Design and Prototype of Next Generation Internet of Things

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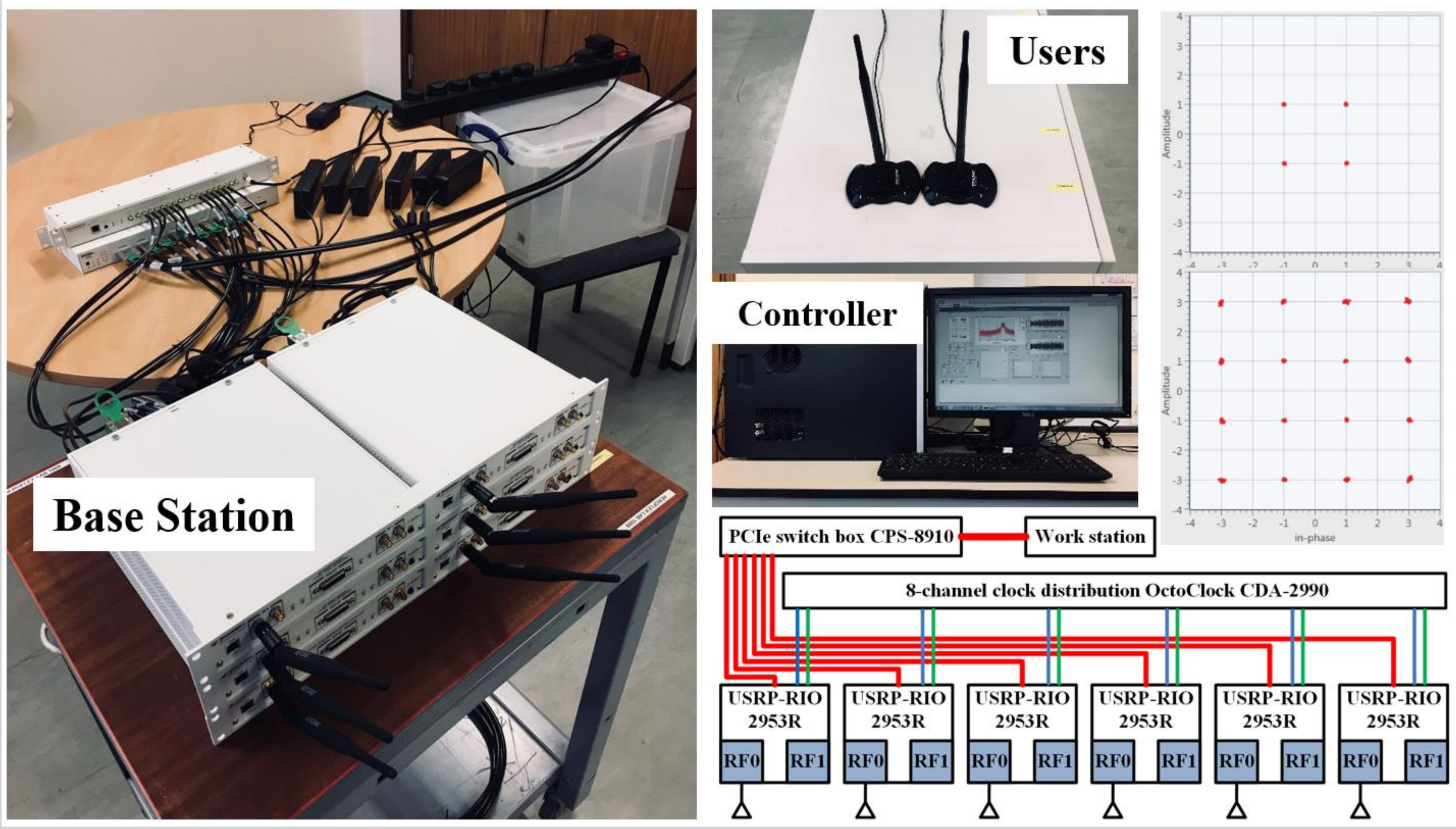
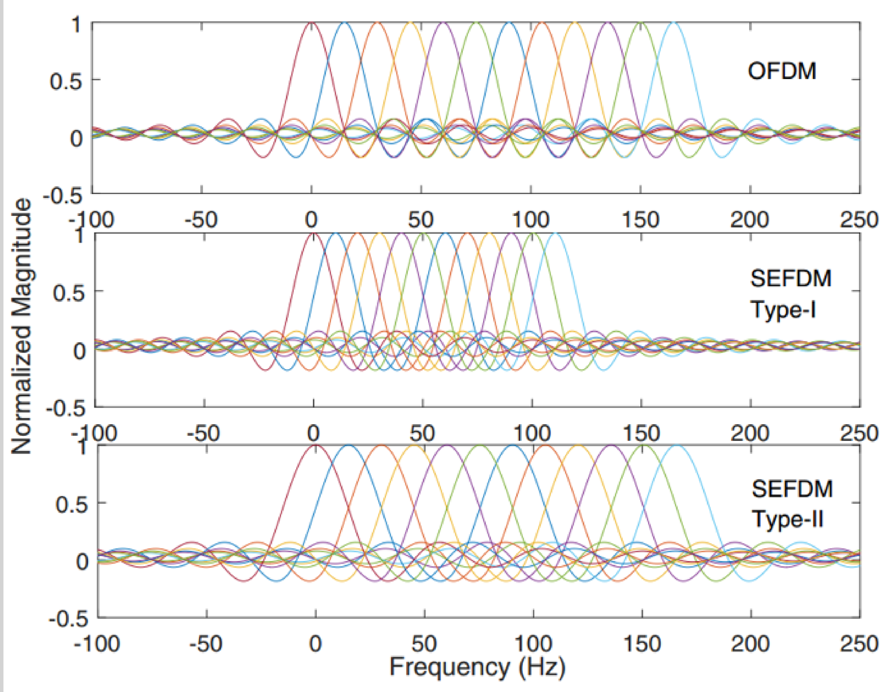
Downlink Scheme

