# Multihop ART-to-ART Path Loss Model

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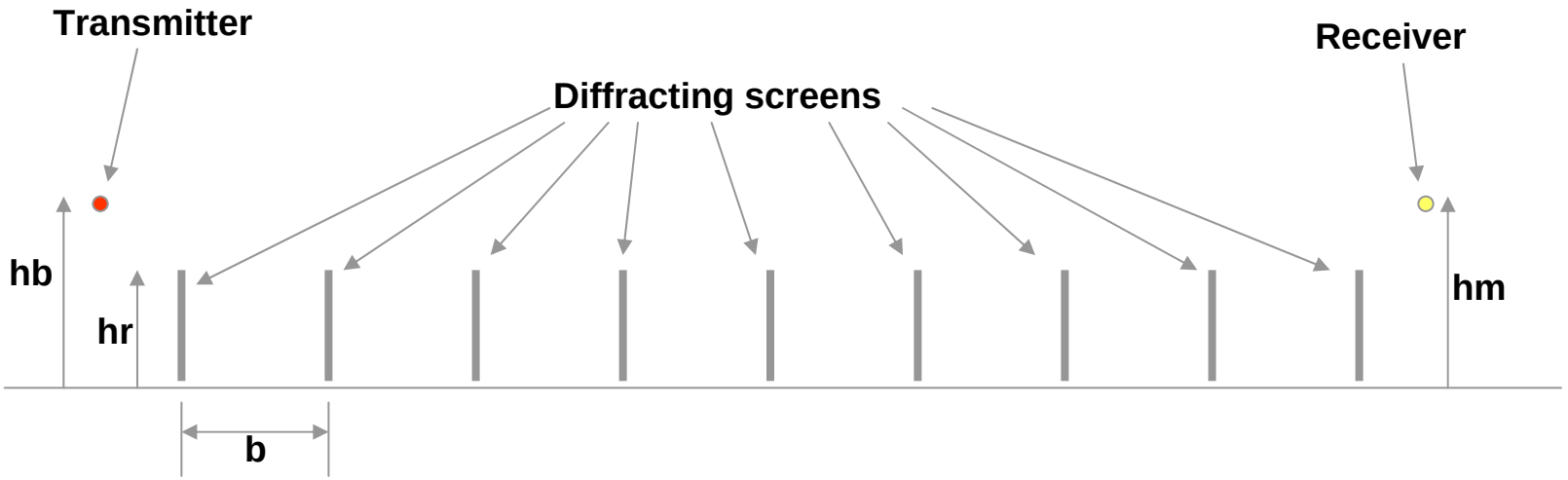
Purpose:

To adopt the recommended path loss model for above rooftop (ART) links

# Introduction

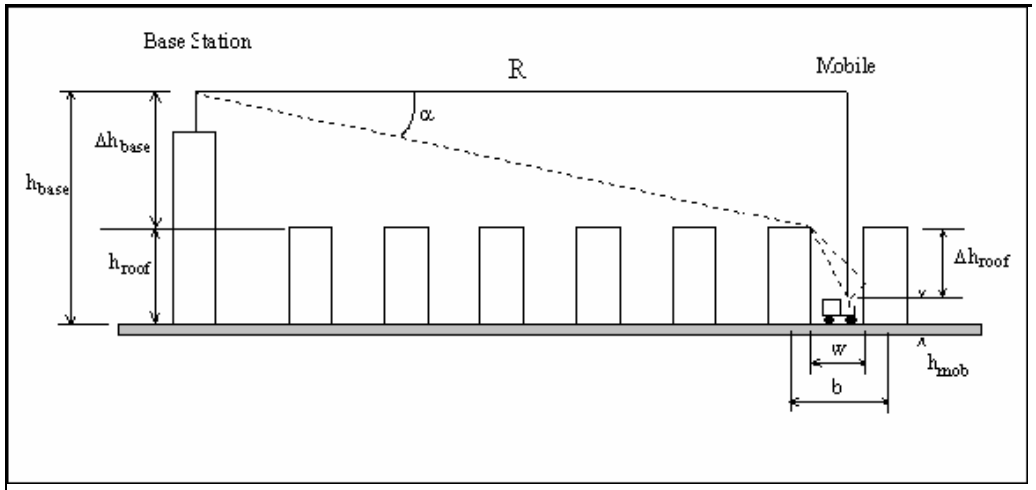
- This presentation considers path loss models for links where the transmit and receive antennas are both located Above Roof Top level (ART) in an urban environment
- Within the context of IEEE 802.16j this covers BS-RS and RS-RS links (BS = Base Station, RS = Relay Station)
- A modified COST 231 W-I path loss model has been proposed earlier. This model is compared in this presentation to Vogler's multi-screen diffraction model, and it is also compared to some measured data at 5.3GHz from the IST MIND project
- The model is shown to give reasonable performance, and it is recommended that it be adopted

