

HUAWEI INTERNATIONAL PTE LTD
RESPONSE TO PUBLIC CONSULTATION ISSUED BY IMDA
ON
NEXT WAVE OF 5G GROWTH & DEPLOYMENT IN SINGAPORE:
POLICY ISSUES & PROPOSED REGULATORY DESIGN FOR 2.1
GHZ BAND

23rd August 2021



For the attention of:

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About Huawei

Huawei is a leading global provider of information and communications technology (ICT) infrastructure and smart devices. We are committed to bringing digital to every person, home, and organization for a fully connected, intelligent world. In fields of communications networks, IT, smart devices, and cloud services, we provide customers with competitive, secure, and reliable end-to-end portfolio of products, solutions, and services. Through open collaboration with ecosystem partners, we create lasting value for our customers, working to empower people, enrich home life, and inspire innovation in organizations of all shapes and sizes. At Huawei, innovation focuses on customer needs. We invest heavily in basic research, concentrating on technological breakthroughs that drive the world forward.

Founded in 1987, Huawei is a private company completely owned by employees. Currently, Huawei has more than 197,000 employees, among which more than 105,000 are R&D employees (53.4% of the total workforce). We operate in more than 170 countries and regions.

We have gained considerable recognition for our continuous progress. In 2020, we ranked 49th in the Fortune Global 500. We have invested more than 720 billion Chinese yuan over the past ten years. In addition, Huawei now ranks 3rd in the 2020 EU Industrial R&D Investment Scoreboard. This is a jump of two places compared to the previous year.

About Huawei 5G

Since its 5G research started in 2009, Huawei has submitted 35500 proposals to 3GPP. If printed out on A4 paper, the proposal copies would be stacked as high as 18 meters. With the largest investment in standards, the broadest domains of research, and the greatest number of patents, Huawei took the least time to convert standards to products.

From 2009 when its 5G research was started to 2020, Huawei has accumulatively invested more than USD 4 billion on 5G R&D. More than 10000 persons have been poured into 5G network research (not including terminals).

For more information, please visit Huawei online at <https://www.huawei.com/en/about-huawei>

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1. SUMMARY OF MAJOR POINTS

- 1.1. Huawei welcomes IMDA's proposal to reform the 2.1 GHz band for 5G use after the expiry of the existing 3G spectrum rights, while being mindful of IMDA's 5G SA policy outcomes. Though 5G SA deployments have gained some traction globally, the mainstream 5G variant is still NSA driving the economies of scales for 5G devices. For consumers to get better 5G speeds and MNOs to get the best of both worlds in the initial years, IMDA could consider allowing the deployment of 5G SA and NSA converged networks.
- 1.2. The emergence of Dynamic Spectrum Sharing (DSS) will provide means for MNOs to introduce 5G by allowing LTE and NR to share the same carrier of their existing spectrum. IMDA could consider permitting MNOs to adopt this technology on 4G or 5G spectrum bands on an interim basis until 5G subscribers becomes predominant.
- 1.3. Huawei concurs with IMDA that spectrum allocation for 3G is still necessary to provide voice and data services to subscribers still holding on to legacy handsets/devices, machine-to-machine (M2M) devices and inbound roamers. Huawei opines that 3G services ought to be retained until all areas currently served by 3G especially deep indoor areas can be fully covered by 4G for continuity of VoLTE and mobile broadband services, and a high degree of inbound roaming VoLTE penetration rate is achieved. MNOs also need time to persuade the remaining 3G subscribers to upgrade their subscriptions and devices.
- 1.4. Huawei agrees with IMDA's approach in allowing the 3.5 GHz band to be used in combination with the 2.1 GHz band to fulfil the 2.1 GHz band nationwide outdoor coverage obligations. In addition to the 3.5 GHz band, IMDA may consider allowing future other 5G spectrum bands or interim DSS carriers to be used for the same purpose. Huawei also proposes that all MNOs to have the same rollout obligations allowing the 3.5 GHz band or other future 5G bands to be used in combination with the 2.1 GHz band to achieve both the minimum 50% and 95% nationwide outdoor coverage milestones.
- 1.5. IMDA's 5G network security requirements and scope are reasonable and covers most of the industry best practices. Huawei is of view that all 5G network equipment should be certified based on the latest internationally-recognised standards namely Network Equipment Security Assurance Scheme (NESAS) version 2.0 and Common Criteria (CC).

