No. IAFI/TRAI/5G Dated 10th January 2022

ITU-APT Foundation of India response to TRAI Consultation Paper on "Auction of spectrum in frequencies identified for International Mobile Telecommunications (IMT) / 5G", released on 30th Nov 2021

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1 Introduction to IAFI response

We, the ITU-APT Foundation of India (IAFI), are a registered non-profit and non-political industry association registered under the Cooperative Societies Act of India. IAFI has been recognized by the International Telecommunication Union (ITU), the UN Organisation for ICT issues, as an international/ regional Telecommunications organisation and has been granted the sector Membership of the ITU Development Bureau (ITU-D) and ITU Telecommunication Standardisation Bureau (ITU-T). IAFI has been working for the last 18 years to encourage the involvement of professionals, corporate, public/private sector industries, R&D organisations, academic institutions, and other agencies in the activities of the ITU(https://www.itu-apt.org/).

In September this year, the government approved a number of structural and process reforms in the Telecom sector. In addition, the Hon'ble Telecom and IT Minister, Shri Ashwini Vaishnaw at the opening of the recent India Mobile Congress 2021 said that the government was open to bringing more reforms in the sector, and invited recommendations from the industry.

5G is a national priority for the country and it is critical to promote a robust, scalable, and intelligent 5G infrastructure capable of handling massive traffic growth. 5G is also critical to support India's Industrial development and make India Atamnirbhar and can unleash new economic opportunities and societal benefits. It can help the country leapfrog the traditional barriers to development as well as advance the 'Digital India' vision. It is estimated that the cumulative economic impact of 5G on India can reach one trillion USD in the next 10 years. With the threat of the Omicron variant of COVID looming large, wireless technologies are once again at the forefront of keeping India connected.

The success of 5G in India depends on the timely release of globally harmonised spectrum in all bands both below 6 GHz and in mmWave bands above 24 GHz. In addition, It is also important to encourage the captive 5G networks for Industries and enterprises in line with other industrialized nations. The timely rollout of 5G services in India is dependent on availability of spectrum at reasonable cost to the operators, at costs which are substantially lower than the rest of the world. However, the reality is just the opposite. In the previous failed auctions of 700 MHz, the average reserve price fixed for the auction in 700 MHz in Feb 2021 was about $1.89 per MHz per pop (adjusted for PPP) which is 34 times higher than that set Internationally ($0.05) and is also higher than the mean winning bid price witnessed worldwide ($0.54). Similarly for the C band spectrum, TRAI had earlier (2018) recommended a reserve price of $0.05 per

MHz per POP which is many times more than the average price seen at recent spectrum auctions around the world.

It is therefore imperative to resolve such inconsistencies. For this we recommend:

- Reserve price for 700 MHz to be $ 0.05 per MHz per POP or ~INR 500 Crores for Nationwide spectrum per MHz.
- Reserve price for C band to be $0.01 per MHz per POP or ~INR 100 Crores for Nationwide spectrum per MHz
- Reserve price for mm wave band should be $0.008 per 10 MHz per pop which is 11.5 times lower than the C band reserve price or ~INR 80 Crores per 10 MHz for Nationwide Spectrum

Our responses below have been categorized in certain categories in order to ensure flow and consistency.

2. Issues related to Quantum of Spectrum and Band Plan

Q1: Whether spectrum bands in the frequency range 526-617 MHz, should be put to auction in the forthcoming auction? Kindly justify your response.

IAFI Response:

This band **526 to 612 MHz** should not be considered for the forthcoming auctions as further discussions are needed for this band in India and in the ITU and APT. Therefore, this band should be parked for the time being.
Additional spectrum for 5G below 1 GHz is also being discussed under Agenda Item 1.5 of WRC-23 for ITU Region 1 (EMEA Region) These frequencies can be used to provide increased capacity and performance in rural areas which higher frequencies cannot cover cost-effectively. In-building coverage will also be enhanced. Increased sub-1 GHz IMT spectrum can give users in rural areas comparable IMT access to those in urban areas and help lower broadband prices, making access to communications services more inclusive and lowering the digital divide. We should therefore wait for the outcome of this agenda item.

Further as mentioned in our response to question 4 below, we believe that the band **612-703 MHz** should be put to auction in the forthcoming auctions. Many countries including USA has already auctioned this band and the technology for this band is also available. In India, the band is lying vacant and not auctioning this band amounts to wasting of scarce resources.

While planning for this band, it is also relevant to mention that the parts of frequency band 470--698 MHz have been identified for IMT applications in India in the NFAP-18 under IND-16 as below

> "Part of the band 470-698 MHz would be made available for IMT once the current and future usage of the band 470-698 MHz by the broadcasting service is finalized"

Further, under the ITU Radio Regulations, which is a global treaty signed by India and all other countries, the band 470-698 MHz is allocated to the Mobile Service and is thus available for 4G/5G services.

Q2: If your answer to Q1 above is in affirmative, which band plans and duplexing configuration should be adopted in India? Kindly justify your response.

IAFI Response:

Please see answer to Q. 11 below

Q3: In case your answer to Q1 is in negative, what should be the timelines for adoption of these bands for IMT? Suggestions to make these bands ready for adoption for IMT may also be made along with proper justification.

IAFI Response:

It is recommended that we should work with the APT for the development of a regional band plan for the band 526-612 MHz, keeping in view the regional band plan for 612-703 MHz.

Q4: Do you agree that 600 MHz spectrum band should be put to auction in the forthcoming auction? If yes, which band plan and duplexing configuration should be adopted in India? Kindly justify your response.

IAFI Response:

Yes, we firmly believe and agree that the entire 600 MHz band (**612-703 MHz**) should be put to auction in the forthcoming auctions. This band can be used to provide increased capacity and performance in rural areas which higher frequencies cannot cover cost-effectively. In-building coverage will also be enhanced. Increased sub-1 GHz IMT spectrum can give users in rural areas comparable IMT access to those in urban areas and help lower broadband prices, making access to communications services more inclusive and lowering the digital divide.

Many countries including USA have already auctioned this band and the technology for this band is also available. In India, the band is lying vacant and not auctioning this band amounts to wasting of scarce resources.
The frequency band 612-703 MHz has been allocated to Mobile Service under the ITU Radio Regulations in Region 3 which covers India and thus available for 4G/5G services.

In addition, for better global harmonization, it is also important to have this band identified for IMT through a Footnote in Section 5 of the Radio Regulations at WRC-23. For this it is recommended that Indian administration should submit a suitable proposal to the WRC-23.

Q5: For 3300-3670 MHz frequency range, which band plan should be adopted in India? Kindly justify your response.

IAFI Response:

For the 3 300 to 3 670 MHz frequency range, 3GPP band n78 band plan is proposed to be utilized. If in future, more spectrum is made available above 3670 MHz for 5G in India, then the operators may decide to opt for band n77 which also has an existing ecosystem.

Q6: Do you agree that TDD based configuration should be adopted for 24.25 to 28.5 GHz frequency range? Kindly justify your response.

IAFI Response:

Yes, TDD is the right configuration as the 3GPP technology for this band is based on TDD configuration only.

However, the band **27.5-28.5 GHz** is allocated to Fixed, Mobile and Fixed Satellite Service (FSS) services in the Radio Regulations and our views on this band are given in response to Question 8 below. The configuration and interference scenarios in this band will need to consider the coexistence issues with Ka band satellite services. These issues are covered in attachment 1. **(See enclosed Attachment 1)**

Further, the GSA (Global mobile Suppliers Association) conducted a coexistence study exclusively for India for mmWave including 28 GHz band in 2020 and concluded that 5G services do not cause any interference to FSS systems (E-to-s gateways). The GSA report is shared in attachment 2. (**See enclosed Attachment 2)**

Q7: In case your response to Q6 is in affirmative, considering that there is an overlap of frequencies in the band plans n257 and n258, how should the band plan(s) along with its frequency range be adopted? Kindly justify your response.

IAFI Response:

For the purpose of deployment flexibility, the band plan choice between n257 and n258 may be left to the operators. If the total spectrum assigned to one operator is below 1000 MHz, then there will be no issue of overlap of frequency ranges between n257 and n258.

Q8: Whether entire available spectrum referred by DoT in each band should be put to auction in the forthcoming auction? Kindly justify your response.

IAFI Response:

i. The band 526-612 is not yet fully developed for IMT services and therefore should not be put to auction in this phase.

ii. Accordingly, all the available spectrum in each of the following bands should be put to auction in the forthcoming auctions:
   a. 600 (612-703)/700/ 800/ 900 MHz
   b. 1800/ 2100/ 2300/ 2500 MHz
   c. 3300-3670 MHz
   d. 24.25 - 28.5 GHz (see Note 1 below)

   Note 1: There are different views amongst IAFI members concerning auction of 27.5 -28.5 GHz for 5G as summarized below:

Views of 5G stakeholders	**Views of satellite stakeholders**
1. 5G-HLF committee constituted by the DoT had identified 24.25 to 29.5 GHz for 5G in India in its report "Making India 5G Ready" dt. 28 Aug 2018[1]. 2. Many countries[2] have already rolled out 5G services in the full 28GHz band 27.5- 29.5 GHz, also known globally as the 5G Frontier[3] band. 3. DoT had assigned the band 24.25 – 28.5 GHz for 5G Technology and Spectrum trials in India as indicated	1. The band 27.5 -28.5 GHz is not identified by the ITU for IMT services in the Radio Regulations and, therefore, should not be auctioned for 5G services. 2. Globally, most countries have opted to deploy 5G in the 26GHz band (24.25-27.5GHz) shared among several MNOs, which is more than sufficient spectrum to provide high-speed data services and preserve 28GHz for FSS. 3. The use of the 27.5-28.5 GHz band is critical for modern satellite systems.

[1] https://dot.gov.in/whatsnew/making-india-5g-ready-report-5g-high-level-forum
[2] https://gsacom.com/paper/mmwave-summary-december-2021-spectrum-update/
[3] http://5g-28frontier.org/

in its official press release[4] dt. 04 May 2021. 4. The band 24.25-28.5 GHz is therefore already approved by the Government for 5G services, and the full band 24.25-28.5 GHz should be put to auction.	Identifying this band for IMT would significantly impact the business viability of satellite operators and the availability of satellite capacity to bridge the digital divide in India. 4. Satellite Operators have made multi-billion-dollar investments in satellite systems for coverage over India and to support the development of national infrastructure, including extensive backhauling for 5G and domestic gateways as FDI. Limiting satellite capacity by restricting access to part of the Ka-band will damage the synergy envisaged between satellite and terrestrial services, both essential and complementary.

