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Title	Comments to the Performance Metrics in IEEE 802.16j-06/013	
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Re:	Response to chair’s call for comments on IEEE 802.16j-06/013	
Abstract	This contribution propose the mapping of channel models to usage models for IEEE 802.16j-06/013	
Purpose	Propose the mapping of channel models to usage models for IEEE 802.16j-06/013	
Notice		
Release		
Patent Policy and Procedures		

Comments to the Performance Metrics in IEEE 802.16j-06/013

This contribution proposes the changes to Section 4 Performance Metrics in IEEE 802.16j-06/013 [1]. The purpose is to further clarify some performance metrics that have already been defined as well as adding one more performance metric and some editorial changes.

1. Propose to replace the text in “4.1.1 Link Budget and Coverage Range (Noise Limited) – single-cell consideration” with the following text in IEEE C802.16j-06/013

---Star of the text for 4.1.1 --

Link budget evaluations is a well known method for initial system planning and this needs to be carried out for RS to BS, RS to MS and BS to MS links separately. The parameters to be used need to be agreed upon after obtaining consensus. Using the margins in the link budget, the expected signal to noise ratio can be evaluated at given distances. Using these results, the noise limited range can be evaluated for the system when the relays are deployed.
Link budget template as adopted from ITU-R M.1225 [15] with slight modifications should be used in the system simulation.
Since relays can be used to extend the range covered by a cell under noise limited environment (i.e. negligible interference from other cells but the limitation coming from the fact that the transmit power is not enough to provide a sufficient signal strength above thermal noise) coverage range is a metric of importance in such cases.
Coverage range is defined as the maximum radial distance to meet a certain percentage of area coverage (x%) with a signal to noise ratio above a certain threshold (target_snr) over y% of time, assuming no interference signals are present. It is proposed that x be 99 and y be 95.
---End of the text for 4.1.1 ---

Also, add a reference [15] in the reference section.

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

2. Original section number 4.1.4 should be modified to 4.2 since multi-user performance metrics should not be under the single-user performance metrics section.

3. Remove original section 4.1.4.1 since it does not provide any details on which three important aspects that need to be considered.

4. Insert the following text under (new) section 4.2, which is simply a further clarification of the original text in 4.1.4.1.1.

---Star of the text for 4.2 --

Although a user may be covered for a certain percentage area (e.g. 99%) for a given service, when multiple users are in a sector/BS, the resources (time, frequency, power) are to be shared among the users. It can be expected that a user’s average data rate may be reduced by a factor of N when there are N active users (assuming resources are equally shared and no multi-user diversity gain), compared to a single user rate.
For example, assume that there is a system, where a shared channel with a peak rate of 2 Mbps can serve 99% of the area. If a user wants to obtain a video streaming service at 2 Mbps, that particular user will be able to obtain the service, but no other user will be able to get any service during the whole video session (which may extend for more than an hour). Therefore, in this example although 99% of the area is covered for the video service, this service is not a viable service for the operator. Coverage performance assessment must be coupled with capacity (# of MSs), to obtain a viable metric.
The users having poor channel quality may be provided more resources so that they would get equal service from the cellular operator. This would adversely impact the total cell throughput. Thus, there is a trade-off between coverage and capacity. Any measure of capacity should be provided with the associated coverage.
Therefore, the number of users that can be supported under a given coverage captures actual coverage performance for a given service.
The suggested performance metric is the number of admissible users (capacity), parameterized by the service (Rmin), and the coverage (allowable outage probability).

Define the Combined Coverage and Capacity Index (*cc*): The number *N* of simultaneous users per cell (e.g. MMR-cell or legacy cell) that can be supported achieving a target information throughput $R\min$ with specified coverage reliability.

This performance metric can be approximated using either a simplified approximate evaluation methodology or a more detailed simulation as described below. Both methods are useful since the approximation methodology can be used to quickly compare two coverage enhancement techniques during the initial system concept development stage. The detailed simulations are useful to evaluate more carefully the most promising concepts. When results are presented the evaluation method used should be reported.

Method 1:

This is a Simplified Methodology to evaluate the Combined Coverage and Capacity Index (cc) using only the rate capability of each user. This can be evaluated without modeling higher layer protocols.

Assume that in a simulation N users are dropped uniformly in the service area. Let the required coverage for a given service be x% and the required information rate for that service be Rmin. The first step in evaluating *cc* is to sort the MSs in descending order of achievable rate, assuming each utilizes the entire resources. Then, only the top x% of the MSs are considered. Assume the number of users in the remaining group is *k*, and the average effective data rate that can be supported by the i-th user is r_i (i = 1 to k).

If r_k < Rmin, then $cc = 0$, indicating that the service cannot be provided with the required coverage, regardless of the number of users. Otherwise,

$$cc = \frac{k}{\sum_{i=1}^{k} \frac{R\min}{r_i}}.$$

Letting N become large, cc approaches the expected value of the number of users that can be supported by the system for that service with the required coverage, x%.

Method 2:

The following is a more detailed methodology to evaluate the combined coverage and capacity metric.

