Enabling immersive experiences in challenging network conditions

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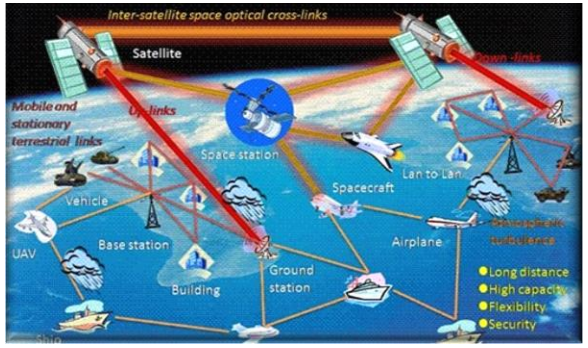
BitRipple

The problem

Markets

Remote Collaboration

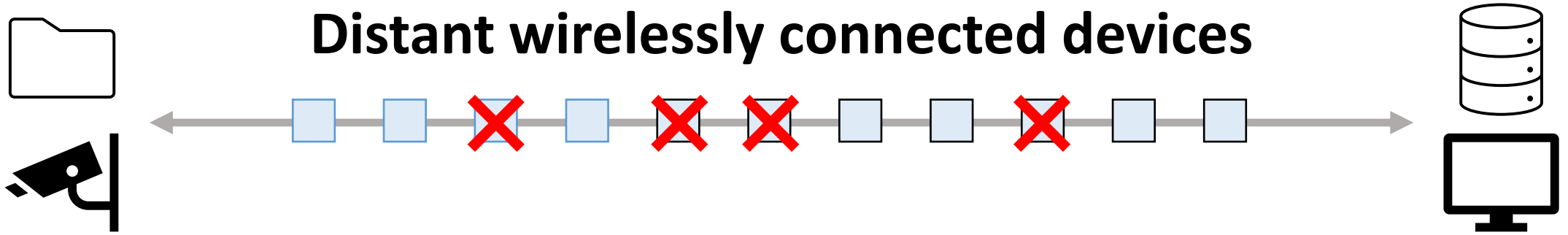


Defense Communications

Immersive experiences

Deliver lots of content with tight latencies

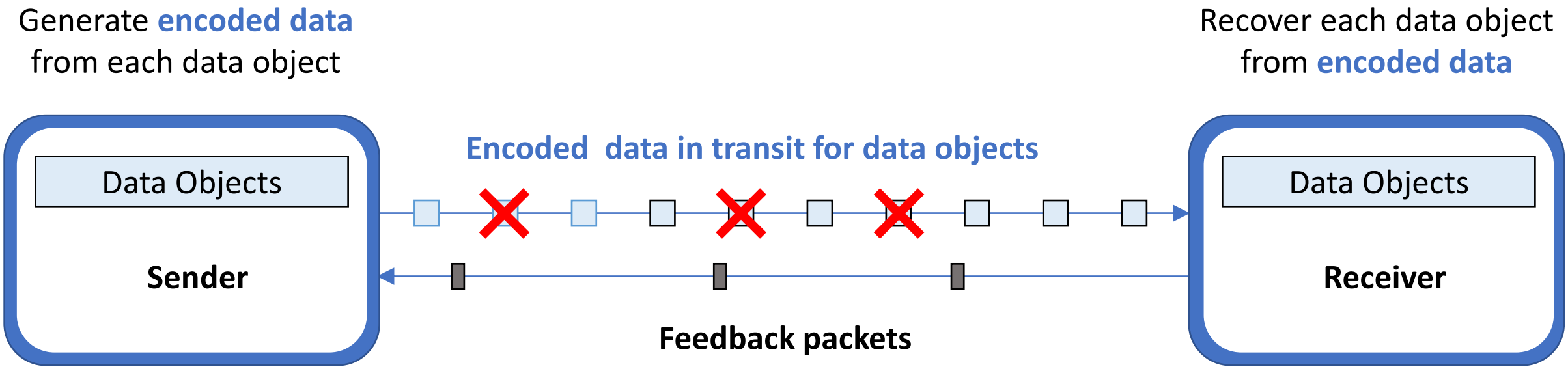
Remote collaboration solutions



Problems

- Difficult to deliver large amounts of data
- Low quality streaming & sluggish responsiveness

