Project	IEEE 802.16 Broadband Wireless Access Working Group <http://ieee802.org/16>
Title	M.1225 RTT Description Template for IEEE 802.16 ITU-R Liaison Correspondence Group
Date Submitted	2006-11-11
Source(s)	Editors: Jose Puthenkulam [mailto:jose.p.puthenkulam@intel.com] Shailender Timiri [mailto:shailender.b.timiri@intel.com] Intel Corporation Euntaek Lim [mailto:et.lim@samsung.com] Hakju Lee [mailto:hakju00.lee@samsung.com] Samsung Electronics Contributors: Reza Arefi, [mailto:reza.arefi@intel.com] Apostolos Papathanassiou, [mailto: apostolos.papathanassiou@intel.com] Hassan Yaghoobi [mailto:hassan.yaghoobi@intel.com] Intel Corporation Wonil Roh, [mailto:wonil.roh@samsung.com] Jiho Jang, [mailto:jiho.jang@samsung.com] Jaeyong Lee [mailto:jyken.lee@samsung.com] Geunhwi Lim [mailto:geunhwi.lim@samsung.com] DS Park [mailto:dspark@samsung.com] Samsung Electronics Mark Cudak [mailto:mark.cudak@motorola.com] Motorola Inc.
Re:	Call for Contributions: Proposed Contribution to ITU-R WP 8F Regarding IMT-2000 Proposal
Abstract	This contribution is the M.1225 Annex 1 draft section which is part of the M.1457 application proposal
Purpose	For discussion and decision
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Contribution for Recommendation ITU-R M.1225 Annex 1

Introduction

This contribution proposes updates to the M.1225 Annex 1 that was developed in IEEE 802.16 WG in Mont-Tremblant in September 2006. This in reply to the call for contributions IEEE L802.16-06/024 that was issued by 802.16 on Sept 28, 2006.

Radio Transmission Technology (RTT) Description Template

Attachment 1

TABLE CONTENTS

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. 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 and data services Etc. Yes, see Recommendation ITU-R F.1763
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)?	10 MHz. Even though system can function in 5MHz, 10 MHz is recommended for optimal 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? 10000 KHz 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.	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.	Nominally 10 MHz (TDD). Measured at the 3dB down points is roughly about 9.4MHz, 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 Distributed permutation of subcarriers Assumptions: 32 data symbols per frame (35 symbols in subframe, 1 symbol for preamble, 2 symbols for control information), 5msec frame duration, 64QAM 5/6 code rate, 30 slots for 2 symbols, 48 data tones per slot. Maximum data rate: 23040kbit/s UPLINK Distributed permutation of subcarriers Assumptions: 18 data symbols per frame (21 symbols in UL subframe, 3 symbols for control channels), 5msec frame duration, 16QAM 3/4 code rate, 35 slots for 3 symbols, 48 data tones per slot. Maximum data rate: 6048kbit/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. NOTE 3 – Describe the frame structure for each user information rate.	Frame length : 5ms The number of time slots per frame : N/A The number of time symbols per frame : 47 symbols 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 35 symbols:12 symbols to 26 symbols:21 symbols (DL:UL) TTG / RTG : 105.7 _sec / 60 _sec Common control overhead : 1 symbol per frame for preamble (see section 2.4 of the RTT System Description for more details) <u>DOWNLINK</u> (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

