

## Radiocommunication Study Groups



**\*\*\* DRAFT \*\*\***

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**TECHNOLOGY**

**\*\*\* DRAFT \*\*\***

### **Institute of Electrical and Electronics Engineers (IEEE)**

#### **UPDATED MATERIAL ON IMT-2000 OFDMA TDD WMAN FOR REVISION 9 OF RECOMMENDATION ITU-R M.1457**

#### **1 Source information**

This contribution was developed by IEEE Project 802®, the Local and Metropolitan Area Network Standards Committee (“IEEE 802”), an international standards development committee organized under the IEEE and the IEEE Standards Association (“IEEE-SA”).

[The content herein was prepared by a group of technical experts in IEEE 802 and industry and was approved for submission by the IEEE 802.16™ Working Group on Wireless Metropolitan Area Networks, the IEEE 802.18 Radio Regulatory Technical Advisory Group, and the IEEE 802 Executive Committee, in accordance with the IEEE 802 policies and procedures, and represents the view of IEEE 802.]

#### **2 Discussion**

Following Documents 5D/122 and 5D/246, this contribution contains updated material on IMT-2000 OFDMA TDD WMAN for Revision 9 of Recommendation ITU-R M.1457 in line with Circular Letter 8/LCCE/95 and the schedule received from ITU-R WP 5D ([IEEE L802.16-08/003](#)). This material represents the update for approval at the final (“X+2”) meeting addressing the development of Revision 9.

In particular, the material required as specified in the update procedure for revisions of Recommendation ITU-R M.1457 (8/LCCE/95) is addressed in the following annexes:

[Annex 1](#): Update of Section 5.6.2

[Annex 2](#): Modifications to Section 5.6.1

[Annex 3](#): Updated GCS

[Annex 4](#): Summary and rationale of the proposed update

[Annex 5](#): Self-evaluation of the proposed update against the evaluation criteria (identical to Annex 5 of 5D/246)

[Annex 6](#): Self-declaration that the proposed amendments are self-consistent between Section 5.6.1, Section 5.6.2, and the GCS.

### **3 Proposal**

We propose that the amendments shown in the electronic attachments in Annexes 1, 2, and 3 be agreed for incorporation in Revision 9 of M.1457.

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## **Annex 1**

### **Update of Section 5.6.2**

The content of the [electronic attachment](#) is to replace Section 5.6.2 of Rec. ITU-R M.1457-8.

## **Annex 2**

### **Modifications to Section 5.6.1**

The modified content of Section 5.6.1 is specified in the relevant attachment to 5D/327, the Chairman's Report of the third meeting of Working Party 5D. The attachment is based on Revision 1 to Document 5D/TEMP/120.

## **Annex 3**

### **Updated GCS**

The updated set of the Global Core Specifications (GCS) for IMT-2000 OFDMA TDD WMAN will be provided separately per established procedures.

## **Annex 4**

### **Summary and rationale of the proposed update**

The main purpose of this update is to align Recommendation ITU-R M.1457 to the most updated versions of the specifications underlying the radio interface IMT-2000 OFDMA TDD WMAN. Furthermore, alignment is made by incorporating the FDD mode of IEEE Std 802.16. The main enhancements are in VoIP capacity, MIMO, load balancing, and handover latency.

Note that this proposal is aligned with the Circular Letter 8/LCCE/95 position that:

*New radio technologies are always encouraged; however, they **should be directed towards the enhancement of the existing IMT-2000 radio interfaces, rather than the creation of a new radio interface.** This will support one of the ITU primary goals of minimizing the number of different radio interfaces and maximizing their commonality, while incorporating the best possible performance capabilities in the various IMT-2000 radio operating environments.*

Accordingly, the proposal does not introduce a new radio interface but updates an existing one. The proposed FDD enhancement is very closely intertwined with the existing OFDMA TDD WMAN radio interface. In fact, IEEE Std 802.16 has included both TDD and FDD modes in a common

framework for many years. TDD and FDD are not two different radio interfaces but simply two distinct modes of the same radio interface, depending on the available spectrum.