Multi-user MIMO-OFDM Platform

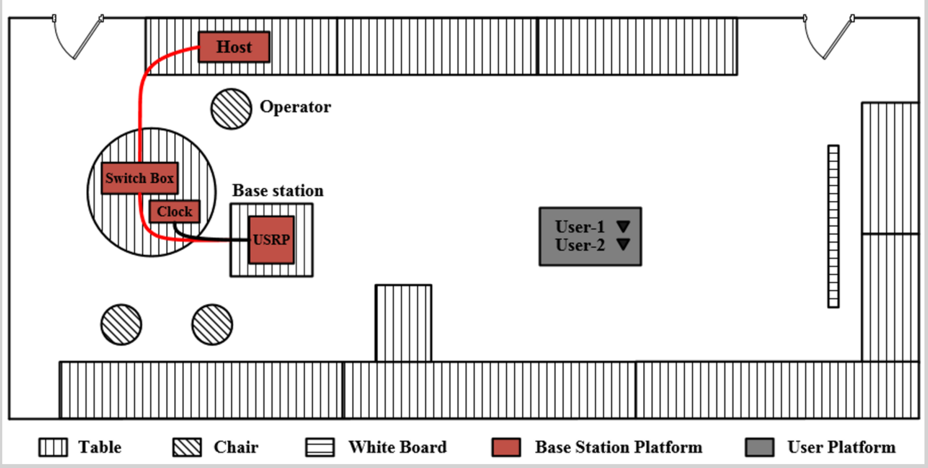


SEFDM Signal Waveform

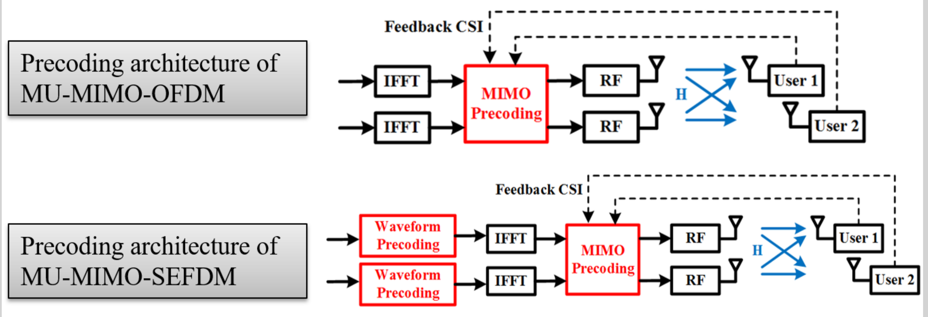


- OFDM (12 sub-carriers, data rate is Rb).
- SEFDM Type-I (12 sub-carriers, bandwidth compression ratio is α=0.67, data rate is Rb).
- SEFDM Type-II (12 sub-carriers, bandwidth compression ratio is α=0.67, data rate is 1.5Rb).

