SCReAMv2

IETF-119 CCWG

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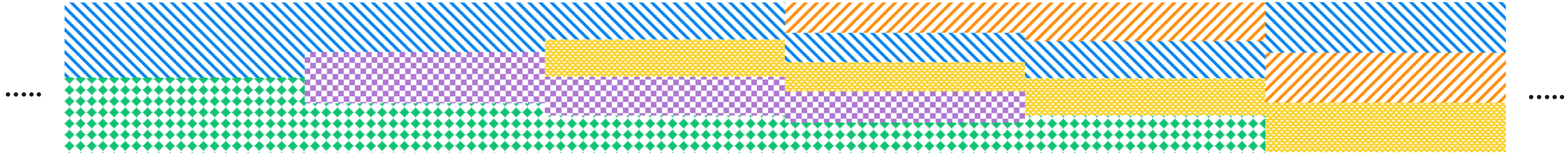
Topics

- 5G properties
- Video coders
- SCReAMv2

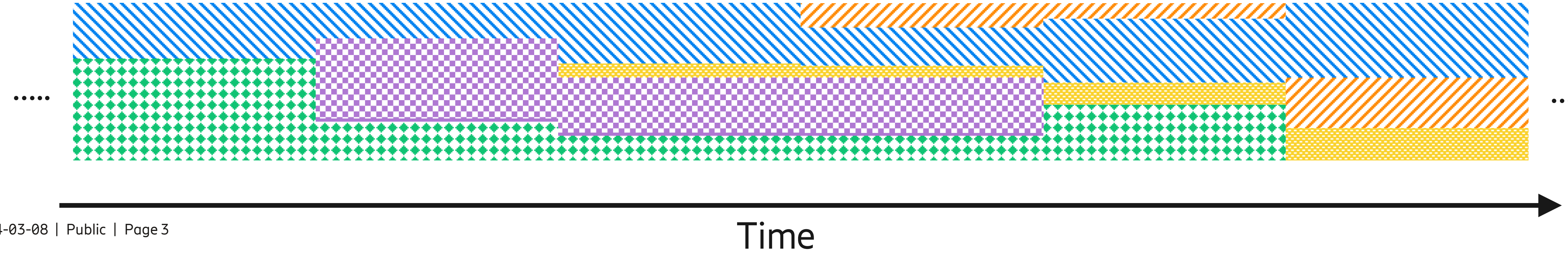
- Source and experiments

5G properties

- Resource allocation in frequency and time (average)
  - End user applications may be bitrate limited
  - Resource allocation can drop in a few RTTs, or in an instant when other users enter in the same cell

