SINGTEL MOBILE SINGAPORE PTE LTD

RESPONSE TO IDA CONSULTATION PAPER - PROPOSED ALLOCATION OF SPECTRUM FOR INTERNATIONAL MOBILE TELECOMMUNICATIONS ("IMT") AND IMT-ADVANCE SERVICES AND OPTIONS TO ENHANCE MOBILE COMPETITION

1. INTRODUCTION

1.1 SingTel Mobile Singapore Pte Ltd (**SingTel Mobile**) refers to the Info-communications Development Authority of Singapore (**IDA**) consultation paper dated 22 April 2014 on the Proposed Allocation of Spectrum for International Mobile Telecommunication (**IMT**) and IMT-Advanced Services and Options to Enhance Mobile Competition (**Consultation Paper**).

1.2 SingTel Mobile is licensed to provide Public Cellular Mobile Telecommunications Services (**PCMTS**) in Singapore and has acquired spectrum right(s) to provide 2G mobile services, 3G mobile services and 4G mobile services. SingTel Mobile also acquired Wireless Broadband Access (**WBA**) Spectrum Right(s) and is licensed to provide wireless broadband services.

1.3 SingTel Mobile is committed to the provision of state-of-the-art telecommunication services and technologies in Singapore. As a leading provider of mobile telecommunication services of 2G, 3G and 4G networks, high speed data services through General Packet Radio Service (**GPRS**), High-Speed Packet Access (**HSPA**), Long Term Evolution (**LTE**) technologies and wireless services on our WiFi platform, SingTel Mobile welcomes the IDA's initiative to establish a framework for the reallocation of spectrum for IMT and IMT-Advanced services in the 700MHz, 900MHz, 1800MHz, 2.3GHz, 2.5GHz and 3.5GHz frequency bands.

1.4 SingTel Mobile welcomes the opportunity to make this submission on the Consultation Paper and the various issues identified by the IDA.

SingTel Mobile Singapore Pte Ltd
Company Registration Number: 201012456C
31 Exeter Road Comcentre
Singapore 239732
Website: www.singtel.com

1.5 This submission is structured as follows:

Section 1 – Introduction
Section 2 – Executive Summary
Section 3 – Specific Commments

2 EXECUTIVE SUMMARY

Spectrum allocation

2.1 SingTel Mobile welcomes the IDA's initiative to establish a framework for the reallocation of spectrum for IMT and IMT-Advanced services in the 700MHz, 800MHz, 2.3GHz, 2.5GHz and 3.5GHz frequency bands.

2.2 SingTel Mobile suggests that long term spectrum rights should be allocated to available 3GPP TDD bands for mobile broadband use. Given the forecasted increase in mobile data traffic in the coming years, it is important for mobile network operators (**MNOs**) to leverage on the advantages offered by Time Division Duplexing LTE (**TDD-LTE**) deployments. A sensible way forward in coping with the predicted traffic increase is the combination of additional spectrum, network densification via small cells, as well as traffic off-loading to unlicensed bands (WiFi Off-Loading).

700MHz band

2.3 SingTel Mobile recommends that IDA fully aligns the 700MHz band plan with the APT700 band plan (3GPP band 28) for 703-803MHz. The IDA's currently proposed APT700 spectrum allocation would only allow 2x32MHz to be utilised for Frequency Division Duplexing LTE (**FDD-LTE**). Full adoption of the APT700 band plan will allow the utilisation of 2x45MHz for mobile broadband services.

2.4 SingTel Mobile recommends postponing the 700MHz spectrum auction until there is greater certainty about the availability of the 700MHz spectrum in Singapore and its neighboring countries (i.e. around 2017/2018). SingTel Mobile also

recommends coupling the 700MHz auction with: (1) the licence reallocation of the 2.1GHz spectrum from 1 January 2022; and (2) the allocation of the 3.5GHz band that can already be auctioned. SingTel Mobile cautions that some degree of uncertainty still exists with regard to the availability of devices and the optimal utilisation of these bands in Singapore. The combined allocation approach provides greatest certainty for the industry to assess future spectrum availability aligned with network and service development plans.

800MHz band and 900MHz band

2.5 SingTel Mobile recommends that the 800MHz frequency band should only be partially re-farmed with the allocation of the spectrum range 880-890MHz to the WCDMA/LTE900 band (3GPP band 8) and allocation of the frequency spectrum 824-834MHz paired with 869-879MHz for mobile broadband services based on a partial adoption of 3GPP band 5. With the recommended spectrum allocation, trunked radio services will not be affected and short range devices (**SRDs**) can co-exist with the spectrally adjacent mobile broadband allocation.

2.6 SingTel Mobile strongly recommends that the 900MHz band be reallocated together with the EGSM portion of the 800MHz band. SingTel Mobile further recommends coupling the 800MHz band and the 900MHz band together with the 2.3GHz TDD and 2.5GHz TDD bands (which are further discussed below) in a multiband auction to be conducted in Q1 2015.

Guard bands and other interference protection approaches

2.7 In relation to guard bands, SingTel Mobile recommends a full alignment with the APT700 band plan (3GPP band 28) 703-803MHz with a 5MHz guard band at the lower band edge of 698-703MHz and a 5MHz guard band at the upper band edge of 803-808MHz. SingTel Mobile supports IDA's proposed enlarged guard band at the upper band edge of the 803-808MHz band as depicted in Figure 1 of the Consultation Paper.

2.8 As noted in the discussion of the 800MHz spectrum range above, SingTel Mobile recommends that the EGSM uplink spectrum 880-890MHz be allocated to the 900MHz band (3GPP band 8). If spectrally adjacent cellular or mobile broadband services operate in downlink mode, protection of this part of the 3GPP band 8 will be required. SingTel Mobile suggests applying an approach detailed in Malaysia's spectrum plan, which specifies out-of-band emission limit at 880.1MHz, requires operator-to-operator coordination, and applies interference mitigation techniques on a case by case basis.

1.4GHz band

2.9 SingTel Mobile suggests that the IDA reserves the 1.4GHz band for mobile broadband services. Mobile supplemental downlink (**SDL**) or unpaired mobile downlink (**UMD**) should remain a priority in the assessment of the future use of this band. SingTel Mobile further submits that, in the medium term, the IDA should facilitate the harmonisation of the 1.4GHz band for SDL use with neighbouring countries.

2.1GHz band

2.10 SingTel Mobile acknowledges the current trend of introducing 4G technology on the 2.1GHz spectrum band and is, in general, open to discussing licence conversions. However, SingTel Mobile shares the concern of many operators worldwide that initiating a licence conversion with only a few years remaining of the license duration is not considered advisable. SingTel Mobile does not support the automatic conversion of all existing 2.1GHz licenses to technology neutral or 3G/4G licences. Instead, SingTel Mobile recommends to the IDA that a procedure be established for Singapore MNOs to apply for a licence conversion in the event an MNO intends to introduce 4G in the 2.1GHz band.

2.3GHz band

2.11 SingTel Mobile strongly recommends that the spectrum in the 2.3GHz band (3GPP band 40) should be made available for mobile broadband deployment. The current

"half band" sharing arrangement of 2300-2350MHz, where Singapore has priority use, would enable Singapore MNOs to deploy the full range of TDD-LTE cells such as outdoor macro cells, outdoor small cells, as well as distributed antennae systems (**DAS**) and indoor small cells. Further, the following half band of 2350-2400MHz, where neighbouring countries have priority, should be made available for indoor deployment use such as DAS and indoor small cells.

2.5GHz band

2.12 SingTel Mobile suggests that the spectrum in the 2.5GHz band (3GPP band 38 and partial 41) should be made available for mobile broadband deployment. The current full band sharing arrangement would facilitate outdoor small cells deployment in shielded urban environment as well as in-building deployment of small cells.

3.5GHz band

2.13 SingTel Mobile acknowledges the importance of the existing C-band applications in Singapore and neighbouring countries for existing satellite services in the 3.5Ghz spectrum. SingTel Mobile recommends exploring the possibility of allocating the frequency spectrum 3.4-3.6GHz for mobile broadband use in the long term with certain restrictions imposed to allow the co-existence of Fixed Satellite Services (**FSS**) and TV Receive Only (**TVRO**) with mobile broadband (TDD-LTE) deployments. Further technical studies and trials need to be undertaken by the IDA to verify the interference issues before allocating 3.4-3.6GHz for such co-existent use.

HetNet development and rollout

2.14 As the international standards and specifications for HetNet has not yet been fully established, SingTel Mobile shares the view of the European Commission (**EC**), Federal Commmunication Commission (**FCC**) and the Small Cell Forum that at this early stage of HetNet deployment, there is no necessity to impose HetNet specific regulation. Once international standards and specifications for HetNet are

established, SingTel Mobile as the technology leader in Singapore will explore and deploy the necessary features and solutions for the benefit of our customers.

2.15 With regards to other HetNet policy implications, SingTel Mobile recommends further changes to IDA's Code of Practice for Info-communication Facilities in Buildings (**COPIF**). The COPIF currently only covers mobile deployment in buildings and MRTs. To support the requirement of HetNet deployment, the COPIF needs to be revised to include outdoor deployment on street light poles, electricity masts or exterior walls of buildings etc.

MVNOs and mobile services market competition

2.16 SingTel Mobile does not consider that there is any basis for regulatory intervention to increase Mobile Virtual Network Operator (**MVNO**) participation in the market for mobile services. MVNOs, by their nature, address niches in a market which are not being met by other market participants. Consequently, market forces must be allowed to determine the extent to which MVNOs enter the market and the niches which they fill unless there is unambiguous evidence of market failure.

2.17 There is no evidence whatsoever of market failure which might justify regulatory intervention. To the contrary, there is ample evidence that Singapore's mobile market is a vibrant and competitive one, and the level of MVNO participation in the market – which may vary over time – is a response to well-functioning market forces which are safeguarding consumer welfare better than any regulatory alternative could be guaranteed to do.

2.18 SingTel Mobile does not believe that the IDA should seek to encourage increased MVNO participation in the mobile services market in Singapore as an end in itself. Any increase in MVNO participation must occur in response to market forces which demonstrate that MVNOs can add value sought by end users not currently available or potentially available from MNOs.

2.19 Internationally, regulation of MVNO access to MNO networks is rare. In the small subset of markets which are regulated, the outcomes of the regulation are not

clearly beneficial or superior to the outcomes which would have arisen without regulation. Indeed, blunt or inappropriate regulatory remedies to increase MVNO participation artificially can reduce consumer welfare and result in net detriment, such as by causing underinvestment in network infrastructure.

2.20 SingTel Mobile strongly recommends the development of the Singapore MVNO participation in the mobile services market based on voluntary commercial negotiations between MNOs and MVNOs. This is in line with international regulatory best practice approaches applied by the EC, the majority of European National Regulatory Authorities (**NRAs**) and the FCC in the USA. Imposing a regulatory MVNO-hosting framework in Singapore may harm the Singapore mobile services market, resulting in a negative impact on customer experience and run the risk that Singapore would lose its leading ICT position.