## Annex 5

### Self-evaluation of the proposed update against the evaluation criteria

The self-evaluation of the “total” radio interface update of IMT-2000 OFDMA TDD WMAN has been made against all evaluation criteria listed in the update procedure contained in Circular Letter 8/LCCE/95. The results are that the proposed updates meet the evaluation criteria as follows:

#### 7.1 “The Evaluation criteria” (Section 7.1 in Circular Letter 8/LCCE/95)

The “requirements and objectives of IMT-2000” and the “Minimum performance capabilities for IMT-2000” as per Attachments 4 and 6 of Circular Letter 8/LCCE/47 were considered. The values included in Circular Letter 8/LCCE/47 were used. The proposed update consists of enhancements to the existing IMT-2000 OFDMA TDD WMAN radio interface. The evaluation of the proposed update was done in the context of the “total” radio interface. As shown in the tables below, the conclusion is that the IMT-2000 OFDMA TDD WMAN radio interfaces with the proposed enhancements continues to meet all evaluation criteria in “Requirements and objectives of IMT-2000” and “Minimum performance capabilities for IMT-2000”.

TABLE 1  
**Requirements and Objectives Relevant to the Evaluation of  
Candidate Radio Transmission Technologies**

IMT-2000 Item Description	Obj/Req	Source	Meets
<b>Voice and data performance requirements</b>			
1. One-way end to end delay less than 40 ms	Req	G.174, § 7.5	Yes
2. For mobile videotelephony services, the IMT-2000 terrestrial component should operate so that the maximum overall delay (as defined in ITU-T Recommendation F.720) should not exceed 400 ms, with the one way delay of the transmission path not exceeding 150 ms	Req	Suppl. F.720, F.723, G.114	Yes
3. Speech quality should be maintained during $\leq 3\%$ frame erasures over any 10 second period. The speech quality criterion is a reduction of $\leq 0.5$ mean opinion score unit (5 point scale) relative to the error-free condition (G.726 at 32 kbit/s)	Req	G.174, § 7.11 and M.1079 § 7.3.1	Yes
4. DTMF signal reliable transport (for PSTN is typically less than one DTMF error signal in $10^4$ )	Req	G.174, § 7.11 and M.1079 § 7.3.1	Yes
5. Voiceband data support including G3 facsimile	Req	M.1079	Yes

IMT-2000 Item Description	Obj/Req	Source	Meets
		§ 7.2.2,	
6. Support packet switched data services as well as circuit switched data; requirements for data performance given in ITU-TG.174	Req	M.1034 §§ 10.8, 10.9	Yes
<b>Radio interfaces and subsystems, network related performance requirements</b>			
7. Network interworking with PSTN and ISDN in accordance with Q.1031 and Q.1032	Req	M.687-1. § 5.4	Yes
8. Meet spectral efficiency and radio channel performance requirements of M.1079	Req	M.1034. § 12.3.3/4	Yes
9. Provide phased approach with data rates up to 2 Mbit/s in phase 1	Obj	M.687, § 1.1.14	Yes
10. Maintain bearer channel bit-count integrity (e.g. synchronous data services and many encryption techniques)	Obj	M.1034, § 10.12	Yes
11. Support for different cell sizes, for example: Mega cell Radius~100-500 km Macro cell Radius $\leq$ 35km, Speed $\leq$ 500 km/h Micro cell Radius $\leq$ 1km, Speed $\leq$ 100 km/h Pico cell Radius $\leq$ 50m, Speed $\leq$ 10 km/h	Obj	M.1035, § 10.1	Yes
<b>Application of IMT-2000 for fixed services and developing countries</b>			
12. Circuit noise- idle noise levels in 99% of the time about 100pWp	Obj	M.819-1, § 10.3	Yes
13. Error performance - as specified in ITU-R F.697	Obj	M.819-1, § 10.4	Yes
14. Grade of service better than 1%	Obj	M.819-1, § 10.5	Yes

TABLE 2

**Generic Requirements and Objectives Relevant to the Evaluation of Candidate Radio Transmission Technologies**

IMT-2000 Item Description	Obj/Req	Source	Meets
<b>Radio interfaces and subsystems, network related performance requirements</b>			
1. Security comparable to that of PSTN/ISDN	Obj	M.687-1, § 4.4	Yes
2. Support mobility, interactive and distribution services	Req	M.816, § 6	Yes
3. Support UPT and maintain common presentation to users	Obj	M.816, § 4	Yes
4. Voice quality comparable to the fixed network (applies to both mobile and fixed service)	Req	M819-1, Table 1, M.1079,	Yes