A1.2.8	Does the RTT use frequency hopping? If so, characterize and explain particularly the impact (e.g. improvements) on system performance.	No
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?	N/A
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 is mandatory and Convolutional Turbo Coding is also supported Modulation schemes: QPSK, 16QAM and 64QAM for downlink, QPSK and 16QAM for uplink. Coding rates: QPSK 1/2, QPSK 3/4, 16QAM 1/2, 16QAM 3/4, 64QAM 1/2, 64QAM 2/3, 64QAM 3/4, 64QAM 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 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 _sec.
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 - 16QAM, 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 - 16QAM, 3/4 coding rate 23 dB - 64 QAM, 2/3 coding rate
A1.2.16	Power classes	Transmit power (dBm) for 16QAM 1. 18 <= Ptx,max < 21 2. 21 <= Ptx,max < 25 3. 25 <= Ptx,max < 30 4. 30 <= Ptx,max Transmit power (dBm) for QPSK 1. 20 <= Ptx,max < 23 2. 23 <= Ptx,max < 27 3. 27 <= Ptx,max < 30 4. 30 <= Ptx,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 e.i.r.p. (effective isotropic radiated power) (dBm).	See A.1.2.16
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 16kbps with 20msec sampling rate, up to 256 users can be supported simultaneously by a RF channel.
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, bit rate 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 subachannels assigned and modulation and coding rate used. DOWNLINK Modulation : QPSK, 16QAM, 64QAM Coding rate : 1/2, 2/3, 3/4, 5/6 3312 kbps(1/2, QPSK, (DL:UL)=(26:21) symbols) ~ 23040 kbps(5/6, 64QAM, (DL:UL)=(35:12) symbols)* UPLINK Modulation : QPSK, 16QAM Coding rate : 1/2, 3/4 1008 kbps(1/2, QPSK, (DL:UL)=(35:12) symbols) ~ 6048 kbps(3/4, 16QAM, (DL:UL)=(26:21) symbols)* *PHY Data Rate=(Data sub-carriers/Symbol period)*(information bits per symbol) [reference by WiMAX white paper]
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 users 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 application with varied QoS requirements are supported. These are summarized together with guidelines for bit rate, latency, traffic priority and jitter to assure a quality user experience. And it enables flexible support of simultaneous use of a diverse set of IP services.
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. Data rates is ranged from 32 Kbps to 64 Kbps and latency is required to be less than 160 msec.

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 characterized as low to high data rates. Data rates is ranged from 5 Kbps to 2 Mbps. The PTT provides ErtPS (extended real-time polling service) as well. ErtPS is characterized as low data rates and low delay data service. Data rates is fixed to 50 Kbps and latency is required to be less than 25 msec.
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 characterized as high data rates service. Data rates is required to be more than 2 Mbps.
A1.2.20.4	For delay unconstrained, connectionless (Class D).	The RTT provides BE (best effort service) corresponding to the Class D. BE is characterized as moderate data rates service. Data rates is ranged from 10 Kbps to 2 Mbps.
A1.2.21	Simultaneous voice/data services: is the proposal capable of providing multiple user services simultaneously with appropriate channel capacity assignment?	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.

	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.	
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 mean 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.
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 45dB.
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 +/-2dB 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 following diversity schemes are provided. Time diversity : interleaving and FEC Space diversity : multiple antennas (Space-time block coding transmission scheme, cyclic delay diversity, receiver diversity) 1 antenna, 2 antennas (optional); The number of BS transmission antenna is 1 while the number of BS receive antennas is up to 4. The number of MS transmission antenna is 1 while the number of MS receive antennas is up to 2. Diversity combining : maximal-ratio combining or MMSE may be used with multiple antennas Frequency diversity : distributed permutation over wideband Minimum number of RF receivers : 1 per MS Minimum number of antennas per mobile unit : 1 per MS

A1.2.23.2	What is the degree of improvement expected (dB)? Also indicate the assumed conditions such as BER and FER.	(See reference [4]) Cyclic delay diversity combining is expected to achieve 3 dB gain. Rx antenna diversity is expected to achieve 3 dB gain (BS and MS with 2 antennas, respectively). With 2x2 MIMO, the spectral efficiency is further improved by 55% to 60% in the downlink and by about 35% in the uplink.

A1.2.24	*Handover/automatic radio link transfer (ALT)* : do the radio transmission technologies support handover? Yes 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.	[See [1] 6.3.22 MAC layer handover procedures] 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.
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.	See Annex C for definitions and details

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.	[See [1] 11.1.7 MOB-NBR-ADV message encodings] 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. Design of criterion depends on the implementation but usually the received signal strength by a mobile station is used.
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 scalable 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. The RF parameters appropriate for use in sharing studies for the above studies have been provided by the WiMAX Forum as indicated by the IEEE and reviewed in the ITU-R Working Parties 8F, 8A, 9B, and 9D.

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. In a PUSC channel (see A1.2.4), all subcarriers are divided into six groups, some of which are allocated to a particular sector and cell. Although at least one group is assigned to each three cell nearby or 3 sector, remains can be assigned as flexible.
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 – macro: $r >$ 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.
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.	[See [1] 6.3.21 Sleep Mode, 6.3.24 Idle Mode] 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.
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. See system description for details.

