M1'S RESPONSE TO IMDA'S SECOND PUBLIC CONSULTATION ON 5G MOBILE SERVICES AND NETWORKS

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PART I: INTRODUCTION

1. M1 is Singapore's most vibrant and dynamic communications company, providing mobile and fixed services to over 2 million customers. With a continual focus on network quality, customer service, value and innovation, M1 links anyone and anything; anytime, anywhere.

2. IMDA's vision is for Singapore to have a thriving digital economy, where every business is a digital business, every worker is empowered by technology, and every citizen a connected citizen. IMDA envisages Singapore to be a global front-runner for innovation in secure and resilient 5G applications and services, and identifies four key focus areas to create a thriving 5G ecosystem in Singapore:

a. Establish regulatory frameworks and policies to maximise value for the economy and welfare for consumers;

b. Enable trusted and resilient 5G systems and services;

c. Enhance the expertise (and quality) of the workforce in 5G and future of networks; and

d. Support a multiplicity of use-cases to anchor Singapore's position in global innovation.

3. M1 supports IMDA's vision and initiatives to create a thriving 5G ecosystem in Singapore. 5G technology and networks will be a critical part of a thriving 5G ecosystem and Singapore's digital economy. Therefore, we believe it is important that the Government's policies and regulatory frameworks are developed to encourage investments in 5G infrastructure, applications and services. We also believe it is important to foster collaboration and partnerships amongst the Government, industry players, institutions and public in the development of 5G. A buy-in from all stakeholders will ensure that there are co-ordinated and concerted efforts to spearhead Singapore to be a global front runner as a Smart Nation.

4. M1 welcomes the opportunity to submit our comments on the second consultation on 5G mobile services and networks. Our specific comments to IMDA's questions are set out in the few sections below:

a. Part II: 5G for Singapore;

b. Part III: Proposed Regulatory Policy and Framework for 5G Deployment in Singapore;

c. Part IV: Initial 5G Market Structure and 3.5 GHz and mmWave Band Plan Options;

d. Part V: Key Obligations and Requirements for 5G Call-for-Proposal; and

e. Part VI: Other Facilitations and Reviews Required

PART II: 5G FOR SINGAPORE

Question 1: *IMDA would like to seek the industry's views on skills requirements and the potential job demands in the future of networks and next generation of application/use-cases with 5G technology.*

5. M1 agrees with IMDA's observation that the major shifts in deploying networks of the future, including 5G, will require a transformation in skills. 5G is expected to support multiple technologies and create a multiplicity of new IoT use cases and applications. We are of the view that new technical skills and job demands in following areas will play an important role in 5G development:

a. New technologies such as Software Defined Networking ("SDN") and Network Functions Virtualisation;
b. IP routing, IOT and cloud applications;
c. Network security requirements; and
d. Radio frequency and fibre technologies, as 5G relies heavily on both wireless and wireline transport medium.

Question 2: *IMDA would like to seek views on: (i) the types of innovative use-cases that could capitalise and further enhance Singapore's competitive advantages, trigger new growth potential and/or strengthen Singapore's existing strategic pillars; and (ii) areas of government support that the industry require in order to enable innovation and development in 5G.*

Potential 5G Use Cases

6. Businesses and consumers are expected to benefit from the transformative impact of 5G. As IMDA has pointed out in its consultation paper, potential use cases for businesses would include automated factories and autonomous systems (e.g. vehicles, drones, logistics load carriers) to achieve greater operational efficiencies, effectiveness and security. Such benefits can positively impact a wide range of vertical industries, such as manufacturing, automotive, healthcare and media sectors. For consumers, 5G would mean that they can enjoy on-demand content with more interactive and immersive experiences. Real-time, anticipatory and autonomous services enabled by 5G such as driverless cars, seamless cloud-based translation, and remote medical services will also enrich consumers' lives.