2.21 SingTel Mobile's specific comments are provided in the following section:

3 SPECIFIC COMMENTS

3.1 More and more NRAs worldwide are releasing spectrum across multiple bands within one multiband auction process. Multiband auctions are becoming the new spectrum licence allocation standard. NRAs are combining within multiband auctions, spectrum bands with similar characteristics (either Sub-1GHz spectrum bands or high frequency spectrum bands) or increasingly combining Sub-1GHz spectrum bands with high frequency spectrum bands. A table detailing a selected sample of recent 4G auctions showing this trend can be found in Annex A. Reflecting recent spectrum allocation trends, SingTel Mobile recommends adopting a multiband spectrum allocation approach for the upcoming spectrum allocations via a multiband auction. IDA has already taken this approach in 2013 for the 1800/2600MHz spectrum auction.

3.2 If high frequency spectrum is combined with the allocation of lower band frequencies (700/800/900MHz), this will facilitate a dual band strategy as operators seek to augment lower band frequency holdings to meet coverage

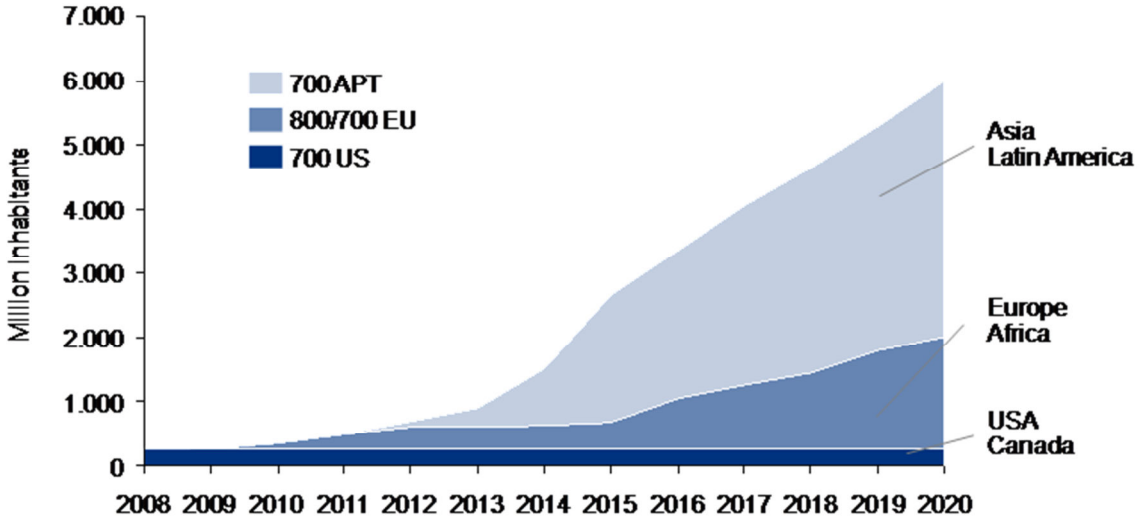
requirements and acquire higher bands to support increasing capacity requirements. Multiple spectrum bands are usually auctioned via the simultaneous release of blocks of spectrum in different bands. The combined allocation approach recognises the synergies between the bands and both the coverage (lower band) and capacity (higher band) requirements of network operators. It provides greatest certainty for the industry to assess future spectrum availability aligned with network and service development plans.

3.3 In Singapore, we note that there has not been any frequency in the sub-1Ghz bands allocated for 4G use. Based on IDA's 3G QoS framework, it is evident that sub-1Ghz band (e.g. 900MHz) will be crucial to meet the stringent IDA 3G QoS standards, especially for in-building coverage requirements. Without sub-1Ghz spectrum allocation to 4G, it will be extremely costly and resource intensive to build base station sites to meet equivalent coverage requirements, with negative impacts on consumer prices.

700MHz band

3.4 SingTel Mobile recommends that the full APT700 spectrum be made available by IDA, i.e. 703-803MHz. A guard band of 5MHz at the lower band edge of 698-703MHz and a 5MHz at the upper band edge of 803-808MHz should be implemented. The APT700 spectrum allocation proposed by IDA would only allow 2x32MHz to be utilised for FDD-LTE. Full adoption of the APT700 band plan will allow the utilisation of 2x45MHz for mobile broadband services.

3.5 The popularity of the APT700 band in Asia Pacific (APAC) and Latin American is expected to grow steadily. The chart below depicts an equipment vendor's projection of the global population covered by 700MHz bands in the coming years.



Global population covered by 700MHz bands[1]

3.6 To date, the device ecosystem for the APT700 plan (3GPP band 28) is still evolving and Qualcomm is the only manufacturer offering LTE Band 28 chipsets. However, several other ASIC (application-specific integrated circuit) vendors are currently developing for the APT700 band and plan to make their components commercially available in 2014. Tier 1 ASIC vendors include Intel, Renesas and Samsung. Tier 2 vendors include Altair, Broadcom, GCT and Sequans.

3.7 Device availability based on the APT700 plan will be driven by chipset availability and by APT700 network deployments in Latin America and APAC regions where the first commercial launch is expected in the second half of 2014 (Taiwan). By the time the APT700 spectrum becomes available in Singapore, a rich device ecosystem will have developed and economy of scale will ensure device affordability.

3.8 Considering the global and regional trend of the APT700 (3GPP band 28) take-up, SingTel Mobile recommends that the IDA reserve the abovementioned 2x45Mhz (703-803Mhz) frequency range exclusively for IMT mobile communications licensed use, instead of any other unlicensed use (such as TVWS) which will be extremely difficult to re-farm in the future.

[1] Alcatel Lucent APT700 Strategic White Paper 2014

3.9 The usage of the APT700 band in Singapore for mobile services is only possible after the switch off of the analogue TV services in Singapore and its neighbouring countries. In 2013, Malaysia, Indonesia and Singapore confirmed their adoption of the APT 700MHz FDD band. The first rollout of digital TV services in Malaysia is expected in the third quarter of 2014, while full nationwide coverage is targeted for the end of 2015. Analogue terrestrial TV broadcast is then scheduled to be switched off in phases in 2015. However, the Malaysian Communications and Multimedia Commission (**MCMC**) has postponed the allocation of 700MHz spectrum until 2018. The first rollout of digital TV services in Indonesia was in 2012 and the full nationwide coverage is targeted to be completed by 2018. Analogue terrestrial TV is to be switched off in the same year.

3.10 Due to the uncertainty of the spectrum availability, SingTel Mobile recommends postponing the 700MHz spectrum auction until there is greater certainty on the availability of the 700MHz spectrum (i.e. around 2017/2018) in Singapore and its neighboring countries. SingTel Mobile also recommends coupling the 700MHz auction with: (1) the licence re-allocation of the 2.1GHz spectrum, which is available from 1 January 2022; and (2) the allocation of the 3.5GHz band which may be available for satellite and mobile communications co-existence use in the future. However, SingTel Mobile cautions that some degree of uncertainty still exists with regards to the availability of devices and the optimal utilisation of these bands in Singapore in a coordinated and efficient manner.

- 700MHz band: 703–748MHz paired with 758–803MHz, 90MHz of bandwidth.
- 2.1GHz band: 1920–1980MHz paired with 2110–2170MHz, 120MHz of bandwidth.
- 3.5GHz band: 3400–3600MHz restricted to shielded in-building use, 200MHz of bandwidth.

3.11 The 3.5GHz band should solely be used for capacity enhancements in shielded in-building deployments (see our response to Question 8 of the Consultation Paper at paragraphs 3.60 to 3.66 for more details), subjected to full tests and trials to

demonstrate that there are no interference issues when satellite services and mobile communications co-exist in such scenarios.

3.12 The combined allocation approach provides greatest certainty for the industry to assess future spectrum availability aligned with network and service development plans.

800MHz band (including allocation of upper range to 900 MHz band)

3.13 SingTel Mobile recommends that the 800MHz frequency band should be partially re-farmed with allocation of the spectrum range 880-890MHz to the WCDMA/LTE900 band (3GPP band 8) and allocation of the spectrum range 824-834MHz paired with 869-879MHz for mobile broadband services based on a partial adoption of 3GPP band 5.

3.14 Allocating the spectrum range 880-890MHz to the WCDMA/LTE900 band (3GPP band 8) supports global harmonisation, which will become quite important once GSM is phased out internationally. GSM900, including EGSM, is used by a large number of operators worldwide and re-farming to 3G services is ongoing or already completed. To date, operators in the Czech Republic, South Korea and Sweden have deployed LTE networks using 900MHz (3GPP band 8). The LTE900 band 8 will play a significant role for global LTE roaming. The LTE900 device ecosystem is already maturing with 246 LTE devices available.

3.15 In Malaysia, the most recent spectrum master plan was released in September 2011. Under the plan, the spectrum in the EGSM band is allocated for Cellular Mobile Services and reserved for IMT-Advanced services in the future which conforms with 3GPP band 8. Indonesia has deployed CDMA850 in the 824-849MHz/869-894MHz band. The CDMA downlink frequency of Indonesian operators can interfere with the EGSM uplink frequency of Singaporean operators. The frequency band of interfered with and interfering operators is as follows[2]:

[2] Source:APT Report on Information of Mobile Operators' Frequencies, Technologies and License Durations in Asia Pacific Countries, September 2010

Indonesia (Interfering)	CDMA800 downlink (MHz)
Smartfren	880.905-885.825
Indosat	887.055-889.515

Singapore (Interfered)	EGSM uplink (MHz)
StarHub	882-887

3.16 In 2009, it was reported that Indonesian CDMA signals interfered with GSM signals in Singapore. Such interference can be mitigated through a bilateral border coordination meeting between Singapore and Indonesia. However, in the case that there is no such proactive engagement between the two countries, other solutions based on international studies exist. These include, but are not limited to, reducing antenna heights, increasing antenna tilts and changing the azimuths of the EGSM system.[3]

3.17 The frequency spectrum 824-834MHz paired with 869-879MHz should be allocated to mobile broadband services based on a partial adoption of 3GPP band 5. Today's upmarket phones already support the combination of multiple 3GPP bands including 3GPP band 8 and 3GPP band 5 (see also response to Question 4 in paragraphs 3.31 to 3.33 for more details on co-existence issues of LTE800 band 5 and LTE900 band 8.)

3.18 SingTel Mobile currently does not recommend the re-farming of the SRD spectrum range 866-869MHz. Interference from spectrally adjacent LTE800 mobile stations may occur in close proximity to SRDs. However as SRDs are license exempt, they do not enjoy any kind of protection. SingTel Mobile recommends that the IDA adopt a similar position as Ofcom in the UK i.e. that the SRDs are allowed to co-exist with the LTE800 and any kind of interference mitigation is left to the sole discretion of the SRD manufacturer[4]. The situation in Singapore is less critical, as there will be no co-channel interference with the LTE800 user devices.

