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**RADIOCOMMUNICATION
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Subject:　Question ITU-R 229-1/8

Institute of Electrical and Electronics Engineers (IEEE)

PROPOSED NEW IMT-2000 TERRESTRIAL RADIO INTERFACE INTENDED FOR INCLUSION IN RECOMMENDATION ITU-R M.1457

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.

IEEE notes that WP 8F intends to produce Revision 7 of Rec. ITU-R M.1457 by its meeting #22 - Japan, 23-31 May 2007 - and submit it to Study Group 8 in June 2007. Therefore, based on the WP 8F work plan, IEEE makes this proposal for the addition of a sixth terrestrial IMT-2000 radio interface in the draft Revision to Recommendation ITU-R M.1457-6.

Attachments 1-3 contain the details of the proposal, according to the requirements in Circular Letters 8/LCCE/95 and 8/LCCE/47. Attachment 1 provides the required cover sheet. Attachment 2 proposes edits to M.1457 in line with this submission. Attachment 3 provides the information requested in the RTT description template. It should be noted that Attachment 3 does not contain all the information required, since it is expected that other organizations will provide the complementary material, including the evaluation. If further information is required, please let us know and we will provide it for the May 2007 meeting of WP 8F.

Proposal

IEEE herewith proposes a new terrestrial radio interface for inclusion in the draft revision to Recommendation ITU-R M.1457-6.

Attachments:
1. Cover sheet
2. Proposed Edits to M.1457
3. Description template A1 and A2 only:
A1.1　　Test environment support
A1.2　　Technical parameters

Attachment 1

Cover Sheet for Submission of proposed radio transmission technologies for IMT-2000 to ITU

(ATTACHMENT 2 of Circular-letter 8/LCCE/47)

The information listed below will be used for cataloguing radio transmission technologies for IMT-2000 by the ITU and will be posted electronically.

This cover sheet (and additional information, if applicable) should be attached when an evaluation group submits a proposal on radio transmission technologies for IMT-2000.

1. Proponent

a) Name of proponent: IEEE 802.16 Working Group on Broadband Wireless Access

b) Proponent category:

ITU-R membership: Yes _x_ No ___

Regional/National standards body: Yes _x_ (Name: IEEE)   No ___

Industry group: Yes ___ (Name: _____) No _x_

Other: (Name:_____)   No _x_

c) Contact point

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2. Proposal identification

a) Name of the proposed RTT   IP-OFDMA

b) Status of proposal:

Revision   ___ (former proposed RTTs name:_____)

New proposal   _x_

3. Proposed RTT(s) service environment (check as many as appropriate)

Indoor   _x_   Outdoor to indoor pedestrian _x_

Vehicular   _x_   Satellite ___

4. Attachments

Technology template for each test environment (partial)

Requirements and objectives template ___

IPR statement ___

Other: Proposed edits to M.1457

(any additional inputs which the proponent may consider relevant to the evaluation) ___

5. Has the proposal already been submitted to an evaluation group registered with ITU?

Yes ___

(Name of evaluation group: _____, Date of submission:_____)

No _x_

6. Other information

Name of person submitting form: Michael Lynch

Date: 17 November 2006

Attachment 2

Proposed edits to M.1457

Baseline document for the proposed edits: Draft revision of Recommendation ITU-R M.1457-5
(Doc. 8/BL/35), Administrative Circular CAR/218.

1 Introduction *[no edits]*

2 Scope *[no edits]*

3 Related Recommendations

[add at the end:]

These existing Recommendations are not part of IMT-2000 but are relevant to this particular
Recommendation:

Recommendation ITU-R F.1763: Radio interface standards for broadband wireless access systems
in the fixed service operating below 66 GHz

Draft New Recommendation ITU-R M.[8A/BWA]: Radio interface standards for broadband
wireless access systems, including mobile and nomadic applications, in the mobile service
operating below 6 GHz

4 Considerations

4.1 Radio interfaces for IMT-2000

[edit as shown below:]

IMT-2000 consists of both terrestrial component and satellite component radio interfaces. All of the
radio interfaces for IMT-2000 both terrestrial and satellite are fully encompassed by this
Recommendation. In particular, the terrestrial radio interfaces are fully defined by information
supplied within this Recommendation and by information incorporated by reference to external
materials. The satellite radio interfaces are fully defined by information supplied with this
Recommendation.

Recommendation ITU-R M.1455 lists the original key characteristics of all radio interface for the
terrestrial component of IMT-2000. The organization of terrestrial radio interfaces within that
Recommendation follows the philosophy that IMT-2000 should comprise a single terrestrial
standard encompassing three high-level groupings: code division multiple access (CDMA), time
division multiple access (TDMA), orthogonal frequency division multiple access (OFDMA), or a
combination thereof. The CDMA grouping accommodates frequency division duplex (FDD) direct
spread, FDD multi-carrier and time division duplex (TDD). The TDMA grouping accommodates
FDD and TDD, single carrier and multi-carrier. The OFDMA radio interface accommodates TDD.
These groupings satisfy the needs expressed by the global community.

Recommendation ITU-R M.1455 also lists the key characteristics of six radio interfaces for the
satellite component of IMT-2000. As highlighted in that Recommendation, due to the constraints on

satellite system design and deployment, several satellite radio interfaces will be required for IMT-2000 (see Recommendation ITU-R M.1167 for further considerations).

A satellite system is severely resource limited (e.g. power and spectrum limited), its radio interfaces are therefore specified primarily based on a whole system optimization process, driven by the market needs and business objectives. It is generally not technically feasible or viable from a business point-of-view to have a radio interface common to satellite and terrestrial IMT-2000 components. Nevertheless, it is desirable to achieve as much commonality as possible with the terrestrial component when designing and developing an IMT-2000 satellite system.

The strong dependency between technical design and business objectives of an IMT-2000 satellite system requires a large scope of flexibility in the satellite radio interface specifications. Future modifications and updates of these specifications may nevertheless be needed in order to adapt to changes in market demands, business objectives, technology developments, and operational needs, as well as to maximize the commonality with terrestrial IMT-2000 systems as appropriate.

The radio interfaces for the terrestrial and satellite components are described in detail in § 5 and 6, respectively.

4.2 Incorporation of externally developed specification material *[no edits]*

4.2 Satellite component interfaces *[no edits]*

5 Recommendations (terrestrial component)

[edit as shown below:]

The Radiocommunication Assembly recommends that the radio interfaces given in § 5.1 to 5.6 should be those of the terrestrial component of IMT-2000.

The organization of terrestrial radio interfaces within this Recommendation follows the philosophy that IMT-2000 should comprise a single terrestrial standard encompassing three high-level groupings: CDMA, TDMA, OFDMA, or a combination thereof. The CDMA grouping accommodates FDD direct spread, FDD multi-carrier and TDD. The TDMA grouping accommodates FDD and TDD, single carrier and multi-carrier. The OFDMA grouping includes the IP-OFDMA radio interface. These groupings satisfy the needs expressed by the global community.

The terrestrial radio interface sections are identified as:

– IMT-2000 CDMA Direct Spread

– IMT-2000 CDMA Multi-Carrier

– IMT-2000 CDMA TDD

– IMT-2000 TDMA Single-Carrier

– IMT-2000 FDMA/TDMA

– IMT-2000 IP-OFDMA.

An overview of each radio interface is provided in § 5.1.1, 5.2.1, 5.3.1, 5.4.1, 5.5.1, and 5.6.1.

The detailed information provided and/or referenced in § 5.1.2, 5.2.2, 5.3.2, 5.4.2, 5.5.2. and 5.6.2 is recommended as the complete definition of the radio interfaces of the terrestrial component of IMT-2000.

5.6 IMT-2000 IP-OFDMA *[new subclause]*

5.6.1 Overview of the radio interface

5.6.1.1 Introduction

The IMT-2000 radio interface specification described in this subclause is designated as IP-OFDMA, for Broadband Wireless – Orthogonal Frequency Division Multiple Access. The core standards specifying IP-OFDMA are overseen and published by the IEEE Standards Association (IEEE-SA) of the global Institute of Electrical and Electronics Engineers (IEEE). The IEEE is a "recognized organization" per Note 1 of § 4.2 and is a Sector Member of ITU-R and ITU-T in the category CV231 ("Regional and other International Organizations.") The relevant IEEE standard, designated as IEEE Std 802.16, is developed and maintained by the IEEE 802.16 Working Group on Broadband Wireless Access.

