Mobility Resilience and Overhead Constrained Adaptation in Mobile 60 GHz Networks

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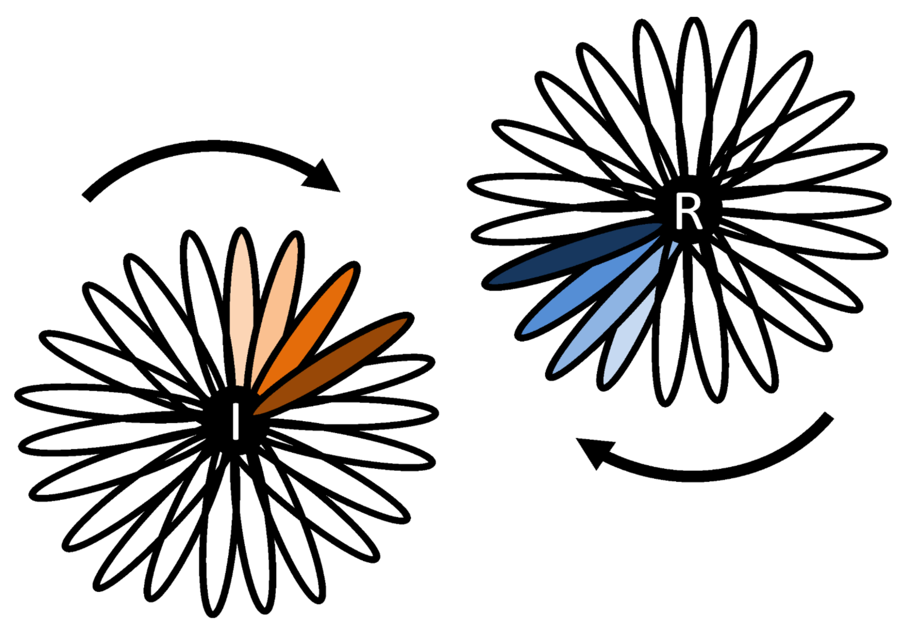
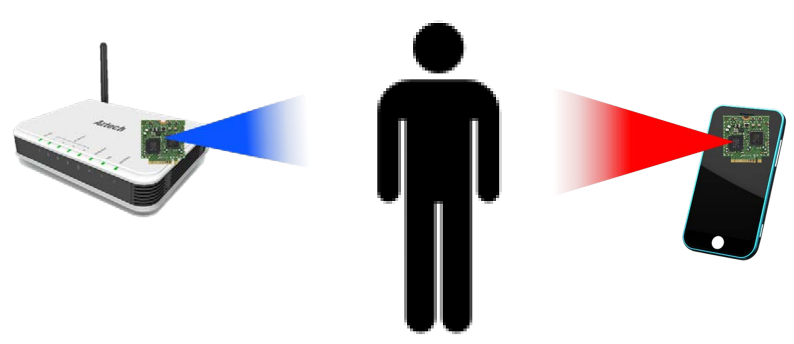
Introduction and Motivation

- 60 GHz Communication
  - 7-14 GHz bandwidth
  - Multi-Gbps rates in 802.11ad
  - **Beamforming Training** to establish directional links