A better way to move data



Encoded data

- **Based on RaptorQ standardized in IETF RFC 6330**
- Encoded data is data generated from a data object that is **expandable** and **interchangeable**
- Each data object recovered from **any portion of** encoded data **equal in size** to the data object

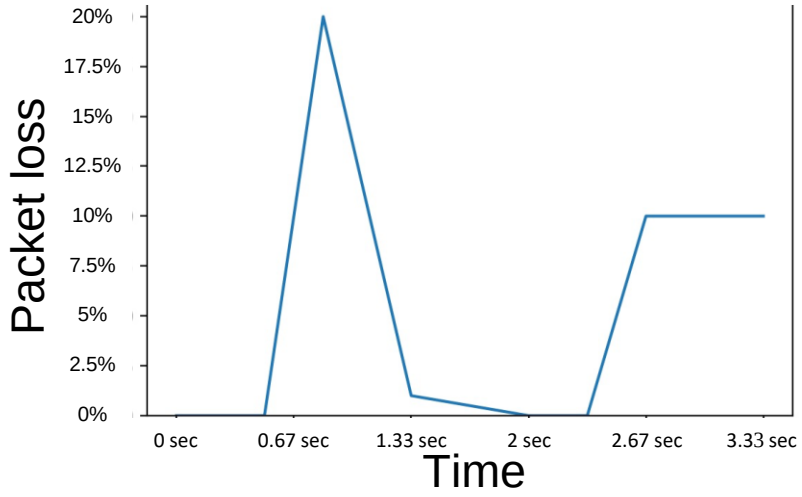
High level protocol idea

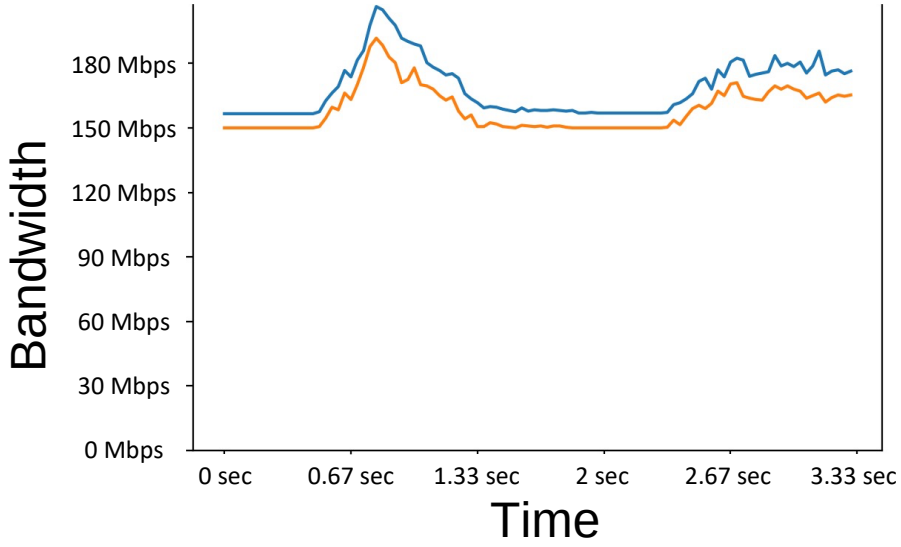
- Send an amount of encoded data for an object so that amount received is slightly more than the object size
  - The amount is adjusted based on feedback as packet loss conditions vary
- Never retransmit
  - Send additional encoded data if feedback warrants this
- Objective
  - Minimize delivery latency of objects
  - Minimize bandwidth used to deliver objects

