Submission in response to:

Consultation Paper issued by the Info-Communications Media Development Authority

on

Second Consultation on 5G Mobile Services and Networks

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Submitted by:

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Summary of Major Points

ATIS is excited about the advent of 5G technologies and deployment, and would like to contribute our thoughts to the consultation paper.

Most Telcos are still recovering returns from their 4G investment. Therefore, from the economy perspective, initial investment into 5G should be closely calibrated to reduce unnecessary duplication of resources, especially heavy infrastructure investments. Also, as a small nation with limited talent pool, innovation should be tapped from all spheres of our population and ecosystem. SMEs and start-ups should be able to participate in the 5G opportunities more directly instead of relying on commercial arrangements with Telcos, which as profit-oriented entities, will inherently impose terms more in their favour. Democratization is now the trend which avails key technologies/applications to almost everybody.

To this end, we recommend that neutral hosting for certain 5G infrastructure network elements could be the best approach. Netlink Trust has been an operating model of such infrastructure sharing arrangement for Singapore's nation-wide fibre coverage. Successful cases from other countries can be studied as well.

To expand the possibilities offered by 5G, opportunities in private networks should be explored, besides public network. This can create another ecosystem in domains such as public safety and encourage innovation in applications not possible under public network arrangements.

With market and industry boundaries fading, and new technologies emerging, ATIS suggest that we need to re-examine the status quo of our existing ecosystem. 5G provides an excellent opportunity for Singapore to recalibrate our ecosystem so that Singapore and Singaporean companies can be more agile, adaptive and creative, without bearing the unnecessary burden of heavy and redundant infrastructure investment and resources. We have to pursue the pervasiveness of (less costly) Wifi to complement 5G and 4. Technology.

Statement of Interest

Established in 1986, ATIS champions industry issues on behalf of the ICT / Telecommunications industry in Singapore. It seeks to provide a common platform for all members of the industry to interact, work together and position Singapore as a leading global InfoCommunications (ICT) hub, co-operating closely with partners in both local and regional ecosystems, including authorities such as IMDA.

ATIS members come from all areas of the ICT / Telecommunications industry including Service Providers and Operators, Equipment Manufacturers, Distributors and Dealers, Value-Added Resellers (VARs), System Integrators (SIs), Consultants and Training organisations.

ATIS is a member of ATIE (Asian Telecom & Information Exchange). Established in 1995, the objective of ATIE Forum is to exchange ideas and experiences of Telecom and IT field among the participating member associations in Asian region. Members comprise telecom/ infocom trade/industry associations from Japan, Korea, Hong Kong, Taiwan, Malaysia, India, etc. The forum also aims to promote further development of the Telecom and IT industry through mutual co-operation amongst others. ATIS hosted the ATIE forum most recently in 2018 in Singapore.

Leveraging on our interaction with our counterparts in the region and our members who are mostly SMEs, our interest in this consultation is to help Singapore capitalize on the 5G opportunities and to optimize the participation of our industry to maximise possibilities for innovation to benefit society and economy.

Views and Responses

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.

Singapore should first identify and understand its strengths in the complete value chain of the 5G ecosystem, especially on new opportunities that arise from 5G that were not possible from 4G technologies or its predecessors.

Network operations and maintenance will continue to demand expertise in the future of networks. There is a shortage of skills in networking and telecommunications. ATiS offers to work with IMDA to develop a training centre to address this.

Mobile apps may provide jobs for innovative apps. However, entry barriers to these professions are not high. Singapore should explore professions that require deep technical expertise in the 5G ecosystem that provide good jobs for Singaporeans.

We agree with the view that there will be an increasing demand for engineers with hybrid and versatile skills across various technical domains relevant to 5G. The emergence of Software Defined Networks will necessitate software skills in networking.

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.

i) Singapore's mindset has been that given our small domestic market and dearth of upstream value chain in our telecom industries, it is safer for Singapore to be a follower, albeit a quick follower, in trying, adopting and deploying innovative solutions by learning from the mistakes of advanced markets like USA, China, Japan and Korea.

