) Australia
2) Bangladesh
3) China, People's Republic of
4) India, Republic of
5) Indonesia, Republic of
6) Iran, Islamic Republic of
7) Japan
8) Korea, Republic of
9) Myanmar
10) New Zealand
11) Singapore
12) Thailand
13) Vietnam, Socialist Republic of

4. References

- Bangladesh (AWG-24/INP-116, AWG-25/INP-16)
- China, People's Republic of (AWG-24/INP-60, AWG-25/INP-62, AWG-26/INP-40(Rev.2))
- India, Republic of (AWG-24/INP-46)
- Indonesia, Republic of (AWG-24/INP-108, AWG-25/INP-80, AWG-26/ INP-46)
- Iran, Islamic Republic of (AWG-24/INP-14)
- Japan (AWG-24/INP-68, AWG-25/INP-22)
- Korea, Republic of (AWG-24/INP-85)
- Myanmar (AWG-24/INP-24)
- New Zealand (AWG-24/INP-27)
- Singapore (AWG-24/INP-38)
- Thailand (AWG-24/INP-19)
- Viet Nam, Socialist Republic of (AWG-24/INP-99)
- Australia (AWG-25/INP-18)
- GSMA (AWG-25/INP-54)
- GSA (AWG-26/INP-55)
- IAFI (AWG-27/INP-XX)

5. Current status of 4G in Asia-Pacific region

5.1. Bangladesh

Table 5-1 Operators 4G network status in Bangladesh

Operator`s Name	Total Subscriber (million)	Number of subscribers using 4G technologies (million)	4G Penetration rate
Grameenphone Ltd	74.781366	8.157869	11%
Robi Axiata Ltd	47.7	6.47	14%
Banglalink Digital Communications Ltd	34.54	2.62	7.60%

*4G service was launched in Bangladesh on 19 February 2018.

5.2. China

According to the Statistic data released by Ministry of Industry and Information Technology, China. By the end of June 2018, the total number of mobile subscribers is 1.51 billion. The total 4G subscribers is 1.11 billion with 4G penetration rate to be 73.51%.

5.3. India

In India, as per Telecommunication Regulatory Authority of India (TRAI) January 2021 Report for the quarter ending September 2020, there are total of 1148.58 million mobile subscribers including 2G,3G & 4G subscribers. . These include 752.09 million wireless Internet subscribers, the Rural mobile Tele-density is 58.74% and Urban mobile Tele density is 134.37%.

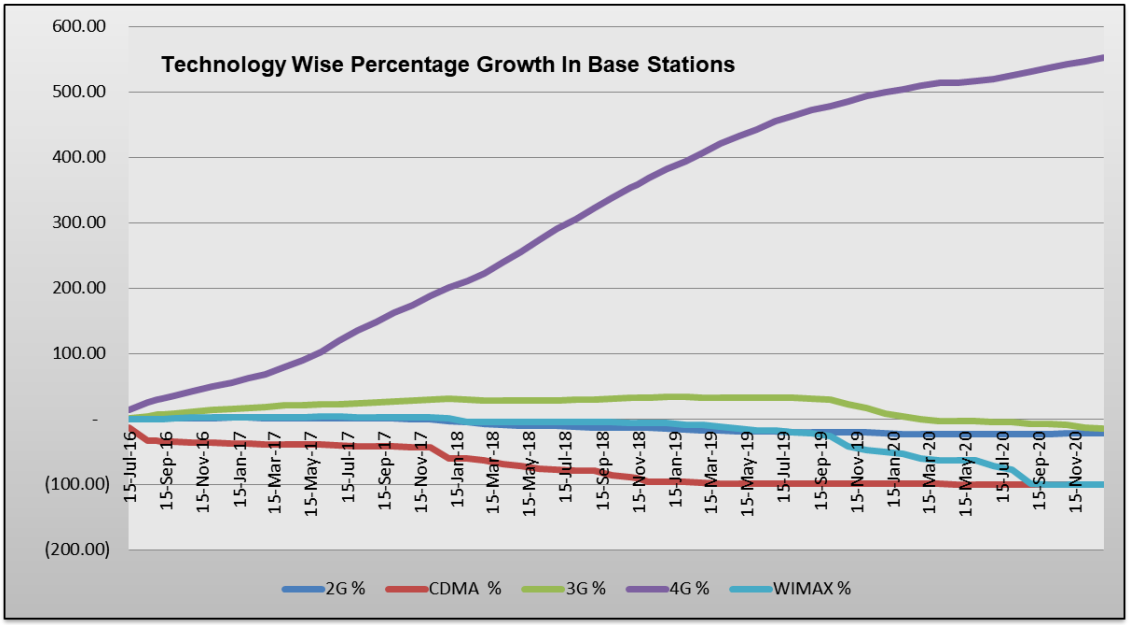
As on September 2020, the subscriber base of top five Wireless Broadband Service providers was as follows –

As on Sept 2020	Total Subscriber base (in million)	4G Subscribers (in million)
RJio	406.21	406.21
Airtel	331.03	152.7
VIL	296	106.1
BSNL& MTNL	133.1	

For details please see:

https://www.trai.gov.in/sites/default/files/QPIR_21012021_0.pdf

Network Deployments and Accessibility: The deployment pattern in India experience indicates that there is a considerable investment and deployment in 4G as is evident in the number of base stations deployed in the period depicted below which indicates the percentage wise growth since July 2016. This demonstrates that there is high demand for Mobile Broadband and the need to cater for the increasing appetite for data services in India. Details of growth in base stations is given in Figure below.



Source: Tarang Sanchar Portal

5.4. Indonesia

As of Quarter 4 in 2018, 4G technologies, consists of LTE and LTE-Advanced, have already covered 70,670 of 83,218 villages in Indonesia.

5.5. Iran

Table 5-2 Operators 4G network status in Iran

Operator's name	Number of 4G subscriptions	Type of 4G technologies
MCI	11,844,145	LTE/LTE-Advanced

Irancell	7,155,753	
Total subscriptions	18,999,898	
Country population	79,926,270	
Penetration rate	23.77%	

5.6. Japan

As shown in Table 1, the penetration rate (i.e. the ratio of number of subscriptions to the total population of Japan*) of 4G (including LTE and LTE-Advanced) is 102.9% as of December 31, 2018.

Table 5-3 Number of subscriptions and penetration rate in Japan

	Number of subscriptions	**Penetration rate**
Mobile Phone	**174,920,000**	**137.0%**
LTE/LTE-Advanced	**131,390,000**	**102.9%**
3G	**43,530,000**	**34.1%**
BWA	**63,520,000**	**49.7%**

*Total population of Japan is about 127,910,000.

5.7. Korea

The total number of mobile phone users exceeds 65.3 million in June 2018 in Korea, surpassing Korea's population, which is about 51.63 million. These 65.3 million users consist of 52.99 million LTE users (LTE commercial service launched in Korea on July 2011), 10.19 million WCDMA users and 2.12 million CDMA users which are accounting for 81.1%, 15.6% and 3.3% of the total number of mobile phone users respectively.

Table 5-4 number of mobile phone users with different services in Korea

Service	**Dec. 2016**	**Dec. 2017**	**Jan. 2018**	**Feb. 2018**	**Mar. 2018**	**Apr. 2018**	**May. 2018**	**Jun. 2018**
CDMA	3,545,455	2,556,242	2,459,504	2,400,064	2,340,696	2,269,845	2,200,453	2,120,524
WCDMA	11,439,821	10,661,566	10,499,440	10,416,008	10,343,957	10,306,481	10,243,875	10,194,233
LTE	46,310,262	50,440,880	50,889,153	51,239,547	51,696,269	52,024,301	52,624,352	52,994,891
Total	61,295,538	63,658,688	63,848,097	64,055,619	64,380,922	64,600,627	65,068,680	65,309,648

Source: Ministry of Science and ICT, 2018.07.31

Currently, mobile operators in Korea, SK Telecom, KT, LG Uplus and MVNO have their subscribers with 27.47 million, 17.02 million, 12.90 and 7.82 million respectively.

Table 5-5 Legacy IMT(2G/3G/4G) Spectrum Allocation Status in Korea

Classification		**Total**
2G	800 MHz (10 MHz), 1.8 GHz Band (20 MHz)	30 MHz
3G	2.1 GHz Band (40 MHz)	40 MHz
4G	800 MHz (50 MHz), 900 MHz (20 MHz), 1.8 GHz Band (90 MHz), 2.1 GHz Band (80 MHz), 2.6 GHz Band (100 MHz)	340 MHz

Total	**410 MHz**

5.8. Myanmar

In Myanmar, radio frequency bands are assigned technology-neutrally for Operators no differentiation on 2G,3G,4G or LTE. According to the independent statistics, 80% of mobile subscribers use smart phones and over 40% of them connect 3G services. Last year PTD assigned 1800Mhz to nationwide operators to provide better QoS to the public.

5.9. New Zealand

New Zealand's 4G mobile networks currently reach population coverage over 98%. The 4G technologies uptake is 58.86% (i.e. approximately 3.75 million 4G subscriptions from a total of about 6.37 million connections, excluding licensed IoT connections) after 6 years when 4G was first deployed in New Zealand.

5.10.Singapore

Based on May 2018 statistics, Singapore's mobile penetration rate is about 148 percent. Of the 8.3 million mobile subscribers, about 75% of them are on 4G networks.

5.11.Thailand

Table 5-6 Operators 4G network status in Thailand

Mobile Operator	No. of 4G Subscribers (Million)	No. of Mobile Subscriber (Million)
Advanced Info Service PCL	18.45	40.1
True Move H Universal Communication Co. Ltd.	11.2	27.2
DTAC Trinet Co.Ltd.	7.9	22.7
Total	37.55	90

Source: Company Annual Report The Stock Exchange of Thailand

5.12.Vietnam

Mobile subscription in total: Around 120 million; and 4G subscription (LTE/LTE-A): 13 millions.

5.13.Australia

Mobile network operators in Australia have extensive deployment of 4G (LTE/LTE-Advanced) services across Australia with consumers having a high take up of 4G capable handsets.

For example, the combined 3G and 4G coverage of Telstra's mobile network now reaches 99.5 per cent of Australia's population. The three largest mobile carriers are rolling out advanced 4G infrastructure in the 700 MHz and 850 MHz spectrum bands.

An estimated 34.84 million mobile voice and data services were in operation in Australia at June 2018. https://www.acma.gov.au/theACMA/communications-report.

Telstra's 4G mobile network coverage area, reaches 99.2% of the Australian population. Telstra has more than 8750 4G enabled sites offering 4G speeds in all the capital CBD's, many suburban areas and in over 1600 regional towns across Australia today.

https://www.telstra.com.au/content/dam/tcom/about-us/investors/pdf%20F/2018-Annual-Report.pdf

Australian mobile network operators do not differentiate service offerings between 3G and 4G and make available the best technology deployed that the mobile handset supports.

5.14.[Insert country's name]

6. Status and future plan of IMT-2020(5G) in Asia-Pacific region

[Editor Note]The chapter includes countries' views on IMT-2020(5G) in Asia-Pacific region, including but not limited spectrum allocation plan, current status of trial/demonstration services, and roadmap for commercialization for IMT-2020 (5G).

6.1. Spectrum allocation plan for IMT-2020 (5G)

6.1.1. Bangladesh

Bangladesh is likely to launch IMT 2020 (5G) Service by 2020. The spectrum allocation for IMT 2020 (5G) is likely to take place before the introduction of 5G in Bangladesh.

6.1.2. China

In November 2017, Ministry of Industry and Information Technology (MIIT) of China has announced the frequency plan for the 3300–3400 MHz, 3400–3600 MHz, and 4800–5000 MHz bands for IMT-2020 system (3300-3400 MHz is limited to indoor scenario only).

On 6th June 2019, The MIIT officially granted the 5G licenses to the nation's major three telecom carriers, including China Mobile, China Telecom and China Unicom, as well as the State-owned China Broadcasting Network Corp. The specific frequency allocation:

- 2 515MHz – 2 675MHz and 4 800MHz - 4 900MHz, total 260MHz bandwidth are allocated to China Mobile
- 3 400MHz – 3 500MHz, total 100MHz bandwidth is allocated to China Telecom
- 3 500MHz – 3 600MHz, total 100MHz bandwidth is allocated to China Unicom

While, China Broadcasting Network Corp has been declared by the country's government to deploy a 5G network across 16 cities using spectrum in the 4.9GHz band, as a 5G trail band. Moreover, 700MHz also is discussing possible allocation scheme for China Broadcasting Network Corp.

