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OFDMA TDD WMAN (IP-OFDMA) SUPPORT OF MINIMUM REQUIREMENTS

1 Introduction

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

IEEE takes note of the "Special Meeting of Working Party 8F to Complete Consensus on the Addition of a New IMT-2000 Radio Interface" described by Study Group 8 in Document 8F/1335, and announced in ITU-R Circular Letter 8/LCCE/155.

We note that the specified terms of reference for that meeting are related to the OFDMA TDD WMAN (IP-OFDMA) radio interface, including "Resolve the situation with regard to 3 of the 7 the Minimum Performance Capabilities (multimedia, handover, and circuit switched) as per Attachment 6 of 8/LCCE/47; using the Technology Working Group, the M.1457 Sub-Working Group and M.1457 Drafting Group 2 reports of the Kyoto WP 8F meeting, as captured in Document 8F/1322 Attachments 6.1, 6.2 and particularly 6.4 to provide guidance."

In that light, we particularly focus on the Minimum Performance Capabilities and Attachment 6.4 of Document 8F/1322. As stated in that attachment, "Step 6 is the review of the evaluation reports and the assessment of the submitted radio transmission technology for compliance with the minimum performance capabilities." Regarding Step 6, Attachment 6.4 states the following conclusion:

Thanks to the detailed technical discussion that was held, consensus was reached on the capability of the proposed new radio interface to meet 4 of 7 the minimum performance capabilities (see Table 2). On the three remaining capabilities it was not possible to achieve full consensus, as reflected in the notes in the table below:

Table 2

Minimum performance requirements

Minimum Performance Capabilities for IMT-2000 Candidate Radio Transmission Technologies

Test environments	**Indoor Office**	**Outdoor to Indoor and Pedestrian**	**Vehicular**
Mobility considerations	mobility type (low)	mobility type (medium)	mobility type (high)
Handover	Note A *1	Note A *1	Note A *1
Support of general service capabilities			
Packet data	Y	Y	Y
Asymmetric services	Y	Y *2	Y *2
Multimedia	Note B	Note B	Note B
Variable bit rate	Y	Y	Y
Data services key capabilities	user bit rates BER	user bit rates BER	user bit rates BER
Circuit-switched low and long delay	at least 2 048 kbit/s Note C	at least 384 kbit/s*3 Note C	at least 144 kbit/s Note C
Packet	at least 2 048 kbit/s Y	at least 384 kbit/s*3 Y	at least 144 kbit/s Y

BER = Bit Error Ratio

*1 / *2 / *3 see Att. 6 of LCCE/47

Note A reference to handover according to LCCE47 has been investigated different by different evaluation groups

Note B Some groups indicated concern with the specific latency involved in the multimedia services

Note C No consensus could be reached due to different understandings of the meaning of "circuit switched services"

We observe from this conclusion that consensus was reached on four of the seven minimum performance capabilities but that consensus was not reached on three others. We here present information regarding the three minimum performance capabilities in question.

For reference, we have included, as Annex 1, the relevant content of Attachment 6 of 8/LCCE/47, which completely specifies the Minimum Performance Capabilities for IMT-2000 Candidate Radio Transmission Technologies.

(1) Handover

(a) Minimum Performance Capability:

Attachment 6 of 8/LCCE/47 indicates that handover is required, with the following note:

Seamless handover required within the environment, for multi-environment technologies proposed for use in more than one test environment seamless inter-environment handovers required for services which can be handled in more than one relevant environment.

(b) Conclusion of Working Party 8F:

Note A: *reference to handover according to LCCE47 has been investigated different by different evaluation groups*

(c) IEEE View: OFDMA TDD WMAN does support this Minimum Performance Capability. From Working Party 8F's note, it appears that different evaluation groups have taken different understandings of the meaning of handover. It is clear that OFDMA TDD WMAN does support seamless handover[1].

Indeed, Doc. 8/186 makes the support of handover very clear; for example, Section 5.6.1.2.1 reads "the radio interface also provides specifications to allow handover of an SS from one BS to another." The detailed MAC layer handover procedures are specified in Section 6.3.22 of the IEEE 802.16 standard.

Additional information can be found in Doc. 8F/1183 regarding the requirement in Rec. ITU-R M.1034, §12.2.3: "Support seamless handover between different IMT-2000 environments such that service quality is maintained and signalling is minimized"; as follows: "Handover schemes are supported using Simple Hard Handover or Optimized Hard Handover. Also both inter-sector (inter-FA) and intra-sector (intra-FA) handovers are supported. Quality of service is maintained by management of the service flows and the MAC connections across the handovers. Also Mobile Station initiated, Base Station initiated and Network initiated Handovers are supported."