7. While there is excitement over what 5G can deliver, M1 would caution that 5G is still nascent and commercial use cases are uncertain. M1 is of the view that in the near term, digitalisation and automation of processes, through harnessing the use of real-time data and enhanced connectivity to achieve greater operational efficiencies, effectiveness and security, would build the foundation for different industries to evolve and develop new use-cases riding on 5G network and capabilities. We foresee 5G use cases to revolve around the enhanced Mobile Broadband ("eMBB") and Ultra Reliable Low Latency Communications ("URLLC") usage

scenarios in the near term. Some impending use cases may include high quality video surveillance, remote operation of vehicles, machineries, and ground robotics to improve productivity and safety, which can potentially be deployed in various vertical industries (e.g. manufacturing and industrial plants, maritime ports / shipyards, drone applications, security etc).

Areas of Government Support for 5G Development

8. A well designed, pervasive, secure and resilient 5G network is expected to support a multiplicity of 5G use cases and applications in a thriving digital economy. As highlighted in M1's response to IMDA's 5G consultation in 2017, the Government plays an important role in facilitating the deployment of 5G in Singapore.

9. A pervasive 5G network requires the nationwide deployment of macro base stations and small cells on buildings and street furniture (e.g. lamp posts, bus stops). Deployment of 5G infrastructure in underground MRT/road tunnels will also pose technical and cost challenges. Mobile operators often face challenges in obtaining approvals from building owners and various authorities to deploy their equipment. Facilitating access to commercial and non-commercial locations will be important. It is crucial that there is buy-in and co-operation from relevant stakeholders such that there are concerted national efforts in deploying 5G networks cost effectively and expediently.

10. There is also a need for a conducive and forward-looking regulatory environment to facilitate investment and deployment of the 5G network, and to encourage innovation on 5G use cases and applications. For example, regulations such as COPIF requirements would need to be reviewed to cater to 5G needs. Regulatory approval processes from various authorities can also be streamlined (e.g. providing a one-stop application and tracking process) to facilitate 5G deployment. As 5G is still nascent, a light-touch approach towards collaboration and funding of 5G trials should be encouraged, where failures can be tolerated to encourage innovation through learning from experience, rather than measuring outcomes based on performance deliverables.

PART III: PROPOSED REGULATORY POLICY AND FRAMEWORK FOR 5G DEPLOYMENT IN SINGAPORE

Question 3: *IMDA would like to seek views and comments on the suitable technical parameters, including the reasonable amount of guard band needed to reduce potential interference between IMT and FSS use in the 3.5 GHz band.*

Use of the 3.5 GHz C-Band Spectrum and Required Guard Band

11. IMDA has proposed to adopt the following strategies to achieve its key policy objectives for 5G:

a. Facilitate early deployment of 5G starting from 2020 based on the standalone ("SA") network specifications;
b. Facilitate sustainable competition with at least two nationwide networks in initial years;
c. Impose regulatory requirements to ensure 5G networks remain resilient and trusted; and
d. Provide flexibility in the regulatory frameworks to allow market to grow and adjust.

12. M1 agrees with IMDA's assessment that deployment of 5G starting from 2020 should be based on the SA architecture. M1 understands that the 3GPP standards based on the SA architecture has been frozen, and the SA architecture allows operators to deliver the full capabilities of 5G which the non-standalone ("NSA") architecture is unable to support, and adopt new technologies such as software-defined networks more effectively for end-to-end deployment. While various countries have made their announcements on 5G deployment, IMDA's strategy for deployment of 5G based on the SA architecture will help Singapore leapfrog to be a global front runner in 5G infrastructure, applications and services.[1]

13. Globally, the 3.5 GHz band is an important band in deploying 5G coverage. To facilitate 5G deployment, the availability of sufficient spectrum within the C-band is crucial, and GSMA has recommended that regulators should assign at least 100 MHz of spectrum per operator in the prime 5G mid-bands and 1 GHz of spectrum in the mmWave bands to best support the fastest 5G services.[2]

