

ST ENGINEERING AND SP TELECOM'S
JOINT RESPONSE TO IMDA

FOR

THE SECOND CONSULTATION ON
5G MOBILE SERVICES AND NETWORKS

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Table of Contents

About ST Engineering	4
About SP Telecom (SPTel)	5
Summary of Main Points.....	6
Statement of Interest	7
Feedback and Response.....	8
Conclusion	222

About ST Engineering

ST Engineering is a global technology, defence and engineering group specialising in the **aerospace, electronics, land systems** and **marine** sectors. A leader in each of our core businesses, ST Engineering brings **innovation and technology** together to create multi-disciplinary smart engineering solutions for our customers in the defence, government and commercial segments in more than 100 countries.

Today, we have a strong **global presence** spread across more than 20 countries and 40 cities in Asia, the Americas, Europe and the Middle East. Our presence in the U.S. continues to play an important role as we build on our strength for the next stage of growth. Spearheaded by our **U.S. headquarters** set up in 2001 in Alexandria, Virginia, we have grown from strength to strength to have established major operations in 17 cities across the U.S.

With a portfolio of world-class and **award-winning** solutions that can be found in the depths of the oceans and up in the vastness of space, we continue to invest in technology and integrate deep, multidisciplinary engineering expertise and capabilities to meet the challenges of tomorrow. Technology and innovation are in our DNA, underpinning what we do as a group. We continue to reinvent and innovate to create game-changing solutions in domains such as **smart cities, robotics**, data analytics, cybersecurity and autonomous solutions.

At ST Engineering, **people** remain our strength. Our global network of subsidiaries and associated companies is supported by our workforce of about 22,000, out of which two-thirds are engineering and technical talents, playing a critical role in helping us stay ahead in the global arena.

www.stengg.com

About SP Telecom (SPTel)

SP Telecom is a Facilities Based Operator (FBO) who owns, builds and powers communications and infrastructure services in Singapore.

A joint venture company of ST Engineering and Singapore Power group, SP Telecom combines the agility and flexibility of a growing company with the strength, reliability and integrity of our parents to help customers succeed. Offering high-value products and innovative services, SP Telecom plays an important role in helping enterprises achieve reliability and resiliency for their network.

We aim to improve the way people, places and things connect with each other by providing advanced network infrastructure, enabling technologies, and building smart ecosystems. We work with partners and customers to offer everyone a connected lifestyle in Singapore.

With our fibre network topology built physically separated from the existing telco providers, SP Telecom truly provides a differentiated design and diverse network solution for the discerning, best-in-class enterprises.

www.sptel.com

This is a joint submission by ST Engineering and SP Telecom. Hence, the responses represent the joint view and position of both organisations.

Summary of Main Points

- ST Engineering supports IMDA's series of Technology Calls ("Tech Calls") for ports and other industry verticals, to drive 5G adoption and use cases;
- ST Engineering agrees with IMDA's policy objective of providing flexibility in the regulatory frameworks by taking into account new spectrum bands that may alter market dynamics, in particular on the flexibility in allocating the mmWave spectrum for private, localised (non-nationwide) 5G enterprise usage as the market evolves. The private 5G enterprise licence should be issued separately from the 2 nationwide public 5G licences in order to drive growth and innovation, as well as enhance competition and vibrancy in the Enterprise segment. This approach is also consistent with 4G private LTE network rollout around the world in countries such as Finland and North America;
- ST Engineering strongly advocates a level playing field for non-MNOs (Mobile Network Operators) and non-MVNOs (Mobile Virtual Network Operators) in the 5G Enterprise segment, and for a more creative regulatory framework and wholesale arrangement for 5G Enterprise, in order to enhance competition and vibrancy in the market. Due to the unique market and technical characteristics of the Enterprise segment, arrangements including but not limited to price transparency frameworks, cost plus models for wholesale access and non-discriminatory practices (for QoS and traffic management), are worth exploring;
- ST Engineering supports IMDA's proposal for two 5G MNOs given the bandwidth constraint. However, ST Engineering is of the opinion that the two MNOs should be accorded the same amount of spectrum to compete equally. In addition, ST Engineering strongly recommends that the two MNOs should deploy their network over diverse physical infrastructure to maximise service resiliency and redundancy.

