Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**OCDMA Proposal for IEEE 802.16.3 PHY**
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Source(s)	Arthur W. Wang WirelessHome Inc. 3780 Kilroy Airport Way, Suite 500 Long Beach, CA90806 Voice: 562-733-3000 Ext 3052 Fax: 562-733-3003 mailto: AWANG@WIRELESSHOME.COM
Re:	Call for Contributions: Initial PHY Proposals, IEEE 802.16.3 Task Group
Abstract	This document presents a preliminary PHY design for BWA from 2 to11 GHz using OCDMA Techniques
Purpose	Consider OCDMA as one of candidates in 802.16.3 PHY standardization process
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OCDMA Proposal for IEEE 802.16.3 PHY

Arthur W. Wang
Sr. Systems Engineer, WirelessHome Inc.

1. Introduction

IEEE 802.16.3 Task Group called for contributions on "initial PHY proposals" for Broadband Wireless Access (BWA) standards for license bands from 2-11 GHz. This documents provides information of an Orthogonal Code Division Multiple Access (OCDMA) based PHY protocol. It is based on technology for WirelessHome Broadband Wireless Access Products. This document also addresses the criteria listed in the Evaluation Table of IEEE802.16.3-00/14 (Call for paper).

2. Overview

The physical layer of a BWA system consists of multiple point-to-multiple-point (P2MP, or PMP) networks. Each network is defined as a "sector" with one Base Station System (BSS) and multiple User Terminals (UT). As shown in Figure 1, the available spectrum is divided in multiple carriers. Each carrier is then subdivided into multiple frames with flexible numbers of downlink and uplink slots for "Time Division Duplex" (TDD).

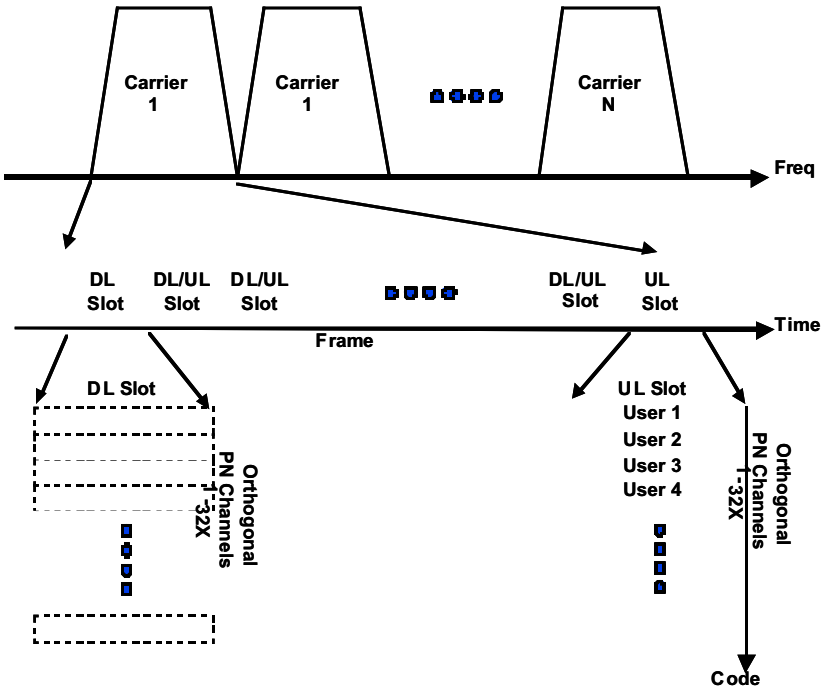

Figure 1. Carrier/Frame/Channel Structure

Both Downlink and Uplink slots are further divided through 32X (X is the spreading factor) orthogonal PN codes with spreading and sum broadcasting downlink and code division multiple access uplink. The focus is on throughput and low peak-to-average ratio in downlink and uplink respectively.

3. Reference Models

Reference models of transmitter and receiver are illustrated below. They present the general functions for the proposed OCDMA PHY.

