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Re:	IP-OFDMA Evaluation Group Comments
Abstract	Summary of Comments and Responses
Purpose	For Information
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Introduction

This document summarizes the responses to some of the questions/comments raised during the evaluation of the IPOFDMA proposal (ITU-R Contribution 8F/1065 and 8F/1079 Revision 1). The document is organized based on responses for each of the sections in the contribution.

Responses to A1 comments

A1.1.1:
Q: Template information is not supplied for each text environment specified. Only a non-compliant mixed environment data is supplied
A: In Appendix 1 of this document, a complete set of simulation results according to the M.1225 requirements is provided for the required test environments, i.e., indoor, outdoor to indoor, and vehicular.

A1.2.2.2:
Q: Transmitter/Receiver isolation requirement is not specified. For example requirements for transmit/receive guard time (RTG/TTG) and switch isolation (or equivalent) need to be specified
A: There is no isolation requirement since this is a TDD system. The time-domain guard bands between UL and DL (TTG and RTG) are provided in response to A1.2.7 (TTG/RTG: 105.7 us/ 60 us).

A1.2.5:
Q: Precise Bandwidth for each permutation is not specified
A:
For 5 MHz:
for PUSC permutation: 4.6047 MHz
for FUSC permutation: 4.6703 MHz
for AMC permutation: 4.7359 MHz
For 10 MHz:
for PUSC permutation: 9.1984 MHz
for FUSC permutation: 9.3078 MHz
for AMC permutation: 9.4609 MHz

A1.2.5.1:
Q: This is not clear. All terminals in the same deployment must use the same RF channel BW all the time (i.e. you cannot, at least in the current status of the IEEE specification, have few terminals with 5 MHZ RF channel and few other terminals with 10 MHz RF channel). In addition, an UL subchannel will have its tiles distributed over the band and hence, even though an MS will be using a small portion of the BW, its signal will span the whole RF channel. A similar argument can be done for the DL (preamble and DL MAP).
If multiple Bandwidth capability is utilized, then the information for purpose of compensating for impairments needs to be supplied.
A: As mentioned in the original response, this RTT allows a base station device or a mobile station device to occupy a flexible, variable RF channel bandwidth though frequency subchannelization. Although there is no explicit simultaneous support of different nominal channel bandwidths, the end effect of suchannelization is the same as the one required in A1.2.5.1: Depending on the need for compensating for transmission impairments, e.g., selection of smaller channel bandwidth in the uplink for the purpose of maximizing coverage or allocation of different channel bandwidths to users with different bit rate requirements in the downlink, the RTT provides variable channel bandwidths, which is transparent to the end user.

A1.2.6:
Q: Numbers provided are user data rates and not channel bit rates.
A: Due to the TDD nature of the RTT proposal, the achieved channel bit rate depends on the DL:UL ratio. If all the total channel bandwidth is allocated to the DL, the maximum achievable channel bit rate is 98,000 kbit/s in 10 MHz channel bandwidth; if the total channel bandwidth is allocated to the UL, the maximum channel bit rate is 49,000 kbit/s in 10 MHz channel bandwidth.

A1.2.7:
Q: Control channel symbol rate and bit rate not specified. ACH bit rate not specified. Power control overhead is missing.
Entry specifying no power control on downlink is in conflict with A3.2.3
A: Due to the fact that control and data signals are transmitted in the same channel in the RTT proposal, the control channel bit rate depends on the number of users allocated in each frame, the way control information is allocated to the frame, e.g., use of sub-MAPs or not, and the used modulation and coding scheme (MCS). In a typical full-buffer data traffic scenario with 10 users per sector without the use of sub-MAPs, the number of OFDMA symbols allocated for control signalling does not exceed six OFDMA symbols. In this case, the control channel symbol rate is 864 kbit/s; if the associated MCS is QPSK 1/2 with repetition coding equal to 4, then the channel bit rate amounts to 216 kbit/s. Regarding power control, which is message based in this RTT proposal, the overhead depends on the power control rate. Consistently with A3.2.3, for a typical uplink power control rate of 20 Hz the power control overhead amounts to 0.88 kbit/s per user when QPSK 1/2 is used for transmitting power control messaging. Please note there is no conflict with the response in A3.2.3 since downlink power control is not required for the downlink operation of the RTT.

A1.2.8:

Q: Is not rotation of the UL tiles (which distributed across the band) in some sense like frequency hopping. Also, the tone assignment in DL PUSC (partial usage of sub-carrier) and FUSC changes every OFDM symbol, so is this not also in some sense like frequency hopping?
A: Although the end effect of subchannel rotation in the uplink as well as the change of the position of user allocations within a frame or from frame to frame in the downlink is similar to frequency hopping, those schemes are not associated with explicit change of the RF carrier and, thus, are not considered as pure frequency hopping techniques.

A1.2.9:
Q: The RTT uses a CDMA ranging channel (MC-CDMA is proposed) for Handover, therefore spreading parameters need to be supplied.
A: It is first noted that the CDMA-based contention channels are used for initial ranging, periodic ranging, bandwidth request, and handover. According to the specifications of the RTT proposal, the CDMA code length is 144 bits which leads to the use of 144 subcarriers per OFDMA symbol; please note that the allocation of CDMA-based contention channels is done within the first 3 OFDMA symbols of the uplink in IP-OFDMA.

A1.2.10:
Q: MC-CDMA is used for ranging and UL sounding, therefore spreading parameters need to be supplied.
A: According to the parameters used for the implementation of the IP-OFDMA technology, CDMA-based transmission is used in initial ranging, periodic ranging, bandwidth request, and handover. Therefore, the response to the related question provided in A1.2.9 fully addresses this comment.

A1.2.11:
Q: PAPR for Downlink not specified. Spreading information not supplied (Ranging channel uses spreading).
A: Regarding PAPR, the provided value of 12 dB (without the application of PAPR reduction techniques which are transparent to the RTT) is valid for both the uplink and downlink operation. Regarding spreading information for ranging, please see the response to the related question in A1.2.9.

A1.2.13:
Q: Interleaver details not specified. Need details for example on delay, number of frames, depth, etc.
A: In the case of convolutional coding (CC), the used interleaver is a block interleaver defined by a two-step permutation; please see Section 8.4.9.3 of References [1] and [2] of the RTT proposal (1079r1) for the details of the interleaver. In the case of convolutional turbo coding (CTC), the inherent two-step interleaver is specified in Section 8.4.9.2.3.2 of References [1] and [2] of the RTT proposal (1079r1).

A1.2.14.1:
Q: If a longer delay spread (longer than the CP can handle) is encountered, performance will suffer depending on the power delay profile of the multipath.
A: Even if the delay spread exceeds the cyclic prefix length, most of the channel impulse response energy is still captured within the cyclic prefix duration; therefore, the encountered intersymbol interference in OFDM/OFDMA systems is relatively low, leading to small performance degradation. Please also see attached Appendix 1 where simulation results for the VehB channel with 120 km/h are explicitly provided (following the M.1225 requirements).

Q: Here, the cyclic prefix is specified as 1/8 of an OFDM symbol which corresponds to 11.4 usec. Any multipath beyond that will results in inter-carrier interference (ICI) and hence will gracefully degrade the performance, depending on the power delay profile of the channel. If the power delay profile has large energy beyond the 11.4 usec delay spread, there will be an increase in ICI, and orthogonality between carriers will be lost. In addition, there will be increased channel estimation loss. Take for example Veh B channel, the performance will be bad. In addition, in one of the answers in Annex 2, the RTT claims support of cell sizes that are up to 35 Km in size. The key question here is that for large cells, what is the probability the delay spread will be within (or reasonable close to) 11.4 usec?
A: As typical for OFDM/OFDMA systems, there will be graceful degradation as the delay spread exceeds the CP length. Please note the additional simulation results in Appendix 1 of this document complying with the M.1225 requirements present Vehicular B data. Note that even if the delay spread exceeds the cyclic prefix length, most of the channel impulse response energy is still captured within the cyclic prefix duration; therefore, the encountered intersymbol interference in OFDM/OFDMA systems is relatively low, leading to small performance degradation. Also note that said performance degradation is evident for small values of the PER (packet error rate), e.g., below 10%. In practical cellular systems supporting HARQ functionality, the target PER is usually higher than 10%, e.g., 30%. Finally, the probability of encountering delay spreads longer than the cyclic prefix is quite small in mobile radio (support of very large cell sizes is usually connected with the existence of LOS connection between transmitter and receiver). Based on the mentioned reasons, it is evident that the impact of channels with delay spread longer than the cyclic prefix on the overall system capacity is marginal.

A1.2.16.1:
Q: Terminal radiated power at the antenna is not specified
A: Original response in A1.2.16 provides the requested values depending on the device power classes.

A1.2.16.1.1:
Q: Maximum peak power is not specified
A: Original response in A1.2.16 provides the requested values depending on the device power classes.

A1.2.16.1.2:
Q: Average transmitter power is not supplied
A: The average transmitter power depends on the device power class as specified in A1.2.16 and the power control command given by the BS. The range of the values of the average transmitter power for each device power class is from the maximum value of A1.2.16 down to the difference between said maximum value minus the dynamic range, please also see the response to a related question in A1.2.22.4 on the minimum transmit power. With respect to practical granularity levels of the average transmitter power, please note the original response in A3.2.3 of 1079r1 on the power control step sizes.

Q: The response does not provide the required answer to the question. Need to clarify the relation between peak and average.

A: The time averaged power over both active and idle periods will be less than the values in A1.2.16 – due to scheduled TDD nature of transmissions. As the exact scheduling of timeslots is implementation dependent specific values vary with each deployment.

A1.2.16.2:
Q: Base station transmit power is not specified
A: The base station transmit power is not limited by the RTT; it is limited by local, regional, and international regulatory requirements.

Q: This response does not provide the required answer to the question.

A: For the base station there is no power control; it is fixed. Also, the answer is a typo. Answer should read, “Not limited by RTT”

A1.2.16.2.1:
Q: Base station maximum peak transmitted power is not specified
A: The peak transmit power is not limited by the RTT; it is limited by local, regional, and international regulatory requirements.

A1.2.16.2.2:
Q: Base station average transmitted power is not specified
A: As for the peak transmit power, the average transmit power is not limited by the RTT; it is limited by local, regional, and international regulatory requirements.

A1.2.17:

Q: Evaluator cannot complete analysis for this item without specific codec scenario as used for related A3 entries
A: Please note that the provided values are related to the peak blocking-limited capacity based on the stated assumptions, i.e., the use of G.726. As the question refers to the maximum values, those values are analytical and not generated by simulation results. Therefore, there is no inconsistency with the A3-related entries, where the results are from simulations.

A1.2.18:
Q: Modulation and Coding schemes need to be specified
A: The supported modulation and coding schemes of the RTT are: QPSK 1/2, repetition coding 6, 4, 2, and 1, 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. Please note that according to Reference [3] of the RTT proposal (1079r1), all modulation and coding schemes are mandatory for downlink operation, while the 64-QAM related modulation and coding schemes are optional in the uplink.

A1.2.18.1:
Q: Note 1 needs to be clarified. One can not achieve both peaks rates at the same time since the maxim DL/UL ratio implies minimum UL/DL ratio
User bit rate in each variable bit rate mode (MCS and repetition rate, UL/DL ratio) needs to be supplied
A: With respect to Note 1 of the original response, it is true that peak data rates cannot be simultaneously achieved for both uplink and downlink due to the TDD nature of the RTT proposal. Regarding the bit rate for each MCS, the bit rates for the different modulation and coding schemes are reported below for a typical 35:12 DL:UL ratio in a 10 MHz bandwidth (28 data symbols for the downlink and 9 data symbols for the uplink) with PUSC permutation and single spatial stream (SISO/SIMO or MIMO STBC; with MIMO SM the data rates in the downlink double); please note that the calculation of the bit rates for other DL:UL ratios is straightforward.

Downlink:
QPSK 1/2, repetition 6: 576 kbit/s
QPSK 1/2, repetition 4: 864 kbit/s
QPSK 1/2, repetition 2: 1,728 kbit/s
QPSK 1/2, repetition 1: 3,456 kbit/s
QPSK 3/4: 5,184 kbit/s
16-QAM 1/2: 6,912 kbit/s
16-QAM 3/4: 10,368 kbit/s
64-QAM 1/2: 10,368 kbit/s
64-QAM 2/3:13,824 kbit/s
64-QAM 3/4: 15,552 kbit/s

64-QAM 5/6: 17,280 kbit/s

Uplink:
QPSK 1/2, repetition 6: 168 kbit/s
QPSK 1/2, repetition 4: 252 kbit/s
QPSK 1/2, repetition 2: 504 kbit/s
QPSK 1/2, repetition 1: 1,008 kbit/s
QPSK 3/4: 1,512 kbit/s
16-QAM 1/2: 2,016 kbit/s
16-QAM 3/4: 3,024 kbit/s
64-QAM 1/2: 3,024 kbit/s
64-QAM 2/3: 4,032 kbit/s
64-QAM 3/4: 4,536 kbit/s
64-QAM 5/6: 5,040 kbit/s

A1.2.19:
Q: Specific codec assumed for the performance information supplied in A3 is not specified
A: As already mentioned in the original response, the RTT is agnostic of the specific codec used. As for the results in A3, the codec used in the simulations is the G.729 with 20 bytes of voice payload generated every 20msec.

A1.2.19.1:
Q: Specific voice coding rates are not specified
A: As also stated in the original response, there are no requirements for specific coding rates. Exemplarily, the codec used in the simulations is the G.729 with 20 bytes of voice payload generated every 20 msec.

A1.2.20:
Q: Bit rate, delay, and BER/FER are not supplied for each service class
A: The parameters related to the bit rate, delay, and BER/FER exclusively depend on the service class and are not related to the RTT. Due to its technology capabilities, the RTT is able to provide support to a wide range of services, see Table 7 of the submission (1079r1).

A1.2.22:
Q: No power control overhead information is provided.

The power control rate is specified in A.1.2.7 above, however, the overhead information required to do this power control is not provided. Sending a power control command that is made off 44 bits at 200 Hz is a lot more expensive than, say, a power control sent at 800 Hz but only with 1 bit. So specifying the rate is not enough
It is understood that the open loop power control rate is 200 Hz (which is implicit by the fact that DL sub frame is sent at 200 Hz). However, can closed loop power control be done at 200 Hz for all users given the amount of overhead required? If not, what will be the impact on performance.
A: As stated in A1.2.22.2, 200 Hz is the max possible power control rate and typically is much less than 200Hz, around 10-20 Hz. At 20Hz, the approximately 1 kbps overhead per user, see the response to a related question in A1.2.7, amounts to less than 1% of the average user throughput in a SIMO deployment, i.e., the impact of the power control overhead on the system capacity is very low. Also note that in the simulations the proponents had to make reasonable assumptions about the power control parameters in order to be in a position to generate realistic results, e.g., with respect to the speed of the power control and the incurred control overhead. Given the fact that link adaptation (change of the user MCS depending on the channel conditions) is applied in addition to the power control in the uplink, i.e., there is a cooperation between link adaptation and power control, it has been verified that a power control rate of 20 Hz provides marginal performance degradation compared to the maximum possible power control rate of 200 Hz. Regarding the number of users that can be handled, support for both full-buffer data traffic (total number of 10-20 users, which leads to 5-10 users per frame) and VoIP traffic (total number of ~150 users for SIMO and voice activity factor equal to 0.4, which leads to 30-40 users per frame) has been fully verified. Note that the total UL control overhead for full-buffer data traffic is 3 OFDMA symbols and the corresponding one for VoIP traffic is 6 OFDMA symbols; please also note that the mentioned control overhead numbers explicitly take into account that both power control of 20 Hz and realistic link adaptation are applied in the uplink.

A1.2.22.4:
Q: Minimum transmit power is not specified since the full power assumption is not specified
A: As stated in A1.2.16, the peak power depends on the used power class (in total there are four power classes). For a nominal transmit power of 24 dBm and the RTT support of a dynamic range of 45 dB, see A1.2.22.3, the minimum transmit power is -21 dBm.

A1.2.23.1:
Q: Degree of diversity improvement is not specified. Minimum number of receivers is not specified. The minimum number of antennas is not specified
A: Please see original response to A3.2.6.1 where a detailed description of diversity improvement and receive/antenna parameters are provided.

