From: "Resnick, Ronald J" <ronald.j.resnick@intel.com>
Subject: **Contribution, Document 8F/1183, to ITU-R Working Party 8F**
Date: May 9, 2007 03:06:42 PM PDT
To: "Roger B. Marks" <r.b.marks@ieee.org>
Cc: "Puthenkulam, Jose P" <jose.p.puthenkulam@intel.com>

To Roger Marks, Chair, IEEE 802.16 Working Group (r.b.marks@ieee.org)

Dear Roger,

The WiMAX Forum® would like to bring to your attention its recent contribution, Document 8F/1183, to ITU-R Working Party 8F.

The document is attached for your reference.

Please feel free to contact us if you have any comments on this contribution.

Sincerely,

Ron Resnick

President, WiMAX Forum

INTERNATIONAL TELECOMMUNICATION UNION

RADIOCOMMUNICATION STUDY GROUPS

Document 8F/1183-E
25 April 2007
English only

Received: 24 April 2007 **TECHNOLOGY**

Subject: Question ITU-R 229-1/8

WiMAX Forum[1]

ADDITIONAL NOTES FOR Doc. 8F/1079(Rev. 1)

Introduction

The "Liaison statement from ITU-R Working Party 8F to IEEE and WiMAX Forum" of 24 January 2007 requested "justification" notes for Tables 8 to 10 of the Requirements and Objectives Template of contribution 8F/1079(Rev.1). The process defined in M.1225 does not require or request justification notes, calling only for explanation "when the candidate SRTT checks the No box" Nevertheless, the additional explanations as requested by WP 8F are provided in this contribution, which is submitted in addition to a formal response to the liaison statement.

This contribution also includes some errata for contribution 8F/1079(Rev.1).

Notes for requirements and objectives template in 8F/1079(Rev.1)

Note: Table 1, Table 2, and Table 3, respectively, correspond to responses to Table 1, Table 2 and Table 3 of the requirements and objectives template in M.1225.

[1] WiMAX Forum is an industry-led, non-profit corporation comprised of more than 440 member companies which has undertaken the task of developing the conformance and interoperability specifications and execution of certification for IEEE 802.16 based systems and products.

TABLE 1

Table 1, Generic requirements and objectives relevant to the evaluation of candidate radio transmission technologies

IMT-2000 Item Description	Obj/Req	Source	Meets?*	Explanatory notes
Voice and data performance requirements				
One-way end to end delay less than 40 ms	Req	G.174, § 7.5	□ Yes □ No Yes	The requirement is for the total one way delay as defined in G.174. This is the delay between the MS and the BS. This is shown in 8F/1079(Rev. 1) section 2.3.1.2 in Figure 12 and is < 40ms
For mobile videotelephone services, the IMT-2000 terrestrial component should operate so that the maximum overall delay (as defined in ITU-T Rec. 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 □ No Yes	The one-way delay as described in Section 2.3.1.3. Overall delay includes the one way transmission path and characteristic delay.
Speech quality should be maintained during □ 3% frame erasures over any 10 second period. The speech quality criterion is a reduction of □ 0.5 mean opinion score unit (5 point scale) relative to the error-free condition (G.726 at 32 kb/s)	Req	G.174, § 7.11 & M.1079 § 7.3.1	□ Yes □ No Yes	The RTT operates independent of a speech codec. IP-OFDMA has no inherent limitation that would prevent it from satisfying this criterion.
DTMF signal reliable transport (for PSTN is typically less than one DTMF errored signal in 10^4)	Req	G.174, § 7.11 & M.1079 § 7.3.1	□ Yes □ No Yes	DTMF signals can be reliably transported in packet data form over IP-OFDMA.
Voiceband data support including G3 facsimile	Req	M.1079 § 7.2.2	□ Yes □ No Yes	As IP-OFDMA supports a packet data transport this capability is expected to be provided as an application over VoIP. No inherent limitation exists for such an application to be supported.
Support packet switched data services as well as circuit switched data; requirements for data performance given in ITU-T G.174	Req	M.1034 §§ 10.8, 10.9	□ Yes □ No Yes and No (see Note 1 below)	Only packet switch data services are supported natively. Please see Note 1.

* Explanation is requested when the candidate SRTT checks the No box.

