3GPP TSG RAN WG1 #73 **R1-131899**
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Agenda item: 6.2.6.1

Source: Broadcom Corporation

Title: Heterogeneous Deployment Scenarios for 3D Channel Modeling

Document for: Discussion and Decision

1 Introduction

At RAN1 #72bis, the scenarios and assumptions for 3D channel modeling were provided in the following two tables [1]:

Table 1. Scenarios and assumptions for 3D channel modeling.

		Urban Micro cell with high UE density	**Urban Macro cell with high UE density**
Layout		Hexagonal grid, 19 micro sites, 3 sectors per site	Hexagonal grid, 19 macro sites, 3 sectors per site
UE mobility (movement In horizontal plane)		3kmph	3kmph
BS antenna height		10m	25m
Total BS Tx Power		41/44 dBm for 10/20MHz	46/49 dBm for 10/20MHz
Carrier frequency		2 GHz	2 GHz
Min. UE-eNB 2D distance		10m [other values FFS]	35m
UE height model	general equation	$h_{UE}=3(n_{fl}-1)+1.5$m	$h_{UE}=3(n_{fl}-1)+1.5$m
	n_{fl} for outdoor UEs	1	1
	n_{fl} for indoor UEs	Replaced by WA	Replaced by WA
Indoor UE fraction		80%	80%
Path loss	Indoor UE 2D distance from external building wall d_{in} for path loss determination	uniform(0,25m)	uniform(0,25m)

Table 2. Scenarios and assumptions for 3D channel modeling calibration.

		Urban Micro cell with high UE density	**Urban Macro cell with high UE density**
UE distribution (in x-y plane)	Outdoor UEs	uniform in cell	uniform in cell
	Indoor UEs	uniform in cell	uniform in cell
Building model	Dimensions (in x-y plane)	not needed	not needed
	Number of buildings per macro cell	NA	NA
	Distribution of buildings in a macro cell	NA	NA
ISD		200m	500m*

- Assumptions in Table 2 are for calibration purposes only in this Study Item (SI)
- Assumptions in Table 2 to be revisited for evaluating relative performance of proposed solutions in future SIs
- *Alternative value = 200m for further study (FFS)
- Working assumption (WA) on number of floors for user equipment (UE) height:
  - Uniformly distributed with an average and variation range
  - Average number of floor: 6 for both Urban Macro cell (UMa) and Urban Micro cell (UMi)
  - Variation range: [-2 to 2]
  - Additional values or adjustments can be FFS as needed
- For a given UE, the UE height calculation has a two-step process:
  - Follow the above-mentioned distribute to find the number of floors x
  - The actual floor the UE is on follows the uniform distribution of [1,x]

- Heterogeneous Networks
  - Channel models developed for UMi *with high UE density* and UMa *with high UE density* scenarios shall support heterogeneous deployment scenarios.
    - It is assumed that for heterogeneous deployment scenarios, the macro base station (BS) height is at 25m and the lower-power node (LPN) is at 10m height.

This contribution compares the above tables with previous assumptions in TR 36.814 [2] and TR 36.819 [3], [3]and with the current evaluation assumptions for small cell enhancements (SCE) in TR 36.872 [4].

2 Comparisons of Assumptions

The following table compares several assumptions for 3D channel modeling with those for SCE scenarios 1 and 2a in TR 36.872, Table A.1-1 in TR 36.819, and Table A.2.1.1-1 in TR 36.814.

Table 3. Comparisons of assumptions for 3D channel modeling and other studies.

Parameter	Scenario	3D	SCE-1	SCE-2a	TR 36.819	TR 36.814
UE mobility	UMi	3 kmph	3 kmph	3 kmph	3 kmph	3 kmph
	UMa	3 kmph	3 kmph	3 kmph	3 kmph	30 kmph
Total BS Transmit Power for 10 MHz	UMi	41 dBm	30 dBm	30 dBm	41 dBm (30 dBm LPN)	41 dBm
	UMa	46 dBm	46 dBm	46 dBm	46 dBm	46 dBm
Carrier frequency	UMi	2 GHz	2 GHz	3.5 GHz	2 GHz	2.5 GHz
	UMa	2 GHz	2 GHz	2 GHz	2 GHz	2 GHz
Minimum UE to eNB 2D distance	UMi	10 m	5 m	5 m	10 m	10 m
	UMa	35 m	35 m	35 m	35 m	25 m
Indoor UE fraction	UMi	80%	80%	80%	0% (80% optional)	50%
	UMa	80%	80%	80%	0% (80% optional)	0%

