A “Block” Adaptive Modulation and Coding PHY

IEEE 802.16 Presentation Submission Template (Rev. 8)
Document Number: **IEEE 802.16.3p-00/39**
Date Submitted: 2000-11-08

Brian Eidson
Conexant Systems Inc
9868 Scranton Road
San Diego, Ca 2121-1762

Voice: 858.713.4720
Fax: 858.713.5555
mailto: brian.eidson@conexant.com

Frederick Enns
Hybrid Networks
6409 Guadalupe Mines Road
San Jose, Ca 95120-5000

Voice: 408.323.6269
Fax:408.323.6472
mailto: rne@hybrid.com

David Fisher
Radia Communications
275 N. Mathilda Suite A
Sunnyvale, CA 95086

Voice: 408.830.9726
Fax: 408.245.0990
mailto:dfisher@radiacommunications.com

John Langley
Com21, Inc
750 Tasman Drive
Milpitas, CA 95035

Voice: 408.544.1990
Fax: 408.953.9299
mailto: jlangley@com21.com

David Williams
Advanced Hardware Architectures
2365 NE Hopkins Court
Pullman, WA 99163-5601

Voice: 509.334.1000
Fax: 509.334.9000
mailto:davew@aha.com

Venue: Session #10, Tampa, FL
Base Document: **IEEE 802.16.3c-00/39**
Purpose: Presentation of PHY Proposal for condsideration by 802.16.3
Notice:

This document has been prepared to assist IEEE 802.16. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein.

Release:

The contributor grants a free, irrevocable license to the IEEE to incorporate text contained in this contribution, and any modifications thereof, in the creation of an IEEE Standards publication; to copyright in the IEEE’s name any IEEE Standards publication even though it may include portions of this contribution; and at the IEEE’s sole discretion to permit others to reproduce in whole or in part the resulting IEEE Standards publication. The contributor also acknowledges and accepts that this contribution may be made public by IEEE 802.16.

IEEE 802.16 Patent Policy:

The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures (Version 1.0) <http://ieee802.org/16/ipr/patents/policy.html>, including the statement “IEEE standards may include the known use of patent(s), including patent applications, if there is technical justification in the opinion of the standards-developing committee and provided the IEEE receives assurance from the patent holder that it will license applicants under reasonable terms and conditions for the purpose of implementing the standard.”

