

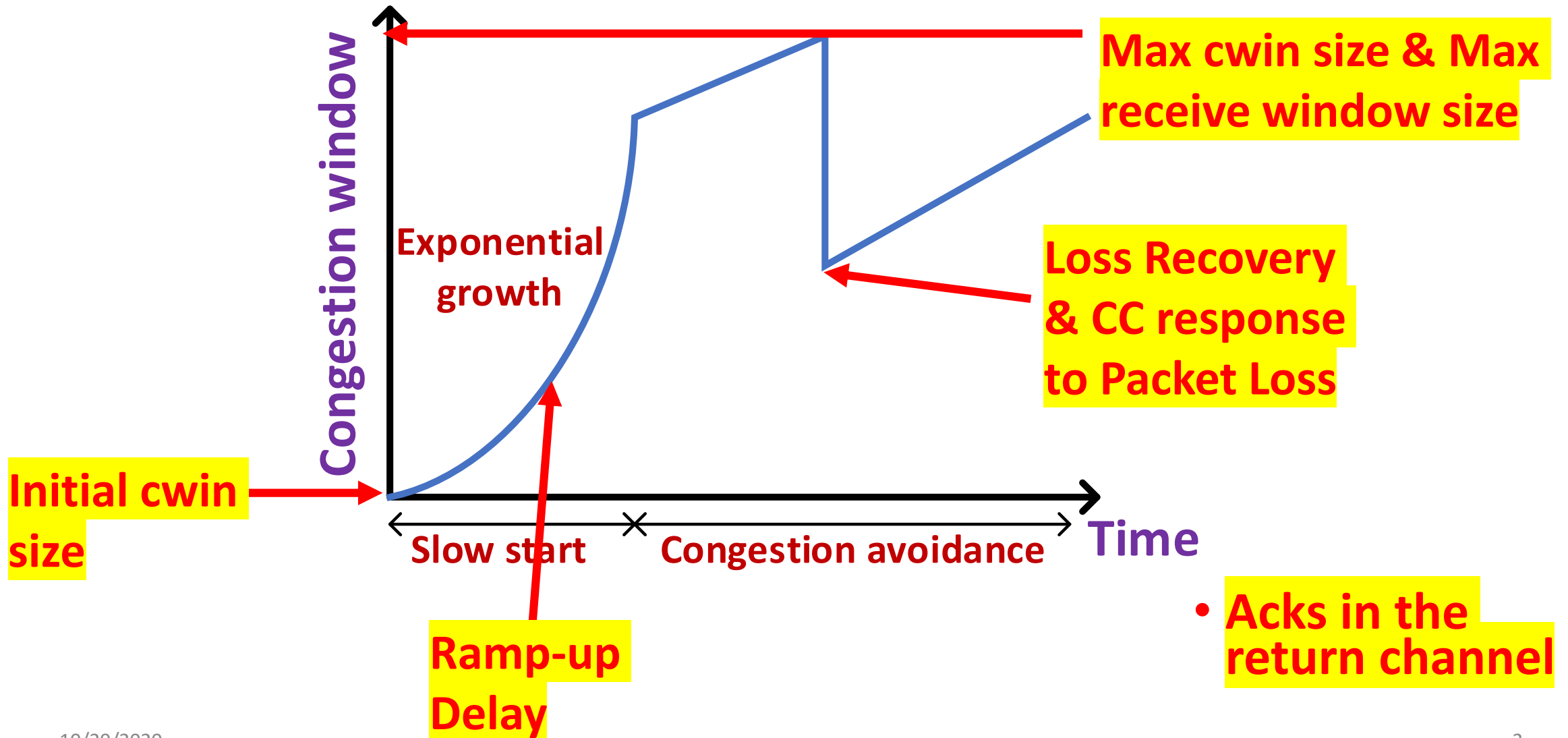
# Impact of QUIC on User's QoE in Satellite Broadband

