Wireless Broadband Alliance (WBA) response to the Consultation Paper Issued by the Info-Communications Media Development (IMDA) Authority of Singapore on 5G Mobile Services and Networks

Founded in 2003, the Wireless Broadband Alliance (WBA) works tirelessly to champion the development of a converged wireless broadband ecosystem; through the seamless, secure and interoperable unlicensed wireless broadband services, and enable outstanding user experience for more than 2 billion global subscribers through our member operators. In order to make this a reality, the WBA is currently championing various initiatives to drive the evolution of Next Generation Wi-Fi, Connected City, Unlicensed and Licensed wireless technologies, Policy advocacy and Wireless Innovation. Today, membership includes major fixed operators; seven of the top 10 mobile operator groups (by revenue) and leading technology companies. WBA member operators collectively serve more than 1 billion subscribers and operate more than 10 million hotspots globally. The WBA Board includes AT&T, Boingo Wireless, BT, Cisco Systems, Comcast, Intel, Liberty Global, KT Corporation, NTT DOCOMO, Orange and Ruckus Wireless.

1) IMDA would like to seek views and comments on the estimated timeline for the deployment of 5G. Besides ensuring that spectrum is made available in a timely manner, what other regulatory measures could assist in facilitating the deployment of 5G technology and applications? What other use cases should IMDA take note of when developing the regulatory framework?

5G intends to enable a seamlessly connected society in the 2020 timeframe and beyond; it brings together people along with things, data, applications, transport systems and cities in a smart networked communications environment.

Several industry bodies are currently defining and working on 5G related topics, such as ITU, ETSI, 3GPP, NGMN, among others.

The WBA has been working on Carrier Wi-Fi roadmap development along with key work on bridging the cellular and Wi-Fi worlds together. The WBA's vision is not to focus on the definition of 5G but rather on the use cases being discussed and how Wi-Fi and other unlicensed technologies can play a key role in enabling those in a 5G framework.

The role of Wi-Fi as an integral part of 5G is based on the key capabilities set out by the industry, with Wi-Fi particularly well-suited to fulfill the densification, in-building coverage, and latency goals of 5G. It is also important to note that Wi-Fi technologies are evolving rapidly, for instance the next generation 802.11ax specification will introduce OFDMA, offering greater granularity in terms of control and scheduling of sub-channels.

New Wi-Fi developments such as 802.11ax and the spectrum bands combination derived efficiencies of technologies such 802.11ad, sub-6Ghz and mmWave set the scene for 5G to leverage.

Wi-Fi is having a significant impact on the definition of 5G, with 5G following Wi-Fi in its adoption of several significant characteristics, including from a technical perspective the use of an EAP

authentication framework and associated broadening of identity concepts, and from a business perspective the focus on new non-consumer, vertical value propositions.

Additionally 5G system needs to support different use cases that diverge significantly in their characteristics, from cost-efficient video-centric enhanced mobile broadband, to the diversity of devices used in massive machine type communications, through to the lowest latency and highest reliability systems. Normally an engineering compromise would have to be made in order to realize a system, meaning that not all use cases can be supported. Instead, 5G conceived of the concept of a "slice" which enables the system characteristics to be tailored to a particular use case (3GPP 22.891 "Study on New Services and Markets Technology Enablers"). Primarily focusing on partitioning the core network, slicing concepts can include the RAN and enabling partitioning of radio resources.

The WBA would like to share with IMDA a reported issued at the end of 2016 on Roadmap for Coexistence and Convergence in 5G – Market Research, with the objective to provide an initial industry assessment on how unlicensed technologies will contribute to 5G framework.

2) To facilitate and understand potential spectrum requirements for IoT deployments in Singapore, IMDA would like to seek views on the following:

i) Based on the current spectrum allocated for mobile services in the sub-1 GHz frequency bands, are there further suitable spectrum resources that could be released to support both IoT and LTE services?

ii) How will future generations of mobile networks (e.g. high capacity, low latency) support the growth of IoT and what would be the spectrum requirements?