Q6: Do you agree that TDD based configuration should be adopted for 24.25 to 28.5 GHz frequency range? Kindly justify your response.
Yes, TDD is the right configuration as the 3GPP technology for this band is based on TDD configuration only.

However, the band 27.5-28.5 GHz is allocated to Fixed, Mobile and FSS services in the Radio Regulations and our views on this band are given in response to Question 8 below. The configuration and interference scenarios in this band will need to consider the coexistence issues with KA band satellite services. These issues are covered in attachment 1.
Attachment 1 - enclosed
GSA (Global mobile Suppliers Association) conducted a coexistence study exclusively for India for mmWave including 28 GHz band in 2020 and concluded that 5G services do not cause any interference to FSS systems (E-to-s gateways). The GSA report is shared in attachment 2.
Attachment 2 – enclosed

3 Issues related to Block Size

Q9: Since upon closure of commercial CDMA services in the country, 800 MHz band is being used for provision of LTE services,
a. Whether provision for guard band in 800 MHz band needs to be revisited?

[4] https://pib.gov.in/PressReleasePage.aspx?PRID=1715927

b. Whether there is a need to change the block size for 800 MHz band? If yes, what should be the block size for 800 MHz band and the minimum number of blocks for bidding for existing and new entrants? Kindly justify your response.

IAFI Response:

Yes. Harmonization of 800 MHz band (see figure below) is desirable given the status of commercial CDMA services in the country and the interest of operators in deploying 4G services in this band. Consistent with the other bands in sub-GHz, 5 MHz block size would enable the use of this band for both 4G and 5G in future.

Block 1 (824 – 829 MHz)	Block 2 (829-834 MHz)	Block 3 (834 – 839 MHz)	Block 3 (839 – 844 MHz)

Q.10 Do you agree that in the upcoming auction, block sizes and minimum quantity for bidding in 700 MHz, 900 MHz, 1800 MHz, 2100 MHz, 2300 MHz and 2500 MHz bands, be kept same as in the last auction? If not, what should be the band-wise block sizes and minimum quantity for bidding? Kindly justify your response.

IAFI Response: No comments

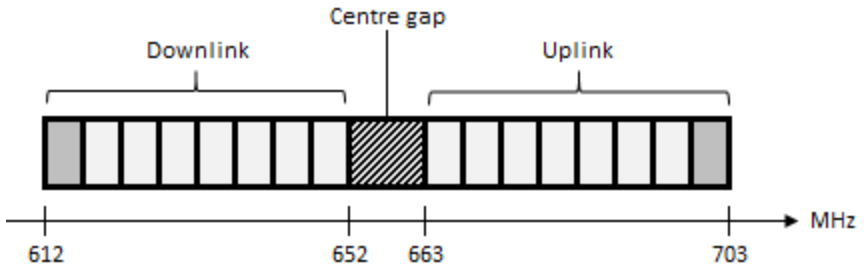
Q 11: In case it is decided to put to auction spectrum in 526-698 MHz bands, what should be the optimal block size and minimum quantity for bidding? Kindly justify your response.

IAFI Response:

In ITU-R Region 3, the wireless group of APT, APT Wireless Group (AWG) has been studying the option of extending the 600 MHz band to utilize additional 5 MHz. The AWG-27 tasked 3GPP to study two new band plan options (B1 and B2) for APT which add 5 MHz to the 35 MHz USA band to create a 40 MHz band.

In ITU-R Region 3, the wireless group of APT, APT Wireless Group (AWG) has been studying the option of extending the 600 MHz band to utilize additional 5 MHz. The AWG-27 tasked 3GPP to study two new band plan options (B1 and B2) for APT which add 5 MHz to the 35 MHz USA band to create a 40 MHz band.

In response to this, 3GPP has completed the study on extended 600 MHz Band in its TR38.860 “Study on Extended 600 MHz NR band” (Release 17). Option B1 as per TR 38.860 is shown in Figure 6.4.1.1-1: Option B1 of the report.

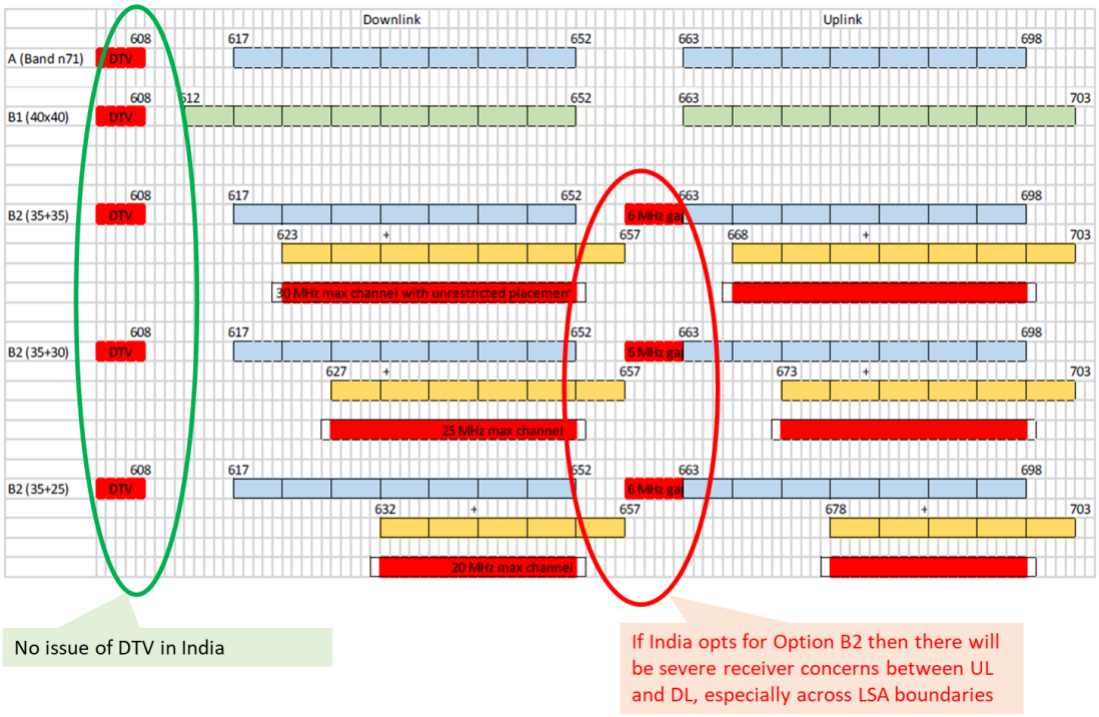


For Option B1, 3GPP TR 38.860 also concludes that

"Option B1 requires that the adjacent broadcast spectrum is repurposed below 612 MHz. The main advantage of this option is that it could be supported with a single 40 MHz filter (channel bandwidths up to 40 MHz could be supported with a single duplex filter, the bill of materials for the UE is reduced, software complexity is reduced, inter-band CA and EN-DC configurations are more easily accommodated) while still maintaining Band n71 filter requirements).Preliminary data show that compliance with the n71 filter requirements including CH36 blocking requirement would be feasible."

Further, it must also be noted that AWG#28 also agreed on the following: "AWG agreed that at least one additional band should be considered for APT 600MHz."

- For the specific case of India, we know the following: No constraints exist from Broadcast usage of the spectrum in the immediate neighborhood of 612 MHz as noted in the 3GPP TR 38.860.
- There is strong interest from Region 3 in the APT discussions on extending 600 MHz band to utilize full 40 + 40 MHz
- For compatibility between n71 and Option B1, 3GPP Specifications have support for handling overlapping frequency bands with different frequency options using Multi-Frequency Band Indicator (MFBI). This has been utilized in the past for LTE and the same is supported for NR as well (e.g., 36.307 and 38.307) Annex A : Frequency arrangement for overlapping operating bands



Given these developments in 3GPP, APT and the specific situation in India that favors utilization of the full 40+40 MHz, Option B1 should be preferred. IAFI is driving the harmonization and adoption of this band plan in APT Region. An announcement of an auction by India will further boost these efforts and lead to early adoption of this band plan by 3GPP

Q.12: What should be optimal block size and minimum quantity for bidding in 3300-3670 MHz band? Kindly justify your response.

IAFI Response:

3GPP 38.101-1 shows the supported channel bandwidths. The block size should be chosen accordingly so that spectrum is optimally utilized as per the use-case.
WRC-23 Agenda Items 1.2 and 1.3 are an opportunity to achieve greater harmonization of the 3.5 GHz range which will be make 5G services more affordable for everyone. Frequencies in the 3.5 GHz range are already used as the basis for commercial 5G networks globally. This spectrum is at a balancing point between coverage and capacity that has provided the perfect environment for much of the earliest 5G connectivity. A channel size of 80-100 MHz per operator lowers network density and reduces the cost of 5G while producing the highest throughput.

3GPP TS 38.101-1 Table 5.3.2-1: Maximum transmission bandwidth configuration NRB (FR1)

SCS (kHz)	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	70 MHz	80 MHz	90 MHz	100 MHz
	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}	N_{RB}
15	25	52	79	106	133	160	216	270	N/A	N/A	N/A	N/A	N/A
30	11	24	38	51	65	78	106	133	162	189	217	245	273
60	N/A	11	18	24	31	38	51	65	79	93	107	121	135

3GPP TS 38.101-1 Table 5.3.5-1 Channel bandwidths for each NR band (FR1) (extract from the table)

NR band / SCS / UE Channel bandwidth														
NR Band	SCS kHz	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	30 MHz	40 MHz	50 MHz	60 MHz	70 MHz	80 MHz	90 MHz	100 MHz
n77	15		Yes	Yes	Yes	Yes	Yes	Yes	Yes					
	30		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes[4]	Yes	Yes[4]	Yes
	60		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes[4]	Yes	Yes[4]	Yes
n78	15		Yes	Yes	Yes	Yes	Yes	Yes	Yes					
	30		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes[4]	Yes	Yes	Yes
	60		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes[4]	Yes	Yes	Yes
NOTE 4: This UE channel bandwidth is optional in this release of the specification.														