Singapore should explore the whole value chain of 5G ecosystem on where Singapore can position its competitive advantages - 5G chip sets, modules, devices/ products, systems, networks, software, hardware, applications etc. It may involve a whole-of-government approach plus close industry collaboration to spearhead some horizontal or vertical value chains where Singapore can excel and be a world leader. Training and development of skills in networking and telecommunications are essential.

ii) Singaporean companies should look beyond domestic markets to explore opportunities in the region, and not limited by what is required in our domestic markets. For example, 5G may provide alternative solutions for last mile fixed wireless access. While Singapore may not need these due to its high fibre penetration rates, there is a demand for such wireless solutions in developing markets in the region due to the high cost of fibre installation over wide-spread territories. Singapore government should facilitate Singaporean companies to participate in regional markets and beyond. Therefore, government support should not be limited to merely cater for our domestic market needs or Singapore government project requirements. ATiS has regional co-operation with similar organisations in Asia so ATiS can assist in regional collaboration.

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.

In the USA, FCC has authorised the use of spectrum in nearly the same frequency range as the 3.5 GHz band in Singapore for their Citizens Band Radio Service (CBRS), for 5G applications. As the market in the USA is bigger we can benefit from economies of scale by adopting as much as possible the technical parameters used in CBRS so that the radio equipment used for CBRS may be used here without much modification.

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 2.5 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.

i) For Singapore to be a global front-runner for innovation in 5G applications and services, we are of the view that the timeline may need to be accelerated to position Singapore as one of the first few countries that are deploying 5G. This will be attractive not only to local but also global 5G players to Singapore to conduct trials involving 5G technologies and innovative services. While there may be high investment risks in deploying 5G too early, the risks can be mitigated by adoption of neutral hosting as elaborated under other sections of our responses in this submission.

ii) We do not have comments yet for this question

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.

i) We understand that most telcos are still recovring the returns from their investment in 4G networks, and that business cases for 5G are still unclear. Therefore, it may be prudent to have one nationwide network as a start. To expand accessibility to this 5G network, we propose the business model of neutral hosting so that not only all telcos, but also SMEs, can participate directly in exploring 5G business cases.

ii) CBRS in USA use 10 MHz channels for enterprises to deploy their private broadband networks and we propose that the 10 MHz channelling be used here for private broadband networks. We further propose that some unrestricted spectrum (say, 20 MHz) and some restricted spectrum (say, 40 MHz) be set aside for shared use by private broadband networks.

iii)- vi) We do not have comments yet for these questions.

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**.**

i) We propose that the usual nation-wide signal coverage not to be applied for 5G network as a start. This enables a more focused, calibrated and prudent approach to investing in 5G infrastructure first in the more promising business cases identified by 5G industry participants. However, to ensure that 5G's distinctive advantages can be played out, certain performance criteria uniquely advantageous from 5G technologies, such as low latency and high bandwidth, should be regulated.

ii)-iii) We do not have comments yet for these questions

iv)- Neutral hosting could be a better alternative arrangement.

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.

We propose that the neutral hosted network be given spectrum rights of 10 to 15 years duration and administrative assignments for private networks.

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.

1.1. Overview on Singapore's existing infrastructure landscape

Currently, Singapore's telecommunications landscape is predominantly helmed by three established incumbent Mobile Network Operators (MNOs) - Singtel, Starhub and M1. A new entrant, TPG will be launching its services in January 2020. The original plan for TPG according to spectrum auction requirements is to have 99% outdoor coverage from October 2018.

As a country with limited space and resources, we believe the industry recognizes that there are significant synergies and cost savings with infrastructure sharing, while putting more emphasis on services and product innovations. Currently, MNOs and other wireless operators do have existing but limited special arrangements between themselves in shared indoor coverage solutions. However, they still largely operate in isolation and deploy their own network infrastructure individually – creating a significant opportunity for synergies.

To encourage competition and providing consumers with additional providers – IMDA has recently introduced the participation of Mobile Virtual Network Operators (MVNOs) such as Circles.Life and MyRepublic, who instead of building their own network infrastructure, enter into commercial agreements with MNOs to utilise the MNOs' infrastructure to provide connectivity and services to their own customers.

The introduction of MVNOs has disrupted the traditional oligopoly model and MNOs are caught in the balance of generating revenue streams while protecting their own market shares. In this case, MVNOs may be vulnerable to possible protective measures by MNOs, who can stifle competition through hoarding and different paces of internal processes. While MNOs co-share their infrastructures with MVNOs, the two parties are also in direct competition. This could be seen by MNOs responding to the competition from MVNOs with the recent launches of SIM-only plans such as GOMO by Singtel and Giga by Starhub in their bid to compete in the lower-end of the mobile phone market. This creates a conflicting and unnatural relationship with MVNOs reliant on MNOs yet competing directly with them. In the face of 4G to 5G evolution, MVNOs may be prevented from participating in the process, hindering the development of more innovative products and differentiation in 5G services.

