Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>
Title	**A Proposal to add Channel Model for Open Rural Area for 16m Evaluation**
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Re:	IEEE 802.16m-07/23 "Call for Comments on Draft 802.16m Evaluation Methodology Document"
Abstract	This contribution proposes to add a channel model for open rural areas for 802.16m Evaluation Methodology
Purpose	Discuss and adopt proposed text in 802.16m Evaluation Methodology document
Notice	
Release	
Patent Policy	

A Proposal to add Channel Model for Open Rural Area for 16m Evaluation

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1. Introduction

This contribution proposes to add a macro-cell channel model for open rural area in the section 3.2.

2. Path Loss Model for Open Rural Areas

One path loss model for open rural areas is based on the COST231 HATA model [1]:

$$PL_{Urban}(dB) = 46.3 + 33.9\log f_c - 13.82\log h_{bs} - a(h_{ms}) + (44.9 - 6.55\log h_{bs})\log d + C_M \quad (1)$$

where $a(h_{ms})$ is defined in equation (3), (4)and(5), and

$$C_M = \begin{cases} 0dB & \text{for medium sized city and suburban areas} \\ 3dB & \text{for metropolitan centers} \end{cases} \quad (2)$$

for a small to medium sized city, the mobile antenna correction factor is given by

$$a(h_{ms}) = (1.1\log f_c - 0.7)h_{ms} - (1.56\log f_c - 0.8)dB \quad (3)$$

and for large city, it is given by

$$a(h_{ms}) = 8.29(\log 1.54 h_{ms})^2 - 1.1dB \quad \text{for} \quad f_c \le 300MHz \quad (4)$$

$$a(h_{ms}) = 3.2(\log 11.75 h_{ms})^2 - 4.97dB \quad \text{for} \quad f_c \ge 300MHz \quad (5)$$

To obtain the path loss in a suburban area, the standard HATA formula in equation (1) is modified as

$$PL_{suburban}(dB) = PL_{Urban} - 2\left[\log(f_c/28)\right]^2 - 5.4 \quad (6)$$

and for path loss in open rural areas, the formula is modified as

$$PL_{Rural}(dB) = PL_{Urban} - 4.78(\log f_c)^2 + 18.33\log f_c - 40.94 \quad (7)$$

The equation (4) in section 3.2.3.1 row 5 is identical to the path loss formula when scenario is medium/ small sized city above.

Except urban and suburban, the open rural area is a kind of very general and representative macro cell scenario, this scenario represents radio propagation in large areas (radii up to 10 km) with low building density. The height of the BS antenna is typically in the range from 10 to 80 m, which is much higher than the average building height. Consequently, LOS conditions can be expected to exist in most of the coverage area, low delay spreads and low angle spreads. In case the MS is located inside a building or vehicle, an additional penetration loss is experienced which can possibly be modeled as a (frequency-dependent) constant value. The BS antenna location is fixed in this propagation scenario, and the MS antenna velocity is in the range from 0 to 200km/h.

The open rural scenario is quite different from urban and suburban, and it takes a big proportion in network coverage design. so, it is proposed that the path loss calculation in open rural scenario being added, the shadow fading factor and fast fading parameter should be described in relevant sections.

Also, the path loss research is carried out by many companies and organization, the newly experimental verified WINNER model [2] is widely accepted.

3. Proposed Text Changes

Insert a new paragraph after Line 36 on Page 34 in section 3.2.2 to describe the open rural scenario:

6. Open Rural macro-cell: This scenario is characterized by large cell radius (approximately 1-10km BS to BS distance), high BS antenna positions (above rooftop heights, between 10-80 m, typically 32 m), low delay spreads and low angle spreads and high range of mobility (0 – 350 km/h). In rural open area, there is low building density, the height of the BS antenna is much higher than the average building height. Consequently, LOS conditions can be expected to exist in most of the coverage area. In case the MS is located inside a building or vehicle, an additional penetration loss is experienced which can possibly be modeled as a (frequency-dependent) constant value.

