Experimental Evaluation of TCP Congestion Control over 60GHz WLAN

Xiao Zhu[1], Yuqi Jin[1], Feng Qian[2], Z. Morley Mao[1]
[1]University of Michigan [2]University of Minnesota

I. Motivation and Problem

- 60GHz millimeter-wave (mmWave) links have enabled a wide range of wireless applications



- TCP congestion control (CC) is crucial for network applications to achieve high throughput and/or low delay
- CC over highly fluctuating 60GHz mmWave is extremely challenging due to its vulnerability to mobility and blockage

How well do different CC algorithms perform over commercial 60GHz WLAN?

II. 60GHz Networking Testbed

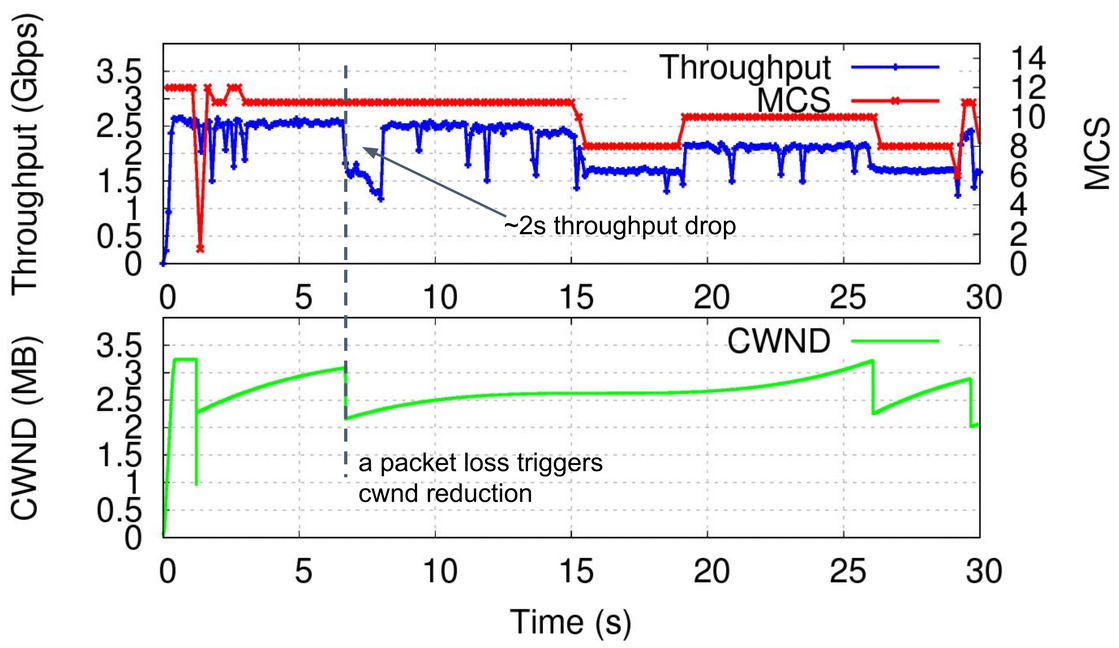
- Two Ethernet configurations
  - (1) 10GbE SFP+ cable, (2) 1Gbps cable
- *iperf3* generates uplink or/and downlink TCP traffic
- CC Switcher: Cubic, Vegas, BBR, etc
- Latency Emulator: leverage *tc netem*
- Different blockage and mobility setups

III. mmNetAnalyzer

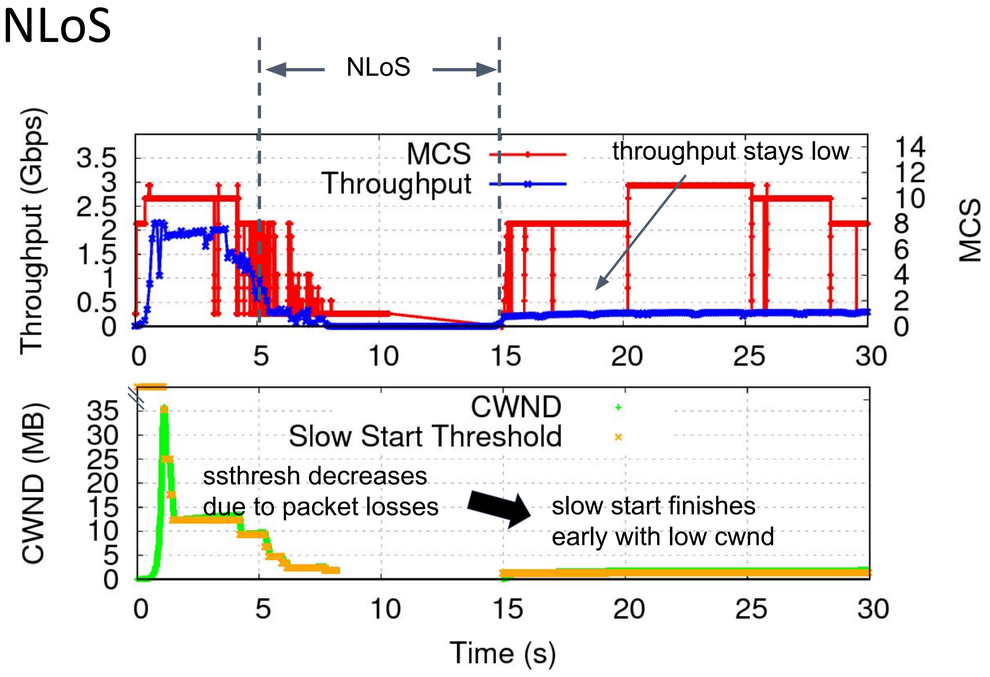
- A cross-layer tool to analyze CC performance over 60GHz mmWave networks
- Examines throughput, delay, and packet loss
- Collects protocol information from multiple layers
  - TCP state information
    - e.g., cwnd, rwnd
    - from *tcpprobe* kernel module
  - 802.11ad physical-layer information
    - e.g., MCS, SQI
    - from *iw* command-line tool

IV. Preliminary Results

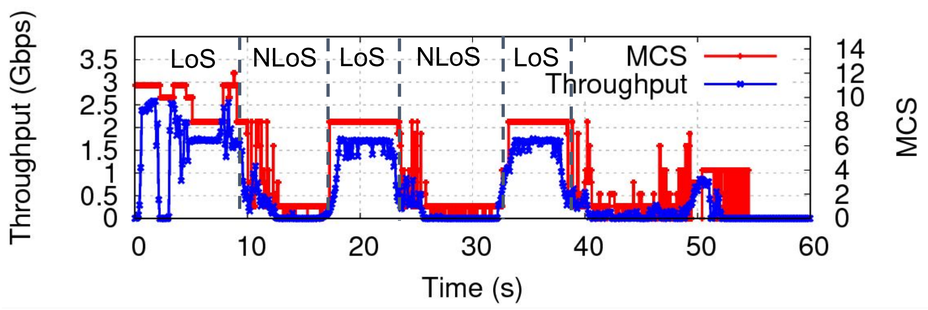
- Cubic under-utilizes the physical resource even under stationary case with low base RTT (1ms)



- Cubic: normal base RTT (50ms), mobility with 10s NLoS



- BBR reacts well to LoS-NLoS transitions under normal base RTT (50ms)



- BBR throughput can drop to very low during its probeRTT phase