- Mobility induced link breakage
  - Sector Misalignment

  - Blockage

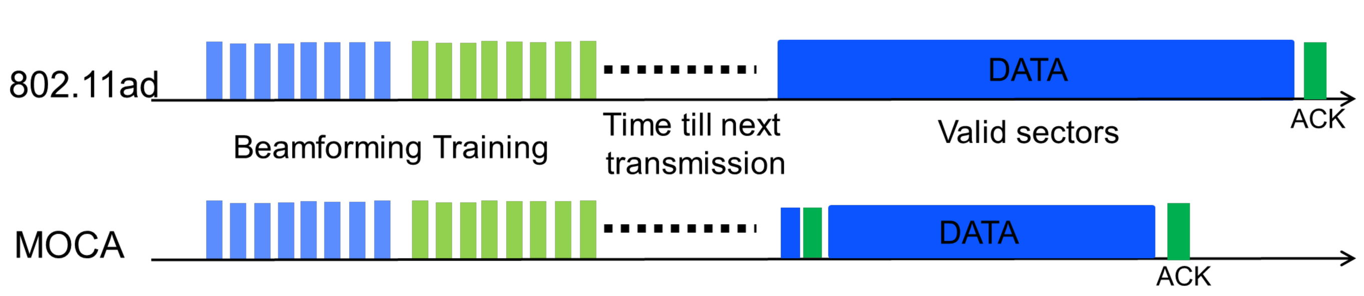


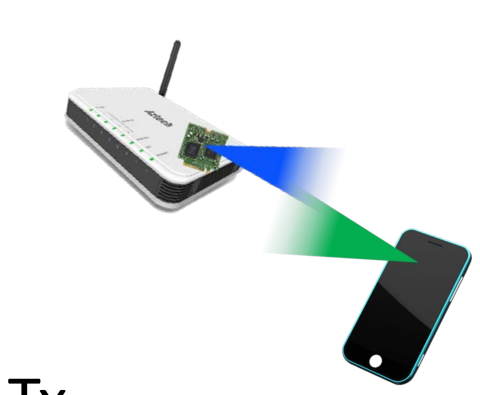
- Problems
  - Need training to restore the link
  - Exhaustive search incurs high overhead
  - Repeated training to overcome intermittent link breakage

Training overhead to restore mobility induced link breakages can decrease throughput despite higher rates

MOCA: Mobility resilience and Overhead Constrained Adaptation

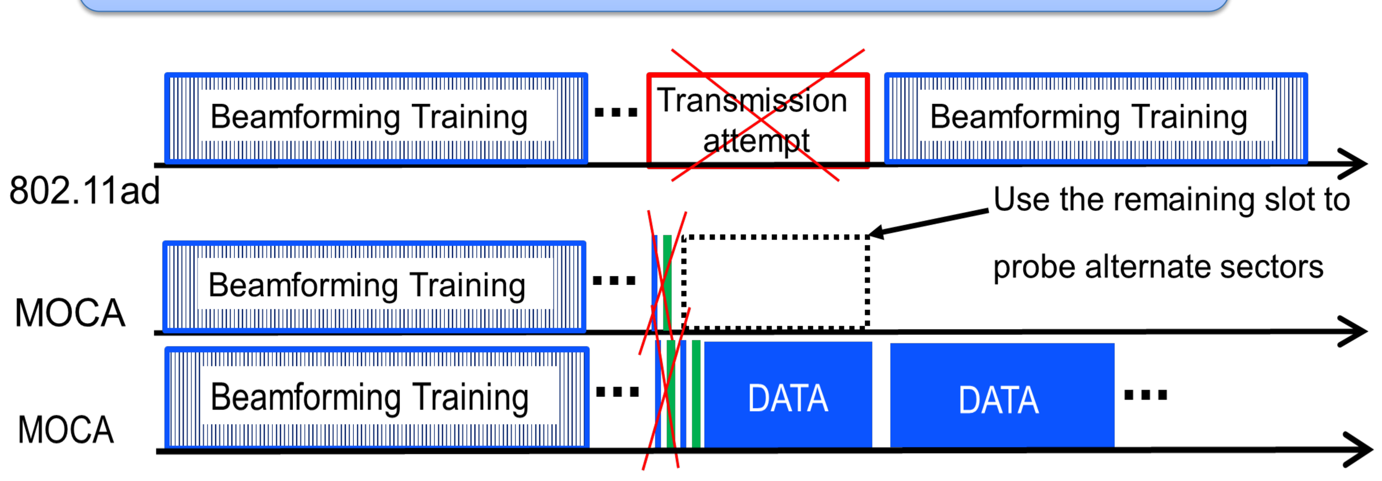
Beam Sounding





- Sounding frames on selected sectors prior to Tx
- Rate selection and beam refinement
- Link breakage inference