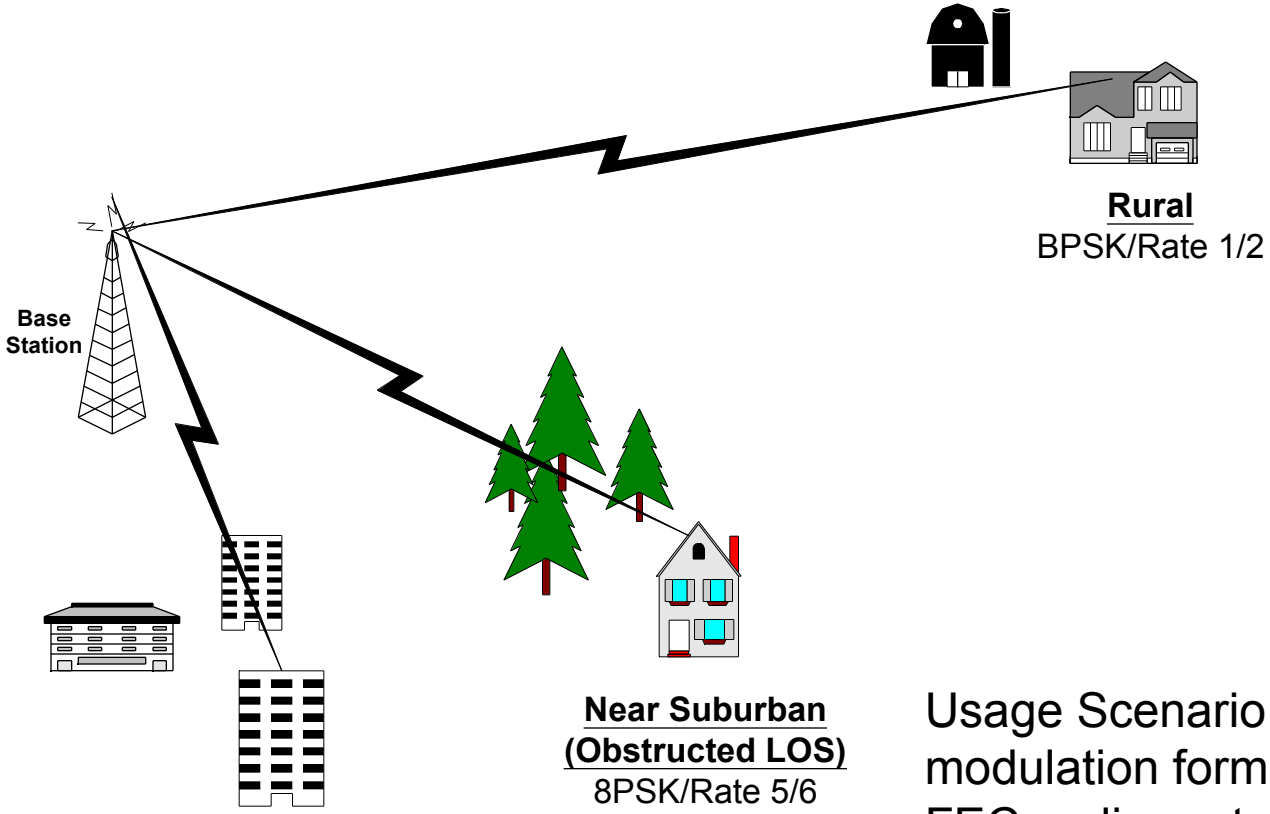
Early disclosure to the Working Group of patent information that might be relevant to the standard is essential to reduce the possibility for delays in the development process and increase the likelihood that the draft publication will be approved for publication. Please notify the Chair <mailto:r.b.marks@ieee.org> as early as possible, in written or electronic form, of any patents (granted or under application) that may cover technology that is under consideration by or has been approved by IEEE 802.16. The Chair will disclose this notification via the IEEE 802.16 web site <http://ieee802.org/16/ipr/patents/notices>.

A “Block” Adaptive Modulation and Coding PHY

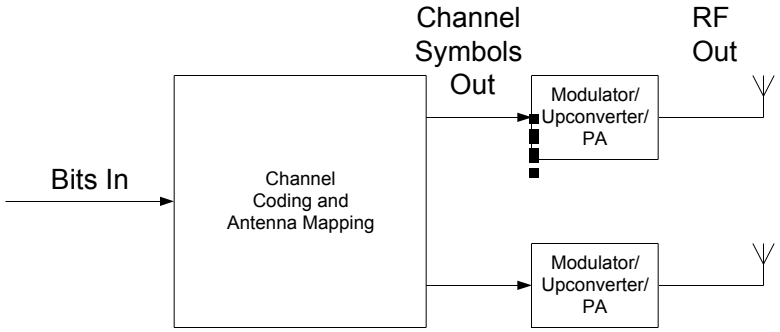
Brian Eidson
Frederick Enns
David Fisher
John Langley
David Williams