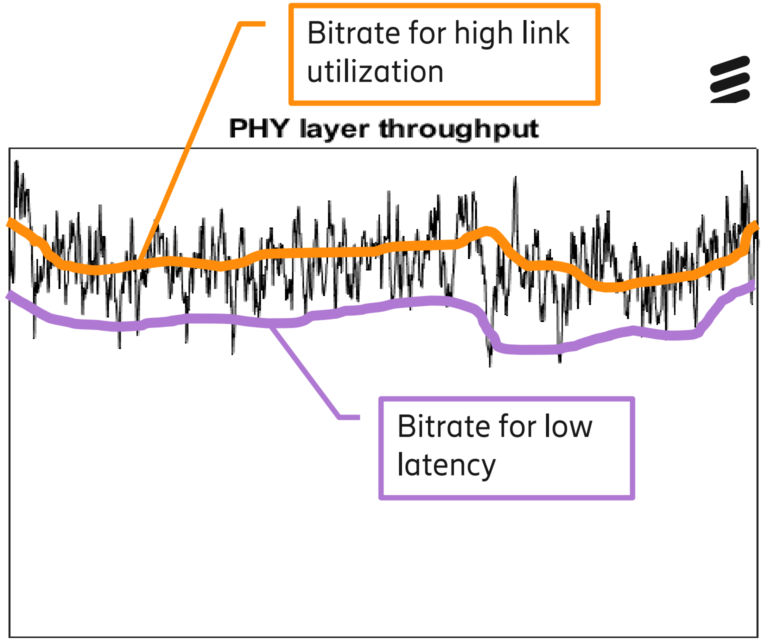


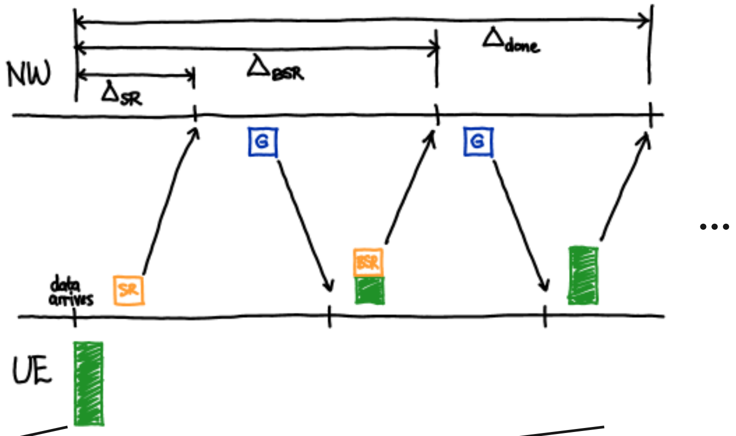
- Actual throughput (average)
  - Modulation and Coding Scheme (MCS) varies with channel quality, power limitation in uplink
  - Result, varying throughput



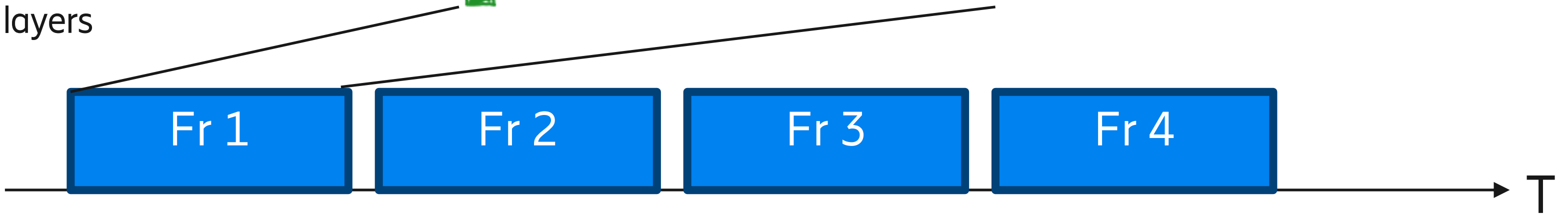
5G properties

- Cellular transport is subject to fast fading → throughput varies on short time scale
  - Trade off between large network buffer, high link utilization **and** small network buffer, reduced link utilization, pick one
  - Throughput can drop quickly
  - Large dynamic range in throughput
- (Dynamic) uplink scheduling of intermittent data
  - Increased delay
  - Reduced link utilization
- Delay can occur due to
  - Congestion, scheduling
  - Hand over, battery saving (DRX)
  - Retransmission on lower radio protocol stack layers

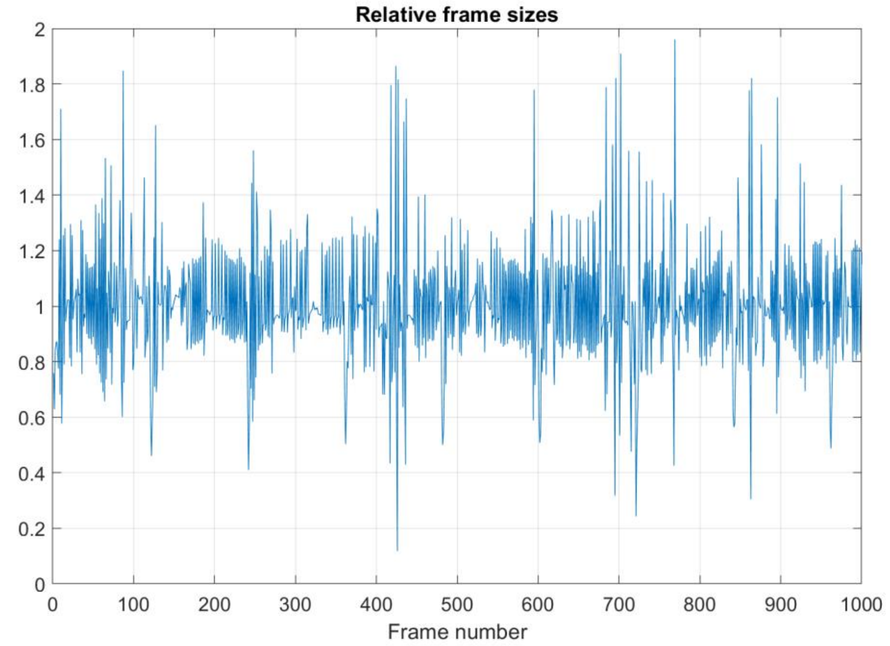




UE = terminal
NW = network
SR = Scheduling request
G = Scheduling grant
BSR = Buffer Status Report

