



MOTOROLA Solutions

**Canopy PMP320 Extended Frequency Range Protocol
Enhancement**

**Recommendations for Unrestricted Certification for 3650-
3700MHz**

System Protocol Description: Between the controlling master device, ABZ89FT7632 (Access Point) and either slave device, ABZ89FT7633 or ABZ89FT7636 (Subscriber Modules).

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

Detailed information regarding the proposed protocol for the Canopy PMP320 product frequency band enhancement. The following is a detailed description of the channel sharing mechanisms for the PMP 320 product which is already certified for Part 90Z restricted operation.

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: Does the system use spectrum sensing to determine if the other devices are transmitting and then find ways to share the bandwidth, or have some other strategy?

The Access Point for the PMP320 system or any other Motorola system whether it be based on standards or proprietary air interface uses a Listen-Before-Talk (hereafter referred to as LBT) protocol that is embedded into a TDD/TDMA frame structure. The detection is done at both power-up and at a regular interval defined by the frame structure of the air interface. This will be done at intervals of 2.5, 5, or 10ms for compatibility between various WiMAX and Canopy proprietary protocols.

The system will use configurable uncommitted uplink data traffic slots for sensing energy present in the channel. The sensing will be accumulated and compared to a pre-determined detection threshold. Upon reaching the detection threshold, the system will respond in such a way as to allow for the access point to terminate transmissions until a predetermined time interval has elapsed.

This time interval will be programmable from a minimum of 2 frames to intervals that are as many as hundreds of frames ($2 \times 5\text{ms} = 10\text{ms}$ to approximately $200 \times 5\text{ms} = 1\text{s}$).

After reaching the predetermined time interval, the system will then go into an equivalent power-up rescan and resume normal operation provided the channel is clear of co-channel traffic.

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 Access Point uses configurable uncommitted uplink data traffic slots. This configuration can be implemented by either SNMP via remote management or through the built in WEB page.

The Access Point will accumulate the energy detected over a configurable number of slots and frames and will be compared to the value of a configurable threshold value. The threshold value can be configured for values that are within the linear portion of the Access Point's Receive Signal Strength Indicator (RSSI) dynamic range. This range can be set for values between -40 to -95 dBm (assuming a 0dBi reference). All values are configured via SNMP management or through direct WEB page configuration.

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 Access Point makes a measurement before initial transmission at power-up and samples the channel every frame (typically 5ms) to accumulate a co-channel signal measurement. The accumulation period is programmable by either SNMP management or via direct WEB page entry. A typical accumulation period is 30 to 50ms.

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

The bandwidth used for all channel occupancy measurements is the same bandwidth being used for system operation. This is configurable for values that range from 3.5MHz to 10MHz.

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

The detection threshold is configured to scale automatically based on the in-use MCS level that the system negotiates. The maximum threshold level will be limited to -40dBm via remote SNMP management or direct WEB page configuration.

The operator can control the upper limit to suit various installation requirements that include point-to-point operation which are inherently less likely to detect or cause co-channel interference problems. The -40dBm threshold is a requirement of the maximum anticipated MCS sensitivity level for a point to point configuration. The threshold level will be configurable in 1dB steps. All threshold levels are normalized to a 0dBi reference level.

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.

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

Not applicable.

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

The Motorola system employs either a standard WiMAX media access layer or a proprietary media access layer that utilizes a TDD/TDMA scheduled transmission which is synchronously framed.

The Customer Premise Equipment (CPE) cannot transmit until they are allocated bandwidth from the Access Point. If the Access Point detects co-channel signals then the uplink MAP (in the case of WiMAX) or the scheduled slot allocation is not granted to the subscriber so the CPE cannot transmit.

In this system, since permission to transmit is granted by the AP, there is no hidden node problem like that experienced by purely contention based protocols (Wi-Fi using CSMA/CA in the Distributed Coordination Function mode). The AP is typically also installed in a high location where it is most likely to receive co-channel interference and is most susceptible to 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?

Traffic load will not affect channel occupancy detection performance since the same number of uplink data slots is committed regardless of system activity level. The same performance will be obtained whether the system is lightly loaded or at maximum capacity because of the reservation of uplink data traffic slots.

Upon detection, the Access Point will cease transmission for a configurable number of frames as discussed above. During this period the Access Point will cease to transmit uplink MAP data and will not allocate bandwidth to CPE devices so the subscriber units will also clear the channel.

2.3.3 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.

The Motorola system will have the ability to address a database of incumbent license holders through several cognitive mechanisms should this be a future requirement.

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

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The Customer Premise Equipment (CPE) cannot transmit until they are allocated bandwidth from the Access Point. If the Access Point detects co-channel signals then the uplink MAP (in the case of WiMAX) or the scheduled slot allocation is not granted to the subscriber so the CPE cannot transmit.

In this system, since permission to transmit is granted by the AP, there is no hidden node problem like that experienced by other purely contention based protocols (i.e. Wi-Fi). The AP is typically also installed in a high location where it is most likely to receive co-channel interference and is most susceptible to detection.

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.

At Power-up or after a system re-boot the Access Point goes into an energy scanning mode where it is allowed to do one full cycle of energy detection before it is allowed to transmit. The scan is a mode where the energy is accumulated for a programmable number of frames (2 frames minimum) to compare against the programmed detection threshold. If the energy detected is less than the detection threshold, the Access Point is allowed to make a transmission.

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

In normal operational mode the system is allowed to accumulate energy over a programmable number of uplink receive slots. The period of accumulation is averaged over a number of frames (typically from 2 to 200) and then the average detected energy is compared to the detection threshold. In this case if one assumes a 5ms frame then that minimum period of time is 10ms.

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

The system master uses the energy detected by several prior frames to control the muting of the transmit function.

2.4.4 Describe how the operational spectrum usage (on air time) is dependant 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?

The amount of on-air activity is directly proportional to the required system load. With little traffic demand, the system does not transmit anything except beacons and “housekeeping” traffic. The majority of the transmit portion of the frame is not used by the transmitter and the system is quiet.

At full load, the system transmits for a greater percentage of the transmit portion of the frame (limited by the user definable uplink/downlink ratio). In either case the same amount of bandwidth is reserved for channel occupancy detection so performance remains unaffected. The uplink slot reservation causes overhead (limits throughput) only in the target system.

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).

The system imposes no limitations on the embedded contention protocol. The same number of detection slots are committed regardless of traffic load and are given the highest level of priority. The other QoS mechanisms in the system are unaffected by this embedded contention protocol.

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?

Since the system described is a synchronously slotted frame based system, both systems would operate effectively with each other because each system can be configured to transmit and receive at the same point in time. The system as described uses a GPS synchronization method to time-align the start-of-frame for all systems deployed globally. This coordination allows for complete simultaneity in system operation.

If the users configure the number of uplink and downlink slots and the duty cycle (uplink/downlink ratio) in an identical manner and each system uses the same set of uncommitted uplink slots for the detection sampling interval, then the two systems will co-exist with no knowledge of the others presence.

If the two systems are not configured in an identical fashion then the active system will transmit for its TX frame cycle then during the receive interval it will listen for activity during the pre-configured uplink contention slots. Upon accumulating sufficient energy for a configured number of frames and after comparison with the pre-configured detection threshold, the system will shut down to allow for the co-channel system to send its traffic.

The system will shut down when the accumulated energy is above the detection threshold and will continue to transmit if it is below the detection threshold. When the co-channel system is clear of the channel then the target system will go back into regular operation. Regular operation will consist of a constant averaging of the energy detected in the uncommitted uplink slots.