Implement TV White Space for more efficient use of unoccupied spectrum

BY DR ALI R EBADI

Reliable connectivity has become desirable in this IT era where it can benefit many aspects of our life including education, health services, security, science and many more. This has driven research into spectrum efficiency, which includes White Space Spectrums for better utilisation of current usage of spectrums economically, rationally and efficiently.

White Space Spectrums refer to frequencies allocated to a terrestrial broadcasting service but are not used efficiently. In using broadcasting spectrum, there are unused spectrums that have been assigned for a guard band or are available as a result of migration from analogue to digital. White Space Spectrums exist naturally between immediate adjacent channels to protect interference from one channel to another.

The recent development of digital dividend (release of spectrum as a result of digital transition) has given the opportunity for the implementation of new applications such as TV White Space (TVWS) by making use of the unoccupied bandwidth of the broadcasting television in the UHF band in the range 470-790MHz, provided that non-harmful interference to existing services is guaranteed. Due to its good propagation characteristics, use of TVWS in this band is ideal for the development of wireless access infrastructure in vast geographical rural areas at an affordable cost, Wi-Fi and also machine-to-machine (M2M) applications.

M2M explains technologies that allow wireless and wired systems to communicate with other devices of the same type, considered as an integral part of IoT (Internet of Things) which has a range of applications such as industrial automation, smart cities, smart schools, smart house and smart healthcare, mainly by monitoring activities in real time. M2M low-power devices can capture natural disasters such as fire, tsunami, earthquake and flood, and deliver low data rate communication between devices, such as for monitoring, tracking and metering.

There are indefinite useful applications that can benefit from the implementation of TVWS but the emphasis is on M2M and broadband to rural areas. TVWS can significantly reduce cost for the broadband in rural areas as compared to microwave links. Currently, a standard has been developed under IEEE 802.22, or Wireless Regional Area Network (WRAN), for devices operating in TVWS. Under this standard, a fixed or portable White Space Device (WSD) is proposed to operate with a geo-location database to avoid harmful interference to existing services.

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There are some challenges that need to be addressed before the implementation of TVWS. One is the determination of the availability of TVWS spectrum in the frequency bands mentioned earlier. Generally, potential availability of TVWS spectrums are from the guard bands of the TV channels. As the digital dividend process varies in different countries, there are no known amounts of available spectrum that are able to be deployed for other applications.

Another challenge is the difficulty to mass-produce TVWS devices.

The operational level of the TVWS needs to be carefully studied and the possibilities of the evolution of the technologies in the broadcasting band have to be taken into consideration in the development of the technical parameters of WSD, to avoid any complications in the future. This may limit the TVWS applications under severe sharing conditions and may either result in very low operational power, or be limited to broadband usage over rural areas. Therefore, a long-term strategy needs to be outlined to ensure smooth spectrum sharing for TVWS usage.

The identification of the free spectrum in the aforementioned frequency bands can possibly be realised by a cognitive radio or geographic sensing. Cognitive radio is a device that is aware of its surrounding and capable of dynamically and autonomously adjusting its operational parameters to match the current operational requirements. By adopting TVWS, the device will continuously detect current spectrum usage, analyse its patterns and autonomously adjust its operational level according to the data gathered. Nonetheless, there are a number of problems associated with this technique, such as hidden node problem and spectrum usage by very short time transmission.

Another method that can be used to identify the available spectrum is geolocation database. This technique requires the development of an extensive database of spectrum utilisation, comprising every regulatory provision of all radio systems and added rules for the identification of the availability of white space spectrum.

Under this technique, a WSD would need to be equipped with Global Positioning System (GPS) to detect its current location and then communicate with the geolocation database to identify the available channel and operational level that it can operate at the time. Once the spectrum is not available or once the WSD moves to another location where the channel is not available, the device needs to immediately vacate the channels to avoid causing interference to the incumbent service.

The regulatory aspect of TVWS involves both national and international levels. Previously, the regulatory issue of TVWS was brought up in WRC-12 in regard to cognitive radio system (CRS) implementation. The discussion, however, concluded that no change in radio regulations is required to accommodate CRS.

The decision implies the freedom of CRS to operate in any frequency band under the condition that they do not violate the current radio regulations in the country or neighbouring countries, and adequate protection is provided to the incumbent services. Nevertheless, studies on CRS will be continued by ITU-R.

To better understand how the WSD works, a simple explanation employing handshaking protocol concept is used. Before WSD start operating at any time and location, the device must discover an authorised White Space Device Database (WSDB) and communicate its unique identifier, current latitude and longitude, antenna height and its antenna polarisation.

Upon receiving this information, WSDB will provide a list of frequencies available to use, maximum permitted EIRP spectral density and several other operational requirements to the WSD based on its current location and time. Next, WSD will exchange information on its intended frequency use based on the available frequency band and its intended maximum EIRP density to use at the specific frequency to the WSDB.

Finally, after receiving WSD's intended operational characteristics, WSDB will send an acknowledgement receipt of the information and at this point WSD will be able to radiate in the broadcasting band. In case the WSD is moved to another location or at any time when the white space spectrum becomes unavailable, the device will need to immediately cease operation and evacuate the band and search for a new band. The same process will be repeated before WSD can operate in the broadcasting spectrum again.

In a nutshell, the implementation of TVWS would be extremely beneficial to society and could lead to more efficient use of spectrum. Although at this stage there are a few challenges that need to be addressed, proper planning and long-term strategy will ensure smooth spectrum sharing of TVWS usage. It is believed that when the implementation is successful, TVWS will become the next much talked about, and efficient, spectrum usage. APB

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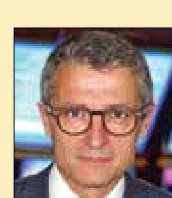

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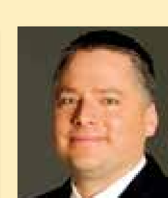

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