AsiaSat
Reaching Further, Bringing You Closer

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6 September 2017
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Wanchai, Hong Kong
Attention: Senior Telecommunications Engineer (Spectrum Planning) 1

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Comment on the Proposed Change in the Allocation of the 3.4-3.7 GHz Band from Fixed Satellite Service to Mobile Service, Consultation Paper, 27 July 2017

Dear Sir/Madam,

AsiaSat notes OFCA's consultation paper on 27 July 2017 on Proposed Change in the Allocation of the 3.4-3.7 GHz Band from Fixed Satellite Service to Mobile Service and would like to offer its views and comments.

This topic has been discussed within the Radio Spectrum and Technical Standards Advisory Committee (SSAC) during November 2016 and March 2017. AsiaSat has submitted its comment on SSAC Paper 9/2016 on 15 November 2016 (See Annex 1), gave a presentation (See Annex 2) and submit a white paper (See Annex 3) on this topic at the March 2017 meeting of SSAC. On 23 February 2017, AsiaSat's CEO also sent a letter to OFCA's Director General, Ms. Elisa Lee, on this topic, in support of the position of OFCA as expressed at the November 2016 SSAC meeting (See Annex 4). This presentation, papers and this letter are on exactly the same topic as that of this consultation and we therefore request that these four annexes (Annex 1 to Annex 4) are considered as a part of our response to this consultation.

At the November 2016 meeting of SSAC, in response to the proposed allocation of the 3.4-3.6 GHz to MS and use for IMT (5G), OFCA, as reflected in the minutes of that meeting, recognized that some other countries, including China are considering or have decided to deploy IMT in this band. However, OFCA, in its response in SSAC document 9/2016 highlighted that within Hong Kong, C-band is received by some 1,600 SMATV systems and 900,000 outlets in Hong Kong. Furthermore, OFCA observed that the findings of the most recent ITU-R Report on the relevant matter which was published in 2015 are in line with that of the above OFTA tests. Consequently, OFCA concluded that the 3.4-3.6 GHz band is not usable for IMT due to harmful interference to existing services.

AsiaSat also notes that in its press release on 10 January 2017, OFCA again recognizes the technical incompatibility between IMT in 3.4-3.6 GHz and C-band satellite reception in Hong Kong and the need to avoid any impact on the existing services ("*At present, there are some 1600 Satellite Master Antenna Television (SMATV) systems for residential use and they are*

connected to some 900 000 residential premises. As such, should the 3.4 - 3.6 GHz band be released for the mobile services, we must first tackle the problem of technical compatibility between the mobile services and the satellite services to avoid any impact on the existing services.")

With OFCA's in-depth understanding of the topic and actively conducting both technical studies and field trials leading up to the report of the Asia-Pacific Telecommunity, fully recognizing the incompatibility between IMT in the 3.4-3.6 GHz and general satellite reception within the entire 3.4-4.2 GHz band in a geographically small area as Hong Kong, AsiaSat is surprised to see what might appear a sudden change of position of OFCA.

Hong Kong has over the years established itself as a telecommunications hub in the Asia-Pacific region with several major teleports serving the entire region. Satellite links are key to this operation and signals from domestic and international satellites are received and redistributed. It has been stated, and correctly so, that the band 3.4-3.6 GHz is less used by satellite networks than the 3.6-4.2 GHz band. However, key satellite operators for Hong Kong, aside from AsiaSat such as Apstar and ChinaSatcom operate in this band. More importantly, it has been clearly demonstrated that there are significant adjacent band incompatibilities. It has been thoroughly proven by ITU, APT and OFTA studies as well as through practical experience from BWA/WiMax operation in other countries that operation of IMT in 3.4-3.6 GHz would be incompatible with general FSS reception in the 3.6-4.2 GHz band within such a small geographical area as that of Hong Kong.

Hong Kong has two satellite operators controlling their satellites through stations located in Hong Kong. These control links are in C-band. To enable safe operation of the satellites, it is instrumental that the control links are kept free from interference.

OFCA indicates that there are about 1,600 SMATV systems with 890,000 user outlets throughout Hong Kong in addition to an unknown number of individual receivers. OFCA mentions that these are not licensed under the Telecommunications Ordinance (TO). However, this does in no way mean that there is anything illegal about such reception or that they should not be protected.

AsiaSat also observes that there is a large number of VSAT networks having user terminals and/or hubs located at teleports and at various customer premises throughout Hong Kong. This also includes networks for program feeds between TV stations. A good portion of the VSAT networks operate at C-band.

For Hong Kong to be able to retain its role as a telecommunications hub and to safeguard the above satellite activities, it is vital that C-band reception is protected also in the future. Within such a limited geographical area as that of Hong Kong, this cannot be achieved if IMT is deployed in 3.4-3.6 GHz. Consequently, AsiaSat strongly advices against allocating the 3.4-3.6 GHz band for the mobile services and identifying it for IMT.

In the following sections, AsiaSat provides its views and comments to the questions raised by OFCA.

Question 1
What are your views on the above Proposed Re-Allocation?

AsiaSat is against the proposed re-allocation.

First, AsiaSat is against losing access to and protection of 300 MHz of satellite bandwidth in a time when pressure on access to satellite spectrum resources is increasing both from increased satellite use and from terrestrial applications lying their eyes on various portions of the satellite spectrum. While the 3.4-3.6 GHz band may be less used (although several of the key satellite operators for Hong Kong have this band on their satellite fleet), the 3.6-3.7 GHz is heavily used by a multitude of satellites, including all AsiaSat's C-band satellites.

Second, OFTA's, ITU and APT studies all show that IMT and FSS reception in the same area is not only infeasible within the same frequency range; it is also infeasible in adjacent frequency bands. Consequently, within a limited area as that of Hong Kong, IMT in 3.4-3.6 GHz is incompatible with FSS in 3.6-4.2 GHz, even 3.7-4.2 GHz.

Question 2
Do you agree with the principle of protecting existing SMATV/EFTNS/SPETS systems operating in the adjacent band of 3.7-4.2 GHz with the implementation of the mitigation measures?

AsiaSat agrees that any satellite reception, including SMATV/EFTNS/SPETS systems need to be protected against interference if IMT is to be introduced and such satellite reception protection should be granted in the entire 3.4 - 4.2 GHz. This also includes direct-to-home (DTH) antennas, VSATs and TT&C stations. When OFCA says that all antenna installations not licensed under the TO will not be entitled to any protection, including existing antenna installations, AsiaSat strongly disagrees. Such use is fully legitimate under current rules and fully in line with current regulatory provisions. For this reason, these antennas installations need to be offered the same protection against IMT as other antenna installations.

From OFTA's field trials, it was shown that at least the filter selected at that time had limited suppression of the adjacent band. Another factor is that front-end filters can only mitigate against LNB overdrive. Interference from unwanted emissions (spurious and out-of-band) of IMT equipment cannot be mitigated by such measures and would require emission mask specifications of IMT equipment to offer adequate protection of satellite reception.

When OFCA, in respect of TT&C stations, assumes that "*the domestic satellite operators would have the necessary technical expertise and resources to implement mitigating measures to alleviate any impact on their systems arising from the Proposed Re-Allocation*", AsiaSat observes that while having the required technical expertise, the satellite operators may not have the required authority to enforce measures to ensure safe TT&C operation, e.g. in respect of imposing required exclusion zones around Earth stations for protection in 3.4-3.6 GHz, 3.6-3.7 GHz and/or 3.7-4.2 GHz, unwanted emission masks on IMT equipment, etc.

In respect of retrofitting all existing FSS receiving antennas with front-end waveguide filters, AsiaSat observes that DTH and SMATV antennas normally have the LNB and feedhorn molded together in one unit. It would therefore not be physically possible to insert a waveguide filter in between and the whole antenna installation would need to be changed. Due to the loss induced before the LNB by the filter, antennas might also need to be replaced with larger antennas to compensate for the losses. AsiaSat also recalls that front-end waveguide filters are expensive, with a price that could easily exceed that of the entire DTH or SMATV receiver.

Any attempt to mitigate interference from IMT, for FSS reception in 3.4-3.6 GHz, 3.6-3.7 GHz and/or 3.7-4.2 GHz, for teleports, TT&C stations, VSATs, SMATVs, DTH, ….., would include a cost. This would also apply to later antenna installations. The question is who should bear this cost. AsiaSat is of the view that it would not be reasonable to impose this cost on the satellite users, but that it rather would need to be imposed on the newcomers if not to be covered by OFCA. This in turn could lead to a discussion as to what would be the required mitigation measures and the satellite users might not have what in their view would be the required measures. Also, how to cope with the increased costs for later antenna installations is not clear to AsiaSat.

Question 3
for implementation of the Proposed Re-Allocation, please suggest or give your views about any mitigating measures to be implemented for the existing systems as well as any precautions to be taken for the operation of the new mobile base stations to be operating in the 3.4-3.6 GHz band.

For mitigation measures, depending on whether the interference is in-band or adjacent band, different mitigation measures may be implemented, either on the IMT side or on the FSS side.

For in-band mitigation techniques, e.g. for protection of existing TT&C or other Earth stations, AsiaSat believes the only way to offer protection is ensure that the IMT signal is sufficiently attenuated at the Earth station location. This can be done by a combination of various measures such as use of MIMO techniques, antenna downtilting, in-door only deployment, low-power base stations and exclusion zones. In addition, it is important that when not in contact with the base station, the user terminal does not have any emissions. Noting ITU studies (ITU-R Report S.2368) which indicates required separation distances in the order of several kilometers even for small-cell indoor IMT deployment, AsiaSat wonders if any realistic IMT operation within Hong Kong can offer adequate protection to FSS reception in 3.4-3.6 GHz.

For adjacent band, in addition to the techniques available to the in-band case, tighter limitations on unwanted emissions of IMT equipment and front-end waveguide filters, in combination with guardbands, would seem to be available. To what extent these mitigation techniques are effective, can be applied and with what limitations is discussed under Question 2 above.