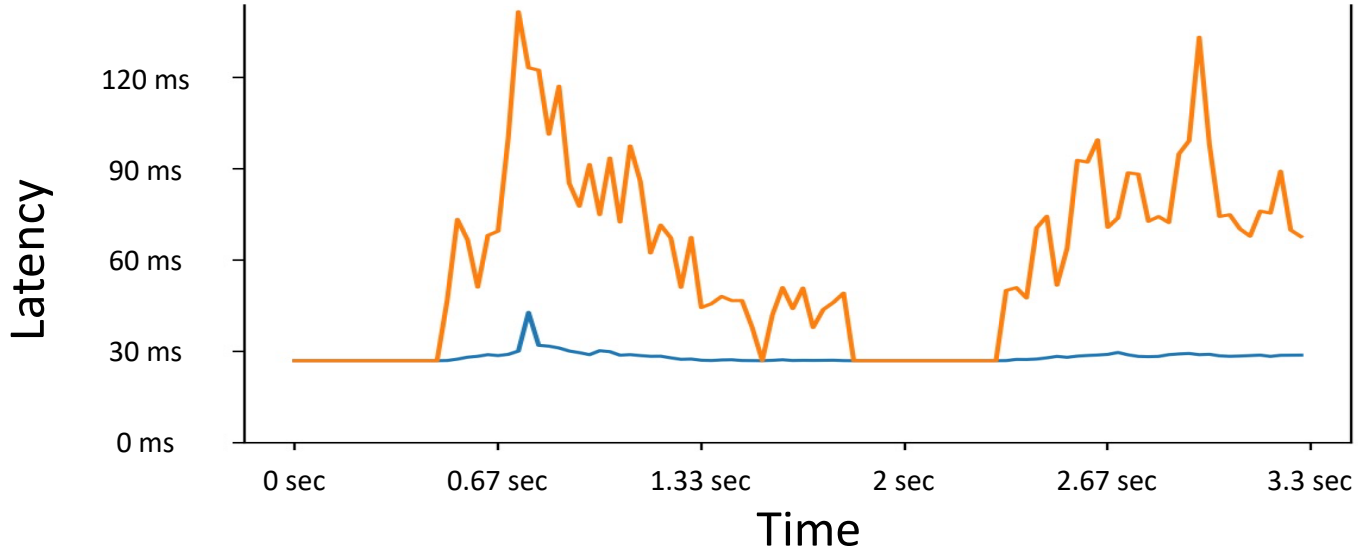
Some details

- Data packet headers contain global sequence numbers
  - Spans the entire stream of packets for all objects (like QUIC)
- Data packet headers contain object information
  - Obj_Id, Obj_Sz, ESI, etc.
- Feedback packets from receiver include
  - Highest global sequence number received
  - Number of packets containing encoded data received
  - Amount of encoded data received for each active object, etc.
- Sender uses feedback
  - Estimates packet loss rate
  - Adjusts how much more encoded data to send for each object, etc.