Accordingly Block Size (10/20/40 MHz of TDD spectrum) for bidding may be decided.

Q13: What should be optimal block size and minimum quantity for bidding in 24.25-28.5 GHz? Kindly justify your response.

IAFI Response:

Given the wireless propagation characteristics, the mmWave band would be most useful for high capacity in a relatively smaller coverage area. At-least 800 MHz of spectrum per operator would be desirable for delivering high quality experience to the end customers.
3GPP 38.101=2 shows the supported channel bandwidths. The block size should be chosen accordingly so that spectrum is optimally utilized as per the use-case.

3GPP TS 38.101-2 Table 5.3.2-1: Maximum transmission bandwidth configuration NRB (FR2)

SCS (kHz)	50 MHz	100 MHz	200 MHz	400 MHz
	N_{RB}	N_{RB}	N_{RB}	N_{RB}
60	66	132	264	N.A
120	32	66	132	264

3GPP TS 38.101-2 Table 5.3.5-1: Channel bandwidths for each NR band (FR2)

Operating band / SCS / UE channel bandwidth					
Operating band	SCS kHz	50 MHz	100 MHz	200 MHz	400[1] MHz
n257	60	Yes	Yes	Yes	
	120	Yes	Yes	Yes	Yes
n258	60	Yes	Yes	Yes	
	120	Yes	Yes	Yes	Yes
n259	60	Yes	Yes	Yes	
	120	Yes	Yes	Yes	Yes
n260	60	Yes	Yes	Yes	
	120	Yes	Yes	Yes	Yes
n261	60	Yes	Yes	Yes	
	120	Yes	Yes	Yes	Yes
NOTE 1: This UE channel bandwidth is optional in this release of the specification.					

Accordingly, Block Size (50/100/200/400 MHz of TDD spectrum) for bidding may be decided.

4 Issues related to Eligibility Conditions

IAFI Response:

Q14-Q15 -NO IAFI RESPONSE

5. Issues related to Interference mitigation in TDD bands

Q16: Is there a need to prescribe any measure to mitigate possible interference issues in 3300-3670 MHz and 24.25-28.5 GHz TDD bands or it should be left to the TSPs to manage the interference by mutual coordination and provisioning of guard bands? Kindly provide justification to your response.

IAFI Response:

Interference mitigation techniques would be required for both the bands 3300 – 3670 and 24.25 – 28.5 GHz. TRAI should provide an enabling provision that allows the TSPs to manage the interference by mutual coordination without prescribing any guard band or other specific measures for the same.
The issue of interference mitigation is an important requirement for 5G. This was even so in the case of 4G. There are multiple techniques for interference mitigation in IMT-2020 (5G). Details of these are available in the following references:

- ITU Report ITU-R M.[IMT.2020.TDD.SYNCHRONIZATION] - Synchronization of IMT-2020 TDD Networks (https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R19-SG05-C-0050)
- ECC report (https://docdb.cept.org/download/1381) on interference mitigation methods.

For interreference issues between FSS and 5G in 27.5-28.5 GHz, please see Attachment 1

Q17: In case your response to the above question is in affirmative,
a. whether there is a need to prescribe provisions such as clock synchronization and frame structure to mitigate interference issues, as prescribed for existing TDD bands, for entire frequency holding or adjacent frequencies of different TSPs? If yes, what should be the frame structure? Kindly justify your response.
b. Any other measures to mitigate interference related issues may be made along with detailed justification.

IAFI Response:

Please refer to details in the two documents mentioned below:

- ITU Report ITU-R M.[IMT.2020.TDD.SYNCHRONIZATION] - Synchronization of IMT-2020 TDD Networks (https://www.itu.int/md/meetingdoc.asp?lang=en&parent=R19-SG05-C-0050)
- ECC reports (https://docdb.cept.org/download/3541 and https://docdb.cept.org/download/1381) on interference mitigation methods.

6 Issues related to Roll-out Obligations

IAFI Response:

Q18 to Q22 - NO IAFI Response

7 Issues related to Spectrum Cap

IAFI Response:

Q23 to Q28 - NO IAFI Response

8 Issues related to Surrender of Spectrum

IAFI Response:

Q29 to Q33 - NO IAFI Response

9 Issues related to Valuation and Reserve price of Spectrum

Q.34 Which factors are relevant in the spectrum valuation exercise and in what manner should these factors be reflected in the valuation of spectrum? Please give your inputs with detailed reasoning.

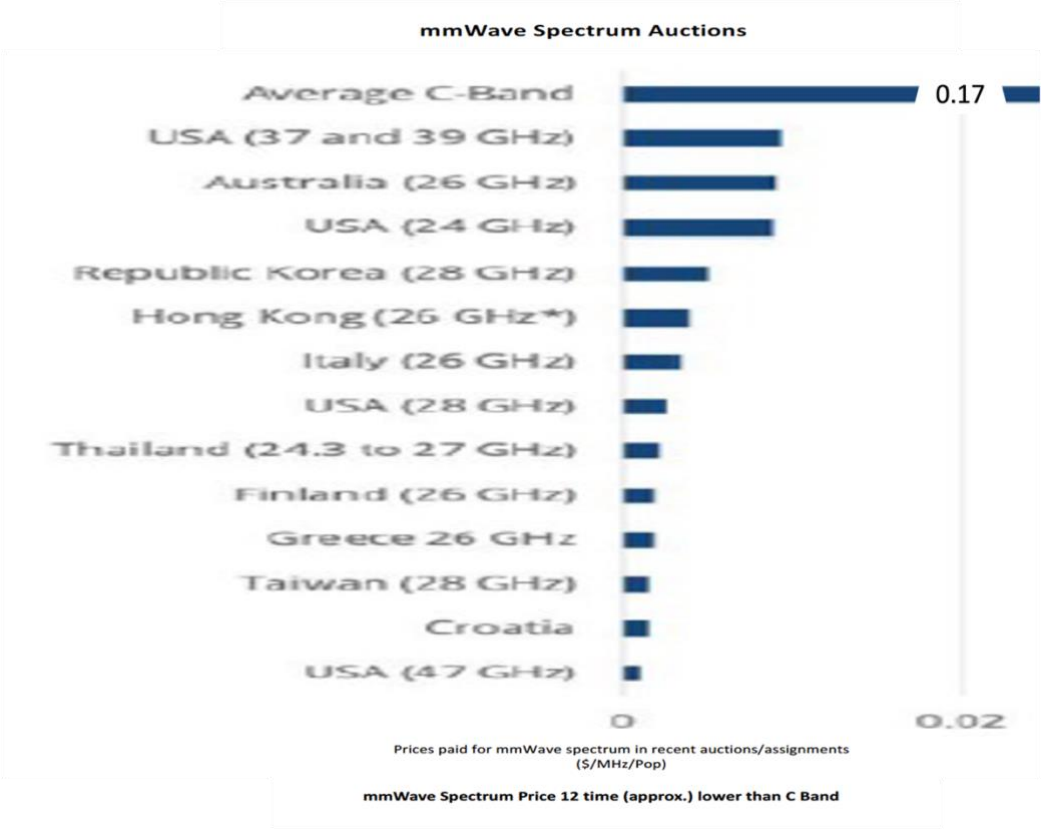
IAFI Response:

For the forthcoming spectrum auctions, the most important and probably the only factor to be considered is a drastic reduction in the reserve price for each band and delinking it from the spectrum valuation.
It is critical to understand that the auction prices do not reflect the true value of spectrum. The auction prices reflect the value to preserve market competitiveness and can be leveraged by incumbents to create barriers to entry. Further the auction prices have no correlation with the revenue potential of a circle but are strongly linked with operator's needs to protect investments. Therefore, it is important to delink the reserve price from spectrum valuation. In fact, there is no need to unnecessarily spend time and resources on estimating the value of spectrum, as the auctions will determine the correct valuation of the spectrum. Artificially calculating the valuation, based on historical data or other parameters and linking the reserve price to such valuation, will lead to skewed auction results.

Attachment 3 provides a detailed analysis of previous spectrum auctions, from which it is quite clear that the auction price is not related to spectrum valuations done by the TRAI during previous auctions.
This is well illustrated by the following examples:

- the average reserve price fixed for the last Auction in 700 MHz in Feb 2021 was about $1.89[5] per MHz per pop (adjusted for PPP) which is 34 times higher than that set Internationally ($0.05) and is also higher than the mean winning bid price witnessed worldwide ($0.54).
- Similarly, the spectrum Valuation for spectrum auctions for recent global Mid-band auctions are much higher as compared to India C band reserve price recommended by the TRAI in 2018, which was the highest even compared to the final auction prices both on ARPU basis and PPP basis– by about 5 times when normalized on ARPU[6] basis and about 14[7] times on PPP basis.
- **According to our calculations, the Reserve price for mm wave band in most recent spectrum auctions is 11.5 times lower than the C band reserve price . Chart below shows the average mm wave auction prices from various global auctions**

[5] See Presentation by Dr. V. Sridhar Professor, IIIT Bangalore, page 10 https://itu-apt.org/system/static/uploads/pdf/Presentation%20by%20Prof.%20V%20Sridhar.pptx
[6] https://itu-apt.org/system/static/uploads/pdf/2021-12-16-Spectrum-Auction-Presentation.pdf see presentation by Parag Kar
[7] See Presentation by Dr. V. Sridhar Professor, IIIT Bangalore, page 10 https://itu-apt.org/system/static/uploads/pdf/Presentation%20by%20Prof.%20V%20Sridhar.pptx



Attachment 3 contains a detailed analysis of the various spectrum auctions in India and some comparisons with some recent auctions in other countries

Based on the above considerations, we recommend that the:

- **Reserve price for 700 MHz to be $ 0.05 per MHz per POP**
- **Reserve price for C band should be $0.01 per MHz per POP**
- **Reserve price for mm wave band should be $0.008 per 10 MHz per pop which is 11.5 times lower than the C band reserve price (based on the following calculations)**
    - Estimate the usable bandwidth of 26 GHz Band (24500-27500 MHz) : 3000 MHz
    - Estimate the usable bandwidth of 3500 MHz Band : 370 MHz
    - Calculate the Bandwidth Ratio : 370/3000
        - Higher frequency band becomes more capacity driven
        - Propagation losses dropped
    - Calculate LSA wise reserve price of 26-28 GHz band using Bandwidth Ratio and the reserve Price of 3500 MHz
    - Reserve Price of 26-28 GHz = RP3500 x Bandwidth Ratio= RP3500 x (370/4250)= RP3500 x 0.087 (i.e. 11.5 times lower than RP3500)

Q.35 In what manner, should the extended tenure of spectrum allotment from the existing 20 years to 30 years be accounted for in the spectrum valuation exercise? Please support your response with detailed rationale/ inputs.