Question 4
What are your views on effecting the Proposed Re-Allocation in the early 2020, giving an advance notice period of two years if the relevant decision of the CA is made in early 2018?

Satellites have an operational life of 15-20 years. All the satellites operating in the AsiaSat locations have an operational life long beyond 2020. Furthermore, all the AsiaSat satellites in the various AsiaSat locations as well as other operational satellites serving Hong Kong, including satellites of other Hong Kong satellite operators, have transponders on-board in the 3.4-3.7 GHz band that will remain operational well after 2020.

Should OFCA decide to remove the FSS allocation and make operation in the 3.4-3.7 GHz band unprotected, this means that many Hong Kong satellites would be operational for many years with transponders that cannot be received by its operators within Hong Kong or offered for services including Hong Kong.

This would constitute a significant financial loss for satellite operators. AsiaSat questions who would be made responsible for compensating this financial loss for satellite operators inflicted by such a decision of OFCA.

To enable satellite operators to take into account such a decision by OFCA and adapt their satellite designs accordingly, an advance notice of one satellite life span, i.e. 15-20 years, would be required.

Question 5
What are your views on the need to protect the TT&C channels of the licensed satellite networks at their specific locations from any harmful interference to be caused by public mobile services?

Satellites are very expensive objects and careless or irresponsible operation can potentially inflict large financial and technical damages to other spectrum users, in particular other satellite operators. As a part of the conditions for the Outer Space License, satellite operators are required by their administration, i.e. OFCA for Hong Kong satellite operators, to ensure a safe operation of the satellites.

Monitoring of the functioning and control of satellites is conducted through TT&C stations. The Hong Kong satellite operators control their satellites through TT&C stations in Hong Kong and as is common in the industry, C-band is used for TT&C on all the satellites.

Protection of the TT&C channels is instrumental to ensure a safe and reliable operation of the satellites. Noting that interference from IMT is demonstrated to occur both in-band in adjacent bands, protection of TT&C stations operating in any portion of C-band must be protected. AsiaSat recognize that the interference and protection mechanisms will vary depending on frequency and TT&C station characteristics. However, all TT&C stations must be ensured an interference free environment to ensure a safe operation of the satellites.

Question 6
Do you have any views on other aspects of or issues relevant to this consultation?

AsiaSat has over the years had a good cooperation with OFCA and before that, OFTA, building a common understanding of the technical issues associated if BWA, WiMax and/or IMT were to operate within Hong Kong. Recognizing the in-depth knowledge of OFCA on the incompatibilities between these applications and FSS if both were to operate in C-band, AsiaSat hopes that OFCA will decide not to identify the 3.4-3.6 GHz band for IMT nor block out the 3.6-3.7 GHz band as a guardband.

AsiaSat notes that OFCA claims that IMT in the 3.4-3.6 GHz band is a part of a global trend and that "everybody is doing it". However, to the best of AsiaSat's knowledge, only 9 and 11 countries out of all the countries in the Asia-Pacific have identified the 3 400 – 3 500 MHz and 3 500 – 3 600 MHz bands respectively for IMT within their territory. Moreover, again to the best of knowledge, with the exception of the announced use for the Olympics by Korea and Japan and the trials by China, no other implementations have been announced in the Asia-Pacific.

Furthermore, AsiaSat agrees that if Mainland China implements IMT in 3.4-3.6 GHz, there is a clear danger of interference across the border. However, the solution to this problem is not to bring the interference also into Hong Kong and remove the protection of satellite Earth stations!

Rather, if such implementation is planned in areas in Mainland which might affect satellite reception in Hong Kong, OFCA should take a proactive role and work with MIIT to ensure that appropriate mitigation techniques, including exclusion zones are established to provide adequate protection of Hong Kong Earth stations.

As mentioned in the introduction to this document, AsiaSat has actively participated in the discussions in SSAC on this topic and has given a presentation at the March 2017 SSAC meeting. Also, AsiaSat's CEO submitted a letter to OFCA's Director on 23 February 2017. These contain further elaboration on several aspects of this issue. Consequently, we request that these four annexes (Annex 1 to Annex 4) are considered as a part of our response to this consultation.

AsiaSat would be happy to provide clarification to any questions that OFCA might have on this issue, to prepare any technical material that OFCA might see relevant and to work together with OFCA on this topic.

Yours sincerely,

CHAN Yat Hung
Manager, Spectrum Management
Asia Satellite Telecommunications Company Limited

Annex 1: AsiaSat comment on SSAC Paper 9/2016, 15 November 2016

AsiaSat comment on SSAC Paper 9/2016:

Incompatibility between Fixed Satellite Service and Mobile Service in C-band

Ref 1) Letter from HKT to CEDB and OFCA (ref: 080630/0114) dated 21 September 2016

Ref 2) Letter from CCIB, CEDB to HKT (ref: CCIB/B 480-20-14/1) dated 31 October 2016

AsiaSat noted in Ref 1) that HKT is inviting OFCA to conduct a thorough review in the band 3400-3600MHz and consider release that band to the mobile industry and in Ref 2) that CCIB has provided its reply to HKT regarding the status of that band and highlighting the fact that allocating that band to mobile services would likely cause unacceptable interference to the majority of uses of satellite services.

AsiaSat concurs with OFCA's findings in P.7 - P.8 of SSAC Paper 9/2016 and CCIB's findings and summary in Ref 2) that mobile services in the band of 3400-3600MHz will cause unacceptable interferences to Fixed Satellite Service in the entire band of 3400-4200MHz and would like to provide more information regarding the incompatibility between Fixed Satellite Service and Mobile Service in C-band.

Incompatibility between Fixed Satellite Service (FSS) and International Mobile Telecommunications (IMT)

Extensive studies (see Annex 1 for a list of reports) were carried out in the ITU and APG (Asia Pacific Telecommunity) to study the compatibility between Fixed Satellite Service (FSS) and the Mobile Service (e.g. IMT, BWA). The former OFTA played an active role in this and conducted both studies as well as field trials and was instrumental in the development of the APT Report on compatibility between BWA and FSS (ref. 1 of Annex 1) which in turn was the basis for the development of the ITU Report on the same issue (ref. 2 of Annex 1). All of the studies on compatibility between BWA or IMT and FSS, the latest one being released in 2015, lead to the same conclusion that sharing between FSS and IMT/BWA in the same geographical area is **not feasible**.

As shown in all these studies, there are three different interference mechanisms which will impact FSS reception:

1. **Co-frequency interference**

   Due to the long distance to the satellite and the power limitations of the satellite, the incoming FSS signal's power flux density at the earth station location is very low. IMT equipment which is much closer to the earth station can produce significantly higher power levels at the input to the FSS receiver than the desired satellite signal.

   Depending on the type of IMT deployment considered, studies have shown that separation distances required to offer adequate protection of FSS receivers in respect of co-frequency interference are in the range of five to tens of kilometres for IMT small-cell indoor deployment to several hundreds of kilometres for IMT macro-cell outdoor deployment. It may also be worth noting that in USA, FCC has used a 150 km protection zone around 86 earth stations operating in the 3.65-3.7 GHz range to protect them against terrestrial interference.

2. **Adjacent band interference**

a. Unwanted out-of-band emissions of IMT transmitters

Due to the very low power level of the incoming FSS signals, unwanted emissions generated by IMT base stations or user terminals operating in an adjacent frequency bands, can create interference to FSS receivers.

Depending on the type of IMT deployment considered, studies have shown that the separation distances required to offer adequate protection to FSS receivers in respect of out-of-band emissions of IMT transmitters, assuming no guardband between the satellite and IMT signals, are in the range of less than a kilometer for IMT small-cell indoor deployment, some few kilometres for IMT small-cell outdoor deployment and tens of kilometres for IMT macro-cell outdoor deployment. This required separation distance may be possible to reduce by use of a guardband between the two signals.

b. FSS receiver LNA/LNB overdrive

Earth station low-noise amplifiers (LNAs) and low-noise block down-converters (LNBs) are optimized for reception of the very low power level of the incoming satellite signal and, hence, have a very high sensitivity. Incoming IMT signals at much higher power levels can severely affect the operating point of the LNA/LNB and drive it out of its dynamic range to where it exhibits a non-linear behaviour. This results in the creation of intermodulation products and gain compression which in turn result in distortion and loss of the FSS signal.

Typically, to achieve a low noise figure to allow reception of the very low incoming satellite signals, LNAs and LNBs are wideband devices with a flat frequency response over the wanted frequency range, having the bandwidth defining filtering only at intermediate frequency (IF) stage, not at the LNA/LNB. As a result, IMT emissions in adjacent bands will have the capability to overdrive the LNA/LNB.

Depending on the type of IMT deployment considered, studies have shown that the separation distances required to offer adequate protection to FSS receivers in respect of LNA/LNB overdrive are about a kilometre in respect of IMT small-cell deployment and around 9 kilometres in respect of IMT macro-cell deployment.

AsiaSat observes the consistent conclusions drawn in all the various studies by ITU, APT and other international organizations:

"When FSS earth stations are deployed in a typical ubiquitous manner or with no individual licensing, sharing between IMT-Advanced and FSS is not feasible in the same geographical area since no minimum separation distance can be guaranteed."

(ITU-R Report S.2368)

AsiaSat notes the geographically very small territory of Hong Kong where central parts are located within a circle with radius of about 5 km and the entire territory within a circle with radius of about 25 km (see

figures 3 and 2). AsiaSat also notes that OFCA in its document informs that C-band is extensively used for satellite TV reception by the general public in Hong Kong and involves some 1600 Satellite Master Antenna Television systems and 900 000 outlets used by domestic households throughout Hong Kong. Additionally, AsiaSat notes that Hong Kong is a telecommunications hub for the region, with several important teleports and numerous corporate VSAT terminals.

One single IMT base station can potentially wipe out all the co-frequency satellite C-band reception in Hong Kong and well into mainland China (see figure 1). This is even if IMT is limited to only small-cell deployment.

