Mobility meets Cloud

MyRepublic response to the consultation paper by the Info-Communication Development Authority of Singapore:

"PROPOSED ALLOCATION OF SPECTRUM FOR INTERNATIONAL MOBLE TELECOMMUNICATIONS ("IMT") AND IMT-ADVANCED SERVICES AND OPTIONS TO ENHANCE MOBILE COMPETITION"

June 19th, 2014

EXECUTIVE SUMMARY

While Singaporeans now have affordable *fixed broadband* access to the cloud at Gigabit access speeds in their home and in their places of work, Singaporeans are still underserved where they spend most of their time, accessing the Internet *On-the-Go* from their morning commute to their favorite Kopitiams and Hawker stalls. In Singapore only "lite" access to the Cloud is possible from our phones and tablets due to a very high cost per mobile MB.

Introducing more competition in mobile access will benefit Singapore. Global experience from other markets shows that markets with three mobile operators – typically characterized by a lack of price competition, mediocre quality of service and pent-up innovation – can be made to deliver more value to consumers by the introduction of a 4th mobile operator.

However, how that competition is introduced should be done in a manner which strives to achieve broader IDA objectives and national interests including enhancing Singapore competitiveness through emerging growth areas, creating opportunities for emerging growth for start-ups and leveraging Singapore's *Hub Status* to deliver emerging Infocomm and media services globally. Initiatives underway to achieve these objectives include the Intelligent Nation 2015 programme, the Masterplan Infrastructure Working Committees, the Data-as-a-Service (DaaS) Programme and Data.gov.sg.

The introduction of regulated MVNOs in Singapore – whether heavy or thin – will not go far enough to lay the foundation to ensure the achievement of the IDA's broader industry and national economic objectives. An MVNO is ultimately tethered to the legacy infrastructure and thinking behind conventional mobile operator service delivery, pricing and quality of experience. An MVNO brings little opportunity to change the economics of delivery of mobile services, hampers meaningful innovation, and ultimately will fail to accelerate the emergence of truly Cloud World.

A better approach would be to lay the foundation for a 4th operator in Singapore, one which owns spectrum and takes up the challenge of redefining the costs of delivering ultra-high quality mobile broadband. Only this approach will achieve the broader industry objectives of driving innovation and economic development.

In order to ensure the upfront viability of this 4th operator, certain conditions would need to be in place. Most important is arming that 4th operator with a suitable mix of radio spectrum enabling both nationwide coverage (sub 1 GHz) as well as capacity (above 1 GHz). Given the maturity of the ecosystem, FDD is preferred, at least to start with. That said, if a potential 4th operator is given a sufficient amount of TDD spectrum, it has the potential to introduce innovative unlimited data plans. Secondly, a regulated national infrastructure sharing framework is required. And finally, for the first 3-5 years, while the 4th operator is building out its infrastructure, a RAN sharing national roaming agreement is necessary in order to meet iDA QoS requirements and end-user needs for ubiquitous national coverage.

MyRepublic would definitely be interested in being that 4th operator in Singapore. Our vision for mobile access is simple – providing affordable, best quality of experience access to the Cloud, from anywhere. MyRepublic would leap to a next generation network architecture – adopting HetNet radio architecture, using small cells, with a flat IP network enabling virtual cloud services. Designed for spectral efficiency, our approach would be to offer greater data bundles for the lowest costs per Gibabyte. Without the burden of a legacy network, MyRepublic would purpose-build an open-architecture, data-centric mobile network delivering data at the lowest cost per bit.

In this paper MyRepublic outlines our recommendations to the iDA for introducing a 4th mobile operator to Singapore. We will share how MyRepublic would realize our vision of bringing an Open innovation model, and transparent data-only pricing models to our Mobility Service offering.

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1. Mobile Broadband in Singapore Today

a. Changing needs of Mobile in a Cloud World

A few years ago when Singaporeans thought about a cloud, invariably they would reach for an umbrella. Today thanks to the Gigabit speeds possible by Singapore's ubiquitous NBN, the massive increase in computing scalability and the agility possible through virtualization, when Singaporeans hear 'cloud' today they reach for their keyboards or tablets. Unfortunately when Singaporeans are on the Go with their phones or tablets, the experience is more 'lite', poor and expensive.

The future is very clear, with the ubiquity of mobile broadband and cloud computing, it will yield a fast-emerging breed of applications and revolutionize how we communicate and interact with the cloud in the process. The future in Singapore is Cloud, with NBN allowing all our data to be stored in the cloud and then to be accessed anytime from our mobile devices. Nowhere is this more evident than in Google Cities like in Kansas USA which has shown with high speed fiber access all data and applications is stored in the cloud, only to be consumed or accessed later on a mobile device.

Access to the cloud from our mobile devices can't be choked by costly Byte fees. Access to the cloud must provide high speed, low latency and affordable Byte charges if "Silicon Valley Singapore" is to lead this innovation.

Mobile networks in Singapore must transform to provide an affordable playground for innovation, for mobile cloud to take off ...

b. Shortcomings for Mobility access to Cloud in Singapore

In Singapore today all three mobile network operators have moved away from unlimited data pricing models. Their rationale: a few users are consuming all the bandwidth. Is this really the issue of a few users consuming all the bandwidth? Maybe the issue is a cost structure not in line with modern Mobile cloud world due to legacy networks, bureaucratic organizational structures and mostly lack of innovation stuck in a Web 1.0 world. Or maybe the real issue is that they can get away with charging more!

Today 39.99$ plan will provide 2 GBytes of mobile data. How can Singaporeans experience the full power of the cloud with 2Gbytes per month? As iDA noted in their consultation paper, the CAGR of mobile traffic is 40-70% over the next few years and users will need 10+Gbytes per month to fully experience the cloud. It would cost over $200 to consume 10GBytes on a post-paid plan – beyond the reach of most Singaporeans.

While Singapore has a fantastic mobile penetration rate at 150% saturation, its cost per Byte is too high. In 2013, the World Economic Forum ranked Singapore's fixed and mobile ICT affordability at 55th in the world, far below the likes of South Korea and Japan – nations renowned for their ultra-fast Internet connectivity.

Pricing of fixed-only telecom services in Singapore is much better. In 2013, the ITU ranked Singapore affordability of fixed access at 14th in the world. However, with the recent increase in competition in the fixed-line fibre broadband market in Singapore, pricing here has become among the worlds best. MyRepublic is the leader in providing the lowest cost Internet access at 49.99$ for 1 Gigabit service.

Innovation in the fixed network thanks to NBN has significantly lowered costs and improved Internet access speeds. However, the high cost and poor service of mobile access in Singapore has inhibited the realization of a Cloud World.

True competition will force all operators to provide affordable, scalable and high quality mobile access thereby enabling true mobile connectivity to the Cloud.

c. Lack of Innovation: "Enable" Cutting-Edge ICT/OTT Services Providers

The future of telecom & ICT will involve acceleration in the separation between:

- infrastructure and access service and revenues; and
- Internet over-the-top (OTT) services, applications and service revenues.

With many OTT applications and business models (including those in M2M and Internet of Things) yet to be created, tested, or even conceived, "Silicon Valley Singapore" can be a prime innovation hub, the place where ideas, business models and companies emerge from – a launching pad to venture into rest of Asia and the world. Local application developers, thanks to NBN have a major advantage in developing Cloud applications; unfortunately this is not the case for mobile today.

Existing mobile access providers are not adequately driving and supporting cloud service innovation, instead they behave like toll-keepers which discourage and/or dampen activity of OTT services. Today when independent developers bring innovative ideas to telecom operators to market across their extensive mobile networks, more often than not they are run around in circles by these gate-keepers before their project is finally dropped. This toll-keeper behaviour is well documented by leading industry analysts including Paul Budde, who observes that big mobile Telco behavior, in trying to ensure that independent applications do not erode their profitability, discourages technological progress and innovation. See the analyst report in **Annex A** which documents this behaviour (*Global Infrastructure – Open Network Insights*, Paul Budde (June 2013), pages 12 to 13)

A new type of Telco – an Open Telco – actively encourages and enables independent developers by providing a test bed to succeed.

d. 4th Operator driving competition, innovation, prices and user experience for Singaporeans

Improving competition will naturally improve quality of experience, pricing and propel innovation. When we look across the world to other markets, we see that the introduction of a 4th operator in other markets has brought a very positive outcome for consumers.

We have attached as **Annex B** a Credit Suisse report that we came across in our research, named "Three's a Crowd; Four's a Feud; Global Lessons from Four Carrier Wireless Markets". The specific context of the report was whether Verizon mobile of the US should be allowed to enter the Canadian market – the mobility telecom regulations in Canada allow 3 new mobile entrants to join the existing 3 entrants, but those rules forbid the entry of large players like Verizon. Some highlights from the report applicable to Singapore include:

- ~30% of OECD countries now have four or more mobile carriers;
- countries with higher population densities are most suitable for a 4th mobile operator;
- ultimately, a 4th mobile operator is seen as breaking up a cozy situation that a market-of-3 is prone to falling into;
- The entrant of a 4th mobile operator brings competition, lower prices and creative innovation for consumers (see page 7 of Annex B, referred to France and Belgium)

We have been tracking the evolution of the market – insofar as competitive moves and competitor responses are concerned. We believe that more competition is needed in mobility in Singapore.

In support of this point, we attach as **Annex C** a UBS Report covering the Singapore telecom landscape. We refer to the second paragraph on the first page, under the heading "Attractive Mobile Market Dynamics" where the analyst states that they believe that the mobile market dynamics are attractive in Singapore since operators do not engage in too much price competition, and have moved in unison towards data caps and surcharges.

In support of the same point, we also attach **Annex D** – a Straits Times article on market convergence around data pricing in Singapore.

According to Ovum Research, this lack of competition in mobility – and in particular pricing that is a premium to 3G creates an impediment to a thriving 4G marketplace and ecosystem.

We think the competitive landscape of mobility in Singapore would greatly benefit from the entry of a 4th operator, which might take the market in a different direction altogether:

- Pricing to End-Consumers for Mobility Services Needs Improvement
- Lack of Innovation: Mobile Access Providers Need to Better "Enable" Cutting-Edge ICT/OTT Services Providers
- The Introduction of a 4th Mobile Operator will Drive Competition in Mobile Access – Improving Prices & Driving Innovation

e. <u>Why can't an MVNO stimulate competition and innovation in Singapore?</u>

In the Singapore context, there have been a number of commercially negotiated MVNOs over the years. Virgin Mobile who is renowned for their marketing prowess is now out of business. Other MVNOs such as SMART have been relegated to niche market players, and have no impact on the wider mobile landscape.

An MVNO, be they heavy or thin, have little control over the Quality of Experience, as an MVNO does not own spectrum and therefore cannot control the End to End QoS. Also as the MVNO relies on an existing Mobile network operator for the radio access, the backhaul, and the vast majority of the cost of carriage, there is no way for an MVNO to innovate on cost of service. MVNO model is (by definition) a Cost+ model.

