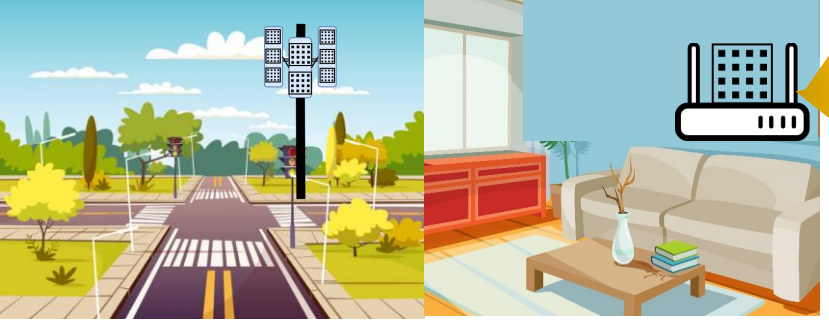

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CommRad: Context-Aware Sensing-Driven Millimeter-Wave Networks

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University of California San Diego

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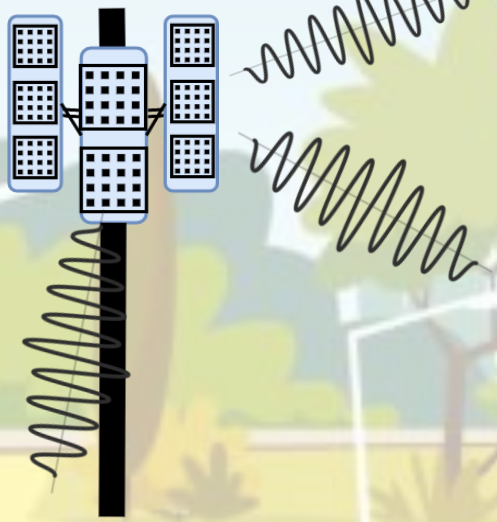
Sensys 2024, Hangzhou, China