A1.2.24:

Q: Very limited information provided on Handover (e.g. hard or soft handover, etc).
A: In IP-OFDMA simple and optimized hard handover is supported. The differentiation between simple and optimized handover is done on the basis of the number of steps of the handover process that have to take place before the network re-entry with the new BS is established: If the MS has to go through all the steps of the handover process then we refer to a simple handover, while if the MS has to go through only a reduced number of steps then we refer to an optimized handover. For example, since the MS explicitly indicates the old BSID during the ranging process with the new BS, the new BS can retrieve the parameters associated with the considered MS from the old BS, e.g., the CIDs and SFID info, the SBC (SS basic capability) context, and REG context, which leads to the execution of only the ranging process for network re-entry, i.e., an optimized handover takes place.

In general, as the MS goes through a deep fade or some momentary signal loss, depending upon the length of this period one of the following things may happen: a) Loss of PHY synchronization, i.e., frequency, time, and power offset, b) loss of MAC synchronization, c) the application times out, or d) loss of BS coverage.

a) If PHY synchronization is lost in the middle of a call, initial and/or periodic ranging has to be performed for acquiring PHY synchronization. Note that this situation may happen only if the deep fade or momentary signal loss extends over a multiple of IP-OFDMA frames, i.e., a multiple of 5 ms.

b) In the case that PHY synchronization is lost and the MS cannot successfully range for a long time, the BS may decide to throw away the MAC context for this MS; this would include parameters like the CIDs and SFID info, SBC context, and REG context. Note that for this to happen the T27 timer has to expire (the T27 timeout value is typically on the order of seconds).

c) As for the previous case, application timeouts are typically also on the order of seconds. Hence, as long as the MS can regain the PHY synchronization within this time, there won't be any dropped call. In other words, the MS has to lose PHY synchronization and not be able to range for several seconds so that a complete (also known as full) network entry takes place. Otherwise, even if the MS loses the PHY synchronization, it will be able to get back to the network in time.

d) One corner case would be when the MS loses PHY synchronization and when it tries to gain it back, it is in a different BS coverage area, e.g., due to the mobility of the MS. In such a case, the MS can now range with the new BS, and, as part of the ranging process, it can provide the old BSID and set the parameter Ranging_purpose_indication=0 so that the new BS will understand that it is trying to do a handover from the old BS. During such a scenario, the new BS can retrieve the MS context from the old BS, thereby preventing the MS from doing a full network entry.

Based on the above information, it becomes obvious that IP-OFDMA typically provides optimized hard handover support in the MS's of the network. In addition, IP-OFDMA has very reliable mechanisms for the MS to do a fast network entry during handover;

please also refer to Tables 11 and 12 of Section 2.3.2 of 1079r1 for a detailed analysis on the latency and duration during handover in different typical scenarios.

A1.2.24.1:
Q: No answer is provided
A: The detailed response provided to the related question in A1.2.24 addressing this comment. Based on the response in A1.2.24, a typical value for the break duration is on the order of 55 ms.

A1.2.24.2:
Q: Very limited information provided on Handover. Details requested are not supplied
A: Please see the detailed response to the same comment in A1.2.24.

A1.2.30.1
Q: Need clarification.

A: The RTT includes a message-based signalling scheme as specified in the IEEE Standard 802.16-2004 and IEEE 802.16e-2005 Amendment. The message-based MAC layer describes enhancements for delivering QoS for a variety of traffic types. The contribution 1079r1 also describes the capabilities in Section 1.4.2.

A1.3.1.1:
Q: BER floor is not specified
A: Please see Appendix 1 of this document with results compliant to § 1 of Annex 2 for voice. Also note that response is consistent with other RTT submissions.

A1.3.1.2:
Q: BER floor is not specified
This Doppler corresponds to approx. 120 km/hr. However, the simulation results included in the proposal only assumes 10% of the users at that speeds and the majority of users are at speeds of 30 km/hr or less. So the claim that the error floor will be below the required GoS requirements at those speeds and delay spreads is not substantiated.
A: Please see Appendix 1 of this document with results compliant to § 1 of Annex 2 for data. Also note that response is consistent with other RTT submissions.

A1.3.1.3:
Q: This entry specifies that 20 usec delay spread can be tolerated without an equalizer while A1.2.14 specifies that an 11.4 μsec

cyclic prefix and a 1-tap equalizer are used.
A: What is implied by the original response in A1.3.1.3 is that there is no additional equalization method required other than the typically used in OFDMA systems, i.e., there is no inconsistency with the response to A1.2.14.

Q: How can 20 μsec delay spread be accommodated with a 11.2 μsec cyclic prefix? No data for Vehicular B is supplied. No link curves are supplied for Vehicular B channel model.
A: Please find the full set of results using the Vehicular B channel model in Appendix 1 of this document.

A1.3.1.5.1:
Q: The Erlang capacity mentioned number does not make sense in the light of the number of VoIP users that can be supported provided in A1.2.17. What is the blocking probability? What is the average call duration? It appears that Erlangs capacity was calculated for uplink and downlink separately and then summed. The results appear to be overstated by at least a factor of 2. In addition, the overhead requirements for encryption do not appear to be considered. See Appendix 3 [of evaluation report from ATIS].
A: Regarding the blocking probability and the average call duration, those are 2% and 2 minutes, respectively.
Regarding the results provided in A1.2.17, first of all please note that those results refer to maximum numbers; the results in A1.3.1.5.1 refer to realistic numbers that can be achieved by IP-OFDMA.
With respect to the calculation of the Erlang capacity, it is explicitly stated in Section 2.3.1.3 that the voice capacity includes both the downlink and uplink portions of the TDD frame. Please note that this is done for the purpose of providing a fair comparison with respect to the calculation of the voice capacity in FDD and TDD systems. Under this consideration, the results are not overstated by a factor of 2.
Finally, regarding the overhead requirements for encryption, note that encryption can be more efficiently applied at the application level which leads to the inclusion of a small number of bytes, e.g., 4 bytes for SRTP, at the MAC layer. If one considers that the CRC is optional and can be turned off without a remarkable performance degradation, then it becomes evident that there is no issue with encryption in the calculations of the voice capacity in IP-OFDMA.
Based on the above calculations/explanations, it is obvious that there is no inconsistency with respect to the number of VoIP users reported in A1.2.17.

Q: Results are given with a model using Vehicular path loss and Pedestrian B3 channel model which is mixing environment information. Results are to be given for each test environment indicated on the cover sheet (Indoor, Outdoor to Indoor Pedestrian, Vehicular). The deployment models specified in Annex 2 of M.1225 were not used in this analysis.
Please see Appendix 1 of this document where a complete set of results in the test environments of M.1225 (indoor, outdoor to indoor pedestrian, and vehicular) is presented.
A1.3.1.5.2:

Q: Results are given with a model using a mixed test environment which does not match the deployment model for the mixed test environment in M.1225. The non-mandated mix uses a different path loss model than that specified in M.1225. Furthermore individual test environment results are not supplied for each test environment indicated on the cover sheet (Indoor, Outdoor to Indoor Pedestrian, Vehicular). Channel B is to be used for this analysis.

A: Please see Appendix 1 of this document where a complete set of results in the test environments of M.1225 (indoor, outdoor to indoor pedestrian, and vehicular) is presented; note that results for the VehB channel are explicitly presented in Appendix 1.

Q: Outage for this data needs to be supplied as it is questionable using the assumptions stated in the 8F/1079Rev 1. See Appendices 1, 2, and 5 [of evaluation report from ATIS].

A: In the following, simulation results for the downlink MAP coverage are presented for 1x3x3 (reuse 3) and 1x3x1 (reuse 1). To enable a direct relation to 1079r1, the simulation assumptions follow Tables 13-15 of the RTT submission; the channel bandwidth is 10 MHz, the number of Tx/Rx antennas is 1/2, i.e., a SIMO system is considered here, and the link layer channel model is the ITU PedB with 3 km/h. Note that the MAP decoding PER is set to 1%.

In Table A, the probability of selecting each of the available modulation and coding schemes (MCS's) is shown for reuse 3 when no interference cancellation is used at the MS. The corresponding results for the use of interference cancellation at the MS are shown in Table B. We note that interference cancellation is based on the use of the MMSE (minimum mean squared error) equalization at the two-branch MS receiver.

Table A: MAP coverage; MCS selection probability for reuse 3 without interference cancellation

MCS	MCS Selection probability
0	0.01%
QPSK 1/12	0.17%
QPSK 1/8	4.24%
QPSK 1/4	12.57%
QPSK 1/2	17.84%
QPSK 3/4	6.91%
16QAM 1/2	20.09%
64QAM 1/2	12.44%
64QAM 2/3	4.99%
64QAM 5/6	20.75%

Table B: MAP coverage; MCS selection probability for reuse 3 with interference cancellation

MCS	MCS Selection probability
0	0
QPSK 1/12	0.09%
QPSK 1/8	2.45%
QPSK ¼	11.15%
QPSK ½	19.65%
QPSK ¾	5.31%
16QAM ½	20.92%
64QAM ½	11.93%
64QAM 2/3	4.91%
64QAM ¾	23.59%

According to Table A, the use of QPSK 1/8, i.e., QPSK 1/2 with repetition 4, guarantees that coverage is satisfied in more than 99% of the cases; note that even the use of QPSK 1/4, i.e., QPSK 1/2 with repetition 2, satisfies the 95% MAP coverage requirement. According to the results of Table B, a further improvement is achieved by the use of interference cancellation at the MS; however, no additional gain with respect to the selected MCS for satisfying the 99% and 95% coverage requirement is achieved compared with the case where interference cancellation is not employed at the MS, see Table A. Therefore, it can be concluded that interference cancellation, although providing better distribution of the MCS selection probability, is not necessary for satisfying the coverage requirements in reuse 3.

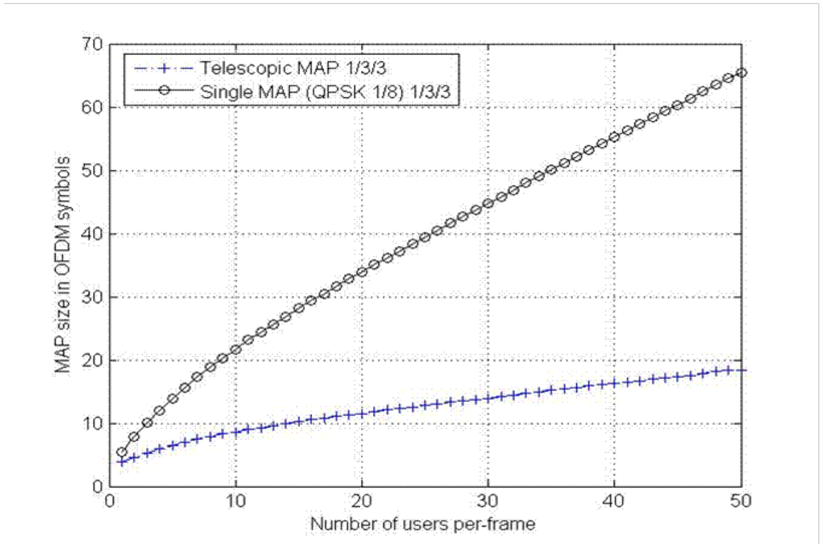
In Table C, the MCS selection probability is shown for reuse 1 when interference cancellation is used at the MS receiver; please note that the results for the case where interference cancellation is not employed are not explicitly shown here. As shown in Table C, the 99% coverage requirement is satisfied by the use of QPSK 1/12, i.e., QPSK 1/2 with repetition 6, while the use of QPSK 1/8, i.e., QPSK 1/2 with repetition 4, can lead to the fulfilment of the 95% coverage requirement.

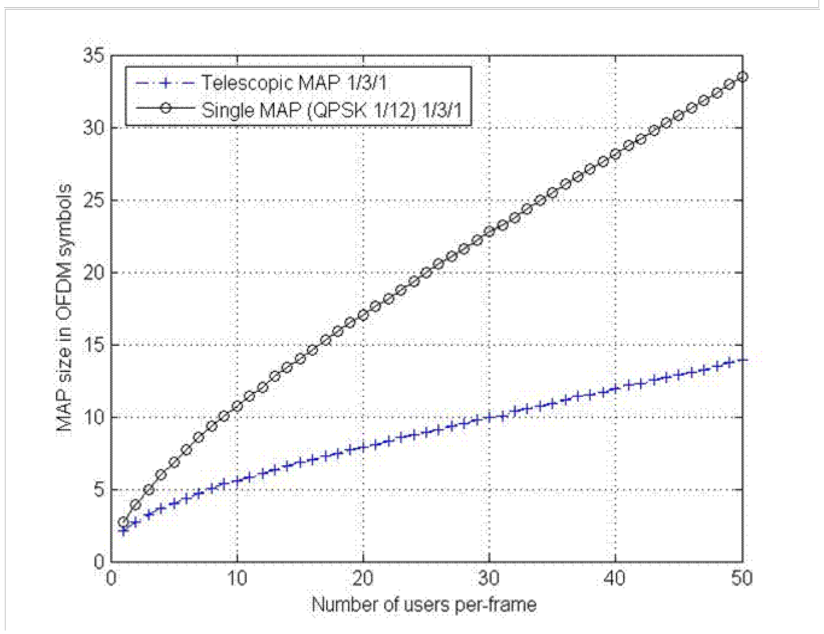
Table C: MAP coverage; MCS selection probability for reuse 1 with interference cancellation

MCS	MCS Selection probability
0	0.37%
QPSK 1/12	2.70%
QPSK 1/8	17.85%
QPSK ¼	28.30%
QPSK ½	22.16%
QPSK ¾	4.60%
16QAM ½	12.11%
64QAM ½	4.68%
64QAM 2/3	2.39%
64QAM ¾	4.83%

Based on the simulation results presented above on the MAP coverage performance of IP-OFDMA, it is shown that there is no MAP coverage issue related to the RTT: In the case of reuse 3 deployments the coverage requirements are satisfied even when interference cancellation is not employed at the MS receiver, while in the case of reuse 1 deployments the coverage requirements are met with the use of interference cancellation at the MS. As a final remark to the results in Tables A through C, note that the performance of the MAP coverage can be further increased by the use of transmit diversity techniques such as CDD (cyclic delay diversity) which can provide an additional link gain on the order of at least 2 dB for 2 antennas at the BS transmitter.

Setting out from the results of Tables A through C, we provide two figures in the following illustrating the total MAP (uplink + downlink) overhead for reuse 3 and reuse 1. Note that telescopic MAPs (sub-MAPs) are assumed for both the data and VoIP traffic. Regarding data traffic, 10 users/sector, for which simulation results are provided in A1.3.1.5.2, typically leads to the allocation of about 5 users per frame based on the user allocation decision at the BS scheduler, which is associated with a MAP overhead of 6 OFDMA symbols for reuse 1. Regarding VoIP traffic, the typical number of users per frame in the reuse 3 case, for which voice simulation results are provided in A1.3.1.5.2, is 20-25; this corresponds to 11-12 OFDMA symbols allocated per frame for MAP. Please note that in the following two figures 1/3/3 corresponds to reuse 3 and 1/3/1 corresponds to reuse 1 (IP-OFDMA terminology).


Telescopic MAP 1/3/3
Single MAP (QPSK 1/8) 1/3/3
MAP size in OFDM symbols
Number of users per-frame
0
10
20
30
40
50
60
70


Telescopic MAP 1/3/1
Single MAP (QPSK 1/12) 1/3/1
MAP size in OFDM symbols
Number of users per-frame
0
5
10
15
20
25
30
35
40
50

A1.3.1.7.1:

Q: Link budget constructed by the evaluation group indicates significant discrepancies from the link budgets given in 8F/1079 Rev 1. See Appendix 4 [of evaluation report from ATIS].