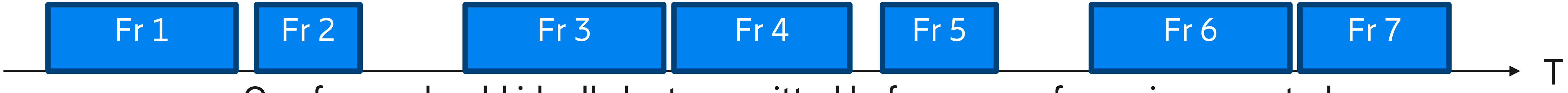


Video coder aspects



- Frame sizes typically vary
  - I-Frames can be large →GDR (Gradual Decoding Refresh) highly recommended
  - Also P-frames vary in size
- Additional headroom required to cope with varying frame sizes → avoid excessive queue build-up for large frames
- Video has a max bitrate → congestion control becomes application limited
- Odd features : Systematic error in output rate, slow rate change.

Example, video frames transmission over a constrained bottleneck



One frame should ideally be transmitted before a new frame is generated

SCReAMv2

- Eventually obsoletes RFC8298
- RTCP : RFC8888
- Congestion control based on
  - Estimated one way delay (similar to LEDBAT CC)
  - Packet loss detection
  - Classic ECN
  - L4S (main focus)
- Sender transmission control soft limits bytes in flight
  - Max bytes in flight = 1.5x CWND
- Media bitrate is (mainly) based on CWND and RTT
- Packet pacing rate > 1.5x media bitrate
- Congestion window validation

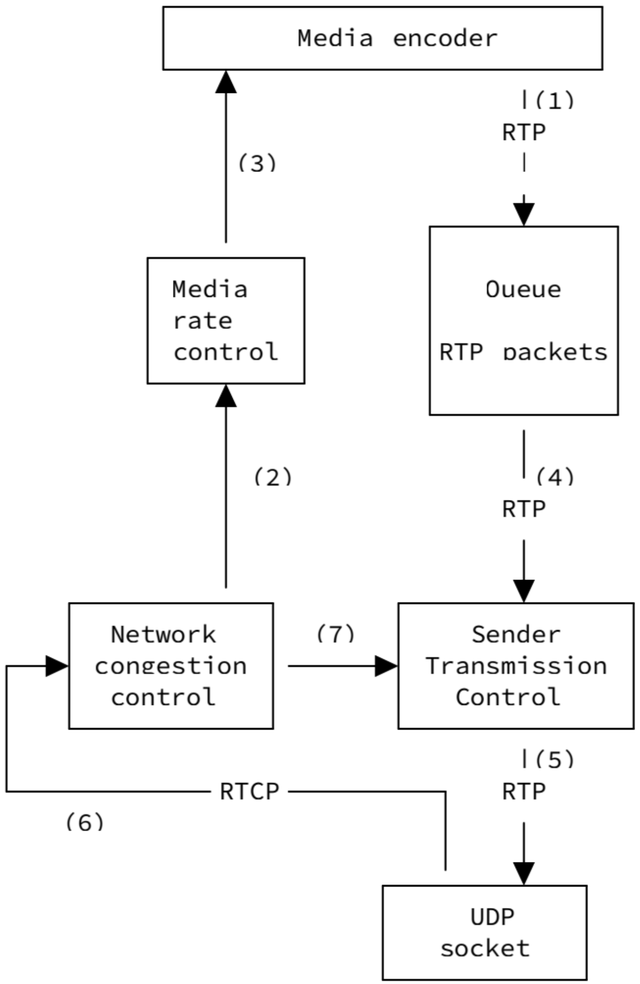


Figure 1: Sender Functional View

Congestion window update

On congestion event, max once per RTT

- Packet loss or classic ECN-CE marking
  - Reduce CWND by fixed value
- Delay based congestion control
  - Average of estimated queue delay to avoid over-reacting to non-congestion events like hand over
  - Virtual L4S marking based back CWND decrease when average queue delay > target delay/2
- L4S based congestion control
  - Reduce CWND proportional to fraction of packets marked (like Prague)
  - Very small CWND → limit reduction