Statement of Interest

- ST Engineering is a home-grown global technology solutions provider, and leader across a wide range of industries and enterprise segments such as land transport, aviation, maritime, manufacturing, MRO (Maintenance Repair and Overhaul), security, smart estates, etc.;
- ST Engineering recognises that 5G, with its differentiated capabilities from 4G, will be an enabling technology that will play a transformative role in Industry 4.0 and digitisation, and open up new possibilities and innovation, especially in the Enterprise segments;
- As such, ST Engineering has an interest to ensure a competitive and vibrant 5G market for the **Enterprise segment** to spur innovation that drives the business models and development of 5G products, services and applications;
- ST Engineering strongly advocates a level playing field for non-MNOs and non-MVNOs in the 5G Enterprise segment;
- ST Engineering strongly advocates IMDA to adopt a more creative regulatory framework and approach towards non-MNOs and non-MVNOs arrangement, and allow private 5G for 5G Enterprise services, to enhance competition and vibrancy in the 5G Enterprise market.

Feedback and Response

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.

ST Engineering's Response

We agree with IMDA's view of the new engineering and technical skillsets that will be necessary for 5G. As 5G is an enabler for industries transformation in different sectors (transport, manufacturing, ports, Smart Cities, etc.), subject matter experts in areas such as data digitisation, automation, machine learning, artificial intelligence, data analytics and IoT will need to be attuned to the technical capabilities (and limitations) of 5G.

Apart from having such "hard skills", ST Engineering is also in the opinion that another set of skillsets is needed - innovation skills and techniques, such as "Design Thinking" (this being one of them) and "facilitation". This involves putting together the creativity, experiences and knowledge of multiple domain and subject experts, to derive an integrative vertical solution that is viable, both technically and commercially, for 5G Enterprise.

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 requires in order to enable innovation and development in 5G.**

ST Engineering's Response

- i) ST Engineering will be focusing on some of the following immediate use cases (but not limited to this list):
 - (a) Maritime Port Operations (eMBB, uRLCC, mMTC);
 - (b) Aviation Airport Operations (eMBB, uRLCC, mMTC);
 - (c) Smart Manufacturing (eMBB, uRLCC, mMTC);
 - (d) Smart Cities (eMBB, mMTC);
 - (e) Public Safety Video Surveillance (eMBB);
 - (f) Autonomous Vehicles / 5G CV2X (uRLLC);
 - (g) UAV (Unmanned Aerial Vehicle) (eMBB, uRLCC)
 - (h) Immersive Multimedia (VR/AR) (eMBB, uRLCC).

Public 5G will be a natural evolution from 4G-LTE. The IMT-2020 has categorised 5G into 3 broad usage scenarios, namely enhanced mobile broadband ("eMBB"), ultra-reliable and low latency communications ("uRLLC") and massive machine type communications ("mMTC").

eMBB improves the bandwidth and latency, bringing about new use cases such as high quality, multi-angle, event video streaming to a large audience. It takes advantage of the broad spectrum available in the 26~28GHz band.

However, it is the latter 2 usage scenarios, uRLLC and mMTC that have the potential to break new grounds with the advent of new applications such as autonomous vehicles, drones, logistics, telemedicine, etc.

Whilst 3GPP's focus has always been to provide mobile connectivity to the masses, the industry also recognises the demand for private LTE or 5G networks to fill a gap in radio access for private enterprises.

As early as 2010, the National Telecommunications and Information Administration (NTIA) has identified a 150MHz band in the 3.5GHz spectrum for shared federal and non-federal use. In the Notice of Proposed Rulemaking released by the FCC in December 2012, the FCC endorsed the band as the Citizens Broadband Radio Service (CBRS) and said this would promote more efficient use of radio spectrum via small cells and spectrum sharing.

6 companies interested in promoting CBRS technology and driving adoption formed the CBRS alliance in 2016. As of mid-2017, the CBRS Alliance has listed over 60 members.

Enterprises today rely on unlicensed Wi-Fi technology for untethered connectivity. While Wi-Fi is fast and easy to deploy, it is still a best effort, unreliable service with poor mobility and QoS support. There exists a technology gap for a reliable, feature-rich mobile technology for enterprises to support Industry 4.0 and mission-critical services for government and military agencies, not subjected to infrastructure sharing with consumer mobile networks and its corresponding high spectrum fees.