2. STATEMENT OF INTEREST

- 2.1. Huawei would like to thank IMDA for inviting the industry and members of the public to comment on the proposed policy design of the 2.1 GHz spectrum band.
- 2.2. Huawei wishes to provide our views and comments to the IMDA's Public Consultation on 2.1 GHz Policy and Regulatory Design, and have submitted our response as set out in this document.
- 2.3. Huawei's overarching position in this document is to promote the adoption of 5G in Singapore including vertical industries' applications and rapid uptake from public for a 5G network experience far better than 4G. Based on Huawei's 5G market references globally, industry scenarios such as Industry 4.0 highly depends on the availability of SA networks to provide ultra-high speed and low latency services, while consumer services needs are mostly fulfilled with NSA network architecture. The public will consider coverage continuity and better experience when choosing 5G. Meantime, while VoNR is still in its infancy, VoLTE will become the de facto standard for 5G and 4G voice services and international roaming as Singapore welcomes more 5G adoption and sunsets 3G.

3. SPECIFIC COMMENTS

CHAPTER 2: TECHNOLOGICAL & MARKET DEVELOPMENTS

3G Networks & Services

Domestically – spectrum still needed to support 3G user needs

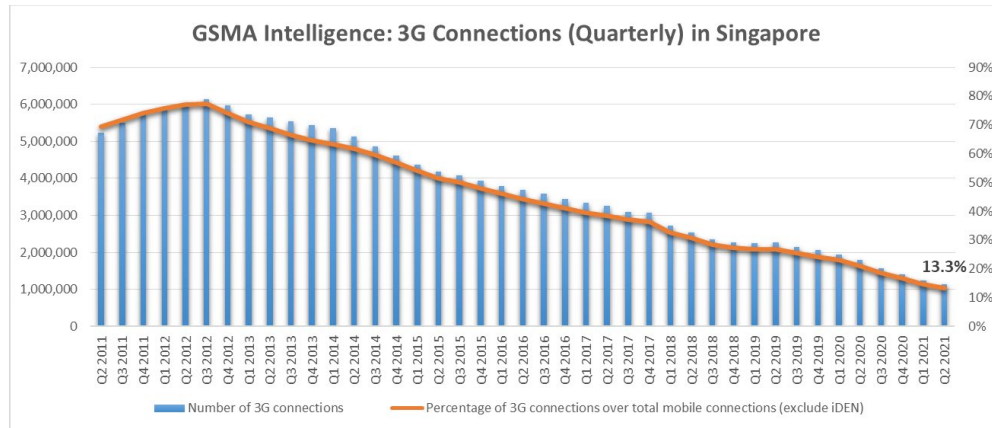
18. The 2.1 GHz band is the main spectrum band supporting 3G services in Singapore today. IMDA notes the following:

- a. While the total number of 3G subscribers in Singapore today has declined, this number is not insignificant. There are approximately 700,000 3G subscriptions as at April 2021 (close to 8% of all mobile subscriptions) and more than 1.5 million handsets/devices still depend on 3G networks today. These handsets and devices may not support 4G voice calls, or are still using 3G SIM cards. Affected users include seniors, foreign workers, transport operators, and healthcare organisations; and
- b. Inbound roamers such as tourists and business travellers may still rely on 3G networks, for both data and voice applications.

As such, 3G services remain relevant in Singapore in the short to medium term.

- 3.1. Huawei acknowledges that spectrum is still needed to support 3G user needs due to the reasons and findings presented by IMDA in paragraph 18 of the consultation paper.
- 3.2. Further to IMDA's findings, Huawei would like to supplement with information obtained from GSMA and Huawei's own market insights.
- 3.3. The latest figures from GSMA Intelligence suggests a downtrend in the number of 3G connections in Singapore which is at 1,130,587 as of end Q2 2021 (13.3% of the total mobile connections excluding iDEN connections in the total mobile connections).

