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Infocomm Media Development Authority  
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Dear Ms Aileen Chia,

RE: Second Consultation on 5G Mobile Services and Networks

Jakkolab thanks IMDA for the opportunity to comment on the rollout of 5G network and services in Singapore.

Jakkolab is a Management Consultancy specialising in Telecommunication and Digital Transformation. It is headed by our Founder, Director and Principal, CHIA Wai Kong who has more than 30 years of global infocomm technology (ICT) experience with Hewlett-Packard, Agilent, Ericsson and Huawei. We offer ICT education and consulting through our partners, and consultancy to regional enterprises for Digital Marketing and Digital Transformation.

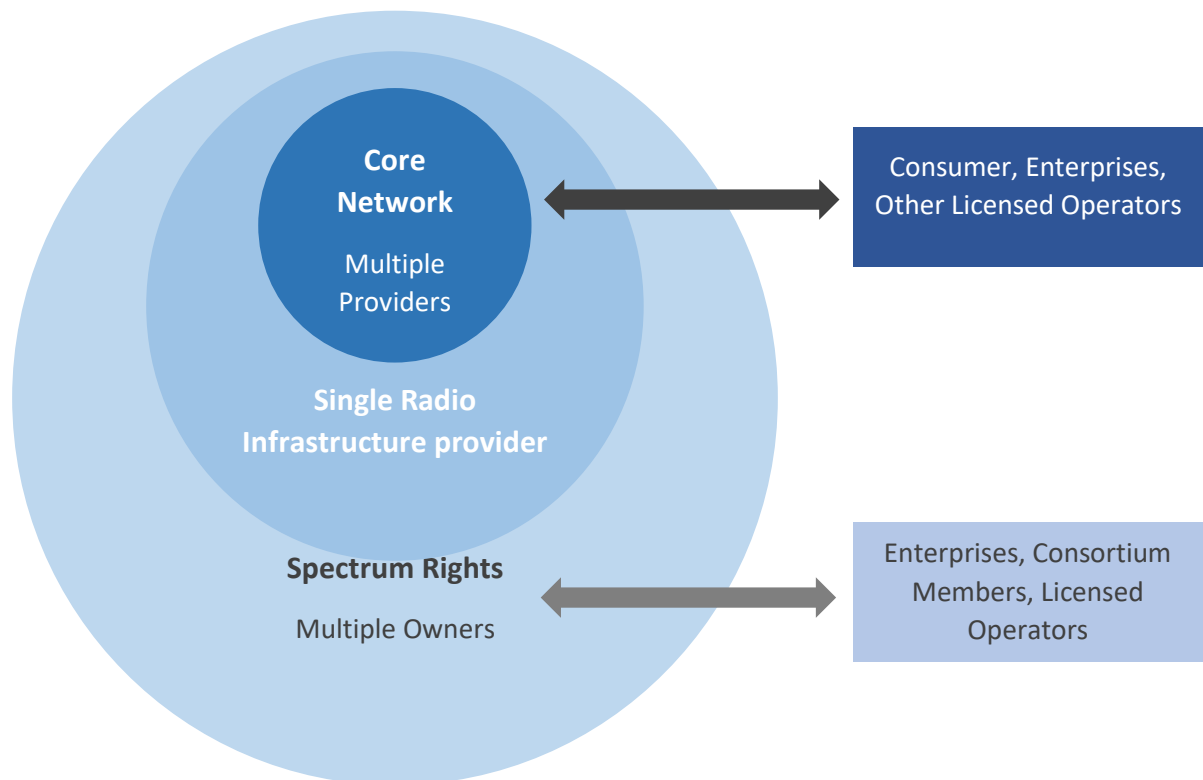
5G mobile network will be a disruptive innovation and implementation. Due to its speed, low latency and high volume of supported devices, 5G technology will bring many new applications in industrial and consumer space. This will allow the development of new business models to flourish, many of which may not even have been imagined today.

It is also disruptive in its implementation because of the large number of cell sites and antennas required. To deploy these equipment, much electrical and high-speed communication connectivity will be required. The construction of these sites, though each small in size, will bring inconvenience to citizens, enterprises and building owners.

The focus of this response from Jakkolab describes an innovative infrastructure sharing model on a nation-wide basis that will minimise the inconvenience to the public while fostering an incubation of new disruptive business models in the region with Singapore in the centre.