NextG Network

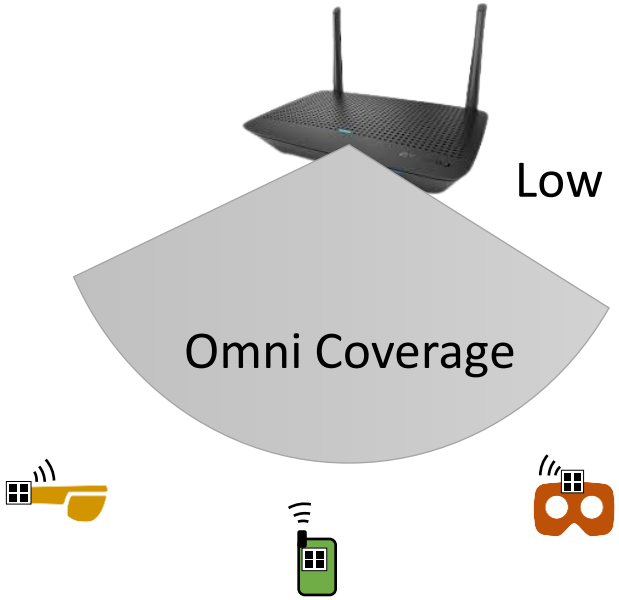


Ultra-High-Speed Links

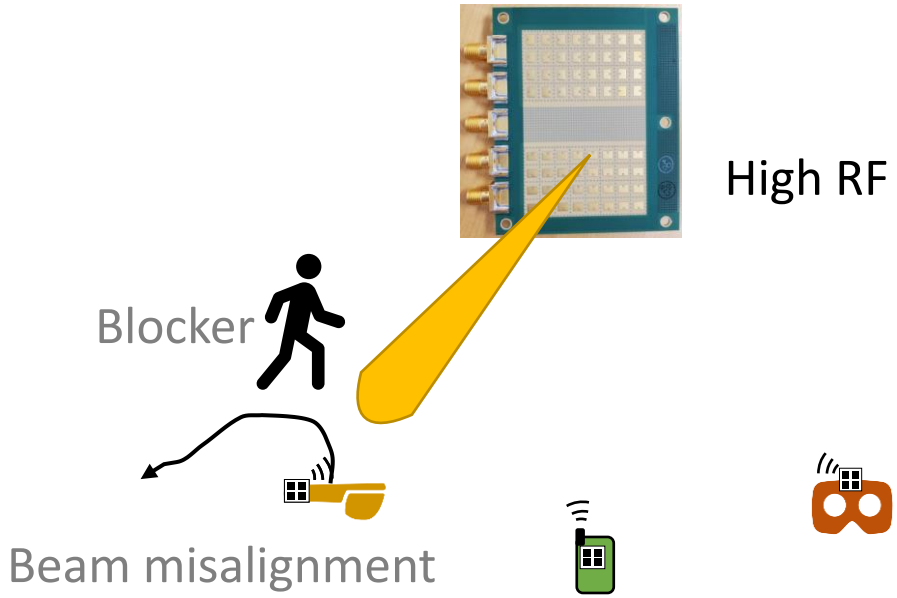
High Reliability with Mobility

Images credit: pngegg.com

MmWave provides high speed but lacks reliability



Sub-6 Network



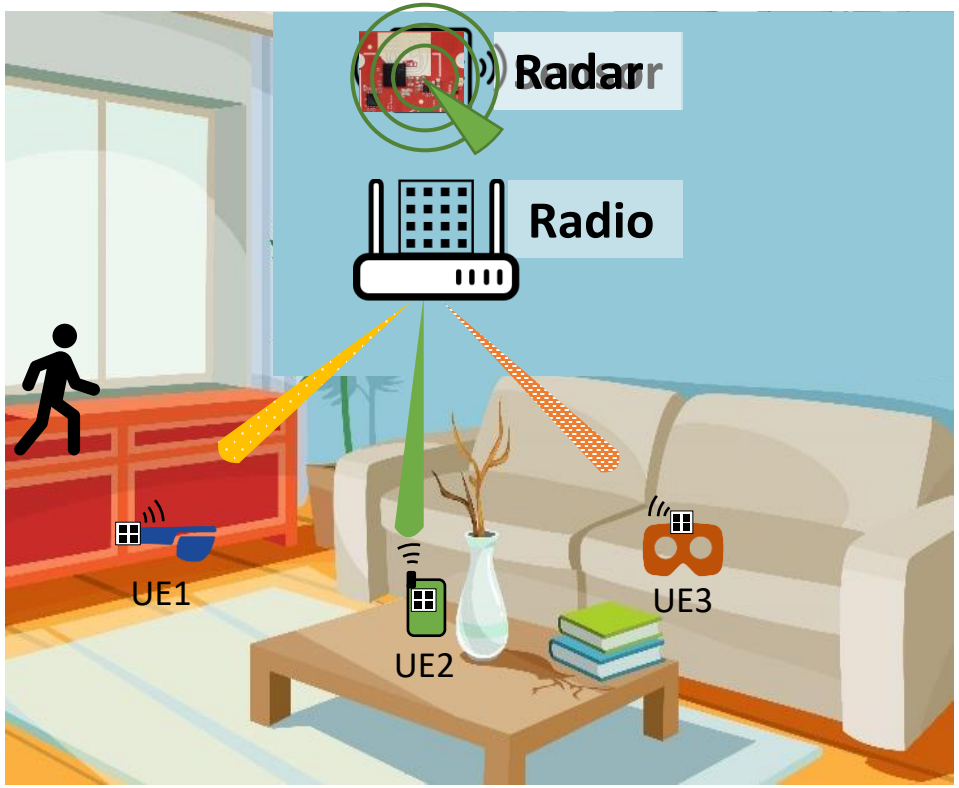
mmWave Network

Despite high-bandwidth, the existence of narrow beams ➔ **low reliability**.

CommRad: New paradigm for Sensing-Driven Communication

- A sensor can
  - Track multi-user beams with high resolution
  - Model environmental reflectors
  - Predict blockages

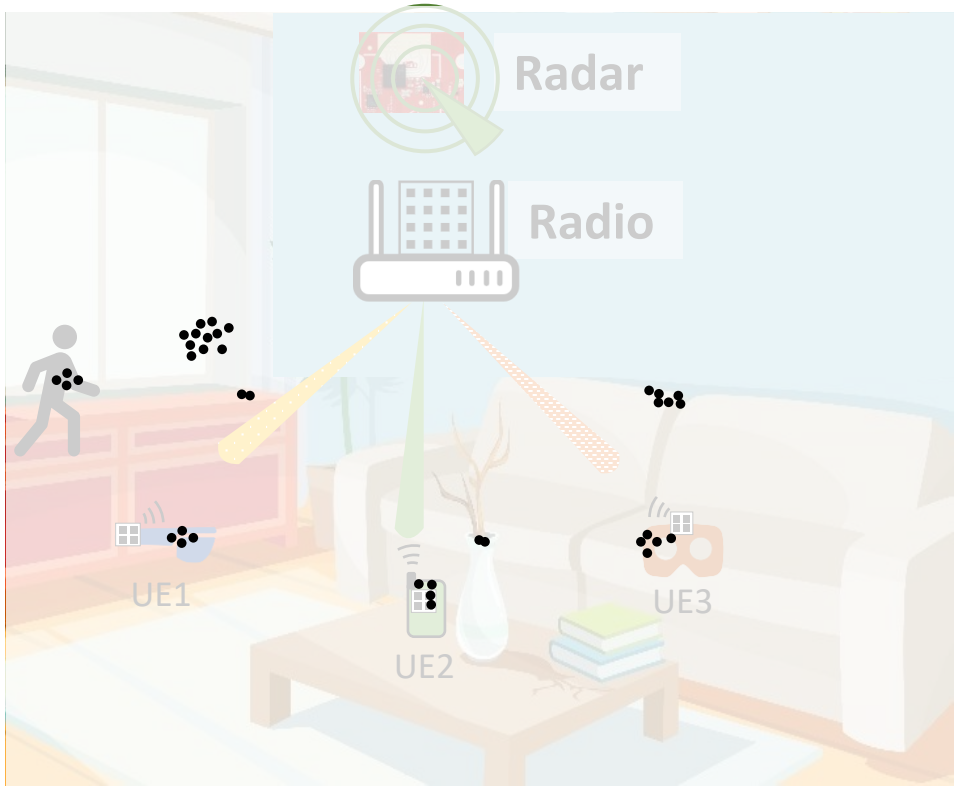
- Why Radar
  - Privacy preserving, weather-resistant, low-light sensing modality
  - Potential to integrate with Radio hardware



