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FURTHER SRS CONSIDERATIONS AND APPLICATION OF SRS TO TSN USE CASES

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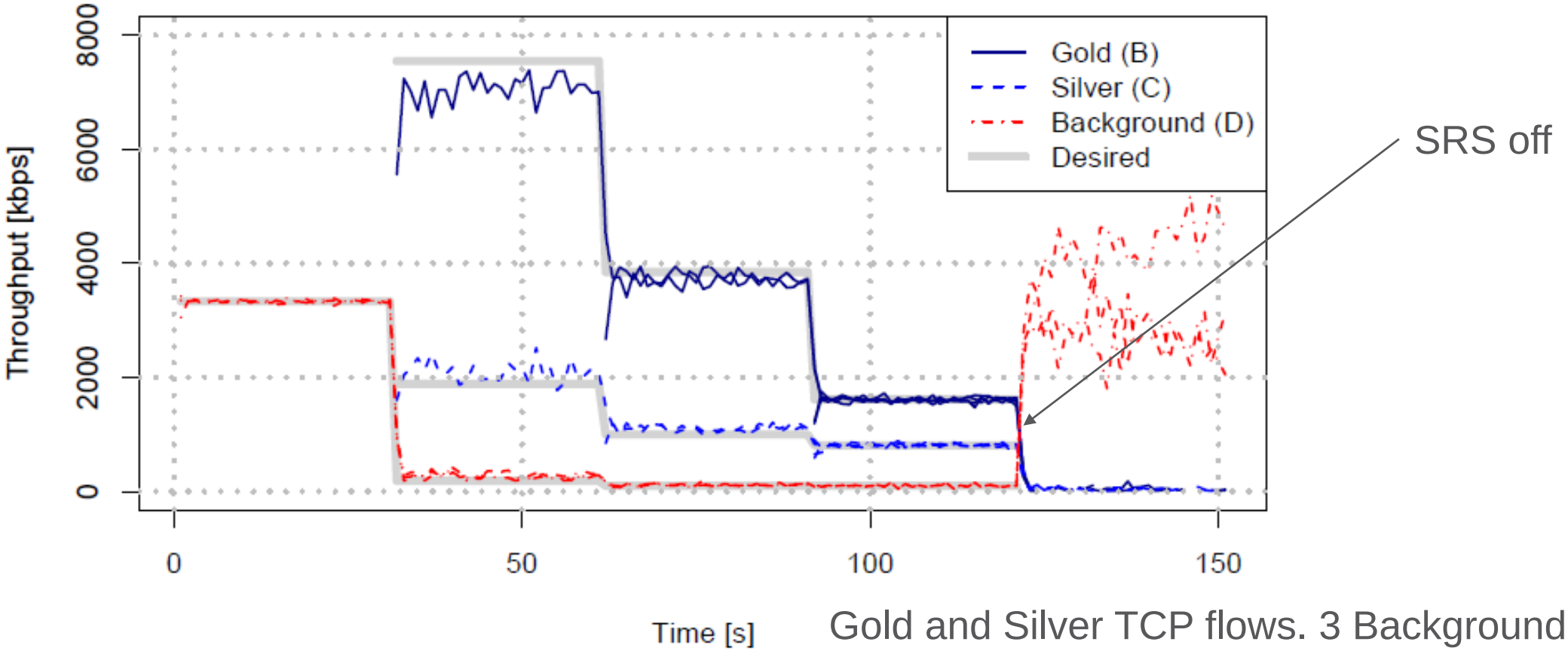
December 12, 2016

STUDIES ON STATELESS RESOURCE SHARING VIA PER PACKET VALUE

- Paper "*Per Packet Value: A Practical Concept for Network Resource Sharing*" published at IEEE Globecom 2016
  - Summary of experience of two years
  - Description of the concept ad related work
  - Conceptual description on how delay requirements and desired resource sharing can be de-coupled
  - Description of potential implementation
  - Simulation results, e.g., how TCP traffic is protected form unresponsive traffic in the same queue
  - Load balancing, resource balancing, feedback for admission control
- We are extending the concept in a university cooperation
- Further papers in progress

EXAMPLE SIMULATION
TCP TRAFFIC IS PROTECTED FORM UNRESPONSIVE TRAFFIC IN THE SAME QUEUE



Gold and Silver TCP flows. 3 Background UDP flows. 5 TCP connections per flow. Gold and Silver class has 1-1, 2-2, 4-4 flows