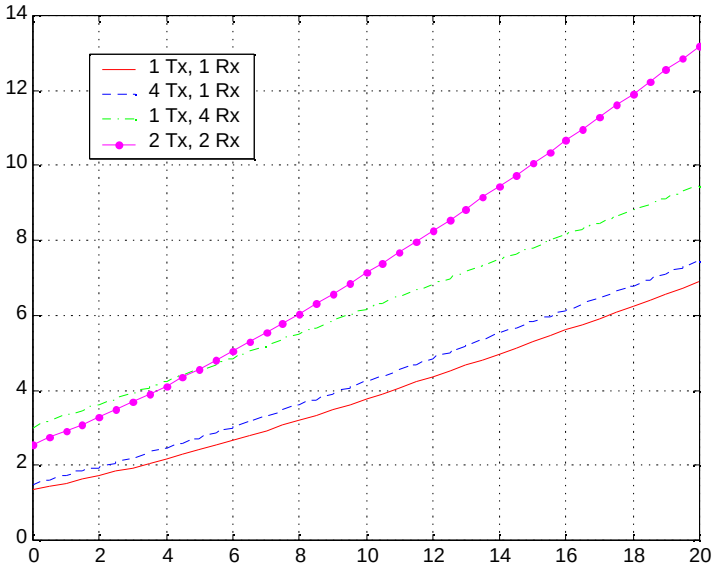
7 November 2000

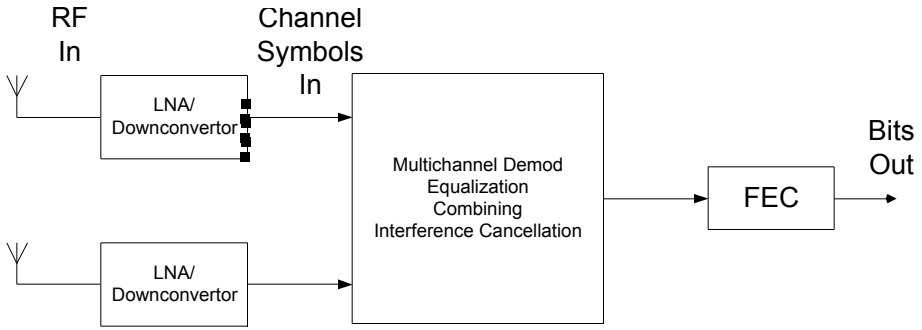
- Single Carrier FDD to Minimize Cost of Radio at Subscriber and Base Stations
- Adaptive Modulation and FEC to optimize link gain for each subscriber's channel conditions
  - BPSK, QPSK, …64QAM, 256QAM
  - Adjustable Rate Turbo codes
- Enhanced Decision Feedback Equalization for multipath channels
- Extensible and scalable to support multi-antenna spatial diversity as needed



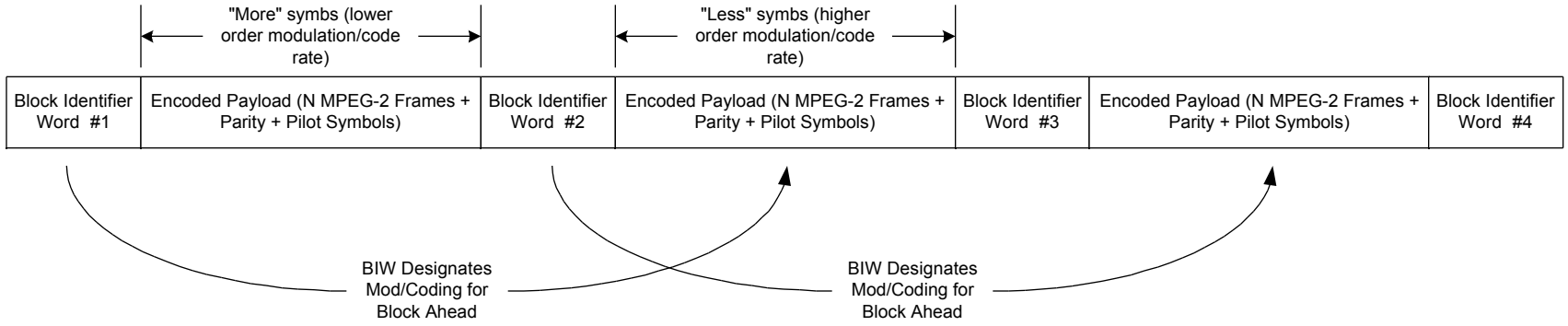
Usage Scenario showing modulation format and FEC coding rate adapted to channel propagation conditions


