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Re:	Call for Comments n Draft Evaluation Criteria IEEE 802.16m-07/014r1
Abstract	This document presents some points and issues regarding technical requirements for P802.16m. These points includes a unified position of IEEE 802 project towards IMT-Advanced and inclusion of environment and geographical information within network elements
Purpose	Introducing realistic scenarios into the evaluation criteria
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Realistic Scenarios for System Evaluation

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Introduction

The proposed evaluation criteria document, [1], does not have a realistic scenario for system level simulations, and as such the evaluation procedure may be biased against systems that offer solutions for real-world problems. This document suggests an approach to introduce realistic scenarios for system evaluation.

The Current Evaluation Approach

Current evaluation approach, which is followed by most of the SDO of cellular networks, uses a totally artificial deployment scenario (the 19 cell wrap around implementation, described in Appendix G) and a set of statistical propagation models, as well as shadow fading models and channel models out of which a large set or realizations can be randomly chosen, simulated and analyzed to provide a large set of statistical measures by which different proposals can be compared. The hope is that the statistical description spans the whole spectrum of conditions and cases by which a real system will be deployed. This approach has a lot of advantages for system level simulations. The deployment is symmetric and manageable, results can be accurately reproduced and it is used everywhere as a representative model for a cellular network thus providing a common grounds for comparison. It has only one major drawback: the basic assumption it is based on is wrong - It has nothing to do with reality:

- Cells in a real network are not hexagonal
- Cells are not even contiguous
- User density is never uniform within a city
- Cells are not equal in size, even within the same hierarchical level
- The path loss model suggested is oversimplified COST HATA model. It is overly optimistic in predicting interference. A different model is needed for interference prediction.
- The propagation models proposed do not take into account indoor users and does not distinguish between users located in ground floors and those located at high floors. The latter are prone to interference and subject to CINR degradation.
- The randomization of shadow fading per drop conceals the high geographical dependence of shadowing.
- The suggested model is 2D. We live in a 3D world.

This fact is not unknown to the community, as we see a lot of effort in synthesizing a large set of environments, each with its own set of parameters (e.g. [2], [3]), and the development and introduction of new statistical models to describe the various physical effects (e.g. [4]).

In this document we are not suggesting to totally dispose of the current evaluation approach but rather to augment it with realistic scenarios, using real geographical data and deterministic models as much as possible, which will serve at least as a sanity check and reassurance that the models apply to real scenarios as well.

Effects of wrong modeling on system evaluation

Using the statistical model for deployment planning and system operation is obviously a mistake. Indeed operators use sophisticated tools, real geographical and building data, a variety of propagation models for different environments and drive tests for testing and calibrating the models.

Using this model alone as the model for system level simulations in the evaluation stage would be as severe a mistake that might lead to errors in technical evaluation. For example:

- The uniform and symmetric structure of the cells may give advantage to technologies optimized for a full cell range. Range and capacity tradeoff (as we find for example in 802.16e/OFDMA) might be penalized. Fortunately no deep system level simulations were made during the 16e project :)
- In real deployments, interference may find quite unexpected paths. The uniform cell model replaces that with random interference caused by different shadowing. Interference cancellation mechanisms, which could be quite beneficial in real scenarios might be deemed unusable in the artificial scenario with its optimistic interference model.
- Unrealistic frequency plans, which might cause unrealistic evaluation of interference, system capacity etc.
- A measure like antenna tilting, provides a significant improvement in "flat earth" scenarios, while if high-rise buildings are taken into account, it might reduce coverage in top floors.
- The 802.16e has the wonderful invention of zones, enabling different re-use patterns in time. It works very well in a uniform set of cells, where we can set the boundary the same in all cells. Can we use it in different cell size environment? Unfortunately, no deep system level simulations were made during the 16e project to verify that :(

These are of course only conjectured examples, but in view of those, it is rather perplexing to see the meticulousness by which the channel models are defined in the document, while path loss models and deployment scenarios suggested are so far from reality that would render the results insignificant to real world problems.

Real city (cities) and physical path loss model as a basis for evaluation

In order to create a model closer to reality the following approach is suggested:

1. Realistic deployment scenarios will be defined. A scenario should include terrain, clutter, building location and user densities, with allocation of users within building on several floors, pedestrian and mobile users along streets. Such scenarios could be:
    a. Several real cities and regions representing dense urban, suburban, rural and hilly terrain environments.
    b. A single region, which contains a realistic mixture of several environments.
    or
    c. An artificial scenario of a region.