Radio interfaces and subsystems, network related performance requirements				
Network interworking with PSTN and ISDN in accordance with Q.1031 and Q.1032	Req	M.687-1 § 5.4	□ Yes □ No Yes	IP-OFDMA provides a packet switch data service that allows interworking with PSTN and ISDN systems through interworking gateways.
Meet spectral efficiency and radio channel performance requirements of M.1079	Req	M.1034 § 12.3.3/4	□ Yes □ No Yes	See A1.3.1.5.2
Provide phased approach with data rates up to 2 Mbit/s in phase 1	Obj	M.687, § 1.1.14	□ Yes □ No Yes	See A1.3.1.5.2
Maintain bearer channel bit-count integrity (e.g. synchronous data services and many encryption techniques)	Obj	M.1034, § 10.12	□ Yes □ No Yes	IP-OFDMA provides support for reliable data transport with bit count integrity. Encryption using AES-CCM is also supported.
Support for different cell sizes, for example - Mega cell Radius ~100-500 km Macro cell Radius □ 35 km,Speed □ 500 km/h Micro cell Radius □ 1 km,Speed □ 100 km/h Pico cell Radius □ 50m,Speed □ 10 km/h	Obj	M.1035 § 10.1	□ Yes □ No Yes	Mega cells are not applicable to the terrestrial RTTs but are implied for Satellite RTT components. IP-OFDMA supports terrestrial deployments and does support Macro, Micro and Pico cells.
Application of IMT-2000 for fixed services and developing countries				
Circuit noise - idle noise levels in 99% of the time about 100 pWp	Obj	M.819-1, § 10.3	□ Yes □ No Yes	These are implementation dependent. IP-OFDMA is, however, capable of meeting this requirement.
Error performance - as specified in ITU-R F.697	Obj	M.819-1, § 10.4	□ Yes □ No Yes	Efficient channel coding schemes are supported (See A3.2.5.2)
Grade of service better than 1%	Obj	M.819-1, § 10.5	□ Yes □ No Yes	No inherent limitation in IP-OFDMA that prevents it from meeting this requirement.

Note 1: The RTT is purely a packet-switched data technology. Circuit-switched data is not supported. However, the RTT will support seamless interworking with circuit-switched systems using media gateways and support for QoS classes.

TABLE 2

Table 2, Generic requirements and objectives relevant to the evaluation of candidate radio transmission technologies

IMT-2000 Item Description	Obj/Req	Source	Meets?*	Explanatory notes
Radio interfaces and subsystems, network related performance requirements				

Security comparable to that of PSTN/ISDN	Obj	M.687-1 § 4.4	Yes No Yes	IP-OFDMA supports AES-CCM for privacy and CMAC and HMAC for message authentication. User and Device authentication are supported through the use of EAP methods. PSTN/ISDN equivalent security can be provided for voice services that are implemented as an application over the RTT. No inherent limitation exists to the level of security that can be provided for voice or data services at the application layer.
Support mobility, interactive and distribution services	Req	M.816 § 6	Yes No Yes	Mobility services are supported within an ASN (RAN) through handovers and across ASNs using through Mobile IP in the CSN. Interactive services are supported as packet data service applications over IP-OFDMA. Distribution services are supported through multicast/broadcast capability
Support UPT and maintain common presentation to users	Obj	M.816 § 4	Yes No Yes	No inherent limitation in IP-OFDMA to prevent it from supporting this as an application over packet data service provided.
Voice quality comparable to the fixed network (applies to both mobile and fixed service)	Req	M.819-1 Table 1, M.1079 § 7.1	Yes No Yes	IP-OFDMA supports appropriate QoS classes to enable support voice applications without impairments.
Support encryption and maintain encryption when roaming and during handover	Req	M.1034 § 11.3	Yes No Yes	IP-OFDMA supports encryption using AES-CCM. 3-way handshake mechanisms and Traffic encryption key refresh mechanisms are supported for maintaining privacy during roaming and handover.

* Explanation is requested when the candidate SRTT checks the No box.