By then end of June 2020, more than 40 thousand 5G Base Stations have been established nationwide and 66 million 5G terminal have connected to the 5G network.

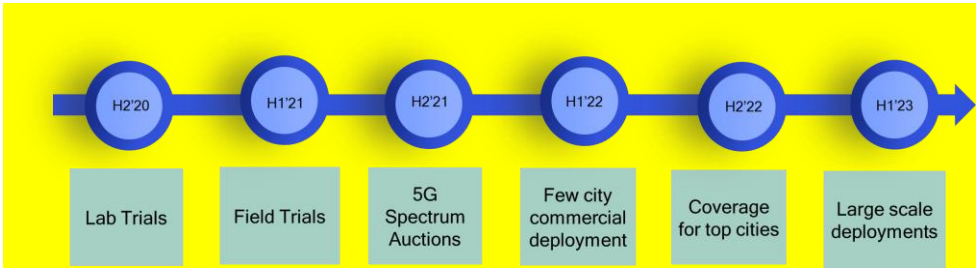
In the future, additional spectrum within the middle range is needed to enable future China 5G deployment and meet the users' increasing requirement of anytime anywhere high data rate communications. The spectrum within the 5 925-7 125 MHz frequency band can partially meet future IMT spectrum needs. In WRC-19, China proposed 5925-7125MHz, or parts thereof, for WRC-23 studies for IMT identification as additional mid-band to drive future 5G development together with other APT countries, i.e. Afghanistan, Cambodia, Lao, Mongolia, Myanmar, Nepal and PNG[2]. China has started the studies on 6GHz and will contribute to ITU-R as appropriate.

6.1.3. India

Government of India, WPC Wing supports technology neutral spectrum. Telecom Service Providers can use any IMT technology in the bands identified for IMT. Government of India supported identification of frequency bands 24.25-27.5 GHz, 37-43.5 GHz (and parts thereof), 47.2-48.2 GHz and 66-71 GHz during the WRC-19. India recognizes the importance of the conditions which were identified during the WRC-19 with respect to the implementation of IMT in these bands. The government of India is working on its next steps for opening up of some or

[2] https://www.itu.int/md/R16-WRC19-C-0110/en

all of these frequency bands for deployment of IMT-2020. Expected roadmap of 5G deployment in India is as follows –



Spectrum Bands Used for Mobile Services in India: current scenario

S No	BAND (MHz)	USAGE
1	800	Initially used for 2G (CDMA). Currently used for LTE
2	900	Initially used for 2G (GSM). Currently used for 2G + LTE
3	1800	Originally only used for GSM, progressive redeployment to LTE
4	2100	Originally only used for 3G, progressive redeployment to LTE
5	2300	Originally used for Point to Point links, now a standardised LTE band for capacity
6	2500	New capacity band for LTE

6.1.4. Indonesia

Initial indications show that Indonesia will stipulate the spectrum licenses for IMT-2020 (5G) around 2022. Frequency bands currently under consideration to be the allocation of IMT-2020 (5G) are 2.6 GHz, 3.3 GHz, 3.5 GHz, 26 GHz and 28 GHz band.

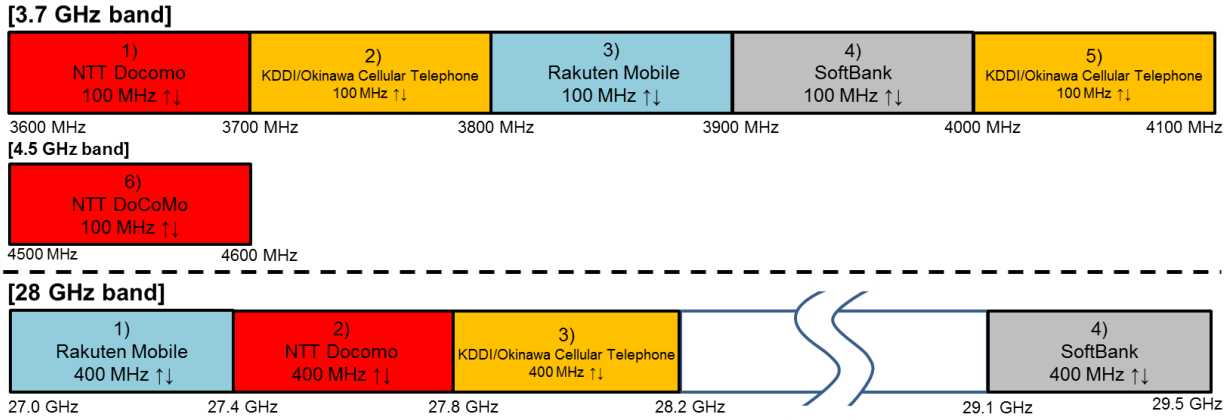
6.1.5. Iran

The current allocated spectrums could be used by operators for 5G. For millimeter-wave range, there isn't any published frequency band plan for IMT-2020 in our country, but in parallel to ongoing ITU-R **AI1.13** studies, related studies and arrangements are happening for on time implementation of IMT2020. The outcome of relevant studies would be tuned by **WRC-19** results. For example following figure shows the frequency band 37-40.5 GHz that has been divided into smaller segments. FDD or TDD utilization would be chosen by operators themselves.

6.1.6. Japan

Toward the launch of 5G in 2020, we have allocated the slots of 100 MHz bandwidth in both 3.7 GHz band (3.6-4.1GHz) and 4.5 GHz band (4.5-4.6GHz), and 400 MHz bandwidth in 28 GHz band (27.0-28.2GHz and 29.1-29.5GHz) on April 2019 to the four mobile operators, taking frequency sharing with incumbent radio systems into account. The results are shown in Figure 6-1.

Figure 6-1-1 The results of 5G frequency spectrum allocation



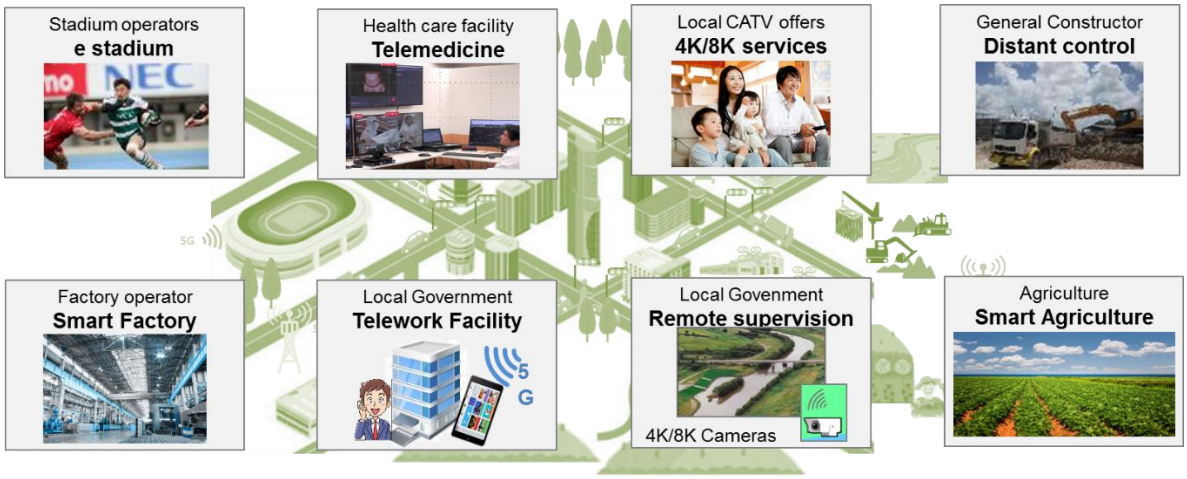
Japan adopted the so-called “beauty contest” on the allocation of 5G frequency spectrum. It had been conducted according to the establishment guidelines for base stations, which set indicators to evaluate the following points:

1. Securing the deployment possibility to all over the country
2. Starting the service early in rural areas
3. Securing the diversity of services

Thus, Japan aims to realize the early nationwide 5G expansion not only to urban areas but also rural areas as follows:

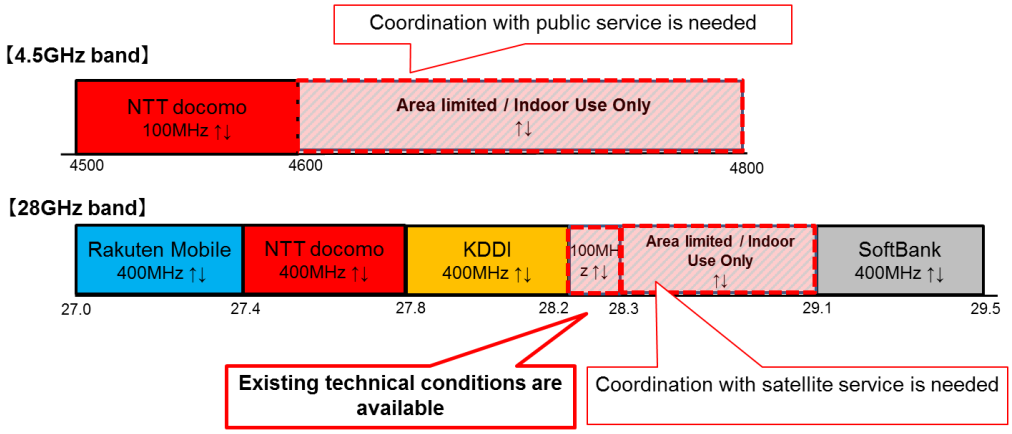
1. Developing 5G advanced base stations* for more than 50% meshes (geographical meshes of 10km square) within five years in both whole country and each region
2. Starting services in all prefectures within two years after frequency spectrum allocation
3. Establishing as many base stations as possible across the country

Figure 6-1-2 Examples of Local 5G usage



In addition, Japan is working on the implementation of a system “Local 5G”, in which 5G is used by different subjects to satisfy their regional or individual needs, in order to promote 5G use within local regions. It is expected that Local 5G will be used in the frequency spectrum of 4.6 to 4.8GHz and 28.2 to 29.1GHz. Especially, even within these, the 100MHz width band from 28.2 to 28.3GHz, is thought to have less issues for consideration compared with other bands, so the band is expected to be institutionalized at the earliest in around August of this year. Figure 2 shows examples of Local 5G usage, and Figure 3 summarizes the candidate bands for Local 5G.

Figure 6-1-3 Candidate bands for Local 5G



6.1.7. Korea

5G spectrum auction has completed in Korea from June 15 to 18, 2018.

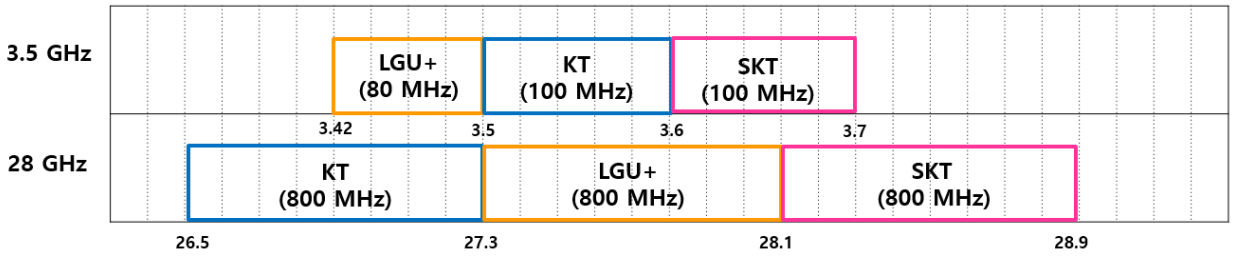
Through this auction, Korea government supplied 280 MHz bandwidth with 28 blocks in 3.5 GHz band and 2.4 GHz bandwidth with 24 blocks in 28 GHz band at the same time.

Frequency bands of auction:

3,420 - 3,700 MHz (total 280 MHz BW, 28 blocks/10MHz unit, Maximum(spectrum cap) 100 MHz per operator, 10 years' license from Dec. 1st 2018)

26.5 - 28.9 GHz (total 2.4 GHz BW, 24 blocks/100MHz unit, Maximum(spectrum cap) 1 GHz per operator, 5 years' license from Dec. 1st 2018)

Figure 6-1-4 The results of 5G frequency spectrum allocation



The obligation of 5G Network Deployment is shown in Table 3.