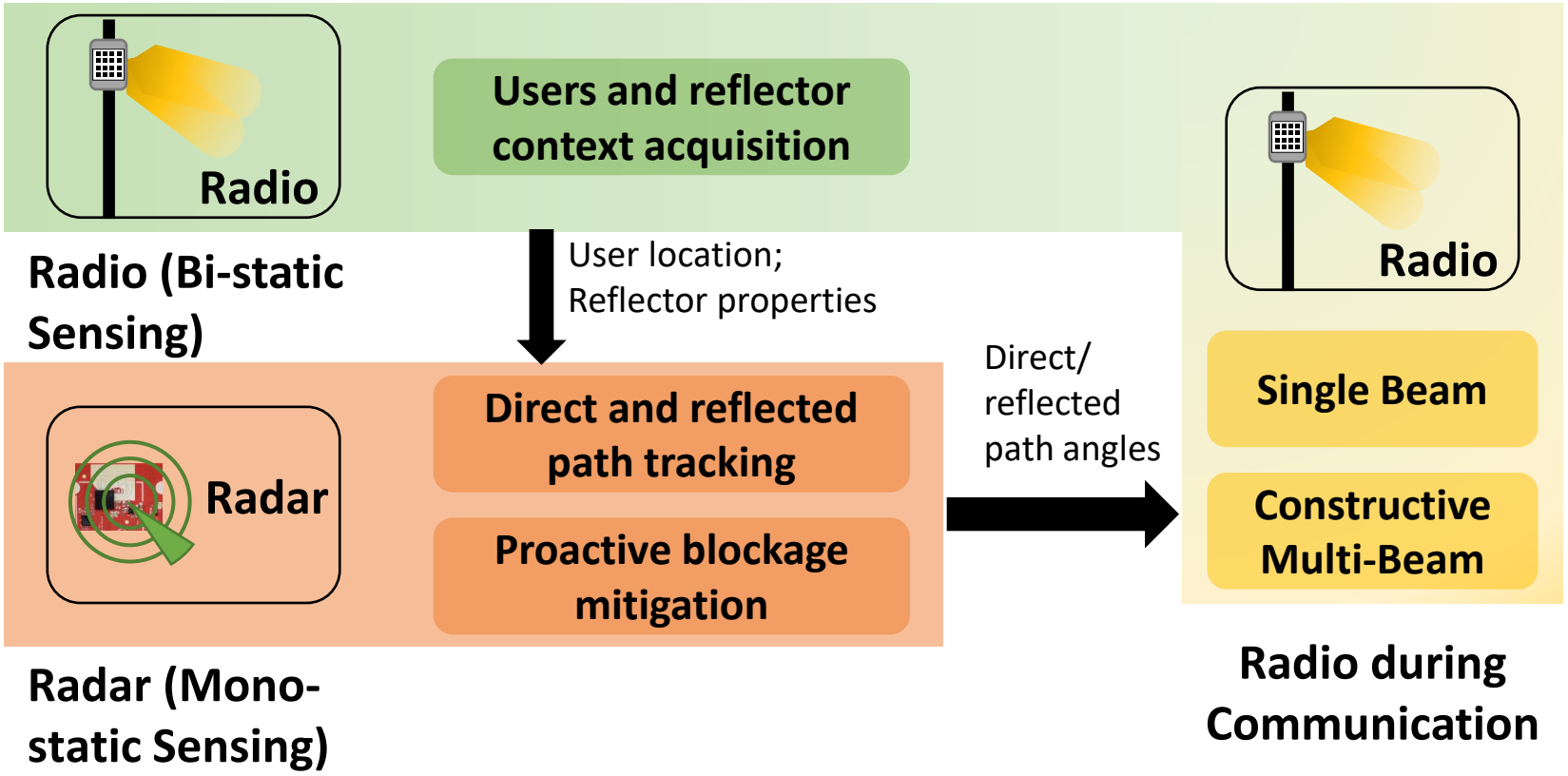
Challenge: Radar's cold-start problem

Radar sensor lacks ***context***

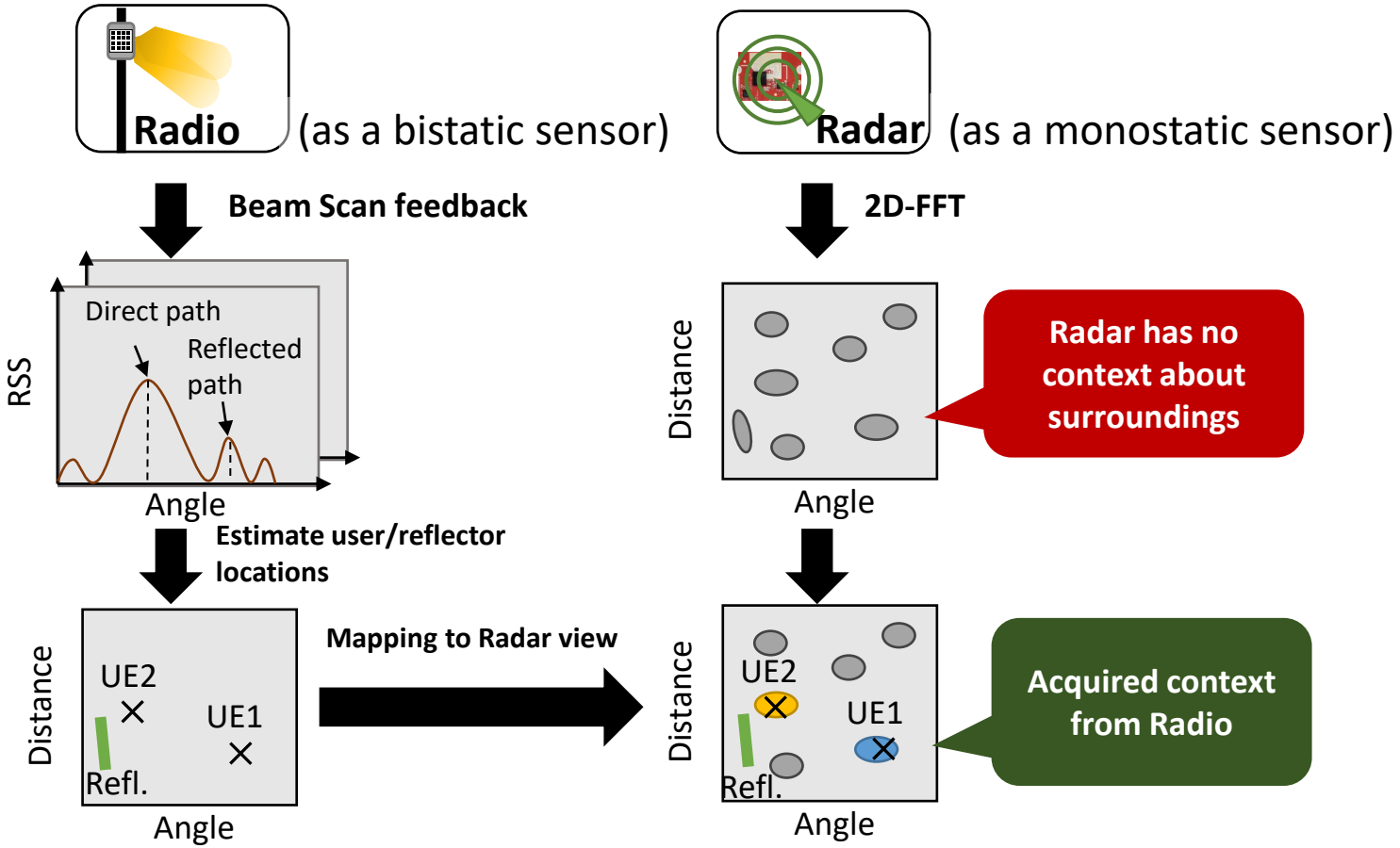
- Which reflection points are active users?
- Which points are reflectors?
- Where is the mobile blocker?