An earlier and more limited version of IEEE Standard 802.16, specified for fixed services only, is the basis of ITU-R Rec. F.1763 ("Radio interface standards for broadband wireless access systems in the fixed service operating below 66 GHz"). The version as enhanced (by the amendment IEEE Std 802.16e) for the mobile service is recommended in [Draft] Recommendation ITU-R M.[8A/BWA]. Both of these ITU-R Recommendations also reference the ETSI HiperMAN standards (ETSI TS 102 177 v1.3.2, ETSI TS 102 178 v1.3.2, and ETSI TS 102 210 v1.2.1), which are fully harmonized with IEEE Standard 802.16.

The radio access network specified in IEEE Standard 802.16 is flexible, for use in a wide variety of applications, operating frequencies, and regulatory environments. IEEE 802.16 includes multiple physical layer specifications, one of which is known as WirelessMAN-OFDMA. The IP-OFDMA specification in this Recommendation is a special case of WirelessMAN-OFDMA specifying a particular interoperable radio interface.

The IP-OFDMA radio interface comprises the two lowest network layers – the physical layer (PHY) and the data link control layer (DLC). The lower element of the DLC is the medium access control layer (MAC); the higher element in the DLC is the logical link control layer (LLC). The PHY is based on orthogonal frequency division multiple access (OFDMA) suitable for use in either a 5 MHz or a 10 MHz channel allocation. The MAC is based a connection-oriented protocol designed for use in a point-to-multipoint configuration. It is designed to carry a wide range of packet-switched (typically IP-based) services while permitting fine and instantaneous control of resource allocation to allow full carrier-class Quality of Service (QoS) differentiation. This allows for support of a differentiated services network simultaneously carrying multiple multimedia services, including multimedia broadcast and multicast services, with varying demands.

IP-OFDMA is specified and suitable for all IMT-2000 frequency bands. Although the WirelessMAN-OFDMA specification includes both TDD and FDD alternatives, IP-OFDMA as defined here operates only in TDD mode.

5.6.1.2 Radio access network architecture

The IP-OFDMA radio interface is designed to carry packet-based traffic, including IP. It is flexible enough to support a variety of higher-layer network architectures for fixed, nomadic, or fully mobile use, with handover support. It can readily support functionality suitable for generic data as well as time-critical voice and multimedia services, broadcast and multicast services, and mandated regulatory services.

The IP-OFDMA radio interface standard specifies Layers 1 and 2; the specification of the higher network layers is not included. It offers the advantage of flexibility and openness at the interface

between Layers 2 and 3 and it supports a variety of network infrastructures. The radio interface is compatible with the network architectures defined in ITU-T Recommendation Q.1701. In particular, a network architecture design to make optimum use of IEEE Standard 802.16 and the IP-OFDMA radio interface is specified in the "Mobile WiMAX End-to-End System Architecture", available from the WiMAX Forum[1].

The IP-OFDMA protocol layering is illustrated in Fig. 1. The core radio interface is defined in the data/control plane. Layer 1 comprises the PHY, which interfaces with the MAC at Layer 2 through the PHY service access point (SAP). The MAC includes three separate sublayers. The lowest of these is the security sublayer, which provides security mechanisms providing authentication, encryption, and key exchange for data privacy and to limit service to authorized use. Above the security sublayer is the core MAC functionality, known as the MAC Common Part Sublayer (MAC CPS). This interfaces, via the MAC SAP, with the Service-Specific Convergence Sublayer (CS), which provides an interface to the IP network via the CS SAP.

FIGURE 1

IP-OFDMA protocol layering, showing service access points (SAPs)
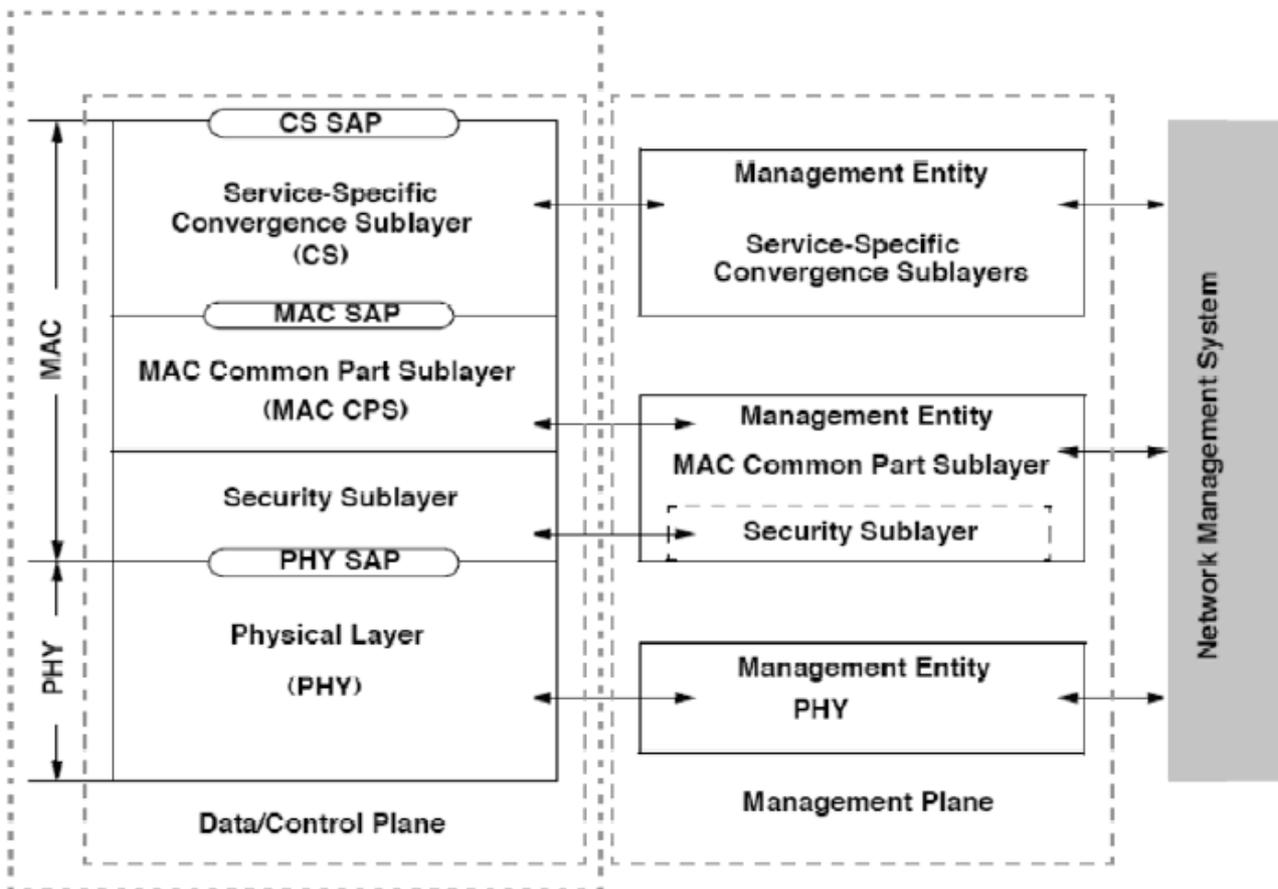
The IP-OFDMA MAC is connection-oriented. Each service, including inherently connectionless services, is mapped to a connection. Various mechanisms, known as scheduling services, are available for the SS to communicate to the BS the resource requirements of its connections. Each

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[1] http://www.wimaxforum.org/technology/documents/WiMAX_End_to_End_Network_Systems_Architecture.zip.

connection is assigned a specific scheduling service. The BS is required to manage a variety of simultaneous connections with disparate QoS requirements.

5.6.1.2.1 BS and SS Functionality

The IP-OFDMA system architecture consists of two logical entities, the base station (BS) and the subscriber station (SS). The basic architectural assumption of IP-OFDMA is of a base station (BS) communicating in point-to-multipoint fashion with a number of fixed or mobile subscriber stations (SSs). The BS is connected to an IP-based backhaul network. It controls and allocates the resources in spectrum and time. Transmissions on the downlink (BS to SS) are divided in both time and frequency (using the multiple subcarriers provide by OFDMA) for assigning communications to individual SSs. Transmissions on the uplink (from SS to BS) take place according to the schedule and in the subchannels assigned by the BS.

