Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
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Abstract	This document provides the minutes of session #6 of the IEEE 802.16.1 PHY group. *The questions and answers as provided in this document are a best effort representation of the actual discussion. The text provided represents the discussion as interpreted by the author, and does not provide verbatim statements. The author concedes that it is entirely possible that the intentions of the speakers were misunderstood and/or inaccurately represented.*
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Release	
IEEE Patent Policy	

Explanation of Notation:
A(nswer by Author/Presenter)
Q(uestion)
R(emark)

March 7, 8:15 AM

Chair: John Liebentrue.

Jeff Foerster presents: *"Physical Layer Proposal for the 802.16 Air Interface Specification"*
(http://grouper.ieee.org/groups/802/16/phy/contrib/802161pc-00_13.pdf *)*

Q: Standard should be DOCSIS oriented? Imho radio largest cost, rather than the chipset.
A: Agree, not really DOCSIS, since that's more MAC-layer. PHY proposal requires a little bit more flexibility of the radio.
Q: H-FDD could reduce the cost compared to OMT, since both transmitter and receiver can be integrated.
A: FDD efficiently supported, need to look at architectual impact of H-FDD.

Procedural interjection by chair: only one question per person, unless queue is short.

Q: 64 QAM should be optional because of the impact on the system cost
A: Agree
R: Teligent analyzed adaptive modulation and found that it gives us orders of magnitude leap in ability to deliver high bandwidth services to customers. Operators do want best level service efforts. Adaptive modulation is for us a requirement. You're right that the guaranteed level of service changes with rain fade, but there are advantages in designing the system for 64-QAM and being able to back off to lower type of modulation.
A: Design of a link for any modulation would have an additional margin on top of it to be resistant to rain fade.
R: If you guarantee a link for 64-QAM, then in the cases where you need to drop back, you can still keep the critical services going at a lower modulation.
R: There's a cost to designing the cell for 64-QAM.
A: You don't design the whole cell for 64-QAM. Only the nearest customers will be able to get this, while the rest of the links will be designed for lower-modulations. Obviously there's no advantage in adaptive modulation for users far from the BS who have only QPSK link.
Q: How are you going to guarantee the level of services when you don't have the right mix of critical and non-critical data? Every dropped call will lead to an angry customer.
A: There are already best effort services out there. Only life-line services should never be dropped, and the critical services, especially voice, should always be delivered at least at the lowest modulation.

Jay Klein intercedes that he will provide more data on this issue in his presentation.

R: We need to have a very serious look at the traffic profile before deciding on adaptive modulation.
Q: You mention using different rates of coding, but changing that isn't equivalent to changing modulation. Being able to change modulation hence gives an advantage.
A: Agreed.
R: In cellular systems, QPSK seen as best to maximize capacity because of the C/I. Using adaptive modulation, you'll have to design your system for 64-QAM and you have to design the systems C/I accordingly.
A: Agreed, 64-QAM will result in smaller cells.
Q: Adaptive modulation only in the downlink, or also in the uplink?
A: Different configurations are possible.

Jay Klein presents *"PHY Layer Basis for BWA"*
(http://grouper.ieee.org/groups/802/16/phy/contrib/802161pc-00_14.pdf *)*