Singapore needs innovation, and a new cost model for connecting to the Cloud. An MVNO is a marketing vehicle and won't transform quality of experience and costs for Singaporeans.

2. Mobile Broadband in Singapore with MyRepublic Mobile

a. MyRepublic Vision for a 4th Mobile Network Operator

MyRepublic does not aspire to be a conventional mobile operator. Our vision is to pioneer a new type of mobile operator focused on ***Openness, Innovation, Quality of Experience*** and ***Costs*** to allow for the full access to the Mobile Cloud.

MyRepublic Mobile would adopt the same business-philosophy that we currently use for our fiber broadband business, with one clear exception. In fiber we focused on providing the fastest speeds for the lowest costs – 49.99$ for one Gigabit/sec service – in mobile we will focus on providing unlimited data bundles designed for cloud at affordable prices for Singaporeans.

MyRepublic Mobile will be an ***"Open Telco"*** – collaborating with global and especially local OTT providers in an unparalleled manner. Net Neutrality will be our key operating principle, avoiding all toll-charges to Internet applications (e.g. Skype, WhatsApp). Walled Garden service models do not work. MyRepublic Mobile will leave the development and fulfillment of services and applications to OTT Internet players, which

we expect to increasingly, come from local Singapore OTT players thanks to the government initiatives to drive "Silicon Valley Singapore".

If Singaporeans are to achieve the full benefits of the Cloud from their Mobile devices, the 2Gigabit Monthly data plans simply will not be sufficient. In order to achieve higher monthly data bundles, **higher data bundles require a step-function reduction in costs**. The size of these affordable data bundles will scale as the consumption of cloud services proliferates.

MyRepublic believes that there is an opportunity to pioneer a "thin operator model", by driving efficiency improvements across the business including in cloud computing, online go-to-market, smart infrastructure sharing and next generation network intelligence. For example, today mobile network operators are spending tens of millions of dollars on OSS systems made by foreign MNC providers. MyRepublic's fibre B/OSS ("MyRepublic B/OSS") was created using open source applications, by Singaporeans for a fraction of the cost. This cloud based IT platform drives cost efficiencies and passes savings on to Singaporeans by adopting a fully automated order-to-cash process.

With a 4th operator in the market, where will the Singapore mobility market settle into over time? We believe that there will be room for all operators to play, with incumbents retaining their core customer base through bundling. We believe that by entering the market, more competitive behaviour will be driven across all operators, benefitting all consumers and businesses.

MyRepublic is open to making commitments to drive innovation to the IDA as part of the condition of being awarded spectrum. For example, these might include:

1. promising to provide unlimited mobile data bundles – offering fibre-like packages – "simple, clear and affordable"
2. undertaking to host MVNOs – in other words, we would commit to build a form of Mobile NBN. Among other things, this would enable new disruptive business models from market participants not traditionally offering mobile access service (e.g. HP, IBM, emerging M2M players)

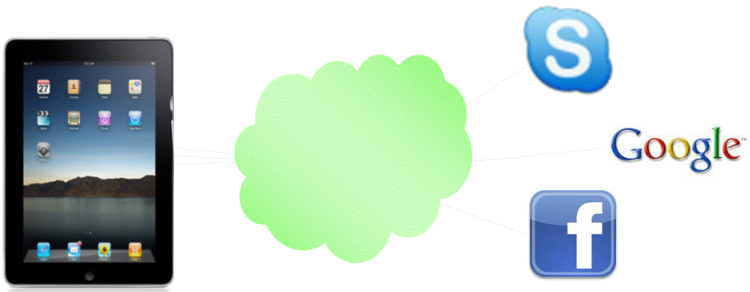
3. committing to being the most spectrally efficient operator by undertaking to use HetNets – specifically pushing the frontier on interworking between different types of access including WiFi. We note that HetNet is not just about spectral efficiency – it is also an enabler of new services, generating new revenue streams (e.g. location based services, data analytics)
4. undertaking to permanently broadcast Singapore free-to-air channels through eMBMS

MyRepublic's fiber broadband business pioneered a new type of Telco then exported it to other NBN markets. With MyRepublic Mobile we would aim to pioneer a new Mobile Network Operator in Singapore, and export it to other markets.

b. <u>MyRepublic The Network – Our Vehicle to Transform Experience & Costs</u>

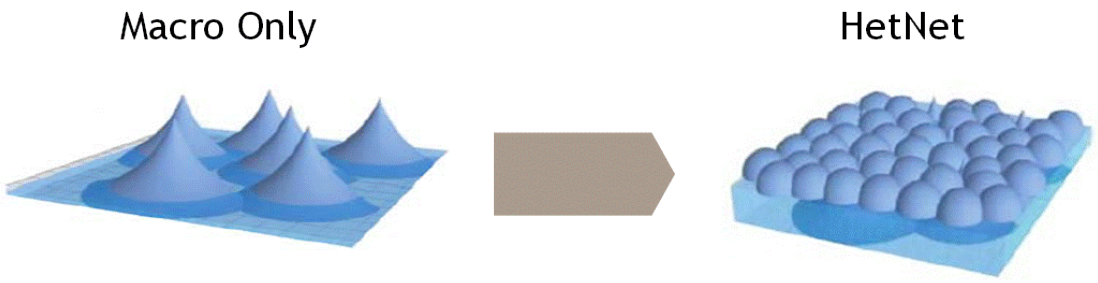
MyRepublic Mobile network vision is to deliver the lowest cost, best quality of experience access to cloud services and applications.

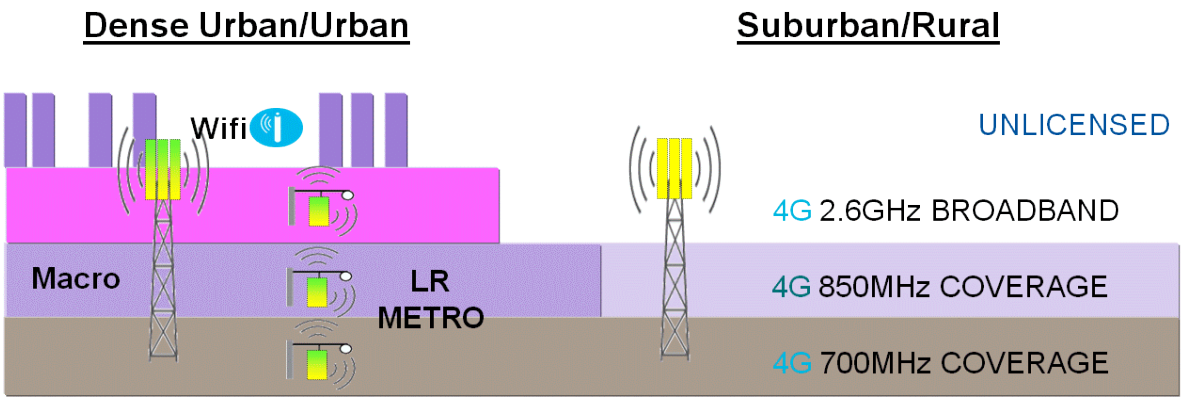
Our network architecture would rely on the latest industry technologies, such as Network Function Virtualization (NFV), Software Defined Networks (SDN), HetNet and net neutral access to Cloud for Service Delivery by OTT. This will enable us to offer greater data bundles for lowest cost to Singaporeans.



1. Device *3. Cloud* *2. Services*

Spectral Efficiency in Singapore can be greatly improved by using the latest technology including a HetNet radio access network architecture. For example, LTE can achieve 50% more Bits/Hz than 3G and this is why MyRepublic would adopt an LTE Advanced network and move aggressively to 5G when available around 2020. Up to 60 to 70% of mobile data is generated by nomadic users indoors. HetNet radio access network architecture, using Macro base-stations to provide coverage and reach and Small Cells to provide capacity hotspots is the ideal architecture to maximize spectral efficiency and provide uniform quality of experience across a cell.





Mobile network operators in Singapore have experienced in the past 12-18 months a number of high profile network outages. For example the IDA imposed a $1.5 million fine over an M1 mobile network outage. The MyRepublic network vision will not compromise on resiliency and reliability.

Overall, more competition will force all mobile operators to improve on their quality of service and reliability, just as was the case in the fixed fiber access market.

A MyRepublic LTE Data-only Mobile network would aim to be the most advanced data-only mobile broadband network in the market, providing the lowest cost of carriage, reliability and best quality of experience in Singapore.

c. MyRepublic Pricing Model

As stated earlier, while mobile penetration in Singapore is one of the highest in the world (at ~150%), mobile data pricing competitiveness is lagging behind at ~50th worldwide according to a recent World Economic Study. Recent events are showing that there is no intention of the incumbent Mobile network Operators to change their pricing model, with recent examples such as Starhub's plan to price for 4G from June 2014 eventually blocked by the iDA, and the move away from all operators away from unlimited data bundles to 2Gigabyte monthly plans.

MyRepublic will introduce a new standard for pricing based on the following key principles:

- Simple, Transparent and Data only
- Unlimited Voice, Unlimited Messaging
- (Always) the highest entry Data Bundle
- No More Bill Shock for normal and roaming use – Clear Maximum Cap
- Data Sharing across family members
- Carry forward of unused Data

MyRepublic Mobile is not aiming to offer gimmicks such as the cheapest mobile plans operator. MyRepublic Mobile will be the lowest cost per Megabyte

3. Pre-Requisites for New 4th Operator to Succeed in Singapore

MyRepublic Mobile or any new 4th licensee will need regulatory support and backing if they are to succeed.

a. General Support: Creating a Smart Commercial/Regulatory Environment

MyRepublic recommends the following key items to support our successful launch:

1. **A Regulated National Roaming Agreement (RAN Sharing)**
    a. A new entrant will need at least 3 years to match the coverage level of the incumbent SPs. Therefore a regulated national roaming agreement will be required to enable a gradual market entry.
    b. A new entrant will need Indoor QoS requirements to be relaxed for 3 years and allow this to be met through our national roaming agreements initially.
2. **Site sharing access at regulated prices** to existing and new sites of all operators. This is needed to accommodate base stations and backhaul of the new entrant.
    a. We also need assurance that existing operators must assist in giving access to its building sites
    b. Specifically, we must avoid the "there-is-no-room-on-rooftop"-problem
    c. We are concerned that if word gets out of a 4th operator, existing operators will work to take up roof top space to squeeze out new operator

d. We need some protection here – for example: "Operators cannot deploy site access capacity UNLESS they are actually using it"

3. **As support for the new mobile Network, Singapore authorities could become an "anchor tenant"** of this new infrastructure., e.g. for public safety, electronic metering or other applications
4. **To allow a data only network, regulatory requirements for functional emergency calls (3GPP TS 12) need to be relaxed**
5. The new entrant should build a nationwide HetNet network. This will mean a 10 fold increase in the number of base stations (i.e. small cells). The regulatory requirements must be adapted to support this many base stations**. As such the iDA will need to adapt regulations to enable HetNet deployments** e.g. power levels, administration, access to sites, QoS definition at Network rather than per site.
6. **We intend to use OpenNet NBAPs, although a rationalization in this area is required** as:
    a. Currently the upfront OpenNet free for NBAPs is way too high
    b. We need our roof top cell sites to be afforded the same classification (and pricing) as non-residential instead of NBAP

b. <u>Spectrum Allocation Needed by a 4th Operator – Overview of MyRepublic Spectrum Recommendations</u>

The market entry conditions are important in order to ensure a fair competition between all operators. MyRepublic would like iDA to take into account the following considerations in spectrum allocation policy to enable a 4th operator to succeed:

1. There must be a specific allocation of new spectrum blocks reserved for new entrants, so that a 4th licensed operator enters into the market
2. The spectrum allocated by iDA should take into consideration the device ecosystem, as well as the cost to rollout a nationwide network. **With that in**

mind, we recommend that the iDA specifically allocate to a 4th operator a combination blocks such that coverage can be provided through sub-1 GHz spectrum (at a minimum 20 MHz), and capacity through over 1 GHz (at a minimum 100 MHz).