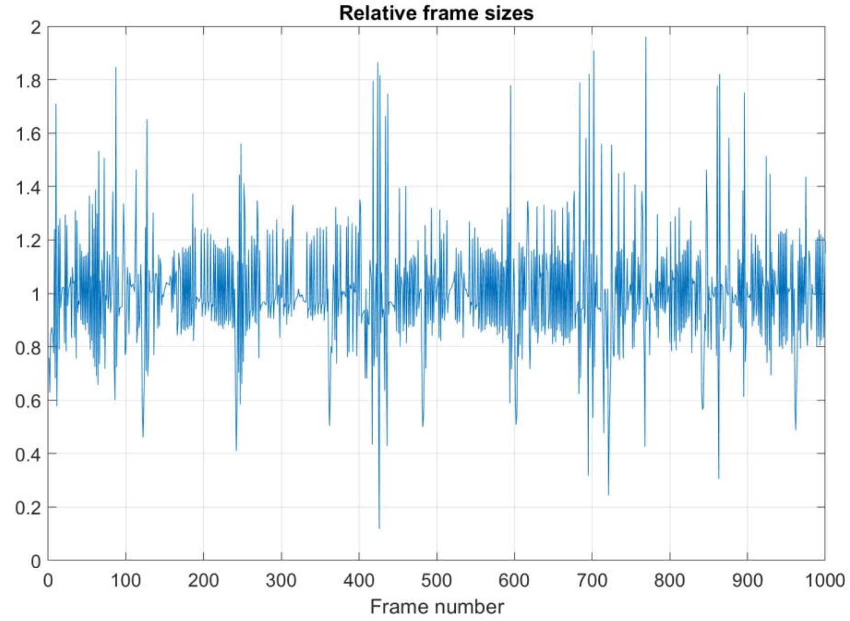
Once per RTT

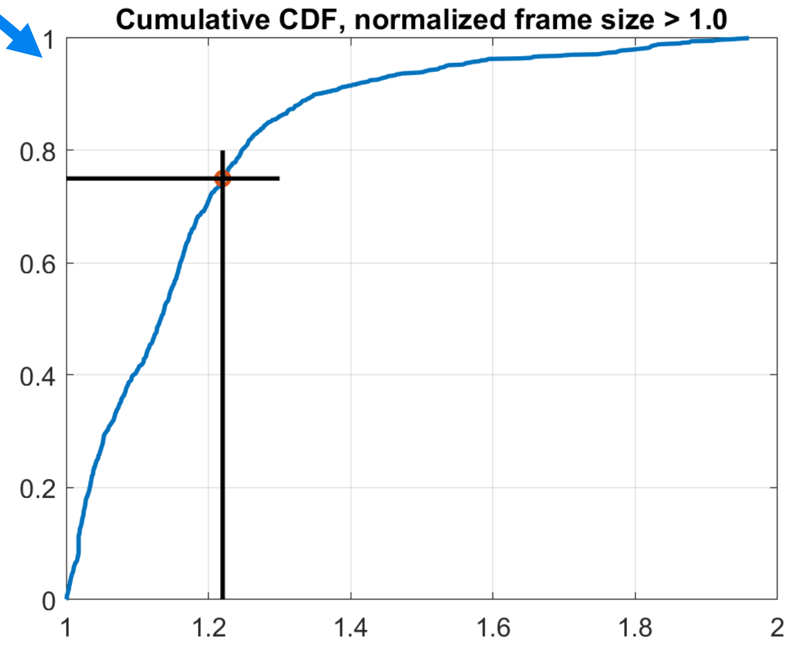
- Increase CWND similar to Prague(Reno)
  - One MSS / RTT
  - In addition, multiplicative increase if uncongested → faster convergence to increased capacity
  - Very small CWND → limit increase
- Non-L4S. Stabilize CWND with inflexion point, similar to Cubic.
- Validate CWND for the case that max media bitrate is reached.