IAFI Response:

The spectrum Valuation and thus the reserve prices for spectrum auctions in India are already much higher than the prevailing global levels. See the following table for recent Mid-band auctions as compared to India C band reserve price recommended by the TRAI in 2018. India's reserve price recommended in 2018 was the highest – about 5 times when normalized on ARPU basis and about 14[8] times higher on PPP basis.

S.No.	Country	Auction Price $/MHz/POP	ARPU	Auction Price $/MHz/POP/ARPU
1	India (reserve Price)	0.05	1.2	0.0417
2	Italy	0.42	13.52	0.0311
3	US	0.875	39.64	0.0221
4	Germany	0.19	13.32	0.0143
5	Hong Kong	0.13	15.42	0.0084
6	Australia	0.21	25.59	0.0082
7	Singapore	0.08	17.65	0.0045
8	UK	0.09	19.87	0.0045
9	Sweden	0.08	22.89	0.0035
10	Greece	0.04	13.65	0.0029
11	Ireland	0.07	28.87	0.0024
12	Slovakai	0.01	11.72	0.0009
13	Latvia	0.01	11.93	0.0008
14	Norway	0.01	32.98	0.0003
	Average (Excluding India)	0.17	20.54	0.008

[8] See Presentation by Dr. V. Sridhar Professor, IIIT Bangalore
https://itu-apt.org/system/static/uploads/pdf/Presentation%20by%20Prof.%20V%20Sridhar.pptx

As such, extended tenure from 20-30 years should have no impact on the reserve price and the spectrum valuation exercise. In any case, the auction will determine the real sale price for 30 years. As such it makes no sense to consider any increase in the reserve price because of this reason. Market forces will determine the correct spectrum valuations based solely on demand and supply constraints.

Q.36 What could be the likely impact of the following auction related telecom reforms announced by the Government in September 2021 on the valuation of various spectrum bands?

(a) Rationalization of Bank Guarantees to securitize deferred annual spectrum payment instalments in future auctions
(b) No spectrum usage charges (SUC) for spectrum acquired in future auctions

IAFI Response:

In September this year, the government carried out a series of reforms for the sectors. These include:

1. Rationalization of Adjusted Gross Revenue: Non-telecom revenue will be excluded on prospective basis from the definition of AGR.
2. Bank Guarantees (BGs) rationalized: Huge reduction in BG requirements (80%) against License Fee (LF) and other similar Levies. No requirements for multiple BGs in different Licenced Service Areas (LSAs) regions in the country. Instead, One BG will be enough.
3. Interest rates rationalized/ Penalties removed: From 1st October, 2021, Delayed payments of License Fee (LF)/Spectrum Usage Charge (SUC) will attract interest rate of SBI's MCLR plus 2% instead of MCLR plus 4%; interest compounded annually instead of monthly; penalty and interest on penalty removed.
4. For Auctions held henceforth, no BGs will be required to secure instalment payments. Industry has matured and the past practice of BG is no longer required.
5. Spectrum Tenure: In future Auctions, tenure of spectrum increased from 20 to 30 years.
6. Surrender of spectrum will be permitted after 10 years for spectrum acquired in the future auctions.
7. No Spectrum Usage Charge (SUC) for spectrum acquired in future spectrum auctions.
8. Spectrum sharing encouraged- additional SUC of 0.5% for spectrum sharing removed.

9. To encourage investment, 100% Foreign Direct Investment (FDI) under automatic route permitted in Telecom Sector. All safeguards will apply.
10. Auction calendar fixed - Spectrum auctions to be normally held in the last quarter of every financial year.
11. Ease of doing business promoted - cumbersome requirement of licenses under 1953 Customs Notification for wireless equipment removed. Replaced with self-declaration.
12. Know Your Customers (KYC) reforms: Self-KYC (App based) permitted. E-KYC rate revised to only One Rupee. Shifting from Prepaid to Post-paid and vice-versa will not require fresh KYC.
13. Paper Customer Acquisition Forms (CAF) will be replaced by digital storage of data. Nearly 300-400 crore paper CAFs lying in various warehouses of TSPs will not be required. Warehouse audit of CAF will not be required.
14. SACFA clearance for telecom towers eased. DOT will accept data on a portal based on self-declaration basis. Portals of other Agencies (such as Civil Aviation) will be linked with DOT Portal.
15. Moratorium/Deferment of upto four years in annual payments of dues arising out of the AGR judgement, with however, by protecting the Net Present Value (NPV) of the due amounts being protected.
16. Moratorium/Deferment on due payments of spectrum purchased in past auctions (excluding the auction of 2021) for up to four years with NPV protected at the interest rate stipulated in the respective auctions.
17. Option to the TSPs to pay the interest amount arising due to the said deferment of payment by way of equity.
18. At the option of the Government, to convert the due amount pertaining to the said deferred payment by way of equity at the end of the Moratorium/Deferment period, guidelines for which will be finalized by the Ministry of Finance.

The clear indication from these reforms is that the government wants to support the growth of telecom sector, which in turn will help grow the economy. Therefore, the TRAI should recommend the following reserve prices for various bands:

- Reserve price for 700 MHz to be $ 0.05 per MHz per POP (~INR 500 Crores for Nationwide spectrum per MHz)
- Reserve price for C band should be $0.01 per MHz per POP (~INR 100 Crores for Nationwide spectrum per MHz)
- Reserve price for mm wave band should be $0.008 per 10 MHz per pop which is 11.5 times lower than the C band reserve price (~INR 80 Crores per 10 MHz for Nationwide Spectrum)

Q.37 Whether the auction determined prices of March 2021 auction be taken as the value of spectrum in the respective band for the forthcoming auction in the individual LSA? Should the prices be indexed for the time gap (even if less than one year or just short of one year)? If yes, please

indicate the basis/ rate at which the indexation should be done, with reasons.

IAFI Response:

NO. We believe that the previous spectrum prices have no relevance to real market value. We feel that the true auction prices of spectrum should be determined by the market through the auction with the following as reserve prices:

- Reserve price for 700 MHz to be $ 0.05 per MHz per POP (~INR 500 Crores for Nationwide spectrum per MHz)
- Reserve price for C band should be $0.01 per MHz per POP (~INR 100 Crores for Nationwide spectrum per MHz)
- Reserve price for mm wave band should be $0.008 per 10 MHz per pop which is 11.5 times lower than the C band reserve price (~INR 80 Crores per 10 MHz for Nationwide Spectrum)

Q.38 If the answer to the above question is in negative, whether the valuation for respective spectrum bands be estimated on the basis of the various valuation approaches/methodologies being followed by the Authority in the previous recommendations, including for those bands (in an LSA) for which either no bids were received, or spectrum was not offered for auction?

IAFI Response:

We believe that the previous spectrum prices have no relevance to real market value. We feel that the true auction prices of spectrum should be determined by the market through the auction with only nominal reserve price.

Q.39 Whether the method followed by the Authority in the Recommendations dated 01.08.2018 of considering auction determined prices of the auctions held in the previous two years be continued, or the prices revealed in spectrum auctions conducted earlier than two years may also be taken into account? Kindly justify your response.

IAFI Response:

None of these two methods is recommended. Global spectrum prices, adjusted to the India ARPU should be used as a method to determine the spectrum valuation and the reserve prices.

Q.40 Whether the valuation exercise be done every year in view of the Governments' intention to have an annual calendar for auction of spectrum? Please support your response with detailed justification.

IAFI Response:

No. It is not necessary to do spectrum valuation every year as it has no relevance to the actual auction price of the spectrum. Effort should be to increase the availability of spectrum through harmonization and other measures, such as clearing of unused or underused bands.

Q.41 Whether there is a need to bring any change in the valuation approaches/ methodologies followed by the Authority for spectrum valuation exercises in view of the changing dynamics in the telecom sector largely due to the usage of various spectrum bands by the TSPs in a technologically neutral manner? If yes, please provide suggestions along with a detailed justification about the methodology.

IAFI Response:

Yes, As mentioned above, the current spectrum valuation approaches/ methodologies followed by the Authority for spectrum valuation exercises should be changed as they do not have any corelation with the actual auction price as clearly shown in Attachment 3.

Our suggestion is to use global benchmark for auction prices, adjusted to the Indian ARPUs.

Q.42 In your opinion, what could be the possible reasons for the relative lack of interest for the spectrum in the 2500 MHz band? Could this be attributed to technological reason(s) such as development of network/device ecosystem or availability of substitute spectrum bands or any other reasons(s)? Please support your response with detailed justification.

IAFI Response:
The main reason for the lack of interest for the spectrum in the 2500 MHz band was the high reserve price as the reserve price was not adjusted for the network/device ecosystem

Q.43 Whether the March 2021 auction determined prices be used as one possible valuation for the spectrum in 2300 MHz band for the current valuation exercise? If yes, should these prices be indexed for the time gap and at what rate? Please justify your response.

IAFI Response:
Our suggestion is to use global benchmark for auction prices, adjusted to the Indian ARPUs.

Q.44 Whether auction determined prices of October 2016 (i.e. for the auction held earlier than two years) be used as one possible valuation for the spectrum in 2500 MHz band for the current valuation exercise? If yes, should these prices be indexed for the time gap and at what rate? Please justify.

IAFI Response:
Our suggestion is to use global benchmark for auction prices, adjusted to the Indian ARPUs.

Q.45 Whether the value of the spectrum in 2300 MHz/ 2500 MHz bands should be derived by relating it to the value of spectrum in any other band by using technical efficiency factor? If yes, which band and what rate of efficiency factor should be used? If no, then which alternative method should be used for its valuation? Please justify your response with rationale and supporting studies, if any.