- For example, for **sub 1 GHz**, one approach to make spectrum available to the 4th operator is as follows:
  - The 850MHz (band 5) 2x10MHz can be made available immediately, and later extended into band 26
  - The new APT 700 band (band 28) can be made available in the future upon shut down of analogue TV. We would be keen to discuss how we could create an open-access sharing model for this band – doing away with the need for this spectrum to be partitioned – so that it can be more efficiently utilized.
  - Existing operators should be restricted to the GSM (900Mhz, band 8) band and allowed to re-farm to more spectrally efficient technologies.
  - All options we consider for sub 1 GHz are FDD-only
- For example, for **above 1 GHz**, one approach to make spectrum available to the 4th operator includes:
  - The most attractive option is for the FDD mainstream bands (band 7 and band 3). However, we understand that the largest part of both bands have been allocated to incumbents. While there are segments still available within these bands, the IDA would be required to restructure the allocations in order to unlock the potential of those segments for a 4th operator. This has been done in other markets, and would result in contiguous spectrum blocks for each telco, thereby better optimizing the spectrum efficiency.
  - Even with the restructuring of band 7 and band 3, there would not be enough spectrum for us to fulfill our vision of unlimited data. Therefore, we need to complement the above FDD options with

additional TDD spectrum of at least 50 MHz in Band 38 and Band 40.

4. Response to iDA Questions

a. Part 2: Spectrum Bands to be Allocated

<MyRepublic Response>

In this section we answer iDA questions related to spectrum requirements. Please also refer to our additional technical **Annex E** on spectrum providing more rationale and also our analysis of the interference issues.

Question 1: *Whether the 700 MHz band should be allocated as a standalone, or coupled with other bands such as the 900 MHz, 800 MHz or the 1.9/2.1 GHz bands.*

<MyRepublic Response>

iDA should allocate 700MHz APT band (band 28). However, IDA should consider allocating other sub 1 GHz bands to a 4th operator first. as a new 4th operator should be well established prior to possible auction of the APT 700 spectrum. I.e. the 800MHz and 900MHz allocation should come prior to the award of 700MHz. Specifically for indoor us and capacity filling, we recommend combining this sub-1GHz spectrum with spectrum blocks in the upper frequency bands (>1GHz, ideally FDD bands 3 or 7. Alternatively with TDD spectrum in Band 38 or 40.

Question 2: 800 MHz

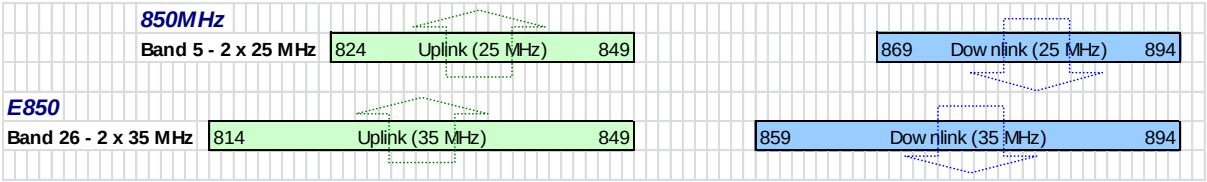
(a) Whether the 800 MHz band should be re-farmed for mobile services;

<MyRepublic Response>

MyRepublic favors Band 5 because of its coverage attributes, as well as the maturity of the device ecosystem that is well established. This band allows limiting the disruption on port communications and can provide at least 2x10MHz of contiguous nationwide usage which is essential for a new entrant to succeed.

That being said, any new entrant would need the iDA to work with neighboring country regulators to ensure interference mitigation in 850MHz. As a mobile operator on band 5 would interfere with Short Radio Devices in Singapore, these devices must be relocated to a new frequency.

By relocating services below the current Band5, this band can be extended by another 2x10 MHz (forming an extened Band or Band 26).



(b) *The band plan that should be preferred by Singapore and the underlying reasons;*

<MyRepublic Response>

MyRepublic favors Band 5 for the following reasons

3. Sub-1GHz frequencies are needed to provide excellent nationwide coverage most cost effectively.
4. Band 5 provides an existing device ecosystem that is well established
5. This band allows limiting the disruption on port communications and can provide at least 2x10MHz of contiguous nationwide usage. 10MHz minimum is needed to provide competitive speeds and bandwidth.
6. This Band can be expanded futher into Band 26 as shown above.

(c) *Details of transitional issues to migrate existing services and systems in the 800 MHz band to the revised band plan;*

<MyRepublic Response>

The following transitional issues would need to be addressed

1. Short Radio Devices must be moved as a new entrant in band 5 will interfere with them.
2. The iDA must negotiate with neighboring countries to ensure there is no inter border interference now and into the future.
3. Note that this 800 MHz band is providing coverage but by itself would not provide the capacity attributes needed for a fourth operator to be successful. Hence it needs to be complemented with a larger band allocation in the upper frequency bands
4. Initially a new entrant will not be able to meet iDA QoS requirements for indoor and outdoor. QoS requirements must be met initially for 3-5 years through a national roaming agreement.

(d) *Possible impact to end users of digital trunked radio and SRD, if, as a result of the eventual 800 MHz band plan: (i) the end users do not have to be migrated but will have to coexist with mobile broadband services; or (ii) the end users have to be migrated; and*

<MyRepublic Response>

Short Radio Devices must be moved as a new entrant in band 5 will interfere with them.

(e) *Possible co-existence issues between mobile broadband, and digital trunked radio and SRD/RFID.*

<MyRepublic Response>

With LTE Band 5 introduction, interference between LTE users and digital trunk Radio users might be mitigated through correct antenna spacing, considering there is already 3MHz guard band.

MyRepublic recommends migrating SRD users as SRD users are directly adjacent to LTE Band 5, SRD users are expected to be interfered by LTE.

Question 3: 900 MHz

(a) *Whether the band should be re-allocated as a standalone band in a market-based allocation framework, and if so, the preferred timeframe for such an allocation exercise;*

<MyRepublic Response>

7. Instead of a spectrum auction, a 4th license competition should be launched and should include the following;

- The 850MHz (band 5) 2x10MHz should be reserved only for new entrants.
    - Existing operators should be restricted to the existing band 8 (900Mhz) allocation and allowed to refarm to more spectrally efficient technologies (WCDMA and LTE).
- Note that this 800 MHz band is providing coverage but by itself would not provide the capacity attributes needed for a fourth operator to be successful. Hence it needs to be complemented with a larger allocation in the upper frequency bands

The award of the 850MHz band should be made as soon as practically possible (early 2015) once agreements can be made with neighboring countries with respect of interference issues in this band.

(b) *Whether the band should be coupled with other spectrum bands for allocation, and if so, which bands and the preferred timeframe for such an allocation exercise; and*

Note that this 800 MHz band is providing coverage but by itself would not provide the capacity attributes needed for a fourth operator to be successful. Hence it needs to be complemented with a larger allocation in the upper frequency bands.

MyRepublic advises to launch a 4th license competition to use 850MHz (Band 5) together with 100 MHz in upper FDD bands (B3 and Band 7) or TDD bands (band 38, 40) which is required for capacity.

(c) *The underlying reasons for your views on the above.*

<MyRepublic Response>

Any new Operator to be successful will need a cost effective sub 1GHz band to provide nationwide coverage and QoS. As already explained, band 5 provides at least 10MHz of spectrum that can achieve good coverage, has a good device ecosystem. This must be reserved for any new operator to be successful.

Existing operators have already invested in 900Mhz and will use software defined radio technology to upgrade their existing base stations to LTE.

Finally 10Mhz is insufficient for a new operator to compete with incumbents on speed. For example SingTel is now advertizing 300Mbps of LTE speed. This requires at least 2x40MHz of spectrum. As such MyRepublic requests in addition to the said Band 5 also a 100 MHz spectrum asset as capacity layer at upper LTE bands to provide competitive speeds with the incumbents. FDD options are Band 3 and 7. TDD options are Band 40 and 38.

Question 4: Sub-1 GHz bands

(a) *The technical issues relating to the allocation of the Sub-1 GHz bands for mobile broadband services, in particular, the guard band requirements between the adjacent bands (e.g., 700, 800 and 900 MHz bands) for mobile broadband services.*

<MyRepublic Response>

No additional guard band between 700MHz band and 800MHz (considering LTE Band 5) is required.

A guard band is required between LTE in 800MHz and GSM in 900MHz as LTE DL band and UL GSM band overlap. 5 to 10MHz guard band will be needed, with the minimum being achievable with through filters on both systems and antenna coordination.

MyRepublic recommends allocating first the lower part of Band 5.

Question 5: 1.4 GHz

(a) *Indication of any industry interest in the use of the 1.4 GHz band.*

<MyRepublic Response>

Today MyRepublic does not see a viable ecosystem for this band.

Question 6: 4G & IMT Advance

(a) *To allow the deployment of 4G and IMT-Advanced systems and services in the 3G bands.*

<MyRepublic Response>

MyRepublic is a strong supporter of deploying the most spectrally efficient technologies. As such MyRepublic advocates the iDA to consider a technology agnostic policy towards spectrum allocation to ensure the flexibility to move to newer technologies and more spectrally efficient radio access technologies rapidly.

Question 7: TDD bands

a) *Indications of industry interest in the allocation of long term rights in the TDD bands, as well as planned services (including small cells) and target market segments for the use of these bands;*

<MyRepublic Response>

While TDD lags behind the FDD eco system, MyRepublic is interested in the TDD bands as a capacity layer, complementing a nationwide coverage layer (sub 1GHz). This layer should be encouraged for the utilization of a HetNet architecture which provided the most efficient spectrum utilization and best quality of experience. Band options are: Band 40 and Band 38. Band 41 in case IDA considers allocating the entire 2.5 GHz band for TDD (instead of provisioning for FDD band 7).