Similarly, one single IMT station operating in the 3.4-3.6 GHz range can potentially block all the satellite reception in the adjacent 3.6-4.2 GHz band practically in the entire Hong Kong Island and Kowloon area (see figure 3). Even if it would be possible to limit IMT base station and user terminal deployment to only indoor operation, one single IMT transmitter could potentially block all satellite reception in adjacent bands in the entire Central to Causeway Bay area or the Tsimshatsui to Mongkok area (see figure 4).

AsiaSat noted that in Ref 1), HKT has suggested that operators can coordinate their base station installations with other operators to avoid potential mutual interference, however, nothing the above, AsiaSat concurs with OFCA that sharing between FSS and IMT in C-band is impossible in Hong Kong. AsiaSat therefore concludes that the coordination approach as suggested by HKT to avoid mutual interference is not feasible in Hong Kong.

Graphical illustration of the required separation distance applied to the case of Hong Kong

Below is a graphical illustration of the possible required separation distance in case of Hong Kong. Depending on the actual parameters of the IMT deployment, these separation distances may vary from those illustrated. It can be seen that;

- a 150 km exclusion zone (as applied by FCC for co-frequency protection) would block the entire Hong Kong, Macau, Guangzhou and surrounding area (see figure 1);

- a 25 km exclusion zone (to protect against adjacent band operation of outdoor macro-cell deployment) would block the entire territory of Hong Kong (see figure 2);

- a 5 km exclusion zone (to protect against adjacent band small-cell outdoor terminals) would effectively block the entire central parts of Hong Kong (see figure 3);

- a 1 km exclusion zone (to protect adjacent band operation of small-cell indoor terminals) would effectively block the entire Central to Causeway Bay area or the Tsimshatsui to Mongkok area (see figure 4).

Figure 1 (A circle with radius of 150km)

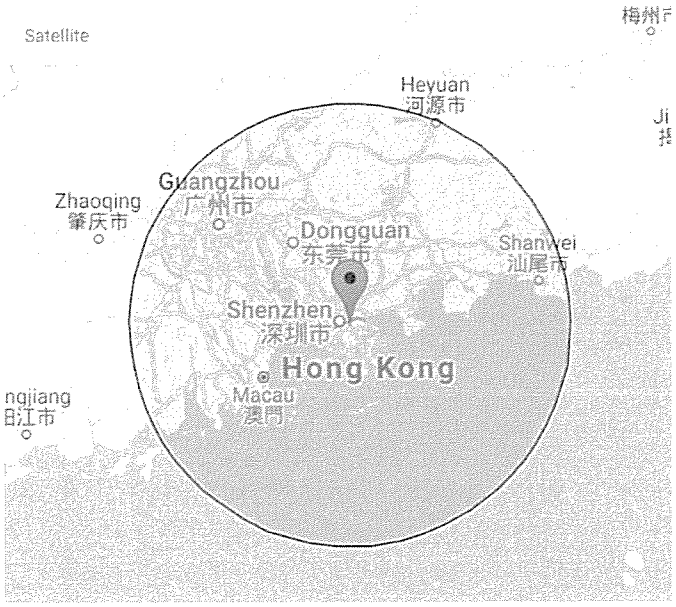


Figure 2 (A circle with radius of 25km)

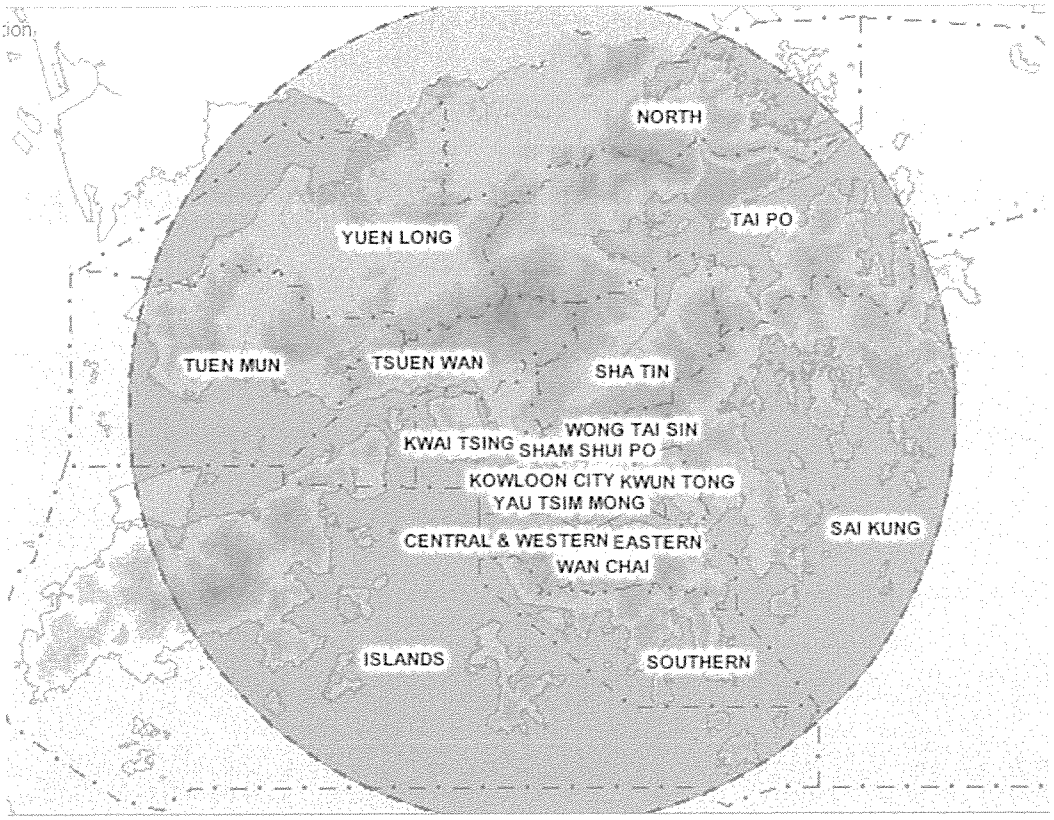


Figure 3 (A circle with radius of 5km)

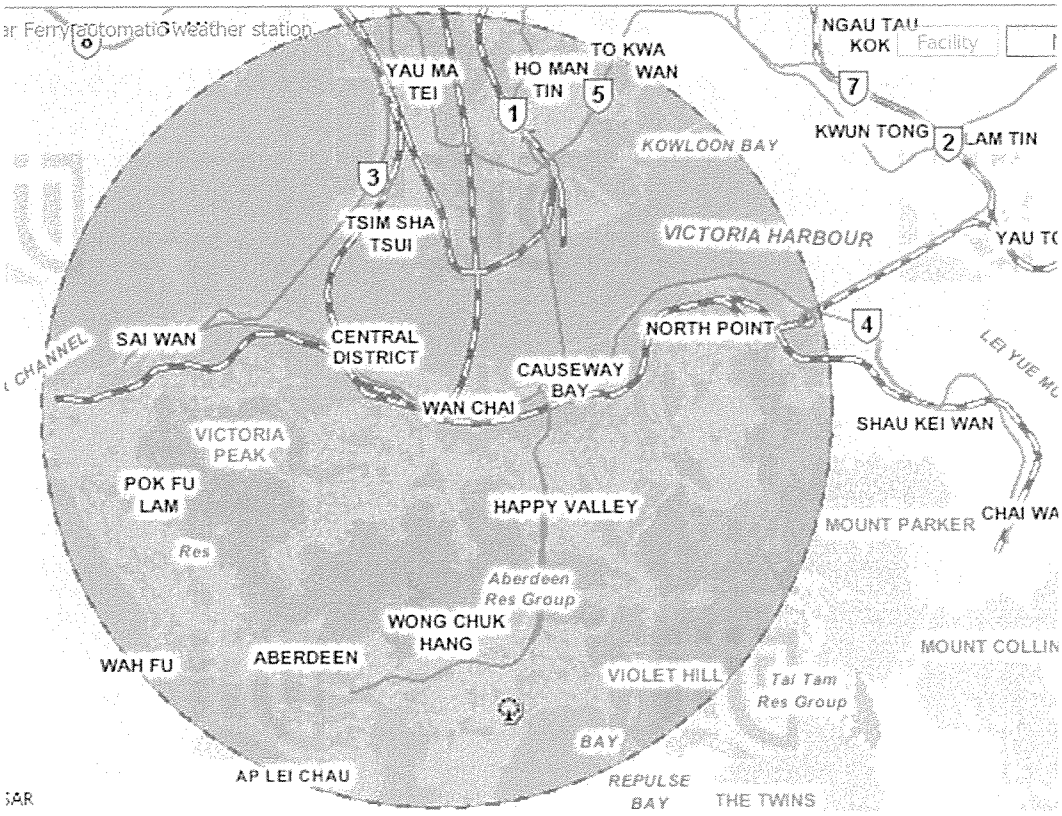


Figure 4 (A circle with radius of 1km)

AsiaSat Request to OFCA:

Noting that C-band is extensively used for satellite TV reception and other satellite networks in Hong Kong and that all sharing studies and field tests have demonstrated that sharing between IMT and FSS is not possible, deploying IMT in C-band in Hong Kong could wipe out all existing satellite C-band receptions in Hong Kong, AsiaSat concurs with the findings in P.8 of SSAC Paper 9/2016 that "3GPP Band 42 is not usable for IMT due to harmful interference to existing services" and requests OFCA to not to consider releasing the band 3 400 – 3 600 MHz to public mobile service.