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).	[See [1] 6.3.6 Bandwidth Allocation and Request mechanism, 6.3.7.3 DL-MAP, 6.3.7.4 UL-MAP, 8.4.4 Frame Structure] 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 per frame basis as as to duly react the traffic and channel conditions. Additionally, the amount of resource in each allocation can range from one slot to the entire frame.
A1.2.32	Does the RTT support channel aggregation capability to achieve higher user bit rates?	No
A1.3	Expected performances.	
A1.3.1	For terrestrial test environment only.	
A1.3.1.1	What is the achievable BER floor level (for voice)? NOTE 1 – The BER floor level is evaluated under the BER measuring conditions defined in Annex 2 using the data rates indicated in § 1 of Annex 2.	Coded BER floor is implementation-dependent but achievable floor is significantly below GoS requirements (10^{-3}) within the specified ranges of tolerable delay spread (20us) and Doppler shifts (250Hz).

A1.3.1.2	What is the achievable BER floor level (for data)? NOTE 1 – The BER floor level is evaluated under the measuring conditions defined in Annex 2 using the data rates indicated in § 1 of Annex 2.	Coded BER floor is implementation-dependent but achievable floor is significantly below GoS requirements (10^{-6}) within the specified ranges of tolerable delay spread (20us) and Doppler shifts (250Hz).
A1.3.1.3	What is the maximum tolerable delay spread (ns) to maintain the voice and data service quality requirements? NOTE 1 – The BER is an error floor level measured with the Doppler shift given in the BER measuring conditions of Annex 2.	The maximum specified range of delay spread (20us in Vehicular B) can be tolerated without an equalizer.
A1.3.1.4	What is the maximum tolerable Doppler shift (Hz) to maintain the voice and data service quality requirements? NOTE 1 – The BER is an error floor level measured with the delay spread given in the BER measuring conditions of Annex 2.	At least 500 Hz, based on the observation that Doppler frequency shows about 570Hz for 250 km/h at 2.5GHz. See supporting material from WiMAX Forum
A1.3.1.5	*Capacity* : the capacity of the radio transmission technology has to be evaluated assuming the deployment models described in Annex 2 and technical parameters from § A1.2.22 through § A1.2.23.2.	
A1.3.1.5.1	What is the voice traffic capacity per cell (not per sector): provide the total traffic that can be supported by a single cell (E/MHz/cell) in a total available assigned non-contiguous bandwidth of 30 MHz (15 MHz forward/15 MHz reverse) for FDD mode or contiguous bandwidth of 30 MHz for TDD mode. Provide capacities for all penetration values defined in the deployment model for the test environment in Annex 2. The procedure to obtain this value is described in Annex 2. The capacity supported by not a standalone cell but a single cell within contiguous service area should be obtained here.	See supporting material from WiMAX Forum
A1.3.1.5.2	What is the information capacity per cell (not per sector): provide the total number of user-channel information bits which can be supported by a single cell (Mbit/s/MHz/cell) in a total available assigned non-contiguous bandwidth of 30 MHz (15 MHz forward/15 MHz reverse) for FDD mode or contiguous bandwidth of 30 MHz for TDD mode. Provide capacities for all penetration values defined in the deployment model for the test environment in Annex 2. The procedure to obtain this value is described in Annex 2. The capacity supported by not a standalone cell but a single cell within contiguous service area should be obtained here.	See reference [4] for details : See supporting material from WiMAX Forum
A1.3.1.6	Does the RTT support sectorization? If yes, provide for each sectorization scheme and the total number of user-channel information bits which can be supported by a single site (Mbit/s/MHz) (and the number of sectors) in a total available assigned non-contiguous bandwidth of 30 MHz (15 MHz forward/15 MHz reverse) in FDD mode or contiguous bandwidth of 30 MHz in TDD mode.	Yes, the RTT supports sectorization. The sectorization and frequency reuse schemes are implementation-dependent and consequently, so are the capacities achieved. The tri-sector scheme is the typical scenario with frequency reuse 1 or reuse 3.