Q: Are we pushing towards 28MHz channelization?
A: Around 5 sets of allocations exist world-wide. For simplicity, best to focus on these sets.
Q: Equalizer requirements same as for continuous modulation?
A: For continuous waveform, slow convergence algorithms can be used, not on burst modulation, however, the equalizer requirements are very low in either case.
Q: Parity check bit for error correction (1 bit / byte) how does this work?
A: Check not hard decision based. With ML soft decision, bit with weakest energy can be found and flipped.
Q: <question missed>
A: In the worst case, with LOS to all other stations, if you use a frequency reuse of 2, then you're limited to QPSK. In practical cases, significant reduction in packet loss rate. For services that tolerate delay, ARQ nicely copes with this loss. For services with very low latency demands, this would be less appealing.
Q: There is no detail on the coding. Codes limited to RS. Used code is weaker than RS interleaved with Viterbi. Second concern is the length of the interleaver.
A: I agree that performance depends on RS code and block length. Low SNR, it performs better for same efficiency and same length code. I will provide more detail for next meeting.
Q: You claim that a dual polarization antenna + OMT is expensive, but they are right now available and costs less than $60.
A: Regular antenna costs $30
Q: Does it include a block filter
A: No, no block filter included
R: OMT could also be used in H-FDD, H-FDD uses only one synthesizer and hence there is no cross-talk.
A: Having a frequency independent device in the RF in beneficial when targeting various bands.
Q: Where is the switch located in the chain. Switches are not agnostic to the band they're used in.
A: The switch architecture is preferred if the channel selection is not known upfront.
Q: What is the advantage of the TDMA in terms of power requirements.
A: Advantage of TDMA like scheduling is in changing the modulation, not in power requirements
Q: Confused on upstream and upstream channel modulations
A: downstream QPSK and 16QAM mandatory, 64QAM optional
Upstream two options:
reduced cost terminal with CPQSK only
QPSK mandatory, and 16/64 QAM optional
Q: How's the selection of fixed vs dynamic modulations going to work
A: Depends on the RF deployment.
R: 8 PSK in other proposal, a modulation format which is a moderate increase (QPSK -> 8 PSK -> 16 QAM) can get the additional benefit of using turbo codes. In two or three years, all codes used will be some form of turbo coding.
A: Agree that turbo codes will be the base coding, but it can also be used for the other modulations. The TFM has two advantages, one is the PA, the other is the modulator, which is basically a VCO.
Q: Is the frequency reuse of 2 you presented here applied to TDD?
A: It's FDD based, but it can deliver almost the same efficient deployment with TDD.
Q: What's the average spectral efficiency of the frequency reuse 2.
A: We didn't calculate this exactly, but it's around 3 bits/s/Hz. The issue is not the average, the adaptability is more important.
R: We should limit to CLAM, if we want guaranteed levels of services.
A: CLAM has its advantages and disadvantages.
Q: The gain to QPSK is thus about 50% (QPSK has 2 bits/s/Hz)
A: Yes
Q: What benefits does SLAM have over CLAM?
A: The bottom line is that it is real time adaptive to the link conditions.
Q: Does it have additional power amplifier implications?
A: No

March 8, 8:10 AM

Chair: Jay Klein

Eric Jacobson presents *"A brief examination of CQPSK for CPE PHY modulation"*
(http://grouper.ieee.org/groups/802/16/phy/contrib/802161pc-00_11.pdf *)*
Lars Lindh presents *"TFM (CQPSK) in the 802.16.1 upstream"*
(http://grouper.ieee.org/groups/802/16/phy/contrib/802161pc-00_17.pdf *)*

R: Terminals need only a small output power. One of the problems is actually to get the power low enough. With a GaAs amplifier you need about 400 mA of bias for stability and with about 5 V, you will end up with about 1.5 W in your output stage, while you only need 10mW out of the CPE. Back-off is thus a problem. Hence cost of the CPE isn't really a good motivation for use TFM.
A(Lars): Agree, but terminals need to be designed for the worst case. We use both TFM and QPSK in our company and it turns out that the amplifier for TFM can be significantly cheaper.
A(Eric): Agree, we need to carefully consider whether constant envelope modulation is necessary.
R: From experience, degradation of TFM compared to QPSK is 1 dB. Given the backoff, however, still 3 dB gain. Uplink traffic efficiency does not need to be stretched, hence the small reduction in efficiency of TFM is not critical. Standard needs to be future proof, needs to provide for home offices.
A(Eric): Agree, the future issue might be important. With GMSK there is a possible migration path, whereas with TFM there is not. Having linear modulation and TFM in one system will result in complexity in the base station.
Q: Is GMSK proposed?
A(Eric): No, but it is very similar, hence I looked at it.
R: Base station Receiver cost is shared among users, so not as critical
Q: What kind of a VCO will you use at 28 GHz, focus on temperature stability, difficult without temperature compensation. I think in reality you'd have a VCO at much lower frequency with a synthesizer.
A(Lars): We're using a closed loop system, with controlled index controlled by the BS.
Q: Radio's should be tunable over 400 MHz, VCO is going to be sensitive.
A(Lars): Quite possible to do it over a broad range with one synthesizer, so you can tune to the transmit and receive frequencies. Don't know the exact range, but I can get you the figure if needed.
Q: Our company does direct VCO modulation, the center frequency might drift, which we compensate by ensuring zero DC power modulation. Is TFM going to coexist with linear modulation?
A(Lars): Most complex parts on IF and not on RF. Stability is derived from the base station. Curves show co-existence performance.
R: Capacity gains of adaptive modulation are substantial enough for providers to mandate them. TFM with its capacity limitations might not be the best for low cost implementation.
A(Lars): We don't think that the reduction in the uplink is so critical. It is in the downlink, so that's why we propose adaptive modulation there.
A(Eric): We need to take a good look at it, not clear whether this is the best choice and whether constant envelope modulation is warranted.
A(Lars): The spectral efficiency of TFM has been criticized by those who do not like adaptive modulation in the downlink. A little strange that capacity doesn't count in the downlink, but more in the uplink, even when the traffic might be assymmetric requiring more capacity in the downlink.
R: BRAN thinks its traffic model is quite right and its supported by several authorities. Of course this is designed according to the European situation. In May (joint BRAN) meeting, traffic models need to be evaluated, so the real need of the efficiency can be determined.
R: Wireless coming as a late player, therefore cost structure needs to be carefully considered.

