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WHITE PAPER / **UNLICENSED USE OF 6 GHZ SPECTRUM**

HOW INCUMBENTS CAN PREPARE FOR RISKS OF INTERFERENCE

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As wireless communications has expanded, the demand for spectrum has grown exponentially. The FCC has decided to open a swath of 6 GHz spectrum for unlicensed use. Incumbents with critical licensed communications in that bandwidth must understand the potential for interference and evaluate their options.

In 2018, the Federal Communications Commission (FCC) voted unanimously to consider opening additional bandwidth for unlicensed use. This was immediately celebrated by the nonprofit Wi-Fi Alliance and proponents of open data. In contrast, incumbent holders of licensed frequencies within that band became concerned and immediately began requesting protections for their mission-critical deployments. After 18 months accepting comments from all interested parties, the FCC voted to move forward with opening additional unlicensed spectrum. This paper examines the details of this new draft order and potential risks for incumbent license holders, and it explores a path forward for the latter to navigate the new playing field. As with any paper covering a current and ongoing subject, details and observations may be rendered moot by any new updates from the FCC.

OPENING SPECTRUM ACCESS

With the proliferation of mobile internet-connected devices has come explosive growth in wireless internet usage. More bandwidth is necessary to support all that traffic. To help address that demand, the FCC's new order makes 1,200 megahertz (MHz) of spectrum in the 5.925-7.125 (6 GHz) band available for unlicensed use, increasing the available spectrum for Wi-Fi by a factor of five.

This move will usher in Wi-Fi 6E, the next standard for wireless, which brings the Wi-Fi 6 standard to the 6 GHz frequency range and will offer higher performance, lower latency and faster data rates compared to any previous version of Wi-Fi. However, the decision will significantly affect utilities operating on licensed communications within the 6 GHz band for critical infrastructure. To assist with the protection of incumbent license holders, the FCC is offering two types of unlicensed operations.

The first type allows for unlicensed access points over the entire 1,200 MHz band to operate at low power, with little to no restriction. As stated by the FCC, the requirement for indoor-only operation and low power is anticipated to protect licensed services from interference.

The second type allows for standard-power unlicensed use of the Universal National Information Infrastructure 5 (U-NII-5) and the U-NII-7 bands, contingent upon placing them under the control of an automated frequency coordination (AFC) system. The AFC will help identify frequencies that unlicensed access points can utilize without causing harmful interference to nearby licensed frequencies.

The AFC system will be based on the FCC's Universal Licensing System (ULS). Standard-power devices will be required to contact the AFC system at least once daily to remain compliant. If contact with the AFC system is not made, the access point will be required to cease operations by the end of the following day. The power limit is set at the same standard-power levels already allowed in the 5 GHz band under the current Wi-Fi standard. (See Figure 1 for frequency ranges.)

Sub-band	Frequency Range (GHz)	Primary Allocation	Predominant Licensed Services
U-NII-5	5.925-6.425	Fixed FSS	Fixed Microwave FSS (uplinks)
U-NII-6	6.425-6.525	Mobile FSS	Broadcast Auxiliary Service Cable Television Relay Service FSS (uplink)
U-NII-7	6.525-6.875	Fixed FSS	Fixed Microwave FSS (uplinks/downlinks)
U-NII-8	6.875-7.125	Fixed Mobile FSS	Broadcast Auxiliary Service Fixed Microwave Broadcast Auxiliary Service

FIGURE 1: *Predominant uses of 6 GHz band. Source: FCC.*

Device Class	Operating Bands	Maximum EIRP	Maximum EIRP Power Spectral Density
Standard-Power Access Point (AFC Controlled)	U-NII-5 (5.925-6.425 GHz) U-NII-7 (6.525-6.875 GHz)	36 dBm	23 dBm/MHz
Client Connected to Standard-Power Access Point		30 dBm	17 dBm/MHz
Low-Power Access Point (indoor only)	U-NII-5 (5.925-6.425 GHz) U-NII-6 (6.425-6.525 GHz) U-NII-7 (6.525-6.875 GHz) U-NII-8 (6.875-7.125 GHz)	30 dBm	5 dBm/MHz
Client Connected to Low-Power Access Point		24 dBm	-1 dBm/MHz

FIGURE 2: *Expanded unlicensed use of the 6 GHz band. Source: FCC.*

RISKS TO INCUMBENT LICENSE HOLDERS

For utilities and other incumbent license holders, the largest risk from the opening of the 6 GHz band will be managing interference on their point-to-point licensed links from unlicensed sources. If existing communication equipment experiences interference due to unlicensed 6 GHz communication devices, current technology does not allow incumbents to identify and isolate the interference. With current communication systems, licensed incumbent frequency holders are unable to accurately identify interference sources, locations or originations. This, combined with the fact that the FCC order allows for no remediation process, places incumbent license holders in an untenable position.

