

DESCRIPTION OF PROPOSED STA

1. Requested STA

Rajant Corporation (“Rajant”) respectfully requests a Special Temporary Authorization (“STA”) for the three stadiums recently added by the National Football League (“NFL”) to its group of venues and an empty, former hotel resort for testing mobile broadband multi-media systems in the 3650-3700 MHz band. Rajant’s STA request (File No. 0857-EX-ST-2016) has the same operating parameters as its pending modification application File No. [0873-EX-ST-2016] for the approved STA Call Sign WJ9XMW. That modification seeks to amend the grant of authority to enable transmissions in an additional 30 MHz of spectrum to include frequencies up to 3700 MHz. Similarly, this STA request seeks approval in that full band, and attaches this Exhibit to demonstrate unrestricted contention-based protocol capability for the upper 25 MHz in the band.

Rajant currently holds a license for 3650-3700 MHz, issued in November 2011, Call Sign: WQON278.¹ Rajant has been developing a multi-media product that makes innovative use of the 3.6 GHz spectrum to provide mobile broadband applications for the NFL. Although Rajant holds equipment authorizations for 3.6 GHz base stations, it continues to design and develop end-user client devices using 3.6 GHz spectrum. Rajant holds an STA to enable it to test its NFL product using the 3650-3670 MHz band in most of the stadiums where the NFL plays.² The FCC granted Rajant’s most recent STA, Call Sign WJ9XMW, on March 24, 2016. On June 10, 2016, Rajant sought a modification of that existing STA to extend its grant to test the NFL product in an additional 30 MHz, up to 3700 MHz.

Due to the success of the tests to date of Rajant’s innovative product, as well as Rajant’s interest in preparing for the Spectrum Access System (“SAS”) framework envisioned by the Commission in its Citizens Broadband Radio Service proceeding,³ Rajant now seeks to test its NFL product in the full 3650-3700 MHz. Rajant understands it must demonstrate unrestricted contention-based capability to access the full range.⁴ As the Commission recognized in its recent Order finalizing

¹ FCC Registration Number (FRN): 0016765612, Call Sign: WQON278, File Number: 0004965332

² See, e.g., STA Call Signs WJ9XBU, WJ9XBV, WI9XZP, WJ9XER, WJ9XMW.

³ See *In Re Amendment of the Commission’s Rules with Regard to Commercial Operations in the 3550-3650 MHz Band*, Order on Reconsideration and Second Report and Order, GN Docket No. 12-354 (rel. May 2, 2016) (“Second Report and Order”).

⁴ See 47 C.F.R. § 90.1319(c).

rules for the Citizens Broadband Radio Service, “advanced techniques such as contention-based protocols ... could be used by the SAS to coordinate power levels in high-density areas among GAA users. . . .”⁵ The next section sets forth a description of the unrestricted contention-based protocol Rajant intends to test under the proposed STA by providing information listed in the relevant Knowledge Database guidance for certifying Part 90 Subpart Z equipment.⁶

Accordingly, Rajant respectfully requests an STA for three additional stadiums and one empty resort to enable testing in the full 50 MHz of its licensed band:

1. Tom Benson Hall of Fame Stadium, Canton, OH
2. U.S. Bank Stadium, Minneapolis, MN
3. Camping World Stadium, Orlando, FL
4. Turnberry Isle Miami, Miami, FL (empty hotel)

2. Unrestricted Contention Based Protocol (KDB 552295 Section 2)

2.1. Unrestricted Protocol Description

Address the key requirements for operation using unrestricted contention based protocol. Please note that this requires recognizing other systems (both similar to yours and different from yours) that operate on a co-channel. Indicate the strategy for sharing the spectrum in terms of: (1) Does the system use spectrum sensing to determine if the other devices are transmitting and then find ways to share the bandwidth, or (2) Does the system have some other strategy?

Rajant’s BreadCrumbs system will use an 802.11y MAC “listen before talk” contention protocol to recognize the presence of other systems and to modify its transmit behavior. This protocol uses Carrier Sense Medium Access with Collision Avoidance (CSMA/CA), a network multiple access method in which carrier sensing is used, but nodes attempt to avoid collisions by transmitting only when the channel is sensed to be “idle”. When they do transmit, nodes transmit their packet data in their entirety.

2.2. Threshold detection to determine occupancy

2.2.1. Describe how your system determines if another system is using the spectrum. At what detection level – relative to 0 dBi receive antenna gain (busy channel threshold), does the device determine if another system is operating on the spectrum?