In addition, there do not appear to be any implementation losses included in the link budget calculations.
A: The link budget provided in Appendix 4 of the ATIS evaluation group shows a difference of ~17 dB for the downlink and ~24 dB in the downlink compared to Table 20 of 1079r1. In the link budgets of said Appendix, the following issues are observed: a) The calculations with respect the actual transmission requirements for achieving the target bit rate of 17.8 kbps are inconsistent, b) the total number of assumed bits the subchannelization gains are missing, and c) the transmit power is reduced by 1 dB. For example with respect to the uplink: a) It is assumed that transmission of 336 bits occurs in each frame of 5 ms while said transmission occurs every 20 ms (~6 dB); further, the use of 15 symbols is not correctly used as the fact that 15 out of 47 symbols are utilized is not considered (~5 dB), b) Since one subchannel is used for satisfying the requirements for voice transmission, the subchannelization gain of ~12 dB is missing. If we include the value of 1 dB from the mismatch in the transmit power assumption, the total number of difference amounts to 6+5+12+1=24 dB. Please also note that implementation losses are absorbed in the noise figure value. Therefore, the calculations of Table 20 in 1079r1 are correct and consistent with the requirements.

A1.3.1.7.2:

Q: Link budget constructed by the evaluation group indicates significant discrepancies from the link budgets given in 8F/1079 Rev 1. See Appendix 4.

In addition, there do not appear to be any implementation losses included in the link budget calculations.
A: Please see detailed explanation on the inconsistent calculations appearing in the referred Appendix in the related comment of A1.3.1.7.1.

A1.3.3:
Q: Maximum user data rates for the different deployment models are not supplied. Supply maximum bit rates for maximum DL/UL ratio and maximum UL/DL ratio (assuming meeting deployment model)
A: For the maximum DL/UL ratio of 35:12 (28 data symbols in the downlink), the maximum user data rate in the downlink is 40,320 kbit/s (use of MIMO SM mode).
For the maximum UL/DL ratio of 21:26 (18 data symbols in the uplink), the maximum user data rate in the uplink is 10,080 kbit/s.

A1.3.4:
Q: Maximum range not supplied for the mandated deployment mode
A: Please see the data provided in Appendix 1 of this document for calculations complying with the M.1225 requirements.
A1.3.7.1:
Q: What were the assumptions used to arrive at 10ms? Does this include any retransmission attempts?
A: The number provided in the original response fully complies with the question requirements; please note that there are no retransmission attempts considered.

A1.3.7.2:
Q: Information in conflict with information in A3.3.2. D1 and D2 delays need to be specified.
A: D1 is the RTD including the vocoder delay, transmission delay, and the radio network delay; it does not include the core network/backbone delay which is assumed to be zero. Therefore, D1 is broken down as (all delays in ms):

D1 = (25 (vocoding) + 5 (Tx) + 5 (Rx) + 35 (radio network)) x 2 = 70 ms x 2 = 140 ms

Please note that 35 ms is the delay through the anchor node which has a functionality similar to ASN or RNC.

D2 is the RTD without the vocoder delay, i.e.,

D2 = (5 (Tx) + 5 (Rx) + 35 (radio network)) x 2 = 45 ms x 2 = 90 ms

A1.3.8:

Q: No specific vocoder used for the analysis is specified. No MOS comparison with G.711 or G.726 is supplied as required
A: IP-OFDMA does not have any default codec as it treats speech as an application. According the MOS measurement in a practical WiMAX network, which was performed within the framework of the TTA evaluation group, it is shown that the MOS of G.729 with FER<1% is around 4.0, which is very close to the maximum values of 4.07 for the MOS of the G.729 codec (the measurement and reference was conducted by using the Chariot tool). It is noted that higher FER may degrade the MOS in accordance to NOTE 1.

A1.3.9.1:
Q: Blocking data is not supplied for 125%, 150%, 175%, and 200% of full load
A: The requested performance metrics are largely implementation dependent and therefore not explicitly provided. Please note that when we say that the results are largely implementation we mean that the blocking and quality performance depends on the link adaptation mechanisms applied in the primary and adjacent cells. Please note that the effect is more pronounced since there might be different operator/vendor equipment in the different cells. Therefore, we decided to not provide explicit numbers on the performance in such an implementation dependent overload scenario. Certainly, it is expected that there will be graceful degradation as the overload increases from 125% to 200%.

Q: This is not a complete answer. Need answers for specific loads: how are the features used for different loading conditions?

A: Section 1.4.2 describes these features. Only the qualitative effect is described, as have other RTT submissions.

A1.4.2:
Q: Out of band and spurious emissions are not specified
A: Wherever applicable, the base station and mobile station equipment of the RTT proposal will comply with out-of-band and spurious emission requirements; no specific value can be provided due to the multitude of local, regional, and international regulatory requirements. Please note that specific compliance tests are defined by the WiMAX Forum and are to be met by all certified equipment w.r.t. out-of-band and spurious emissions.

A1.4.5:
Q: Frequency range of the synthesizer is specified to be 5 or 10 MHz, however it is unreasonable to have a synthesizer range be the same as the Bandwidth of the technology.
Clarify step size.
A: With synthesizer range we understand the channel bandwidths supported. In the case that the evaluator refers to the carrier frequency range supported, please refer to Reference [3] of the RTT proposal (1079r1) for the list of all band classes from 2.3 GHz to 3.8 GHz and the corresponding channel frequency step size.

A1.4.7.1:
Q: Question not answered as to ISDN services provided
A: IP-OFDMA provides a packet switch data service that allows interworking with PSTN and ISDN systems through gateways, i.e., as long as there is an appropriate media gateway, interworking with ISDN will be fully supported.

A1.4.8:
Q: Information concerning radio resource control capabilities for provision of roaming between private and public IMT-2000 systems is not provided.
A: Original response covers the question; please also see responses in A3.3.1.

A1.4.11:
Q: Receiver linearity requirements are not specified
In conflict with A3.6.7 and A3.2.2.4
No MS information is provided.

A: Please note that receiver linearity is not mandated but typically expected by devices (both BS and MS) implementing this RTT. As such, there is no conflict with A3.6.7 and A3.2.2.4. Note that linearity has to be met within the dynamic range (e.g., w.r.t. out-of-band emissions, spurious emissions, intermodulation), which is provided in A.3.6.8.

Q: The description conflicts with A3.6.7

A: The IP-OFDMA devices, i.e., both BS and MS equipment, are expected to have linear operation for providing good performance across all system deployment scenarios. Since linearity is not a requirement by the RTT, there is no conflict with A3.6.7.

A1.4.13:
Q: Signal processing estimates are not provided
A: The digital signal processing requirements are both manufacturer and device implementation specific, i.e., they are different for BS's and MS's and they are also different between vendors of the same device. In the following an example of a particular design is provided:
Gate count: 1M~1.5M gates
RAM requirements: 200~300KB
The above values include IFFT/FFT, channel estimator, MIMO decoder, and channel decoder. Among the mentioned blocks, the hardware size of MIMO decoder is dependent on the implementation and more sophisticated algorithms such as the MLD (maximum likelihood decoder) may require more hardware complexity than other blocks. Also, most of the blocks can be implemented in hardware; some of blocks such as the FFT and the channel estimator can be implemented in high performance DSP's. For the considered DSP-based implementation example, the requirement MOPS are between 200 and 300 MOPS. Please note that the required memory size is also dependent on the support of HARQ. E.g., if 3 Mbps throughput is required for HARQ, the minimum metric buffer should be more than 64 kBytes and if the throughput requirement is doubled, the buffer requirement will also be doubled.

A1.4.16:
Q: Question on evolution of existing technologies is not answered
A: Due to the support of handover and roaming between this RTT and existing technologies, there are no impact or constraints to the evolution of the latter.

A1.4.17:
Q: RTT specifies GPS synchronization of Base stations. This is not specified in this entry.
A: As stated in Sections A1.4.3, A3.2.7, A3.4.2.2.1,and A3.5.1, GPS is typically used for BS synchronization without this being a stringent requirement. This is the reason for not explicitly stating this neither in A1.4.17 nor in A3.2.9.

A1.5:
Q: Data duty cycle need to be taken into account for link budget computation in 8F/1079R1.
A: The data duty cycle is implicitly considered in the link budget calculations.

Q: Please justify -171 dBm/Hz noise + interference level.
A: The assumed interference margin is 3dB and the thermal noise is -174 dBm/Hz; thus, the interference+noise level is -174 + 3 = -171 dBm/Hz.

Q: Please provide link curves with channel estimation error.
A: Please see response to A3.4.1.2 for results on the performance degradation at high mobility scenarios. In low mobility scenarios, i.e., typically below 30 km/h, the performance degradation varies from 0.5 dB to 1 dB depending on the channel model and the used channel estimation technique.

Q: Please justify log-normal fade margin of 5.56 dB.
A: Assuming a 8dB standard deviation for the log-normal shadow fading, the value of 5.56 dB used for the Shadow Fade margin in the table assures a 75% coverage probability at the cell edge and 90% coverage probability over the entire area.

A1.5.5:
Q: Cable and connector loss for BS is not specified
A: The value entered in this item refers to just the generic link budget in 2.3.4.2. Section 2.3.4.1 link budgets include these losses using M1225 default values; further, please note the link budget analysis provided in Appendix 1 of this document which complies with the M.1225 requirements on pathloss/channel model combinations and traffic services.

A1.5.8:
Q: Ratio of intra-sector interference is not provided
A: Original response addresses this comment.

A1.5.9:
Q: Ratio of in-cell interference to total interference is not specified. Subcarrier frequency errors could be a source of in-cell interference
A: As mentioned in the original response, the ratio is implementation dependent. However, please note that in the system level simulations we explicitly account for the intercarrier interference (ICI) generated by mobility, which leads to realistic results with respect to the consideration of the impact of mobility to the overall system performance.

A1.5.11:
Q: Maximum information rate is not supplied
A: According to the assumptions in our response to comment in A1.2.18.1, the maximum information rate in the downlink is 72.38 dBHz and the maximum information rate in the uplink is 67.02 dBHz.

Responses to A3 comments

A3.1.1.1:
Q: Reuse definition needs to be clarified.
A: We assume 3-sector cells. When we refer to reuse 3 we mean that 1/3 of the total available bandwidth is used in each sector of a cell; when we refer to reuse 1 we mean that each sector of a cell uses the total available bandwidth.

Q: Are VoIP services only supported in reuse 3 system?
A: No. VoIP services are supported in reuse 1 system as well. The VoIP simulation results presented in 1079r1 can be viewed as the minimum achievable results because of the use of reuse 3 and SIMO transmission; in practice, due to the fact that reuse 1 with MIMO transmission will be typical for the IP-OFDMA system deployment, the VoIP capacity will be higher than the one reported in the proposal.

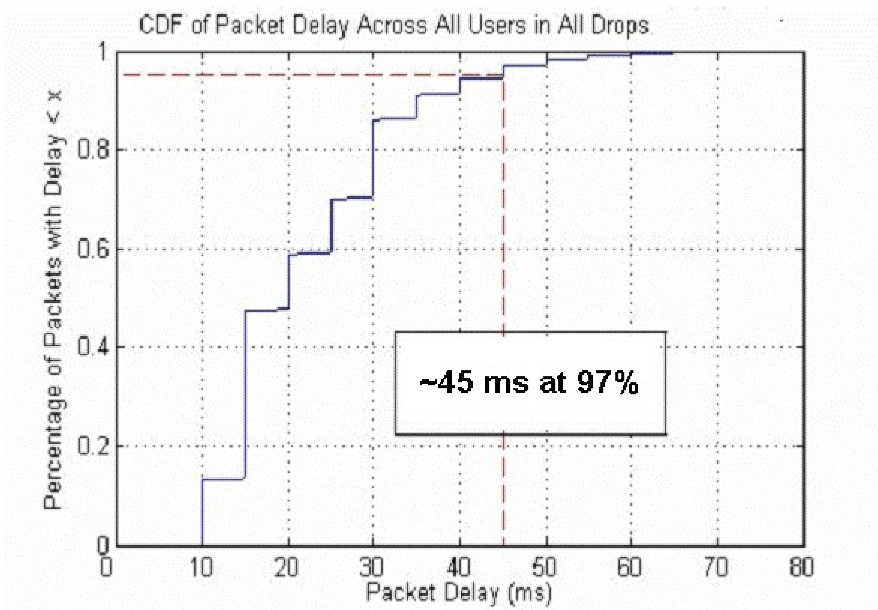
Q: The voice traffic capacity has to taken into account the frequency reuse. Does 90 Erlangs/MHz/cell taken into account of reuse 3? I.e., does this number imply 900 Erlangs or 2700 Erlangs over the 30 MHz bandwidth.
A: Yes, the frequency reuse is taken into account. Please note that the total bandwidth is 10MHz and reuse 3 is accomplished by using bandwidth segmentation, i.e., each sector of the cell uses 1/3 of the total bandwidth. According to the definition of 1079r1, 90 Erlangs/MHz/cell implies 30 Erlangs/MHz/sector; since a sector in reuse 3 utilizes 1/3 of the total bandwidth, we have 100 Erlangs/sector or 300 Erlangs/cell for a 10 MHz bandwidth. Thus, for a 30 MHz bandwidth 900 Erlangs/cell are supported.

Q: Results are given with a model using Vehicular path loss and Pedestrian B3 channel model which is mixing environment information. What should be used along with the Ped B3 channel is the corresponding ITU pedestrian path loss model and alternatively a vehicular channel model should be used with the ITU vehicular path loss model. Results are to be given for each test environment indicated on the cover sheet (Indoor, Outdoor to Indoor Pedestrian, Vehicular). Furthermore, the deployment models in Annex 2 of M.1225 are to be used. The results are to be supplied using 1% blocking and 50% Voice Activity Detection, however, the submission used 2% blocking and 40% VAD (page 54, section 2.3.1.3).
A: The results in the proposal are based on widely-accepted industry channel/propagation model combinations that are currently

more popular than the original ITU M1225 combinations. Please note the additional simulation results in Appendix 1 of this document that fully comply with the pathloss model/ITU channel combinations. With respect to the comment on the voice simulation assumptions, please see the response to a related question also within the comments in A3.1.1.1.

Q: How is the effect of handoff latency modeled in this analysis? How are VoIP services supported by the hard handoff algorithm.
A: Handoff is implicitly modelled in the assignment of a MS to its best-serving sector. Please note that this is true of other studies/proposals as well.

Q: For the voice capacity using VOIP, What needs to be reported along with the number of Erlangs/MHz/cell (for a given reuse pattern) is also some metric to describe the latency or outage. Provide mean and 97% tail latency distribution.
A: Please refer to Section 2.3 of the proposal (1079r1), which describes those metrics in detail. Especially with respect to latency, please see following graph on the packet delay (latency) distribution; please note that the delay is well below the 100 ms bound.



Q: How many base station and mobile station transmitter and receiver antennas are used for this capacity? For a fair comparison with other technologies, only mandatory features of the standard should be used to meet the requirements.
A: This is a 1TX/2 RX antenna transmission scheme (SIMO). This is the baseline scheme used for evaluating the performance of

the system. Please note that this is a mandatory feature of the standard; also note that other RTT submissions used multiple antenna schemes.

Q: Is the bandwidth request contention based? How is the request queuing delay simulated? If not, provide overhead computation for pre-allocated UL-MAP for all VoIP users in the system.
A: Both polling and contention-based schemes are supported. It is contention-based at entry and uses piggy-backed bandwidth request mechanisms during active transfer. Please refer to Section 2.3 of the proposal (1079r1) describing the simulation assumptions in detail.

Q: Is the transmitter side packet drop captured in FER accounting?
A: Yes, it is explicitly captured in FER accounting.

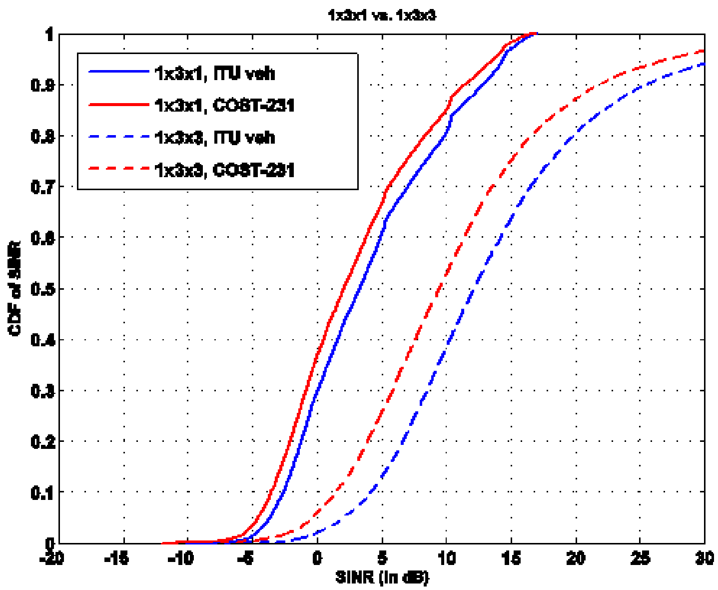
Q: How is the FCH, DL-MAP, UL-MAP reliability and overhead modeled? How is CQI feedback and ACK feedback reliability and overhead modeled?
A: The simulations are for the traffic channel only. A conservative fixed overhead is assumed for the number of user allocations. As is standard practice, perfect feedback is assumed, i.e., no errors to the feedback channel are accounted for. Please see the detailed response to the related comment on MAP overhead and reliability in A1.3.1.5.2, where it is demonstrated that no issue regarding both overhead and reliability is encountered with respect to the MAP performance.

