Arrangements for the Frequency Spectrum in

the 900 MHz and 1800 MHz Bands upon

Expiry of the Existing Assignments for

Public Mobile Telecommunications Services and

the Spectrum Utilisation Fee

Second Consultation Paper

SmarTone Mobile Communications Limited ("SmarTone") is pleased to provide its comments on the second consultation paper regarding the "Arrangements for the frequency spectrum in the 900 MHz and 1800 MHz bands upon expiry of the existing assignments for public mobile telecommunications services and the spectrum utilisation fee" (the "2nd Consultation Paper") issued by the Communications Authority ('CA") on 14 February 2017.

Spectrum, a valuable public asset owned, managed and allocated by the Government, is the backbone infrastructure of mobile telecommunications services and a driver of our economy. SmarTone's major considerations are based on the maximisation of public interest and consumer's utility for the healthy development of the market and industry, also Hong Kong.

With this in mind, SmarTone would like to provide its comments as follows.

Question 1:	*What are your views on the proposals of the CA to adopt the hybrid administratively-assigned cum market-based approach for the Re-assignment of the 900/1800 MHz Spectrum, by re-assigning 2 x 10 MHz of spectrum in the 1800 MHz band to each of the incumbent spectrum assignees through the offer of a right of first refusal, based on the overriding public policy reasons of safeguarding the provision of 4G services in the Remaining MTR Stations, and ensuring territory-wide continuity of 2G services if demands exist post 2020/21, and re-assigning the rest of the 900/1800 MHz Spectrum by way of auction?*

Option for re-assignment of the 900/1800 MHz spectrum

1. SmarTone agrees with the CA's considered view that the hybrid administratively-assigned cum market-based approach under Option 3 is the

option that best meets the multiple objectives for the spectrum re-assignment.

2. The four identified objectives in spectrum management are "Ensuring Customer Service Continuity", "Efficient Spectrum Utilisation", "Promotion of Effective Competition" and "Encouragement of Investment and Promotion of Innovative Services".

3. SmarTone agrees with the CA's view that Option 1 will preserve the status quo of the present spectrum assignments and amounts to a de facto perpetuation of the existing assignments and distribution of the 900/1800 MHz spectrum for another 15-year term. Option 1 is thus the least effective among the three options in meeting the objectives of efficient spectrum utilisation and promotion of effective competition.

4. As pointed out in SmarTone's submission to the first consultation paper issued by the CA on 3 February 2016 ("1st Consultation Paper"), the merger of two mobile network operators ("MNOs") in 2014 has resulted in spectrum over-concentration as the merged entity holds almost half of the spectrum in the 1800 MHz band. Rationalisation of spectrum distribution in the 1800MHz band is long-needed and thus Option 1, which perpetuates the current asymmetry in spectrum holdings in the 1800 MHz band, is not supported by SmarTone.

5. Also, optimisation of spectrum holdings of existing MNOs by adding or reducing their holdings in the 900/1800 MHz spectrum is not possible under Option 1. On the other hand, Option 3 offers the opportunity for the MNOs to adjust their respective spectrum holdings in the 900/1800 MHz band through auction. Existing MNOs or new entrant may bid for spectrum to achieve a larger frequency slot of, for instance, 2 x 20 MHz (which is currently the maximum carrier bandwidth supported by the 4G LTE technology) so as to attain higher spectral efficiency.

6. SmarTone agrees with the CA's view that, with the adjustment of the amount of the Right of First Refusal ("RFR") spectrum (i.e., 2 x 10 MHz of spectrum in the 1800 MHz band) under Option 3, the issue of 4G service continuity, especially in the MTR stations, can be effectively addressed. Hence the objective of ensuring customer service continuity can also be met under Option 3.

7. For the last objective regarding encouragement of investment and promotion of innovative services, SmarTone agrees with the CA's view that Option 3

would strike a balance between the need for certainty for investment while meeting the other objectives in spectrum re-assignment. The MNOs with the RFR spectrum would achieve a level of certainty about their spectrum holdings and hence they can continue to make long-term investment. Also, with the opportunity to adjust their spectrum holdings through auction so as to attain higher spectral efficiency, the existing MNOs would be encouraged to invest and promote innovative services under Option 3.

RFR Spectrum

8. In its response to the 1st Consultation Paper, the amount of RFR spectrum proposed by SmarTone was 15 MHz x 2 (i.e., 10 MHz x 2 in the 1800 MHz band and 5 MHz x 2 in the 900 MHz band for each MNO currently holding the respective spectrum). SmarTone believes that its proposal would result in the least disruption cost in both spectrum bands and hence RFR spectrum in the amount of 15 MHz x 2 is the preferred option. Nevertheless, SmarTone considers that the suggestion made by OFCA's consultant that each of the incumbent MNOs be offered 2 x 10 MHz of the RFR spectrum in the 1800 MHz band is acceptable in order to address the issue of 4G service continuity at MTR premises. As mentioned in our submission to the 1st Consultation Paper, the 900/1800 MHz bands are the core bands for the provision of 4G services at MTR premises. The deployment of other spectrum (e.g., 2.5/2.6 GHz band) in MTR premises will take time and unlikely to be completed by 2020. Also, the offer of 2 x 10 MHz of the RFR spectrum in the 1800 MHz band will minimise reconfiguration of the existing IRS (Integrated Radio System) and thereby lower the risk to 4G service continuity at MTR premises.

9. SmarTone agrees with the CA's considered view that the existing spectrum holdings or subscriber numbers of MNOs should not have any relevance in determining the size of the RFR spectrum. Since the primary purpose of the RFR spectrum is to ensure 4G service continuity, but not to ensure general service quality of individual MNOs, the size of RFR spectrum should be the same absolute amount for each of the existing MNOs regardless of their existing spectrum holdings or subscriber numbers. If MNOs wish to obtain more spectrum according to their business needs, such demand can be satisfied through bidding for the necessary spectrum in the auction under Option 3.

10. It is noted that in the recent auction of the 900 MHz spectrum in Singapore, similar practice as the RFR proposal in the 2nd Consultation Paper was adopted by the Singapore's regulator, IMDA. IMDA has assigned a uniform

amount of RFR spectrum (i.e., 10 MHz) in the 900 MHz band to each of the 3 incumbent MNOs. One of the incumbent MNOs has obtained an extra 10 MHz block in the 900 MHz band through bidding in the auction.

Question 2:	*What are your views and comments on the methods of setting the SUF as proposed in paragraphs 92 – 100 above?*

11. The auction reserve price for the 900/1800 MHz spectrum is now proposed to be set accordingly to the previous auction reserve prices in the auction of spectrum in the 2.5/2.6 GHz and 2.1 GHz bands conducted in March 2013 and December 2014 (i.e., $15 million per MHz and $48 million per MHz respectively), which are equivalent to $19 million and $54 million per MHz in 2021price level. The CA's present inclination is that the final value would be closer to the higher end.

12. The minimum price for the RFR spectrum is now proposed to set also according to the values of spectrum in the 2.5/2.6 GHz and 2.1 GHz bands, which were $30.8 million and $59 million per MHz, which are equivalent to $38 million and $67 million per MHz in 2021 price level. The CA's present inclination is that the final value would be closer to the higher end.

13. SmarTone's views on the abovementioned level of auction reserve price and minimum price for the RFR spectrum are as follows.

14. As stated in its submission on the 1st consultation paper, SmarTone considers that it is not desirable to set a high reserve price for a competitive bidding, or it will run the risk of intervening market forces in determining an economically efficient price for the spectrum. The auction of 850/900 MHz band in 2011 was quoted in our last submission to show that reserve price is not a determining factor to the auction result. In that spectrum auction, the reserve price was set at HK$30 million for 2 x 5 MHz, while the final auction prices for the spectrum were $875 million and $1,077 million for the two 5 MHz paired spectrum blocks.

15. The risk of setting a high reserve price is examined in a recent report released by the GSMA in February 2017 entitled "*Effective Spectrum Pricing: Supporting better quality and more affordable mobile services*" (the "GSMA Report"). The following paragraphs are extracted from the GSMA Report.

> *"The primary objectives for any regulator when setting reserve prices should be to promote an efficient allocation of spectrum one that will*

maximize long-term benefits for society. This is best achieved by allowing the market to identify the price. Such an outcome is only possible if reserve prices are set conservatively, below the expected market value. Otherwise, there is a risk that genuine demand is choked off."

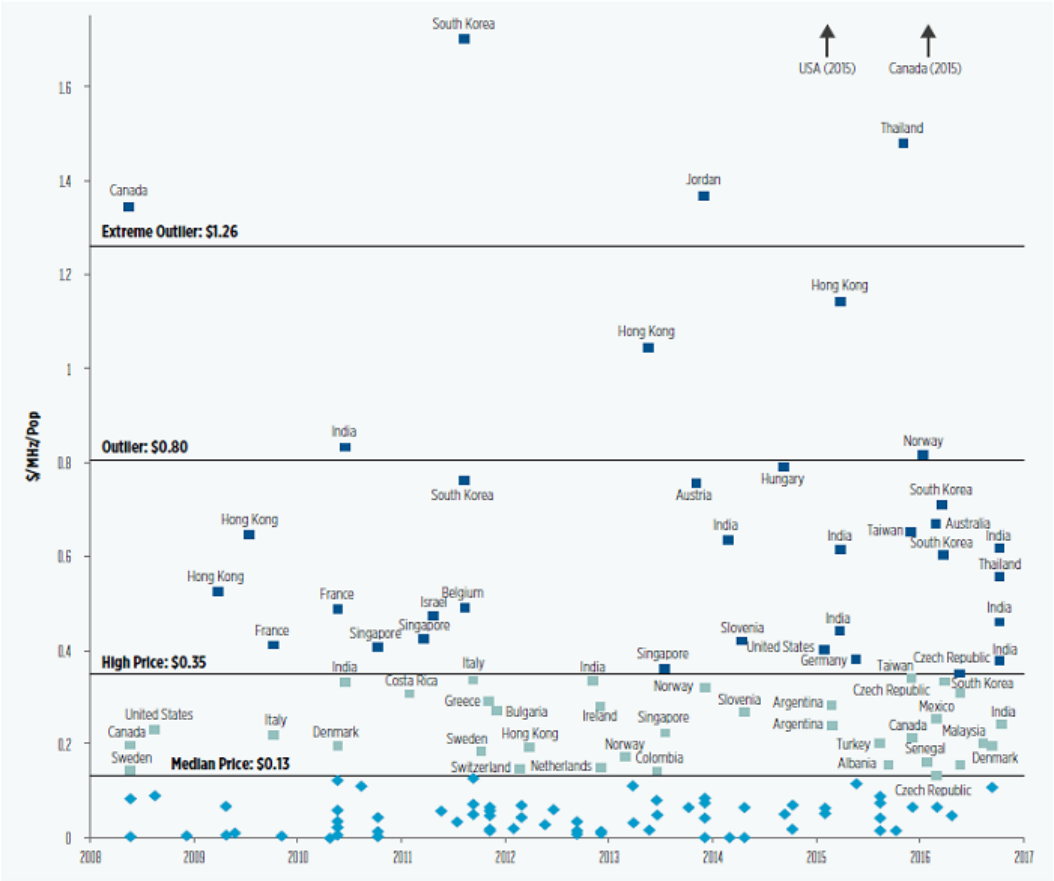
"In this report, we have identified compelling empirical evidence, backed by economic theory, that high prices for spectrum depress operator incentives to invest and compete, resulting in lower quality and higher prices for consumers. This provides a further rationale for conservative reserve pricing."

16. As mentioned in paragraph 11 above, the current inclination of the CA is to set the auction reserve price for the 900/1800 MHz band according to the reserve price of the 2.1 GHz spectrum auction conducted in December 2014 (i.e., $48 million per MHz). However, it is noted that the average final price of that spectrum auction (i.e., $49.2 million per MHz) was only 2.5% higher than the reserve price. This may well be an alerting indicator that the reserve price for the 2.1 GHz auction in 2014 was already on the high side. Given that the final Spectrum Utilization Fee ("SUF") will be determined by auction, it is suggested that the reserve price for the 900/1800 MHz spectrum could be set at a more conservative level than it is currently proposed.

17. It is noted that the SUF/MHz/Population of the last 2.1 GHz bidding's reserve price in HK in 2014 (i.e., HK$6.65) was also much higher than that of the 1.8 GHz band auction in Singapore in 2013 (i.e., HK$1.53).

18. The GSMA Report has provided a very comprehensive study of the spectrum price and spectrum reserve price covering spectrum auctions worldwide from 2000 to 2016. It is noted that both the reserve price and the auction price ($/MHz/Pop) of the 2.1 GHz spectrum auction in HK in 2014 are significantly higher than most of the compared auctions worldwide and are classified as "Outlier" and "Extreme Outlier" (see Figures 7 and 9 of the GSMA Report extracted below).

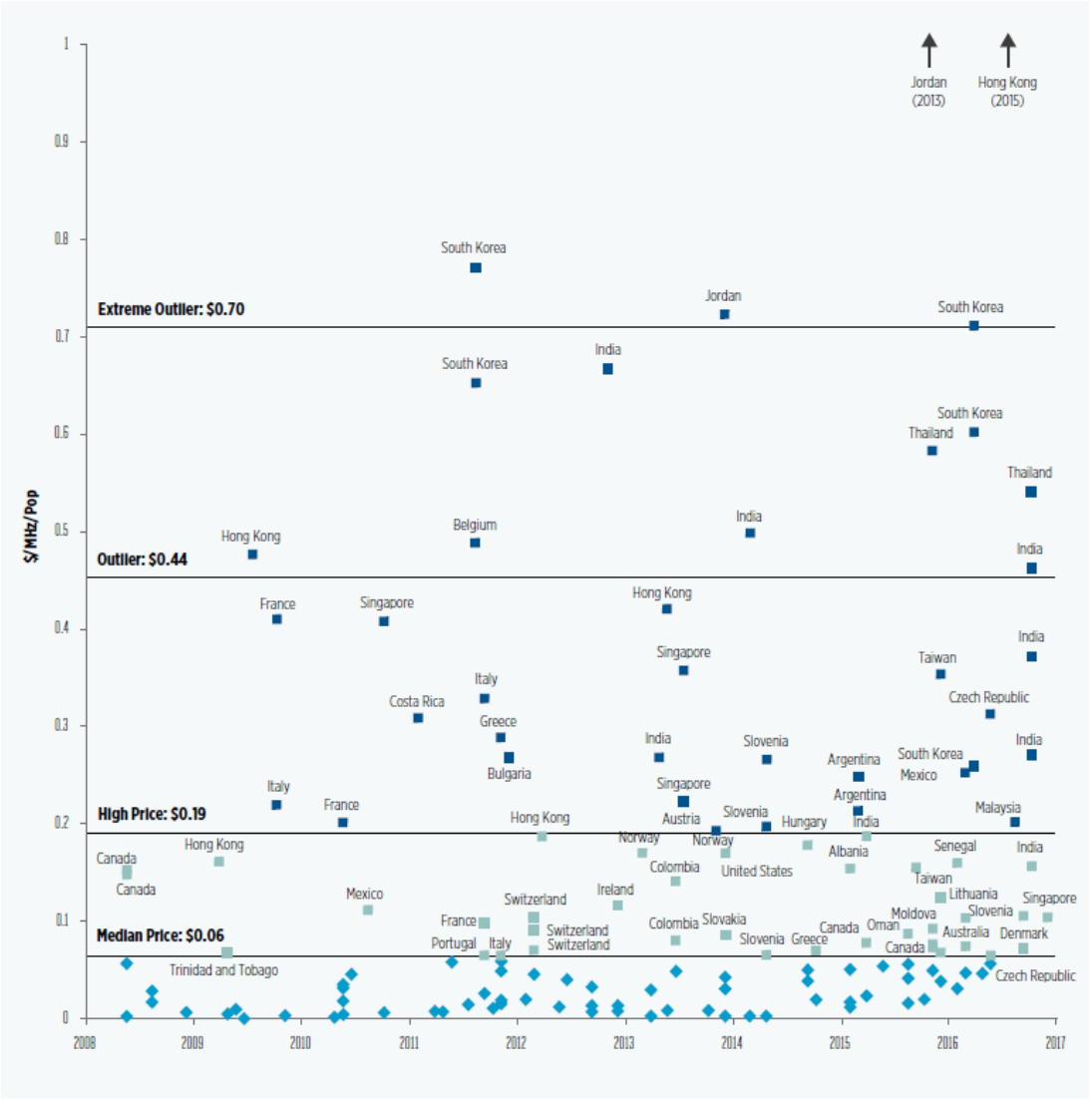
FIGURE 7: CAPACITY SPECTRUM PRICES BY CATEGORY (2008-2016)



Notes: Capacity bands include AWS, PCS, 1800 MHz, 2100 MHz and 2600 MHz; prices are adjusted for PPP exchange rates, inflation and licence duration, and include annual fees. Colour key same as Figure 6.

Source: NERA Economic Consulting Global Spectrum Auction Database.