ST Engineering is of the view that government support in the area of spectrum allocation for private enterprise usage would be a right direction to encourage innovation and development of Industry 4.0, smart city and other private enterprise applications without the burden of high spectrum costs and the inertia of incumbent telcos for faster innovation and development of 5G for enterprises.

Most operators cited 5G Business Case and Economics as the greatest challenge. 5G MNOs which have to invest in spectrum and infrastructure for nationwide coverage, will unduly load the cost unto MVNOs or system integrators that are providing private 5G applications for Industry 4.0, smart ports, campuses, etc. where usage is localised.

Therefore, it is important to set the right policies to encourage enterprise 5G applications innovation and development to take full advantage of what 5G technology can offer, and not be subjected to the priorities of the MNOs.

- ii) ST Engineering supports IMDA's intention to extend the frequency fee waiver period for 5G trials under the Technical Trial and Market Trial frameworks until the commencement of the spectrum rights in the relevant spectrum bands. This will continue to lower the regulatory and cost barriers with the intent of encouraging the industry to trial 5G capabilities in Singapore.

ST Engineering noted IMDA's announcement to launch a series of Technology Calls ("Tech Calls") for ports, and its intention to extend it to other industry verticals. ST Engineering strongly supports these initiatives and views these Tech Calls as important catalysts to drive 5G adoption by solving real world problems in areas such as education, smart city, ports and aviation, Industry 4.0 and immersive media.

In addition, ST Engineering would like to suggest to set up a new training programme dedicated to 5G and associated technologies such as Network Slicing, Mobile Edge Computing, etc. under the TechSkills Accelerator (TeSA) framework. This dedicated 5G programme will be equivalent to the current Cyber Security Associates and Technologists (CSAT) programme which focuses on cybersecurity.

The government plays a critical role as a convener to mobilise all the disparate industry users (within a vertical), to attain a critical mass or economy of scale, especially in a small market like Singapore. For example, the maritime industry has different stakeholders and for them to be able to benefit from 5G, there is a need to come together (perhaps as a consortium) to share the costs of investment (of 5G). The authority can play a neutral role here to convene the different stakeholders for a common good for the industry, which can to propel Singapore as a leading use case of 5G for maritime.

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.

ST Engineering has no comments.

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**
- ii) Whether current deployments in the 2.5GHz 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.**

ST Engineering's Response:

- i) ST Engineering agrees with the timelines on the expected availability of the next wave of 5G spectrum. Further to this, ST Engineering agrees with IMDA's policy objective to provide flexibility in the regulatory frameworks to allow the market to grow and adjust.

Specifically, ST Engineering supports IMDA's regulatory framework that will allow migration paths for future network builds and technology upgrades, taking into account new spectrum bands that come on board which may alter market dynamics. As IMDA noted, this will allow the market to grow and adjust to the fast pace of technological advancements and market developments, particularly in 5G Enterprise and Industry 4.0 use cases and requirements. It will also enable greater diversity in infrastructure development and support IMDA's drive for trusted and resilient networks.

In particular, IMDA should have the flexibility and option to allocate mmWave spectrum for private, localised (non-nationwide) 5G enterprise usage as the market evolves. The private 5G enterprise licence should be issued separately from the 2 nationwide public 5G licences in order to drive growth and innovation, as well as enhance competition and vibrancy in the Enterprise segment. This approach is also consistent with 4G private LTE network rollout around the world in countries such as Finland and North America.

- ii) ST Engineering has no comments.

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.**

ST Engineering's Response:

- i) ST Engineering agrees that Singapore should have two nationwide networks as a start. This is based on the paired 3.5GHz and mmWave (26/28GHz) spectrum package primarily due to spectrum limitation in the 3.5GHz band. IMDA should ensure that the 2 facilities-based networks are **separated, for physical infrastructure and backhaul connectivity as well as operationally**, to provide maximum service resiliency and redundancy.

However, ST Engineering is concerned that this can potentially give the two 5G MNOs an advantage over non-MNOs in the Enterprise segment, given the market characteristics of the segment.

