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10 January 2022

Attention: Shri Syed Tausif Abbas
Advisor (Networks, Spectrum and Licensing)
Telecommunications Regulatory Authority of India
New Delhi
Email: advmn@trai.gov.in

Consultation Paper on Auction of Spectrum in frequency bands identified for IMT/5G

Respected Sir,

Viasat appreciates the opportunity to provide comments on the *Consultation Paper on Auction of Spectrum in frequency bands identified for IMT/5G*[1]. Viasat submits these comments to provide input on the questions posed in the consultation paper. Viasat's comments address questions related to the proposed identification of the band **27.5-28.5 GHz** as part of the auction plans. The plan to auction this spectrum is of concern to the wider ICT industry, space industry and whole-of-government because of the following regulatory risks TRAI is likely to encounter:

1) **India needs to prioritise spectrum for 5G consistent with service requirements:** global research[2] demonstrates that the highest demand for 5G spectrum is in the mid-bands (3.5 GHz), while there is little 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 does not have global uptake.

   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 by terrestrial players. 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. Viasat notes that Brazil, another large economy, recently attempted to

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1 Telecom Regulatory Authority of India (TRAI), Consultation Paper on "Auction of Spectrum in frequency bands identified for IMT/5G", https://www.trai.gov.in/consultation-paper-auction-spectrum-frequency-bands-identified-imt5g.

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

auction mmWave spectrum for 5G, which resulted in unsold spectrum[3]. Viasat also brings TRAI's attention to the fact that one of the major countries promoting 5G in the 28 GHz band, Korea, has not seen any material demand for 5G services in the 28 GHz band with just 161 mmWave 5G base stations deployed after several years instead of the required 45,000 by the end of 2021[4].

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[5].

2) **27.5-29.5 GHz (28 GHz) band spectrum is critical for India's growing space economy:** India's ability to address market demand for advanced High Throughput Satellite (HTS) networks that provide cost-effective broadband connectivity will be severely impaired if access to the core Ka band spectrum, including the critical 27.5-28.5 GHz band segment, is offered in the spectrum auction for IMT/5G. Today's advanced satellite networks depend on access to the entire 28 GHz band to deliver cost-effective connectivity to millions of people and hundreds of millions of devices annually. Any reduction of this spectrum will reduce India's access to satellite services for consumers and government users. Viasat notes the efforts of the India Government to advance its space economy, through initiatives being supported and prioritised by Prime Minister Narendra Modi[6]. Satellite access to the entire 27.5-29.5 GHz band is essential to fulfil these Government initiatives.

3) **Undermining the PM-WANI objectives:** connectivity for everybody in India is a complex mission that can only be achieved by a mix of terrestrial and satellite connectivity. Lowering costs of access to broadband services is a key input to the implementation of PM-WANI[7] objectives. Halving the required 28 GHz spectrum that satellites require will prevent India from realizing the benefits providing advanced broadband services to all in a timely and cost-efficient way. Viasat notes that national broadband infrastructure costs are significantly lowered when satellite-powered connectivity is incorporated into broadband initiatives such PM-WANI, as shown by recent studies in APAC[8].

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[3] 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/.

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

[5] 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/.

[6] The Economic Times, *Space sector has been opened up to 'exponentially innovate': PM Modi*, (Oct. 11, 2021), https://economictimes.indiatimes.com/news/science/space-sector-has-been-opened-up-to-exponentially-innovate-pm-modi/articleshow/86931871.cms.

[7] Department of Telecommunications, *PM-WANI Central Registry*, https://pmwani.cdot.in/wani.

[8] Cost of Infrastructure Ownership in APAC (Network Strategies, New Zealand): http://www.strategies.nzl.com/industry-comment/dedicating-28ghz-spectrum-band-to-satellite-services/

4) **Affecting India's regional position as market leader**: 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, 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.