Table 6-1-1. The obligation of 5G network deployment

Classification	Reference station	% of obliged deployment by year	
		3 Years (15%)	5 Years (30%) (Sum)
3.5 GHz Band	150,000 Stations	22,500 Stations	45,000 Stations
28 GHz Band	100,000 (based on equipment)	15,000	-

In case of 3.5 GHz band, it was imposed duty to deploy 22,500 stations (15%) in 3 years and 45,000 stations (30%) in 5 years of 150,000 stations as a reference number. In case of 28 GHz band, it was imposed duty to deploy 15,000 equipment and stations (15%) in 3 years of 100,000 equipment and stations, at the level of nationwide LTE obligation, as a reference number

6.1.8. Myanmar

The following bands could potentially be made available by PTD for assignment in the next 5 years:

- Unassigned portions of the 850/900 MHz and 2100 MHz bands;
- 700 MHz;
- 1800 MHz;
- 2300 MHz; and,
- 2600 MHz.

These bands were identified for consideration in light of the allocations of the updated NTFA (National Table of Frequency Allocation), spectrum already assigned and spectrum release activities internationally with a particular emphasis of Asia-Pacific Telecommunity (APT) countries.

This Roadmap sets out the release of 2.6 GHz, a portion of 900 MHz, followed by 1.8 GHz, 700 MHz and the balance of unassigned 800 and 900 MHz over a 5-year period. The Roadmap is consistent with the priorities established by PTD and has considered the comments received from stakeholders in the consultation process. Previously, Ministry/PTD had made provision in a separate process for the 4th operator including a portion of spectrum in the 900MHz and 2100MHz bands.

6.1.9. New Zealand

New Zealand is currently considering the possible re-allocation of four frequency bands for IMT-2020. Among these bands, the 3.5 GHz band has higher potential for early re-allocation than others. The band plan and exact frequency boundaries are still under consideration.

The table below provides more information about these bands:

Table 6-1-2. The obligation of 5G network deployment

	Band Name	Frequency range	Status
1	3.5 GHz	3 410 - 3 800 MHz	Consultation with industry stakeholders about possible early re-allocation in spite of the expiry date of incumbent spectrum rights is October 2022 Planned to be re-allocated for 5G use by 2020 New band plan and exact frequency boundaries are still under consideration
2	26/28 GHz	24.25 - 27.5 GHz / 27.5 - 28.35 GHz	Monitoring ITU-R studies on related WRC-19 agenda items, including Agenda item 1.13 (24.25-27.5 GHz) and Agenda item 1.5 (27.5-29.5 GHz) New band plan and exact frequency boundaries subject to review in 2019/2020 when there is more clarity about WRC-19 decisions and equipment tuning range Coordination regime between transmitting earth station (FSS uplink) and 5G are still under consideration to allow continuity of FSS operation in 27.5-28.35 GHz
3	1.5 GHz	1 427 - 1 518 MHz	Monitoring ITU-R studies on the sharing and compatibility analysis between IMT and mobile-satellite services Re-allocation for 5G to be considered once appropriate transitional programme for existing fixed links in this band is identified New band plan and exact frequency boundaries subject to review in 2020/2021 when there is more clarity on a harmonised band plan and broader equipment availability based on either FDD, TDD or SDL arrangement

4	600 MHz	610 - 698 MHz	Re-allocation for 5G to be considered once appropriate alternative solutions have been identified to address existing use of the band, including radio microphones Band plan is likely to follow 3GPP Band Class 71

6.1.10. Singapore

Singapore is looking to make available a mixture of low (below 1 GHz), high (1-6 GHz) and millimeter wave (above 6 GHz) frequencies for 5G from 2020 and beyond. Both the spectrum availability and timeline is dependent on several factors such as the outcome of the frequency bands identified for consideration at the 2019 World Radiocommunication Conference (WRC-19) for 5G deployments, spectrum harmonization with neighboring countries, and local spectrum reframing and migration timelines.

6.1.11. [Thailand]

[TBD]

6.1.12. Vietnam

Vietnam is considering several bands for 5G but has not allocated yet. Candidated bands can be found below:

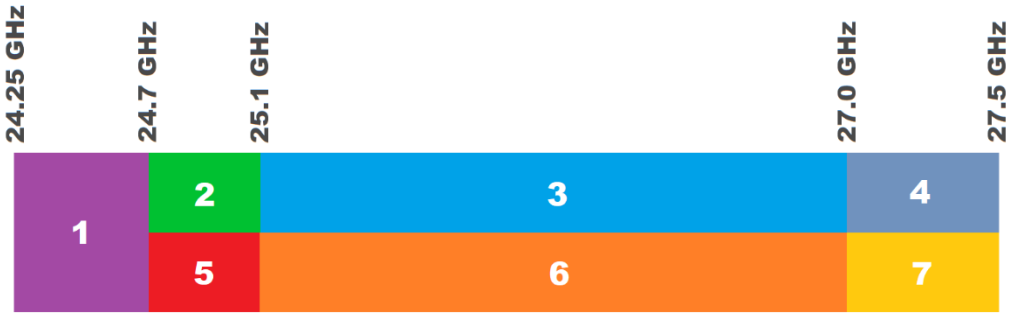
- 700 MHz
- 1500 MHz
- 2300 MHz
- 3300-3400 MHz
- 4800-4990 MHz
- 24.25-27.5 GHz

Viet Nam allows Mobile Operators to deploy IMT systems in their licensed bands (850 MHz, 900 MHz, 1800 MHz and 2100 MHz) with WCDMA, LTE, LTE-A and beyond.

6.1.13. Australia

The ACMA has a technology flexible spectrum allocation plan for the band 24.25 – 27.5 GHz that can be used for IMT-2020 (5G) services. The spectrum plan is shown in Figure 1 below.

Figure 6-1-5 Planned arrangements for wireless broadband services in the 26 GHz band



1. Class-licensing [3] for indoor use—Australia-wide.
2. Class-licensing for indoor and outdoor use—Australia-wide.
3. Spectrum licensing [4]—defined areas. Includes additional conditions to protect SRS earth stations.
4. Spectrum licensing with additional FSS coexistence conditions within certain areas.
5. Apparatus licensing [5]—Australia-wide.
6. Apparatus licensing—Australia-wide, except defined areas. Includes additional conditions to protect SRS earth stations.
7. Apparatus licensing with additional conditions to protect FSS uplinks – Australia-wide except defined areas. New FSS earth stations will also be permitted (except in defined areas) on a first-in-time coordinated basis with apparatus licensed wireless broadband services.

Further information can be found in the ACMA paper *Future use of the 26 GHz band: Planning decisions and preliminary views*.

The ACMA is currently undertaking a planning and consultation phase as part of the spectrum refarming of the 24.25 –27.5 GHz band and timeframes for this spectrum being available are yet to be determined.

Licences in Australia are issued on a technology flexible basis as such any of the following IMT bands will be able to be used in Australia to provide 5G services:

Table 6-1-3 5G licenses bands with 3GPP technology in Australia

Frequency range	3GPP Band
703-748 / 758-803 MHz	28
825-845 / 870-890 MHz only	5
890-915 / 935-960 MHz only	8
1710-1785 / 1805-1880 MHz	3

[3] Class licensing—broad spectrum access arrangements which are open to all users. Intention is to facilitate localised private 5G networks

[4] Spectrum licensing—use of a specified frequency band in a defined geographical area

[5] Apparatus licensing—use of individual devices, usually on a site-specific basis. Intention is to facilitate localised private 5G networks

1920-1980 / 2110-2170 MHz	1
2302-2400 MHz	40
2500-2570-2620-2690 MHz	7
3400-3700 MHz	42/43 Nr77/78
24250-27500 MHz(*)	N258

(*) Band is consistent with WRC-19 Agenda Item 1.13 being considered for IMT-2020 services

The bands 3400 – 3700 MHz and 24250 – 27500 MHz are likely to be the pioneer bands for IMT-2020 services in Australia with Telstra already launching 5G services in the 3400 – 3700 MHz band.

6.1.14. [Insert country's name]

…

6.2. Current status for IMT-2020 (5G) trial/demonstration services

6.2.1. Bangladesh

One trial/demonstration of 5G service has been conducted by Huawei Technologies (Bangladesh) Ltd with mobile operator Robi Axiata Ltd on 25th July 2018. This trial/demonstration was conducted in 28 GHz (26.65-29.19 GHz) frequency band and the maximum speed achieved was 4.5 Gbps.

6.2.2. China

The 5G Trials in China include two phases, Technology R&D Trial (Phase 1) and Product R&D Trial (Phase 2). The target of phase 1 is to promote 5G core technology research and development in China, to verify 5G technology schemes and to support global unified 5G standards. Then the phase 2 Trial aims to validate the 5G product.

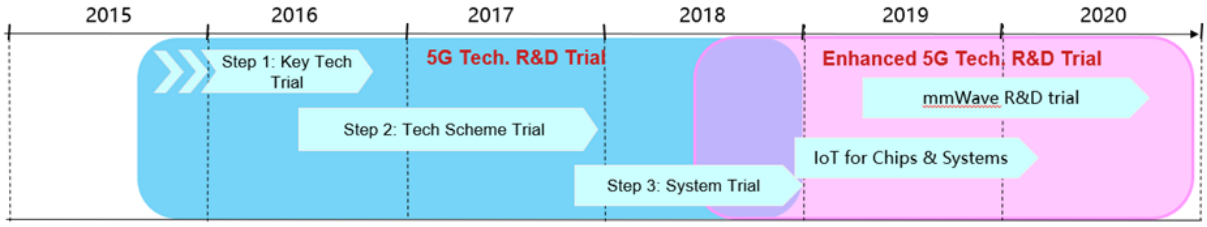


Figure X China 5G Trial plan

- **Technology R&D Trial (Phase 1)**: led by the IMT-2020 (5G) Promotion Group and conducted from 2016 to 2018. In January 2016, the Ministry of Industry and Information Technology (MIIT) in China has launched the 5G technology R&D Trial (Phase 1). The three steps of this trial are as follows:

Step 1 (Key technology trial): implemented from January 2016 to September 2016, focusing on the test of 5G key technology prototypes, the evaluation of function and performance, and promoting the standards consensus building.

Step 2 (Technology scheme trial): implemented from June 2016 to December 2017 targeting to test the performance of single base station and to verify the functionality and performance of different vendors' 5G technology schemes.

Step 3 (System trial): Implemented from June 2017 to December 2018, targeting to verify the networking and interconnection performance of 5G system, and demonstrate the 5G typical services.

- **Product R&D Trial (Phase 2)**: considered as the 5G scale trial in China as well, will be led by Chinese operators and conducted from 2018 to 2020. In the beginning of 2019, he Ministry of Industry and Information Technology (MIIT) in China has launched the 5G product R&D Trial (Phase 2). The two steps of this trial are as follows:

Step 1 (IoT tests between chips and system): implemented from January 2019 to January 2020, focusing on Interoperability between chips companies and 5G system vendors; both 2.6GHz and 3.5GHz are trial bands; and Non-standalone (NSA) and Standalone (SA) are considered as 5G networks in the test.

Step 2 (mmWave R&D trial): implemented from January 2020 to December 2020 targeting to test the performance of mmWave base station and to verify the functionality and performance of different vendors' 5G technology schemes in mmWave.

6.2.3. India

Department of Telecommunication (DoT) in India has initiated 5G Hackathon (https://www.5ghackathon.in) which provides great platform for start-ups and SMEs to test their ideas and innovative skills. With this they can leverage state of the art technology for the solution of global problems.

WPC Wing is in the process of identifying spectrum for 5G trials in 3.3-3.6 GHz and 26 GHz bands for trials and demonstration of 5G capabilities in the country.

6.2.4. Indonesia

From 2017 to 2019, there has been a total of ten IMT-2020 (5G) trials conducted in sevral cities of Indonesia. 3 The responsible organization for those trials is Ministry of Communications and Informatics (MCI), Republic of Indonesia in collaboration with mobile operators.

All trials applied varies uses cases with various frequency bands as detailed in the table below.

