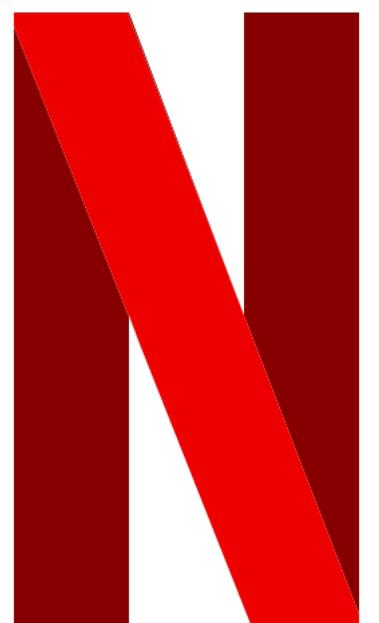


Manipulating Congestion Control To Improve Video Streaming Over Starlink

Liz Izhikevich

Reese Enghardt, Te-Yuan Huang, Renata Teixeira



Work From SIGMETRICS'25:

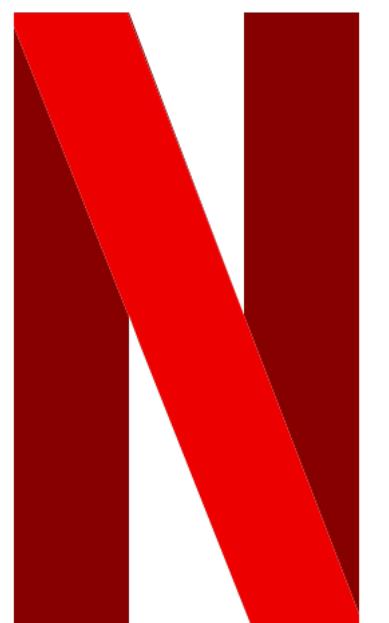
A Global Perspective on the Past, Present, and Future of Video Streaming over Starlink

LIZ IZHIKEVICH, University of California, Los Angeles, USA

REESE ENGHARDT, Netflix, USA

TE-YUAN HUANG, Netflix, USA

RENATA TEIXEIRA, Netflix, USA



How does LEO affect video streaming?



Research Questions

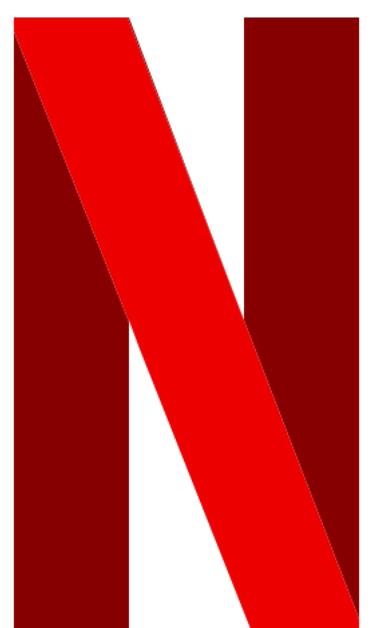
- What is LEO's role in video delivery?

Video streaming over LEO is rapidly rising in popularity, especially in Africa



Research Questions

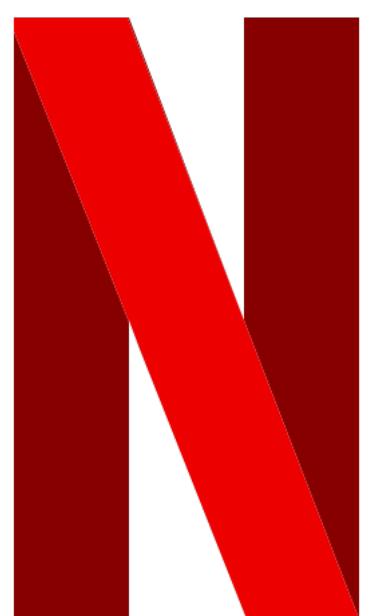
- What is **LEO's role** in video delivery?
- What is the **quality of experience** when streaming video over LEO?