Target bitrate update

- Executed when congestion window is updated
- `targetRate = CWND*8/RTT`

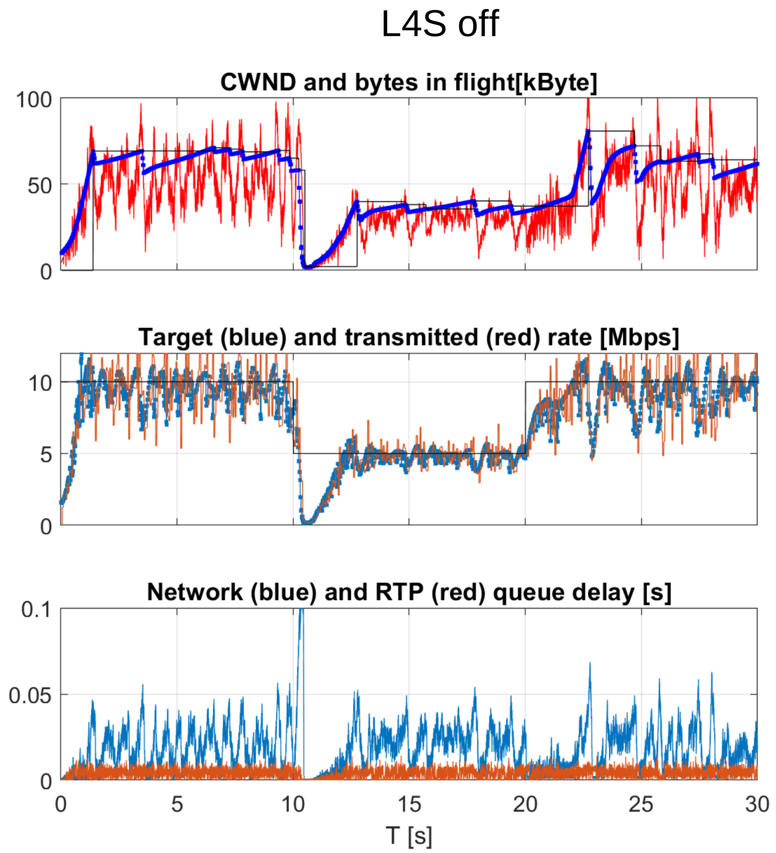
  `CNWD [byte], RTT [s]`
- Additional down-scaling based on 75%-ile of normalized frame size
- For not-L4S : scale down additionally when bytes in flight > CWND
- For very small CWND : Scale down target rate slightly

