BS-RS, BS-MS and RS-RS NLOS Multihop Path Loss Model

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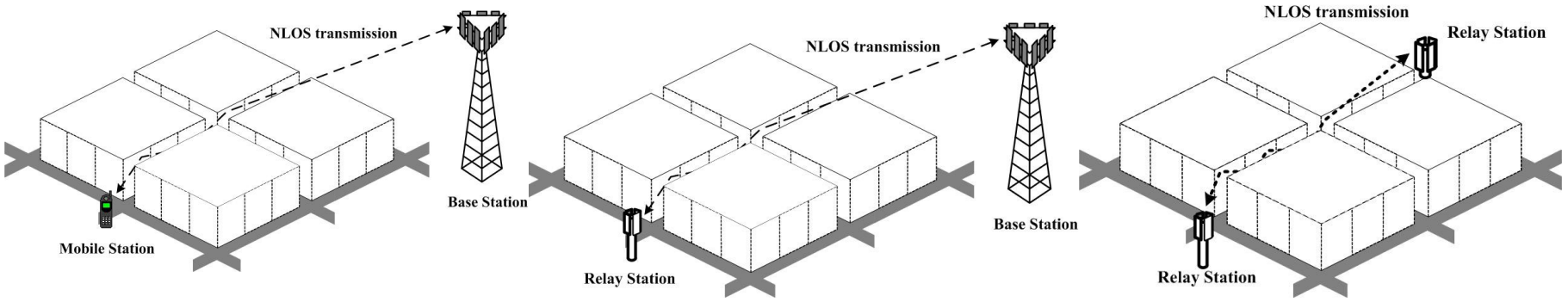
Purpose:
To further clarify the NLOS path model for BS-RS, BS-MS and RS-RS and comparison with WINNER model

Introduction

- In this contribution, a comparison is made of path loss models for the BS-RS, BS-MS or RS-RS link in a multihop network, where one antenna (BS/RS) is located above the rooftop, and one antenna (RS/MS) is located below the rooftop



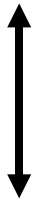
BS-RS/BS-MS for RS/MS below rooftop
NLOS scenario

- In the WINNER report [1] the path loss model recommended for urban and suburban macrocells up to 5GHz is the COST 231 Hata model with free space correction factor for frequency:-

Suburban:

$$P_S\ d \quad 44.9 \quad 6.55\log h_b \quad \log \frac{d}{1000} \quad 45.5 \quad 35.46 \quad 1.1h_m \quad \log f\ MHz \quad 13.82\log h_b \quad 0.7h_m$$

Urban:



3dB difference

$$P_S\ d \quad 44.9 \quad 6.55\log h_b \quad \log \frac{d}{1000} \quad 48.5 \quad 35.46 \quad 1.1h_m \quad \log f\ MHz \quad 13.82\log h_b \quad 0.7h_m$$

Free space correction factor: $20\log \frac{f\ MHz}{2000}$

Proposed BS-RS/BS-MS NLOS model
IEEE 802.16j submission [2]

The path loss model for this case is given in [2] as:

$$P\ dB \quad 38.4 \quad 35\log d \quad 20\log \frac{f\ GHz}{5} \quad 0.7h_m$$

In the WINNER report [1], table 3.12, the path loss for urban macrocells at 5GHz is given as:

$$P\ dB \quad 38.4 \quad 35\log d$$

This is obviously where the model in [2] originates from (note the absence of the last term though)

From this equation, and the COST 231 Hata equation the values assumed in [1] for the basestation height and the mobile height can be calculated.

Proposed BS-RS/BS-MS NLOS model
IEEE 802.16j submission [2]

$$35 \quad 44.9 \quad 6.55\log h_b$$

Equating terms for the path loss exponent yields h_b

$$h_b \quad 32.5m$$

$$38.4 \quad 48.5 \quad 44.9 \quad 6.55\log h_b \quad \log 1000$$

$$35.46 \quad 1.1h_m \quad \log 2000 \quad 13.82\log h_b$$

$$0.7h_m \quad 20\log \frac{5000}{2000}$$

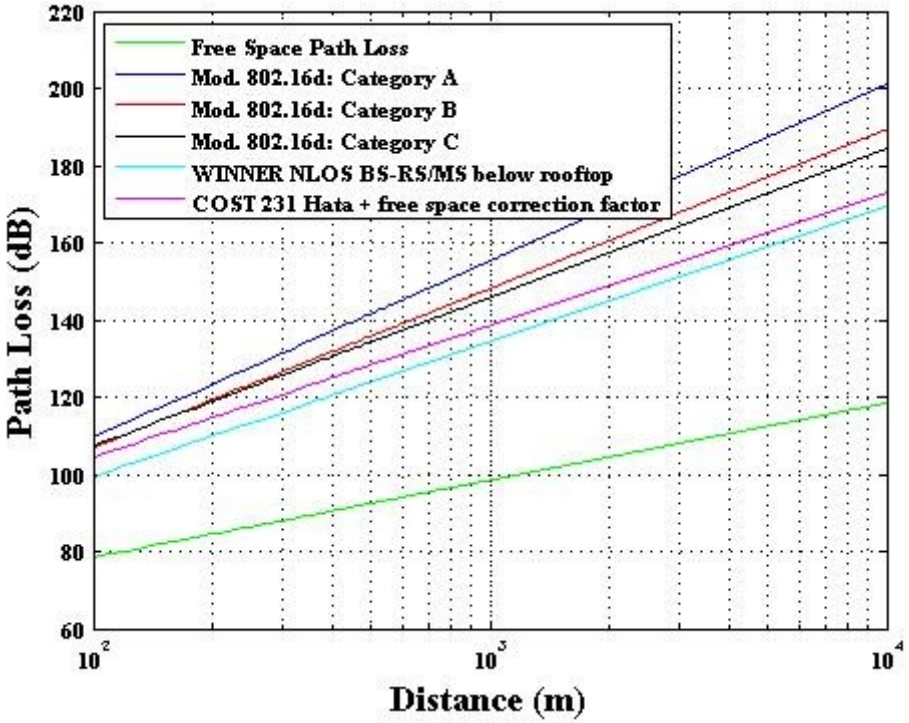
Equating the constant terms we can solve for h_m

$$h_m \quad 3.1m$$

These values allow comparisons with the modified IEEE 802.16d path loss model to be made [3] (see next slide).

