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Abstract	This contribution introduces requirements to 802.16m for discussion.	
Purpose	This document introduces a 802.16m requirements	
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Requirements for 802.16m

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1. Introduction

IEEE 802.16m amends the IEEE 802.16 WirelessMAN-OFDMA specification to provide an advanced air interface for operation in licensed bands. It will meet the cellular layer requirements of IMT-Advanced next generation mobile networks [1]. It will be designed to provide significantly improved performance compared to other high rate broadband cellular network systems. For the next generation mobile networks, it is important to consider increasing peak, sustained data rates, corresponding spectral efficiencies, system capacity and cell coverage as well as decreasing latency and providing Quality-of-Service while carefully considering overall system complexity.

1.1 System performance of systems in legacy spectrum

The following table shows system performance of current system or candidate for IMT-2000.

	Carrier frequency	Bandwidth	Duplex	Peak data rate		Spectral efficiency	
				DL	UL	DL	UL
3GPP WCDMA (HSPA)	2GHz	5 MHz	FDD	14Mbps @ 5MHz	5.8Mbps @ 5MHz	0.8bps/Hz	0.3bps/Hz
3GPP2 CDMA2000 (1xEVDO-RevB)	2GHz	1.25MHz (15 channel/ max 5MHz)	FDD	3.1Mbps @ 1.25MHz	1.8Mbps @ 1.25MHz	1bps/Hz	0.3bps/Hz
IEEE 802.16 WiMAX [2]	2.5GHz	5, 7, 8.75, 10 MHz	TDD	46Mbps* / 32Mbps** @ 10MHz	8Mbps* /14Mbps** @ 10MHz	1.9bps/Hz *	0.8bps/Hz *

Table 1. system performance for IMT-2000, * : DL/UL = 3, ** : DL/UL = 1, all for 2x2 MIMO or CSM

Table 2 shows system requirements for ongoing projects for beyond IMT-2000 broadband wireless communication systems.

	Bandwidth (MHz)	Duplex	Peak data rate		Spectral efficiency		Mobility support
			DL	UL	DL	UL	
3GPP LTE [3]	[1.25],[1.6],2.5,5,10, 15,20	TDD/ FDD	100Mbps @ 20MHz	50Mbps @ 20MHz	3~4 times Better than WCDMA	2~3 times Better than WCDMA	~350km/h
3GPP2 UMB[4]	~20(in 1.25MHz block)	FDD	500Mbps @ 20MHz	150Mbps @ 20MHz	Outdoor high speed user 3bps/Hz/Sector	Outdoor high speed user 1bps/Hz/Sector	~350km/h
IEEE 802.20 [5]	1.25,5, 10,15,20	FDD	18Mbps @ 5MHz	9Mbps @ 5MHz	3km/h 2bps/Hz/Sector 120km/h 1.5bps/Hz/Sector	3km/h 1bps/Hz/Sector 120km/h 0.75bps/Hz/Sector	~250km/h
	2.5,5,10, 20,30,40	TDD					

Table 2. system requirement for beyond IMT-2000

2. 802.16m requirements

Since IEEE 802.16m shall meet the cellular layer requirements of IMT-Advanced next generation mobile networks, it is important to understand what kinds of features and technologies are required for the IMT-Advanced.

2.1 Key features of IMT-Advanced

As identified in various documents including ITU-R M.1645, IMT-Advanced can be as following:

- High degree of commonality of design worldwide
- Compatibility of services within IMT-Advanced and with the fixed networks
- High quality
- Small terminal suitable for worldwide use
- Worldwide roaming capability
- Capability for multimedia applications within a wide range of services and terminals

Systems beyond IMT-2000, for which there may be a need for a new wireless access technology to be developed around the year 2010, capable of supporting high data rates with high mobility. High mobility here covers high speed on highways or fast trains (60km/h to 250km/h, or more.) It is predicted that potential new radio interfaces will need to support data rates of up to approximately 100Mbps for high mobility such as mobile access and up to approximately 1Gbps for low mobility such as nomadic/local wireless access, by around the year 2010. [6]

2.2 Key technologies of IMT-Advanced

Key technologies of IMT-Advanced can be listed as below [6]:

1. System related technologies
- Voice over IP (VoIP)
- Optimization of IP,
- Fault-tolerant network architecture
- Mobile platform technology
- Security and privacy
- Cryptography
- Authentication and mobile electronic commerce
- Billing
- Intelligent data filtering

2. Access network and radio interface
- Modulation and coding schemes
- Multiple access schemes
- Adaptive radio interface
- New antenna concepts and technologies
- Handover between different radio interfaces (vertical and horizontal)
- Dynamic QoS control

3. Utilization of spectrum
- Multiple Input Multiple Output (MIMO)
- Adaptive antennas
- Adaptive dynamic channel assignment
- Spectrum sharing

2.3 802.16m Requirements

2.3.1 General Requirements

- IEEE 802.16m architecture shall be flexible to support required services from ITU-R.
- IEEE 802.16m system shall support different cell sizes which are expected for cellular layer systems.
- IEEE 802.16m system shall provide seamless interworking with legacy radio access systems including legacy 802.16 systems.
- IEEE 802.16m shall provide high spectral efficiency up to 10bps/Hz. In order to provide high spectral efficiency, IEEE 802.16m system shall support key technologies of IMT-Advanced.