14. M1 notes from IMDA's consultation paper that 100 MHz of spectrum is set aside as guard band to prevent potential interference between IMT and FSS in the 3.5 GHz band. M1 proposes to make available the 3.6 – 3.65 GHz spectrum for restricted/indoors 5G IMT, and the guard band between IMT and FSS be reduced to 50 MHz. We believe this arrangement could be feasible, as the 5G indoor Equivalent Isotropically Radiated Power ("EIRP") is likely to be very low, while

[1] Singapore can also be the first country to have a full 5G in Asia.
[2] *5G Spectrum Positions*, GSMA, Nov 2018. Countries such as South Korea has also allocated 100 MHz each to 2 operators and 80 MHz to a 3rd one, as well as 800 MHz per operator in the 28 GHz band.

the indoor to outdoor isolation is considerably high. This arrangement could also be supplemented with proper design of 5G indoor infrastructure, which will reduce signal spillages and interference to FSS. M1's proposal will also make available two blocks of contiguous 100 MHz of spectrum within the C-band for mobile operators to deploy 5G coverage.

15. To maximise the efficient use of available spectrum, IMDA may also introduce proper mitigation measures to facilitate the co-existence of IMT and FSS.[3] Such measures may include outlining the restriction zones where there are dense deployment of FSS, and ensuring optimal antennae installation through techniques such as multi-antenna beam forming and antenna backplane screening.

Question 4: *IMDA would like to seek views and comments on the following: (i) whether the industry agrees with the timelines on the expected availability of the next wave of 5G spectrum; (ii) whether current deployments in the 2.5 GHz FDD spectrum band (based on 3GPP Band 7) and in the 2.5 GHz TDD spectrum band (based on 3GPP Band 38), should be refarmed to 3GPP Band 41 for future 5G services in Singapore, and the views on the associated cost and challenges.*

Next Wave of 5G Spectrum

16. In its consultation paper, IMDA has considered the next wave of spectrum bands that may be used for 5G in future. IMDA is of the view that these spectrum bands can be opened up a few years later, for example around 2025, when the global ecosystem is more ready for cost efficient deployment.

17. M1 agrees with IMDA's assessment that the ecosystem for the next wave of 5G spectrum will need more time to mature beyond 2021. Nonetheless, we would suggest that the preparation works to clear up the next wave of 5G spectrum should commence early, so that the new spectrum can be released in time when the demand exceeds the initial spectrum allocation.

Refarming 2.5 GHz Spectrum for 5G Use

18. M1 is of the view that refarming the spectrum in 3GPP Band 7 and 3GPP Band 38 to 3GPP Band 41 would not be a feasible approach at this point in time. Unless proper coordination between Singapore and its neighbouring countries can be implemented seamlessly and effectively, potential co-existence and interference issues are likely to arise. It will also be challenging to introduce additional operator-specific filters based on current 5G Active Antenna Systems ("AAS") technology, in order to support the co-existence of Band 41 5G services in Singapore and neighbouring countries operating 4G FDD services in the same band.

[3] As it is in the case of Hong Kong's Office of the Communications Authority ("OFCA), which had issued an information note detailing the mandatory implementation of mitigation measures to mitigate any potential interference between the FSS and IMT systems operating within the C-Band.

19. In addition, the 3GPP Band 7 currently serves a substantial amount of 4G traffic. If the spectrum is being refarmed, it will affect the service quality of 4G services.

PART IV: INITIAL 5G MARKET STRUCTURE, 3.5 GHZ AND mmWAVE BAND PLAN OPTIONS

Question 5: *IMDA would like to seek views, comments and suggestions on: (i) whether Singapore should have two nationwide networks as a start given the considerations and trade-offs; (ii) The proposed 3.5 GHz lot sizes and spectrum packages; (iii) Whether 5G equipment would be able to support 3.5 GHz bandwidths in multiples of 50 MHz; (iv) The value, if any, in assigning the remaining 50 MHz restricted 3.5 GHz spectrum in the same assignment exercise as the unrestricted lots; (v) The proposed mmWave lot sizes and preferred band plan option; and vi) The rank order preference of the 3.5 GHz spectrum package and mmWave lot combinations.*