Annex 1: Reports on compatibility studies between FSS and BWA/IMT

1. Report No. APT/AWF/REP-5, Mar 2008
http://www.apt.int/AWG-RECS-REPS (Report No. 5)
APT Report on "The Coexistance of Broadband Wireless Access Networks in the 3400 - 3800 MHz Band and Fixed Satellite Service Networks in the 3400 - 4200MHz Band"

2. Report ITU-R S.2199, Nov 2010
http://www.itu.int/pub/R-REP-S.2199-2010
Studies on compatibility of broadband wireless access (BWA) systems and fixed-satellite service (FSS) networks in the 3 400-4 200 MHz band

3. Report ITU-R M.2109, 2007
http://www.itu.int/pub/R-REP-M.2109
Sharing studies between IMT Advanced systems and geostationary satellite networks in the fixed-satellite service in the 3 400-4 200 and 4 500-4 800 MHz frequency bands

4. Report ITU-R S.2368, Jun 2015
http://www.itu.int/pub/R-REP-S.2368-2015
Sharing studies between International Mobile Telecommunication-Advanced systems and geostationary satellite networks in the fixed-satellite service in the 3 400-4 200 MHz and 4 500-4 800 MHz frequency bands in the WRC study cycle leading to WRC-15

Annex 2: AsiaSat presentation in SSAC regarding Compatibility Studies of Mobile and Satellite Systems in the C-band, 27 March 2017

AsiaSat

Reaching Further, Bringing You Closer

Compatibility Studies of Mobile and Satellite Systems in the C-band

Spectrum Management

March 2017

The Importance of C-band

Spectrum

- ITU table of allocations allows Fixed Satellite Services (FSS) only in selected bands
- Bandwidth requirements for traditional satellite applications needs to be met in the selected band
- Civilian use

Rain fade

- High rain intensity in large portions of Asia
- Low link availability at higher frequencies
- Only band where FSS services can realistically be provided with high availability due to rain fade characteristics

Satellite with C-band payload

- Many satellites available
- Existing receivers
- Well established, inexpensive technology
- Satellites with wide coverage to serve remote locations and sparsely populated areas
- Currently widely used for a multitude of satellite services like;
  - TV broadcast to cable networks and individual receivers,
  - VSAT networks,
  - Internet providers,
  - Backhaul for cellular networks,
  - Point-to-multipoint links,
  - Satellite News Gathering
  - Communication for ships
  - Disaster relief
- Important part of the telecommunications infrastructure, including TV distribution, for many developing countries

Situation in C-band

- The issue on the use of this frequency band (3 400 – 3 600 MHz) for various broadband terrestrial applications to individual users has been debated for many years and is not new.
- In the early 2000's, this band was being considered for Broadband Wireless Access (BWA) / WiMax applications.
- To provide protection of the FSS receive earth stations, some separation distance between the stations of the BWA network and the FSS receive earth stations is required.
- The magnitude of this separation distance depends on the parameters of the networks, the protection criteria of concerned satellite networks and the deployment of the two services and if the two services operate in the same or in adjacent frequency bands.

Study and situation in Hong Kong

- In 2003 – 07 study cycle, former OFTA was instrumental in conducting studies and field trials and in developing Report APT/AWF/REP-5 of the Asia-Pacific Telecommunity (APT) on this topic.
- OFTA's Report subsequently largely served as the basis when APT created their Report No. APT/AWF/REP-5 which incorporated the study from several Asian countries.
- OFTA's report confirmed that broadband wireless access (BWA) at 3 400 – 3 600 MHz would cause interference to FSS in co-frequency or adjacent band operation
- Public mobile services of IMT involve high density base stations over the HK territory, that would likely cause harmful interference to satellite services.
- Currently, there are some 1,600 SMATV systems and 900,000 outlets in Hong Kong
- There are several teleports in Hong Kong, including AsiaSat, APSTAR, ABS, Reach, Hong Kong role as a telecom hub

IMT in C-band - Impact on C-band reception

Already successfully share with the Fixed Service in many places

- Normally microwave links with few transmitters
- Point-to-point networks with directive antennas

⇒ Special arrangements to mitigate interference (site shielding, ….)

IMT/BWA have different characteristics:

- Large number of base stations and ubiquitously deployed user terminals
- Area coverage and non-directional antennas

Mitigation techniques can be implemented only for a small number of terrestrial stations (base stations or user terminals) at fixed, known locations, and only with respect to a small number of earth stations also at specific known locations

Area coverage with non-directional antennas creates more interference than point-to-point links with directional antennas

IMT in C-band – Impact on C-band reception

- Distance to satellite ≈ 36,000 – 41,000 km
- Terrestrial transmitter much closer
  ⇒ Large difference in path loss
  (~ 97 - 98 dB relative to terrestrial transmitter at 500 m distance)
- Earth station antenna off axis discrimination is relatively low
  (< ~ 35 - 40 dB for 1.8 m antenna)
- Satellite EIRP levels only moderately higher than those of terrestrial transmitters
  (e.g. ~20 dB higher than a 100W (20 dBW) base station)
  Aggregation of many terrestrial transmitters will increase the interference level
  ⇒ Terrestrial signals much higher than satellite signal at LNB input

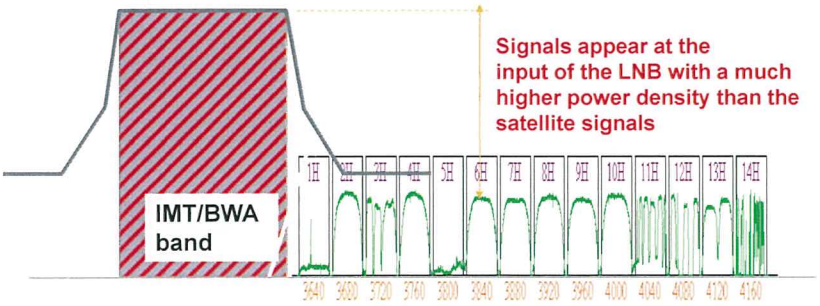
IMT in C-band – Impact on C-band reception

- In-band interference
- Interference from unwanted emissions (outside the signal bandwidth)
- Overdrive of LNB's

⇒ Exclusion zones around earth stations are required if satellite services and IMT are to co-exist in C-band

(AsiaSat understands that in USA, FCC has introduced 150 km exclusion zones around earth stations to protect them against in-band interference from FWA (Fixed Wireless Access) networks)

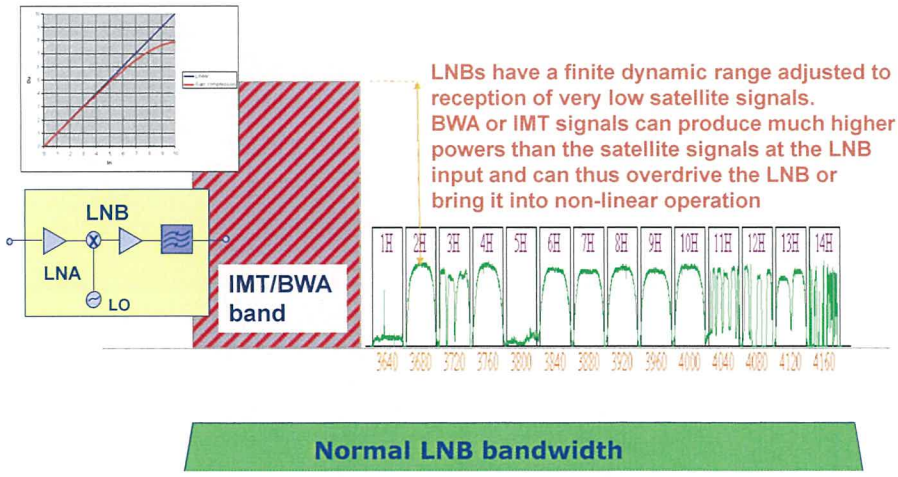
IMT in C-band - Unwanted emissions



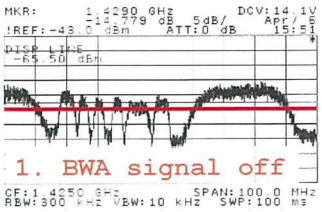
How much suppression of out-of-band components can one realistically expect from BWA or IMT equipment?

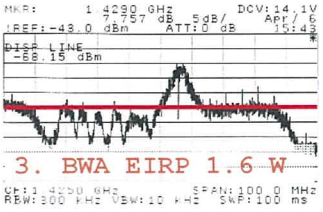
- In Report ITU-R S. 2368, it quotes 3GPP TS 36 104

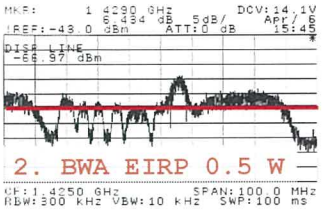
Overdrive of LNB

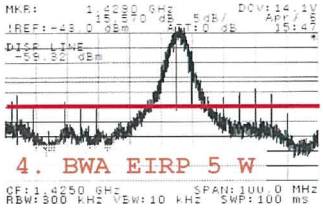


Overdrive of LNB









- Example of gain compression and intermodulation of LNB by single BWA base station
- (BWA signal at 3.505 GHz, spectrum plots 3.775-3.675 GHz in-band interference is outside the plots)

Interference has already been encountered in countries where BWA has been introduced

- Hong Kong
- Australia
- Fiji
- Indonesia
- Bolivia
- Caribbean
- China
- Russia
- Mongolia
- Africa

The interference from IMT into FSS will be similar to (mobile) BWA

Growing international recognition of the adverse impact on satellite reception

ITU	(International Telecommunications Union)
ABU	(Asia-Pacific Broadcasting Union)
APT	(Asia-Pacific Telecommunity)
CEPT	(European Conference of Postal and Telecommunications Administrations)
CITEL	(Inter-American Telecommunication Commission)
APSCC	(Asia-Pacific Satellite Communications Council)
CASBAA	(Cable & Satellite Broadcasting Association of Asia)
NABA	(North American Broadcasters Association)
GVF	(Global VSAT Forum)
SUIRG	(Satellite Users Interference Reduction Group)
ESOA	(European Satellite Operators Association)
SIA	(Satellite Industry Association)

WiMax Forum

Key reports from the last three study cycles in ITU-R (2003 – 2015)