Indoor Experiment



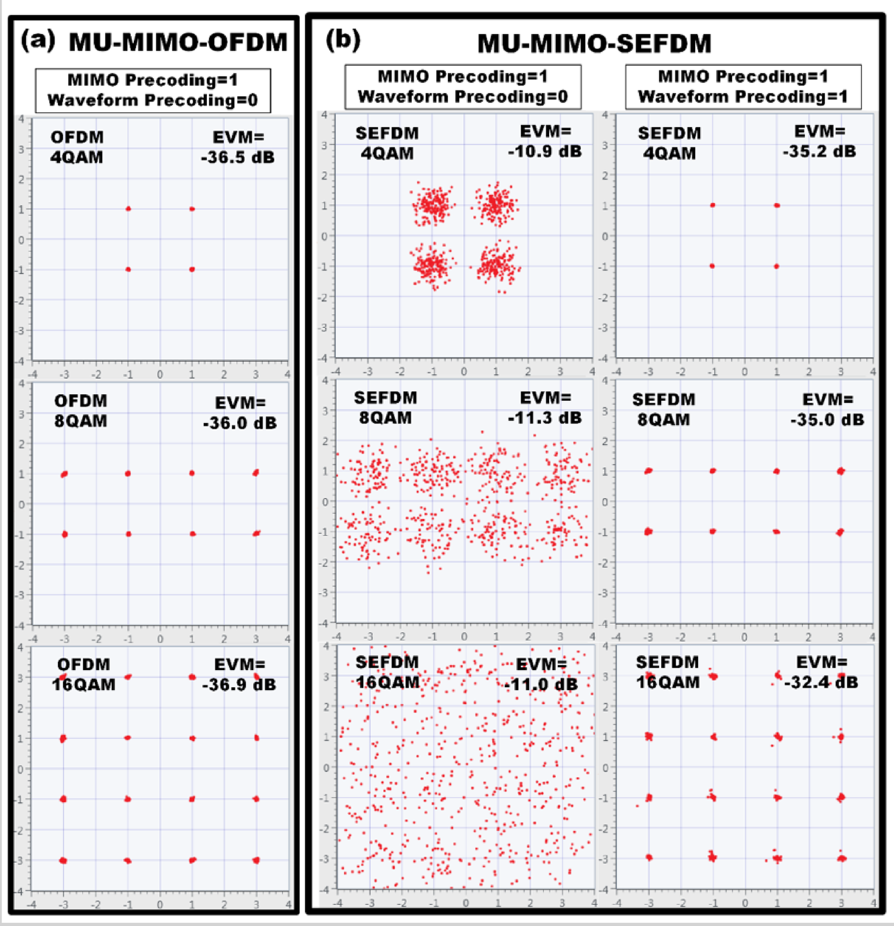
Precoding Schemes

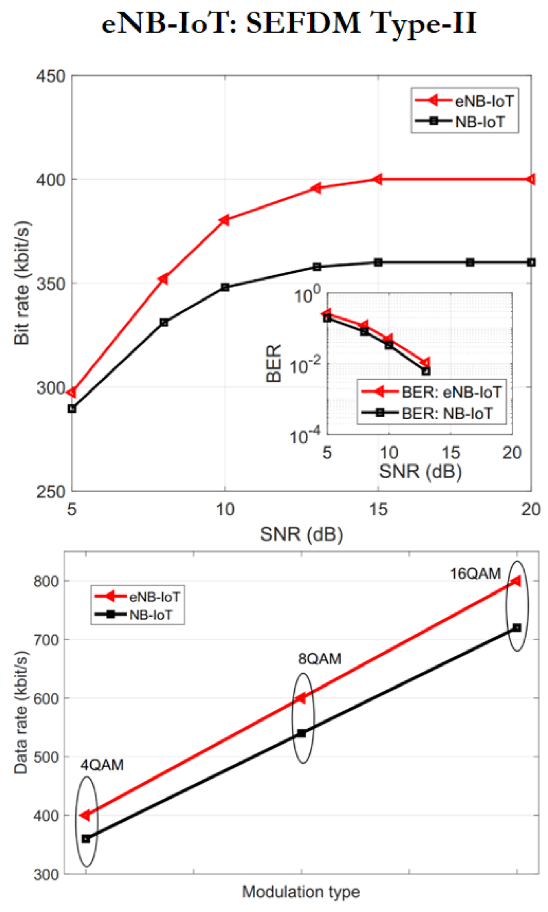


The self-created ICI challenges signal