Enhancing the Public Good Through Wireless Innovation: The Benefits of Globally Harmonized "White Spaces" Rules

I. License-Exempt Spectrum: History and Background

In the past, exclusive licenses for specific frequency bands and specific purposes dominated government spectrum policy. In the last decade, however, governments around the world have embraced the concept of "license-exempt" spectrum as another way to bring citizens innovative new wireless technologies. License-exempt spectrum refers to frequency bands, such as those bands used for Wi-Fi technologies, for which regulators do not grant exclusive licenses, but instead protect against interference and achieve important operational safeguards through equipment certification and clear and enforceable technical rules.

The result of this shift has been dramatic. License-exempt spectrum has been, and continues to be, a powerful catalyst for innovation and investment. Today, there are over four billion human and intelligent machine users of the Internet, and license-exempt networks carry the majority of their data traffic. For example, for PCs and laptops, license-exempt networks carry 57% of total traffic, greater than the share of Ethernet connections and cellular data combined. For smartphones and tablets, license-exempt networks carry almost 70% of traffic generated.

Experience over the past ten years in particular—including the exceptional growth of Wi-Fi wireless local area networks—has confirmed that this spectrum provides a unique and powerful platform for innovation. This is true because innovators using license-exempt spectrum generally face significantly lower barriers to entry compared to licensed spectrum. This enables innovators to deliver an unlimited array of license-exempt offerings that improve citizens' lives and government operations, including Wi-Fi hotspots; wireless medical devices; industrial, monitoring, logistics, and inventory systems; wireless headsets; cordless phones; remote car door openers; RFID; and wireless keyboards.

Now countries are taking the next step in spectrum policy, through the license-exempt use of the "TV White Spaces." As certain spectrum resources are more intensely used, countries adopting this innovation create significant new opportunities to leverage the underutilized portions of their spectrum resources. Typically, bands assigned for television broadcast include unused (or interleaved) frequencies between TV channels. These unused frequencies are called "TV White Spaces." At the frequencies below 1 GHz, such as those allocated to television broadcasting, radio waves travel farther and penetrate objects more easily at a given power level than those at frequencies currently available for license-exempt operations. These physical characteristics make the TV White Spaces frequencies particularly useful for many new and existing applications, in addition to their value for TV broadcast services. In fact, the use of TV White Spaces is expected to increase the range of license-exempt technologies by a factor of three or more over today's Wi-Fi technologies, and provide greater usability as well, by allowing the devices to more easily penetrate walls and other obstructions.

As a result of these benefits, countries around the world have adopted or are working to adopt license-exempt TV White Spaces regulations. In the U.S., the Federal Communications Commission ("FCC") finalized rules to make that spectrum available in 2010. These rules permit license-exempt devices to operate on TV channels that are not in use in their vicinity, subject to specific technical requirements designed to prevent interference to TV broadcasting

and other authorized users of the TV bands. In the U.K., Ofcom has published its TV White Spaces rules and is close to making these devices operational. Regional efforts are underway as well. The European Commission's Radio Spectrum Policy Programme directs Member States to foster new technologies, including those using white spaces. The European Commission's Programme has triggered the formation of a Task Group under the European Telecommunications Standards Institute to develop a harmonized European standard for white space devices operating in the 470-790 MHz bands. Seeing this progress, several other countries have joined this effort. For example, Canada has already initiated a regulatory proceeding, and Singapore and Finland have each begun the process of developing national approaches to TV White Spaces. Many more will soon follow.

II. How White Spaces Technologies Will Benefit Your Country

The best measure of the promise of White Spaces technologies is the history of Wi-Fi. Today, countries that developed globally harmonized license-exempt spectrum rules give their citizens access to Wi-Fi-powered personal computers, printers, videogame consoles, streaming devices, security cameras, medical devices, MP3 players, digital cameras, smartphones, and tablets. Worldwide, approximately 439 million households use Wi-Fi networks—a number that is expected to grow to nearly 800 million by 2016—and there are also millions of publicly available Wi-Fi hotspots. Nearly one billion new Wi-Fi devices are sold every year, and that number is expected to continue to grow. These developments were made possible because of the availability of smart, globally harmonized spectrum rules in countries around the world.