(b) *Views on whether the use of the TDD bands solely for the deployment of in-building TDD systems is feasible, and the underlying considerations thereof;*

<MyRepublic Response>

MyRepublic does not believe that TDD bands should be solely restricted to indoor. In China Band 40 (2.3GHz) was restricted to indoor, however this was only due to interference considerations with Military applications. MyRepublic is not aware of any such restrictions in Singapore.

(c) *Views on whether the use of TDD bands for partial deployment of outdoor and in-building TDD systems is feasible, and the underlying considerations thereof;*

<MyRepublic Response>

There should be no restriction. The TDD layer should be used for indoor and outdoor.

(d) *views on the use of TDD bands for small cell deployment as part of a HetNet;*

<MyRepublic Response>

While HetNets provide the most efficient usage of spectrum, there are cases where a Macro will provide the most cost efficient coverage & capacity solution. As such MyRepublic would advise the iDA to provide the flexibility to deploy HetNet and Macro sites in TDD bands.

(e) *Views on the mitigation techniques requirement for co-existence (e.g., separation distance, transmit power, and UL-DL configuration);*

<MyRepublic Response>

MyRepublic advocates the allocation of 50MHz TDD Band 38 to single operator to avoid the usage of a guard-band between TDD operators. A guard-band between FDD and TDD is required; the size of the guard band will define if additional filters are needed on both systems.

Please refer to MyRepublic **Annex F** on frequency bands interference.

(f) *views on the implication of the TDD bands on a half-band sharing basis with neighbouring jurisdictions; and*

<MyRepublic Response>

MyRepublic advocates for a full band allocation of band 40 and 38 with interference mitigation agreed with neighboring countries. For example power levels at neighboring borders and resolving synchronization issues. This is a strategy deployed by NBN in

Australia, where Vivid Wireless spectrum (now Optus) in Metro areas and NBNCo in rural areas.

(g) *views on the implication of the TDD bands on a full-band sharing basis (primarily for in-building deployment) with neighbouring jurisdictions.*

<MyRepublic Response>

MyRepublic advocates for a full band allocation of band 40 and 38 with interference mitigation agreed with neighboring countries. For example power levels at neighboring borders and resolving synchronization issues. This is a strategy deployed by NBN in Australia, where Vivid Wireless spectrum (now Optus) in Metro areas and NBNCo in rural areas.

Question 8: 3.5 GHz

(a) *Indications of industry interest in the allocation of long term rights in the 3.5 GHz band, as well as planned services and target market segments for the use of these bands;*

<MyRepublic Response>

MyRepublic is currently following the discussion happening around the world on 3.5 GHz. MyRepublic believes that the 3.5 GHz band presents an opportunity for deployment of fixed wireless access, wireless backhaul for small cells, indoors and outdoors small cell for capacity or perhaps even macrocellular for targeted high capacity demands.

MyRepublic considers that this band is most likely amenable to Time Division Duplexing (TDD) due to the relatively large duplex gap that would be required for Frequency Division Duplexing (FDD) at this frequency. MyRepublic believes that additional works should be done in the Singapore context regarding the possible use of 3.5 GHz and coordination at regional and international levels should be considered in the context of harmonization and achieving economies of scale.

We attach as **Annex G** what we believe to be a very interesting presentation which addresses a number of topics around 3.5 GHz including business models.

(b) *Views on whether the use of the 3.5 GHz bands solely for the deployment of in-building mobile systems is feasible, and the underlying considerations thereof;*

<MyRepublic Response>

There should be no restriction. The 3.5GHz layer should be used for indoor and outdoor.

(c) *Views on possible impact to end users of FSS and TVRO, if (i) the end users do not have to be migrated; or (ii) the end users have to be migrated; and*

<MyRepublic Response>

Further studies would need to be conducted to assess the potential interferences between LTE and FSS/TVRO. FSS/TVRO users would have to be migrated if antenna spacing, guardband and additional filters can not provide sufficient isolation to prevent interference between systems.

(d) *Views on possible co-existence issues between TDD systems, and FSS and/or TVRO systems.*

<MyRepublic Response>

Further studies would need to be conducted to assess the potential interferences between LTE and FSS/TVRO.

Question 9: HetNets

(a) Views on key policy areas related to technical, service provisioning or end-user impact that should be considered in the deployment of HetNet; and

<MyRepublic Response>

HetNet will introduce new challenges because its deployment is expected to be at the heart of many communities. The core challenges can be summarized as gaining general public acceptance with regards to health and safety and scaling of the planning and administrative processes needed for rapid approval. From a technical consideration, compliance with transmitted radio frequency power is essential. The 3GPP has defined several small cell classifications with associated power and deployment guideline as illustrated below (source: 3GPP).

Class #	Maximum EIRP	Application	Comments
1	< 100 mW	Small /Home office small cell	• Deployed by the consumer • Certification against local SAR 1 g recommended (this test being more stringent than local SAR 10 g); if compliant, no RF safety distance is required • Note: Even if the SAR test is not required by regulation (EIRP < 20 mW), operators can ask for the SAR values.
2	100 mW < EIRP < 1 W	Indoor and outdoor local metro cells	• Deployed by professional staff, thus ensuring installation conditions meet a minimum separation distance of 20 cm are maintained. For example, wall-mounted indoor at a minimum 2.10 m height (the usual height used by indoor Wi-Fi AP in enterprise application), and therefore automatically compliant to exposure limits when ICNIRP limits apply. • If more stringent local limits, then minimum safety distance estimation (EIRP adjustment) and installation conditions definition accordingly are recommended
3	1 W < EIRP < 5 W	Outdoor local metro cells	• Same as Class 2 Installed by professionals • Distance estimation/EIRP adjustments to meet compliance with exposure limits

(b) Other policy implications that may arise with HetNet.

<MyRepublic Response>

Recognizing the number of entities that could be involved, the amount of paperwork required, and the length of time a multitude of processes can entail, current processes associated to traditional network deployment (i.e macro) will result into deployment delay and higher cost. Streamlining the approval process becomes mandatory. MyRepublic believes the policies in the following areas might need to be revised for HetNet: back-up power rule, backhaul access rule, environmental consideration, building permits, applicable taxes and fees.

Declaration of Small Cell equipment should be eased to allow a streamlined and optimized process (i.e declaration of batches of small cells versus individual equipment declaration, tax relief, exemption based compliance…)

Please refer to MyRepublic Annex E for further details on policy recommendation.

a. Part 2: Spectrum Bands to be Allocated

Question 10: MVNOs

(a) *Views and comments from potential MVNOs on their level of interest to enter the mobile market and the target market segments of potential MVNOs (e.g., pre-paid or post-paid, niche or general consumer segments);*

<MyRepublic Response>

MyRepublic has little interest in launching an MVNO in Singapore.

Why? An MVNO is ultimately tethered to the legacy infrastructure and thinking behind conventional mobile operator service delivery, pricing and quality of experience. An MVNO brings little opportunity to change the economics of delivery of mobile services, hampers meaningful innovation, and ultimately will fail to accelerate the emergence of truly Cloud World.

An MVNO, be they heavy or thin, have little control over the Quality of Experience, as an MVNO does not own spectrum and therefore cannot control the end-to-end QoS. Also as the MVNO relies on an existing Mobile network operator for the radio access and the backhaul, the vast majority of the cost of carriage, there is no way for an MVNO to innovate on cost of service. The MVNO model is by definition a Cost+ model.

In the Singapore context, there have been a number of commercially negotiated MVNOs over the years. Virgin Mobile who is renowned for their marketing prowess is now out of business. Other MVNOs such as SMART have been relegated to niche market players, and have no impact on the wider mobile landscape.

Furthermore, in our investigation of other markets such as New Zealand, we observe the phenomenon which takes place when a Tier 2 fixed line operator seizes the irresistible opportunity to provide MVNO services in the view that this will allow it to position its fixed line & MVNO services as a "bundle" into the market. Typically launched with much marketing fanfare, the bundle ultimately lacks meaningful and substantive value. The end result is a handful of consumers – seeking a genuinely improved experience – signing up at the outset. Ultimately disappointed and disillusioned with the lack of any meaningful improved experience or value for money, customers churn-off over-time as the hollow marketing sheen of the MVNO value proposition wears off, and the MVNO operator is left with a sub-scale pool of customers. In the launch of MyRepublic New Zealand, we have had the opportunity to witness this phenomenon first-hand.

(b) *Views from the industry on the interest and viability for a new MNO to enter the market, and whether the market environment, or technology or spectrum developments have changed since the 2013 4G spectrum auction that have made the business case attractive for a new MNO to enter;*

<MyRepublic Response>

MyRepublic is extremely interested in launching an MNO in Singapore, providing the right conditions are in place – listed above, which include the right mix of spectrum allocation and a RAN sharing national roaming agreement in place for the first 3-5 years.

What has changed since the 2013 spectrum auction? The major change for MyRepublic is the potential availability of sub-1GHz spectrum coupled with a larger allocation in the above 1 GHz for capacity.

Our network architecture vision, with an LTE only data network, virtualized radio access and core network, HetNet radio access, with the fastest access to the cloud OTT is maturing where we feel confident we can provide a step function reduction in cost and the best Quality of Experience in Singapore to be competitive.

Question 11: Depth of MVNO

(c) *The 'depth' of MVNO deployment envisaged by new entrants, in particular, the viability of a 'Heavy/Full' MVNO deployment model versus the other models, given that the former would have the most flexibility to differentiate its services to compete with the MNOs;*

<MyRepublic Response>

Singapore needs innovation, a new cost model for connecting to the Cloud. An MVNO is a marketing vehicle and won't transform quality of experience and costs for Singaporeans.

An MVNO doesn't meet our vision for the lowest cost, best quality of experience and "Open Telco" in Singapore.

Question 12: MVNO Hosting Framework

(d) *Possible mechanisms to implement an MVNO-hosting framework, and the relative merits and usefulness of each of these approaches;*

<MyRepublic Response>

An MVNO doesn't meet our vision for the lowest cost, best quality of experience and "Open Telco" in Singapore.

(e) *The viability of a regulatory and/or voluntary commitment approach for MVNO-hosting and the kinds of regulatory or incentives required and which spectrum bands to tie-in the MVNO-hosting incentives;*

<MyRepublic Response>

An MVNO doesn't meet our vision for the lowest cost, best quality of experience and "Open Telco" in Singapore.

Question 13: MVNOs Business Models

(f) *The output/outcome indicators to be imposed on MNOs that would be relevant for MVNOs;*

<MyRepublic Response>

An MVNO doesn't meet our vision for the lowest cost, best quality of experience and "Open Telco" in Singapore.

(g) *The level of wholesale pricing to the MNO's access network (in unit rates) that would justify the business case for market entry;*

<MyRepublic Response>

MyRepublic is happy to discuss in detailed sessions with iDA on the regulatory framework to support regulated RAN sharing while a 4th operator builds out their network to meet QoS requirements.