3.19 Based on SingTel mobile's proposal, trunked radio communication will not be affected and the impact on the SRDs will be minimal.

[3] Mitigation of external interference on an EGSM network between Pakistani and Indian operator
[4] Ofcom The award of 800 MHz and 2.6 GHz spectrum IM

900MHz band

3.20 As noted in paragraphs 3.13 to 3.16, SingTel Mobile recommends that the 900MHz band be re-allocated including the EGSM portion of the 800MHz band. SingTel Mobile further suggests coupling the 900MHz band together with the 2.3GHz TDD and 2.5GHz TDD bands in a multiband auction to be conducted in Q1 2015 as follows:

- 900MHz band: 880–915MHz paired with 925–960MHz, 70MHz of bandwidth.
- 800MHz band: 824–834MHz paired with 869–879MHz; 20MHz of bandwidth with certain restrictions to ensure co-existence with the LTE900 3GPP band 8.
- 2.3GHz band: 2300–2350MHz based on priority half band sharing, 50MHz of bandwidth.
- 2.3GHz band: 2350–2400MHz for in-building use only, 50MHz of bandwidth.
- 2.5GHz band: 2570–2620MHz restricted to outdoor small cells and in-building use, 50MHz of bandwidth.

3.21 The bundling of the abovementioned frequency spectrum will provide MNOs with: (a) lower FDD frequency bands, that are ideally suited to achieve area coverage and good in-building penetration and; (b) higher frequency bands such as the 2.3GHz and the 2.5GHz that will serve as a capacity overlay for outdoor coverage via macro cell deployment or as small cell underlay in the urban outdoor environment. The combined allocation approach recognises the synergies between the bands, and both the coverage (lower band) and capacity (higher band) requirements of MNOs. It provides greatest certainty for the industry to assess future spectrum availability aligned with network and service development plans.

3.22 Given the expected growth of mobile data traffic, MNOs need the certainty to be able to cope with the envisaged mobile data tsunami. Unlike the previous generation of mobile technology, the capacity provided by lower band FDD deployments will soon reach its limits, as the number of macro cell site cannot be

further increased. Deploying FDD small cells "in-band" raises technical difficulties and does not efficiently address the asymmetric nature of the mobile data traffic.

3.23 A combination of FDD macro/micro cell sites in the lower and the higher frequency bands, urban small cells (FDD or TDD), in-building deployed small cells (FDD or TDD), and DAS will ensure sufficient capacity in the midterm and the provision of high quality mobile broadband services.

3.24 Conducting the multiband auction in Q1 2015 would reflect the availability of the spectrum bands. It would also provide market participants with a sufficient timeframe to migrate subscribers from existing 900MHz spectrum lots to alternative bands or alternative technologies (such as 2G to 3G), if necessary, in the case of band allocation alterations between MNOs as a result of the multiband auction. The proposed multiband auction would provide the industry with certainty to assess future spectrum availability aligned with network and service development plans.

Allocation of Sub-1GHz spectrum and guard bands

3.25 As indicated in our response to Question 1 at paragraphs 3.4 to 3.12, SingTel Mobile recommends a full alignment with the APT700 band plan (3GPP band 28) 703-803MHz with a 5MHz guard band at the lower band edge of 698-703MHz and a 5MHz guard band at the upper band edge of 803-808MHz.

3.26 SingTel Mobile supports IDA's proposed enlarged guard band at the upper band edge of the 803-808MHz band as depicted in Figure 1 of IDA's Consultation Paper. The more commonly seen 803-806MHz guard band is already causing concern in New Zealand. A study initiated by the Ministry of Business, Innovation and Employment of New Zealand highlighted a potential interference issue where the LTE700 base stations are located in close proximity to other fixed services operating 803MHz[5]. Therefore, there will be a need to allocate a larger guard band in order to lower the interference between LTE700 downlink and other services in the 800MHz range.

[5] Coexistence of LTE in the 700 MHz band and Fixed Service systems in the KK band, May 13.

3.27 The proposed guard band at the lower band edge may be extended to 9MHz, based on the DVB-T inherent channel raster adopted in neighbouring jurisdictions. In the case of Indonesia and Malaysia, Digital Terrestrial Broadcasting TV would be based on an 8MHz bandwidth leaving a guard band from 694MHz to 703MHz.

3.28 Despite the 9MHz guard band, there might be an incompatibility issue due to signal interference from LTE user equipment (**UE**) transmitters to DTV receivers for DVB-T, in particular if the LTE700 UE transmits on larger bandwidth (>5MHz). Such a scenario may occur in suburban areas where the LTE700 UE transmits in close proximity to DTV antennas mounted on low level rooftops[6].

3.29 As indicated in our response to Question 2 at paragraphs 3.13 to 3.19, interference from spectrally adjacent LTE800 Mobile Stations may occur in close proximity to SRDs (866-869MHz), however SRDs are license exempt and do not enjoy any kind of protection. The compatibility situation in Singapore is less critical compared to the one in the UK, as there will be no co-channel interference with the LTE800 user devices. In the case of additional LTE800 assignment for spectrum range 824-834MHz paired with 869-879MHz, a guard band at the lower 3GPP band 5 edge of 3MHz (821-824MHz) should be adopted. Also a 5MHz guard band at the upper band edge of the LTE800 UL (834-839MHz) will ensure minimum interference with future services.

3.30 SingTel Mobile recommends that the EGSM uplink spectrum 880-890MHz be allocated to the 900MHz band (3GPP band 8). If spectrally adjacent cellular or mobile broadband services operate in downlink mode, protection of the abovementioned part of the 3GPP band 8 will be required. To our knowledge, there are no existing studies detailing the co-existence requirements for the LTE800 DL with the LTE900 UL. However, the co-existence issues of 2G and 3G technologies of band 5 and band 8 are well known and documented. Some studies indicate that a guard band of 2MHz to 2.5MHz will be sufficient. Others state that co-existence of the 850MHz and the 900MHz systems with only 2.5MHz guard band will require

[6] Coexistence Simulation Study for APT700MHz LTE UE to DTV RX interference by Alcatel-Lucent Singapore.

additional interference mitigation on both the 850MHz system and the 900MHz systems[7].

3.31 For the co-existence between the LTE900 (band 8) and the spectrally adjacent LTE800 (band 5), SingTel Mobile recommends the approach similar to the one documented in Malaysia's spectrum plan[8]. The following summarises the spectrum plan's key points:

- No guard band specified, instead spurious emission and out-of-band emission RF power levels at 880.1 MHz are stipulated;
- Assignment holders are expected to take full advantage of interference mitigation techniques such as antenna discrimination, tilt, polarization, frequency discrimination, shielding/blocking (introduce diffraction loss), site selection, and/or power control to facilitate the coordination of systems; and
- In the event of any interference, operator-to-operator coordination will be required. In the event that the interference remains unresolved after 24 hours, the affected parties may escalate the matter to the MCMC for a resolution.

3.32 In the same document, the MCMC also explored how spectrum ranges 825-835MHz/870-880MHz (part of band 5/26) can coexist with 880-915MHz/925-960MHz (band 8). Since the downlink 870-880MHz spectrum potentially may interfere with the uplink 880-915MHz spectrum, technical requirements have been proposed to measure the interference and to mitigate it. See table below. The study was done only for 3G 850MHz as System A with GSM 900MHz and 3G 900MHz as System B.

[7] Alcatel Lucent - Consultation Paper on Assignment of Available Frequency Spectrum in the 850 MHz, 900 MHz and 2 GHz Bands

[8] Requirements for Mobile Cellular Systems and International Mobile Telecommunications (IMT) Systems Operating in the Frequency Bands 825 MHz to 835 MHz Paired with 870 MHz to 880 MHz and 880 MHz to 915 MHz Paired with 925 MHz to 960 MHz

System A	System B	Technical Requirements
3GPP DL (850 MHz)	GSM UL (900 MHz)	System A to ensure that unwanted emissions (spurious emissions and out-of-band emissions) shall be equal to or below -61dBm/100kHz at 880.1 MHz. Transmit filters are required at System A in order to achieve this value. Receive filters may be required on case by case basis by System B operator.
3GPP DL (850 MHz)	3GPP UL (900 MHz)	System A to ensure that unwanted emissions (spurious emissions and out-of-band emissions) shall be equal to or below -49dBm/1MHz at 880.1 MHz. Transmits filters are required at System A in order to achieve this value. Receive filters may be required on case by case basis by System B operator.

3.33 We would like to recommend that the IDA undertake further study, research and trials to determine the appropriate technical requirements for the coexistence of LTE operating the in the 850MHz spectrum with GSM/3G/LTE in the 880-915MHz/925-960MHz as follows:

System A	System B	Technical Requirements
LTE800 DL (850MHz)	GSM UL (900 MHz)	TBD by IDA
LTE800 DL (850MHz)	3GPP UL (900 MHz)	TBD by IDA
LTE800 DL(850MHz)	LTE900 UL (900 MHz)	TBD by IDA

<u>1.4GHz band</u>

3.34 SingTel Mobile suggests that the IDA reserves the 1.4GHz band for mobile broadband services in the future. Mobile supplemental downlink (SDL) or unpaired mobile downlink (UMD) should remain a priority in the assessment of the future use of this band. IDA should facilitate the harmonisation of the 1.4GHz

band for SDL use with neighbouring countries in the medium term. In Malaysia and Indonesia, the 1.4GHz band is allocated for digital audio broadcasting (DAB) services or terrestrial networks and for satellite networks, however none of these services have developed in the band.

3.35 SingTel Mobile believes that there is considerable scope for the adoption of 1.4GHz band for the SDL carrier including in Europe, Middle East, Africa, Australia, Canada and Mexico. In Europe, the European Conference of Postal and Telecommunications Administrations (**CEPT**) has recently harmonised the 1.4GHz band for SDL. The ECC Report 88[9] [10] concluded that the most appropriate regulatory framework for the future use of the 1452-1492MHz band is the harmonisation of this band for mobile broadband services and SDL.

3.36 The application of the SDL technology, in the form of 1.4GHz bonded with 2.1GHz, has already been trialled on Orange's network in Toulouse, France in February 2013[11] [12]. Orange, in cooperation with Ericsson and Qualcomm, successfully demonstrated the use of SDL technology on a mobile network, thereby confirming the potential of this concept to increase mobile broadband capacity and enhance user experience.

3.37 Besides significant capacity and throughput enhancements of the SDL technology, the 1.4GHz band would also offer significant advantages in terms of coverage relative to the 2.1GHz and the 2.6GHz bands.