Chi-Jiun Su, John Border, Bhavit Shah, Rob Torres  
Hughes Network Systems

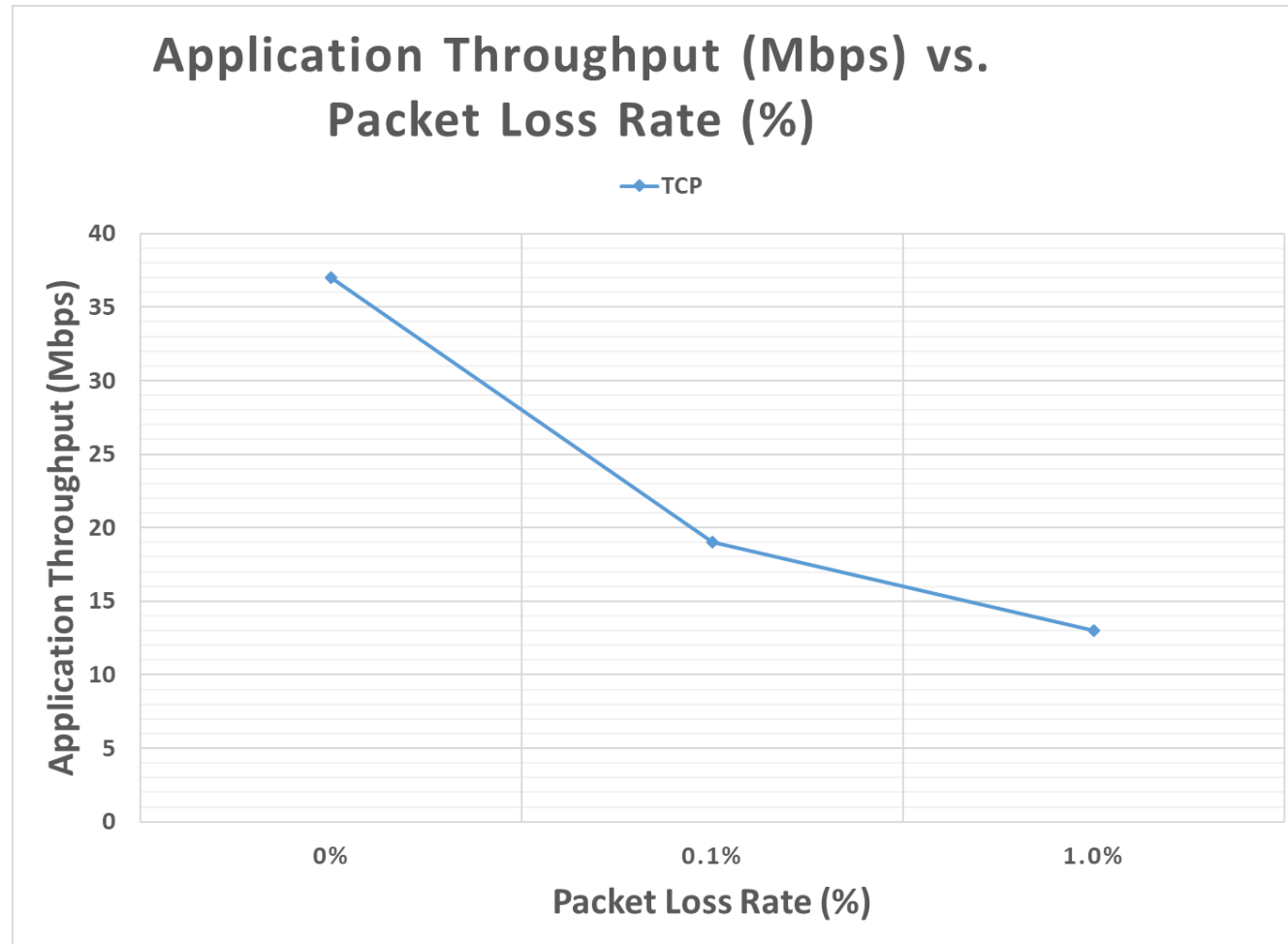
# Importance of Satellite Broadband

- Serves a crucial role in bridging the digital divide by connecting underserved and unserved areas where terrestrial infrastructure is infeasible.