FIGURE 9: CAPACITY SPECTRUM RESERVE PRICES BY CATEGORY (2008-2016)



Notes: Capacity bands include AWS, PCS, 1800 MHz, 2100 MHz and 2600 MHz; prices are adjusted for PPP exchange rates, inflation and licence duration, and include annual fees. Colour key same as Figure 6.

19. In view of the above, the current proposal to set the reserve price for the auction spectrum as well as the minimum fee for the RFR spectrum close to the 2.1 GHz bidding would likely run the risk of the prices being set at a level that is already very high as compared to international practice. SmarTone is concerned that a high reserve price for the auction spectrum and the minimum fee for the RFR spectrum for the 900/1800 MHz band would result in uneconomic and inefficient pricing of the valuable spectrum resources, which would eventually undermine consumer interest in Hong Kong.

20. In this regard, SmarTone would like to suggest the following alternative mechanisms to set the reserve price and the minimum fee for the RFR spectrum.

21. An alternative to set the reserve price is by making reference to the average of the reserve prices of the two latest auctions (i.e., 2.5/2.6 GHz and 2.1 GHz), that is $19 million and $54 million per MHz at 2021 price levels, which equals to $36.5 million per MHz.

22. Similarly, the minimum price for the RFR spectrum could be set at the average of the past two auctions (i.e., 2.5/2.6 GHz and 2.1 GHz), that is $38 million and $67 million per MHz at 2021 price levels, which equals to $52.5 million per MHz.

23. As both the 2.5/2.6 GHz and 2.1 GHz spectrum auctions are regarded by the CA as a "reasonable starting point for reference" (paragraph 94 of the 2nd Consultation Paper), using the average prices of these two auctions will ensure a better balance and avoid the risks of setting the reserve prices and the minimum price for the RFR spectrum too high or too low.

24. The other alternative is to set the reserve price by making reference to international benchmark, such as the median reserve price in overseas auctions. As shown in the GSMA Report (Figures 8 & 9), the median reserve prices for similar spectrum auctions is about US$0.31 and US$0.06 per MHz per population (equivalent to HK$2.4 and HK$0.47). For comparison, the current proposed auction reserve price in the 2nd Consultation Paper is at HK$54 million per MHz, which equals to HK$7.3 per MHz per population.[1] It is also worth noting that the average prices of the last two auctions (i.e., 2.5/2.6 GHz and 2.1 GHz spectrum auction) is HK$4.9 per MHz per population[2], which is still higher than the international median prices as quoted in the GSMA Report.

[1] HK$54,000,000 divided by 7,400,000 population

[2] HK$36,500,000 divided by 7,400,000 population

Question 3: What are your views and comments on the method of payment of SUF?

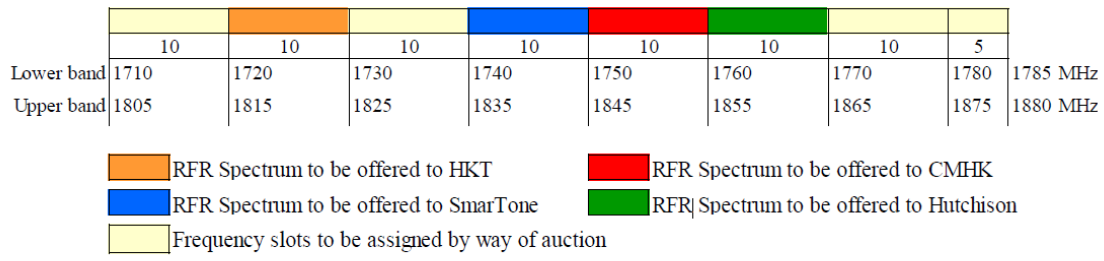
25. SmarTone welcomes the proposal that the spectrum assignees of the 900/1800 MHz spectrum will be given a choice to pay the SUF either by lump sum payment upfront or by annual installments. This would allow mobile operators to have the flexibility to make financial arrangement for the payment of SUF according to their own business needs.

26. It is noted that for the annual installments, the current proposal is to increase the subsequent installments (other than the first installment) by a pre-set fixed percentage annually which aims to reflect the time value of money to the Government. SmarTone submits that during the process of determining the fixed percentage, considerations should also be given to the prevailing interest rates in the market (e.g. the best lending rates of banks) so as to determine the interest rate on the SUF annual installments that strike a balance between Government and business financing.

27. On the issue of tax deductibility of SUF, SmarTone notes the CA's view that it is fundamentally a matter of tax policy independent of the SCED's determination of the levels of SUF. However, SmarTone would like to reiterate its view that SUF should be tax deductible, because the nature of SUF is unchanged regardless of the payment method.

Question 4: What are your views on the band plan proposed above for the re-assignment of the 2 x 75 MHz of spectrum in the 1800 MHz band? Would you consider the proposed frequency slots to be re-assigned to individual incumbent spectrum assignees as the RFR Spectrum an optimal arrangement from the industry's point of view?

Figure 1: Proposed Band Plan for the 1800 MHz Frequency Band



28. SmarTone considers that the above proposed band plan for 1800 MHz is an optimal arrangement from the industry's point of view for the following reasons:

- The proposed band plan is compatible with 2G, 3G / UMTS and 4G / LTE carrier bandwidth. It allows operators to deploy the technology that is suitable for their immediate need, and allows them to re-farm it to other technology in future.

- The RFR spectrum is the same slot of spectrum each MNO currently occupies in the 1800 MHz band, thus it is supported by the points of interconnection ("POI") of common antenna system ("CAS") in indoor sites and MTR and thereby reduces system reconfiguration works for the POI.

- The proposed band plan allows most of the existing MNOs (except one) the opportunity to acquire 20 MHz contiguous spectrum in the 1800 MHz band (which is currently the maximum carrier bandwidth supported by 4G LTE technology), thus improving the spectral efficiency and avoiding spectrum fragmentation at the largest extent possible.

Question 5: What are your views on the band plan proposed above for the re-assignment of the 2 x 25 MHz of spectrum in the 900 MHz band?

Figure 2: Proposed Band Plan for the 900 MHz Frequency Band

	5	5	5	5	5	
Lower band	890	895	900	905	910	915 MHz
Upper band	935	940	945	950	955	960 MHz

Frequency slots to be assigned by way of auction

29. SmarTone has no objection to the proposed band plan in 900 MHz as it is compatible with 2G, 3G / UMTS and 4G / LTE carrier bandwidth. It allows MNOs to deploy the technology that is suitable for their immediate need, and allows them to re-farm it to other technology in future, as shared in para 26 above.

Question 6:	*What are your views on the use of the SMRA format that has been adopted in the spectrum auctions held by the CA in recent years to auction off the Auctioned Spectrum in the 900 MHz and 1800 MHz bands?*

30. Since the SMRA format has been adopted in previous spectrum auctions, SmarTone has no objection to the proposal.

Question 7:	*What are your views on the proposed SC requiring all licensees to seek the prior consent of the CA and to make proper arrangements for the affected customers before phasing out their provision of 2G services and other generations of mobile services in the future?*

31. In its submission to the 1st Consultation Paper, SmarTone submits that it is against the principle of technology neutrality and efficient use of spectrum if MNOs are mandated to provide 2G services for 3 years after 2020. Whether to continue to provide 2G services beyond 2020 should be a commercial decision for the MNOs.

32. SmarTone therefore welcomes the move from the previously proposed three-year transitional period for 2G services to the current proposal of requiring operators to seek the prior consent of the CA before phasing out 2G services. It will provide flexibility to MNOs to phase out 2G services based on their own commercial considerations and optimising on the bandwidth thus released to enhance customer service.

33. It should be noted that phasing out 2G services is an international trend. For example, Singapore has completed the 2G switch-off in April 2017 and Australia is also implementing 2G switch-off in stages.

34. In this regard, SmarTone would urge that no unnecessary burden would be placed on MNOs when they seek CA's prior consent to phase out 2G services. The proposed special condition should not prevent operators from using the spectrum for more advanced mobile technologies, which would benefit more mobile services customers.

35. SmarTone would also encourage OFCA to take a more proactive role in the 2G phase-out exercise, such as by conducting public education or publicity

programmes to facilitate the migration of 2G services to more advanced services.

Question 8:	*Do you have any views on other aspects of the proposed framework for the Re-assignment of the 900/1800 MHz Spectrum not explicitly asked in the questions set out in the paragraphs above?*

36. SmarTone would like to provide its views on the following three issues, though they were not explicitly asked in the questions of the 2nd Consultation Paper.

Spectrum Cap at 40%

37. SmarTone supports the imposition of spectrum cap (as mentioned in paragraphs 110 to 112 of the 2nd Consultation Paper) to prevent over-concentration of spectrum hold by a particular bidder, which will affect competition in the downstream market. Spectrum cap is commonly found in many overseas spectrum auctions, e.g., Singapore, UK, Germany, and many EU countries.

38. A summary of international practices on spectrum cap is provided in Annex A for the CA's reference. It is a common practice of overseas regulators to impose spectrum cap during major spectrum auctions with a view to balancing spectrum holdings among MNOs (e.g., UK, Singapore, EU countries, Canada, Australia, New Zealand). Spectrum cap is an important regulatory measure to prevent spectrum hoarding or spectrum concentration in the hands of a few financially-strong entities which would be harmful to market competition and consumer interests.

39. In regard to the level of spectrum cap, however, it is SmarTone's view that it should be set at 80 MHz instead of 90 MHz. As mentioned earlier, the present holdings by the merged entity in 2014 (which is about 90 MHz or 45% of the 900/1800 MHz spectrum) in the band is already above the market concentration threshold as defined in the "Guideline on the Merger Rule" (further explained in para 38 below) and hence the spectrum cap should be set at a level that prevents the re-occurrence of spectrum over-concentration in the band.

40. It is worth noting that in the bidding of 2.3 GHz in the UK in 2016, BT/EE was not allowed to bid for the 2.3 GHz spectrum because it had already held 45% of "immediately useable" spectrum in the UK at that time. Ofcom's concern

was that if BT/EE can acquire more "immediately useable" spectrum, this could harm competition. After the bidding, BT/EE's share of "immediately useable" spectrum would fall to 42%.

41. Our proposed spectrum cap of 80 MHz already represents 40% of the total amount of 900/1800 MHz spectrum. It is worth noting that in the "Guideline on the Merger Rule" jointly issued by the Competition Commission and the CA (the "Merger Guidelines"), it is stated in paragraph 3.13 that "*for a horizontal merger where the post-merger combined market share of the parties to the transaction is 40% or more, it is likely that the merger will raise competition concerns and the Commission is likely to make a detailed investigation of the transaction*". Hence, based on the Merger Guidelines, a market share of 40% or more would give rise to competition concerns. As market share can be measured by transmission capacity or bandwidth (paragraph 3.38 of the Merger Guidelines), our proposed threshold of 40% of the 900/1800 MHz spectrum is in line with the principles as set out in the Merger Guidelines.

42. It is noted that the spectrum cap in the last 2.1 GHz spectrum reassignment exercise was set at 40 MHz or 34% of the total amount of 2.1 GHz spectrum available for reassignment (i.e., 118.4 MHz), which is lower than our proposed spectrum cap of 40%.

43. SmarTone wishes to emphasise the importance of setting the right level of spectrum cap at the outset because it is difficult to reverse the problem of spectrum over-concentration after assignment of the spectrum. Any adverse impacts caused by spectrum over-concentration in the relevant markets and consumers would be long-lasting.

44. SmarTone notes and agrees with the CA's clarification that a joint venture of MNOs is subject to the same spectrum cap (i.e., 90 MHz instead of 180 MHz). SmarTone would also wish the CA to clarify that, in the case that two or more MNOs with RFR spectrum form a joint venture to bid for the spectrum, the full amount of the RFR spectrum that has been exercised should be counted for the purpose of spectrum cap calculation. For example, if two MNOs have each exercised 20 MHz of RFR spectrum, the joint venture of the two MNOs will be eligible to acquire a maximum of 50 MHz (under the CA's current proposal) or 40 MHz (under SmarTone's proposal) of the 900/1800 MHz spectrum from auction.

45. SmarTone would also wish the CA to clarify that connected bidders should be disallowed to participate in the auction, following the same treatment as in previous auctions such as the 2.1 GHz auction.

Accelerate Spectrum Supply to Drive Economic and Societal Development

46. SmarTone welcomes the CA's workplan announced in March 2017 to release more spectrum for mobile use and look forward to having a more detailed roadmap regarding the release of the spectrum as mentioned in the workplan (i.e., 700 MHz, 3.5 GHz and 26/28 GHz).

47. Timely release of spectrum and a clear roadmap of spectrum release plan are essential for MNOs to plan ahead, including their decisions related to the re-assignment of the 900/1800 MHz spectrum.

48. In this regard, SmarTone has commissioned a consultant (Contactica Asia Limited) to conduct a study on overseas spectrum requirements for mobile networks (the "Consultant Report") and is pleased to enclose the Consultant Report in Annex B for the CA's reference.

49. Key findings of the Consultant Report point to the urgent need for Hong Kong to accelerate the supply of spectrum which could, in turn, drive economic development and enhance liveability for all. The Consultant Report also shows that Hong Kong would have a significant spectrum deficit of between 788 MHz and 1248 MHz by 2020. Many countries, which are expected to have spectrum deficit, are finding ways to fill the gap so as to support the exponential growth of mobile data usage.

50. The Consultant Report has identified spectrum in the 700 MHz and 3.5 GHz bands that are already being used or planned to be used in many countries worldwide for mobile services.

51. Overseas studies (i.e., UK, US and Brazil) have shown that substantial economic benefits can be derived from the early release of spectrum. Such economic gains cannot be realised if governments do not ensure sufficient spectrum is made available in a timely manner to the market. For instance, UK Ofcom estimated that bringing forward the release of 700MHz spectrum by one year would create additional net economic gains of up to £45M. In Brazil, the use of 700MHz for mobile broadband will contribute an additional US$1.4 billion to the Brazilian GDP.

52. Regarding the interference issue with the fixed satellite services in the 3.5 GHz band, it has either been resolved or under trial in the following countries:

- China – Compatibility trials will be completed in the first half of 2017
- Singapore – IDA will conduct further technical assessments on the co-existence between mobile and satellite services
- UK – Ofcom has conducted a study about the possible interference of 3.4 GHz LTE services to satellite services operating above 3.6 GHz. It concluded that there is a very low likelihood of interference
- Japan – Technical study about the coexistence of incumbent systems (satellite and microwave links) with mobile were concluded in 2013 and the 3.5 GHz band was subsequently allocated to three mobile operators (each with 40 MHz)
- South Korea - Although some of the spectrum in the 3.5 GHz band is used for satellite services, the South Korea Government plans to release at least 160 MHz of spectrum to mobile by 2018

53. The Consultant Report has the following key recommendations for CA's consideration:

- On 700 MHz band
  - Advance the Analogue Switch Off (ASO) plan in HK by helping the public to switch to digital TV services and conduct a cost/benefit analysis on a subsidisation scheme for migration of residual analogue TV;
  - Develop its own ASO plan harmoniously with that of the Guangdong province;
  - Initiate plans and provide a clear timetable for the release of 700 MHz to mobile operators
- On 3.5 GHz band
  - Determine the actual usage of this band by satellite operators and the actual number of SMATV customers in HK
  - Identify the part of spectrum in the band that could be released to mobile operators in a short period and issue a phased spectrum release plan
  - Plan for the migration of satellite services to a higher frequency band, e.g., Ku band which offers better performance and is widely used

throughout the world for Direct-to-home ("DTH") satellite transmissions and where spare spectrum is available for the services

- Specify a target date when the entire band will be made available to mobile.

Deploying Next Generation Mobile Infrastructure for Smart City

54. One of the key initiatives announced in the Policy Address by the Chief Executive in 2015 is to develop HK as a "Smart City". To build a more connected and efficient city, which is one of the widely adopted definitions of "Smart City", a robust mobile network is the natural and crucial backbone in the deployment of secure and reliable smart city solutions for Hong Kong. The next generation of mobile network infrastructure will be built using small cell networks employing 5G wireless technology. It would require multiple times of antenna locations than now. To support the increased density of small cell that will be required to unleash the potential and benefits of smart city enabled by 5G wireless technology, it is important that the Hong Kong Government embrace the role, and develop associated policies, to facilitate the rollout of mobile network so as to meet the emerging wave of smart-city applications such as Internet of Things (IOT). SmarTone would like to take this opportunity to urge the Hong Kong Government to expedite mobile network rollout and support the new small cell deployment model by, inter alia, establishing a single coordinating body for efficient approvals or permit issuance required for the installation of mobile base stations and small cells. Currently, these are handled by various government departments often in a xylo manner and could be long drawn out and inefficient. The administrative complexity of the current approval process involving various government departments has, for instance, significantly increased the time required for obtaining approval for the rollout of new mobile cell sites.

55. Small cells can be installed at various locations including lamp poles, payphone kiosks, bus stops and on building external walls. While such installations are all technically feasible, they are subject to various departments' approvals that will take a very long time to obtain under the current regime. For example, the installation of small cells on external walls of buildings will at least require the approval from both the Buildings Department and Lands Department. Similarly, the progress of installation of small cells on lamp poles, payphone kiosks and bus stops is also slow as various departments' approval and permits are required. There is no coordinated process to facilitate mobile network rollout which consumes

energies and resources which could otherwise be devoted to other gainful use to benefit the community or consumers.