Channel
Symbols
Out
RF
Out
Bits In
Channel
Coding and
Antenna Mapping
Modulator/
Upconverter/
PA
Modulator/
Upconverter/
PA

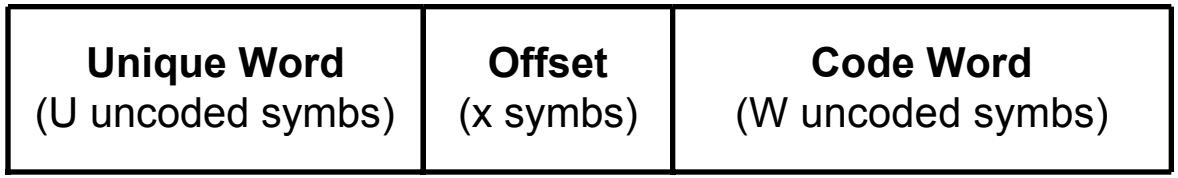

1 Tx, 1 Rx
4 Tx, 1 Rx
1 Tx, 4 Rx
2 Tx, 2 Rx
0
2
4
6
8
10
12
14
16
18
20


RF
In
Channel
Symbols
In
LNA/
Downconvertor
LNA/
Downconvertor
Multichannel Demod
Equalization
Combining
Interference Cancellation
FEC
Bits
Out

- **Same modulation/code rate used for duration of block**
- **‘Uncoded’ “Block Identifier Words” used to:**
  -
  -

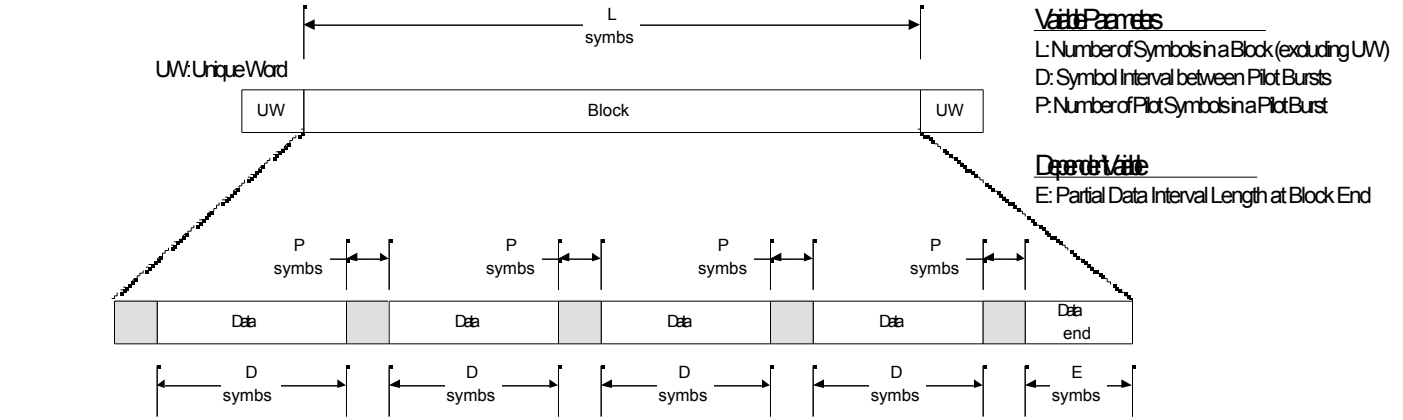


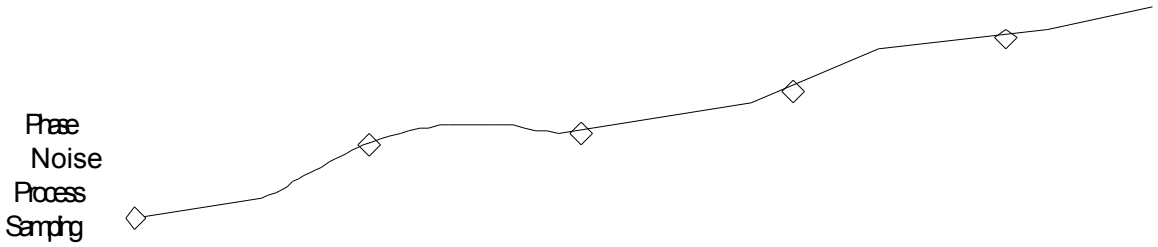
Note: Blocks shown as multiple MPEG frames for convenience only. Block length can be arbitrary.