The favorable propagation characteristics of the TV White Spaces promise to make White Spaces devices even more powerful than their Wi-Fi ancestors. White Spaces technologies will greatly expand the utility and help reduce the cost of using license-exempt devices for government operations; last-mile connections for rural broadband deployments; healthcare; smart grid energy systems; remote sensing and smart meters; local broadband networks (including home, municipal government, and campus-wide networks); and machine-to-machine communications. White Spaces will also help relieve over-burdened licensed mobile networks by allowing phone and tablet users to use White Spaces and other license-exempt bands when licensed spectrum is crowded, or to avoid reaching data caps. Most importantly, making TV White Spaces available for license-exempt use may lead to innovations beyond our current imagination. Ten years ago, no one could have imagined the life-enriching effects that Wi-Fi has had. The same may be true for White Spaces technologies.

Because of these advances, widespread use of license-exempt spectrum could provide great benefits to your country's national economy. Several studies quantify the economic benefits of existing Wi-Fi applications. A 2012 Microsoft-sponsored study found that the value of fixed, home Wi-Fi use generates approximately $52 to $99 billion of consumer surplus worldwide each year. And the Consumer Federation of America estimates that the annual value of activity in the unlicensed space more generally at more than $50 billion in the United States alone. The global numbers are likely to be staggering.

Finally, the "opportunistic use" concept central to license-exempt White Spaces use will offer important technical benefits to countries that adopt globally harmonized rules. Opportunistic use is the idea that radio technologies should identify and use different frequencies within a closely defined band, based on what frequency is available for interference-free operation at a given time in a given geographic location. This is a powerful idea. Opportunistic

use allows for real-time flexibility. Although the particular unused TV channels vary from location to location, White Spaces devices have the flexibility and agility to locate and operate on the unused channels, no matter where the devices are located. They can use careful geolocation or spectrum-sensing technology to detect and avoid incumbent services. This means that previously unused spectrum becomes a valuable resource.

III. Current Developments and Uses of White Spaces

The TV White Spaces are already being used on a license-exempt basis today. In the U.S., four trials serve as examples of the utility of White Spaces technologies:

- In the State of Ohio, the White Spaces enable broadband access for healthcare providers throughout a local hospital, including patient rooms, waiting areas, cafeterias and meeting rooms. The outdoor video surveillance component of the initiative has helped provide additional security for hospital operations.

- In the Commonwealth of Virginia a city has used White Spaces to provide high-speed Internet service throughout the area, extending broadband Internet access to local schools, as well as the Claudville business district.

- In California, TV Bands White Spaces enable "Smart Grid" technologies that manage applications such as supply-and-demand of electricity and system control and data acquisition of substations, and provide broadband Internet access to underserved areas.

- Finally, a city in the State of North Carolina embarked on a three-pronged "Smart City" initiative, focusing on improved wireless broadband access by both public safety officials and citizens in public areas; remote monitoring and management of wetland areas; and real-time traffic monitoring to reduce congestion, fuel consumption, travel time, and to support local law enforcement during emergency situations. That same city is home to the world's first commercially-deployed White Spaces network.

The U.S. trials are just the beginning. Scotland, England, Finland, and Singapore also have each hosted important white spaces trials.

- In Isle of Bute, Scotland, TV White Spaces are being tested as a way of providing broadband access to residents of this rural and rugged island, in a manner tailored to the local economy. For example, one white spaces trial application allows cattle breeders to track cattle movements as required by law, and to follow the price of livestock at market.

- In Cambridge, England, a consortium set up city center coverage allowing for "pop up" Wi-Fi hotspots, as well as base stations outside the city providing for rural connectivity. The trial also enabled machine-to-machine communication, allowing, for example, city dustbins to alert the City Council when they were full and needed emptying.

- In Helsinki, Finland, a White Spaces trial has deployed both indoor and outdoor networks, enabling a test of White Spaces devices in three environments: indoor, outdoor, and outdoor rural.