Moshe Ran presents *"Improving ECC schemes of proposals 802.16.1pc-00/14 and 802.16.1pc-00/13"*
(http://grouper.ieee.org/groups/802/16/phy/contrib/802161pc-00_18.pdf *)*

Q: How many iterations did you use
A: 4 iterations and finite word-length, using soft-quantized information.
Q: What decoder did you use?

A: Hamming codes have very efficient soft decoders, various implementations are possible.

Chair interjects that people need to use the microphone to ask questions.

Q: Did you try the MAP decoder?
A: No, they are very complex, focus on reasonable complexity.
Q: We tried MAP decoder for satellite applications, it gives better performance.
A: We would get about _ dB gain according to our simulations, but pay a high price in complexity.
Q: Do you have an interleaver?
A: Yes, we have a bit block interleaver, more complex interleavers do not provide worthwhile gain.
Q: Is your code similar to the hamming product codes in that it is optimal around one code rate?
A: Appending one gives a family of product codes which can be shortened for any block size you need.
Q: When you change the size, does it change the distance-performance capacity?
A: You don't loose performance by shortening the codes. I gave some details on how you can tailor your code to the block length.
Q: Is the channel Gaussian?
A: Yes, but the slope of the Viterbi decoder does not change, as it tends to whiten the noise during iterations. This a difference between between convolutional codes and block turbo codes.
Q: What's the delay?
A: Approximately 2 to 3 blocks of the product code.
Q: One issue tried to solve in the [00/14] proposal (RS with extra parity check) was to solve the performance at low BER of RS. Also uncertain on which turbo code to use. In your simulation you ignore decoder failure around 10e-3 10-e4.The extra parity check gives a one dB improvement there due to the soft decoding. The upstream is using RS that can be programmed. The efficiency drops for small packets. Registration and contention is self-healing with multiple tries, so coding gain is not the best performance measure.

- Can both PHY's be merged?

Discussion:

R: We want to get to one PHY proposal, but not sure how to get there.
R: There's ambiguity: This can also mean multiple PHY's under one MAC.
R: Better address this question at the end.
Motion to address this question at the end.
No objections: question will be addressed later.

- Turbo codes (BTC? others?):

Straw-Poll	**favorable**	**unfavorable**
"Is it the sense of the task group to give further consideration to turbo codes as a FEC for a BWA standard"	32	1
"*Is it the sense of task group to have BPC as a FEC scheme"*	23	14
"*Is it the sense of the task group to give further consideration to Block Product Codes as a FEC for a BWA standard"*	20	9

- TMF (or other constant env. modulation schems):

Straw-Poll	**favorable**	**unfavorable**
"*Is it the sense of the task group to give further consideration to a constant envelope modulation scheme for the uplink (terminal transmitter)"*	19	24
"*Is it the sense of the task group to give further consideration to TFM modulation for the uplink (terminal transmitter)"*	14	30

- Adaptive modulation

Straw-Poll	favorable	unfavorable
s it the sense of the task group to give further consideration to adaptive modulation scheme"	51	1
"Is it the sense of the task group to give further consideration to adaptive modulation scheme on the downplink"	42	0
"Is it the sense of the task group to give further consideration to adaptive modulation scheme on the uplink"	45	0
"Is it the sense of the task group to give further consideration to CLAM"	32	9
"Is it the sense of the task group to give further consideration to SLAM"	36	7
"*Is it the sense of the task group to give further consideration to SLAM downstream"*	34	6
"*Is it the sense of the task group to give further consideration to SLAM upstream"*	39	3
"*Is it the sense of the task group to give further consideration to CLAM downstream"*	25	13
"*Is it the sense of the task group to give further consideration to CLAM upstream"*	25	11

<Questions below were identified, but not voted on due to lack of time.>

- Support for multiple duplex access schemes
- Multiple Channel bandwidth
- Do we need a traffic model for generating requirements
- Can both PHY's be merged

March 09, 2000

Chair Jay Klein:

Agenda:

Plan review 8:15-8:20
Propagation Vikas Kukshya 8:20-8:40
Wei Zhang 8:40-9:00
David Falconer 9:00-9:20
Discussion 9:20-9:45
Break 9:45-9:10
General modeling: 10:10-10:30
John & Tom 10:30-10:50
Discussion 10:50-11:20
Open issues 11:20-11:45
Integration plan with proposals 11:45-12:00

Agenda approved unanimously.