Table-6-2-1 IMT-2020 trials information in Indonesia

Operator	Frequency Band	Use Cases	Date
PT XL Axiata, Tbk.	15 GHz	Peak throughput demonstration	March 2017
PT Telekomunikasi Selular	72 GHz	Peak throughput demonstration	May 2017
PT Telekomunikasi Selular	28 GHz	1. 5G Autonomous Electric Vehicle 2. 5G Experience Center • VR Cycling, Driving, Football • Suten Robot • 5G Tablet • 3D Gold Medal 3. 5G Live Streaming • Interactive Time Slice 4. Throughput Performance Test • Channel BW Configuration • Power Output Tuning • Indoor/outdoor test	August 2018 (during Asian Games XVIII event)
PT XL Axiata, Tbk.	15 GHz & 28 GHz	1. Showcase • VR Experience • Waste Management • Water Management • Water Monitoring • Beam Tracking 2. Technical Test • Reflector existence	August 2018

		• Distance configuration • Angle between AAU & TUE configuration	
PT Indosat, Tbk.	28 GHz	1. 3D Augmented Reality 2. Technical Test • Peak Throughput • Beam Tracking • 4K Video Streaming (latency)	November 2018
PT Smart Telecom	28 GHz	"Industry 4.0 in Industrial Area" 1. Showcase • Remote industry monitoring with 360° camera and VR • Remote troubleshooting with drone and VR view 2. Technical test • Peak throughput • UL throughput when execute remote monitoring and troubleshooting	August 2019
PT XL Axiata, Tbk.	28 GHz	"Holographic Call for Productivity" 1. Holographic call demonstration 2. Coverage test 3. 5G-LTE Dual Connectivity 4. 5G Handover Mobility	August 2019
PT Hutchison 3 Indonesia	28 GHz (for access), 23 GHz & 80 GHz (for transport)	"Real Time Interactive e-Education" 1. Showcase: Remote class with interactive holographic call and interactive white board 2. Technical Test: • 5G – LTE Dual Connectivity • 5G Data Call Setup • 5G DL/UL Throughput and Latency Test • 5G Mobility Test • 5G Voice Call : VoLTE Fallback	September 2019
PT Telekomunikasi Selular	28 GHz & 3.5 GHz (indoor)	1. Showcase5G Video Call • Smart surveillance for security and traffic monitoring • Smart air patrol • Immersive Collaboration • Seamless Gaming 2. Technical Test • Channel collaboration with VR • Immersive entertainment • Bandwidth configuration • Obstacle existence test • Coverage & power test • Mobile walk test: RSRP, RSRQ and SINR distribution • Throughput Performance Test	November 2019
PT Telekomunikasi Selular	28 GHz	1. Showcase • 5G Smart Agriculture • 5G Public Safety: Video Surveillance • 5G AR Remote Assistance 2. Peak throughput test	December 2019

In 2020, Indonesia plan to conduct coexistence trial between IMT-2020 and FSS services (as existing services) in ext-C Band. The objective of the trial is to find value of guardband, separation distance and filter usage based (if required) pursuant to Indonesia real condition

6.2.5. Iran

This administration encourages operators, vendors and searching laboratories to conduct 5G tests. Accordingly, one operator crossed 1 Gbps down-streaming record in-building. There are also several NB MTC-IoT networks in various areas such as smart-cities, portal operations, transportation, etc. which are mainly implemented by collaboration of start-ups and operators.

6.2.6. Japan

We have conducted 5G Field Trials in both urban cities and rural areas from fiscal year (FY) 2017 as summarized in Table 2. Table 6-2-2 shows the latest trials conducted in FY 2018.

Table 6-2-2 5G Field Trials in Japan in FY 2018

	Responsible Organization	Technical Overview	Trial Overview	Main Trial Locations	Technology
I	NTT DOCOMO	Avg. 2-4Gbps (user terminal) / Avg. 4-8Gbps (base station)	・Sightseeing ・Smart Cities ・Telemedicine	*1 ・Tokushima ・Wakayama	eMBB (4.5, 28GHz)
II	NTT Communications	Avg. 1Gbps (mobility)	・Transport	*2 ・Osaka ・Ibaraki	eMBB (4.5, 28GHz)
III	KDDI	URLLC with Avg.300Mbps (terminal uplink)	・Construction ・Drones ・Snowplows	*2 ・Osaka ・Hiroshima ・Nagano	URLLC (3.7, 4.5, 28GHz)
IV	ATR (Research Corporation)	Avg. 2Gbps (Indoor)	・Smart factory ・Education	*3 ・Fukuoka ・Tokyo	eMBB (28GHz)
V	SoftBank	10ms latency (End-to-End)	・Transport	*2 ・Ibaraki ・Shizuoka	URLLC (4.5, 28GHz)
VI	Wireless City Planning	1 million devices/km2 density	・Smart highway ・Smart office	*2, *3 ・Miyagi ・Ishikawa ・Osaka	mMTC (3.7, 4.5, 28GHz)

*1 Urban micro-cell or urban macro-cell

*2 Suburban macro-cell (outdoor) or rural macro-cell

*3 Indoor hotspot

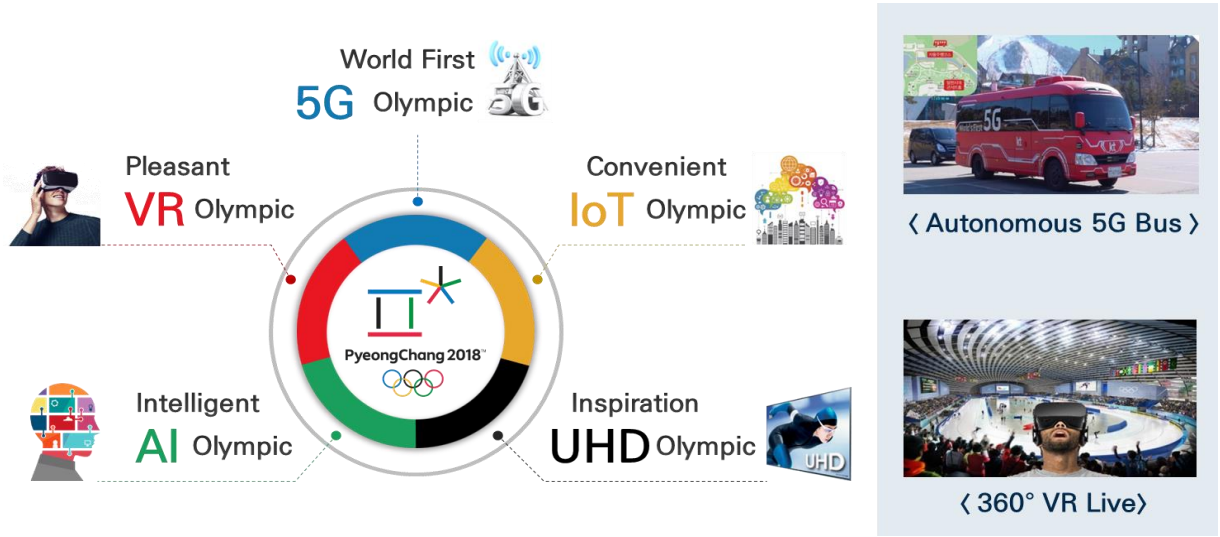
And we will continue to conduct these trials in FY 2018 or later. In future trials, rural areas will be more focused on as implementation sites.

6.2.7. Korea

5G Trials for Olympic Winter Games PyeongChang 2018

Olympic Winter Games PyeongChang 2018 (2018.2.9~25) provided a whole new Olympics experience with the 5 advanced ICT Services which were demonstrated as listed in below.

Figure 6-2-1 Pyeongchang Olympic 5G trial: 5 advanced ICT services



(Source: Ministry of Science and ICT)

Korea successfully showed various 5G trial services such as autonomous 5G car and 360 degree VR live show by using these 5 advanced ICT technologies. Regarding 5G trial network, Korea operators built a pre-standard 5G network running in 28 GHz band with vendors for Winter Olympics, and recorded peak data rate of up to 3.5 Gbps on a 5G mobile tablet using the network. The system (comprising 22 5G links at 10 different sites) delivered 3,800 terabytes of data during the two-week event.

Figure 6-2-2 Pyeongchang Olympic 5G trial: Network

(Source: Ministry of Science and ICT)

5G Trials for Vertical Industries

Due to the saturation of the traditional mobile service market, there are many attentions to new 5G service market for vertical industries. Considering this trend, MSIT has started the 5G Trials for Vertical Industries from Apr. 2018 to Dec. 2020. The detailed information about 5G trail service for vertical industries is shown in Table 4.

Table 6-2-3 5G Trials for Vertical Industries

Organization/ Services	Main partners	Services	Main locations	Technology
KT	·IT Telecom	·Intersection safety	·Seoul Sangam	eMBB/URLLC
Autonomous Driving	·Unmanned Solution	·Commute Shuttle bus	·Gyungi Pangyo	

	·E-Intelligence	·Personal mobility	·Daegu Alphacity	
ETRI **Smart City**	·KT ·Jinyoung I&C ·Intellivix	·Smart Street ·Safety/Convenience	·Daejeon ·Daegu	eMBB/mMTC
SKT **Smart Industry**	·KETI ·Wizcore ·Schaffler Korea	·Machine Vision ·Multi-function robot ·Facility mgmt. AR	·Ansan ·Banweol	eMBB/URLLC
KT **Disaster/ Security**	·ETRI ·TI Square ·Texcell Netcom	·Fire/Tunnel accident ·Pedestrian accident intelligent support	·Gangwon Prov. ·Pyeongchang	eMBB/mMTC
SKB **AR/VR**	·SKT ·Looxid ·Avavision	·XR service for underprivileged ·360/interactive VR	·Busan city	eMBB/URLLC

6.2.8. [Myanmar]

[(Not provided)]

6.2.9. New Zealand

Two industry-led 5G trials were undertaken in New Zealand since 2018. The first trial was conducted by one mobile network operator in the frequency ranges 3.6-3.7 GHz and 26.65-27.45 GHz for outdoor trials in Auckland and Wellington. The second trial was conducted by another mobile network operator in the frequency range 27.525-28.325 GHz for indoor and restricted outdoor trials in Auckland.

6.2.10. Singapore

Singapore has waived the frequency fees associated with 5G trials from May 2017 to December 2019 to facilitate the deployment of 5G services in Singapore. A total of 14 different frequency bands are eligible for frequency fees waiver for 5G trials if their use cases fall under one of the three categories defined by ITU-R (i.e. eMBB, uRLLC, mMTC) and subject to assessment of trial plans and the technical conditions of use. More information is available from this url:

https://www.imda.gov.sg/regulations-licensing-and-consultations/frameworks-and-policies/spectrum-management-and-coordination/spectrum-planning/5g-technology

6.2.11. [Thailand]

[TBD]

6.2.12. Vietnam

Vietnam is considering approving to first 5G trial test (eMBB service) in 2019.

6.2.13. Australia

Telstra launched commercial 5G services in selected areas of Australia on 28 May 2019, using 3.4-3.6 GHz spectrum.

Telstra has also conducted a number of 5G technology trials using Experimental/Scientific Licenses issued by ACMA. These licenses are issued on a no-interference, no-protection basis. Because much of the hardware available for trial is based on the technical requirements that apply to other overseas markets, the choice of operating frequency/band is limited and creates the need

to carefully consider the incumbent licensees. In those cases, formal frequency coordination studies were conducted and interference mitigation processes are put in place as necessary.

Table 6-2-4 5G Trials in Australia

Band	Timing	Description	Location
15 GHz	Mid 2016	Early trial/demonstration using prototype test-bed hardware. Single site.	Melbourne
3.6 GHz	Late 2017	Vendor equipment evaluation.	Launceston and Ballarat
27 GHz	Early 2018	Trial/demonstration with a small cluster (10 sites) in a metropolitan area.	Gold Coast
27 GHz	Mid 2018	Vendor equipment evaluation with fixed terminal.	Bendigo
27 GHz	Mid 2018	Indoor coverage and technology demonstration.	Melbourne and Sydney

While mobile network operators have undertaken IMT-2020 (5G) trials in Australia in a range of frequency bands, these trials utilise experimental/scientific licences and the ACMA provides no commitment that those bands will be made available for mobile broadband services in the longer term.