In brief, the BS is responsible for:

- configuring and updating basic parameters

- performing bandwidth allocation for DL (per connection) and UL traffic (per SS) and performing centralized QoS scheduling, based on the QoS/service parameters and the active resource requests from the SS

- communicating to all SSs, through the maps, the schedule of each frame and supporting other data and management broadcast and multicast services

- Transmitting/receiving traffic data and control information as MAC protocol data units (PDUs)

- Performing connection admission control and other connection management functions

- Providing other SS support services such as ranging, clock synchronization, power control, and handover.

The SS is responsible for:

- Identifying the BS, obtaining MAC parameters, and joining the network

- Establishing basic connectivity, setting up additional data and management connections, and negotiating any optional parameters as needed

- Generating resource requests for connections that require them, based on the connection profiles and traffic

- Receiving broadcast/multicast PDUs and unicast PDUs and forwarding them appropriately

- Making local scheduling decisions based on the current demand and history of resource requests/grants

- Transmitting only when instructed by the BS to do so or the SS has some information that qualifies for transmission in one of the allowed contention slots

- Unless in sleep mode, receiving all schedule and channel information broadcast by the BS and obeying all medium access rules

- Performing initial ranging, maintenance ranging, power control, and other housekeeping functions

Fig. 1 is limited to describing a system including a BS and the SSs with which it communicates. However, the IP-OFDMA radio interface also provides specifications to allow handover of an SS from one BS to another. Such handover would typically occur as a mobile device moves toward an adjacent cell. However, it might also occur due to system-wide efforts at load balancing.

5.6.1.3 Layer 1: Physical Layer (PHY)

The IP-OFDMA radio interface is a special case of the WirelessMAN-OFDMA air interface specified in § 8.4 of IEEE Standard 802.16. It uses orthogonal frequency-division multiple access (OFDMA), which is an extension of orthogonal frequency-division multiplexing (OFDM).

5.6.1.3.1 OFDMA Technology Overview

OFDM divides the channel by frequency into orthogonal subcarriers. Data to be transmitted is divided into parallel streams of reduced data rate (and therefore longer symbol duration) and each stream is modulated and transmitted on a separate subcarrier. The lengthened symbol duration improves the robustness of OFDM to delay spread. Furthermore, the introduction of a cyclic prefix (CP) eliminates intersymbol interference if the CP duration is longer than the channel delay spread.

In a typical OFDM implementation, all of the transmitter's subcarriers are, at any given time, addressed to a single receiver; multiple access is provided solely by TDMA time slotting. OFDMA, however, divides the subcarrier set into subsets, known as subchannels. Each subchannel can address a different receiver at any given time. In the downlink, each subchannel may be intended for a different receiver or group of receivers. In the uplink, multiple SSs may transmit simultaneously as long as they are assigned different subchannels.
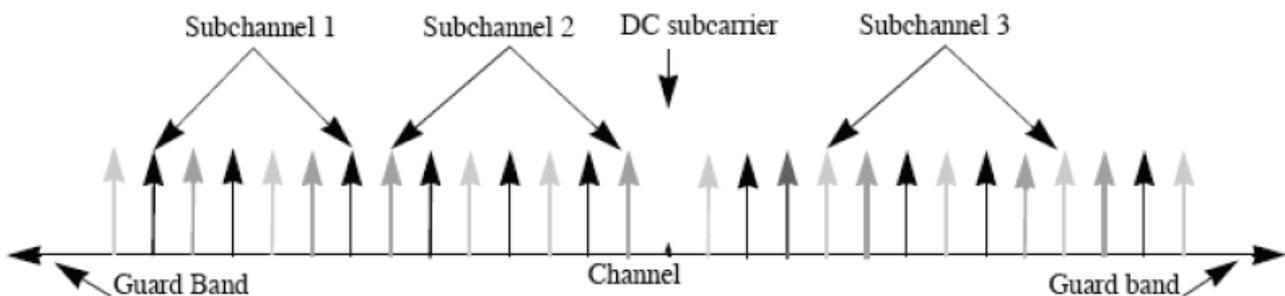
Subcarriers are used for three purposes:

— Data transmission

— Pilot transmission, for various estimation purposes

— Null transmission, for guard bands and at DC

The concept is illustrated in Fig. 2. As indicated, the subcarriers forming one subchannel need not be adjacent.

FIGURE 2

OFDMA frequency description, schematically showing three subchannels

Subchannelization is a multiple access technique. It provides OFDMA systems increased scheduling flexibility and a number of performance advantages, including enhanced scalability and advanced antenna array processing capabilities.

5.6.1.3.2 IP-OFDMA Physical Layer Details

The IP-OFDMA PHY utilizes OFDMA with either 512 subcarriers in a 5 MHz channel or 1024 subcarriers in a 10 MHz channel. The primitive PHY parameters are listed in Table 1.

TABLE 1

IP-OFDMA Primitive PHY Parameters

| FFT Size (N_{FFT})	512	1024
System Channel Bandwidth (*BW*)	5 MHz	10 MHz
Sampling Frequency (F_s)	5.6 MHz	11.2 MHz
Subcarrier Frequency Spacing ($\Delta f = F_s / N_{FFT}$)	10.9375 kHz	
Useful Symbol Time ($T_b = 1 / \Delta f$)	~91.43 μs	
Guard (CP) Time ($T_g = T_b / 8$)	~11.43 μs	
OFDMA Symbol Duration ($T_s = T_b + T_g$)	~102.9 μs	
Frame Duration	5 ms	
OFDMA Symbols per frame	48	

5.6.1.3.3 Framing and Subchannelization

IP-OFDMA PHY utilizes a 5 ms TDD frame. The frame includes first downlink and then uplink subframes, divided by a time gaps to allow the transceivers to switch between receive and transmit. The two gaps (TTG and RTG) are both included in the 5 ms duration. The asymmetry between the uplink and downlink subframe durations is configurable on a systemwide basis.

The frame structure is illustrated schematically in Fig. 3.

FIGURE 3

Schematic illustration of frame structure
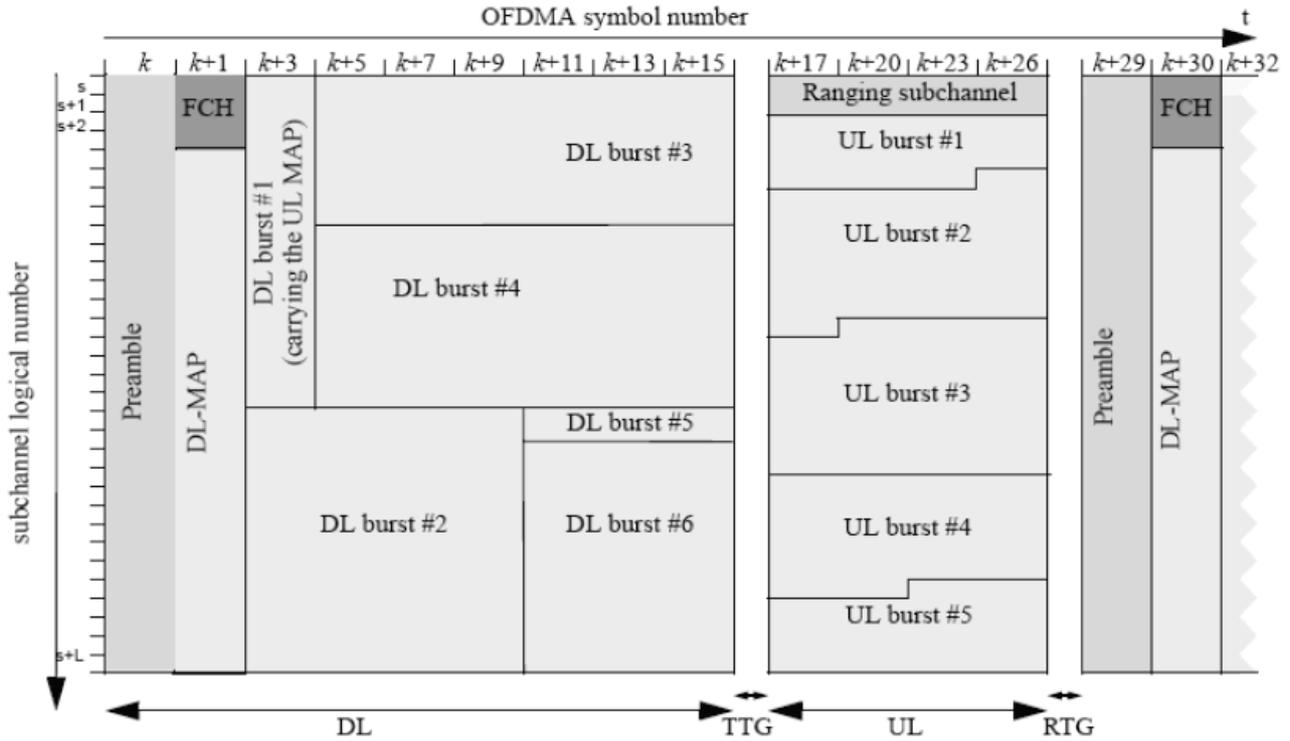
The frame is shown in two dimensions. The horizontal dimension represents time, which maps directly into the OFDM symbol sequence. The vertical dimension represents the list of available logical subchannels. This maps into frequency, although only indirectly, since the subcarriers in a given logical channel are not arranged in sequential order.