Note that the model specified in [2] does not correctly handle the dependence on mobile height (i.e. it is not consistent with COST 231 Hata). A better approach would be to use the full COST 231 Hata equation plus the free space correction factor. This allows both the base and mobile height to be specified.

Example results



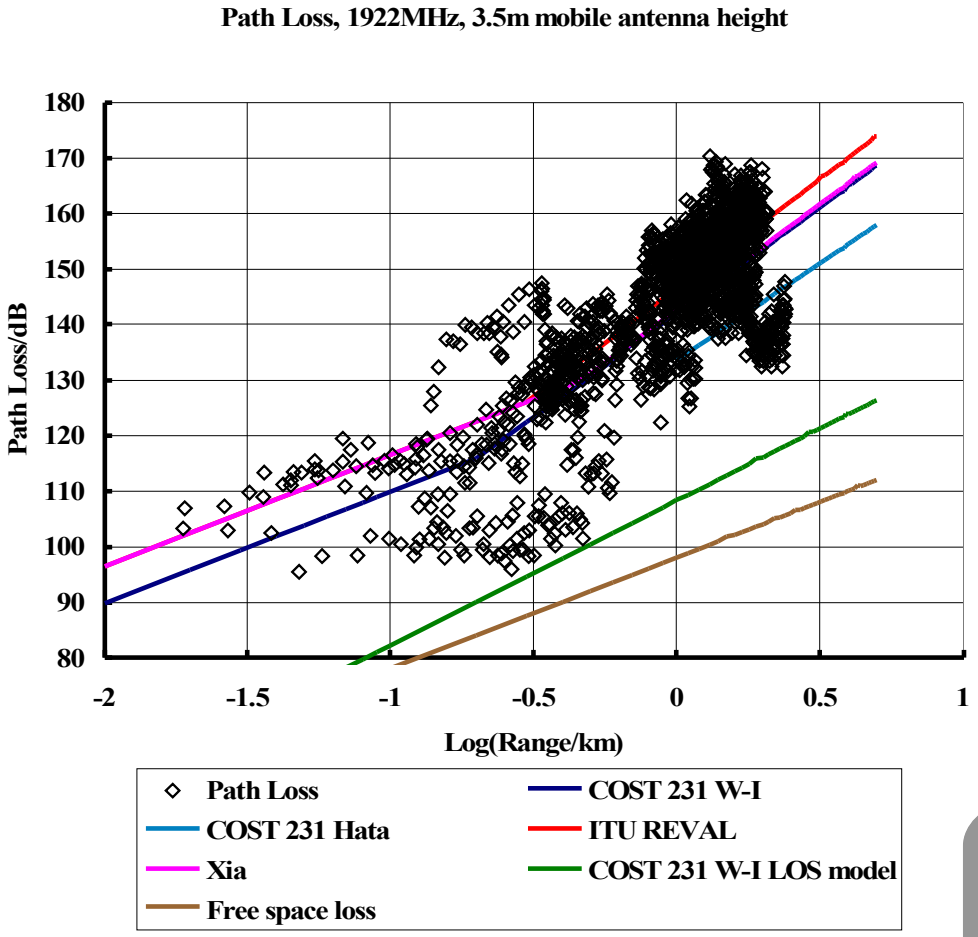
For these plots:-

h_b=32.5m
h_m=3.1m
f = 2GHz

It can be seen that the channel model proposed in [2] is offset from the COST 231 Hata model due to the extra '0.7h_m' term.

COST 231 Hata predicts lower path loss than the modified IEEE 802.16d model. Nortel measurements in Central London also found that COST 231 Hata underestimates path loss (see next slide).

Nortel 2GHz Path Loss Measurements
Central London



Comparison of 2GHz path loss measurements in Central London with several path loss models.

Best fit is COST 231 W-I. This is another potential model for the BS-RS/MS path, with the RS/MS below rooftop. This was not considered previously because it is only valid up to 2GHz, although a free space correction factor could be added, as proposed by WINNER. However, the modified IEEE 802.16d models B&C would also give good agreement with these results.

The modified IEEE 802.16d model given in [3] is still recommended for this path

Summary and Conclusion

- Proposed model in [2] is not consistent with WINNER (COST 231 Hata) model [1]
- COST 231 Hata appears to underestimate path loss
- Recommend using modified IEEE 802.16d path loss model for this link

References

[1] 'Final report on link level and system level channel models', IST-2003-507581 WINNER, D5.4 v.1.4, Nov. 18th, 2005

[2] 'Channel Models and Performance Metrics for IEEE 802.16j Relay Task Group', D.Chen, I-Kang Fu, M.Hart, W.C.Wong, IEEE C802.16j-06/020, 1/5/2006

[3] 'Multihop Path Loss Model (Base to Relay and Base to Mobile)', Dean Kitchener et al., IEEE C802.16j-06/011, 1/5/2006