Q: Clarify which codec is used since 4 options are listed. Explain why is 40% voice activity used instead of 50% as required by M1225?
A: The codec used in the simulations is the G.729 with 20 bytes of voice payload generated every 20msec. All users are assumed to have the same codec (G.729). The voice activity factor (VAF) was chosen to be equal to 40% as that seemed to be the more widely-used value. With VAF of 50% the capacity will be somewhat reduced because it will be partly offset by the reduced overheads in each frame.

Q: Provide details on power control and rate adaptation algorithms on DL and UL.
A: Only rate adaptation is used in the DL based on effective SINR measurement at the MS while feedback delay of two frames (10 ms) is explicitly taken into account. UL uses slow power control every 20 frames in addition to rate adaptation; the power control is based on the received powers in each sector without any centralized RRC. Please also see the detailed responses to the power control related comments in A1.2.7 and A1.2.22.

Q: Provide average DL single antenna C/I for reuse 3. Provide average UL pathloss distribution. Provide interference over thermal distribution on UL.

A: Please find below the C/I distributions for both reuse 1 and reuse 3 and for both the ITU vehicular and COST-231 environments (the latter being a popular pathloss model used in evaluations in the literature and standardization bodies). In the UL case, the SINR is heavily dependent on the user allocations within the frame of each sector and each cell of the 19-cell network. Therefore, we do not provide any specific information on the C/I distribution.



Q: Provide link level simulations.
A: Please see Section 2.3.4 of proposal (1079r1) as well as the results presented in Appendix 1 of this document.

Q: Provide detailed description on system and link simulation interface.
A: Please see Section 2.3 of the proposal (1079r1). We have provided information consistent with other RTT submissions and M.1225 requirements.

Q: With mixed channel model simulations, VoIP capacity is shown to be < 9 Erlangs/MHz/cell for reuse 1, SIMO, 10 MHz PUSC Subchannelization. When 90 users are loaded in 3 sectors, the 10% of VoIP users exceeds 97% tail latency of 100 ms latency on DL.
A: The presented VoIP capacity for reuse 3 and SIMO transmission is 90 Erlangs/MHz/cell for 10 MHz PUSC subchannelization.

These results represent minimum achievable VoIP capacity of the proposal; in reuse 1 with MIMO transmission, the VoIP capacity is on the order of 120 Erlangs/MHz/cell, which amounts to ~200 user calls per sector in 10 MHz reuse 1. According to the response in a similar question in A3.1.1.1, the packet delay is well below the 100 ms bound.

Q: DL dimension in a TDD 2:1 10 MHz system is shown to be exhausted when 135 VoIP calls are admitted into each cell. Hence the upper bound on the VoIP capacity is 13.5 Erlang/Mhz/cell in reuse 1 system
A: It is unclear how the number of 135 VoIP calls is derived. As shown in the response to a MAP overhead related question in A1.3.1.5.2 and in the response to a similar question in A3.1.1.1, IP-OFDMA reliably supports 200 user calls per sector in a 10 MHz bandwidth for reuse 1 in the case of MIMO transmission, which translates to a voice capacity of 120 Erlangs/MHz/cell (please also note the explanation with respect to the definition of the voice capacity in a TDD system in A1.3.1.5.1).

Q: We understood that the voice activity factor assumed for voice capacity simulation was 40% in the proposal, which is different from one in M.1225 (50%). What is a rationale to use the different assumption? What are possible impacts on the voice capacity results if you use 50% for the voice activity factor?
A: We chose 40% as that seemed to be the more widely-used value. With voice activity factor (VAF) of 50% capacity the capacity will reduce but partly offset by the reduced overheads. With VAF 0.5, we estimate the numbers to roughly 60 and 67 Erlangs/MHz/cell for 5 and 10 MHz bandwidths respectively. Please also see response to a similar question in A3.1.1.1.

Q: Why did the simulation in proposal assume "Vehicular" for path loss model and "Pedestrian B" for channel impulse response model, which are for different test environments? Is it possible to consider capacity based on path loss model and channel impulse response model from the same test environment, such as "Vehicular", "Outdoor to indoor and pedestrian" and/or "Indoor office"?
A: The Vehicular path loss model is the more popular path loss model in industry today, in combination with the Pedestrian-B and Vehicular-A channel models. Hence the motivation for the particular choice of models used.

Q: We understood that the call blocking rate assumed for voice capacity simulation was 2% in the proposal, which is different from one in M.1225 (1%). What is a rationale to use the different assumption? What are possible impacts on the voice capacity if you use 1% for the call blocking rate?
A: Actually, the results presented were rounded down and happened to correspond to the 1% blocking. For 2% blocking, the capacity would be 92 Erlangs/MHz/cell. The difference is marginal.

Q: This simulation appears to mix two environments – is it reasonable to use ITU Pedestrian-B at step 3 of §2.3.1.1, yet use vehicular path loss and antenna height in §2.3.1.2?
A: Additional results in Appendix 1 of this document use the ITU channel/pathloss model combinations according to M.1225.

Q: Why is 2.3 GHz used in page 23 and 2.5 GHz used elsewhere (e.g., page 58, Table 20)? What is the relationship to link budget?
A: The results were produced independent of one another, hence this difference. The difference in the link budget is ~1dB and negligible in the spectral efficiency (bps/Hz).

Q: What is the voice quality (MOS) for each user under these conditions?
A: Please see response to the similar comment in A1.3.8.

A3.1.1.2:
Q: Results are given with a model using a mixed test environment which does not match the deployment model for the mixed test environment in M.1225. The non-mandated mix uses a different path loss model than that specified in M.1225. Furthermore individual test environment results are not supplied for each test environment indicated on the cover sheet (Indoor, Outdoor to Indoor Pedestrian, Vehicular). Channel B is to be used for this analysis
A: Please see Appendix 1 of this document where a complete set of results in the test environments of M.1225 (indoor, outdoor to indoor pedestrian, and vehicular) is presented; note that results for the VehB channel are explicitly presented in Appendix 1.

Q: Outage for this data needs to be supplied as it is questionable using the assumptions stated in the 8F/1079Rev 1. See Appendices 1, 2, and 5.
A: Please see detailed response to the same question in A1.3.1.5.2 where it is shown that there is no issue with respect to the outage.

Q: Results used log normal shadowing standard deviation of 8 dB rather than the mandated 10 dB.
A: Please see Section 3.2 of Appendix 1 of this document where 10 dB lognormal shadowing standard deviation is assumed for OIP and 12 dB for indoor consistently with the M.1225 requirements.

Q: It is apparent that these numbers assume ideal channel estimates. In addition, for the UL MIMO case, it seems also that ideal case of MMSE combining is also assumed to separate the two users (ideal MMSE combing corresponds to the case where the two user's channel are completely orthogonal, hence the MMSE in this case will be interference free and will be almost equivalent to MRC combining with 2 Rx antennas). These two critical assumptions explain the 32% gain in throughput in the UL MIMO mode compared to the UL SIMO mode. It needs to be pointed out, however, that this is unrealistic. Our simulation for UL spatial multiplexing suggest a maximum of 10-12% improvement in throughput with two antennas.
A: The use of ideal channel estimates is common practice for system level simulations. Regarding UL MIMO (collaborative MIMO transmission), we assume sub-optimal MLD (maximum likelihood decoder) at the BS receiver. This explains why the gain is larger

than the gain of the MMSE receiver. Also note that said gains were verified with an independent simulator with practical channel estimation where impairments are accounted in two ways: 1) By explicitly modeling the inter-carrier interference which accounts for increased degradation due to the MS speed and 2) in the link-to-system mapping interface.

Q: The DL MIMO specified by the proposal is Vertical spatial Multiplexing (8.4.8.1.4). The submission claims 55% improvements in the DL MIMO throughput relative to a baseline 1 transmit, 2 receive antenna SIMO case. This percentage of improvement is possible only if the receiver has perfect knowledge of the channel (which is exactly what is stated in the assumption table) as well as there is no gap-to-capacity due to particular channel code being used. Hence, it seems that this 55% gain is totally unrealistic. In fact, according to our MIMO simulations (which assumes a practical system implementation and proportional fair scheduling as it is assumed in the submission), gains of the 2x2 MIMO case with respect to the base line 1x2 SIMO case are only noticeable for users with a geometry of 8 dB or more. However, the percentage of users that will have such geometry is no more than 10% (under these circumstances the gains are ~ 20%). Therefore, it is extremely doubtful that any practical system implementation will achieve this 55% gain in throughput.
A: The DL MIMO scheme of the proposal is based on adaptive switching between STBC and SM. In the low SNR region, STBC is usually selected which outperforms the baseline 2 receive antenna SIMO case when interference cancellation is assumed for both schemes. In the higher SINR region use of sub-optimal MLD for SM decoding provides a significant gain compared to MMSE, especially in highly correlated channels, i.e., correlation factor > 0.5. Therefore, the more than 50% gain of MIMO compared to SIMO is well justified also intuitively.

Q: What frequency reuse is assumed for the simulation?
A: Frequency reuse 1.

Q: Clarify whether the simulations considered mutual inference between MIMO users (What is the model?).
A: Yes, mutual interference is modeled by considering a spatial correlation factor of 0.5 at both transmit and receive sides (this model is widely known and used in the literature and standardization bodies).

Q: How many base station and mobile station transmitter and receiver antennas are used for this capacity? For a fair comparison with other technologies, only mandatory features of the standard should be used to meet the requirements. Does SIMO imply 1Tx 2 Rx? Simulation assumptions include 4 Rx options.
A: SIMO is 1Tx and 2Rx antennas; MIMO is 2Tx and 2Rx antennas. All antenna configurations and simulation assumptions refer to mandatory features of the IP-OFDMA technology.

Q: What's the FER distribution among users?

A: The fairness criterion as defined in 3GPP2 is satisfied.

Q: How is the FCH, DL-MAP, UL-MAP reliability and overhead modeled? How is CQI feedback and ACK feedback reliability and overhead modeled? Overhead accounting is clearly insufficient.
A: Please see response to similar question in A3.1.1.1.

Q: Provide details on power control and rate adaptation algorithms on DL and UL.
A: Please see response to similar question in A3.1.1.1, as well as A1.2.7 and A1.2.22.

Q: Provide average DL single antenna C/I for reuse 3. Provide average UL pathloss distribution. Provide interference over thermal distribution on UL.
A: Please see response to similar question in A3.1.1.1.

Q: Provide link level simulations.
A: Please see response to similar question in A3.1.1.1.

Q: Provide detailed description on system and link simulation interface.
A: Please see response to similar question in A3.1.1.1.

Q: A TDD 2:1 10 MHz system is simulated with realistic channel estimation performance and control channel modeling. The DL capacity of the proposed technology is shown to be 0.9 Mbps/MHz/cell in a 3 sector/cell system with frequency reuse 1.
A: Please see response to similar question in A3.1.1.1.

Q: Results in A3.1.1.1 and A3.1.1.2 do not use the required M.1225 deployment models for the given test environment, especially power, area, coverage, and user density. All the results are to use a consistent set of assumptions between the deployment models and the link budgets for simulations. Furthermore, Table 11 from M.1225 (deployment results matrix) is missing in submission.
A: Please see Appendix 1 of this document where a complete set of results in the test environments of M.1225 (indoor, outdoor to indoor pedestrian, and vehicular) is presented.

Q: The propagation model “COST 231 Suburban” used in 1079R1-E is not consistent with well-known “COST 231 Hata”. Details should be provided. Why did you use it for simulation?
A: The “COST-231 Suburban” used is the same as the “COST-231 Hata” model.

A3.2.1:

Q: Detailed delay analysis is not provided. D1 and D2 delays are to be specified.
A: Please see detailed response to a similar comment in A1.3.7.2 (definition of D1 and D2).

Q: This section is closely related to the item #1 "One-way end-to-end delay less than 40 ms." in "Voice and data performance requirements".
Therefore, referenced ITU Recommendation need to be ITU-T G.174 and G.114 that referred from G.174.
G.114 contains the guidance on the daley performance issue of IP over VoIP.
A: The M.1079 is end-to-end delay performance requirement whereas G.174 is delay contribution from specific components to the end-to-end delay.

A3.2.2.1:
Q: Peak Transmitter powers are not supplied (is to be the same as used in link budgets)
A: Please note that the link budget values are for specific scenarios while the answer in A3.2.2.1 is for the technology of the proposal.

A3.2.2.2:

Q: The answer given provides peak powers and dynamic ranges for both BS and MS and different modulation schemes but average power is not mentioned. Also missing is any mention of MS power for 64 QAM.
A: Please see the response to the related comment in A1.2.16.1.2. MS transmission of 64 QAM is optional and not required by the RTT. Hence the power is not provided.

A3.2.2.3.1:
Q: Adjacent channel emission is not supplied. Transmitter linearity and filtering and PA requirements are not specified.
A: Wherever applicable, the base station and mobile station equipment will comply with adjacent channel emission requirements; no specific value can be provided due to the multitude of local, regional, and international regulatory requirements. Please note that there are specific compliance tests defined by the WiMAX Forum and are to be met by all certified equipment. Regarding linearity, this has to be met within the dynamic range, e.g., w.r.t. out-of-band emissions, spurious emissions, intermodulation, which is provided in A.3.6.8. Finally, notice that PA-related issues are covered in A3.2.2.2.

Q: A generic spectrum mask needs to be presented by the proponent.
A: Currently, the WiMAX Forum is working on defining the spectrum masks depending on local, regional, and regulatory

requirements of the geographical areas where WiMAX systems will be deployed. Please note that all WiMAX certified equipment shall comply with those spectrum mask requirements. Since this effort will be finally approved by the involved regulatory bodies, there should not be any concern regarding compliance to requirements.

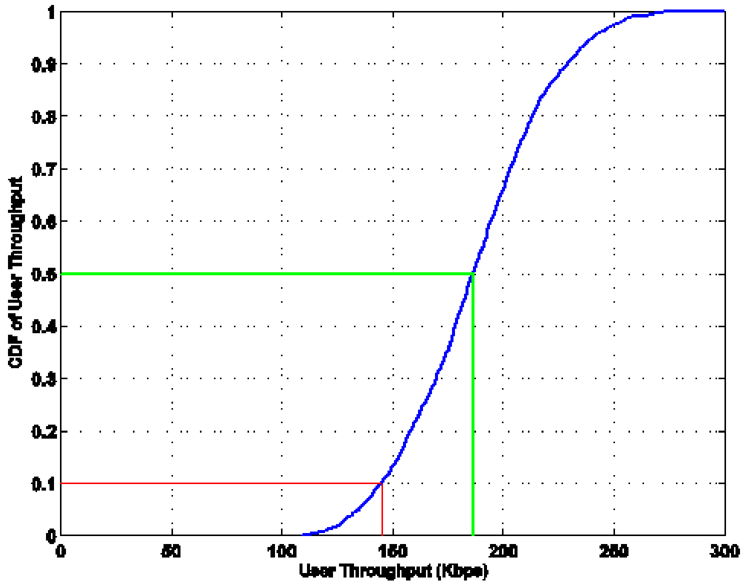
A3.2.2.4:
Q: Receiver linearity requirements are not stated.
A: Linearity has to be met within the dynamic range (e.g., w.r.t. out-of-band emissions, spurious emissions, intermodulation), which is provided in A.3.6.8.

Q: The response provided gives maximum allowable signal levels and required sensitivity levels. While these are important when determining receiver linearity, other factors such as expected blocker signals and adjacent channel signals must be considered.
A: There is no specified linearity requirement for the RTT. Hence these additional factors are not specified through requirements, but will be implemented to meet regulatory requirements for specific RF bands.