Coverage reliability for a particular system (cell radius, shadow fading environment, relay station placement, and so on) with a particular number of users n each requiring information throughput $R\min$ is calculated using a static system simulator. The static simulator shall model all other-user interference affects using appropriate path loss models and power control models (if any). The static simulator shall model a scheduler and resource manager that allocates resources such that as many users as possible achieve Rmin. Bandwidth is shared by the BS and RSs, while the BS and each RS have their own power resource. The static system simulator is run repeatedly with each run modeling a different instance of random drops of n MSs. Each simulator run results in $n_{s,i}$ MSs being served and $n_{b,i}$ MSs being blocked due to insufficient carrier to interference plus noise ratio and/or insufficient time-frequency (or power) resources. $n = n_{b,i} + n_{s,i}$. In this equation, i is an index identifying a particular simulation run. Coverage reliability is a function of n and is:

$$\frac{1}{M \times n} \sum_{i=1}^{M} n_{s,i}$$

where M is the total number of simulation runs. The Combined Coverage and Capacity Index *cc* is the largest n for which

$$\frac{1}{M \times n} \sum_{i=1}^{M} n_{s,i} > x$$

---End of the text for 4.2 --

5. Section 4.2 should now be 4.3 and all subsections should be numbered as 4.3.1 to 4.3.5. Replace (new) 4.3.4 text with the following.

---Start of the text for 4.3.4 --

The throughput of a user is defined as the ratio of the number of information bits that the user successfully received divided by the amount of time the user is actually requesting data.

---End of the text for 4.3.4 --

6. Remove (new) section 4.3.5 "The CDF of packet delay per user" since this is an obvious metric and it does not provide any supporting text for it to be a key performance metric.

7. Add a new performance metric "Packet loss ratio per user" in section 4.3.5 with supporting text as follow.

---Start of the text for 4.3.5 ---

The packet loss ratio per user is defined as one minus the ratio of total number of successfully received packets over the number of total transmitted packets. Typically for VoIP application, 2% packet loss ratio is tolerable. For gaming and video streaming application, packet loss ratio is typically less than 1%. Both the 1-way delay and packet loss ratio per user are important performance metrics in assessing different QoS schemes.

---End of the text for 4.3.5 ---

8. Section 4.3 "Fairness Criteria" should now be 4.4 and all subsections should be numbered as 4.4.1 to 4.4.4. Replace the first paragraph in section 4.4 with the following.

--Start of the 1st paragraph text for 4.4 ---

Since one of the primary objectives of the introduction of relays is to have uniform service coverage resulting in a fair service offering for best effort traffic, a measure of fairness under best effort traffic assumption is important in assessing how well the relaying solutions perform. With QoS differentiated traffic and algorithms designed to meet QoS requirements, it is more important to satisfy QoS than to be fair.

--End of the 1st paragraph text for 4.4 ---

9. Replace Appendix B Link Budget with the following updated text.

The link budget template as adopted from ITU-R M.1225 [15] with slight modifications is given in Table below. Entries that have explicit numerical values in the table (such as power levels, cable losses, etc) shall be used by proponents in their respective system simulations.

Item	Downlink	Uplink
Test environment	Suburban/urban macro-cell, micro-cell, indoor pico-cell	Suburban/urban macro-cell, micro-cell, indoor pico-cell
Multipath channel class	Cases I-IV	Cases I-IV
(a0) Average transmitter power per traffic channel	dBm	dBm
(a1) Maximum transmitter power per traffic channel after power back-off	dBm	dBm
(a2) Maximum total transmitter power	dBm	dBm
(b) Cable, connector, and combiner losses (enumerate sources)	3 dB	0 dB
Body Losses	0 dB	3 dB
(c) Transmitter antenna gain	17 dBi for BS 11 dBi for RS	0 dBi for MS 11 dBi for RS
(d1) **Transmitter e.i.r.p. per traffic channel = (a1 – b + c)**	dBm	dBm
(d2) **Total transmitter e.i.r.p. = (a2 – b + c)**	dBm	dBm
Penetration Loss (Ref: 3GPP2) [Determine how to use these numbers for different environments, revisit if 20dB is a reasonable value for building penetration)]	20 dB (Building) 10 dB (Vehicular)	20 dB (Building) 10 dB (Vehicular)
(e) Receiver antenna gain	0 dBi 11 dBi for RS	17 dBi for BS 11 dBi for RS
(f) Cable and connector losses	0 dB	3 dB
Body Losses	3 dB	0 dB
(g) Receiver noise figure	10 dB	5 dB
(h) Thermal noise density (H) (linear units)	–174 dBm/Hz 3.98×10^{-18} mW/Hz	–174 dBm/Hz 3.98×10^{-18} mW/Hz
(i) Receiver interference density (NOTE 1) (I) (linear units)	dBm/Hz mW/Hz	dBm/Hz mW/Hz
(j) **Total effective noise plus interference density** **$= 10 \log (10^{((g + h)/10)} + I)$**	dBm/Hz	dBm/Hz
(k) Information rate (10 log (R_b))	dB(Hz)	dB(Hz)
(l) Required $E_b/(N_0 + I_0)$	dB	dB
(m) **Receiver sensitivity = (j + k + l)**		
(n) Hand-off gain	dB	dB
(o) Explicit diversity gain	dB	dB
(o′) Other gain	dB	dB
(p) Log-normal fade margin	dB	dB
(q) **Maximum path loss** **= {d1 – m + (e – f) + o + n + o′ – p}**	dB	dB
(r) Maximum range	m	M