Comments for IDA Consultation on Proposed Regulatory Framework for TV White Space Operations in the VHF/UHF Bands

Submitted by: InterDigital, Inc.

InterDigital, Inc. ("InterDigital") hereby respectfully submits its comments in response to the IDA Consultation on Proposed Regulatory Framework for TV White Space Operations in the VHF/UHF Bands.

InterDigital is an industry leader in exploring and developing dynamic spectrum use technologies. Since its founding in 1972, the company has been a wireless pioneer that has designed and developed a wide range of technologies used in digital cellular and wireless products and networks, including 2G, 3G, 4G and IEEE 802-related products and networks. The company actively participates in and contributes to the standards bodies that drive the design and function of each generation of wireless technologies. These bodies include IETF, ETSI, 3GPP, SAE, and IEEE 802 among others.

Some of InterDigital's recent contributions to the worldwide standards have been in areas involving multi-carrier technology, heterogeneous deployments, interference management, dynamic spectrum management, small cell support, relays, machine-type communications, security and video over wireless.

Inter Digital is motivated by its commitment to wireless innovation and believes in the strong potential of spectrum sharing technology to meet unprecedented spectrum demand. InterDigital's Dynamic Spectrum Management (DSM) solutions exploit and aggregate the capacity of underutilized bands to dynamically add more capacity to commercial LTE and Wi-Fi® systems, dramatically supplementing bandwidth. Our Wi-Fi (DSM-Wi-Fi) and LTE (DSM-LTE) solutions are being developed for standards-based interoperability to enable scalable and cost-effective solutions. InterDigital is working actively to lead initiatives within key standards organizations such as ETSI, 3GPP, IETF and 802.11 to foster adoption of spectrum sharing capabilities, as well as to enable efficient use of the TV white spaces.

In the remainder of this paper, we address the questions that we feel we bring a meaningful contribution to, specifically to questions 1 to 16, 18 to 25, and 28 to 32.

Comments

Question 1:

IDA invites views on adopting a licence-exempt approach for WSDs in Singapore, subject to the devices meeting the conditions set by IDA.

InterDigital strongly supports the need for shared spectrum policies. As such we believe that both the licence-exempt approach and the multi-tier model as proposed in [3] are complementary approaches that each brings benefits to the wireless industry and the economy. The multi-tiered approach, unlike the licensed exempt spectrum models, can offer QoS guarantees to secondary users who would otherwise be hesitant to invest in network infrastructure using license-exempt spectrum. Furthermore, spectrum transactions can be used to generate incentives for incumbents to free up additional spectrum.

Question 2:

IDA invites views on designating a restricted number of TVWS channels to support the deployment of services that require certainty of spectrum access.

We agree that designating a restricted number of TVWS channels can support the deployment of services that require certainty of spectrum access. However, this approach may raise the challenge of how to determine the right amount of channels to be reserved for those services. If that is not determined accurately, or if the needs change in time and/or space, then this approach may lead to inefficient use of spectrum.

To make efficient use of spectrum, rather than reserving a fixed number of channels, a more dynamic approach of channel assignment may be taken, such that the services requiring certainty of spectrum access (priority users/services) are assigned the amount of channels as needed (as a function of time and location). For example, a channel assigned to a priority user in Location A may be assigned to a user that does not require certainty of spectrum access (non-priority user) in location B. The remaining channels may be used opportunistically for non-priority users and services. InterDigital believes that the number of channels assigned to priority services should not be fixed or static, but rather determined dynamically by the database based on the spectrum needs in any given area at a given time. For instance, in areas where there is a greater need for guaranteed access, the database could assign more spectrum for this and reduce the amount of spectrum assigned to the other users/services. Conversely, when there is less need for guaranteed spectrum access in a given area or at a given time, the database could allow the use of more spectrum by the other systems. To ensure that all user types may access the spectrum in a given area, the amount assigned for guaranteed spectrum access could be upper bounded by a certain limit.

We further believe that the development of advanced spectrum assignment algorithms would allow the provisioning of QoS and adequate capacity of spectrum for systems requiring guaranteed spectrum access, despite the use of a dynamic band planning. Such algorithms would need to give priority to the spectrum request from the users requiring guaranteed spectrum over the requests from the other users, while ensuring that the amount of spectrum assigned for guaranteed access is upper bounded to a reasonable value. It should be noted that such a dynamic approach to frequency assignments is in line with regulatory efforts in other bands in the US and Europe (e.g. the Priority Access for the 3.5 GHz band, as in the FCC NPRM 12-148, and the LSA for the 2.4 GHz band).

