Channel Characteristics at several mmWaves spectrums for Indoor Environment Applications

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The increasing numbers of sophisticated electronic devices and applications requiring access to telecommunications and internet connectivity is creating demand for seamless, very high bandwidth wireless connectivity for the increasing numbers of users that such services attract [1]. There is a shortage of spectrum below 6GHz and existing spectrum is fragmented. Solutions include spectrum sharing, new allocations within 5G and an increasing interest in the millimeter-wave (mm-wave) bands [2]. The mmWave bands, defined as frequencies between 30 and 300 GHz, provide vast potential resources of bandwidth [3]. Research within 5G is considering the band 20-90 GHz, focusing on characterization and modelling of the spatial channel and the antenna technologies that might permit dense utilization of the bands and infrastructure [4].

In this paper mm-wave indoor propagation characteristics (see Table 1) including path loss models and multipath delay spread values for systems with both directional and omnidirectional antennas are presented. The four candidate frequencies 28, 39, 60 and 73 GHz for 5G wireless network across mm-wave band are compared for line-of-sight (LOS) and non-line-of-sight (NLOS) scenarios for a 3rd floor Chesham Building (See Fig. 1), Bradford University. The indoor environment model includes labs, researcher rooms, windows, doors, furniture and a corridor. Comparisons are made using data obtained from 3D ray tracing studies at pre-mentioned four frequencies over Tx-Rx separation ranging distance from 0.5 m to 60 m. In addition, the frequency-dependent electrical properties (conductivity-σ and permittivity-ε) of common building materials are applied for these studies. Results from Fig 2, show the material type effect on the propagation behavior due to reflection, diffraction and penetration from different thickness of wall as well as objects. Furthermore, the power received and delay spread reduces with the increasing of frequency, while the number of ray paths increased.

Table 1: The Propagation characteristics of mmWave Communications in |Different Bands.

Frequency Band	**PLE**		**Rain Attenuation @ 200m**		**Oxygen Absorption @ 200m**
	LOS	*NLOS*	*5mm/h*	*25mm/h*	
28 GHz	1.8-1.9	4.5-4.6	0.18 dB	0.9 dB	0.04 dB
38 GHz	1.9-2.0	2.7-3.8	0.26 dB	1.4 dB	0.03 dB
60 GHz	2.23	4.19	0.44 dB	2 dB	3.2 dB
73 GHz	2.0	2.45-2.69	0.6 dB	2.4 dB	0.09dB

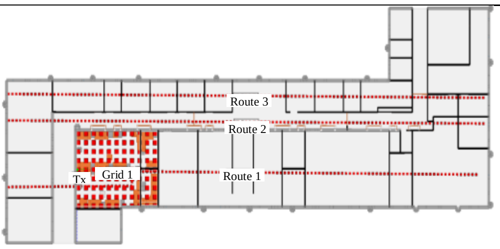

Fig. 3: The scenario model.

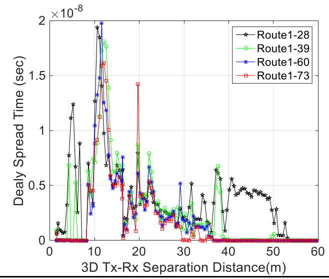

Fig. 2a: The Delay Spread vs. 3D Tx-Rx Separation distance for different frequencies of Route-1.

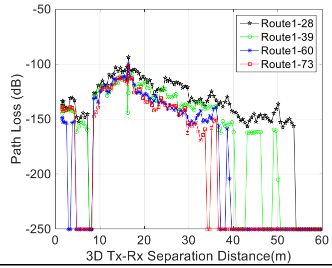

Fig. 2b: The Path Loss vs. 3D Tx-Rx Separation distance for different frequencies and (a) Route-1,

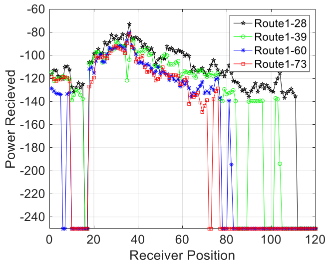

Fig. 2c: The Received Power vs. Receiver Positions of each receiver point to transmitter point for different frequencies and (a) Route-1

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