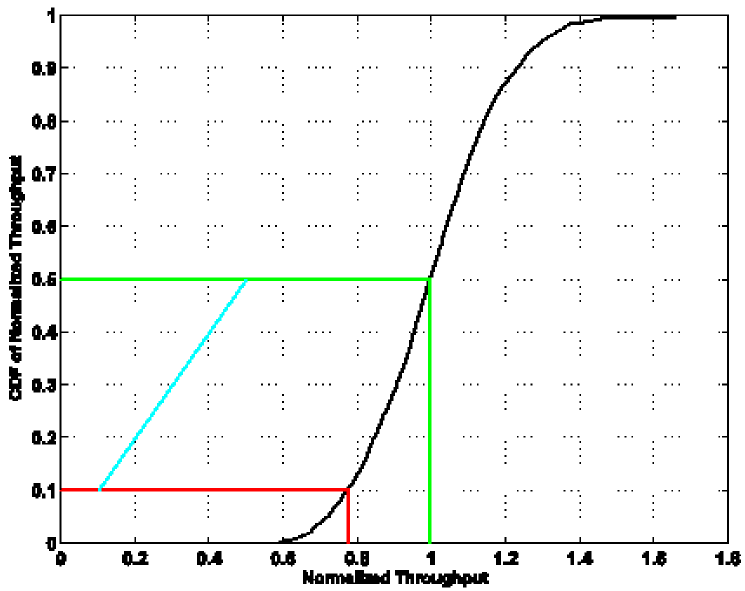
A3.2.3:
Q: What needs to be stated here also is that the UL power control is message based and each message is 44 bits. What needs to be evaluated here is that how many users in a fully loaded cell can be power controlled at the full PC rate or equivalently, what is the maximum PC rate that can be used for a fully loaded cell/sector, and whether that will be sufficient to provide the expected performance.
A: As stated in A1.2.22.2, 200 Hz is the max possible power control rate and typically is much less than 200Hz, around 10-20 Hz. At 20 Hz, the approximately 1 kbps overhead, please see the response to a related question in A1.2.7, amounts to less than 1% of the average user throughput in a SIMO deployment, i.e., the impact of the power control overhead on the system capacity is very low.

Q: Answer provided conflicts with technology description template in A1.2.7. Please clarify power control on the DL.
A: There is no conflict. A1.2.7 only suggests that no power control was used for the specific results tabulated.

Q: Please provide system level study with power control rate / system performance and overhead tradeoff..
A: Please find in the following two graphs with sample system level simulation results (CDF of user throughput and CDF of normalized user throughput) for UL SIMO in the ITU vehicular environment with mixed mobility; the power control rate is 20 Hz. Please also refer to the response to a similar question in A1.2.22 on power control where a detailed explanation of the tradeoff between power control overhead and system level performance is provided.



CDF of User Throughput
User Throughput (Kbps)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
50
100
150
200
250
300



A3.2.4:
Q: Transmitter/Receiver isolation requirement is not specified. For example requirements for transmit/receive guard time (RTG/TTG) and switch isolation (or equivalent) need to be specified.
For TDD, we need to specify the guard periods between UL and DL
A: Please see response to the same question in A1.2.2.2.

A3.2.5.1:
Q: Digital signal processing requirements are not supplied. At a minimum the evaluation should review the signal processing estimates (MOPS, memory requirements, gate counts).
A: Please see response to the same question in A1.4.13.

Q: When using 512 and 1024 point FFT for 5 MHz and 10 MHz (chip x1 sampling), respectively, the required analog filters' implementation complexity needs to be specified.
A: The implementation of analog filters for the different system bandwidths, e.g., 5 MHz and 10 MHz, is a requirement for the device compliance testing and does not impose any substantial increase of the overall device cost and complexity.

A3.2.6:
Q: The proposal indicates 2 or more transmit antennas at the base station. For MIMO operation, the indication in the proposal is that two MIMO streams are supported. The RTT needs to clarify how will that be done in the case where the base station have more than 2 transmit antennas (4 transit antennas for example), i.e. how those 2 spatial streams will be mapped to the 4 transmit antennas.
A: In the RTT proposal we only deal with the 2 transmit antenna MIMO system which is considered as the RTT baseline. However, the WiMAX Forum system profiles contain the use of 4 transmit antennas with the same MIMO transmission schemes, i.e., STBC and SM, as optional features for compliance and interoperability testing.

Q: For the Beamforming operation and since the RTT is TDD, it is not clear that there are enough provisions in the RTT to take advantage of the channel reciprocity to enable DL beamforming using UL channel estimates. Specifically, the IEEE 802.16 specification has provisions to enable the basestation to do an over the air calibration for its transmit and receive chains' mismatches thus enabling the base station to take advantage of the channel reciprocity. Again, many of those provisions are not included in the baseline specifications published by the WiMAX profiles. This would put the burden the base station hardware to either ensure minimal mismatch between the transmit and receive chains or provide a mechanism in the hardware to perform calibration.
A: The WiMAX Forum specifies in detail the necessary tests for device compliance and interoperability testing. As it is common practice for beamforming systems, BS equipment explicitly addresses the issue of transmit/receive chain mismatch in a transparent way for the MS devices.

Q: With reference to Doc. 1079(Rev. 1), the CEG sought clarification on page 35, A1.2.23.1, "State the dB of performance improvement introduced by the use of diversty" (also for A1.2.23.2); though there are several diversity scenarios possible with MIMO technology, perhaps an answer can be provided for the simplest diversity scheme. Please provide further details.

A: Diversity gain depends on many factors – but just to give a rough idea, 2 RX antennas can give a gain of between 4-6db in the link budget in a fading channel for 1% PER, PUSC permutation and 100B packets (such as ITU-PedB).

A3.2.6.1:
Q: In order to get transmit diversity in the MIMO mode, the BS station must use a number of transmit antennas that is larger than the number of DL streams being transmitted and this would require provisions in the RTT so that the base station can map those independent streams to the antennas. As, pointed out earlier, those provisions do exist in the IEEE 802.16e specifications. However, they don't exist in the baseline system profiles published by the WiMAX Forum. In addition, receive diversity at the MS will be obtained only when the number of receive antennas used at the MS is larger than the DL streams being sent by the basestation.
A: According to the 2x2 MIMO scheme of the proposal, the combination of TX diversity at low SINR's through STBC and data rate

increase at high SINR's through SM enables high performance without requiring higher number of antennas at both ends of the communication link, please see system capacity results provided in A1.3.1.5.2. The use of more transmit and/or receive antennas can only lead to further improvements of the system performance but is not a requirement for the system operation.

Q: When uplink CSM is used, received diversity will be achieved at the base station only if the number of receive antennas at the base station is larger than the number of users that are involved in the CSM or one of those user has a very weak signal at the base station.
A: Even for the baseline system (2 receive antennas at the BS) and even for the MMSE receiver, the performance is close to optimal since the spatial streams originate from different user signals which are uncorrelated. Appropriate scheduling and power control can further ensure that the performance at the system level is close to optimal. Certainly, the use of more receive antennas at the BS can only lead to further improvements of the system performance but is not a requirement for the system operation.

Q: The gains listed here needs to be verified. Also, need to state at which BER, PER these gains are achieved. In addition, it is questionable that you can get 2-4 dB SNR gain from SM compared to the single antenna system while at the same time the throughput is doubled.
A: As stated above, the reason for the high gains is the fact that the spatial streams originate from different user signals which are uncorrelated. Note that those gains are valid for both at high, e.g., 30%, and low, e.g., 1%, FER regions.

A3.2.6.2:
Q: No details given on how this is done in the current RTT
A: The deployment details are implementation dependent.

A3.2.6.3:
Q: No details given on how this is done in the current RTT
A: The deployment details are implementation dependent. For clarification, with distributed antennas systems the proponents understand systems that are considered as a generalization of conventional repeater systems for the purpose of increasing coverage, e.g., in dead spots, or increasing the spectrum capacity and the battery life of mobile devices. The distributed antenna module is usually connected with the home BS via an exclusive RF link. Although connections via the same RF link used in the cell are possible, the connection with the same RF link construct so-called relay channels categorized as another area known as cooperative communications. Therefore, when we refer to distributed antenna systems the proponents understand generalized repeater systems and not relay systems.

Q: Clarification on what "distributed antenna" means in A3.2.6.3. Explain what was the proponent understanding and rationale for the answer and other Brazilian Evaluation Groups understandings.

A: Please see response to the related comment in A3.2.6.3.

A3.2.8:
Q: What is the delay requirement VoIP that is referred to here? What are the exact simulation setup? What is the reuse frequency used? This number of users also does not make sense in the light of the answer to A3.1.1.1 above regarding the Erlang Capacity/MHz/Cell.
A: Note that the delay requirements for VoIP traffic satisfy the ITU-R M.1079 criteria. Note that the response in this section is based on the use of the G.726 codec and frequency reuse 3. However, the results are in accordance with the ones provided in A3.1.1.1 – please note that the results in this section are given in VoIP calls per sector. Finally, please refer to the detailed response on the Erlang capacity to a similar question in A1.3.1.5.1, where it is shown that there is no inconsistency with respect to the reporting of voice capacity results in 1079r1.

A3.2.9:
Q: RTT specifies GPS synchronization of Base stations. This is not specified in this entry.
A: As stated in Sections A1.4.3, A3.2.7, A3.4.2.2.1, and A3.5.1, GPS is typically used for BS synchronization without this being a stringent requirement. This is the reason for not explicitly stating this in A3.2.9.

Q: Proposal requires two transmitters at the Base Station.
A: According to the WiMAX Forum Wave I System Profile, there is no requirement for the use of more than one antenna at the BS; further, please note that even for the Wave II System Profile, a single antenna may be used for transmission of the DL control information (DL MAP). With respect to the last statement, please note the results on the MAP performance presented in A1.3.1.5.2 (1-Tx, 2-Rx antennas).

A3.2.10:
Q: It is our understanding that only hard handover is supported in the baseline system specified by the WiMAX profiles.
A: Yes, Simple Hard Handover and Optimized Hard Handover is supported. As the MS is only attached to one BS at a time significantly less complexity is expected, please also see response in Section A3.2.10 of the proposal (1079r1). Also refer to A1.2.24 for a detailed analysis on handover for IP-OFDMA.

Q: Provide evidence that HHO is sufficient for reuse-1.
A: Please see Section 2.3.2 of the proposal for the handover performance in an extended set of handover scenarios. Also refer to A1.2.24 for a detailed analysis on handover for IP-OFDMA.

Q: How would the implementation of one ASN profile over another impact handover complexity?

A: The impact of the ASN profile largely causes differentiation only in the specific functions on a BS versus an ASN-Gateway. So the handover complexity of the RTT should be more or less independent of the ASN profile and more dependent on the type of handover used over the RTT instead.

Q: With reference to Doc. 1079(Rev. 1), Pg. 10, para on "Security," 2nd sentence: Paragraph 1, need to clarify "topology." MS cannot communicate directly with the CSN – has to pass thru' the ASN. Further this statement leads one to believe that the ASN is not part of the authentication mechanism. Why is there not a triangle of trust? Please provide further information on the security transfer between NSPs in the handover calculations.

A: The triangle of trust issue is addressed by key binding. There is a 3-way handshake performed between the BS in the ASN and the MS at the end of the PKMv2 protocol which enables the MS to securely access the network as its encryption keys will be bound to the BS in the ASN. See Section 7.8.1 in the IEEE-802.16e-2005 Amendment.

A3.3.2:

Q: Is this RTD or one-way delay? Sounds more like the latter. Please clarify.

A: Yes, the 60 ms seems to be the 1-way end-to-end delay. The end-to-end round trip delay (RTD) should be 120ms, not 60ms.

A3.3.3:
Q: Very limited information provided on Handover. Is only Hard Handover supported? Average number of handovers is not supplied.
A: Please see the detailed response to the same question in A1.2.24.

A3.3.4:
Q: No quantitative information is provided
A: Please see the detailed response to the same question in A1.2.24.

A3.3.5:
Q: Maximum user bit rate is not supplied.
A: 'Well above' because the values can be increased by changing the DL/UL ratio that this number is calculated for, as has been done in A3.4.1.1. For example, in 10 MHz system with DL/UL ratio equal to 2:1, DL MAP overhead of 6 OFDMA symbols and UL control overhead of 3 OFDMA symbols, i.e., total number of 24 DL data symbols and total number of 12 UL data symbols, the maximum bit rate in the DL (2 Tx antennas, MIMO spatial multiplexing mode, MCS 64-QAM 5/6) is 34.56 Mbps and the maximum bit rate in the UL (1 Tx antenna, MCS 64-QAM 5/6) is 6.72 Mbps.

A3.3.7:
Q: Voice quality is not demonstrated. Specifically, data to verify the G.726 error free performance and no more than 0.5 MOS degradation with 3% frame error rate is not supplied.
A: Please see response to a similar question in A1.3.8.

Q: If we assume G.726, what are the MOS scores of this codec operating over the IP-OFDMA radio channel under the same conditions as A3.1.1.1? What are the MOS scores in the presence of 3% frame erasures?

A: Please see response to the similar comment in A1.3.8.

A3.3.8:
Q: Blocking and quality performance are not specified for 125%, 150%, 175%, and 200% load.
A: Please see the response to the same question in A1.3.9.1.

Q: A best case and worst case should be presented.
A: When we say that the results are largely implementation dependent, we mean that the blocking and quality performance depends on the link adaptation mechanisms applied in the primary and adjacent cells. Please note that the effect is more pronounced since there might be different operator/vendor equipment in the different cells. Therefore, we decided to not provide explicit numbers on the performance in such an implementation dependent overload scenario.

A3.4.1.2:
Q: This Doppler corresponds to a speed of approx. 250 km/hr @ 2.5 GHz carrier frequency. However, no data in the submitted proposal support this claim. The mobility profile included in the proposal only go up 120 km/hr for only 10% of the users with the majority of users below 30 km/hr. This claim is very important since it will affect the performance of channel estimation.
A: Increasing the mobile speed to 250 km/h will lead to a graceful degradation of the link performance. It is important to note that the system will not break down; rather, a higher SINR will be required for achieving the same FER performance. The said performance degradation is largely dependent on the used MCS (modulation and coding scheme). Since at this high speed the most robust MCS is chosen, i.e., QPSK 1/2, then the expected degradation is relatively small. Further, the expected degradation is more evident for small values of the FER, e.g., below 10%. In practical cellular systems supporting HARQ functionality, though, the target PER is usually higher than 10%, e.g., 30%. If one additionally considers the fact that the percentage of high mobility users in the network is typically small, e.g., smaller than 10%, then the overall impact of high mobility users on the system capacity is marginal.
Regarding the performance of channel estimation, when using channel estimation according to the MMSE (minimum mean squared error) approach, the following results are valid at a PER of 1%; please note that those are results from link level

simulations for the SIMO system (1 Tx, 2-Rx antennas) and PUSC permutations in the downlink:

For QPSK 1/2:
For VehA: When going from 120 km/h to 250 km/h, the performance degradation is 0.8 dB.
For VehB: When going from 120 km/h to 250 km/h, the performance degradation is 1.6 dB.
For 16-QAM 1/2:
For VehA: When going from 120 km/h to 250 km/h, the performance degradation is 1.2 dB.
For VehB: When going from 120 km/h to 250 km/h, the performance degradation is 3.1 dB.

Please note that the results in Appendix 1 of this document cover the cases for VehA 120 km/h and VehB 120 km/h.

A3.4.1.4:
Q: If a longer delay spread (longer than the CP can handle) is encountered, performance will suffer depending on the power delay profile of the multipath.
A: Please see response to the same question in A1.2.14.1.

Q: Here, the cyclic prefix is specified as 1/8 of an OFDM symbol which corresponds to 11.4 usec. Any multipath beyond that will results in inter-carrier interference (ICI) and hence will gracefully degrade the performance, depending on the power delay profile of the channel. If the power delay profile has large energy beyond the 11.4 usec delay spread, there will be an increase in ICI, and orthogonality between carriers will be lost. In addition, there will be increased channel estimation loss. Take for example Veh B channel, the performance will be bad. In addition, in one of the answers in Annex 2, the RTT claims support of cell sizes that are up to 35 Km in size. The key question here is that for large cells, what is the probability the delay spread will be within (or reasonable close to) 11.4 usec?
A: Please see response to the same question in A1.2.14.1.