- ITU-R Report ITU-R S.2368-0, 2015

Sharing studies between International Mobile Telecommunication-Advanced systems and geostationary satellite networks in the fixed-satellite service in the 3 400-4 200 MHz and 4 500-4 800 MHz frequency band in the WRC study cycle leading to WRC-15

http://www.itu.int/pub/R-REP-S.2368-2015

- ITU-R Report ITU-R S.2199-0, Nov 2010

Studies on compatibility of broadband wireless access (BWA) systems and fixed-satellite service (FSS) networks in the 3 400-4 200 MHz band

http://www.itu.int/pub/R-REP-S.2199-2010

- ITU-R Report ITU-R M.2109-0, 2007

Sharing studies between IMT Advanced systems and geostationary satellite networks in the fixed-satellite service in the 3 400-4 200 and 4 500-4 800 MHz frequency bands

http://www.itu.int/pub/R-REP-M.2109

- APT Report No. APT/AWF/REP-5, Mar 2008

APT Report on "The Co-existence of Broadband Wireless Access Networks in the 3400 - 3800 MHz Band and Fixed Satellite Service Networks in the 3400 - 4200MHz Band"

http://www.apt.int/AWG-RECS-REPS (Report No. 5)

Results from the relevant studies

- All studies arrived at the same conclusions and general separation distance
- Conclusions form Report ITU-R S.2368
  - Feasible
    - FSS stations locations are well known
    - implement IMT-Advanced to avoid interference to FSS stations
    - FSS protection criteria to determine the separation distances
  - Not Feasible
    - ubiquitous FSS earth stations or no individual licensing
    - no minimum separation distance can be guaranteed
  - Constrain future FSS earth stations in the bands 3 400-4 200 MHz and 4 500-4 800 MHz in the same area
- Most of the separation distances for different deployments would cover all or large portions of the territory of HK

Separation distance between IMT and FSS (Report ITU-R S.2368)

In-band interference		
IMT-Advanced	Long term	Short term
suburban/urban macro-cell	tens of km	exceed 100km (effects of terrain taken) In some cases, the required separation distances are larger, up to 525 km.
small-cell outdoor	tens of km	30km or larger up to exceed 100km (typical low antenna height in urban environment) One study shows hundreds of km
small-cell indoor	from 5km to tens of km	vary from about 5km to tens of km, could up to 120km One study shows hundreds of km

Separation distance between IMT and FSS (Report ITU-R S.2368)

Adjacent band interference (Due to unwanted emissions from IMT equipment)	
IMT-Advanced	Separation distance
suburban/urban macro-cell	tens of km
small-cell outdoor	around 5km
small-cell indoor	around 1km

Note: By introducing a guardband between the IMT and FSS signals, it may be possible to reduce the separation distance.

LNA/LNB overdrive	
IMT-Advanced	Separation distance
suburban/urban macro-cell	around 9 km
small-cell outdoor	around 1km
small-cell indoor	not study yet

Exclusion zone as summarized from previous studies

1 km exclusion zone

- to protect against adjacent band operation of small-cell indoor terminals

5 km exclusion zone

- to protect against adjacent band operation of small-cell outdoor terminals

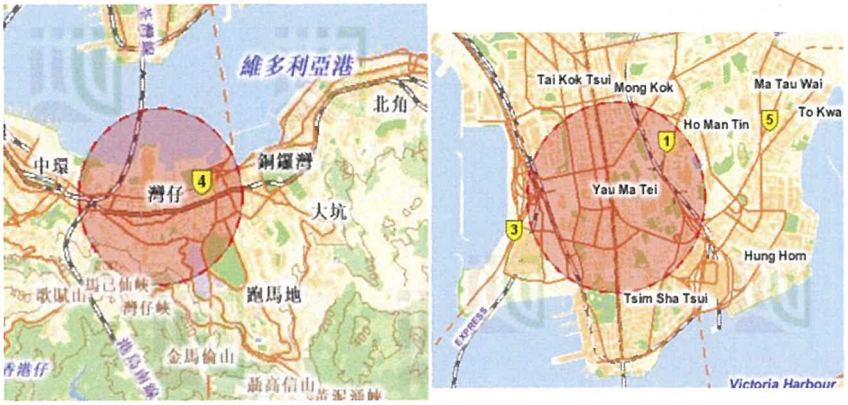
25 km exclusion zone

- to protect against adjacent band operation of outdoor macro-cell deployment

150 km exclusion zone

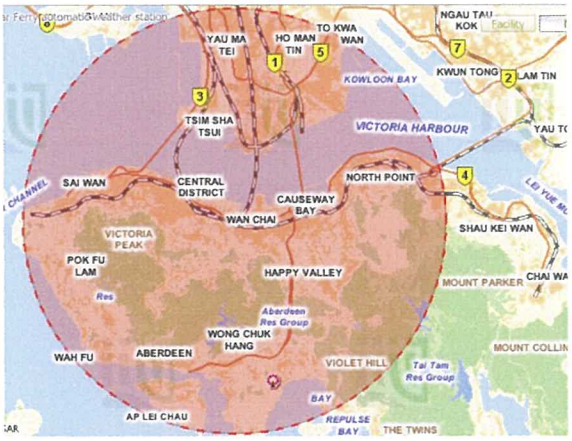
- as applied by FCC for co-frequency protection

Exclusion zone (1 km radius)



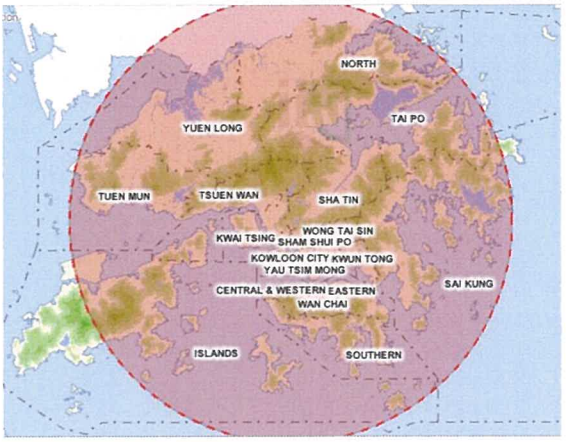
A 1 km exclusion zone (to protect against adjacent band operation of small-cell indoor terminals) would effectively block the entire Central to Causeway Bay area or the Tsimshatsui to Mongkok area

Exclusion zone (5 km radius)



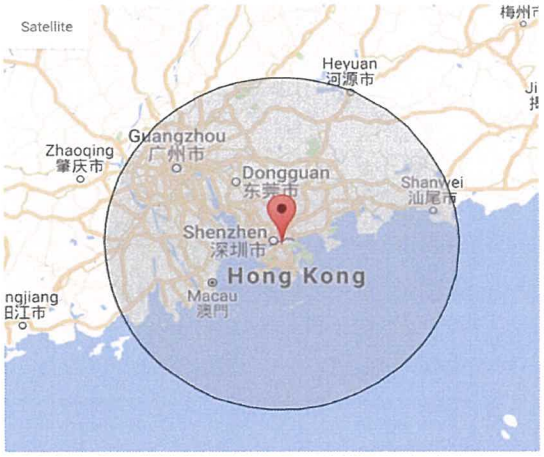
A 5 km exclusion zone (to protect against adjacent band operation of small-cell outdoor terminals) would effectively block the entire central parts of Hong Kong

Exclusion zone (25 km radius)



A 25 km exclusion zone (to protect against adjacent band operation of outdoor macro-cell deployment) would block the entire territory of Hong Kong

Exclusion zone (150 km radius)



A 150 km exclusion zone (as applied by FCC for co-frequency protection) would block the entire Hong Kong, Macau, Guangzhou and surrounding area

Conclusions

- There are large number of C-band receiving terminals, according to OFCA 's statistics, over the territory of Hong Kong
- IMT deployment in 3 400 – 3 600MHz in Hong Kong will severely affect the C-band satellite reception
- all the reports on this topic including OFCA, APT, ITU and reports conducted in other organizations all arrive not only at the same conclusions, they also arrive at very similar separation distances.
- coexistence of the satellite services and the public mobile services in C-band in the same geographical area is not feasible as demonstrated by a number of sharing studies
- When implemented with the required separation distance to offer protection shown on maps of HK, it makes the conclusion relatively clear

IMT cannot protect FSS within an area as small as HK

Annex 3: AsiaSat paper circulated within SSAC concerning the importance of retaining C-band for satellite service in Asia Pacific Region, March 2017

AsiaSat
Reaching Further, Bringing You Closer

The importance of retaining C-band for satellite service in Asia Pacific Region March 2017

Asia Satellite Telecommunications Co. Ltd. (AsiaSat)

It has come to our attention the recent public release regarding suggested use of the 3 400 – 3 600 MHz band for 5G services in Hong Kong and OFCA's negative response in this respect. AsiaSat fully support the decision by the Office of the Communications Authority (OFCA) not to include 3 400 – 3 600 MHz band in its spectrum release plan for 2017-2019. AsiaSat re-iterates our serious concern on the proposal due to the fact that coexistence of the satellite services and the public mobile services in C-band in the same geographical area is not feasible as demonstrated numerous sharing studies.

1. Why is C-band so important for satellite services in Asia Pacific region?

C-band is heavily used for satellite communications in Asia Pacific Region for a multitude of services including very small aperture terminal (VSAT) networks, internet services, point-to-multipoint links, satellite news gathering, TV broadcasting to satellite master antenna television (SMATV), direct-to-home (DTH) receivers and feeder links for mobile satellite service. The wide coverage of satellites in C-band enables services to be provided to developing countries, to sparsely populated and geographically remote areas and over large distances (e.g. providing program content and data distribution between continents).

Due to its ubiquitous coverage, high availability and instant connectivity, C-band FSS plays a key role on the socio-economic development of many countries to provide vital services and is also crucial for disaster relief operations. This band is also used by governments in conjunction with international commitments; for example, the World Meteorological Organization (WMO) uses this band to distribute meteorological data throughout the world and maritime and aeronautical safety related information is relayed through stations operating in this frequency band. Furthermore, due to its lower frequency, in particular in regions characterized by high rain attenuation, C-band is the only realistic satellite band where FSS services can be provided with high availability.