Allocation of the 3.5 GHz C-Band Spectrum

20. M1 agrees with IMDA's assessment that there should be at least two nationwide networks as a start given the considerations and trade-offs in the C-band. However, we note that IMDA is considering to assign 2 spectrum packages of (a) a 50 MHz unrestricted lot, and (b) a 100 MHz lot comprising a 50 MHz unrestricted lot paired with a 50 MHz restricted lot. IMDA is of the view that there is little value in making available the remaining 50 MHz restricted 3.5 GHz (3.4 – 3.45 GHz) by pairing it with a 50 MHz unrestricted lot, as aggregating non-contiguous spectrum would be less efficient.

21. M1 is concerned with IMDA's proposed assignment approach. M1 believes it is critical to have a level playing field between the two nationwide 5G mobile operators. To this end, IMDA should assign two 100 MHz spectrum packages, each package comprising a 50 MHz unrestricted lot paired with a 50 MHz restricted lot. This will allow the deployment of two comparable 5G networks and facilitate sustainable competition in the wholesale and retail markets.

22. M1 proposes (as indicated in our earlier section) to make available the 3.6 – 3.65 GHz spectrum in the guard band between IMT and FSS for restricted use. The impact to FSS is likely to be minimal, as the FSS operates in the downlink (Space to Earth) direction and is unlikely to be affected by indoor or underground 5G systems. This approach will make available two blocks of contiguous 100 MHz spectrum for allocation.

23. If the use of 3.6 – 3.65 GHz spectrum in the guard band for restricted use is technically not feasible, M1 will then urge IMDA to make available the remaining 50 MHz restricted 3.5 GHz (3.4 – 3.45 GHz) spectrum for assignment. M1 expects the 3GPP standards Release 16 to be available in mid-2020 to support intra-band non-contiguous carrier aggregation, before the availability of 3.5 GHz spectrum in 2021. IMDA should allow mobile operators to assess how best to implement intra-band non-contiguous carrier aggregation and minimise spectrum inefficiency.

24. On 5G equipment, M1 understands that they would be able to support 3.5 GHz bandwidths in multiples of 50 MHz.

Allocation of mmWave Spectrum and Band Options

25. In its consultation paper, IMDA has proposed 3 possible band options for mmWave. Of the three possible options, IMDA's preference is for either Option B or C as the channelling arrangements are more aligned with the 3GPP bands n257 and n258. M1 would recommend the adoption of Option B, with spectrum lot allocation that is efficient for maximum bandwidth performance in mmWave. While this is the preferred allocation plan, IMDA should remain open to allocation adjustments in future when more mmWave spectrum are opened up for use.

26. On the rank order preference of the 3.5 GHz spectrum package and mmWave lot combinations, M1 prefers 100 MHz of C-band for both Lot A (3.45 GHz to 3.55 GHz) and Lot B (3.55 GHz to 3.65 GHz).

PART IV: KEY OBLIGATIONS AND REQUIREMENTS FOR 5G CALL FOR PROPOSAL

Question 6: *IMDA would like to seek views, comments and suggestions on: (i) the proposed network rollout and performance obligations to be imposed on the spectrum right holders; (ii) The methodology and measurement criteria for the coverage obligation; (iii) The network design and resilience challenges of 5G (in particular, enabling technologies, such as SDN, NFV and Cloud Computing that may fundamentally change how the network would be designed and deployed and possible measures to address them, and whether there are other aspects that should be considered to enable trusted and resilient 5G network; and (iv) the framework for the provision of 5G wholesale services.*

Network Coverage and Performance Obligations

27. In its consultation paper, IMDA has proposed for spectrum right holders for the 5G SA networks to provide >50% coverage within 24 months from the commencement of 3.5 GHz spectrum right, and to put the mmWave band to use within 12 months from the commencement of mmWave spectrum right. Spectrum right holders may use a combination of spectrum to meet the >50% coverage requirement.

