



**EXECUTIVE SUMMARY**

**DECISION ISSUED BY THE  
INFO-COMMUNICATIONS MEDIA DEVELOPMENT AUTHORITY**

**POLICY FOR FIFTH-GENERATION (5G) MOBILE NETWORKS AND  
SERVICES IN SINGAPORE**

**17 October 2019**

**EXECUTIVE SUMMARY**  
**DECISION ON POLICY FOR 5G MOBILE NETWORKS AND SERVICES**  
**IN SINGAPORE**

1. The Info-communications Media Development Authority (“**IMDA**”)’s vision is for Singapore to have a thriving Digital Economy, where every business is a digital business, every worker is empowered by tech, and every citizen a connected citizen. World-class connectivity infrastructure, both wired and wireless, will be needed to realise this vision. 5G, touted to be the next quantum leap in mobile technology, will be key in supporting Singapore’s efforts in attaining this vision.
2. On 7 May 2019, IMDA released its second public consultation on 5G. The consultation set out Singapore’s overall 5G vision and strategy, as well as the proposed policy design and regulatory frameworks to facilitate the deployment of 5G networks. At the end of the two-month public consultation on 9 July 2019, IMDA received comments from 63 respondents. IMDA thanks all respondents for sharing their feedback and views.
3. The sections below summarise IMDA’s overall 5G strategy for Singapore and the policy and regulatory framework for 5G network deployment, after taking into consideration all views from the public consultation.

**Overall 5G Vision and Strategy for Singapore**

4. 5G has the potential to support the transformation of industry sectors and the overall economy. Today, 5G is at the nascent stage of market and technology development. International 5G deployments have been focused on delivering higher speed connectivity, with limited demonstration of industrial and enterprise applications that leverage the full capabilities of 5G. Thus, there is an opportunity to position Singapore as a front-runner for innovation in secure and resilient 5G applications and services. Industry feedback supported this vision too.
5. The industry supported IMDA’s proposed 5G strategy to go beyond pervasive deployment of 5G infrastructure and to focus on growing the 5G innovation ecosystem. This was especially so in the areas of use-case and talent development.
6. As a start, IMDA in collaboration with the National Research Foundation launched a \$40 million grant in June 2019. This was to support the innovation and research efforts in 5G development for strategic clusters such as Maritime Operations, Urban Mobility, Smart Estates, Industry 4.0, Government

applications and Consumer applications, where benefits and transformative impact of 5G can be demonstrated, to provide deep learnings and to catalyse future 5G developments. The initiative also supports a series of open 5G testbeds and R&D efforts to foster collaboration amongst institutes of higher learning, industry and other government agencies and to drive capability development for 5G applications and services.

## **Policy Design and Regulatory Framework for 5G Network Deployment**

7. The industry largely supported the following policy outcomes for 5G network deployment in Singapore:
  - a. Maximise value of 5G for the economy and welfare for the consumers;
  - b. Facilitate efficient allocation of scarce spectrum resources;
  - c. Bring about 5G networks that are secure and resilient; and
  - d. Support the growth of Singapore's telecommunications sector.
8. However, in light of current market realities and the lack of readiness of the 5G equipment ecosystem today, industry players proposed some adjustments to the policy design and regulatory framework.
9. **Two 5G nationwide networks as a start:** IMDA holds the view that competition at the infrastructure layer, where feasible, will ensure that operators are incentivised to invest in new technology, innovate, upgrade and compete. Thus, it will be important to have at least two nationwide networks as a start. The limited spectrum resources in the initial few years are not able to support more than two nationwide networks with optimal capacity to deliver the full potential of 5G technology. IMDA will thus facilitate further competition at the services or retail layer. This will put Singapore in a stronger position to realise our 5G policy outcomes and grow our 5G innovation ecosystem.
10. **Two optimally sized spectrum packages to deliver full-fledged 5G capabilities:** To bring about two nationwide networks, IMDA will allocate equal amounts of the forerunner 3.5 GHz band, i.e., 100 MHz lot each. The industry has agreed that this was optimal. This is for the provision of nationwide 5G services in view of its better propagation characteristics to provide wide-area coverage. IMDA has commenced its exercise to move existing satellite users to alternative bands and targets to free up the 3.5 GHz band for 5G use from 2021 onwards.
11. The 26 GHz and 28 GHz bands (collectively known as “**mmWave**”) are the other spectrum bands identified for 5G to deliver ultra-high-speed broadband.

However, the short-range propagation of mmWave band means that the deployment on these bands will likely be localised. IMDA has assessed that there is sufficient mmWave band for all existing mobile network operators (“**MNOs**”) (i.e., four lots of 800 MHz) and will allow all four MNOs to acquire the mmWave band, if they wish, to deploy localised networks to enhance innovation to enterprise users.