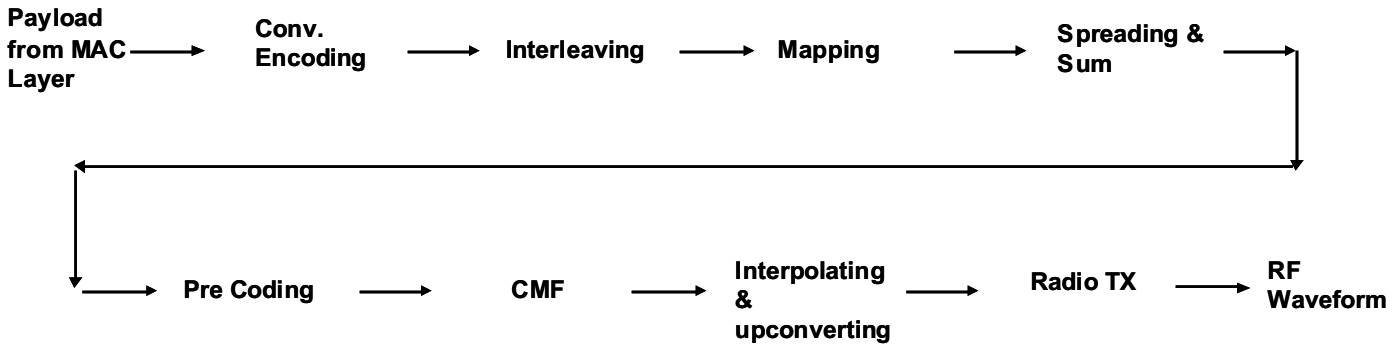

Figure 2. Transmitter Reference Model

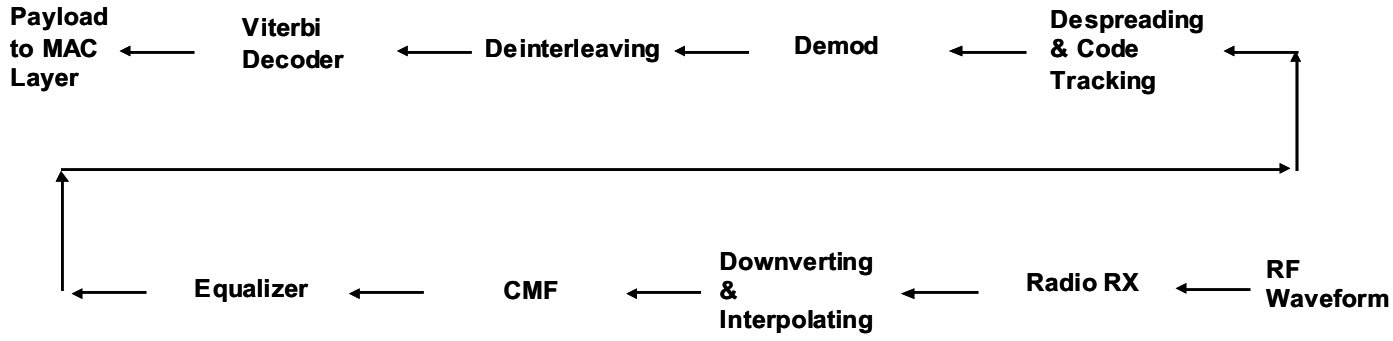

Figure 3. Receiver Reference Model

4. Features

Development Cost: This proposal allows the same signal processing components in the base station and subscriber premises, thus reducing development and chipset cost.

CPE Cost: In residential access market, cost of customer premises equipment (CPE) is an important factor for business success. CDMA technology minimizes the "peak power requirement" enabling the selection of low cost power amplifier.

Multipath Resistance: Multipath effect is reduced through the application of time domain equalizer. It has been shown to be the most efficient for systems with high gain antenna.

Variable Data Rates: Both downlink and uplink could be configured to support the underlying modulations, QPSK rate 1/2, QPSK rate 3/4, QAM 8 rate 2/3 and QAM 16 rate 3/4 for nominal data rates of 20, 30, 40, and 60 Mbps respectively.

Minimal Self-Interference: The usage of synchronous CDMA waveform minimizes self-interference among signals from multiple co-sector users. Interference between adjacent cell-site is further reduced by an additional long code overlay on top of the waveform.

Optimized for Asymmetric Traffic: For Internet access, the traffic is heavily asymmetric, this proposal applies both time and code (channel) division multiple access to divide the uplink bandwidth, which achieves high flexibility over competing technologies.

Proven Technology: Leveraging mobile technologies will reduce cost and expedite development and test

5. Drawbacks

Power Balance: Due to the nature of CDMA, inbound power shall be adjusted to be equal at the base station. Such requirement imposes complexity to the base station product development.

6. Relationship with Similar Standards

The comparison of proposed OCDMA PHY design with 4 similar standards are summarized below

Standards vs Proposal	**ITU JRG 8A/9B**	**DOCSIS 1.1**	**IEEE 802.11a**	**HIPERLAN**	**OCDMA Proposal**
Frequency	3.5 GHz (priority 1)	2.5 GHz	5 GHz	5 GHz	3 & 5 GHz
Target Environment	Wireless	Wired	Indoor Wireless	Indoor/Outdoor Wireless	Outdoor Wireless
Duplexing		FDD	TDD		TDD
Multiple Access	FDMA/TDMA	FDMA/TDMA	OFDM	OFDM	OCDMA
Modulation	π/4-DQPSK	BPSK QPSK QAM16 QAM64? QAM256?	BPSK 1/2, 2/3, 3/4 QPSK 1/2, 2/3, 3/4 QAM16 1/2, 2/3, 3/4 QAM64 1/2, 2/3, 3/4	BPSK 1/2, 3/4 QPSK 1/2, 3/4 QAM16 9/16, 3/4 QAM64 3/4	QPSK 1/2, 3/4 QAM8 2/3 QAM16 3/4
Forward Error Correction	BCH(106,92,2)	RS	Convolution, K=7	Convolution, K=7	Convolution, K=9

Table 1. Comparison with Other Standards

7. Intellectual Property Statement

WirelessHome may have intellectual property rights (IPR) in the proposed PHY. It will comply with the IEEE IPR rules regarding disclosure and licensing.

8. Summary

WirelessHome OCDMA protocol is tailored for broadband fixed wireless services, especially in the small-office-and-home-office (SOHO) and residential markets. Similar technology has been shown its popularity in the mobile environment (IS-95, UMTS, or CDMA2000). Adoption of this proposal will minimize the cost of customer premises equipment and enhance the efficiency of spectrum usage.

Most OFDM based technologies have been shown applications for systems in indoor (e.g. 802.11a) environment with low gain (<6 dBi) antenna to combat severe multipath. It remains further evaluation of its usage for systems with high gain antenna (>18 dBi) or applied mainly to outdoor communications.

9. References

[1] ITU-R JRG 8A/9B Chair's Report, (205e) March 2000.

[2] Data-Over-Cable Service Interface Specifications, Radio Interface Specification, March 11, 1999.

[3] IEEE 802.11a, Part11: Wireless LAN Medium Access Control and Physical Layer Specifications, Sep. 1999

[4] Broadband Radio Access Networks (BRAN), HIPERLAN Type 2, Feb 2000.