3.38 Further, carrier aggregation was introduced and standardised earlier with HSPA+ Release 9 and LTE Release 10. The use of carrier aggregation for combination of LTE frequency bands with the 1.4GHz SDL band is planned for in LTE Release 12 and beyond. Qualcomm expects the first chipset in the second half of 2014 and

[9] ECC Decision (13)03, The harmonised use of the frequency band 1452-1492MHz for Mobile/Fixed Communications Networks Supplemental Downlink (MFCN SDL)
[10] ECC Report 188, Future Harmonised Use of 1452-1492 MHz in CEPT, approved February 2013
[11] Press Release Orange - PR_Orange_experimentation_Lband_280612_EN
[12] Press Release Orange, Ericsson and Qualcomm - PR_SupplementalDownlink_Orange_Ericsson_Qualcomm_EN_210213_def

predicts the earliest network deployments to occur in 2015[13]. End user devices will develop in line with network deployments and demand.

3G band

3.39 Worldwide, the first operators are now starting to deploy LTE networks in the 2.1GHz spectrum band. One of seven commercially launched LTE-Advanced networks, , LG U Plus in South Korea, is providing services using the 2.1GHz band. Additionally, about ten out of 288 commercially launched LTE networksare providing services using the 2.1GHz band. 423 LTE user device models out of 1,563 currently support the 2.1GHz band.

3.40 NRAs worldwide have started converting technology specific spectrum licenses to technology neutral licenses. One example is the EC, which in 2004 introduced the Wireless Access Policy for Electronic Communications Services (WAPECS), a more flexible spectrum management approach developed by the Radio Spectrum Policy Group (RSPG). It is based on the principles of service and technology neutrality, and a move to a harmonised authorisation scheme. The 2.1GHz band is one of the WAPECS bands. Based on WAPECS, the European member states initiated the establishment of technology neutral licenses, including for the 2.1GHz spectrum band. The status of the current 2.1GHz license conversion is shown in the following table[14].

Country	2.1GHz Band Usage
Austria	3G
Belgium	2G+3G+4G
Switzerland	3G (Neutral in Jan. 2017 at the latest)
Czech Republic	3G
Germany	3G (Spectrum auctioned in 2010: neutral)
Spain	3G (But Ministry of Industry plans to introduce technological neutrality before 2015)
Finland	3G

[13] Qualcomm presentation at the ITU Regional Forum in Tunis, May 13.
[14] Cullen International, 2014

France	3G
Hungary	3G
Ireland	3G
Italy	3G
Netherland	3G
Poland	3G
Portugal	3G+4G
Sweden	Neutral
Slovakia	3G
United Kingdom	3G+4G

Table 1: Status of 2.1GHz license conversion in Europe

3.41 The majority of European member states have not yet converted licences in the 2.1GHz band. The main reason for this is that related licenses were allocated at the beginning of the century and are close to expiration. A license conversion is not sensible for most operators before the spectrum is reallocated. The situation is similar in Singapore's neighbouring countries of Malaysia and Indonesia.

3.42 The first 3G license in Malaysia was issued in 2003 and the first 3G network was launched in 2005. The frequency in the 2.1GHz band has been used for 3G services for over 10 years. In December 2012, MCMC issued the 2.6GHz spectrum band to eight mobile operators for 4G services. Therefore, the re-farming of the 2.1GHz band for 4G services was deemed to be not necessary in the very near future. Additionally, it will take around four years until the first 3G license ends in 2018.

3.43 The first 3G license in Indonesia was issued in 2003 and the first 3G network was launched in 2006. Currently, the 2.1GHz band is still used for 3G services and the 3G market continues to grow. In March 2013, the regulator awarded additional blocks of 3G mobile spectrum to Telkomsel and XL Axiata. 4G services started this year in 2014 using re-farmed spectrum in the 800MHz, the 1800MHz and the 1900MHz bands. The 2.1GHz band is also considered to be one of the candidates for 4G services in the future. However, licenses have not yet been converted.

3.44 SingTel Mobile notes the current trend of introducing 4G technology on the 2.1GHz spectrum band. SingTel Mobile is, in general, open to discussing license conversions. However, SingTel Mobile shares the concern of many operators worldwide that initiating a license conversion with only a few years remaining of the license duration is not considered advisable. With this in mind, SingTel Mobile recommends that the IDA does not automatically convert all existing 2.1GHz licenses to technology neutral or 3G/4G licenses, but establishes a procedure for Singapore MNOs to apply for a license conversion in the event that an MNO intends to introduce 4G in the 2.1GHz band.

3.45 SingTel Mobile would like to highlight possible negative impacts in connection with the conversion of the 2.1GHz 3G licenses to 4G licenses or technology neutral licenses. The 3G market in Singapore is currently still growing. Customer experience might be impacted if an operator in Singapore introduces 4G in the 2.1GHz band and re-farms its entire 2.1GHz spectrum band for 4G, as not all handsets support 3G in the 900MHz band. Additionally, visiting tourists may also be impacted if their handset can only support 3G in 2.1GHz.

3.46 From a technical perspective, there are no co-existent issues when re-farming from 3G to 4G (IMT-A). LTE's scalable air interface supports channel bandwidths ranging from 1.4MHz, 3MHz, 5MHz, 10MHz, 15MHz to 20MHz, enabling MNOs to gradually re-farm the 3G spectrum. MNOs can choose to re-farm spectrum in 1.4MHz, 3MHz or 5MHz steps, depending on the underlying traffic mix and device situation. It is expected that 3G and LTE/LTE-A services will co-exist for quite some time, particularly given that the global LTE subscriber take-up is still relatively small (200 million) compared to 1.5 billion 3G/HSPA subscribers. Globally, the number of 3G/HSPA subscribers is still growing and a substantial portion of Singapore's 15 million visitors will require 3G/HSPA roaming services. However, the take-up of LTE subscriptions is faster than the take-up of any previous mobile technology and may warrant a partial re-farming of the 3G spectrum.

3.47 The coexistence of LTE and UMTS is assessed in CEPT Report 40. Based on interference simulations, CEPT proposed frequency separation between LTE (E-

UTRA FDD) channel edge and UMTS (UTRA FDD) carrier centre frequency of 2.5MHz or more as summarised in the table below.

	Frequency spacing between UMTS carrier centre frequency and LTE carrier centre frequency	Frequency spacing between UMTS carrier centre frequency and LTE channel edge	Frequency spacing between UMTS channel edge and LTE channel edge
LTE 1.4 MHz	3.2 MHz	2.5 MHz	0 kHz
LTE 3 MHz	4 MHz	2.5 MHz	0 kHz
LTE 5 MHz	5 MHz	2.5 MHz	0 kHz
LTE 10 MHz	7.5 MHz	2.5 MHz	0 kHz
LTE 15 MHz	10 MHz	2.5 MHz	0 kHz
LTE 20 MHz	12.5 MHz	2.5 MHz	0 kHz

3.48 CEPT Report 40 also details the co-existence of LTE systems with various channel bandwidths. The conclusion is that no guard band is required when an operator uses the nominal channel spacing as specified by 3GPP. CEPT's co-existence simulation results show that even in an uncoordinated deployment scenario, the predicted ACIR (Adjacent Channel Interference Ratio) values were achieved.

3.49 There is no explicit guard band needed between LTE carriers since the spacing is based on the sum of half the channel bandwidth of each of the adjacent carriers.

TDD bands

3.50 LTE is a common global standard for both paired and unpaired spectrum allowing operators to leverage available spectrum and to deploy converged networks with a common core network. Both FDD-LTE as well as TDD-LTE offer very high data rates, low latency, and seamless interworking with 3G as well as between the FDD and the TDD networks.

3.51 By Q1 2014, a total of 32 TDD-LTE networks in 21 countries had been launched including 13 FDD/TDD LTE convergent networks. An additional 47 TDD-LTE commercial networks are either in deployment or planned[15]. The Swedish MNO Hi3G, Saudi Arabian STC, Russian Megafon, China Mobile (Hong Kong) and Australian Optus, amongst others, have deployed TDD/FDD converged networks.

3.52 FDD-LTE and TDD-LTE networking convergence technology has already been in operation since December 2012. China Mobile (Hong Kong) and five equipment manufacturers provide FDD-LTE and TDD-LTE dual-mode networking solutions. Converged FDD/TDD networks share the same LTE core network, load balancing may distribute flows within LTE carriers as needed, and TDD and FDD network switching delay has been reduced to 50-60ms. Network equipment manufacturers are actively cooperating with chipsets and terminal manufacturers to develop TDD/FDD end-to-end industrial chains that support multi-mode operation.

3.53 Thus far, all 3G chipset manufacturers also manufacture TDD-LTE chipsets. By June 2013, 15 chipset manufacturers had launched more than 20 TDD-LTE chipsets covering single-mode and multi-mode multi-frequency chipsets. In August 2013, Samsung announced that it has the world's first commercially available devices (new Galaxy S4s and S4 minis) that can seamlessly handover between FDD and TDD LTE networks. At present, there are 269 devices for the 2.3GHz band (3GPP band 40), 278 devices for the 2.5GHz band (3GPP band 38) and 17 devices for the 3.5GHz band (3GPP band 42).

3.54 The inherent advantage of TDD-LTE technology is the flexibility to configure different DL and UL ratios which suit the asymmetric nature of mobile data, therefore enhancing spectrum efficiency/capacity, especially in a small cell deployment scenario.

3.55 In a small cell deployment scenario, the Guard Period that accommodates the time necessary for the round trip propagation delay between the UE and the eNodeB, can be reduced to a minimum of 1 symbol or 71μsec which corresponds to a cell range of 5km. Furthermore, when TDD-LTE is being utilised in a small cell

[15] GSA, Global Mobile Broadband Market Update 2014

deployment scenario, the loss in capacity from TDD guard bands becomes trivial due to the very small coverage area.

3.56 Given the forecasted increase in mobile data traffic in the coming years, it is important for MNOs to leverage the advantages offered by TDD-LTE deployments. A sensible way forward in coping with the predicted traffic increase, is by increasing the densification of mobile networks via small cells in combination with existing FDD macro cells and adding TDD-LTE as capacity expansion layers. Therefore, SingTel Mobile recommends that the available E-UTRA TDD bands of 2.3GHz, 2.5GHz and potentially 3.5GHz in the future, be allocated for mobile broadband use.

3.57 SingTel Mobile recommends that spectrum in the 2.3GHz band (3GPP band 40) should be made available for mobile broadband deployments. The current half band sharing arrangement of 2300-2350MHz, where Singapore has priority use, would enable Singapore MNOs to deploy the full range of TDD-LTE cells such as outdoor macro cells, outdoor small cells, as well as DAS and indoor small cells. Furthermore, the following half band of 2350-2400MHz, where neighbouring jurisdictions have priority, should be made available for indoor deployment use such as DAS and indoor small cells.