As an example of advanced spectrum assignment algorithms, InterDigital's DSM system includes channel management that continuously monitors available channels and aggregates data transmission across multiple channels. Where a priority channel is unused, secondary users can benefit from the added capacity. If a priority user requires a channel, a fast evacuation procedure makes it available quickly and the secondary users maintain their links, albeit aggregated over fewer channels.

Question 3:

In the event where IDA designates channels to support such services, IDA invites views on the appropriate regulatory approach in designating and managing these TVWS channels and the regulatory framework for the operations of prioritised WSDs.

As indicated in the response to Question #2, InterDigital believes that a dynamic approach to assigning channels to services requiring guaranteed spectrum access is feasible using a multi-tier shared spectrum model. A possible regulatory framework for this hierarchical shared system may be the license-by-rule, whereby the WSDs operating in that spectrum are required to comply with a set of rules. Moreover, all WSD devices (including prioritized and non-prioritized) would use the same license-by-rule framework. We believe that the license-by-rule approach helps in implementing a more dynamic use of spectrum than traditional licensing or temporary licensing, thus increasing the spectrum availability at a given time. It will also enable a larger number of users to have access to the band, as this access can be made without the costs of a traditional license. This will be beneficial in managing not only the quality of service requirements of the prioritized users, but also managing the spectrum for non-prioritized users and avoiding harmful interference to incumbent users.

InterDigital also believes that a uniform approach to licensing for multiple tiers will allow for a more flexible determination of the band assignments by the database, which is also desirable to achieve overall spectral usage efficiency for the TVWS band. Although a license-by-rule approach allows for term-less licensing, we believe that as the automatic authorizations are controlled by the database, the time related aspects of the assignment process can be covered sufficiently. Such control will only allow access for certain users based on frequency, time, and location in order to protect the incumbent users and other prioritized users.

Question 4:

IDA invites views on allowing operation of WSDs in the 694 MHz – 806 MHz band until IDA allocates these frequencies for IMT deployment.

InterDigital is hesitant to support allowing operation of WSDs in the 694MHz-806 MHz, if the spectrum will eventually be reallocated for IMT deployment. InterDigital believes that few WSD networks would use this spectrum given the uncertainty. As a compromise, we recommend that IDA permits operation of WSDs in the 694MHz-806MHz band prior to the re-allocation and after the band has been reallocated for IMT deployment as a non-priority user. This approach would spur innovation in spectrum sharing technologies and some of the techniques proposed by the European commission, and PCAST could be suitable in this band.

Question 5:

IDA invites views on adopting a database approach as the mandated method to access white space spectrum.

InterDigital shares IDA's view that a database approach should be adopted as the mandated method for WSDs to access white space spectrum. However, InterDigital also believes that spectrum sensing technology should be included as a complementary method that would operate simultaneously with the database approach. Sensing results could optionally be reported so as to improve database accuracy and to support value added applications that may be offered by a database provider. InterDigital also believes there are scenarios reflecting a significant industry need where sensing is sufficient to protect incumbent systems. For example, InterDigital's work with this technology reveals that it protects incumbent users particularly well in systems designed for small scale or indoor environments with limited transmission power. In these cases, secondary spectrum access, based on sensing, can deliver significantly more efficient spectrum utilization than reliance on a database approach alone.

Question 6:

IDA invites views on the proposed general requirements for the database query and registration.

InterDigital supports the proposed general requirements for the database query and registration. Registration with the database is key to enabling database management algorithms for interference mitigation, as well as to allow the WSDs to adhere to the validity time of the channel. Both registration and querying the database upon expiration of the time validity are necessary to support database services and guaranteed access provisions (see our answers to questions #2, #31). We also think it is

beneficial to harmonize with the framework provided by IETF's PAWS protocol [7], and as such we believe it is beneficial for the WSDs to inform the database of the selected operating channel.

Question 7:

IDA invites views on the three situations in which a WSD must query the database. In particular, IDA invites views on defining 50m as the maximum distance that WSDs are allowed to move from its original location, without contacting the geolocation database.

We think that international harmonization of regulations on TVWS helps to improve economies of scale and simplify the design and commercialization process. As this distance of 50m is consistent with the FCC rulings on TVWS [1], we support this harmonized approach.

