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Statistical Modelling of Through Wall Attenuation and Depolarization at 10 and 30 GHz

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As high-throughput systems operating in the millimetre-wave bands begin to emerge, there is a pressing need to investigate through-wall attenuation at higher frequencies. Because walls are generally complex, multi-layered structures, knowledge of the dielectric properties of the superficial wall material is generally insufficient to predict the relevant propagation behaviour. Intuition suggests that propagation characteristics will vary between general wall types, different walls of the same general type, and different locations on a given wall. While past work has tended to focus on reporting isolated measurements, a more complete statistical characterization is highly desirable in practical applications.

To this end, we conducted through-wall attenuation and depolarization measurements at 10 and 30 GHz at tens of exterior, interior load bearing and interior partition walls around the University of British Columbia campus. Measurement efficiency and accuracy were prime considerations so we created an automated test fixture based upon bislider positioners to simplify collection of measurement data at multiple points on a given wall. A block diagram of the 30 GHz channel sounder is shown in Fig. 1. Typical measurement locations are shown in Fig. 2. A summary of the data collected to date is given in Table I.

Based on the measured data, we are developing a statistical model of through-wall attenuation that captures the manner in which through-wall attenuation (in dB), depolarization (in dB) and the attenuation coefficient (in dB/cm) varies between general wall types, different walls of the same general type, and different locations on a given wall together with a general indication of how these results scale with frequency. Such differences are greatest for exterior walls, moderate for interior load bearing walls, and least for interior partition walls. A typical attenuation distribution at 10 GHz is shown in Fig. 3. The complete statistical model, including both attenuation and depolarization, will be of tremendous value to those who need to conduct system level studies or ray tracing based simulations of indoor and indoor-outdoor wireless communications systems.

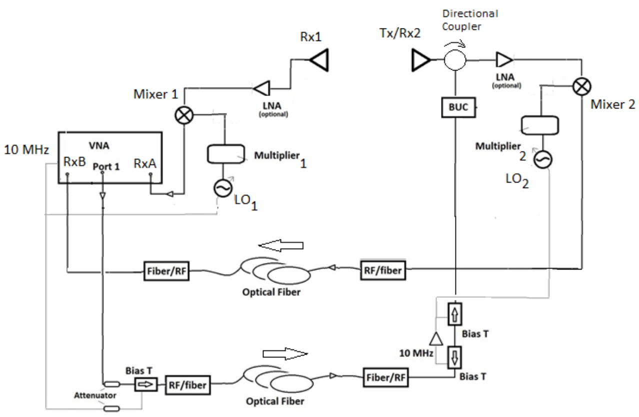

Fig. 1 - 30 GHz transmission and reflection channel sounder configuration.

Table I: 40 points on each of 33 different walls have been measured.

Materials	Thickness	# of walls
Wood	4.25-28 cm	6
Drywall	6.5-37.25 cm	6
Concrete	19-34.25 cm	5
Glass	0.7-2.2 cm	6
Metal	5.5-13.25 cm	5
Brick	38.5 cm	5

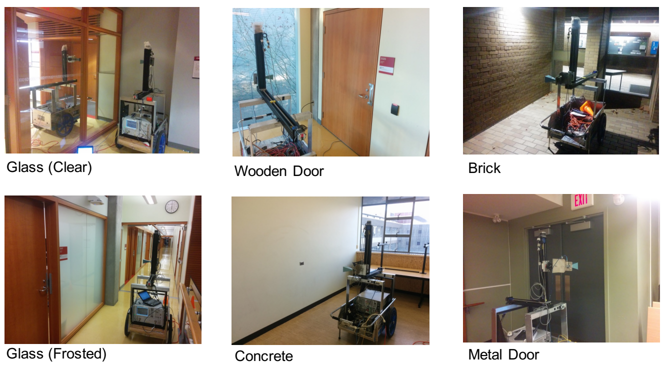

Fig. 2 – Typical measurement locations and wall types on the UBC campus.

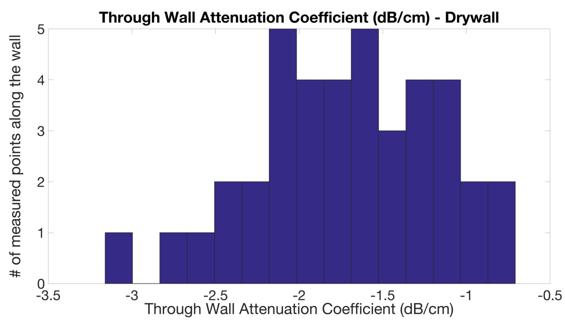

Fig. 3 – Typical attenuation distribution at 10 GHz.