detection. Two precoding methods are available

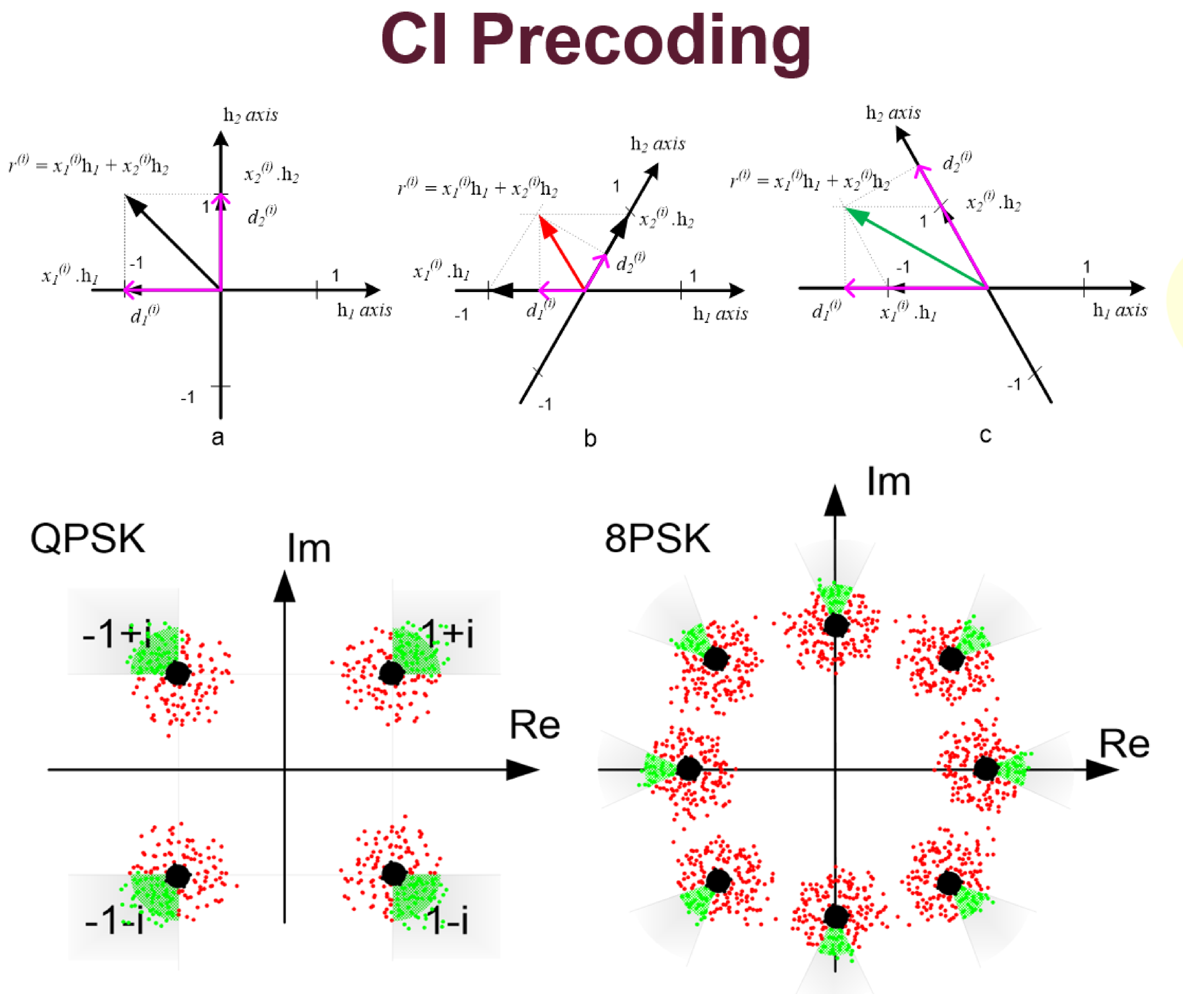
(a) Zero Forcing Precoding (ZFP)
(b) Constructive Interference Precoding (CIP)