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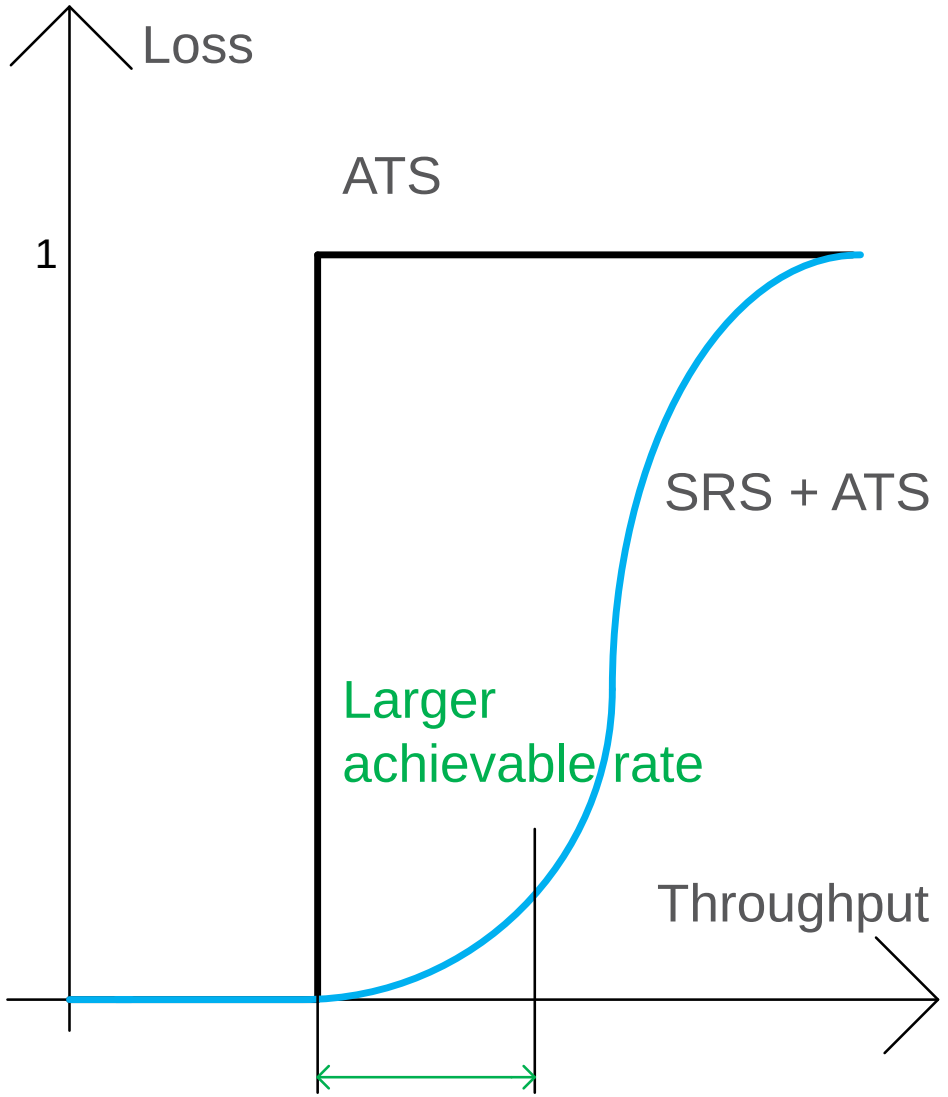
APPLICATION OF SRS TO TSN USE CASES

RECAP – COMBINATION OF ATS & SRS
LOSS VS. THROUGHPUT

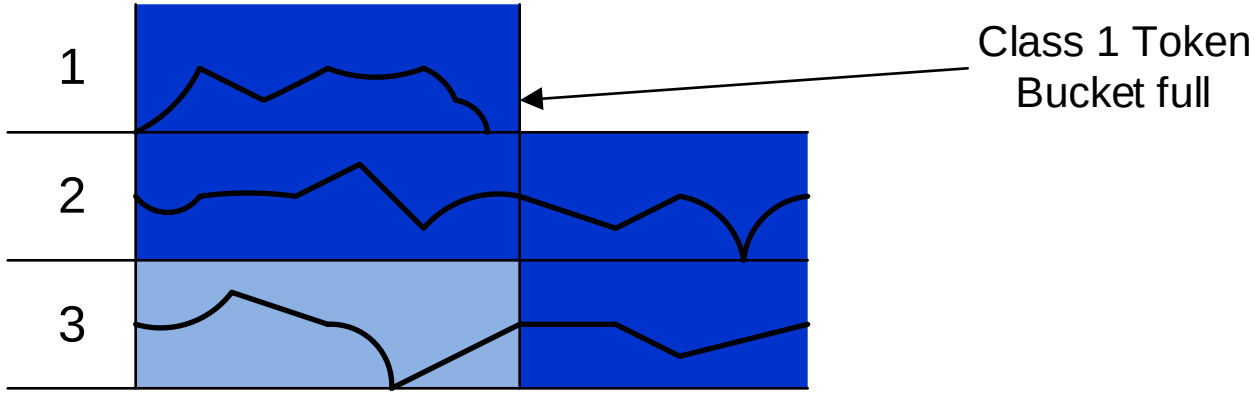
- The possibility of forwarding non-guaranteed packets results in a larger achievable flow rate
- The packet value determines
  - Whether or not a packet is guaranteed
  - Whether a non-guaranteed packet is dropped or forwarded (note: there can be more important and less important non-guaranteed packets)
- The size of the larger bucket is chosen based on a compromise between (1) delay, (2) allowed total guaranteed rate, and (3) allowing excess traffic
  - In many cases, slightly increased delay is still within the E2E delay budget