WBA would like to point out the central role that technologies using unlicensed (license exempt) spectrum will play in meeting the demand for IoT services (IMDA mentions this in footnote 10). We can cite the Ericsson Mobility report from November 2016, which forecasts over 88% of the 18.1B IoT devices will be connected by unlicensed spectrum in 2022.

Based on the industry survey from WBA the major applications and/or services that will be enabled/improved by using unlicensed technologies as part of 5G are Smart cities, IoT Sensor Networks, Safety and Surveillance, Smart Home and Healthcare – all scoring more than 50%.

Some of the main drivers mentioned for using unlicensed spectrum technologies for IoT are enhanced throughput, cost and coverage, and to a lesser extent, latency and energy/battery life.

3) IMDA would like to seek views and comments from industry on what they consider will be the key technologies for 5G and whether current regulatory frameworks sufficiently facilitate the deployment of such technologies.

From the industry survey performed by WBA in late 2016, 62% of the respondents believe that 5G will be a combination of licensed and unlicensed technologies and 23% believe that it will be predominantly licensed technologies. Among Operator respondents, on the other hand, the percentage shifts to almost a 50/50 split between a combination of licensed and unlicensed technologies and predominantly

licensed technologies. Moreover, 88% of the respondents find unlicensed spectrum technologies relevant for 5G

With a response rate of 80%, Wi-Fi is - by far - the unlicensed spectrum technology that companies see as the main candidate to play a relevant role in 5G. To a lesser extent, other technologies such as Sigfox and LoRa are also expected to play a relevant role.

4) IMDA would like to seek views and comments on whether going forward, there is a need for further spectrum below 1 GHz to be identified and release for mobile services?

No comments

5) IMDA would like to seek views and comments on following:

i) The frequency arrangement that is better suited for adoption in Singapore for the L band (i.e. SDL, TDD or FDD) and the supporting reasons; and

ii) The timeline for access to the L band and the availability of the equipment (specifically whether it will be available earlier or later than 2020).

No comments

6) Considering the spectrum bands within the range of 1-6 GHz to support the deployment of enhanced mobile broadband services, IMDA would like to seek views on whether all of the 91 MHz of spectrum in the L-band should be allocated for IMT to address Singapore's data demand and growth.

No comments

7) If it is only the extended C-band that is considered for IMT, would the migration of existing satellite users to the other parts of the C-band (i.e. 3.7-4.2 GHz) impact their service provisioning?

No comments

8) Considering the challenges of co-channel deployment of FSS and IMT services in the extended C-band, IMDA would like to seek views and comments on the coexistence measures for adjacent bands and cross border operations.

No comments

9) IMDA would like to seek views and comments on whether there are other frequency bands in the 1-6 GHz frequency band that IMDA should consider for IMT / 5G.

Due to the increasing demands for mid-band unlicensed spectrum (note our response to Q2 on IoT, our responses to Q15-18 on Unlicensed LTE, and the growing demand from Wi-Fi), we would also recommend that IMDA consider designating the 6 GHz band for license exempt operation. [*We can cite the activity in the US, and the study items in Europe that are already looking into this. It will be important to note that these proposals are looking at the possibility of unlicensed operation with the understanding that incumbent services would be appropriately protected from interference.]*

WBA members consider it vital to obtain additional mid-band spectrum (i.e. spectrum between 1 GHz and 10 GHz) for unlicensed (license exempt) operations, as long as any incumbents are adequately protected.

10) IMDA would like to seek your views and comments on the following:

i) The role mmWave bands will play in delivering the vision of 5G, in particular, what services could not be delivered by alternative frequency bands and / or technologies;

ii) The amount of spectrum required in the mmWave spectrum bands to meet 5G applications that will require higher bandwidths; and

iii) The specific mmWave bands that you consider should be a priority in Singapore for IMT services and why?