ZF Precoding

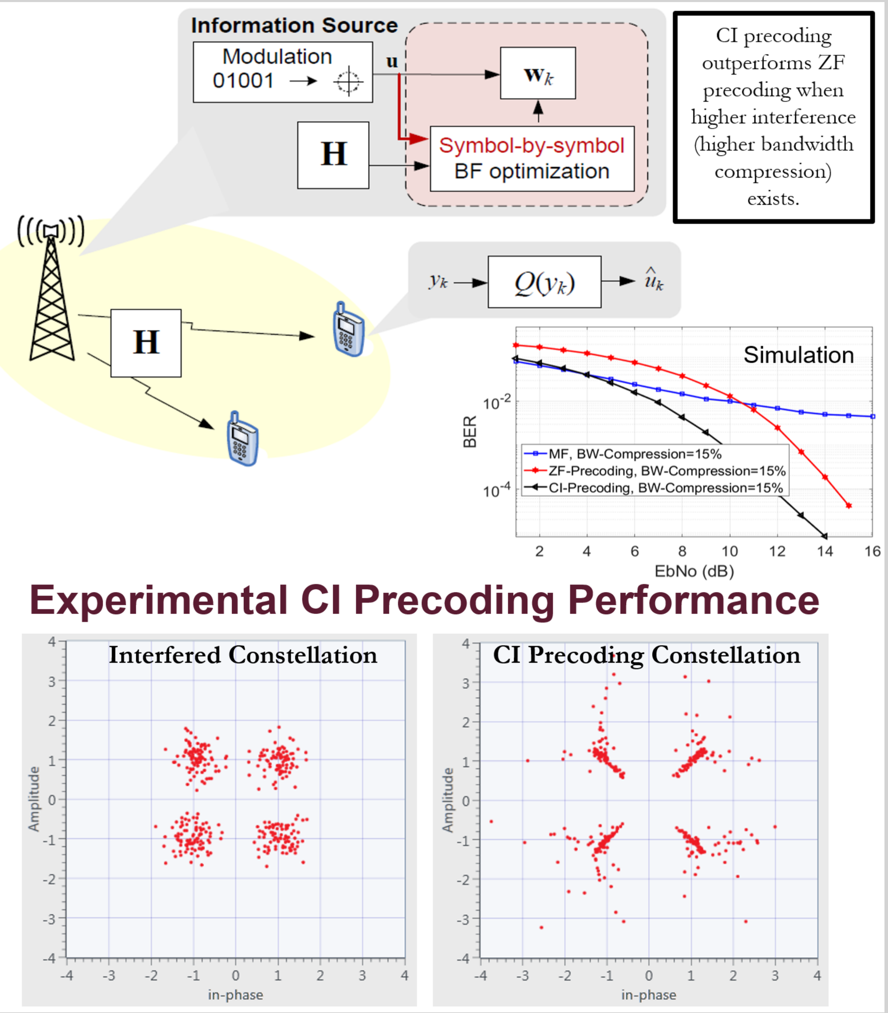




CI Precoding

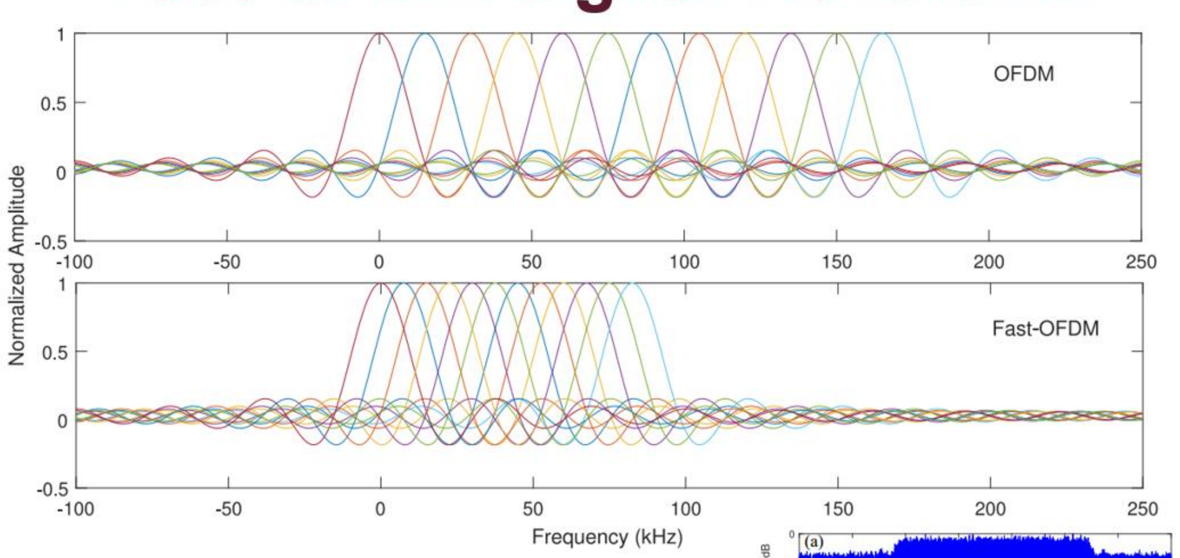


Experimental CI Precoding Performance

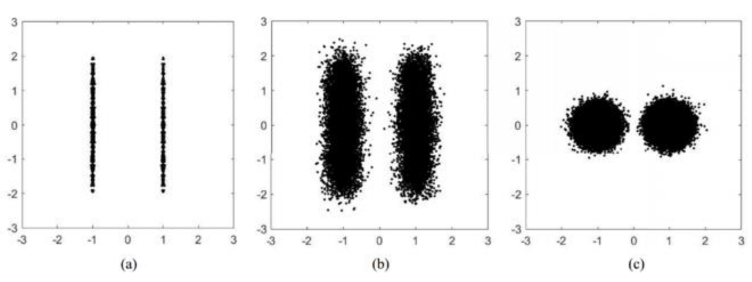


Uplink Scheme

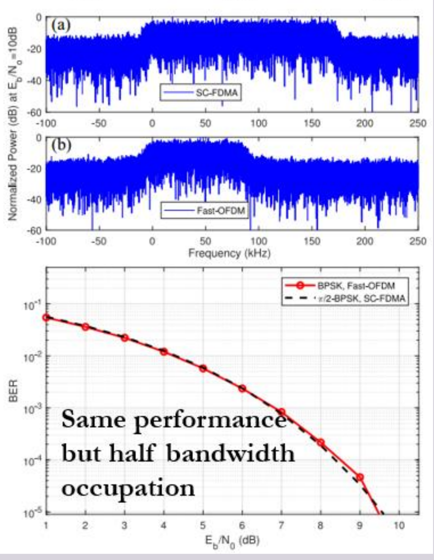