Those differing from the 3D assumptions are highlighted such as the UMi SCE scenarios 1 and 2a with LPN assume 30 dBm total BS transmit power for 10 MHz. In particular, the assumption of carrier frequency f_c can impact the 3D path loss (PL) models. For example, the following 3D PL models for non-line-of-sight (NLOS) outdoor-to-indoor (O-to-I) [5] were derived from Table B.1.2.1-1 in TR 36.814 with $f_{c\text{-}UMi}$ = 2.5 GHz and $f_{c\text{-}UMa}$ = 2 GHz:

$$PL_{UMi\text{-}NLOS\text{-}3D}(d_{3D}) = 33.05 + 36.70 \log_{10}(d_{3D}) + PL_{tw} + PL_{in} - G$$

$$PL_{UMa\text{-}NLOS\text{-}3D}(d_{3D}) = 19.57 + 39.09 \log_{10}(d_{3D}) + PL_{tw} + PL_{in} - G$$

where

$$\text{3D distance } d_{3D} = [\,(d_{out} + d_{in})^2 + (h_{UE} - h_{BS})^2\,]^{0.5}$$

$$\text{Loss through wall } PL_{tw} = 20 \text{ dB}$$

$$\text{Loss inside } PL_{in} = 0.5\, d_{in}$$

$$\text{Height gain } G = \eta \min(h_{UE} - 1.5, h_{Environment})$$

$$\eta = 1.1 \text{ dB/m}$$

For $f_{c\text{-}UMi}$ = 2 GHz, the UMi NLOS O-to-I path loss becomes:

$$PL_{UMi\text{-}NLOS\text{-}3D}(d_{3D}) = 30.53 + 36.70 \log_{10}(d_{3D}) + PL_{tw} + PL_{in} - G$$

For $f_{c\text{-}UMi}$ = 3.5 GHz as in SCE scenario 2a, it becomes:

$$PL_{UMi\text{-}NLOS\text{-}3D}(d_{3D}) = 36.84 + 36.70 \log_{10}(d_{3D}) + PL_{tw} + PL_{in} - G$$

Higher carrier frequency such as 3.5 GHz has already been proposed for FD-MIMO [6] [7] [8]. In addition, the UMi SCE scenarios 1 and 2a with LPN assume the minimum UE to eNB 2D distance at 5 m. Since the corresponding UE-to-eNB 3D distance is approximately 10 m, the path loss models in TR 36.814 are still applicable.

Proposal: The following assumptions for low power nodes can be included in heterogeneous deployment scenarios for 3D channel modeling:

- Carrier frequency: 3.5 GHz
- Total BS Tx power for 10 MHz: 30 dBm
- Minimum UE to eNB 2D distance: 5 m

3 Conclusion

This contribution has presented the following proposal for discussion and decision.

Proposal: The following assumptions for low power nodes can be included in heterogeneous deployment scenarios for 3D channel modeling:

- Carrier frequency: 3.5 GHz
- Total BS Tx power for 10 MHz: 30 dBm
- Minimum UE to eNB 2D distance: 5 m

4 References

[1] R1-131756, Nokia Siemens Networks, *et al.*, "Way forward on scenarios for 3D channel modeling."

[2] 3GPP TR 36.814, "Further advancements for E-UTRA physical layer aspects."

[3] 3GPP TR 36.819, "Coordinated multi-point operation for LTE physical layer aspects."

[4] R1-131685, Huawei, HiSilicon, "Small cell enhancements for E-UTRA and E-UTRAN physical layer aspects," 3GPP TR 36.872 v0.1.0.

[5] R1-131248, Nokia Siemens Networks, Nokia, "Path loss modeling for UE-specific elevation beamforming and FD-MIMO."

[6] R1-131033, Samsung, "Further discussions on scenarios for FD-MIMO and elevation domain beamforming."

[7] R1-131428, NTT DOCOMO, "Scenarios for UE-specific beamforming and FD-MIMO."

[8] R1-131533, CMCC, "Channel measurements results on elevation related parameters."