With the accelerated development of 5G mobile technologies and the surge in adoption of Internet of Things (IoT) and Machine to Machine (M2M) connectivity, it is envisaged that additional infrastructure capital expenditure, and possibly increased operational expenses are required to ensure efficiency, resilience and security. The global IoT market is forecasted to reach US$1,567 Bn, with a CAGR of 39% from 2018 to 2020. While it may not fully apply to Singapore, IoT spending is forecasted to be the highest in discrete manufacturing and utilities by 2020. This OPEX increase for maintenance and security could be a concern for all MNOs and business owners.

Ultimately, 5G could create a commercial dilemma with the requirement for more physical space, balancing the aesthetics with the complexity of structural deployment for all MNOs. For example, to enable the usage of 5G's new spectrum without infrastructure sharing, new antennas for all MNOs must be erected on rooftops which has a physical space constraint due to other uses such as solar panels. An agreed model of infrastructure sharing will allow all wireless operators to participate without being hampered by any infrastructure ownership bias.

We have noted IMDA's strategic goals, which are as follows:

1. Maximise value of 5G for the economy and welfare for the consumers
2. Facilitate efficient allocation of scarce resources such as spectrum
3. Trusted and resilient 5G network design.
4. Support growth of vibrant telecommunications sector

As we rationalise the assignment of two 5G operators, the assignment of exclusive spectrum to operators may not necessary optimise the use of spectrum. Neutral hosting can potentially facilitate co-sharing of spectrum or a more dynamic allocation of spectrum depending on usage by operators, thereby improving the efficiency of use. We believe a shared infrastructure system is in line with IMDA's strategic goals and will also provide a favourable economic outcome for all key stakeholders of a successful 5G ecosystem which largely depend on network densification. Lastly, the creation of a successful ecosystem could lead to more innovations and help Singapore achieve her goal of becoming a smart nation.

1.2. Infrastructure Sharing / Neutral Hosting Model

With each generation of technology, there are new opportunities for telecommunications players and landscape. With 5G upon us, operators are aware that costs will increase with infrastructure investments on top of upgrading their existing tepid growing 4G networks, to cope with new demands for different industries.

With Singapore being a country with limited space, replicated network infrastructure for MNOs results in a highly complex structural arrangement in terms of aesthetics and site acquisition. Without infrastructure and network sharing, the already limited spectrum for 5G will have to be split among individual providers, which may cause instability in their services and may affect the competitiveness in the industry due to hoarding.

If 5G licenses are awarded to only two selected MNOs, it may limit innovations to only those from these two MNOs unless the ecosystem evolves and truly enables and encourages true competition and innovations. Even if the two MNOs encourage participation of other operators to leverage on their 5G network for innovative products and solutions, commercial deals between the parties may be in favour of the two MNOs and hence diminish the incentives for other operators or participants to realise their innovation with the uncertainty of ROI.

The use of neutral host infrastructure can be the key in balancing the network and associated costs with the need for dense coverage and capacity, especially within certain locations and iconic venues. This may also enhance privacy and security at a national level.

A neutral host infrastructure comprises of a single shared network structural solution provided to all MNOs and MVNOs. There is much to gain in terms of efficiency and cost savings when the neutral host, working with the government to obtain use of necessary physical space and

resources in a specific geographical area (i.e. within a building or a sports stadium or street lamp posts) can provide all-inclusive connectivity with 24/7 service uptime with the help of a predictive maintenance system.

Figure 1 shows an example of neutral host infrastructure by Wireless Infrastructure Group (WIG).