The frame begins with a preamble for synchronization. The following OFDM symbol contains the frame control header (FCH) and the downlink map (DL_MAP), transmitted simultaneously on different subchannels. The FCH includes frame configuration data. The DL-MAP indicates the use of the DL subframe, in time and subchannel allocation. The UL-MAP that follows provides similar information for the uplink, though the allocation is relevant not to the current frame but to a subsequent one, in order to allow the SS time to prepare an appropriate transmission er in accordance with the UL-MAP.

The construction of the subchannel from individual subcarriers is called the permutation. IP-OFDMA provides a number of possible permutations. The optimal choice depends on the deployment scenario and instantaneous circumstances; therefore, the permutation may differ from one ODFM symbol to the next. The specification supports a sequence of permutation zones in the frame, so that different subscriber stations can be served with different permutations.

5.6.1.3.4 Adaptive Modulation and Coding

IP-OFDMA supports a variety of modulation and coding alternatives. The control is adaptive and dynamic, so that the BS may select different options for communicating with different SSs and may order the SS to alter the choices in order to optimize the tradeoff of robustness versus capacity.

The BS selects the modulation from among QPSK, 16QAM, and 64QAM. For forward error correction, Convolutional Coding and Convolutional Turbo Coding with variable code rate and repetition coding are specified. Block Turbo Code and Low Density Parity Check Code (LDPC) are supported as optional features.

Data randomization is specified in order to reduce the peak-to-average power ratio. Interleaving is specified to increase frequency diversity.

5.6.1.3.5 Fast feedback and Hybrid ARQ

IP-OFDMA specifies an uplink fast-feedback channel to provide time-critical PHY parameter data to the BS. Parameters include signal-to-noise ratio, MIMO coefficients, and MIMO configuration parameters.

Additional UL acknowledgment channels may be allocated by the BS to support hybrid automatic repeat request (HARQ).

5.6.1.4 Layer 2: Medium Access Control Layer (MAC)

The medium access control layer (MAC) functionality controls access to the medium, which in this case is the radio spectrum. The MAC is also responsible for basic functions such as data encapsulation, fragmentation, radio resource control, radio link control, error detection and retransmission, QoS, security, sleep mode, and handover.

Although the IP-OFDMA radio interface is designed primarily to support a connectionless network layer, such as IP, the IP-OFDMA MAC is connection-oriented. All services, including inherently connectionless services, are mapped to a connection. The connection provides a mechanism for requesting resource allocation, associating QoS and traffic parameters, transporting and routing data, and all other actions associated with the terms of the service. A 16-bit connection identifier (CID) is assigned to designate each connection. The MAC uses the CID to identify all information exchanged between BS and SS, including management and broadcast data. The CID provides a simple and direct way to differentiate traffic. All MAC-level QoS functions, such as the classifier and QoS scheduler, use the CID to identify and differentiate traffic in order to maintain the service level and fairness among connections.

5.6.1.4.1 Convergence Sublayer (CS)

At the transmitter side, the Convergence Sublayer is responsible for transforming packet-based protocol data units from the higher layer protocol into MAC service data unit (SDUs), possibly using payload header suppression (PHS) to suppress some of the packet headers and reduce the burden of carrying them over the air. The CS then classifies each MAC SDU, assigning it to a particular connection, and passes it to the MAC CPS. At the receiver side, the CS is responsible for the inverse operations, including reassembly of packets into their original format with complete headers.

The CS contains a classification function that determines on which connection a particular packet shall be carried and which PHS rule applies for that packet. The operation is illustrated in Figure 4, which shows the downlink case. Classifier parameters are configured during dynamic service signaling.

FIGURE 4

Classification and CID mapping (downlink)
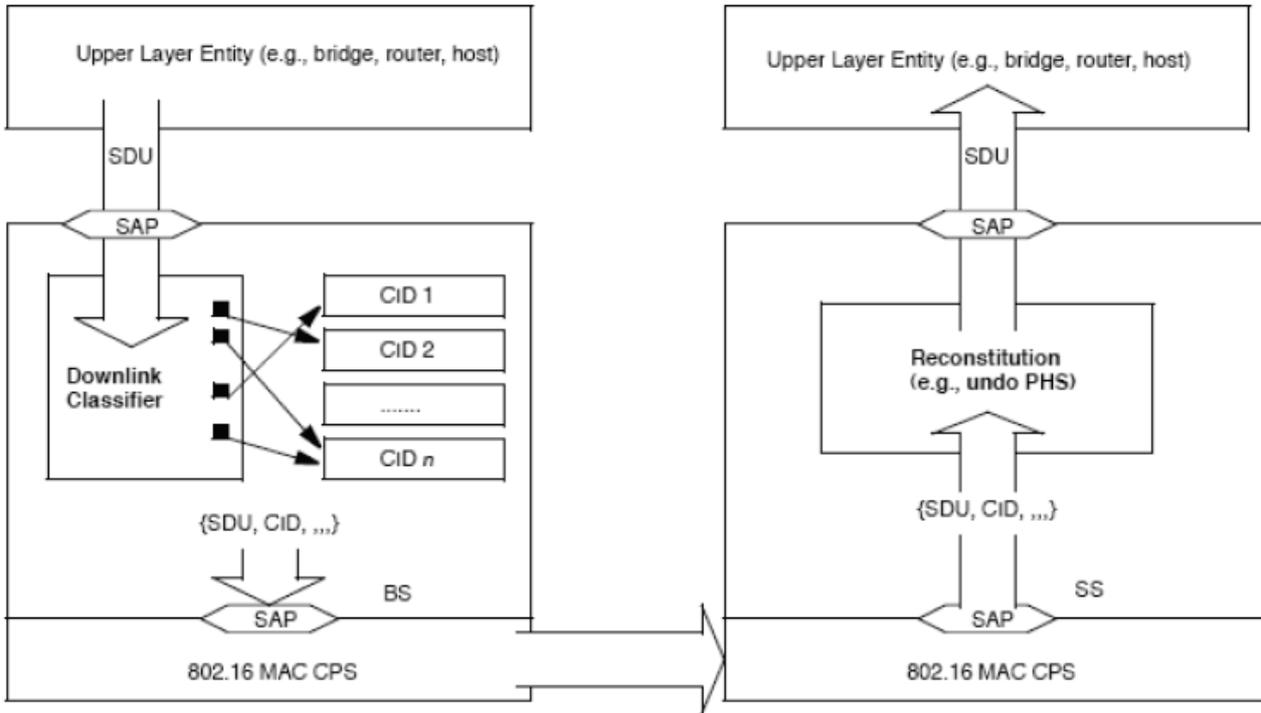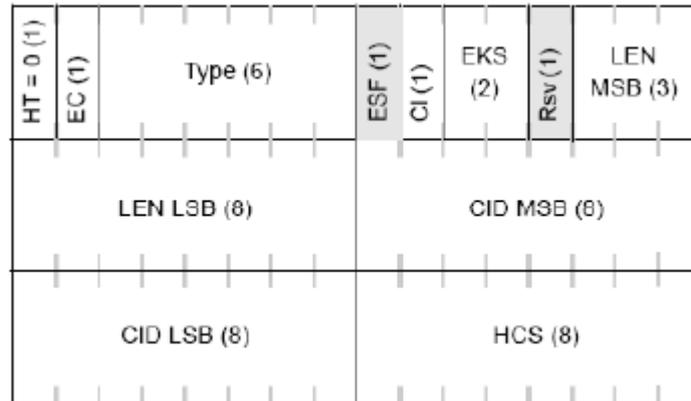

5.6.1.4.2 MAC Common Part Sublayer (CPS)

The MAC CPS is responsible for performing the core MAC functions. It receives MAC service data units (SDUs) from the CS and encapsulates them in its native MAC PDU format for transmission over the PHY. The MAC CPS also manages the transport connections and QoS, controlling access to the radio spectrum by the SSs.