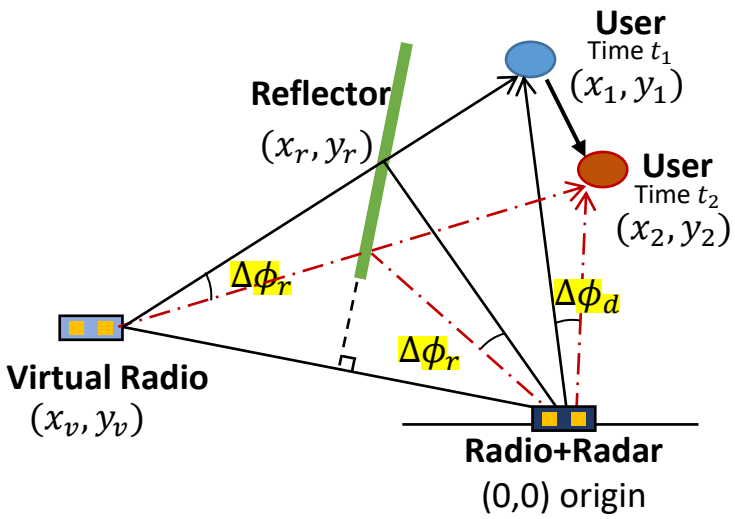
CommRad: Collaborative Learning Framework



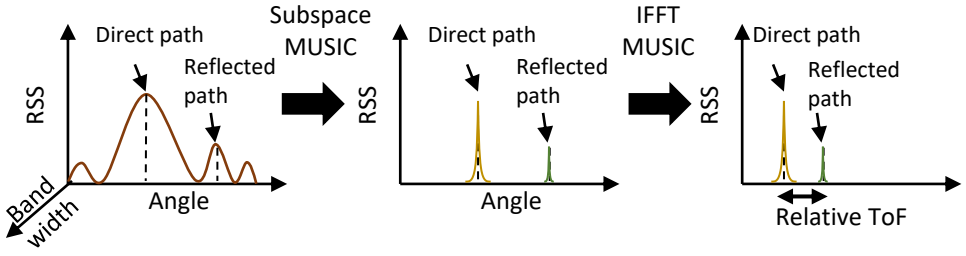
Acquiring Context for **Users**



Radar aids in direct/reflected path tracking



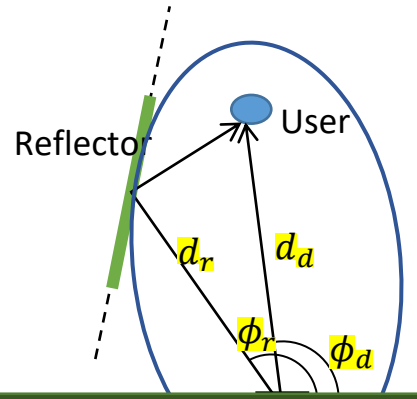
How to estimate virtual Radio location?



