IEEE P802.15
Wireless Personal Area Networks

Project	IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)
Title	Questions and Concerns on the Wideband MBOK Proposal
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Re:	
Abstract	[Issues and Concerns over the Motorola/XSI Merge Proposal #2]
Purpose	[To understand the credibility of Merge Proposal #2 and to solicit responses so all can better understand the proposal and the implications]
Notice	
Release	

1 Introduction

The wideband MBOK approach has not had the benefit of the no-voter responses in the down-selection process unlike the Multi-band OFDM proposal. The no-voter responses have clearly made the Multi-band OFDM stronger and much more robust. We feel that before any compromise solution, consisting of the Multi-band OFDM PHY and the wideband MBOK PHY, is considered, the wideband MBOK proponents need to address the following concerns and questions.

2 World-wide Compliance

The MBOK proposal relies on implementing a Soft Spectral Adaptation (SSA) scheme to ensure compliance with potentially different world-wide regulations. However, the CRL presentation in January 2003 shows that the SSA scheme would require the implementation of at least a 4-bit, 71.1 GHz DAC, or maybe even a 284.4 GHz DAC. We were unable to obtain information regarding the power consumption, complexity, or implementation feasibility of such a high-speed DAC. To better understand the global compliance capability of the MBOK proposal **we would like answers to the following questions:**

a. Is such a high-speed DAC feasible in Silicon?

b. What is the expected power consumption and die-area of such a high-speed DAC?

c. What is the trade-off between the DAC sampling rate and the depth and width of the notch that can be generated using SSA?

d. If it is not feasible to implement the SSA scheme in Silicon, are there any other mechanisms that can be used to ensure world-wide compliance? If yes, can you provide details on feasibility, power consumption and die area?

3 System Performance

The MBOK proposal has provided performance results for only some of the modes. In addition, multiple receiver architectures have been assumed to address issues related to performance, complexity and the different modes. In reality, only one of the architectures can be chosen for an implementation. To better understand the proposal and the trade-offs associated with an implementation, we would like all results to be presented for a single preferred architecture. To better understand the capabilities and limitation of the MBOK proposal, **we would like answers to the following questions:**

a. Can you present all the requirements stated in the selection criterion document, namely the performance, complexity, die-area, power consumption, SOP and coexistence for the preferred receiver architecture?

b. Performance results in the presence of multi-path, SOP performance and robustness to narrow-band interferers have not been presented for the MBOK modes corresponding to 114 Mbps and 200 Mbps. Can you provide all results for these two modes?

c. ***Robustness to Narrow-band Interferers:*** Document 15-03-0449-03-003a demonstrates that the MBOK system does not meet the requirements of the selection criteria document in its ability to handle narrow band interferers. It is shown to be about 10 dB worse than the MB-OFDM system. The MBOK proposal claims that narrow-band interference rejection is performed using an external tunable notch filter. Can you provide details on the mechanism to detect a narrow-band interferer, the effectiveness and complexity of the detection circuitry and the loss in performance due to inserting a tunable notch filter at the receiver? Is the insertion loss due to the tunable notch filter also considered for all the other performance results? If not, could you provide results assuming the presence of a tunable notch filter for all other scenarios as well?

d. The 114 Mbps mode has two possible coding schemes, one with a K = 7 convolutional code and the other with a K = 4 convolutional code. The K = 4 convolutional code has been used to enable an iterative soft decoder and demodulator. It is confusing to an implementer if multiple coding schemes are specified for the same data rate. If the proponents feel that one coding scheme provides a better performance versus complexity trade-off, they should choose the better of the two coding schemes. Otherwise, an implementer has to build multiple decoders at the receiver. In addition, it is not clear how a DEV would decide on which of the two coding schemes to use for this data rate.

e. A RS code is used as a concatenated code for data rates of 112 Mbps, 200 Mbps, 224 Mbps and 448 Mbps. The use of a concatenated code results in latency due to the need to receive the entire code word before decoding/de-interleaving and the latency of the decoder operation. For instance, a latency of two code words at a data rate of 112 Mbps corresponds to ~8 microseconds. However, the SIFS time specified in the MBOK proposal is 5 microseconds. How is it possible to meet the SIFS time, if a concatenated code is used?

f. The acquisition curves presented in document 802-15-03/334r5 (slide 58) shows that the system is acquisition limited. For instance, when transmitting at a data rate of 114 Mbps and operating at an Eb/N0 of 4 dB (corresponds to sensitivity) approximately 15% of the packets are missed even when the false alarm probability is set at a high value of 1%. This is a serious deficiency in the system and would have a greater impact at lower data rates and hence needs to be addressed. In addition, could you also provide the acquisition time necessary to obtain this performance? Can you also provide acquisition results in the presence of simultaneously operating piconets?

g. The current MBOK proposal does not provide any details about the complexity of the packet detection/synchronization circuitry. Document 15-03-0449-03-003a shows that the complexity of the synchronization block could be significant. Do you agree with these results? If not, could your provide details on the complexity of the acquisition/synchronization block?

h. ***Simultaneously Operating Piconets:*** The current MBOK proposal provides four code sets for the 2-BOK and 4-BOK modes in order to support four simultaneously operating piconets. However, only one code set has been provided for the 64-BOK mode. Can you provide four codes sets for the 64-BOK mode as well to ensure that four simultaneously operating piconets can be supported without relying on specific multi-path conditions to provide piconet separation?

i. ***SOP Performance:*** The simultaneously operating piconet results provided in the current MBOK proposal document 802-15-03/334r5 (slide 50), does not seem to take the entire contribution of implementation losses into account. Could you provide SOP results that take the implementation loss into account as well?