The economic benefits estimated for India and the cost advantages available from 28 GHz satellite broadband services are only possible if the entire 27.5 – 29.5 GHz band is fully allocated and authorized for satellite services throughout India. India will be particularly vulnerable to demand constraints and higher costs if portions of the 28 GHz band are allocated to 5G/IMT, because 5G/IMT is being prioritised globally in spectrum below 6 GHz and because 28 GHz band for terrestrial 5G/IMT lacks global harmonisation. Viasat looks forward to further discussions on these important issues and would be grateful for the opportunity to have your kind audience for a short presentation on Viasat's solutions, technology, and capabilities to suit India's needs.

Viasat detailed comments to the questions posed are provided in the **attached annex**.

Sincerely,

Cristian Gomez
Senior Director
Government & Regulatory APAC

Enclosed: annex containing responses to the specific questions posed.

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About Viasat

Viasat is a global communications company that believes everyone and everything in the world can be connected. Founded in 1986 and based in Carlsbad, California; with 5800+ employees globally, including our engineering solutions team based in Chennai, India. Viasat's broadband services power hundreds of millions of internet connections annually on land, in the air, and at sea, with reliable networking and advanced cybersecurity. Viasat is recognized for quality satellite broadband solutions, for example, by U.S. News & World Report as one of the top internet service providers (ISPs) in the United States, by Fortune for advancing a commercial connectivity solution that has a measurable social impact, by CNET as the best satellite provider for rural connectivity in the United States, and by Fast Company's World Changing Ideas list for using satellite-connected Wi-Fi hot spots to provide broadband service where wireless infrastructure is too costly to install.

Viasat will start launching the next generation satellite broadband network, known as the ViaSat-3 constellation, next year followed by the ViaSat-4 network. These satellite networks are designed and built to operate across the entire 27.5-31 GHz band, including the critical 27.5-29.5 GHz (28 GHz) band (Earth-to-space) and the 17.7-21.2 GHz band (space-to-Earth). Today, these are the most effective spectrum bands for advanced, cost-effective satellite broadband services. Each of three ViaSat-3 global satellites will provide over one Terabit per second of throughput. ViaSat-4 will materially increase this throughput to 5-7 Terabits per second. Through technical advancements, Viasat has **been able to reduce satellite broadband capacity costs by a factor of 400 and increase capacity by a factor of 500**, when compared with legacy satellite networks. These advances, combined with the necessary spectrum, result in much higher speeds, and more bandwidth, at affordable costs that can be passed on to consumers and government users throughout the world, including in India on land, in the air, and at sea.

ANNEX: RESPONSES TO THE QUESTIONS POSED

Q5. Do you agree that TDD based configuration should be adopted for **24.25 to 28.5GHz** frequency range?

Viasat Response: The frequency range of the band identified for 5G/IMT by the ITU at WRC-19 is 24.25-27.5 GHz (known as 26 GHz band), among other mmWave bands[9]. Spectrum above 27.5 GHz is not identified for 5G/IMT by the ITU. In addition, the band 27.5-29.5 GHz has been protected by the ITU for satellite broadband services, including earth stations in motion (ESIM) at WRC-19[10], and is under study for expanded satellite use in WRC-23 Agenda Items 1.16 (non-geostationary ESIM) and 1.17 (satellite-to-satellite links).

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[11].

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

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.

WRC-19 during its lengthy deliberations, adopted an identification of the 24.25-27.5 GHz band for 5G/IMT. The Conference did not include the 27.5-28.5 GHz band as part of the 5G/IMT identification, as stated in the

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9 *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/.

10 *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.

11 *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.

TRAI Consultation Paper[12]. Use of spectrum for 5G/IMT in the 27.5-28.5 GHz band would be inconsistent with the RRs which are internationally binding treaty obligations.