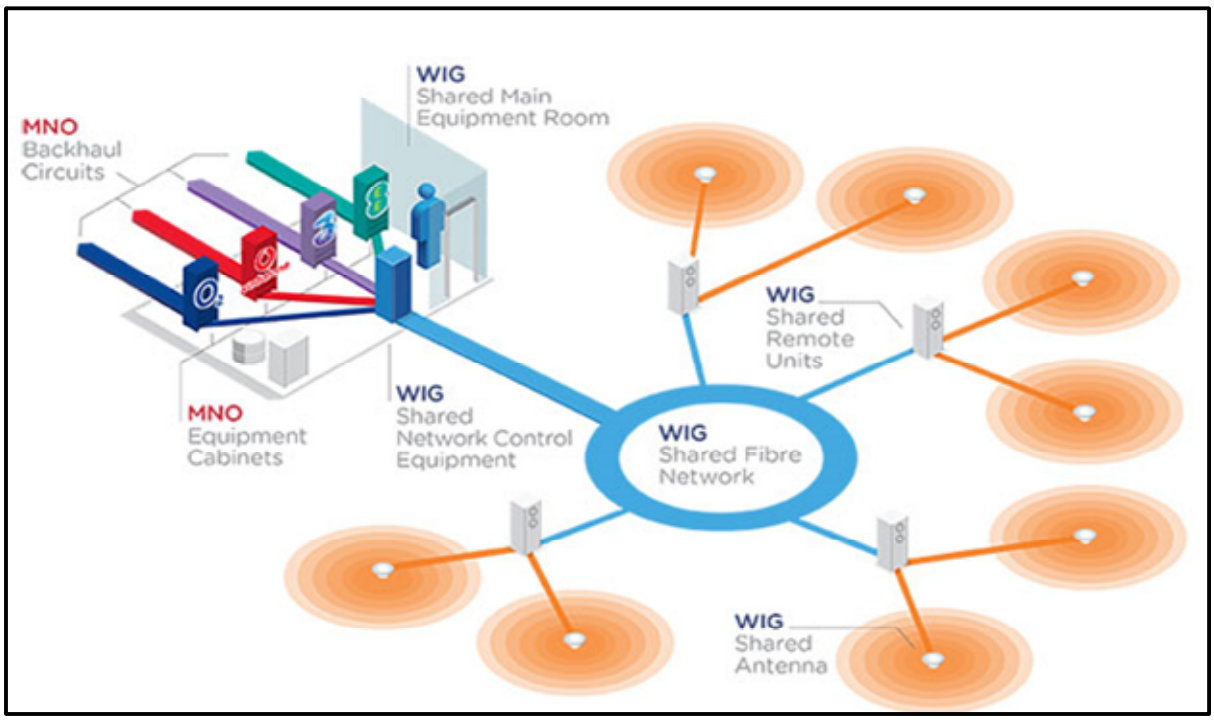


Figure 1: Neutral Hosting model by WIG

Source: ["Indoor Networks" by Wireless Infrastructure Group (http://www.wirelessinfrastructure.co.uk/indoor-networks/)]

The neutral host model, being non-exclusive in nature to instil differentiation and competition, also brings together cooperation of the private and public sector, where all stakeholders are better off from an economic standpoint. The reduced cost and improved economics can create synergies that may allow all stakeholders to gain economically and develop a better working relationship with government agencies.

A more balanced relationship with healthy competition which advances innovations, will also enable pricing fairness and promotes service-based differentiation from MNOs and MVNOs.

Venue owners stand to gain as well, being able to cater to multiple operators with better streamlined communications, extensive coverage and connectivity while ensuring lesser visual pollution to their properties.

A neutral host model in coordination with appropriate government regulations (i.e. IMDA, LTA) would reduce the physical requirements and administrative burdens of venues owners and all stakeholders. The obligations and burdens of dealing with both MNOs and MVNOs would rather be shifted to the neutral host provider who would be better equipped and more aptly prepared to deal with stakeholders at all levels.

1.3. Challenges of Neutral Hosting and Solutions

The commercial delivery of a neutral hosting model has its challenges being a relatively new concept and hence carries the risk of miscommunication between stakeholders. Netlink Trust provides a good example and starting point for operators to model after and to further develop.

The sharing of costs, risks and processes between the spectrum owner, venue owner, neutral host, MNOs and MVNOs are not insurmountable challenges. To mitigate these potential problems, we believe that it is imperative to establish a regulatory framework with all stakeholders to manage the delivery and deployment process.

COPIF should be expanded to include spaces and facilities needed for 5G infrastructure for both indoor and outdoor locations. Similarly, a committee, largely led by key operators and the government agency should be set up to govern network infrastructure sharing between the stakeholders. This committee will provide a guideline for the division of responsibility for deployment, accessibility to network infrastructure and ongoing requirements of each stakeholder.

This practice is not entirely new, as we have seen it being developed in different countries currently.