IAFI Response:
Our suggestion is to use global benchmark for auction prices, adjusted to the Indian ARPUs.

Q.46 In your opinion, what could be the possible reasons for the relative lack of interest for the spectrum in the 700 MHz band? Could this be attributed to technological reason(s) such as development of network/device ecosystem or availability of substitute spectrum bands or any other reasons(s)?

The main reason for the lack of interest and failure for the spectrum auctions in the 700 MHz band was the high reserve price for this band. Average reserve price fixed for 700 MHz in Feb 2021 auction was about $1.89 per MHz per pop (adjusted for PPP) which was several times higher than that set Internationally ($0.05) and was also higher than the mean winning bid price witnessed worldwide ($0.54). In addition, the reserve price for metros was set to about $8.72, several times higher than mean winning bid prices in other country. The 700 MHz auction was therefore designed for failure.

Q.47 Whether the value of spectrum in 700 MHz band be derived by relating it to the value of other spectrum bands by using a technical efficiency factor? If yes, with which spectrum band, should this band be related and what efficiency factor or formula should be used? Please justify your views with rationale and supporting studies, if any.

IAFI Response:
Our suggestion is to use global benchmark for auction prices, adjusted to the Indian ARPUs.

Q.48 If your response to the above question is in negative, what other valuation approach(es) be adopted for the valuation of 700 MHz spectrum band? Please support your response with detailed methodology.

IAFI Response:
Our suggestion is to use global benchmark for auction prices, adjusted to the Indian ARPUs.

Q.49 Whether the valuation of the 3300-3670 MHz spectrum band should be derived from value of any other spectrum band by using technical efficiency factor? If yes, what rate of efficiency factor should be used? If no, which other method(s) should be used for its valuation? Please justify your response with rationale and supporting documents, if any.

IAFI Response:
The spectrum Valuation and thus the reserve prices for spectrum auctions in India are already much higher than the prevailing global levels. See the following table for recent Mid-band auctions as compared to India C band reserve price recommended by the TRAI in 2018. India's reserve price recommended in 2018 was the highest – about 5 times when normalized on ARPU basis and about 14[9] times higher on PPP basis.

S.No.	Country	Auction Price $/MHz/POP	ARPU	Auction Price $/MHz/POP/ARPU
1	India (reserve Price)	0.05	1.2	0.0417

[9] See Presentation by Dr. V. Sridhar Professor, IIIT Bangalore
https://itu-apt.org/system/static/uploads/pdf/Presentation%20by%20Prof.%20V%20Sridhar.pptx

2	Italy	0.42	13.52	0.0311
3	US	0.875	39.64	0.0221
4	Germany	0.19	13.32	0.0143
5	Hong Kong	0.13	15.42	0.0084
6	Australia	0.21	25.59	0.0082
7	Singapore	0.08	17.65	0.0045
8	UK	0.09	19.87	0.0045
9	Sweden	0.08	22.89	0.0035
10	Greece	0.04	13.65	0.0029
11	Ireland	0.07	28.87	0.0024
12	Slovakai	0.01	11.72	0.0009
13	Latvia	0.01	11.93	0.0008
14	Norway	0.01	32.98	0.0003
	Average (Excluding India)	0.17	20.54	0.008

Our suggestion is to use global benchmark for auction prices, adjusted to the Indian ARPUs.

Q.50 In case you are of the opinion that frequencies in the range 526-698 MHz should be put to auction in the forthcoming spectrum auction, whether the value of 526-698 MHz be derived by using technical efficiency factor? If yes, with which spectrum band, should this band be related and what efficiency factor or formula should be used? Please justify your suggestions.

IAFI Response:
Our suggestion is to auction only 612-703 MHz. Further our suggestion for the reserve price calculation is to use 700 MHz global benchmark adjusted for ARPU and adjusted for the network/device ecosystem

Q.51 If your response to the above question is in negative, which other valuation approach(es) should be adopted for the valuation of these

spectrum bands? Please support your suggestions with detailed methodology, related assumptions and any other relevant factors.

IAFI Response:
See Reply to question 50 above.

Q.52 Whether the value of spectrum in 24.25 - 28.5 GHz band be derived by relating it to the value of other bands by using technical efficiency factor? If yes, with which spectrum band, should this band be related and what efficiency factor or formula should be used? Please justify your suggestions.

IAFI Response:
Reserve price for mm wave band should be $0.008 per 10 MHz per pop which is 11.5 times lower than the C band reserve price (based on the following calculations)

- Estimate the usable bandwidth of 26 GHz Band (24500-27500 MHz) : 3000 MHz
- Estimate the usable bandwidth of 3500 MHz Band : 370 MHz
- Calculate the Bandwidth Ratio : 370/3000
  - Higher frequency band becomes more capacity driven
  - Propagation losses dropped
- Calculate LSA wise reserve price of 26-28 GHz band using Bandwidth Ratio and the reserve Price of 3500 MHz
- Reserve Price of 26-28 GHz = RP3500 x Bandwidth Ratio= RP3500 x (370/4250)= RP3500 x 0.087 (i.e. 11.5 times lower than RP3500)

Q.53 If your response to the above question is in negative, which other valuation approaches should be adopted for the valuation of these spectrum bands? Please support your suggestions with detailed methodology, related assumptions and other relevant factors.

IAFI Response:
See response to Question 52.

Q.54 Whether international benchmarking by comparing the auction determined price in countries where auctions have been concluded be used for arriving at the value of these new bands? If yes, then what methodology can be followed in this regard? Please explain.

IAFI Response:

Our suggestion is to use global benchmark for auction prices, adjusted to the Indian ARPUs. Based on these assumptions, Following Values are recommended

- Reserve price for 700 MHz to be $ 0.05 per MHz per POP (~INR 500 Crores for Nationwide spectrum per MHz)
- Reserve price for C band should be $0.01 per MHz per POP (~INR 100 Crores for Nationwide spectrum per MHz)
- Reserve price for mm wave band should be $0.008 per 10 MHz per pop which is 11.5 times lower than the C band reserve price (~INR 80 Crores per 10 MHz for Nationwide Spectrum)

Q.55 For international benchmarking, whether normalization techniques be used for arriving at the valuation of these new bands in the Indian context? If yes, please justify your response with rationale /literature, if any.

IAFI Response:
Yes, Our suggestion is to use global benchmark for auction prices, adjusted to the Indian ARPUs. Other Option is to use the PPP valuations but we prefer the ARPU as the basis for normalization.

Q.56 Whether a common methodology/ approach should be used for valuation of all sub-1 GHz bands, which are currently planned for IMT? If yes, suggest which methodology/ approach should be used. Please give your views along with supporting reasoning and documents/ literature, if any.

IAFI Response:
Yes, except for the band 612-703 MHz, which should be adjusted for the network/device ecosystem

Q.57 Whether the extrapolated ADP based on a time-series analysis, may be considered as the valuation itself or some normalization may be performed taking into account the financial, economic and other parameters pertaining to a particular auction? If yes, which factors should be considered and what methodology should be followed?

IAFI Response:
Our suggestion is to use global benchmark for auction prices, adjusted to the Indian ARPUs for calculation of reserve price.

Q.58 Whether the value arrived at by using any single valuation approach for a particular spectrum band should be taken as the appropriate value of that band? If yes, please suggest which single approach/ method should be used. Please justify your response.

IAFI Response:
As mentioned above, studies have shown that the auction prices do not reflect the true value of spectrum, rather these reflect the value to preserve market competitiveness. Further, auction are leveraged by incumbents to create barrier to entry and are linked with operator's needs to protect investments. It is this clear that any valuation approach for a particular spectrum band should not be taken to compute as the appropriate value of that band.

Q.59 In case your response to the above question is negative, will it be appropriate to take the average valuation (simple mean) of the valuations obtained through the different approaches attempted for valuation of a particular spectrum band, or some other approach like taking weighted mean, median etc. should be followed? Please justify your response.

IAFI Response:
Our suggestion is to use global benchmark for auction prices, adjusted to the Indian ARPUs for calculation of reserve price.

Q.60 Is there any valuation approach other than those discussed above or any international auction experience/ approach that could be used for arriving at the valuation of spectrum for 700 MHz/ 800 MHz/ 900 MHz/ 1800 MHz/ 2100 MHz/ 2300 MHz/ 2500 MHz/ 3300-3670 MHz/ 24.25 - 28.5 GHz/ 526 - 698 MHz bands? Please support your suggestions with a detailed methodology and related assumptions.

IAFI Response:
Please see our responses above. Based on these responses, we believe that TRAI should only work on computing the reserve price and should not compute the valuation.

Q.61 Should the reserve price be taken as 80% of the valuation of spectrum? If not, then what ratio should be adopted between the reserve price for the auction and the valuation of the spectrum in different spectrum bands and why?

IAFI Response:

Please see our responses above. Based on these responses, we believe that TRAI should only work on computing the reserve price and should not compute the valuation.

Q.62 Whether the realized/ auction determined prices achieved in the March 2021 auction for various spectrum bands can be directly adopted as the reserve price in respective spectrum bands for the forthcoming auction? If yes, should these prices be indexed for the time gap since the auction held in March 2021 and at which rate the indexation should be done?