56. The problem of piecemeal approvals for cell site installation was discussed in a recent report entitled "*How 5G can help municipalities become vibrant smart cities*" by Accenture Strategy[3].

> *"Currently, applications for small-cell implementations can take up to 18 to 24 months for approval….such an approval cycle will pose a tremendous challenge to both telecom operators and municipalities."*
>
> *"In many cities, the approval cycle requires several separate tribunals for approval. Committees such as a neighborhood association, a planning commission, a zoning commission, the county council and others may each require a separate decision-making process."*
>
> *"Municipalities should consider ways to ensure departmental coordination on decision-making. Given some of the time-consuming situations that telecom operators have faced as a result of piecemeal approval from the required city departments,* ***it is clear that providing operators with a single point of contact for inter-departmental approvals would save time for both operators and city officials****."*

57. In a recent report entitled "Small Cells Siting: Regulatory and Deployment Considerations, December 2016"[4], issued by the Small Cell Forum and 5G Americas, it is recommended that there should be a single executive to coordinate all approvals (e.g., in a smart city programme) required for small cells installation. It also calls for streamlining of paperwork and filing to minimise the approval processes and reduce the workload of the administration.

58. As a reference case, the US Federal Communications Commissions (FCC) had announced in August 2016 a further plan to facilitate deployment of small cells in the US. It has excluded distributed antennae system (DAS) and small cell deployment from the federal review process so as to enable mobile operators to densify their networks with less restrictions. Tom Wheeler, FCC

[3] https://www.accenture.com/t20170222T202102__w__/us-en/_acnmedia/PDF-43/Accenture-5G-Municipalities-Become-Smart-Cities.pdf

[4] http://www.5gamericas.org/files/7714/8193/0832/SCF190_Small_cell_siting-final.pdf

Chairman, said that "*The interconnected world of the future will be the result of decisions we make today. That is why 5G is a national priority, and why today's agreement to streamline small cell deployment will play a critical role in the successful deployment of next generation wireless service*."[5]

59. In a paper issued by the European Commission ("EC") entitled *"5G for Europe: An Action Plan"* in September 2016[6], one of the action items proposed by the EC is to identify the immediately actionable best practices to increase the consistency of administrative conditions and time frames to facilitate denser cell deployment:

> *"A simplification of the deployment conditions for dense cellular networks would reduce costs and support investments. The proposed European Electronic Communications Code aims to remove deployment barriers for the installation of small cells, subject to meeting common technical requirements.*
>
> *Member States should work to eliminate these barriers in the interests of speedy and cost effective deployment. In addition, other administrative aspects sometimes create unnecessary burdens for the installation of small cells, such as local planning procedures, high site rental charges, the variety of specific limits on electromagnetic field (EMF) emissions and of the methods required to aggregate them.*
>
> *Therefore, the Commission will further encourage best practice by national, regional and local authorities in the deployment conditions for small access points."*

60. It is anticipated that some 50 billion devices will be connected to mobile networks worldwide in 2020[7], and a large proportion of the communications will be made between machines instead of humans. For smart city to give rise to enhanced liveability, for instance, for it to have the capability to handle the vast amount of traffic generated by the future smart city applications, it needs a fast, responsive and reliable mobile network. The successful delivery of advanced mobile services, such as 5G, to meet with the ever-growing demand of the public, is therefore pivotal to the development of a smart city,

[5] https://www.mobileworldlive.com/featured-content/home-banner/fcc-looks-to-streamline-5g-rollout/

[6] https://ec.europa.eu/transparency/regdoc/rep/1/2016/EN/1-2016-588-EN-F1-1.PDF

[7] Presentation of Ericsson's former CEO Hans Vestberg

which depends on the collaboration of a large number of stakeholders, including industry players and policy makers. The Hong Kong Government should play the important and facilitating role to enable faster mobile network rollout, which will benefit the mass mobile phone users in Hong Kong. As seen from the above overseas experience, inter-bureau coordination is much needed to streamline and expedite the approval process for cell site installation without jeopardizing the required regulation undertaken in the interest of the public. A “cross-bureau” function or task force, if set up to consolidate the current piecemeal approval process, will save time and efforts on the part of both the industry and the administration for other more gainful deployment. SmarTone strongly believes that such a measure will help mobile network development in Hong Kong so that we will not continue to lag behind other international cities. The economic and societal benefits to be gained are certainly in the interest of the general public as a whole.

Annex A - Overseas Practices on Spectrum Cap

Countries	Year	Spectrum Bands	Description of the Spectrum Cap
Austria	2010[1]	2.6 GHz	2 x 30 MHz, applied to operators who already held 900 MHz or 1800MHz spectrum
	2013[2]	800 MHz	2 x 20 MHz
		900 MHz	2 x 30 MHz
		Sub-1 GHz	2 x 35 MHz
Australia	2009/2010[3]	3.6 GHz	No applicant permitted more than 30 MHz of spectrum in any given area
	2016[4]	1800 MHz (Regional)	2 x 25 MHz (Category 1 areas)
Canada	2014[5]	700 MHz	Limited to one paired block of prime spectrum if fulfilling the following criterion: • National (over 10% market share) • Regional large wireless service providers (over 20% market share in the respective licence areas)

[1] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/74359/annex_8.pdf, P.7

[2] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/74359/annex_8.pdf, P.8

[3] http://www.acma.gov.au/Industry/Spectrum/Radiocomms-licensing/Spectrum-licences/auction-summary-36-ghz-wireless-access-service-20092010-1

[4] http://www.acma.gov.au/theACMA/auction-summary-1800-mhz

[5] https://www.ic.gc.ca/eic/site/ic-gc.nsf/eng/07398.html#j14

Czech Republic	2013[6]	800 MHz	2 x 10 MHz
		1800 MHz	2 x 23 MHz, including existing holdings
		2.6 GHz paired	2 x 20 MHz
Denmark	May 2010[7]	2.6 GHz	2 x 20 MHz
	Jun 2012[8]	800 MHz	2 x 20 MHz
France	2015[9]	700 MHz	• a maximum of three blocks applied (Six 2 x 5 MHz blocks were auctioned) • hold no more than 2 x 30 MHz of lower band spectrum (700 MHz, 800 MHz and 900 MHz)
Germany	2010[10]	Multiband auction (800 MHz, 1800 MHz, 2.1 GHz, 2.6 GHz)	For 800 MHz • T-Mobile and Vodafone were subject to a cap of 2 x 10 MHz • E-Plus and Telefonica were subject to a cap of 2 x 15 MHz • new entrants were limited to 2 x 20 MHz
Greece	2011[11]	900 MHz	Cap which is dependent on the number of bidders • four bidders: 2 x 12.5 MHz

[6] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/74359/annex_8.pdf, P.21

[7] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/74359/annex_8.pdf, P.26

[8] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/74359/annex_8.pdf, P.28

[9] http://www.arcep.fr/index.php?id=8571&tx_gsactualite_pi1%5Buid%5D=1754&tx_gsactualite_pi1%5BbackID%5D=26&cHash=f84b469781e9c9dd9257b05d40bfb8c8&L=1

[10] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/74359/annex_8.pdf, P.33

[11] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/74359/annex_8.pdf, P.40

			• otherwise: 2 x 15 MHz
		1800 MHz	• 2 x 35 MHz • a spectrum floor of 2 x 5 MHz in the 900 MHz band would have been applied if there were four or more bidders
Ireland	2012[12]	Multiband auction (800 MHz, 900 MHz, 1800 MHz)	• 2 x 20 MHz cap for sub-1 GHz spectrum • total cap of 2 x 50 MHz for all bands
Italy	2011[13]	Multiband auction (800 MHz, 1800 MHz, 2.1 GHz, 2.6 GHz)	• 2 x 20 MHz cap on sub-1 GHz spectrum • 55 MHz cap on joint paired and unpaired 2.6 GHz spectrum
Netherlands	2010[14]	2.6 GHz (paired and unpaired)	For 2.6 GHz paired, the following caps apply: • 2 x 10 MHz for KPN • 2 x 5 MHz for T-Mobile • 2 x 10 MHz for Vodafone
	2012[15]	Multiband auction (800 MHz, 900 MHz, 1800 MHz, unpaired 1900 MHz, 2.1 GHz, unpaired 2.6 GHz)	• 2 x 10 MHz of 800 MHz
New Zealand	2014[16]	700 MHz (9 lots of 2 x 5 MHz)	• three lots maximum applied to each bidder in the first phase of the auction

[12] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/74359/annex_8.pdf, P.45

[13] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/74359/annex_8.pdf, P.52

[14] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/74359/annex_8.pdf, P.58

[15] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/74359/annex_8.pdf, P.59

[16] https://www.rsm.govt.nz/projects-auctions/completed/digital-switchover-and-the-digital-dividend/700-mhz-auction-overview

Portugal	2011[17]	Multiband auction (450 MHz, 800 MHz, 900 MHz, 1800 MHz, unpaired 2.1 GHz, 2.6 GHz, unpaired 2.6 GHz)	• 800 MHz: 2 x 10 MHz • 900 MHz: 2 x 5 MHz, or 2 x 10 MHz for new entrants • Cumulative 800/900 MHz: A "deferred" cap of 2x20 MHz on existing holdings and holdings won in the auction, which means that any spectrum in excess of 2x20 MHz must be either traded or handed back by December 2015. • 1800 MHz: 2 x 20 MHz (including existing holdings) • 2.6 GHz: 2 x 20 MHz
Norway	2013[18]	800 MHz	• 2 x 10 MHz and applies to all bidders
		900 MHz	• 2 x 15.2 MHz, including existing holdings • Apply to all bidders
		1800 MHz	• 2 x 20 MHz, including existing holdings • Apply to all bidders
Romania	2012[19]	Multiband auction (800 MHz, 900 MHz, 1800 MHz, 2.6 GHz, unpaired 2.6 GHz)	• 800 MHz: 2 x 15 MHz • 900 MHz: 2 x 15 MHz • Cumulative 800/900 MHz: 2 x 20 MHz

[17] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/74359/annex_8.pdf, P.64

[18] https://www.google.com.hk/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0ahUKEwiRmfzt65vTAhWEFZQKHdCxDjsQFggiMAE&url=https%3A%2F%2Fwww.nkom.no%2Faktuelt%2Fh%25C3%25B8ringer%2F_attachment%2F9106%3F_download%3Dtrue%26_ts%3D140f281f90a&usg=AFQjCNGUdm5wWssHxqPsl22ikLVYnrUVlA

[19] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/74359/annex_8.pdf, P.70

Singapore	2016 (Auction taken place in April 2017)[20]	700 MHz	• 2 x 20 MHz, if there is a winning new entrant bidder • 2 x 20 MHz, if there is no winning new entrant bidder
		900 MHz	• 2 x 10 MHz, if there is a winning new entrant bidder • 2 x 15 MHz, if there is no winning new entrant bidder
		2.3 GHz/2.5 GHz	• 2 x 45 MHz, if there is no winning new entrant bidder
		Global spectrum cap	• 2 x 75 MHz, if there is a winning new entrant bidder • 2 x 100 MHz, if there is no winning new entrant bidder
Slovak Republic	2013[21]	Multiband auction (800 MHz, 1800 MHz, 2.6 GHz, unpaired 2.6 GHz)	• 800 MHz: 2 x 10 MHz • 1800 MHz: 2 x 20 MHz
Slovenia	2014[22]	Multiband auction (800 MHz, 900 MHz, 1800 MHz, 2.1 GHz, unpaired 2.1 GHz, 2.6 GHz, unpaired 2.6 GHz)	• 900 MHz: 2 x 15 MHz cap • 1800 MHz: 2 x 30 MHz cap • Sub-1 GHz: 2 x 30 MHz cap • Total: 2 x 105 MHz cap

[20] https://www.imda.gov.sg/~/media/imda/files/regulation%20licensing%20and%20consultations/frameworks%20and%20policies/spectrum%20management%20and%20coordination/spectrum%20rights%20auctions%20assigment/final%20information%20memorandum.pdf?la=en

[21] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/74359/annex_8.pdf, P.76

[22] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/74359/annex_8.pdf, P.82

Spain	May 2011[23]	900 MHz	Movistar and Vodafone were prevented from participating in the auction of this band
		1800 MHz	Orange, Movistar and Vodafone were prevented from participating in the action of this band
	July 2011[24]	Multiband auction (800 MHz, 900 MHz, 2.6 GHz, unpaired 2.6 GHz)	• Sub-1 GHz: 2 x 20 MHz • a limit of 115 MHz on joint 1800 MHz, 2.1 GHz and 2.6 GHz spectrum
	Nov 2011[25]	re-auction of unsold spectrum: 900 MHz and 2.6 GHz unpaired	• sub-1 GHz: 2 x 25 MHz • for higher frequency bands: raised to 135 MHz
Sweden	March 2011[26]	800 MHz	2 x 10 MHz
Switzerland	2012[27]	Multiband auction (800 MHz, 900 MHz, 1800 MHz, 2.1 GHz, unpaired 2.1 GHz, 2.6 GHz, unpaired 2.6 GHz)	• 2 × 135 MHz of the total available FDD spectrum • between 800 MHz and 900 MHz: 2 × 25 MHz • 900 MHz: 2 × 20 MHz • 1800 MHz: 2 × 35 MHz • 2.1 GHz: 2 × 30 MHz

[23] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/74359/annex_8.pdf, P.70
[24] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/74359/annex_8.pdf, P.85
[25] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/74359/annex_8.pdf, P.86
[26] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/74359/annex_8.pdf, P.91
[27] https://www.ofcom.org.uk/__data/assets/pdf_file/0028/74359/annex_8.pdf, P.97

The United Kingdom	2016[28]	2.3 GHz	A spectrum cap of 255 MHz on "Immediately useable" spectrum (i.e., as BT/EE held 45% of immediately useable spectrum in UK at that time (which was more than 255MHz), it was not allowed to bid for the 2.3 GHz band spectrum)
	2012[29]	Sub 1 GHz	2 x 27.5 MHz
		Overall spectrum cap	2 x 105 MHz

[28] https://www.ofcom.org.uk/about-ofcom/latest/media/media-releases/2016/ofcom-outlines-rules-for-mobile-spectrum-auction

[29] https://www.ofcom.org.uk/__data/assets/pdf_file/0031/46489/statement.pdf

CONTACTICA

TAKING THE RISK OUT OF TELECOMMUNICATIONS

International Study on the Spectrum Requirements for Mobile Networks – Implications for Hong Kong

Prepared for

SmarTone

30th March 2017

CONTACTICA Asia Ltd
2120 Leighton Centre
77 Leighton Road
Causeway Bay
Hong Kong

Tel: +852 3101 1935
Fax: +852 2791 6362

SmarTone

International Study on the Spectrum Requirements for Mobile Networks – Implications for Hong Kong

Table of Contents

SmarTone

International Study on the Spectrum Requirements for Mobile Networks – Implications for Hong Kong

Executive Summary

Contactica has been asked by SmarTone to undertake an independent review of how other countries or regions are responding to the growing demand for new mobile spectrum and consider the likely implications for Hong Kong. This review has identified the following key findings:

- **The high growth of smartphone adoption and increase in mobile data will continue at an increasing rate. Forecasts from various sources suggest mobile data usage will be ten times its 2014 level by 2019, up to 250 Exabytes per annum.**
- **The impact of this exponential growth will have profound implications for the demand for spectrum; the ITU and GSMA forecast that between 1350Hz and 1800MHz will be required by 2020. This is more than double the spectrum currently allocated in most counties.**
- **Hong Kong does not compare favourably with other countries regarding allocated mobile spectrum. Hong Kong is also likely to experience above average growth, both in demand for smartphones and data usage, but has the lowest spectrum allocation amongst the countries benchmarked for this report. The Office of the Communications Authority (OFCA) in Hong Kong, however, currently has no firm plans or detailed roadmap to release new spectrum for mobile before 2020.**
- **The report has identified spectrum in the 700MHz and 3.5GHz bands, bands that is already being used in many countries worldwide:**
  - **Global support for the 700MHz band is ubiquitous. As of October, 2016 over 50 countries have allocated or committed to APT FDD (Band 28) for LTE deployments and in January, 2017 there were 34 commercially launched networks in 17 countries.**
  - **The 3.5GHz band is an excellent choice for mobile development in the near term. The band of interest to mobile networks runs from 3400MHz to 3600MHz, a total of 200MHz, which is a significant amount of spectrum and equivalent to over a third of Hong Kong's current total spectrum.**

  Given the advantages of the 700MHz and 3.5GHz bands OFCA should take immediate steps to review, plan and release new spectrum in these bands as soon

as possible. This would provide the much-needed new spectrum, offering good coverage and in-building penetration while supporting higher bandwidth subscriber applications.

