Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Evaluation Criteria for Modulation Techniques (Contribution to IEEE802.16.3)**
Date Submitted	**2000-09-06**
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Re:	IEEE 802.16.3-00/07r1 document. Response to "802.16.3 Invitation for Contribute" on Evaluation Criteria for the list of Key Characteristics of the Sub-11 Air interface for Session #9.
Abstract	This document presents a list of evaluation criteria by which the Key characteristics that were established by the 802.16.3 Task Group by the end of Session #8.
Purpose	This contribution will be presented and discussed within the Task Group in Session #9 for possible adoption for technical assessment of various Modulation Schemes.
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Evaluation Criteria for Modulation Techniques

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Introduction:

The suggested Modulation Techniques by the Task Group in Session #8 were listed as; QPSK, m-QAM, and OFDM techniques. Comparisons of these types of modulation schemes have to be based on the applicability, lower complexity, and reduced cost factors for the services and the market that is identified within the Functional Requirement Document (IEEE 802.16.3-00/02r3). In order to perform a thorough assessment of the above list of modulation techniques, we propose to verify the following evaluation criteria on each of selected modulation scheme:

The evaluation criteria for modulation techniques should be based on the following factors:

- Bits/Sec/Hz rate
- Modulation complexity (e.g., for each QPSK, m-QAM, OFDM modulation scheme)
- Operational for downstream continuous and upstream Burst transmission
- Carrier recovery complexity requirements
- Phase recovery requirements
- Phase Noise sensitivity
- Normalized C/I performance (Interference Rejection Factor)
- Bit Error Rate P_b vs E_b/N_o (dB) performance
- Coherent or non-coherent detection capability
- Modulation BW requirements
- Factors affecting pulse shaping (ISI, filtering, …):
    - Thermal noise
    - Band limitation and delay interference
    - Adjacent channel interference
    - Co-Channel interference

- Synchronization complexity (in burst or in continuous transmission modes)
- Asymmetric Up/Down link transmission flow
- Modulation and demodulation complexity
- Receiver sensitivity
- Combating capability with Frequency –selective fading channel cases
- System performance factors:
    - Overall data rate
    - BW requirements
    - Adaptive equalization requirements
    - Impact on output power level (Linear power amp. Requirement0
    - Processing time delay
    - Sensitivity level at frequency error and phase noise error

- Applicability for the Sub 11 GHz band channels; (e.g., for NLOS)
- Implementation complexity and its economical factor.

The above list of evaluation factors is important to assess for each modulation scheme in order to evaluate their applicability, technical effectiveness, performance, and their economical benefits of one against others.

How to apply the above evaluation Criteria:

Most of the factors mentioned above can be assessed by compiling what is available in literature about each of these access schemes and will require application of simulation or preferred a prototype test results to evaluate the performance related factors.

Based on list of services and types of traffic, the area of operation of the BWA system (upstream and downstream) which are specified within the Functional Requirement Document, and for selected list of RF channel models, each of the modulation technique shall be simulated and tested individually. Then, there shall generate their BER performance and other performance factors such as; ISI rejection results, digital filter shaping characteristics, LO synthesizer operation, demodulation clock jitter, carrier and symbol clock recovery for the evaluation purposes.

In addition, based on past experiences on Modem implementation complexity including clock recovery and phase noise level control and the overall modulation performance results for each scheme, we shall compile all the pros and cons of each modulation technique. Of course, each of above assessment criteria can have different weighting (to be determined) for a final conclusion on the modulation techniques.