Figure 1 Number and Percentage of 3G Connections in Singapore (Source: GSMA Intelligence)

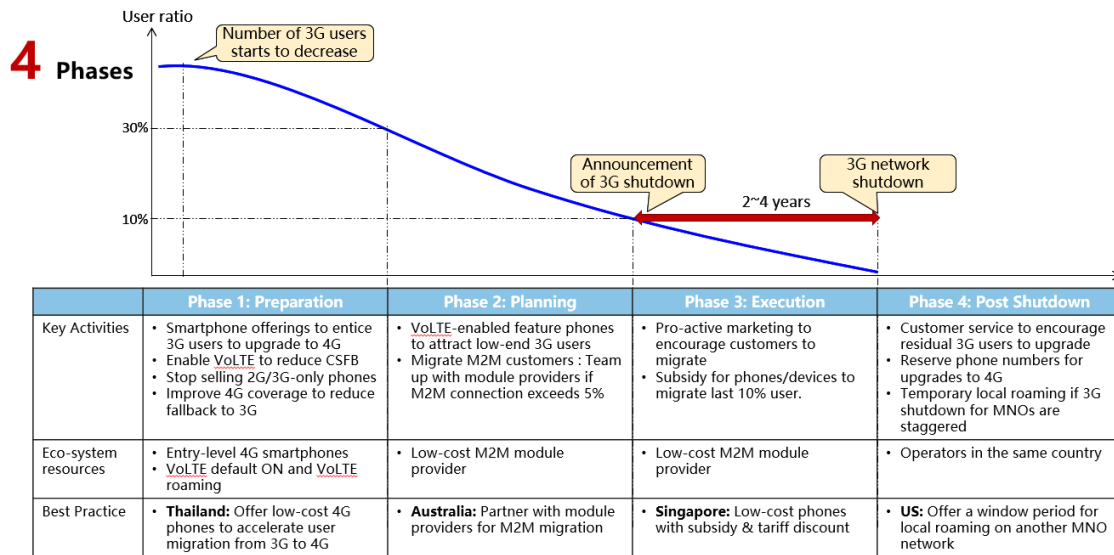


- 3.4. Although 3G is perceived as a sunset industry in Singapore, phasing out of this technology does not happen overnight. 3G services ought to be retained until all areas currently served by 3G especially deep indoor areas (such as inside lifts and basements) can be fully covered by 4G for continuity of VoLTE and mobile broadband services, and a high degree of inbound roaming VoLTE penetration rate is achieved.
- 3.5. Huawei views VoLTE as the most fundamental voice service for 5G, 4G users and inbound roamers after 3G is shut down. This is because 4G voice users can no longer perform Circuit Switched Fall Back (CSFB) to 3G while 5G SA users will rely on VoLTE for Evolved Packet System Fall Back (EPS FB) until VoNR becomes mainstream. Not to mention, at the present stage, VoLTE itself still lacks adoption globally, as there are only around 30% of the mobile operators that have launched 4G have also deployed commercial VoLTE services¹.
- 3.6. MNOs will need time to systematically migrate the remaining 3G subscribers out to 4G or 5G. Based on Huawei's market experience, MNOs could adopt a phased approach in shutting down 3G networks (refer to details in Figure 2) so as to minimise any adverse impact to the remaining 3G subscribers. Some best practices for the different phases are also mentioned in Figure 2.

¹ <https://data.gsmaintelligence.com/research/research/research-2020/volte-5g-will-provide-the-long-awaited-boost>

Figure 2 Four Phases for a Smooth Transition toward 3G Shutdown

Smooth Transition for Sunset of 3G



CHAPTER 3: PROPOSAL TO ALLOCATE 2.1 GHZ FOR 5G SA IN SINGAPORE

20. Bearing in mind the global technological and market developments discussed in the preceding section, as well as the state of our domestic mobile market, IMDA considers that the best and most efficient use of the 2.1 GHz band would be for the provision of 5G services. Therefore, IMDA proposes to refarm the 2.1 GHz band for 5G use after existing 3G spectrum rights in this band expire on 31 December 2021.

IMDA's 5G Policy Outcomes

23. In refarming 2.1 GHz for 5G, the long-term policy outcomes in IMDA's 5G Decision must be achieved. In particular:

- a. IMDA seeks to facilitate deployment of 5G on SA network architecture. This is because only SA network standards will deliver the full capabilities and performance of 5G such as network virtualisation, intelligence at network edges, and dynamic provisioning or differentiated services for different use-cases. This is opposed to 5G Non-Standalone (NSA) networks, which can only deliver faster mobile broadband speeds;

- 3.7. Huawei welcomes IMDA's move to refarm the 2.1 GHz band for 5G use after the expiry of the existing 3G spectrum rights, as the new spectrum right holders could leverage the better propagation characteristics of the 2.1 GHz to allow outdoor base station signal to reach deeper indoor areas as compared to 3.5 GHz or to rollout a whole new nationwide 5G SA network.