3.58 To mitigate interferences at the 2.3GHz band edge, a guard band of 5MHz (2345-2350MHz) should be applied. Other mitigation techniques may involve operator-to-operator coordination on a case by case basis (i.e. filtering, TX power level reduction and antenna azimuth and tilt optimization) in border areas if the need arises.

3.59 SingTel Mobile recommends that spectrum in the 2.5GHz band (3GPP band 38) should also be made available for mobile broadband deployments. The current "full band" sharing arrangement would facilitate outdoor small cells deployment in shielded urban environments and in-building deployment of small cells. The mitigation of interference can be achieved by deploying low powered small cells as mentioned above. Reflecting the restricted usage of the 2.5GHz TDD band and also international benchmarks, SingTel Mobile expects lower reserve prices for the

2.5GHz TDD band of far less than 50% of the reserve price which IDA proposed in 2013 for the 2.5GHz FDD band.

3.5GHz band

3.60 SingTel Mobile recommends allocating the 3.5GHz frequency spectrum band 3.5GHz (i.e. 3400-3600MHz) for mobile broadband use in the future, with certain restrictions imposed to allow the co-existence of Fixed Satellite Services (FSS) and TV Receive Only (TVRO) with mobile broadband (TDD-LTE) deployments. More extensive study and detailed trials should be conducted to ascertain the interference issues and evaluate the mitigation methods available when FSS, TVRO and IMT mobile communications systems co-exist.

3.61 SingTel Mobile acknowledges the importance of existing C-band applications in Singapore and neighboring countries and proposes to restrict the use of 3.5GHz band for specific in-building deployments.

3.62 The 3.5GHz band holds potential for small cell applications in traffic hotspots, either in a public or corporate environment. Incidentally, the majority of data traffic occurs in indoor environments and the 3.5GHz band's large bandwidth of 200MHz makes it well suited for capacity enhancing applications. Thus it enables MNOs to utilise a TD-LTE carrier of 20MHz or even to aggregate several 20MHz carriers to provide LTE-A services.

3.63 The limited signal propagation characteristics in the 3.5GHz band combined with low powered eNodeBs can, from a mere radio propagation perspective, facilitate in-building deployment of small cells with a greatly reduced risk of harmful interference for geographically or spectrally adjacent users. SingTel Mobile does not foresee that existing FSS and TVROs will have to be migrated when MNOs utilise the 3.5GHz band for in-building deployments using small cells (micro cells, pico cells) and in particular, where small cells are being deployed in shielded environments such as MRT platforms, department store basements, shopping malls, etc. The typical EIRP of class 2 small cells (Indoor and Outdoor Metro cells) range from 0.1W to 1W and ranges from 1W to 5 W for class 3 (Outdoor

Metro Cells)[16]. Low emitted RF power levels in combination with the shielding effects of internal building structures and outer walls will add significant levels of insulation.

3.64 The in-building deployment of 3.5GHz small cells at higher floor levels needs to be assessed further. A potential interference situation with TVRO may occur where a 3.5GHz small cell is being deployed on e.g. third floor of a building with a TVRO in close proximity or even with FSS. SingTel Mobile recommends that IDA assesses the use cases of the 3.5GHz small cell deployment in an in-building scenario in depth and provides MNOs with deployment guidelines. Recent studies conducted by ITU and SIA (Satellite Industry Association) refer to the outdoor use of 3.5GHz macro and micro cell application which is distinctly different from a shielded, in-building deployment scenario[17] [18].

3.65 Usage of the 3.5GHz band is gaining momentum. Orange in France is conducting an LTE-A trial in the 3.5GHz band with carrier aggregation on the 2.5GHz band. eAccess in Japan is conducting an LTE-A trial in the 3.5GHz band with carrier aggregation on the 1800MHz band. Softbank in Japan is also conducting an LTE-A trial in the 3.5GHz band. Thus far, Menatelecom in Bahrain, UK Broadband in the UK, ABC Communication in Canada and Neo-Sky in Spain have operational networks in the 3.5GHz range and 13 more network deployments are planned in this spectrum range.

3.66 The 3.5GHz device ecosystem is still underdeveloped and only 17 devices are currently available, however it is expected that the 3.5GHz band could also play a significant role in the deployment of small cells, which would result in an improved 3.5GHz TDD device ecosystem. 3.5GHz multimode- multi-frequency devices are likely to become available.

[16] Alcatel Lucent - Small Cells Regulatory Considerations Strategic White Paper.
[17] REPORT ITU-R M.2109 Sharing studies between IMT-Advanced systems and geostationary satellite networks in the fixed-satellite service in the 3 400-4 200MHz
[18] SIA_Sharing Considerations Between Small Cells and Geostationary Satellite Networks in the Fixed-Satellite Service in the 3.4-4.2 GHz Frequency Band

Policy considerations for development of HetNet

3.67 HetNet is defined as a network with complex interoperations amongst various access technologies between macro-cell, small-cell, and in some cases WiFi network elements belonging to one mobile operator's network. It provides a mosaic of coverage and capacity layers, with handoff capability between the network elements provided by the same mobile network operator. At this point in time, to the best of our knowledge, the international standards and specifications for HetNet has not yet been fully established.

3.68 Several NRAs and organisations worldwide have studied whether there is a requirement for HetNet specific regulation. HetNet specific regulations are neither recommended nor have they been imposed, especially in this early stage of the worldwide HetNet deployment. The Radio Spectrum Committee of the EC stated in 2008 that, "Noting that femtocells operate as part of the operator's existing network (using the same frequencies) and that the operator remains in control of the femtocell at all times, it is reasonable therefore to assume that femtocells will comply with the existing technical licensing conditions in each specific case."[19] The FCC has also noted that small cells are one of the technologies that the US mobile industry has been looking at to improve efficiency of mobile radio frequency. The chairman of the FCC stated in 2009 that the "FCC will look to make spectrum policies more flexible to encourage the use of unlicensed spectrum, smart antennas and small cells."[20] Nevertheless, HetNet specific regulation has not been imposed in either case.

3.69 The Small Cell Forum published in 2011 the "Regulatory Support for LTE Femtocells" paper stating that, "The use of LTE femtocells need not give rise to any concerns of a regulatory nature which have not already been addressed for femtocells working with other technologies and there should be no need for any more restrictive LTE-specific regulatory conditions to be imposed on their deployment and use." Additionally the forum reported the status of femtocell

[19] Regulatory Aspects of Femtocells – Second Edition, Femto Forum, March 2011
[20] See sources at note 19, above

regulation internationally and did not find any need to impose HetNet specific regulation.

3.70 SingTel Mobile shares the view of the EC, FCC and the Small Cell Forum that there is no necessity to impose HetNet specific regulation, particularly at this early stage of HetNet deployment. Once international standards and specifications for HetNet are established, SingTel Mobile as the technology leader in Singapore will explore and deploy the necessary features and solutions for the benefit of our customers.

3.71 With regards to other HetNet policy implications, SingTel Mobile recommends reviewing IDA's Code of Practice for Info-communication Facilities in Buildings (**COPIF**). The current COPIF only partially covers the requirement of HetNet deployment, which is not only deployed in buildings and MRTs, but also outdoors on street light poles, electricity masts or exterior walls of buildings. SingTel Mobile recommends conducting the review of COPIF to reflect technical requirements to include typical locations of HetNet deployments and to align rental rates and administrative fees of HetNet sites towards the existing in-building and outdoor sites arrangement under COPIF.

Options to enhance mobile market competition

3.72 SingTel Mobile does not consider that there is any basis for regulatory intervention to increase MVNO participation in the market for mobile services. MVNOs, by their nature, address niches in a market which are not being met by other market participants. Consequently, market forces must be allowed to determine the extent to which MVNOs enter the market and the niches which they fill unless there is unambiguous evidence of market failure.

3.73 Internationally, regulation of MVNO access to MNO networks is rare. In the small subset of markets which are regulated, the outcomes of the regulation are not clearly beneficial or superior to the outcomes which would have arisen without regulation. Indeed, blunt or inappropriate regulatory remedies to increase MVNO

participation artificially can reduce consumer welfare and result in net detriment, such as by causing underinvestment in network infrastructure.

3.74 SingTel Mobile strongly recommends the development of the Singapore MVNO participation in the mobile services market based on voluntary commercial negotiations between MNOs and MVNOs. This is in line with international regulatory best practice approaches applied by the EC, the majority of European NRAs and the FCC in the USA. Imposing a regulatory MVNO-hosting framework in Singapore may harm the Singapore mobile services market, resulting in a negative impact on customer experience and run the risk that Singapore would lose its leading ICT position.

The IDA has not made out any need for regulatory intervention

3.75 Singapore has one of the world's highest mobile penetration rates (156%),[21] amongst the world's most affordable mobile voice and broadband,[22] and a wide variety of innovative services. These world-leading mobile services were developed due to a vibrant competitive landscape. To justify interfering with the existing competitive market, the IDA would require unambiguous proof that:

(a) there is market failure requiring regulatory intervention;
(b) the proposed regulatory intervention would remedy that market failure; and
(c) the potential negative impacts on market-based competition caused by the regulatory intervention are outweighed by the benefits arising from that intervention.[23]

[21] Department of Statistics Singapore, *Latest Data* (26 May 2014) at http://www.singstat.gov.sg/statistics/latest_data.html.
[22] See ITU, *Measuring the Information Society* (2013), tables 3.17 and 3.20 at http://www.itu.int/en/ITU-D/Statistics/Documents/publications/mis2013/MIS2013_without_Annex_4.pdf . Singapore is not represented in table 3.17, but using the ITU's methodology at pages 110-112 with current public data on prices gives Singapore a score of 0.6, ranking it equal third with Germany, just behind the UK, ahead of France and well ahead of Hong Kong.
[23] In this regard, see the regulatory principles in section 1.5 of the Telecommunications Code of Practice for Competition in the Provision of Telecommunications Services 2012.

3.76 SingTel Mobile is not aware of any economic analysis regarding the state of competition in the mobile services market in Singapore or analysis of the consequences of any intervention which might be proposed.

3.77 Indeed, the mobile services market in Singapore is competitive and vibrant. Singapore's mobile voice and data prices are amongst the lowest in the world, and significantly lower than those in countries with greater MVNO participation, as discussed below.

3.78 While the average inflation in Singapore over the course of the last four years was approximately 3.7% (CAGR), the communications price index decreased by (on average) 1.3% per annum and in total 5.2% over the last four years[24] (see Annex B). Communications were the largest of the only three consumer price index (CPI) components which have consistently declined over this period in the CPI basket and have not contributed to the overall inflation, as shown below:

- Communications contributed -0.1% out of 3.7% CPI CAGR
- Recereation & Entertainment contributed -0.04%
- Household Durables contributed -0.02%

3.79 Comparing the mobile data packages offered by MNOs in Singapore against MNOs internationally, it is clear that the Singapore's per unit prices are at the very low end. Even MNOs in countries like Hong Kong or France, where MVNO regulation was imposed, offer mobile data packages at a higher per unit price level (see Annex C). Regulatory intervention in Singapore is not justified by the evidence.