# TCP Not Optimized for High BDP Satellite Link



# Unmodified TCP Does Not Perform Well over an Uncongested High Capacity Satellite Link

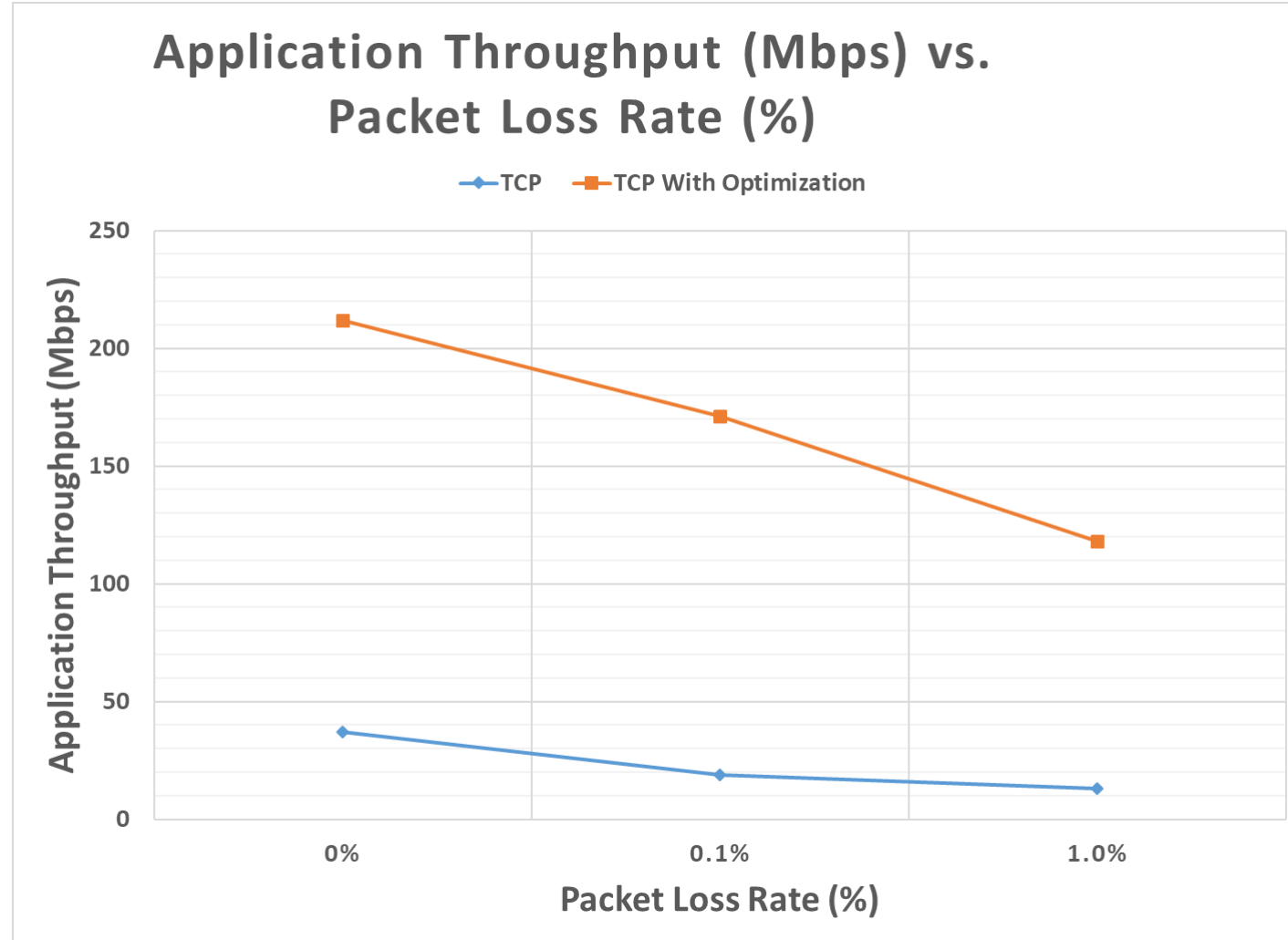


**Max throughput is limited to under 40 Mbps and getting worse with packet loss**

# Impact on User's QoE

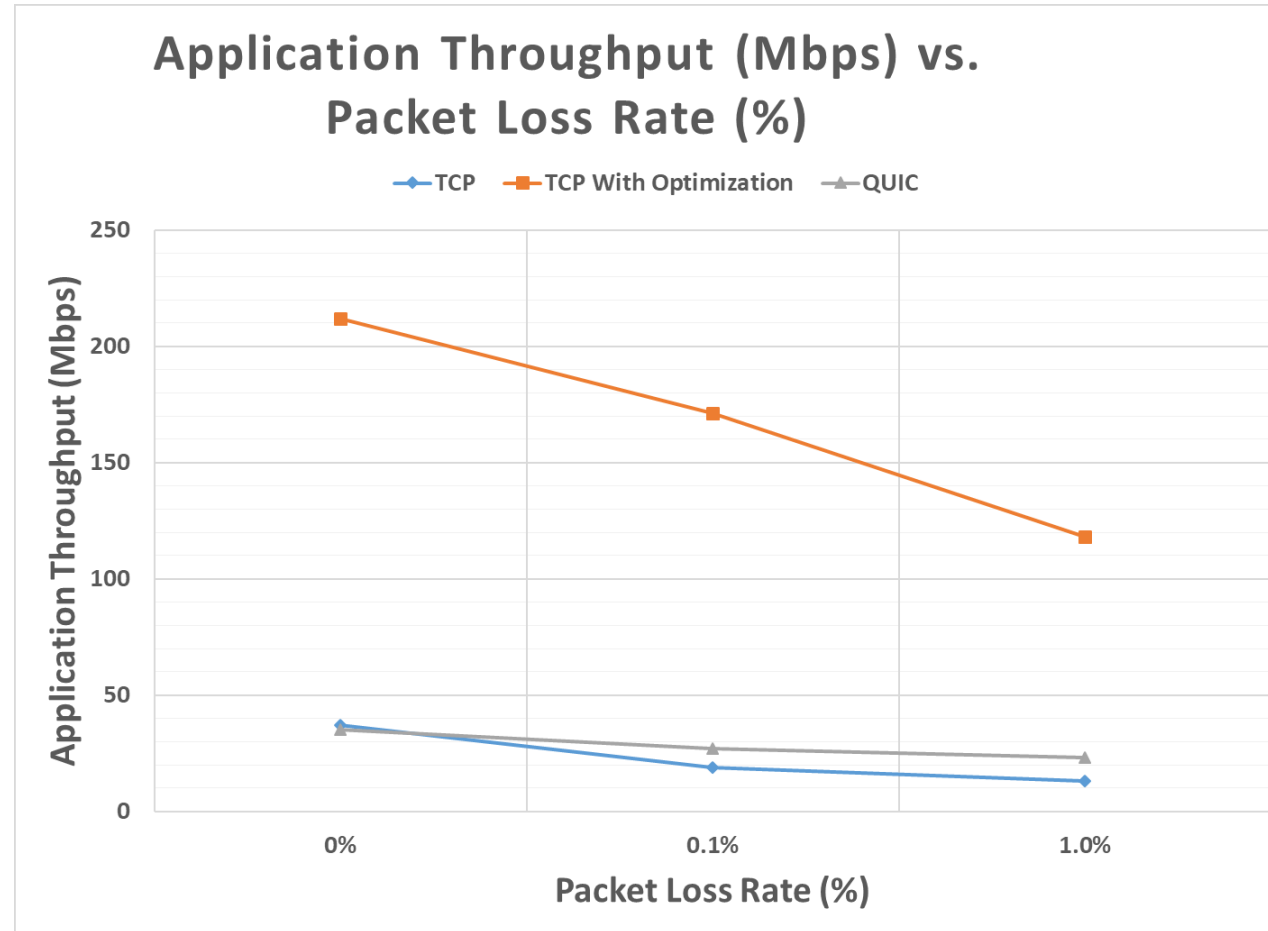
- Interactive web browsing
  - Insufficient Initial cwnd size, long ramp-up delay, slow end-to-end loss recovery, too many acks in return channel
- Video streaming
  - slow end-to-end loss recovery, insufficient max cwnd and rcv window size , too many acks in return channel, long ramp-up delay
- Bulk traffic
  - insufficient max cwnd and rcv window size, slow end-to-end loss recovery , too many acks in return channel