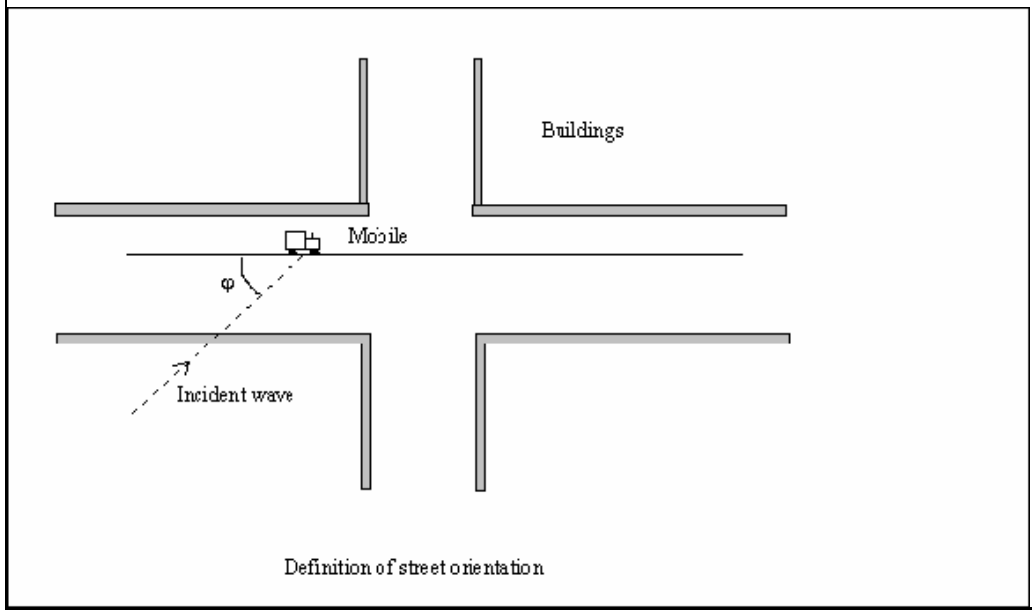
# Multi-screen diffraction scenario




b = Distance between diffracting screens
hb = Transmit antenna height
hr = Height of diffracting screens
hm = Receive antenna height

# Parameters for COST 231 W-I Model




Definition of street orientation

The parameters used in the COST 231 W-I model are as shown in the illustrations on the left