28. IMDA also stated that as a start, it will not impose Quality of Service ("QoS") requirements on the nationwide networks, but reserve the right to do so subsequently when there is greater certainty on 5G demand.

29. M1 is of the view that IMDA should exercise some caution and flexibility with regard to imposing network coverage obligations. The 5G network rollout would be demand driven, and is also subject to mobile operators' abilities to access building sites and infrastructure to deploy 5G equipment. M1 would suggest IMDA considers a lower coverage requirement (e.g. >30%) within the 24 months, or allow a longer period to achieve >50% coverage. On the measurement criteria to ascertain network coverage obligations, M1 understands that indicators such as geographical area, population, and number of base stations deployed are commonly considered. To this end, we believe that the use of geographical areas would offer a simple and objective way to ascertain network coverage. Given that 5G use cases would be driven by the enterprise segment in the initial period, we suggest that IMDA allows operators to determine the coverage areas to fulfil the obligation. For example, IMDA should allow non-contiguous coverage, as the initial 5G use cases could be in scattered locations or hotspots to support the enterprise segment.

30. M1 also agrees that QoS requirements on the nationwide networks should not be imposed as a start. As 5G is expected to be different from 3G/4G network, where the formal is likely to be service experience driven, IMDA could work with mobile operators at a later stage to identify the suitable QoS requirements for 5G.

Network Design and Resilience

31. The 5G network architecture is expected to be diverse and distributed, supporting multiple technologies and a large number of connected devices. This will pose challenges to vendors and operators to ensure that all integration points in the 5G network will be secured, and a myriad of security specifications and best practices would have to be considered and adopted.

32. M1 envisages that a security-by-design approach needs to be adopted to ensure that security considerations are incorporated as the 5G network is built. We expect the 5G network design and operation to minimally comply with the relevant security specifications and best practices from international bodies, such as the 3GPP security specifications, cyber security guidelines from Cloud Security Alliance and Openstack, and the ISO/IEC standards. In addition, as the 5G network is expected to support Multi-Edge Computing ("MEC"), it is important that customers' applications do not reside within the 5G network. This will ensure that any threat from external applications will be isolated and will not affect the 5G network and other customers.

33. Unlike 3G/4G, 5G is expected to support more advanced capabilities such as the URLLC and massive Machine Type Communications ("mMTC") applications. Therefore, should there be a failure in 5G network, some applications and use cases in 5G would not be able to fall back on the 3G/4G network. Separate redundancy and resiliency measures may have to be considered for these applications. Voice and data services can still fall back on 4G, in the event that there is an outage in 5G network, or in locations where there is no 5G coverage.

5G Wholesale Arrangement

34. IMDA stated that spectrum right holders shall provide 5G wholesale services to other mobile service providers, specifically to any MNOs and MVNOs, upon request. The negotiation principles for wholesale access published by IMDA under the decision on "Framework for the Allocation of Spectrum for IMT and IMT-Advanced Services and for the Enhancement of Competition in the Mobile Market" dated 18 February 2016 continue to remain relevant and will apply. IMDA will update the negotiation principles guiding wholesale access provision and will issue a separate consultation in due course.

35. While M1 notes that the negotiation principles for wholesale access will remain relevant, we envisage that wholesale arrangements in 5G would be more complex, as 5G is expected to have greater flexibility to support various wholesale access arrangements and use cases. Therefore, while it is important that the wholesale access framework must facilitate level playing field and access to wholesale arrangements expediently, the framework should not be overly prescriptive and restrictive, and discourage investments in 5G.

