2 . **Unrestricted Certification under Part 90Z (3650-3700 Band)**

In order to ensure that a device complies with the requirements of unrestricted contention based protocol, the following information should be provided in the application.

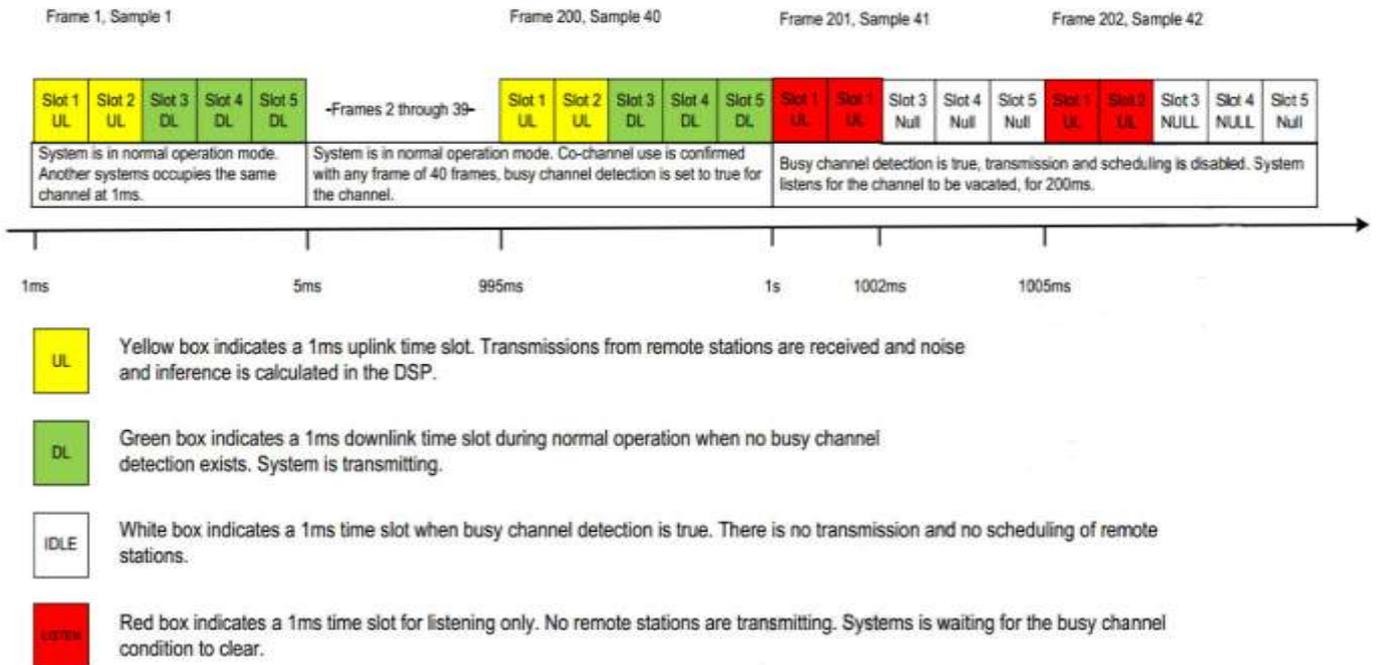2.1. Unrestricted Protocol Description

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?

The system uses multiple configured channels and spectrum sensing, to share spectrum with other systems operating on a co-channel. If there are other systems operating on a co-channel the system will vacate the channel, allowing other systems to have exclusive use of the channel. The system can be configured with up to 4 channels of 10, 15, or 20 MHz each. Any combination of 1 to 4 non-overlapping channels totaling up to 50MHz in the range of 3650 to 3700MHz can be configured. An example would be 20MHz + 10MHz + 10MHz + 10MHz.

At startup, the system listens without transmitting for 200ms on each configured channel. The system will only transmit on a configured channel if the co-channel signal level is below -60dBm/MHz (configurable to be more, but not less sensitive, please refer to 2.2.4). The system is capable of transmitting on any subset of the configured and available channels, while not transmitting on the remaining configured channels found to be busy.