However as an example, the Korea Communication Commission (KCC) push for guidelines for the wholesale pricing of voice minutes with the country's mobile network operators for the introduction of mobile virtual network operators (MVNOs). The KCC has said that wholesale minutes will be between 31% and 44% cheaper than retail prices, with larger discounts offered to those virtual operators that have invested higher amounts in their own equipment, thus reducing their dependence on the network operators themselves. Companies considering an entrance to the MVNO sector, argued that such ventures would only be feasible if wholesale charges were some 60% cheaper than retail.

Any linkages to retail pricing must also be dynamic and tied to changes in retail pricing. For example, an incumbent could agree a wholesale price for voice minutes or data GigaBytes, and soon after reduce their retail price by 50% on a special promotion. This would make it impossible for MVNO or the RAN Sharing MNO to compete. Any pricing agreement must therefore be linked to the retail price and change (downwards) as the retail price changes.

(h) *The non-price terms and conditions imposed by MNOs, such as minimum volume or revenue commitments, that would be acceptable for a positive MVNO business case;*

<MyRepublic Response>

MyRepublic is happy to discuss in detailed sessions with iDA on the regulatory framework to support regulated RAN sharing while a 4th operator builds out their network to meet QoS requirements.

(i) *Details of the business and financial model of potential MVNOs;*

<MyRepublic Response>

MyRepublic is happy to discuss in detailed sessions with iDA on the regulatory framework to support regulated RAN sharing while a 4th operator builds out their network to meet QoS requirements.

(j) *The ability of MNOs to differentiate classes of service and allow priorities to cater to the needs of government demand or other MNVOs; and*

<MyRepublic Response>

MyRepublic is happy to discuss in detailed sessions with iDA on the regulatory framework to support regulated RAN sharing while a 4th operator builds out their network to meet QoS requirements.

(k) *Any other relevant considerations that IDA should take into account in structuring a framework to encourage the hosting of MVNOs.*

<MyRepublic Response>

MyRepublic is happy to discuss in detailed sessions with iDA on the regulatory framework to support regulated RAN sharing while a 4th operator builds out their network to meet QoS requirements.

Mobility meets Cloud

Supporting Annex & Documentation
Annex E: Detailed recommendations on Spectrum Bands Allocation

MyRepublic response to the consultation paper by the Info-Communication Development Authority of Singapore:

"PROPOSED ALLOCATION OF SPECTRUM FOR INTERNATIONAL MOBLE TELECOMMUNICATIONS ("IMT") AND IMT-ADVANCED SERVICES AND OPTIONS TO ENHANCE MOBILE COMPETITION"

June 19, 2014

Table of Contents

1. Overview of MyRepublic Spectrum Recommendation

The market entry conditions are important in order to ensure a fair competition between all operators. MyRepublic would like iDA to take into account the following considerations in spectrum allocation policy to enable a 4th operator to succeed:

- iDA should allocate 700MHz APT band at a later date aligned with 5G introduction (2019/2020 timeframe); A new 4th operator should be well established prior to the auction of this spectrum.
- Access to a low frequency band in order to competitively offer a nationwide service is critical to a new entrant.
    - MyRepublic advises to auction GSM (900MHz) and the 850MHz (Band 5) together.
    - However in the 850MHz (band 5) 2x10MHz should be reserved only for new entrants.
    - Existing operators should be restricted to the GSM (900Mhz) band and allowed to refarm to more spectrally efficient technologies.
- New Operators will also need additional capacity to better serve end users demands for mobile broadband services.
    - The iDA should reserve a spectrum in high frequency bands, ideally in FDD bands 3 and 7, alternatively TDD spectrum in Band 38 or 40. to complement the nationwide coverage at 850MHz. The iDA should reserve at least 100 MHz in these bands to a new entrant and award this spectrum at the same time at the lower band (850MHz band 5).
- MyRepublic strongly believe that HetNet network architecture provides the best quality of experience and lowers the cost per bit.
    - As such the iDA will need to adapt regulations to enable HetNet deployments e.g. power levels, administration, access to sites, QoS definition at Network rather than per site.
- Initially a new entrant will need a regulated National Roaming agreement with one of the existing operators to be in place until new entrant can reach IDA QoS requirements
- QoS – need to relax the IDA quality of service requirements – give us a chance to ramp up (e.g. 5 years to achieve)

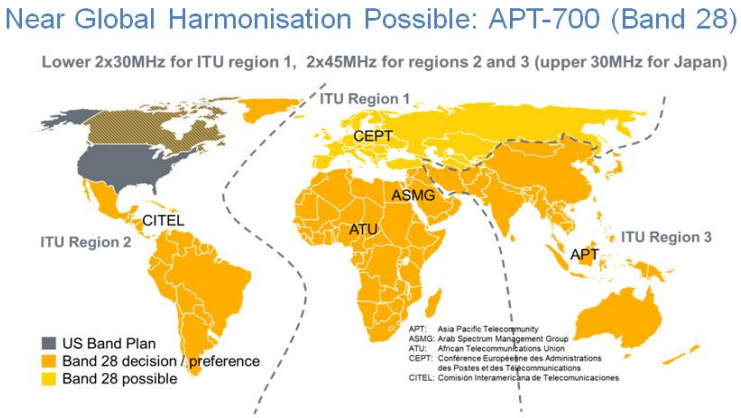
In the subsequent sections we will elaborate further on MyRepublic view on spectrum band allocation.

2. Spectrum below 1GHz

We welcome the iDA works on identifying and freeing spectrum below 1GHz. The sub-1 GHz spectrum is ideal for economically deploying mobile coverage relatively quickly in wide areas, as well as for in-building use. The digital dividend band (APT700) and the 800MHz band and the refarmed band (900MHz) are important to

meeting the broadband demand and will have a great impact on the economic growth. Mobile network operators face the challenge of meeting rising mobile broadband demand. The availability of new devices, applications and faster access technologies are leading to increases in subscriber usage. Some analysis are showing mobile data usage per subscriber increasing from roughly 0.5 GB per user each month in 2013 to 5.0 GB per user each month in 2017. In that sense identifying more spectrums for mobile broadband below 1GHz is critical to meet the demand.

The **700 MHz Asia-Pacific Telecommunity band plan** (APT), known as the '2x45 MHz' option, offers the best chance for delivering the benefits of regional harmonisation. This arrangement of the 698-806MHz band provides the largest bandwidth of usable spectrum, offering the best chance for delivering the benefits of mobile broadband to populations in the region.



The band is likely to be allocated for mobile Broadband (MBB) services in both Asia Pacific and Latin America with different timing between 2014 and 2017; it has the potential to become the most used band for LTE worldwide covering over 4bn people.

Asia Pacific:

- Some countries: Japan, Taiwan, Korea, Thailand, Australia, New Zealand already allocated this band for MBB with auctions being already done or about to be done in 2013
- Trials have started in some countries in both Asia Pacific and Latin America with experimental licenses. Live networks are expected in 2014 timeframe.
- Recently the Indian regulator TRAI published its decision to allocate the 700 spectrum for IMT in this band arrangement, with an auction planned for 2014-2015.

Latin America:

- Although expected to follow the US band plan the Latin American countries expressed their preference for the APT band arrangement. The decision is

highly supported by both CITEL and the GSMA Latin America and the international community that assesses this band as being nearly worldwide harmonized in the future.

- A number of countries have already published their decision to auction in the coming period 2013-2014: Colombia, Chile, Brazil, Mexico, Uruguay, and Panama, with others stating their preference for the APT channelization for the future spectrum allocation to mobile broadband services.
- Brazil launched in February 2013 the consultation on the 700 MHz APT, planning the auction for 2014.
- Mexico just published in March 2013 the new telecom law under which all 90MHz of the 700 band will be awarded to a wholesaler that had to build the network between 2014 and 2018.

Europe, Middle East, Africa:

- The **second Digital Dividend** (694–790MHz) was included at the WRC-2012 in the agenda of the next conference in 2015 (Resolution 232 (WRC-12)). Under the A.I.1.2 the member states of the Region 1 (EMEA) have to examine the results of ITU-R studies on the use of the frequency band 694-790 MHz by the mobile, except aeronautical mobile, and take the appropriate measures.
- The debate is how to allocate this spectrum to achieve the best economies of scale and harmonization within the region and with the countries adopting the APT band plan.
- In Barcelona at MWC, **GSMA announced that the European operators agreed on an arrangement in this band that allow alignment with the APT band plan (lower duplexer).** Work is ongoing to define the technical parameters that will allow this approach.

The release of the 700 MHz band for mobile broadband will not prevent further development of the TV broadcast industry. A suitably developed transition to digital TV can be arranged for additional broadcast program streams and richer content options even when accommodating mobile broadband in the 698 – 806 MHz range due to the improved spectrum efficiency of digital TV. In the Singapore context, as indicated by IDA, the spectrum is not expected to be available prior to 2020, once the Analogue-Switch Off is completed in Singapore and the neighboring countries. While the 700MHz APT is largely acknowledged as a premium band for operator, the current timeline might deter new entrant.

Similar to 700 MHz APT band, **the 800MHz band** is recognized as a premium spectrum for mobile operator as this low frequency band enables operator to offer nationwide coverage with the lowest investment. South Korea is leading the way in terms of deployment inside the 800MHz band. This band is favored amongst operators with existing CDMA networks who are transforming and evolving their

network into next generation. This ensures an existing ecosystem in the 800MHz band, specifically in Band 5.

On the 800 MHz band, iDA seems to favor 3GPP band 26. This band arrangement is clearly the optimal use of the 800 MHz in terms of bandwidth nevertheless this band allocation brings some refarming and ecosystem availability challenges. For example while Band 5 is already supported by the main smartphone manufacturers such as Apple and Samsung, Band 26 is not yet popular.

In view of Singapore economic activities, the use of trunked radio is critical for port, logistics and transport operations. Spectrum allocation should not impede economic vitality and competitiveness of other sectors. **A transitional way would be to allocate this frequency based on 3GPP band 5 arrangement first**. The main challenge regarding the 800MHz band is to ensure the spectrum is clean. Currently one of the existing mobile operators is using the EGSM spectrum to offer 2G service and CDMA networks in neighboring countries might be operating in the 850 MHz band, subset of Band 5. **A pre-requisite to the band 5 allocation is the insurance of clean spectrum and agreement with neighboring countries to avoid interference** and system disruption at the border. Band 5 could be used in a phased approach. For example the lower part of the band could be used first, while waiting for the EGSM right to come to terms in 2017. This would enable an initial deployment with 2*10 MHz spectrum with a further expansion to 2*20 MHz.

3. Spectrum above 1GHz

From operators' perspective, choosing which frequency band to operate LTE networks is always one of the most critical decisions since it will significantly impact their coverage and capacity plan, eventually their entire business model and long term sustainability.