12. IMDA will thus make available two spectrum packages, each comprising one 100 MHz lot in the 3.5 GHz band and one 800 MHz lot in the mmWave band. The remaining two mmWave lots will be assigned to other requesting MNOs.
13. To encourage services-based competition as a means to bring about greater choice and innovation, the two nationwide operators will also be required to provide wholesale services to other MNOs and mobile virtual network operators for locations where the 3.5 GHz band is used for 5G deployment.
14. **Longer spectrum duration to provide investment certainty:** The duration of the spectrum rights will be set at a longer duration of 15 years for the 3.5 GHz band and approximately 16 years for mmWave band<sup>1</sup>.
15. **Standalone networks to deliver full-fledged 5G capabilities:** There is global industry consensus that only 5G standalone (“**SA**”) networks can deliver full-fledged 5G capabilities such as network slicing, ultra-reliable and low latency communications (“**uRLLC**”) and massive machine type communications (“**mMTC**”)<sup>2</sup>. This is opposed to 5G non-standalone (“**NSA**”) networks, which are built over existing 4G networks and can only deliver faster speeds. While the equipment ecosystem for SA networks in the 3.5GHz band is more developed, the roadmap for the mmWave SA equipment ecosystem globally remains uncertain.
16. To ensure Singapore’s 5G networks are future-ready and can deliver full-fledged 5G capabilities, IMDA will require deployment of 5G SA networks over the 3.5 GHz band from the start. MNOs who wish to deploy NSA networks in the 3.5 GHz band, over and above their SA networks, must seek IMDA’s prior approval. MNOs must ensure that their NSA deployments will not compromise IMDA’s policy outcome of achieving two 5G SA networks and capabilities within the stipulated timeframes.

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<sup>1</sup> The 3.5 GHz and mmWave spectrum rights will end at the same time.

<sup>2</sup> Users can benefit from up to 25 times improvement in latency at one millisecond as well as the ability to support up to 1000 times more devices per square kilometre. 5G also offers the flexibility to slice network resources to provide differentiated and customised services for various use-cases.

17. As the roadmap for the mmWave SA equipment ecosystem is still nascent, IMDA will allow MNOs the flexibility to choose SA or NSA deployment for the mmWave band in the interim. For MNOs who choose to deploy NSA networks, these operators must deploy SA networks within 24 months from when the ecosystem is ready.
18. **Early network rollout with strong performance to support use-cases:** In view of the deployment challenges and the uncertainties of early 5G use-cases, IMDA will not require nationwide 5G SA coverage from the outset. Instead, IMDA will require operators awarded the 3.5 GHz band to achieve at least 50% outdoors 5G SA coverage within 24 months, i.e., end 2022. The proposed network architecture is expected to be able to support 5G use-cases requiring enhanced mobile broadband (“eMBB”) experience, uRLLC and mMTC, as well as network slicing, amongst other full-fledged 5G capabilities.
19. In view of IMDA’s policy outcomes, IMDA’s preference is for 3.5 GHz spectrum right holders aim to achieve nationwide 5G outdoor coverage within 5 years from the commencement of the 3.5 GHz spectrum right, i.e., by end 2025. The MNOs may propose a reasonable timeline to achieve nationwide coverage.
20. This approach will give the MNOs the flexibility to determine the areas for 5G rollout during the ramp-up period, while ensuring that Singapore will get to enjoy the full-fledged benefits of 5G.
21. **Resilient and secure 5G networks by design:** IMDA will require 5G networks: (a) be designed to meet key resilience and security requirements stipulated in the relevant IMDA Codes of Practice (and to exceed such requirements where possible); and (b) be architected based on principles such as Defence-in-Depth<sup>3</sup> and Zero-Trust Environment<sup>4</sup>, at the outset. These requirements are necessary in view of the increased security risks brought about by 5G networks that are virtualised with intelligence at the edge, and larger number of devices connected to them.
22. **5G operators to be selected based on merits of proposals that best deliver outcomes that meet IMDA’s policy objectives:** The allocation of spectrum for nationwide deployment will be done via a call for proposal (“CFP”) approach, instead of an auction. This is in recognition that the auction mechanism will not be able to bring about the desired policy outcomes in this first wave of spectrum assignment.

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<sup>3</sup> A series of defensive mechanisms that are multi-layered with redundancies to increase the security of a system and address different attack vectors.

<sup>4</sup> An organisation should not trust anything inside or outside the perimeters of its networks and systems and must verify everything trying to connect to its networks and systems before granting access.

23. Applicants will submit detailed proposals for their 5G deployment. IMDA will score and rank the proposals according to the following: (a) network design and resilience (40%); (b) network rollout and performance (35%); (c) price offered for one lot of 3.5 GHz band (15%); and (d) financial capability (10%). The weights reflect their relative importance vis-à-vis IMDA's 5G policy outcomes.
24. **Reasonable spectrum pricing:** The base price of one 100 MHz lot of 3.5 GHz band is \$55 mil, which had considered the intrinsic value of the 3.5 GHz band, international and local benchmarks, and IMDA's econometric assessment of Singapore's mobile market. Applicants must propose an offer price higher than \$55 mil. Given the adequate supply of mmWave band, IMDA will not impose any premium beyond the annual fees.

### Other Issues

25. **Active measures to address radio frequency ("RF") radiation related concerns:** IMDA notes the concerns from members of the public on health issues relating to 5G deployments. It has been assessed that the current ambient level of RF radiation is very low in Singapore, typically below 0.7% of the International Commission on Non-Ionizing Radiation Protection ("ICNIRP")'s guidelines. The World Health Organisation has also found no convincing scientific evidence of adverse health effects from very low RF exposures to populations or individuals.
26. IMDA will conduct measurements for emissions from mobile networks, including 5G operations, to ensure that the networks' RF radiation levels in Singapore continue to be well within the ICNIRP guidelines.
27. **Facilitation for 5G network rollout:** 5G networks will be dense and require more use of public and private space and furniture. They may include areas such as rooftop spaces, street lamps and sign posts. IMDA will work closely with other agencies to facilitate the smooth deployment of 5G networks, as well as address any deployment concerns.

## Next Steps

28. MNOs will be invited to participate in the CFP process, starting 17 October 2019. Interested MNOs can submit their proposals for 5G spectrum by 12 noon, 21 Jan 2020.
29. IMDA will review the proposals submitted and aims to announce the CFP award decision by mid-2020.