# Split TCP Optimized for Satellite Link Provides Significant Improvement



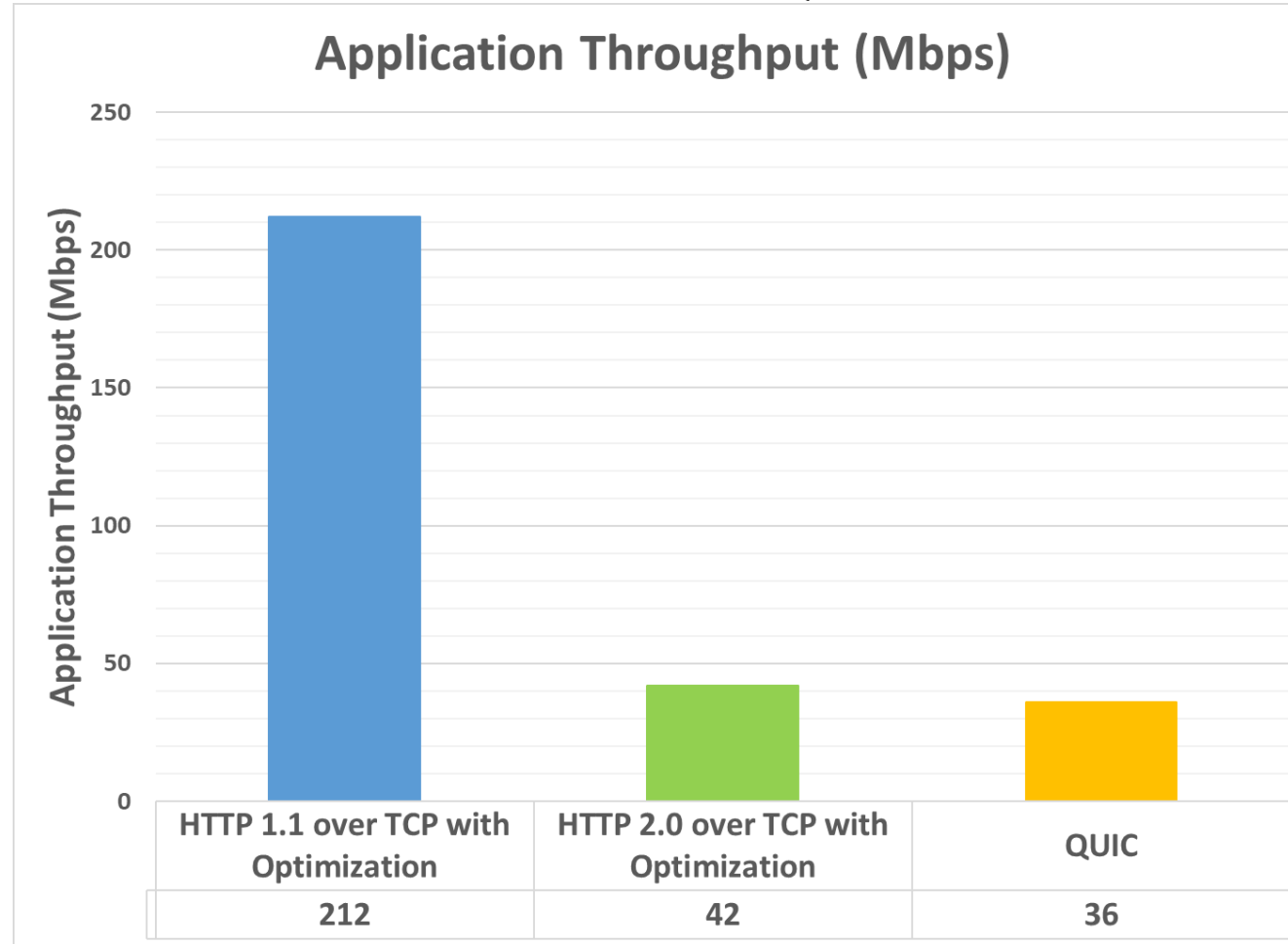
**~5x-8x Improvement over unmodified TCP**

# QUIC Makes Optimization for Satellite Link No Longer Feasible



**End-to-end encrypted QUIC not amenable for optimization as in TCP and performs only as good as or slightly better than unmodified TCP**

# Application Layer Flow Control Incurs Additional Bottleneck in QUIC and HTTP/2



**Application layer flow control limit not sufficiently large enough for satellite link**



# Help Bring Back Better User's QoE to Sat Broadband

- Recent encrypted protocols make existing acceleration techniques no longer work in satellite broadband and good user's QoE can no longer be provided
- Not forget another billion users who may receive internet service via satellite broadband and take into account of satellite link characteristics in design, implementation and operation of internet protocols
- Adopt satellite-friendly features and configurations which do not compromise security and privacy
- Innovate better approaches to make encrypted protocols perform over a satellite link as well as over a terrestrial link.
- For details on results and experiment setup, please refer to the following paper:
  - "J. Border, B. Shah, C. Su and R. Torres, "Evaluating QUIC's Performance Against Performance Enhancing Proxy over Satellite Link," 2020 IFIP Networking Conference (Networking), Paris, France, 2020, pp. 755-760."