Pre-emptive Fast Recovery



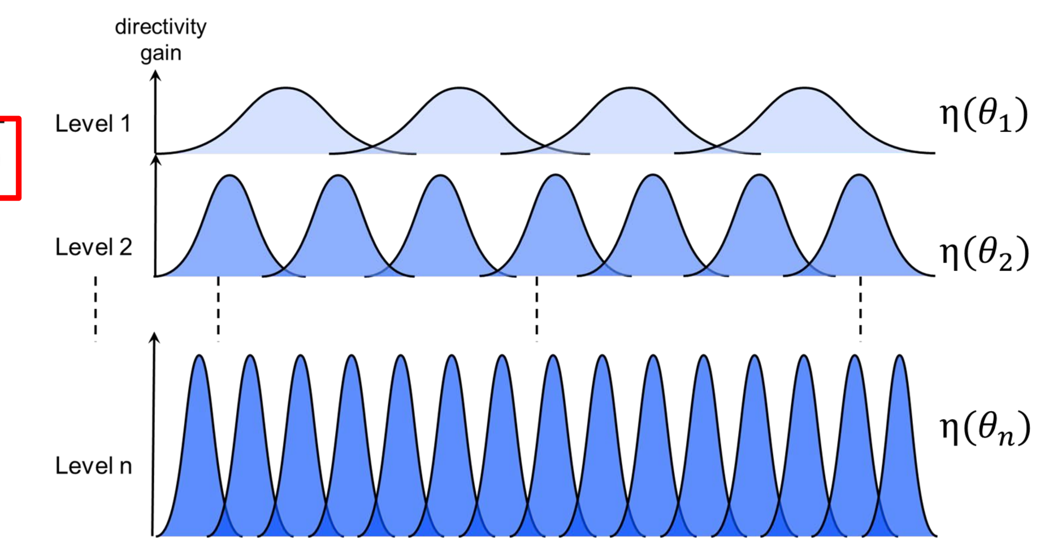
- Sound fail-over sectors upon breakage identification
  - Sector Expansion
  - Proactive search for NLOS paths
- Switch to fail-over sectors if successful
- Avoid packet loss and training overhead

Beamwidth Adaptation

- Jointly adapting rate and beamwidth in response to mobility
- Maximize average link throughput rather than data rate
- Exploiting multi-level codebook design

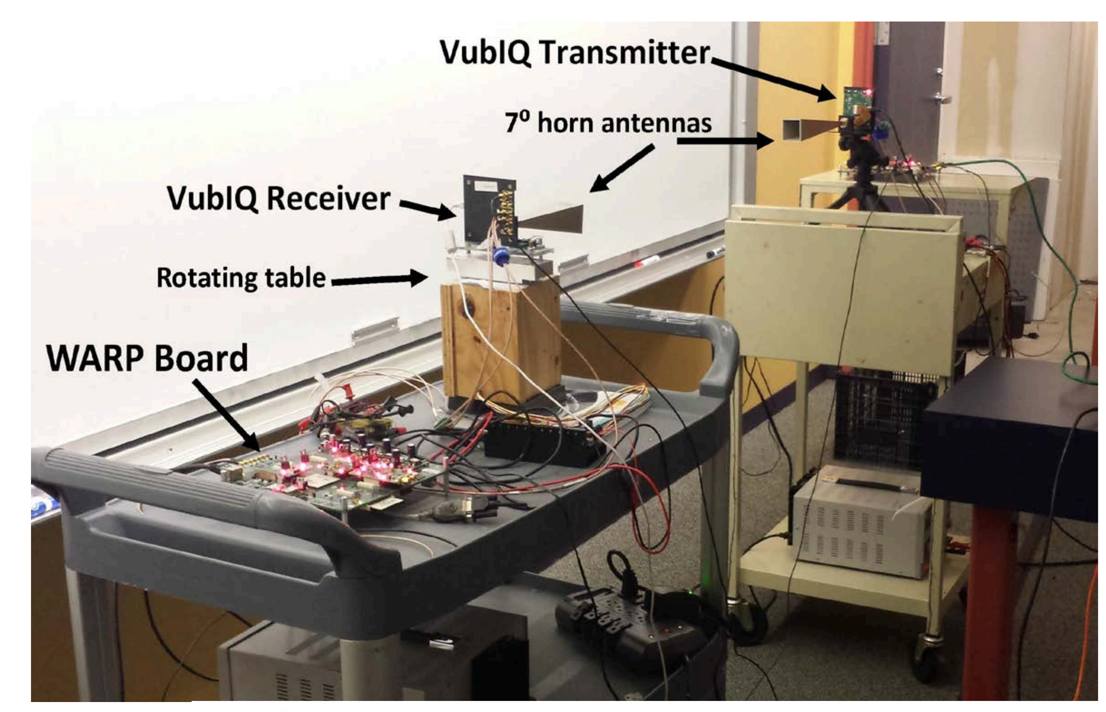
$$\eta(\theta) = \frac{(1-\beta(\theta))r(\theta)t_{slot}}{(1-\beta(\theta))(t_{slot}) + \beta(\theta)t_{BFT}(\theta)}$$

$$\theta_{MOCA} = \underset{\theta\epsilon[\theta_1,\theta_n]}{\arg\max}\ \eta(\theta)$$