1.4. Contributions from Private Sector

Neutral hosting offers benefits beyond business viability and ROI. With the creation of a new value-based business, it can spur investment from the private sector which will accelerate and boost innovation in the industry with proper regulations on ownership in place for a better Point to Point Protocol (PPP) working model to evolve.

Private sector investment provides a source of unbiased capital that could act as the equalizer or tie breaker for all stakeholders. Private investors' interest are aligned with that of the Neutral Host, and they can bring forth new insights and import best practices outside of MNOs and MVNOs.

1.5. Potential 5G Ongoing Concerns and Development

There are several considerations to implement 5G infrastructure sharing. Some of which can be found below:

1. Working with vendors on Active Antenna System (AAS) issues
    - We suggest having different models for consultation with operators over friendly round table exploration to understand its suitability and feasibility

2. Sharing of 5G outdoor Radio Access Network (RAN)
    - We suggest that each operator own their own core but differentiate with their own offerings and content

3. Sharing of 5G indoor RAN
    - We suggest that indoor RAN can be shared with Wi-Fi operators by developing Indoor 3.5 model of full sharing, for key infrastructure such as fibre-ready scheme

4. Agreeing on key infrastructure such as iconic venues which should be equipped with a common set of equipment for safety and security purposes (i.e. kill switch)
    - The neutral host can work and consult with the relevant Government authorities to understand the requirements and implement accordingly

5. Long term development of Predictive Maintenance
    - Besides overcoming technical challenges, service providers will need to ensure that they comply with applicable legal and regulatory requirements.

6. In 5G, we expect exponential growth of M2M, security devices and communications. Service providers will need to ensure they have processes in place for compliance with any applicable licensing and/or registration requirements.

2. Proposed Platform for Neutral Hosting

Regulators can play a role by establishing regulations that facilitate small cell deployment. For example, 21 state legislatures in the United States have enacted small cell legislation that streamlines regulations. 5G infrastructure sharing will be led by the government, either by legislation or through any government funding or incentives granted for the deployment of 5G infrastructure.

Over the past few years, we have seen infrastructure sharing enforced by legislation as mandated by the country, or by way of contractual agreement between network providers. Such arrangements can be seen in countries like UK - between Vodaphone (UK) and Telefonica (UK) who jointly shares infrastructure sharing through a common platform JV to enhance 5G rollout. Other markets have also embraced network sharing such as: Korea, Philippines, China and even in Brunei. In Indonesia, neutral hosting arrangements are prevalent with asset and venue owners collaborating to provide improved coverage – specifically in indoor environments.