A1.3.1.7	*Coverage efficiency* : the coverage efficiency of the radio transmission technology has to be evaluated assuming the deployment models described in Annex 2.	
A1.3.1.7.1	What is the base site coverage efficiency (km^2/site) for the lowest traffic loading in the voice only deployment model? Lowest traffic loading means the lowest penetration case described in Annex 2.	See supporting material from WiMAX Forum
A1.3.1.7.2	What is the base site coverage efficiency (km^2/site) for the lowest traffic loading in the data only deployment model? Lowest traffic loading means the lowest penetration case described in Annex 2.	See supporting material from WiMAX Forum
A1.3.2	For satellite test environment only	
A1.3.2.1	What is the required C/N_0 to achieve objective performance defined in Annex 2?	
A1.3.2.2	What are the Doppler compensation method and residual Doppler shift after compensation?	
A1.3.2.3	*Capacity* : the spectrum efficiency of the radio transmission technology has to be evaluated assuming the deployment models described in Annex 2.	
A1.3.2.3.1	What is the voice information capacity per required RF bandwidth (bit/s/Hz)?	
A1.3.2.3.2	What is the voice plus data information capacity per required RF bandwidth (bit/s/Hz)?	
A1.3.2.4	*Normalized power efficiency* : the power efficiency of the radio transmission technology has to be evaluated assuming the deployment models described in Annex 2.	
A1.3.2.4.1	What is the supported information bit rate per required carrier power-to-noise density ratio for the given channel performance under the given interference conditions for voice?	
A1.3.2.4.2	What is the supported information bit rate per required carrier power-to-noise density ratio for the given channel performance under the given interference conditions for voice plus data?	
A1.3.3	*Maximum user bit rate (for data)* : specify the maximum user bit rate (kbit/s) available in the deployment models described in Annex 2.	The maximum bit rates are well above 20160 kbps. (DL/UL ratio = 2:1, PUSC, 64QAM, 5/6 coding rate)
A1.3.4	What is the maximum range (m) between a user terminal and a BS (prior to hand-off, relay, etc.) under nominal traffic loading and link impairments as defined in Annex 2?	See supporting material from WiMAX Forum. The maximum range depends on the deployment and the QoS of a connection
A1.3.5	Describe the capability for the use of repeaters.	Repeaters can be used. There is nothing in the technology that precludes the use of repeaters.

A1.3.6	*Antenna systems* : fully describe the antenna systems that can be used and/or have to be used; characterize their impacts on systems performance, (terrestrial only); e.g., does the RTT have the capability for the use of: – remote antennas: describe whether and how remote antenna systems can be used to extend coverage to low traffic density areas; – distributed antennas: describe whether and how distributed antenna designs are used, and in which IMT-2000 test environments; – Smart antennas (e.g., switched beam, adaptive, etc.): describe how smart antennas can be used and what is their impact on system performance; – other antenna systems.	The air-interface does not place any restrictions on the types of antenna systems. In particular, there is extensive support for a full range of smart antenna technologies, including beamforming, Transmit/Receive diversity and MIMO. The uses of remote and distributed antennas are not precluded.
A1.3.7	Delay (for voice)	Voice services are provided in the PS-domain with appropriate QoS setting (UGS, rtPS or ErtPS)
A1.3.7.1	What is the radio transmission processing delay due to the overall process of channel coding, bit interleaving, framing, etc., not including source coding? This is given as transmitter delay from the input of the channel coder to the antenna plus the receiver delay from the antenna to the output of the channel decoder. Provide this information for each service being provided. In addition, a detailed description of how this parameter was calculated is required for both the uplink and the downlink.	The minimum delay is roughly 10ms assuming a 5ms TDD frame and the maximum is implementation and traffic load-dependent (scheduling metric, traffic load, buffer sizes, retransmission scheme etc)
A1.3.7.2	What is the total estimated round trip delay (ms) to include both the processing delay, propagation delay (terrestrial only) and vocoder delay? Give the estimated delay associated with each of the key attributes described in Fig. 6 that make up the total delay provided.	Assuming a 20ms vocoder, 5ms frame and ignoring queuing delay (typically <30ms), the RTD delay is approximately 60ms
A1.3.7.3	Does the proposed RTT need echo control?	Yes
A1.3.8	What is the MOS level for the proposed codec for the relevant test environments given in Annex 2? Specify its absolute MOS value and its relative value with respect to the MOS value of ITU-T Recommendation G.711 (64 k PCM) and ITU-T Recommendation G.726 (32 k ADPCM). NOTE 1 – If a special voice coding algorithm is indispensable for the proposed RTT, the proponent should declare detail with its performance of the codec such as MOS level. (See § A1.2.19)	The RTT supports VoIP and is not limited to any particular codecs. Applications/implementations determine the choice of codec.
A1.3.9	Description of the ability to sustain quality under certain extreme conditions.	