Research Questions

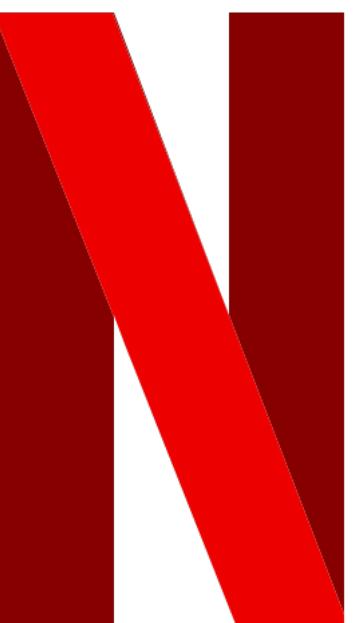
- What is **LEO's role** in video delivery?
- What is the **quality of experience** when streaming video over LEO?

Often equivalent or better than terrestrial connections...but increased bitrate switches and rebuffers



Research Questions

- What is **LEO's role** in video delivery?
- What is the **quality of experience** when streaming video over LEO?
- How can we improve **bitrate switches** and **network rebuffers** for video streaming over LEO?



Research Questions

- What is **LEO's role** in video delivery?
- What is the **quality of experience** when streaming video over LEO?
- How can we improve **bitrate switches** and **network rebuffers** for video streaming over LEO?

Existing **congestion control** &
adaptive bitrate design
principles can partially help, but
are not sufficient



What is the Quality of Experience when streaming over Starlink?





r/Starlink · 2 yr. ago
r00x

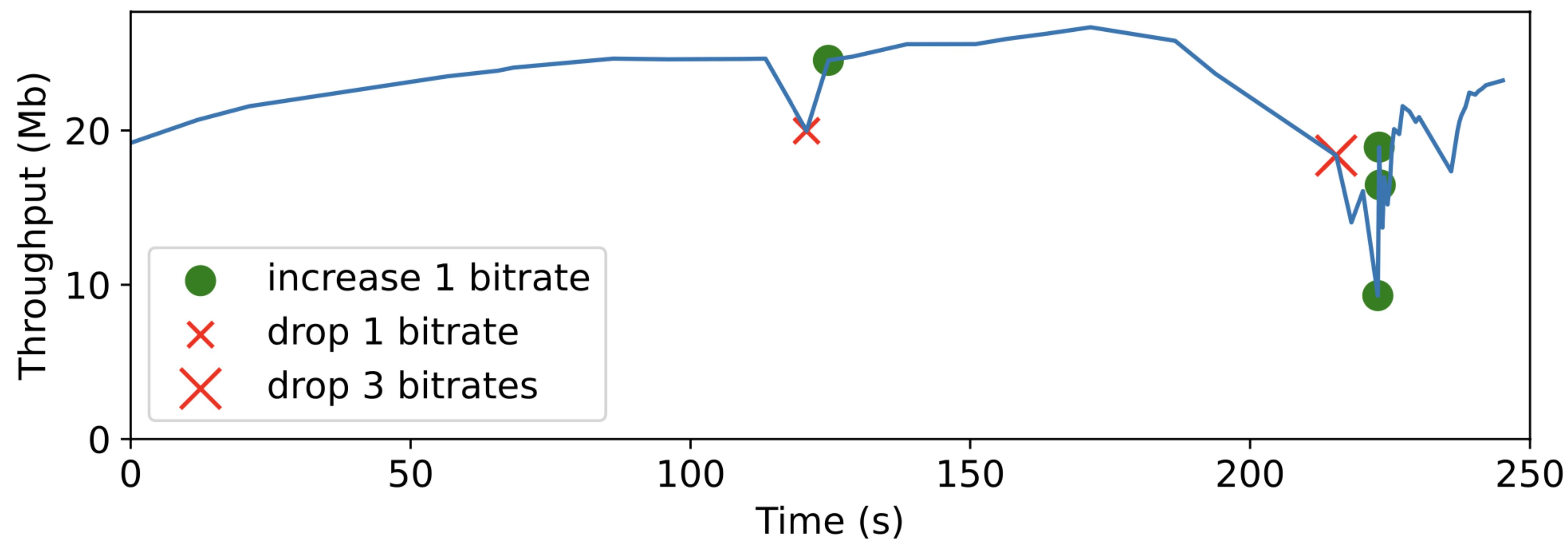
...

