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Re:	Requirements for P802.16m-Advanced Air Interface
Abstract	This version has been revised according to the comment resolution conducted by TGM in Session #50
Purpose	Updated high-level system requirements for the P802.16m draft
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## 2 **1.0 Overview**

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4 The 802.16m ammendment shall be developed in accordance with the P802.16 project authorization  
5 request (PAR), as approved on 6 December 2006 [1], and with the Five Criteria Statement in IEEE  
6 802.16-06/055r3 [2].

7 According to the PAR, the standard shall be developed as an ammendment to IEEE Std 802.16 [3][4]. The  
8 scope of the resulting standard shall fit within the following scope:

9 *This standard amends the IEEE 802.16 WirelessMAN-OFDMA specification to provide an*  
10 *advanced air interface for operation in licensed bands. It meets the cellular layer requirements*  
11 *of IMT-Advanced next generation mobile networks. This ammendment provides continuing support*  
12 *for legacy WirelessMAN-OFDMA equipment.*

13

14 And the standard will address the following purpose:

15 *The purpose of this standard is to provide performance improvements necessary to support*  
16 *future advanced services and applications, such as those described by the ITU in Report ITU-R*  
17 *M.2072.*

18

19 The standard is intended to be a candidate for consideration in the IMT-Advanced evaluation process  
20 being conducted by the International Telecommunications Union– Radio Communications Sector (ITU-  
21 R) [5][6][7].

22 This document represents the high-level system requirements for the 802.16m ammendment. All content  
23 included in any draft of the 802.16m ammendment shall meet these requirements. This document,  
24 however, shall be maintained and may evolve. These system requirements embodied herein are defined  
25 to ensure competitiveness of the evolved air interface with respect to other mobile broadband radio  
26 access technologies as well as to ensure support and satisfactory performance for emerging services and  
27 applications. These system requirements also call for significant gains and improvements relative to the  
28 preexisting IEEE 802.16 system that would justify the creation of the advanced air interface.

29 To accelerate the completion and evaluation of the standard, to improve the clarity and reduce  
30 complexity of the standard specification, and to further facilitate the deployment of new systems, the  
31 number of optional features should be minimized.

1

2 **2.0 References**

- 3 [1] IEEE 802.16m PAR, December 2006, <http://standards.ieee.org/board/nes/projects/802-16m.pdf>
- 4 [2] IEEE 802.16 WG, "Five Criteria Statement for P802.16m PAR Proposal," IEEE 802.16-06/55r3,  
5 November 2006, [http://ieee802.org/16/docs/06/80216-06\\_055r3.pdf](http://ieee802.org/16/docs/06/80216-06_055r3.pdf)
- 6 [3] IEEE Std 802.16-2004: Part 16: IEEE Standard for Local and metropolitan area networks: Air  
7 Interface for Fixed Broadband Wireless Access Systems, June 2004
- 8 [4] IEEE Std. 802.16e-2005, IEEE Standard for Local and metropolitan area networks, Part 16: Air  
9 Interface for Fixed and Mobile Broadband Wireless Access Systems, Amendment 2: Physical  
10 and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed  
11 Bands, and IEEE Std. 802.16-2004/Cor1-2005, Corrigendum 1, December 2005
- 12 [5] Recommendation ITU-R M.1645: Framework and overall objectives of the future development  
13 of IMT-2000 and systems beyond IMT-2000, January 2003
- 14 [6] ITU-R Document 8F/TEMP/568: Guidelines for evaluation of radio interface technologies for  
15 IMT-Advanced, May 2007
- 16 [7] ITU-R Document 8F/TEMP/574: Requirements related to technical system performance for  
17 IMT-Advanced radio interface(s) [IMT.TECH] , May 2007
- 18 [8] WiMAX Forum™ Mobile System Profile, Release 1.0 Approved Specification (Revision 1.4.0:  
19 2007-05-02), <http://www.wimaxforum.org/technology/documents>
- 20 [9] FCC Docket no 94-102 this includes order numbers 96-264, 99-96, 99-245.
- 21 [10] Communications Assistance for Law Enforcement Act of 1994 (CALEA), Pub. L. No. 103-414,  
22 108 Stat. 4279.
- 23 [11] Communications Assistance for Law Enforcement Act and Broadband Access and Services First  
24 Report and Order and Further Notice of Proposed Rulemaking. ET Docket No. 04-295, RM-  
25 10865, 20 FCC Rcd 14989 (2005).

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### 3.0 Definitions

Sector	A sector is a physical partition of a cell. Cells are typically partitioned into three or more sectors. One or more antennas per sector may be used at the BS to provide coverage to users within each sector..
Cell	A collection of sectors (typically 3) belonging to the same BS
WirelessMAN-OFDMA Reference System	A system compliant with a subset of the WirelessMAN-OFDMA capabilities specified by IEEE 802.16-2004 and amended by IEEE 802.16e-2005 and IEEE 802.16Cor2/D3, where the subset is defined by <u>WiMAX Forum Mobile System Profile, Release 1.0 (Revision 1.4.0: 2007-05-02)</u> , excluding specific frequency ranges specified in the section 4.1.1.2 (Band Class Index)
Legacy MS	A mobile station (MS) compliant with the WirelessMAN-OFDMA Reference System
Legacy BS	A BS compliant with the WirelessMAN-OFDMA Reference System
IEEE 802.16m MS	A MS compliant with the IEEE 802.16 WirelessMAN-OFDMA specification specified by IEEE 802.16-2004 and amended by IEEE 802.16e-2005 and IEEE 802.16m
IEEE 802.16m BS	A BS compliant with the IEEE 802.16 WirelessMAN-OFDMA specification specified by IEEE 802.16-2004 and amended by IEEE 802.16e-2005 and IEEE 802.16m
H-FDD MS	A half-duplex FDD MS is defined as a MS that is not required to transmit and receive simultaneously

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2 **4.0 Abbreviations and acronyms**