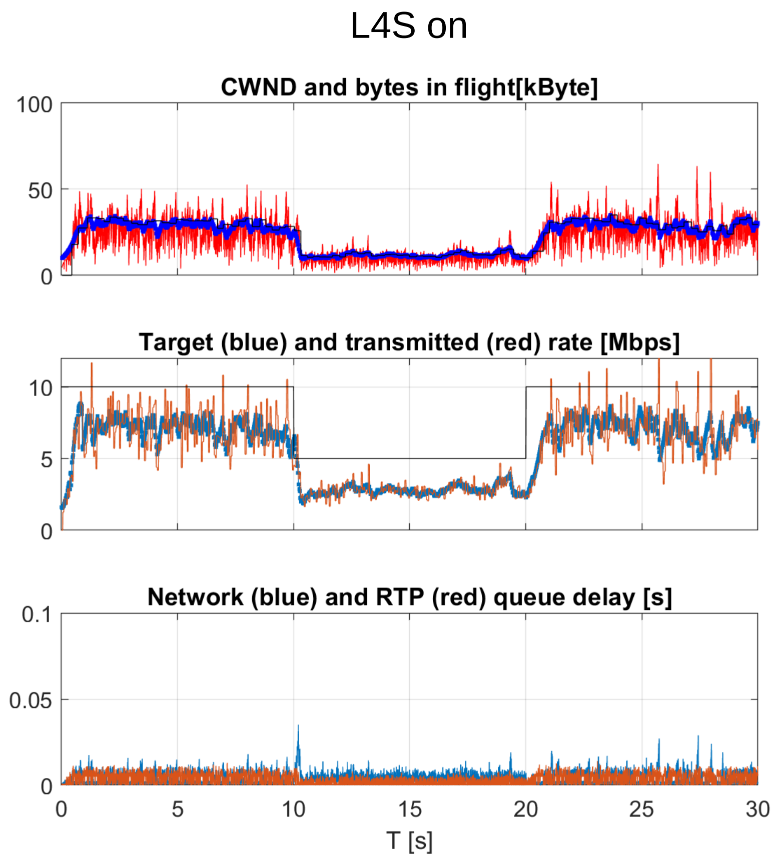




Delay based and L4S based congestion control

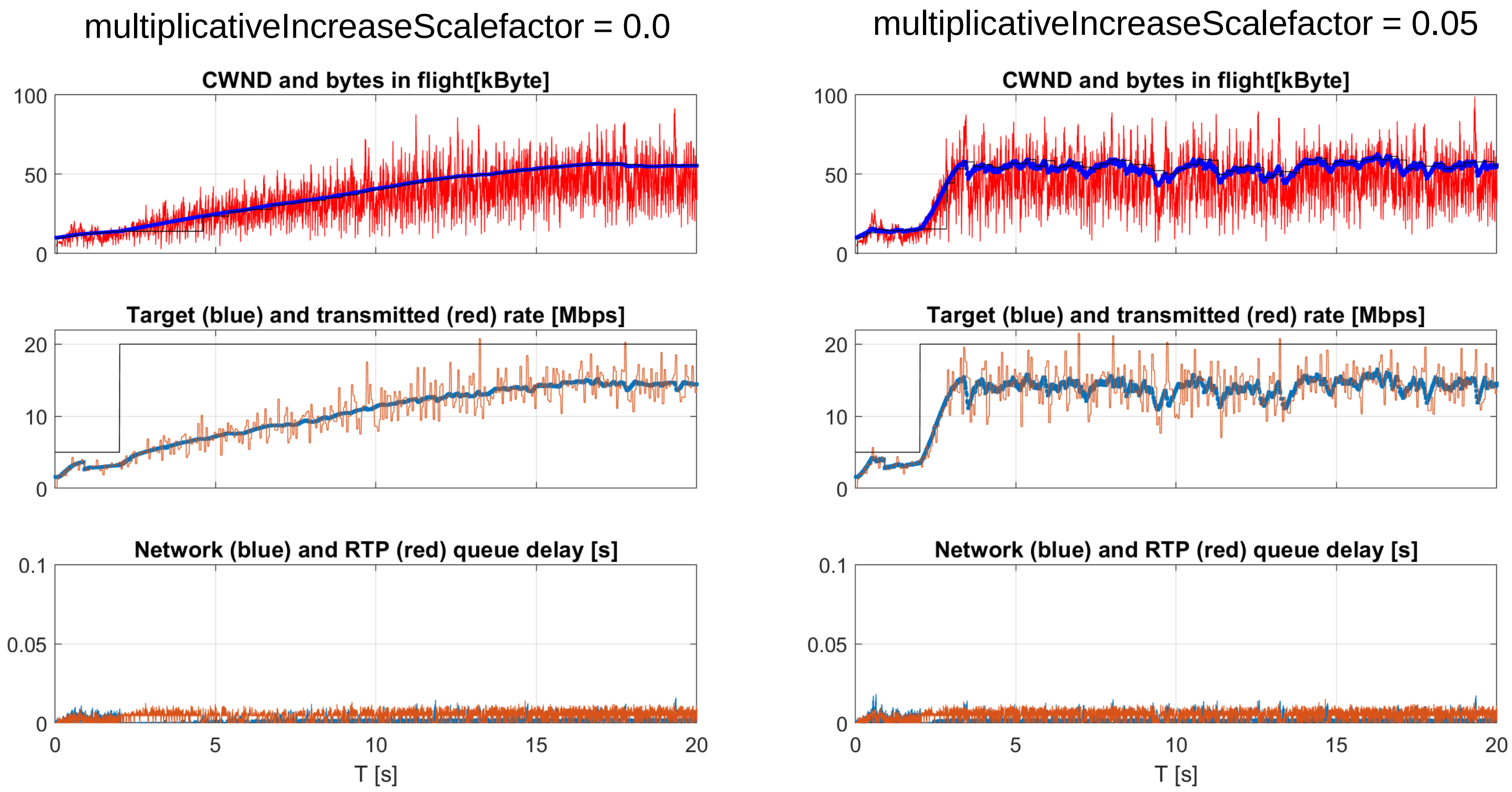
- Congestion control is delay based when L4S is not enabled or marking does not occur
- Delay based CC should be sufficiently responsive but should not over-react on non-congestion events
- Note: Bytes in flight can exceed CWND





Multiplicative increase

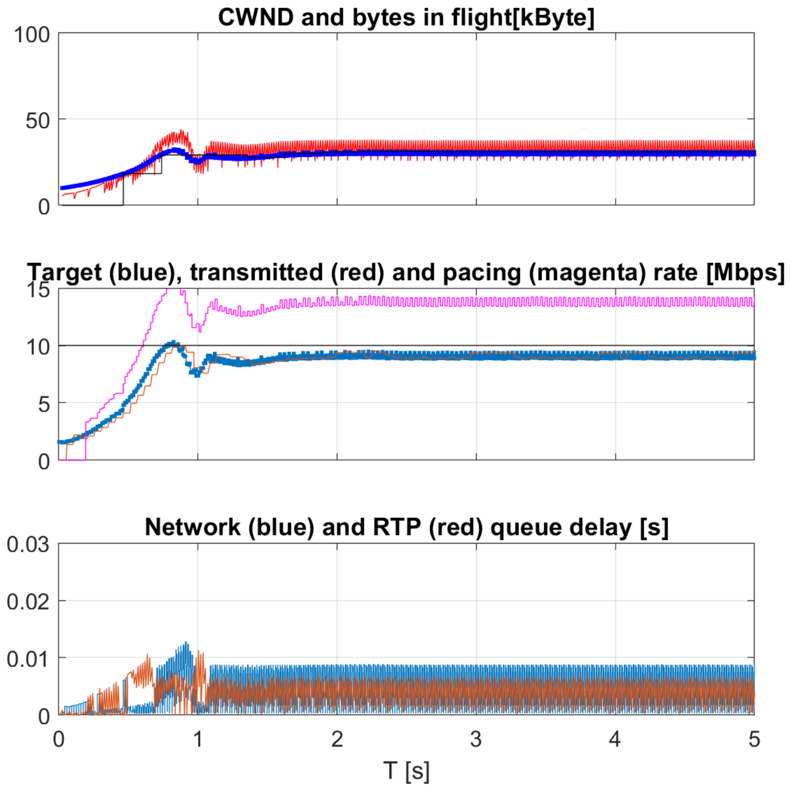
- Multiplicative increase gives faster convergence when link throughput increases
- 0.05 = up to 5% CWND increase per RTT