3.80 MNOs in Singapore are constantly pushing the bounds of service innovation. For example, SingTel Mobile just launched the world's first full-featured commercial Voice over LTE service and LTE-Advanced services which offer consumers 300 Mbps theoretical peak download speeds.[25] There is no dominant MNO and each MNO competes fiercely to bring value to end users.

[24] Department of Statistics, Singapore
[25] SingTel Mobile, *SingTel, Samsung and Ericsson unveil world's first full-featured Voice over LTE service* (19 May 2014) at http://info.singtel.com/about-us/news-releases/singtel-samsung-and-ericsson-unveil-

3.81 Furthermore, SingTel Mobile has not seen any economic analysis suggesting that regulatory intervention designed to increase MVNO participation would be superior to allowing the market to determine the outcome. In this regard, SingTel Mobile notes the comments of the predecessor to the UK's sector regulator Ofcom, OFTEL, when it originally declined to regulate MVNO access to MNO networks in the UK. OFTEL stated that:

"OFTEL takes the view that many of the benefits attributed to MVNOs by respondents could be achieved by market developments in the absence of MVNOs."[26]

Market forces must determine the role for MVNOs in the absence of market failure

3.82 When the IDA last looked at regulatory intervention regarding MVNOs in 2001, it noted that its regulatory approach is to "rely on market forces where appropriate to achieve its policy objectives, as these are generally more effective than regulation in fostering competition and safeguarding consumer welfare."[27] SingTel Mobile strongly supports this statement and believes that it remains true when applied to the mobile services sector. This reflects the guiding regulatory principle in the Telecommunications Code of Practice for Competition in the Provision of Telecommunications Services 2012 (the **Telecom Code**).[28] SingTel Mobile urges the IDA to keep this guiding principle at the heart of its approach to the vibrant mobile services sector in Singapore.

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worlds-first-full-featured-voice-over-lte and SingTel Mobile, *SingTel first Singapore mobile operator to roll out live 300Mbps 4G service and China 4G roaming* (28 May 2014) at http://info.singtel.com/about-us/news-releases/singtel-first-singapore-mobile-operator-roll-out-live-300mbps-4g-service-and-.

[26] OFTEL, *Statement on Mobile Virtual Network Operators* (October 1999) paragraph 2.28 at http://www.ofcom.org.uk/static/archive/oftel/publications/1999/consumer/mvno1099.htm

[27] IDA, *Proposed Regulatory Approach for 3G Mobile Virtual Network Operators* (5 September 2001) pages 1-2, at http://www.ida.gov.sg/policies-and-regulations/consultation-papers-and-decisions/completed/Proposed-Regulatory-Approach-for-3G-Mobile-Virtual-Network-Operators-MVNOs.

[28] Section 1.5.1 of the Telecom Code.

3.83 Imposing a regulatory MVNO-hosting framework in Singapore may lead to:

(a) Allocative inefficiency by distorting price-cost relationships;
(b) Discouraging investment and innovation by both MNOs and MVNOs;
(c) MVNOs seeking to serve customer demand which is already being competitively met by MNOs (demand-side mismatch); and
(d) firms entering the MVNO market without existing experience and competencies necessary to run an MVNO businesss (supply-side mismatch), such as a lack of ICT platforms and a lack of experience in telecommunications businesses.

3.84 In such cases, the inefficient costs of enabling MVNOs to enter the market (and the costs of unsustainable MVNOs leaving the market) are ultimately passed on to all consumers, leading to a net decrease in consumer welfare.

3.85 Where regulation forces an MNO and MVNO into a commercially unpalatable relationship, the resulting collaboration is less likely to succeed than when the relationship is the result of private negotiations and will not deliver the benefits that market-based arrangements will deliver.[29] The more invasive the regulatory intervention, the more grave the harm to the commercial relationship. This may be one factor in Hong Kong having *fewer* MVNOs than Singapore, notwithstanding regulated access to MNO networks in that market, as discussed below.[30]

3.86 In Singapore today, MNOs are effectively and efficiently serving consumers, using spectrum allocation and network investment to their full potential. This is underscored by our requests earlier in this submission to allocate further spectrum to MNOs.

3.87 The IDA's Consultation Paper notes that MVNOs in Singapore are serving niche markets. However, contrary to the implication in the Consultation Paper that this is

[29] The IDA recognised this in its previous consultation: *Proposed Regulatory Approach for 3G Mobile Virtual Network Operators* (5 September 2001) page 2, at http://www.ida.gov.sg/policies-and-regulations/consultation-papers-and-decisions/completed/Proposed-Regulatory-Approach-for-3G-Mobile-Virtual-Network-Operators-MVNOs.

[30] Hong Kong has 11 licensed MVNOs according to the OFCA website, whereas Singapore has 13 licensed MVNOs according to the IDA's website. Market share is discussed below.

problematic, SingTel Mobile submits that this is further evidence of the effectiveness of MNO competition fostered by market forces in Singapore.

3.88 Indeed, it is not unusual for MVNOs to play a niche role in competitive markets. MVNOs that do the best in many markets are those which target niches.

3.89 This niche nature of MVNOs is a further reason for the IDA to abstain from regulating MVNOs' access to MNO networks. The niche that an MVNO chooses to target will have dramatic ramifications on the price and non-price terms it negotiates with its host MNO. A regulator attempting to set any minimum terms is likely to restrict the MVNO market to particular opportunities, and is likely to retard or distort the market. In fact, setting minimum terms is a likely to lead to "lowest common denominator" approach where those minimum terms are completely inappropriate for some niches or MVNO segments.

Internationally, regulated MVNO access is rare and international examples provide no basis for intervention in Singapore

3.90 The IDA has identified the UK and the Netherlands as countries in which MVNO entry has led to service innovation and reduction in market prices. However in those countries, regulators have not intervened to assist MVNOs to access MNO networks.

3.91 OFTEL's decision in 2001 not to intervene in the UK mobile market to artificially support MVNOs (discussed above) has been continued by its successor, Ofcom, which has continued this restrained regulatory posture for the past 13 years.

3.92 In the Netherlands, regulated access existed to the dominant carrier's network before 2004. However the regulation was removed in that year when the telecommunications law changed. There has been no meaningful correlation between regulated access obligations on the dominant carrier, KPN, and MVNO activity in the Netherlands. Before 2004, even though access obligations only applied to KPN, MVNOs were hosted by several Dutch MNOs, including MNOs not subject to any access regulation. In particular, Tele2, the first MVNO in the

Netherlands, was hosted by Telfort rather than KPN, demonstrating that commercial forces rather than regulatory settings drove initial MVNO entry in the Netherlands.[31]

3.93 MVNOs in the UK and the Netherlands have developed in response to specific market forces in those countries – meeting unmet demands and/or exploiting the specific supply side competencies of the firms which launched MVNO services which competencies were not shared by MNOs. France (to which the IDA also referred in its Consultation Paper) is another example of a market in which MVNOs are addressing unmet demand in a market. In that country, all major mobile market indicators lag the European norms and Singapore's equivalent position. As a prime example, mobile penetration in France remains the lowest in Europe.[32]

3.94 MNOs in France voluntarily negotiated with MVNOs as it allowed the MNOs to use spectrum capacity and network assets in which they had invested and which would have been underutilised without the cost-efficient customer acquisition and servicing which MVNOs could offer to MNOs. MNOs in Singapore do not suffer from the same underutilisation of capital intensive assets. MNOs here have achieved exceptional mobile penetration, and mobile data coverage is excellent. MNOs are meeting consumer demand.

3.95 The success of MVNOs depends on market and country specific characteristics. Germany and Netherlands are the best examples in terms of successful MVNO markets with currently 157 active MVNOs (including sub brands) with a market share of approximately 14.5% in Germany and 65 active MVNOs (including sub brands) with a market share of approximately 17% in the Netherlands. The NRAs in Germany and the Netherlands do not impose any MVNO regulations. Both Germany and Netherlands are territorial countries with high distribution costs for MNOs in rural areas. Natural MVNO partners for MNOs in Germany and the

[31] Tele2, *Tele2 AB Becomes First MVNO in the Netherlands* (24 August 2001) at http://www.tele2.com/media/press-releases/2001/tele2-ab-becomes-the-first-mvno-in-the-netherlands1/

[32] France's active SIM penetration the lowest in Europe, at 98%, in 2011. See GSMA, *European Mobile Industry Observatory 2011*, page 11 at http://www.gsma.com/publicpolicy/wp-content/uploads/2012/04/emofullwebfinal.pdf.

Netherlands are retailer and media companies extending the reach of MNOs naturally and cost efficiently into rural areas. Consequently, 29% of the German and 34% of the Dutch MVNOs are media companies and retailers allowing MNOs to improve their distribution reaches. None of the eight MVNOs (including sub brands) in Hong Kong are retailers or media companies, showing that the value add of retailers and media companies for MNOs in a mainly urban Hong Kong (which also apply to a mainly urban Singapore) is restricted. Thus, related MVNO business models are less viable in Hong Kong or Singapore.

3.96 20% of the German MVNOs are telecom related MVNOs. There are currently more than 100 regional and nationwide fixed network operators without mobile capability in Germany competing against the German incumbent operator Deutsche Telekom which offers quadruple play offers. In order to compete against Deutsche Telekom, these smaller fixed network operators have sought to expand their product portfolios by becoming MVNOs and thereby offering quadruple play services. Additionally, non-integrated MNOs without fixed networks also profited from related MVNOs by extending their product portfolio. This MVNO business model is, like regional distribution, less viable in Singapore given that the majority of fixed network providers in Singapore are integrated fixed and mobile operators.

3.97 11% of German MVNOs, 12% of Dutch MVNOs and 25% of MVNOs in Hong Kong are niche MVNOs offering successful mobile services for migrants. PLDT in Singapore shows that the migrant MVNO model is also successful in Singapore without regulatory intervention.

3.98 The examples above illustrate that country and market specific characteristics plays a large part in determining the number of viable MVNOs in a particular market. In Singapore's case, factors conducive to a number of MVNO models are largely inapplicable, which explains the number of MVNOs in Singapore.

3.99 The Consultation Paper also refers to Hong Kong as a market which regulates MVNO access to MNO networks. However, SingTel Mobile urges the IDA to make regulatory decisions about MVNOs in Singapore based on Singapore's market conditions and not those that prevailed in Hong Kong at the time that Hong

Kong's regulator, then the Office of the Telecommunications Authority (**OFTA**), intervened in the market.