Question 8:

IDA invites views on the output power transmission of WSDs as shown in Table 2.

The values in Table 2 are consistent with the FCC rulings on TVWS [1], and we agree with this harmonized approach.

Question 9:

IDA invites views on allowing the Fixed Devices to have tuneable output power that is capped at a maximum of 4Watts EIRP.

So long as these devices with a tunable output power are shown to meet the spectrum mask and not cause interference on adjacent channels for each level that the device may be tuned, we think this is consistent with the FCC rulings on TVWS [1] and we agree with this harmonized approach.

Question 10:

IDA invites views on the requirement of a Unique WSD Identifier and for this identifier to be based on standards developed by recognised standards organisations.

InterDigital supports the use of a Unique WSD Identifier based on standards developed by recognized standards organizations.

Question 11:

IDA invites views on the proposed maximum transmission level of 100mW EIRP for WSDs operating in channels adjacent to a local broadcast channel.

InterDigital supports the 100mW EIRP limit for WSDs operating in channels adjacent to a local broadcast channel.

Question 12:

IDA invites views on the proposed OOB emission limit of -56.8dBm, which will be imposed on WSDs operating in channels that are directly adjacent to a local broadcast service.

We think that the measurement BW for OOB emissions should be specified in order to remain consistent with the discourse of the FCC rulings. We assume that for OOB emissions the -56.8dBm limit is for a 100 kHz BW as would be consistent with the FCC.

Question 13:

IDA invites views on defining the OOB emission limits for WSD to WSD operations.

InterDigital agrees with IDA's view that OOB emission limits may not be necessary for adjacent WSD to WSD operation. As indicated in our answer to Question #31, we believe that reporting the WSD operational parameters to the database may enable more advanced frequency assignment schemes that can help reduce or avoid mutual interference between adjacent channel WSDs. For example, when a WSD system that has a high OOB emission mask requests channel availability, the database may signal to that specific WSD that certain channels are not available. This approach may protect WSD already operating in adjacent channels, and may be used to enable QoS provisioning for the WSD.

Question 14:

IDA invites views on the proposed approach to manage coexistence between a WSD and the other secondary services within the TVWS channels.

InterDigital believes that the database approach described by IDA in sections 29 to 31 can be used to manage the co-channel coexistence between a WSD and the other secondary users (such as licensed PMR and licensed wireless microphones). We also believe that additional enhancements may be needed to enable higher efficiency of spectrum use. As shown in section 36 of IDA's consultation paper, the separation distance (for co-channel operation) between a WSD and a secondary user is 9 km and 3 km for 4 W and 100 mW WSD transmit power, respectively. This distance may be too large and may result in significant restrictions to the areas where WSDs may operate. This is why we think that additional

enhancements may be needed. One such example is spectrum sensing. The regulatory framework should allow future extensions to incorporate sensing information to detect the presence of other secondary users. Another example may be to assign some pre-defined channels for the licensed PMR and licensed wireless microphones, where those devices are priority users, but not exclusive users. In this approach, the time validity concept may be used to control the access to the channel for other WSDs, thus ensuring the protection of the secondary users.

Question 15:

IDA invites views on the proposed propagation model and parameters used to determine the maximum transmission power level of a WSD.

InterDigital agrees with IDA's proposal to use the Hata-Okumura propagation model to determine the maximum transmission power level of a WSD, as this model is widely recognized as well suited for urban environments. Regarding the parameters, in reference to Note 8 on page 13 of the IDA consultation paper, we feel that an antenna height of 30 m for a portable device may be too high ([2]).

Question 16:

IDA invites views on its proposal for the protection of licence-exempt and licensed wireless microphones. IDA also invites views and comments on the optimal number of safe harbour channels required to ensure that licence-exempt wireless microphones can continue to be used once WSDs are deployed.

InterDigital believes IDA's proposal to use safe harbor channels for the protection of license-exempt wireless microphones has both advantages and disadvantages. Although dedicating channels for wireless microphones solves the co-existence issue, it does so at the cost of reduced spectrum efficiency. An alternative approach would be to have the license-exempt microphones register with the database. This would allow the database to better manage the spectrum and coordinate resources (i.e. channels, power, etc) between WSDs and secondary services. However, requiring both existing and new license-exempt wireless microphones to register may be a difficult task.

Question 18:

IDA invites views on whether the proposed demarcation zone approach is sufficient in terms of managing cross border interference issue and if there are any other factors IDA should consider.