Anyone else struggle with poor quality on streaming services (Netflix/Amazon Prime mostly)?

Troubleshooting

Title. I've found Netflix and Amazon Prime are the worst offenders; regularly dropping stream quality from 4K UHD down to lower resolutions, all the way to unwatchable potato quality sometimes (Prime especially), despite the

Starlink Throughput Changes Cause Bitrate Switches



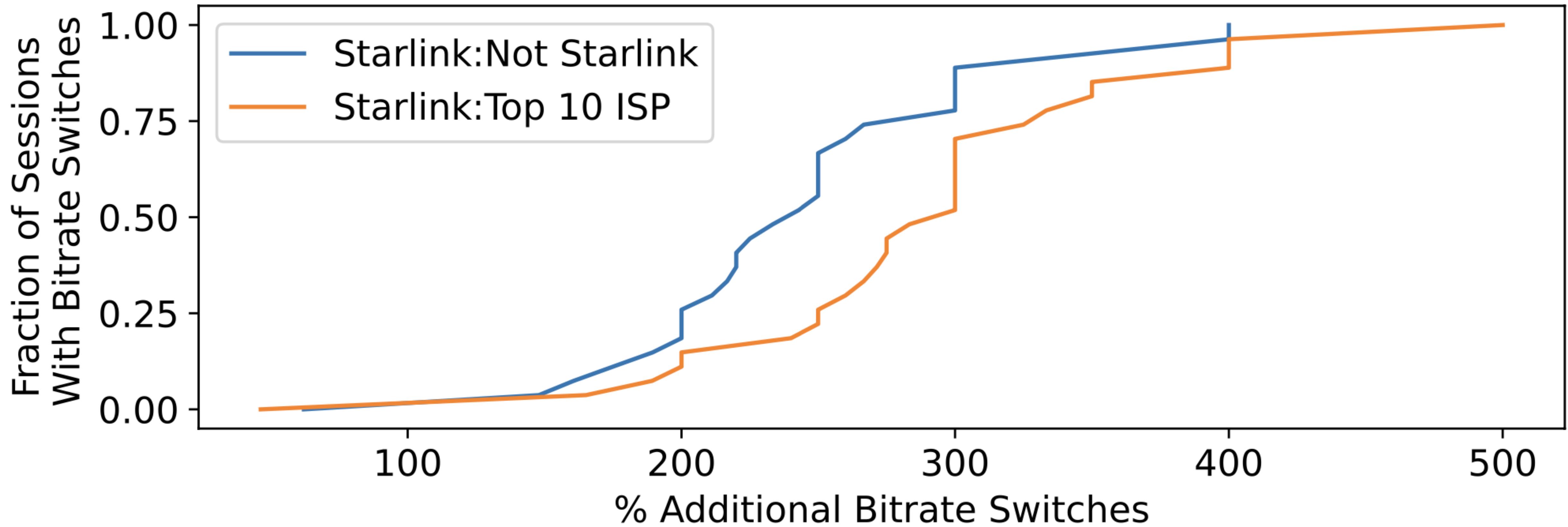
Analyzing Bitrate Switches Across All Starlink Streamers