CRITICAL SPORADIC TRAFFIC AND ATS

- Some sporadic traffic can be quite critical, but actual traffic happens rarely
  - e.g., alarms
- ATS requires reservation for all traffic to guarantee lossless delay bounded delivery. This is not efficient from dimensioning perspective
- Some classes might be able to tolerate losses when critical sporadic traffic is present

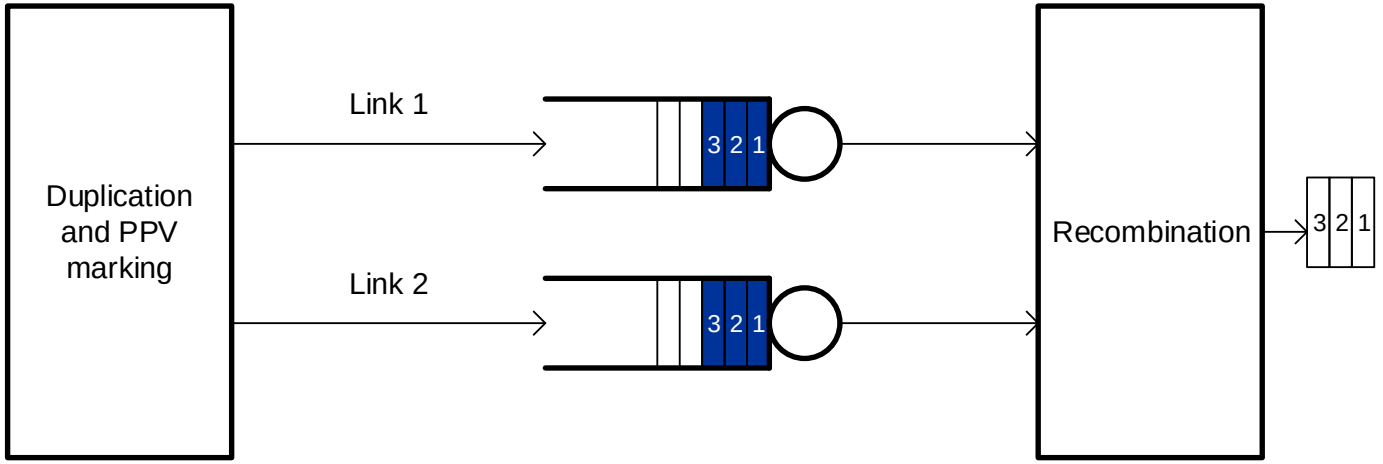
CRITICAL SPORADIC TRAFFIC AND ATS



- Define classes
  - 1) critical sporadic
  - 2) critical-a
  - 3) critical-b (it tolerates losses when critical sporadic traffic is present)
- Dimension the link for 1+2 and 2+3 (take maximum)
- When class 1 is present,
  - Classes 1 and 2 are included in interleaved shaping and are guaranteed
  - Class 3 is treated as non-Guaranteed traffic
- When class 1 is not present include classes 2 and 3 in Interleaved shaping and they are guaranteed traffic
  - Detect presence of class 1 by its token bucket being not full
- (Can be extended for more classes of sporadic and critical)