In addition, the Parliamentary "Standing Committee on Information Technology (2020-21)" by the Seventeenth Lok Sabha in its report on "India's Preparedness for 5G" was presented to the Indian Parliament on 08 Feb. 2021 (and is included as an annexure to TRAI's CP[13]), reference use of the spectrum for 5G IMT only up to 27.5 GHz and not up to 28.5 GHz (*see* page 143, para 29). Moreover, on page 141, paragraph 23, the Cellular Operators' Association of India (COAI) provided a recommendation of a spectrum block size of 400 MHz per 5G operator in the mmWave bands, which can be easily met within the 3.25 GHz of globally harmonized 5G/IMT spectrum in the 26 GHz band (*i.e.*, 24.25 to 27.5 GHz), identified by WRC-19.

Q.8 Whether entire available spectrum referred by DoT in each band should be put to auction in the forthcoming auction? Kindly justify your response.

Viasat Response: Viasat supports the auction of the band 24.25-27.5 GHz for 5G/IMT but **strongly opposes to auction the band 27.5-28.5 GHz for 5G/IMT**. Viasat is of the view that offering the band 27.5-28.5 GHz for auction will not meet economic, technical, and long-term policy outcomes expected for the government digital vision of India because:

1) **There is a global lack of demand for 5G IMT in the 28 GHz** (and in mmWave bands in general) given its high cost of the deployment versus the reduced coverage (hundred metres) this spectrum can provide for terrestrial broadband. Demand studies support this view, as well examples of underutilisation and under-investment in South Korea, failure to sell this spectrum for 5G IMT in Brazil at auction, the US change of focus from mmWave to mid-bands, the commitment of Europe to preserve the full 28 GHz band for FSS satellite and ESIM as well as China, Russia, Australia, and dozens of other countries.

2) **Ubiquitous broadband via ESIM (land, sea, air) will serve connectivity needs of India** which cannot be provided by terrestrial 5G IMT infrastructure, and for which the full 28 GHz band is critical.

3) **Infrastructure costs for India will be significantly lower** if the full 28 GHz band is assigned to satellite-powered broadband while rapidly deploying connectivity using Ultra-High Throughput satellite broadband that can cover the entire territory. For example, the PM WANI initiative will be particularly well suited for expanding internet access rapidly and at lower cost. Recent infrastructure Total Cost of Ownership (TCO) studies confirm how satellite broadband is more cost effective when deployed as part of terrestrial broadband solutions and even more cost effective when combined with Wi-Fi. The following snapshot display a TCO comparison in one recent study[14]:

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[12] TRAI Consultation Paper, paragraphs 1.42 and 3.41.

[13] TRAI Consultation Paper, Annexure II.

[14] Dedicating 28 GHz for satellite: benefits from Total Cost of Ownership: http://www.strategies.nzl.com/industry-comment/dedicating-28ghz-spectrum-band-to-satellite-services/

The lowest cost alternative is scenario 3, followed by scenario 4. Both scenarios are more cost effective than the other two scenarios which include access over 5G technologies (Exhibit 4.2).