A1.3.9.1	*System overload (terrestrial only)* : characterize system behaviour and performance in such conditions for each test services in Annex 2, including potential impact on adjacent cells. Describe the effect on system performance in terms of blocking grade of service for the cases that the load on a particular cell is 125%, 150%, 175%, and 200% of full load. Also describe the effect of blocking on the immediate adjacent cells. Voice service is to be considered here. Full load means a traffic loading which results in 1% call blocking with the BER of 1×10^{-3} maintained.	The RTT provides many features that can be used to ensure optimal loading in the event of system overload. Among these are admission control, handover, rate adaptation, fractional frequency reuse and power control.
A1.3.9.2	*Hardware failures* : characterize system behaviour and performance in such conditions. Provide detailed explanation on any calculation.	This is implementation-dependent. The RTT does not preclude any means to build in redundancy or other reliability features.
A1.3.9.3	*Interference immunity* : characterize system immunity or protection mechanisms against interference. What is the interference detection method? What is the interference avoidance method?	In addition to frequency reuse, and intelligent scheduling/RRM, the RTT's TDD OFDM interface is inherently robust against delay spread, suitable for multi-user detection and supports various smart antenna schemes. Also, the RTT does not preclude any means to cancel interference or to protect against interference
A1.3.10	Characterize the adaptability of the proposed RTT to different and/or time-varying conditions (e.g. propagation, traffic, etc.) that are not considered in the above attributes of § A1.3.	The RTT supports modulation and coding adaptation, HARQ, power control and opportunistic scheduling
A1.4	Technology design constraints	
A1.4.1	*Frequency stability* : provide transmission frequency stability (not oscillator stability) requirements of the carrier (include long term – 1 year – frequency stability requirements (ppm)).	
A1.4.1.1	For BS transmission (terrestrial component only).	BS frequency tolerance °¬ ± 2ppm of carrier frequency BS to BS frequency accuracy °¬ ± 1% of subcarrier spacing
A1.4.1.2	For MS transmission.	MS to BS frequency synchronization tolerance °¬ 2% of the subcarrier spacing

A1.4.2	*Out-of-band and spurious emissions* : specify the expected levels of base or satellite and mobile transmitter emissions outside the operating channel, as a function of frequency offset.	Base stations and terminals supporting this RTT will comply with local, regional, and international regulations for out of band and spurious emissions, wherever applicable. Similar to other IMT-2000 RTTs, terminals adhering to a single global mask will be used to provide global roaming.
A1.4.3	*Synchronisation requirements* : describe RTT's timing requirements, e.g. – Is BS-to-BS or satellite land earth station (LES)-to-LES synchronisation required? Provide precise information, the type of synchronisation, i.e., synchronisation of carrier frequency, bit clock, spreading code or frame, and their accuracy. – Is BS-to-network synchronisation required? (terrestrial only). – State short-term frequency and timing accuracy of BS (or LES) transmit signal. – State source of external system reference and the accuracy required, if used at BS (or LES) (for example: derived from wireline network, or GPS receiver). – State free run accuracy of MS frequency and timing reference clock. – State base-to-base bit time alignment requirement over a 24 h period (μs).	BS-to-BS synchronisation : Yes. All BSs should be time and frequency synchronized to a common source signal. The common source signal is typically provided by GPS. BS-to-network synchronisation: No. BS-to-network synchronisation is not required. Frequency accuracy : BS frequency tolerance °¬ ± 2ppm of carrier frequency Timing accuracy °¬ 1usec compared to reference timing. Source of external system reference and the accuracy : GPS(the synchronizing reference shall be a 1 pps timing pulse and a 10 MHz frequency reference) Free run accuracy : MS frequency tolerance °¬ maximum 2% of the subcarrier spacing Timing tolerance: 25% of minimum guard interval(± (Tb/32)/4) The BS's timing accuracy is required to be 1•Ï sec compared to reference timing when GPS locked.