Question 7: *IMDA would like to seek views, comments and suggestions on the spectrum assignment framework, including: (i) The proposed assignment approach; (ii) The spectrum right duration of the 3.5 GHz package and mmWave lots; (iii) The evaluation criteria, sub-criteria and weights to assess the proposals; (iv) The assessment methodology, including evidence (documentary or otherwise) to evaluate the proposals; and (v) The enforcement and/or audit mechanisms to ensure that applicants are able to deliver on their proposals.*

Spectrum Assignment Approach

36. In its consultation paper, IMDA has proposed to assign 5G spectrum via a call for proposal ("CFP") approach. Mobile operators will compete based on the merits of their proposals that can best deliver future-ready 5G networks to meet IMDA's policy objectives. Specifically, IMDA is considering to assign the 3.5 GHz and mmWave bands together via a one-envelope CFP approach. M1 supports IMDA's proposal to assign 5G spectrum via the CFP approach. Spectrum assignment via auction will undermine the investments in 5G infrastructure, and will not bring about the desired policy outcomes of building a thriving 5G ecosystem. IMDA would note that the previous spectrum in 2016 has led to unreasonably high spectrum prices and impact to the industry.

Spectrum Rights Duration

37. IMDA has also proposed around 12 – 15 years for the duration of spectrum rights to provide sufficient investment certainty for the mobile network operators, especially considering the denser deployment needed, while catering for technological changes and new 5G spectrum bands that will become available in the coming years. Additionally, IMDA has proposed for the 3.5 GHz and mmWave spectrum rights to expire at the same time. This implies that the mmWave spectrum rights will have a longer spectrum right duration. M1 is the view that the proposed 12 – 15 years spectrum duration would appear to be appropriate and is generally in line with global practices. Nonetheless, a longer spectrum duration (e.g. 20 years) will provide greater business certainty to operators and encourage investments in 5G.

Evaluation Criteria

38. IMDA has proposed the evaluation criteria of the CFP to be based on the following:

a. Network Rollout and Performance (30%)
b. Network Design and Resilience (40%)
c. Financial Capability (15%)
d. Offer Price (15%)

39. As 5G is still nascent and commercial use cases will take some years to develop, M1 believes it is critical that IMDA's policies and spectrum assignment approach are designed to encourage investment in 5G networks. M1 is concerned with the base price which mobile operators are expected to pay for the 3.5 GHz spectrum, given that IMDA is considering setting the base price using the international benchmarks of 5G spectrum auctioned prices. To encourage

the development of 5G, M1 is of the view that 5G spectrum licences should be assigned to mobile operators at no cost. M1 will urge IMDA to prioritise investment in long-term national infrastructure and the economic benefits which it can bring, over market valuation of the spectrum and revenue generation through spectrum fees. By assigning the 5G spectrum licences to operators at no cost, M1 would propose to simplify the evaluation criteria as follows:

a. Network Rollout and Performance (30%)
b. Network Design and Resilience (40%)
c. Financial Capability (30%)

<u>One-time Application and Processing Fees</u>

40. IMDA has stated in its consultation paper the successful applicants will be required to pay the one-time application and processing ("A&P") fees for both the 3.5 GHz and the mmWave bands, as set out below.

Spectrum	One-time A&P fee	Annual charge
3.5 GHz: 50 MHz unrestricted	S$3,000	S$77,000
3.5 GHz: 50 MHz unrestricted paired with 50 MHz restricted	S$6,000	S$154,000
mmWave: 800 MHz	S$48,000	S$1,232,000

41. M1 is concerned that the annual charge for the 800 MHz of mmWave appears to be disproportionately high. This implies that a mobile operator assigned with 5G spectrum in the initial allocation exercise could pay up to about $1.5 million in administrative fees on a recurring basis. M1 submits that IMDA should reduce the fees to commensurate the administrative efforts in managing the spectrum assignment. We believe the annual charge for mmWave should not be more than the charge for the 100 MHz spectrum in the 3.5GHz band.

Question 8: *IMDA would like to seek views and comments on the trade-offs (particularly on resilience, 5G capabilities) and technical feasibility of the various levels of infrastructure sharing.*

42. IMDA has stated that in view of the spectrum constraints in the initial years, it will encourage infrastructure sharing amongst mobile operators as a means of achieving more cost effective network deployment. In this regard, IMDA has highlighted a few possible sharing models in its consultation paper.