6.2.14. [Insert country's name]

…

6.3. Roadmap for commercialization of IMT-2020 (5G)

6.3.1. Bangladesh

Bangladesh is likely to adopt IMT 2020 (5G) Service by 2020

6.3.2. China

The operators in China pay a lot of attention on 5G, they make great efforts on 5G R&D and standardization. Currently, the operators are working on their initial strategy of 5G network evolution and pre-commercial plan. The operators plan to conduct large-scale pre-commercial trial with more than 100 sites per city (several cities will be chosen) in 2019 and deploy more 5G commercial sites in 2020.

China issued 5G commercial operation licenses on 6th June to 4 mobile network operators in 2019. This document provides an introduction on 5G system implementation of Chinese MNOs.

China Telecom, China Unicom, China Mobile and China Broadcasting Network obtained 5G commercial operation licenses and announced their 5G Logos, listed in Table 6-3-1 in detail.

Table 6-3-1 5G commercial operation licenses in China

Mobile network operator	5G brand Logo
China Telecom	$5G^{Hello}$
China Unicom	$5G^{n}$
China Mobile	$5G^{+}$
China Broadcasting Network	$5G^{G}$

China Telecom

China Telecom has conducted 5G innovation demonstration trials in 17 cities including Beijing, Shanghai and Shenzhen, and is planning to expand to more than 40 cities. China Telecom has extensive cooperation in 5G application innovation to jointly build a new 5G ecosystem. It

has developed more than 200 trial customers and partners, focusing on key business scenarios of vertical industries of government affairs, manufacturing, transportation, logistics, education, medical care, media, police, tourism and environmental protection.

China Unicom

In April 2019, China Unicom officially opened 5G pre-commercial services in 7 cities (Shanghai, Beijing, Guangzhou, Shenzhen, Nanjing, Hangzhou and Xiong'an). 5G is accessible in the World Garden Expo and Winter Olympics Stadiums in Beijing.

China Unicom released the "7+33+N" network deployment plan, which is to provide a continuous urban coverage in the 7 cities, hotspot coverage in other 33 cities and 5G dedicated networks for vertical industries in N cities to promote 5G application and industrial upgrading.

China Unicom established the 5G Application Innovation Alliance with partners from Intelligent Transportation, New Media, Industry Internet, Medical care, Education and Tourism. Several 5G trials have already been launched in vertical industries.

China Unicom also released its 5G terminals, including 6 smart phones, 5 industry terminals and 4 modules. 5G Terminal Innovation Research and Development Center will be established.

China Mobile

In December 2018, China Mobile launched 5G scale trials. Trial networks have been built mainly in five cities in China (Hangzhou, Guangzhou, Shanghai, Suzhou and Wuhan), in which more than 500 stations were built and the trial covered 26 scenarios. SA and NSA chipsets were available in the first quarter in 2019 and 5G terminals in the second quarter of 2019. Pre-commercial use of 5G NSA and SA vertical industries is expected to start in the second half of 2019. And scale commercial use will begin in 2020.

China Mobile has established 5G Joint Innovation Center in 2016, complaining partners from network equipment, instruments, chipsets and terminals to give full play to the influence of 5G eco-system and promote integrated development with various industries.

6.3.3. India

Department of Telecommunications recently auctioned spectrum in 700, 800, 900, 1800, 2100, 2300, and 2500 MHz bands. The details of auction result are available at https://dot.gov.in/spectrum-management/2828. The government of India is also planning to open up other spectrum bands which were recently identified for IMT in WRC-19 for deployment of IMT-2020..

6.3.4. Indonesia

At present the addition of radio frequency spectrum that can be used for the 5G implementation has been included in the National Medium Term Development Plan (RPJMN) target for 2020-2024. It is expected that 5G can be implemented within this time period by also considering the demand for 5G needs in Indonesia and waiting for the adoption of primary legislation which supports the presence of 5G in Indonesia through a more comprehensive sharing policy breakthrough. By 2024, it is projected that we need at least 1882 MHz (one thousand eight hundred and eighty two Mega Hertz) spectrum bandwidth. Currently, our spectrum availability is at 737 MHz (seven hundred and thirty seven Mega Hertz). Our target is to achieve additional spectrum bandwidth at least 1310 MHz (one thousand three hundred and ten Mega Hertz) in 2024 by releasing spectrums in low, middle, and high band which are important for 5G implementation.

Indonesia is still in the process of conducting trials and related studies in order to develop the roadmap of IMT-2020 (5G) implementation in Indonesia. In order to accelerate the roadmap release, Minister of Communication and Informatics has formed 5G Task Force in August 2020 that consist of 5 Working Groups:

1. Working Group Radio Frequency Spectrum
2. Working Group Business Model
3. Working Group Infrastructure
4. Working Group Device and Ecosystem
5. Working Group Regulation

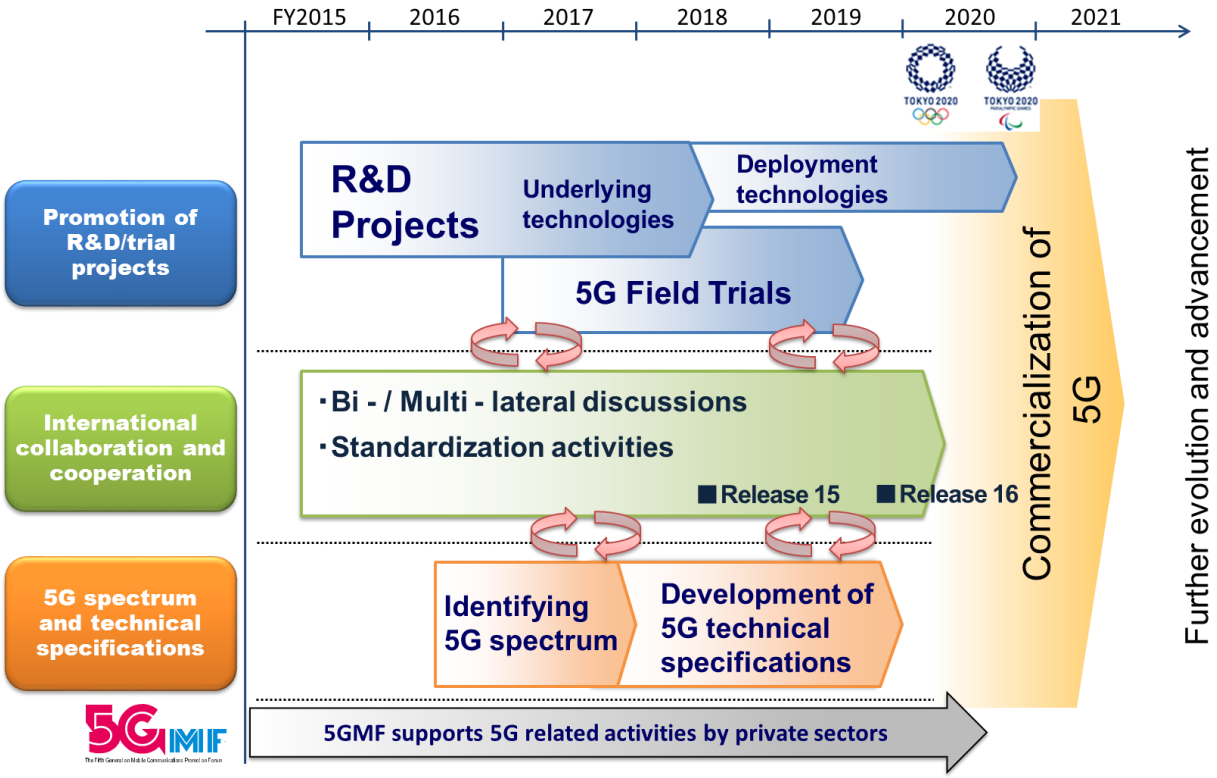
6.3.5. Iran

In Iran research and pilot projects on new applications such as car networking as a new 5G future markets have been started. We expect that the volume of 5G commercialization will grow by the new 5G applications, similar to global trends.

6.3.6. Japan

We are aiming to commercialize 5G service in 2020, in which the Summer Olympics and Paralympics will be held in Tokyo. Towards this commercialization, we are currently proceeding with R&D/trial projects, international collaboration/cooperation, and development of 5G technical specifications as summarized in Figure 6-3-1.

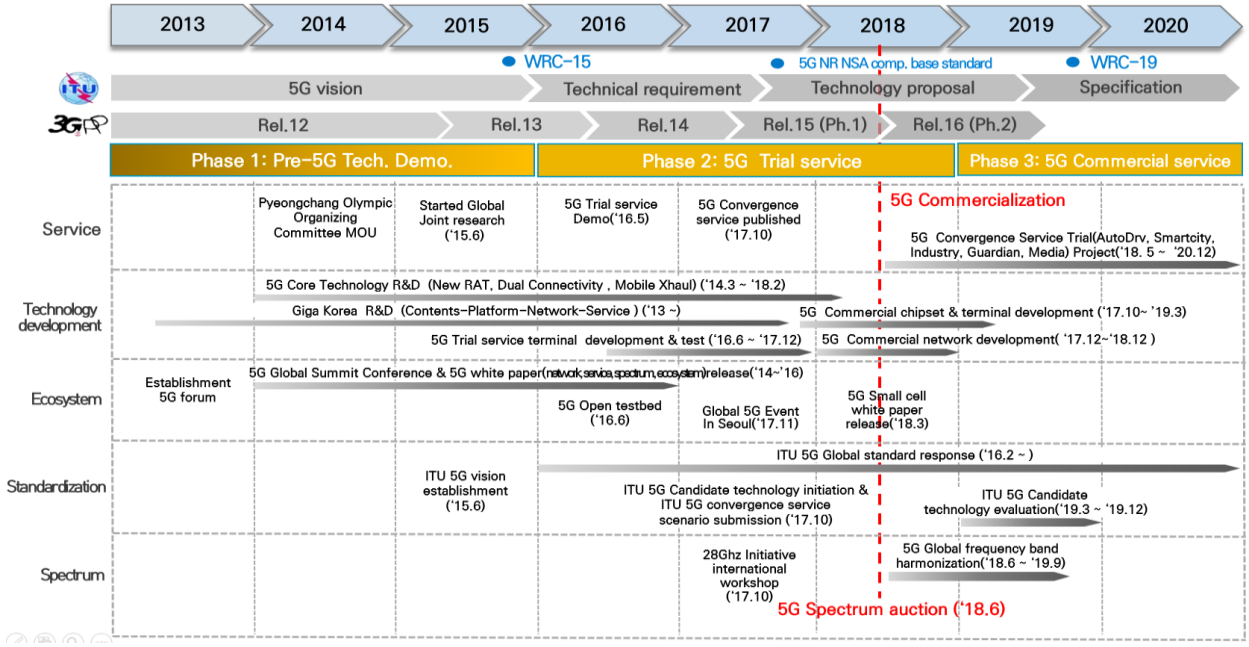
Figure 6-3-1 Roadmap for commercialization of 5G in Japan



6.3.7. Korea

The Republic of Korea is preparing for the world`s first country to commercialize 5G based on our 5G policy experience. In the 2019, when 5G is commercialized, the Republic of Korea will promote trial service in various fields using 5G technology. In 2022, the Republic of Korea plans to promote more advanced services such as autonomous vehicle with 5G.

Figure 6-3-2 5G Roadmap in Korea



(Source: Ministry of Science and ICT)

6.3.8. [Myanmar]

[No roadmap for commercialization yet.]

6.3.9. New Zealand

New Zealand is in the process of developing a Spectrum Roadmap for 5G. The roadmap will likely cover government's policies for facilitating the timely release of multiple spectrum bands and the deployment of 5G network based on use cases of eMBB, URLLC and mMTC.

New Zealand held a series of industry workshops in late October 2017 to discuss views on 5G requirements, possible 5G applications and 5G spectrum demands with stakeholders. Subsequently, a formal public consultation commenced in March 2018. Submissions closed on 30 April 2018. Refer to https://www.rsm.govt.nz/projects-auctions/current-projects/preparing-for-5g-in-new-zealand/submissions-received.

6.3.10. Singapore

Singapore plans to publish our plans and roadmap for 5G around the end of 2018. More information will be made available in this url:

https://www.imda.gov.sg/regulations-licensing-and-consultations/consultations/consultation%20papers/2017/public-consultation-on-5g-mobile-services-and-networks

6.3.11. [Thailand]

[TBD]

6.3.12. Vietnam

Not have official roadmap yet. But mobile operators are expected to deploy commercial 5G network immediately after they complete trial tests.