A1.4.4	*Timing jitter* : for BS (or LES) and MS give: – the maximum jitter on the transmit signal, – the maximum jitter tolerated on the received signal. Timing jitter is defined as r.m.s. value of the time variance normalized by symbol duration.	BS The BS's timing accuracy is required to be 1•Ï sec compared to reference timing. MS MS Transmit symbol timing accuracy within ± (Tb/32)/4
A1.4.5	*Frequency synthesizer* : what is the required step size, switched speed and frequency range of the frequency synthesizer of MSs?	Frequency step size : 250 KHz Switched speed : 200 •Ï sec Frequency range : 3.5, 5, 7, 8.75, 10 MHz Start frequencies are various, depending on channel bandwidth and profile
A1.4.6	Does the proposed system require capabilities of fixed networks not generally available today?	No

A1.4.6.1	Describe the special requirements on the fixed networks for the handover procedure. Provide handover procedure to be employed in proposed RTT in detail.	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.
A1.4.7	Fixed network feature transparency	
A1.4.7.1	Which service(s) of the standard set of ISDN bearer services can the proposed RTT pass to users without fixed network modification.	Convergence Sublayer in the proposed RTT supports interface to various fixed networks such as ATM, Ethernet, IP, and VLAN.

A1.4.8	Characterize any radio resource control capabilities that exist for the provision of roaming between a private (e.g., closed user group) and a public IMT-2000 operating environment.	Handover between the different access networks is basically supported. Furthermore, Operator ID in the signalling during the handover enable mobile stations to recognize the operator of access network they are handed over to.
A1.4.9	Describe the estimated fixed signalling overhead (e.g., broadcast control channel, power control messaging). Express this information as a percentage of the spectrum which is used for fixed signalling. Provide detailed explanation on your calculations.	The fixed MAP overhead is typically about 10% in a 10MHz channel with a 5ms frame size.

A1.4.10	Characterize the linear and broadband transmitter requirements for BS and MS (terrestrial only).	BS - Tx dynamic Range = 10 dB - Spectral flatness according to the following: °¬ °æ2 dB for spectral lines from °© Nused/4 to 1 and +1 to Nused/4 Within +2/-4 dB for spectral lines from – Nused/2 to Nused/4 and +Nused/4 to Nused/2 - Per sub-carrier flatness °¬ 0.1 dB - Power difference between adjacent subcarriers according to the following: Tx downlink radio frame shall be time-aligned with the 1pps timing pulse within 1 •Ï sec - Tx relative constellation error according to the following: QPSK-1/2 °¬ -15.0 dB QPSK-3/4 °¬ -18.0 dB 16QAM-1/2 °¬ -20.5 dB 16QAM-3/4 °¬ -24.0 dB 64QAM-1/2 (if 64-QAM supported) °¬ -26.0 dB 64QAM-2/3 (if 64-QAM supported) °¬ -28.0 dB 64QAM-3/4 (if 64-QAM supported)°¬ -30.0 dB MS - Tx dynamic Range = 45 dB - Tx power level min adjustment step = 1 dB - Tx power level min relative step accuracy = ± 0.5 dB - Spectral flatness according to the following: °¬ °æ2 dB for spectral lines from °©Nused/4 to °©1 and +1 to Nused/4 Within +2/-4 dB for spectral lines from –Nused/2 to –Nused/4 and +Nused/4 to

A1.4.11	Are linear receivers required? Characterize the linearity requirements for the receivers for BS and MS (terrestrial only).	BS No. The PAPR of the proposed RTT is around 12dB, and which is not required a stringent linear receiver.
A1.4.12	Specify the required dynamic range of receiver (terrestrial only).	BS Max input level on-channel reception tolerance = -45 dBm Max input level on-channel damage tolerance = -10 dBm MS Max input level on-channel reception tolerance = -30 dBm Max input level on-channel damage tolerance = 0 dBm Max input level sensitivity (Distributed permutation of subcarriers) -85.1 dBm - QPSK-3/4 -82.8 dBm - 16QAM-1/2 -78.7 dBm - 16QAM-3/4 -77.6 dBm - 64QAM-1/2 -74.5 dBm - 64QAM-2/3 -73.4 dBm - 64QAM-3/4 -71.5 dBm - 64QAM-5/6 Sensitivity numbers are calculated based on assumption of repetition factor 1