We filter for video streaming sessions that are

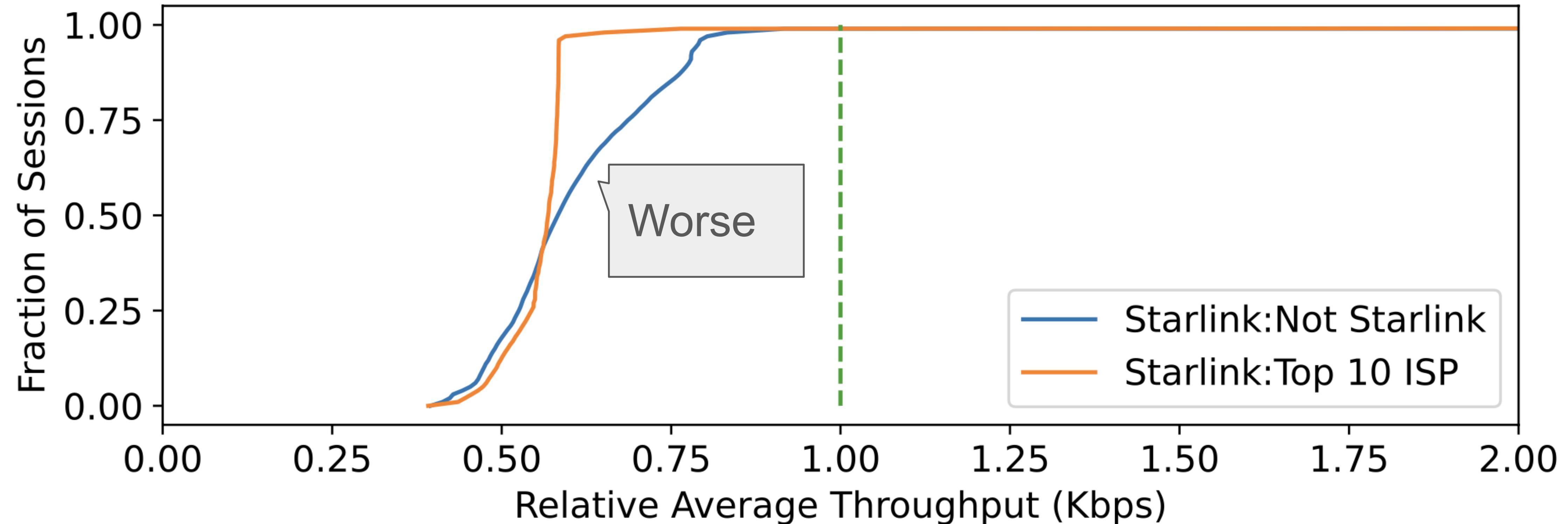
- (1) theoretically capable to stream at least at a 720p high definition
- (2) at least 5 minutes long
- (3) destined towards TVs
- (4) streamed during the first week of April 2024
- (5) associated with Starlink

Millions of
streaming sessions
for Starlink alone!

Video streaming over Starlink suffers from increased bitrate switches



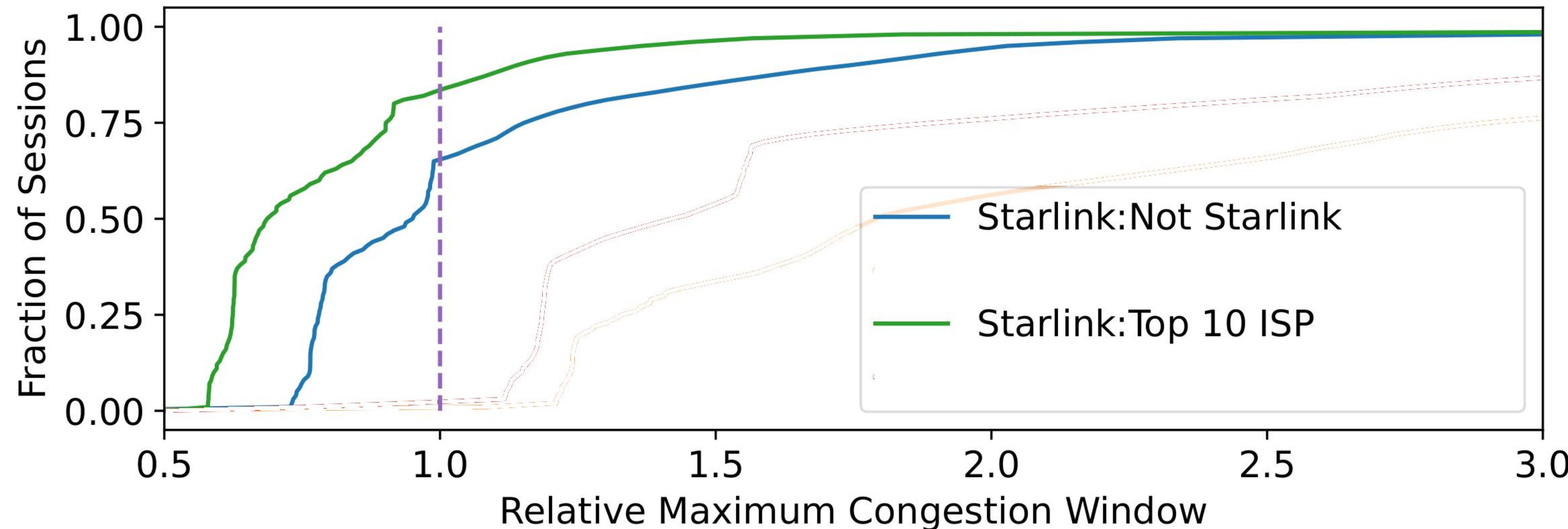
Starlink's reduced throughput likely contributes to bitrate switches