Network access indication similar to PSTN (e.g. dialtone)	Req	M.1034 § 11.5	Yes No Yes (see Note 2 below the Table)	See Note 2. No inherent limitation in IP-OFDMA to prevent it from supporting this as an application.
Meet safety requirements and legislation	Req	M.1034 § 11.6	Yes No Yes	No inherent limitation in IP-OFDMA to prevent it from supporting this requirement.
Meet appropriate EMC regulations	Req	M.1034 § 11.7	Yes No Yes	No inherent limitation in IP-OFDMA to prevent it from supporting this requirement.
Support multiple public/private/ residential IMT-2000 operators in the same locality	Req	M.1034 § 12.1.2	Yes No Yes	No inherent limitation in IP-OFDMA to prevent it from supporting this requirement.
Support multiple mobile station types	Req	M.1034 § 12.1.4	Yes No Yes	IP-OFDMA supports Fixed CPE style devices, Laptop terminals, Handsets, and PDA style devices and consumer electronic style devices.
Support roaming between IMT-2000 operators and between different IMT-2000 radio interfaces/ environments	Req	M.1034 § 12.2.2	Yes No Yes	The authentication credentials used in existing IMT-2000 RTTs can be used with the appropriate EAP methods over this RTT that provides a generic EAP encapsulation method. Hence roaming across IP-OFDMA networks can be made possible with appropriate interworking support in the Core networks.
Support seamless handover between different IMT-2000 environments such that service quality is maintained and signalling is minimized	Req	M.1034 § 12.2.3	Yes No Yes	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.
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 No Yes	IP-OFDMA supports multiple cell sizes with flexible location of the Base Station. It also allows extension of coverage using repeaters. Hierarchical cells and umbrella cells are also possible to be deployed.

Support multiple operator coexistence in a geographic area	Req	M.1034 § 12.2.5	Yes No Yes	Multiple operators can be supported in a geographic area using the NAP (Network Acess Provider – infrastructure owner/operator) and NSP (Network Service Provider – service operator) concepts supported by IP-OFDMA. The network can be shared by multiple virtual operators or NSPs.
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 No Yes	IP-OFDMA supports different RF bands and flexible band sharing in different countries. IP-OFDMA supports the frequency arrangements for TDD.
Support mechanisms for minimizing power and interference between mobile and base stations	Req	M.1034 § 12.2.8.3	Yes No Yes	There is support for power control in IP-OFDMA and also the interference between Mobile stations and Base stations are eliminated using the Transmit to Transmit Gap and the Receive to Transmit Gap in TDD mode.
Support various cell types dependent on environment (M.1035 § 10.1)	Req	M.1034 § 12.2.9	Yes No Yes	Macro cells, Micro cells and Pico cells are all supported.
High resistance to multipath effects	Req	M.1034 § 12.3.1	Yes No Yes	IP-OFDMA uses OFDM technology that is inherently very robust to multipath effects.
Support appropriate vehicle speeds (as per § 7) NOTE: applicable to both terrestrial and satellite proposals	Req	M.1034 § 12.3.2	Yes No Yes	IP-OFDMA supports vehicular speeds up to 120km/hr with no degradation and supports higher speeds with graceful degradation.
Support possibility of equipment from different vendors	Req	M.1034 § 12.1.3	Yes No Yes	IP-OFDMA allows equipment from different vendors to interoperate. Presently efforts are underway to certify interoperability of the equipment by the WiMAX Forum.
Offer operational reliability as least as good as 2nd generation mobile systems	Req	M.1034 § 12.3.5	Yes No Yes	Operational reliability is equivalent to other IMT-2000 RTTs and previous generation systems.
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 No Yes	IP-OFDMA allows multiple services to be accessed from a single terminal and also ability to use the terminal in more than one environment.
End-to-end quality during handover comparable to fixed services	Obj		Yes No Yes	The optimized hard handover supported by the RTT provides very little, unnoticeable, interruption to voice and data services.