From a technology perspective, current licensed point-to-point (PTP) communication systems are designed without any consideration for in-band interference. Furthermore, because of the mission-critical nature of these systems, they are designed to operate under high reliability requirements of 99.999% or higher uptime with low latency. When in-band interference is experienced, existing licensed systems are unable to identify or adapt to the interference and will sacrifice reliability and throughput. This could force incumbents to find alternative solutions for their existing licensed PTP links in order to backhaul critical data with the desired low latency.

There are numerous ways under the FCC order for interference to occur on licensed communication paths. First, interference could occur in spite of the AFC system. AFC deployments are based on the ULS database, where many coordinates can be inaccurate. In some cases, this will allow Wi-Fi 6E standard-power access points (AP) to be located near actual towers utilizing 6 GHz PTP microwave receivers. Licensees will not have protection from interference if inaccurate ULS data exists.

Second, the low-power unlicensed requirements have the potential to allow interference. Incumbent license holders have argued that there have been insufficient studies to measure the impact of low-power indoor units and whether they can cause interference.

Easily the most troubling unstudied component is the effect of the density of placement for these APs. Additionally, there is a dearth of studies investigating the ability to have low-power APs placed outdoors, which eliminates attenuation from the building. There is virtually no protection from the interference these low-power APs may cause since AFC is not required of them. (See Figure 2 for details about band use and associated power levels.)

The data used to determine the FCC's order may not fit within the acceptable tolerances of licensed

systems based on a multitude of factors, including region, radios utilized, antenna model and density of population. Several utility groups representing the critical infrastructure industry collaborated to execute a "CII User Study" in Houston, Texas, to provide a real-world analysis of the potential impact of unlicensed 6 GHz band systems. In the Houston Metropolitan Statistical Area, 2,325 receivers were used to study the impact of interference from low-power, indoor APs. The resulting report determined that "if the current proposal for increased use of the band nationwide is adopted, interference from unlicensed devices will compromise the operation and reliability of CII mission-critical communications."

CRITICAL INFRASTRUCTURE INDUSTRY (CII) COLLABORATION

The CII User Study was a collaboration among the Edison Electric Institute (EEI), the American Gas Association (AGA), the American Public Power Association (APPA), the American Water Works Association (AWWA), the National Rural Electric Cooperative Association (NRECA), the Nuclear Energy Institute (NEI), and the Utilities Technology Council (UTC).

THE PATH FORWARD

With so much risk of interference of licensed communication on mission-critical data paths, it will be important for incumbents to take proactive steps in preparation for Wi-Fi 6E. The main objective would be to put a plan in place to deal with any impacts to licensed critical communications.

Since Wi-Fi 6E will be a nonfactor until access points get released in the fourth quarter of 2020, the interim is a golden opportunity to gather data and establish a plan before interference issues can arise. To that end, it is a good idea for any incumbent license holder to perform a study on all existing microwave links and establish baseline data.

To develop a comprehensive picture, this study should be of a technical and financial nature. This begins with verifying site and tower locations and updating them on ULS if necessary. Having accurate location data in ULS is essential to correctly populating any AFC system that would protect those microwave paths.

Incumbents should establish baseline data for all existing paths to determine the current noise floor, existing link loss values and current reliability on the 6 GHz-band link. From those baselines, a company can evaluate which links are at the most risk of experiencing negative impacts from unlicensed interference. This prioritization exercise should also help identify a subset of core critical paths. The review should consider the criticality of each link to the overall network, such as North American Electric Reliability Corp. (NERC)-defined Critical Infrastructure Protection sites. The review must also consider the potential impact of fines or obligations resulting from loss of communication for each link or set of links.

The company should understand exactly what data is being transmitted on the licensed paths, as well as average and peak data usage on those links. This information will be invaluable in determining which links would have the capability of handling interference by achieving more receiver sensitivity through the lowering of the throughput of the radios. This would be performed by reducing the modulation scheme currently used on links that do not require the data.

Based on these studies, a flow chart of criteria and a list of options should be created for each path to put in place a plan for these paths in case inference from unlicensed communications reaches an unacceptable level. The company can work with specialized consultants to perform technical and cost-benefit analyses on its options. These could include purchasing and operating a third-party link interference monitoring system; moving some sites to the 11 GHz spectrum; or utilizing fiber as an alternative data connection, whether leased or owner-built.

Additionally, depending on the capabilities of the current link, there are options for remaining on the 6 GHz band even in the face of interference concerns. Some radio

systems have the ability to add a second frequency to a path, even unlicensed, which would provide a backup in case the primary link is affected by interference. Taking this a step further, links that have been or could be modified for cross-polarization interference cancellation (XPIC) can provide approximately 30 dBm of protection from interference at a single polarization.

One other component not to neglect is how the network would deal with the errors or link loss from interference. A further look into the network protection mechanisms already in place may be necessary to see that an existing network is fully prepared for interference.

CONCLUSION

A new generation of unlicensed Wi-Fi looms and, for better or worse, everyone must deal with its impacts. As the FCC proceeds with plans to open the 6 GHz spectrum for the benefit of public users, incumbent license holders' data could be at risk. Fortunately, the lag in hardware availability creates a window for license holders to perform studies and put plans into action to mitigate this risk.

BIOGRAPHIES

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