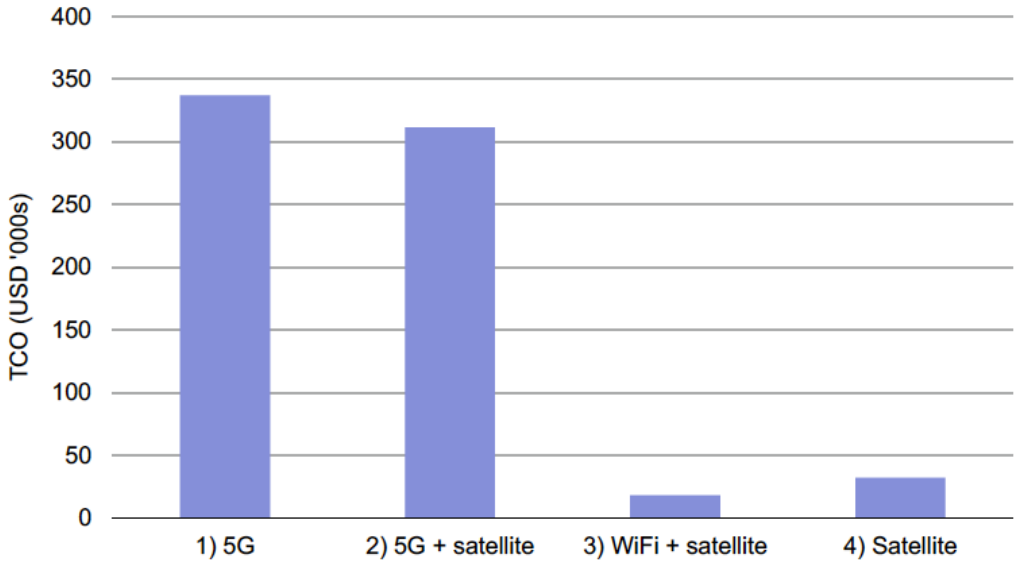

Exhibit 4.2: *Model results [Source: Network Strategies]*

Q.12 What should be optimal block size and minimum quantity for bidding in **24.25-28.5GHz**?

Viasat Response: 5G/IMT operators can provide 5G/IMT services using 400 MHz spectrum assignments in the mmWave bands, as recommended by the 3GPP standards organization. TRAI should align this 5G/IMT spectrum assignment size to the 5G/IMT spectrum blocks to be auctioned in the 26 GHz mmWave band. Spectrum offered for 5G/IMT services should also follow a full policy analysis of public resource allocation to include at least: 1) detailed demand analysis, 2) cost-benefit analysis of aligning the auction blocks with ITU harmonized allocations, 3) finalization, through public consultation, of the National Frequency Allocation Plan, 4) a space sector spectrum plan, via public consultation on spectrum requirements for satellite connectivity services, 5) consider, as policy option, the auction of 26 GHz band only (24.25-27.5 GHz) in accordance with global demands, given the global harmonization of that band and low level of uptake of mmWave spectrum for 5G/IMT services to date.

In addition, the Parliamentary "Standing Committee on Information Technology (2020-21)" by the Seventeenth Lok Sabha in its report on "India's Preparedness for 5G" was presented to the Indian Parliament on 08 Feb. 2021 (and is included as an annexure to TRAI's CP[15]), reference use of the spectrum for 5G IMT only up to 27.5 GHz and not up to 28.5 GHz (*see* page 143, para 29). Moreover, on page 141, paragraph 23, the Cellular Operators' Association of India (COAI) provided a recommendation of a spectrum block size of 400 MHz per 5G operator in the mmWave bands, which can be easily met within the 3.25 GHz of globally harmonized 5G/IMT spectrum in the 26 GHz band (*i.e.*, 24.25 to 27.5 GHz), identified by WRC-19.

Q.15 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?

Viasat Response: Viasat responds to Q.15 for the 24.25-28.5 GHz spectrum only. Viasat urges TRAI to only consider interference mitigation after a high-level plan has been devised and agreed for the use of each of the separate 26 GHz and 28 GHz bands. Viasat notes that 5G/IMT systems have been designed to be incompatible with 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.

In terms of in-band interference, IMT/5G systems are not being designed to be compatible with the existing and widespread satellite use of the same 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 satellite services, in violation of the principles of Resolution 238[16]. Notably, these studies may understate the incompatibility 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 that operate at very different parameters (such as power levels and antenna pointing) than those they otherwise have identified as relevant to the ITU studies[17].

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, again, the ITU did not even consider designating the 28 GHz band for terrestrial IMT/5G services.

Viasat has 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, Viasat urges the DOT and TRAI to 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 below. Viasat emphasizes 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

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15 *Id.*

16 *See* ITU-R, Resolution 238 (WRC-15).

17 *See* e.g., 3GPP TS 38.104 V15.2.0 (2018-06).

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.

In terms of out-of-band interference, Viasat, as with many satellite operators, uses the 28 GHz band. As such, we are concerned 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. Therefore, we respectfully request that the TRAI 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. Viasat also requests that the TRAI ensures that the aggregate level of terrestrial out-of-band emissions from the 26 GHz band into the adjacent 28 GHz band does not cause interference to satellite receivers in the 28 GHz band.