- **Various studies have shown that real economic benefits can be derived from the early release of spectrum. For example, in the UK Ofcom has estimated that bringing forward the release of 700MHz spectrum by one year would create additional net economic gains of up to £45m.**
- **If Hong Kong is to maintain its reputation for being at the forefront of mobile technology developments, OFCA must take action by setting a clear roadmap for the timely release of additional spectrum for mobile broadband services.**

The demand for mobile services globally is increasing rapidly, largely driven by growth in the number of smartphone users and the data traffic they generate. The rate of adoption of LTE has exceeded that of all other mobile technologies and the deployment of 4G networks has transformed consumer behaviour, with faster connections being exploited by a proliferation of data enabled devices. Consumers are using smartphones and other mobile devices for increasingly bandwidth-heavy applications, in particular video-based applications. Data forecasts from multiple sources indicate that demand for data will increase by a factor of six to ten between 2014 and 2019.

This exponential data growth dictates that mobile operators will require significantly more spectrum, and in higher frequency bands, to meet demand. The ITU estimates that between 1,340MHz and 1,960MHz in total will be required by 2020. However, there is currently only 582MHz of licensed spectrum allocated in Hong Kong for mobile and Broadband Wireless Access (BWA), 552MHz of which has been allocated to the four mobile operators. In other words, Hong Kong only has an allocation of about one third of what it is projected to need in the next three years and OFCA currently has no firm plan or detailed roadmap to release any new spectrum during this period. This is very likely to result in an under-supply of spectrum just at a time when the need for spectrum is growing rapidly.

The two most attractive bands to deliver this much-needed spectrum in Hong Kong are the 700MHz and 3.5GHZ bands, offering extended coverage, good in-building penetration and bandwidth. These bands are already widely in use in many countries and there is readily available equipment and terminals. We therefore see no reason why OFCA should not release spectrum in these bands for mobile use in Hong Kong immediately.

The 700MHz band will allow the Mobile Network Operators (MNOs) in Hong Kong to deploy higher-performance mobile broadband services over greater distances with better in-building penetration, than currently offered. As such OFCA needs to take immediate action to release spectrum in this band.

The 3.5GHz band is an excellent choice for spectrum in the near term. The band runs from 3,400MHz to 3,600MHz, a total of 200MHz, which is a significant amount of spectrum and equivalent to over a third of Hong Kong's current total spectrum available to the mobile operators. The band has already been partially or fully allocated in many other countries but has not yet been assigned for mobile in Hong Kong due to concerns of interference with fixed satellite systems service. Contactica, however, believes that any in-band interference would be minimal due to the small number of satellites TV services in this band in Hong Kong and urge OFCA to investigate further. Early resolution of any potential issues will ensure the release of this band for mobile to help meet the growing demand for spectrum to cope with the rapid change and innovation in the International Mobile Communications (IMT) sector.

In addition, there are substantial socio-economic benefits that arise from more spectrum being made available which of course will be lost if sufficient spectrum is not available. For example:

- In the UK Ofcom, has estimated that bringing forward the release of 700MHz spectrum by one year would create additional net economic gains of up to £45m.
- It has also been estimated in the UK that the release of 3G spectrum in 2000 led to consumer welfare gains of $39 billion
- In Brazil, it is anticipated that the use of 700MHz for mobile broadband will contribute an additional US$1.4 billion to the Brazilian GDP, create over 4,300 new job opportunities and generate additional tax revenues of $1.3 billion by 2020; and
- In the USA, a seminal economic study calculated that an increase of 60MHz of spectrum would lead to retail price declines of 8% per annum and an increased consumer surplus of $8.8 billion annually.

The unique position of spectrum as being an economic input, the supply of which can only be increased by government, means that the socio-economic gains that flow from more

spectrum being available need government action. Unless governments, or the appropriate regulatory agency, ensure that spectrum is available in a timely fashion to meet consumer demand, the economic benefits will be delayed at best or lost altogether.

The key recommendations of this report are:

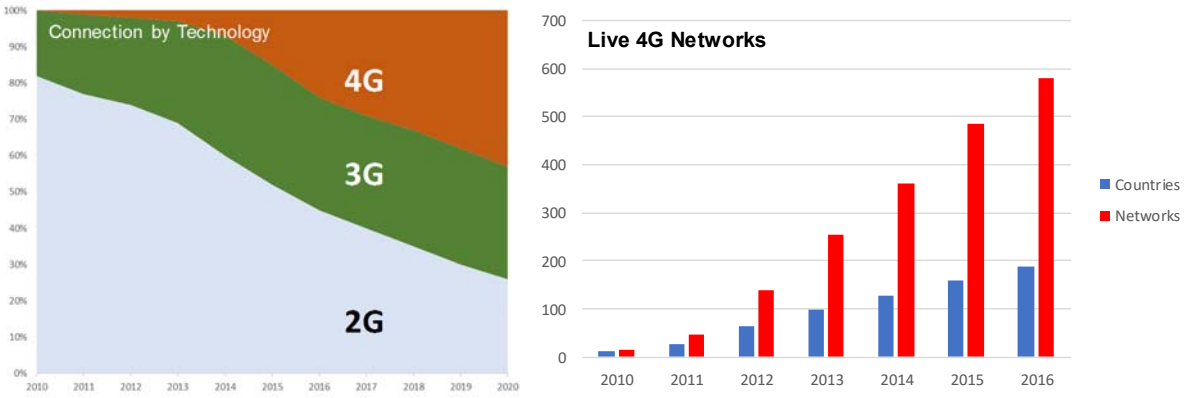
- The Hong Kong government and OFCA must recognise the need to release additional spectrum as soon as practical to ensure supply is ahead of demand.
- OFCA should develop a roadmap of its planned spectrum release schedule so that MNOs and other spectrum users can develop their own commercial strategies.
- Hong Kong should develop its own Analogue Switch Off (ASO) plan independently of Guangdong province to clear the 700MHz band.
- OFCA needs to immediately initiate plans for the allocation of 700MHz to mobile operators.
- OFCA should identify the 3.4GHz – 3.6GHz spectrum that can be immediately released to mobile operators.
- OFCA should specify a target date when the entire 3.5GHz band will be made available to mobile networks.

1. Introduction

The demand for mobile services globally is increasing rapidly, largely driven by growth in the number of smartphone users and the data traffic they generate. The installed base of smartphones has increased from 1.4 billion in 2013 to 3.8 billion at the end of 2016, accounting for half of total connections (excluding M2M) worldwide. Asia is driving the current phase of smartphone growth and the Asia-Pacific region will account for half of the 1.9 billion new smartphone connections forecast globally by 2020[1]

4G uptake is driving the surge in mobile broadband adoption and the proportion of 4G connections is forecast to almost double between 2016 and 2020, from 23% to 41%. LTE networks have more than doubled from 253 networks in 97 countries in 2013 to 580 networks in 188 countries as of 2016. This growth in connections and networks is shown in Figure 1.

Figure 1: Connection by Technology and Live 4G Networks

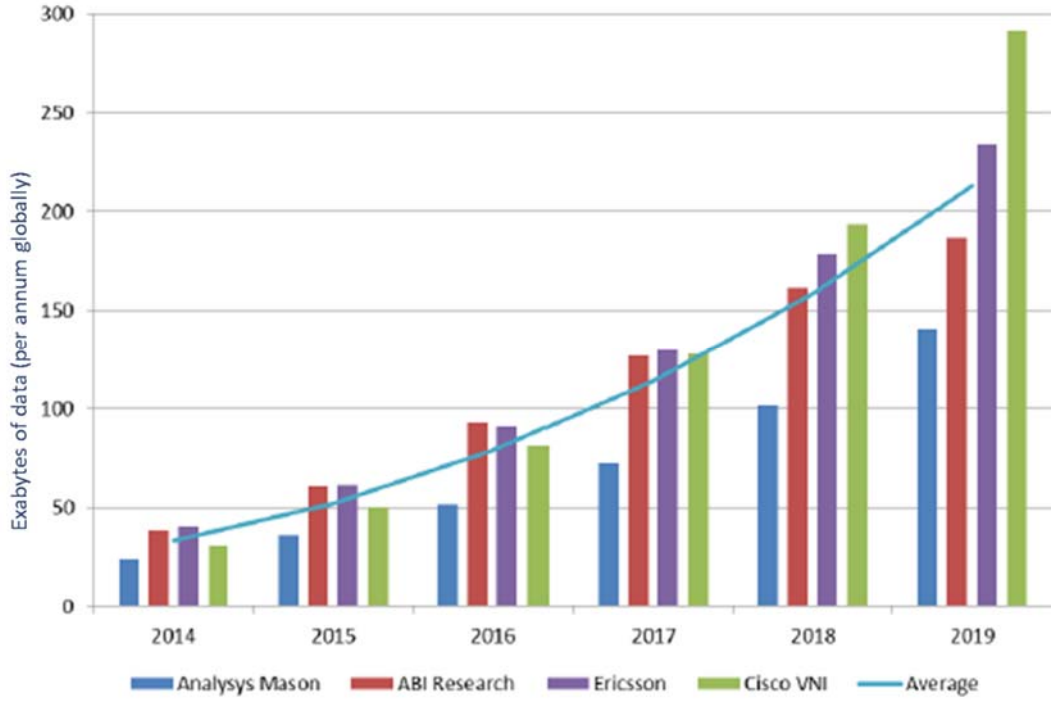


Source: GSMA The Mobile Economy 2017

The rate of adoption of LTE has exceeded that of all other mobile technologies and the deployment of 4G networks has transformed consumer behaviour, with faster connections being exploited by a proliferation of smartphones. These smartphones are also being used for increasingly bandwidth-heavy applications. Forecasts from multiple sources shown in Figure 2 indicate global mobile data will increase by a factor of between six and ten from 2014 to 2019.

[1] GSMA The Mobile Economy 2017

Figure 2: Growth From 2014 – 2019 Expected to be 6 – 10X



Source: Analysis Mason, Global Mobile Network Traffic, Oct 2014, ABI Research. Mobile Data Traffic & Usage, Oct 2014, Cisco VNI Mobile Forecast. Jan 2015, Ericsson Mobility Report, Feb 2015

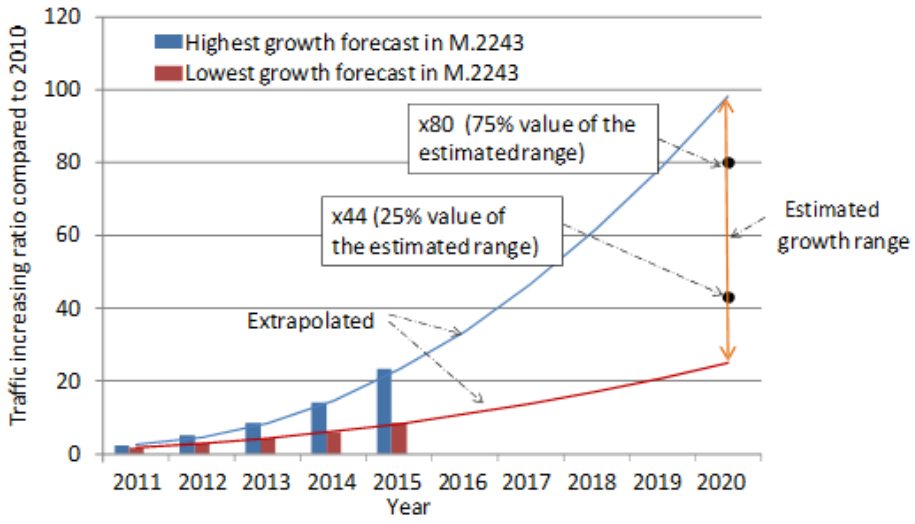
Cisco predicts that globally mobile data traffic will grow seven-fold between 2016 and 2021, a compound annual growth rate of 47% [2]. Cisco also predicts that in Asia Pacific mobile data traffic will grow 7.6-fold from 2016 to 2021, a compound annual growth rate of 49% and will reach 22.8 Exabytes per month by 2021, up from 3.1 Exabytes per month in 2016.

The International Telecommunications Union's (ITU) official spectrum demand model[3] also assumes that mobile traffic will increase between 44 and 80-fold between 2010 and 2020 as shown in Figure 3.

[2] Cisco; http://www.cisco.com/assets/sol/sp/vni/forecast_highlights_mobile/

[3] Report ITU-R M2290-0 (12/2013)

Figure 3: Mobile Traffic Forecasts Toward 2020 by Extrapolation



Source: Report ITU-R M.2290-0

Installation of additional sites and improvements in spectral efficiency alone will not be sufficient to cater for this projected exponential data growth. To meet demand, mobile operators will require access to significantly more spectrum. The ITU estimates[4] that between 1,340MHz and 1,960MHz will be required by 2020 as shown in Figure 4. This aligns with the GSM Association's (GSMA) estimate of between 1,600MHz and 1,800MHz.

Figure 4: The Amount of Spectrum Identified in ITU Radio Regulations

User Density Settings	Total Spectrum Requirements (MHz)	Region 1		Region 2		Region 3	
		Already Identified (MHz)	Additional Spectrum Requirements (MHz)	Already Identified (MHz)	Additional Spectrum Requirements (MHz)	Already Identified (MHz)	Additional Spectrum Requirements (MHz)
Low	**1340**	981 - 1181	**159 - 359**	951	**389**	885 - 1177	**163 - 455**
High	**1960**	981 - 1181	**779 - 979**	951	**1009**	885 - 1177	**783 - 1075**

Source: ITU

[4] Ibid

Given that these spectrum projections are more than double most existing country allocations for mobile, e.g. 552MHz in Hong Kong, new frequency bands are required. ITU WRC-15 has identified new bands for IMT which are applicable to Region 3 and Hong Kong:

- Sub-700 MHz UHF (470MHz – 698MHz)
- L-Band (1427MHz - 1518 MHz)
- C-Band (3.4GHz – 3.6GHz)

The 700MHz band (Band 28) was standardized by the Asia Pacific Telecommunity (APT) in 2010[5] and was initially allocated to mobile services and identified for IMT / mobile broadband in Region 1 at ITU WRC-12[6]. ITU WRC-15[7] confirmed that the timely release of this band is essential to ensure LTE services can cost-effectively expand capacity to meet growing demand, especially in rural areas and for in-building coverage.

ITU has proposed and received widespread support for a band plan for Region 1 that is compatible with the APT's 700MHz approach.

For LTE deployment, the APT700 band offers several benefits over other LTE bands:

- Sub 1 GHz frequency with increased coverage
- Efficient spectrum utilization offering a contiguous 45MHz, i.e. 2 X 45MHz for FDD or 1 X 100MHz for TDD
- Global adoption

The ITU has recommended that the lower C-Band (3.4GHz – 3.6GHz) be allocated to mobile services alongside existing satellite services and that a significant portion be identified for IMT/mobile broadband. C-Band offers excellent capacity, supports faster services and is most suitable for urban areas or small cells.

C-Band has been largely used for Fixed Satellite Services (FSS), e.g. satellite TV and broadband, especially in the tropics where rainfall has restricted the use of other higher frequency bands. However, recent technological developments mean alternative satellite spectrum in higher frequency bands, e.g. Ku and Ka bands, is able to deliver improved

[5] APT Report "Harmonised Frequency Arrangements for the Band 698-806 MHz", September 2010

[6] ITU WRC-12

[7] ITU WRC-15

performance and better value services in all areas, including the tropics. Most modern "Direct to Home" (DTH) satellite services now use the Ku band (12GHz – 18GHz) requiring only a small dish less than a meter in diameter.

This frees up C-Band spectrum for other applications such as mobile broadband.

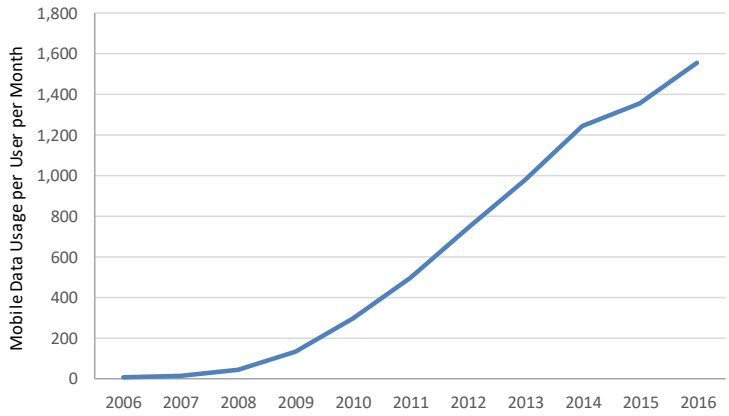
2. Spectrum Situation in Hong Kong

Since the introduction of mobile communications in the mid-1980's, the market in Hong Kong has grown rapidly. There are now some 17.2 million (Post-paid SIM and Pre-paid SIM) subscribers in Hong Kong, representing a penetration of 235%[8], amongst the highest rate in the world. As in many other countries the market has consolidated to four network operators in recent years, namely:

- HKT
- Hutchison
- SmarTone
- China Mobile

The rapid growth in data usage by mobile phone users from 2006 to 2016 is shown in Figure 5. At the end of 2016 the average data usage per subscriber per month was approaching 1,600 Mbytes.