6.3.13. Australia

Licences in Australia are issued on a technology flexible basis. This allows licensees to develop their own timeframes for the deployment of new technologies.

On 28 May 2019, Telstra launched commercial 5G services using the 3.6 GHz band at more than 200 sites across 10 cities. The roll-out is still in its early stages and will grow in the coming months and years.

Telstra notes that the ACMA is prioritizing a 26 GHz spectrum auction where 5G is expected to be the deployed technology.

6.3.14. [Insert country's name]

…

6.4. Other information for 5G preparations

6.4.1. Bangladesh

We have conducted one trial/demonstration with only one of the mobile phone operators. However, we may conduct further demonstration by other operators in near future before the launch of 5G service.

6.4.2. China

In WRC-19, China proposed 5925-7125MHz, or parts thereof, for WRC-23 studies for IMT identification as additional mid-band to drive future 5G development together with other APT countries including Afghanistan, Cambodia, Lao, Mongolia, Myanmar, Nepal. In order to accommodate different views, it was finally agreed to study frequency-related matters for the terrestrial component of IMT identification 7025-7125 MHz in all 3 regions and 6425-7025 MHz in Region 1, which was included in WRC-23 AI 1.2.

In the future, additional spectrum within the middle range is needed to enable future China 5G deployment and meet the users' increasing requirement of anytime anywhere high data rate communications. The spectrum within the 5 925-7 125 MHz frequency band can partially meet future IMT spectrum needs. In WRC-19, China proposed 5925-7125MHz, or parts thereof, for WRC-23 studies for IMT identification as additional mid-band to drive future 5G development together with other APT countries, i.e. Afghanistan, Cambodia, Lao, Mongolia, Myanmar, Nepal and PNG[6]. China has started the studies on 6GHz and will contribute to ITU-R as appropriate.

IMT-2020 Candidate Technology Submission of China

China submitted the IMT-2020 candidate technology to ITU-R WP 5D on IMT-2020 terrestrial radio interfaces (Seoul, January 2018) and then proposed the RIT developed in accordance with the latest 3GPP Technical, including NR plus NB-IoT as a RIT at the 29th ITU-R WP 5D meeting (Japan, October 2018).

China submitted a contribution on final proposal for IMT-2020 candidate technology based on 3GPP technology (NR+NB-IoT) at the 32nd ITU-R WP 5D meeting (Brazil, July 2019).

6.4.3. India

National Digital Communication Policy (https://dot.gov.in/sites/default/files/EnglishPolicy-NDCP.pdf) is oriented towards next-generation-networks like 5G. Besides this, the 5G high level forum for 5G has ambitious plans for 5G preparations. Premier institutions in the country have planned indigenous 5G test beds in India. Besides this, the 5G high level forum for 5G has ambitious plans for 5G preparations.

[6] https://www.itu.int/md/R16-WRC19-C-0110/en

6.4.4. Indonesia

In recent Asian Games 2 XVIII (August 18th – September 2nd 2018, a Joint Cooperation between Ministry of Communications and Informatics (MCI) Indonesia and Ministry of Science and ICT (MSIT) Korea, produced a showcase and trial of IMT-2020 (5G) in the city of Jakarta, Indonesia.

The 5G showcase was operated and supported by TELKOMSEL (PT Telekomunikasi Selular).

6.4.5. [Iran]

[(Not provided)]

6.4.6. [Japan]

[(Not provided)]

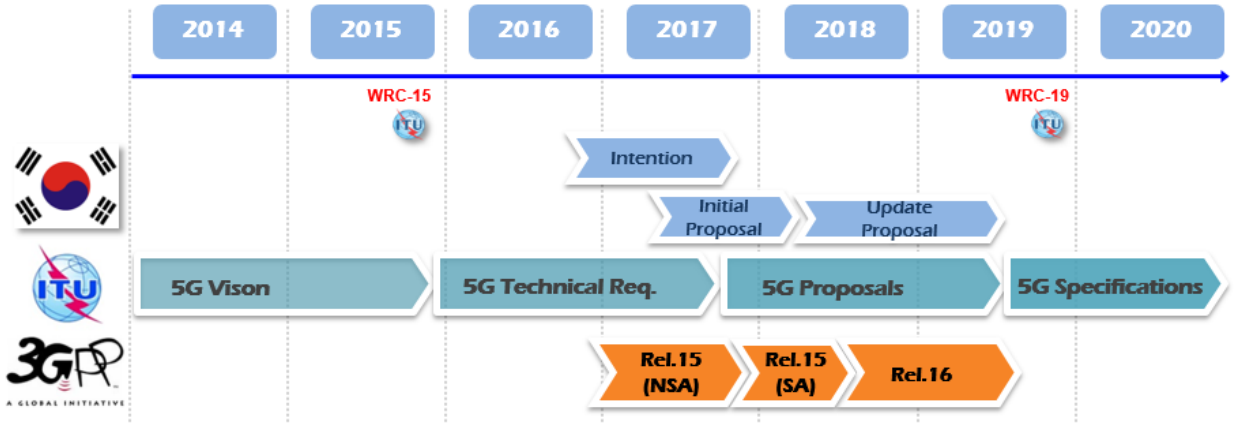
6.4.7. Korea

IMT-2020 Candidate Technology Submission of Korea

The Republic of Korea indicated the willingness to submit the IMT-2020 candidate technology to ITU-R WP 5D in Workshop on IMT-2020 terrestrial radio interfaces (Munich, 4 October 2017) and then proposed RIT (initial description) developed in accordance with the latest 3GPP New Radio Technical Specifications (Release 15) at the 29th ITU-R WP 5D meeting (Seoul, January 2018).

The Republic of Korea will submit a contribution updated proposal for IMT-2020 candidate technology based on 3GPP New Radio (NR) RIT in the future ITU-R WP 5D meeting.

Figure 6-4-1 IMT-2020 candidate technology submission plan of Korea and 5G 28GHz Frontier Workshop Activity



After WRC-15, among several administrations and mobile industry there were demands to discuss the 28 GHz band for 5G continuously outside of ITU-R/WRC. It was decided to organize the 28 GHz Frontier Workshop according to the agreements and efforts from administrations and mobile industries to share recent actions and developments related to the 28 GHz frequency band and to discuss possible steps to progress further towards opening a global mass market for 5G equipment and services in this 5G Frontier band.

The 1st 28 GHz Frontier Workshop was held in December 2016 at TTA and 3rd 28 GHz Frontier Workshop was held in January 2018 at Seoul in Korea. The 5th 28 GHz Frontier Workshop will be held in October 2018 at Fukuoka in Japan. All the relevant information of 28 GHz Frontier band can be seen at the 28 GHz Frontier Website*.

*URL: http://5g-28frontier.org/

6.4.8. [Myanmar]

(Not provided)

6.4.9. New Zealand

For more IMT-2020/5G information, please refer to https://www.rsm.govt.nz/projects-auctions/current-projects/preparing-for-5g-in-new-zealand

6.4.10. Singapore

More IMT-2020/5G information will be made available in this url:

https://www.imda.gov.sg/regulations-licensing-and-consultations/consultations/consultation%20papers/2017/public-consultation-on-5g-mobile-services-and-networks

6.4.11. Thailand

Table 6-4-1 Recent IMT-2020(5G) activities in Thailand

Date	Activity
20 Feb 2018	5G Workshop between Thailand and Japan.
24 May 2018	5G Preparation Informal Meeting between NBTC and Telecommunication Industry and Research Institution.
13 Jun 2018	Establish 5G Preparation Task Force – NBTC Telecommunication Industry and Research Institution. WG1 : Spectrum and Telecommunication Standard for 5G. WG2 : Regulatory Matters for 5G.
6 July 2018	First Official Meeting of 5G Preparation Task Force WG 1.

6.4.12. Vietnam

Vietnam is studying on allocating new frequency bands for 5G. Besides, some big mobile operators are researching on manufacturing 5G devices in Vietnam.

6.4.13. Australia

The Australian Government considers that 5G is more than an incremental change for mobile communications. Instead, it provides the underlying architecture that will enable the next wave of productivity and innovation across different sectors of the Australian economy. Efficient rollout of 5G and uptake of the services it supports has the potential to produce far-reaching economic and social benefits and support growth of Australia's digital economy. This will be supported by the rollout of the National Broadband Network (NBN) allowing greater capabilities for the seamless delivery of services across high speed mobile, fixed line and fixed wireless networks.

The Australian Government wants to create an environment that allows Australia's telecommunications industry to be at the forefront of seizing the benefits of 5G across the economy. The communications sector will lead the rollout of 5G networks in Australia. However, the Government can create the policy and regulatory environment to support a more efficient rollout, given its potential benefits to the economy.

The Australian Government's direction will be to support the timely rollout of 5G in Australia to enable the next wave of broad-based industry productivity, and support the growth of Australia's digital economy.

Further information is included in Australian Government's 5G—Enabling the future economy paper published by the Department of Communications and the Arts.

6.4.14. [Insert country's name]

7. Activities of Industry for IMT-2020(5G) in Asia-Pacific region

[Editor Note: The chapter will provide industry opinions (e.g. trails, spectrum plan and so on) from operators, vendors, chip manufacturers and handset manufacturer; as well as standard activities (e.g. 3GPP) on IMT-2020(5G) should be considered in Asia-Pacific region.]

7.1. Standardisation status and plans onwards

[Editor Note: The sub-chapter provides IMT-2020(5G) standardization activities in 3GPP and ITU-R WP5D. For examples, summary of IMT-2020 submission and evaluation process could be considered from activities of ITU-R WP5D. While both technical characteristics and summary of available bands and bandwidth in Rel-15, Rel-16 plans and general description of 3GPP self-evaluation could be provided from3GPP activities.]

7.1.1. ITU-R

For more than 30 years, ITU-R has been coordinating efforts of government, industry and private sector in the development of a global broadband multimedia international mobile telecommunication system, known as IMT. In early 2012, ITU-R embarked on a program to develop "IMT for 2020 and beyond", setting the stage for 5G research activities that are emerging around the world. Through the leading role of Working Party 5D, ITU-R has finalized its view of a timeline towards IMT-2020, which can be found in Figure 7-1-1. The detailed investigation of the key elements of 5G are already well underway, once again utilizing the highly successful partnership ITU-R has with the mobile broadband industry and the wide range of stakeholders in the 5G community. In September 2015, ITU-R has finalized its "Vision" of the 5G mobile broadband connected society. This view of the horizon for the future of mobile technology will be instrumental in setting the agenda for the World Radiocommunication Conference 2019, where deliberations on additional spectrum are taking place in support of the future growth of IMT. The latest member of the IMT family is IMT-2020 which calls for support for enhanced mobile broadband (eMBB) and for new 'use cases' that require massive machine-type communications (mMTC) and ultra-reliable and low latency communications (URLLC).