Q.20 What should be associated roll-out conditions for the allocation of spectrum in **24.25 to 28.5** GHz frequency range?

Viasat Response: Rollout conditions for 5G/IMT seek to maximise spectrum utilisation and prevent loss of opportunity costs. Rollout conditions should, therefore, be consistent with policy provisions for public resource utilisation to achieve maximum spectrum use. A plan for an auction of mmWave spectrum should follow a study of demand-supply and minimise risks of underutilization or suboptimal use by offering only the spectrum that is necessary to meet the market demand. Since the future of 5G/IMT in mmWave remains uncertain, TRAI should apply market analysis principles to minimise suboptimal spectrum assignment as follows:

a) As a first step, avoid the risks of a multiband 5G/IMT spectrum auction that is likely to result in spectrum being unsold or underutilized through lack of investment. Instead, TRAI should consider a simple auction to include only key bands with the highest global demand for 5G/IMT, for example the 3.5 GHz band, as shown in global studies of spectrum demand for 5G/IMT.

b) As a second step, auction only the 26 GHz band (24.25-27.5 GHz) at a later stage, since this band is globally identified for 5G/IMT and lacks demand (as shown in the cases of Brazil with unsold spectrum[18] and South Korea with unmet rollout conditions[19]). Viasat notes that WRC-23 will decide on additional IMT identifications in mid-band spectrum[20] (Agenda Item 1.2) and TRAI may wish to also incorporate these outcomes on its auction planning for the period 2022-2024.

[18] Unsuccessful auction of mmWave spectrum in Brazil 2021: https://www.reuters.com/business/media-telecom/brazil-reschedule-auction-unsold-5g-spectrum-minister-says-2021-11-05/

[19] Unmet 5G rollout conditions in mmWave in South Korea: http://www.koreaherald.com/view.php?ud=20210910000417

[20] WRC-23 agenda item 1.2: https://www.itu.int/en/ITU-R/study-groups/rcpm/Pages/wrc-23-studies.aspx

c) Plan and consider rollout conditions for 26 GHz uses after deployments of 5G/IMT have occurred in the 3.5 GHz band, ensuring these have been met first. Only plan at that stage the possibilities of auctioning 26 GHz according to market demands at that point in time; recognizing that in markets such as the United States, 5G in mmWave appears to be used by mobile customers in less than 0.7% of the time[21].

Q.23 Keeping in mind the importance of 3300-3670 MHz and **24.25- 28.5** GHz bands for 5G, whether spectrum cap per operator specific to each of these bands should be prescribed? If yes, what should be the cap?

Viasat Response: Viasat notes that the 26 GHz band spans 24.25-27.5 GHz. The current mobile spectrum landscape in India indicates oversupply, considering the 700 MHz band remains unsold over two previous auctions. In other words, the current mobile spectrum landscape in India indicates excess supply, which would require TRAI to carefully plan the next auction to match demand. As explained in Viasat's responses to the Consultation, Viasat urges TRAI to limit the inclusion of mmWave spectrum in any 5G/IMT auction to the internationally harmonized 24.25-27.5 GHz spectrum. The 3.25 GHz of spectrum available is more than adequate to meet any of the nascent and still uncertain 5G/IMT requirements for mmWave spectrum.

Q.26 For computation of overall spectrum cap of 35%, should the spectrum in 3300-3670MHz and 24.25-28.5GHz bands be included?

Viasat Response: Viasat notes that the 26 GHz band spans 24.25-27.5 GHz. The current mobile spectrum landscape in India indicates oversupply, considering the 700 MHz band remains unsold over two previous auctions. In other words, the current mobile spectrum landscape in India indicates excess supply, which would require TRAI to carefully plan the next auction to match demand. As explained in Viasat's responses to the Consultation, Viasat urges TRAI to limit the inclusion of mmWave spectrum in any 5G/IMT auction to the internationally harmonized 24.25-27.5 GHz spectrum. The 3.25 GHz of spectrum available is more than adequate to meet any of the nascent and still uncertain 5G/IMT requirements for mmWave spectrum.