IAFI Response:
The reserve prices should be recalculated based on global benchmark for auction prices, adjusted to the Indian ARPUs. Based on these, we have recommended the following reserve prices:

- Reserve price for 700 MHz to be $ 0.05 per MHz per POP (~INR 500 Crores for Nationwide spectrum per MHz)
- Reserve price for C band should be $0.01 per MHz per POP (~INR 100 Crores for Nationwide spectrum per MHz)
- Reserve price for mm wave band should be $0.008 per 10 MHz per pop which is 11.5 times lower than the C band reserve price (~INR 80 Crores per 10 MHz for Nationwide Spectrum)

Q.63 to Q 67

IAFI Response:

NO IAFI Response

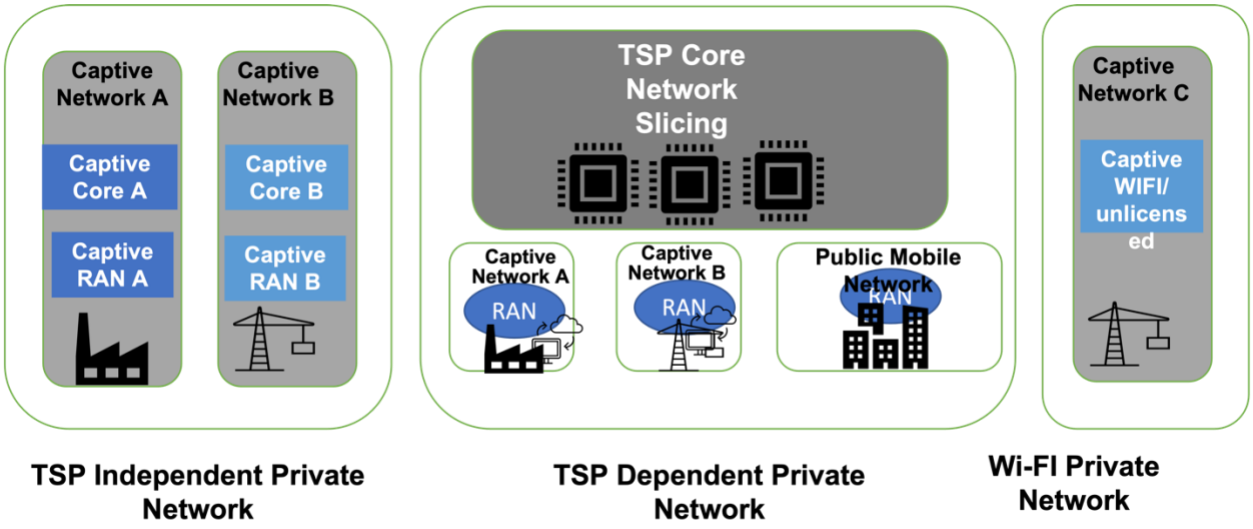
10 Issues related to Spectrum for Private Cellular Networks

Q.68 To facilitate the TSPs to meet the demand for Private Cellular Networks, whether any change(s) in the licensing/policy framework, are required to be made. If yes, what changes are required to be made? Kindly justify your response.

IAFI Response

Mobile cellular network technology is generally deployed and operated by licensed TSPs. Private networks are a big change to this construct, and

questions remain about which party should design, deploy, operate, and own them.
There are three major options to deploy/own and operate a private network:



i. A fully captive network (TSP independent Private Network) in a locally licensed enterprise spectrum. Regulators worldwide are investigating, or already allocating, spectrum that can be locally licensed for private 4G/5G networks. For broadband services, these are typically mid-band allocations, such as CBRS spectrum (3.5GHz) in the US and 3.7-3.8GHz in parts of Europe, which offer protected use in small license areas. They are generally low-power allocations to better enable re-use. The Band 4890-4990 MHz is also highly suitable for this kind of approach in India.

ii. A licensed TSP owns and deploys a private network for a captive user using his TSPs own spectrum and/or his own core network using network slicing. An alternate option is for the captive user to have his own network using spectrum leased from a licensed operator. Protected use makes this option attractive for high-end customers. The challenge is that it doesn't scale well to tens or hundreds of thousands of users/devices. Mechanisms and regulations to more easily sub-lease/share licensed spectrum for private networks are in development, but for now this is a custom designed network by a TSP for a private entity with a deep business relationship with the TSP. It is noted that one of the principal technical features of 5G/IMT highlighted by mobile operators is the possibility to implement services to private networks through 'Network Slicing '.

iii. A captive LTE or 5G network operating in an Unlicensed spectrum. Classically, this means 5 GHz, which is primarily used by Wi-Fi today. For the future, 6GHz is under evaluation in the US and Europe and offers interesting options, particularly if part of the band is regulated to

require synchronized sharing, which would radically improve performance when multiple users want to access the same band. In some markets, unlicensed mmWave is also an option for mobile 5G.

An example of private LTE solution can be seen at the new terminal at the Port of Rotterdam. Europe's largest port. The Port was expanding to accommodate the increasing number of ships. From the beginning, the company envisioned an automated system to handle the increased volume of goods and ships. What the company didn't envision was the congested Wi-Fi networks that made its automated terminal too expensive to operate. From day one, they had a lot of issues with the Wi-Fi connectivity, as multiple WIFI systems interfered with each other. The Wi-Fi interference caused outages, and each outage led to an expensive delay. A private LTE network brought costs back into line for Rotterdam World Gateway and enabled the company to continue operating the automated terminal. Ericsson deployed the network in the midband, which the Dutch government had temporarily made available for companies that want to test private cellular networks and this spectrum is expected to become more permanently available to industry in 2022.

In terms of physical deployment, the term "private network" refers to networks with radio, core, and transmission resources dedicated to the enterprise and – crucially – under the control of the enterprise. This generally means network equipment will be deployed on the customer premises, regardless of which party manages it day-to-day.

Here are some licensing models for meeting the requirements of the private networks

Spectrum Type	Description
Licensed Spectrum Owned by Operators	• Continuation of the classic spectrum licensing model • Protected use makes this spectrum attractive to users with reliability concerns • Mechanisms to lease/share spectrum for private networks are in development
Dedicated Enterprise Spectrum	• Model being pursued in multiple markets • E.g., Germany to allocate 100 MHz (3.7-3.8 GHz) to industrial users • Attractive where available; however, some risk of being a niche ecosystem
Unlicensed Spectrum (w/ Asynchronous Sharing)	• 5 GHz is the lead band; U.S. to open 6 GHz, with Europe to follow • Listen-before-talk regulations already embedded in 5 GHz • Most useful for private 5G networks that do not require URLLC
Unlicensed Spectrum w/ Synchronized Sharing	• In new unlicensed allocations (e.g., 6 GHz), there is an opportunity to introduce new sharing mechanisms • Over-the-air synchronization is a lightweight way to improve sharing • Enables more reliable performance in co-sited deployments; makes unlicensed spectrum suitable for URLLC applications

Source: Heavy Reading

Q.69 To meet the demand for spectrum in globally harmonized IMT bands for private captive networks, whether the TSPs should be permitted to give access spectrum on lease to an enterprise (for localized captive use), for a specific duration and geographic location? Kindly justify your response.

Access to spectrum is one of the keys to unlocking the private networking market. The ability to deploy private networks without dependencies on public cellular systems or licensed operators gives enterprises greater ability to control their operations and removes friction from the market. Both unlicensed spectrum and so-called "enterprise spectrum" offer this advantage.

Dedicated enterprise spectrum offers protected use and is therefore interesting to organizations with demanding reliability and availability requirements. This applies particularly to industrial IoT applications, but also to any organization wanting to run production-critical systems with minimal risk of downtime.

Unlicensed spectrum is, by design, easy to access and widely available. This is traded against the possibility that neighbours can interfere, making some organizations reluctant to rely on unlicensed for production-critical networks. Interestingly, simulations show 5G radio innovations such as Coordinated MultiPoint (CoMP), combined with good network design, can be used to achieve consistent, highly reliable performance in shared frequency bands. In the medium term, extending into 6GHz offers the potential to introduce synchronized sharing to unlicensed spectrum to significantly improve efficiency and reliability where there are multiple users.

Three frameworks are commonly discussed for sharing of spectrum for private captive networks:

1. **CBRS-type approaches:**The planned 'Citizens Broadband Radio Service' approach in the United States in the 3.5 GHz band aims to support three tiers using dynamic sharing. The top tier is made up of the incumbents (e.g. radars, satellite companies and wireless ISPs) who have the most protection. The secondary tier includes Prioritised Access License (PAL) holders, who will pay to buy rights to use a portion of the available spectrum where it is not in use by the top tier. The third tier comprises General Authorised Access (GAA) and is available to anyone but will have the least protections. Portions of the spectrum are reserved for GAA and PAL tiers in areas where the incumbent is not using the spectrum. PAL and GAA users can access each other's reserved portion of spectrum where it is not registered as being used in the SAS database.

2. Licensed Shared Access: Incumbent licence holders can sub-license spectrum to other users in a controlled way. The traditional model was

developed in Europe for the 2.3 GHz band. It has two tiers including the incumbent and secondary users (e.g. mobile operators) who are permitted to use the spectrum in areas when it is available. More advanced models are being developed.

3. **Concurrent Shared Access** (e.g. club licensing): Unlike the approaches above, this only allows one class of user but allows them to share spectrum with each other in a coordinated way. This allows sharing between mobile operators to improve data speeds and spectrum efficiency. Policy makers increasingly see automated spectrum sharing as a means of opening up additional spectrum for 4G and 5G captive and private mobile services. The use of automated spectrum access systems for shared use of radio spectrum will become the norm in the future:

- In April of this year, in the USA, the FCC authorised[10] the use of the 6 GHz band (5925-7125 MHz) for two types of unlicensed operations - standard-power and indoor low-power operations. FCC authorised standard-power access points using an automated frequency coordination system (AFC) to protect the fixed service (microwave links). This makes the 6 GHz band as the third frequency band in the USA in which FCC authorised the use of automated spectrum access systems to enable spectrum sharing.

- ● The European Electronic Communications Committee (ECC) Strategic Plan 2020-2025[11] will be promoting spectrum sharing through its technical and regulatory work and balancing the interests of spectrum users including verticals.
- South Korea's Ministry of Science and Technology Information and Communication Announcement No. 2020-384 issued under administrative notice of partial amendment to the technical standards of radio equipment for radio stations that can be operated without licenses, In order to realize the benefits of high-speed data and accelerate the spread of 5G convergence services across the industry, 5G-class performance unlicensed technologies (WiFi 6E, 5G NR-U, etc.) can be used in the 6GHz band[12]

Dedicated and unlicensed spectrum does not, however, mean there is no room for operators in this market. It is widely believed that in future, spectrum will be decoupled from the decision about who designs, operates and maintains private networks. Already there is evidence that operators themselves see

[10] https://www.federalregister.gov/documents/2020/05/26/2020-11236/unlicensed-use-of-the-6-ghz-band

[11] https://cept.org/ecc/ecc-strategic-plan

[12] [8]https://msit.go.kr/web/msipContents/contentsView.do?cateId=_law4&artId=2942268

opportunities in dedicated enterprise spectrum, and several are preparing to offer managed private networks in these bands. There is also, of course, a very large market for wide-area and multi-site services that operators can offer alongside on-campus private network services. TSPs can use the 3GPP network slicing technology to meet some of the industrial and enterprise needs. However, there will remain a need for small, localized, independent, private broadband networks for specialized users including critical infrastructure, industrial, utilities and enterprises.