Support multiple operator networks in a geographic area without requiring time synchronization	Obj		Yes No Yes	Assuming each operator is using a separate RF channel there is no need to synchronize the transmissions across operators. However if the same RF channel is used by operators in adjacent cells, time synchronization is expected and this is typically only true when infrastructure sharing is utilized.
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 No Yes	Layer 3 functions used with IP-OFDMA are very much independent of the RTT. Voice and Data services are supported as applications over a packet data air interface.
Desirable that transmission quality requirements from the upper layer to physical layers be common for all services	Obj	M.1035 § 8.1	Yes No Yes	IP-OFDMA treats all services equally and hence provides the same transmission quality for all services. As traffic QoS levels are supported the individual services can avail the QoS schemes for best overall throughput and transmission quality.
The link access control layer should as far as possible not contain radio transmission dependent functions	Obj	M.1035 § 8.3	Yes No Yes	The link access control layer is not in IP-OFDMA and uses logical constructs provided by the radio layer for its operation. These provide a good degree of radio independence.
Traffic channels should offer a functionally equivalent capability to the ISDN B-channels	Obj	M.1035 § 9.3.2	Yes No Yes	ISDN B-channels provide 64 kbits/s data rates and the IP-OFDMA RTT can provide a constant bit rate (UGS) service at multiples of 64 kbits/s.
Continually measure the radio link quality on forward and reverse channels	Obj	M.1035 § 11.1	Yes No Yes	Radio link quality is measured on both the Forward and Reverse links. On the forward link the Preambles and Pilots are used to measure link quality. On the reverse link, Pilots and Channel Quality Indications (CQI) feedback is provided.
Facilitate the implementation and use of terminal battery saving techniques	Obj	M.1035 § 12.5	Yes No Yes	Sleep and Idle modes are two power saving modes that are supported by IP-OFDMA.
Accommodate various types of traffic and traffic mixes	Obj	M.1036 § 1.10	Yes No Yes	IP-OFDMA can support a variety of traffic types and traffic mixes. Voice and other constant bit rate real-time traffic, video, gaming and other real-time traffic and less delay sensitive web and other data traffic are examples of traffic types supported.

Application of IMT-2000 for fixed services and developing countries				
Repeaters for covering long distances between terminals and base stations, small rural exchanges with wireless trunks etc.	Req	M.819-1 Table 1	Yes No Yes	Repeaters are supported and can be deployed for long range coverage as required.
Withstand rugged outdoor environment with wide temperature and humidity variations	Req	M.819-1 Table 1	Yes No Yes	IP-OFDMA implementations can tolerate rugged outdoor temperature and humidity conditions comparable to other IMT-2000 RTTs.
Provision of service to fixed users in either rural or urban areas	Obj	M.819-1 § 4.1	Yes No Yes	IP-OFDMA has the required characteristics for fixed services for rural and urban applications as well.
Coverage for large cells (terrestrial)	Obj	M.819-1 § 7.2	Yes No Yes	Large cell coverage is possible.
Support for higher encoding bit rates for remote areas	Obj	M.819-1 § 10.1	Yes No Yes	IP-OFDMA provides multiple encoding schemes using QPSK, 16QAM and 64QAM.
Additional satellite- component specific requirements and objectives				
Links between the terrestrial and satellite control elements for handover and exchange of other information	Req	M.818-1 § 3.0	Yes No NA	Does not apply to IP-OFDMA as it specifies a terrestrial component only.
Take account for constraints for sharing frequency bands with other services (WARC-92)	Obj	M.818-1 § 4.0	Yes No NA	Does not apply to IP-OFDMA as it specifies a terrestrial component only.
Compatible multiple access schemes for terrestrial and satellite components	Obj	M.818-1 § 6.0	Yes No NA	Does not apply to IP-OFDMA as it specifies a terrestrial component only.
Service should be comparable quality to terrestrial component as far as possible	Obj	M.818-1 § 10.0	Yes No NA	Does not apply to IP-OFDMA as it specifies a terrestrial component only.
Use of satellites to serve large cells for fixed users	Obj	M.819-1 § 7.1	Yes No NA	Does not apply to IP-OFDMA as it specifies a terrestrial component only.
Key features e.g. coverage, optimization, number of systems	Obj	M.1167 § 6.1	Yes No NA	Does not apply to IP-OFDMA as it specifies a terrestrial component only.
Radio interface general considerations	Req	M.1167 § 8.1.1	Yes No NA	Does not apply to IP-OFDMA as it specifies a terrestrial component only.
Doppler effects	Req	M.1167 § 8.1.2	Yes No NA	Does not apply to IP-OFDMA as it specifies a terrestrial component only.

Note 2: These are application specific and not mandated by the RTT. But applications may support this.

