Macro Cellular Network Transition from 2.1 GHz to 28 GHz Millimeter Wave Frequency Band

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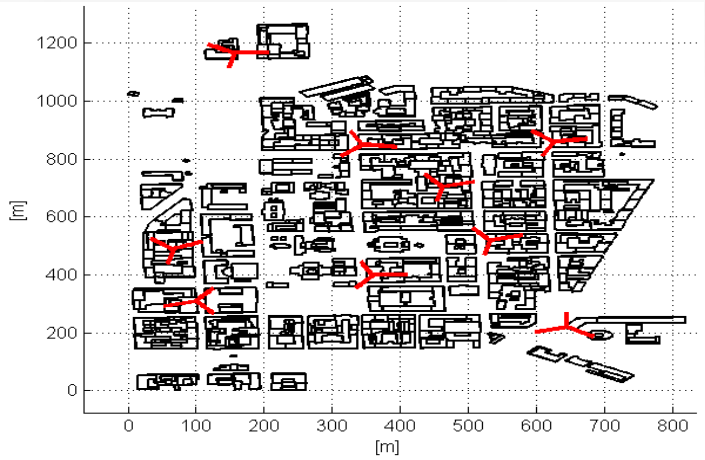
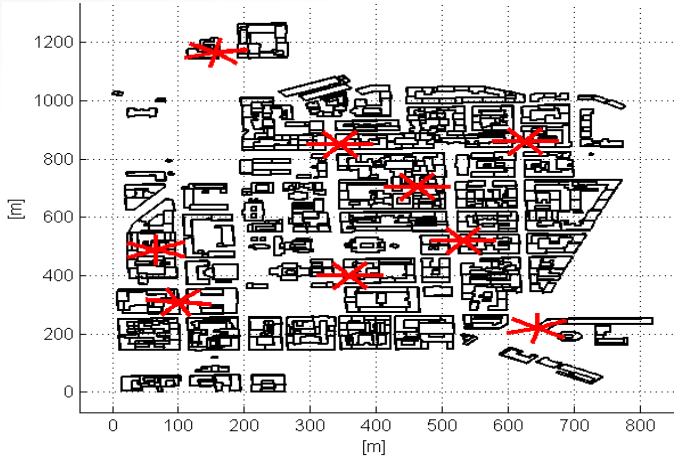
Helsinki, Finland

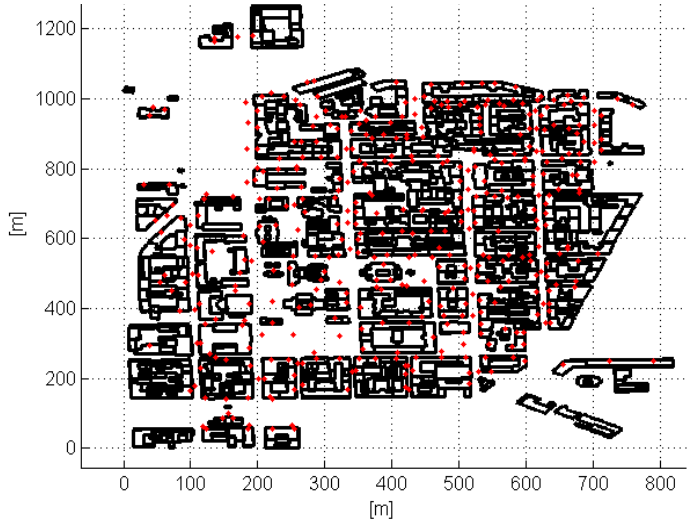
Helsinki downtown

Google earth view of targeted area from Helsinki city. The three dimensional view of buildings generated through MATLAB is also shown.

Site plan and distribution of test points







There were nine sites in the targeted area, and a minimum separation of 100° and 50° in an azimuth plane is provided among the different sectors of the same site for 3-sector and 6-sector site, respectively. 884 test locations were randomly selected with 85.4% and 14.6% probability for an indoor and outdoor location, respectively.