This model has a single radio infrastructure provider, multiple core providers and multiple spectrum rights owners. It will protect revenue streams and stir innovation while minimising inconvenience.

Below is a graphical representation of the proposed model:



The availability of 5G network slicing will give rise to many new operating models similar but significantly more advanced than today's Mobile Virtual Network Operators (MVNOs) such as Circles.Life and MyRepublic. A new class of industrial 5G MVNOs will emerge. They can lease spectrum, share radio infrastructure but be able to provide their own core (which is cheaper to build, in Singapore context, than radio infrastructure). For it is known that most incumbent operators will not release their latest network features to MVNOs<sup>1</sup>

A shared radio infrastructure is also the best way to ensure access to shared-license and licence-exempt spectrum deployment because incumbent operators will likely want to prioritise deployment of equipment that use their paid-for spectrum.

Sincerely,

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<sup>1</sup> <http://telecoms.com/opinion/how-5g-will-revolutionise-the-mvno-market/>

## Responses to IMDA Questions:

*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.*

Key innovation for 5G will be in Applications, not the deployment of cells in low and mid-band. The innovation includes not only the development of applications but also the ecosystem that comes with it such as regulatory and legal skills. 5G is no longer just a telecom infrastructure. It is about the development of an ecosystem focussed on applications.

If Singapore were to develop skills in cell site planning and deployment, then let us focus on mmWave band. While such skills were not widely required in the past, it will be for 5G because of the large number of small cells needed. These will be both outdoor and indoor sites and antennae.

We should also develop skills to design, bring to production and test devices in mmWave.

We envision that there will also be more new industrial and some consumer devices coming up for certification, some designed locally and some procured cheaply via online channels. So a regime has to be designed to certify these new devices with corresponding skills to monitor and enforce compliance.

There will also be skills required to build and manage the new business models and the regulatory model suggested in the answer Question 8.

*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*

The wholesale model described in response to Q8 will certainly encourage a vibrant ecosystem to be developed with disruptive business models and innovative applications and services. This maps very well to IMDA's Key Priorities for the Digital Economy Framework for Action<sup>2</sup> to Accelerate, Compete and Transform.

There can be tremendous savings from the elimination of duplicate radio infrastructure and the reduction of inconvenience to citizens, enterprises and Government. There will also be better aesthetics in the city with fewer obvious antennae and cell sites.

In the high rise landscape of Singapore, rooftop access is premium. Securing this asset and getting access to it has been a common bane of local mobile operators and their contractors. This will be alleviated with shared radio infrastructure operated by a single provider.

Singapore was the first country to innovate with the 3-tier separation model of our fixed broadband infrastructure which has given rise to a vibrant fixed broadband market

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<sup>2</sup> <https://www2.imda.gov.sg/programme-listing/digital-economy-framework-for-action>

locally. The model of a 2-tier separation is very widely adopted and many country regulators and operators have studied and adapted our model to the 2-tier model.

The region still has a developing fixed infrastructure, especially for fibre-to-the-home/kerb/premise, thereby limiting the development of new applications in fixed broadband that Singapore entrepreneurs can develop and export.

Mobile broadband connectivity, on the other hand, is fastest growing in Asia. Even in countries like Myanmar and Cambodia, IOT applications using mobile technology are starting to emerge. Singapore companies and entrepreneurs need to capitalise on this growth to develop applications to solve local and regional problems.

Another growing trend is the use of broadband by enterprise workers outside of traditional office workspaces as the Future of Work evolves. This is already happening with shared workspaces, working in client offices without the client providing network access. Besides the staples of laptops, mobile phones and tablets, the new worker will also bring with him/her various IOT-type assistive devices like sensors and wearables which will require connectivity of various bandwidth and latencies. To optimise use of such devices, indoor coverage similar to FWA using a 5G network may be required. Thus FWA coverage will still be required despite affordable fibre broadband.

*ii) Areas of government support that the industry require in order to enable innovation and development in 5G.*

Such savings from Q2 (i) can be used to fund grants for application development because that is where the real innovation will happen. As mentioned in this consultation paper itself, Singapore is not a big player in networking space. We do not have resources to develop core network components and elements. So let us focus and invest in areas where we can make a difference: new applications, bespoke devices and new business models. These can then be adapted for regional export.

The 5G initiatives announced on 27 June are great actions in the right direction. More needs to be done.

