Near-Ground Wave Propagation Measurements at VHF ISM Band

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Establishing reliable ad hoc radio communication in complex indoor and outdoor environments is a challenging task. The main issues arise from the fact that in most scenarios there is lack of line-of-sight path between the transmitter and receiver and the presence of a multitude of scatterers in the communication channel that give rise to significant signal attenuation and fading. This is especially true for high frequencies (UHF and above). To remedy this, different complex approaches such as signal routing through multiple cooperative radios in the channel, multiple-input and multiple-output (MIMO), or other diversity schemes have been developed. Besides complexity and cost such systems often times require significant power which is a major issue for most ad hoc networks. An alternative for significantly reducing the effect of multi-path and attenuation in a communication channel is to resort to low frequencies radios. At HF-VHF band it is expected that the path-loss and multipath fading be far less than those observed at higher frequency.

In this paper, performance of ad hoc radios operating at ISM (Industrial, Scientific and Medical) band of 40.68MHz is investigated. The allotted bandwidth for this ISM band is 40kHz. It is also noted that for such frequency band, in most scenarios transmitters and receivers are close to the ground and thus near-ground wave propagation is dominant. For channel characterization a measurement system is constructed, which can provide coherent filed measurements in complex indoor and outdoor environment in the HF through lower VHF band with a very large dynamic range. This system is equipped with an extremely low-profile ($\lambda/250$) two-element monopole antenna incorporating air-core inductors as the transmitter to facilitate ease of measurements at 40.68MHz. A very small, battery operated transmitting source is designed and integrated with the antenna. The transmitter unit meets the requirements of ISM band and is suitable for near-ground operation due to the fact that the antenna is vertically polarized and has an omnidirectional radiation pattern.

The measurements are conducted at various indoor/outdoor scenarios with various combination of Tx/Rx antennas separation. These scenarios are categorized as follows: 1) Both Tx and Rx antennas are located inside the building, 2) Both the Tx and Rx are located outside the building, and 3) Either Tx or RX is located inside and the other one is outside of the building. The experiments are carried out in realistic complex multipath-rich indoor/outdoor environments. Details of the measurement systems and statistical nature of wave propagation in the above-mentioned scenarios will be presented at the symposium.