Vikas Kukshya presents (8:20-8:40)*"Multipath measurements and Modeling for Fixed Broadband Point-to-Multipoint Radio Wave Propagation Links under Different Weather Conditions."*

(http://grouper.ieee.org/groups/802/16/phy/contrib/802161pc-00_12.pdf *)*
Wei Zhang presents (8:40-8:55) *"Recommendation on channel propagation model for local multipath distribution Service."*
(http://grouper.ieee.org/groups/802/16/phy/contrib/802161pc-00_16.pdf *)*
David Falconer presents (8:55-9:10) *"Proposed System Impairment Model"*
(http://grouper.ieee.org/groups/802/16/phy/contrib/802161pc-00_15.pdf *)*

Q: what's the granularity necessary for evaluation?
A(David): a good granularity for the delays is about 10 ns, for the phase 45 degrees is sufficient
Q: In the uplink, we have burst, so the slow channel variation does not apply there
A: True, but the channel bursts are in the order of 1 ms, so sufficiently long, an equalizer will have to adapt to each user individually. Inbetween bursts of a single user, the channel may change, so new adaptation needs to be done.
Q: Is the channel reciprocal?
A: No, because the beamwidth of the BS is very wide, and that of the CPE narrow, so it depends on the position of the scatterers.
Q: What determines the channel dynamics?
A: Mostly the weather, but moving scatterers will also cause doppler.
Q: Changes in the weather are relatively slow to the symbol rate. 802.16.1 focuses on business environment, so there will not be a lot of of mobile scatters
A: True, but the vegetation will cause some variation.
R: The crane model seems incorrect, since the error in measurements become very large. Short links as presented in the first presentation are not really of interest to this group.
A: Antenna used is about 1 foot, so the far field is about 10 m. The reason for using the Crane model is to use a simple mathematical equation. The model was adjusted to take into account the attenuation. We can use the power contours and delay contours very easily for site-planning, so it's an easy deployment technique.
R: The rain analysis can not be done on short links.
Q: Has anybody here looked at the different polarizations?
A: Indoor circular polarization seems to cause less delay spread indoors. Outdoor study with help of radar data is still going on. In presentation one, only vertical polarization was used.
R: Some people claim that polarization diversity does not work around 40 GHz, so study of horizontal polarization would also be in order.

Summary:
Identified Model Types

- Type I: LOS, no multi-path – Basic PHY performance, inherent degradations
- Type II: LOS, light multi-path – Some degradation allowed
- Type III: LOS, moderate multi-path – More degradations allowed.

Chair requests the adhoc modeling committee (Dave Falconer, Tom Kolze, Yigal Leiba, John Liebetreu) to come up with 3 models for the above Types.

10:15-10:35 John Liebetreu presents the progress report of the adhoc modeling committee concerning amplifiers.

R: measurements based on class A/B amplifier, while this industry generally uses class A amplifiers, so the model might be too aggressive. Modifying the model makes the small signal response non-linear.
A: It still needs to be investigated whether the model is too aggressive. The focus on an ongoing NIST study will be on class A amplifiers.
Q: AM-to-PM doesn't seem to be a problem, so the model is probably too aggressive
Q: Did you correlate these model with 3rd order models, such as a Voltera series.
A: One of the purposes of the model is to look at the spectral emission guidelines. A voltera series might be a worthwile approach to take for inband effects.

Tom Kolze presents the progres report of the adhoc modelling committee concerning phase noise model.
Q: What needs to be changed here to make it a good model for performance evaluation (rather than just for comparison)?

A: It needs more detail on where and what the slopes of the model are.
R: It won't be 20dB per decade in the close range.
R: The model is short-term important to evaluate parameters in the target propopals, but here is value in making the model more accurate for future interface specification.
R: We need to agree on the normalized frequency response of a theoretical modem in order to be able to compute the degradation of the BER.
R: In the current proposals, the modulations are almost all the same, so this might not be a critical part of evaluating proposals.
R: PHY proposals need to specify their requirements such that we can determine the cost of their proposal in terms of the ODU.

Call for contributions
(http://grouper.ieee.org/groups/802/16/phy/docs/802161p-00_??.pdf) [exact document number unknown at time of completion of this document] composed and unanimously approved.

Meeting adjourned.