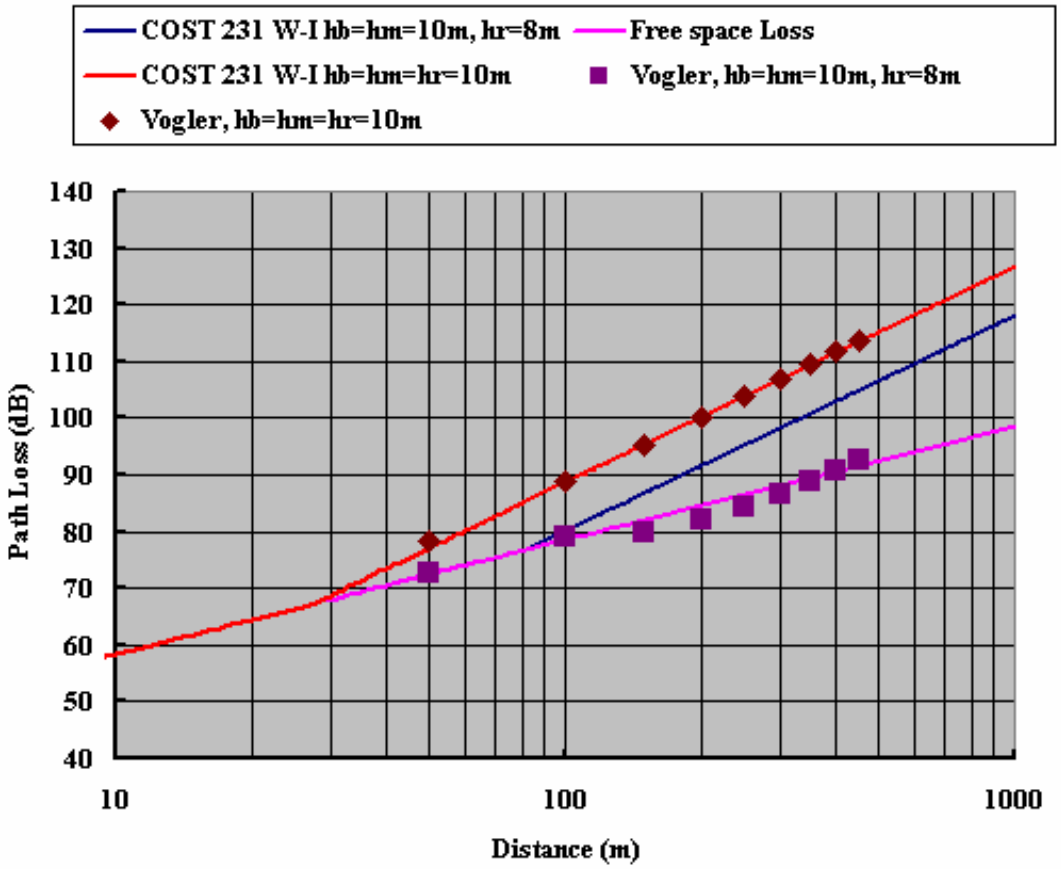
# Modified COST 231 W-I Model

- The COST 231 W-I model consists of three terms:-
  - Free space loss
  - Multi-screen diffraction loss
  - Rooftop-to-street diffraction loss
- For the ART scenario there is no rooftop-to-street diffraction and so the third component is dropped. The free space and multi-screen diffraction terms only are then used to estimate the ART-to-ART path loss

# Parameter Settings for Comparison

- Building/diffraction screen spacing, b = 50m
- Width of street, w = 30m
- Tx antenna height, hb = 10m
- Rx antenna height, hm = 10m
- Roof/diffraction screen heights, hr = 8m, 10m
- Street orientation, $\phi = 90°$
- Frequency, f = 2GHz

# Results of Comparison




Results show that when the Tx and Rx antennas are mounted at the rooftop height, the Vogler multi-screen diffraction analysis agrees with the modified COST 231 W-I model