3.100 In Hong Kong, MVNO access to MNO networks was regulated in 2001 in conjunction with the award of four 3G spectrum licences. Prior to that spectrum allocation process, Hong Kong had six 2G MNOs. It is readily apparent, from documents released by OFTA at the time, that the MVNO access regime was a compromise to allow existing 2G licensed operators an avenue to continue their operations while preserving 3G auction revenues for the government.

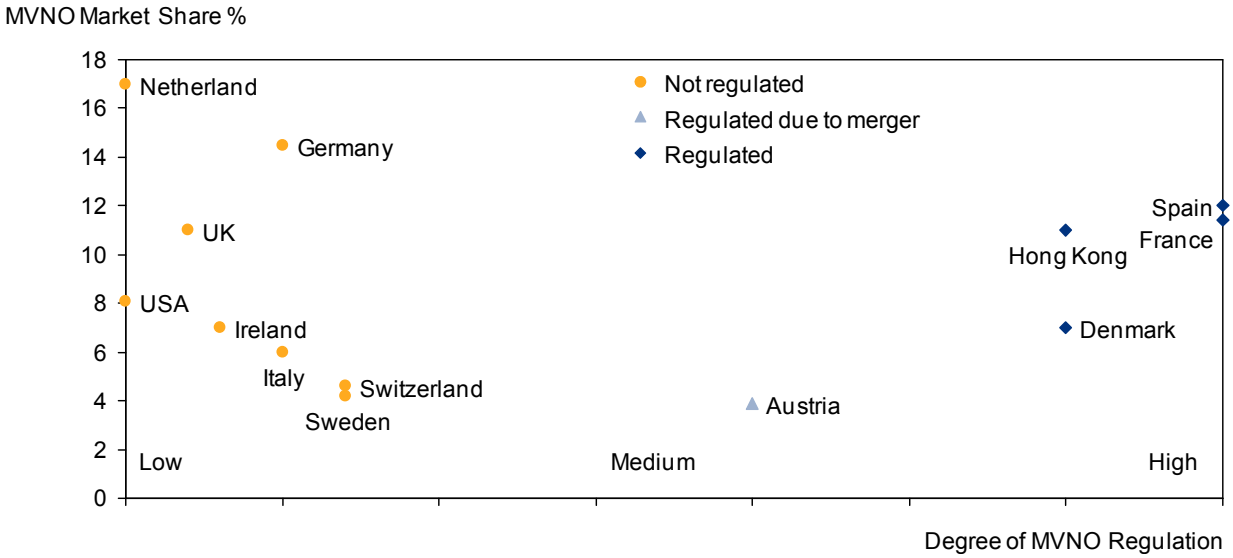
3.101 There was no economic justification or consumer welfare analysis that underpinned OFTA's decision. Though vague references were made to fostering competition, the focus of the so-called "open access" policy was on providing a "soft landing" to businesses which the regulator was concerned would be stranded due to a particular government policy.

3.102 Unnecessary regulation may itself spur incentives for inefficient behaviour. For example, MVNOs may pursue arbitrage opportunities that are created by such regulation or use wholesale price regulation for initiating unsustainable price wars. One example of such inappropriate regulation is the establishment of a strong regulatory MVNO hosting framework in Denmark at the beginning of the century. It caused market distortions and unnecessary market consolidation harming sustainable infrastructure competition.

3.103 The Danish NRA opted for the introduction of a strong MVNO hosting framework as an extreme measure to encourage market liberalization. The two large MNOs, TDC and Sonofon, were classified as dominant providers. They were obliged not only to offer non-discriminatory services to MVNOs but also had to produce a reference offer similar to reference offers provided by fixed network operators. Special contract conditions could be negotiated between the parties on the basis of this reference offer, however the price was fixed using a retail minus methodology with a 25% discount on retail offerings. In addition, MVNOs were given discounts on outgoing calls instead of interconnection charges in proportion to the generated incoming calls.

3.104 Due to regulatory intervention, the resulting competition was brutal and mainly based on low end user prices. The no frills business model was implemented by MVNO Telmore and established MNOs made the mistake of joining the price war. Difficult business conditions forced the MNO Orange out of the market and the operator was taken over by the smaller competitor Telia, reducing the number of infrastructure based operators by one. Additionally, the two most important MVNOs were acquired by their host MNOs (Telmore by TDC and CBB-Mobil by Sonofon) and the two smaller MNOs had to merge due to strong price pressure in the market. This impacted customers, as they were forced to migrate to the remaining MNOs. It also affected employment in the telecom sector, due to market consolidation.

3.105 Regulators around the world generally agree that the market itself, through voluntary commercial agreement, is best positioned to regulate the provision and growth of MVNO participation in a market. In most countries, regulators have refrained from mandating that MNOs grant MVNOs open access to their networks. The merit of voluntary commercial agreement, with NRAs refraining from regulatory intervention, can also be observed from international benchmarks comparing MVNO participation in markets where the participation is based on market mechanisms and those where participation is based on regulatory intervention. Internationally, MVNO participation based on market forces usually leads to more vibrant MVNO participation, and MVNOs have higher market shares compared to markets based on regulatory intervention. When MVNO access is created by regulation, it has been noted that MVNOs emerge as value destroying competitors in markets for mobile services whereas, even in the absence of mandatory access provisions, MVNOs have successfully entered the industry in many jurisdictions.



Comparison of degree of MVNO regulation and vs MVNO market share as at December 2013[33]

Regulatory intervention would undermine investment

3.106 Finally, SingTel Mobile submits that any proposed regulatory intervention will undermine investment in the mobile services sector.

3.107 The IDA has long recognised that regulatory intervention imposes costs. In its previous consultation on the topic, the IDA noted that there is a need to balance any desire to foster competition against the need to encourage investment in 3G networks.[34] The same principle applies more widely. In its 1999 consultation on the topic OFTEL concluded that:

> *"[The] limited benefits [which could be facilitated by MVNOs] could be outweighed by the costs arising from establishing MVNOs, namely the potential adverse impact on infrastructure investment and network costs."*[35]

[33] Ovum, MVNO forecast. Analysys, MVNO market Analysis.
[34] Though SingTel Mobile reiterates that any intervention should be conditional on actual evidence of market failure and an assessment of the minimum intervention necessary to address such failure. Competition should not be artificially skewed by bolstering the number of competitors or downstream providers of mobile services beyond the level determined to be sustainable by competitive market forces.
[35] OFTEL, *Statement on Mobile Virtual Network Operators* (October 1999) paragraph 2.28 at http://www.ofcom.org.uk/static/archive/oftel/publications/1999/consumer/mvno1099.htm.

3.108 SingTel Mobile continues to invest in its networks and platforms at a time of increasing revenue pressure for MNOs, as over-the-top service providers undercut MNO services without shouldering any of the burdens of the network investments necessary to deliver their traffic and free from the regulatory burdens of telecommunications licensees. Regulating access to MNO networks would place even greater pressure on MNOs and is likely to lead to less investment in networks and platforms than would be the case if the regulatory intervention had not occurred and the market left to determine the appropriate outcome.

3.109 SingTel Mobile also continues to invest in market-leading network enhancements. As noted above, we have just introduced LTE-Advanced, bringing theoretical peak download speeds to consumers of up to 300 Mbps. We have also launched the world's first fully-featured commercial Voice over LTE to Singapore, collaborating not only with network equipment vendors, but also with handset manufacturers, to ensure that Singapore stays at the cutting edge of mobile technologies and making the most efficient use possible of the spectrum that we have purchased. [36]

3.110 In the absence of market failure there is no justification at all for imposing regulatory costs. Furthermore, regulatory intervention would reduce SingTel Mobile's incentive to invest in such future-looking developments.

Entry by new MVNOs or MNOs

3.111 The IDA should continue its current regulatory practice, in line with the requirements of the Telecom Code, and allow the market to decide whether new MNOs or MVNOs are ready to enter the market. The IDA can best support this outcome by:

(a) continuing to license MVNOs which wish to enter the market based on private commercial negotiations with MNOs; and
(b) allocating all available spectrum to any MNO willing to pay for it, without reserving spectrum for commercially uncompetitive uses.

[36] See sources at note 25, above.

3.112 To intervene in a market to specifically support an MVNO business model or additional MNO entry, the IDA needs to conduct rigorous market analysis and determine that there is market failure which requires the IDA to intervene in order to protect consumers or prevent anti-competitive conduct. Further, the IDA must also determine that regulation intended to artificially support the particular MVNO business model or MNO entry addresses a real, and not illusory, consumer protection or competition concern and is no broader than necessary to achieve IDA's stated goals.[37]

Broad regulatory intervention questions

3.113 SingTel Mobile considers that the IDA should continue to license MVNOs to provide services in Singapore, but should not create new regulations to artificially support MVNO entry or expansion which is not warranted by market conditions.

3.114 The licensing regime should ensure that MVNOs which own or operate their own telecommunications systems, facilities or network elements are subject to appropriate regulations commensurate regulations which apply to MNOs as Facilities Based Operators. This is an important consideration for ensuring a level playing field necessary to foster competition, as recognised in the Telecom Code, which provides that IDA will treat similarly situated Licensees on an equivalent basis and, to the extent feasible, make regulatory requirements technologically-neutral.[38]

3.115 Similarly, it would be a grave mistake for the IDA to go as far as tying MVNO access to particular spectrum bands. In jurisdictions where such approaches have been taken, it is due to the access regulation being tied to spectrum auctions. SingTel Mobile is not aware of any instance where a regulator has justified regulated access to particular spectrum on the basis that MVNOs should have access to the inherent properties of a particular spectrum band. Such an approach

[37] See sections 1.5.1 and 1.5.4 of the Telecom Code
[38] Sections 1.5.8 and 1.5.5 of the Telecom Code respectively

to access regulation would be a dangerous unprecedented intervention into the operation of a competitive market.

3.116 Tying spectrum allocation to additional, non-related conditions would impact the license valuation and the underlying business case of the participating operators in the multiband auction. It may cause suboptimal spectrum license allocations impacting future customer experience and investment in infrastructure, which in turn affects Singapore's reputation as the leading infocommunication nation.

3.117 SingTel Mobile does not believe that the IDA should seek to encourage increased MVNO participation in the mobile services market in Singapore as an end in itself. Any increase in MVNO participation must occur in response to market forces which demonstrate that MVNOs can add value sought by end users which are not currently available or potentially available from MNOs.

3.118 There is no evidence whatsoever of market failure which might justify regulatory intervention. To the contrary, there is ample evidence that Singapore's mobile market is a vibrant and competitive one, and the level of MVNO participation in the market – which may vary over time – is a response to well-functioning market forces which are safeguarding consumer welfare better than any regulatory alternative could be guaranteed to do.