ST Engineering strongly put forward the need to have a different regulatory framework and approach on the “wholesale arrangement for Enterprise segment”, or even private 5G for the Enterprise segment arrangement, to spur greater competition and encourage innovation in the segment. This is important as the Enterprise segment is expected to be one of the key drivers to exploit 5G to its fullest potential and reap the productivity benefits from it. ST Engineering's views and concerns are further elaborated in our response to Question 6(iv) below.

- ii) ST Engineering is for the opinion that a level playing field should be established across the 2 facilities-based networks. Both networks should be assigned

comparable spectrum blocks instead of the proposed band plan where one operator is assigned the 100MHz of the spectrum while the other is assigned the 50MHz of the spectrum in the 3.5GHz band.

One possible option is to reduce the Guard band to the 50MHz, thereby freeing up 50MHz of the 'Restricted' band from 3,600~3,650MHz. As this band is 'Restricted' to indoor and localised use, interference to fixed satellite services is minimised.

The lower 'Restricted' 50MHz in the 3.5GHz band can then be allocated for Private LTE/5G use.

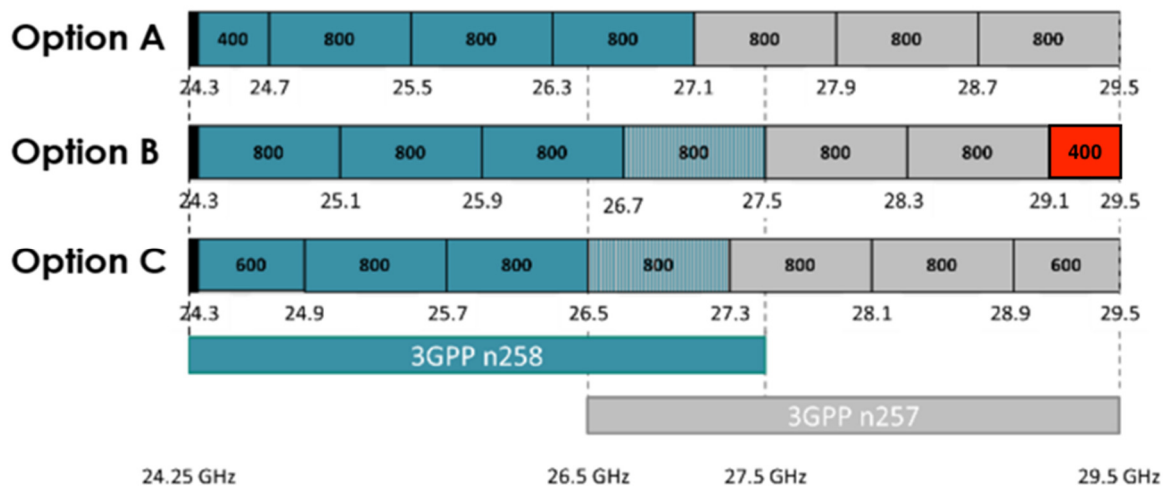
Proposed Band Plan Option for the 3.5GHz Band



- iii) ST Engineering has no comments.
- iv) ST Engineering has no comments.

- v) The 400MHz in the mmWave spectrum should be allocated for private 5G use. In consultation with key network equipment vendors, Option B (see below diagram) is preferred in anticipation that the earlier equipment will support the higher frequency plans.

Proposed Band Plan Options for the mmWave Spectrum



- vi) ST Engineering has no comments.

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.**

ST Engineering's Response:

i) & iii)

ST Engineering envisages 5G will provide ultra-reliable Low Latency Communications (uRLLC) with uncompromised network availability. The success of mission-critical applications is dependent on the resilient design and implementation of the 5G network.

In this regard, the **physical security** of base stations and Multi-Access Edge Computing (MEC) is the key consideration and should be housed in secure physical premises. Cloud-RAN centralises the digital processing functions to the Network Functions Virtualisation (NFV) enabled servers but requires direct fibre to Remote Radio Heads (RRH) that are limited to a distance of 10~20km. This will require investment in fiber distribution network. To provide diversity, the 2 network operators should ensure **no sharing of fibre and fibre distribution network**. In this respect, SPTel is keen to work with the IMDA and potential 5G operators to facilitate the alternative fibre distribution network. SPTel's footprint of secure nodes would also be ideal to host 5G radio and MEC hosting.

ii) ST Engineering has no comments.