To assist the development of relevant skills, we need to extend the scope of funding for training beyond those covered in CITREP, expanding into telecom and IT regulation.

IMDA should also host and fund cross-domain workshops focussed on specific industry themes because this is where the innovative solutions will come from. Example includes basic telecom and technology training for building management, construction, transport, healthcare and food industries among others.

*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.*

Jakkolab has no comment in this area.

*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; and*

We agree that it is prudent to offer spectrum in multiple phases as and when more devices will become available at affordable prices, whether these be handsets or IOT devices. The message from the paper that spectrum will be available in phases is good. Industries will take this as positive that more will become available as demand from applications increases. Jakkolab has no further comment in this area.

*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.*

Jakkolab has no comment in this area.

*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;*

Jakkolab is proposing a model of a single 5G radio infrastructure operator similar to Netlink Trust as described in the introduction. While having two nation-wide networks can support resilience, a properly designed single radio network can achieve the same result with less disruption and inconvenience to citizens, enterprises and building owners. There will be the cost reduction from elimination of random duplication of network elements on the radio side. This will be similar to the business and support model of indoor DAS (not the technology).

Already in US cities like New York and San Francisco<sup>3</sup>, there are central planners and network element providers for radio equipment on a limited scale. Some of the problems encountered include operators refusing to share poles<sup>4</sup>. If there were a single RAN operator, pole and antenna sharing will not be a problem.

Singapore can take this bold step to make it nationwide.

*ii) The proposed 3.5 GHz lot sizes and spectrum packages;*

Jakkolab has no comment in this area.

*iii) Whether 5G equipment would be able to support 3.5 GHz bandwidths in multiples of 50 MHz;*

Jakkolab has no comment in this area.

*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;*

Jakkolab has no comment in this area.

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<sup>3</sup> [https://extenetsystems.com/case\\_studies/san-francisco/](https://extenetsystems.com/case_studies/san-francisco/)

<sup>4</sup> <https://www.fiercewireless.com/wireless/multi-tenant-small-cell-deployments-prove-challenging>

*v) The proposed mmWave lot sizes and preferred band plan option; and*

Jakkolab has no comment in this area.

*vi) The rank order preference of the 3.5 GHz spectrum package and mmWave lot combinations.*

Jakkolab has no comment in this area.

*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;*

With 5G, it is expected that there will be interest in private use spectrum by corporations or consortiums, eg. use by autonomous vehicle operators. We have seen spectrum being held by non-telecom players in other countries for very specific industrial purposes (such as mining). We also see emergency services and enterprises using eLTE in UK, South America and South Pacific. Such spectrum rights ownership (physical or virtual) will grow under 5G. In addition to giving spectrum rights owners better prediction for their own equipment and device development, it will also grow the revenue stream for IMDA in spectrum rights auctions. In some cases, spectrum rights may only be for a specific frequency band in a specific geography, eg Jurong Island.

We see this model being offered in Germany<sup>5</sup>, while UK regulator OFTA has been contemplating this for more than a year<sup>6</sup>.

A single network planner/operator that supports frequency spectrum leased by a consortium from IMDA and possibly sub-leased to members and partners will give rise to many interesting applications and business models, leading to a more dynamic market. It will also support development of unlicensed spectrum use on the 5G infrastructure. In the current model, a spectrum owner is also the 5G radio network operator will have less incentive to deploy and promote unlicensed spectrum radio networks.

Again, it is the experience of regulation, management and enforcement of such models which is important, less so of the experience of deployment itself.

*ii) The methodology and measurement criteria for the coverage obligation;*

Jakkolab has no comment in this area.

*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*

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<sup>5</sup> <https://www.techradar.com/sg/news/germany-makes-private-5g-spectrum-available-for-industry>

<sup>6</sup> [https://www.ofcom.org.uk/\\_data/assets/pdf\\_file/0022/111883/enabling-5g-uk.pdf](https://www.ofcom.org.uk/_data/assets/pdf_file/0022/111883/enabling-5g-uk.pdf)

When deploying SDN and NFV, one needs to consider not only the application software that run on the SDN and NFV platform but also the operating system and firmware make, model and versions.