Q: We have two questions on this issue. One is the verbiage of "delay spread". We believe you mean the "maximum excess delay" of delay profile because Vehicular B channel model has the path of 20us delay with -16dB power. Is our understanding correct? Second, even if our understanding is correct, the 20us delay occurs ISI (inter-symbol-interference) in the proposed system with CP=11.4us (See Table 2 in Section 1.3.3, A1.2.1.4 in Section 2.1, and Table 14 in Section 2.3.3.1), and the performance is significantly degraded in such a condition. Whilst the CP of Tg/4(=22.8us) is defined in Table 384b in the 802.16e standard document. What is your assumption of the items listed in the Reference mentioned above?

A: Yes, we've used 'delay spread' to mean excess delay. There will be 'graceful degradation' in the performance due to ISI as the excess delay goes beyond the CP length, without the need to resort to sophisticated equalizers. Note that the fading is still essentially flat for the specified sub-carrier spacing.
The CP factor can be adjusted depending on the requirements and propagation environments. The maximum value as stated

above is ~22.8 μsec. The CP factor of 11.84 μsec is the recommended value for typical Vehicular multi-path environment to trade off support for delay spread and power efficiency.

A3.4.1.6:
Q: Specific voice coding rates are not specified
A: As also stated in the original response, there are no requirements for specific coding rates. Exemplarily, the codec used in the simulations is the G.729 with 20 bytes of voice payload generated every 20 msec.

Q: Information on bit rate variability, delay variability, and error protection variability is not provided
A: As stated in the response to this section, specific vocoder parameters are independent of the RTT and are implementation specific.

A3.4.1.7:
Q: Does the number of CIDs limit the number of bearers?
A: No, there is no limitation imposed on the number of bearers.

A3.4.2.1.2:
Q: Guard bands are not specified.
Explanation is needed as to why guardbands are RF band specific.
A: It is stated that guard bands are RF band specific due to the fact that local, regional, and international regulatory requirements will instruct the required guard bands for the RTT deployment.

Q: What are the requirements for guardbands between IP-OFDMA and IMT-2000 technologies in the same band?
A: We provided response according to other RTT submissions. Please note, though, that there are extensive studies within ITU regarding sharing of IP-OFDMA with other IMT-2000 technologies.

Q: Is frequency planning is necessary?
A: As it is demonstrated in the response on the MAP transmission performance in A1.3.1.5.2, there is no issue regarding the MAP overhead even in reuse 1 (1x3x1). Further, the results presented in both the 1079r1 as well as the attached Appendix 1 provide sufficient proof that there is no issue associated with the capability of IP-OFDMA to provide high spectrum efficiency in reuse 1 deployments in both the downlink and the uplink. Based on those comprehensive results, frequency planning is not necessary for IP-OFDMA.

A3.4.2.2.2:

Q: Symbol structure designed to reduce the effects of delay spreads up to 20 µsec needs explanation since the cyclic prefix is 11.2 µsec.
A: See the response to similar comments in A1.2.14.1.

A3.4.2.3.1:
Q: Explanation is needed as to how the same frequencies can be used across layers by proper segmentation of the PUSC Subchannels.
A: According to the PUSC permutations of this RTT, see Section 1.3.2 of the proposal (1079r1), the available bandwidth can be, e.g., segmented into three portions for frequency reuse 3 and each portion can be used by different layers without interfering with the other two.

Q: What is "proper segmentation" of the PUSC channels?

A: See Sections 8.4.3.2 and 8.4.4.4 in the IEEE Standard 802.16-2004 and IEEE 802.16e-2005 Amendment for definition of segments and also concept of segments using PUSC.

A3.4.2.4.2:
Q: Explanation of the reason the RTT is suited is needed.
A: IP-OFDMA makes use of time division duplexing. In TDD the channel reciprocity between the uplink and the downlink can be utilized for applying beamforming in the most optimum way. Please also see Section 1.3.5 for a comprehensive explanation of the suitability of this RTT for adaptive antennas.

A3.5.3.1:
Q: Please explain how a subscriber of the ISDN/PSTN would discover an E.164 compliant number, and how that would then be used to establish bearer services to a subscriber of "IP-OFDMA."

Please explain how a subscriber of "IP-OFDMA" would establish bearer services to a subscriber of the ISDN/PSTN. Please explain how teleservices are supported.

A: As voice bearer services are supported as an application using Voice over IP, classical examples are how applications like Voice is supported over the Internet today. There is nothing in the RTT that restricts being able to discover a E.164 number or provide teleservices using Voice over IP.

A3.5.3.3:
Q: Depth of fading tolerated is not supplied
A: As mentioned in our detailed response in A1.2.2.4, IP-OFDMA has very reliable mechanisms for handling dropped calls. Even if the depth of the fading leads to a fading duration of seconds, IP-OFDMA has the necessary mechanisms for enabling reliable

network re-entry. Certainly, depending on the scenario, the use of simple or optimized handover will lead to different required times for regaining entry to the network. Please refer to Tables 11 and 12 of Section 2.3.2 of 1079r1 for a detailed analysis on the latency and duration during handover in different typical scenarios; those tables provide realistic values for the latency and the duration of handover.

A3.6.1:
Q: Transmitter/Receiver isolation requirement is not specified. For example, requirements for transmit/receive guard time (RTG/TTG) and switch isolation (or equivalent) need to be specified
A: Please see response to the same comment in A1.2.2.2.

A3.6.2:
Q: Average transmitter power is not specified
A: Please see response to the same question in A1.2.16.1.2.

Q: 4 power classes in the system? Class 4 is => 4 dBm?
A: Table 129 in Reference [3] of the RTT proposal (1079r1) provides the information on the power classes; note that Reference [3] refers to the WiMAX Forum Mobile System Profile, Release 1.0 Approved Specification (Revision 1.2.2: 2006-11-17).

Q: Question on 12 dB: Is this value for terminal? What is the number of subcarriers fof 12 dB? 12 dB is that for the max number of carriers?
A: The value of 12 dB is a typical value applicable to both the terminal and the BS and is valid for the maximum number of subcarriers (1024 subcarriers in 10 MHz bandwidth).

A3.6.3:
Q: Round trip delay is not supplied
A: Please see detailed response on the RTD in the related comment of A1.3.7.2.

Q: Delay need to be further checked with ITU recommendations.
A: Please note that the requirement for the total one-way delay as defined in G.174. This is the delay between the MS and the BS. As shown in the RTT proposal (1079r1), please see Figure 12 in Section 2.3.1.2, that the total one-way delay as defined in G.174 is smaller than 40ms (< 40 ms), which fully complies to the requirements.

A3.6.4:
Q: Maximum peak MS transmit power is specified as 1 W (Power Class 3) however, A3.2.2.2 and A1.2.16 gives a Power Class 4

with an unspecified maximum power.
A: This is not limited by RTT but by regulations, i.e., there is no issue related to the Power Class.

A3.6.5:
Q: Frequency of power control is not specified.
A: Please see the detailed answers to the related comments in A1.2.7 and A1.2.22.

A3.6.6:
Q: Entry specifies that linear transmitters are used but no requirements are specified.
A: Please see our response to comment in Section A3.2.2.3.1.

Q: Section A1.4.10 does provide more data but a couple of key points are missing. For example adjacent channel power ratios (ACPR) figures are needed. As well 64 QAM modulation has been left out of the discussion.

A: Some of the parameters are implementation specific and as the RTT does not have specific linearity requirements, they are more addressed as part of interoperability and certification procedures of the WiMAX Forum and not in the standard. 64QAM is optional on the UL hence it is left out.

A3.6.7:
Q: Entry specifies that linear receivers are used but no requirements are specified, while A1.4.11 specifies that linear receivers are not required.
A: Please see our response to comment in Section A3.2.2.4; linear receivers are not required but are typically implemented for this RTT.

A3.6.13:
Q: Sleep ratio is not specified
A: The response to this section fully addresses this comment.

A3.6.14:
Q: Frequency range of the synthesizer is specified to be 5 or 10 MHz, however it is unreasonable to have a synthesizer range be the same as the Bandwidth of the technology.
Clarify step size.
A: Please see the response to the same questions in A1.4.5.

Q: Does a step size of "200 and 250kHz" imply a step size of 50kHz?

A: Yes it could; however, as the RF band support is implementation specific it is not universally required.

A3.6.15:
Q: Digital signal processing requirements are not supplied. At a minimum the evaluation should review the signal processing estimates (MOPS, memory requirements, gate counts).
A: Please see the detailed response to the same question in A1.4.1.3.

A3.7.1.1:
Q: Base site coverage efficiency is not supplied.
A: Please see Appendix 1 of this document where coverage efficiency is provided for all test environments according to M.1225.

Q: The evaluation group's outage simulation results indicate a significant outage problem with the simulation assumptions stated in the submission. See Appendices 1, 2, and 5.
A: According to the detailed response in the same question in A1.3.1.5.2, there is no issue with respect to the outage of IP-OFDMA.

Q: Link budget constructed by the evaluation group indicates significant discrepancies from the link budgets given in 8F/1079 Rev 1. See Appendix 4.
A: According to the detailed response in the same question in A1.3.1.7.1, there is no issue with the link budget of 1079r1.

Requirements and Objectives

T1.1
Q: No information supplied to show that you can achieve 40 ms delay with VoIP A3.3.2 states that one-way delay is 70 ms.
A: The requirement is for the total one way delay as defined in G.174. This is the delay between the MS and the BS. This is shown in 8F/1079(Rev. 1) section 2.3.1.2 in Figure 12 and is < 40ms.

T1.2
Q: Again, no information supplied to show that you can achieve these delays.
A: The one-way delay as described in Section 2.3.1.3. Overall delay includes the one way transmission path and characteristic delay.

T1.3
Q: Voice quality is not demonstrated. Specifically, data to verify the G.726 error free performance and no more than 0.5 MOS degradation with 3% frame error rate is not supplied.
A: Although the RTT operates independent of specific speech codecs, please see detailed response in A1.3.8 that fully addresses this comment.

T1.4
Q: No Information to support yes is provided
A: DTMF signals can be reliably transported in packet data form over IP-OFDMA.

T1.5
Q: No Information to support yes is provided
A: As IP-OFDMA supports a packet data transport, this capability is expected to be provided as an application over VoIP. No inherent limitation exists for such an application to be supported.

T1.6
Q: Note 1 specifically states that circuit switched data is not supported
A: Only packet switch data services are supported natively. The RTT is purely a packet-switched data technology. Circuit-switched data is not supported. However, the RTT will support seamless interworking with circuit-switched systems using media gateways and support for QoS classes.

T1.7
Q: Information in A3.5.3.1 states that ISDN is not natively supported
A: IP-OFDMA provides a packet switch data service that allows interworking with PSTN and ISDN systems through interworking gateways.

T1.11
Q: No information provided to show that you can support a large cell considering the amount of delay spread that must be dealt with
Again 500 km/hr, no data provided, ability to do channel estimation at those speeds is questionable.
A: Please see response to comments in A1.4.14.1 and A3.4.1.2. Mega cells are not applicable to the terrestrial RTTs but are implied for Satellite RTT components. IP-OFDMA supports terrestrial deployments and does support Macro, Micro and Pico cells.

T1.12
Q: No information provided
A: These are implementation dependent. IP-OFDMA is, however, capable of meeting this requirement.

T1.13
Q: No information provided
A: Efficient channel coding schemes are supported (See A3.2.5.2)

T1.14
Q: No information provided to support this.
Blocking metric used in submission was 2%
A: No inherent limitation in IP-OFDMA that prevents it from meeting this requirement; please also see response to related comment in A3.1.1.1 fully addressing this issue.

T2.1
Q: 8F/1079 Rev 1 Section 1.4.7 states security capabilities including AES encryption
A: IP-OFDMA supports AES-CCM for privacy and CMAC and HMAC for message authentication. User and Device authentication are supported through the use of EAP methods.
PSTN/ISDN equivalent security can be provided for voice services that are implemented as an application over the RTT. No inherent limitation exists to the level of security that can be provided for voice or data services at the application layer.

T2.3

Q: No answer was supplied
A: No inherent limitation in IP-OFDMA to prevent it from supporting this as an application over packet data service provided.

T2.4
Q: Voice quality is not demonstrated. Specifically, data to verify the G.726 error free performance and no more than 0.5 MOS degradation with 3% frame error rate is not supplied.
A: Please see response to comment in A1.3.8 that fully addresses this issue.

T2.5
Q: No information provided to support the answer that encryption can be maintained during handover or roaming.
A: IP-OFDMA supports encryption using AES-CCM. 3-way handshake mechanisms and Traffic encryption key refresh mechanisms are supported for maintaining privacy during roaming and handover.

T2.6
Q: No information provided to support answer
A: No inherent limitation in IP-OFDMA to prevent it from supporting this as an application. These are application specific and not mandated by the RTT. But applications may support this.

T2.7
Q: Not clear from the proposal whether they can meet the E911 requirements.
A: No inherent limitation in IP-OFDMA to prevent it from supporting this requirement.

T2.11
Q: No information supplied to show that the RTT can do that
A: The authentication credentials used in existing IMT-2000 RTTs can be used with the appropriate EAP methods over this RTT that provides a generic EAP encapsulation method. Hence roaming across IP-OFDMA networks can be made possible with appropriate interworking support in the Core networks.

T2.14
Q: No information on guard bands and out of band emissions has been provided to justify ability to coexist
A: Multiple operators can be supported in a geographic area using the NAP (Network Acess Provider – infrastructure owner/operator) and NSP (Network Service Provider – service operator) concepts supported by IP-OFDMA. The network can be shared by multiple virtual operators or NSPs.

T2.15
Q: No information supplied to show that the RTT can do that
A: IP-OFDMA supports different RF bands and flexible band sharing in different countries. IP-OFDMA supports the frequency arrangements for TDD.

T2.16
Q: RTT does not describe any interference management scheme
A: There is support for power control in IP-OFDMA and also the interference between Mobile stations and Base stations are eliminated using the Transmit to Transmit Gap and the Receive to Transmit Gap in TDD mode. Those schemes have been extensively addressed during the responses to evaluator comments.

T2.18
Q: Delay spreads larger than the Cyclic Prefix will cause a problem. It is not clear that Vehicular B channel model can be accommodated. Severity of the problem will depend on the power delay profile of the multipath (e.g. Veh B). In any case the resistance is not high in this instance.
A: Detailed data provided for VehB in Appendix 1 of this document fully addresses this issue.

T2.23
Q: No Information to assess.
A: The optimized hard handover supported by the RTT provides very little, unnoticeable, interruption to voice and data services. Please see detailed response to the related comment in A1.2.24.

T2.24
Q: The RTT describes a TDD system which requires synch.
A: Assuming each operator is using a separate RF channel, there is no need to synchronize the transmissions across operators. However, if the same RF channel is used by operators in adjacent cells, time synchronization is expected and this is typically only true when infrastructure sharing is utilized.

T2.25
Q: No Information to assess.
A: Layer 3 functions used with IP-OFDMA are very much independent of the RTT. Voice and Data services are supported as applications over a packet data air interface.

T2.28

Q: Information in A3.5.3.1 states that ISDN is not natively supported
A: ISDN B-channels provide 64 kbits/s data rates and the IP-OFDMA RTT can provide a constant bit rate (UGS) service at multiples of 64 kbits/s.

T2.35
Q: No information provided to show that you can support a large cell considering the amount of delay spread that must be dealt with
A: Please see response to T2.18; IP-OFDMA does support large cells.

T3.3
Q: Interworking functions are necessary for supporting ISDN services
A: Interworking functions are only needed when interfacing to non-IP networks.

T3.4
Q: System is not stable under reuse 1 with time varying traffic.
A: System is stable even with reuse 1 with 2 antennas and practical interference cancellation, which is expected to be the norm. It has been demonstrated in this document, see for instance A1.3.1.5.2, that IP-OFDMA the capability to have minimum frequency planning. Resource management of time-varying traffic across cells is provided in the ASN.

T3.8
Q: No Information to assess.
A: IP-OFDMA and has no inherent weakness in its design.