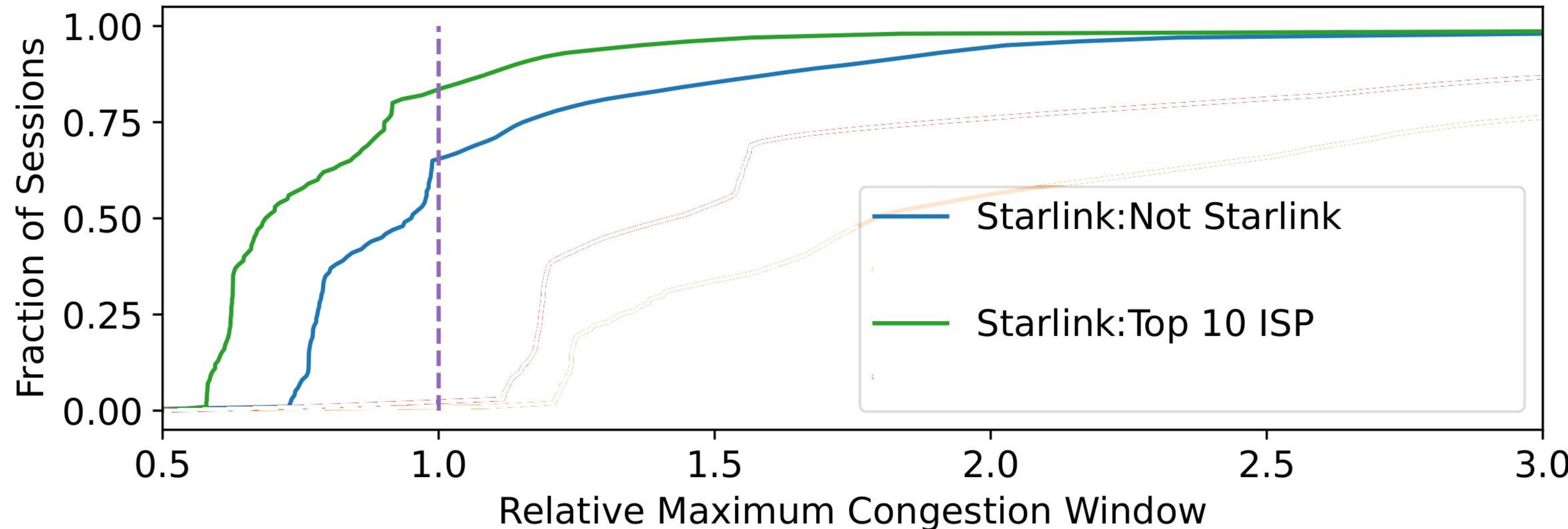
Improving Bitrate Switches Using Congestion Control