- In Singapore, White Spaces are being used to advance the "smart cities" concept, including intelligent metering for utilities, as well as to reduce interference and boost signal strength for a range of broadband devices.

Having now resolved questions about the technical feasibility of TV White Space networks, companies are transitioning from trials to small-scale commercial deployments.

Equipment manufacturers are likewise moving forward with designing, testing, and certifying equipment for use in TV White Spaces. The IEEE is also actively developing the 802.22 standard to accommodate a wide variety of applications using cognitive radio technology in TV White Spaces, incorporating technologies such as spectrum sensing, dynamic spectrum access, and geolocation techniques. Similarly, the 802.11af task group is developing a complementary standard for use of Wi-Fi devices in the TV band white spaces and the Weightless SIG intends to develop another complementary standard for machine-to-machine communications in the TV band white spaces. Finally, the FCC has approved nationwide TV Bands White Spaces database administrators and devices.

Due to these advances, White Spaces devices will likely be available in the marketplace within a year. Other countries are close behind and are working hard to ensure that their citizens will have access to these new technologies as soon as possible. As the New York Times, the Financial Times, the Economist, and many other publications have recognized, regulators that move forward with this technology will enable a significant increase in wireless broadband and other innovative applications. Your country has the opportunity to be among the first in the world to realize the benefits of White Spaces access. Even if your country is unable to join the ranks of the early adopters that will soon have white spaces devices, however, you should still begin the process of changing your nation's rules to accommodate these devices. As with Wi-Fi before it, white space devices are likely to become ubiquitous. Once that occurs, constituents ranging from businesses and consumers to education and public safety organizations will come to expect that their devices will work in your country just as they do elsewhere in the world.

IV. Purpose and Overview of Model Rules

The Model White Spaces Rules which follow here are designed to give you a template on which to base rules for license-exempt use of TV White Spaces in your country. They are based on the existing U.S. and proposed U.K. regulations, to ensure the benefits of globally harmonized rules so your country will have access to globally standard technologies.

To be sure, the process of providing license-exempt spectrum access to white space devices will vary across different jurisdictions. Accordingly, the model rules also offer flexibility to regulators as they consider their own legal environment and regulatory regime. In some cases, regulators can enable white space devices by a simple amendment to existing rules, while in other cases these changes may require legislative changes. However, the underlying

technical approaches identified in the model rules for enabling white space device operation will be the same.

Importantly, as the pilot programs described above demonstrate, your country does not need to fully implement regulatory changes prior to approving commercial trials for white space devices. Supporting these pilot programs will enable the regulator to see the consumer benefits that can be delivered by TV band white spaces networks prior to full-blown regulations being implemented.

In summary, the Model Rules include provisions that provide a technical framework for your country to enable license-exempt access to valuable, underutilized spectrum while protecting incumbent licensees. Under the Model Rules:

- License-exempt white space devices can use one of two separate methods to prevent harmful interference to incumbents: geolocation or spectrum sensing.

- The geolocation method requires white space devices to determine their physical location and to avoid incumbent licensees in their vicinity by contacting a database that contains information about incumbents and the frequencies on which they operate. This method is designed with a fail-safe: white space devices may operate only after receiving permission from a database, and may be shut down if there is a risk of harmful interference.

- The regulator may designate one public entity or multiple private entities to administer databases. The rules also describe database administrator responsibilities.

- White space devices must meet minimum accuracy requirements for determining their location, and must communicate with a database in a secure manner. A white space device must cease operations if a database indicates that the frequencies in use by the device are no longer available.

- Alternatively, the spectrum sensing method of avoiding interference requires devices to scan the frequencies in their vicinity, and to employ a "listen before talk" technique to determine if any incumbents are present prior to transmitting. White space devices must also monitor the frequencies that they use, and must vacate those frequencies if an incumbent licensee is detected.

- Regardless of the mechanism that a white space device uses to avoid causing harmful interference, all devices must comply with operational rules, such as transmit power and emissions limits, to protect incumbents.

Finally, upon request and as a reference, we can provide a compendium of technical studies and releases from the FCC and Ofcom related to their study and regulation of the TV White Spaces.