Encapsulation may be as simple as adding necessary information to the SDU. However, the MAC CPS also has the possibility of dividing a single SDU into multiple fragments before transmission, for reassembly at the receiving MAC CPS. Fragmentation allows more efficient support of higher layer protocols with variable-size SDUs, given that the underlying PHY used a fixed frame size. The MAC CPS also has the complementary option to pack multiple higher layer payloads into a single PDU. Since MAC encapsulation introduces some fixed overhead per PDU, this can improve the efficiency of carrying small SDUs.

A MAC PDU consists of a six-byte MAC header, a variable-length payload, and an optional cyclic redundancy check. Four header formats, distinguished by the HT field, are defined. The generic header is shown in Fig. 5.

FIGURE 5

Generic MAC header format

HT = 0 (1)	EC (1)	Type (6)	ESF (1)	CI (1)	EKS (2)	Rsv (1)	LEN MSB (3)
LEN LSB (8)			CID MSB (8)				
CID LSB (8)			HCS (8)				

MAC PDUs generally contain either MAC management messages or convergence sublayer data. However, one header type is reserved for uplink PDUs that contain no payload, conveying their information (such as a resource request) in the content of the header itself. Additional subheaders are also defined. For example, the SS can use the grant management subheader to convey bandwidth management needs to the BS. The fragmentation subheader contains information that indicates the presence and orientation in the payload of any fragments of SDUs. The packing subheader is used to indicate the packing of multiple SDUs into a single PDU. The grant management and fragmentation subheaders may be inserted in MAC PDUs immediately following the generic header if so indicated by the Type field. The packing subheader may be inserted before each MAC SDU if so indicated by the Type field.

5.6.1.4.2.1 Uplink scheduling services

The scheduling algorithm is not specified in the standard but is critical to efficient multimedia delivery when the BS supports a variety of disparate connections. The BS is presumed capable of scheduling its own downlink transmissions based on QoS information developed in the CS. Uplink scheduling is more complicated because, while resource allocation is under the control of the BS, only the SSs know in real time their immediate transmission demands.

In order to allow efficient QoS-based scheduling, a number of uplink scheduling services are defined, with a specific service assigned to each connection. The QoS categories are summarized in Table 2.

TABLE 2

IP-OFDMA Uplink scheduling services

QoS Category	Typical Applications	QoS Specifications
UGS Unsolicited Grant Service	VoIP	• Maximum Sustained Rate • Maximum Latency Tolerance • Jitter Tolerance
rtPS Real-Time Packet Service	Streaming Audio or Video	• Minimum Reserved Rate • Maximum Sustained Rate • Maximum Latency Tolerance • Traffic Priority
ErtPS Extended Real-Time Packet Service	Voice with Activity Detection (VoIP)	• Minimum Reserved Rate • Maximum Sustained Rate • Maximum Latency Tolerance • Jitter Tolerance • Traffic Priority
nrtPS Non-Real-Time Packet Service	File Transfer Protocol (FTP)	• Minimum Reserved Rate • Maximum Sustained Rate • Traffic Priority
BE Best-Effort Service	Data Transfer, Web Browsing, etc.	• Maximum Sustained Rate • Traffic Priority

Resource requests, for transmission slots, are initiated by a specific connection at the SS. However, grants are allocated not to the connection but to the supporting SS. The SS is required to manage the slots allocated to it, assigning them to the multiple connections it supports. By distributing the management and permitting local resource allocation, over-the-air negotiation is minimized and rescheduling decisions are made more quickly and effectively.

5.6.1.4.2.2 Radio Link Control

As noted in Section 5.6.1.3.2, IP-OFDMA supports adaptive modulation and coding. The MAC CPS is responsible for radio link control. This involves managing the modulation and coding selection at the SS through interactive message exchange based on monitoring the ratio of carrier signal to noise and interference.

5.6.1.4.2.3 Energy conservation in the mobile SS

The IP-OFDMA MAC CPS controls two energy-saving modes –Sleep Mode and Idle Mode – to conserve energy in the mobile SS. During Sleep Mode, the SS observes pre-negotiated periods without transmission. Idle Mode is intended as a mechanism to allow the SS to become periodically available for DL broadcast messaging without registration at a specific BS as the SS traverses an air link environment populated by multiple BSs, typically over a large geographic area.

5.6.1.4.2.4 Handover

The IP-OFDMA MAC CPS supports three handover methods – Hard Handover (HHO), Fast Base Station Switching (FBSS) and Macro Diversity Handover (MDHO).

5.6.1.4.3 Security sublayer

The security sublayer, which operates between the PHY and the MAC CPS, is responsible for providing strong encryption, decryption, mutual authentication, and secure key exchange. Security is maintained as a separate sublayer so that it may be upgraded as necessary. Also, the key functionality internal to the sublayer is also modular, to provide easy maintenance upgrade. For example, the protocol provides a means of identifying one from a set of supported cryptographic suites, each of which specifies data encryption and authentication algorithms, and the rules for applying those algorithms to a MAC PDU payload.

The IP-OFDMA security sublayer utilizes a security association (SA), which is a set of information shared between the transmitter and receiver. Each SA contains information on the cryptographic suite used for that SA and may also contain keys, such as the traffic encryption keys (TEKs), along with the key lifetimes and other associated state information. Prior to transmission, the MAC PDUs are mapped to an SA. The receiver uses the CID to determine the correct SA and applies the corresponding processing to the received PDU.

Device and user authentication use the IETF EAP protocol. IP-OFDMA encrypts user data using the AES-CCM cryptographic suite, with the Advanced Encryption Standard (AES) algorithm in the counter with CBC-MAC (CCM) mode, with 128-bit keys. The keys are generated using EAP authentication and managed by a Traffic Encryption Key (TEK) state machine. MAC management messages are AES encrypted and authenticated. A three-way handshake scheme is supported to optimize re-authentication during handover.

5.6.1.5 Smart antennas

IP-OFDMA specifies the use of smart antenna technologies, including antenna beamforming, space-time coding, and spatial multiplexing, which increase the cell size, data throughput, and spectral efficiency. These techniques reduce the sensitivity of the system to fading and multipath transmission effects.

5.6.2 Detailed specification of the radio interface

The standards contained in this section are derived from IEEE Standard 802.16. The global core specifications for IMT-2000 IP-OFDMA are contained at http://ties.itu.int/u/itu-r/ede/rsg8/wp8f/wp8f-tech/GCSrev5/5-6/.

5.6.2.1 IEEE Standard 802.16

IEEE Standard 802.16 describes the IP-OFDMA radio interface.

SDO	Document No.	Status	Issued date	Location
IEEE	802.16-2004	Published	01/10/2004	http://standards.ieee.org/getieee802/802.16.html
IEEE	802.16e-2005 & Cor1	Published	28/02/2006	http://standards.ieee.org/getieee802/802.16.html
IEEE	802.16f-2005	Published	01/12/2005	http://standards.ieee.org/getieee802/802.16.html