Q.70 In case spectrum leasing is permitted,

i. Whether the enterprise be permitted to take spectrum on lease from more than one TSPs?

ii. What mechanism may be prescribed to keep the Government informed about such spectrum leasing i.e., prior approval or prior intimation?

iii. What timeline should be prescribed (in number of days) before the tentative date of leasing for submitting a joint request by the TSPs along with the enterprise, for approval/intimation from/to the Government?

iv. Whether the spectrum leasing guidelines should prescribe duration of lease, charges for leasing, adherence of spectrum cap provisions, roll out obligations, compliance obligations. If yes, what terms and conditions should be prescribed?

v. What other associated terms and conditions may be prescribed?

vi. Any other suggestion relevant to leasing of spectrum may also be made in detail.

Kindly justify your response.

Spectrum leasing is not the only way to make available spectrum for private IMT networks. However, if leasing is used, there should be strong mechanism to monitor and enforce SLAs between TSP and private network customer. This is important in a scenario where the TSP owns and/or manages the mobile infra, in which case the private enterprise is dependent on TSP providing the committed QoS for its business-critical applications. There are two scenarios:

(a) TSPs own & manage complete mobile infra and provides SLA bound secured connectivity to customer's enterprise services & applications (e.g., VPN) – This is known as private network provided by the TSP as a service

(b) TSP owns and manages radio infra and provides secured connectivity to Private network customer owned & managed core network (aka RAN sharing). Other than assured QoS, this topology enables to meet the other important goal of

private networks, which is that the data of the private enterprise is contained within its premises.

There are several limitations to the first mentioned approach of enabling private networks by way of TSPs providing this as a service.

- Private enterprises will be dependent on TSPs providing the required QoS and security of the data transmitting on their radio and core networks.
- This model may work for less critical applications but is not suitable for business or mission critical applications that require guaranteed end-to-end QoS and complete control of subscriber information and user data.
- Network slicing can mitigate this issue but only to a limited extent by dedicating compute or transmission resource

Q.71 Whether some spectrum should be earmarked for localized private captive networks in India? Kindly justify your response.

Yes, some spectrum should be earmarked for localized private captive networks in India. We believe that 5G spectrum should be easily available to meet the spectrum needs of dedicated/captive private broadband LTE/5G networks. It is worth noting that the concept of private LTE/5G with own dedicated spectrum has been well accepted and is being supported in many countries.

In India also, the DOT has already earmarked portions of IMT bands for the following captive mobile networks:

- 10+10 MHz in 700 MHz has been earmarked for Captive use of Defence services
- 5+5 MHz in 700 MHz has been earmarked for Captive use of Rail services
- Spectrum has been earmarked for Railways GSM-R network in 800-900 MHz

Many countries have also already earmarked dedicated spectrum for captive private 4G/5G networks . Some examples of these are:

- The band 3.7-3.8 GHz is already being considered as part or extension to the 3.4-3.7 GHz in many countries. In Europe, an EC Implementation Decision[13] harmonises the radio spectrum in the 3.4-3.8 GHz (or 3.6 GHz) band for the future mobile broadband (5G) and sets a deadline for releasing spectrum. A number of countries have decided to keep part or all of the 3.7-3.8 GHz available only for shared

[13] https://ec.europa.eu/digital-single-market/en/news/commission-decides-harmonise-radio-spectrum-future-5g

or local licensing for enterprise customers and private broadband applications.

- The German regulator BnetzA, as an example, decided[14](November 21st 2019) to make 100MHz of the mid band (in particular 3.7 – 3.8 GHz of spectrum available only for private local & regional broadband applications, after it awarded 300MHz in the same band (3.4-3.7 GHz) to mobile operators through auctions for wide area licensing.
- BnetzA has recently reported[15] 67 private broadband licenses granted in 10 months in the 3.7- 3.8 GHz band.
- Sweden regulator PTS[16] announced that the 3720-3800 MHz be reserved for a new assignment by local license without selection procedure 2020/21 to support enterprise broadband applications.

Q.72 In case it is decided to earmark some spectrum for localized private captive networks, whether some quantum of spectrum be earmarked (dedicatedly) from the spectrum frequencies earmarked for IMT services and/or spectrum frequencies earmarked for non-IMT services on location-specific basis (which can coexist with cellular-based private captive networks on shared basis)? Kindly justify your response with reasons.

Captive mobile networks are already currently operating in non IMT bands such as trunking services. The issue is the use of IMT bands in which 3GPP mobile technology is available.

There are a number of bands which are not used by TSPs in india but can be used for Private 5G/LTE networks. Some examples of these are:

- 3.7-4.2 GHz
- 4.889 – 4.999 GHZ
- 5950-6450 GHz

Q.73 In case it is decided to earmark some quantum of spectrum for private captive networks, either on exclusive or shared basis, then

a) Spectrum under which band(s) (or frequency range) and quantum of spectrum be earmarked for Private Network in each band? Inputs may be provided considering both dedicated and shared spectrum (between geographically distinct users) scenarios.

b) What should be the eligibility conditions for assignment of such spectrum to private entities?

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[14] http://www.bundesnetzagentur.de/lokalesbreitband

[15] https://enterpriseiotinsights.com/20200827/channels/news/67-local-licences-in-10-months-5g-in-the-home-of-industry-40

[16] https://pts.se/contentassets/430b8fbfa510476d8d70bc2c7ff73da3/spectrum-orientation-plan-200505.pdf

c) What should be the assignment methodology, tenure of assignment and its renewal, roll-out obligations?
d) What should be the pricing mechanism for assignment of spectrum in the band(s) suggested for private entities forlocalized captive use and what factors should be considered for arriving at valuation of such spectrum?
e) What should be the block size and spectrum cap for different spectrum band(s) suggested in response to point (a) above.
f) What should be the broad frameworkfor the process of
(i) filing application(s) by enterprise at single location, enterprise at multiple locations, Group of companies.
(ii) payment of spectrum charges,
(iii) assignment of frequencies,
(iv) monitoring of spectrum utilization,
(v) timeline for approvals,
(vi) Any other
g) Any other suggestion on the related issues may also be made with details.

IAFI Response:

Yes, some spectrum should be earmarked for localized private captive networks in India. We believe that 5G spectrum should be easily available to meet the spectrum needs of dedicated/captive private broadband LTE/5G networks. It is worth noting that the concept of private LTE/5G with own dedicated spectrum has been well accepted and is being supported in many countries.

In India also, the DOT has already earmarked portions of IMT bands for the following captive mobile networks:

- 10+10 MHz in 700 MHz has been earmarked for Captive use of Defence services
- 5+5 MHz in 700 MHz has been earmarked for Captive use of Rail services
- Spectrum has been earmarked for Railways GSM-R network in 800-900 MHz

Many countries have also already earmarked dedicated spectrum for captive private 4G/5G networks . Some examples of these are:

- The band 3.7-3.8 GHz is already being considered as part or extension to the 3.4-3.7 GHz in many countries. In Europe, an EC Implementation Decision[17]harmonises the radio spectrum in the 3.4-

[17] https://ec.europa.eu/digital-single-market/en/news/commission-decides-harmonise-radio-spectrum-future-5g

3.8 GHz (or 3.6 GHz) band for the future mobile broadband (5G) and sets a deadline for releasing spectrum. A number of countries have decided to keep part or all of the 3.7-3.8 GHz available only for shared or local licensing for enterprise customers and private broadband applications.

- The German regulator BnetzA, as an example, decided[18](November 21st 2019) to make 100MHz of the mid band (in particular 3.7 – 3.8 GHz of spectrum available only for private local & regional broadband applications, after it awarded 300MHz in the same band (3.4-3.7 GHz) to mobile operators through auctions for wide area licensing.
- BnetzA has recently reported[19] 67 private broadband licenses granted in 10 months in the 3.7- 3.8 GHz band.
- Sweden regulator PTS[20] announced that the 3720-3800 MHz be reserved for a new assignment by local license without selection procedure 2020/21 to support enterprise broadband applications.

India spectrum in mid band and particularly 4890-4990 MHz should be earmarked for Private LTE/5G

TRAI can lay the groundwork in preparation for the implementation of a future automated spectrum access system in this band by not having spectrum licences in this band. https://cept.org/ecc/ecc strategic-plan

Traditionally spectrum licences are utilised to deploy commercial mobile broadband networks with extensive base station infrastructure serving large geographic areas. In contrast, with shared arrangements for apparatus licensed LA WBB, the density of base stations will be relatively lower than those of commercial WBB networks, leading to a lower unwanted emission from 5G base stations into the adjacent band.

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[7] https://cept.org/ecc/ecc-strategic-plan
[8] https://msit.go.kr/web/msipContents/contentsView.do?cateId=_law4&artId=2942268

[18] http://www.bundesnetzagentur.de/lokalesbreitband
[19] https://enterpriseiotinsights.com/20200827/channels/news/67-local-licences-in-10-months-5g-in-the-home-of-industry-40
[20] https://pts.se/contentassets/430b8fbfa510476d8d70bc2c7ff73da3/spectrum-orientation-plan-200505.pdf

Attachment 1 - Considerations for 27.5-28.5 GHz sharing between 5G and FSS

The mmWave frequency range of the band identified for 5G/IMT by the ITU at WRC-19 is 24.25-27.5 GHz (known as the 26 GHz band), among other mmWave bands[21]. Spectrum above 27.5 GHz was not on the agenda of the WRC-19 when 26 GHz and other bands were identified for 5G/IMT by the ITU. In addition, the band 27.5-29.5 GHz is allocated to Fixed satellite service on a coprimary basis with Fixed and Mobile Service. There are several provisions in the Radio regulations to protect satellite services and a number of new provisions were added at WRC-19[22] for protection of satellite broadband services, including earth stations in motion (ESIM) in this band. The band is also under study for expanded satellite use in WRC-23 Agenda Items 1.16 (non-geostationary ESIM) and 1.17 (satellite-to-satellite links).