2. A set of base station locations will be given for that scenario. The base station locations could be locations of real base stations in an already existing cellular network.

3. The path loss model used for path loss calculations will be a deterministic physical model, such as one of the multiple knife-edge models or even ray tracing, if applicable. NO SHADOW fading needs to be simulated as the physical environment produces the shadowing naturally (per measurement point).

4. Using a planning tool, the path loss between each base station towards a grid of measurement points spread around the tested area will be calculated off line and be given as an input the simulation tool. The points will be located on the ground and in buildings.

5. The resulting path loss matrix will be used in the simulation, as described in [1], replacing the path loss and shadow fading calculations.

Figure 1, below, shows an example of such a region. This is a 5 by 7km area, which mixes a hilly terrain, with two urban regions, and a sub-urban one. The map shows the main roads as well as streets, and buildings in the area are depicted by polygons. For that area a building database, which includes each building height is also available. Prediction points can be defined within the buildings for pedestrian and home users, while for vehicular users a set of points can be defined along the streets.

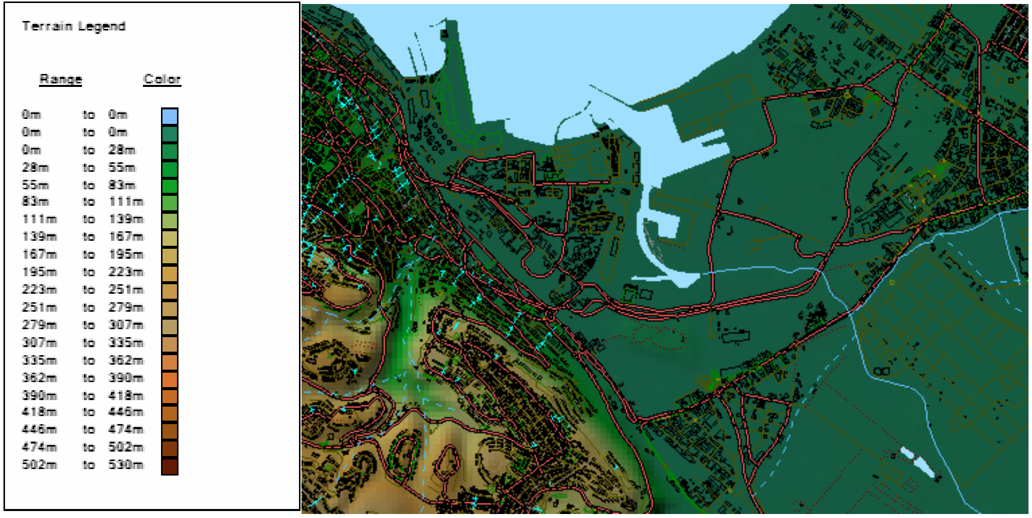

Figure 1: A real mixed environment Area

The base stations of an existing GSM-1800/UMTS cellular network are shown in Figure 2. There are 62 of them. The coordinates of 13 of them are given below in table 1.

Table 1: Base Station Location

Site No.	X	Y	Antenna Height ASL
1	149982	246389	96
2	150254	243829	270
3	150266	246229	91
4	151189	245581	45
5	150253	247287	46
6	151032	243128	256
7	152438	244515	58
8	150325	246471	97
9	150721	245499	100
10	150130	247319	54
11	151019	243860	161
12	149978	244460	262
13	150300	245933	116