- **BIW sent uncoded at lowest modulation format**
  - **Unique Word selected for strong autocorrelation properties**
  - **Code Word designates Modulation Format and Code Rate**

- **Used for carrier phase tracking**
  - **Aggregated in bursts for AWGN averaging**
  - **Bursts regularly spaced within block for easy loop tracking**
  - **Parameterizable; could potentially differ by mode or change to one of several settings on the fly**

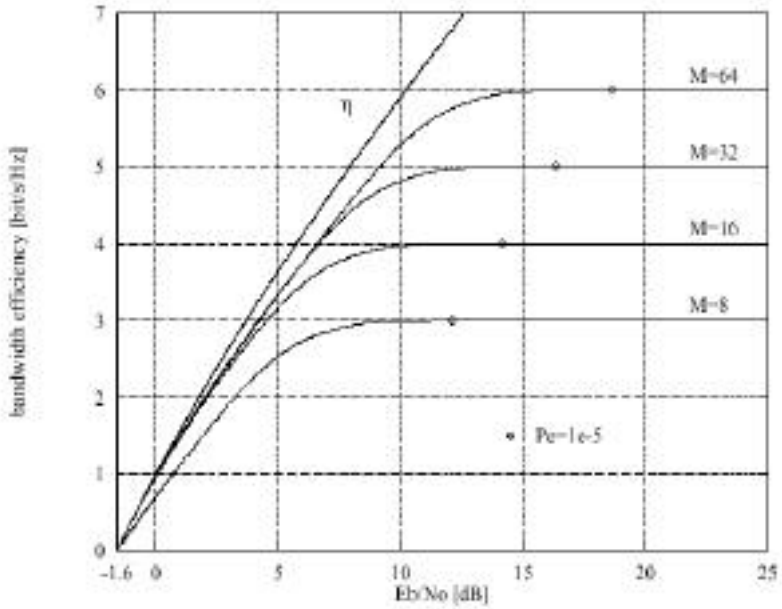




- Block Sync based on uncoded Block Identifier Word preceding every every block
- Unique Word is uncoded, so correlation against this known word possible
  - Acquisition speedup
    - initial carrier phase + AFC
    - Near-simultaneous frame sync achieved during recovery from fades
  - Enables quicker channel changes

Modulation Format	Relative Link Gain
BPSK	18 dB
QPSK	12 dB
16QAM	6 dB
64QAM	0 dB
256QAM	-6 dB

Channel Link Gain with respect to 64QAM



Bandwidth Efficiency for Various Modulation Formats

Modulation	Phase Noise at 10KHz offset (dBc/Hz)	Phase Noise at 100KHz offset (dBc/Hz)	Power Amp Back off from 1 dB comp.
QPSK	-75	-85	4
16QAM	-75	-85	6
64QAM	-85	-95	9
OFDM*	-97	-117	14

*512 tone, 6 MHz channel, ~5 Msymb/sec, 64QAM

- **Spectrally Efficient**
  - System operator can adjust modulation and coding to optimize service to wide range of subscribers
- **Simple Implementation**
  - CPE based on Cable Modem chipsets and widely available radio hardware
- **Single carrier (more tolerant to phase noise) minimizes cost of both BTS & CPE Radios**
  - RF Hardware typically ≥ in cost to baseband
- **Link gain can be adjusted over >20 dB range to compensate for wide-range of channel impairments**