If the radio detects an 802.11 frame preamble, the medium is assumed to be busy. The signal threshold value is -97 dBm. Signals that are not valid 802.11 are treated as noise. Noise greater

⁵ Second Report and Order ¶ 197.

⁶ FCC Office of Engineering and Technology, Guidance Regarding Devices Operating in the 3650-3700 MHz Band Under Part 90Z, KDB 552295 v02r02 (rel. Apr. 8, 2013).

than or equal to -85 dBm will be treated as busy medium (i.e. the system will assume that another system is operating on the spectrum).

2.2.2. How long does the system observe to determine if the channel is busy – at the initial time and in between communications?

The system measures the channel every 16 microseconds to see if it is busy, which includes the amount of time required for a wireless interface to process a received frame and to respond with a response frame.

2.2.3. What is the bandwidth being monitored versus bandwidth occupied for all modes of operation?

The bandwidth being monitored is the entire occupied channel, 20 MHz.

2.2.4. How much variability is provided to the system operator to adjust busy channel detection threshold?

There is no variability provided to the system operator.

2.2.5. What is the operating system threshold (receive threshold) compared to the monitoring threshold (busy channel threshold)?

The detection mechanisms leverage the same hardware as the actual radio sub-system and therefore are capable of operation over the same power range. The receive sensitivity for valid 802.11 data is -97 dBm. Non-802.11 signals of -85 dBm or more also cause a channel to be considered busy.

2.2.6. What additional checks does the system perform to determine if the spectrum is being used before initiating a transmission?

802.11 contention is also resolved through Request to Send / Clear to Send (RTS/CTS) messaging. The radio wishing to send a data message sends the smaller RTS frame to the radio it wishes to send a message to. The receiving radio then sends a CTS message if it believes that the channel is clear.

2.2.7. Does the master and the client perform the threshold detection? If master only performs the detection how does it determine if the client may interfere with the other system (hidden node detection mechanism)?

Both the master and client perform threshold detection.

2.3. Action taken when occupancy is determined

2.3.1. What action does your system take when it determines occupancy? Does it vacate the channel or does it have some back-off and retry strategy? What is the impact of traffic on the spectrum sensing or avoidance performance?

The radio uses an exponential back-off and retry (re-sense) protocol. If occupancy is detected, the system immediately suspends transmission, waits a configurable back-off period, and then re-senses the channel. Other than exponentially increasing back-off times, the traffic does not have an impact on the spectrum sensing or avoidance performance.

2.3.2. If you use other means, please describe how the device determines the existence of other systems and what steps it takes to either share the channel or avoid its use.

Not applicable.

2.3.3. Describe any mechanism that would limit a transmission from a remote station if only the master detects occupancy (hidden node avoidance mechanism).

RTS/CTS will be used if a data packet is not acknowledged after several retries. (See 2.2.6)

2.4. Opportunities for other transmitters to operate

2.4.1. When describing occupancy profile, clarify any differences between start-up acquisition mode of spectrum, and operational modes.

The described behavior of the system is operational immediately upon power-up and prior to any frames being transmitted.

2.4.2. In operational mode, how long does the system transmit before stopping giving others a reasonable time to transmit before continuing?

The system will stop transmitting after detecting other systems on its frequency after 87 micro seconds.

2.4.3. Does the system (master and / or client) listen prior to every transmission? If no, explain.

Yes, the master and client listen prior to every transmission following the standard 802.11 MAC.

2.4.4. Describe how the operational spectrum usage (on air time) is dependent on system load conditions (no load, typical and overload). For example, if a station does not have any information to transmit, describe any regular or recurring transmission that may take place.

Each radio sends a small beacon frame once per second. In addition, a small data frame is sent every 3.6 seconds.

2.4.5. Describe if there are any limitations imposed by the contention protocol on what applications are used (i.e. limitations on Quality of Service).

In the presence of other co-channel systems, the shared nature of the channel will reduce available capacity. The only other limitation would be user throughput requirements.

2.4.6. Describe how applications or configuration of services can affect spectrum usage. To describe your occupancy sharing capability you can assume that two systems on a co-channel are the same (your systems being described). How would they share the spectrum?

Applications can send a variable amount of traffic into the system up to the limits of the 802.11n protocol. Occupancy sharing is handled by the CSMA/CA protocol described earlier operating on a “listen before talk” scheme. The sharing of capacity will be dynamic as network load varies between the two systems. As one system reduces usage due to decreasing network load, it frees time for the second system to support an increase in load. Statistically, this dynamic system results in equal access to both systems.