As a general comment, while spectrum above 1 GHz are widely used for mobile, as proven by the 2.6GHz FDD auction previously held in Singapore, auctioning a high frequency band spectrum on its own is not attractive to a new entrant, only to an incumbent. This is mainly due to the upfront cost required to offer a nationwide coverage while solely relying on high frequency band spectrum. Generally speaking, two to three times the number of sites could be required in a high frequency band deployment compared to a low frequency band deployment, putting additional financial constraint on a new entrant. In addition as these site locations are not available today, site acquisition, maintenance and rental costs would be prohibitively high. This is why high frequency band spectrum are ideal to offer additional capacity, but must be accompanied with a lower frequency band nationwide deployment. This is already illustrated in mobile network deployment history, where 900MHz and 1800MHz were primarily used in GSM and later on 900MHz and 2100MHz in 3G. The same is the case in the USA for 4G, where

700MHz is deployed initially followed by 1900, AWS and higher frequency bands are added for capacity.

MyRepublic prefers FDD bands 3 (1800MHz) and 7 (2.5 GHz) due to its mature device eco-system. However, given the spectrum availability in Singapore as well as the need to allocate at least 100 MHz, TDD need to be considered as an alternative.

Industry Interest in TDD

When 2.5GHz was officially allocated to TD-LTE commercial deployment in Japan, US and China, it has been becoming a strong market moment to deploy TD-LTE around the world in that band by traditional mobile operators, i.e. China Mobile, China Telecom, SBB, Sprint, Globe(SingTel group) and so on... Soon after the TD-LTE eco-system is built, WiMAX networks in either Band 41 or Band 40 (2.3GHz) have been speeding up the migration to TD-LTE as TDD only operation for both mobile or wireless broadband services.

With its shorter coverage range, 2.3GHz and 2.6GHz are more likely to be used and are best suited for capacity layer in the urban environment which will demand much higher broadband wireless capacity within a smaller area. Recently, all traffic growth is coming from DL oriented wireless broadband services. There is a strong intension of operators to utilized TDD spectrum to offer wireless broadband services since it is much more cost efficient in term of flexibility to adapt different DL/UL traffic radio according to the end user behavior.

However, building a TDD only 2.5GHz network due to the increased number of sites as previously mentioned is not sustainable for a new entrant, and the iDA should look to couple the award of TDD 2.5GHz with a sub 1GHz FDD band.

2300-2400 MHz

Under the ITU recommendation M.1036, there was consensus endorsed by all the regions and administrations including supporting the TDD only arrangement in this band. 3GPP identified this TDD-only band as B40.

The 100MHz available in the 2300MHz band would provide a significant contribution to meeting the mobile broadband spectrum demands at both Asia Pacific and other regions.

In Asia (APT)

According to the existing application and future planning of 2300-2400MHz in APT administrations, the band is being used or planned to be used for IMT and/or BWA technologies in a number of Asia Pacific countries. As a matter of urgency for Region 3, APT developed the bands of 2300-2400MHz frequency arrangements, in order to maximize potential benefit of harmonization (see APT document AWF/REP-120).

The APT report and survey of administrations feedback on 2300-2400 MHz concludes that unpaired operations only should be considered, and no mixing of FDD and TDD access schemes inside the 2.3GHz band in any country.

Administrations such as China, Korea, Vietnam, Malaysia, Thailand, and India already stated that the band of 2300-2400MHz for IMT/BWA TDD deployment. China allocated the band 2300- 2400MHz to IMT TDD system in 2002. Following this allocation, CMCC set up networks based on LTE TDD technology in this band and provide IMT services.

In Europe (CEPT/EC)

After WRC-2007, there was a round of discussion in CEPT ECC PT1 about the frequency arrangement study of the band of 2300-2400MHz. Considering the existing application such as PMSE , military and others , it was concluded the ECC would not initiate the frequency arrangement study of the given band.

More recently, the EU spectrum inventory has identified a number of bands where spectrum is currently under-utilized or sharing usage may be possible. It has been illustrated the potential future use of the 2300-2400MHz band for unpaired technologies such as the TDD variant of LTE as a means of supporting the asymmetric applications in mobile broadband is undertaken study by CEPT ECC FM 52/53.

At the national level, administrations such as Sweden, Finland, and Ireland etc. have allocated or planned the band application in IMT/ LTE TDD for IMT. In others, where the band is partially utilized by other applications the sharing of the band between the incumbent and IMT is under consideration using a Licensed Shared Access mechanism. The EU regulatory framework is – under the LSA concept – giving to the users of the shared spectrum access rights that are guaranteed by a regulator, making possible to ensure a predictable quality of service.

In the light of the advantage of the 2.3GHz band with 100MHz bandwidth and the global IMT identification status, it is better to facilitate the band mobile usage as much as possible.

As illustrated in the next sub-section, special guard band requirement would need to be considered if the band is allocated to different operators. As the operators might operate unsynchronized networks, a 5 MHz guardband between unsynchronized TDD systems is required.

2.5GHz/2.6 GHz (band 38)

The local current proposed allocation plan for the 2.6 GHz is in line with ITU-R Recommendation M.1036 arrangement C1 (FDD/TDD).

Regarding spectrum allocation and how many spectrum lots to allocate per band, IDA should consider the guard band requirement. In the current implementation, LTE FDD system at 2.6 GHz (Band7) will co-exist with TD-LTE system at 2.6 GHz (Band 38). In such deployment, as per the GSMA report " The 2.6GHz Spectrum Band – An opportunity for Global Mobile Broadband", a minimum guard band of 5 MHz is necessary to address potential interference between TDD and FDD systems operating in adjacent bands in the same geographical area. In order to ease the frequency coordination and interference management, the ITU recommends including the 5 MHz guard band inside Band 38. This would enable easier interference management between neighboring countries.

A frequency separation of 5 MHz is required as well between two unsynchronized TDD networks.

Taken this into account, the following figure illustrates the potential allocation scenarios based on the number of lots allocated:

The allocation pattern chosen by IDA might attract or deter new entrant. Indeed high frequency spectrum being favored to provide capacity, a minimum bandwidth should be available to a new entrant to offer capacity/speed per cell that is at least on par with existing network. Considering a 20 MHz TD-LTE will provide lower capacity/speed than a 2*20MHz LTE FDD network (assuming same antenna configuration and cell size), allocating the full band to one single operator might attract additional interest.

3.5GHz

On 3.5GHz, several discussions are currently happening in the world (EU, US, Japan, etc.). MyRepublic believes that, among the potential uses of the band, the 3.5 GHz band presents an opportunity for deployment of fixed wireless access, wireless backhaul for small cells, indoors and outdoors small cell for capacity, or perhaps even macrocellular use for targeted high capacity demands.

MyRepublic considers that this band is most likely amenable to Time Division Duplexing (TDD) due in large part to the relatively large duplex gap that would be required for Frequency Division Duplexing (FDD) at this frequency. MyRepublic believes that more works should be done in the Singapore context regarding the possible use of 3.5GHz and coordination at regional and international level should be considered in the context of harmonization and achieving economies of scale.

Spectrum Allocation Strategy

Generally speaking, traffic is not homogeneously spread inside the network. Most of the network traffic is indeed carried by few cells. Additionally inside one cell, several hotspots can be identified, where additional capacity should be focused. These hotspots are indoors, as most of the mobile broadband communication today is happening indoors but outdoors as well specifically in crowded areas (e.g bus shelter, outdoor stadium…). While TDD bands might be regulated to be used only indoors, there is no technical constraint preventing from deploying TDD in indoors and outdoors environments. Limiting the TDD usage to indoors only might then impact the business revenue of the operator by preventing the deployment of capacity where needed.

China Mobile is using the 2.3 GHz spectrum solely for indoor usage but this is due to special regulation limitation. Indeed China Mobile is not authorized to use the 2.3 GHz spectrum nation-wide to prevent potential interference with military usage in China. Based on Singapore spectrum allocation, there seems to be no reason to restraint the usage to indoors only.

It should be left to operators based on their traffic distribution between outdoor and indoor and their respective traffic characteristics, i.e. voice, video and wireless broadband services to determine if they will reserve certain TDD frequency spectrum for indoor applications only. From a service perspective, the TDD band might be used to complement the capacity of the lower frequency band, primarily used to provide nationwide coverage. Due to the frequency nature of the band, the cell will be smaller at the high frequency band. The network will then be made of a nationwide network at a low frequency band, complemented with additional cells where capacity requires it, creating a HetNet network to better serve the end users.

At borders, special cares should be considered to avoid interfering neighboring countries. As mentioned by IDA, two deployment considerations are envisaged:

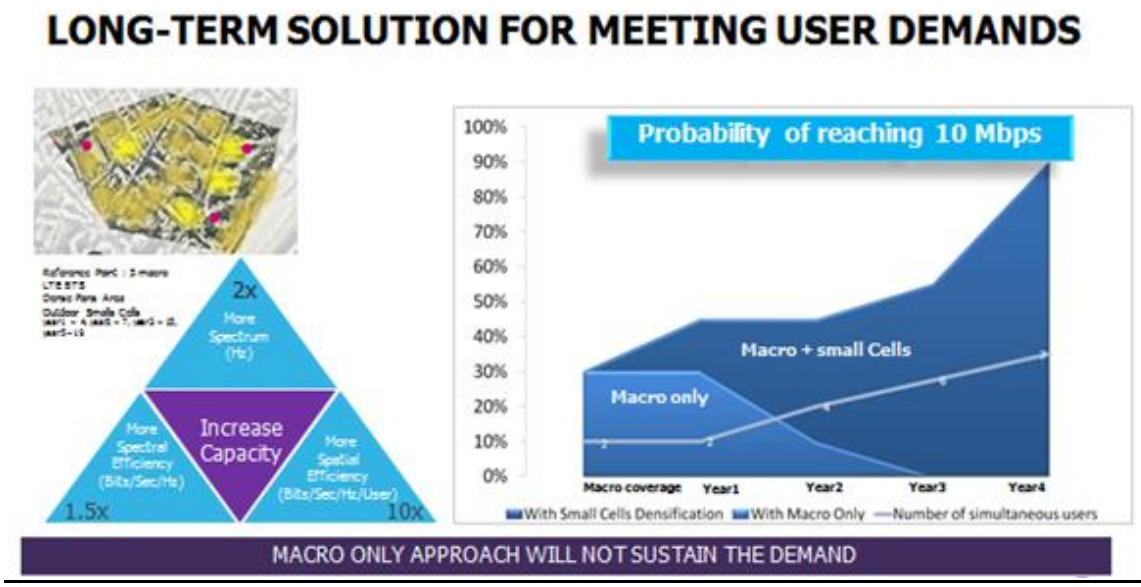
- Half- band sharing where only half of the full bandwidth is available in Singapore
- Full-band sharing where the entire band is available in Singapore and the neighboring countries.

Considering the growing data requirement and pressure on spectrum availability, the full-band sharing solution would enable the operator to maximize the benefit of the band in most of the country. Specific configuration and restriction might be required at the border to avoid interference such as power regulation, frequency allocation regulation. This will have to be mutually agreed with neighboring countries on a case by case basis based on current and future implementations.

4. HetNets for the Best Quality of Experience and Lowest cost per Bit

Deploying HetNets enables MyRepublic to meet the objectives of providing superior coverage and quality while reducing the carbon footprint and while helping to respond to citizens' demands for a better communication experience.