Q.51 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?

Viasat Response: Viasat notes that the 26 GHz band spans 24.25-27.5 GHz only. Mobile spectrum pricing is largely valued using international price benchmarking across 5G spectrum auctions, and the large majority of these auctions have taken place in the mid-bands (3.5 GHz), for example, the recent US auction[22] of 5G/IMT spectrum in 3.7 GHz. Market-based assignments rely on pricing data from auctions for an indication of market price to set a base price and allow price discovery to occur via the auction. Therefore, it would be expected that TRAI will use pricing data from proxy 5G/IMT auctions, such as the 3.7 GHz spectrum auction in the US.

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[21] 5G mmWave connections used in less than 1% of the time in the US: https://www.lightreading.com/5g/the-age-of-mmwave-5g-sputters-to-dusty-death/a/d-id/770838

[22] S&P Global: *US C-band auction becomes world' costliest mid-band 5G auction yet* (Apr. 22, 2021), https://www.spglobal.com/marketintelligence/en/news-insights/research/us-c-band-auction-becomes-worlds-costliest-mid-band-5g-auction-yet.

Q.59 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/ 800MHz/900MHz/1800MHz/2100MHz/2300MHz/2500MHz/3300-3670 MHz/ **24.25 - 28.5 GHz**/ 526 - 698 MHz bands? Please support your suggestions with a detailed methodology and related assumptions.

Viasat Response: we note that the 26 GHz band spans 24.25-27.5 GHz only. Viasat notes that mobile spectrum valuation must consider the wider policy implications of placing specific bands for auction, for example, determining the highest value use of a band. The long-term economic impacts should also be considered, as the auction outcome may be detrimental to expected long-term benefits. The long-term economic benefits through spectrum use are directly related to the level of demand for spectrum by a particular service. This logic would point to the fact that demand for the band 27.5-28.5 GHz is driven by satellite broadband uses (spectrum committed for this service in over 100 countries). No significant demand exists for this band for 5G/IMT uses. Hence, in policy terms, the band 27.5-28.5 GHz does not represent a feasible option for maximum economic value as part of a 5G auction plan in India.

TRAI needs to consider demand trends, cost-benefits, and opportunity costs. This is because pricing a spectrum band will not meet policy objectives for resource allocation if all the costs arising from offering such asset are not considered. Viasat provides information to assist TRAI in undertaking these analyses below:

Satellite-powered broadband to connect the whole of India: spectrum requirements and economic benefits

India's vast territory, population density and demand for ubiquitous and reliable ultra-fast broadband requires careful allocation of spectrum resources to incentivize cost-effective deployment of broadband across India, with increased choices and solutions for consumers, businesses and government uses.

Spectrum access should be **prioritised according to demand** to those services that can realise the highest economic benefit for the citizens of India. For example, recent studies[23] indicate that countries are prioritising spectrum in the mid-bands (below 6 GHz) for the deployment of terrestrial 5G networks, with the majority of 5G deployments using the 3.5 GHz band.