Starlink Users Experience Smaller Congestion Windows with TCP NewReno

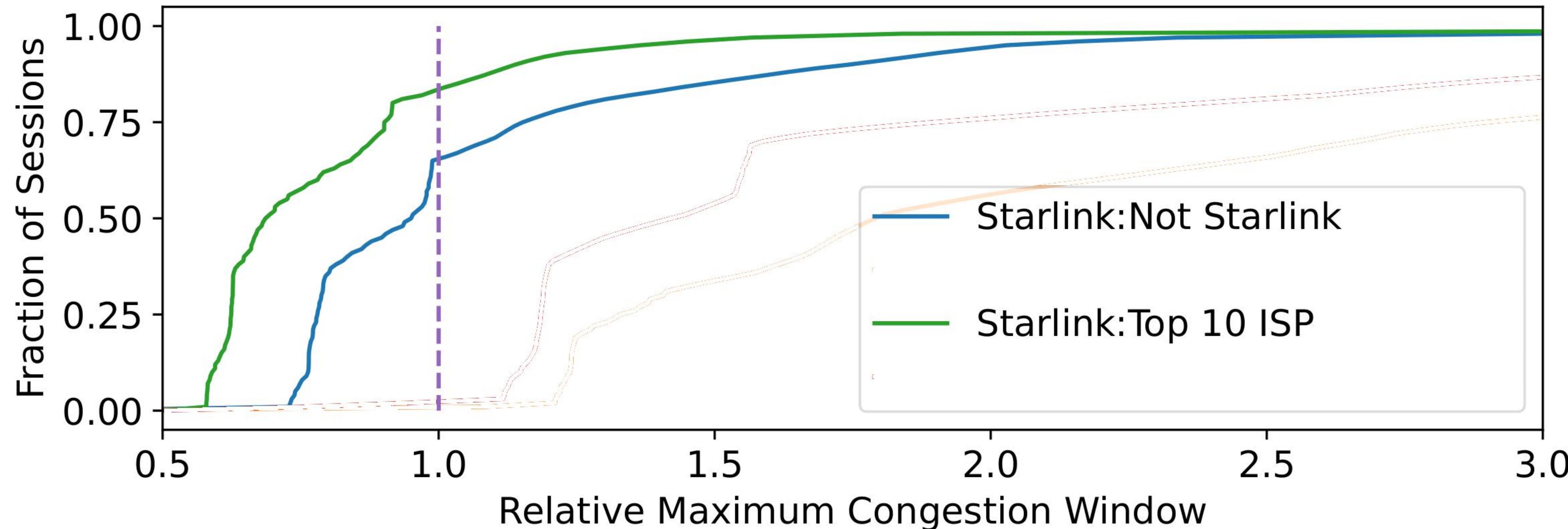


Starlink Users Experience Smaller Congestion Windows with TCP NewReno



Starlink High RTTs/Packet Drop/Packet Re-Ordering -> **Smaller Congestion Windows** -> Lower Throughput

Starlink Users Experience Smaller Congestion Windows with TCP NewReno



Starlink High RTTs/Packet Drop/Packet Re-Ordering -> **Smaller Congestion Windows** -> Lower Throughput

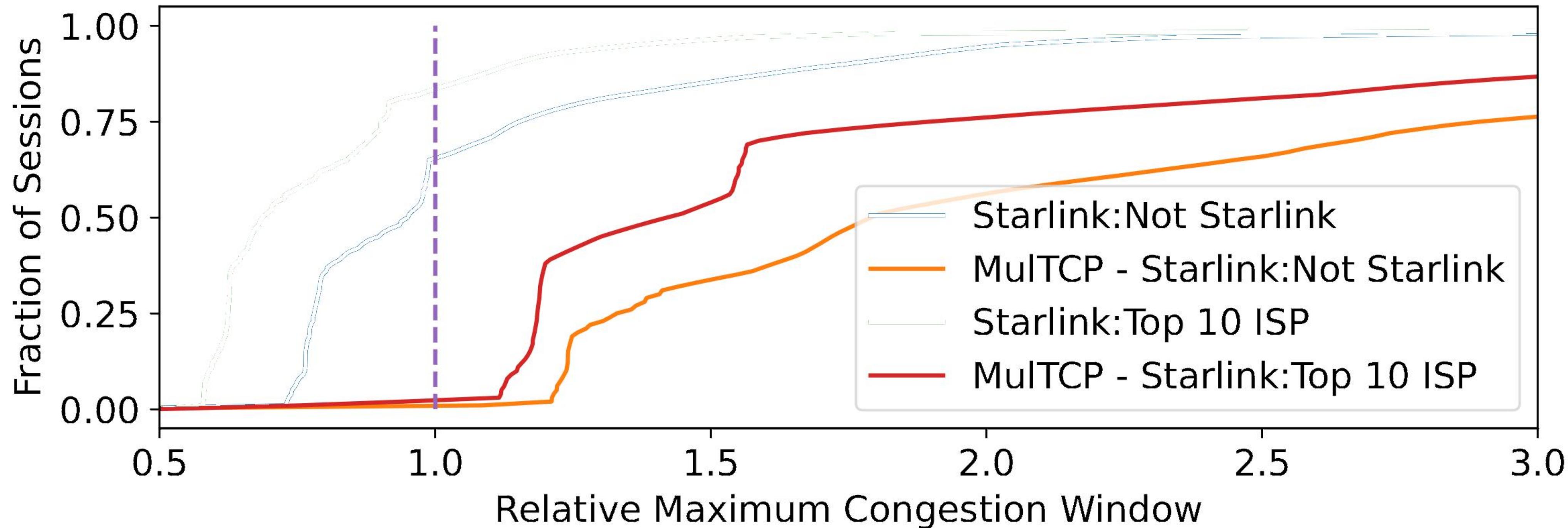
Hypothesis: increase congestion windows -> higher throughput?