Figure 5: Mobile Data Growth in Hong Kong from 2006 - 2016



Source: OFCA, Jan 2017

There is currently 582MHz of licensed spectrum allocated in Hong Kong for mobile and Broadband Wireless Access (BWA), 552MHz of which has been allocated to the four mobile operators. The allocation by band is shown in the following Figure 6.

[8] OFCA, Jan 2017

Figure 6: Spectrum Allocation for Mobile in Hong Kong

Frequency Band	Bandwidth Allocated (MHz)	Total by Band (MHz)
850MHz	2 X 12.5	25
900MHz	2 X 29.9	59.8
1800MHz	2 X 74.4	148.8
2100MHz	2 X 59.2	118.4
2300MHz	1 X 60	60
2600MHz	2 X 70	140
Total		**552**

Source: OFCA

This total allocation is the lowest of the countries that have been chosen for benchmark. Australia is the highest with 1,008MHz, followed by China with 687MHz and Taiwan with 650MHz. A comparison of the five counties can be seen in the following Figure 7.

Figure 7: Comparison of Spectrum Allocation by Country / Region for Mobile

Country	UK	Australia	Singapore	China	Taiwan	Hong Kong
Regulator	Ofcom	AMCA	IMDA	MII	NCC	OFCA
Total Spectrum Allocated (MHz)	606.8	1008	595.6	687	650	552
Av. Spectrum per Operator (MHz)	151.7	252	148.9	229	108.3	138
Number of Operators	4	4	4	3	6	4
Total Subscribers (Mn)	93.4	21	8.6	1358	29.2	17.2
Planned ASO Date	Completed	Completed	2017	2020	Completed	2020
Commercialised 700MHz	2020	Yes	2017	-	Yes	-
Commercialised 3.4GHz - 3.6GHz	2017*	Yes	-	Trials	-	-

*Note: 124MHz already allocated to UK Broadband for BWA; auction planned for mobile allocation of 116MHHz by end of 2017.
Sources: Ofcom, AMCA, IMDA, MII, NCC, OFCA

Figure 8 provides a spectrum breakdown by country, showing details of the individual bands allocated. Hong Kong currently has a spectrum gap of 54.8MHz when compared to the UK and Australia's allocation of 1008MHz is almost double that of Hong Kong.

Figure 8: Spectrum Allocation for Mobile by Country / Region and Band

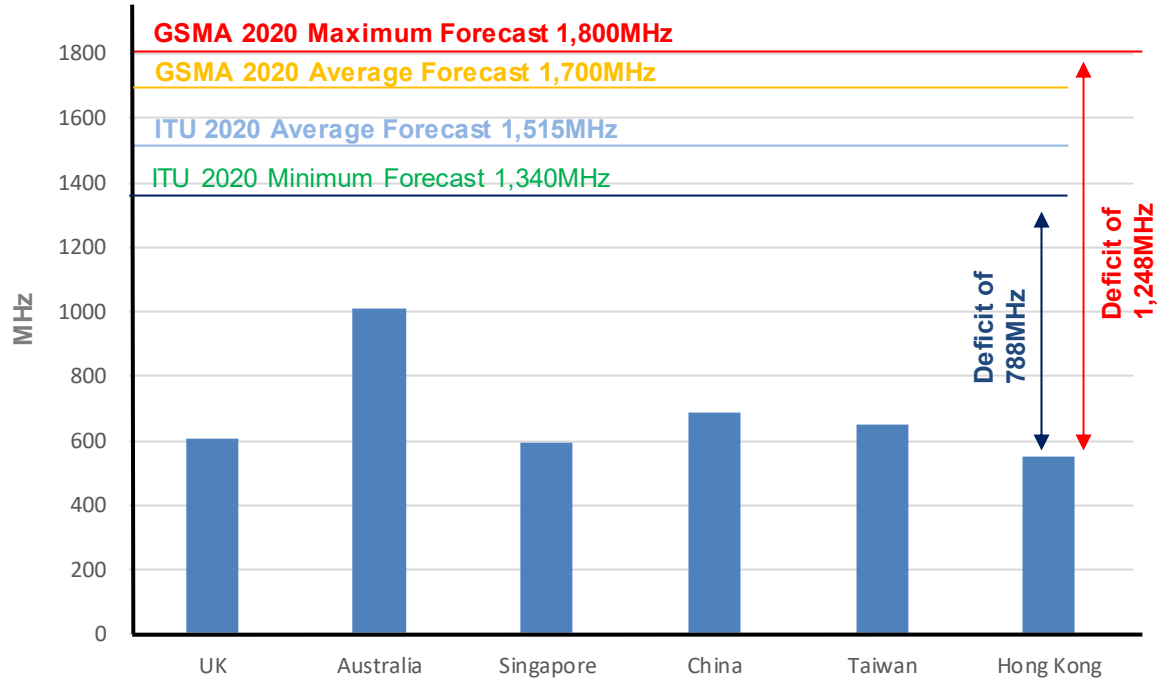
Frequency	Band	UK	Australia	Singapore	China	Taiwan	Hong Kong
700MHz	28	-	2 X 45	Planned in 2017	-	2 X 45	-
800MHz	20	2 X 30	-	-	-	2 X 20	-
850MHz	5		2 X 20	2 X 10	2 X 10		**2 X 12.5**
900MHz	8	2 X 34.8	2 X 25	2 X 40	2 X 26	2 X 35	**2 X 29.9**
1500MHz (L-Band)	32	1 X 40	-	-	-	-	-
1800MHz	3	2 X 71.6	2 X 75	2 X 75 / 1 X 15	2 X 70 / 1 X 10	2 X 75	**2 X 74.4**
1900MHz	39	-	1 X 20	2 X 59.8 / 1 X 15	1 X 70	-	-
2100MHz	1	2 X 59.5	2 X 60	-	2 X 45 / 1 X 15	2 X 55	**2 X 59.2**
2300MHz	40	-	1 X 98	2 X 20	1 X 100	-	**1 X 60**
2500MHz	41	-	2 X 70	2 X 60 / 1 X 36	2 X 80 / 1 X 55	-	-
2600MHz	7	2 X 70	-	-	1 X 55	2 X 70 + 1 X 50	**2 X 70**
2600MHz	41	1 X 35	-	-	-	-	-
3.4GHz - 3.6GHz	42	(116MHz) Planned 2017	1 X 300	-	Conducting Trials in 2017	-	-
Total (MHz)		606.8	1008	595.6	687	650	**552**

Source: Ofcom, AMCA, IMDA, MII, NCC, OFCA, spectrummotinorimg.com

The ITU has predicted that between 1,340MHz to 1,960MHz will be required for IMT / mobile broadband by 2020. The GSMA forecast that between 1,600MHz and 1,800MHz will be required by 2020. The ITU /GSMA average forecast is more double the spectrum currently available in most countries.

Based on ITU and GSMA predictions of future requirements, Hong Kong will have a spectrum deficit of between 788MHz and 1,248MHz by year 2020 as indicated in Figure 9.

Figure 9: Hong Kong Spectrum Deficit by 2020



Source: ITU, GSMA

This spectrum deficit will have a serious impact on the ability of Hong Kong's operators to meet growing subscriber bandwidth demands and further develop LTE services. This is before any consideration is given to spectrum requirements for 5G trials or early 5G network deployments, which will in themselves further exacerbate the increasing bandwidth requirements. Mobile services in Hong Kong will struggle to meet growing demand without more spectrum.

OFCA has recently stated that it will launch a public consultation in the second half of 2017 on the vacation of the 3.4GHz – 3.7GHz band (currently assigned for fixed satellite service provision), with a view to re-allocating it to mobile services in 2020, and that "the CA strive to assign spectrum in the 26 GHz and 28 GHz bands for the provision of 5G services in 2019 at the earliest". However, OFCA currently has no firm plan or detailed roadmap for the release of new mobile spectrum over the next three years.

OFCA has previously stated that there is 35MHz still available for mobile services in the 1.9GHz to 2.2GHz band, including about 5MHz in the 1900 – 1904.9MHz band and 29.7MHz in the 1.9 – 2.2GHz band. However, there is no LTE terminal support for Band 34

(2010-2025MHz) and the requirement for a guard band between the top of Band 33 (1900 – 1920MHz) and Band 1 (1920 – 1980MHz) will further reduce the usable spectrum. Even if all 35MHz of this spectrum was usable, it is insignificant given the spectrum deficit of almost 1GHz indicated in Figure 9.

We understand that one reason OFCA has given for not releasing more spectrum is that it believes it would be economically inefficient for operators to acquire spectrum and deploy equipment in advance of standards being finalized, e.g. in the case of 5G. Contactica, however, believes that it is not OFCA's role to protect MNOs from making inefficient decisions that it should let MNOs take the risk of acquiring spectrum in advance of standards if MNOs wish to do so. MNOs are likely to be in a better position to assess those risks than OFCA.

Of the bands identified for International Mobile Telecommunication (IMT) and mobile broadband use by ITU, the two most promising for Hong Kong are the 700MHz band (Digital Dividend) and the 3.4GHz – 3.6GHz band (Extended C-Band). The early release of these bands would provide the much-needed additional new spectrum for both coverage (700 MHz) and high bandwidth subscriber applications (3.4GHz – 3.6GHz).

The 700MHz and 3.5GHz bands are already deployed or planned to be released for mobile use in many countries. Some 58 commercial networks have already been launched, with 34 and 24 networks launched in the 700MHz[9] and 3.5GHz[10] bands respectively. Of our five benchmarked countries, the 700MHz band is already in use in Australia and Taiwan and firm release dates have been set for mobile use in Singapore (2018) and the UK (2020).

The 3.5GHz band was released in the UK and Australia in 2015. In the UK, the spectrum has been used by UK Broadband (Relish) for fixed broadband wireless access, and Ofcom plans to release the remaining 116MHz of spectrum in this band for mobile use during 2017.

In Singapore, the IMDA is currently investigating the release of this band and the MIIT in China has stated that IMT vs. Fixed Satellite Systems (FSS) compatibility trials will be completed during the first half of 2017.

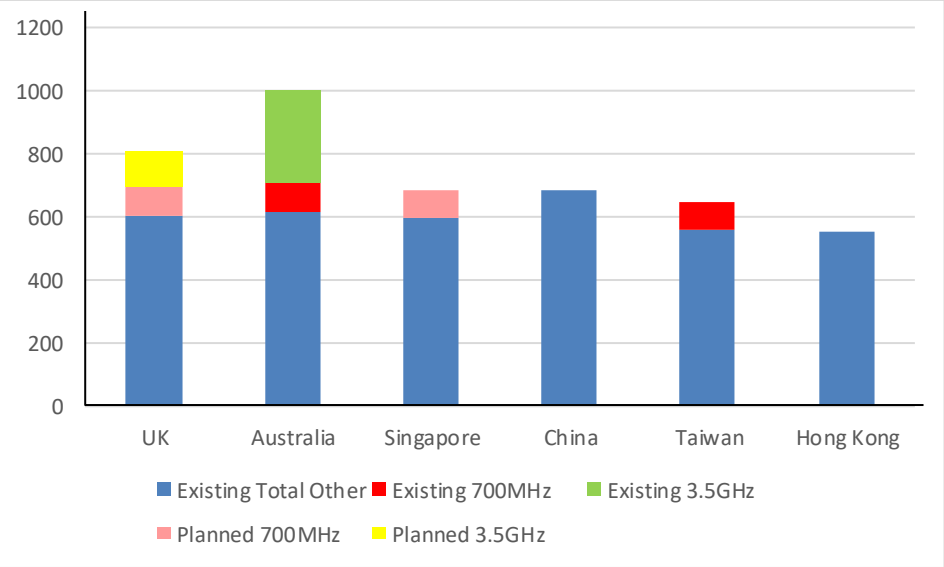
---

[9] GSA

[10] GSA

Status of the use of these two bands for mobile in our benchmarked countries is shown in Figure 10.

Figure 10: Use of 700MHz and 3.5GHz Bands for Mobile in Benchmarked Counties / Regions



Source: Ofcom, AMCA, IMDA, MII, NCC, OFCA spectrummonitoring.com, Contactica

Given the advantages of the 700 MHz and 3.5 GHz bands, OFCA must take urgent steps to review, plan and implement the release of new spectrum in these bands.

- Both bands have long been commercialised; there are multiple networks in operation for each of the bands all over the world.
- The amount of spectrum that could potentially be made available is approx. 300MHz, equivalent to 54% of existing capacity.
- Terminal availability is widespread for both bands.
- Interference issues resulting from co-existence within the bands can be resolved
- The characteristics of the two bands complement each another by providing excellent coverage (700MHz) and supporting high bandwidth applications (3.5GHz).

3. The 700 MHz Band

Global support for the 700MHz band is ubiquitous. As of October, 2016 over 50 countries have allocated or committed to APT FDD (Band 28) for LTE deployments and in January, 2017[11] there were 34 commercially launched networks in 17 countries.

Early release of the 700 MHz band in Hong Kong will allow MNOs to deploy higher-performance mobile broadband services over greater distances with better in-building penetration, than the services they offer today.

OFCA needs to be more proactive in adopting ITU recommendations with regard to spectrum allocation changes so that Hong Kong subscribers can continue to benefit from the mobile revolution and emerging new technologies such as 5G. For Hong Kong to maintain its leadership position in the rapidly evolving world of mobile communication, OFCA must take immediate action to release spectrum in this band.

3.1. Background

As nations began digitizing television services in the late 1990s rendering the "reclamation" of a part of the analogue TV spectrum bandwidth feasible, the 700MHz band was considered as excellent spectrum for LTE. It is low frequency spectrum with good propagation characteristics and is therefore well suited to providing wide area coverage and better in-building penetration than higher frequencies.

Twenty years ago, the Federal Communications Commission (FCC), the US sector regulator, demonstrated leadership and vision in spectrum management and started preliminary work on allocation of frequencies in the 700MHz band.

In the 2007 WRC meeting[12], the decision was made to allocate the 700MHz band for IMT services. The following year, the FCC auctioned off parts of the 700MHz band.

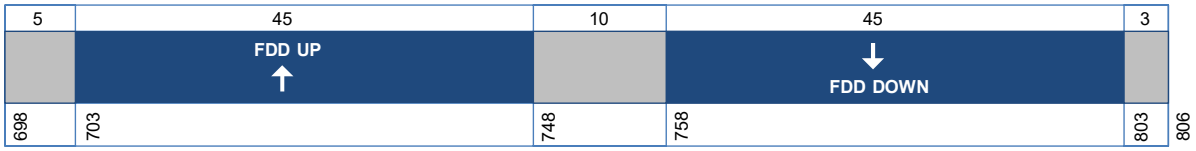
In September 2010, the 9th Asia Pacific Telecommunity Wireless Forum Meeting issued a report entitled "Harmonized Frequency Arrangements for the Band 698-806MHz"[13] and

[11] http://gsacom.com/paper/gsa-snapshot-apt700-band-global-status-regulatory-deployments-devices/

[12] APT Report Harmonized Frequency Arrangement 2010

since then there has been no looking back. The report focused on the APT700 FDD band plan (3GPP Band 28), specifically 703-748MHz for the uplink, 10MHz guard band and 758-803MHz for the downlink, as shown in Figure 11.

Figure 11: The APT700 Band Plan



Source: Contactica

As of October 2016, over 50 countries have allocated, committed to or recommend APT700 FDD (band 28) for LTE system deployments, including[14]:

Latin America: Argentina, Brazil, Chile, Colombia, Costa Rica, Curacao, Dominican Republic, Ecuador, Honduras, Mexico, Panama, Peru, Venezuela

Asia-Pacific / Oceania / Middle East & Africa: Afghanistan, Australia, Bangladesh, Bhutan, Brunei, Cambodia, Fiji, India, Indonesia, Japan, Laos, Malaysia, Myanmar, Nepal, New Zealand, Pakistan, Papua New Guinea, Philippines, Singapore, South Korea, St. Maarten, Taiwan, Thailand, Tokelau, Vanuatu, Vietnam, United Arab Emirates (part of the 700MHz band), Zimbabwe

Cisco VNI forecasts that in Asia Pacific, mobile data traffic will grow seven-fold from 2016 to 2021, reaching 22.8 Exabytes from a current level of 3.1 Exabyte per month[15].

It has long been recognized that allocation of the 700MHz band to mobile communications is a key solution for meeting the challenge of massive mobile data growth, highlighted above. It provides the telecommunications industry and telecommunications regulators with the additional spectrum needed for the deployment of new mobile broadband networks and capacity.