Fast-OFDM Signal Waveform



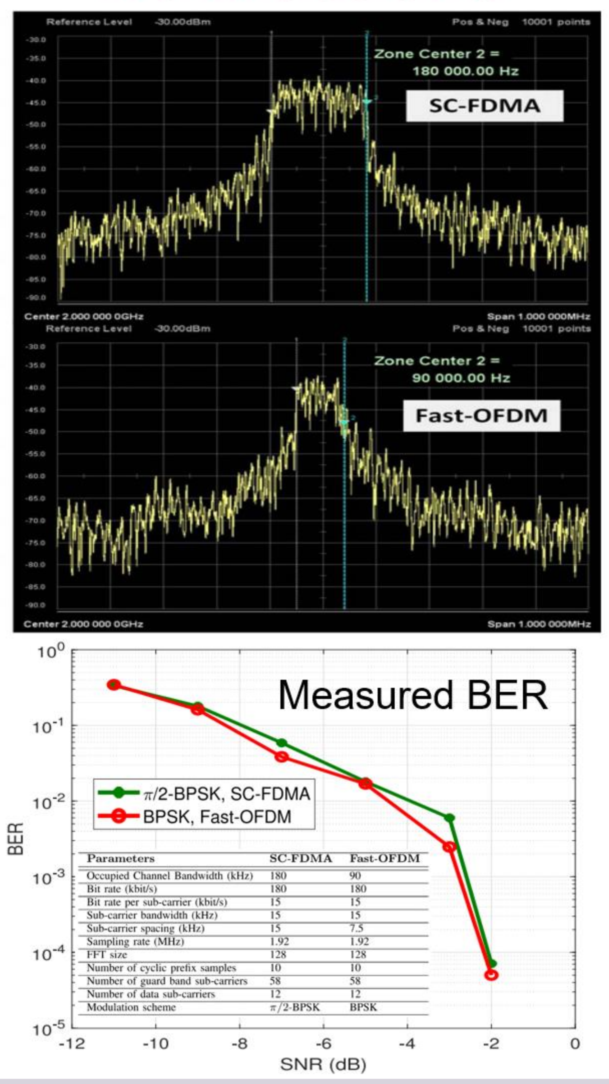
BPSK constellation comparison



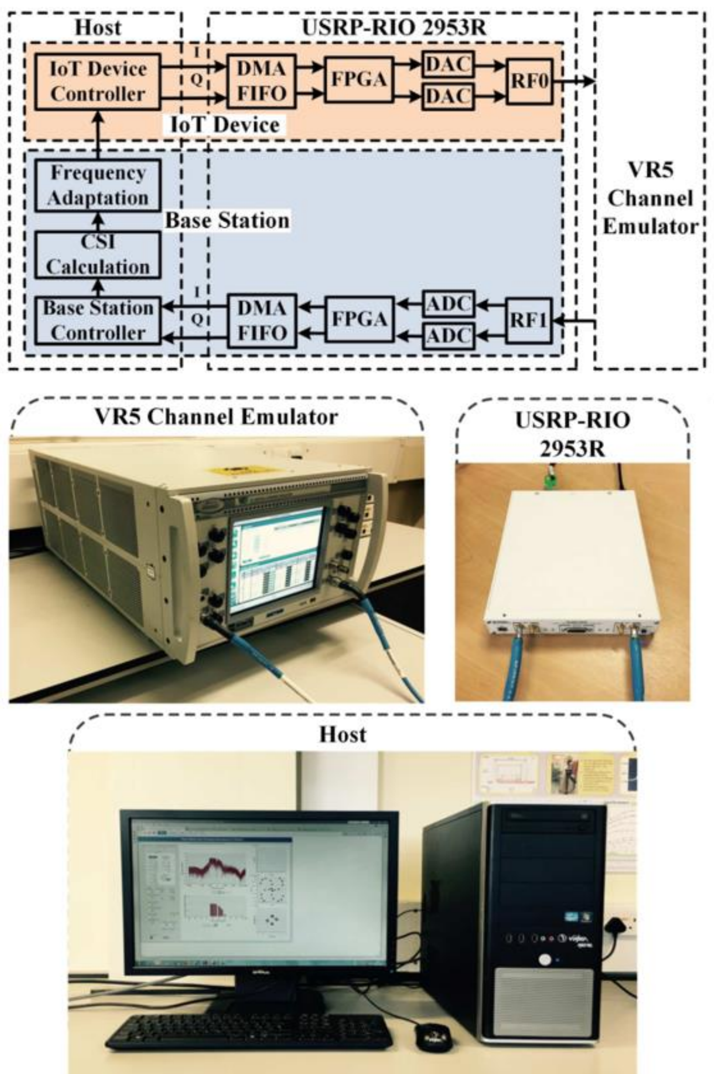
(a) Ideal Fast-OFDM.
(b) Fast-OFDM in AWGN channel at Eb/No = 10 dB.
(c) OFDM in AWGN channel at Eb/No = 10 dB.