After startup, during normal operation, the system uses a TDD protocol which transmits 2-4ms of every 5ms frame interval (depending on the configured downlink/uplink sub-frame ratio, 3:2 is the default configuration). Meanwhile the system continues to monitor the co-channel utilizing the receiving time slots, 3~1ms of every 5ms frame. By using digital signal processing with an interference calculation algorithm, the system is able to accurately measure the noise/co-channel interference signal while receiving the desired signal from the remote station at the same time, allowing spectrum sensing to occur on a continuous basis during normal operation. Every 200ms, a busy channel detection decision is made based on the received co-channel signal level during the past forty 5ms frames (200ms). If anytime of 200ms the co-channel noise/interference signal level exceeds the -60dBm/MHz busy channel detection threshold in a given channel, transmission on that channel by the base station and scheduling of remote station transmission is disabled, effectively vacating the channel and allowing other systems to have exclusive use of the channel. Listening on that channel continues, and the system will not begin transmitting on that channel again until the co-channel interference signal level drops below the -60dBm/MHz busy channel detection threshold, indicating that the other system has stopped using the channel. The monitoring period to determine that the channel is again clear for use is 200ms. The system will not begin using the channel for transmission and will not schedule remote

stations to transmit on the channel until the channel is no longer in use by another system. The diagram below illustrates system operation starting at the moment another system occupies the channel.

| UL | Yellow box indicates a 1ms uplink time slot. Transmissions from remote stations are received and noise and inference is calculated in the DSP. |

| DL | Green box indicates a 1ms downlink time slot during normal operation when no busy channel detection exists. System is transmitting. |

| IDLE | White box indicates a 1ms time slot when busy channel detection is true. There is no transmission and no scheduling of remote stations. |

| LISTEN | Red box indicates a 1ms time slot for listening only. No remote stations are transmitting. Systems is waiting for the busy channel condition to clear. |

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?

The system listens for 200ms at startup. If the received co-channel signal exceeds the busy channel detection threshold of -60dBm/MHz the system will continue to listen and will not start transmitting until the received co-channel signal during the previous 200ms interval drops below the -60dBm/MHz busy channel detection threshold. Similarly, if during normal operation, any received co-channel signal level for the previous 200ms interval exceeds the -60dBm/MHz busy channel detection threshold, the system will stop transmitting on the channel and will continue to listen until the received co-channel signal level drops below the -60dBm/MHz busy channel detection threshold. The busy channel detection threshold relative to 0 dBi receive antenna gain is -60dBm/MHz.

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

At startup the system will listen for 200ms to determine if the channel is busy. During normal operation the system will determine that the channel is busy when the received co-channel noise level for the past forty 5ms frames (200ms) exceeds the -60dBm/MHz busy channel detection threshold.

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

The bandwidth being monitored is the total configured system (occupied) bandwidth. For example, if the operator configures two channels, channel A (3650-3670MHz), and channel B (3670-3680MHz), then the bandwidth would be monitored by two processes, process A monitors the 20MHz of channel A(3650-3670MHz), and process B monitors 10MHz of channel B (3670-3680MHz).

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

The busy channel detection threshold can be configured to be more sensitive than the default -60dBm/MHz setting, up to -100dBm, but cannot be configured to be less sensitive than -60dBm/MHz.

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

The receive threshold is -104dBm, the busy channel threshold is -60dBm/MHz.

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

None.

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)?

Only the master (base station) performs the busy channel detection. When the base station detects that the channel is busy in 200ms, it stops transmitting in 2ms and stops scheduling the client in 5ms, freeing the channel. The client will only transmit when it has been scheduled to do so by the base station.

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?

When the system determines that a channel is busy it vacates the channel. It stops transmitting on the channel and stops scheduling clients to transmit on the channel, but continues to monitor the channel waiting for the channel to clear. The impact on traffic is a reduction of system capacity equal to the channel bandwidth of the channel on which transmission has stopped. Spectrum sensing continues on the busy channel and transmission will be resumed when the channel is no longer busy.

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).

If the base station detects the channel is occupied, transmission on the channel will be stopped in 2ms. The remote station will no longer be scheduled by the master to transmit on the occupied channel. The remote station only transmits when it has been scheduled to transmit by the master (base station).

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.

See 2.1.

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

In operational mode, when busy channel detection is not active, the system transmits for 2ms to 4ms of every 5ms frame interval and receives for 1ms to 3ms. During receive digital signal processing is used to measure the co-channel interference level. If the channel is determined to be busy the system vacates the channel within 200ms and gives the other system exclusive use of the channel.

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

The system receives and listens for 1 to 2ms of every 5ms frame.

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.

With no load the system will transmit for 1ms of every 5ms frame interval. In typical and overload conditions the system will transmit for 3ms to 4ms of every 5ms frame interval (depending on the configured downlink:uplink sub-frame ratio).

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).

None.

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?

The system provides the ability to allocate smaller size of channel when two or more stations are in use, which eliminates co-channel interference. For example,there is 3650-3690 MHz available, but there are two networks that need to use the channel, then the two systems could use 20MHz sub-channel each to eliminate the interference.