(a) Radio beam scan RSS with scan angle

(b) Subspace MUSIC spectrum

(c) Mapping user and reflector in radar view

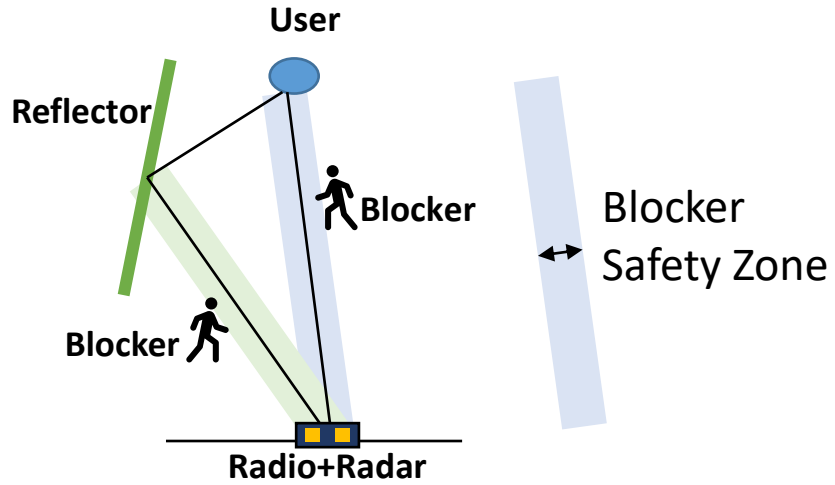


➔Acquired reflector location, orientation and size

➔ Mathematically calculate virtual Radio Location

CommRad's Collaborative Learning helps in direct and reflected path tracking

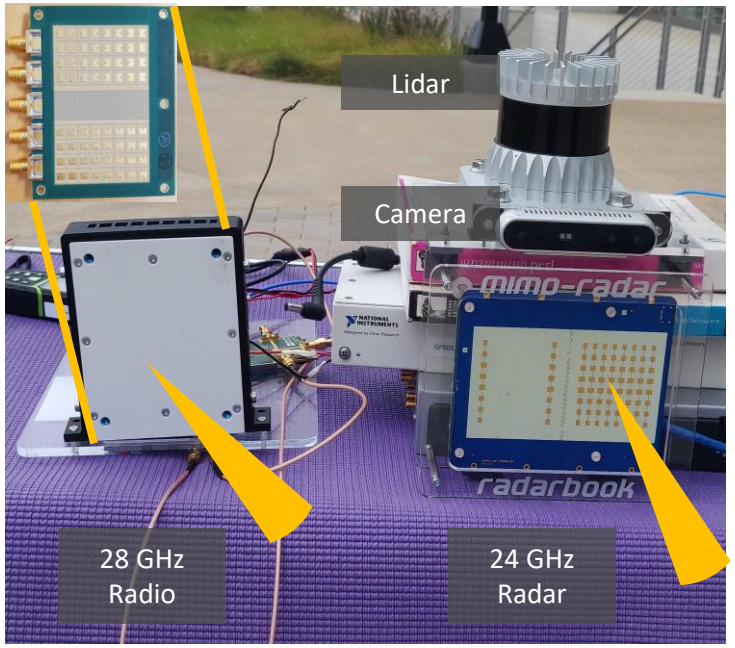
Radar aids in proactive blockage mitigation



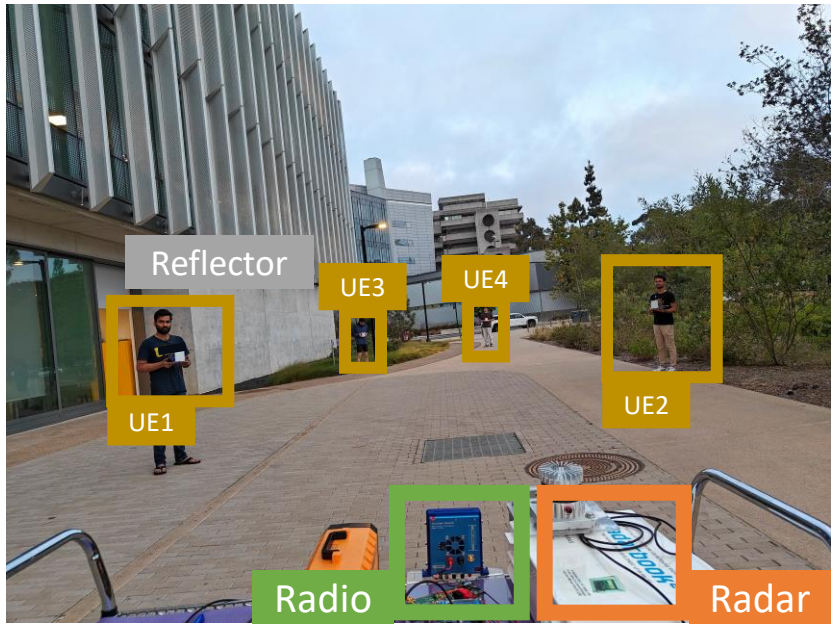
➔Radar tracks Blocker location and velocity
➔Estimate Blocker arrival time and departure time