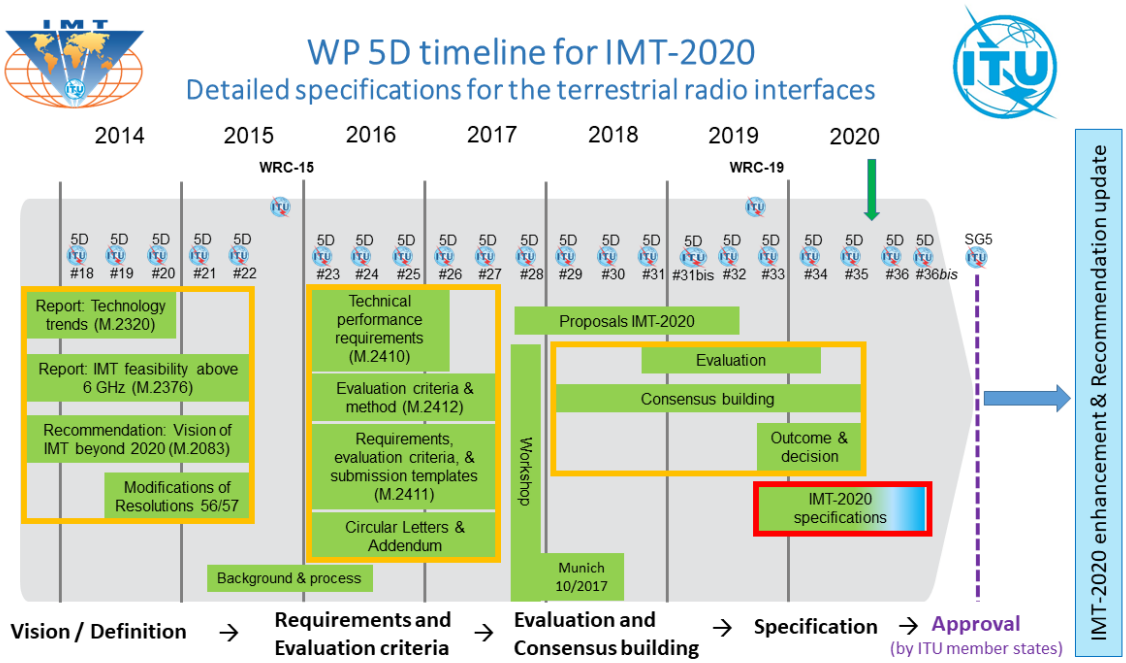


Figure 7-1 Timeline and Process for IMT-2020 in ITU-R[7]

On October 4, 2017 ITU-R WP5D organized in Munich, Germany, a Workshop on IMT-2020 terrestrial radio interfaces. The Workshop was organized with three main objectives, including explained the procedures for submission of proposals and subsequent acceptance, introduced possible proposals of radio interface technologies to be included in IMT-2020, and introduction of the Independent Evaluation Groups (IEG) which will verify the performance of candidates

Until ITU-R WP5D #31bis, three entities, including China, Korea and 3GPP, has submitted updated proposals to ITU-R; while other proponents, such as India and ETSI DECT, also indicated their willingness to submit proposals. Furthermore, the deadline of submitted IMT-2020 candidate proposal will be met at WP5D #32; meanwhile, all proponents should submit their final completion proposal. Finally, ITU-R WP5D will finalize IMT-2020 specification in the end of 2020 by processed of consensus building and evaluation by IEGs.

7.1.2. 3GPP

The 3rd Generation Partnership Project (3GPP) unites seven telecommunications standard development organizations (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC), known as “Organizational Partners” and provides their members with a stable environment to produce the Reports and Specifications that define 3GPP technologies.

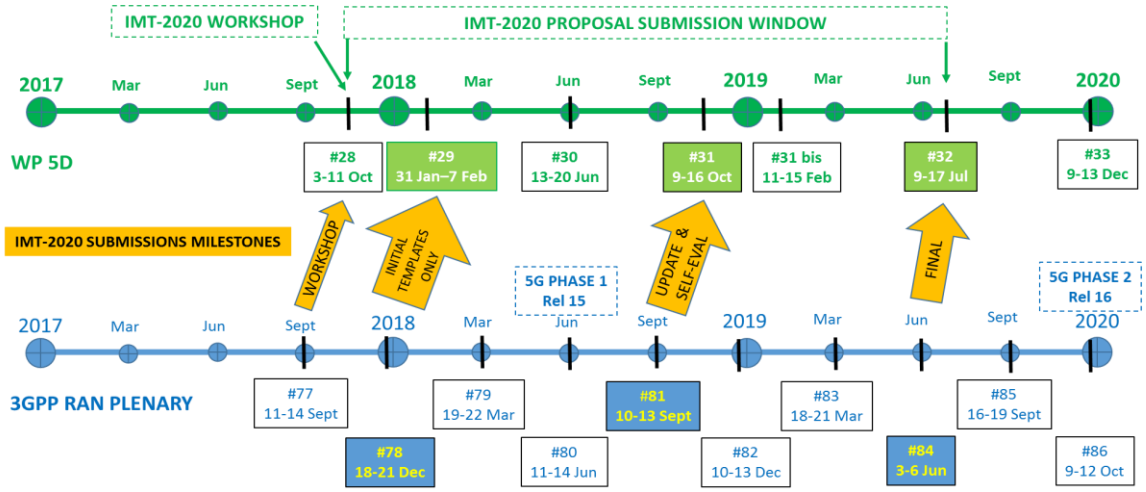


Figure 7-2 Timeplan on 3GPP self-evaluation

From 2015, 3GPP aims to the definition of a full system (Radio and Core Network), and 3GPP specifications is labeled “5G” from Release 15 onwards. Further 5G standards evolution is expected in 3GPP Release 16. The work programme for Release 16 was agreed in 2018 and covers various functions for use of 5G in vertical markets (such as 5G V2X, industrial IoT and URLL improvements, as well as use of 5G NR in unlicensed spectrum bands). It also covers generic improvements in areas such as positioning, use of MIMO and power consumption. The Release specification is targeted to be frozen in March 2020, with ASN.1 notation of protocol specs frozen in June 2020.

Release 17 planning work has already started. Approval of content/work areas is scheduled for December 2019; with a functional freeze date set at Q2 2021, with protocol specs finalised from Q3 2021.

[7] ITU-R WP5D website on “On the road to IMT-2020 and the globalization of 5G.” (https://www.itu.int/en/ITU-R/study-groups/rsg5/rwp5d/Pages/on-road-IMT-2020.aspx)

From Spectrum aspect:

The frequency ranges in which NR can operate according to this version of the specification are identified below table:

Table 7-1 3GPP NR frequency range

Frequency range designation	Corresponding frequency range
FR1	410 MHz – 7125 MHz
FR2	24250 MHz – 52600 MHz

The following NR bands have been specified as in 3GPP TS 38.101 V16.4.0

Table 5.2-1: NR operating bands in FR1

NR operating band	**Uplink (UL) *operating band* BS receive / UE transmit F_{UL_low} – F_{UL_high}**	**Downlink (DL) *operating band* BS transmit / UE receive F_{DL_low} – F_{DL_high}**	**Duplex Mode**
n1	1920 MHz – 1980 MHz	2110 MHz – 2170 MHz	FDD
n2	1850 MHz – 1910 MHz	1930 MHz – 1990 MHz	FDD
n3	1710 MHz – 1785 MHz	1805 MHz – 1880 MHz	FDD
n5	824 MHz – 849 MHz	869 MHz – 894 MHz	FDD
n7	2500 MHz – 2570 MHz	2620 MHz – 2690 MHz	FDD
n8	880 MHz – 915 MHz	925 MHz – 960 MHz	FDD
n12	699 MHz – 716 MHz	729 MHz – 746 MHz	FDD
n14	788 MHz – 798 MHz	758 MHz – 768 MHz	FDD
n18	815 MHz – 830 MHz	860 MHz – 875 MHz	FDD
n20	832 MHz – 862 MHz	791 MHz – 821 MHz	FDD
n25	1850 MHz – 1915 MHz	1930 MHz – 1995 MHz	FDD
n26	814 MHz – 849 MHz	859 MHz – 894 MHz	FDD
n28	703 MHz – 748 MHz	758 MHz – 803 MHz	FDD
n29	N/A	717 MHz – 728 MHz	SDL
n30[3]	2305 Mhz – 2315 MHz	2350 MHz – 2360 MHz	FDD
n34	2010 MHz – 2025 MHz	2010 MHz – 2025 MHz	TDD
n38[10]	2570 MHz – 2620 MHz	2570 MHz – 2620 MHz	TDD
n39	1880 MHz – 1920 MHz	1880 MHz – 1920 MHz	TDD
n40	2300 MHz – 2400 MHz	2300 MHz – 2400 MHz	TDD
n41	2496 MHz – 2690 MHz	2496 MHz – 2690 MHz	TDD
n47[11]	5855 MHz – 5925 MHz	5855 MHz – 5925 MHz	TDD[10]
n48	3550 MHz – 3700 MHz	3550 MHz – 3700 MHz	TDD
n50	1432 MHz – 1517 MHz	1432 MHz – 1517 MHz	TDD[1]
n51	1427 MHz – 1432 MHz	1427 MHz – 1432 MHz	TDD
n53	2483.5 MHz – 2495 MHz	2483.5 MHz – 2495 MHz	TDD
n65	1920 MHz – 2010 MHz	2110 MHz – 2200 MHz	FDD[4]
n66	1710 MHz – 1780 MHz	2110 MHz – 2200 MHz	FDD
n70	1695 MHz – 1710 MHz	1995 MHz – 2020 MHz	FDD
n71	663 MHz – 698 MHz	617 MHz – 652 MHz	FDD
n74	1427 MHz – 1470 MHz	1475 MHz – 1518 MHz	FDD
n75	N/A	1432 MHz – 1517 MHz	SDL
n76	N/A	1427 MHz – 1432 MHz	SDL
n77[12]	3300 MHz – 4200 MHz	3300 MHz – 4200 MHz	TDD
n78	3300 MHz – 3800 MHz	3300 MHz – 3800 MHz	TDD
n79	4400 MHz – 5000 MHz	4400 MHz – 5000 MHz	TDD
n80	1710 MHz – 1785 MHz	N/A	SUL
n81	880 MHz – 915 MHz	N/A	SUL
n82	832 MHz – 862 MHz	N/A	SUL
n83	703 MHz – 748 MHz	N/A	SUL
n84	1920 MHz – 1980 MHz	N/A	SUL
n86	1710 MHz – 1780 MHz	N/A	SUL
n89	824 MHz – 849 MHz	N/A	SUL
n90	2496 MHz – 2690 MHz	2496 MHz – 2690 MHz	TDD[5]
n91	832 MHz – 862 MHz	1427 MHz – 1432 MHz	FDD[9]
n92	832 MHz – 862 MHz	1432 MHz – 1517 MHz	FDD[9]

n93	880 MHz – 915 MHz	1427 MHz – 1432 MHz	FDD[9]
n94	880 MHz – 915 MHz	1432 MHz – 1517 MHz	FDD[9]
n95[8]	2010 MHz – 2025 MHz	N/A	SUL

NOTE 1: UE that complies with the NR Band n50 minimum requirements in this specification shall also comply with the NR Band n51 minimum requirements.
NOTE 2: UE that complies with the NR Band n75 minimum requirements in this specification shall also comply with the NR Band n76 minimum requirements.
NOTE 3: Uplink transmission is not allowed at this band for UE with external vehicle-mounted antennas.
NOTE 4: A UE that complies with the NR Band n65 minimum requirements in this specification shall also comply with the NR Band n1 minimum requirements.
NOTE 5: Unless otherwise stated, the applicability of requirements for Band n90 is in accordance with that for Band n41; a UE supporting Band n90 shall meet the requirements for Band n41. A UE supporting Band n90 shall also support band n41.
NOTE 6: A UE that supports NR Band n66 shall receive in the entire DL operating band.
NOTE 7: A UE that supports NR Band n66 and CA operation in any CA band shall also comply with the minimum requirements specified for the DL CA configurations CA_n66B and CA_n66(2A) in the current version of the specification.
NOTE 8: This band is applicable in China only.
NOTE 9: Variable duplex operation does not enable dynamic variable duplex configuration by the network, and is used such that DL and UL frequency ranges are supported independently in any valid frequency range for the band.
NOTE 10: When this band is used for V2X SL service, the band is exclusively used for NR V2X in particular regions.
NOTE 11: This band is unlicensed band used for V2X service. There is no expected network deployment in this band.
NOTE 12: In the USA this band is restricted to 3700 – 3980 MHz.

Table 5.2-1: NR operating bands in FR2

Operating Band	**Uplink (UL) operating band BS receive UE transmit**	**Downlink (DL) operating band BS transmit UE receive**	**Duplex Mode**
	F_{UL_low} – F_{UL_high}	F_{DL_low} – F_{DL_high}	
n257	26500 MHz – 29500 MHz	26500 MHz – 29500 MHz	TDD
n258	24250 MHz – 27500 MHz	24250 MHz – 27500 MHz	TDD
n259	39500 MHz – 43500 MHz	39500 MHz – 43500 MHz	TDD
n260	37000 MHz – 40000 MHz	37000 MHz – 40000 MHz	TDD
n261	27500 MHz – 28350 MHz	27500 MHz – 28350 MHz	TDD

In addition, 3GPP has started the standardization of new frequency bands of 6.425-7.025GHz, 7.025-7.125GHz and 10.0-10.5GHz, as in New SI proposal: Study on IMT parameters for 6.425-7.025GHz, 7.025-7.125GHz and 10.0-10.5GHz [8]

From 5G/IMT-2020 evaluation aspects:

Then, 3GPP self-evaluation was triggered from 2017; as well as a specific evaluation plan was approved in Figure 7-2-2. Based on the evaluated results presented, 3GPP concluded that there is a high level of confidence in the community that 3GPP's submission to IMT-2020 will meet the ITU requirements.