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<b>BS</b>	base station
<b>CALEA</b>	Communications Assistance for Law Enforcement Act
<b>CPE</b>	customer premises equipment
<b>DL</b>	downlink
<b>E-MBS</b>	enhanced multicast broadcast service
<b>FDD</b>	frequency division duplex
<b>H-FDD</b>	half-duplex frequency division duplex
<b>IMS</b>	IP multimedia subsystem
<b>IP</b>	Internet Protocol
<b>ITU-R</b>	International Telecommunications Union – Radio Communications Sector
<b>LAN</b>	local area network
<b>LBS</b>	location based services
<b>MAC</b>	medium access control layer
<b>MBS</b>	multicast broadcast service
<b>MBSFN</b>	multicast broadcast single frequency network
<b>MIH</b>	media independent handover
<b>MIMO</b>	multiple input multiple output
<b>MS</b>	mobile station
<b>NCMS</b>	network control and management services
<b>OFDMA</b>	orthogonal frequency division multiple access
<b>PAN</b>	personal area network
<b>PAR</b>	project authorization request
<b>PDU</b>	protocol data unit
<b>PHY</b>	physical layer
<b>QoS</b>	quality of service
<b>RAN</b>	radio access network
<b>RAT</b>	radio access technology
<b>RRM</b>	radio resource management
<b>RS</b>	relay station
<b>TDD</b>	time division duplex
<b>UL</b>	uplink
<b>VoIP</b>	voice over IP
<b>WAN</b>	wide area network

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## 5.0 General requirements

This section contains general requirements for IEEE 802.16m systems. These requirements are intended to address and supplement the requirements specified by the ITU-R for IMT-Advanced systems.

IEEE802.16m shall meet the IMT-Advanced requirements.

Some of the requirements in this document are separated for the mobile station (MS) and the base station (BS). Such requirements shall be construed as minimum performance requirements for the MSs and BSs. The system requirements described in this document shall be met with a system comprised solely of IEEE 802.16m compliant MSs and BSs.

### 5.1 Legacy support

IEEE 802.16m shall provide continuing support and interoperability for legacy WirelessMAN-OFDMA equipment, including MSs and BSs. Specifically, the features, functions and protocols enabled in IEEE 802.16m shall support the features, functions and protocols employed by WirelessMAN-OFDMA legacy equipment. IEEE 802.16m shall provide the ability to disable legacy support.

This continuing support shall be limited to the WirelessMAN-OFDMA Reference System which is defined as system compliant with a subset of the WirelessMAN OFDMA capabilities specified by IEEE 802.16-2004 and amended by IEEE 802.16e-2005 and IEEE 802.16Cor2/D3, where the subset is defined by WiMAX Forum Mobile System Profile, Release 1.0 (Revision 1.4.0: 2007-05-02), excluding specific frequency ranges specified in the section 4.1.1.2 (Band Class Index).

The following are backward compatibility requirements:

- An IEEE 802.16m MS shall be able to operate with a legacy BS, at a level of performance equivalent to that of a legacy MS.
- Systems based on IEEE 802.16m and the WirelessMAN-OFDMA Reference System shall be able to operate on the same RF carrier, with the same channel bandwidth; and should be able to operate on the same RF carrier with different channel bandwidths.
- An IEEE 802.16m BS shall support a mix of IEEE 802.16m and legacy MSs when both are operating on the same RF carrier. The system performance with such a mix should improve with the fraction of IEEE 802.16m MSs attached to the BS.
- An IEEE 802.16m BS shall support handover of a legacy MS to and from legacy BS and to and from IEEE 802.16m BS, at a level of performance equivalent to HO between two legacy BSs.
- An IEEE 802.16m BS shall be able to support a legacy MS while also supporting IEEE 802.16m MSs on the same RF carrier, at a level of performance equivalent to that a legacy BS provides to a legacy MS.

### 5.2 Complexity

IEEE 802.16m should minimize complexity of the architecture and protocols and avoid excessive system complexity. It should enable interoperability of access networks, support low cost devices and minimize total cost of ownership.

IEEE 802.16m should only provide enhancements in areas where the WirelessMAN-OFDMA Reference System does not meet the requirements.



1 The IEEE 802.16m system shall satisfy the performance requirements in Section 7.0. In addition, the  
2 complexity of MSs and BSs shall be minimized by adhering to the following:

- 3 a) The performance requirements shall be met with mandatory features only.
- 4 b) Optional features shall be considered only if they provide significant functional and performance  
5 improvements over mandatory features.
- 6 c) Support of multiple mandatory features which are functionally similar and/or have similar impact  
7 on performance shall be avoided.
- 8 d) The number of states of protocols and procedures should be minimized.

9 All enhancements included as part of the IEEE 802.16m ammendment should promote the concept of  
10 continued evolution, allowing IEEE 802.16 to maintain competitive performance as technology  
11 advances beyond 802.16m.

### 12 **5.3 Services**

13 IEEE 802.16m should support legacy services more efficiently as well as facilitate the introduction of  
14 new/emerging types of services.

15 IEEE 802.16m and its services architecture shall be flexible in order to support services required for  
16 next generation mobile networks, such as those identified by Report ITU-R M.2072 and IMT-Advanced  
17 (IMT.SERV).

18 IEEE 802.16m shall support different quality of service (QoS) levels for different services. IMT-  
19 Advanced QoS requirements shall be supported including end-to-end latency, throughput, and error  
20 performance.

### 21 **5.4 Operating frequencies**

22 IEEE 802.16m systems shall operate in RF frequencies less than 6 GHz and be deployable in licensed  
23 spectrum allocated to the mobile and fixed broadband services and shall be able to operate in  
24 frequencies identified for IMT-Advanced.

25 An 802.16m compliant system shall meet the following coexistence requirements:

- 26 a) IEEE 802.16m shall be capable of coexisting with other IMT-Advanced technologies.
- 27 b) IEEE 802.16m shall be capable of coexisting with other IMT-2000 technologies.