IMT-2000 Item Description	Obj/Req	Source	Meets
		§ 7.1	
5. Support encryption and maintain encryption when roaming and during handover	Req	M.1034 § 11.3	Yes
6. Network access indication similar to PSTN (e.g. dialtone)	Req	M.1034 §§ 11.5	Yes
7. Meet safety requirements and legislation	Req	M.1034, § 11.6	Yes
8. Meet appropriate EMC regulations	Req	M.1034, § 11.7	Yes
9. Support multiple public/private/residential IMT-2000 operators in the same locality	Req	M.1034, § 12.1.2	Yes
10. Support multiple mobile station types	Req	M.1034, § 12.1.4	Yes
11. Support roaming between IMT-2000 operators and between different IMT-2000 radio interfaces/environments	Req	M.1034, § 12.2.2	Yes
12. Support seamless handover between different IMT-2000 environments such that service quality is maintained and signaling is minimized	Req	M.1034, § 12.2.3	Yes
13. Simultaneously support multiple cell sizes with flexible base location, support use of repeaters and umbrella cells as well as deployment in low capacity areas	Req	M.1034, § 12.2.5	Yes
14. Support multiple operator coexistence in a geographic area	Req	M.1034, § 12.2.5	Yes
15. Support different spectrum and flexible band sharing in different countries including flexible spectrum sharing between different IMT-2000 operators (see M.1036)	Req	M.1034, § 12.2.8	Yes
16. Support mechanisms for minimizing power and interference between mobile and base stations	Req	M.1034, § 12.2.8.3	Yes
17. Support various cell types dependent on environment (M.1035 § 10.1)	Req	M.1034, § 12.2.9	Yes
18. High resistance to multipath effects	Req	M.1034, § 12.3.1	Yes
19. Support appropriate vehicle speeds (as per § 7) Note: applicable to both terrestrial and satellite proposals	Req	M.1034, § 12.3.2	Yes
20. Support possibility of equipment from different vendors	Req	M.1034, § 12.1.3	Yes
21. Offer operational reliability at least as good as 2nd generation mobile systems	Req	M.1034, § 12.3.5	Yes
22. Ability to use terminal to access services in more than one environment, desirable to access services from one terminal in all environments	Obj	M.1035, § 7.1	Yes
23. End-to-end quality during handover comparable to fixed	Obj	M.1034-1	Yes

<b>IMT-2000 Item Description</b>	<b>Obj/Req</b>	<b>Source</b>	<b>Meets</b>
services		§ 11.2.3.4	
24. Support multiple operator networks in a geographic area without requiring time synchronization	Obj		Yes
25. Layer 3 contains functions such as call control, mobility management and radio resource management some of which are radio dependent. It is desirable to maintain layer 3 radio transmission independent as far as possible	Obj	M.1035, § 8	Yes
26. Desirable that transmission quality requirements from the upper layer to physical layers be common for all services	Obj	M.1035, § 8.1	Yes
27. The link access control layer should as far as possible not contain radio transmission dependent functions	Obj	M.1035, § 8.3	Yes
28. Traffic channels should offer a functionally equivalent capability to the ISDN B channels	Obj	M.1035, § 9.3.2	Yes
29. Continually measure the radio link quality on forward and reverse channels	Obj	M.1035, § 11.1	Yes
30. Facilitate the implementation and use of terminal battery saving techniques	Obj	M.1035, § 12.5	Yes
31. Accommodate various types of traffic and traffic mixes	Obj	M.1036, § 1.10	Yes
<b>Application of IMT-2000 for fixed services and developing countries</b>			
32. Repeaters for covering long distances between terminals and base stations, small rural exchanges with wireless trunks etc.	Req	M.819-1, Table 1	Yes
33. Withstand rugged outdoor environment with wide temperature and humidity variations	Req	M.819-1, Table 1	Yes
34. Provision of service to fixed users in either rural or urban areas	Obj	M.819-1, § 4.1	Yes
35. Coverage for large cells (terrestrial)	Obj	M.819-1, § 7.2	Yes
36. Support for higher encoding bit rates for remote areas	Obj	M.819-1, § 10.1	Yes
<b>Satellite component (Not required for RTT submission)</b>			
37. Links between the terrestrial and the satellite control elements for handover and exchange of other information	Req	M.818-1, § 3.0	N/A
38. Take account for constraints for sharing frequency bands with other services (WARC-92)	Obj	M.818-1, § 4.0	N/A
39. Compatible multiple access schemes for terrestrial and satellite components	Obj	M.818-1, § 6.0	N/A
40. Service should be comparable quality to terrestrial component as far as possible	Obj	M.818-1, § 10.0	N/A
41. Use of satellites to serve large cells for fixed users	Obj	M.819-2, § 7.1	N/A