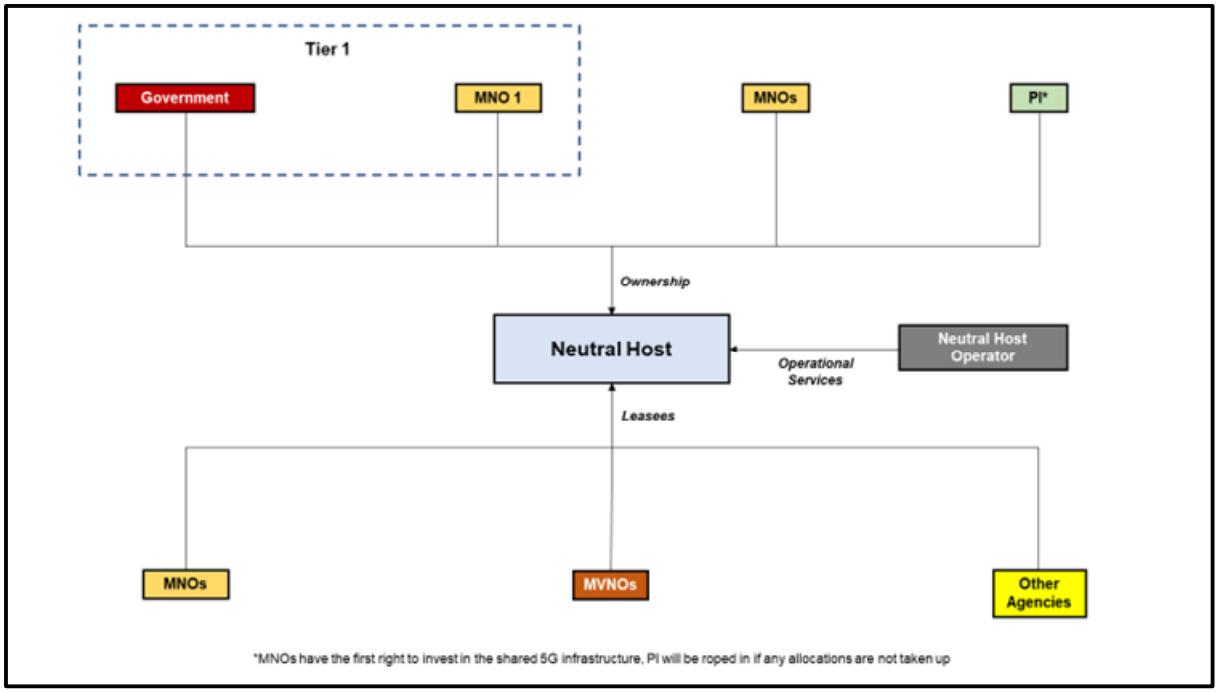


Figure 2: Proposed Structure for Neutral Hosting

Using Figure 2 for exploration, there can be a shared ownership between the government and the MNOs.

Private investor ("PI") may be allowed to join the ownership structure if there are any allocations not taken up. These parties will co-invest in a shared 5G network infrastructure, which will be managed and operated by the neutral host company.

The neutral host will lease the cellular network and equipment to all telecommunication companies, providing them with the infrastructure for their 5G services. All telecommunication companies will save on redundant capital expenditure from investing in individual infrastructure and will speed up the process of a 5G roll-out.

3. Global Case Studies of Shared Wireless Infrastructure

Case Study #1: intu Trafford Centre (Manchester, UK)

intu Trafford Centre is the second largest shopping venue in the UK with over 1.8 million square feet of prime retail space. With 35 million visitors each year, it was crucial for intu Trafford Centre to build a network infrastructure that can comprehensively meet the huge data traffic demand on a multi-carrier, multi-technology basis. Additionally, minimising any visual disruption in the building architecture is vital for the quality of customer experience.

Wireless Infrastructure Group (WIG) was appointed to design a single wireless solution that supports the voice and data services for all UK MNOs. WIG designed and launched a Distributed Antenna System (DAS) network that supports 4G services as well as significantly enhancing 2G and 3G services within the centre. Based on a fibre optic backbone and utilising multi-operator equipment components, the DAS consists of the following features:

- 125 strategically located antenna points
- 13km of coaxial and fibre optic cabling
- 22 intelligent, 4G compatible remote unit nodes
- 1 central equipment room supporting DAS control equipment and individual customer base station

DAS implementation ensure better connectivity for all visitors and retailers in intu Trafford Centre, with the system fully shareable allowing MNOs to readily connect and deliver service without the need to duplicate the equipment deployment. DAS provides an efficient route to upgrade ensuring its continued suitability for hosting future mobile technologies and services on a cost-effective basis. DAS also minimizes any visual pollution that could

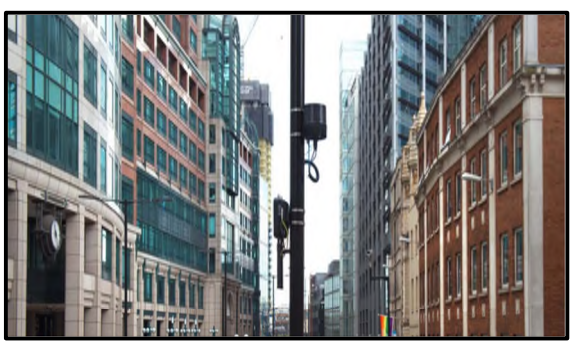
Source: ["Wireless Infrastructure Group provides intu Trafford Centre with a superfast 4G makeover" by Wireless Infrastructure Group, Sep 2015 (http://www.wirelessinfrastructure.co.uk/wp-content/uploads/2015/09/wig-trafford-centre-case-study.pdf)]

Source: ["INTU TRAFFORD CENTRE" by Cushman & Wakefield (http://retailproperty.cushwake.com/scheme/The-Trafford-Centre-Manchester/photography)]

The City of London, as known as “Square Mile”, is the business hub of the city and one of the world’s leading financial centre. With more than 400,000 workers passing through the streets each day and 10 million visitors a year, ensuring strong network coverage is important for the Square Mile. However, mix of historical buildings and contemporary skyscrapers present considerable issues for operators. Square Mile has suffered with numerous mobile black-spots and patchy coverage and performance from a public Wi-Fi system put in place in 2007.