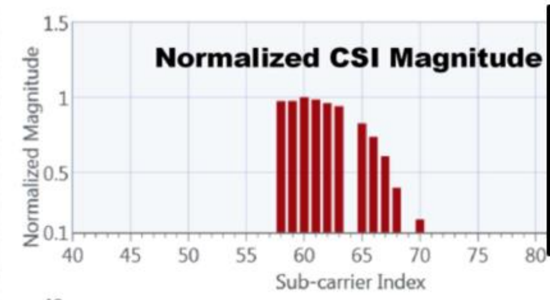


Enhancement of Connections

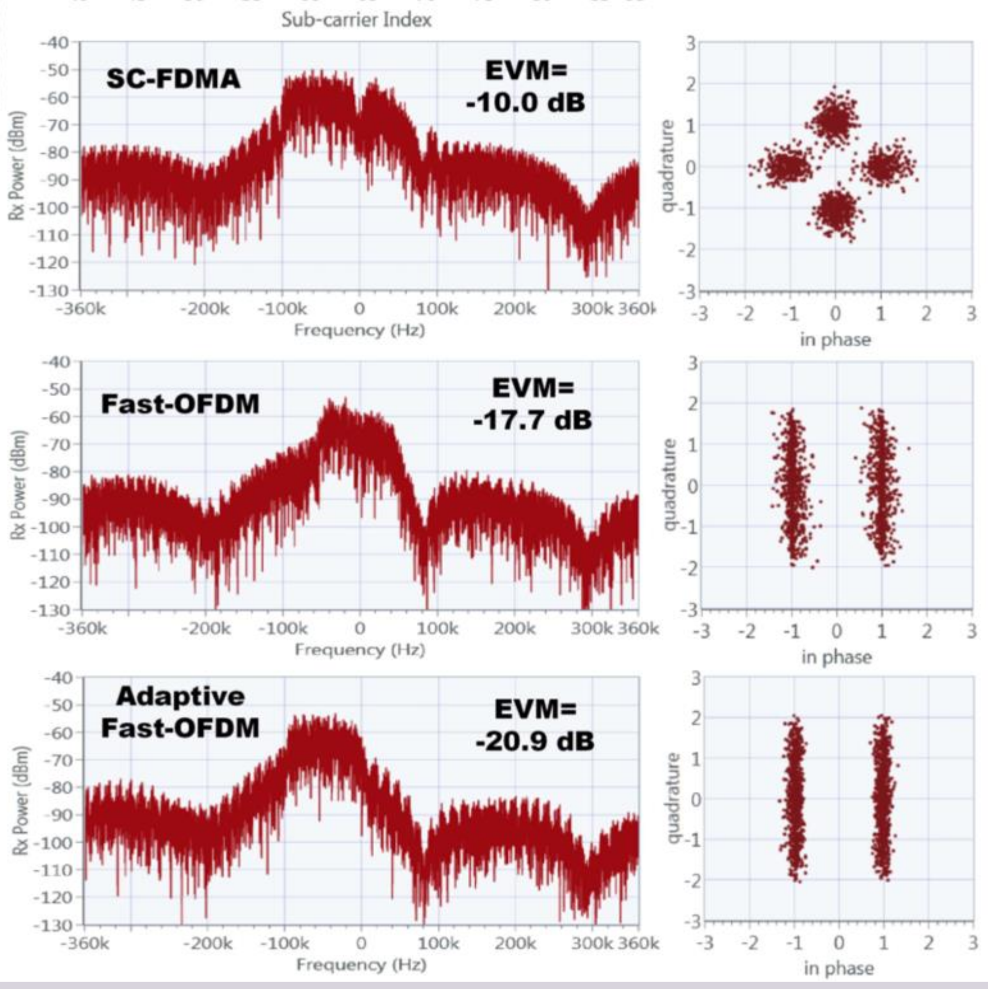


Enhancement of Power Efficiency



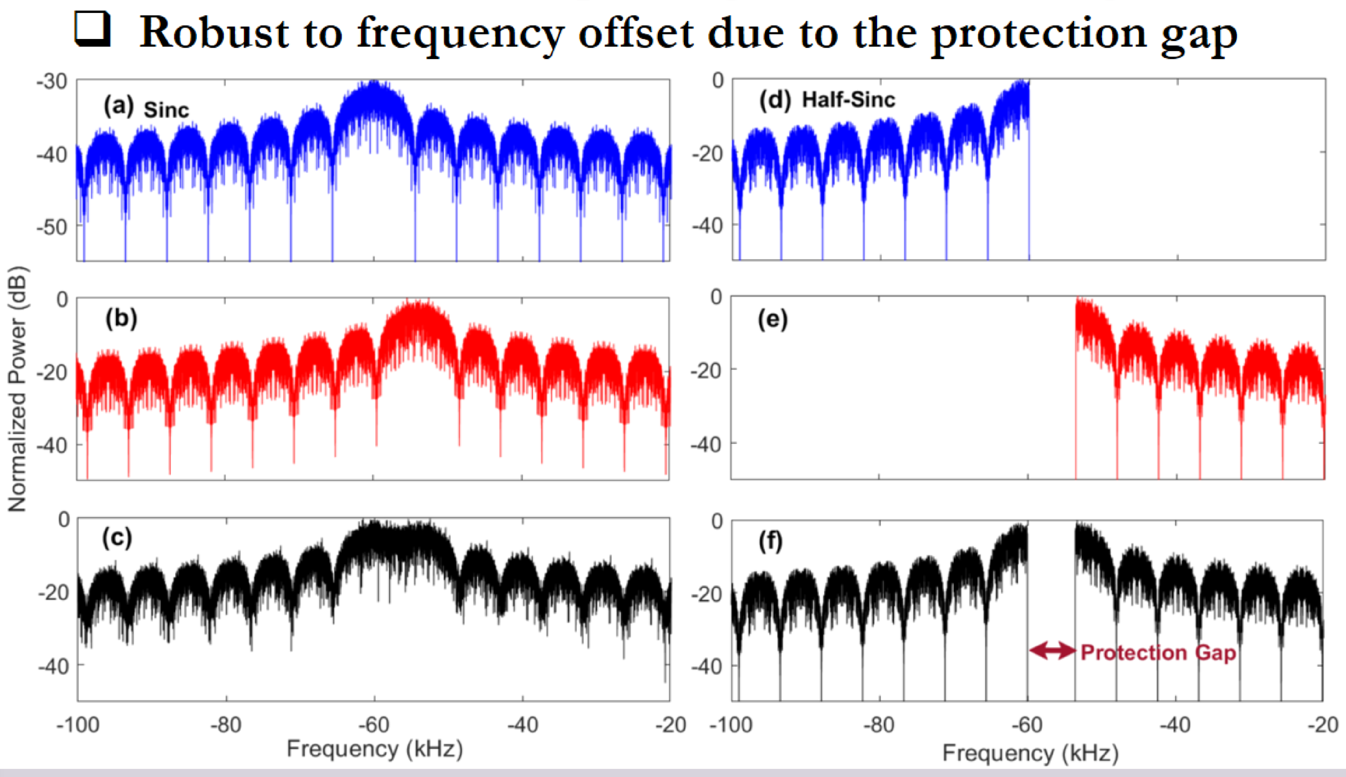


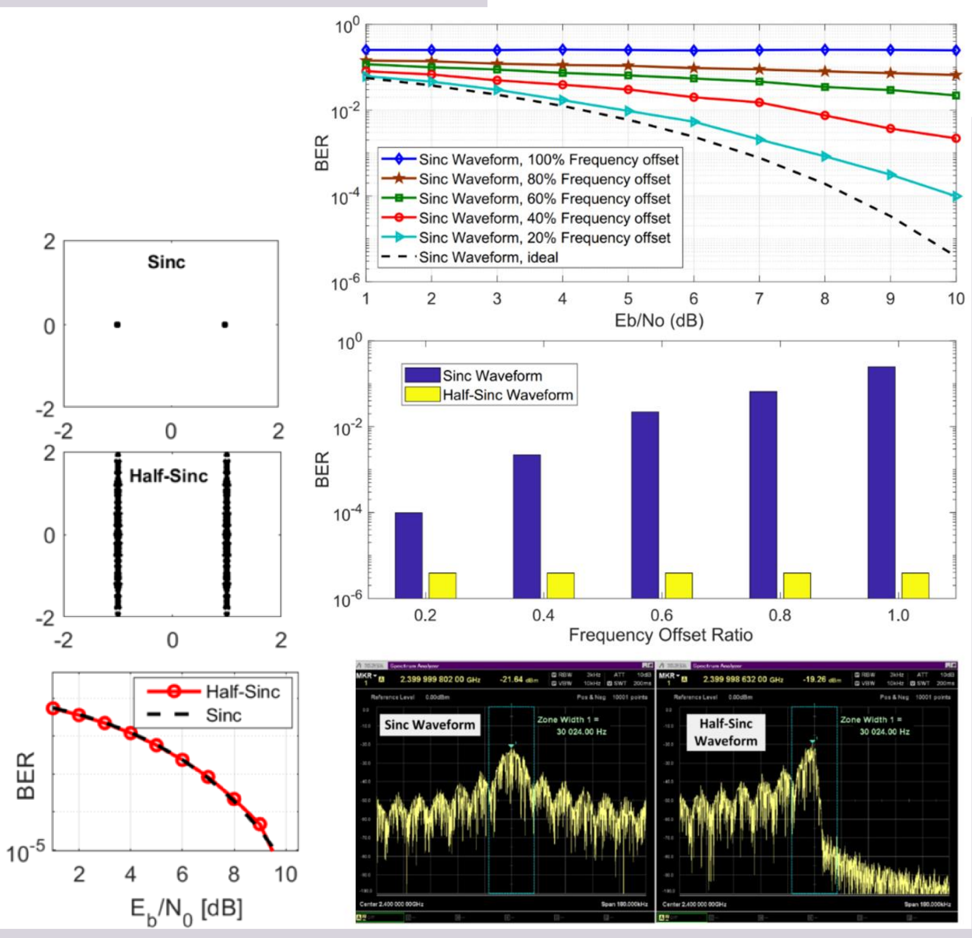
- Adaptive Fast-OFDM can shift the occupied spectrum to a better channel portion based on SNR.
- CSI at each sub-carrier is estimated to indicate SNR



Half-Sinc Signal Waveform

- Double data rate via packing two Half-Sinc signals
- Robust to frequency offset due to the protection gap