A1.4.13	What are the signal processing estimates for both the handportable and the BS? – MOPS (millions of operations per second) value of parts processed by DSP (digital signal processing), – gate counts excluding DSP, – ROM size requirements for DSP and gate counts (kbytes), – RAM size requirements for DSP and gate counts (kbytes). NOTE 1 – At a minimum the evaluation should review the signal processing estimates (MOPS, memory requirements, gate counts) required for demodulation, equalization, channel coding, error correction, diversity processing (including Rake receivers), adaptive antenna array processing, modulation, A-D and D-A converters and multiplexing as well as some IF and baseband filtering. For new technologies, there may be additional or alternative requirements (such as FFTs etc.). NOTE 2 – The signal processing estimates should be declared with the estimated condition such as assumed services, user bit rate and etc.	It is an implementation issue not covered by the description.
A1.4.14	*Dropped calls* : describe how the RTT handles dropped calls. Does the proposed RTT utilize a transparent reconnect procedure – that is, the same as that employed for handoff?	No specific process to handle call dropping recovery is defined. However, mobile station can recover the connection after call dropping by means of the Idle mode re-entry procedure.

A1.4.15	Characterize the frequency planning requirements: – frequency reuse pattern: given the required *C*/*I* and the proposed technologies, specify the frequency cell reuse pattern (e.g. 3-cell, 7-cell, etc.) and, for terrestrial systems, the sectorization schemes assumed; – characterize the frequency management between different cell layers; – does the RTT use an interleaved frequency plan? – are there any frequency channels with particular planning requirements? – all other relevant requirements. 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.	The RTT supports frequency reuse configuration of 1 and 3. In order for MS to provide BS with a correct DL channel quality information, MS is required to properly measure CINR of preamble with considering the frequency reuse configuration: i.e. For frequency reuse of 3, consider the modulated subcarriers of the preamble only. For frequency reuse of 1, consider both the unmodulated and the modulated subcarriers of the preamble. There are 114 different preamble code sets in the proposed RTT to differentiate the cell ID and sector ID's per each sector. The RTT can use both the interleaved frequency plan and the non-interleaved frequency plan.
A1.4.16	Describe the capability of the proposed RTT to facilitate the evolution of existing radio transmission technologies used in mobile telecommunication systems migrate toward this RTT. Provide detail any impact and constraint on evolution.	
A1.4.17	Are there any special requirements for base site implementation? Are there any features which simplify implementation of base sites? (terrestrial only)	No
A1.5	Information required for terrestrial link budget template Proponents should fulfil the link budget template given in Table 6 and answer the following questions.	see Annex C Link Budget
A1.5.1	What is the BS noise figure (dB)?	4 dB (See supporting material from WiMAX Forum)
A1.5.2	What is the MS noise figure (dB)?	7 dB (See supporting material from WiMAX Forum)
A1.5.3	What is the BS antenna gain (dBi)?	15 dBi (See supporting material from WiMAX Forum)

A1.5.4	What is the MS antenna gain (dBi)?	-1 dBi (See supporting material from WiMAX Forum)
A1.5.5	What is the cable, connector and combiner losses (dB)?	0 dB (See supporting material from WiMAX Forum)
A1.5.6	What are the number of traffic channels per RF carrier?	Function of required QoS
A1.5.7	What is the RTT operating point (BER/FER) for the required E_b/N_0 in the link budget template?	1% FER
A1.5.8	What is the ratio of intra-sector interference to sum of intra-sector interference and inter-sector interference within a cell (dB)?	Depends on environment and receiver implementation
A1.5.9	What is the ratio of in-cell interference to total interference (dB)?	Negligible at low doppler (<300 Hz) and depends on receiver implementation at high doppler
A1.5.10	What is the occupied bandwidth (99%) (Hz)?	Depends on nominal bandwidth, permutation scheme, and on the sub-channelization utilized. See supporting material from WiMAX Forum
A1.5.11	What is the information rate (dBHz)?	See supporting material from WiMAX Forum