CommRad takes preventive action against blockages

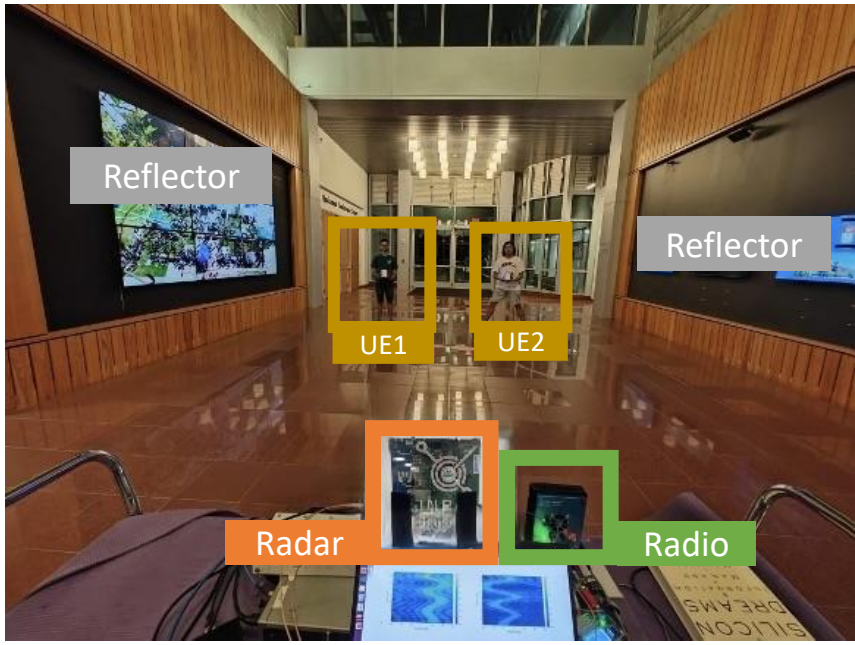
Implementation: Synchronized Radar + Radio Platform