iv) ST Engineering is of the view that the current framework for the provision of 5G wholesale services is adequate for the 5G consumer segment. However, it is not suitable for 5G Enterprise segment for the following reasons:

- Unlike consumer segment where retail pricing is publicly available, in the Enterprise segment, pricing is confidential and non-public. This makes it difficult for MVNOs to determine if the wholesale price and commercial terms are competitive and reasonable as there will be no available benchmark. This is compounded by the fact that the MNOs could also be competing for the same Enterprise customers, creating a conflict of interest or monopolistic behaviour.
- Unlike the consumer segment where the primary services are wholesale voice, SMS and 4G data, Enterprise use cases are more fragmented due to the disparate industry verticals (e.g. transport, smart manufacturing, Industry 4.0., etc.) and has different technical requirements (e.g. uRLLC, mMTC). This complex, fragmented market makes it difficult for MVNOs to determine if the commercial and technical terms from MNOs are reasonable and competitive, and whether there are discriminatory practices.
- Unlike 4G where there are 3 to 4 MNOs creating the right market conditions for the growth and proliferation of MVNO entrants; 5G has only 2 MNOs and there are limited options and choices for MVNOs. With less competition, there is less impetus and incentives for the 2 5G MNOs to support MVNOs in the 5G Enterprise segment, unless there is regulatory intervention. Also, unlike 4G where there are 3 to 4 MNOs, with consolidation in 5G to only two MNOs, this could potentially open up opportunity for the emergence of private (non-nationwide) 5G FBO.
- Furthermore, even in the consumer segment, the MVNO market in Singapore is relatively nascent and catalysed by the entry of the fourth MNO in 4G. It remains to be seen if the current vibrant MVNO market in the consumer segment is sustainable. MNOs have also publicly mentioned that there are too many MVNOs and MVNOs and consolidation may happen in a few years. This points to the fact that the business case for MVNOs is inherently challenging as MVNOs do not have as many levers as MNOs. Hence, without a strong regulatory framework for 5G Enterprise segment, the competitive and vibrant MNO and MVNO market that IMDA envisage may not materialise.

Hence, a more creative Regulatory Framework and approach, and updated Negotiation Principles for Wholesale Access and/or Private 5G Enterprise Network is required to create a level playing field for all players, i.e. the non-MNOs and non-MVNOs. This will best serve the interests of the end customers

(i.e. the Enterprises), and also enhance competition and vibrancy in the market. Due to the unique market and technical characteristics of the Enterprise segment, arrangements including but not limited to price transparency frameworks, cost plus models for wholesale access and non-discriminatory practices (for QoS and traffic management) are worth exploring.

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.**

ST Engineering's Response:

- i) In addition to the proposed evaluation criteria, we are of the view that network diversity should be a key consideration to ensure that the 2 awarded operators are diverse and separated.
- ii) ST Engineering has no comments.
- iii) ST Engineering has no comments.
- iv) ST Engineering has no comments.
- v) ST Engineering has no comments.

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.

ST Engineering's Response:

Singapore currently has 4 Mobile Network Operators (MNO). With the advent of 5G evolution and the initial planned allocation to 2 network operators, infrastructure sharing by co-investment or leasing is a good option to lower the capital investment required for 5G.

Technologies such as Cloud-RAN that can be deployed on top of a hosted NFV/MEC infrastructure and Network Slicing for the carriage of traffic back to the mobile network core appears promising but are still in development stage.

SPTel has pioneered Edge Cloud for IoT at SPTel Edge Hubs with the potential to support 5G MEC and Cloud-RAN. SPTel is keen to work with IMDA and potential 5G operators to conduct joint validation of the different levels of infrastructure sharing.

This is an area where IMDA can facilitate industry joint investigation, trials and collaboration to advance 5G infrastructure sharing in the build up towards the spectrum allocation/bid exercise.

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.**

ST Engineering has no comments.

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.**

Conclusion

ST Engineering and SPTel supports IMDA's objective of creating a thriving 5G ecosystem in Singapore to enable Industry 4.0 and innovations that accelerate industry transformation and digitalisation. As 5G is use case dependent, it will herald new business models and innovations, especially for the Enterprise segment. With the spectrum constraint and a limited number of MNOs, it is important to create a level playing field for non-MNOs and non-MVNOs in order to realise the innovative, competitive and vibrant 5G market envisioned by IMDA.