- 3.8. At the same time, Huawei is also mindful of IMDA’s 5G policy outcomes one of which is to facilitate the deployment of 5G on SA network architecture with full-fledged capabilities as opposed to on NSA architecture which can only deliver faster mobile broadband speeds.
- 3.9. Though the NSA architecture is an early variant of the 5G technology, this variant is currently still the mainstream architecture globally. According to the Global mobile Supplier Association’s (GSA’s) 5G Stand Alone Global Market Status: Member Report June 2021, the number of operators investing in 5G NSA has reached 440, while there are only 79 operators investing in public 5G SA networks (as shown in Figure 3). With more and more operators investing into 5G NSA, the development of 5G ecosystem will likely be geared toward 5G NSA for economies of scale. This is reflected in the same GSA member report (refer to Figure 4) where we see 303 commercially-available 5G SA devices out of all 810+ announced 5G devices. Out of the 456 announced 5G SA devices, 54% (247) of them take the form of phone.

Figure 3 Number of operators investing in 5G SA for public networks versus number investing in 5G non-SA (Source: GSA)

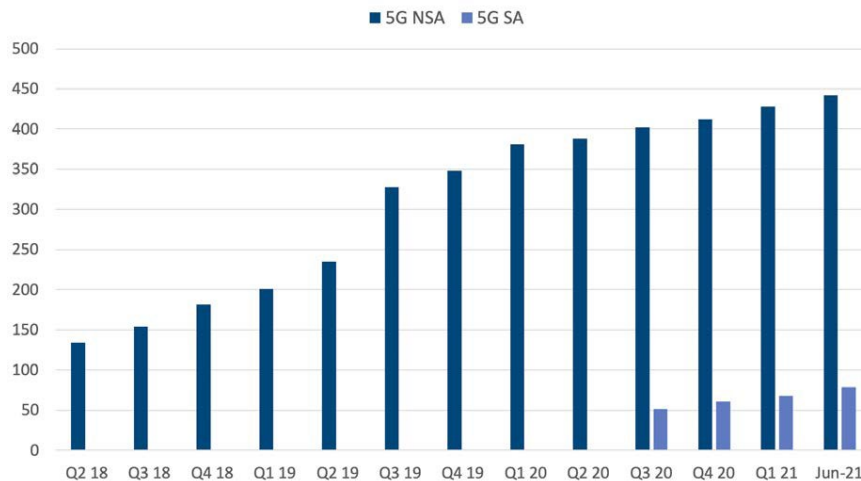
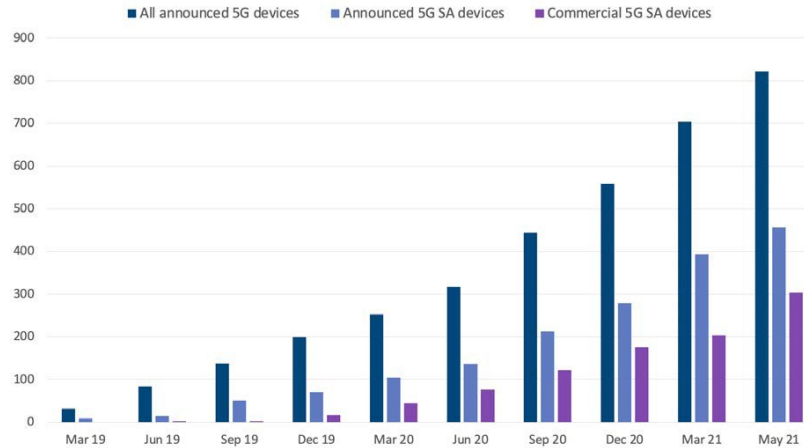


Figure 4 Announced and commercially available 5G devices with stated 5G SA support (Source: GSA)