[13] Ibid

[14] http://gsacom.com/paper/gsa-snapshot-apt700-band-global-status-regulatory-deployments-devices/

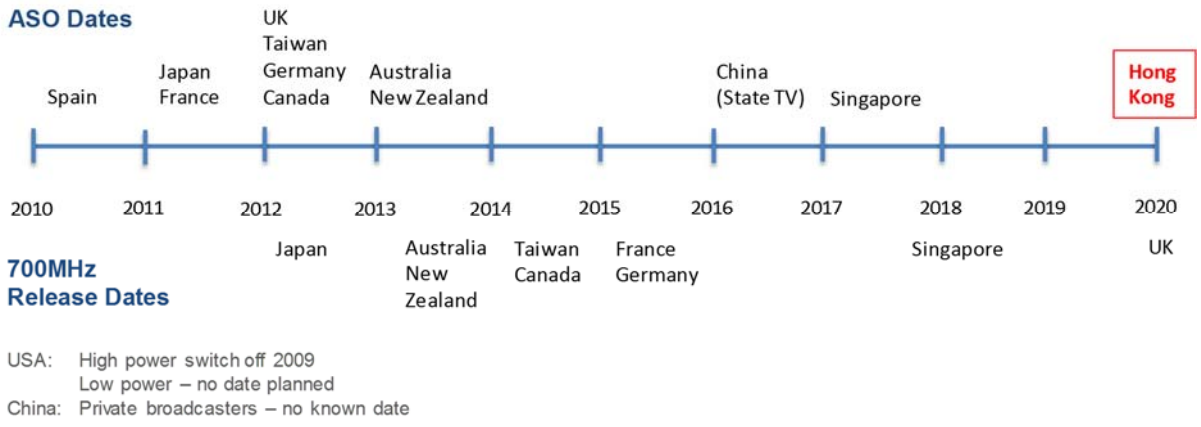
[15] http://www.cisco.com/c/dam/assets/sol/sp/vni/forecast_highlights_mobile/index.html

3.2. Analogue Switch Off (ASO)

The APT 700MHz band plan aims to align and optimize the use of the freed broadcast spectrum after the analogue television switch off (ASO), allowing greater flexibility for the deployment of mobile broadband services such as LTE.

Figure 12 indicates the ASO dates and planned ASO dates and 700MHz spectrum release for various countries, highlighting that Hong Kong is one of the last countries to switch off analogue television.

Figure 12: ASO Release Dates for Various Countries / Regions



Sources: ITU, IMDA, (Singapore), Contactica (China) and Ovum "Spectrum Auction Tracker 2016"

3.3. Benchmarked Countries / Regions

China

The China State Administration of Radio, Film, and Television (SARFT) mandated that all state broadcasting channels stop broadcasting in analogue mode by 2015. Contactica understands, based on various informal sources, that the last few CCTV (national broadcaster) channels stopped analogue broadcast in mid-2016 but that there could still be a small number of analogue channels on air in rural areas of Guangdong.

Taiwan

Taiwan complete ASO in 2012 and the 700MHz spectrum has been available for mobile use since 2014

Singapore

The Singapore regulator IMDA has firm plans for the auction of 700MHz spectrum in 2017, before completion of analogue switch-off (ASO). The spectrum will therefore be available for use from the 1st January 2018.

UK

In 2014 Ofcom decided to "make the 700MHz band available for mobile data as soon as practically possible. Initial plans showed that it would be possible to complete the programme by no later than the end of 2021. We have been looking for ways to complete the programme sooner than this."[16] In October 2016 Ofcom realized its intention, stating "We will aim to bring forward release of the 700MHz band to Q2 2020"[17].

Australia

In Australia, the auction of 700MHz spectrum took place in 2013, with 60MHz (2 X 30MHz) initially being made available. Auction of the remaining 30MHz (2 X 15Mhz) of FDD spectrum in this band is imminent and scheduled during the first half of 2017.

[16] https://www.ofcom.org.uk/__data/assets/pdf_file/0024/46923/700-mhz-statement.pdf

[17] https://www.ofcom.org.uk/__data/assets/pdf_file/0031/92659/Maximising-the-benefits-of-700-MHz-clearance-Statement.pdf

3.4. Global Status

South East Asia

In 2013[18], Brunei Darussalam, Indonesia, Malaysia and Singapore pledged commitment to align with the Asia Pacific Telecommunity 700MHz Band Plan.

Indonesia has strongly supported the APT700 MHz band plan since the initiation of band harmonisation. The Director-General of the Indonesian regulator (Posts and Information Resources & Equipment (SDPPI)) stated, "This is also in line with the current regulation of our Master Plan for Digital Television, which allocates the 694-806MHz for digital dividend in Indonesia."

South Asia

The South Asian Telecommunications Regulators' Council (SATRC) consists of nine regulatory bodies from Afghanistan, Bangladesh, Bhutan, India, Iran, Maldives, Nepal, Pakistan and Sri Lanka. In May 2013[19], the nine SATRC countries endorsed the adoption of the APT700 MHz frequency band plan and agreed to accelerate transition from analogue to digital broadcast TV services in 700 MHz band.

Europe

Europe has made significant progress in this arena. On 26th May 2016, the European Council "adopted a general approach on a draft decision[20] aimed at boosting broadband services. The 700MHz band, which offers high speeds and extensive coverage, would be made available for wireless broadband in Europe by 2020."

From a subsequent European Council press release:[21] "The 700MHz band should be assigned to mobile operators and made available for wireless broadband use by 30 June 2020 at the latest in all EU Member states. Duly justified exceptions – on grounds defined in the Decision – are possible until 30 June 2022."

---

[18] https://www.imda.gov.sg/infocomm-and-media-news/whats-trending/2013/7/optimising-spectrum-

[19] http://www.gsma.com/spectrum/wp-content/uploads/2013/07/Telstra-_-Asia-Pacific-Telecommunity-APT-700-MHz-Whitepaper-FINAL-VERSION.pdf

[20] http://www.consilium.europa.eu/en/press/press-releases/2016/05/26-freeing-up-700-mhz-band-for-mobile/

[21] http:/Europe.eu/rapid/press-release_IP-16-4405_en.htm

Austria, Finland, France, Germany, Iceland, Slovenia, Sweden and the UK have already either committed to, have started or completed steps for the allocation of 700MHz ahead of the EU deadline noted above.

Hong Kong

By comparison, Hong Kong's stated position is behind most other countries. We note OFCA has set 2020 as merely the *working target* for ASO, whereas European Union nations, amongst the slowest of all the nations surveyed, will already have 700MHz available for use by 2020.

3.5. Current Global Network Deployment Status

Support for the 700MHz band amongst the infrastructure and terminal vendors is also ubiquitous. According to the GSA[22], as of January 2017:

- 550 terminals compliant with the APT band plan have been announced
- 34 commercially launched 700MHz networks in 17 countries utilizing band 28.

A list of these countries is shown in the following Figure 13. This list of course does not include those countries using 700MHz but in a different band plan, e.g. the USA.

[22] http://gsacom.com/paper/gsa-snapshot-apt700-band-global-status-regulatory-deployments-devices/

Figure 13: Countries / Regions with Commercially Launched 700MHz LTE Networks

Country	Network	Launched
Argentina	Personal	2016 (Est)
Australia	Optus	23/07/2014
Australia	Telstra	25/07/2014
Bhutan	TashiCell	02/04/2016
Brazil	Claro	15/06/2016
Brazil	TIM Brazil	15/06/2016
Brazil	Algar Telecom	18/11/2016
Chile	Entel PCS	17/05/2016
Chile	Movistar	17/05/2016
Chile	Claro	18/10/2016
France	Bouygues Telecom	08/07/1905
France	Free Mobile	08/07/1905
Japan	KDDI	2015 (Est)
Japan	NTT DoCoMo	2015 (Est)
Mongolia	Unitel	01/11/2016
New Zealand	Vodafone	18/07/2014
New Zealand	Spark	28/08/2014
New Zealand	2degrees	26/01/2015
Nigeria	Glo (Globacom)	04/10/2016
Panama	Cable & Wireless Panama	11/03/2015
Panama	Movistar	27/03/2015
Panama	Claro	06/08/2015
Papua New Guinea	Digicel	26/03/2014
Papua New Guinea	Telikom PNG	31/10/2016
Peru	Movistar	25/07/2016
Peru	Claro	06/09/2016
Philippines	Globe	06/06/2016
Philippines	Smart	06/06/2016
Suriname	Telesur	29/01/2016
Taiwan	FarEasTone	03/06/2014
Taiwan	Taiwan Mobile	04/06/2014
Taiwan	Asia Pacific Telecom	24/12/2014
Taiwan	Ambit Microsystems	15/05/2015
Vanuatu	Digicel	19/01/2016

Source: GSA

3.6. Recommendations

OFCA needs to be more proactive in relation to 700MHz band, specifically in terms of:

- Co-ordination with the Chinese authorities; while the 700MHz band may not be clean in Guangdong due to existence of some residual households still receiving analogue television, it would be worthwhile to know:
  - approximately how many households in Guangdong are still receiving analogue television
  - what the plans are of the Guangdong authorities to migrate these residual households to DTT.
- Advancing ASO in Hong Kong: DTT services were launched in Hong Kong at the end of 2007. In September 2014, over two and a half years ago, OFCA stated that the percentage of households capable of receiving DTT services was approximately 80%. This percentage needs to be regularly monitored and publicly reported. Continued efforts must be made in the form of public education and other initiatives to expedite the process. The costs involved in subsidizing the migration of the residual analogue TV households in Hong Kong (i.e. installing DTT set-top box in order to receive free-to-air broadcasts) should be estimated and compared with the economic benefits of earlier allocation of the 700MHz spectrum for mobile use.
- Hong Kong can continue in its own ASO efforts regardless of the status in Guangdong. Having twice deferred ASO, OFCA now needs to advance its ASO date, perhaps to 2018.
- OFCA needs to immediately initiate plans for spectrum allocation of the 700MHz band and produce a clear timetable to be issued by the second half of 2017, including a revised ASO date and (phased) release of 700MHz spectrum.

Some of this can be done in parallel. In fact, the allocation of the 700 MHz spectrum can be done in advance of ASO, as was done in Singapore. This will enable MNOs in Hong Kong to better plan their network topology and network deployment investments.

4. The 3.5GHz Band

The 3.5GHz band is an excellent choice for mobile development in the near term. The band of interest to mobile networks runs from 3400MHz to 3600MHz, a total of 200MHz, which is a significant amount of spectrum and equivalent to over a third of Hong Kong's current total spectrum.

This 3.5GHz spectrum (Band 42) has already been partially or fully allocated in many other countries worldwide, with 24 commercially networks introduced in fifteen countries.[23] However, OFCA has no firm plans to assign this spectrum for mobile use in Hong Kong due to concerns of interference to fixed satellite systems services.

Interference has not been identified as a significant problem in countries already using this band for wireless broadband, e.g. UK and Australia, and Contactica believes that the in-band interference would be minimal due to the small number of satellites providing services in this band in Hong Kong. OFCA should therefore investigate further, as resolving any potential conflict or interference will help meet the growing mobile spectrum demand to cope with the rapid change and innovation in the communications sector.

4.1 Background

The World Radiocommunication Conference (WRC-15)[24] confirmed the lower part of the C-Band of 3400-3600MHz (Band 42) as new spectrum capable of supporting the ever-increasing mobile usage and data demand. This band had been partially identified prior to WRC-15, but in WRC-15 became a globally harmonized identification for International Mobile telecommunications (IMT).

4.2 Global Status

Many countries have either announced plans for release of spectrum in this band or are already deploying networks. This band offers the greatest potential for the early release of

[23] GSA

[24] http://www.itu.int/en/ITU-D/Regional-Presence/AsiaPacific/Documents/Events/2016/Feb-SMS4DC-Pacific/RA-15%20and%20WRC-15.pdf

suitable spectrum for both 4G and 5G trials and commercial networks. However, Hong Kong has not yet committed to a planned release date.

Figure 14 indicates the heavy activity in the 3.5GHz space. The Global TD-LTE Initiative (GTI) considers that this band will very soon become mainstream.

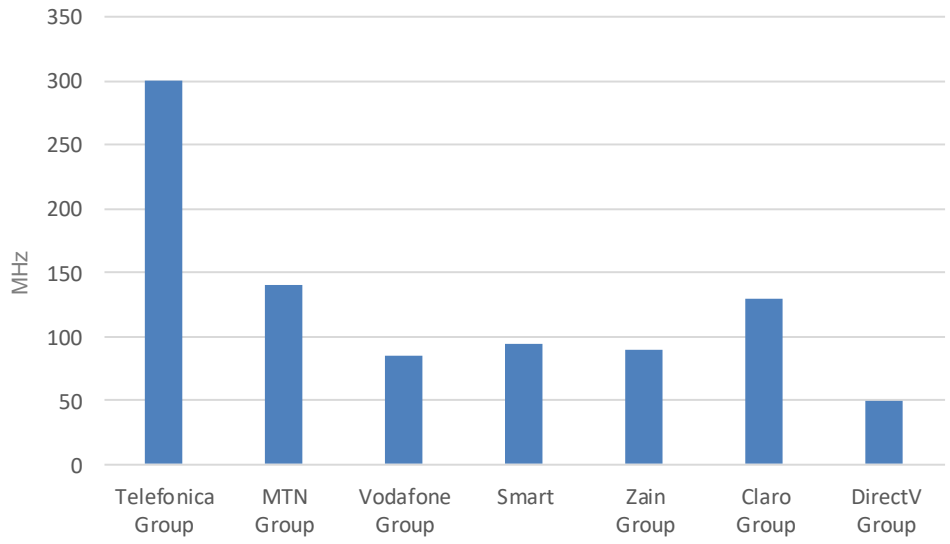
Figure 14: Announcements on 3.5GHz Trials or Licenses for Commercial Deployment

Source: Global TD-LTE Initiative (GTI)

In addition to individual independent MNOs around the world being granted licenses, it is important to note that some of the large global / regional operators have already been allocated sizeable amount of spectrum in the 3.5GHz band[25]. This approximate spectrum allocation is shown in Figure 15.

[25] Source: Global TD-LTE Initiative (GTI)

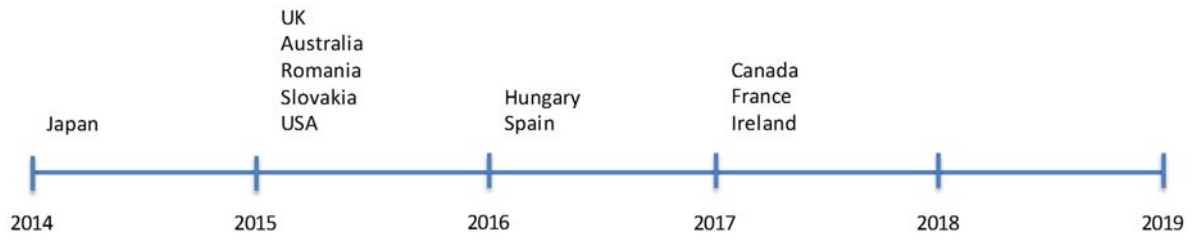
Figure 15: 3.5 GHz Spectrum Allocations for Major Global / Regional Operators



Source: Global TD-LTE Initiative (GTI)

Figure 16 indicates the timeline of the release of 3.4GHz – 3.6GHz spectrum for various countries. As can be seen, Hong Kong has yet to announce a plan for the release of this spectrum.

Figure 16: Timeline of the release of 3.4 GHz – 3.8 GHz Spectrum in Selected Countries



Source: Ovum "Spectrum Auction Tracker 2016", Ofcom, Canada Government

According to the GSA, as of 31 January 2017, there are already 23 commercially launched networks worldwide in Band 42 (3.4GHz – 3.6GHz). The list of these networks in fifteen countries shown in Figure 17.

Figure 17: LTE-TDD (Band 42) Global Status

Country	Operator
Bahrain	Menatelecom
Belgium	Broadband Belgium
Canada	ABC Communications
Canada	Bell Mobility
Canada	CCI Wireless
Canada	NetSet
Canada	Telus
Canada	Xplornnet
Iran	Mobinet
Iran	MTN Irancell
Ireland	Imagine Group
Italy	GO Internet
Jordan	Umniah
Nigeria	Cyberspace
Nigeria	MYN HTN Hynet
Peru	Claro
Philippines	PLDT
Slovak Republic	4ka (TO.doma)
Slovak Republic	Slovanet
Spain	Neo-sky
Tanzania	Vodacom
UAE	Etisalat
UK	UK Broadband

Source: GSA

4.3 Benchmarked Countries / Regions

China

MIIT has stated that IMT vs. Fixed Satellite Systems (FSS) compatibility trials, as well studies for required measures (if any), will be completed in the first half of 2017, meaning that the results will be out in 4 months. OFCA are therefore in a position to start immediate planning for spectrum release in this band.

Taiwan

The NCC has not yet stated any firm plans to release this band for mobile as the satellite operators have been lobbying against release of this spectrum. It should be noted, however,

that penetration of Cable TV (Hybrid Fibre Coaxial) and Direct to the Home (DTTH) satellite TV remains very high in Taiwan.

Singapore

The IMDA is still investigating release of this band for mobile use. In February 2016, the IDA stated "For the 3.5GHz band, IDA expects to conduct further technical assessments on the co-existence between mobile services and existing users, before deciding on the long-term plan for this band"[26]

UK

In 2015[27], Ofcom launched its mobile spectrum auction to meet growing demand for mobile connectivity and 190MHz of spectrum was auctioned in the 2.3GHZ and 3.4GHz bands, with 124MHz of this in the 3.4GHz band. This has been used for fixed broadband access by UK Broadband (Relish). Ofcom now plans to release the remaining 116MHz of spectrum in this band for mobile use during 2017.