28 The IEEE 802.16m system should be able to use spectrum flexibly to provide TDD and FDD duplex  
29 modes. The IEEE 802.16m system should be able to aggregate multiple channels in more than one  
30 frequency band within the scope of a single MAC protocol instance.

### 31 **5.5 Operating bandwidths**

32 IEEE 802.16m shall support scalable bandwidths from 5 to 20 MHz. Other bandwidths shall be  
33 considered as necessary to meet operator and ITU-R requirements.

### 34 **5.6 Duplex schemes**

35

1 IEEE 802.16m shall support both Time Division Duplex (TDD) and Frequency Division Duplex (FDD)  
2 operational modes. The FDD mode shall support both full-duplex and half-duplex MS operation.  
3 Specifically, a half-duplex FDD (H-FDD) MS is defined as a MS that is not required to transmit and  
4 receive simultaneously.

5 A BS supporting FDD mode shall be able to simultaneously support half duplex and full duplex  
6 terminals operating on the same RF carrier. The MS supporting FDD mode shall use either H-FDD or  
7 FDD.

8 IEEE 802.16m shall support both unpaired and paired frequency allocations, with fixed duplexing  
9 frequency separations when operating in FDD mode.

10 System performance in the desired bandwidths specified in Section 5.5 should be optimized for both  
11 TDD and FDD independently while retaining as much commonality as possible.

12 The UL/DL ratio should be configurable. In TDD mode, the DL/UL ratio should be adjustable. In the  
13 extreme, the IEEE 802.16m system should be capable of supporting downlink-only configurations on a  
14 given carrier.

15 In FDD mode, the UL and DL channel bandwidths may be different and should be configurable (e.g.  
16 10MHz downlink, 5MHz uplink).

### 17 **5.7 Support of advanced antenna techniques**

18 The IEEE 802.16m standard shall define minimum antenna requirements for the BS and MS. For the BS,  
19 a minimum of two transmit and two receive antennas shall be supported. For the MS, a minimum of one  
20 transmit and two received antennas shall be supported. This minimum is consistent with a 2x2 downlink  
21 configuration and a 1x2 uplink configuration.

22 IEEE 802.16m shall support MIMO and beamforming operation. IEEE 802.16m shall further support  
23 single-user and multi-user MIMO techniques.

### 24 **5.8 Support for government mandates and public safety**

25 IEEE 802.16m shall be able to support public safety first responders, military and emergency services  
26 such as call-prioritization, pre-emption, push-to-talk.

27 802.16 shall support regional regulatory requirements, such as Emergency Services (E9-1-1) [9] and the  
28 Communications Assistance for Law Enforcement Act (CALEA) [10] [11].

## 6.0 Functional requirements

This section contains system level functional requirements targeting higher peak rates, lower latency, lower system overhead as well as PHY/MAC features enabling improved service security, QoS and radio resource management (RRM).

### 6.1 Peak data rate

This section defines the peak data rate achievable between a BS and a MS under ideal conditions.

IEEE 802.16m shall support the peak, expressed as a normalized peak rate (i.e. absolute maximum supported data rate divided by the occupied channel bandwidth) as specified in Table 1.

**Table 1–Normalized peak data rate**

Requirement Type	Link direction	MIMO Configuration	Normalized peak rate (bps/Hz)
Baseline	Downlink	2x2	8.0
	Uplink	1x2	2.8
Target	Downlink	4x4	15.0
	Uplink	2x4	5.6

Notes applicable to Table 1:

- a) The baseline requirement denotes the minimum peak data rate achievable between a BS and an MS equipped with the minimum supported antenna configuration defined in Section 5.7.
  - b) The target requirement denotes the minimum peak data rate achievable between a BS and a MS equipped with a higher order antenna configuration, as specified in Table 1, that exceeds the minimum MS antenna configuration.
  - c) Other MIMO antenna configurations beyond those of Table 1 can be used. For example, the extended uplink requirement for the 2x4 configuration would apply to an uplink 2x2 configuration etc.
  - d) The specified requirements of normalized peak rates are not distinguished by duplex mode. Rather, 100% of available radio resources are assumed – for the purposes of computing Table 1– allocable to downlink and uplink respectively regardless of duplexing mode. For example, for TDD, when assessing downlink performance, all available radio resources are assigned for downlink transmission.
  - e) Table 1 accounts for layer 1 overhead due to provisioning of radio resources for essential functions such as pilots, cyclic-prefix, guard bands and guard intervals.
- a) The specified minimum supported normalized peak rates are applicable to all bandwidths in Section 5.

1 **6.2 Latency**

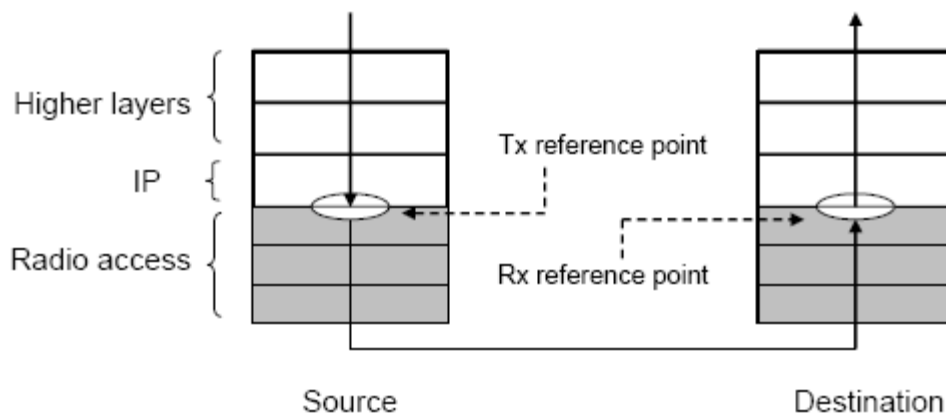
2 Latency should be further reduced as compared to the WirelessMAN-OFDMA Reference System for all  
 3 aspects of the system including the air link, state transition delay, access delay, and handover.