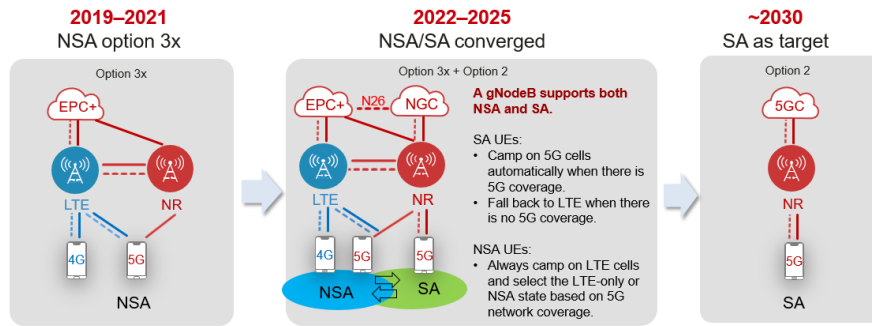
3.10. Huawei proposes that the MNOs bidding for the 2.1 GHz spectrum be allowed to deploy 5G networks on SA and NSA converged architecture so as to reap the full benefits from the 5G ecosystem and bolster the returns on investment in the initial years of 5G deployment where most of the expenditure is being channeled to spectrum and network infrastructure. The investments by MNOs into such deployments will be well-protected because the same RAN equipment (gNodeB) can simultaneously support 5G services from User Equipment (UE) that is either 5G SA/NSA dual-mode or NSA-only enabled (refer to Figure 5).

3.11. In the initial years of 5G, as 5G devices and services are predominantly for consumers, MNOs will want to build 5G networks that deliver faster mobile broadband speeds than 4G. Such 5G network performance can be realised by implementing either SA or NSA architecture depending on how much 5G spectrum each MNO owns. If the bandwidth of the 5G spectrum owned by an MNO is less than its 4G spectrum, adopting the SA/NSA converged architecture will not only allow this MNO to provide better consumer 5G speeds compared to SA-only architecture, but also fulfil IMDA’s 5G SA network rollout requirements.

3.12. Huawei envisions that both SA and NSA 5G variants will coexist for a long time until the 5G SA ecosystem matures and becomes mainstream globally.

Figure 5 5G NSA and SA Will Coexist for A Period of Time

RAN: NSA and SA Will Coexist for a Long Time, NSA Will Smoothly Evolve to SA



CHAPTER 2: TECHNOLOGICAL & MARKET DEVELOPMENTS

4G Networks & Services

Domestically – 4G spectrum remains important to support continuing demands of users and deliver good service experience for 4G users

17. 4G is expected to remain the “anchor” mobile technology and service in Singapore for some years to come. As 4G services are well supported by multiple spectrum bands, IMDA has assessed that there is less need to allocate additional spectrum for 4G at this juncture. In this connection, IMDA does not intend to provide additional spectrum and repurpose the 2.1 GHz spectrum for the provision of 4G services.

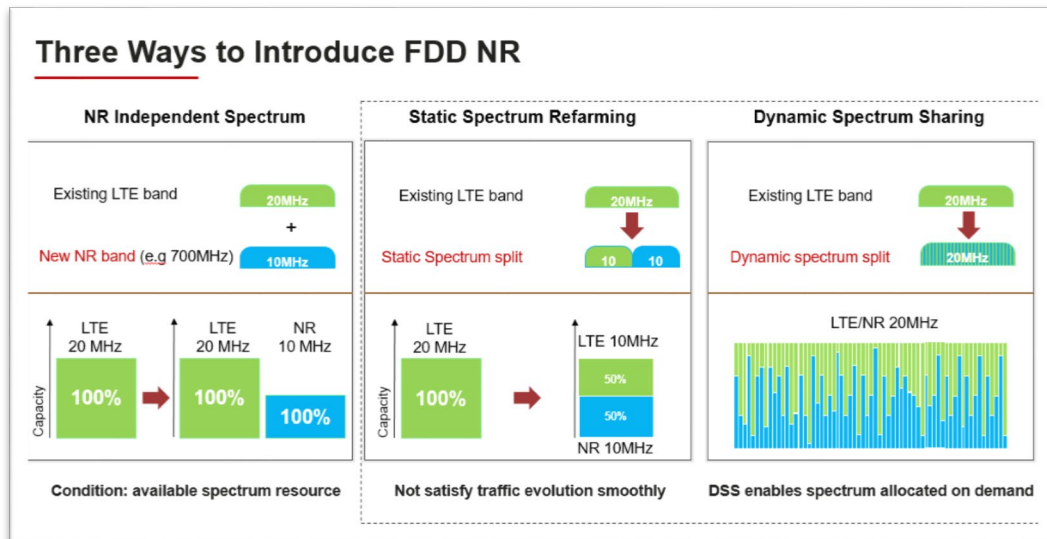
3.13. Meanwhile, as acknowledged by IMDA in paragraph 17 of the consultation paper, 4G will likely remain the “anchor” mobile technology and service in Singapore for some years to come. However, in the same paragraph, IMDA states its intention not to provide additional spectrum and repurpose the 2.1 GHz spectrum for 4G, as 4G services are well supported by multiple spectrum bands.

