URBAN ART-ART Path Loss Model

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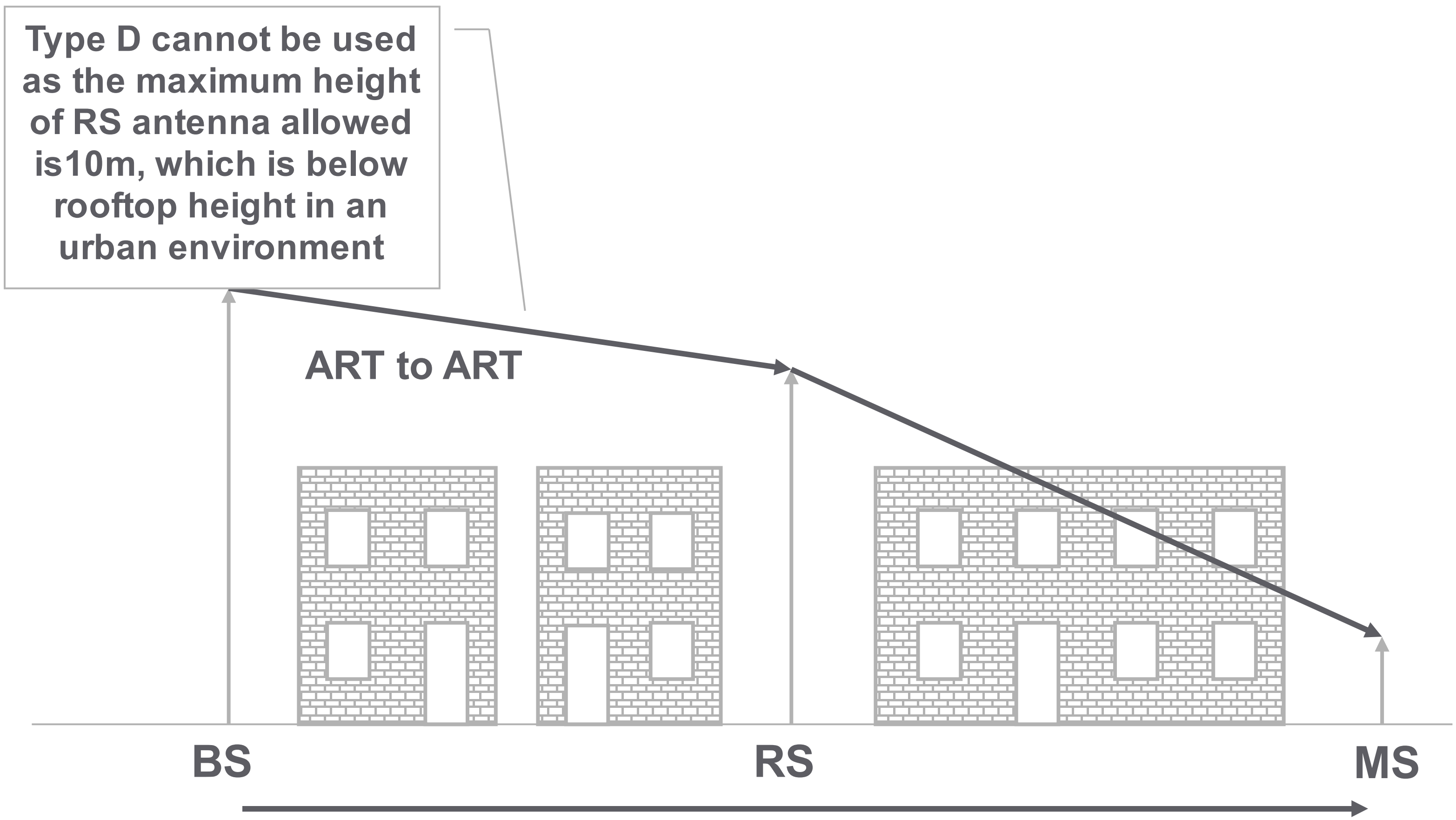
Purpose:
To address the missing path loss model in 802-16j-06-013r1 by including a path loss model for Urban ART-ART case

Introduction

- The Type D LOS pathloss model specified in IEEE 802.16j-06/013r1 for ART to ART propagation is not suitable for use in an urban environment
  - Average rooftop heights in the urban environment are greater than the maximum receive antenna height of 10m allowed by the Type D LOS pathloss model – which is taken into account by a rapid degradation of the signal after a break point.
- COST 231 Walfisch-Ikagami pathloss model specified in IEEE 802.16j-06/013r1 for ART to BRT NLOS propagation in an urban environment can be modified to be used for ART to ART case by removing the ART to street defraction component in the model.

Incompatibility of Type D and Type E Pathloss Models for the ART-ART Urban Environment



ART to BRT (NLOS) model (cost 231 Walfisch-Ikagami **model) for urban includes several hops of over-the-building propagation component and a rooftop_to_street diffraction (last hop) component.**

Urban LOS ART to ART Pathloss Model

> The basic transmission loss is composed of two terms: free space loss (L_0) and multiple screen diffraction loss (L_{msd})

- The rooftop-to-street diffraction and scatter loss (L_{rts}) component of the NLOS COST 231 Walfisch-Ikagami model is neglected

$$L = \begin{cases} L_0 + L_{msd} & \text{for } L_{msd} > 0 \\ L_0 & \text{for } L_{msd} \quad 0 \end{cases}$$