4 The following latency requirements shall be met by the system, under unloaded conditions.

5

6 **6.2.1 Data latency**

7 The data latency is defined in terms of the one-way transit time between a packet being available at the  
 8 IP layer (Tx reference point) in either the MS/ Radio Access Network and the availability of this packet  
 9 at IP layer (Rx reference point) in the Radio Access Network / MS.



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Figure 1 Illustration of reference points for the maximum data latency

Table 2–Maximum data latency

Link direction	Max. latency (ms)
Downlink (BS->MS)	10
Uplink (MS->BS)	10

15  
 16

17 **6.2.2 State transition latency**

18 Performance requirements for state transition delay define the transition from IDLE mode to ACTIVE  
 19 mode.

20 IDLE to ACTIVE\_STATE transition latency is defined as the time it takes for a device to go from an  
 21 idle state (fully authenticated/registered and monitoring the control channel) to when it begins  
 22 exchanging data with the network on a traffic channel measured from the paging indication (i.e. not  
 23 including the paging period).

**Table 3–Maximum state transition latency**

<b>Metric</b>	<b>Max. latency (ms)</b>
IDLE_STATE to ACTIVE_STATE	100 ms

### 6.2.3 Handover interruption time

This section addresses handover performance requirements, and specifically the interruption times applicable to handovers between 802.16m BSs for intra- and inter-frequency handover.

The maximum handover interruption times specified in Table 4 apply to handover of IEEE 802.16m MSs between IEEE 802.16m BSs operating in the absence of legacy MSs under normal operating conditions.

The handover interruption time represents the time duration that a MS cannot receive service from any BS during a handover.

**Table 4–Maximum handover interruption**

<b>Handover type</b>	<b>Max. interruption time (ms)</b>
Intra-frequency	30
Inter-frequency	100

## 6.3 QoS

IEEE 802.16m shall support QoS classes, enabling an optimal matching of service, application and protocol requirements (including higher layer signaling) to radio access network (RAN) resources and radio characteristics. This includes enabling new applications such as interactive gaming [5].

IEEE 802.16m shall provide support for preserving QoS during handover with other RATs when it is feasible.

## 6.4 Radio resource management

IEEE 802.16m shall enable the advanced RRM for efficient utilization on radio resources. This may be achieved by appropriate measurement/reporting, interference management and flexible resource allocation mechanisms.

### 6.4.1 Reporting

IEEE 802.16m shall enable advanced RRM by enabling the collection of reliable statistics over different timescales, including system (e.g. dropped call statistics, BS loading condition, channel occupancy), user (e.g. terminal capabilities, mobility statistics, and battery life), flow, packet, etc.

## 1 **6.4.2 Interference management**

2 IEEE 802.16m shall support interference mitigation schemes.

3 IEEE 802.16m shall support flexible frequency re-use schemes.

## 4

## 5 **6.5 Security**

6 IEEE 802.16m shall include a security function which provides the necessary means to achieve:

- 7 • protection of the integrity of the system (e.g. system access, stability and availability)
- 8 • protection and confidentiality of user-generated traffic and user-related data (e.g. location
- 9 privacy, user identity)
- 10 • secure access to, secure provisioning and availability of services provided by the system

11 The impact of security procedures on the performance of other system procedures, such as handover

12 procedures, shall be minimized.

13 The security function should be self-contained and capable of maintaining security without relying on

14 specific behaviors on the part of algorithms/protocols at any other functions or layers outside the

15 security function. Such dependencies, if and when necessary, shall be explicitly specified.

## 16

## 17 **6.6 Handover**

18 IEEE802.16m shall support handover within and between all cell types in an IEEE802.16m system.

19 IEEE802.16m shall provide handover with WirelessMAN-OFDMA Reference systems.

20 IEEE 802.16m shall provide support for handover with other RATs. However, an IEEE 802.16m MS is

21 not required to be multi-mode.

22 IEEE802.16m shall provide service continuity during handover for both inter-RAT and intra-RAT

23 handover.

24 IEEE 802.16m should support IEEE 802.21 Media Independent Handover (MIH) Services.

25 Mobility procedures should be fully compatible with the IEEE 802.16 Network Control and

26 Management Services (NCMS).

## 27

## 28 **6.7 Enhanced multicast broadcast service**

29 IEEE 802.16m shall provide support for an enhanced multicast broadcast service (E-MBS), providing

30 enhanced multicast and broadcast spectral efficiency (Section 7).

31 IEEE 802.16m shall support E-MBS delivery via a dedicated carrier.

32 IEEE 802.16m shall support switching between broadcast and unicast services, including the case when

33 broadcast and unicast services are deployed on different frequencies.

34

### 6.7.1 MBS channel reselection delay and interruption times

E-MBS functionality defined as part of IEEE 802.16m shall support the following requirements for maximum MBS channel change interruption times when applied to broadcast streaming media.

**Table 5–MBS channel reselection maximum interruption times**

MBS channel reselection mode	Max. interruption time (s)
Intra-frequency	1.0
Inter-frequency	1.5

Note that requirements of Table 5 apply to the interruption time between terminating delivery of MAC PDU's from a first MBS service to the MAC layer of the MS, and the time of commencement of delivery of MAC PDU's from a second MBS service to the MS MAC layer.

### 6.8 Location based services (LBS)

IEEE 802.16m shall provide support for high resolution location determination.

### 6.9 Reduction of user overhead

IEEE 802.16m shall provide improved mechanisms for reducing overhead as compared to the WirelessMAN-OFDMA Reference System in the bearer stream associated with headers of higher layer protocols.

### 6.10 System overhead

Overhead, including overhead for control signaling as well as overhead related to bearer data transfer, for all applications shall be reduced as far as feasible without compromising overall performance and ensuring proper support of systems features.

### 6.11 Enhanced power saving

The 802.16m draft shall provide support for enhanced power saving functionality to help reduce power consumption in devices for all services and applications.