Synchronized Radar and mmWave Radio platform

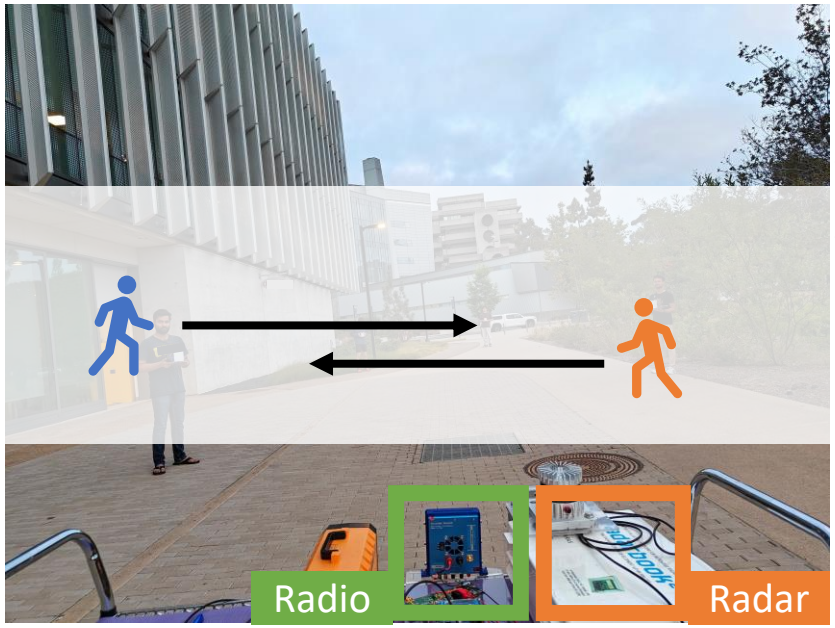


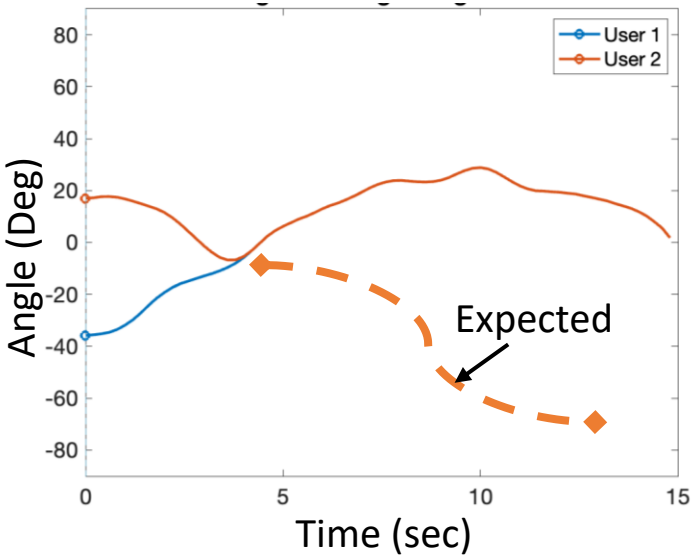
Outdoor deployments



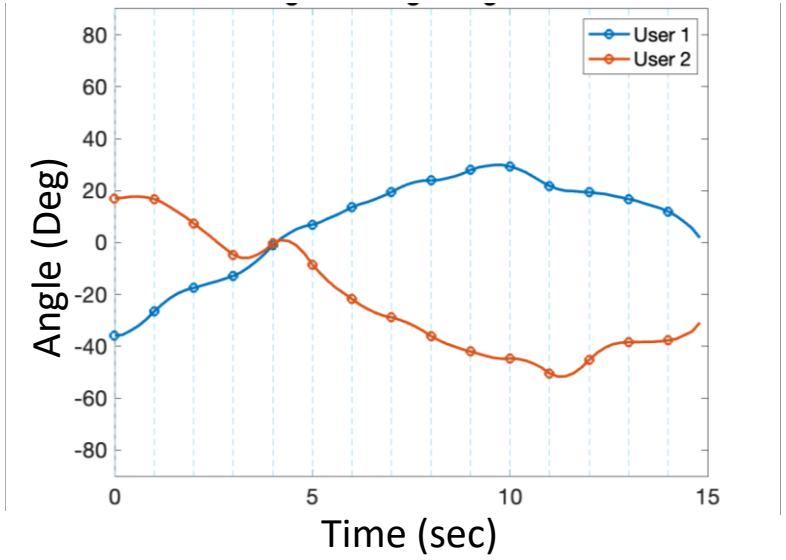
Indoor deployments

CommRad improves multi-user tracking





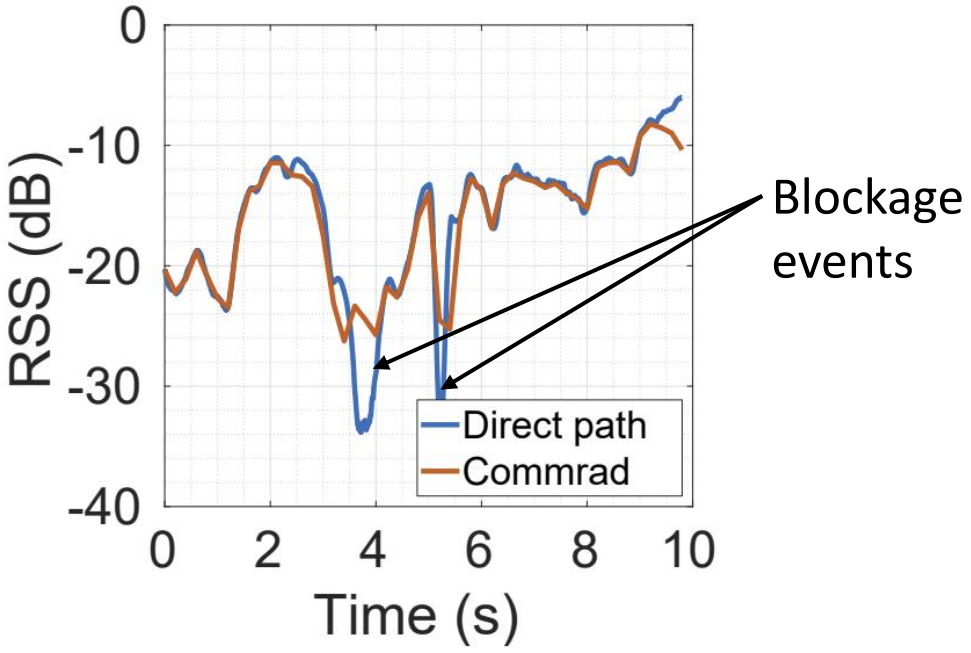
No collaborative learning

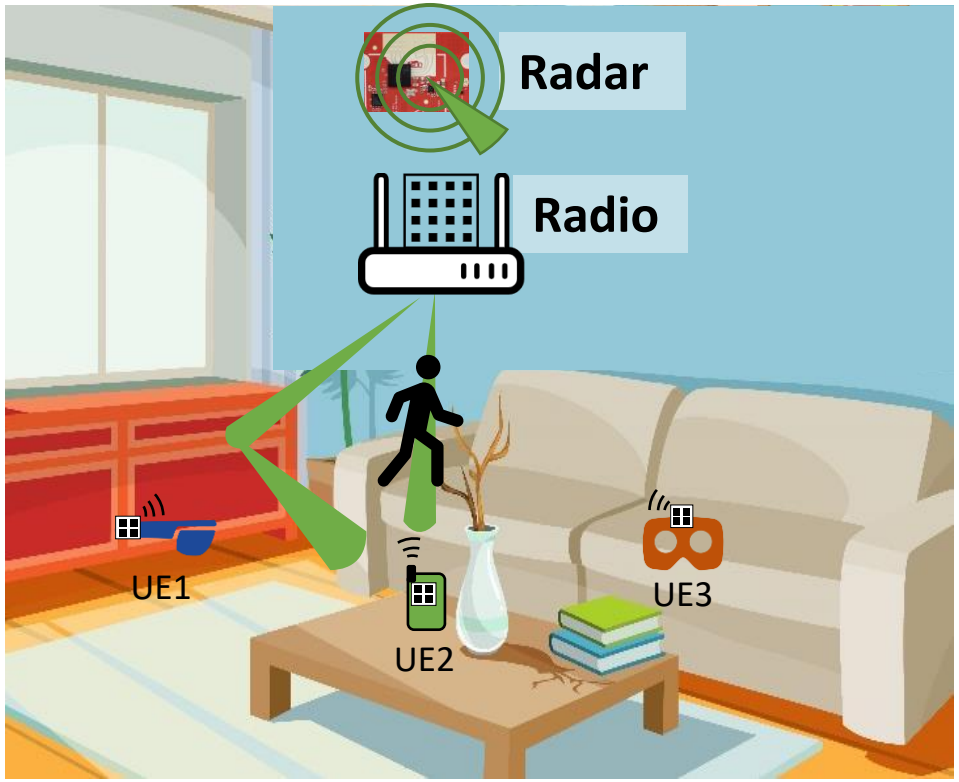


CommRad collaborative learning