HetNets consists of Macro Cells and Smaller cells which are low-powered, with small form factors devices that can be put almost anywhere. They are being deployed in homes, enterprises, and metropolitan areas. Of particular interest to mobile operators are the small cells used in metropolitan areas. They need power and backhaul, wireline or wireless.



It is challenging for Mobile Network Operators to accommodate subscribers' rapidly changing capacity and QoE expectations with today's macro-only networks. There are various means for addressing the large traffic growth projected over the next five years. With more than 25-fold growth in traffic, it is easy to show that traditional cell splitting of the macro network will lead to an unsustainable business case.

Even if all the future technologies of LTE Advanced are deployed (that is, carrier aggregation, eICIC, MIMO and CoMP), at best a factor of 1.5x increase in spectral efficiency would be achieved. This is still an order of magnitude off from what is needed to address the 25-fold traffic growth over the next five years.

Clearly, the only solution for meeting this growth is densification of the network with more cost-effective small cells. Increasing the spatial efficiency of the network can provide 10x increase in network capacity. HetNet also decrease the cost per bit, enabling mobile network operators to cost-effectively provide high-bandwidth capacity and coverage directly to where it is needed in all environments. With HetNet, MyRepublic cannot only add high capacity to traffic hotspots to improve end users' QoE, but also extend network coverage to indoor locations that have traditionally been challenging to cover with a macro-only solution.

To reach these benefits it is essential to facilitate the deployment of HetNet, defining a dedicated administrative procedure that make the installation much easier and faster than the macro-base stations.

Cells location is going to be diversified; deployments are expected to be in the heart of many communities. Small cells are also not placed on towers. Rather, they are mounted on walls or columns when deployed indoors and put on sides of buildings or on common street furniture, such as lamp posts, utility poles, and traffic lights, when deployed outdoors. And of course the underlying property is either publicly or privately owned. Right of ways, rents, and permissions can become very quickly real challenges for cost and timely deployment.

A second striking difference is the cell count by urban areas that will be much higher. Scaling the administrative process will be one of the main challenges in the deployment of this new technology.

HetNet specificities may change the industry model, traditionally used for roll-out, and see new arrangements emerge in interfacing the public entities.

Public authorities have even a more important role than before: by their choices in terms of policy, they may either unleash roll-out of small cells.

In many countries, securing regulatory approval for the deployment of macro cells is challenging for Telecom operators. They often mean undue delays and high costs associated with approvals.

The core Regulatory and policy considerations for small cells can be categorized in EMF-related questions on one side, and scaling of the planning and administrative processes needed for rapid approval on another side.

Based on the benefits of HetNets, there are room for improvement in the diverse level of policies, regulations and laws: starting at national level up to the community level. Some examples around the world:

1. In regards to Planning, Identify wireless infrastructure network as strategic and essential infrastructure for a country. This puts the right signal that would allow prioritizing roll-out of such an infrastructure in the local authority planning agenda. Example: UK
2. Again concerning Planning: create synergies between fixed and mobile networks. When anticipating public policies for fostering fibre networks within a city, it should be anticipated that metro cells will need granular backhaul networks and new buildings could benefit from the pre-installation of HetNet access points.
3. Tax: deployment of small cells should be seen as aligned with green and environmentally friendly initiatives, and thus be encouraged and supported. In this context tax relief or reduction should be considered as a means to facilitate and incentivize faster deployment of mobile broadband networks that benefit society, operators, and administration.Several examples: Middle Class Tax Relief in 2012 by FCC, “cost reduction” regulation by EC, Mexico initiative.
4. Planning & RF: there is an opportunity for simplifying the Installation guidelines of small cells- Based on products classification and constraints criteria around a set of parameters: equipment size, weight, power, typical installation design, a concept of inherent compliance could be defined and even standardized at ITU. The next steps would be to make them available for application by the national regulatory bodies, to simplify the authorization process (example ANFR in France).
5. There is room for improvement in terms of harmonization of RF-exemption plans and emitted RF limits.
6. Last, Codes of Best Practices have been successful in many countries to support the discussion between stakeholders for Macro deployment. Revision of Code of Best Practices taking into account newest technology trends like the need for power, backhaul, and mounted on existing non-traditional structures would be beneficial.

While HetNets come with volumes of more cells the administrative paper work will increase considerably. It is necessary that the administrative approach towards HetNet should be adapted as for similar type of infrastructures in size and visual impact, for example the CCTV, in regards to application, deployment and operations.

Mobility meets Cloud

Supporting Annex & Documentation
Annex F: Frequency bands interference

MyRepublic response to the consultation paper by the Info-Communication Development Authority of Singapore:

"PROPOSED ALLOCATION OF SPECTRUM FOR INTERNATIONAL MOBLE TELECOMMUNICATIONS ("IMT") AND IMT-ADVANCED SERVICES AND OPTIONS TO ENHANCE MOBILE COMPETITION"

June 19, 2014

Table of Contents

1. Overview of interference scenario

This paper analyses the potential interference scenario when introducing LTE in 2.6 GHz band (Band 38), in 800MHz band (Band 5) and 700 MHz APT Band (Band 28)

MyRepublic believes the following considerations need to be taken when introducing LTE:

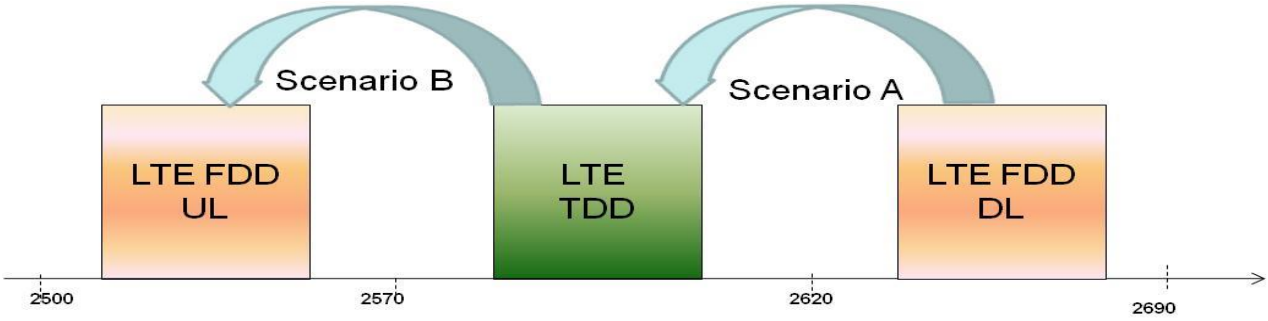
- A minimum guard band of 5 MHz is required between FDD LTE system in Band 7 and TD-LTE system in band 38. A minimum of 10 MHz guard band is required to remove the need for additional filters
- A minimum guard band of 5 MHz is required between unsynchronized TDD systems
- A minimum guard band of 3 MHz is required between FDD LTE in 800MHz and GSM system. Additional filters are required as well unless the guard band is larger than 10 MHz
- LTE 800MHz and CDMA850MHz systems can be adjacent
- SRD users need to be migrated to another band
- Interference to Trunk Radio equipment is expected to be mitigated through correct antenna spacing and existing 3 MHz guard band.

The following sections detail the interference analyses.

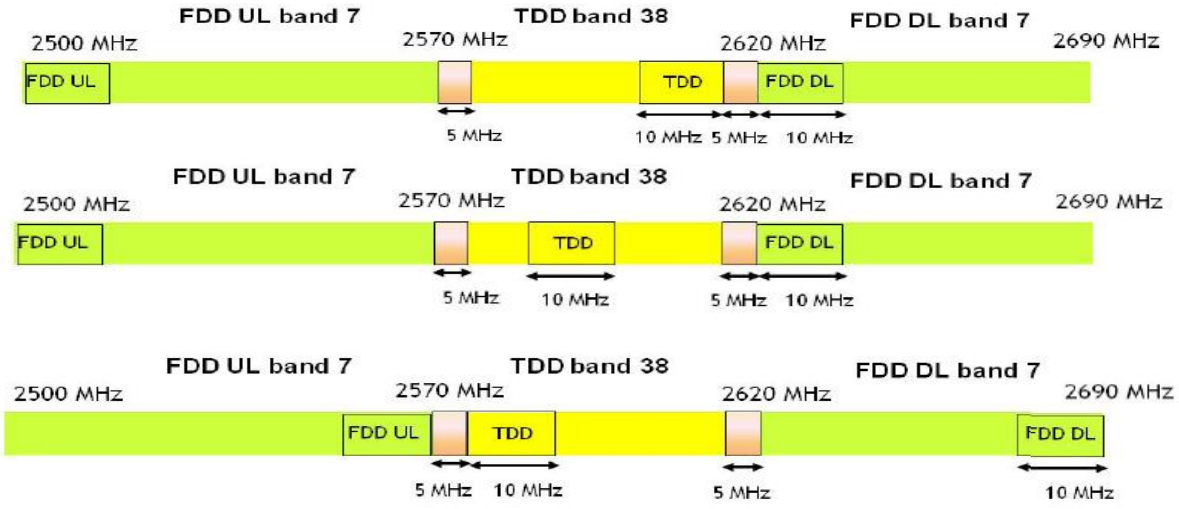
2. LTE FDD & TD-LTE in the 2.6 GHz band

2 critical BS-to-BS interfering scenarios caused from 1 BS transmission to the other BS reception in the adjacent channel:

- DL transmission of the LTE FDD system affecting the reception of the LTE TDD system in UL, when the LTE TDD system is operating close to the DL band of the LTE FDD system (Scenario A)
- DL transmission of the LTE TDD system affecting the reception of the LTE FDD system in UL, when the LTE TDD system is operating close to the UL band of the LTE FDD system (Scenario B)



(1) For TD LTE and FDD LTE coexistence, different guard band scenarios can arise



(2) The Assumptions Applied

FDD LTE (Other Network) → TD-LTE (network A)

- Assumptions
  - Assumed TD-LTE eNB Tx Power = 46 dBm at antenna port
  - Spurious Emissions based on 3GPP 36.104 Emission Limits (Spurious)
  - Blocking is based on ALU Measurements in TD LTE eNB to achieve 0.4 dB desensitization

TD-LTE (network A) → FDD LTE (Other Network)

- Assumptions
  - Assumed eNB Tx Power = 46 dBm at antenna port
  - Spurious Emissions based on Out of Band Emission measurements
  - Blocking is based on 3GPP 36.104 Blocking Criteria

Based on the study illustrated below, a >10MHz guardband is the requirement to provide sufficient isolation between both systems without installing filters. However defining such a guardband might not be feasible. By applying a smaller guardband , i.e 5Mhz for example, the isolation requirement is met by deploying additional filters on both systems.