43. M1 understands that unlike passive network sharing, active network sharing (MORAN and MOCN) is less prevalent today. While active network sharing could facilitate a cost effective network deployment, it will also give rise to more complex technical and commercial arrangements especially when 5G is still a fledgling technology.

44. The hosted model is a simpler model, where each mobile operator assigned with the 5G spectrum can carry out their 5G network design, implementation, optimisation and future enhancement independently and efficiently. They are also able to work individually with other mobile operators and MVNOs to share their deployed 5G network resources and capacities, under the wholesale sharing principles which IMDA will seek to develop in due course. As active network sharing involves more complex arrangements, the hosted model may likely be the preferred approach in the initial period. Nonetheless, the final choice of the network sharing model is subject to the technical assessment and commercial arrangements between the sharing partners.

Question 9: *IMDA would like to seek views and comments on the following:*

(i) the synchronisation approach for 5G TDD networks in a multi-operator environment for the 3.5 GHz and mmWave bands, specifically for the following:

a. *Synchronised networks: the required frame alignment, compatible frame structures and BEM specifications for AAS and non-AAS base stations; and*
b. *Unsynchronised networks: the amount of guard band, geographical separation and BEM specifications for AAS and non-AAS base stations;*

(ii) the adoption of other suitable mitigation measures to mitigate interference between unsynchronised networks; and

(iii) the need for IMDA to mandate a regulatory requirement for synchronisation across the 5G TDD networks or leave it to operators to co-ordinate their network deployment and parameters in order to reduce interference between networks.

45. The 3GPP Release 15 specifications on 5G TDD requires coordinated network arrangement by defining a common selection of frame structure to support proper synchronisation across the 5G TDD networks operating in the same frequency band, so as to avoid causing interference.

46. However, in the upcoming 3GPP Release 16 specifications, M1 notes that a new feature called Dynamic TDD may provide a possibility of unsynchronised TDD network arrangement in certain usage scenarios. This may allow unsynchronised TDD deployment in indoor environment or small cells deployment, while outdoor deployment may still require proper coordination between 5G operators operating in the same frequency band. As the 3GPP Release 16 specifications have not been finalised yet, M1 would suggest that IMDA and operators conduct a further assessment on the unsynchronized TDD network arrangement after the completion of 3GPP Release 16 specifications.

47. We would also recommend that IMDA adopts a light-touch approach on 5G TDD network synchronisation and leave it to the mobile operators to coordinate on the network parameters for the synchronisation arrangement. IMDA should also facilitate the coordination with neighbouring countries on 5G TDD synchronisation to avoid cross-border interference. Currently, operator-specific filters are not available for AAS macro base stations and hence will not be able to mitigate cross-border interference.

PART V: OTHER FACILITATIONS AND REVIEWS REQUIRED

Question 10: *IMDA would like to seek views and comments on the following: (i) the interest from industry players to leverage 5G spectrum or other mobile spectrum bands for fixed-wireless services that support mobile connectivity; and (ii) the policies (e.g., spectrum allocation, numbering) that should be considered to facilitate such use-cases.*

48. M1 is of the view that there is likely to be little demand for fixed-wireless services in Singapore, as there is already nationwide access to high-speed connectivity over the Next-Generation Nationwide Broadband Network ("NGNBN").

49. IMDA has cited studies which suggested lower electromagnetic fields ("EMF") levels are expected for 5G deployments as compared to existing networks, and that exposure levels will also be a small fraction of the limits set by the International Commission on Non-Ionising Radiation Protection ("ICNIRP") and IEEE. M1 concurs with the importance of addressing public safety and health concerns that may stem from exposure to EMF, and encourages the alignment to international best practices on the applicable EMF limits. However, M1 would caution against imposing overly restrictive limits, or basing limits on subjective judgements that are not supported by a credible scientific basis. As highlighted by GSMA, the outcome of impeding mobile network roll-outs should be avoided to the extent possible[4], while ensuring that public interests are being considered.

[4] Arbitrary Radio Frequency Exposure Limits: Impact on 4G Network Deployment, GSMA, Nov 2014.