# (SD2020-464) Enabling Reliable Mmwave Link Using Multi-Beam Pro-Active Tracking

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## BACKGROUND

Millimeter-wave communication with high throughput and high reliability is poised to be a gamechanger for V2X and VR applications. However, mmWave links are notorious for low reliability since they suffer from frequent outages due to blockage and user mobility. Traditional mmWave systems are hardly reliable for two reasons. First, they create a highly directional link that acts as a single point of failure and cannot be sustained for high user mobility. Second, they follow a `reactive' approach, which reacts after the link has already suffered an outage.

## TECHNOLOGY DESCRIPTION

In response to this limitation, researchers from UC San Diego have designed mmReliable, a reliable mmWave system that implements smart analog beamforming and user tracking to handle environmental vulnerabilities. It creates custom beam patterns with multiple lobes and optimizes their angle, phase, and amplitude to maximize the signal strength at the receiver. Such phase-coherent multi-beam patterns allow the signal to travel along multiple paths and add up constructively at the receiver to improve throughput. Of course, multi-beam links are resilient to occasional blockages of few beams in multi-beam compared to a single-beam system. With user mobility, mmReliable proactively tracks the motion in the background by leveraging continuous channel estimates without affecting the data rates. We implement mmReliable on a 28 GHz testbed with 400 MHz bandwidth and a 64 element phased-array supporting 5G NR waveforms.

## APPLICATIONS

V2X and VR applications

## ADVANTAGES

Rigorous indoor and outdoor experiments demonstrate that mmReliable achieves close to 100% reliability providing 1.5 times better throughput than traditional single-beam systems.

## STATE OF DEVELOPMENT

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### OTHER INFORMATION

**KEYWORDS**

wireless, 5G, millimeter wave, 5G NR, V2X, mobility, reliability, signal processing

**CATEGORIZED AS**

- Communications
  - Wireless

**RELATED CASES**

2020-464-0

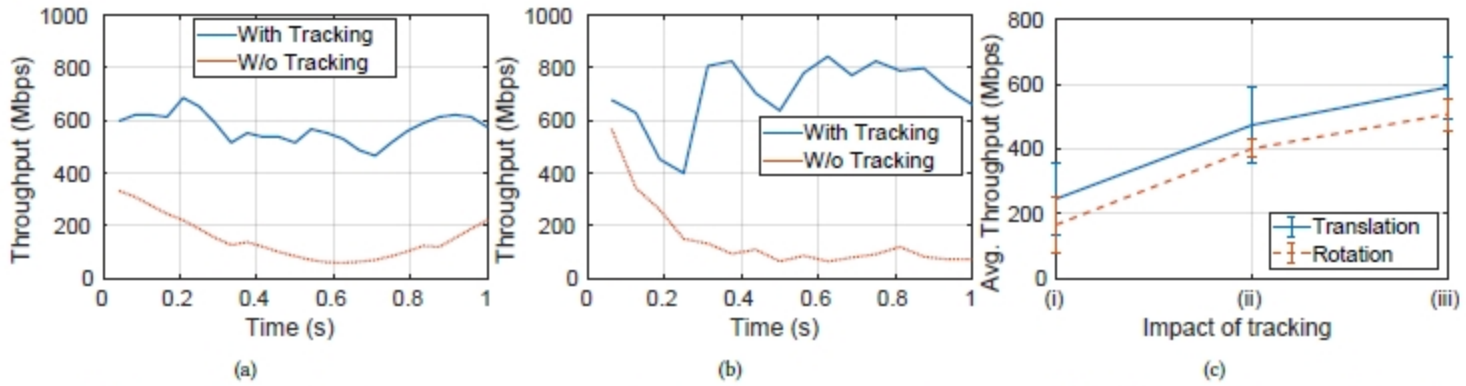


**Figure 18: Effectiveness of tracking: (a) Rotation time series, (b) Translation time series. (c) Average Throughput gain (i) No Tracking, (ii) With Tracking (iii) Tracking plus constructive combining.**

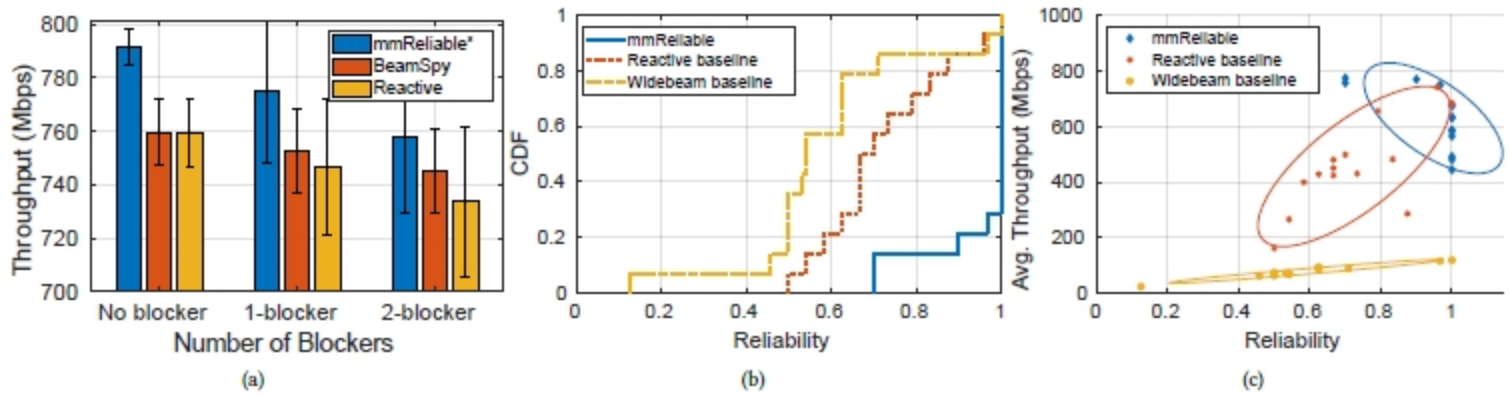


**Figure 19: End-to-end performance gain of mmReliable compared to baselines: (a) Static link with blockages (*evaluates mmReliable without proactive user tracking) (b) Reliability for mobile link (b) Overall Throughput-Reliability Trade-off.**

## INTELLECTUAL PROPERTY INFO

This technology is patent pending. Worldwide rights currently available. Companies interested in commercializing this invention should contact

UC San Diego (innovation@ucsd.edu)

## RELATED MATERIALS

- Ish Kumar Jain, Raghav Subbaraman, Dinesh Bharadia. Two beams are better than one: Enabling reliable and high throughput mmWave links . arXiv.org > eess > arXiv:2101.04249 - 01/12/2021

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