Free Space Loss

> The free space loss is given by:

$$L_0(dB) = 32.4 + 20\log(d / km) + 20\log(f / MHz)$$

Multiscreen Diffraction Loss

- For the multiscreen diffraction term various parameters have to be defined that describe the environment:
  - Base station antenna height, h_{Base}
  - Average rooftop height, h_{Roof}
  - Building separation (building centre-to-building centre) b
- The multiple screen diffraction term represents the propagation over multiple rooftops and this is given by the following expression:

$$L_{msd} = L_{bsh} + k_a + k_d \log\left(\frac{d}{km}\right) + k_f \log\left(\frac{f}{MHz}\right) - 9\log\left(\frac{b}{m}\right)$$

L_{bsh}

- The term L_{bsh} describes the dependence of the loss on the height of the BS antenna

$$L_{bsh} = \begin{cases} -18\log\left(1 + \frac{\Delta h_{Base}}{m}\right) & \text{for } h_{Base} > h_{Roof} \\ 0 & \text{for } h_{Base} \le h_{Roof} \end{cases}$$

k_a

> The term k_a represents the increase of the path loss for base station antennas below the rooftops of the adjacent buildings

$$k_a = \begin{cases} 54 & \text{for } h_{Base} > h_{Roof} \\ 54 - 0.8\dfrac{\Delta h_{Base}}{m} & \text{for d} \quad 0.5\text{km and } h_{Base} \quad h_{Roof} \\ 54 - 0.8\dfrac{\Delta h_{Base}}{m}\dfrac{d/km}{0.5} & \text{for d} < 0.5\text{km and } h_{Base} \quad h_{Roof} \end{cases}$$

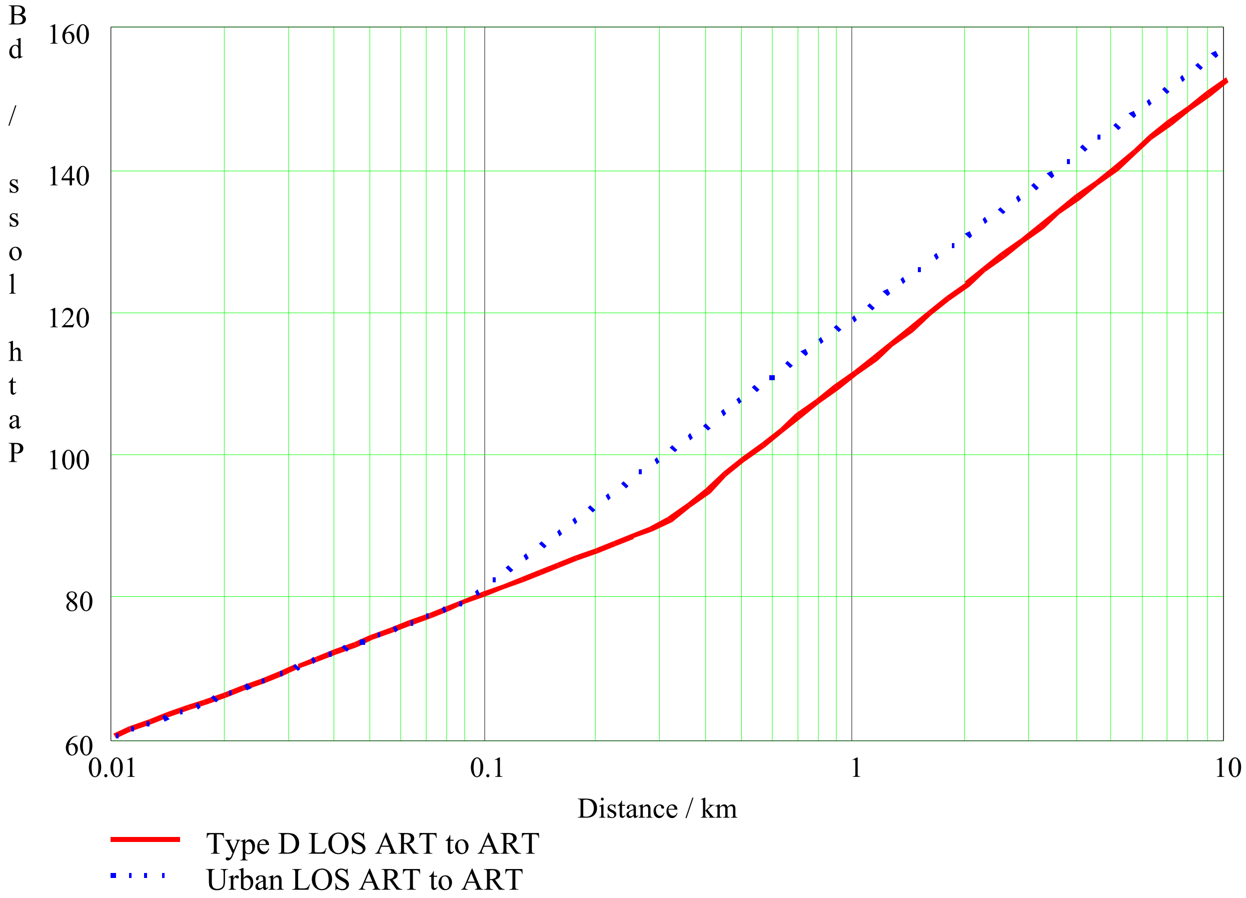
k_d and k_f

- The terms k_d and k_f control the dependence of the multi-screen diffraction loss on distance and radio frequency, respectively

$$k_d = \begin{cases} 18 & \text{for } h_{Base} > h_{Roof} \\ 18 - 15\dfrac{\Delta h_{Base}}{h_{Roof}} & \text{for } h_{Base} \le h_{Roof} \end{cases}$$

$$k_f = -4 + 1.5\left(\frac{f/\mathrm{MHz}}{925} - 1\right)$$

Comparison of Type D and Proposed Urban LOS ART to ART Pathloss Models



b : 60m
h_{Roof} : 25m
h_{Base} : 30m
h_{RS} : 30m