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[1] One key question regards the meaning of "seamless handover." This term is not clearly defined with IMT-2000 sources. The ITU-R / ITU-T Terms and Definitions database, "providing access to all the abbreviations and acronyms, terms and definitions contained in the ITU-R and ITU-T Publications," includes only one definition: "The process by which latency and data loss incurred during handover is within a range acceptable to users (e.g., below a certain limit) for real-time services." No limit is specified as part of the Minimum Performance Capabilities.

(2) Multimedia

(a) Minimum Performance Capability:

Attachment 6 of 8/LCCE/47 indicates that multimedia is required, under the category of "Support of general service capabilities." No additional details are indicated.

Recommendation ITU-R M.1224 defines multimedia service as follows: "A service in which the interchanged information consists of more than one type (e.g. video, data, voice, graphics). Multimedia services have multivalued attributes which distinguish them from traditional telecommunication services such as voice or data. A multimedia service may involve multiple parties, multiple connections, the addition/deletion of resources and users within a single communication session."

(b) Conclusion of Working Party 8F:

Note B: *Some groups indicated concern with the specific latency involved in the multimedia services*

(c) IEEE View:

Working Party 8F conclusion implicitly acknowledges that OFDMA TDD WMAN does support multimedia services. Indeed, it supports multimedia services as defined in Rec. ITU-R M.1224, as the OFDMA TDD WMAN support for interchange of more than one type of information is specified in Section 6.3.5 of the IEEE 802.16 standard. Different multimedia services can be scheduled using these capabilities. The standard enables systems providing communications between multiple parties and supports multiple connections as well as the addition/deletion of resources and users within a single session. The Working Party 8F conclusion indicates concern with the specific latency in OFDMA TDD WMAN. However, the relevant criterion is simply support for multimedia service capability. No multimedia performance requirements are specified. Given the understanding that OFDMA TDD WMAN supports multimedia service, this Minimum Performance Capability is met.

(3) Circuit-switched low and long delay

(a) Minimum Performance Capability:

Attachment 6 of 8/LCCE/47 indicates the "Data services key capabilities." Regarding "Circuit-switched low and long delay" services, the requirements are to support (with bit error ratio $\leq 10^{-6}$) user bit rates of at least 2048, 384, and 144 kbit/s, respectively, in the Indoor Office, Outdoor to Indoor, and Pedestrian Vehicular test environments.

(b) Conclusion of Working Party 8F:

Note C: *No consensus could be reached due to different understandings of the meaning of "circuit switched services"*

(c) IEEE View:

OFDMA TDD WMAN does support all of the required data rates at the given bit error ratio. We do not belabor the point, as the Working Party 8F conclusion implicitly acknowledges that fact. Indeed, the table indicates that Working Party 8F concluded that the radio interface supports these same data rates (at the given BER) as packet-switched services.

Therefore it is clear that the Working Party 8F conclusion indicates a lack of consensus solely due to different understandings of the meaning of "circuit switched services."

While 8/LCCE/47 does not define "circuit switched services," additional information is provided in Rec. M.1225, which says (A1.2.20): "See Recommendation ITU-R M.1224 for the definition of "circuit transfer mode", "packet transfer mode", "connectionless service", and for the aid of understanding "circuit switched" and "packet switched" data services. Therefore, to assist in our understanding of "circuit switch services", we turn to ITU-R M.1224, which offers this definition:

> ***Circuit transfer mode***
>
> *A transfer mode in which transmission and switching functions are achieved by permanent or quasi-permanent allocation of channels, bandwidth or codes between identified points of a connection.*

Rec. ITU-R M.1224 is the only Vocabulary document cited as a reference in 8/LCCE/47 (see Attachment 5: "List of Recommendations and Task Group 8/1 Documents for IMT-2000 Relevant to the Evaluation Process"). Therefore, it is clear that this is the appropriate definition for use in understanding the Minimum Performance Capabilities in 8/LCCE/47. We believe that this should resolve any uncertainty within Working Party regarding the meaning of "circuit switched services."