TABLE 3

Table 3, generic requirements and objectives relevant to the evaluation of candidate radio transmission technologies

IMT-2000 Item Description	Obj/Req	Source	Proponents Description	Explanatory notes

Fixed Service - Power consumption as low as possible for solar and other sources	Req	M.819-2 Table 1	These are implementation dependent and are not restricted by the RTT definition	Yes, IP-OFDMA can be implemented with very low power consumption.
Minimize number of radio interfaces and radio sub-system complexity, maximize commonality (M.1035 § 7.1)	Req	M.1034-1 § 11.2.1	Yes	IP-OFDMA can be implemented on Mobile Stations much like other IMT-2000 RTTs. IP-OFDMA Radio Subsystem provides packet data services using TCP/IP/ UDP protocols also supported in other IMT-2000 RTTs.
Minimize need for special interworking functions	Req	M.1034-1 § 11.2.4	Yes. Interworking functions are only needed when interfacing to non-IP networks.	Interworking functions are only needed when interfacing to non-IP networks.
Minimum of frequency planning and inter-network coordination and simple resource management under time-varying traffic	Req	M.1034-1 § 11.2.6	Yes	IP-OFDMA supports Flexible Frequency Reuse schemes and therefore provides the capability to have minimum frequency planning. Resource management of time-varying traffic across cells is provided in the ASN.
Support for traffic growth, phased functionality, new services or technology evolution	Req	M.1034-1 § 11.2.7	Yes	The flexibility for supporting additional traffic by adding additional RF channels is possible. Also the PHY and MAC layer of IP-OFDMA has extensibility features to allow for evolution.

Facilitate the use of appropriate diversity techniques avoiding significant complexity if possible	Req	M.1034-1 § 11.2.10	Yes	IP-OFDMA supports Space Time Diversity techniques using industry standard techniques.
Maximize operational flexibility	Req	M.1034-1 § 11.2.11	Yes	IP-OFDMA supports a lot of flexibility in allowing operators to deploy the technology and configure it
Designed for acceptable technological risk and minimal impact from faults	Req	M.1034-1 § 11.2.12	Yes	IP-OFDMA is technologically implementable and has no inherent weakness in its design.
When several cell types are available, select the cell that is the most cost and capacity efficient	Obj	M.1034-1 §[9.2] M.1035 § 10.3.3	Yes	Cell selection is performed by decoding the DL Preambles, FCH, MAPs and then doing initial ranging. The Mobile Station can always select the best cell type in a hierarchical cell based on cost and capacity that is indicated by the QoS and service parameters exchanged during the capability negotiations during connection setup.
Minimize terminal costs, size and power consumption, where appropriate and consistent with other requirements	Obj	M.1036 § 2.1.12	Yes	IP-OFDMA is being implemented on handsets today and have been found to be appropriate in cost, size and power consumption with respect to other IMT-2000 RTTs.

Errata for 8F/1079(Rev. 1)

1. In section 1.3.5, on page 17, in Table 4, UL column, CTC row: 3/4 code rate should be included in the supported code rates. Hence the contents should be: "1/2, 2/3, 3/4, 5/6".
2. In section 2.1, on page 30, row A1.2.16.2: Instead of "See A.1.2.16" the answer should read, "Not limited by RTT".
3. In section 2.1, on page 32, A1.2.24.1: no answer was provided. It should be, "Refer to section 2.3.2.2 Table 11".
4. In section 2.1, on page 35, in row A1.2.24.1 has no answer. The answer should read, "Refer to section 2.3.2.2 Table 11".
5. In section 2.1, on page 40, in row A1.3.7.2. in the answer, instead of the RTD of "60 ms" it should be "120ms".
6. In section 2.1, on page 47, in row A1.5.1 to A1.5.5. instead of the present answers it should read "See link budget in section 2.3.4". This avoids inconsistency with simulation results.
7. In section 2.3.1.2, on page 53,under VoIP packet assumptions, delete the following sub-bullets below as they are not used in the simulation results:

   "- G722.2 (AMR) codec: 12-31B of voice payload every 20sec.

   - G711 codec: 8B of voice payload every 1 msec."
8. In the chapter 3 self evaluation, on page 72, row A3.2.5.2: "8 bits CRC" should be corrected as "32 bits CRC".
9. In the chapter 3 self evaluation, on page 77, A3.2.10, correct the reference from "Section 2.2.2.2" to "Section 2.3.2".
10. In the chapter 3 self evaluation, on page 77, in row A3.3.2 the calculation of D1 should read as: "D1 = 20ms (vocoder) x 2 + 50ms (max. one-way air interface delay) x 2 = 140ms. Maximum one-way air-interface delay includes delays in the ASN (RAN) depicted in the Figure 6 in M.1225".
11. The endnote references in 1079(Rev. 1). do not show the correct reference numbers, although these automatic references functioned correctly in the version as submitted to ITU-R.

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