- Required QoS for IMT-Advanced shall be provided including end-to-end latency, throughput, and error performance.
- IEEE 802.16m system shall provide powerful and efficient security mechanism to protect network, system, and user.

2.3.2 System Requirements

2.3.2.1 Air Interface Requirement

IEEE 802.16m specification shall meet the following performance requirement.

Characteristic		Requirement
Peak Data Rate	Downlink	1Gbps @ Nomadic 100Mbps @ High mobility
	Uplink	TBD
Expected spectral efficiency	Micro cell (DL/UL)	TBD
	Macro cell (DL/UL)	TBD
Bandwidth		Scalable bandwidth including 5, 7, 8.75, 10 MHz
Center frequency		Frequency is expected to be decided in WRC07

Table 3. Proposed air interface requirement for IEEE 802.16m

2.3.2.2 QoS requirements

IMT-Advanced system shall support the MAC level QoS to meet the end user QoS requirements for the various applications. The system should support the following types of services with different data rates, delay, and packet error rates.

- Conversational/Real-time Services
- Streaming Services
- Interactive Services
- Background Services

The system should realize low-delay and highly reliable radio transmission using error control techniques, and enable flexible allocation of radio resources depending on the required QoS. Minimizing the system latency under various conditions (e.g. handover, re-entry from Idle Mode, and packet transmission) should be required.

Table 4 shows the QoS classes and profiles for the IMT-Advanced system into Conversational, Streaming, Interactive and Background [8]. Table 4 shows an example of parameters. Parameters shall be considered and values shall be decided for 802.16m requirements.

Table 4. QoS Classes and Profiles

Traffic Class	Conversational	Streaming	Interactive	Background
Fundamental Characteristics	Preserve time relation (variation) between information entities of the stream Conversa-tional pattern (stringent and low delay)	Preserve time relation (variation) between information entities of stream	Request response pattern Preserve payload content	Destination is not expecting the data within a certain time Preserve payload content
Example of the Application	Voice	Streaming Video	Web browsing	Background download of email
Allowed delay	< 150ms(high quality) < 400ms(minimum)	< 10 sec(initial delay)	< 4sec/page	unspecified
Allowed error rate	< 3%(frame error rate)	< 2%(packet loss rate)	0%	0%
Maximum Bitrate	Very low rate Data: ≤ 16 kbps Low rate Data & Low Multimedia: ≤ 144 kbps Medium multimedia: ≤ 2 Mbps High multimedia: ≤ 30 Mbps Super high multimedia: 30 Mbps ~ 100 Mbps / 1 Gbps			
Transfer Delay (ms)	100 ~ m*aximum value*	280 ~ m*aximum value*		

The characteristics and examples of the above mentioned QoS classes are as described below.

- The Conversational class means the traffic communicated in real time, which is sensitive in delay or jitter. This traffic class includes Voice over IP.
- The Streaming class means the traffic occurring when the user receives the video and audio service in real time. This traffic class is sensitive to delay or jitter.
- The Interactive class means the traffic occurring when the user requests and receives data to/from the server. This traffic class includes web browsing.
- The Background class shows the typical best effort characteristics. No transmission delay is considered when transmitting data in this class. It has very low data packet transmission error rate. This traffic class includes email, SMS and file downloading.

The following parameters are used to classify QoS.

- Maximum bit rate (kbps): The number of bits transmitted from/to the IMT-Advanced system for certain period of time.
- Allowed delay: The delay that meets QoS of the service
- Allowed error rate: The error rate that meets QoS of the service

2.3.2.3 Security requirements

Requirements for Secrecy and Privacy

- More powerful, enhanced (high-speed/small-size and low-power) confidentiality and integrity protection for traffic transmission, control information
- More efficient, robust user/device authentication scheme
- Location privacy scheme

- Reliable and flexible service availability protection scheme

Requirements for Inter-working Security
- Delay constrained handover and roaming support without changing the security level (Especially, seamless mobility across heterogeneous networks with the negotiation of security mechanisms/algorithms)
- Minimum performance/capacity degradation due to the security feature provisioning

Reference

[1] P802.16m PAR
[2] WiMAX Forum, 2006, “Mobile WiMAX – Part I: A Technical Overview and Performance Evaluation.”
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[6] Rec. ITU-R M.1645, 2003, “Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000.”
[7] 3GPP & 3GPP2 Spatial Channel Model AHG, SCM Text V7.0, “Spatial Channel Model Text Description.”
[8] TTA IMT-Advanced requirements