The City of London initiated a plan in 2017, to significantly improve wireless connectivity through the Square Mile with a free, public Wi-Fi network offering gigabit-speed internet. It also planned to incorporate 4G small cells to enhance mobile coverage and capacity at the street level. The City of London offered around 3,600 street assets for the creation of a next-generation Wi-Fi network that will lay the foundation for a 5G system, with a key stipulation that the backhaul system be neutral host and open to all service providers. The City of London also requires an unobtrusive deployment of equipment throughout Square Mile, as they are sensitive to the appearance of equipment on street furniture in terms of size and number required.

CCS Metnet provided the solution through a neutral host backhaul for the wireless network structure in the Square Mile. The small cell network is able to carry traffic for all UK MNOs, boosting connectivity in dense urban environment. CCS Metnet deployed small cells and Wi-Fi access points on lampposts, CCTV posts, and illuminated street signs, providing seamless, ultra-fast broadband that can deliver high-bandwidth services such as video-calling and video-on-demand. Each node has a wide 270-degree field of view, so only one unit is required per site, satisfying the physical constraints.

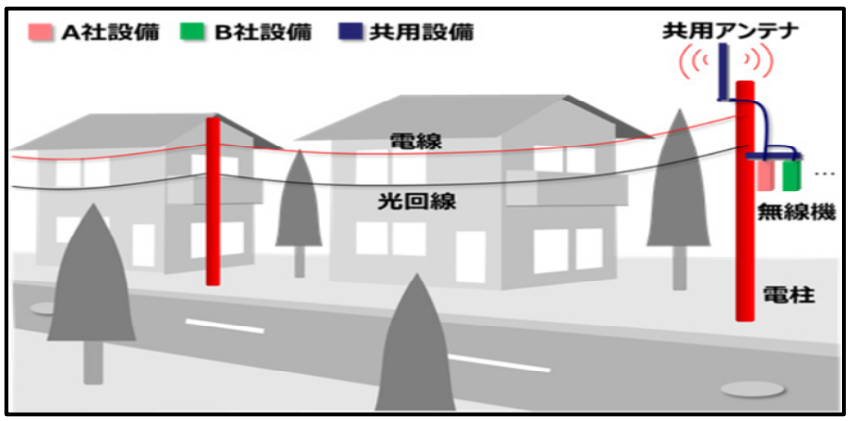


*Source: ["Enabling Neutral Host - Network Economics: CCS Case Study" by GSMA, Aug 2018 (*https://www.gsma.com/futurenetworks/wp-content/uploads/2018/09/180920-CCS_GSMA_Case_Study-FINAL_NE-Modelling-removed.pdf*)]*

*Source: ["'Square Mile' of London Receives Blanket WiFi" by Gordon Kelly, Trusted Reviews, 5 February 2011 (*https://www.trustedreviews.com/news/square-mile-of-london-receives-blanket-wifi-2731582*)]*

Source: ["City of London publishes Square Mile skyline plan" by Elizabeth Pfeuti, Financial News London, 29 December 2017 (https://www.fnlondon.com/articles/city-of-london-publishes-square-mile-skyline-plan-20171229)]

Case Study #3: Japan



In Japan, Tokyo Electric Power Company ("TEPCO"), KDDI Corporation ("KDDI"), Softbank Corporation ("Softbank"), Rakuten Mobile Network Corporation ("Rakuten") is aiming to jointly introduce 5G mobile network through power infrastructure such as telephone poles belonging to TEPCO.

In 5G, high-frequency bands are used to increase speed and capacity, and the number of base stations is expected to increase as compared to those currently deployed for 4G. Securing physical location for installation will be a challenge when number of base stations increases, hence TEPCO is working with KDDI to share base station equipment among operators through its power infrastructures. Softbank and Rakuten are participating to confirm the feasibility of sharing structural resources. With this shared arrangement, it is possible to meet diverse needs such as development of flexible base stations in both urban and rural areas.