Having clarified the appropriate definition, IEEE submits that OFDMA TDD WMAN supports this Minimum Performance Capability. IEEE 802.16, which forms the basis of OFDMA TDD WMAN, specifies (6.3.5) "scheduling services" that "represent the data handling mechanisms supported by the MAC scheduler for data transport on a connection." In particular, the Unsolicited Grant Service (UGS) "is designed to support real-time uplink service flows that transport fixed-size data packets on a periodic basis, such as T1/E1 and Voice over IP without silence suppression. The service offers fixed-size grants on a real-time periodic basis, which eliminate the overhead and latency of SS requests and assure that grants are available to meet the flow's real-time needs. The BS shall provide Data Grant Burst IEs to the SS at periodic intervals based upon the Maximum Sustained Traffic Rate of the service flow. The size of these grants shall be sufficient to hold the fixed-length data associated with the service flow (with associated generic MAC header and Grant management subheader) but may be larger at the discretion of the BS scheduler."

As noted in Doc. 8/186 (5.1.9, Table 94), support for UGS in explicitly mandatory and required for implementation of both the base station and the mobile station.

Therefore, OFDMA TDD WMAN satisfies this Minimum Performance Capability.

3 Conclusion

OFDMA TDD WMAN satisfies all seven Minimum Performance Capabilities defined in 8/LCCE/47.

4 Proposal

We propose that entries in Table 2 where the Notes A, B and C are shown be replaced with "Yes" and the notes be deleted. We support the draft revision of Recommendation ITU-R M.1457-6 as shown in Doc. 8/186 and support its approval at the earliest opportunity.

Annex 1: Attachment 6 of 8/LCCE/47 (Satellite Test Environment excluded)

Table of Minimum Performance Capabilities for IMT-2000 Candidate Radio Transmission Technologies

Task Group 8/1 will consider candidate radio transmission technologies that meet the following minimum performance capabilities in at least one test environment, as indicated in Step 6 of the IMT-2000 radio interface development process described in Attachment 1 to this circular.

1 Terrestrial Test Environments

Minimum Performance Capabilities for IMT-2000 Candidate Radio Transmission Technologies

Test environments	**Indoor Office**	**Outdoor to Indoor and Pedestrian**	**Vehicular**
Mobility considerations	mobility type (low)	mobility type (medium)	mobility type (high)
Handover	Required*[1]	Required*[1]	Required*[1]
Support of general service capabilities	Required / Not required	Required / Not required	Required / Not required
Packet data	Required	Required	Required
Asymmetric services	Required	Required*[2]	Required*[2]
Multimedia	Required	Required	Required
Variable bit rate	Required	Required	Required
Data services key capabilities	user bit rates BER	user bit rates BER	user bit rates BER
Circuit-switched low and long delay	at least 2 048 kbit/s $\leq 10^{-6}$	at least 384 kbit/s*[3] $\leq 10^{-6}$	at least 144 kbit/s $\leq 10^{-6}$
Packet	at least 2 048 kbit/s $\leq 10^{-6}$	at least 384 kbit/s*[3] $\leq 10^{-6}$	at least 144 kbit/s $\leq 10^{-6}$

BER = Bit Error Ratio

*1 Seamless handover required within the environment, for multi-environment technologies proposed for use in more than one test environment seamless inter-environment handovers required for services which can be handled in more than one relevant environment.

*2 The evaluated technologies close but not quite capable to meet the minimum performance capabilities for user bit rates (not less than 64 kbit/s) as specified in the table in one direction for this test environment, but meeting the minimum performance capabilities in the other direction, will also be considered in the consensus building process (Step 7), if:

– it is compliant with the requirements and objectives for IMT-2000 which are summarised in Attachment 4; and

– ITU-R Task Group 8/1 acknowledges it offers advantages of other criteria for evaluation of IMT-2000 technologies such as spectrum efficiency, technology complexity, quality, flexibility, implication on network interfaces, or handportable performance optimization capabilities.

*3 Maximum user bit rate for data is one of the important key criteria for evaluation of IMT-2000 technologies. It is strongly desirable that IMT-2000 technologies are capable of 384 kbit/s or higher user bit rates for data services in the outdoor to indoor and pedestrian test environments. The evaluated technology for this environment which is capable of at least 144 kbit/s user bit rate but not capable of 384 kbit/s will be also considered in the further consensus building process (Step 7), if:

– it is compliant with the requirements and objectives for IMT-2000 which are summarised in Attachment 4; and

– it fulfils the minimum performance capabilities for the vehicular test environment in this table; and

– ITU-R Task Group 8/1 acknowledges it offers advantages of other criteria for evaluation of IMT-2000 technologies such as spectrum efficiency, technology complexity, quality, flexibility, implication on network interfaces, or handportable performance optimization capabilities.