Following are key considerations for sharing on 27.5-28.5 GHz between 5G and FSS services:

i. Global research[23] demonstrates that the highest demand for 5G spectrum is in the mid-bands (3.5 GHz), while there is limited demand for 5G in mmWave spectrum in the 26 and 28 GHz bands. A potential auction for 5G in 2022 should prioritize spectrum that is best suited for services where demand exists, such as the 3.5 GHz band, and not offer spectrum for 5G applications that do not have any significant global uptake.

ii. The same studies show that 5G in mmWave spectrum in the 26 GHz and 28 GHz bands has not had significant use. Offering bands with low demand poses the risks of spectrum being unsold or, even worse, being underutilised. Both of these outcomes will result in a costly regulatory failure for India, through the loss of substantial economic opportunities. These losses will result from a failure to allocate the 27.5-28.5 GHz spectrum for higher economic value uses and, from denying Indian citizens, business and public entities the opportunity to enjoy ubiquitous, cost-effective satellite broadband. TRAI must note the example of Brazil, another large economy, which recently

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21 *See* ITU Press Release, *WRC-19 identifies additional frequency bands for 5G*, (22 Nov. 2020) (those bands include the following: 24.25-27.5 GHz, 37-43.5 GHz, 45.5-47 GHz, 47.2-48.2 and 66-71 GHz), https://news.itu.int/wrc-19-agrees-to-identify-new-frequency-bands-for-5g/.

22 *See* ITU Radio Regulations, adopting Footnote 5.517A authorizing geostationary ESIM as a part of the Fixed Satellite Service in the 27.5-29.5 GHz and 17.7-19.7 GHz bands.

23 ABI Research: *Emerging Markets Broadband Objectives: Spectrum Requirements* (2021), https://go.abiresearch.com/lp-emerging-markets-broadband-objectives-spectrum-requirements.

attempted to auction mmWave spectrum for 5G. This resulted in unsold mmWave spectrum[24]. TRAI's should also note the fact that one of the major countries promoting 5G in mmWave, Korea, has not seen any material demand for 5G services in the mmWave bands with just 161 mmWave 5G base stations deployed after several years instead of the government-required 45,000 by the end of 2021[25] as specified in Korea's rollout conditions.

iii. Offering the 27.5-28.5 GHz band in the upcoming 5G auction for low-demand and costly 5G broadband uses in mmWave spectrum will result in Indian citizens being denied the benefits of high-demand, advanced satellite broadband services. Auctioning the spectrum will risk lost GDP revenues per annum to India's economy of USD72-184.6 billion[26].

iv. The ITU's Radio Regulations (RR), in accordance with No.31 of ITU's Constitution, is a *binding* international treaty document. It identifies 41 Radio Services to which the spectrum - 8.3 kHz to 275 GHz - is allocated. India uses most of these radio services for terrestrial, maritime, aeronautical and space applications. Publications, including recommendations by the ITU, focus on optimizing and providing guidelines for spectrum use by its 193 member administrations of the ITU. For example, the ITU adopted Recommendation ITU-R S. 2223 on "Technical and operational requirements for GSO FSS earth stations on mobile platforms in bands from 17.3-30 GHz" in 2011 and then updated it in 2016[27].

v. The RR is a binding treaty document ratified by India. India is one of the major (top 14) contributors to the ITU budget, paying 10 contributory units to the ITU each year. It is therefore in India's interest to act in coherence with its ITU work, positions and resources that have been invested globally by harmonizing spectrum use domestically with its participation at the ITU. Remaining consistent with the globally agreed RR provisions is also appropriate in the Indian National Frequency Allocation Plan (NFAP) ensuring the conditions for the use of spectrum by national stakeholders is aligned with the Radio Regulations. This is the primary method to guarantee

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[24] Reuters, *Brazil to reschedule auction for unsold 5G spectrum, minister says* (Nov. 5, 2021), https://www.reuters.com/business/media-telecom/brazil-reschedule-auction-unsold-5g-spectrum-minister-says-2021-11-05/.

[25] The Korea Herald, *Telecos lag in mmWave 5G equipment installation: lawmaker* (Sept. 10, 2021), http://www.koreaherald.com/view.php?ud=20210910000417.

[26] Plum: *Expanding digital connectivity through satellite broadband in the 28 GHz band* (Oct. 2021), https://plumconsulting.co.uk/expanding-digital-connectivity-through-satellite-broadband-in-the-28-ghz-band/.

[27] *See* ITU-R Recommendation S.2223, *Technical and operational requirements for GSO FSS earth stations on mobile platforms in bands from 17.3-30 GHz* (2011, revised 2016), https://www.itu.int/pub/R-REP-S.2223.

certainty for investment and ICT development in India, including for global satellite services.

vi. In the case of the 28 GHz band, satellite operators have made substantial investments based on the global validation of satellite broadband use of the band at both WRC-15 and WRC-19. The decisions of these Conferences provided confidence for those investments and the result is that satellite networks are being built and deployed around the world for expansive use of the 28 GHz band.

vii. The vast majority of Asia-Pacific is harmonising satellite broadband solutions with global markets for the purpose of securing ubiquitous fast-broadband across land, sea, and air, particularly in the full 28 GHz band. This is because the 28 GHz band is being implemented not just for residential, business and government-critical satellite broadband services across urban areas and beyond, but also this is the key band identified by the International Telecommunication Union (ITU) for use by earth stations in motion (ESIM). The market for advanced broadband connectivity in the aviation, maritime and land transport (*e.g.*, trains, buses, public safety vehicles) sectors has been the key driver for the ITU Members States in ensuring sufficient spectrum is available for ESIM on a global basis. Over 120 countries and growing, including Europe[28], China, Australia, Brazil, Russia, Mexico, Nigeria, and other important economies, representing more than half the global population, have secured the full 28 GHz for ubiquitous satellite broadband to provide nationwide satellite broadband services.

viii. There is also the need to consider interference mitigation for the use of 28 GHz bands between 5G/IMT systems and satellite services, including ESIM, on a co-frequency basis. Hence, at a minimum, TRAI should decouple the 26 and the 28 GHz bands for separate analysis and public consultation because the interference contexts for services in each band are very different. Resolution 169 (WRC-19) provides pfd limits for ESIM deployments and has clear directions on deployment of ESIMs (Annex 1 to Provisions for earth stations in motion to protect non-geostationary fixed satellite service systems in the frequency band 27.5-28.6 GHz, Protection of non-geostationary mobile-satellite service feeder links in the frequency band 29.1-29.5 GHz from earth stations in motion, Provisions for maritime and aeronautical earth stations in motion to protect terrestrial services in the frequency band 27.5-29.5 GHz. Also Resolves 1.2 (and 1.2.2, 1.2.3 and 1.2.4) clearly state that ESIM needs to provide protection to terrestrial services to which the frequency band 27.5-29.5 GHz is allocated and operating in accordance with the Radio Regulations.

ix. In terms of in-band interference, it is expected that some additional protection measures will be required for IMT/5G systems to be compatible with the existing and widespread satellite use of the same

[28] https://docdb.cept.org/download/1675

spectrum. As technical studies by both the terrestrial IMT/5G and the satellite industries have shown, introducing terrestrial IMT/5G services in the same bands as satellite services could constrain the continued evolution of both services, in violation of the principles of Resolution 238[29]. Notably, these studies may understate the compatibility issues of terrestrial IMT/5G with satellite use of the 28 GHz band, because in its separate 3GPP standards process, the terrestrial IMT/5G industry is defining terrestrial IMT/5G technologies

x. Separate and apart from incompatibility issues is the risk of aggregate IMT/5G interference from any terrestrial transmissions in the 28 GHz band into satellite receivers in space (which are designed to receive 28 GHz uplink signals from satellite user terminals and gateways). This issue has not been studied at the ITU in the context of today's broadband satellites, because designating the 28 GHz band for terrestrial 5G services was not on the agenda of WRC-19 when it considered allocation of mmWave bands for IMT.

xi. Satellite stakeholders have supported the study and the development of reasonable operating parameters for terrestrial IMT/5G in the 26 GHz band through the ITU WRC-19 process. To this end, it is expected that the DOT and TRAI will conform domestic deployment of terrestrial IMT/5G in the 26 GHz band to the operating parameters decided in Resolution 242 (WRC-19) as well as additional out-of-band domain and spurious domain emission limits described. It is noted the importance of the portion of Resolution 242 (WRC-19) that requires IMT/5G base stations within the 26 GHz band with higher power operations (e.i.r.p per beam exceeding 30 dB (W/200 MHz)) to not point their antenna beams upward at the geostationary satellite orbit and maintain a minimum separation angle of ≥± 7.5 degrees.

xii. There is a concern about potential out-of-band emissions from 26 GHz band IMT/5G systems into the 28 GHz band. Any departure from the spectrum use described in Resolution 242 (WRC-19) would increase out-of-band emissions in the 28 GHz band. The potential impact of increased out-of-band emissions from the 26 GHz band could adversely affect the interference environment in the 28 GHz band by impacting the ability of satellites receiving signals from earth stations TRAI must require appropriate out-of-band limitations on terrestrial IMT/5G operations using the 26 GHz band to protect satellite services in the 28 GHz band. At a minimum, terrestrial IMT/5G stations should be required to comply with out-of-band domain and spurious domain emission limits in the frequencies above 27.5 GHz as described in Recommendations ITU-R SM. 1541-6 and ITU-R SM. 239. In the case of ITU-R SM.329, the category B limits should apply. TRAI must ensure that the aggregate level of terrestrial out-of-band emissions from the 26 GHz band into the adjacent 28

[29] *See* ITU-R, Resolution 238 (WRC-15).

GHz band does not cause interference to satellite receivers in the 28 GHz band.

Attachment 2 - Global mobile Suppliers Association (GSA) mmWave coexistence study for India

Global mobile Suppliers Association
Technical Report
mmWave bands for 5G – India

Created: 03–09–2020
Version: 1.0: Published 15th October 2020

https://drive.google.com/file/d/1r41C_273dJx0fyp-ZpM0BPFlH-rwIzm6/view?usp=sharing

Attachment 3 – Detailed study of previous spectrum Auctions in India and other countries

Spectrum Auctions
in India
Key Learnings
&
Way Forward

Parag Kar

https://itu-apt.org/system/static/uploads/pdf/2021-12-16-Spectrum-Auction-Presentation.pdf see presentation by Parag Kar