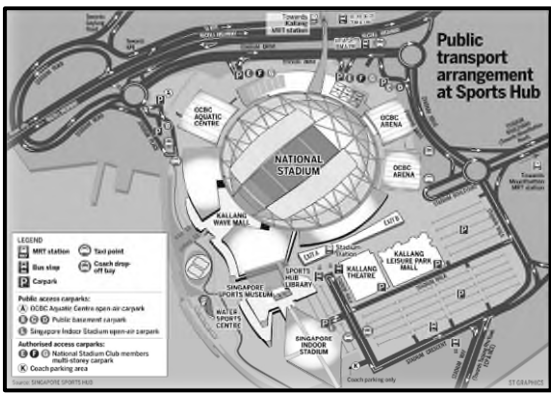
Case Study #4: Korea

In Korea, the Ministry of Science and ICT announced in 2018 that three MNOs – SK Telecom, KT Corp., LG Uplus Inc. – and one ISP, SK Broadband, would share the cost of building the infrastructure for a 5G network. It is estimated that they would save about US$938m over the next 10 years, as it would keep the operators from making redundant investments. This move would also accelerate 5G roll-out, and lower barriers for other operators and partners in the future to offer mobile and multi-play services.

The Korean government is concerned with the underlying infrastructure and is using its heavy influence over the operators to accelerate network sharing, in an attempt to meet physical constraints, making it cost-effective and speed up roll-out. Recently, South Korea became the first country to launch the commercial 5G network, putting them at the forefront of 5G innovation.

Source: ["Korea sets the pace for infrastructure sharing, which is vital for 5G" by Caroline Gabriel, ReTHINK, 25 Apr 2019 (https://rethinkresearch.biz/articles/korea-sets-the-pace-for-infrastructure-sharing-which-is-vital-to-5g/)]

Case Study #5: Singapore Sports Hub



Singapore Sports Hub is an iconic venue that attracts over 15 million visitors a year through its hosting of international events, multiple attractions and facilities. It comprises of Singapore National Stadium, with a capacity of 55,000 and Singapore Indoor Stadium which sits 12,000. Additionally, there are facilities such as Kallang Wave Mall, a 41,000 sqm retail and entertainment precinct, multiple courts for badminton, netball, volleyball and table tennis, an aquatic centre with capacity for 6,000, Sports Library and Sports Museum. With a heavy flow of traffic especially during events, Singapore Sports Hub needed a comprehensive solution providing coverage for all telecommunication companies in Singapore.

Asia Networks led by MR Ong Sing Jye is currently the neutral host for the cellular and Wi-Fi networks to provide coverage. As the wireless operator in building Distributed Antenna System (DAS) for Singapore Sports Hub, they provided capabilities for 2G, 3G, LTE, Wi-Fi and public safety networks to cover over 280,000 sqm. Asia Networks leases the cellular technology to all of Singapore's major telecommunication companies under lease agreements monitored by IMDA. Provisions for technology upgrades and expenditure were included in the lease to ensure service provision are able to keep up with evolving technology. The system has been worked well since 2014.

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.

We have no comment yet for this question.

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.

i) While Singapore's high fibre penetration reduces the need for fixed - wireless services, we would encourage the authority to allow the use of 5G spectrum for such services in order to encourage innovative uses and also for test beds in Singapore for fuller deployment in overseas markets. In Singapore, fixed-wireless services could be used for shore-to-ship communications to realise our Smart Port vision.

ii) We have no comment yet for this question.

Conclusion

ATIS is pleased to contribute its feedback to the consultation paper. We welcome the advent of 5G, and especially the opportunities it enables not only to provide better services and solutions, but also to learn from past experience to re-calibrate Singapore's overall approach to the ecosystem.

For Singapore to power the nation via innovation, we need to examine the opportunities in 5G that facilitate innovative ideas and products. While 5G encompasses innovative technologies, most of the network and device technologies are subjected to standardization and the intellectual properties are owned by major global players outside Singapore in the telco ecosystems. While standardization facilitates interoperability of solutions from vendors and hence provides competitive solutions for end-users, it also hampers differentiations and hence innovation if the solutions are within the standardised framework.

We are of the view that there could be little differentiation in network technologies from telcos as limited by standardization. As such, neutral hosting can provide a cost-effective and calibrated approach to providing 5G infrastructural services while Singaporean companies focus on innovation other than standardised network technologies.

Use of 5G in private networks could also carve out niche areas for Singapore to excel. Injection of right training to build a pool of skills more suited towards the software nature of new generation networks, is critical.

Ultimately, complementing 5G networks with the pervasive (and low cost) WiFi networks is a critical design of future networks.