General simulation and antenna parameters

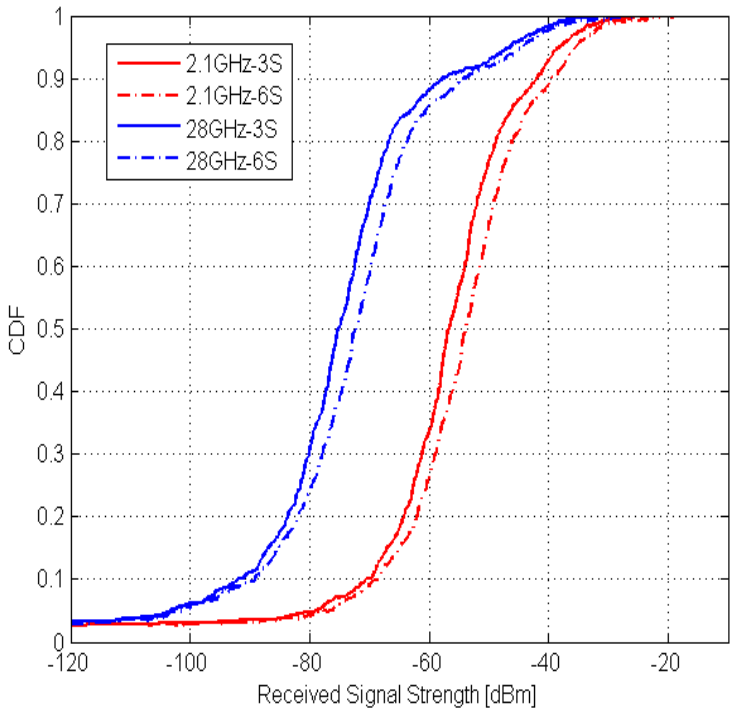
	2.1 GHz		28 GHz	
	Unit	**Value**	**Unit**	**Value**
Frequency	GHz	2.1	GHz	28
System bandwidth	MHz	20	MHz	20/200
TX power	dBm	46	dBm	46
Antenna height	m	30	m	30
Building penetration loss	dB	15	dB	26.5
UE noise figure	dB	8	dB	8
Polarization		Vertical		Vertical
Rooftop diffraction		Enabled		Enabled

• An extended 3GPP antenna model with 65˚ HPBW in a horizontal plane, and 7˚ HPBW in a vertical plane with 20 dB of FBR and -18 dB of SLL is used for antenna masking.

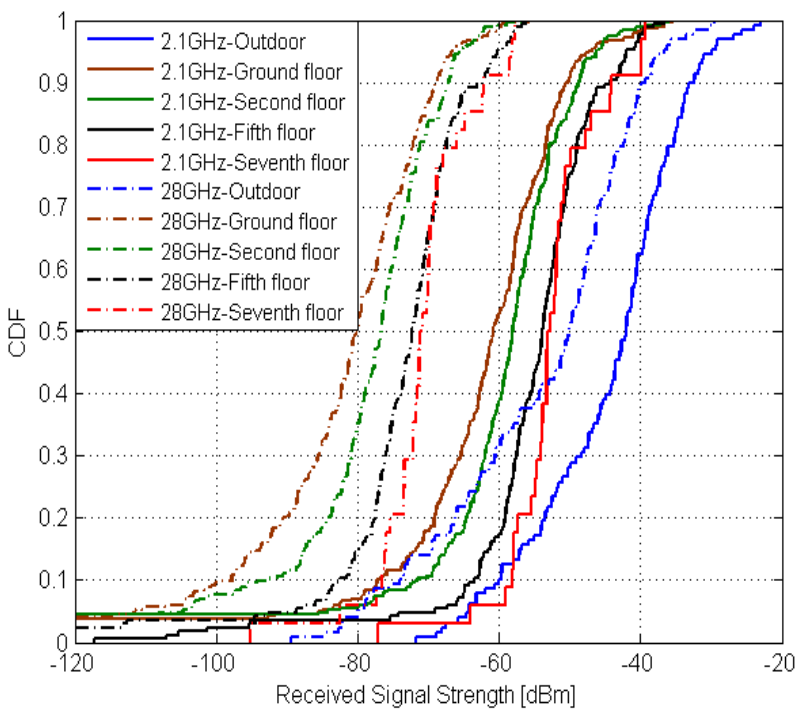
• An extended 3GPP antenna model with narrow half power beamwidth of 32˚ in a horizontal plane, assuming 23 dB of FBR and -18 dB of SLL is used for antenna masking. However, the vertical HPBW was not changed.