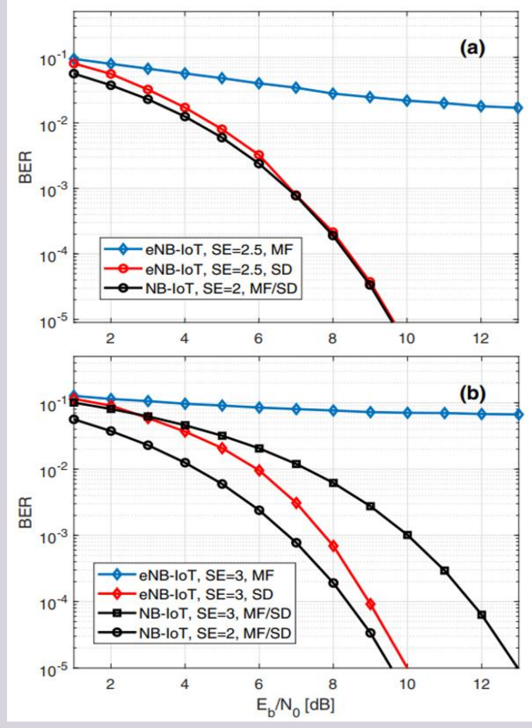




Enhancement of Data Rate

NB-IoT: OFDM

eNB-IoT: SEFDM Type-II



Parameters	SE (bit/s/Hz)	Data rate
NB-IoT	2 (QPSK)	R_b
eNB-IoT	2.5 (QPSK)	$1.25R_b$ (+25%)
NB-IoT	3 (8PSK)	$1.5R_b$ (+50%)
eNB-IoT	3 (QPSK)	$1.5R_b$ (+50%)

- Performance of QPSK modulated eNB-IoT signals (a) α=0.8. (b) α=0.67 and QPSK, 8PSK modulated NB-IoT signals.
- Non-orthogonal signal waveform is better than dense modulation formats to improve IoT data rate !