<b>IMT-2000 Item Description</b>	<b>Obj/Req</b>	<b>Source</b>	<b>Meets</b>
42. Key features (e.g. coverage, optimization, number of systems)	Obj	M.1167, § 6.1	N/A
43. Radio interface general considerations	Req	M.1167, § 8.1.1	N/A
44. Doppler effects	Req	M.1167, § 8.1.2	N/A

TABLE 3

**Subjective Requirements and Objectives Relevant to the  
Evaluation of Candidate Radio Transmission Technologies**

<b>IMT-2000 Item Description</b>	<b>Obj/Req</b>	<b>Source</b>	<b>Meets</b>
1. Fixed Service- Power consumption as low as possible for solar and other sources	Req	M.819-1. Table 1	Yes
2. Minimize number of radio interfaces and radio sub-system complexity, maximize commonality (M.1035, § 7.1)	Req	M.1034, § 12.2.1	Yes
3. Minimize need for special interworking functions	Req	M.1034, § 12.2.4	Yes
4. Minimum of frequency planning and inter-network coordination and simple resource management under time-varying traffic	Req	M.1034, § 12.2.6	Yes
5. Support for traffic growth, phased functionality, new services or technology evolution	Req	M.1034, § 12.2.7	Yes
6. Facilitate the use of appropriate diversity techniques avoiding significant complexity if possible	Req	M.1034, § 12.2.10	Yes
7. Maximize operational flexibility	Req	M.1034, § 12.2.11	Yes
8. Designed for acceptable technological risk and minimal impact from faults	Req	M.1034, § 12.2.12	Yes
9. When several cell types are available, select the cell that is the most cost and capacity efficient	Obj	M.1034, § 10.3.3	Yes
10. Minimize terminal costs, size and power consumption, where appropriate and consistent with other requirements	Obj	M.1036, § 1.12	Yes



TABLE 4

**Minimum Performance Capabilities**

<b>Test environments</b>	<b>Indoor Office</b>	<b>Outdoor to Indoor and Pedestrian</b>	<b>Vehicular</b>
<b>Mobility Considerations</b>	mobility type (low)	mobility type (medium)	mobility type (high)
Handover	Yes	Yes	Yes
<b>Support of general service capabilities</b>			
Packet data	Yes	Yes	Yes
Asymmetric services	Yes	Yes	Yes
Multimedia	Yes	Yes	Yes
Variable bit rate	Yes	Yes	Yes

**8.1 Compatibility with the existing IMT-2000 radio interfaces**

The proposed update fits well within the framework of the existing IMT-2000 OFDMA TDD WMAN radio interface. All features supported in the existing IMT-2000 OFDMA TDD WMAN are still supported in the proposed update.

**8.2 Harmonization within multiple proposals**

See Section 9.2.

**“Other Considerations” (Section 9 in 8/LCCE/95)**

**9.1 Benefits of the proposed enhancement**

The proposed enhancements improve the performance of IMT-2000 OFDMA TDD WMAN radio interface.

**9.2 Harmonization and consensus building**

Through their membership and through liaison communications, the SDO stakeholders, the IEEE and the WiMAX Forum, have established harmonization and consensus building. IEEE expects that the system profile submitted by the WiMAX Forum will be fully consistent with IEEE Std 802.16.

**9.3 Enhanced performance capabilities**

The proposed update is fully in line with the ongoing activities on the vision for the enhancements of IMT-2000, also reflected in the Roadmap for the future updates of Recommendation ITU-R M.1457.