### 6.12 Multi-RAT operation

IEEE 802.16m shall support interworking functionality to allow efficient handover to other radio access technologies. Those of interest include:

- IEEE 802.11
- 3GPP GSM/EDGE, UTRA (FDD and TDD) and E-UTRA (FDD and TDD)
- 3GPP2 CDMA2000

## 7.0 Performance requirements

The performance requirements are specified in terms of absolute performance and relative performance with respect to that of the WirelessMAN-OFDMA Reference System. The performance metrics will be evaluated per the baseline configuration and baseline system assumptions detailed in the evaluation methodology document.

For relative performance requirement, this performance goals are specified in terms of spectral efficiency performance relative to WirelessMAN-OFDMA Reference System using 2 transmit and 2 receive antennas at the BS and 1 transmit and 2 receive antennas at the MS..

Typical overhead as defined in the evaluation methodology shall be accounted for when evaluating the performance.

Performance metrics are as specified in the evaluation methodology document..

The performance requirements shall be met without inclusion of the relay stations.

### 7.1 User throughput

#### 7.1.1 Relative performance

The targets for average user-throughput and cell-edge user throughput of downlink/uplink for data only system for baseline antenna configuration are shown in Table 6. Both targets should be achieved relative to WirelessMAN-OFDMA Reference System performance as per antenna configuration defined above.

**Table 6–Data only system**

Metric	Relative throughput	
	DL data (xWirelessMAN-OFDMA Reference System )	UL data (xWirelessMAN-OFDMA Reference System )
Average user throughput	> 2x	>2x
Cell edge user throughput	> 2x	>2x

#### 7.1.2 Absolute performance

The targets for average user-throughput and cell-edge user throughput of downlink/uplink for data only system for baseline antenna configuration are shown in Table 7.



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**Table 7. Absolute throughput of data only system**

Metric	DL data (bits/second/Hz)	UL data (bits/second/Hz)
Average user throughput	TBD	TBD
Cell edge user throughput	TBD	TBD

**7.2 Sector throughput and VoIP capacity**

Sector throughput is as defined in the evaluation methodology. It is the total unidirectional sustained throughput (downlink/uplink), excluding MAC & PHY layer overheads, across all users scheduled on the same RF channel. Sector throughput requirements must be supported for user distributions defined in the 16m evaluation methodology in a fully loaded cell surrounded by other fully loaded cells using the same RF channel (i.e. an interference limited environment with full frequency reuse).

**7.2.1 Relative sector throughput and VoIP capacity**

**Table 8–Relative sector throughput (bps/Hz/sector)**

Speed (km/h)	DL	UL
TBD	>2x	>2x

**Table 9–Relative VoIP capacity**

Speed (km/h)	Capacity (Active users/MHz/sector)
TBD	>1.5x

**7.2.2 Absolute sector throughput and VoIP capacity**

**Table 10–Sector throughput (bps/Hz/sector)**

Speed (km/h)	DL	UL
TBD	TBD	TBD

**Table 11–VoIP capacity**

Speed (km/h)	Capacity (Active Users/MHz/sector)

TBD	> 60 (FDD)
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VoIP capacity assumes a 12.2 kbps codec with a 40% activity factor such that the percentage of users in outage is less than 3% where a user is defined to have experienced a voice outage if less than 97% of the VoIP packets have been delivered successfully to the user within a delay bound of 50 ms.

The packet delay is defined based on the 97 percentile of the CDF of all individual users 97 packet delay percentiles (i.e., first for each user the 97 percentile of the packet delay CDF is determined then the 97 percentile of the CDF that describes the distribution of the individual user delay percentiles is obtained).

### 7.3 Mobility

Mobility shall be supported across the IEEE 802.16m network. IEEE 802.16m shall be optimized for low speeds such as mobility classes from stationary to pedestrian and provide high performance for higher mobility classes. The performance shall be degraded gracefully at the highest mobility. In addition, the IEEE 802.16m shall support maintaining the connection up to the highest supported speed.

Table 12 summarizes the mobility performance.

**Table 12–Mobility support**

Mobility	Performance
Stationary, Pedestrian 0 - 10 km/h	Optimized
Vehicular 10 - 120 km/h	Marginal degradation
High Speed Vehicular 120 - 350 km/h	System should be able to maintain connection

Vehicular speeds in excess of 350 km/h and up to 500 km/h may be considered depending on frequency band and deployment.

### 7.4 Cell coverage

IEEE 802.16m shall provide significantly improved coverage with respect to the WirelessMAN-OFDMA Reference System.

Based on the same configuration, the link budget of the limiting link (e.g. DL MAP, UL bearer) of IEEE 802.16m shall be improved by at least 3 dB compared to the WirelessMAN-OFDMA Reference System.

IEEE 802.16m shall support legacy cell sizes allowing for co-location of IEEE 802.16e deployments.

Support for larger cell sizes should not compromise the performance of smaller cells. It is also required to support increased number of simultaneous users and enhanced user penetration rates. Specifically, IEEE 802.16m shall support the deployment scenarios captured in Table 13 in terms of maximum cell range.

IEEE 802.16m should be sufficiently flexible to support a variety of coverage scenarios for which the performance targets of Sections 6 and 7 should be met. Reference scenarios shall be defined that are representative of current WIRELESSMAN-OFDMA Reference System deployments.

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2 Note that cell coverage is calculated based on both control channel and traffic channel coverage in the  
3 uplink and downlink.

4

**Table 13–Deployment scenarios**

Cell range	Performance target
Up to 5 km	Optimized Performance targets defined in Sections 7.1-7.3 should be met
5-30 km	Graceful degradation in system/edge spectral efficiency
30-100 km	System should be functional (thermal noise limited scenario)

5

## 6 **7.5 Enhanced multicast-broadcast service**

7 As outlined in Section 6, IEEE 802.16m shall support enhanced multicast-broadcast service for IMT-  
8 Advanced multimedia multicast broadcast services in a spectrally efficient manner.

9 The IEEE 802.16m enhanced multicast-broadcast service may support large cells (e.g. 50 km).

10 Minimum performance requirements for E-MBS, expressed in terms of spectral efficiency over 95%  
11 coverage area, appear in Table 14.