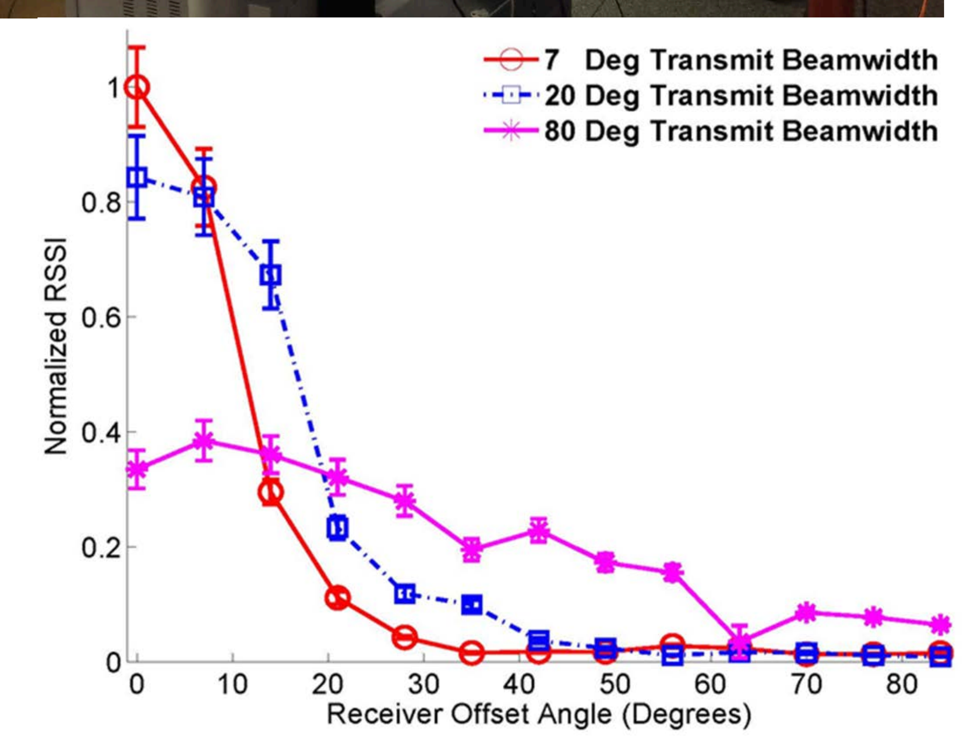
Implementation and Evaluation

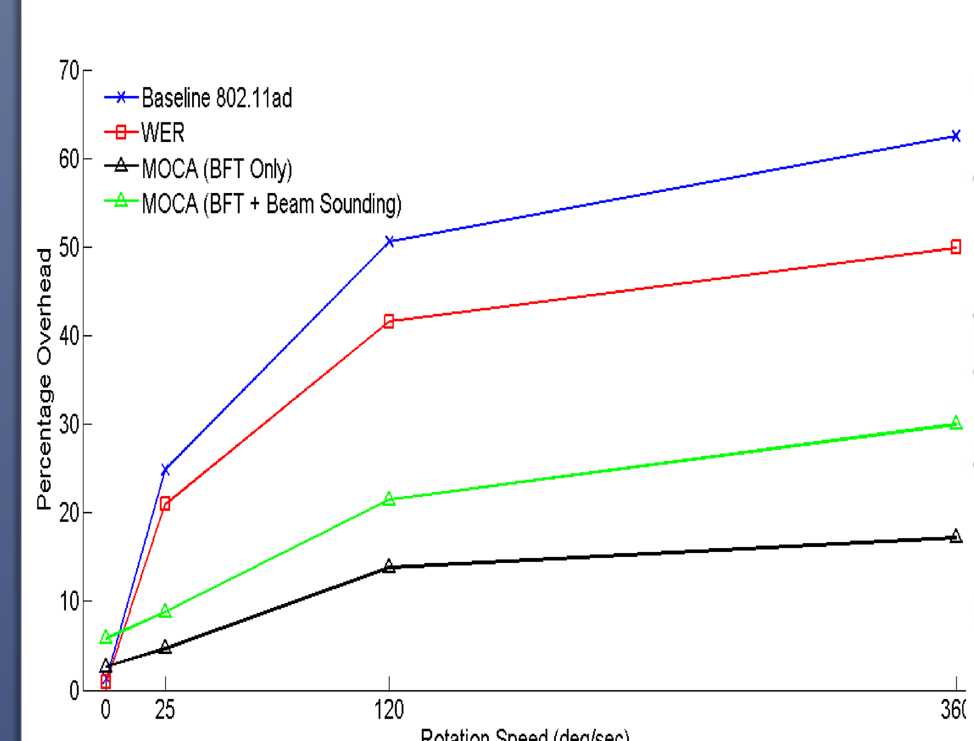
- 60 GHz Testbed
  - VubIQ transceivers
  - WARP baseband