		Guardband		
		5MHz	10MHz	>10MHz
		LTE FDD Tx -LTE TDD Rx		
Out-of-band Criterion		103.5 dB	103.5 dB	35.0 dB
Blocking Criterion		91.0 dB	86.0 dB	31.0 dB
LTE TDD and LTE FDD inside a same XXpol antenna		30.0 dB		
Additional filter isolation	TX side	73.5 dB	73.5 dB	5.0 dB
	RX side	61.0 dB	56.0 dB	1.0 dB
Achieved isolation 0.5m vertical antenna separation or 3m horizontal antenna separation		62.0 dB		
Additional filter isolation	TX side	41.5 dB	41.5 dB	0.0 dB
	RX side	49.5 dB	24.0 dB	0.0 dB
Achieved isolation 3m vertical antenna separation		78.0 dB		
Additional filter isolation	TX side	25.5 dB	0.0 dB	0.0 dB
	RX side	13.0 dB	8.0 dB	0.0 dB
		LTE TDD Tx -LTE TDD Rx		
Out-of-band Criterion		106.5 dB	106.5 dB	35.0 dB
Blocking Criterion		100.0 dB	94.0 dB	76.0 dB
LTE TDD and LTE FDD inside a same XXpol antenna		30.0 dB		
Additional filter isolation	TX side	76.5 dB	76.5 dB	5.0 dB
	RX side	70.0 dB	64.0 dB	46.0 dB
Achieved isolation 0.5m vertical antenna separation or 3m horizontal antenna separation		62.0 dB		
Additional filter isolation	TX side	44.5 dB	44.5 dB	0.0 dB
	RX side	38.0 dB	32.0 dB	14.0 dB
Achieved isolation 3m vertical antenna separation		78.0 dB		
Additional filter isolation	TX side	28.5 dB	28.5 dB	0.0 dB
	RX side	22.0 dB	16.0 dB	0.0 dB

Please note that similar isolation requirements will apply to indoors deployment as well, preventing the sharing of indoor system for unsynchronized network.

LTE 2600 FDD & LTE 2600 TDD CO-EXISTENCE: strong isolation required
While 3GPP defines LTE bands, it also defines some isolation guidelines to guarantee a proper coexistence of various systems in different bands.

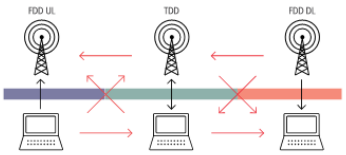
Coexistence of LTE FDD in band 7 (2500 – 2570 MHz UL; 2620- 2690MHz DL) and LTE TDD in band 38 (2570 – 2620 MHz) has been studied; BS-BS and UE-UE interference are critical.

Due to stringent isolation requirement it has been proposed to consider 5MHz guard band between LTE FDD and LTE TDD bands from the LTE TDD band as illustrated below.

Many operators are engaged in actions in 3GPP to permit BS co-siting and antenna sharing with 2x5MHz guard bands, taken in the TDD block.

Extracts :

- "Studies performed and discussed in technical international fora show that **a minimum guard band of 5 MHz is necessary to address potential interference between TDD and FDD systems operating in adjacent bands in the same geographical area.**
- ITU Option 1 requires only two interfaces between FDD and TDD spectrum with clear rules for frequency coordination and interference management. As a result, two 5 MHz guard bands should be considered in this model at 2570-2575 MHz and 2615-2620 MHz. Provided that ITU Option 1 is adopted by all neighbouring countries, these same rules apply both across borders and between regions within countries."



Source: The 2.6GHz Spectrum Band – An Opportunity for Global Mobile Broadband (GSMA report)

- "**Compatibility between FDD and TDD or two unsynchronised TDD blocks leads to the conclusion that a frequency separation of 5 MHz is needed.**
- These frequencies may be left as guard blocks, alternatively national administration may authorise the use of these frequencies between the full power base transmit (unrestricted) blocks and base receive blocks, however, where it is necessary to protect adjacent base receivers the use of these blocks should be restricted to a low power and its Out of block mask to more stringent values. Therefore, two BEMs are proposed in this subsection, one for the 'restricted' TDD block and the other for the 'unrestricted' block. Nevertheless, such 'restricted' TDD blocks can not claim the same level of protection as for the "unrestricted" blocks."

Source: CEPT Report 19, 21-dec-2007, Editorial revision 17 March 2008

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- "As service providers deploy TD-LTE, they must pay close attention to the coordination between FDD and TDD systems. Since TDD radios both transmit and receive in the same spectrum band, excessive interference issues can be created amongst the transmitted and received signals of collocated TDD/FDD systems. To avoid interference, TDD and FDD systems can either be separated physically or with adequate spectrum guard bands.
- In Sweden, Hi3G has deployed a collocated TDD/FDD system and demonstrated that while collocation can be achieved, it requires careful interference management. Hi3G benefits from effectively having guard-bands in excess of 10 MHz between its TDD and FDD systems. We believe that collocated TDD/FDD systems will experience excessive interference in cases where there is less than 10-MHz guard-band separation.
- This will add constraints to future infrastructure collocation and sharing arrangements, and complicate network consolidation in cases where TDD and FDD networks are involved. It may also cause conflict between competing service providers in cases where interference occurs (or is believed to occur) between adjacent TDD and FDD systems."

http://www.telecomasia.net/content/collocated-fddtd-lte-raises-interference-issues

3. LTE introduction in 800MHz band.

While introducing LTE 800MHz, the potential interference scenarios with other systems are:

1. LTE 800 with GSM900 or UMTS 900
2. LTE 800 coexistence with CDMA 850
3. LTE 800 coexistence with Trunk Radio and SRD

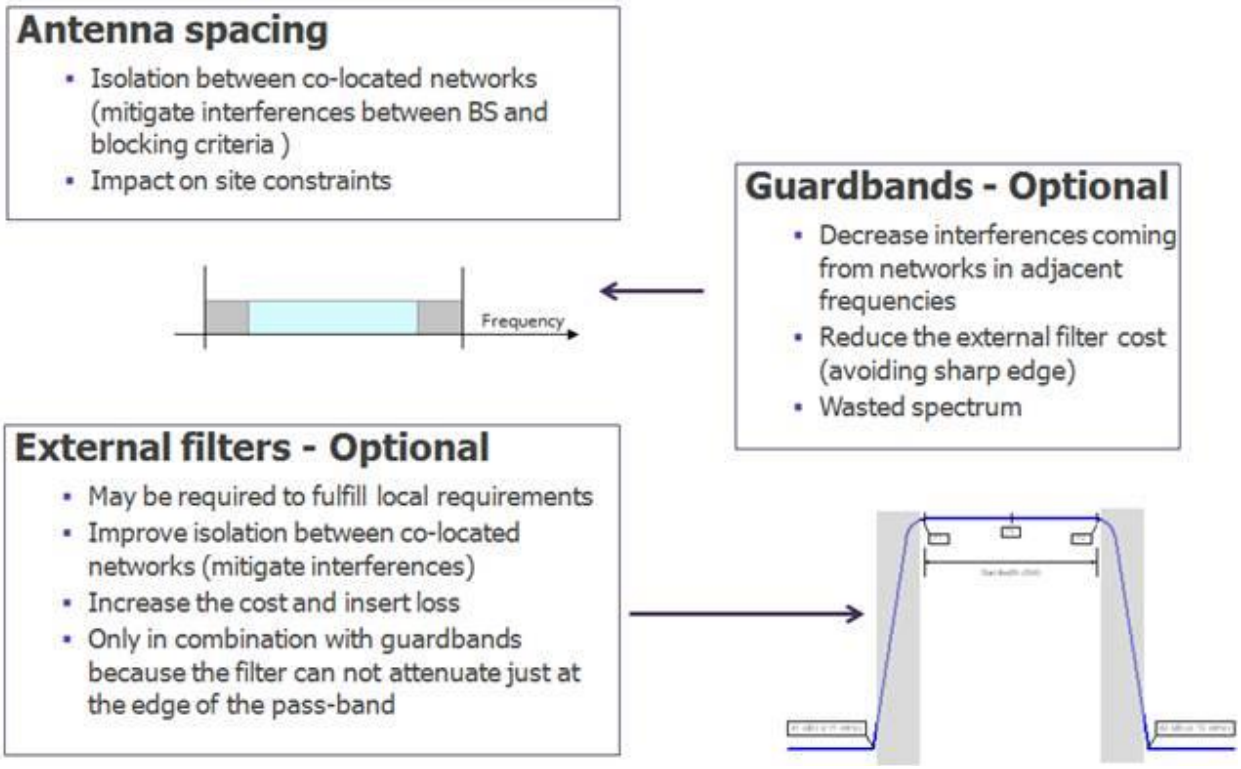
Careful spectrum planning would need to be agreed with Malaysia and Indonesia, as specific configuration might be required at the border to avoid interference. Indeed in the same geographical areas, LTE850, CDMA850, (E)GSM and UMTS900 might co-exist, creating potential interference scenario.

a) LTE 800 and GSM900/UMTS 900.

For LTE 800 MHz (e.g Band 5) and GSM 850/900 or UMTS 850/900 to co-exist in the same geographical area, the required isolation for spurious emission and receiver blocking ranges from as low as 45 dB up to the maximum of 105 dB depending on guardband separation between both systems. The high isolation required is due to the fact that LTE850 DL band is almost adjacent to the other system UL band and this specific scenario will create interferences.

As illustrated below, the isolation can be obtained through:

- Antenna spacing
- Guardband
- External filters



Based on previous studies between LTE and GSM, the isolation requirement for spurious emission and receiver blocking are:

- Spurious emission: 105 dB
- Receiver Blocking: 59 dB

In order to reach such isolation, a >10MHz guardband would be required. However such requirement would severely impact the remaining available spectrum. As such lower guard band should be required, but this would mean additional filters should be added in each site to cater for the required additional isolation.

With a 3 MHz guardband and antenna vertically separated by 3m, a 63dB isolation between LTE DL and GSM UL can be achieved. This is not sufficient, additional filters are required to provide additional 42 dB isolation. Filters on the existing GSM sites might be requested as well.

b) LTE800 and CDMA850

Band5 is a common band amongst CDMA operator. CDMA850 network is already deployed in Malaysia. Special spectrum planning would be required at the border in case of LTE850 MHz deployment in Singapore in order to avoid degrading both systems. Similar considerations would be required if Malaysia and Indonesia decide

to enable LTE deployment in 800MHz band. LTE 800 and CDMA 850 systems can be adjacent, there is no need for guardband.

c) LTE 800 and Trunk Radio.

Considering Band5 allocation for LTE800, there is a minimum 3 MHz guardband between the LTE band and the Trunk Radio band. Considering the interference scenario will be UL<->UL and DL<->DL, this could be resolved by antenna spacing and guard band.

d) LTE 800 and SRD.

Considering SRD is adjacent to LTE Band5, coexistence of both systems will create interference. Specifically considering the difference of power, the LTE DL will interfere with the SRD systems. Given the nature of SRD equipment, deploying filters might be difficult. The best solution would be to migrate SRD to another band.

4. LTE introduction in 700MHz

Based on initial studies there is no need for guard band between the 700MHz band and the 800MHz when:

- LTE 700MHz and LTE 800 (Band 5) co-exist
- LTE 700MHz and CDMA850 co-exist
- LTE 700MHz and EGSM co-exist