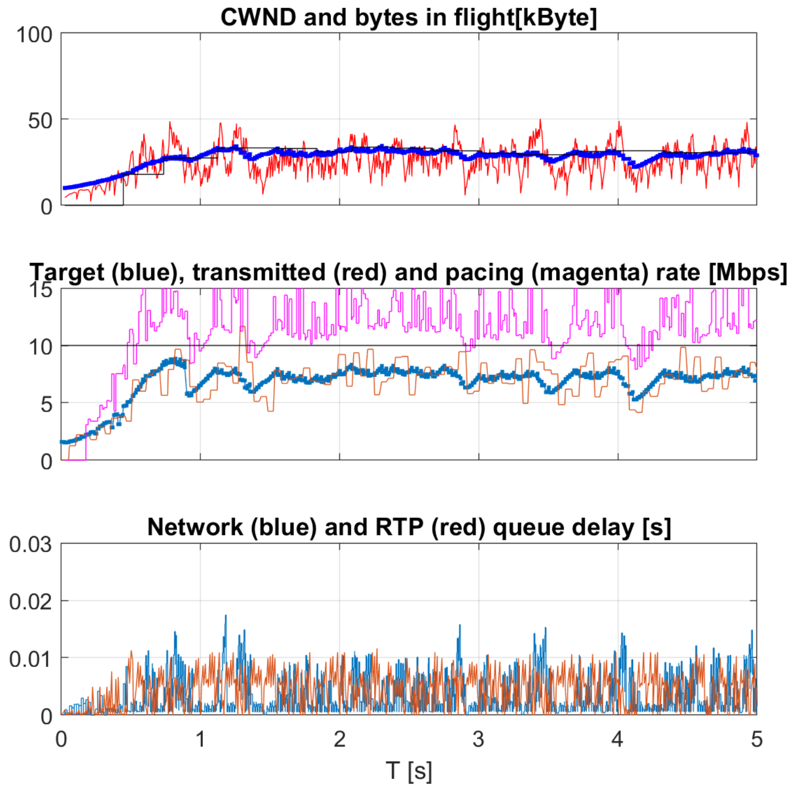
Packet pacing

- Default pacing overhead is 50%, i.e pacing rate is 1.5x media bitrate
- In addition: Large frames → pace even faster
- Objective : Avoid that large frames are held unnecessarily in RTP queue