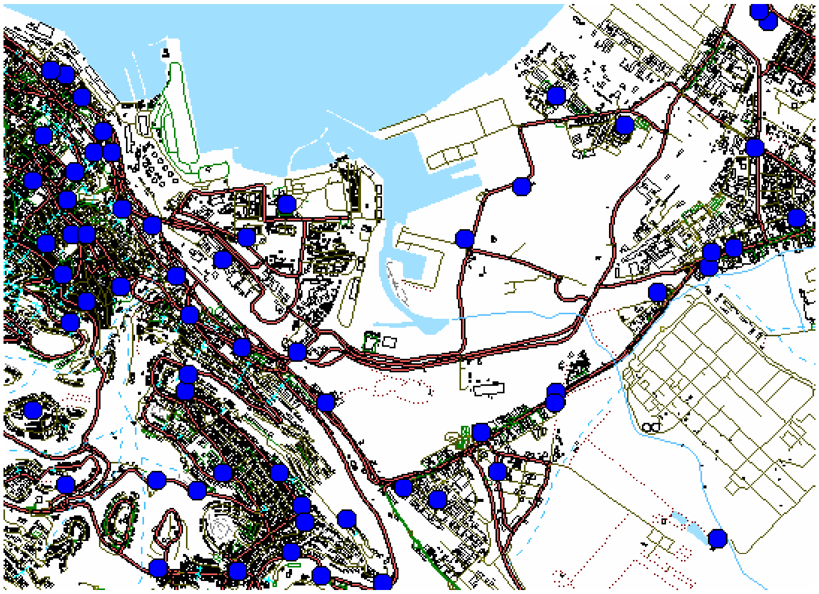

Figure 2: Base station Location

Figure 3 shows the land-use of the different parts of the map. This information can be used for user type/ user mix selection, as well as for channel model selection in each area.

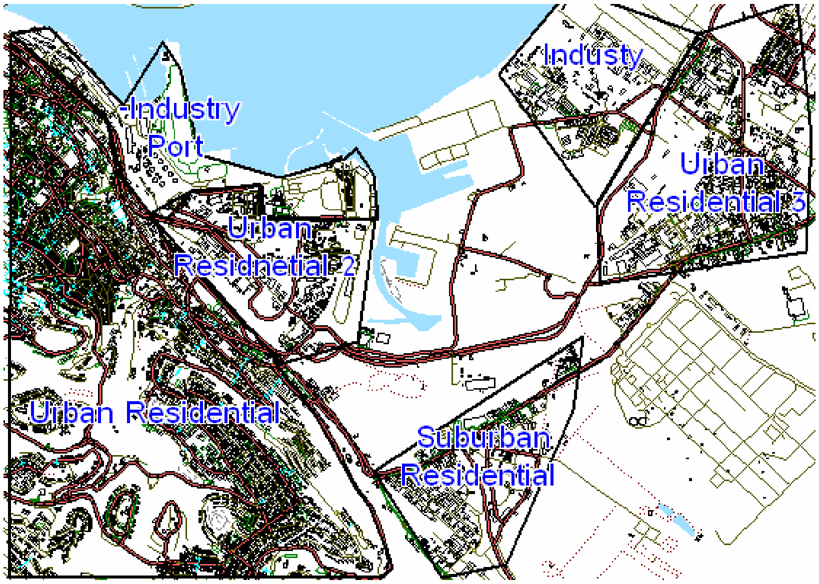

Figure 3: Land-use

Measurement points were located within each building, in every floor (every 3m). Additionally, points were located along the streets.

Using a diffraction only model, based on [5], the path losses (or rather the path gains) were calculated from every base station (with antenna height of 20m above ground) to each measurement point. A small sample of the results is given in the table 1, showing in each entry the path gain (in dB) between the measurement point and each base station site. About 30,000 points are needed to cover the entire area, with "building" resolution.

Table 1: Path Gain Matrix

This table, provided as an input to the simulation shows the path gain (in dB) between each measurement point and each base station site, actual size of such a table can be as large as 50,000 rows and ~60 columns

Points			Sites												
x	y	z	1	2	3	4	5	6	7	8	9	10	11	12	13
155276.9	243518.5	96	-131	-156	-130	-138	-144	-156	-124	-130	-128	-142	-164	-156	-129
154721.3	247521	270	-129	-154	-131	-130	-139	-150	-144	-127	-131	-138	-163	-130	-130
155073.9	247362.7	91	-129	-130	-128	-141	-132	-146	-129	-128	-130	-131	-167	-130	-136
150756.2	246944	45	-126	-154	-120	-140	-110	-156	-129	-111	-118	-112	-160	-149	-122
155812.4	246328.9	46	-151	-130	-133	-147	-136	-150	-133	-132	-139	-136	-164	-130	-131
150518.3	246197.8	256	-109	-152	-102	-114	-115	-139	-122	-105	-112	-116	-156	-148	-105
151311	245996.6	58	-117	-122	-115	-107	-119	-158	-126	-115	-112	-119	-160	-149	-127
151189.4	245353.7	97	-142	-150	-129	-101	-145	-160	-118	-117	-108	-121	-159	-139	-115
151040.5	244640.7	100	-121	-115	-119	-114	-123	-118	-133	-120	-114	-123	-112	-115	-118
152567.8	244601.3	54	-124	-156	-123	-119	-125	-157	-98	-124	-121	-126	-159	-155	-123
152567.8	244601.3	161	-124	-149	-123	-119	-125	-151	-99	-124	-121	-126	-156	-145	-123
152567.8	244601.3	262	-124	-122	-123	-119	-125	-121	-102	-124	-121	-126	-146	-123	-123
153906.1	244365.4	116	-156	-175	-155	-151	-167	-165	-119	-155	-150	-162	-176	-168	-153
150206	243880.7	116	-157	-92	-162	-137	-164	-146	-163	-162	-155	-158	-124	-131	-161

