# Technical requirements for a Point to Multipoint Broadband Wireless System Operating in a 1 MHz wide channel

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**Objectives:**

1. Support fixed and mobile broadband services in a unified network. Applications include:
   * SCADA
   * AMI Backhaul
   * DA Applications
   * Mobile Workforce Management
   * Video surveillance
2. Support a Base Station (BS) service area up to 40 miles from the base station
3. Non-line-of-sight
4. Support multi-sector and multi-cell deployments with a minimum of 3 orthogonal sub-channels. A higher number of sub-channels (e.g., 6 sub-channels) is desired because it offers more reuse flexibility in case of interference.
5. Total throughput per sector up to 2 Mb/s
6. One way latency as low as 10 ms

**Technical considerations & requirements:**

1. The band of operation may have unpaired spectrum (e.g., IVDS) or paired spectrum (e.g., Upper 700 MHz A Block). Time Division Duplexing (TDD) should be used to enable operation in both band types. Moreover, TDD offers significant flexibility and throughput advantages over Frequency Division Duplex (FDD) for asymmetrical services.
2. The services described above are all reverse asymmetrical, i.e., they require significantly more bandwidth in the uplink direction (from the remote station to the base station) than in the downlink direction (from the base station to the remote station). This implies the air interface should have flexibility in configuring the duration of the downlink and uplink sub-frames (referred to as the DL:UL ratio) such that the capacity in the downlink sub-frame and the capacity in the uplink sub-frame are optimized for each deployment.
3. Typical deployments may use 1 (omni), 2 or 3 sector towers. Depending on the type of deployment and depending on the number of 1 MHz wide channels available, it is desirable to support operation of a sector in any subset of downlink and uplink sub-channels. For example six sub-channels supports not only a reuse factor of 6, but also 3 (2+2+2) and 2 (3+3) in a single channel.
4. A consumer market 802.16 based systems leverage the relatively large number of sub-channels and the asymmetrical traffic characteristics (i.e., much higher throughput required in downlink than in uplink direction) to balance the CINR, i.e., the Base Station transmits at high power over the full channel while the Remote Stations transmit at a relatively low power over a few sub-channels only. In the case of a 1 MHz wide channel however, the total number of sub-channels is relatively small. Moreover, the reverse asymmetrical nature of the traffic requires the peak rate of uplink transmission by a Remote Station to be the same or higher than the Base Station. As a consequence, the number of sub-channels used by the Base Station and by the Remote Stations is similar. A balanced system requires therefore the Remote Stations to be able to transmit at a similar power level as the Base Station.
5. Support of 40 miles radius translates into a round trip delay of 430 µs. In order not to exceed the minimum necessary overhead gaps, the actual gaps should be configurable according to the longest distance in the system. The system should support however a maximal value of BS TTG = 430 µs plus the minimum required receive to transmit switching time.
6. The relatively narrow channel does not offer much benefit in frequency diversity. Continuous subcarriers per sub-channel offer greater flexibility to reduce interference both in the transmit and receive directions.
7. Significant reduction in subcarrier spacing relative to the 10.94 KHz of the WiMAX standard is not recommended because it introduces Inter-Carrier Interference.. This consideration led to the adoption of 128 FFT scheme which was designed by 802.16 for 1.25 MHz wide channels.
8. The channel is relatively narrow and therefore a large number of pilots is not required to measure the frequency response of the channel. This consideration and the need to reduce overhead as much as possible, suggests that Band- AMC permutation is better suited for this system than PUSC permutation in both the downlink and uplink directions. For example, a downlink PUSC system employs 4 pilots vs 2 pilots in AMC 2 X 3.
9. Efficient use of the 1 MHz wide channel requires the same bandwidth span in all phases of communication, i.e., the downlink subframe, the uplink subframe, the preamble and the CDMA code transmission should all employ the same set of subcarriers.
10. Frame Duration: Some applications require very low latency and therefore a frame duration as low as 5 ms needs to be supported. On the other hand, delay tolerant applications may require high throughput which increases with the increase in frame duration due to reduced per frame overhead and reduced fragmentation.
11. The use of multiple zones in downlink and uplink sub-frames offers the opportunity to create groups of Remote Stations in the sector and optimize certain parameters for each of the groups. The downside however is the additional overhead. It is recommended to maintain a single AMC zone in the downlink and in uplink directions.

1. Providing a broadband experience in a 1 MHz channel:
   * Dynamic allocation of bandwidth by sector based on demand.
   * Maximize FEC code in the uplink direction. This is accomplished by optimizing closed loop power control
   * Reduce 802.16 protocol overhead
   * Automatic PHS