12

13

**Table 14–MBS minimum spectral efficiency vs. inter-site distance**

Inter-site distance (km)	Min. spectral efficiency (bps/Hz)
0.5	4
1.5	2

14

15 The following notes apply to Table 14:

16 1. The performance requirements apply to a wide-area multi-cell multicast broadcast single  
17 frequency network (MBSFN).

18 2. The specified spectral efficiencies neglect overhead due to ancillary functions (such as  
19 synchronization and common control channel) and apply to both mixed unicast-broadcast and  
20 dedicated MBS carriers, where the performance is scalable with carrier frequency bandwidth.

21

## 22 **7.6 Location-based services performance**

23 IEEE 802.16m systems (this may include MS, BS, or both depending on the solution) should provide  
24 support for LBS. IEEE 802.16m systems should satisfy the requirements in Table 15.

1 **Table 15–Location-based service requirements**

Feature	Requirement	Comments
Location determination latency	< 30 s	
Handset-based position accuracy (in meters)	50m (67% of the time) – 150m (95% of the time)	Need to meet E911 Phase II Requirements
Network-based position accuracy (in meters)	100m (67% of the time) – 300m (95% of the time)	

2

3 **8.0 Operational requirements**

4

5 **8.1 Support for multi-hop relay**

6 IEEE 802.16m should provide mechanisms to enable multi-hop relays.

7

8 **8.2 Synchronization**

9 The system shall support the ability to synchronize frame timing and frame counters across the entire  
10 system deployed in a given geographic area, including synchronization among all BSs and MSs  
11 operating on the same or on different carrier frequencies and among neighboring IEEE 802.16m systems,  
12 whether operated by the same operator or not. The requirement for frame timing synchronization is key  
13 to coexistence of TDD systems and would be useful, but not essential, for FDD systems as well.

14 **8.3 Co-deployment with other networks**

15

16 **8.3.1 Co-deployment requirements**

17 It is envisioned that the IEEE 802.16m can be deployed in the same or overlapping geographical areas  
18 with other wireless networks based on different RAT (Radio Access Technologies). They may or may  
19 not have the same network topology. Moreover, it is anticipated that IEEE 802.16m is to be deployed in  
20 the same (on a co-channel and no co-channel basis) or adjacent RF bands as non IEEE 802.16m legacy  
21 networks. For instance, these non-802.16 networks may operate in the adjacent licensed frequency bands  
22 such as CDMA2000, 3GPP (e.g., GSM, UMTS, HSDPA/HSUPA, LTE), in unlicensed bands such as  
23 802.11x networks, or in the same frequency band on an adjacent carrier such as TD-SCDMA. The  
24 802.16m standard shall provide a method whereby coexistence of networks specified on the basis of the  
25 IEEE 802.16m amendment with these networks as well as other IEEE 802.16 networks can be achieved  
26 from the perspective of being both an interferer and being a victim depending on the coexistence  
27 scenarios of section 8.3.2

### 1 **8.3.2 Coexistence scenarios**

2 Depending on the bands allocated for the IMT Advanced systems, different coexistence scenarios  
3 requirements (due to unknown outcome of WRC 2007) should be envisaged for IEEE 802.16m based  
4 system:

- 5 1. 802.16m and non 802.16m systems have primary access in the band (licensed). Spectrum  
6 sharing cannot be enabled on a short term basis between a 802.16m system and other 802.16m  
7 or non 802.16m systems.
- 8 2. 802.16m and non 802.16m systems have primary access in the band (licensed). Spectrum  
9 sharing can be enabled on a short term basis between a 802.16m system and other 802.16m or  
10 non 802.16m systems.
- 11 3. 802.16m has secondary access in the band of some other non 802.16m primary systems:
  - 12 a. On a non co-channel basis/coordinated or non coordinated
  - 13 b. On a co-channel basis/coordinated on non coordinated

## 1 **Annex A: Usage models (informative)**

2  
3 IEEE 802.16m should support a wide range of deployment scenarios and usage models including a)  
4 those considered during formulation of the existing standards and b) as envisioned by IMT-Advanced  
5 requirements. The examples provided in this section are informative only.

6 IEEE 802.16m should support different usage models. More specifically, it should cover (but not be  
7 restricted to):

- 8 1) Higher data rates and improved performance (compared to WirelessMAN-OFDMA  
9 Reference System) in legacy cell sizes (of several kilometers radius).
- 10 2) Very high data rates in smaller cells
- 11 3) High mobility optimized scenarios
- 12 4) Deployment with Multi-hop Relay Networks
- 13 5) Co-Deployment with Other Networks
- 14 6) Provision for PAN/LAN/WAN Collocation / Coexistence

15 This section is informative only. It includes service and application scenarios and deployment scenarios.  
16 The deployment scenarios described in the following sections include topologies networks and  
17 frequency reuse schemes where 802.16m terminals and BSs are exclusively used, where a mix of  
18 802.16m and 802.16e (migration from legacy to new systems), a scenario where fixed and mobile relay  
19 stations (used for coverage and throughput enhancements) are used and a scenario optimized for high  
20 mobility. It also describes deployments with other systems.

### 22 **A.1 Service and application scenarios**

23 The types of services that can be provided by IEEE802.16m-based packet-switched network can  
24 include:

- 25 • Voice services (e.g. VoIP and conference call)
- 26 • Data services (e.g., Email, IMS, web browsing, file transfer, internet gaming, white boarding)
- 27 • Multimedia services (e.g., Audio and/or video streaming, broadcast, interactive conferencing)

28 To meet IMT-Advanced requirements, IEEE 802.16m may also support new services, new features, and  
29 new devices. For example, real-time gaming or real-time video streaming service over high definition  
30 screens may be a typical service in the future. High priority E-commerce, telemetric,  
31 Broadcast/Multicast for TV, news, and advertisement over the handheld may be popular services as well.