Simple simulation of protocol results



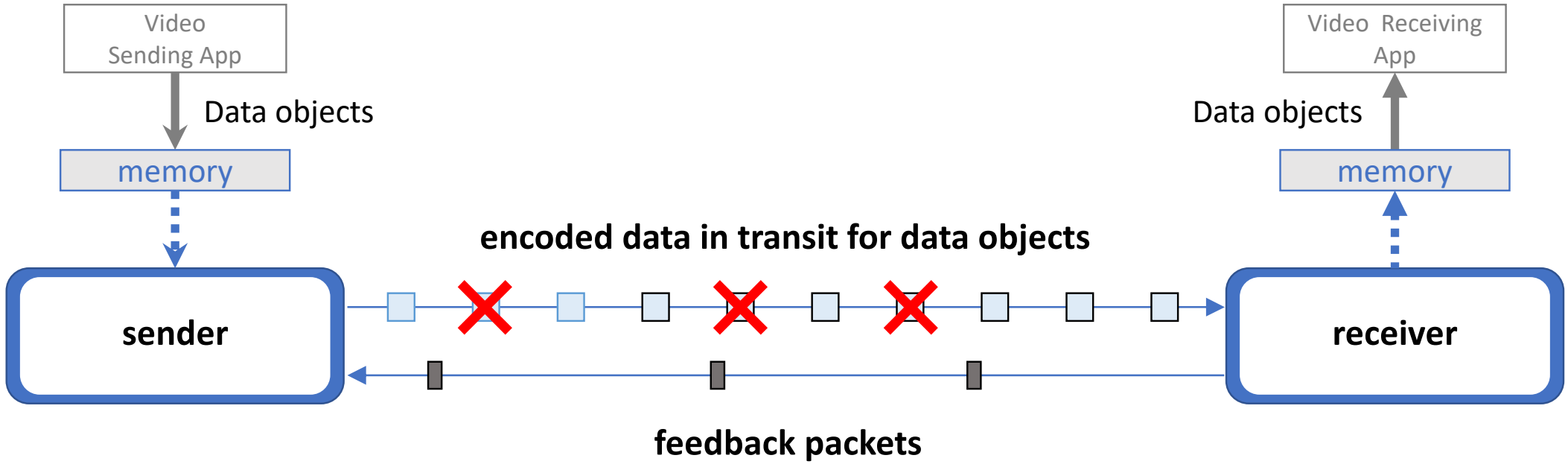




Using protocols

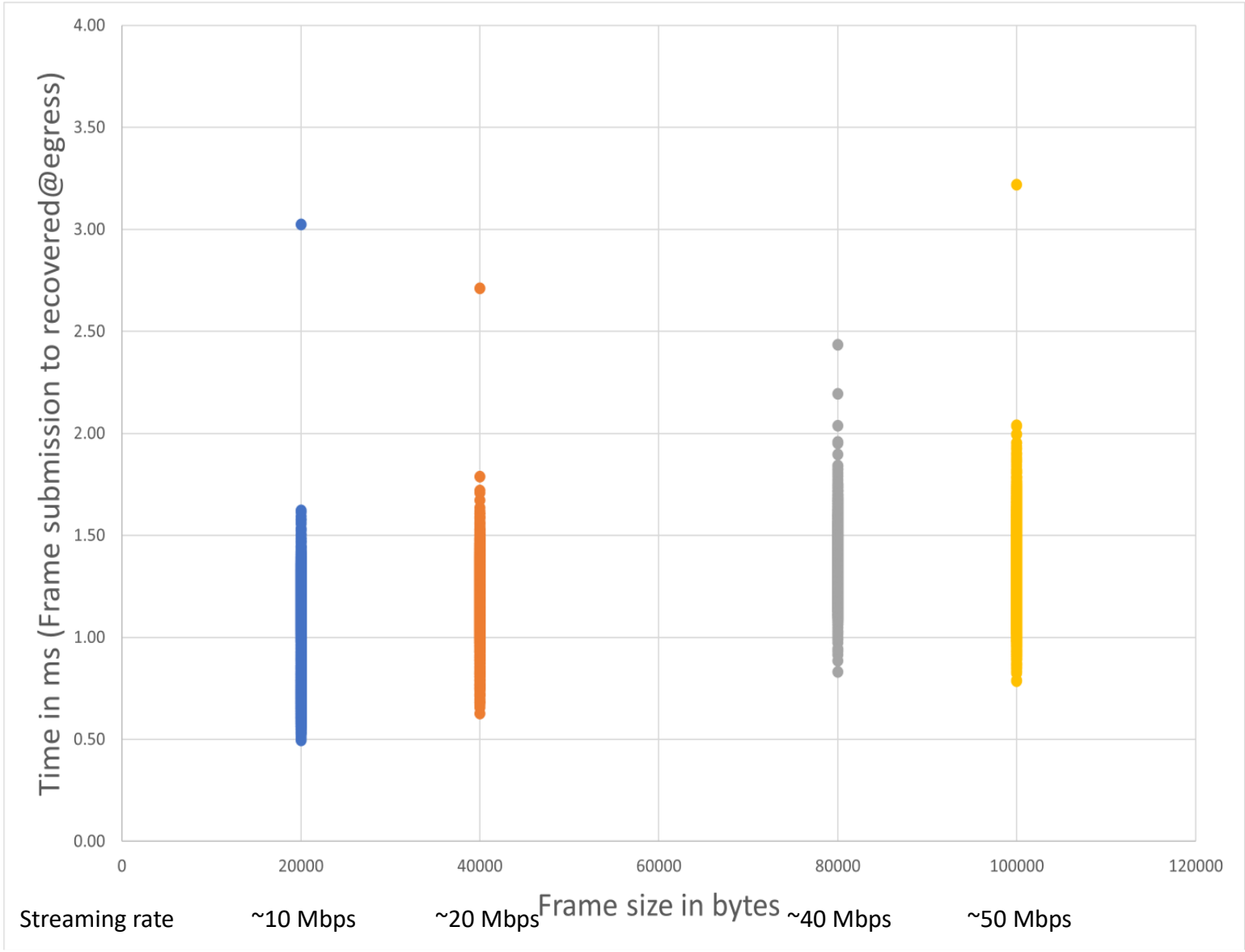
Optimal retransmission-based solution

Software design



Software latency

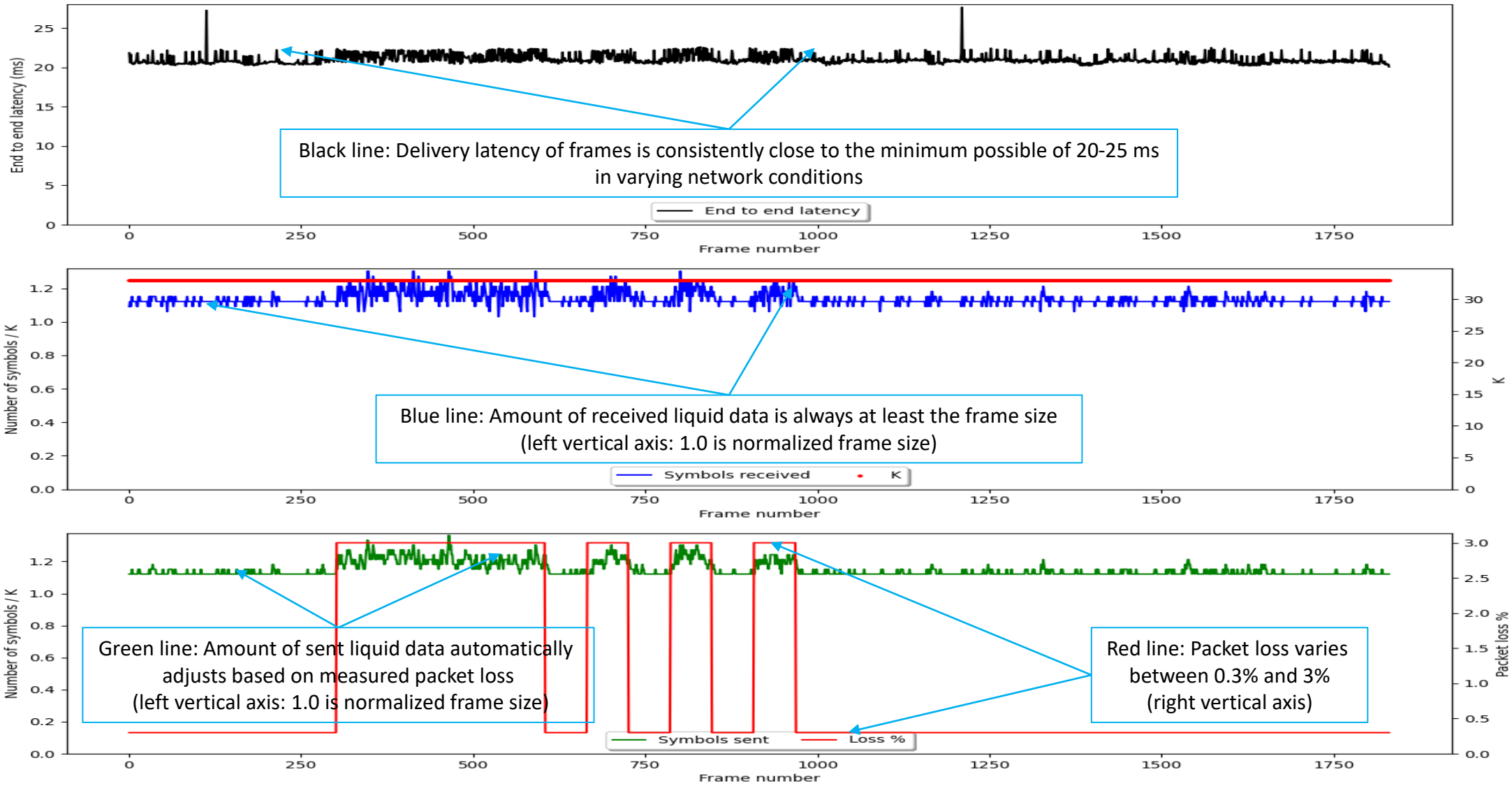
60 fps streams



10,000 frames sent at each rate