T3.9
Q: No Information to assess.
A: Cell selection is performed by decoding the DL Preambles, FCH, MAPs and then doing initial ranging. The Mobile Station can always select the best cell type in a hierarchical cell based on cost and capacity that is indicated by the QoS and service parameters exchanged during the capability negotiations during connection setup.

Appendix 1: IP-OFDMA Coverage/Capacity Evaluation using M1225 models

Contents

Introduction

This document contains the results of simulations for IP-OFDMA coverage and capacity performance evaluation based on the guidelines provided in ITU-R M1225 . The baseline model used is a 5 MHz bandwidth TDD system with 1 transmit (Tx) antenna and 2 receive (Rx) antennas in both the downlink and uplink (1x2 SIMO – Single-Input Multiple-Output). Further details of the deployment models considered and simulation assumptions are described in the corresponding sections below.

Coverage

The coverage analysis has been performed using the link budget template and default parameter values in M1225, except that the carrier frequency used is 2500 MHz. The link budgets table are presented in section and the preceding sections describe the deployment models and assumptions.

Deployment models

The deployment models considered are Indoor, Outdoor-to-Indoor Pedestrian (OIP), Outdoor Pedestrian and Vehicular. For each model, both Channels A and B were evaluated and for each channel the speech, low-delay-data (LDD) and unconstrained-delay-data (UDD) cases were considered. Furthermore, since IP-OFDMA is a purely packet-based architecture (i.e., no circuit domain) with HARQ, the speech and LDD cases were emulated using lower target PER and lower number of HARQ retransmissions compared to UDD. The 'circuit-switched long delay' case was not evaluated as it was felt to be not relevant to IP-OFDMA.

Assumptions

The bearer rates take into account the overhead due to retransmissions. Since the system is lightly-loaded per the M.1225 requirements, the Rx interference density is negligible and the downlink repetition and uplink subchannelization gains are explicitly accounted for. The log-normal fade margins are calculated for a 95% area coverage. Note that a site is defined as an omni cell for the Indoor and Pedestrian cases and as a 3-sector cell for the Vehicular case.

The link budgets are for a 5 MHz bandwidth, PUSC SIMO (1Tx-2Rx antennas in both downlink and uplink) system. The diversity gain is included in the Eb/No, hence there is no explicit diversity gain in the link budget tables. The required QPSK-1/2 Eb/No values for the given target PER are obtained from link-level simulations that model the IP-OFDM PHY compliant with the IEEE-16e specifications and using the corresponding link channel models from ITU-R M1225 and a MRC receiver.

The cell ranges in the link budget tables (Table 7 to) are calculated using the corresponding pathloss models from M1225. The corresponding cell areas are calculated assuming omni cells for Indoor, OIP and Outdoor Pedestrian, and 3-sector cells for Vehicular. In addition to the M1225 parameter values, the link budget is also calculated for optimized parameter values.

Link Budgets

Table 1. Link Budgets for Speech (Channel A)

Frequency, MHz	2500	Downlink	Uplink	Downlink	Uplink	Downlink	Uplink	Downlink	Uplink
Test environment		Indoor	Indoor	OIP	OIP	Pedestrian	Pedestrian	Vehicular	Vehicular
Multipath channel class		A	A	A	A	A	A	A	A
Mobile speed		0.5 km/h	0.5km/h	3 km/h	3 km/h	3 km/h	3 km/h	120 km/h	120 km/h
Test service		Speech	Speech	Speech	Speech	Speech	Speech	Speech	Speech
Note									
Bit rate	kb/s	17.8	17.8	17.8	17.8	17.8	17.8	17.8	17.8
Average TX power per traffic ch	dBm	< 10	< 4	< 20	< 14	< 20	< 14	< 30	< 24
Maximum TX power per traffic ch	dBm	10	4	20	14	20	14	30	24
Maximum total TX power	dBm	10	4	20	14	20	14	30	24
Cable, conn and combiner losses	dBm	2	0	2	0	2	0	2	0
Tx antenna gain	dBi	2	0	10	0	10	0	13	0
TX EIRP per traffic channel	dBm	10	4	28	14	28	14	41	24
Total TX EIRP	dBm	10	4	28	14	28	14	41	24
RX antenna gain	dBi	0	2	0	10	0	10	0	13
Cable and connector losses	dB	0	2	0	2	0	2	0	2
Receiver noise figure	dB	5	5	5	5	5	5	5	5
Thermal noise density	dBm/Hz	-174	-174	-174	-174	-174	-174	-174	-174
RX interference density	dBm/Hz	-1000	-1000	-1000	-1000	-1000	-1000	-1000	-1000
Total effect noise+interf density	dBm/Hz	-169	-169	-169	-169	-169	-169	-169	-169
Information rate	dBHz	42.5	42.5	42.5	42.5	42.5	42.5	42.5	42.5
Required Eb/(No+Io)	dB	9.2	9.1	8.9	8.6	8.9	8.6	7.3	7.8
RX sensitivity	dBm	-117.3	-117.4	-117.6	-117.9	-117.6	-117.9	-119.2	-118.7
Explicit diversity gain	dB	0	0	0	0	0	0	0	0
Other gain (DL repetition / UL subchannelization)	dB	7.8	12.3	7.8	12.3	7.8	12.3	7.8	12.3
Log-normal fade margin	dB	15.4	15.4	26.3	26.3	11.2	11.2	11.4	11.4
Maximum path loss	dB	119.7	118.4	127.1	125.9	142.2	141.1	156.6	154.6
Maximum range	km	0.47	0.42	0.26	0.24	0.62	0.58	4.89	4.34
Coverage efficiency	km^2/site	0.70	0.57	0.21	0.18	1.21	1.05	46.67	36.63
Optimized Parameters									
Maximum TX power per traffic ch	dBm	13	10	23	20	23	20	40	24
Tx antenna gain	dBi	2	2	10	0	10	0	17	0
RX antenna gain	dBi	2	2	0	10	0	10	0	17
Maximum path loss	dB	124.7	126.4	130.1	131.9	145.2	147.1	170.6	158.6
Maximum range	km	0.692	0.784	0.36	0.40	0.85	0.95	13.46	6.46
Coverage efficiency	km^2/site	1.51	1.93	0.40	0.49	2.28	2.81	352.97	81.41

Table 2. Link Budgets for Speech (Channel B)

Frequency, MHz	2500	Downlink	Uplink	Downlink	Uplink	Downlink	Uplink	Downlink	Uplink
Test environment		Indoor	Indoor	OIP	OIP	Pedestrian	Pedestrian	Vehicular	Vehicular
Multipath channel class		B	B	B	B	B	B	B	B
Mobile speed		0.5 km/h	0.5 km/h	3 km/h	3 km/h	3 km/h	3 km/h	120 km/h	120 km/h
Test service		Speech	Speech	Speech	Speech	Speech	Speech	Speech	Speech
Note									
Bit rate	kb/s	17.8	17.8	17.8	17.8	17.8	17.8	17.8	17.8
Average TX power per traffic ch	dBm	< 10	< 4	< 20	< 14	< 20	< 14	< 30	< 24
Maximum TX power per traffic ch	dBm	10	4	20	14	20	14	30	24
Maximum total TX power	dBm	10	4	20	14	20	14	30	24
Cable, conn and combiner losses	dBm	2	0	2	0	2	0	2	0
Tx antenna gain	dBi	2	0	10	0	10	0	13	0
TX EIRP per traffic channel	dBm	10	4	28	14	28	14	41	24
Total TX ERP	dBm	10	4	28	14	28	14	41	24
RX antenna gain	dBi	0	2	0	10	0	10	0	13
Cable and connector losses	dB	0	2	0	2	0	2	0	2
Receiver noise figure	dB	5	5	5	5	5	5	5	5
Thermal noise density	dBm/Hz	-174	-174	-174	-174	-174	-174	-174	-174
RX interference density	dBm/Hz	-1000	-1000	-1000	-1000	-1000	-1000	-1000	-1000
Total effect noise+interf density	dBm/Hz	-169	-169	-169	-169	-169	-169	-169	-169
Information rate	dBHz	42.5	42.5	42.5	42.5	42.5	42.5	42.5	42.5
Required Eb/(No+Io)	dB	8.6	7.9	6.9	6.9	6.9	6.9	7.5	7.9
RX sensitivity	dBm	-117.9	-118.6	-119.6	-119.6	-119.6	-119.6	-119.0	-118.6
Explicit diversity gain	dB	0	0	0	0	0	0	0	0
Other gain (DL repetition / UL subchannelization)	dB	7.8	12.3	7.8	12.3	7.8	12.3	7.8	12.3
Log-normal fade margin	dB	15.4	15.4	26.3	26.3	11.2	11.2	11.4	11.4
Maximum path loss	dB	120.3	119.6	129.1	127.6	144.2	142.8	156.4	154.5
Maximum range	km	0.49	0.47	0.29	0.27	0.70	0.64	4.83	4.31
Coverage efficiency	km^2/site	0.77	0.68	0.27	0.22	1.52	1.28	45.54	36.19
Optimized Parameters									
Maximum TX power per traffic ch	dBm	13	10	23	20	23	20	40	24
Tx antenna gain	dBi	2	2	10	0	10	0	17	0
RX antenna gain	dBi	2	2	0	10	0	10	0	17
Maximum path loss	dB	125.3	127.6	132.1	133.6	147.2	148.8	170.4	158.5
Maximum range	km	0.725	0.860	0.40	0.44	0.96	1.04	13.30	6.42
Coverage efficiency	km^2/site	1.65	2.32	0.50	0.60	2.87	3.42	344.43	80.42

Table 3. Link Budgets for LDD (Channel A)

Frequency, MHz	2500	Downlink	Uplink	Downlink	Uplink	Downlink	Uplink	Downlink	Uplink
Test environment		Indoor	Indoor	OIP	OIP	Pedestrian	Pedestrian	Vehicular	Vehicular
Multipath channel class		A	A	A	A	A	A	A	A
Mobile speed		0.5 km/h	0.5 km/h	3 km/h	3 km/h	3 km/h	3 km/h	120 km/h	120 km/h
Test service		LDD2048	LDD2048	LDD384	LDD384	LDD384	LDD384	LDD144	LDD144
Note									
Bit rate	kb/s	2273.3	2273.3	426.2	426.2	426.2	426.2	159.8	159.8
Average TX power per traffic ch	dBm	< 10	< 4	< 20	< 14	< 20	< 14	< 30	< 24
Maximum TX power per traffic ch	dBm	10	4	20	14	20	14	30	24
Maximum total TX power	dBm	10	4	20	14	20	14	30	24
Cable, conn and combiner losses	dBm	2	0	2	0	2	0	2	0
Tx antenna gain	dBi	2	0	10	0	10	0	13	0
TX EIRP per traffic channel	dBm	10	4	28	14	28	14	41	24
Total TX EIRP	dBm	10	4	28	14	28	14	41	24
RX antenna gain	dBi	0	2	0	10	0	10	0	13
Cable and connector losses	dB	0	2	0	2	0	2	0	2
Receiver noise figure	dB	5	5	5	5	5	5	5	5
Thermal noise density	dBm/Hz	-174	-174	-174	-174	-174	-174	-174	-174
RX interference density	dBm/Hz	-1000	-1000	-1000	-1000	-1000	-1000	-1000	-1000
Total effect noise+interf density	dBm/Hz	-169	-169	-169	-169	-169	-169	-169	-169
Information rate	dBHz	63.6	63.6	56.3	56.3	56.3	56.3	52.0	52.0
Required Eb/(No+Io)	dB	5.2	6.9	6.3	7.3	6.3	7.3	4.6	7.1
RX sensitivity	dB	-100.2	-98.5	-106.4	-105.4	-106.4	-105.4	-112.4	-109.9
Explicit diversity gain	dB	0	0	0	0	0	0	0	0
Other gain (DL repetition / UL subchannelization)	dB	1.3	0.0	7.0	6.3	7.0	6.3	7.8	9.3
Log-normal fade margin	dB	15.4	15.4	26.3	26.3	11.2	11.2	11.4	11.4
Maximum path loss	dB	96.2	87.1	115.1	107.4	130.3	122.5	149.8	142.8
Maximum range	km	0.08	0.04	0.13	0.08	0.36	0.23	3.76	2.45
Coverage efficiency	km^2/site	0.02	0.00	0.05	0.02	0.41	0.17	27.56	11.70
Optimized Parameters									
Maximum TX power per traffic ch	dBm	13	10	23	20	23	20	40	24
Tx antenna gain	dBi	2	2	10	0	10	0	17	0
RX antenna gain	dBi	2	2	0	10	0	10	0	17
Maximum path loss	dB	101.2	95.1	118.1	113.4	133.3	128.5	163.8	146.8
Maximum range	km	0.11	0.07	0.18	0.14	0.43	0.32	8.86	3.13
Coverage efficiency	km^2/site	0.04	0.02	0.10	0.06	0.57	0.33	153.09	19.09

Table 4. Link Budgets for LDD (Channel B)

Frequency, MHz	2500	Downlink	Uplink	Downlink	Uplink	Downlink	Uplink	Downlink	Uplink
Test environment		Indoor	Indoor	OIP	OIP	Pedestria n	Pedestria n	Vehicula r	Vehicular
Multipath channel class		B	B	B	B	B	B	B	B
Mobile speed		0.5 km/h	0.5 km/h	3 km/h	3 km/h	3 km/h	3 km/h	120 km/h	120 km/h
Test service		LDD204 8	LDD204 8	LDD384	LDD38 4	LDD384	LDD384	LDD144	LDD144
Note									
Bit rate	kb/s	2273.3	2273.3	426.2	426.2	426.2	426.2	159.8	159.8
Average TX power per traffic ch	dBm	< 10	< 4	< 20	< 14	< 20	< 14	< 30	< 24
Maximum TX power per traffic ch	dBm	10	4	20	14	20	14	30	24
Maximum total TX power	dBm	10	4	20	14	20	14	30	24
Cable, conn and combiner losses	dBm	2	0	2	0	2	0	2	0
Tx antenna gain	dBi	2	0	10	0	10	0	13	0
TX EIRP per traffic channel	dBm	10	4	28	14	28	14	41	24
Total TX ERP	dBm	10	4	28	14	28	14	41	24
RX antenna gain	dBi	0	2	0	10	0	10	0	13
Cable and connector losses	dB	0	2	0	2	0	2	0	2
Receiver noise figure	dB	5	5	5	5	5	5	5	5
Thermal noise density	dBm/H z	-174	-174	-174	-174	-174	-174	-174	-174
RX interference density	dBm/H z	-1000	-1000	-1000	-1000	-1000	-1000	-1000	-1000
Total effect noise+interf density	dBm/H z	-169	-169	-169	-169	-169	-169	-169	-169
Information rate	dBHz	63.6	63.6	56.3	56.3	56.3	56.3	52.0	52.0
Required Eb/(No+Io)	dB	4.3	5.6	4.3	5.6	4.3	5.6	4.6	7.2
RX sensitivity	dB	-101.1	-99.8	-108.4	-107.1	-108.4	-107.1	-112.4	-109.8
Explicit diversity gain	dB	0	0	0	0	0	0	0	0
Other gain (DL repetition / UL subchannelization)	dB	1.3	0.0	7.0	6.3	7.0	6.3	7.8	9.3
Log-normal fade margin	dB	15.4	15.4	26.3	26.3	11.2	11.2	11.4	11.4
Maximum path loss	dB	97.1	88.4	117.1	109.1	132.3	124.2	149.8	142.7
Maximum range	km	0.08	0.04	0.15	0.09	0.40	0.25	3.76	2.44
Coverage efficiency	km^2/site	0.02	0.01	0.07	0.03	0.51	0.20	27.56	11.55
Optimized Parameters									
Maximum TX power per traffic ch	dBm	13	10	23	20	23	20	40	24
Tx antenna gain	dBi	2	2	10	0	10	0	17	0
RX antenna gain	dBi	2	2	0	10	0	10	0	17
Maximum path loss	dB	102.1	96.4	120.1	115.1	135.3	130.2	163.8	146.7
Maximum range	km	0.12	0.08	0.20	0.15	0.48	0.36	8.86	3.11
Coverage efficiency	km^2/site	0.05	0.02	0.13	0.07	0.72	0.40	153.09	18.86

Table 5. Link Budgets for UDD (Channel A)