## 1 **A.2 Deployment scenarios**

2  
3 The IEEE 802.16m RAT should be suitable for deployment in a number of propagation environments  
4 including

- 5 • Outdoor environments including outdoor-to-indoor environments (e.g., rural, urban, suburban)
- 6 • Indoor environments (e.g., hot-spot, overlay for improved coverage and/or capacity)

7 The end users in an IEEE802.16m-based network also should be supportable with different levels of  
8 mobility including

- 9 • Fixed/Stationary (e.g., CPE with fixed antenna)
- 10 • Pedestrian or quasi-static (e.g., portable devices)
- 11 • Mobile (e.g., handsets)
- 12 • High mobility

### 13 14 **A.2.1 Frequency reuse**

15 In the usage model example of cellular networks, a network coverage area can be served by a number of  
16 BSs each of which may further contain a certain number of sectors. For areas that need enhanced  
17 coverage or require additional throughput, flexible frequency reuse schemes can be employed. The  
18 frequency reuse scheme should allow for both hard reuse and soft reuse, where soft reuse refers the case  
19 where the power on some of the tones is reduced rather than not used. IEEE 802.16m should allow for  
20 adaptive frequency reuse schemes, which enable frequency reuse when; e.g., coverage improvement is  
21 necessary.

22 IEEE 802.16m should support the flexibility of applying different reuse patterns in different zones. For  
23 example, the MBS can employ reuse 1 pattern, while other unicast services can employ another reuse  
24 pattern.

25 In the consideration of the frequency reuse planning, the resulting system signal to interference ratio  
26 should be maintained to satisfy the minimum system performance requirement and this interference  
27 should include all co-channel and adjacent channel interferences resulting from the same system and  
28 from other co-existing systems.

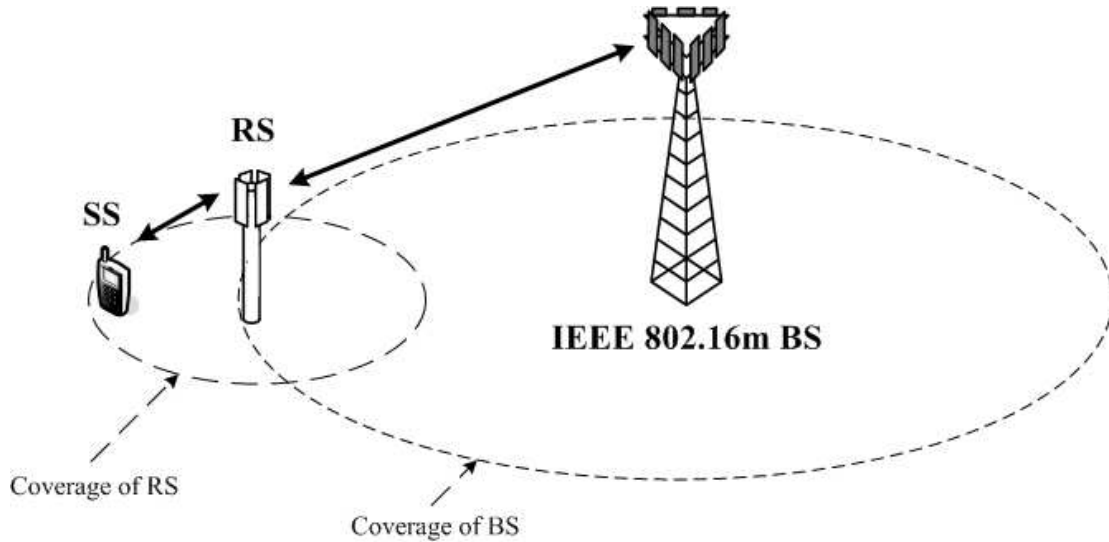
29 In an IEEE 802.16m system different frequency reuse patterns may be used in every BS.

### 30 **A.2.2 Deployment with multi-hop relay networks**

31 IEEE 802.16m aims to develop an air interface providing high transmission rate as specified in the IMT-  
32 Advanced requirements. The target transmission rate is much higher than that defined in the IEEE  
33 802.16e standard. Cost effective provisioning of high data rate coverage over a wide area as well as to  
34 avoid coverage holes in the deployment areas are important deployment requirements. Intelligent relays  
35 are an effective technology to achieve those goals with lower investment costs and lower operational  
36 costs. In addition, upgrading the networks in order to support higher data rates is equivalent to an  
37 increase of signal-to-interference plus noise ratio (SINR) at the receivers' front-end. Also, through  
38 deployment the network providers have to avoid coverage area holes.

1 A traditional solution to increase the receiver's SINR is to deploy additional BSs or repeaters to serve  
2 the coverage area holes with required data rates. Unfortunately, the cost of BS is high and the wire-line  
3 backhaul may not be available everywhere. On the other hand, repeater has the problem of amplifying  
4 the interference and has no intelligence of signal control and processing. In order to achieve a more cost-  
5 effective solution, relay stations (RS) capable of decode and forward the signals from source to  
6 destination through radio interface. Here, RSs do not need a wire-line backhaul; the deployment cost of  
7 RSs is expected to be much lower than the cost of BSs. The system performance could be further  
8 improved by the intelligent resource scheduling and cooperative transmission in systems employing  
9 intelligent relays.

