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?

Answer: The FCC mentions the WiMAX technology as an example of restricted contention protocol:
"34. Under the Commission's rules, contention-based protocols can be broadly categorized as either "unrestricted" or "restricted." ... restricted contention protocols can prevent interference only with other devices incorporating the same protocol. WiMAX, with its scheduling protocol, currently stands as the main example of a restricted contention technology. In its present format, WiMAX technology effectively prevents interference among multiple transmitters on a single WiMAX system. Different WiMAX systems can be coordinated to avoid interfering with each other, thus providing each WiMAX device a "reasonable opportunity to operate." (FCC 07-99).

WiMAX Protocol Brief:

WiMAX MAC protocol is a centralized protocol in which the base station controls access to the air interface. In the downlink, all decisions related to the allocation of bandwidth to various MSs are made by the BS, which does not require the involvement of the MS. As packets arrive for each terminal, the BS schedules them for the PHY resources, based on their QoS requirements. Once dedicated PHY resources have been allocated for the transmission of the MAC PDU, the BS indicates this allocation to the MS, using the specific MAC messages.
In general, WiMAX terminal is a slave to the BS. In the uplink, the MS requests resources by using a contention bases protocol. WiMAX uses a truncated binary exponential backoff algorithm for contention-resolution during polling of user terminals. When it needs to send a bandwidth request the MS first enters a contention resolution phase, if selecting a uniformly distributed random number between 0 and BACKOFF WINDOW. This random value indicates the number of transmission opportunities—allocated resources for multicast/broadcast poll—the MS will wait before sending its bandwidth request. BACKOFF WINDOW is the maximum number of transmission opportunities an MS can wait before sending the pending bandwidth request. If it does not receive a bandwidth allocation based on the UL MAP message within a time window specified by a timer, the MS assumes that its bandwidth request message was lost, owing to collision with another MS, in which case MS increases is backoff window and repeats the process. If bandwidth is still not allocated after a maximum number of retries, the MAC PDU is discarded.

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?

Answer: The product is designed to listen to the environment signals by HW means and detect their power. Once the detected power is higher that a predefined threshold it is decided that there is another system operating in the same spectrum. The threshold is configurable and its default value is -90 dBm.

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

Answer: The spectrum is observed in between communications in time periods in which the system is silent, which are the TTG and RTG gaps (the duration of each gap is about 50 microseconds).

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

Answer: The whole occupied bandwidth is being monitored.

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

Answer: The detection threshold is configurable by the operator. Its range is -90 to-45 dBm.

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

Answer: The default monitoring threshold is approximately the same as the receive threshold.

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

Answer: 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)?

Answer: In WiMAX the downlink and uplink transmissions are controlled by the master (BS). In case that the master transmission is disabled the slaves (CPEs) cease the transmission as well.

2.3. Action taken when occupancy is determined

Answer: In case that another system is detected in the spectrum, the transmission is ceased for a predefined period of time.

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?

Answer: In case that another system is detected in the spectrum, the transmission is ceased for a predefined period of time. Then the system tries to transmit again expecting the other system to free the channel. If the other system continues to transmit, the transmission is ceased again and the process is repeated after a period of time. The traffic does not change the operation of the CBP mechanism.

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.

Answer: No other means are used.

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).

Answer: None.

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.

Answer: The mechanism is designed to work in the operational mode.

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

Answer: between 200 to 600 milliseconds, depends on the CPU load

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

Answer: the master is listening about every 40 WiMAX frames (200 milliseconds).

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.

Answer: In no load there are only control and synchronization signals being transmitted. In typical and overload the data transmission is taking place too in medium and high spectral power density, respectively.

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).

Answer: the traffic capabilities are reduced as a result of applying contention protocol. However the profiles of quality of service stay unchanged.

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?

Answer: If two our systems are operating on the same spectrum, on the average they will share the usage time of the spectrum in a fair way. On one hand the system is programmed to free the spectrum if it is operating in it and another system tries to use it. On the other hand after the transmission shut down period the system tries to get control over the spectrum resource. Then the other system detects its presence in the spectrum and frees it for a period of time etc. This is done in order to prevent the situation when just one system is using the resource all the time when it is in a full load.