6 Recommendations (satellite component) *[no edits]*

7 Recommendations on unwanted emission limits *[no edits]*

Attachment 3

Description Template: A1 and A2

A1.1	Test environment support	
A1.1.1	In what test environments will the RTT operate?	- indoor - outdoor to indoor and pedestrian, - vehicular - mixed
A1.1.2	If the RTT supports more than one test environment, what test environment does this technology description template address?	One template for all
A1.1.3	Does the RTT include any features in support of FWA application? Provide detail about the impact of those features on the technical parameters provided in this template, stating whether the technical parameters provided apply for mobile as well as for FWA applications.	Yes (cf. Recommendation ITU-R F.1763). Flexible mixed fixed and mobile design. - QoS - Dynamic bandwidth allocation - Continuous and variable bit rate support - Support of nomadic operation - Support of fixed wireless voice, image, video and data services.
A1.2	Technical parameters NOTE 1 – Parameters for both forward link and reverse link should be described separately, if necessary.	
A1.2.1	What is the minimum frequency band required to deploy the system (MHz)?	5 MHz or 10 MHz (10 MHz provides better performance).
A1.2.2	What is the duplex method: TDD or FDD?	TDD
A1.2.2.1	What is the minimum up/down frequency separation for FDD?	N/A
A1.2.2.2	What is requirement of transmit/receive isolation? Does the proposal require a duplexer in either the mobile station (MS) or BS?	Does not require a duplexer.
A1.2.3	Does the RTT allow asymmetric transmission to use the available spectrum? Characterize.	Yes. The ratio of uplink to downlink transmission can be reconfigured on a system-wide basis.
A1.2.4	What is the RF channel spacing (kHz)? In addition, does the RTT use an interleaved frequency plan? NOTE 1 – The use of the second adjacent channel instead of the adjacent channel at a neighbouring cluster cell is called "interleaved frequency planning". If a proponent is going to employ an interleaved frequency plan, the proponent should state so in § A1.2.4 and complete § A1.2.15 with the protection ratio for both the adjacent and second adjacent channel.	5000 kHz or 10000 kHz The RTT does not use an interleaved frequency plan
A1.2.5	What is the bandwidth per duplex RF channel (MHz) measured at the 3 dB down points? It is given by (bandwidth per RF channel) × (1 for TDD and 2 for FDD). Provide detail.	For 5 MHz (TDD): about 4.7 MHz, depending on the permutation used. For 10 MHz (TDD): about 9.4 MHz, depending on the

		permutation used.
A1.2.5.1	Does the proposal offer multiple or variable RF channel bandwidth capability? If so, are multiple bandwidths or variable bandwidths provided for the purposes of compensating the transmission medium for impairments but intended to be feature transparent to the end user?	The RTT offers variable RF channel bandwidth capability through the use of OFDMA subchannelization.
A1.2.6	What is the RF channel bit rate (kbit/s)? NOTE 1 – The maximum modulation rate of RF (after channel encoding, adding of in-band control signalling and any overhead signalling) possible to transmit carrier over an RF channel, i.e. independent of access technology and of modulation schemes.	DOWNLINK For the 10 MHz case this is the calculation: Distributed permutation of subcarriers Assumptions: 32 data symbols per frame (35 symbols in subframe, 1 symbol for preamble, 2 symbols for control information), 5 ms frame duration, 64 QAM 5/6 code rate, 30 slots for 2 symbols, 48 data tones per slot. Maximum data rate: 23040 kbit/s UPLINK Distributed permutation of subcarriers Assumptions: 18 data symbols per frame (21 symbols in UL subframe, 3 symbols for control channels), 5 ms frame duration, 16 QAM 3/4 code rate, 35 slots for 3 symbols, 48 data tones per slot. Maximum data rate: 6048 kbit/s
A1.2.7	*Frame structure*: describe the frame structure to give sufficient information such as: – frame length, – the number of time slots per frame, – guard time or the number of guard bits, – user information bit rate for each time slot, – channel bit rate (after channel coding), – channel symbol rate (after modulation), – associated control channel (ACCH) bit rate, – power control bit rate. NOTE 1 – Channel coding may include forward error correction (FEC), cyclic redundancy checking (CRC), ACCH, power control bits and guard bits. Provide detail. NOTE 2 – Describe the frame structure for forward link and reverse link, respectively.	Frame length: 5 ms The number of time slots per frame: N/A The number of time symbols per frame: 48 symbols (including TTG and RTG gaps) The number of subcarriers per each symbol: 1024 FFT Resource allocation: 2 dimensional structure for frequency and time (see section 2.4 of the RTT System Description for more details) Subchannel structure: see Section 2.2 of the RTT System Description for details Ratio of DL and UL subframe: Ranging from

	NOTE 3 – Describe the frame structure for each user information rate.		35 symbols: 12 symbols to 26 symbols: 21 symbols (DL:UL) TTG / RTG : 105.7 _s / 60 _s Common control overhead : 1 symbol per frame for preamble (see section 2.4 of the RTT System Description for more details) DOWNLINK (See A1.2.5.1) Distributed permutation of subcarriers The number of subcarriers per slot : 48 (data) + 8 (pilots) Guard subcarrier: 184 (including DC subcarrier) The channel bit or symbol rate is variable, depending on the number of allocated slots, and the modulation and coding rate. Power control rate: no power control Adjacent permutation of subcarriers The number of subcarriers per slot : 48 (data) + 6 (pilots) Guard subcarrier : 160 (including DC subcarrier) UPLINK Distributed permutation of subcarriers The number of subcarriers per slot : 48 (data) + 24 (pilots) Guard subcarrier : 184 (including DC subcarrier) The channel bit or symbol rate is variable, depending on the number of allocated slots, and the modulation and coding rate. Power control rate : 200 Hz Adjacent permutation of subcarriers The number of subcarriers per slot : 48 (data) + 6 (pilots) Guard subcarrier : 160 (including DC subcarrier)
A1.2.8	Does the RTT use frequency hopping? If so, characterize and explain particularly the impact (e.g. improvements) on system performance.		No

	particularly the impact (e.g. improvements) on system performance.	
A1.2.8.1	What is the hopping rate?	N/A
A1.2.8.2	What is the number of the hopping frequency sets?	N/A
A1.2.8.3	Are BSs synchronized or non-synchronized?	Synchronized in frequency and in time for TDD operation, even though frequency hopping is not used.
A1.2.9	Does the RTT use a spreading scheme?	No
A1.2.9.1	What is the chip rate (Mchip/s)? Rate at input to modulator.	N/A
A1.2.9.2	What is the processing gain? 10 log (chip rate/information rate).	N/A
A1.2.9.3	Explain the uplink and downlink code structures and provide the details about the types (e.g. personal numbering (PN) code, Walsh code) and purposes (e.g. spreading, identification, etc.) of the codes.	N/A
A1.2.10	Which access technology does the proposal use: TDMA, FDMA, CDMA, hybrid, or a new technology? In the case of CDMA, which type of CDMA is used: frequency hopping (FH) or direct sequence (DS) or hybrid? Characterize.	OFDMA
A1.2.11	What is the baseband modulation technique? If both the data modulation and spreading modulation are required, describe in detail. What is the peak to average power ratio after baseband filtering (dB)?	DOWNLINK QPSK, 16 QAM, 64 QAM for data modulation. Spreading modulation does not apply. UPLINK QPSK, 16 QAM for data modulation. Spreading modulation does not apply. PAPR is about 12 dB without any PAPR reduction scheme.
A1.2.12	What are the channel coding (error handling) rate and form for both the forward and reverse links? E.g., does the RTT adopt: – FEC or other schemes? – Unequal error protection? Provide details. – Soft decision decoding or hard decision decoding? Provide details. – Iterative decoding (e.g. turbo codes)? Provide details. – Other schemes?	Convolutional Coding and Convolutional Turbo Coding are supported Modulation schemes: QPSK, 16 QAM and 64 QAM for downlink, QPSK and 16 QAM for uplink. Coding rates: QPSK 1/2, QPSK 3/4, 16 QAM 1/2, 16 QAM 3/4, 64 QAM 1/2, 64 QAM 2/3, 64 QAM 3/4, 64 QAM 5/6. Coding repetition rates: 1x, 2x, 4x and 6x. Unequal error protection: None Soft decision decoding and iterative decoding: It is an implementation issue not covered by the description.
A1.2.13	What is the bit interleaving scheme? Provide detailed description for both uplink and downlink.	The bit interleaving scheme is the same for both uplink and