Regarding ppossible interference to satellite services operating above 3.6GHz band, Ofcom, in its report entitled "Award of the 2.3 and 3.4GHz spectrum bands" included a study on coexistence issues for the LTE 3.4GHz band including issues for satellite services. Ofcom concluded there is a very low likelihood that 3.4GHz LTE will interfere with satellite services operating above 3.6GHz. "We remain of the opinion that the likelihood of interference from new services in the 3.4 GHz band to Permanent Earth Stations (PES) operators in the 3.6 GHz band is low with practical deployment scenarios."

Australia

Australia has already released 300MHz of spectrum in Band 42 to Optus (90MHz) and NBNco.

[26] https://www.imda.gov.sg/~/media/imda/files/inner/pcdg/consultations/20150707_secondpublicconsultation/decision.pdf?la=en

[27] https://www.ofcom.org.uk/about-ofcom/latest/media/media-releases/2015/2016-spectrum-auction

4.4 Other Countries

According to the Global TD-LTE Initiative (GTI) "Regulators in (ITU) Region 3 have speeded up the planning of this band and it is expected to finish the planning soon in some representative countries, e.g. in Japan and China".

According to the GTI, in Japan, "introduction of LTE-Advanced systems to 3400 – 3600MHz band was studied during 2012-2013. The technical requirements such as the coexistence with the incumbent systems (satellite, and microwave links) were concluded." Japan has granted spectrum to three operators: KDDI, Softbank, and DoCoMo have each been granted 40MHz of spectrum in the 3.5GHz band.

As per the GTI, "in South Korea although some of the capacity in the 3.5 – 3.7GHz range is used for fixed satellite services, the government plans to release at least 160MHz of capacity at 3.5GHz for mobile broadband services by 2018 as part of its Mobile Gwanggaeto Plan."

In Europe, the Communication[28] dated October 2016 from the European Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Regions, entitled "5G for Europe: An Action Plan", the European Commission clearly states "3.5GHz seems to offer high potential to become a strategic band for 5G launch in Europe". In fact, the 3.5GHz and 700MHz bands were identified to be pioneer spectrum bands for 5G.

4.5 Current Use of 3.5 GHz Band in Hong Kong

Band 42, which covers 200MHz of TDD spectrum (3.4GHZ to 3.6GHz) overlaps with Extended C-band used for satellite TV reception in Hong Kong. OFCA claims that there are currently 1,600 SMATV systems for residential use, connected to some 900,000 households in Hong Kong.

However, initial Contactica research indicates that:

- There is not a complete overlap between C-band and the spectrum of interest to MNOs.

[28] https://ec.europa.eu/digital-single-market/en/news/communication-5g-europe-action-plan-and-accompanying-staff-working-document

- Possible interference to satellite services in the 3.4GHZ to 3.6GHz band; the SMATV Table 29 issued by OFCA, indicate that there are only 2 satellites with services in the 3.4GHZ to 3.6GHz band in Hong Kong and they do not appear to be targeted at mainstream audiences, viz Thaicom 5 (serving only 70,000 households, whose transponder is at 3,408 3,563MHz and Palapa D (unknown number of households served). The remaining satellites, from currently publicly available information, do not carry TV channels in the extended C-band.

This implies that the work needed to migrate satellite out of this band should be fairly straightforward. For example, the Ku band, offering better performance and already widely used throughout the world for DTH satellite transmissions, is a logical choice for any required migration.

However, as not all the 3.4 GHz to 3.6GHz spectrum is currently being used, it is first necessary to determine just how much is actually being used, and clear sufficient bandwidth to facilitate immediate co-existence with mobile. Release of this spectrum to mobile could be done in phases and testing on mitigation techniques should be conducted if necessary.

4.6 Recommendations

The 3.5GHz band is an excellent choice for mobile development in the near term and has already been partially or fully allocated in many other countries. As such OFCA must:

- Immediately investigate the actual usage of this band by the satellite operators.
- Accurately determine the “actual” number of SMATV customers.
- Identify the spectrum that could be immediately released to the mobile operators and issue a phased spectrum release plan.
- Plan for the migration of FSS services to a higher frequency band, e.g. Ku band where spare spectrum is available
- Specify a date when this band in its entirety will be made available to mobile.

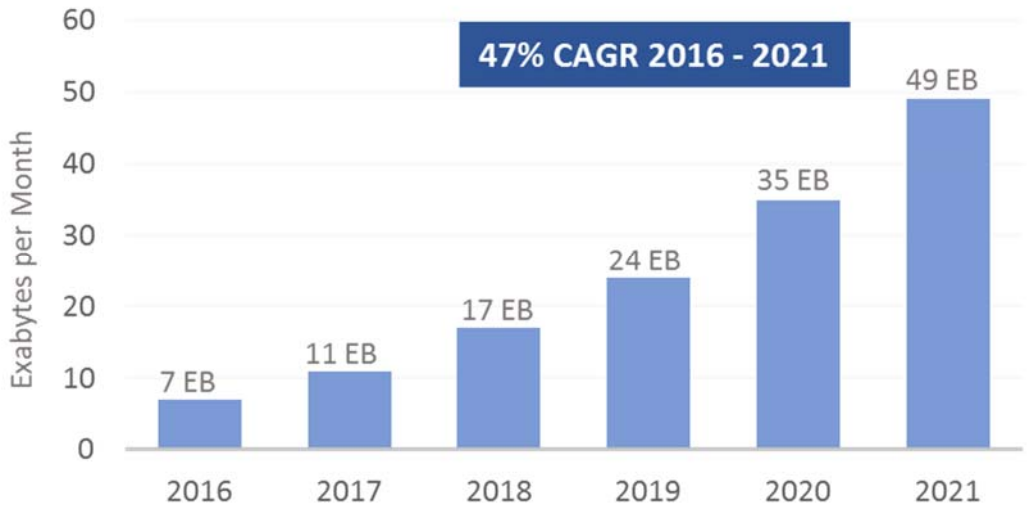
[29] http://www.ofca.gov.hk/filemanager/ofca/en/content_295/st_smatv.pdf

5. The Socio-Economic Benefits of Spectrum

5.1 Increasing Demand for Spectrum

Spectrum is a fundamental resource of the digital society. It is a key input to the production of telecommunications services – both fixed and mobile. Over the next four years, the amount of mobile data traffic is forecast to increase from 11 ExaBytes[30] (EB) in 2017 to 49 EB in 2021[31] as shown in Figure 18.

Figure 18: Global Mobile Data Forecast 2016 – 2021



Source: CISCO VNI 2017

The increase in the demand for mobile data traffic will, in turn, create a greater need for more spectrum. To respond to this need for more spectrum, network operators can take a number of measures to use existing spectrum more efficiently; for example, increasing the number of base stations, encouraging substitution by WiFi and deploying more recent, more efficient generations of technology.

However, it is inescapable that more spectrum will be needed to support increased demand. The GSMA has estimated that increased data traffic will require an extra 600 – 800MHz of

[30] 1 EB = 10^{18} bytes. This is equivalent to one billion GigaBytes

[31] CISCO (2017) 'Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2016 – 2021'

spectrum on average per country[32]. An above average amount of extra spectrum may be needed in Hong Kong because, first, demand in Hong Kong over the past ten years has grown at a compound annual growth rate of 81%[33], which is well above the global average of 65.5%[34] and, secondly, the amount of spectrum available to operators in Hong Kong is below the global average for advanced economies.

If sufficient spectrum is not available to network operators, and ultimately consumers, the economic benefits that will come from advanced mobile data applications cannot be realised.

5.2 The Socio-Economic Benefits of Mobile Data Services

> "Projections indicate that use of the 700MHz band for mobile broadband will generate substantial economic benefits globally. As an example, in Brazil, it is anticipated that it will contribute an additional US$1.4 billion to the Brazilian GDP, create over 4,300 new job opportunities and generate additional tax revenues of $1.3 billion by 2020, according to a report from ATDI. If any country doesn't move quickly to make the 700MHz spectrum available to operators, then it is very likely that they will be unable to take advantage of these positive economic benefits, both from a consumer and a business point of view." [35]

The direct value of spectrum can be fairly easily ascertained by putting it up for sale and seeing what potential users are prepared to pay. However, the true value of spectrum extends beyond the purely financial benefit for the licensee to widen socio-economic benefits for society. The wider socio-economic benefits of spectrum used for mobile services has been the subject of much analysis by academic researchers and other interested bodies, such as the European Commission, national regulatory authorities and the GSMA. This part of the report highlights some of the key findings from these studies.

---

[32] GSMA 'Data demand explained' June 2015

[33] Authors' calculation based on OFCA data.

[34] Authors' calculation based on CISCO VNI data.

[35] GSMA Blog "The need for 700 MHz spectrum can't be underestimated" 15 June 2016. http://www.gsma.com/newsroom/blog/need-700-mhz-spectrum-cant-underestimated/

One of the most widely cited academic papers was written by Hazlett and Gomes in 2009[36]. They examined the consumer welfare gains that followed from the release of spectrum in a panel of 28 countries. Two highlights from their empirical analysis were:

- The UK 3G auction, of 140MHz of 2.1GHz spectrum, held in 2000 yielded a consumer welfare gain of $39 billion.
- An increase of 60MHz in the USA on a base of 170MHz was associated with retail price declines of 8% per annum and a raise on consumer surplus of $8.8 billion annually.

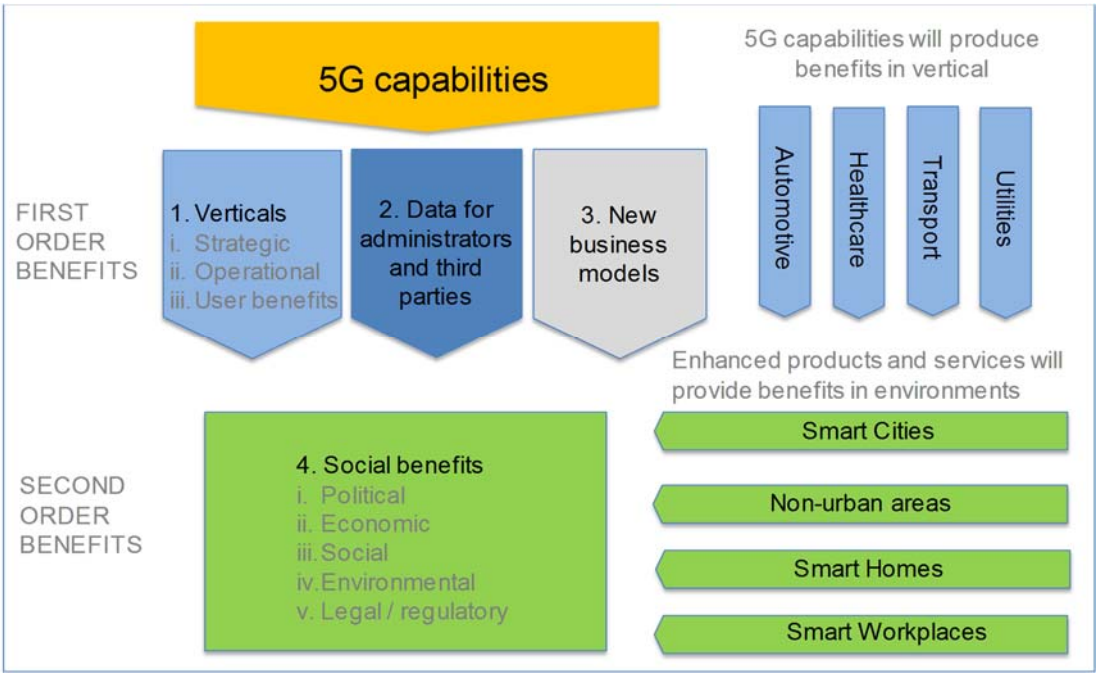
Among their overall conclusions was that "the amount of allocated spectrum and the degree of market competitiveness are key drivers of retail market outcomes". It follows that not allocating spectrum than can be used by mobile operators and/or restricting the level of competition in the market reduces consumer welfare causing economic harm.

Tech4i[2] et al in a report for the European Commission[37] (EC) have taken a more forward looking approach and developed a model for capturing the first and second order benefits of 5G capabilities with a specific focus on four vertical industry segments. Their model is shown in Figure 19.

[36] Hazlett, Thomas W., and Roberto E. Muñoz. "A welfare analysis of spectrum allocation policies." The Rand Journal of Economics 40.3 (2009): 424-454.

[37] Tech4i[2], Realwireless, Trinity College Dublin and InterDigital (2016) 'Identification and quantification of key socio-economic data to support strategic planning for the introduction of 5G in Europe' https://ec.europa.eu/digital-single-market/en/news/5g-deployment-could-bring-millions-jobs-and-billions-euros-benefits-study-finds

Figure 19: Benefits and Impact Modelling of 5G Capabilities



Source: Tech4i^2 et al, Figure 7

First order benefits are described as focussing on the direct benefits for producers of goods and services and themselves break down into three types:

- The industry sectors studied in the report will utilize 5G services to obtain strategic and operational benefits to support and develop their core activities;
- Data and information for administrators and third parties benefit from the opportunity to enhance the provision of services including traffic management, security and healthcare;
- New business models to take advantage of the enhanced capabilities of 5G networks.

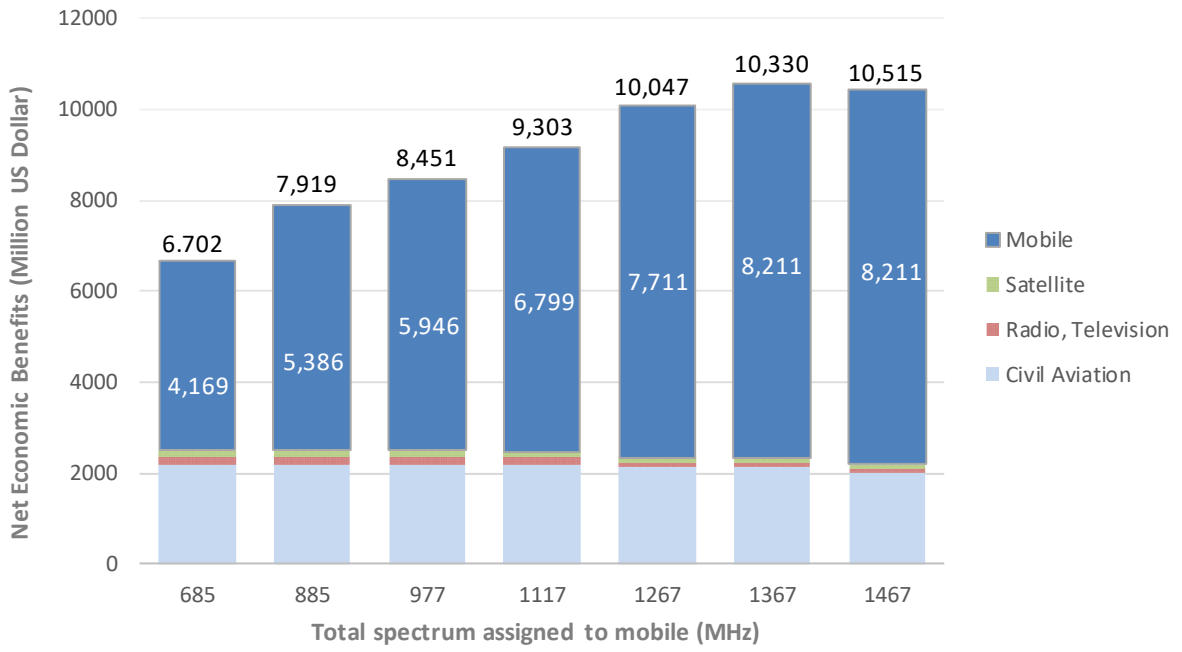
These first order benefits then have “knock on” or second order impacts arising from the use of goods and services. Second order benefits are generally more indirect benefits to society and a whole. According to Tech4i^2 et al these could include enhanced productivity, reduced pollution and enhanced security. These benefits are realised in the workplace, the home, non-urban areas and in cities.

Tech4i^2 et al quantify the first and second benefits for the four vertical market sectors across the whole of the European Union. They estimate these to be €62.5 billion of first order benefits and a further €113.1 billion of second order benefits, against a total deployment cost of 5G of €56.6 billion by 2025.

Another study that examined the potential economic benefits of spectrum took Vietnam as a case study and was conducted by the Vietnam National University and the Economic Research Institute of Post and Telecommunications[38] for the GSMA. This study also examined the additional spectrum needed to realise these benefits and the cost of spectrum not being available.

A key finding of this study is how the economic benefit from spectrum is related to the spectrum available. It found that the net economic benefit arising from mobile services would increase by almost 50% in 2020 as spectrum increased from the base scenario (the spectrum allocated at the time of the research in 2015). The results or their analysis are shown in Figure 20.