*A sum of additional 16 dB gain is considered for the case of 28 GHz frequency.

Received Signal Level



Overall RX level

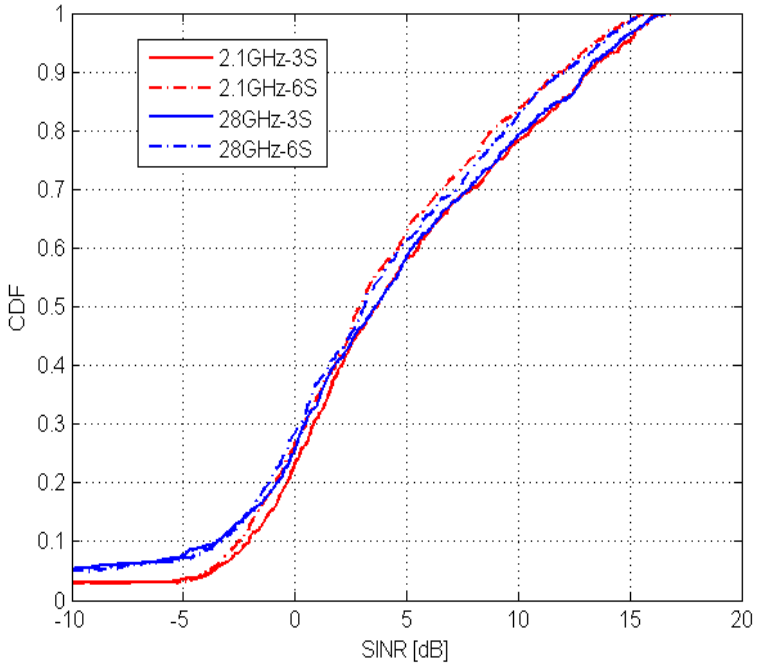


RX level at different floors

*A sum of additional 16 dB gain is considered for the case of 28 GHz frequency.

SINR and Spectral Efficiency Analysis

	Frequency [MHz]	Bandwidth [MHz]	Cells [No.]	Mean SINR [dB]	Mean Cell SE [bps/Hz]	Mean Area SE [bps/Hz]	Mean Area Capacity [Gbps]	Relative Gain [%]
2.1GHz-3S	2.1	20	27	4.51	1.93	52.23	**1.04**	0
2.1GHz-6S	2.1	20	54	3.71	1.74	94.21	**1.88**	80.38
28GHz-3S	28	20 / 200	27	4.01 / 1.71	1.81 / 1.31	48.98 / 35.41	**0.98 / 7.08**	-6.21 / 578
28GHz-6S	28	20 / 200	54	3.54 / 1.87	1.71 / 1.34	92.09 / 72.55	**1.84 / 14.5**	76.33 / 1289



Assuming 20 MHz system bandwidth at 2.1 GHz and 28 GHz.

• Cell spectral efficiency is directly related to SINR, and the results presented in Table show that cell spectral efficiency tends to decrease with higher order sectorization; whereas it is marginally reduced by migrating to 28 GHz frequency from 2.1 GHz considering same system bandwidth.

• Utilizing 10 times extra spectrum at 2.8 GHz yields 578% of capacity gain for traditional macro 3-sector sites.

sAGA Ray Tracing Tool

• The results shown in this presentation were obtained through “sAGA” ray tracing tool . It is an indigenous tool developed at European Communications Engineering Ltd in MATLAB environment. Ray tracing technique used in this tool is based on Image Theory (IT) algorithm. Unlike a quasi three dimensional environment, it supports ray tracing in full three dimension. Transmitter can be placed at the rooftop of the building, and it also tracks the signal paths with diffraction from the rooftops. It takes MAP as an input in .txt or .xls file format defined in locally defined format. Information about building coordinates and building height is integrated in single file.