Collaborative Learning Resolves Location Ambiguity

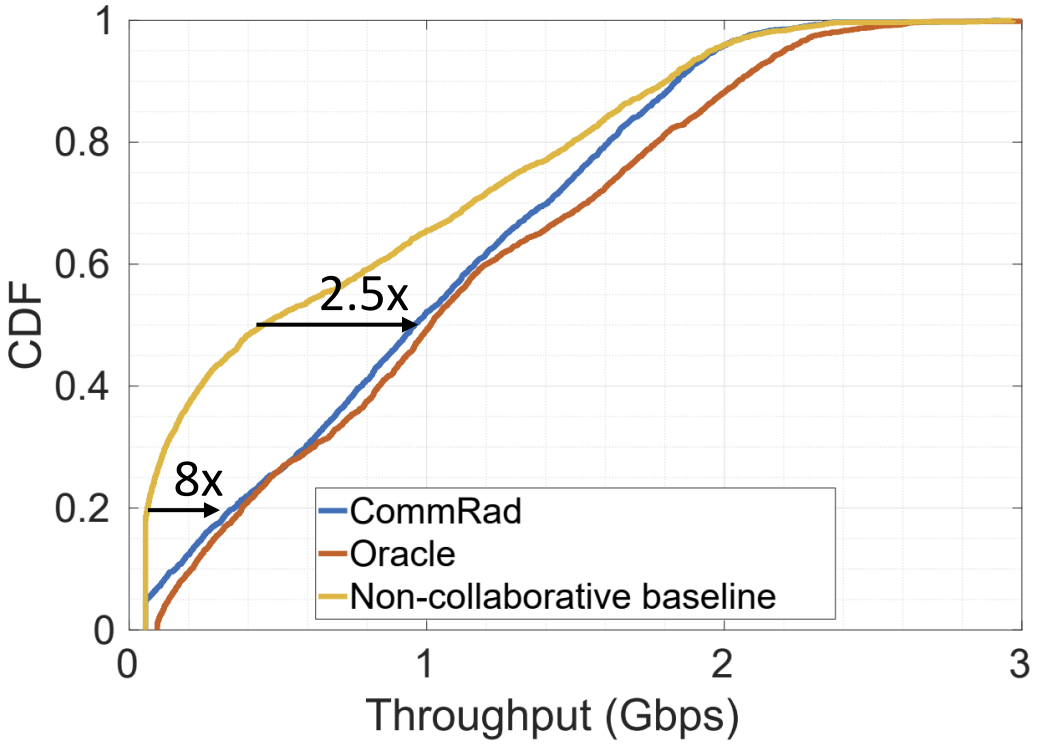
CommRad maintains a reliable link under blockages

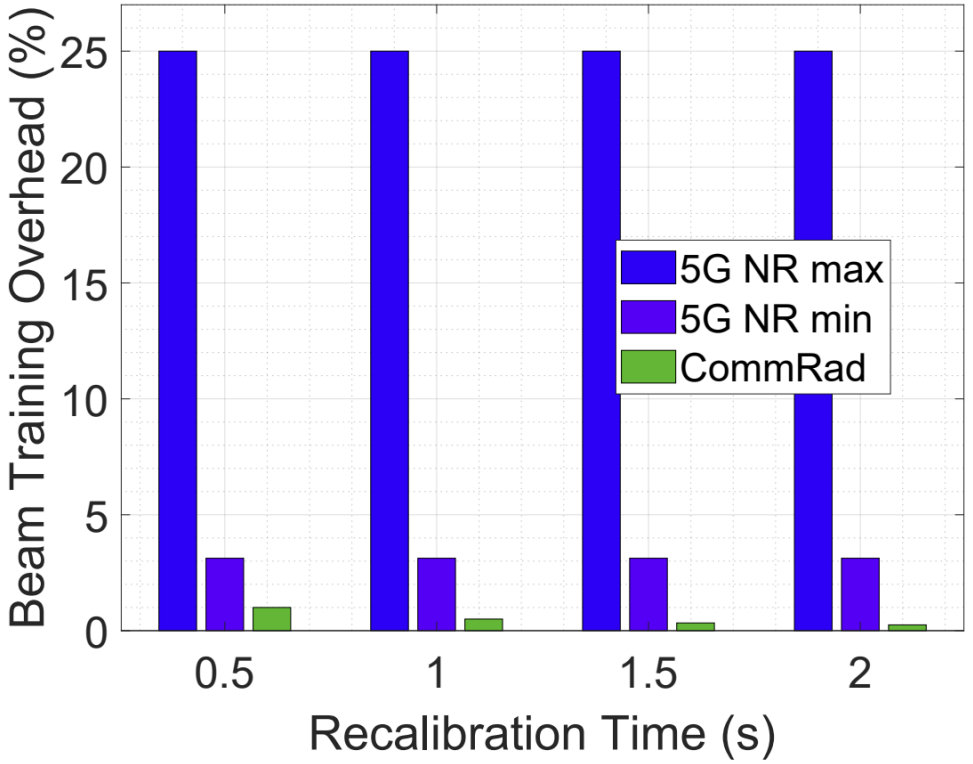




CommRad mitigates blockage via reflected path tracking

CommRad achieves high throughput with low overhead





2.5x higher median throughput

<1% Radio overhead

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Artifacts link: https://wcsng.ucsd.edu/commrad