InterDigital agrees with IDA's view that a demarcation zone is a straightforward approach to manage coexistence with cross border TVWS deployments. At the same time, making the zone flexible based on power may be beneficial in extending the areas where WSD can operate. Lastly, the limit of -120 dBm

for the signal propagated by the WSD to the northern borders of Singapore seems low, and we would like clarification on what bandwidth is to be used for measurement.

Question 19:

IDA invites views on the aggregate interference effect of WSD and whether any adjustment in terms of technical requirement is needed.

InterDigital agrees with the IDA that no technical requirements are needed to adjust for aggregate interference.

Question 20:

IDA invites views on using GPS as the method to determine location accuracy, and on whether 50m is a sufficient location accuracy requirement for the operation of WSDs.

InterDigital believes that the methods to determine the location should be implementation specific, and only the location accuracy needs to be specified. The devices certified to operate as WSD need to meet minimum performance requirements, which include the location accuracy. As mentioned in our response to Question #7, we believe that a requirement of 50 m for location accuracy is consistent with the FCC regulations, and using it may help enable economies of scale for the WSD.

Question 21:

IDA invites views on allowing the manual input and internal storage of geographic coordinates for indoor Fixed Devices.

Question 22:

IDA invites views on the requirement of an approval process for the installer of indoor Fixed Devices and the necessary conditions for approval.

InterDigital agrees with the IDA's proposal to allow manual input and internal storage of geographic coordinates for indoor Fixed Devices, as well as with the requirement that only licensed or approved companies are allowed to conduct the installation.

Question 23:

IDA invites views on the possible types of TVWS network topologies and use case scenarios.

InterDigital envisions TVWS being used as a backhaul solution for use cases where a traditional backhaul solution is too expensive or impractical. One such use case is for hard to reach locations where wireline backhaul infrastructure is prohibited due to environmental constraints or not practical. A network topology such as the one shown in Figure 5 is envisioned for such a use case. TVWS could also be used for the backhaul of small cell network to a concentration point which would facilitate the indoor deployment of femtocells. The deployment of femtocells in high rise buildings could be critical to lower the interference level and provide a significant capacity increase in these environments. For this use case, a network topology similar to the one shown in Figure 6 is envisioned.

In addition to the TVWS network topologies illustrated in Figures 5 and 6, InterDigital envisions TVWS being used in the deployment of small cell master client networks. In one such use case, a Mobile Network Operator (MNO) would deploy a Heterogeneous Network (HetNet) composed of LTE macro cells operating in licensed spectrum and an underlay of LTE small cells operating in TVWS; where the small cell network is used to offload traffic from the macro cell. In such a deployment, the small cell eNB(s) act as a Fixed/Mode II device and the UEs act as Mode I devices.

We can also envision use cases where Wi-Fi APs operating in TVWS are deployed to provide wireless connectivity across a campus or in public spaces such as a malls, restaurants, transportation terminals, etc. Wi-Fi APs deployed in a planned manner as Fixed devices could be used to provide coverage over wider areas, while Wi-Fi APs deployed in an ad hoc manner as Mode II devices could be used to provide "hotspot" coverage. Such a network could consist of Wi-Fi APs deployed in both manners.

Question 24:

IDA invites views on the payment of fees for the use of database services.

It should be possible for database providers to provide value added services such as coexistence services or providing channel quality metrics in exchange for fees. The payment of fees for such services could provide incentives for companies to develop innovative technologies and spur economic growth.

Additionally there is a strong political mandate in the US to implement market-based incentives for agencies to make available more spectrum [5]. We propose that market mechanisms may be used to enhance the value of TVWS spectrum. We note that high spectrum efficiency does not always translate to a high quality of experience, and market mechanisms may better reflect the best overall allocation of spectrum.

Question 25:

IDA invites views on both approaches in managing the database (i.e. industry-managed or government-managed database).

In our view the preferred solution would be to allow commercial entities to develop and manage the database, as this would encourage increased competition, foster innovation, and potentially lower the costs of development and deployment of the database, as well as the cost of using the services of the database (if applicable). We agree that some government involvement would be needed, for example for supervision and definition of relevant policies.