In the career of our Principal with core network switching, he has seen and experienced software being a culprit in catastrophic network collapse due to in-built automatic load balancing and runaway processes. These are usually caused by a single vendor with a network using a version of single software. This was the reason why the traditional circuit-switched networks evolved into a dual control plane architecture at the core. This principle must not be ignored in SDN architectures. The danger with SDN and NFV is that the underlying hardware and firmware may be COTS (Commercial-off-the-shelf) from the same sub-vendors. If there is a vulnerability in the OS version, for example, having 2 SDN vendors does not solve the problem if the single underlying COTS hardware has the same version of OS.

Taking a leaf out of Cloud and Software-as-a-Service vendors, even with single vendor architecture, they deploy usually both the current and previous versions of software simultaneously in different nodes so as to lessen the impact of the failure of the new version. It does require a good design to decouple between the layers for this to work effectively.

The same applies for security vulnerabilities.

#### *iv) The framework for the provision of 5G wholesale services.*

Jakkolab proposes a 3 ring model (please see the introduction to this response):

1. Core (which will belong to existing and new operators (FBOs))
2. Radio infrastructure or non-core (which will belong to a single operator)
3. Spectrum (which will belong to existing and new operators; enterprises and business consortiums)

Each level can have wholesale:

1. Core wholesale: which connects other licensed operators (OLOs), other connectivity providers and enterprise customers connected via fixed network infrastructure
2. Radio infrastructure wholesale: This is the main wholesale where operators or consortiums or large enterprises that own spectrum can license or lease use the cell sites and connecting infrastructure for a fee and under a Service Level Agreement
3. Spectrum wholesale: spectrum rights owners, especially consortiums, can lease parts of the spectrum to members and partners for a fee. The fee may or may not include use of the radio infrastructure and the core. Members may negotiate with radio infrastructure providers and core providers directly if the infrastructure is not included.

Core network owners have Service Level Agreements (SLA) with radio infrastructure operator. Spectrum rights owners can sub-lease spectrum to members and can lease use of the spectrum to end users.

*Question 7: IMDA would like to seek views, comments and suggestions on the spectrum assignment framework, including:*

#### *i) The proposed assignment approach;*



Jakkolab has no comment in this area.

*ii) The spectrum right duration of the 3.5 GHz package and mmWave lots;*

Jakkolab has no comment in this area.

*iii) The evaluation criteria, sub-criteria and weights to assess the proposals;*

Jakkolab has no comment in this area.

*iv) The assessment methodology, including evidence (documentary or otherwise) to evaluate the proposals; and*

Jakkolab has no comment in this area.

*v) The enforcement and/or audit mechanisms to ensure that applicants are able to deliver on their proposals.*

Jakkolab has no comment in this area.

*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.*

Jakkolab thinks that the core and non-core interface is a good separation point in the technology for infrastructure sharing. It has already been considered for migration of services for 5G NR with NSA migrating to SA architecture. 5G was designed to operate with various levels of MVNOs so the technology caters for vertical (application) and horizontal (network layer) separation. This capability has been demonstrated in New Zealand<sup>7</sup>.

As discussed in Question 6 (iii), the resilience element can be designed in even with a single operator for the radio infrastructure.

As for service provisioning difficulties and delays, such problems are more organisational and procedural than technical.

*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:*

In general, this problem will be easier to solve if there were to be only one radio network infrastructure provider in Singapore, with resources shared.

*a. Synchronised networks: the required frame alignment, compatible frame structures and BEM specifications for AAS and non-AAS base stations; and*

Jakkolab has no comment in this area.

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<sup>7</sup> <https://www.zdnet.com/article/huawei-and-spark-showcase-separated-5g-network-in-new-zealand/>



*b. Unsynchronised networks: the amount of guard band, geographical separation and BEM specifications for AAS and non-AAS base stations;*

Jakkolab has no comment in this area.

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

Jakkolab has no comment in this area.

*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.*

Jakkolab has no comment in this area.

*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*

Potentially, there will be new Internet Service Providers (ISPs) who will provide Enterprise broadband in buildings that are not fibered up today. Today, Netlink Trust encounters problems with old commercial buildings which are not already fibered up, access issues with building management. Buildings not already covered may still need roadworks to bring fibre to the office. So there still are opportunities for Fixed Wireless Access (FWA) application of 5G.

Please also consider future nature of work and design of workspaces in answer to Question 2 (i).

*ii) The policies (e.g., spectrum allocation, numbering) that should be considered to facilitate such use-cases.*

Jakkolab has not comment in this area.

***End of Comments***