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

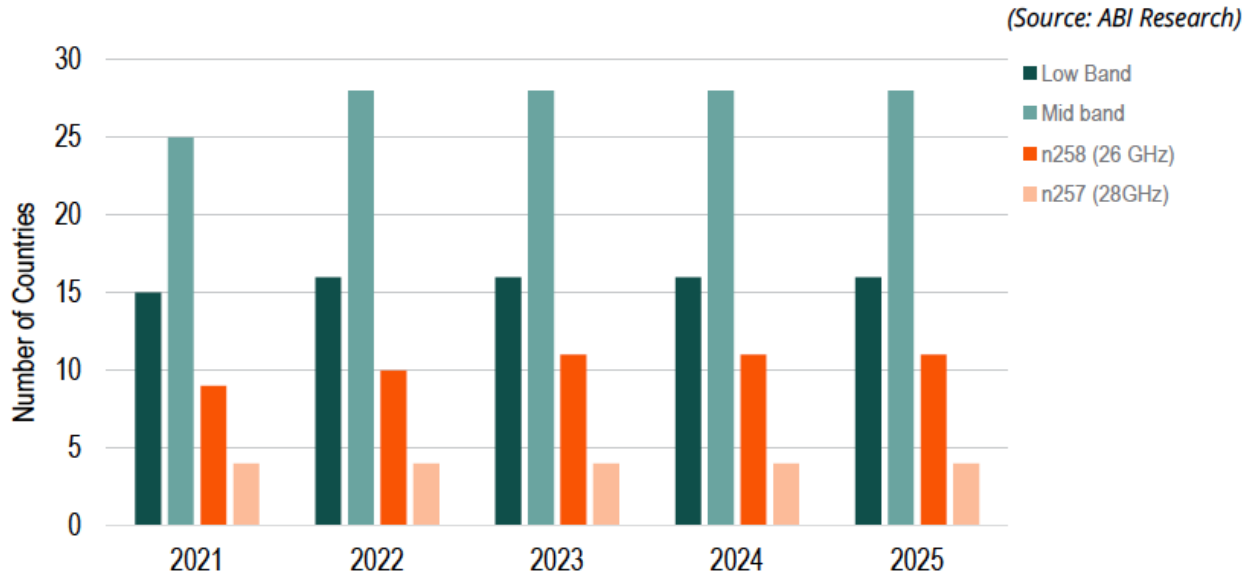

Figure 1. Current and expected spectrum allocation for terrestrial 5G in emerging markets, 2021-2025

In contrast, high bands in the mmWave spectrum **(26 & 28 GHz) are not being prioritised for terrestrial 5G/IMT** because of their high cost of deployment, greatly reduced coverage and limited ecosystem that can serve only niche applications, leading to a lack of demand. For India, the challenge to deploy terrestrial 5G/IMT is even greater, considering that 5G/IMT mobile networks must have access to fibre infrastructure (fibre availability in India represents only about 8% of the territory). The 26 GHz band (24.25 – 27.5 GHz) was globally harmonised for 5G (IMT) by the ITU at WRC-19 and Viasat supports use of the 26 GHz band for 5G/IMT in India. However, the **28 GHz band (27.5 – 29.5 GHz) is not a designated band for 5G/IMT by the ITU. The 28 GHz band is a critical band for advanced Ultra High Throughput Satellite networks, including for ubiquitous satellite ESIM[24] (maritime, aviation and land based) on a global basis, which has been validated by the ITU at WRC-19**.

Countries have prioritised the entire 28 GHz band (27.5 – 29.5 GHz) without fragmenting it or splitting it with 5G/IMT services, because 5G/IMT has vast amounts of spectrum available already (as seen in figure 1). For example, to fully benefit from the economics and national coverage of satellite-powered broadband, the entire European Union, most of the Americas, Africa, Middle East, China, Australia, and increasingly across ASEAN, have protected the band 27.5 – 29.5 GHz for its ongoing use for satellite broadband services.

Satellites are dependent on the amount of spectrum available to deliver services, and any reduction of available spectrum will impact the capacity available to the multiplicity of users being served. The prioritisation of the full 28 GHz band for satellite broadband will have a significant impact for India in terms of the potential economic benefits India can achieve from the use of this spectrum[25]. Splitting or reducing the

[24] ESIM: Earth Stations in Motion. Satellite broadband connectivity for applications requiring mobility (i.e., maritime routes and ports, aviation routes and airports, and ground-based mobility such as trains, trucks and government uses.

[25] 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/.

amount of spectrum available to satellite broadband services in the 28 GHz band will leave India unable to materialise these benefits and will impair India's ability to successfully plan and accommodate emerging demands that only satellite-powered connectivity can achieve.