3.14. Huawei believes that IMDA has already carefully considered all factors before arriving at this conclusion. On the other hand, Huawei would like to highlight the emergence of technologies such as Dynamic Spectrum Sharing (DSS) that provides a very useful migration path from LTE to NR by allowing LTE and NR to share the same carrier. DSS² was included in 3GPP Release 15 and enhanced in Release 16. Further enhancements are expected to be included in 3GPP Release 17, which will ensure sufficient scheduling capacity for NR devices on the shared carrier as the number of NR devices in the network increases.

² Refer to 3GPP website for more details of DSS: <https://www.3gpp.org/dss>

3.15. Rather than adopting the traditional approach of spectrum refarming, MNOs can instead “gracefully” transition existing spectrum bands from being used for 3G or 4G to succeeding technologies such as 5G. In other words, by adopting DSS on existing spectrum bands, MNOs can in the interim monitor the traffic growth and uptake of 5G before deciding to completely refarm the spectrum. This flexibility will prevent MNOs from over-investing into 5G prematurely and offer MNOs a grace period to meet the demands and maintain/increase the quality of service on both 4G and 5G. Worth-noting, as 5G becomes mainstream, the users’ expectation on 4G service quality will become higher – full HD/4K video everywhere will become a norm, driving MNOs to continue to invest in 4G.

Figure 6 Dynamic Spectrum Sharing



3.16. There are three ways of introducing 5G spectrum, namely allocating new spectrum, static spectrum refarming and DSS (refer to Figure 6). The 3.5 GHz new spectrum band was issued as part of IMDA’s 5G Call for Proposal (CFP). As part of this consultation paper, IMDA proposes to statically refarm the 2.1 GHz band from 3G networks.

3.17. Going forward, with the increasing demand for 5G services and 4G traffic reaching near peak, more 5G spectrum can be introduced through either static refarming of existing 4G spectrum or implementing DSS on existing 4G band in the interim. Huawei is of view that DSS fits well into this scenario, being able to cater for uncertainties over traffic distribution between 4G and 5G within each cell-site, given DSS’s ability to allocate spectrum to 4G/5G on demand.

- 3.18. Apart from this scenario, IMDA could consider allowing DSS to be implemented on the 2.1 GHz band in the interim, so as to allow MNOs to meet 4G traffic demands in hotspots and areas with high user density especially during this on-going pandemic period.
- 3.19. On top of adopting DSS on 2.1 GHz to meet 4G and 5G traffic demands at the same time, MNOs can also consider implementing higher order Multiple Input and Multiple Output (MIMO) and beamforming solutions that can further enhance the spectral efficiency such as FDD massive MIMO. Such solution can provide capacity gains of up to 5 times and work hand-in-hand with DSS and 5G on FDD spectrum bands in near future.

CHAPTER 3: PROPOSAL TO ALLOCATE 2.1 GHZ FOR 5G SA IN SINGAPORE

Policy Issues for 2.1 GHz

Support Next Wave of 5G Growth for all MNOs & Service Enhancements

29. The deployment of all 5G SA nationwide networks must meet IMDA's requirements, in order to further IMDA's 5G policy outcomes:

a. All 5G SA networks must meet the following baseline requirements:

i. Commitment to deploy 5G SA networks – in line with the long term policy outcomes in IMDA's 5G Decision, MNOs must commit to SA deployments in 5G spectrum bands⁴;

ii. Rollout and deployment milestones

I. For 5G CFP winners⁵: Existing coverage commitments (i.e., rollout milestones) arising from the CFP will continue to apply. In relation to their nationwide (at least 95%) outdoor coverage obligations, CFP winners can use both the 3.5 GHz and the 2.1 GHz bands in combination to meet such obligations.