4 Multi-path Robustness

The performance in a multi-path environment is one of the critical features for a high-rate UWB PHY. The MBOK proposal has not clearly stated the receiver requirements in handling the multi-path channels and the system impairments that have been included in these simulations. **Clarifications on the following points would help us understand the MBOK proposal better.**

a. Simulation results presented in document 15-03-0449-03-003a shows that the 200 Mbps and 480 Mbps modes reach an error floor in a multi-path channel environment in the presence of realistic system impairments. If you do not agree with this conclusion, can you present detailed simulation results to the contrary and the assumptions on system impairments that are made?

b. All the multi-path performance results presented in the MBOK proposal assumes a 150 finger RAKE. Does an implementer have to implement this many RAKE fingers to obtain a performance capable of meeting the selection criterion document? If not, can you provide detailed simulation results to justify how many RAKE fingers are needed?

c. In a presentation by the MBOK proponents in January 2004, it was stated that an equalizer, especially a DFE, is required at the receiver to ensure that there is no error floor. However no simulation results were presented to show the system performance when an equalizer is used, the complexity requirements of the equalizer or whether a

DFE is feasible (from a complexity perspective) for the 64-BOK mode and the DFE training requirements (convergence time, hardware). Can you present detailed simulation results when an equalizer is used and provide additional information on the expected complexity (gate count) of the equalizer and also address issues related to equalizer training?

d. The MBOK proposal from May 2003 states that DFE error propagation is not an issue for UWB multi-path channels. This is justified by simulations performed at a very high SNR of 9.6 dB and 12.6 dB. This ignores the fact that the MBOK proposal has an FEC and operates at an E_b/N_0 of ~4 dB for a BER of 10^{-5}. In addition, the DFE uses the tentative decisions generated at the channel SNR, which corresponds to ~1 dB for a Rate ½ code. Can you provide results characterizing the impact of DFE error propagation at the realistic operating point?

e. It has been stated by many, including the MBOK proponents that the transmitter back-off needs to be included in the link budget analysis and performance results. The MBOK proposal needs a theoretical transmitter back-off of ~2 dB for some of the modes (2-BOK, 4-BOK, etc). However, neither the link budget table nor the performance results seem to include this back-off. Can you provide results after including this theoretical back-off value?

f. Simulation results have shown that the 112 Mbps mode out performs the 114 Mbps mode and the 224 Mbps mode out performs the 200 Mbps mode. In addition, the rate difference between 112 Mbps and 114 Mbps and 200 Mbps and 224 Mbps is negligible and therefore does not seem to add any value to the system. Would the authors consider dropping the 114 and 200 Mbps mode from the proposal in an effort to improve the system and reduce the number of unnecessary options?

5 Complexity

a. Please provide a complete complexity analysis for the reference receiver used to generate the system performance results. When providing digital gate count, also specify the clock frequency that is assumed.

b. Document 802-15-03/334r5 presents the complexity of a CIDD for a K = 3 convolutional code as 175 K gates. However, the proposal assumes the use of a K = 4 convolutional code. Will you present complexity results that are consistent with the modes that are described in the proposal? In addition, since the link budget resuts assume the use of both the CIDD and decoder for the K=7 convolutional code, please include the complexity of both these decoders in the final gate count.

6 Coexistence

a. The selection criteria document requires either simulations or analysis based results for the distance at which the UWB receiver can tolerate other in-band/out-of band devices like IEEE 802.11a, IEEE 802.11b, Bluetooth, etc. The MBOK proposal states that these are out-of-band devices and hence would not impact the UWB system. However, this assumes infinite out-of-band rejection at the UWB receiver which is not practical. Please provide the results on the minimum distance at which these devices can be tolerated and the corresponding assumptions on the front-end filter at the UWB receiver?

7 Clear Channel Assessment

a. Document 802.15-03/343r1, which was presented in September 2003, demonstrates that the MBOK proposal has great difficulty with clear channel assessment in a multi-path environment. In addition, CCA seems to work for only CM1 channel environment for ranges up to 4 meters. In addition, this does not take into account any crystal mismatches between the various DEVs. Would you please state the assumptions that were made in generating the CCA performance results? Do you have any mechanism to ensure improved CCA performance? If so, could you please provide details?