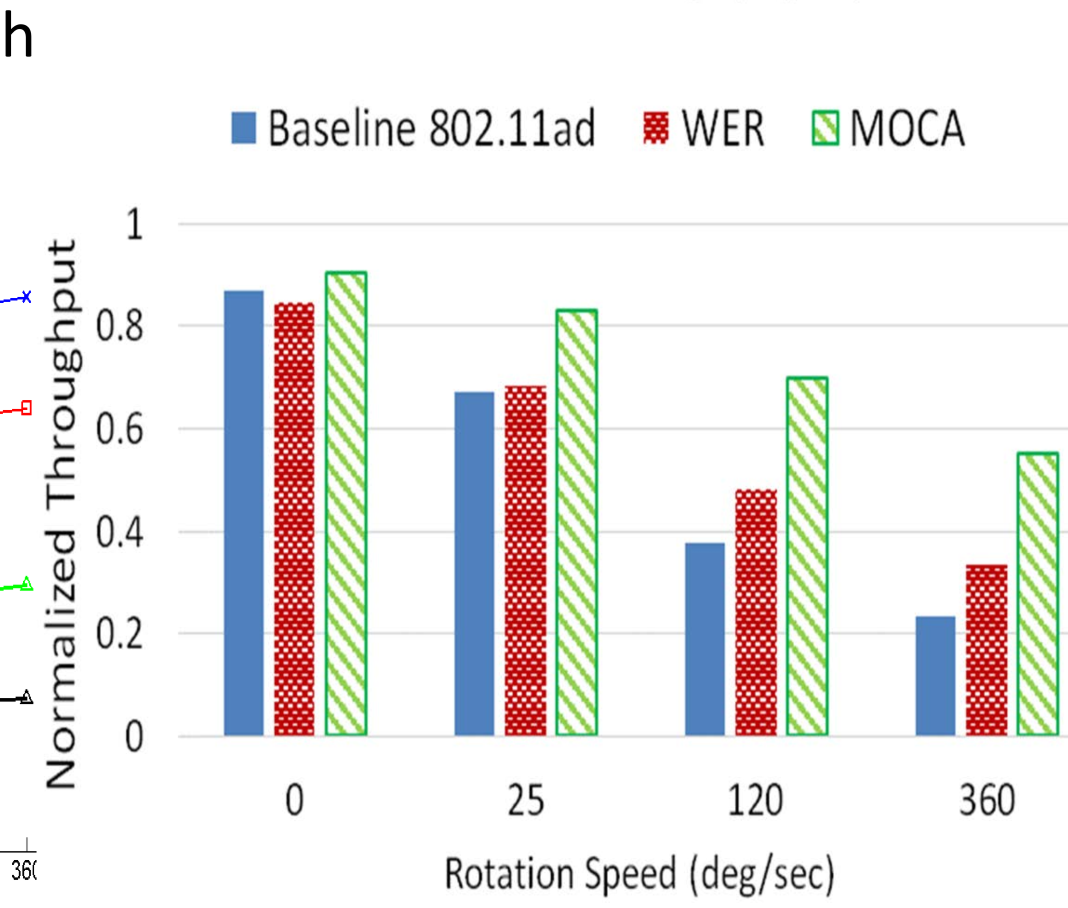


- Channel Measurements
- Lab, office and classroom environments
- Misalignment and rotation

- Results
- Slightly higher overhead in MOCA under low mobility
- Significantly low overhead under high mobility due to lower training frequency
- 1.5x-2x gains in throughput due to fast recovery and beamwidth adatptation approaches.







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