Make congestion control less aggressive with “MuTCP”

MuTCP: Emulating three concurrent connections

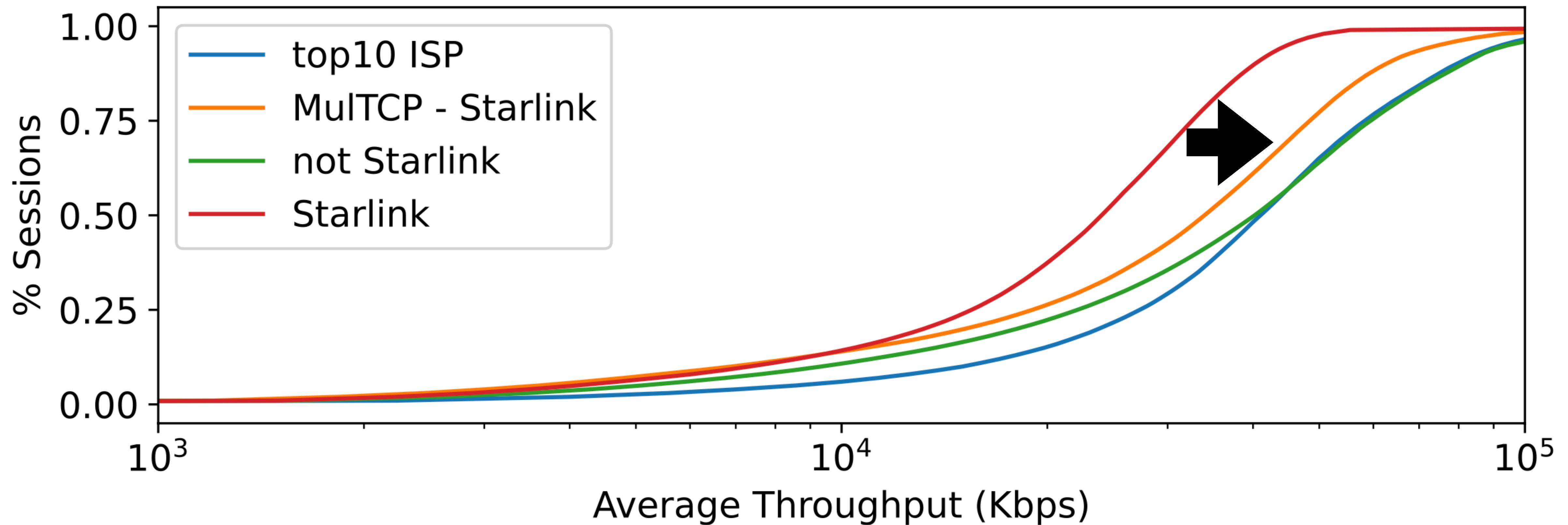
- congestion window grows by three bytes for every ACKed byte
- upon packet loss, window is reduced by one byte

Less aggressive congestion control increases congestion window for Starlink Users



Less aggressive congestion control increases Starlink average throughput

- We run an A/B Test assigning users to TCPReno or MuTCP



Less aggressive congestion control has benefits and drawbacks

- + Bitrate Switches decrease by 5%
- Retransmits increase by 300%



In-Network queues are filled to a greater capacity

Summary

- TCP congestion control limits Starlink throughput, leading to increased bitrate switches when streaming video
- Manipulating congestion control fixes old problems, but introduces new problems
- Future work: explore rate-based congestion control (BBR) and not loss-based congestion control (TCP Reno)

Questions?

lizhikev@ucla.edu