Using these data the suggested method can be "plugged in" any existing simulation, where the path gain matrix replaces the path loss and shading calculations. An MS drop would be just a selection of a measurement point.

Proposed Text Changes

Add the following text

Appendix-K: Optional System Analysis using Real Scenarios

In this optional analysis proponents will prove the system performance in a realistic scenario described below. The chosen scenario is a based on a deployment of a real cellular network with the following data:

1. The base stations are located at the coordinates given at the attached file.
2. Measurement points were defined for this scenario, in every building floor and along the streets.
3. The path gains between each base station and each measurement point were calculated. The results are available in the attached files, one for in-building and one for street points.
4. A set of regions in the map will determine user density, user mix and channel model selection within each region.
5. The proponents will determine the antenna sector orientation, antenna tilt and frequency plan that would produce the best performance.

The simulation will follow the same lines as the system simulation described in Chapter 12:

1. MSs are dropped throughout the system. The drop will be made by selecting a number of measurement points corresponding to the number of MSs needed. Each mobile corresponds to an active user session that runs for the duration of the drop. For pedestrian and in-building MSs, all measurement points will be available for selection. For vehicular MSs only the streets' measurement points will be selected.

2. Mobiles are assigned channel models according to their location. Depending on the simulation, these may be in support of a desired channel model mix, or separate statistical realizations of a single type of channel model.
3. MSs are dropped according to the specified traffic mix. The simulation runs are done with an increment of MSs per sector until a termination condition is met as shown in Figure 12-1.
4. Sector assignment to an MS is based on the received power at an MS from all potential serving sectors. The sector with best path to MS, taking into account antenna gains is chosen as the serving sector.
5. Mobile stations are randomly dropped over the area such that each sector has the required numbers of users. Although users may be in regions supporting handoff each user is assigned to only one sector for counting purposes. All sectors of the system shall continue accepting users until the desired fixed number of probe and load users per sector is achieved everywhere.
6. Fading signal and fading interference are computed from each mobile station into each sector and from each sector to each mobile for each simulation interval.
7. Packets are not blocked when they arrive into the system (i.e. queue depths are infinite). Users with a required traffic class shall be modeled according to the traffic models defined in this document. Start times for each traffic type for each user should be randomized as specified in the traffic model being simulated.
8. Packets are scheduled with a packet scheduler using the required fairness metric. Channel quality feedback delay, PDU errors and ARQ are modeled and packets are retransmitted as necessary. The ARQ process is modeled by explicitly rescheduling a packet as part of the current packet call after a specified ARQ feedback delay period.
9. Simulation time is chosen to ensure convergence in desired output metrics.
11. Performance statistics are collected for MSs in all cells according to the output matrix requirements.
12. All sectors in the system shall be dynamically simulated. MSs movement will be made along the streets.

References

[1] IEEE C802.16m-07/080r1- *Draft IEEE 802.16m Evaluation Methodology Document*

[2] Correia L., (ed.): *Flexible Personalized Wireless Communications, COST 259: European Co-operation in Mobile Radio Research* , Wiley 2001

[3] D5.4 *Final Report on Link Level and System Level Channel Models* IST-WINNER, Nov. 2005. Available at *http:/www.ist-winner.org*

[4] IEEE C802.16j-06/009: *Correlated Lognormal Shadowing Model*, Dean Kitchener et. al. May 2006.

[5] ITU-R Rec. P.526: *Propagation by diffraction*