Frequency, MHz	2500	Downlink	Uplink	Downlink	Uplink	Downlink	Uplink	Downlink	Uplink
Test environment		Indoor	Indoor	OIP	OIP	Pedestrian	Pedestrian	Vehicular	Vehicular
Multipath channel class		A	A	A	A	A	A	A	A
Mobile speed		0.5 km/h	0.5 km/h	3 km/h	3 km/h	3 km/h	3 km/h	120 km/h	120 km/h
Test service		LDD2048	LDD2048	LDD384	LDD384	LDD384	LDD384	LDD144	LDD144
Note									
Bit rate	kb/s	2985.7	2985.7	559.8	559.8	559.8	559.8	209.9	209.9
Average TX power per traffic ch	dBm	< 10	< 4	< 20	< 14	< 20	< 14	< 30	< 24
Maximum TX power per traffic ch	dBm	10	4	20	14	20	14	30	24
Maximum total TX power	dBm	10	4	20	14	20	14	30	24
Cable, conn and combiner losses	dBm	2	0	2	0	2	0	2	0
Tx antenna gain	dBi	2	0	10	0	10	0	13	0
TX EIRP per traffic channel	dBm	10	4	28	14	28	14	41	24
Total TX ERP	dBm	10	4	28	14	28	14	41	24
RX antenna gain	dBi	0	2	0	10	0	10	0	13
Cable and connector losses	dB	0	2	0	2	0	2	0	2
Receiver noise figure	dB	5	5	5	5	5	5	5	5
Thermal noise density	dBm/Hz	-174	-174	-174	-174	-174	-174	-174	-174
RX interference density	dBm/Hz	-1000	-1000	-1000	-1000	-1000	-1000	-1000	-1000
Total effect noise+interf density	dBm/Hz	-169	-169	-169	-169	-169	-169	-169	-169
Information rate	dBHz	64.8	64.8	57.5	57.5	57.5	57.5	53.2	53.2
Required Eb/(No+Io)	dB	2.2	4.1	2.6	4.5	2.6	4.5	1.7	4.6
RX sensitivity	dB	-102.0	-100.2	-108.9	-107.0	-108.9	-107.0	-114.1	-111.2
Explicit diversity gain	dB	0	0	0	0	0	0	0	0
Other gain (DL repetition / UL subchannelization)	dB	0.0	-1.3	7.0	5.3	7.0	5.3	7.8	9.3
Log-normal fade margin	dB	15.4	15.4	26.3	26.3	11.2	11.2	11.4	11.4
Maximum path loss	dB	96.7	87.5	117.6	108.0	132.8	123.2	151.5	144.1
Maximum range	km	0.08	0.04	0.15	0.09	0.42	0.24	4.17	2.65
Coverage efficiency	km^2/site	0.02	0.00	0.07	0.02	0.54	0.18	33.94	13.72
Optimized Parameters									
Maximum TX power per traffic ch	dBm	13	10	23	20	23	20	40	24
Tx antenna gain	dBi	2	2	10	0	10	0	17	0
RX antenna gain	dBi	2	2	0	10	0	10	0	17
Maximum path loss	dB	101.7	95.5	120.6	114.0	135.8	129.2	165.5	148.1
Maximum range	km	0.12	0.07	0.21	0.14	0.49	0.34	9.84	3.39
Coverage efficiency	km^2/site	0.04	0.02	0.13	0.06	0.76	0.36	188.53	22.39

Table 6. Link Budgets for UDD (Channel B)

Frequency, MHz	2500	Downlink	Uplink	Downlink	Uplink	Downlink	Uplink	Downlink	Uplink
Test environment		Indoor	Indoor	OIP	OIP	Pedestrian	Pedestrian	Vehicular	Vehicular
Multipath channel class		B	B	B	B	B	B	B	B
Mobile speed		0.5 km/h	0.5 km/h	3 km/h	3 km/h	3 km/h	3 km/h	120 km/h	120 km/h
Test service		LDD2048	LDD2048	LDD384	LDD384	LDD384	LDD384	LDD144	LDD144
Note									
Bit rate	kb/s	2985.7	2985.7	559.8	559.8	559.8	559.8	209.9	209.9
Average TX power per traffic ch	dBm	< 10	< 4	< 20	< 14	< 20	< 14	< 30	< 24
Maximum TX power per traffic ch	dBm	10	4	20	14	20	14	30	24
Maximum total TX power	dBm	10	4	20	14	20	14	30	24
Cable, conn and combiner losses	dBm	2	0	2	0	2	0	2	0
Tx antenna gain	dBi	2	0	10	0	10	0	13	0
TX EIRP per traffic channel	dBm	10	4	28	14	28	14	41	24
Total TX EIRP	dBm	10	4	28	14	28	14	41	24
RX antenna gain	dBi	0	2	0	10	0	10	0	13
Cable and connector losses	dB	0	2	0	2	0	2	0	2
Receiver noise figure	dB	5	5	5	5	5	5	5	5
Thermal noise density	dBm/Hz	-174	-174	-174	-174	-174	-174	-174	-174
RX interference density	dBm/Hz	-1000	-1000	-1000	-1000	-1000	-1000	-1000	-1000
Total effect noise+interf density	dBm/Hz	-169	-169	-169	-169	-169	-169	-169	-169
Information rate	dBHz	64.8	64.8	57.5	57.5	57.5	57.5	53.2	53.2
Required Eb/(No+Io)	dB	2.3	3.8	1.7	4.0	1.7	4.0	1.7	4.7
RX sensitivity	dB	-101.9	-100.5	-109.8	-107.5	-109.8	-107.5	-114.1	-111.1
Explicit diversity gain	dB	0	0	0	0	0	0	0	0
Other gain (DL repetition / UL subchannelization)	dB	0.0	-1.3	7.0	5.3	7.0	5.3	7.8	9.3
Log-normal fade margin	dB	15.4	15.4	26.3	26.3	11.2	11.2	11.4	11.4
Maximum path loss	dB	96.6	87.8	118.5	108.5	133.7	123.7	151.5	144.0
Maximum range	km	0.08	0.04	0.16	0.09	0.44	0.25	4.17	2.64
Coverage efficiency	km^2/site	0.02	0.01	0.08	0.02	0.60	0.19	33.94	13.55
Optimized Parameters									
Maximum TX power per traffic ch	dBm	13	10	23	20	23	20	40	24
Tx antenna gain	dBi	2	2	10	0	10	0	17	0
RX antenna gain	dBi	2	2	0	10	0	10	0	17
Maximum path loss	dB	101.6	95.8	121.5	114.5	136.7	129.7	165.5	148.0
Maximum range	km	0.12	0.08	0.22	0.15	0.52	0.35	9.84	3.37
Coverage efficiency	km^2/site	0.04	0.02	0.15	0.07	0.85	0.38	188.53	22.11

Table 7. Link Budgets for Speech (Channel A)

Data Capacity

The data capacity was evaluated using system-level simulations based on the deployment models and parameter values detailed in M1225 and for a carrier frequency of 2500 MHz. In the following, Table 8 through Table 10 contain the system parameters used for the performance evaluation. Table 11 summarizes the results.

Air-Interface Parameters

Table 8. OFDMA Parameters

Parameters		Values
System Channel Bandwidth (MHz)		5
Sampling Frequency (Fp in MHz)		5.6
FFT Size (NFFT)		512
Sub-Carrier Frequency Spacing		10.94 kHz
Useful Symbol Time (Tb = 1/f)		91.4 µs
Guard Time (Tg =Tb/8)		11.4 µs
OFDMA Symbol Duration (Ts = Tb + Tg)		102.9 µs
Frame duration		5 ms
Number of OFDMA Symbols		48 (including ~1.6 symbols for TTG/RTG)
DL PUSC	Null Sub-carriers	92
	Pilot Sub-carriers	60
	Data Sub-carriers	360
	Subchannels	15
UL PUSC	Null Sub-carriers	104
	Pilot Sub-carriers	136
	Data Sub-carriers	272
	Subchannels	17

Propagation and Channel Parameters

Table 9. Propagation and Channel Models

Parameters	Indoor	OIP	Ped	Veh
Channel Impulse Response Model	ITU-Indoor A/B	ITU-Outdoor-to-Indoor & Pedestrian A/B		ITU-vehicular A/B
Propagation Model	ITU-Indoor	ITU-Outdoor-to-Indoor & Pedestrian		ITU-Vehicular
Log-Normal Shadowing Std dev	12 dB	10dB		
BS Shadowing Correlation	1 between sectors, 0.5 between cells			
Penetration loss Mean	0	12	0	
Penetration loss SD	0 dB	8	0	

Simulation Parameters

Table 10. System Parameters

Parameters	Indoor	OIP	Pedestrian	Vehicular
Number of Cells	19 (3 floors)	19		
Cell configuration	Omni			3-sector
Operating Frequency	2500 MHz			
Duplex	TDD			
Channel Bandwidth	5 MHz			
Cell/Sector Radius	20m	150 m	250m	1.5km
BS-BS distance	35m	260 m	430m	2.6km
Antenna Pattern	Omni			70° (-3 dB) with 20 dB front-to-back ratio
BS Height	N/A			15m above rooftop
BS Antenna Gain	2 dB	10 dB		13 dB
MS Antenna Gain	0 dB			
BS Maximum Power Amplifier Power	10 dBm	20 dBm		30 dBm
Mobile Terminal Maximum PA Power	4 dBm	14 dBm		24 dBm
# of BS Tx/Rx Antenna	1Tx, 2Rx			
# of MS Tx/Rx Antenna	1Tx, 2Rx			
Receiver Type	Based on the minimum mean squared error (MMSE) estimator			
MS Noise Figure	5 dB			
BS cable loss	2 dB			
Frequency Reuse	1			
Users/Sector	10			
Traffic Type	Full Buffer			
Channel Estimation	Dependent on the MS speed; degradation amounts to ~1 dB for low mobility (3 km/h) and ~2 dB for high mobility (120 km/h)			
Antenna Correlation	0 at BS, 0.5 at MS			
PHY Abstraction	Based on the Mean Instantaneous Capacity			
Scheduler	Proprietary Proportional Fair			
Link Adaptation	Adaptive for initial transmissions, non-adaptive for retransmissions, 2-frame delay feedback implemented			
HARQ	Max 4 retransmissions, non-adaptive, synchronous			
HARQ Operating PER	30%			
Power Control	No power control on downlink, slow power control (10 Hz) on uplink			
Coding	CTC			
Frame Overhead	11 OFDM Symbols (7 DL, 3 UL, 1 TTG)			
Data Symbols per Frame	24 for downlink, 12 for uplink (after excluding downlink and uplink overhead)			
DL/UL Partition	24:12			

Simulation Methodology

The simulations employ a dynamic simulator that models the evolution of the channel of the subscriber and interferers in time, and employs a PHY abstraction to predict link layer performance. The data is collected over several trials (drops) for the MSs of the center cell BS of the 19-cell layout. A drop is defined as a simulation run for a given set of users over a specified number of TDD frames. For each drop the methodology is as follows:

The system is modeled as a network of 19 cells. The cells are omni-cells for the Indoor, OIP and Pedestrian outdoor cases, and 3-sectored cells for the Vehicular case.

MSs are first dropped randomly throughout the system with a minimum distance - based on the deployment scenario - of the MS from the BS. Each mobile corresponds to an active user session that runs for the duration of the drop.

Cell/Sector assignment is based on the received power at an MS from all potential serving cells/sectors. The cell/sector with highest received power at the MS, taking into account slow fading characteristics

(path loss, shadowing, and antenna gains) is chosen as the serving cell/sector. Each user is assigned to only one cell/sector.
Mobile stations served by the center cell/sector are randomly selected one-at-a-time until the required number of active users have been selected.
MSs are assigned channel models with the given probabilities.
The signal and interference are computed for each MS by considering the propagation model and assigned channel models. Mean Instantaneous Capacity (MIC) is used for the link to system mapping. .
Packets are scheduled with a packet scheduler using the proportional fairness metric. Channel quality feedback delay, PDU errors and HARQ are modeled and packets are retransmitted as necessary. A non-adaptive, synchronous retransmission scheme is used for HARQ transmissions.
Performance statistics are collected only for MSs in the center cell (of the middle floor for the Indoor deployment). Layer 1 and layer 2 overheads are accounted for in computing the performance metrics.

Simulation Results

Table 11 summarizes the results for the Indoor, OIP, Pedestrian and Vehicular deployment cases.
The user throughput is defined with respect to the entire TDD frame, including both downlink and uplink sub-frames. Thus, it is calculated as the successfully delivered bits at the MAC SAP (Service Access Point) averaged over the entire simulation time, where the simulation time includes both downlink and uplink sub-frame times.
The downlink/uplink spectral efficiency is defined with respect to the downlink/uplink sub-frame of the TDD frame respectively. Thus, it is calculated as the successfully delivered bits at the MAC SAP (Service Access Point) averaged over all users and the net downlink/uplink resources.

Table 11. IP-OFDMA System Performance (5MHz TDD, 2:1 DL/UL ratio)

Deployment	DL		UL	
	5th %ile user throughput (kbps)	Spectral Efficiency (bps/Hz/cell)	5th %ile user throughput (kbps)	Spectral Efficiency (bps/Hz/cell)
Indoor Office	216	1.47	95	0.92
OIP	136	1.37	89	0.88
Pedestrian Outdoor	164	1.37	99	0.90
Vehicular	138	2.82	85	2.20

Deployment Model Results Matrix

The results are summarized in the deployment model matrix of Table 13 through Table 15 using the M1225 format. The numbers are based on the capacity simulation assumptions. The numbers within parentheses are based on the link budget, which are for low-loading scenarios and therefore are more optimistic.

Table 12. Deployment model result matrix for Indoor Office

Input assumptions				
Test environment		Indoor office		
Test service		Data		
Base station antenna height (m)		Not Applicable		
Any other assumptions made by the proponent (e.g. antenna pattern, sectorization etc.)		Omni cells, 3 floors with 7 cells per floor		
Deployment results				
Total number of cell sites	Total number of RF channels	Number of voice channels per RF channel	Coverage efficiency (km^2/site)	Spectrum efficiency (Mbit/s/cell)
8 (min 1) per floor of area 10000 m2	1	n/a	0.001 (max 0.57 km2)	1.5 Mbps/MHz/cell (DL) 0.9 Mbps/MHz/cell (UL)

Table 13. Deployment model result matrix for OIP

Input assumptions				
Test environment		Outdoor-to-Indoor		
Test service		Data		
Base station antenna height (m)		Not Applicable		
Any other assumptions made by the proponent (e.g. antenna pattern, sectorization etc.)		Omni cells		
Deployment results				
Total number of cell sites	Total number of RF channels	Number of voice channels per RF channel	Coverage efficiency (km^2/site)	Spectrum efficiency (Mbit/s/cell)
566 (min 217)	1	n/a	0.07 (max 0.18)	1.4 Mbps/MHz/cell (DL) 0.9 Mbps/MHz/cell (UL)

Table 14. Deployment model result matrix for Pedestrian

Input assumptions				
Test environment	Pedestrian			
Test service	Data			
Base station antenna height (m)	Not Applicable			
Any other assumptions made by the proponent (e.g. antenna pattern, sectorization etc.)	Omni cells			
Deployment results				
Total number of cell sites	Total number of RF channels	Number of voice channels per RF channel	Coverage efficiency (km^2/site)	Spectrum efficiency (Mbit/s/cell)
128 (min 24)	1	n/a	0.2 (max 0.6)	1.4 Mbps/MHz/cell (DL) 0.9 Mbps/MHz/cell (UL)

Table 15. Deployment model result matrix for Vehicular

Input assumptions				
Test environment	Vehicular			
Test service	Data			
Base station antenna height (m)	15m			
Any other assumptions made by the proponent (e.g. antenna pattern, sectorization etc.)	3-sector cells			
Deployment results				
Total number of cell sites	Total number of RF channels	Number of voice channels per RF channel	Coverage efficiency (km^2/site)	Spectrum efficiency (Mbit/s/cell)
35 (min 5)	1	n/a	4.4 (max 36.6)	2.8 Mbps/MHz/cell (DL) 2.2 Mbps/MHz/cell (UL)

References

Recommendation ITU-R M.1225, “Guidelines for Evaluation of Radio Transmission Technologies for IMT-2000”

ITU-R Working Party 8F Contribution 1065

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