## **Annex 6**

### **Self-declaration that the proposed amendments are self-consistent between Section 5.6.1, Section 5.6.2, and the GCS**

The proposed amendments are self-consistent between Sections 5.6.1, 5.6.2, and the GCS.

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## **5.6.2 Detailed specification of the radio interface**

The standards contained in this section are derived from the global core specifications for IMT-2000 contained at <http://ties.itu.int/u/itu-r/ede/rsg5/IMT-2000/GCS/GCSrev9/5-6>. The following notes apply to the sections below, where indicated: (1) The relevant SDOs should make their reference material available from their website. (2) This information was supplied by the recognized external organizations and relates to their own deliverables of the transposed global core specification.

*Note by the Secretariat: In accordance with the established procedure for updating this Recommendation, the SDO's information regarding the development of standards transposed from the global core specifications will be submitted to ITU by [????] and included in the sections below when the final text is sent out for approval.*

The specifications for OFDMA TDD WMAN are provided in the elements of Section 5.6.2.1 that are specifically included in the corresponding elements of Section 5.6.2.2. Anything in Section 5.6.2.1 that is not mentioned in Section 5.6.2.2 is excluded.

### **5.6.2.1 IEEE Std 802.16**

#### **Standard for Local and Metropolitan Area Networks – Air Interface for Broadband Wireless Access Systems**

This standard specifies the air interface, including the medium access control layer (MAC) and physical layer (PHY), of combined fixed and mobile point-to-multipoint broadband wireless access (BWA) systems providing multiple services. The MAC is structured to support multiple PHY specifications, each suited to a particular operational environment.

##### **5.6.2.1.1 Release 1**

###### **5.6.2.1.1.1 IEEE Std 802.16-2004**

#### **IEEE Standard for Local and metropolitan area networks – Part 16: Air Interface for Fixed Broadband Wireless Access Systems**

This revised standard specifies the air interface, including the medium access control layer and multiple physical layer specifications, of fixed BWA systems supporting multiple services. It consolidates IEEE Std 802.16<sup>TM</sup>, IEEE Std 802.16a<sup>TM</sup>, and IEEE Std 802.16c<sup>TM</sup>, retaining all modes and major features without adding modes. Content is added or revised to improve performance, ease deployment, or replace incorrect, ambiguous, or incomplete material, including system profiles.”

###### **5.6.2.1.1.2 IEEE Std 802.16e-2005 and Cor1**

#### **IEEE Standard for Local and metropolitan area networks – Part 16: Air Interface for Fixed and Mobile Broadband Wireless Access Systems – Amendment 2: Physical and Medium Access Control Layers for Combined Fixed and Mobile Operation in Licensed Bands**

This document provides enhancements to IEEE Std 802.16-2004 to support subscriber stations moving at vehicular speeds and thereby specifies a system for combined fixed and mobile broadband wireless access. Functions to support higher layer handover between base stations or sectors are specified. Operation is limited to licensed bands suitable for mobility below 6 GHz. Fixed IEEE 802.16 subscriber capabilities are not compromised. In addition to mobility enhancements, this document contains substantive corrections to IEEE 802.16-2004 regarding fixed operation

### **5.6.2.1.1.3 IEEE Std 802.16f-2005**

#### **IEEE Standard for Local and metropolitan area networks – Part 16: Air Interface for Fixed Broadband Wireless Access Systems – Amendment 1: Management Information Base)**

This document provides enhancements to IEEE Std 802.16-2004 to define a management information base (MIB) for the MAC and PHY and associated management procedures.

### **5.6.2.1.2 Release 1.5**

#### **IEEE P802.16Rev2**

#### **[Draft] Standard for Local and metropolitan area networks – Part 16: Air Interface for Broadband Wireless Access Systems**

This standard specifies the air interface, including the medium access control layer (MAC) and physical layer (PHY), of combined fixed and mobile point-to-multipoint broadband wireless access (BWA) systems providing multiple services. The MAC is structured to support multiple PHY specifications, each suited to a particular operational environment.

*[Editor's Note: The content for 5.6.2.2 will be supplied in a contribution from the WiMAX Forum.]*

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