		uplink and downlink.	the same for both uplink and downlink. All encoded data bits shall be interleaved by a block interleaver with a block size corresponding to the number of coded bits per the encoded block size.
A1.2.14		Describe the approach taken for the receives (MS and BS) to cope with multipath propagation effects (e.g. via equalizer, Rake receiver, etc.).	To cope with the multipath propagation effect, the cyclic prefix and 1-tap equalizer are employed. The length of cyclic prefix is 1/8 of symbol duration thus 11.4 _s.
A1.2.14.1		Describe the robustness to intersymbol interference and the specific delay spread profiles that are best or worst for the proposal.	The intersymbol interference can be removed by the use of sufficiently longer cyclic prefix than delay spread.
A1.2.14.2		Can rapidly changing delay spread profile be accommodated? Describe.	Yes, delay spread variation within the length of cyclic prefix does not cause the intersymbol interference.
A1.2.15		What is the adjacent channel protection ratio? NOTE 1 – In order to maintain robustness to adjacent channel interference, the RTT should have some receiver characteristics that can withstand higher power adjacent channel interference. Specify the maximum allowed relative level of adjacent RF channel power (dBc). Provide detail how this figure is assumed.	Min adjacent channel rejection at BER=10-6 for 3 dB degradation C/I 11 dB – 16 QAM, 3/4 coding rate 4 dB - 64 QAM, 2/3 coding rate Min non-adjacent channel rejection at BER=10-6 for 3 dB degradation C/I 30 dB – 16 QAM, 3/4 coding rate 23 dB - 64 QAM, 2/3 coding rate
A1.2.16		Power classes	Transmit power (dBm) for 16QAM 1. $18 \leq P_{tx,max} < 21$ 2. $21 \leq P_{tx,max} < 25$ 3. $25 \leq P_{tx,max} < 30$ 4. $30 \leq P_{tx,max}$ Transmit power (dBm) for QPSK 1. $20 \leq P_{tx,max} < 23$ 2. $23 \leq P_{tx,max} < 27$ 3. $27 \leq P_{tx,max} < 30$ 4. $30 \leq P_{tx,max}$
A1.2.16.1		*Mobile terminal emitted power* : what is the radiated antenna power measured at the antenna? For terrestrial component, give (dBm). For satellite component, the mobile terminal emitted power should be given in	See A.1.2.16

	e.i.r.p. (effective isotropic radiated power) (dBm).	
A1.2.16.1.1	What is the maximum peak power transmitted while in active or busy state?	See A.1.2.16
A1.2.16.1.2	What is the time average power transmitted while in active or busy state? Provide detailed explanation used to calculate this time average power.	See A.1.2.16
A1.2.16.2	Base station transmit power per RF carrier for terrestrial component	See A.1.2.16
A1.2.16.2.1	What is the maximum peak transmitted power per RF carrier radiated from antenna?	Not limited by RTT
A1.2.16.2.2	What is the average transmitted power per RF carrier radiated from antenna?	Not limited by RTT
A1.2.17	What is the maximum number of voice channels available per RF channel that can be supported at one BS with 1 RF channel (TDD systems) or 1 duplex RF channel pair (FDD systems), while still meeting ITU-T Recommendation G.726 performance requirements?	The maximum number of voice channels per 1 RF channel depends on the bit rate and sampling rate supported by the codecs defined in the G.726. For instance, in case of the bit rate of 16 kbps with 20 msec sampling rate, up to 256 users can be supported simultaneously by a 10 MHz RF channel, while meeting the delay requirements of VoIP. In the case of a 5 MHz channel up to 120 users can be supported.
A1.2.18	*Variable bit rate capabilities* : describe the ways the proposal is able to handle variable baseband transmission rates. For example, does the RTT use: – adaptive source and channel coding as a function of RF signal quality? – Variable data rate as a function of user application? – Variable voice/data channel utilization as a function of traffic mix requirements? Characterize how the bit rate modification is performed. In addition, what are the advantages of your system proposal associated with variable bit rate capabilities?	Variable bit rate is supported by the flexible resource allocation. By assigning the variable number of subchannels and using various modulations and coding rates frame by frame, the bit rate for each user can be variable frame by frame. Modulation and coding rate is usually defined by user's RF signal quality (CQI). For higher data rates, the bit rate information is provided to the receiver via scheduling mechanisms and associated control signalling every frame.
A1.2.18.1	What are the user information bit rates in each variable bit rate mode?	The user information bit rates are variable according to the number of subchannels assigned and modulation and coding rate used. For 10 MHz: DOWNLINK Modulation : QPSK, 16 QAM, 64 QAM Coding rate : 1/2, 2/3, 3/4, 5/6 3312 kbit/s (1/2, QPSK, (DL:UL)=(26:21) symbols) ~ 23040 kbit/s (5/6, 64 QAM, (DL:UL)=(35:12) symbols).

		See equation below.
		UPLINK
		Modulation : QPSK, 16 QAM
		Coding rate : 1/2, 3/4
		1008 kbit/s (1/2, QPSK, (DL:UL)=(35:12) symbols) ~ 6048 kbit/s (3/4, 16 QAM, (DL:UL)=(26:21) symbols). See equation below.
		Equation used: PHY Data Rate=(Data sub-carriers/Symbol period) $\_$ (information bits per symbol)
A1.2.19	What kind of voice coding scheme or codec is assumed to be used in proposed RTT? If the existing specific voice coding scheme or codec is to be used, give the name of it. If a special voice coding scheme or codec (e.g. those not standardized in standardization bodies such as ITU) is indispensable for the proposed RTT, provide detail, e.g. scheme, algorithm, coding rates, coding delays and the number of stochastic code books.	Due to the IP-based characteristics of the radio interface it can utilize any speech codec.
A1.2.19.1	Does the proposal offer multiple voice coding rate capability? Provide detail.	Yes. The RTT supports flexible data rate for each user and also provide variety scheduling services. A constant bit rate is provided by UGS service, while a variable bit rate is provided by ErtPS service. See A.1.2.18, A1.2.20.1 and A1.2.20.2
A1.2.20	*Data services* : are there particular aspects of the proposed technologies which are applicable for the provision of circuit-switched, packet-switched or other data services like asymmetric data services? For each service class (A, B, C and D) a description of RTT services should be provided, at least in terms of bit rate, delay and BER/frame error rate (FER). NOTE 1 – 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. NOTE 2 – See ITU-T Recommendation I.362 for details about the service classes A, B, C and D.	Yes, a wide range of data services and applications with varied QoS requirements are supported. These are summarized in Table 2 of Attachment 2 in this submission.
A1.2.20.1	For delay constrained, connection oriented (Class A).	The RTT provides UGS (unsolicited grant service), corresponding to the Class A. UGS is characterized as constant and low data rates and low delay data service.

A1.2.20.2	For delay constrained, connection oriented, variable bit rate (Class B).	The RTT provides rtPS (real-time polling service), corresponding to the Class B. rtPS is utilized for low to high data rate services. The RTT provides ErtPS (extended real-time polling service) as well. ErtPS is utilized for low data rate and low delay data services.
A1.2.20.3	For delay unconstrained, connection oriented (Class C).	The RTT provides nrtPS (non-real-time polling service), corresponding to the Class C. nrtPS is utilized for high data rate services.
A1.2.20.4	For delay unconstrained, connectionless (Class D).	The RTT provides BE (best effort service) corresponding to the Class D. BE is utilized for moderate data rate services.
A1.2.21	Simultaneous voice/data services: is the proposal capable of providing multiple user services simultaneously with appropriate channel capacity assignment? NOTE 1 – The following describes the different techniques that are inherent or improve to a great extent the technology described above to be presented. Description for both BS and MS are required in attributes from § A1.2.22 through § A1.2.23.2.	Yes, multiple parallel services are supported with different QoS requirements. Each service is associated with a set of QoS parameters that quantify aspects of its behavior. These parameters are managed using the dynamic service provisions, represented by the DSA and DSC message dialog.
A1.2.22	*Power control characteristics* : is a power control scheme included in the proposal? Characterize the impact (e.g. improvements) of supported power control schemes on system performance.	Yes. A closed loop power control scheme and an open loop power control scheme are included. By means of these power control schemes, the interference level is reduced and the uplink system level throughput is increased.
A1.2.22.1	What is the power control step size (dB)?	Power control step size is variable ranging from 0.25 dB to 32 dB. An 8-bit signed integer in power control information element indicates the power control step size in 0.25 dB units. Normally implemented in 1

		dB increments.
A1.2.22.2	What are the number of power control cycles per second?	The power control cycle of closed-loop power control is dependent on the rate of power control information element transmission, but less than 200 Hz. Due to TDD nature, the open loop power control cycle is inherently identical to the number of frames per seconds, thus 200 Hz.
A1.2.22.3	What is the power control dynamic range (dB)?	The minimum power control dynamic range is 45 dB.
A1.2.22.4	What is the minimum transmit power level with power control?	The RTT supports 45 dB under the full power assumption
A1.2.22.5	What is the residual power variation after power control when RTT is operating? Provide details about the circumstances (e.g. in terms of system characteristics, environment, deployment, MS-speed, etc.) under which this residual power variation appears and which impact it has on the system performance.	The accuracy for power level control can vary from +/-0.5 dB to +/-2 dB depending on the power control step size. +/- 0.5 dB for step size +/-1 dB +/- 1.0 dB for step size +/-2 dB +/- 1.5 dB for step size +/-3 dB +/- 2.0 dB for otherwise
A1.2.23	*Diversity combining in MS and BS* : are diversity combining schemes incorporated in the design of the RTT?	Yes.
A1.2.23.1	Describe the diversity techniques applied in the MS and at the BS, including micro diversity and macro diversity, characterizing the type of diversity used, for example: – time diversity: repetition, Rake-receiver, etc., – space diversity: multiple sectors, multiple satellite, etc., – frequency diversity: FH, wideband transmission, etc., – code diversity: multiple PN codes, multiple FH code, etc., – other scheme. Characterize the diversity combining algorithm, for example, switch diversity, maximal ratio combining, equal gain combining. Additionally, provide supporting values for the number of receivers (or demodulators) per cell per mobile user. State the dB of performance improvement introduced by the use of diversity. For the MS: what is the minimum number of RF receivers (or demodulators) per mobile unit and what is the minimum number of antennas per mobile unit required for the purpose of diversity reception? These numbers should be consistent to that assumed in the link budget template of Annex 2 and that assumed in the calculation of the "capacity" defined at § A1.3.1.5.	The standard supports beamforming, transmit/receive diversity and MIMO. The receiver also supports maximal ratio combining. There is no need for a Rake receiver because it is an OFDM system.
A1.2.23.2	What is the degree of improvement expected (dB)? Also indicate the assumed conditions such as BER and FER.	