2. Evidence for incompatibility between Satellite Services and Mobile Services in C-band

2A. History:

The issue on the use of this frequency band (3 400 – 3 600 MHz) for various broadband terrestrial applications to individual users has been debated for many years and is not new.

In the early 2000's, this band was being considered for Broadband Wireless Access (BWA) / WiMax applications. Office of the Telecommunications Authority (OFTA[1]) of the Hong Kong, was instrumental in conducting studies and field trials and in developing Report APT/AWF/REP-5 of the Asia-Pacific Telecommunity (APT) on this topic. This Report subsequently largely served as the basis when ITU-R created their Report S.2199.

Due to the incompatibility between BWA and Satellite Services as concluded in these reports, OFCA decided not to introduce BWA in the 3 400 – 3 600 MHz band, but rather in other frequency bands. History has shown that the decision taken by OFCA was a wise and correct decision that prevented severe interferences and massive service disruptions of satellite reception like other countries experienced (both in overlapping as well as adjacent frequency bands) due to their opening of this frequency band for BWA/WiMax usage without careful considerations like OFCA did.

At WRC-07 (year 2007), proposals to use all or portions of the 3 400 – 4 200 MHz band for future mobile phone networks (IMT) were considered. Compatibility studies carried out in preparation for this Conference

[1] The Office of the Telecommunications Authority (OFTA) ceased to function on 31 March 2012. Its powers and duties are transferred to the Office of the Communications Authority (OFCA), the executive arm and secretariat of the Communications Authority (CA).

revealed that even though IMT might be different from BWA and WiMax in respect of usage, access protocols etc., the potential for interference into FSS reception is the same. Consequently, ITU-R Report M.2109 arrived at the same conclusions as the BWA reports.

WRC-07 decided not to identify any portion of this band for IMT, but allowed some countries to identify the 3 400 – 3 600 MHz band, or portions of it, for IMT within their own territory (7 countries in the Asia-Pacific for the 3 400 – 3 500 MHz band and 9 countries for the 3 500 – 3 600 MHz band, China being one of the countries for both bands). However, recognizing the incompatibility between IMT and FSS reception, an important requirement to allow these countries to identify IMT within their own territory was that defined power flux density limits need to be met all along their borders to protect FSS reception in other countries.

During WRC-15 (year 2015), IMT in, amongst others, C-band was again considered. Studies conducted in the study cycle leading up to WRC-15, as contained in ITU-R Report S.2368 confirm that again, even though the new IMT characteristics may be different in some aspects, the impact of IMT as an interferer to FSS reception remain unchanged and consequently, the previous studies conducted by OFCA, APT and ITU and their results are equally applicable for later generation IMT operating in this band.

For the Asia-Pacific, WRC-15 made no changes in respect of IMT in the 3 400 – 4 200 MHz band, but allowed two more countries (Australia and the Philippines) to identify the band 3 400 – 3 600 MHz for IMT within their own territory, but again on the same express conditions for protecting FSS in other countries.

2B. Summary of the results of various sharing studies on the coexistence between mobile service and satellite service in C-band

As shown in a number of sharing studies done from early 2000 to year 2015 (see section 2A for detail and see annex 1 for a list of reports), there are three different interference mechanisms which will impact FSS reception:

1. **Co-frequency interference**
   Due to the long distance to the satellite and the power limitations of the satellite, the incoming FSS signal's power flux density at the earth station location is very low. IMT equipment which is much closer to the earth station can produce significantly higher power levels at the input to the FSS receiver than the desired satellite signal.

   Depending on the type of IMT deployment considered, studies have shown that separation distances required to offer adequate protection of FSS receivers in respect of co-frequency interference are in the range of five to tens of kilometres for IMT small-cell indoor deployment to several hundreds of kilometres for IMT macro-cell outdoor deployment. It may also be worth noting that in USA, FCC has used a 150 km protection zone around 86 earth stations operating in the 3 650 – 3 700 MHz range to protect them against terrestrial interference.

2. **Adjacent band interference**
   a. Unwanted out-of-band emissions of IMT transmitters
      Due to the very low power level of the incoming FSS signals, unwanted emissions generated by IMT base stations or user terminals operating in an adjacent frequency bands, can create interference to FSS receivers.

      Depending on the type of IMT deployment considered, studies have shown that the separation distances required to offer adequate protection to FSS receivers in respect of out-of-band emissions of IMT transmitters, assuming no guardband between the satellite and IMT signals, are in the range of less than a kilometer for IMT small-cell indoor deployment, some few kilometres for IMT small-cell outdoor deployment and tens of kilometres for IMT macro-cell outdoor deployment. This required separation distance may be possible to reduce by use of a guardband between the two signals.

b. FSS receiver LNA/LNB overdrive

Earth station low-noise amplifiers (LNAs) and low-noise block down-converters (LNBs) are optimized for reception of the very low power level of the incoming satellite signal and, hence, have a very high sensitivity. Incoming IMT signals at much higher power levels can severely affect the operating point of the LNA/LNB and drive it out of its dynamic range to where it exhibits a non-linear behaviour. This results in the creation of intermodulation products and gain compression which in turn result in distortion and loss of the FSS signal.

Typically, to achieve a low noise figure to allow reception of the very low incoming satellite signals, LNAs and LNBs are wideband devices with a flat frequency response over the wanted frequency range, having the bandwidth defining filtering only at intermediate frequency (IF) stage, not at the LNA/LNB. As a result, IMT emissions in adjacent bands will have the capability to overdrive the LNA/LNB.

Depending on the type of IMT deployment considered, studies have shown that the separation distances required to offer adequate protection to FSS receivers in respect of LNA/LNB overdrive are about a kilometre in respect of IMT small-cell deployment and around 9 kilometres in respect of IMT macro-cell deployment.

3. Sharing Situation in Hong Kong

Spectrum utilization, including satellite spectrum utilization, is different for every country and in different parts of the world. As a result, a solution that may be working one place, may not necessarily work in another place. Spectrum for new mobile applications can be found in different frequency bands in different parts of the world. In the Asia-Pacific, with the exception of Japan and Korea, C-band is heavily used and is the dominant frequency band for FSS throughout the region. As mentioned by OFCA, in Hong Kong alone, there are currently an estimated 1,600 C-band SMATV systems and 900,000 outlets. Additionally, there are several C-band teleports and VSAT terminals and hubs operating throughout the SAR, establishing Hong Kong as a satellite communications hub, serving the entire Asia-Pacific region.

It may also be worth noting that in USA, FCC introduced 150 km exclusion zones around a number of grandfathered earth stations to protect their co-frequency operation in the 3 650 – 3 700 MHz band. Such large exclusion zones are implementable in geographically large countries like the US. However, it is clear that it would not be achievable within the limited geographical area of Hong Kong.

AsiaSat observes the consistent conclusions drawn in all the various studies by ITU, APT and other international organizations:
"*When FSS earth stations are deployed in a typical ubiquitous manner or with no individual licensing, sharing between IMT-Advanced and FSS is not feasible in the same geographical area since no minimum separation distance can be guaranteed.*"
(ITU-R Report S.2368)

AsiaSat notes the geographically very small territory of Hong Kong where central parts are located within a circle with radius of about 5 km and the entire territory within a circle with radius of about 25 km (see figures 3 and 2). One single IMT base station can potentially wipe out all the co-frequency satellite C-band reception in Hong Kong and well into mainland China (see figure 1). This is even if IMT is limited to only small-cell deployment.

Similarly, one single IMT station operating in the 3 400 – 4 200 MHz range can potentially block all the satellite reception in the adjacent 3 600 – 4 200 MHz band practically in the entire Hong Kong Island and Kowloon area (see figure 3). Even if it would be possible to limit IMT base station and user terminal deployment to only indoor operation, one single IMT transmitter could potentially block all satellite reception in adjacent bands in the entire Central to Causeway Bay area or the Tsimshatsui to Mongkok area (see figure 4).

Graphical illustration of the required separation distance applied to the case of Hong Kong

Below is a graphical illustration of the possible required separation distance in case of Hong Kong. Depending on the actual parameters of the IMT deployment, these separation distances may vary from those illustrated. It can be seen that;

- a 150 km exclusion zone (as applied by FCC for co-frequency protection) would block the entire Hong Kong, Macau, Guangzhou and surrounding area (see figure 1);

- a 25 km exclusion zone (to protect against adjacent band operation of outdoor macro-cell deployment) would block the entire territory of Hong Kong (see figure 2);

- a 5 km exclusion zone (to protect against adjacent band small-cell outdoor terminals) would effectively block the entire central parts of Hong Kong (see figure 3);

- a 1 km exclusion zone (to protect adjacent band operation of small-cell indoor terminals) would effectively block the entire Central to Causeway Bay area or the Tsimshatsui to Mongkok area (see figure 4 and figure 5).