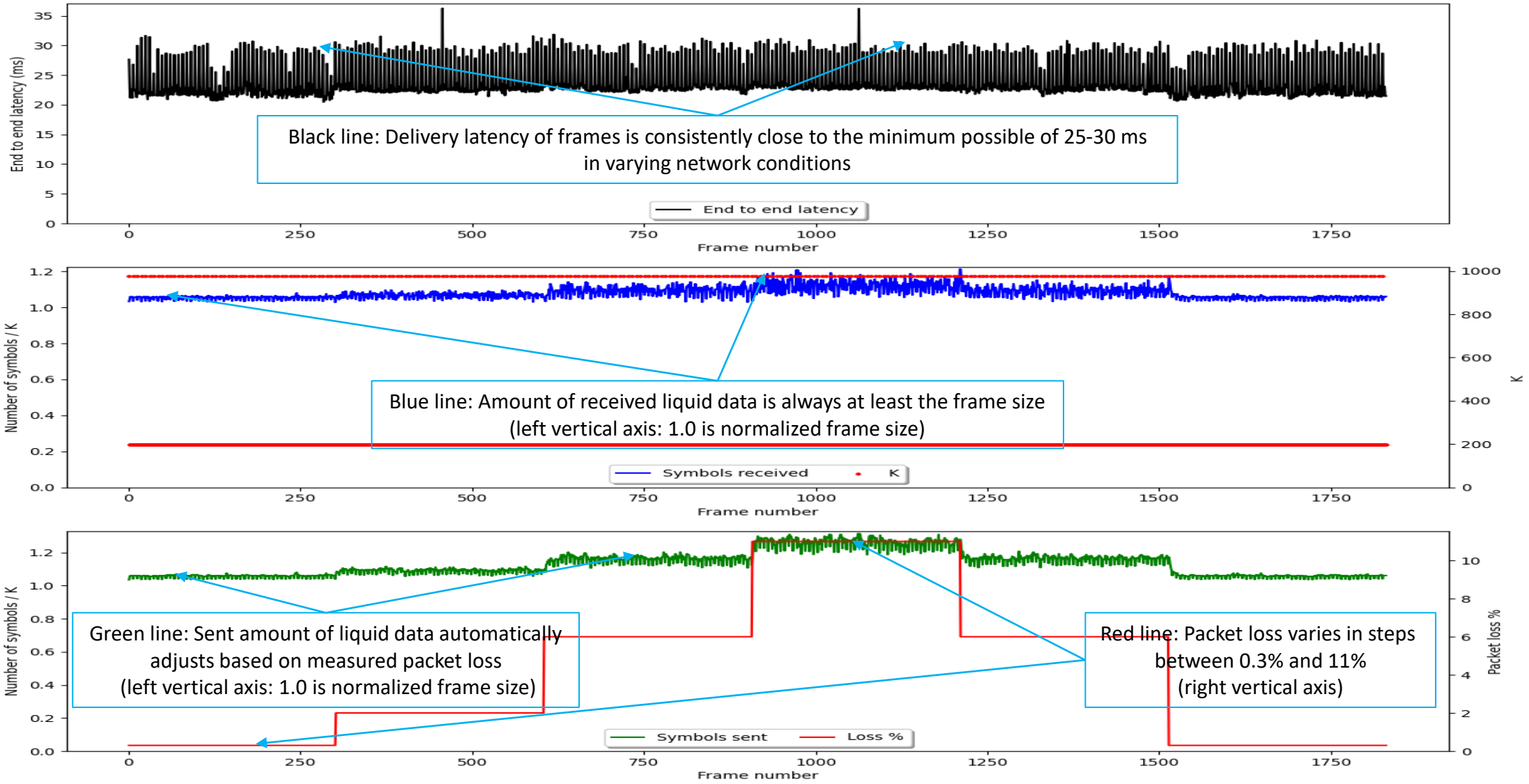
Results

9.6Mbps – 30fps – 40KB frames – 3% spiky losses – 40ms RTT – 1 minute run



Results

100Mbps – 30fps – Mix of 250KB + 1.25MB frames – steps losses – 40ms RTT – 1 minute run



Tunnel Demo at NAB 2023

Some future work

- Multiple interface delivery
- Rate control protocols
- Overall design of transport and network policies
  - Focus on minimizing delivery latency
  - Design of network buffering policies
  - Design of link layer retransmission policies
  - Interactions between this type of delivery and network policies

Thank You!