Insert a new subsection 3.2.3.6 after Line 2 on Page 37:

3.2.3.6 Open Rural macro-cell

According to the newly experimental result of WINNR model [2], the path loss is

LOS:

$$PL(dB) = 44.2 + 21.5\log_{10}(d[m]) + 20*\log_{10}(f[GHz]/5.0) \quad 20m < d < d_{BP}$$

$$PL(dB) = 8.7 + 40.0\log_{10}(d[m]) - 19.5\log_{10}(h_{BS}[m]) - 19.5\log_{10}(h_{ms}[m]) + 0.5\log_{10}(f[GHz]/5.0) \quad d > d_{BP}$$

NLOS:

$$PL(dB) = 55.4 + 25.1*\log_{10}(d[m]) + 21.3*\log_{10}(f[GHz]/5.0) - 0.13(h_{BS}[m]-25)\log_{10}(\tfrac{d}{d_0}) - 0.9(h_{ms}[m]-1.5)$$

Where d = distance

d_{BP} = $4 \cdot h_{ms} \cdot h_{BS} \cdot f / c$

h_{BS} = the height of the base station

h_{ms} = the height of the mobile station

f = the centre-frequency (Hz)

c = the velocity of light in vacuum

s = standard deviation

d_0 =100 meter (the reference distance)

As option, the COST231 HATA open rural path loss model offset could be used as follow: For the COST 231 Hata open rural path loss model, the path loss equation is identical to that of the urban macro model in (4), except for a C=0dB correction factor instead of 3dB, and a offset for open rural area.

The original Hata offset for open rural areas was [18]:

$$PL_{Rural}(dB) = PL_{Urban} - 4.78(\log f_c)^2 + 18.33\log f_c - 40.94$$

Because the original Hata offset is used and verified for years, it is adopted here. Again, a frequency scaling factor of 26log10(fc) is used to account for the path loss change according to the carrier frequency.

Insert text between Lines 10 and 11 on Page 39 in Section 3.2.4 as follows:

Open rural macro-cell: NLOS:8dB, LOS: 6dB

Insert new subsection 3.2.5.6 on Page 45 after between Lines 7 and 8 as follows:

3.2.5.6. Open Rural macro-cell

Cluster #	Delay [ns]			Power [dB]			AoD [°]	AoA [°]	Ray power [dB]			
1	0	5	10	0.0	-15.0	-16.8	0	0	-0.23*	-22.8**	Cluster ASD = 2°	Cluster ASD = 3°
2	20			-15.5			17	44	-28.5			
3	20			-16.2			17	-45	-29.2			
4	25	30	35	-15.3	-17.5	-19.2	18	-48	-25.3			
5	45			-20.5			-19	50	-33.5			
6	65			-18.9			18	-48	-31.9			
7	65			-21.1			-19	51	-34.2			
8	90			-23.6			-20	-54	-36.6			
9	125			-26.1			-22	57	-39.1			
10	180			-29.4			23	-60	-42.4			
11	190			-28.3			-22	59	-41.3			

Table xx:: Open rural macro-cell CDL(LOS)

In the LOS model, Ricean K-factor is 13.7 dB, which corresponds to 500m distance between Tx and Rx.

Cluster #	Delay [ns]			Power [dB]			AoD [°]	AoA [°]	Ray power [dB]		
1	0	5	10	-3.0	-5.2	-7.0	0	0	-13.0	Cluster ASD = 2°	Cluster ASD = 3°
2	0			-1.8			-8	28	-14.8		
3	5			-3.3			-10	38	-16.3		
4	10	15	20	-4.8	-7.0	-8.8	15	-55	-14.8		
5	20			-5.3			13	48	-18.3		
6	25			-7.1			15	-55	-20.1		
7	55			-9.0			-17	62	-22.0		
8	100			-4.2			-12	42	-17.2		
9	170			-12.4			20	-73	-25.4		
10	420			-26.5			29	107	-39.5		

Table xx:: Open rural macro-cell CDL(NLOS).

4. References

[1] Theodore S.Rappaport, "Wireless Communication principle and practice, Second edition", chapter 4, 2004-03.
[2] IST-WINNER II Deliverable D1.1.1 v1.0, "WINNER II Interim Channel Models", December 2006.