Figure 1. A circle with radius of 150km (as applied by FCC for co-frequency protection)

Figure 2. A circle with radius of 25km (to protect against adjacent band operation of outdoor macro-cell deployment)

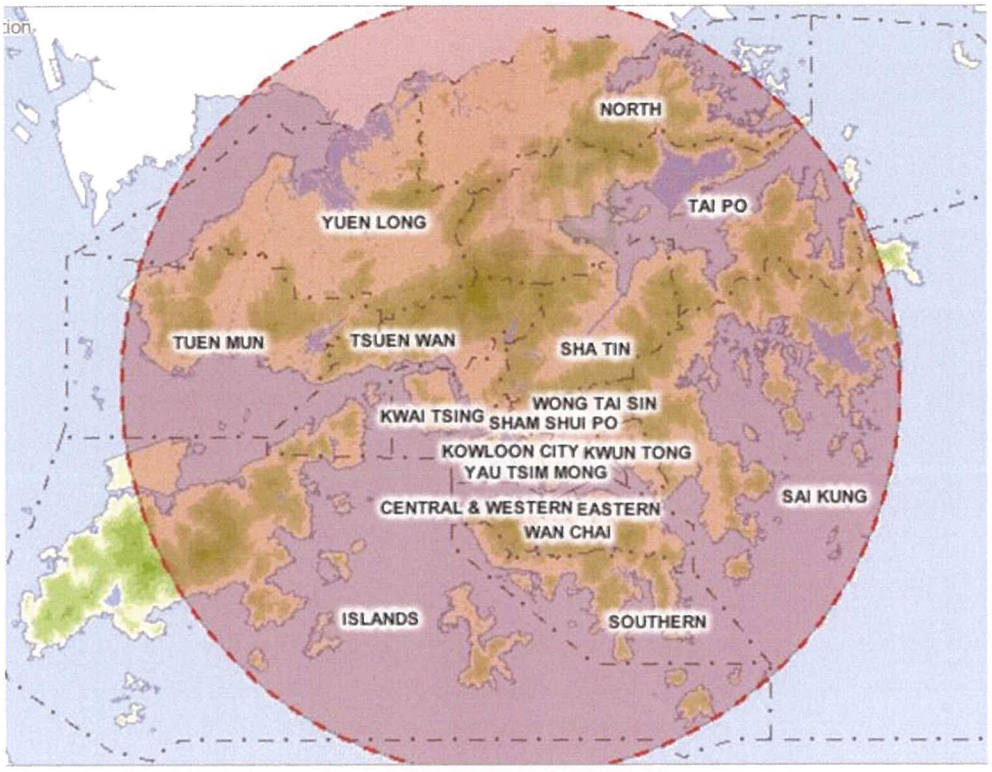


Figure 3. A circle with radius of 5km (to protect against adjacent band small-cell outdoor terminals)

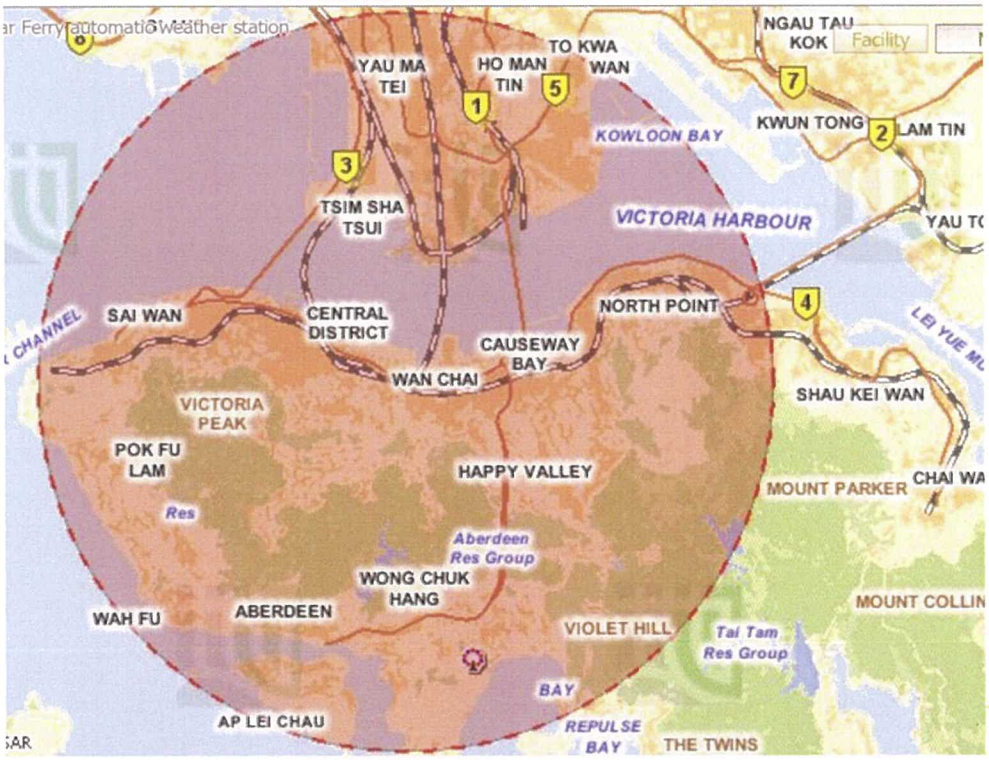
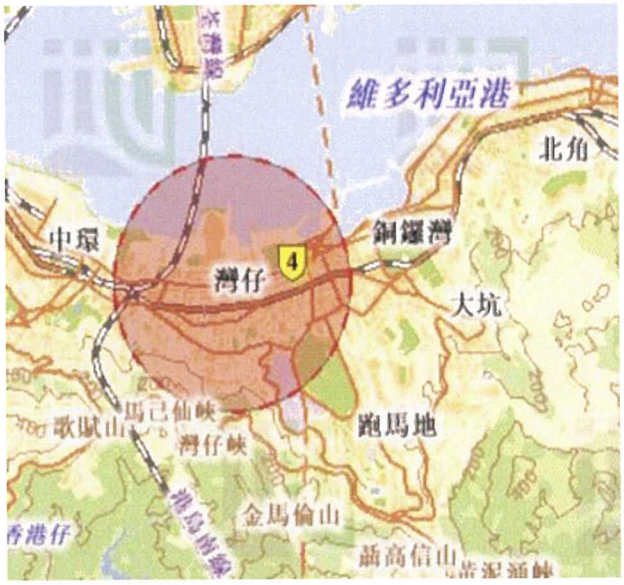


Figure 4. A circle with radius of 1km (to protect adjacent band operation of small-cell indoor terminals)

Figure 5. A circle with radius of 1km (to protect adjacent band operation of small-cell indoor terminals)



4. Summary

C-band is extensively used for satellite TV reception and other satellite networks in Hong Kong and is heavily used for satellite communications in Asia Pacific Region for a multitude of services. Due to its ubiquitous coverage, high availability and instant connectivity, C-band FSS plays a key role on the socio-economic development of many countries to provide vital services and is also crucial for disaster relief operations. Due to its lower frequency, in particular in regions characterized by high rain attenuation, C-band is the only realistic satellite band where FSS services can be provided with high availability.

All sharing studies and field tests have demonstrated that sharing between IMT and Satellite Services is not possible, deploying IMT in C-band in Hong Kong could wipe out all existing satellite C-band receptions in Hong Kong and cause detrimental impact to satellite services. It is extremely important to retain C-band for satellite service in Asia Pacific Region, AsiaSat fully supports OFCA's decision for **not** releasing the band 3 400 – 3 600 MHz to public mobile service in its spectrum release plan for 2017-2019.

Annex: Reports on compatibility studies between FSS and BWA/IMT

1. Report No. APT/AWF/REP-5, Mar 2008
http://www.apt.int/AWG-RECS-REPS (Report No. 5)
APT Report on "The Coexistance of Broadband Wireless Access Networks in the 3400 - 3800 MHz Band and Fixed Satellite Service Networks in the 3400 - 4200MHz Band"

2. Report ITU-R S.2199, Nov 2010
http://www.itu.int/pub/R-REP-S.2199-2010
Studies on compatibility of broadband wireless access (BWA) systems and fixed-satellite service (FSS) networks in the 3 400-4 200 MHz band

3. Report ITU-R M.2109, 2007
http://www.itu.int/pub/R-REP-M.2109
Sharing studies between IMT Advanced systems and geostationary satellite networks in the fixed-satellite service in the 3 400-4 200 and 4 500-4 800 MHz frequency bands

4. Report ITU-R S.2368, Jun 2015
http://www.itu.int/pub/R-REP-S.2368-2015
Sharing studies between International Mobile Telecommunication-Advanced systems and geostationary satellite networks in the fixed-satellite service in the 3 400-4 200 MHz and 4 500-4 800 MHz frequency bands in the WRC study cycle leading to WRC-15

Annex 4: Letter from AsiaSat CEO to OFCA's Director on 23 February 2017

AsiaSat
Reaching Further, Bringing You Closer

23rd February 2017

Miss Eliza LEE
Director-General of Communications
The Office of the Communications Authority
29/F, Wu Chung House
213 Queen's Road East
Wan Chai, Hong Kong
(Fax: +852 2803 5111)

Dear Eliza

It has come to our attention with the public release from HKT regarding their suggested use of the 3 400 – 3 600 MHz band for 5G services in HK. It is clear that after the last meeting of the Radio Spectrum and Technical Standards Advisory Committee (SSAC) in November 2016, HKT is taking a more aggressive position in pushing for the opening up of the band for the mobile operators benefit.

AsiaSat wants to express our support to OFCA's response and re-iterate our concern raised during the SSAC meeting and the follow-up submission on 15.11.2016 to the SSAC Secretary on our serious concern on the HKT proposal.

AsiaSat has always supported OFCA's efforts to maintain and further develop Hong Kong as a highly developed community and with telecommunications of different sorts, including terrestrial mobile and satellite applications.

However, as OFCA is fully aware, the issue on the use of this frequency band (3 400 – 3 600 MHz) for various broadband terrestrial applications to individual users has been debated for many years and is not new. In the early 2000's, this band was being considered for Broadband Wireless Access (BWA) / WiMax applications. OFTA was instrumental in conducting studies and field trials and in developing Report APT/AWF/REP-5 of the Asia-Pacific Telecommunity (APT) on this topic. This Report subsequently largely served as the basis when ITU-R created their Report S.2199.

The conclusions in these reports were clear:

"*To provide protection of the FSS receive earth stations, some separation distance between the stations of the BWA network and the FSS receive earth stations is required. The magnitude of this separation distance depends on the parameters of the networks, the protection criteria of concerned satellite networks and the deployment of the two services and if the two services operate in the same or in adjacent frequency bands. With the parameters and assumptions used in the studies in this report, the required separation distance is at least in the order of tens of kilometers in the case of co-frequency operation and a few kilometers in the case of adjacent band operation when there is no shielding or blockage with respect to the interfering signal.*

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When the BWA stations and/or FSS earth stations are deployed in a ubiquitous manner and/or without individual licensing or registration, the locations of the stations are not known and hence, no minimum separation distance can be guaranteed. Coexistence of BWA networks operating within the 3 400-3 800 MHz range and FSS networks operating in any part of the 3 400-4 200 MHz range therefore in this case becomes difficult within the same geographical area." (from the APT Report).