Annex A

List of recent 4G auctions

Country	Year	Spectrum Band	Spectrum Duplexing	Amount of Spectrum
Australia	2012	700 MHz	FDD	2 x 45 MHz
		2500 MHz	FDD	2 x 70 MHz
Austria	2013	800 MHz	FDD	2 x 30 MHz
		900 MHz	FDD	2 x 35 MHz
		1800 MHz	FDD	2 x 75 MHz
Czech Republic	2013	800 MHz	FDD	2 x 30 MHz
		1800 MHz	FDD	2 x 24.8 MHz
		2600 MHz	FDD	2 x 70 MHz
		2600 MHz	TDD	1 x 50 MHz
France	2011	800 MHz	FDD	2 x 30 MHz
		2600 MHz	FDD	2 x 50 MHz
Germany	2010	800 MHz	FDD	2 x 30 MHz
		1800 MHz	FDD	2 x 25 MHz
		2000 MHz	FDD	2 x 19.8 MHz
		2000 MHz	TDD	1 x 19.2 MHz
		2600 MHz	FDD	2 x 70 MHz
		2600 MHz	TDD	1 x 50 MHz
Greece	2011	900 MHz	FDD	2 x 35 MHz
		1800 MHz	FDD	2 x 20 MHz

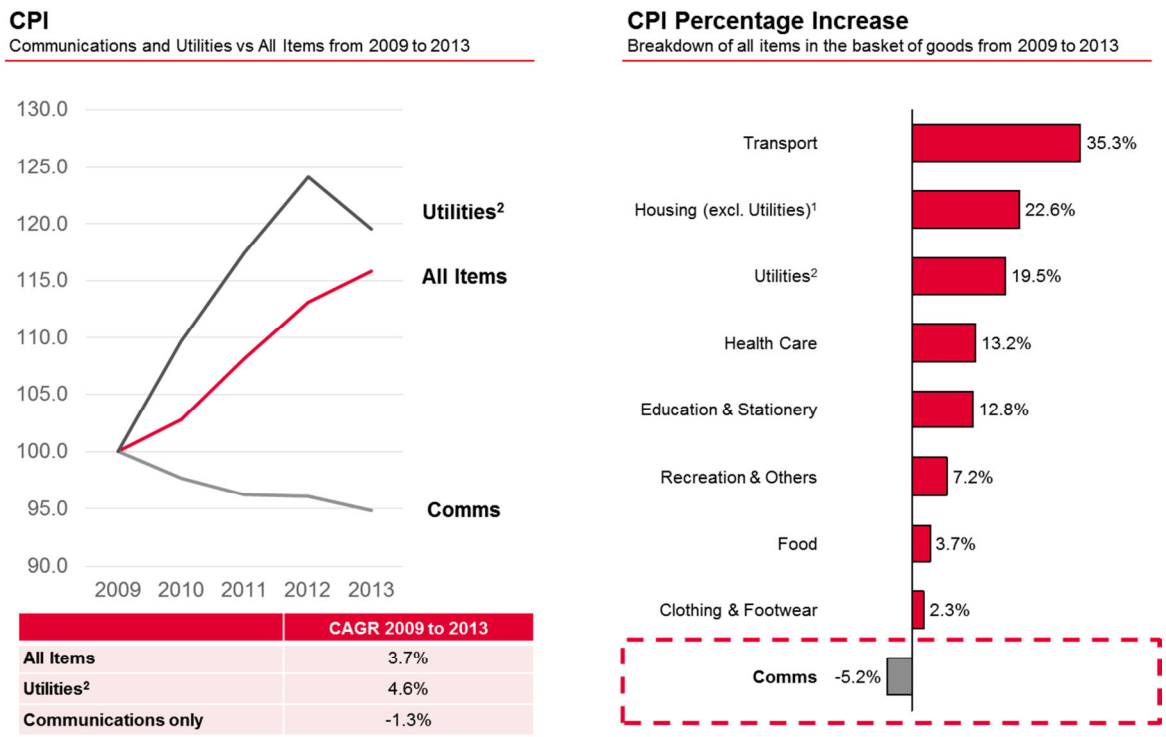
Country	Year	Spectrum Band	Spectrum Duplexing	Amount of Spectrum
Hong Kong	2009	800 MHz	FDD	2 x 5 MHz
		900 MHz	FDD	2 x 5 MHz
		2000 MHz	TDD	1 x 9.7 MHz
India	2014	800 MHz	FDD	2 x 3.75 MHz (per Service Area)
		1800 MHz	FDD	2 x 10 MHz (per Service Area)
Ireland	2012	800 MHz	FDD	2 x 30 MHz
		900 MHz	FDD	2 x 35 MHz
		1800 MHz	FDD	2 x 75 MHz
Italy	2011	800 MHz	FDD	2 x 30 MHz
		1800 MHz	FDD	2 x 15 MHz
		2600 MHz	FDD	2 x 60 MHz
		2600 MHz	TDD	1 x 30 MHz
Netherlands	2012	800 MHz	FDD	2 x 30 MHz
		900 MHz	FDD	2 x 35 MHz
		1800 MHz	FDD	2 x 70 MHz
		1900 MHz	TDD	1 x 14.6 MHz
		2100 MHz	FDD	2 x 10 MHz
		2600 MHz	TDD	1 x 55 MHz
Norway	2013	800 MHz	FDD	2 x 30 MHz
		900 MHz	FDD	2 x 15 MHz
		1800 MHz	FDD	2 x 55 MHz

Country	Year	Spectrum Band	Spectrum Duplexing	Amount of Spectrum
Pakistan	2013	1800 MHz	FDD	2 x 20 MHz
		2100 MHz	FDD	2 x 30 MHz
Portugal	2011	450 MHz	FDD	1 x 1.25 MHz
		800 MHz	FDD	2 x 30 MHz
		900 MHz	FDD	2 x 10 MHz
		1800 MHz	FDD	2 x 57 MHz
		1900 MHz	TDD	1 x 10 MHz
		2600 MHz	FDD	2 x 70 MHz
		2600 MHz	TDD	1 x 50 MHz
Singapore	2013	1800 MHz	FDD	2 x 75 MHz
		2500 MHz	FDD	2 x 60 MHz
South Korea	2013	800 MHz	FDD	2 x 5 MHz
		1800 MHz	FDD	2 x 10 MHz
		2100 MHz	FDD	2 x 10 MHz
Switzerland	2012	800 MHz	FDD	2 x 30 MHz
		900 MHz	FDD	2 x 35 MHz
		1800 MHz	FDD	2 x 75 MHz
		2100 MHz	FDD	2 x 60 MHz
		2100 MHz	TDD	1 x 35 MHz
		2600 MHz	FDD	2 x 70 MHz
		2600 MHz	TDD	1 x 50 MHz
Taiwan	2013	700 MHz	FDD	2 x 45 MHz

Country	Year	Spectrum Band	Spectrum Duplexing	Amount of Spectrum
		900 MHz	FDD	2 x 30 MHz
		1800 MHz	FDD	2 x 60 MHz
United Kingdom	2013	800 MHz	FDD	2 x 30 MHz
		2600 MHz	FDD	2 x 70 MHz
		2600 MHz	TDD	1 x 45 MHz

Annex B

Communications price index has consistently declined, dropping a total of 5.2% between 2009-13



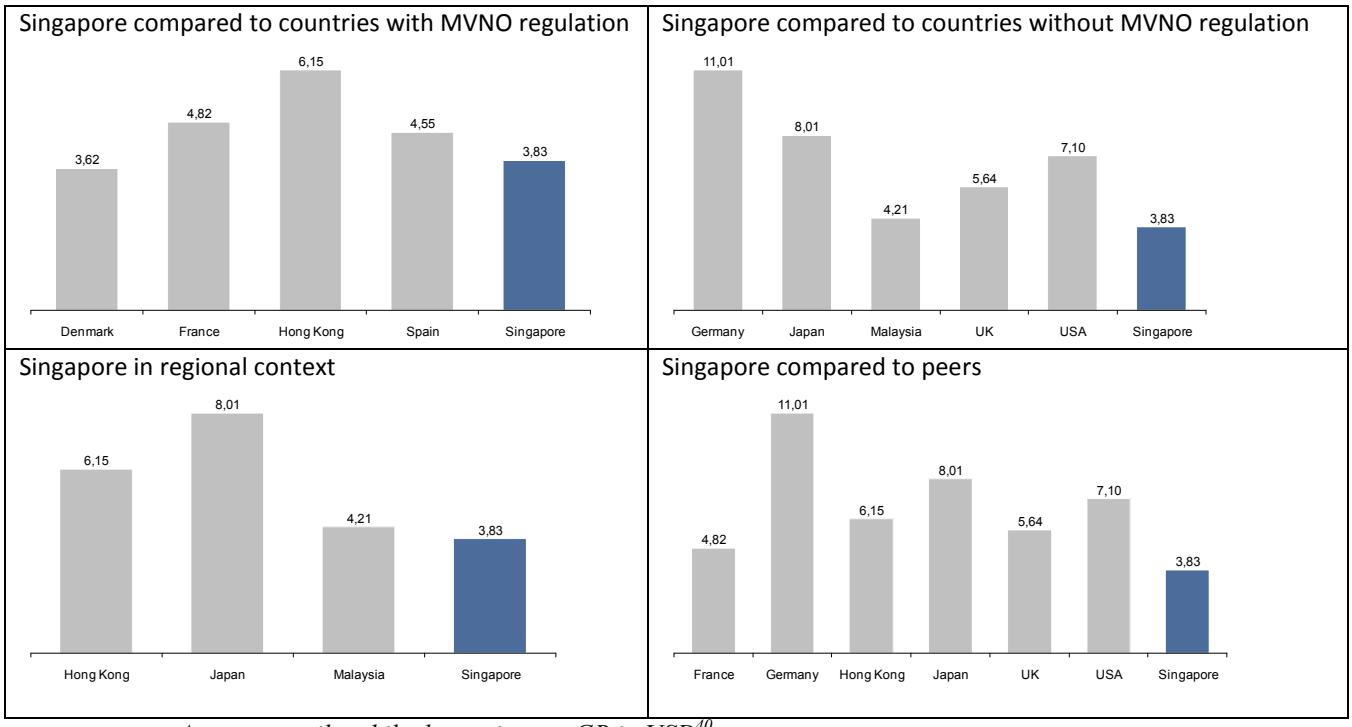
	CAGR 2009 to 2013
All Items	3.7%
Utilities²	4.6%
Communications only	-1.3%

Development of communications prices in comparison to consumer price index[39]

[39] Department of Statistics, Singapore

Annex C

Mobile Data Retail Prices per GB (in USD)



Average retail mobile data price per GB in USD[40]

[40] Detecon retail price benchmark as of 30.05.2014. Benchmark basis are retail prices of mobile data package with highest amount of GB data included of two leading MNO in respective country normalised per GB and converted to USD.