Fixed frame sizes == ideal

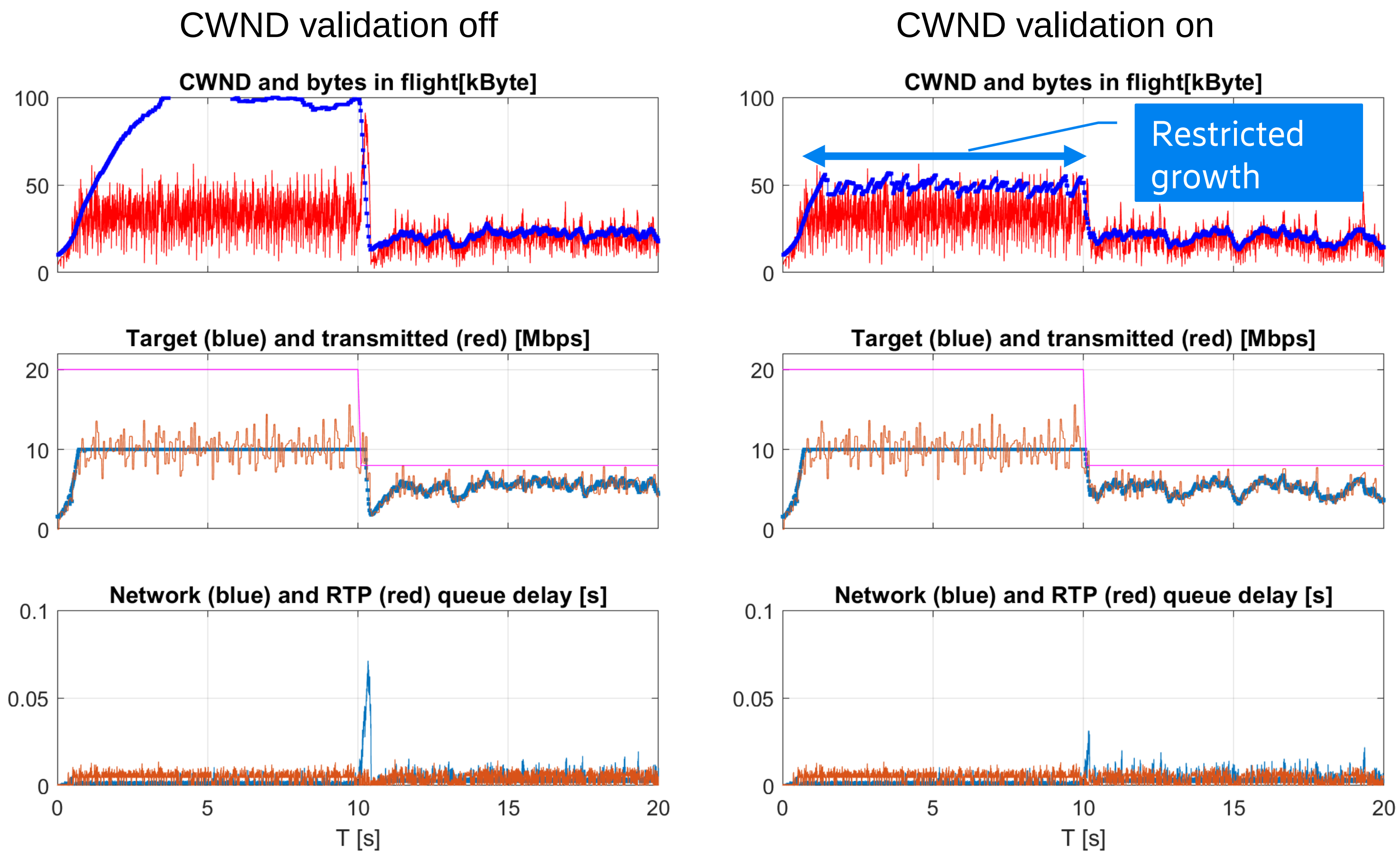


Variable frame sizes == what to expect



Congestion window validation

- SCReAM can often be application limited
  - Max video bitrate reached
- Congestion window growth becomes restricted when SCReAM becomes application limited
- Example, max target rate is 10Mbps
- Note, relax the restriction when uncongested <u>and</u> max target bitrate <u>not</u> reached

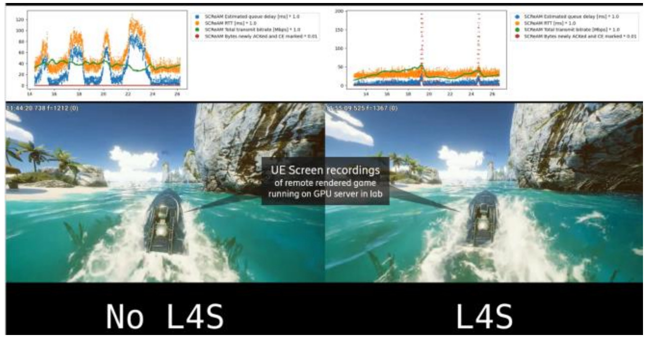


Sources

- IETF draft : https://datatracker.ietf.org/doc/draft-johansson-ccwg-rfc8298bis-screamv2/
- Code : https://github.com/EricssonResearch/scream
  - Continuously developed since March 2015
  - SCReAM code
  - BW test application, the plumber's aid
  - Multicamera gstreamer and C++ wrapper (multicam)
  - Complete gstreamer with multicam support (gstscream)

Experimentation, so far pretty much L4S-ish

- Small RC cars
  - https://www.youtube.com/watch?v=RZmS10djDEg
- Large RC Cars
  - https://www.youtube.com/watch?v=H8CBOKgHTOQ
- Boat Attack cloud rendered gaming
  - https://www.ericsson.com/en/news/2021/10/dt-and-ericsson-successfully-test-new-5g-low-latency-feature-for-time-critical-applications



- *On the wish list, integration into WebRTC*

Questions, comments ?

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