Based on these conclusions, OFCA decided not to introduce BWA in the 3 400 – 3 600 MHz band, but rather in other frequency bands. History has shown that the decision taken by OFCA was a wise and correct decision that prevented severe interferences and massive service disruptions of satellite reception like other countries experienced (both in overlapping as well as adjacent frequency bands) due to their opening of this frequency band for BWA/WiMax usage without careful considerations like OFCA did.

It may also be worth noting that in USA, FCC introduced 150 km exclusion zones around a number of grandfathered earth stations to protect their co-frequency operation in the 3 650 – 3 700 MHz band. Such large exclusion zones are implementable in geographically large countries like the US. However, it is clear that it would not be achievable within the limited geographical area of Hong Kong.

At WRC-07, proposals to use all or portions of the 3 400 – 4 200 MHz band for future mobile phone networks (IMT) were considered. Compatibility studies carried out in preparation for this Conference revealed that even though IMT might be different from BWA and WiMax in respect of usage, access protocols etc., the potential for interference into FSS reception is the same. Consequently, ITU-R Report M.2109 arrived at the same conclusions as the BWA reports.

WRC-07 decided not to identify any portion of this band for IMT, but allowed some countries to identify the 3 400 – 3 600 MHz band, or portions of it, for IMT within their own territory (7 countries in the Asia-Pacific for the 3 400 – 3 500 MHz band and 9 countries for the 3 500 – 3 600 MHz band, China being one of the countries for both bands). However, recognizing the incompatibility between IMT and FSS reception, an important requirement to allow these countries to identify IMT within their own territory was that defined power flux density limits need to be met all along their borders to protect FSS reception in other countries.

During WRC-15, IMT in, amongst others, C-band was again considered. Studies conducted in the study cycle leading up to WRC-15, as contained in ITU-R Report S.2368 confirm that again, even though the new IMT characteristics may be different in some aspects, the impact of IMT as an interferer to FSS reception remain unchanged and consequently, the previous studies conducted by OFCA, APT and ITU and their results are equally applicable for later generation IMT operating in this band.

For the Asia-Pacific, WRC-15 made no changes in respect of IMT in the 3 400 – 4 200 MHz band, but allowed two more countries (Australia and the Philippines) to identify the band 3 400 – 3 600 MHz for IMT within their own territory, but again on the same express conditions for protecting FSS in other countries.

When HKT implies that "everyone is doing it" and if not exactly the 3 400 – 3 600 MHz band is released for 5G, Hong Kong would be lagging behind, AsiaSat believes this is inaccurate and that even some of the examples selected by HKT are not completely correctly reflected. This is confirmed by OFCA's paper (SSAC 9/2016).

As already mentioned, only 9 and 11 countries out of all the countries in the Asia-Pacific have identified the 3 400 – 3 500 MHz and 3 500 – 3 600 MHz bands respectively for IMT within their territory. Moreover, to the best of knowledge, with the exception of the announced use for the Olympics by Korea and Japan and the trials by China, no other implementations have been announced in the Asia-Pacific.

Looking outside the Asia-Pacific, AsiaSat also understand that even though there are IMT identifications, very little implementation has happened or has been decided. Moreover, many countries has not identified the 3 400 – 3 600 MHz band for IMT in their national tables of allocation. This could be due to the incompatibility with other services or because the demand can be met in other frequency bands. E.g. in Europe, AsiaSat understands that even though the European Union has identified the 3 400 – 3 800 MHz band for IMT within the Union, no implementation has yet taken place or has been announced. AsiaSat also notes that in OFCA's presentation at the last SSAC meeting, OFCA has diligently identified several bands around 2 GHz for mobile applications in Hong Kong. Moreover, with the switching-off of analoge TV, expected to take place in 2020, more spectrum would become available in the 700 MHz bands. AsiaSat notes that 2020 is only three years away and notes that it takes time to build and bring into service a network.

When HKT implies that there will be IMT implemented in 28 European countries by 2020, AsiaSat believes this is not accurate and cannot find any information in the 5G manifesto that HKT is referring to support that the stakeholders have actually agreed to this or that this implementation will happen in exactly the 3 400 – 3 800 MHz band.

AsiaSat also notes that HKT is referring to the data rate requirements for the new mobile applications to be in the order of 100 Mbps and higher. In the compatibility studies for the 3 400 – 4 200 MHz band leading up to WRC-15 and as contained in ITU-R Report S.2368, only channel bandwidths up to 20 MHz were considered. For mobile applications requiring high bit rates, CPM15 in its report to WRC-15 advised that:

"The demand for high bit rates, especially in densely populated areas, could be accommodated in higher frequency bands (e.g. above 6 GHz) than those currently being considered in studies, however the technical information required for compatibility studies has yet to be developed and these studies and proposals are being explored for future work, beyond WRC-15".

Consequently, WRC-15 established WRC-19 Agenda Item 1.13 to study IMT identifications in a number of frequency bands above 6 GHz for applications requiring high bit rates. AsiaSat therefore cannot agree with HKT's view that the 3 400 – 3 600 MHz band would be appropriate to meet such demands. AsiaSat believes that HKT should rather focus on the higher frequency bands which are currently being studied in preparation for WRC-19 as more appropriate for such applications. From OFCA's presentation at the last SSAC meeting,

AsiaSat also notes that all 5G trials reported from outside China would seem to be looking at higher frequencies. This further indicate that higher frequency bands would be better suited for providing high bit rates.
It is worth noting that spectrum utilization, including satellite spectrum utilization, is different for every country and in different parts of the world. As a result, a solution that may be working one place, may not necessarily work in another place. Spectrum for new mobile applications can be found in different frequency bands in different parts of the world. In the Asia-Pacific, with the exception of Japan and Korea, C-band is heavily used and is the dominant frequency band for FSS throughout the region. As mentioned in the presentation by OFCA, in Hong Kong alone, there are currently an estimated 1,600 C-band SMATV systems and 900,000 outlets. Additionally, there are several C-band teleports and VSAT terminals and hubs operating throughout the SAR, establishing Hong Kong as a satellite communications hub, serving the entire Asia-Pacific region.

It has been stated, and correctly so, that the band 3 400 – 3 600 MHz is less used by satellite networks than the 3 600 – 4 200 MHz band. However, key satellite operators for Hong Kong, aside from AsiaSat such as Apstar and ChinaSatcom operate in this band. More importantly, it has been clearly demonstrated that there are significant adjacent band incompatibilities. Operation of 5G in 3 400 – 3 600 MHz would be completely incompatible with FSS reception in the 3 600 – 4 200 MHz band within such a small geographical area as that of Hong Kong.

During the SSAC meeting in November 2016, HKT has started preparations to conduct field trials for an underground deployment (at the lower level of Wan Chai MTR station). As pointed out by AsiaSat during the SSAC meeting, studies have already been conducted in respect of general indoor small cell deployment. The conclusions, as seen in ITU-R Report S.2368 clearly shows that a separation distances in the order of several kilometers are required in case of in-band interference and in respect of adjacent band interference, separation distances required is in the kilometer range. For this reason, general indoor small-cell deployment of 5G in the 3 400 – 3 600 MHz band would be incompatible with FSS reception in the 3 400 – 4 200 MHz band within Hong Kong.

To obtain compatibility with FSS reception, significantly higher attenuation to the outdoor would be required. For some locations within the MTR tunnels, AsiaSat will not rule out that such attenuation can be achieved. However, AsiaSat wonders what would be the value of a network that can only be used deep down in tunnels and would user terminals be built for a frequency band can only be used deep down in tunnels? Moreover, how would OFCA control and ensure that signal levels outdoor do not reach levels where FSS reception is unduly interfered with? Would OFCA establish pfd limits to be met everywhere outdoor? Would these be the same pfd limits as contained in the footnotes in the Radio Regulations to protect FSS reception? AsiaSat has little insight into the field trials being planned, but will study the results of the tests. However, no matter what the results of such a field trial might be, AsiaSat has many questions as to the value of such a network, how this would be regulated and licensed. It would be more effective to select the proper frequency band to avoid the need for continuous monitoring and regulation.

AsiaSat is looking forward to the continued good cooperation with OFCA on this very important issue and would welcome any questions you might have. AsiaSat also intends to prepare a presentation for the next SSAC meeting where we will discuss some of the elements that we have mentioned in this letter as well as in the document that we already have submitted to the SSAC Secretary.

References

1) Letter from HKT to CCIB/ CEDB and OFCA, "Request for Urgent of Spectrum Supply in Hong Hong", 21 September 2016

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3) OFCA paper SSAC 9/2016,
http://www.ofca.gov.hk/filemanager/ofca/en/content_751/SSAC_Paper_9_2016.pdf

4) HKT presentation at the 13th SSAC meeting, "New Proposed Spectrum for Mobile Services Date: Nov 2016"

5) AsiaSat paper to the SSAC secretary, "AsiaSat comment on SSAC Paper 9/2016: Incompatibility between Fixed Satellite Service and Mobile Service in C-band"

6) HKT paper, "Spectrum Supply in Hong Kong",
https://www.hkt.com/staticfiles/PCCWCorpsite/Press%20Release/2017/Jan/20170110e%20Spectrum%20Supply%20Paper.pdf

7) OFCA's press release: OFCA's Response to HKT's Open Criticisms Concerning Spectrum Management, Assignment and Supply, 10 Jan. 2017
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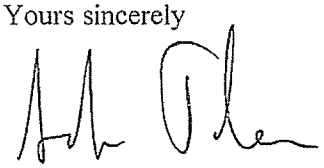
Yours sincerely



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