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Resilience for mmWave Communication through Multi-IRS

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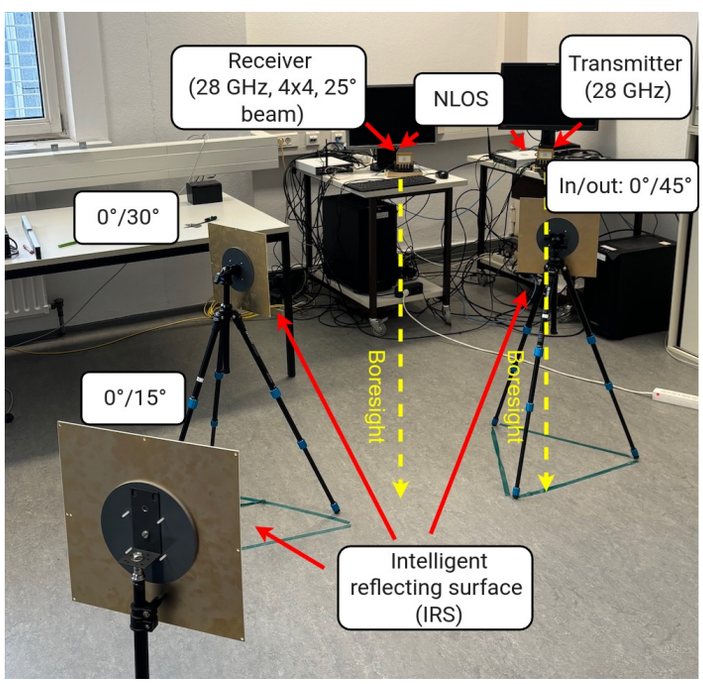
Can Non-Reconfigurable-Reflectors (NRR) be used to create artificial redundant communication links for ensuring resilience in mmWave communication systems? How closely can we approach the wideband signal behavior using multiband splicing over half of its bandwidth?



The setup operates at 28 GHz and it consists of two X410 USRPs, two BBox Lite frontends, one UD Box 5G and three XRifle reflectors. The transmitted signal is generated via Matlab, using the IEEE 802.11be standard. The OFDM waveform spans a bandwidth of 320 MHz. The receiver captures the signal with a sampling rate of 500 MS/s. The frequency response is computed from the EHT-LTF field of the received frames. Three NRRs (INC: 0°, REF: 15°; INC: 0°, REF: 30°; INC: 0°, REF: 45°) are perfectly aglined with the transmitting and receiving nodes; which do not communicate via line of sight (LoS).

KEY FINDINGS

In order to assess how resilience is improved, two different scenarios were analyzed: one in the presence of three artificial reflections from the NRRs without LoS, and one where only LoS is available. For both cases, there is a mobile user randomly walking around the setup for 10 s. Results reveal that in the latter case, there is a 1.2 s communication outage; whereas in the former case there is never a communication outage. This follows from the fact that communication outage would only occur if all three NRRs are blocked simultaneously. The packet success rate is then 0.996 and 0.875 for the NRR and LoS cases, respectively.

Live processing of the channel impulse response (CIR) is done in the receiving host station, where ideally three strong taps are visible and they disappear when the corresponding communication link is blocked. Given that existing infrastructure is restricted in the supporting bandwidth, we verify the wideband results via multiband splicing; where the CIR is estimated by using a single 160 MHz signal in combination with a sparse recovery algorithm. Results reveal that multiband splicing is accurate in discovering the positions of the original channel taps.

Joana Angjo, Anatolij Zubow and Falko Dressler, "Side Effects of IRS: On the Need for Coordination in 6G Multi-Operator IRS-assisted Networks," Proceedings of IEEE Global Communications Conference (GLOBECOM 2023), 4th Workshop on Emerging Topics in 6G Communications (6GComm), Kuala Lumpur, Malaysia, December 2023.

Sigrid Dimce, Anatolij Zubow, and Falko Dresser, "mmSplicer: Toward Experimental Multiband Channel Splicing at mmWave Frequencies," Proceedings of 43rd IEEE International Conference on Computer Communications (INFOCOM 2024), Poster Session, Vancouver, Canada, May 2024.