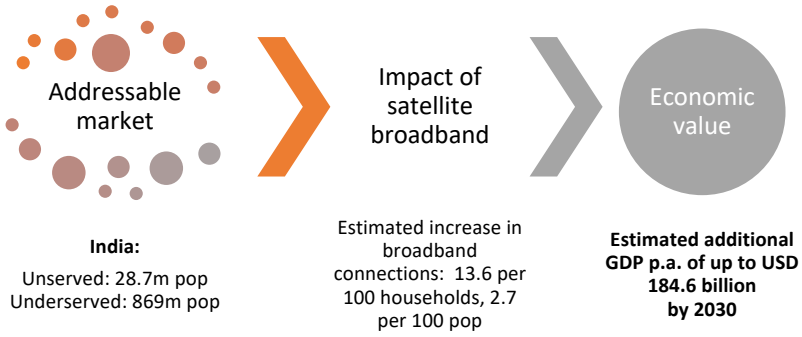

Figure 2. Estimated economic benefits of allocating the full 28 GHz band (27.5 – 29.5 GHz) for satellite broadband in India (Source: Plum Consulting, 2021)

In India, satellite-powered broadband deployment in the full 28 GHz band will contribute to economic benefits from:

- improved broadband service quality and ubiquitous access across urban and suburban areas
- broadband connectivity for unserved and underserved communities
- wider choice of broadband and pricing options
- new applications and connectivity services for expanding market segments, such as land, aeronautical and maritime transport routes, through ESIM.

This is particularly important in fulfilling India's commitments to connect 1.5 billion people in the next two years through the government led BharatNet and PM WANI projects.

The wider bandwidth which is possible through the use of the 27.5 – 29.5 GHz band for satellite means that satellite operators are able to deliver higher throughputs. Furthermore, new Ultra High Throughput Satellite systems operate multiple narrow spot beams that facilitate high frequency reuse, and these can be dynamically activated and configured to adapt to traffic demand and user density. These advantages translate into lower cost per bit transferred, as illustrated in figure 3 below[26]. Equipment costs for satellite systems using the 28 GHz band are also more affordable, smaller in size and widely available.

[26] Morgan Stanley Analysis… *LEO Satellites: Possibilities And Obstacles* (July 22,2020), https://news.satnews.com/2020/07/22/morgan-stanley-analysis-leo-satellites-possibilities-and-obstacles/.

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

Viasat Response: If considered, this should be in bands internationally identified for 5G/IMT uses by the ITU. 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[27]'.

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)?

Viasat Response: If considered, this should be in bands internationally identified for 5G/IMT uses by the ITU. 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[28]'. Technical risks exist from allowing private local use of spectrum for non-IMT and IMT uses outside bands identified for IMT.

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.

Viasat Response: If considered, this should be in bands internationally identified for 5G/IMT uses by the ITU. 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[29]'. Technical risks exist from allowing private local use of spectrum for non-IMT and IMT uses outside bands identified for IMT. To minimise risks of spectrum being hoarded, underutilised, or traded by private local users back to 5G/IMT operators (resulting in losses to the India Government and windfall gains to private network licensees), TRAI will benefit from first assessing the level of long-term demand, roll-out success, and spectrum efficiency of the use of the 26 GHz by 5G/IMT operators before committing any exclusive long-term use of spectrum to private networks. For example, in the case of South Korea, (where national 5G mobile operators failed to meet the rollout obligations in mmWave[30]), localized private 5G

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27 GSMA: *5G Network Slicing*, https://www.gsma.com/futurenetworks/ip_services/understanding-5g/network-slicing/.

28 *Id*.

29 *Id*.

30 5G mmWave implementation fails to meet rollout conditions in South Korea: http://www.koreaherald.com/view.php?ud=20210910000417

networks could be comfortably accommodated in the same band (26 GHz), as this band is likely to remain underutilised, as a result of a premature auction which led to an inefficient outcome.