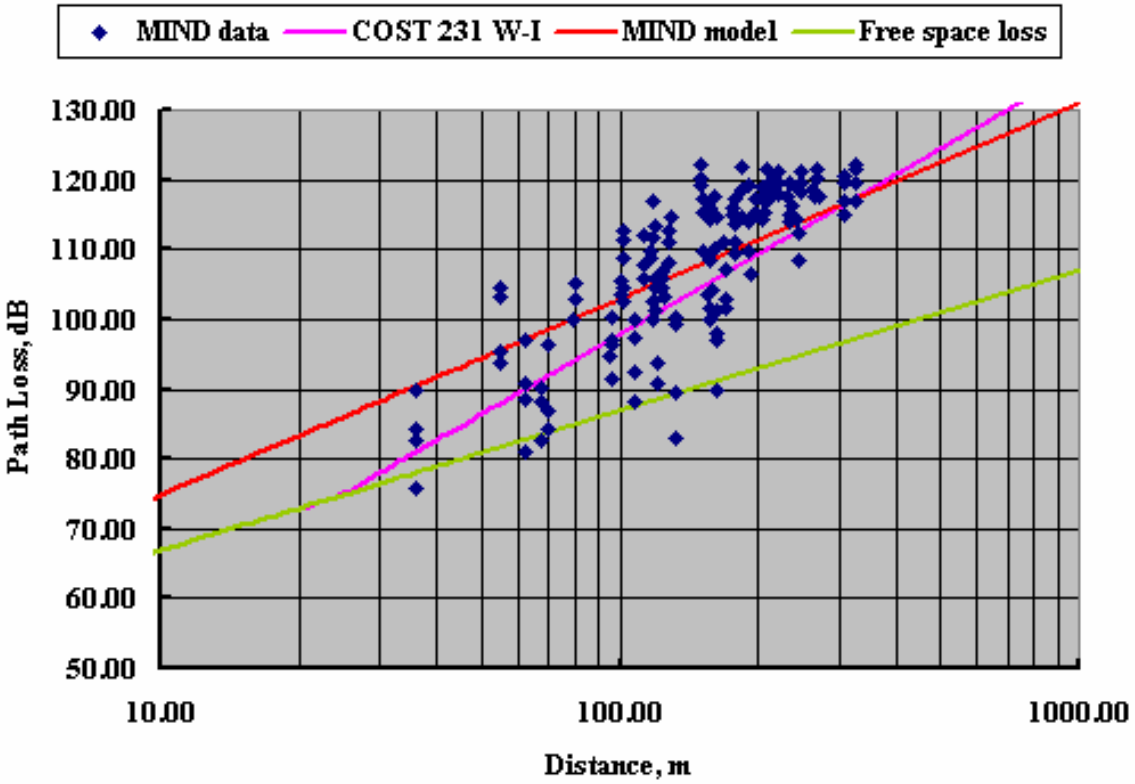
As the Tx and Rx antennas are raised above the diffraction screens, the Vogler analysis quickly predicts a path loss close to free space path loss

From the Vogler results should we expect close to free space path loss for the ART-to-ART links?

# IST MIND Results at 5.3GHz

- Rooftop radio channel measurement campaign in Latokaski, a suburban area outside Helsinki
- Most houses were greater than 5m in height but less than 8m, with trees taller than the houses in between
- Measurements at 5.3GHz
- Measurements were made with Tx and Rx antenna heights of 5 and 8m

# Comparison of COST 231 W-I with IST MIND Measurements




The plot shows a comparison of the modified COST 231 W-I model with the measured data from IST MIND, and the IST MIND empirical path loss model

For this case:-
b = 50m
w = 30m
hr = 6.5m
hb = hm = 8m
f = 5.3GHz

Measured above rooftop path loss does not correspond to free space loss, having an exponent >2. The modified COST 231 W-I model gives a reasonable estimate of the path loss, although it appears to slightly underestimate it (note: the model is being used a long way out of its specified frequency range)

# Discussion

- The path loss for (limited) above rooftop measurements at 5.3GHz has been found to be greater than free space path loss
- This is due to the effects of trees/foliage
- Shadowing effects due to trees or perhaps very tall buildings are likely to have a similar effect in urban areas
- A simple uniform height multi-screen diffraction model therefore leads to an optimistic path loss for the above rooftop case
- The modified COST 231 W-I model appears to give a reasonable estimate of the path loss, even at 5GHz

# References


- 'The Attenuation of Electromagnetic Waves by Multiple Knife-Edge Diffraction', L.E.Vogler, NTIA Report 81-86, October 1981
- 'On the Propagation Characteristics of the 5GHz Roof-to-Rooftop Meshed Network', IST Mobile & Wireless Telecommunications Summit, 17-19 June 2002, Thessaloniki, Greece