There is an established and growing ecosystem of equipment supporting unlicensed operation around 60 GHz. The majority of this unlicensed activity has been focused on WiGig for in-room distribution of very high-bandwidth applications – such as wireless connectivity for virtual reality headsets. However there are also outdoor, urban distribution system being developed for these unlicensed bands. Facebook's Terragraph system would be one example.[1] The US FCC also recently moved to designate 64-71 GHz for unlicensed operation in order to provide very large bandwidths for innovation, both indoor and outdoor.

Due to the propagation characteristics of signals in the 60 to 70 GHz ranges, which will not pass through even the lightest of building materials, we recommend that any sort of licensing regime that may be contemplated include a local or in-building general authorization aspect that would allow unlicensed or licensed-by-rule access to the spectrum on a no-protection and non-interference basis.

11) Considering that there are 11 candidate bands under consideration at WRC-19, how would making available the 28 GHz band help in the deployment of 5G services in Singapore? Would this band play a significant role in achieving the targets set out for 5G (i.e. higher throughput, ultra-low latency)?

No comments

12) If the 28 GHz band is opened for IMT services in Singapore, would there be any future competing services that may be deployed in this band which may cause interference issues?

No comments

[1] https://code.facebook.com/posts/1072680049445290/introducing-facebook-s-new-terrestrial-connectivity-systems-terragraph-and-project-aries/

13) IMDA seeks views and comments on the estimated spectrum demand of 3360 MHz by 2025 and whether this estimate is realistic?

No comments

14) Noting that several regulators have made available mmWave bands for IMT services, IMDA would like your views and comments on whether access to the mmWave spectrum should be provided earlier than 2022 for commercial network deployment?

No comments

15) Considering the current regulations/policies for license-exempt use and the possibility of LTE-U interfering with Wi-Fi users, IMDA would like to seek views and comments on the following:

i) The adoption of LBT to facilitate sharing of license-exempt spectrum and whether there would be any implication arising from such a requirement;

ii) The need for further technical requirements and regulatory measures to facilitate the sharing of license-exempt spectrum in an efficient and fair manner; and

iii) The need for companies with commercial LTE-U networks to upgrade to LAA once the software/hardware products are commercially available.

WBA consider the following technical aspects to be critical for fair coexistence of collocated LAA and Wi-Fi networks:

- Listen Before Talk (LBT) channel access mechanism with adaptive back off and a contention window that is compatible with 802.11
- Appropriate Clear Channel Assessment level and smart channel selection
- Maximum transmission duration which does not impact voice and video services over Wi-Fi
- Mitigation mechanisms for the hidden node problem

WBA is concerned that the LAA / LTE-U specification may mandate use of LBT only where regulations require it, which could be detrimental to existing Wi-Fi deployments. It is the understanding of WBA that pre-standard LTE-U does not employ LBT, though it does limit maximum transmission duration, which raises concerns with respect to Wi-Fi coexistence.

Coexistence of LTE-U and/or LAA with Wi-Fi will be dependent upon the specifics of the implementation. It's not clear that one technology will coexist "better" than the other. It is relevant to share that exchange of liaison statements between IEEE and 3GPP are underway, which show there is still in progress the definition of the appropriate levels for some of the LAA parameters.

Another important issue is that LAA, as a global standard, likely to have a larger ecosystem of equipment, both on the infrastructure and client when comparing with the proprietary LTE-U technology.

WBA would like to share with IMDA a report on Unlicensed Spectrum - Market Drivers and Roadmap that can provide additional information related with license-exempt technologies. This document was developed by the WBA members and release by the end of 2016. The focus of our analysis was on identifying the market drivers for the deployment of these technologies and the expected market evolution.

