Project	**IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>**
Title	**Improved Air Interface Techniques within 802.16m Project Scope**
Date Submitted	**2007-01-11**
Source(s)	Michael Webb Dale Branlund BRN Phoenix Inc. 2500 Augustine Drive Santa Clara, CA 95054 Voice: (408) 572-9706 Fax: (408) 351-4911 [mailto: mwebb@brnphoenix.com]
Re:	Call For Initial Input regarding P802.16m Project, 12/25/06
Abstract	This contribution provides input to 802.16 Task Group m requesting the scope of the project include air interface techniques that improve spectral efficiency, link quality and range, provide more efficient support of large numbers of users and provide support for higher levels of mobility.
Purpose	This document is submitted in response to the Call For Initial Input regarding P802.16m Project, 12/25/06, issued by the 802.16 Working Group.
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 material 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.
Patent Policy and Procedures	The contributor is familiar with the IEEE 802.16 Patent Policy and Procedures <http://ieee802.org/16/ipr/patents/policy.html>, including the statement "IEEE standards may include the known use of patent(s), including patent applications, provided the IEEE receives assurance from the patent holder or applicant with respect to patents essential for compliance with both mandatory and optional portions of 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:chair@wirelessman.org> as early as possible, in written or electronic form, if patented technology (or technology under patent application) might be incorporated into a draft standard being developed within the IEEE 802.16 Working Group. The Chair will disclose this notification via the IEEE 802.16 web site <http://ieee802.org/16/ipr/patents/notices>.

Input on Scope of 802.16m Project

Michael Webb
Dale Branlund
BRN Phoenix

Abstract

This contribution provides input to 802.16 Task Group m requesting the scope of the project include air interface techniques that improve spectral efficiency, link quality and range, provide more efficient support of large numbers of users and provide support for higher levels of mobility.

Background

The 802.16m PAR identifies the project scope as an amendment of the existing 802.16 OFDMA specification to provide an advanced air interface for operation in licensed bands that will meet the requirements of IMT-Advanced, as discussed in ITU-R M.1645 and related documents (M.2072, M.2078, etc.).

M.1645 identifies a set of potential new capabilities for systems beyond IMT-2000 driven by the increasing demands users will place on wireless access networks. This includes:

- Higher peak user rates and aggregate throughput (up to 100 Mbit/sec)
- Increased user and service penetration rates
- Greater ability to simultaneously support a wide range of multimedia services
- Management of different quality of service levels

M.1645 provides a discussion of some of the key technology trends that should be considered in the development of systems beyond IMT-2000, including those in the following areas:

- System related technologies (packet network architectures, platform technologies, etc.)
- Access network and radio interface (multiple access schemes, adaptive radio interfaces, antenna technologies, etc.)
- Utilization of spectrum (hierarchical cell structures, adaptive antenna systems and MIMO, spectrum sharing, etc.)
- Mobile terminals (platforms, integration, user interfaces, SDR, etc.)
- Applications (data coding and compression, codecs, API's, middleware, etc.)

M.1645 also provides a high-level discussion of the spectrum alternatives for systems beyond IMT-2000 and concludes that significantly more efficient use of existing spectrum is needed and should be enabled by technology advances. It states that analysis of new spectrum demand should consider advances in technology and "all efforts will be made to use the spectrum as efficiently as possible to limit the additional spectrum demand".

While the existing 802.16 OFDMA standard provides significant advancements beyond existing IMT-2000 systems currently deployed around the world, it needs to be further advanced in order to fully realize the goals of IMT-Advanced. The 802.16 Working Group has already recognized this as evidenced by the commencement of the 802.16m project. We believe that advancements need to be focused in the following areas and these areas should constitute the technical focus of Task Group m:

- Efficient use of spectrum through advanced antenna methods beyond those in the current standard
- Additional techniques to improve link quality and range
- Efficient support of large numbers of multimedia users over a wide range of usage patterns
- Improved support of high levels of mobility, while maintain high spectral efficiency and link rates

Spectral Efficiency and Advanced Antenna Methods

IEEE 802.16-2004 and 802.16-2005 describe the use of AAS (beamforming) and MIMO. These multi-antenna techniques provide improvements to 802.16 OFDMA system coverage and capacity performance through the creation of higher-order diversity and independent spatial channels within an 802.16 cell.

The existing techniques have not been the subject of evaluation or assessment by an authorized 802.16 Task Group in the recent past. Recent advancements in adaptive antenna processing techniques and underlying signal processing technologies (including higher order MIMO, hybrid MIMO/AAS and multi-user detection and interference cancellation) are not necessarily reflected in the current 802.16 standards.

As discussed above, systems beyond IMT-2000 will require levels of spectral efficiency significantly higher than that enabled by baseline 802.16 OFDMA modes. Specifically, spectral efficiency in the range of 8-10 bps/second/Hz/cell will be needed to achieve the subscriber penetration rates and aggregate data rates needed to ensure commercial success for these networks, given the bandwidth-intensive multimedia services they must support.

While the existing 802.16 MIMO and AAS modes do provide improved coverage and capacity compared to the mandatory modes (and existing IMT-2000 systems), it is our view that enhanced techniques are now feasible that can provide an order-of-magnitude improvement in spectral efficiency and capacity relative to baseline 802.16 OFDMA PHY modes and existing IMT-2000 systems.

The 802.16 m TG should include enhancements to the 802.16 MIMO and AAS modes within the scope of the project for the explicit purpose of increasing the capacity, aggregate link rates and spectral efficiency of an improved air interface to be considered for IMT-Advanced. The Task Group should undertake the following steps to evaluate and assess candidate solutions:

- Define new user capacity demand and traffic models for a range of multimedia service profiles
- Define network deployment models and cost targets, including likely spectrum allocation(s)
- Solicit proposals for systems incorporating advanced multi-antenna methods and signal processing techniques, with performance metrics supported by simulation
- Assess proposals against capacity demand and network deployment models

Techniques to Improve Link Quality and Range

The TG should consider enhancements to the existing standard to improve link quality and range. In addition to the use of advanced antenna system methods discussed above, which inherently provide link performance improvements, the following techniques should be considered:

- Advanced diversity methods
- Advanced modulation and coding schemes

Efficient Support of Large Numbers of Users

TG m should consider enhancements to the existing standard to reduce the amount of PHY and MAC layer overhead, particularly in cases of large numbers of users with small or sporadic bandwidth demands, and provide more efficient use of available capacity. The following items should be considered:

- Reducing MAP overheads
- Spatial scheduling constructs in order to fully exploit multi-user antenna technologies
- Higher capacity access/bandwidth request techniques

Improved Support of High Mobility

TG m should consider enhancements to the existing standard to support higher levels of mobility without degradation of spectral efficiency and link rates. Most of the techniques discussed above will contribute to this goal. The following additional items should be considered:

- Shorter frame lengths to improve channel coherency
- Additional training for rapid channel estimation (mid-ambles, preambles or post-ambles)
- Rapid power control mechanisms
- Joint channel estimation and decoding methods