A1.2.24	*Handover/automatic radio link transfer (ALT)* : do the radio transmission technologies support handover? Characterize the type of handover strategy (or strategies) which may be supported, e.g. MS assisted handover. Give explanations on potential advantages, e.g. possible choice of handover algorithms. Provide evidence whenever possible.	Yes. The RTT supports handover and also provides means for expediting handover. Each base station broadcasts the information on the list of neighboring base stations and their channel information such as the operating center frequency, preamble index and synchronization periodically. The channel information in this broadcasting is used for a mobile station to synchronize with the neighboring base station. After a mobile station monitors the signal strength of a neighboring base station and seeks suitable base station(s) for handover, the mobile station or its serving base station can initiate handover by handover request message. But only the mobile station can transmit handover indication message to the its serving base station. After transmitting handover indication message, the mobile station stops monitoring the downlink frame of its serving base station and performs network re-entry to target base station. To reduce the handover latency further, the serving base station provides the target base station with network entry information on a mobile station to be handed over the target base station. Further information is available in the IEEE 802.16 standard; Section 6.3.22 MAC layer handover procedures.
A1.2.24.1	What is the break duration (s) when a handover is executed? In this evaluation, a detailed description of the impact of the handover on the service performance should also be given. Explain how the estimate was derived.	
A1.2.24.2	For the proposed RTT, can handover cope with rapid decrease in signal strength (e.g. street corner effect)? Give a detailed description of: – the way the handover detected, initiated and executed, – how long each of this action lasts (minimum/maximum time (ms)), – the time-out periods for these actions.	Yes. A base station broadcasts the criterion which is being used for mobile station to request handover. The mobile station issues handover request message whenever the criterion is met. The handover criterion depends on the implementation but usually the received signal strength by a mobile station is used. Further information is available in the IEEE 802.16 standard; Section 11.1.7

		MOB-NBR-ADV message encodings.
A1.2.25	Characterize how the proposed RTT reacts to the system deployment (e.g. necessity to add new cells and/or new carriers) particularly in terms of frequency planning.	All base stations can use the same frequency or different frequency depending on the frequency reuse deployment scenario. OFDMA subchannelization allows various permutations of subcarriers. A distributed permutation of subcarriers, e.g., PUSC (partial usage of sub-carrier) in this RTT, minimizes interferences from neighboring cells and/or sectors in case of the frequency reuse of 1. Different operators usually use different frequencies.
A1.2.26	*Sharing frequency band capabilities* : to what degree is the proposal able to deal with spectrum sharing among IMT-2000 systems as well as with all other systems: – spectrum sharing between operators, – spectrum sharing between terrestrial and satellite IMT-2000 systems, – spectrum sharing between IMT-2000 and non-IMT-2000 systems, – other sharing schemes.	The proposed RTT utilizes OFDMA which has inherent interference protection capabilities due to allocation of a varying subset of available sub-carriers to different users. This capability, complemented by interference mitigation techniques described in ITU-R Report M.2045 such as use of appropriate filters and linear power amplifiers would ensure excellent potential for optimum spectrum sharing between the proposed RTT and other IMT-2000 systems. ITU-R WP 8F is in the process of performing sharing studies between fixed/nomadic and mobile IEEE 802.16 and IMT-2000. Preliminary results show similarities with the case of coexistence between IMT-2000 TDD and FDD technologies as captured in Reports ITU-R M.2030 and M.2045.
A1.2.27	*Dynamic channel allocation* : characterize the dynamic channel allocation (DCA) schemes which may be supported and characterize their impact on system performance (e.g. in terms of adaptability to varying interference conditions, adaptability to varying traffic conditions, capability to avoid frequency planning, impact on the reuse distance, etc.).	Various permutations of OFDMA subcarriers enable dynamic usage of the spectrum among cells to balance the load and/or average interferences.
A1.2.28	*Mixed cell architecture* : how well does the RTT accommodate mixed cell architectures (pico, micro and macrocells)? Does the proposal provide pico, micro and macro cell user service in a single licensed spectrum assignment, with handoff as required between them? (terrestrial component only). NOTE 1 – Cell definitions are as follows: – pico – cell hex radius: $r < 100$ m – micro: 100 m $< r < 1\ 000$ m	The proposed RTT can support flexible frequency reuse operation thus mixed cell architecture is supported well on the same or different frequencies depending on the implementation.

	– macro: $r > 1\,000$ m.	
A1.2.29	Describe any battery saver/intermittent reception capability.	
A1.2.29.1	*Ability of the MS to conserve standby battery power* : provide details about how the proposal conserves standby battery power.	The battery power saving of mobile station is supported by the sleep mode and the idle mode operations. Since the RTT basically provides packet-based transmission, both two modes operate in a slotted mode. In those modes, a mobile station communicates to its serving base station only in a listening interval and saves its power consumption otherwise. The information on listening, sleep and idle intervals are determined by the negotiation between the base station and the mobile station before the mobile station transits to either of two modes. A mobile station maintains the connection to its serving base station even in the sleep mode, while a mobile station in the idle mode returns system resources relevant to the existing connection to a base station. In latter case, the mobile station is managed by the multiple base stations grouped in a paging zone. Further information can be found in the IEEE 802.16 standard Sections 6.3.21, Sleep Mode, and 6.3.24, Idle Mode.
A1.2.30	*Signalling transmission scheme* : if the proposed system will use RTTs for signalling transmission different from those for user data transmission, describe the details of the signalling transmission scheme over the radio interface between terminals and base (satellite) stations.	The same RTT is used for both user data and signalling transmission.
A1.2.30.1	Describe the different signalling transfer schemes which may be supported, e.g. in connection with a call, outside a call. Does the RTT support: – new techniques? Characterize. – Signalling enhancements for the delivery of multimedia services? Characterize.	Flexible message-based signalling scheme is used.
A1.2.31	Does the RTT support a bandwidth on demand (BOD) capability? BOD refers specifically to the ability of an end-user to request multi-bearer services. Typically, this is given as the capacity in the form of bits per second of throughput. Multi-bearer services can be implemented by using such technologies as multi-carrier, multi-time slot or multi-codes. If so, characterize these capabilities. NOTE 1 – BOD does not refer to the self-adaptive feature of the radio channel to cope with changes in the transmission quality (see § A1.2.5.1).	Yes. The scheduling service is provided for both downlink and uplink traffic. In order for the scheduler to make an efficient resource allocation and provide the desired QoS and data rate in the uplink, mobile stations must feedback accurate and timely information as to the traffic conditions and QoS requirements. To this end, multiple uplink bandwidth request mechanisms, such as

		bandwidth request through ranging channel, piggyback request and polling are provided to support uplink bandwidth requests. Frequency and time resource allocation in both downlink and uplink is on a per frame basis to duly react to the traffic and channel conditions. Additionally, the amount of resource in each allocation can range from one slot to the entire frame. Further information can be found in the IEEE 802.16 standard, Sections 6.3.6 Bandwidth Allocation and Request mechanism, 6.3.7.3 DL-MAP, 6.3.7.4 UL-MAP, and 8.4.4 Frame Structure.
A1.2.32	Does the RTT support channel aggregation capability to achieve higher user bit rates?	No.

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