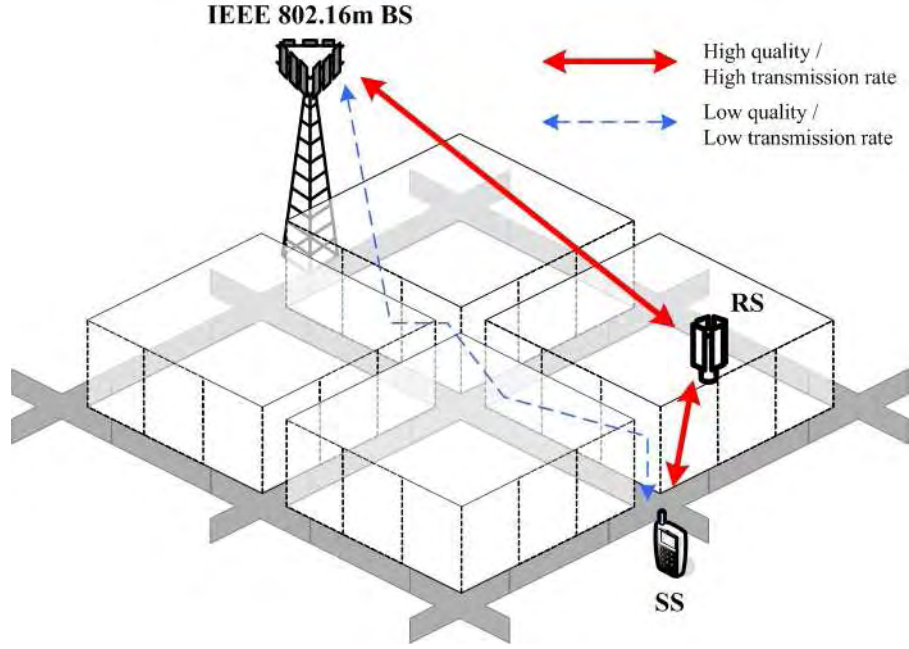
10 Deploying RS can improve IEEE 802.16m network in different dimensions. The following figures  
11 illustrate the different benefits can be achieved by deploying RS in IEEE802.16m network.



12 **Figure 2–Coverage extension by deploying RS in a IEEE 802.16m network**

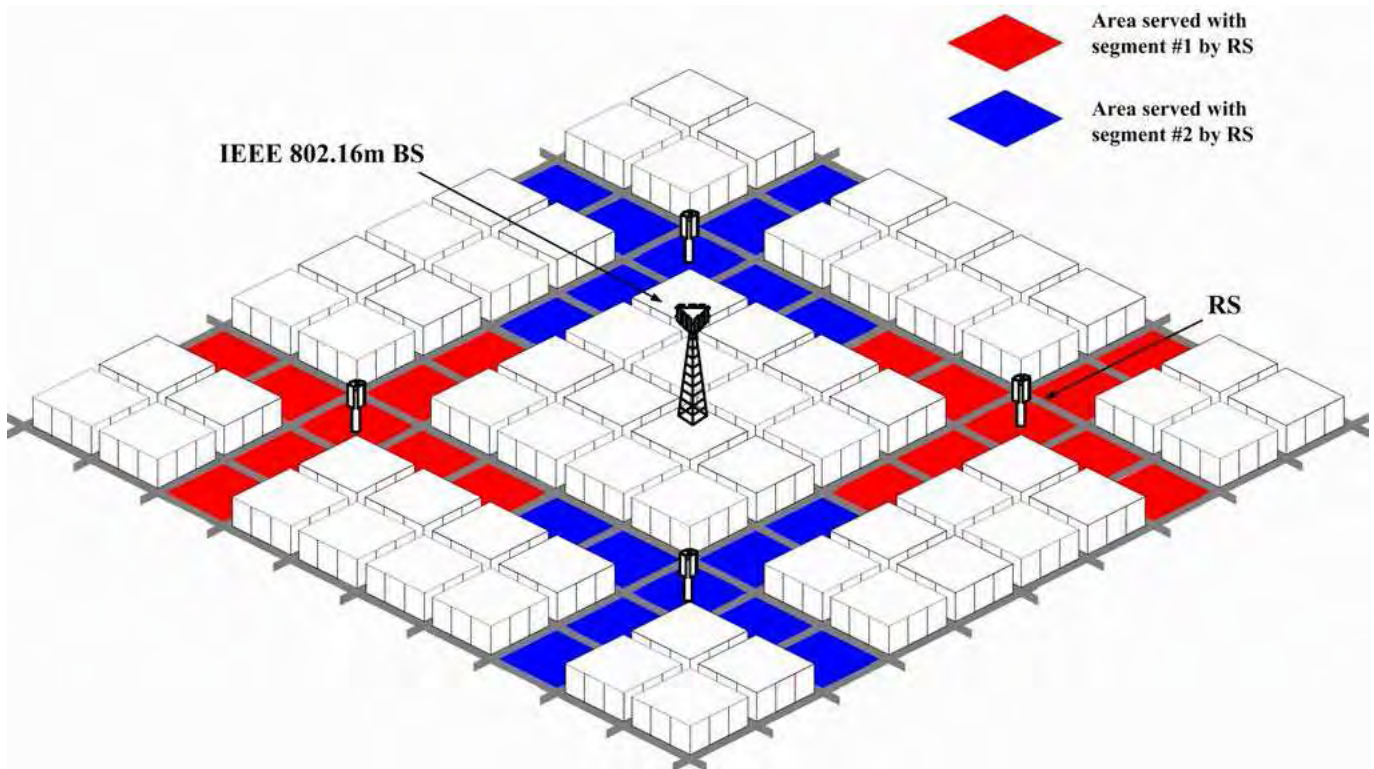
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Figure 3—Deploying RS can enhance transmission rate for the SS located in shaded area or cell boundary



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Figure 4—More aggressive radio resource reuse by deploying RS in IEEE 802.16m network

1 **A.2.3 High mobility optimized scenario**

2 IEEE802.16m should provide services to high-speed users. In this scenario, the speed of the MSs is  
3 usually higher than 120 km/h and can be up to 350 km/h. The MSs may experience large penetration  
4 loss. The service environment may change dynamically and rapidly. The air interface may be optimized  
5 for high-speed users.

6 **A.2.4 Provision for PAN/LAN/WAN collocation / coexistence**

7 As a provision for proper operation of various wireless access technologies on multi-radio terminals,  
8 IEEE 802.16m should provide methods to mitigate interference from other wireless radios on the same  
9 (collocated) device given minimum adjacent channel isolation. As a result, an IEEE 802.16m radio will  
10 not suffer from interference from other wireless devices, or cause destructive interference to other  
11 wireless devices. Currently, Wi-Fi and Bluetooth radios are likely to coexist/collocate with an IEEE  
12 802.16m radio.

13

14