II. For all other MNOs⁶: IMDA will require such MNOs to deploy a new 5G SA network using the 2.1 GHz band which meets the 5G SA outdoor coverage requirements described below:

A. At least 50% using the 2.1 GHz band within 2 years from commencement of the 2.1 GHz spectrum rights; and

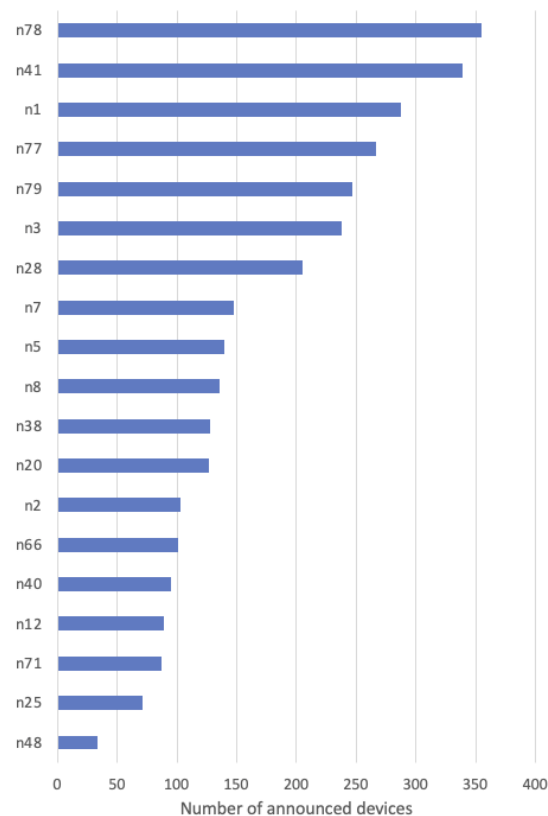
B. Nationwide (at least 95%) within 5 years from commencement of 2.1 GHz spectrum rights. The MNOs can use the 2.1 GHz band and any of their other 5G spectrum bands⁷ to meet the nationwide coverage obligation.

3.20. Huawei notes that IMDA proposes a set of baseline requirements for the deployment of all 5G SA nationwide networks, which are described in paragraph 29 of the consultation paper.

3.21. In regard to the proposed rollout and deployment milestones, Huawei concurs with IMDA's approach of allowing other 5G spectrum bands in combination with the 2.1 GHz band to meet 2.1 GHz deployment requirements. Specifically, IMDA proposes to allow the "5G CFP winners" to meet nationwide 5G SA outdoor coverage obligations with both the 3.5 GHz and the 2.1 GHz bands in combination, while "all other MNOs" to meet the nationwide coverage obligation with 2.1 GHz and any of their other 5G spectrum bands including the 3.5 GHz band.

3.22. Huawei is of view that apart from the 3.5 GHz band, any other spectrum bands could be used in combination with 2.1 GHz to meet rollout and deployment requirements, the reason being the emergence of a strong 5G SA ecosystem with chipsets and devices supporting spectrum bands more than merely 3GPP bands n78 and n1. Figure 7, extracted from GSA’s 5G Stand Alone Global Market Status: Member Report June 2021, shows that other than 3GPP bands n78 and n1, bands n41, n3 and n28 are supported by more than 200 announced 5G SA devices. In the same figure, we also notice the emergence of band n40 as being supported by 5G SA devices.

Figure 7 Sub-6 GHz support by band, announced 5G SA devices (Source: GSA)



3.23. While Huawei is well aware that spectrum bands n41, n3, n7, n8, n28, n38 and n40 are currently not being earmarked as 5G spectrum bands in Singapore, IMDA could consider allowing the use of these bands to meet the 2.1 GHz rollout and deployment requirements in case they are later being designated as 5G spectrum bands or allowed as DSS carriers on interim basis. Allowing so will bolster IMDA’s 5G policy in delivering the full capabilities and performance of 5G SA networks. Huawei recalls that IMDA has mentioned in the *SECOND*

CONSULTATION ON 5G MOBILE SERVICES AND NETWORKS dated 7th May 2019 that in terms of 5G capacity, spectrum holding of less than 40 MHz would not give throughput speeds that are noticeably different from 4G today. By allowing other 5G spectrum bands to be used in combination with 2.1 GHz will level the playing field for all MNOs and allow them to hold spectrum of more than 40 MHz.

- 3.24. Other than the nationwide outdoor coverage obligation, IMDA also requires “all other MNOs” to achieve at least 50% 5G SA outdoor coverage using 2.1 GHz within 2 years from commencement of the 2.1 GHz spectrum rights. “All other MNOs” mentioned here include 5G CFP joint winners that may be bidding separately and deploying their network with 2.1 GHz in a manner that is not made known by IMDA in the current consultation paper. Based on Huawei’s understanding, if the joint winners of 5G CFP bid separately and deploy their network in the manner not mentioned, they will need to concurrently meet the 50% outdoor coverage requirement and rollout milestones for both the 3.5 GHz and 2.1 GHz bands at the same time.
- 3.25. Huawei is of view that the rollout and deployment requirements should be structured in such a way that provides full flexibility and neutrality to MNOs in deciding the manner in which the 2.1 GHz spectrum be used to deploy their 5G SA network, which is deemed most profitable and sustainable to their businesses. In other words, we propose that all MNOs, not differentiating between “5G CFP winners” and “all other MNOs”, to have the same rollout obligations allowing the 3.5 GHz band or other future 5G bands to be used in combination with the 2.1 GHz band to achieve both the minimum 50% and 95% nationwide outdoor coverage milestones.