Figure 20: Comparison of Scenarios in 2020



Source: Vietnam National University and the Economic Research Institute of Post and Telecommunications

The left most bar on the chart shows the base scenario with no more spectrum released or reassigned from other applications, i.e. 685MHz. Each bar to its right shows the effect of

[38] ERIPT and FET-UET (2015) 'The socio-economic impact of allocating spectrum for mobile broadband services in Vietnam'

releasing or reassigning more spectrum. For example, the first bar to the right, labelled 885 MHz, is the effect of all remaining IMT identified spectrum (a further 200Mhz) being made available to mobile operators, which has no effect on other spectrum using sectors. The bar to the right of that shows the additional benefit when 90MHz of the 700MHz band is also made available and this has some cost effect on broadcasters.

The conclusion is that with each additional amount of spectrum there is a net economic gain driven through the economic benefits from mobile communications, until the final right hand bar.

Over and above the quantifiable economic gain, the authors identify three social benefits associated with the development of mobile broadband:

- Innovation that creates new businesses and employment outside the mobile sector;
- Bringing mobile and internet access services to rural communities; and
- Improved public access to education and health services and e-government for all.

The UK regulator, Ofcom, planned to release 700MHz spectrum in 2021, but in October 2016 decided that the release of this spectrum would be brought forward to 2020[39]. In this statement, they quantified the likely economic benefit of bringing the spectrum release forward. The 700MHz band in the UK has been used for analogue TV, which was switched off at the end of 2012. The band was then used largely for digital terrestrial TV (DTTV) although it was always planned that this would be moved to the 600MHz band to allow 700MHz to be used for mobile data. Ofcom granted 700MHz licences to DTTV broadcasters on a temporary basis and retained the right to clear the band early if necessary.

In its 2014 Statement on 700MHz spectrum[40], Ofcom estimated that the benefit of changing the use of this spectrum from DTTV to mobile data would total between £900m and £1.3 billion, largely attributed to lower network costs from needing fewer base stations and improvement in performance in hard to reach locations. They further estimated that most of these savings would be passed on to consumers through lower prices.

---

[39] Ofcom (2016) 'Maximising the benefits of 700MHz clearance: enabling acceleration of 700MHz clearance and use of the 700MHz centre gap' https://www.ofcom.org.uk/consultations-and-statements/category-1/maximising-benefits-700mhz-clearance

[40] Ofcom (2014) 'Decision to make the 700 MHz band available for mobile data – statement' https://www.ofcom.org.uk/__data/assets/pdf_file/0024/46923/700-mhz-statement.pdf

Against this benefit, Ofcom estimated costs of up to £660m, though stressed that there was potential for reduction in these costs as better information becomes available. The resulting minimum net benefit, therefore, would be £240m

The 2016 statement[41] estimated the additional benefit of bringing the change of use of the 700MHz forward by 18 months. Ofcom calculated the benefits as between £19m and £60 over the period against costs of between £14 - £15m. On top of these quantified benefits would be a number of unquantified benefits. Figure 21 is extracted from the Ofcom statement and shows the identified costs and benefits.

[41] op cit footnote 18

Figure 21: Summary of economic costs and benefits of bringing forward the release of the 700 MHz band to Q2 2020 in 1st January 2016

Benefits	Quantified Benefits	Total Benefits
18 months' extra national availability of paired spectrum	£19m - 55m quantified benefits.[20] Some unqualified benefits on top of this	£19m - 60m of quantified benefits
18 months' extra availability of centre gap	Scale of benefits uncertain but estimated at up to £5m	
95 - 99% of households retain access to interim multiplexes for 15 months longer than other end 2021 plan	Scale of benefits not quantified	Some unqualified benefits which could be small but could also prove significant
Costs	**Quantified Costs**	**Total Costs**
Incremental cost of increase to PSME	£5m	£14m -£15m of quantified costs
Consumer related costs	£1m - £2m	Unquantified cost resulting from reduction in coverage of interim multiplexes. Likely to be outweighed by unquantified benefits of interim multiplexes running beyond the end of 2018
Incremental infrastructure economic cost [21]	£8m	
1 - 5% households lose access to interim multiplexes early	Unquantified - not likely to be material to our analysis. Outweighed by viewer benefits.	

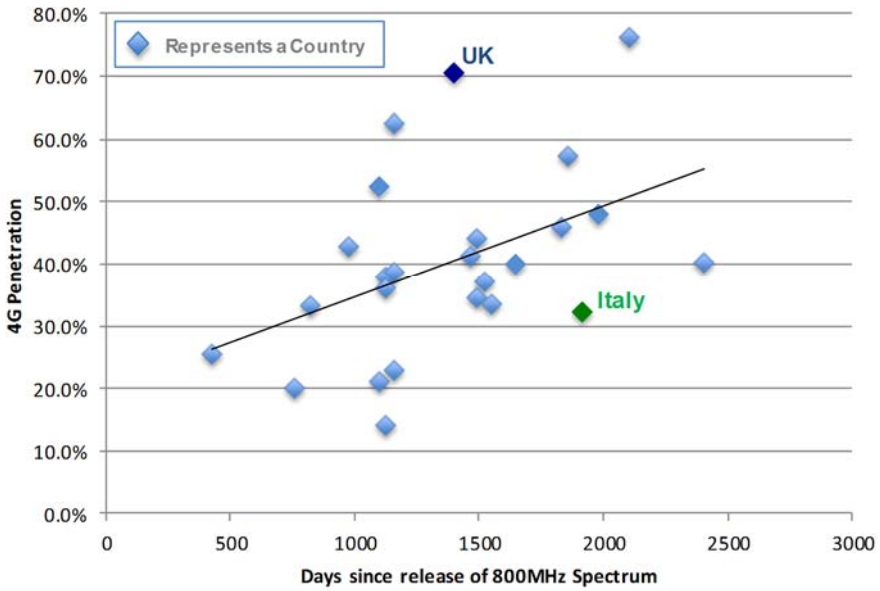
Source: Ofcom

We have undertaken our own analysis of the relationship between timing of the release of data and consumer outcomes, in particular the level of take up of mobile data services. Our analysis is based on a report on the social and economic benefits of spectrum harmonization

policy in Europe published by the GSMA[42]. That study focussed on 800MHz band and examined timing of release of spectrum along with other policies related to, for example, auction design. One of their five core findings was that citizens have benefited where EU Member States licensed spectrum earlier. Through a series of simple correlations, they show a positive correlation between the spectrum award date and the take up and coverage of 4G.

We have produced our own correlation using data from the GSMA report and other sources to plot the relationship between the length of time since 800 MHz was released and the penetration rate of 4G at the end of 2016 for EU countries. This is shown in Figure 22.

Figure 22: Correlation between release of 800MHz Spectrum and 4G subscriptions



Source: Contactica

In the chart, each diamond represents a country and shows the level of 4G penetration on the Y axis and the number of days since release of 800MHz spectrum on the X axis. The upward sloping line is the trend line and has a correlation coefficient of 0.45 or 45%.

[42] GSMA (2015) 'The socio-economic benefits of greater spectrum policy harmonization in the EU' http://www.gsma.com/spectrum/socio-economic-benefits-of-greater-spectrum-policy-harmonisation-in-the-eu/

Two countries have been highlighted; the UK (blue) and Italy (green). The relative positions of the UK and Italy are of particular interest. The UK has a penetration rate substantially higher than the trend line. If it were on the line it would have a penetration rate a little above 40% whereas it is in fact over 70%. There are two potential reasons for this difference. First, one operator, EE, was permitted to use its 1800MHz for 4G services in August 2012: six months ahead of the release of 800MHz, giving 4G a head start. Secondly, and in contrast to Italy, there were just six months between Ofcom's 800MHz auction and the clearance of the spectrum allowing the launch of 4G services. Vodafone and O2 launched their first 800MHz 4G service in August 2013, a whole year after EE.

In Italy, the auction took place in September 2011, but the spectrum was not cleared until Q1 2013. It may not be surprising, therefore, that penetration in Italy lags behind the trend as it took so long to clear the spectrum.

Based on the evidence presented in the report, the GSMA recommends that countries are encouraged to make new mobile bands available to capture the full economic benefits as soon as possible. The GSMA also recommends that countries should look to harmonise best practice concerning spectrum clearing, again to ensure spectrum is available for use as soon as possible.

Hong Kong's early release of spectrum in the 850MHz band is not matched by release of 700MHz or 3.5GHz spectrum, where it is now lagging behind many other countries.

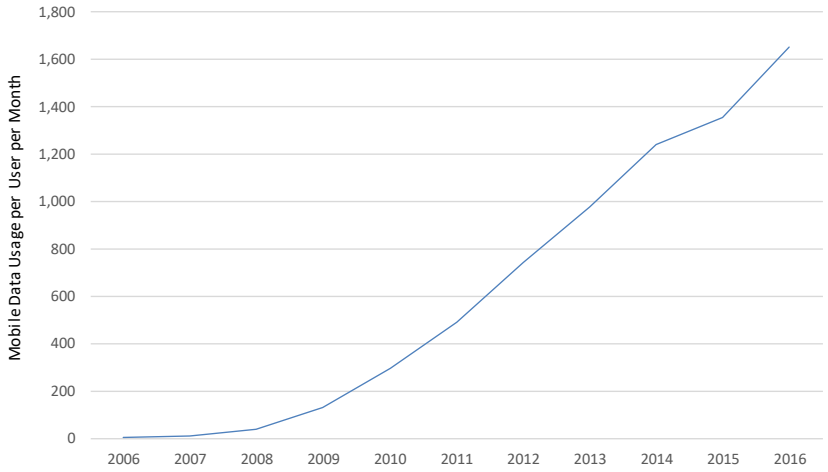
3.3. The Important Role of Government Policy

Spectrum is a finite resource allocated under licence to operators. The government, or its agent, controls supply of spectrum such that, in economic terms, the supply curve is perfectly inelastic as supply does not increase in response to demand, as would happen if spectrum was not finite and supplied under market conditions. By contrast, demand is set in the market by consumers making price/utility trade-offs.

The increasing variety of actual and potential applications for spectrum means that demand is increasing even when price remains the same. Economically, the downward sloping demand curve is shifting to the right as consumers are prepared to use more mobile telephony at the same price. We do not have access to industry wide price data and so are

unable to calculate the relationship between prices and demand. However, we can see that demand for data in Hong Kong is growing exponentially, as seen in Figure 23.

Figure 23: Growth in Mobile Data Usage per User in Hong Kong



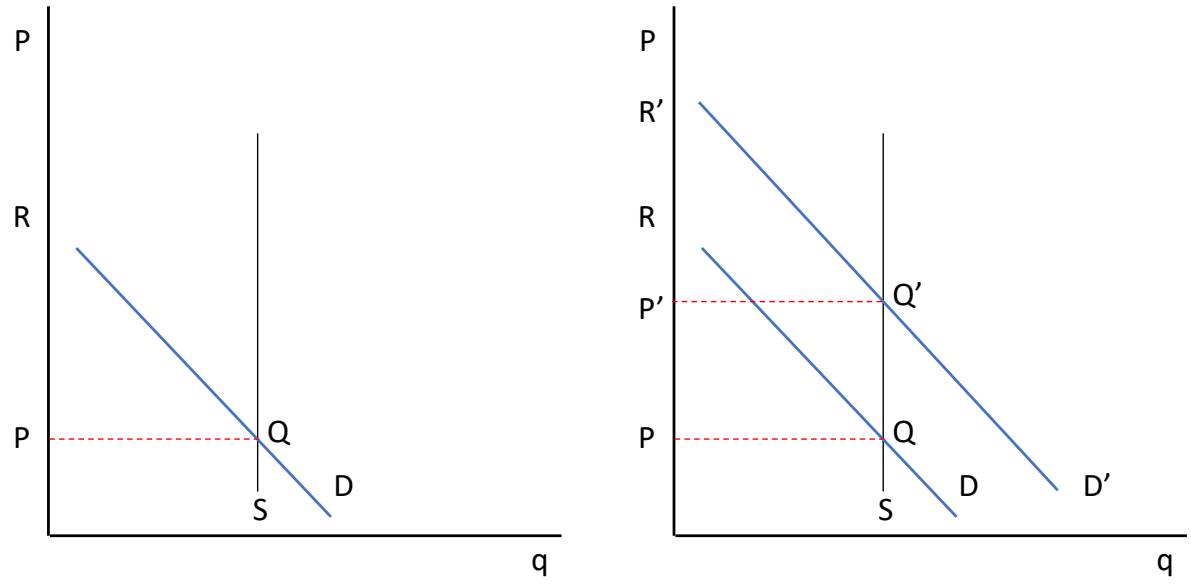
Source: OFCA

Once demand exceeds supply then usage can only be managed by suppliers raising prices to reduce demand, leading to a consumer welfare loss. The size of the loss depends on price elasticity of demand and the size of the rightward shift in demand. This is illustrated in Figure 24.

The left-hand panel represents the situation at time T_0. The vertical line S is the supply curve and the sloping line D, demand. Price (P) is set where the demand and supply curve intersect. The triangle PQR represents consumer surplus.

The right had panel illustrates the change in demand at time T_{0+1} when the demand curve has moved to the right, illustrated as D'. However, as the supply of spectrum is inelastic, it cannot respond to the new demand conditions and so price rises to P' and the new consumer surplus is represented by the triangle P'Q'R'.

Figure 24: Consumer Welfare Effects with Perfectly Inelastic Supply



Source: SPC Network

By how much consumer surplus changes depends on the gap between D and D' and the slope of the demand curve. However, if the area of P'Q'R' is less than PQR then there is a decline in consumer surplus. Even were P'Q'R' to be equal to PQR there would be no increase in consumer surplus from the change in demand conditions.

To reduce this welfare loss the obvious response is for governments to release more spectrum to ensure a welfare gain for consumers so that prices can remain at P.

A second order effect is that industries that could build applications that use additional spectrum are unable to do so. At least some of the economic activity of those industries would generate will be lost or moved to another jurisdiction.

However, it should be noted that there might be some social cost if the additional spectrum needed to satisfy the new demand levels is already occupied. Reallocating spectrum from one use to another may cause some loss, but if the use of that spectrum is more valuable to mobile than to existing users, then there will be an economic gain from the reallocation.

Although there are some ways in which spectrum can be used more efficiently, as was noted earlier, more spectrum will be needed to support increased demand. Only the government

and its agents can make more spectrum available. Unless spectrum is released in a timely fashion it is likely that existing spectrum will become congested and the only response mobile networks can make to try and control the amount of traffic on their network is to raise the price to deter usage. This will have a detrimental economic effect on users with commensurate knock-on effects on the wider economy.

6. Conclusions

This report has surveyed the growing subscriber demand for mobile data and the resulting spectrum requirements. It has highlighted the situation with regard to availability of appropriate spectrum in Hong Kong and compared that with a selection of benchmark countries. In doing so we have found that:

- Hong Kong has the least amount of available spectrum amongst the five countries / regions reviewed.
- Consequently, the gap between spectrum in Hong Kong and the forecast need for spectrum is the largest amongst these six countries.
- Whilst many countries have a roadmap for the release of spectrum in future, giving mobile operators information to help plan expansion, no such roadmap exists in Hong Kong. In fact, OFCA's latest Spectrum Release Plan for 2017 – 2019 issued on the 21st February 2017 states that there is no spectrum available for release during this three-year period.

The report has surveyed evidence from various studies on the socio-economic benefits of spectrum availability. It has found compelling evidence that there are net gains from increased availability that, combined with effective competition, means that consumers and society more broadly are the prime beneficiaries of more spectrum. The flipside of this finding is that insufficient spectrum means consumers and society will not realize these gains. As a natural and finite resource, only the government or appropriate agency can ensure sufficient spectrum is available for license.

Two spectrum bands have been highlighted in this report that are already being used for mobile broadband, but for which there are currently no firm plans or detailed roadmap to release in Hong Kong, i.e. the 700MHz and 3.4GHz – 3.6GHz bands

The 700MHz is the "digital dividend" band which becomes available with the switch off of analogue TV (ASO). Most countries have either switched off analogue TV or have plans to do so in the near future, allowing this spectrum to be released for mobile broadband. Hong Kong has a "working target" date for ASO of 2020, but this date has already been deferred twice. The band cannot be used for mobile until it has been cleared of analogue TV signals, however, our research indicates that the vast majority of Hong Kong households already receive digital TV. It is therefore our view that OFCA should set an earlier date for ASO,

perhaps 2018, and produce a clear timetable for this spectrum to be released to mobile operators. This could be in advance of ASO, as happened in Singapore.

The 3.4GHz – 3.6GHz band has characteristics that are particularly useful for advanced mobile data services. It has already been made available in many countries and there are plans to make it available soon elsewhere. Again, other than OFCA's recent statement indicating that the CA will launch a public consultation in the second half of 2017 on the vacation of the 3.4GHz – 3.7GHz band (currently assigned for fixed satellite service provision), with a view to re-allocating it to mobile services in 2020, there is currently no firm plan for its release in Hong Kong. From our research, the use of this spectrum for satellite TV in Hong Kong is very limited and we therefore see no reason for further delay in setting a clear timetable for release of this spectrum, as co-existence is technically possible in the interim.

Overall, if Hong Kong is to maintain its reputation for being at the forefront of mobile technology developments, it needs to take action, initially by setting a clear roadmap for the timely release of additional spectrum.