It is notable that, in 2018 October, 3GPP Workshop on 5G NR, hosted by the European Commission, has been a comprehensive briefing from the key experts in 3GPP for the benefit of the IEGs, whose job it will be to report to ITU on whether the 3GPP system for 5G meets the performance requirements for an IMT-2020 technology. The workshop creates a chance for all

[8] RP-200513, New SI proposal: Study on IMT parameters for 6.425-7.025GHz, 7.025-7.125GHz and 10.0-10.5GHz, RAN#87e, Electronic Meeting, March 16-19, 2020

of the Independent Evaluation Groups to contact the 3GPP leadership and experts directly at any time in the process, to build on the dialogue started in Brussels.

In conclusion, IMT-2020 standards and evaluation activities reflect perfectly 5G research project's pre-standards work and also the priorities for ITU-R WP5D and 3GPP work from Release 15 onwards. The alignment between IMT-2020, 5G R&D and the 3GPP work plan is an important achievement, which will help greatly at the World Radiocommunication Conference 2019, where deliberations on additional spectrum in support of IMT will take place.

7.2. Worldwide status of 5G trials

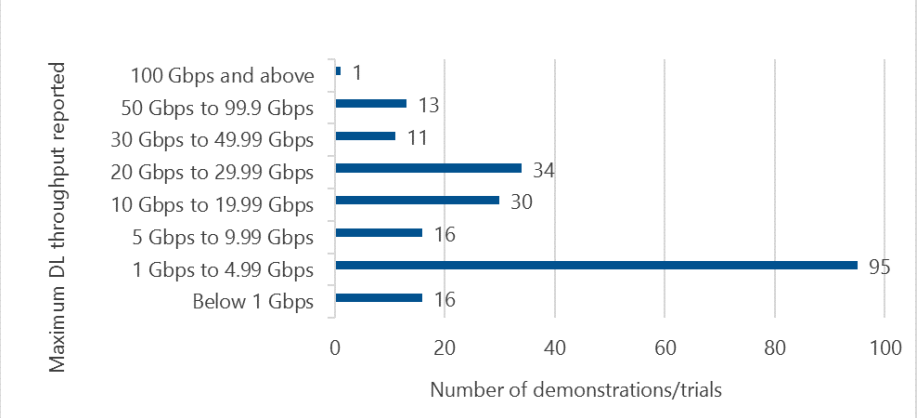
[Editor Note: The sub-chapter provides on summary of completed trials from operators and/or as vendors and some reflections/conclusion from all trails, which showing capabilities for 5G in various frequency bands – low to high and different bandwidths.]

Globally, many mobile operators have announced over 600 separate demonstrations, tests or trials that we have been able to identify [9].

Early tests and trials focused on: new radio (NR) interfaces operating in spectrum bands not previously used for mobile telecoms services; network slicing to support delivery of services tailored to specific types of customer or service; combinations of technologies such as massive MIMO, or complex beam-forming that are needed to achieve very high speeds; and backhaul, cloud- and edge-computing arrangements to support very low latencies. Tests being conducted by more advanced players then evolved to include: the launch of pilot 5G networks; delivery of calls end-to-end; and tests of 5G applications such as 5G connected drones, stadium applications, holograms and connected vehicles. Recent tests have been looking at issues such as: interoperability of SA 5G NR with core network systems; delivery of 4K ultra-HD CCTV and broadcast services; and use of 5G for robotic surgery. Trials have also focused on testing the spectrum bands likely to be used in any given country, with a lot of activity in C-band spectrum and mmWave.

Network throughput

One of the key metrics that has been reported is the peak downlink throughput of the various demonstrations, tests and trials. The demonstrations and trials are not really comparable, as they use varying amounts of spectrum and different types of equipment, in contrasting physical environments and for a range of applications. Nonetheless, it is interesting to note that many of them report that speeds well in excess of 1 Gigabit per second have been achieved. Trials for very high speeds are proofs of concept; it is not expected that commercial 5G networks will be able to deliver the very highest speeds indicated in the chart below for some time to come. Figure 7-3 summarises the results of the demonstrations and trials where information has been made available: 216 in total.



[9] GSA, Global Progress to 5G – Trials, Deployments and Lunches.

Figure 7-3 Network throughput (DL) reported in 5G demonstrations and trials (base: 216 demos/ trials)

Source: GSA, Global Progress to 5G – Trials, Deployments and Lunches

Speeds reported have most commonly fallen into the 1 to 4.99 Gbps range. Within this range, the average speed reported in the trials is 2.26 Gbps. If these speeds are eventually realised in commercial networks, they would represent substantial improvements on current LTE speeds. In some LTE networks, DL maximum throughput speeds have now reached 1.2–1.6 Gbps within small geographical pockets, but in networks into which LTE-Advanced technologies have been introduced, the average maximum DL throughput remains 399 Mbps (based on data for 259 networks). Data on the maximum DL throughput speeds available from early 5G services is not commonly provided by the operators yet. GSA will track this information as it is released to assess to real speeds of live 5G networks.

Latency

5G networks are expected to have substantially reduced latency compared with current mobile networks. This is another key metric for demonstrations and trials, as vendors and operators seek to achieve the 5G benchmarks. Once again, Figure 7-4 reported by demonstrations and trials are not comparable, as they involve very different configurations (air interface latency, 'end-to-end' latency, etc.) and even in field trials, do not take place under real network conditions but are illustrative of the fact that low latencies are being achieved. It is interesting to point out that most trials (for which data has been reported) have achieved latencies of between 1 and 1.99 ms.

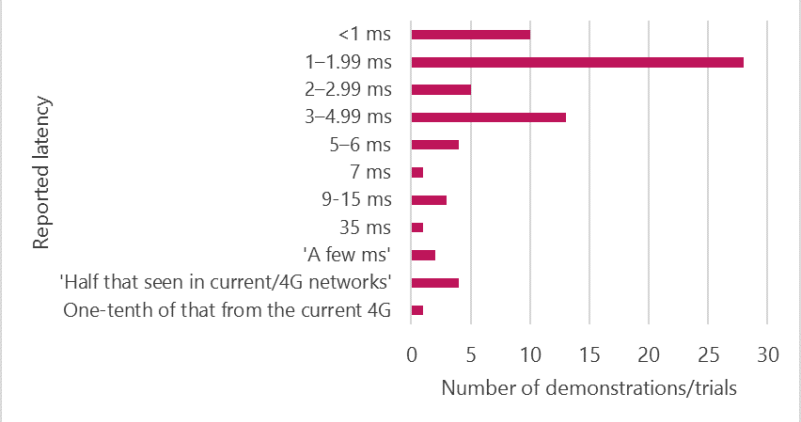


Figure 7-4 Latencies reported in 5G demonstrations and trials (base: 69 demos/trials)

Source: GSA, Global Progress to 5G – Trials, Deployments and Lunches

7.3. Early commercial 5G implementations and views from operators

[Editor Note: The sub-chapter provides what are plans of commercial networks started; and these 5G networks would like support what frequency bands and with what bandwidths. Contributions on operators' views onwards could come from operators or external organizations, e.g. GSMA.]

Editors Note: This section needs to be updated

Below table is the list of live commercial network.

Table 7-1 Commercial 5G of operators in Asia-Pacific region

Operator	Country	Launch Date	Freq. (MHz)
Telstra	Australia	28/05/2019	3500
KT	Korea, South	01/12/2018	3500/28000

LG Uplus	Korea, South	01/12/2018	3500/28000
SK Telecom	Korea, South	01/12/2018	3500/28000
Vodafone	Qatar	23/04/2019	3500
Sunrise	Switzerland	02/05/2019	700/3500
Swisscom	Switzerland	02/05/2019	3500
Etisalat	United Arab Emirates	30/05/2019	15000
EE (BT)	United Kingdom	30/05/2019	3500
Sprint (SoftBank)	United States of America	30/05/2019	2500
Verizon Wireless	United States of America	03/04/2019	28000
Verizon Wireless	United States of America	01/10/2018	28000

Sources: GSMA Intelligence in June 2019

Below table is the list of global licneses 5G band in different countries.

Table 7-2 Licenses granted in core 5G bands in various markets globally

County	**Band**					
	Low band	**Mid band**				**High band**
		1500 MHz	**2600 MHz**	**3.5/3.7 GHz**	**4.8 GHZ**	
Australia				3.5/3.7 GHz		
Austria				3.5/3.7 GHz		
Canada	600 MHz					
China			2.6 GHz	3.5 GHz	4.8 GHz	
Czech Republic				3.7 GHz		
Denmark	700 MHz					
Finland	700 MHz*			3.5/3.7 GHz		
France	700 MHz*					
Germany	700 MHz*			3.5/3.7 GHz		
Hong Kong						28 GHz
Iceland	700 MHz*			3.5/3.7 GHz		
Italy	700 MHz			3.7 GHz		26 GHz
Japan				3.7 GHz**	4.8 GHz***	28 GHz
Korea, South				3.5/3.7 GHz		28 GHz
Kuwait				3.5/3.7 GHz		
Latvia				3.5 GHz		
Norway	700 MHz					
Oman				3.5/3.7 GHz		
Qatar				3.7 GHz		
Saudi Arabia				3.5/3.7 GHz		
Spain				3.7 GHz		
Sweden	700 MHz					
Switzerland	700 MHz	1500 MHz		3.5 GHz		
United Arab Emirates				3.7 GHz		
United Kingdom				3.5 GHz		
USA	600 MHz					24GHz/28GHz

Sources: GSMA Intelligence in June 2019
**Current LTE deployments*
*** 3.6-4.1GHz*

****4.5-4.6GHz*

7.4. Plans onwards of 5G implementations

[Editor Note: The sub-chapter provides information on the foreseen implementations and product developments ongoing. Contributions could come from vendors and external organizations, e.g. GSA.]

We can expect the device ecosystem to continue to grow quickly and for more information about announced devices to become available as they reach the market. Based on vendors' previous statements and recent rates of device release, we might expect to see the number of commercial devices approaching the 200 mark by the end of Q3 2020, (although many device launch timetables were announced before COVID-19 had an impact on businesses worldwide, so there is potential for the number of new launches to be lower than this). Some external organizations, e.g. GSA, will be tracking and reporting regularly on these 5G device launch announcements.

7.5. The possibilities for smart society and industrial development

[Editor Note: The sub-chapter provides information on what is the possible impact for the APT countries societies and industrial development and relevant opportunities; and how can 5G assist in creating new opportunities with IoT connections.]

One of the obvious differences between IMT-2020 and previous generations of cellular networks lies in IMT-2020's strong focus on machine-type communication and the Internet of Things (IoT). The capabilities of IMT-2020 thus extend far beyond mobile broadband with ever increasing data rates. More specifically, IMT-2020 supports communication with unprecedented reliability and very low latencies, and also massive IoT connectivity. This paves the way for numerous new use cases and applications in many different vertical domains, including the automotive, healthcare, agriculture, energy and manufacturing sectors. In manufacturing in particular, IMT-2020 may have a disruptive impact as related building blocks, such as wireless connectivity, edge computing or network slicing, find their way into future smart factories.

In order to ensure the success of 5G for vertical industry aspect, there are several points to be further consideration. For example, it is necessary on globally or regionally harmonized spectrum, for both licensed and license-exempt allocations. Moreover, the ability to deploy and operate private 5G networks in well-defined areas (e.g. within a factory). The required spectrum could be acquired directly from the spectrum regulators through regional/ local licenses or – in some cases – obtained from a mobile network operator through subleasing in a specific geographic area. Besides, it is important to indoor and outdoor user equipment localization with accuracy in the certain of level. Additionally, the ability to monitor the current network state continuously in real-time even as a user, to take quick and automated action in the event of problems and to perform efficient root-cause analyzes. Meanwhile, E2E network slicing across heterogeneous technologies, countries and network operators, with facility for dynamic and user-friendly establishment and release of fine granular, application-specific network slices characterized by well-defined QoS and security properties. Furthermore, other factors also can further create more advantages for *industrial development by IMT-2020 technologies*, such as very low E2E latencies, high synchronicity between different devices, potentially ultra-high communication service availability, appropriate security concepts, highly flexible and versatile air interface capable and Support of multiple tenants using the same physical connectivity infrastructure in a factory.