Question 28:

IDA invites views on the proposed approach and communications protocols between the following:

i) WSD and IDA website containing the list of authorised database administrators

ii) WSD and the database

InterDigital believes that the IETF's PAWS protocol [7] should be used as a basic framework to define the communication protocols between the WSD and the database. Moreover, to address requirements specific to IDA, we believe that enhancements or extensions to the PAWS protocol could be considered, while still using the IETF protocol as the basic framework.

Question 29:

IDA invites views on the proposed frequency of update for Time A validity and Time B validity.

Time validity A is consistent with the existing incumbents as well as with the FCC regulations for TVWS [1]. Regarding Time Validity B, we believe that reducing it may result in a more efficient use of spectrum. At the same time, further studies are needed for the tradeoff between the value of Time Validity B and increase in complexity (database and signaling) associated with a smaller validity time.

Question 30:

IDA invites views on requiring the adjustment of the value for Time A validity and Time B validity, and for this to be within the range of 6 to 24 hours.

InterDigital believes that the ability to adjust the value for Time validity A and Time validity B is a good step that will enable more dynamic and more efficient spectrum assignment methods. If the lower bound of the range (in particular for the Time validity B) is less than the proposed value of 6 hours, then it can be used effectively by the database to control the interference between WSD (see also our answers to questions #3, #6 and #14).

Furthermore, InterDigital believes that the IDA should consider including a mechanism that would allow for the preemption of a channel prior to the expiration of both time validity factors. Such a mechanism could prove very useful for use cases where TVWS channels are used to provide communications for first responders during an emergency or a disaster recovery mission.

Question 31:

IDA invites views on the benefits and costs of a requirement for WSD to report its operational parameters to the database.

We think that all devices using spectrum with guaranteed access requirements must report some operational parameters. Given our opinion that spectrum should be made available for guaranteed spectrum access (see our response to question 2) either through reservation, market, or another mechanisms, such reporting is needed by devices such that the database may respond to queries by other devices who wish to subsequently use the spectrum. These could include for example, the number of spectrum resources they will occupy.

If some spectrum ranges are left for non-prioritized use, then reporting operational parameters may still be useful to enable spectrum sharing services.

Question 32:

IDA invites views on the benefits of including within the TVWS regulations a requirement for WSD to register its contact parameters to the database.

InterDigital shares IDA's view that it is necessary for a Fixed Device to provide comprehensive contact information to the database. Furthermore, we believe that the registration of such information for a Portable Device is not necessary and therefore should not be required.

Conclusion

InterDigital welcomes the opportunity to express our views on the “Proposed Regulatory Framework for TV White Space Operations in the VHF/UHF Bands”.

We appreciate the consideration of our comments and welcome any questions concerning our technologies.

Respectfully submitted,

Angelo Cuffaro, Senior Director, InterDigital Innovation Labs

angelo.cuffaro@interdigital.com, (514)904-6271

InterDigital Canada Ltee

1000 Sherbrooke Street West

10th Floor

Montreal Quebec, Canada H3A 3G4

References

[1] FCC - SECOND MEMORANDUM OPINION AND ORDER, September 23rd, 2010 –URL:

http://hraunfoss.fcc.gov/edocs_public/attachmatch/FCC-10-174A1.pdf

[2] FCC - THIRD MEMORANDUM OPINION AND ORDER – April 5th 2012 –URL:
http://transition.fcc.gov/Daily_Releases/Daily_Business/2012/db0405/FCC-12-36A1.pdf

[3] – FCC 12-148 – NPRM - Enabling Innovative Small Cell Use In 3.5 GHZ Band NPRM & Order – URL:

http://www.fcc.gov/document/enabling-innovative-small-cell-use-35-ghz-band-nprm-order

[4] – PCAST report – July 20th 2012: Realizing the full potential of government-held spectrum to spur economic growth - URL:
http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_spectrum_report_final_july_20_2012.pdf

[5] White House- Office of the Press Secretary – Presidential Memorandum – Expanding America's Leadership in Wireless Innovation - June 14th, 2013. URL:
http://www.whitehouse.gov/the-press-office/2013/06/14/presidential-memorandum-expanding-americas-leadership-wireless-innovatio

[6]. FCC Part 15 requirements for Television Band Devices, URL: http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&SID=4fa641b4ec7a99c5ae4be2eee1e36dd4&rgn=div5&view=text&node=47:1.0.1.1.16&idno=47#47:1.0.1.1.16.8

[7]. IETF Protocol to Access White Space Database, http://tools.ietf.org/html/draft-ietf-paws-protocol-06