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iii. Network design and resilience

The design of 5G networks should meet (I) key resilience and security requirements stipulated in the relevant IMDA Codes of Practice (or exceed such requirements where possible); and (II) IMDA's resilience and cybersecurity requirements specified based on the following principles, from the outset:

- I. **Defence-in-Depth**: Adopt security-by-design principles by implementing various defence mechanisms which are secure and scalable (e.g., capability to turn on encryption upon request);
- II. **Zero-trust Environment**: Ensure that the 5G network is always secure and trusted through the deployment of network security solutions (e.g., implementing a “demilitarised zone” and other relevant measures);
- III. **Network Element Assurance**: Ensure that a risk assessment strategy and policy will be applied to the 5G infrastructure (e.g., through policy compliance with the Network Equipment Security Assurance Scheme currently being defined by 3rd Generation Partnership Project (3GPP) and Global System for Mobile Communications, and demonstrate how security assurance is achieved such as through the security testing of equipment);
- IV. **Resilience by Outcome**: Demonstrate end-to-end network resilience to minimise outages and impact;
- V. **Minimise Dependency**: Configure network, to the extent feasible, to minimise instances where a failure of the (a) fibre network used to provide broadband services, and/or (b) infrastructure used to provide other mobile services in a geographical area, could also affect 5G services in the same geographical area; and
- VI. **Adopt Technology**: Use of advanced technologies for resilience purposes, e.g., the use of automation and machine learning to detect, respond and recover from service disruption expeditiously; and

3.26. IMDA has set a reasonable scope to cover most of the consideration on network security. International standards like Network Equipment Security Assurance

Scheme (NESAS) and/or Common Criteria (CC) which is the globally accepted security baseline will be a good reference for IMDA.

3.27. NESAS, as a standardised cybersecurity assessment mechanism, has been jointly defined by international bodies such as GSMA and 3GPP together with major global operators, vendors, industry partners and regulators. It provides an industry-wide security assurance framework to facilitate improvements in security levels across the mobile industry. Network equipment vendors subject their product development and lifecycle processes to a comprehensive security audit against the current active NESAS release. Security Assurance Specifications (SCAS) will specify the security requirements and test cases for network equipment implementing one or more 3GPP network functions.

3.28. For example, in the latest NESAS Version 2.0, it has introduced updates to the definitions and terms as below:

- 3.28.1. Compliance Declaration and Conformance Claim templates introduced
- 3.28.2. NESAS development and product lifecycle management document updated to apply more generically to potential NESAS derivative schemes
- 3.28.3. Auditor competency requirements and guidelines added
- 3.28.4. Interim development and product lifecycle management audits are provided for
- 3.28.5. Evidence evaluation and product evaluation added to the test lab requirements
- 3.28.6. New security requirement on third party components added to the scheme

3.29. The other certification like CC certification is another widely-recognised security certification which provides standardised guidelines and specifications to evaluate 5G products on whether they have reached to the level of trusted security assurance for 5G wireless access.

3.30. In term of execution, IMDA, as our government regulator, will set the policies and regulations regards to the necessary certification for 5G security assurance, while the MNOs will need to work closely with their equipment vendor to ensure that the certification requirements are met as they roll-out the 5G network.

4. CONCLUSION

Huawei is happy to clarify any doubts or questions that IMDA might have in regard to our response to this consultation paper.

5. REFERENCES

- 5.1. GSMA Intelligence
- 5.2. Global mobile Supplier Association's (GSA's) 5G Stand Alone Global Market Status: Member Report June 2021
- 5.3. 3GPP website: <https://www.3gpp.org/dss>
- 5.4. GSMA website: <https://www.gsma.com/security/resources/fs-13-network-equipment-security-assurance-scheme-overview/>
- 5.5. Common Criteria website: <https://www.commoncriteriaportal.org/ccra/index.cfm>