16) During the interim period before regulations are finalised, IMDA plans to facilitate industry trials for LAA/LTE-U technologies. As such IMDA would like to seek views and comments on the following:

i) Besides the information listed in Para 80, should MNOs/MVNOs interested in conducting LTE-U trials submit any further information for IMDA's assessment; and

No comments

ii) To minimise impact to Wi-Fi users, should IMDA limit LAA/LTE-U trials to parts of the 5 GHz licence-exempt spectrum?

In order to obtain the most useful information on the impacts to Wi-Fi users, and the broader questions around coexistence between Wi-Fi and LAA/LTE-U, the WBA recommends that IMDA support LAA/LTE-U trials in the 5725-5850 MHz range. This portion of the 5 GHz band supports the widest range of Wi-Fi use cases and applications, and therefore impacts can be gauged against a variety of Wi-Fi deployment types.

17) IMDA would like to seek views and comments on the following:

i) The possibility of deploying LAA and / or MuLTEfire in other frequency bands besides the licence-exempt 5 GHz band; and

ii) The regulatory and coexistence measures that should be adopted for MuLTEfire.

3GPP has an open study item to look at LAA/eLAA operation in the 3.5 GHz CBRS band for the US market. These items are considering creating a new Band 49 definition, which would support Frame Structure 3 (LBT-enabled LTE) in the 3550-3700 MHz range with the operating parameters outlined in the CBRS rules.

MulteFire technology is working on implementing the control and paging channels in the unlicensed bands (unlike LAA and LWA, which retain control and paging in the licensed "anchor" bands). Therefore, the impacts of congestion (e.g. increased channel access delays and retransmits) could be more substantial with MulteFire than with LAA or LWA because control messages could be disrupted. Additionally, there are no broad industry organizations, such as 3GPP or the Wi-Fi Alliance, who have yet taken up testing of MulteFire (either in regards to its coexistence with Wi-Fi, or how it will behave in congested environments). For these reasons, at this time it's hard to understand how well MulteFire will coexist with Wi-Fi.

Once equipment is available WBA would like to perform a testing program to validate the coexistence of these technologies (LAA, LWA, LWIP and MulteFire) with Wi-Fi.

18) Considering that the LWA approach would not create coexistence issue with Wi-Fi users, would this approach be better suited for countries with extensive Wi-Fi usage?

In addition, LTE-WLAN Aggregation (LWA) one other option to consider is the LTE WLAN Radio Level Integration with IPsec Tunnel (LWIP). LWIP has defined a LTE/WLAN Radio Level Integration with IPsec solution with bearer switching which addresses legacy WLAN deployment scenarios. The terminal device uses an IPSec tunnel over the WLAN infrastructure.

Given that LWA/LWIP utilize the native 802.11 MAC layer to carry the LTE datagrams, they will "look" like Wi-Fi to other Wi-Fi stations operating co-channel. Because the issues of 802.11 coexistence in heavily utilized areas is well known, it is safe to say that remedies for LWA operating in concert with heavily utilized Wi-Fi is better understood than LTE-U or LAA operating with Wi-Fi

19) IMDA would like to seek views on how the above approaches (i.e. LAA, MuLTEfire and LWA) would enhance the capacity of the mobile network in ways that Wi-Fi offloading is not able to achieve.

One of the areas where WBA has been leading is on the development of Wi-Fi Offload and Wi-Fi Roaming services supported by the Next Generation Hotspot (NGH) Program based on Passpoint, using 802.1X / EAP authentication / 802.11u standards. These technologies enhanced the user experience via an automatic discovery and selection capability which means the user no longer needs to take any steps to connect to the Public Wi-Fi network initially, but rather the device will connect whenever in range of a network supporting its credential.

WBA has been developing, since 2011, wide industry trials and testing between mobile operators, cable operators, ISPs, cities, infrastructure vendors, technology players and device manufacturers. These technologies are today well-understood / mature and are in active deployment globally.

Upcoming technologies like LAA, LWA, and MulteFire are still in an initial phase of development and support in mobile devices will take many years to become widespread.