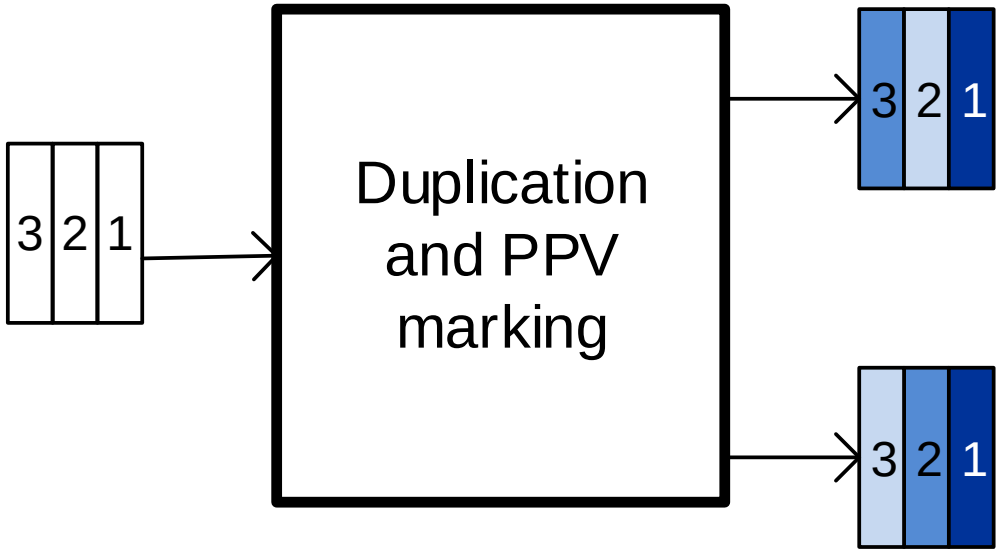
802.1CB AND SRS – EFFECTIVE FRAME REPLICATION FOR TSN

- Frame replication may require too much capacity
  - Sending and guaranteeing each and every packet on both links
- Especially for less critical content, Especially for less critical content
- We propose to
  - relax the guarantees and capacity demand,
  - while still having a chance for all packets to go through in case of link failure



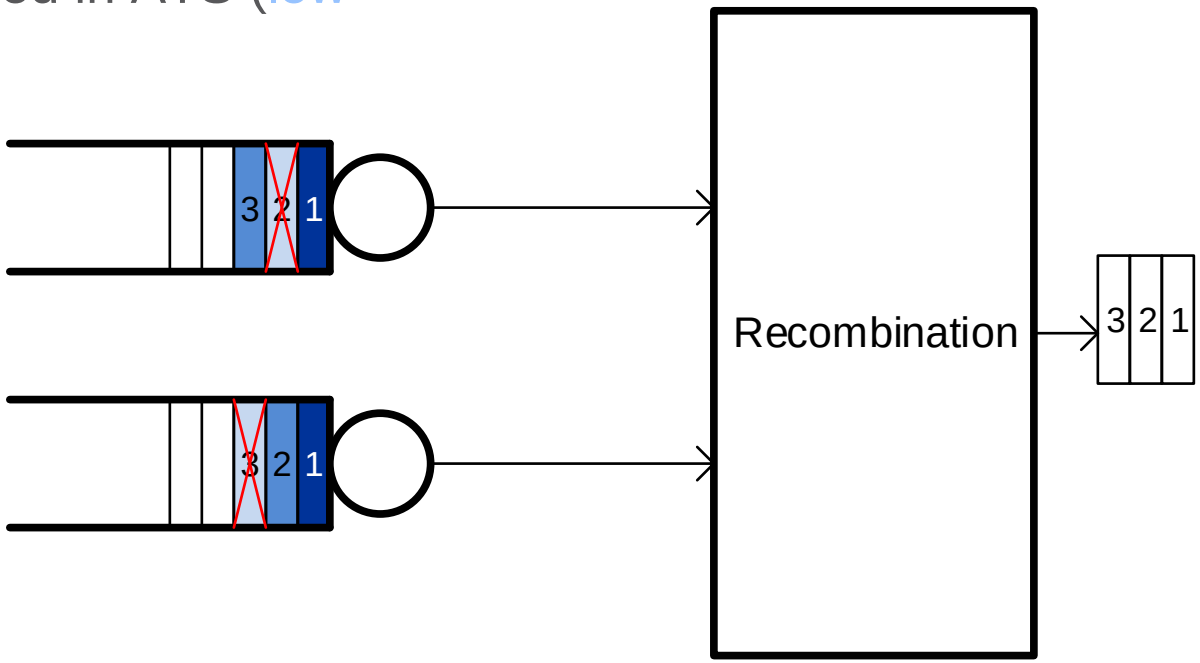
802.1CB AND SRS – EFFECTIVE FRAME REPLICATION FOR TSN

- In case of duplicate sending define two classes of flows
  - 1) very critical
  - 2) critical
- The **very critical traffic** is sent with **high** PPV on both links
  - Received even if a link is down or if one copy is corrupted
- The packets of **critical traffic** are also sent on both links
  - With **medium** PPV on one
  - A **low** PPV on the other

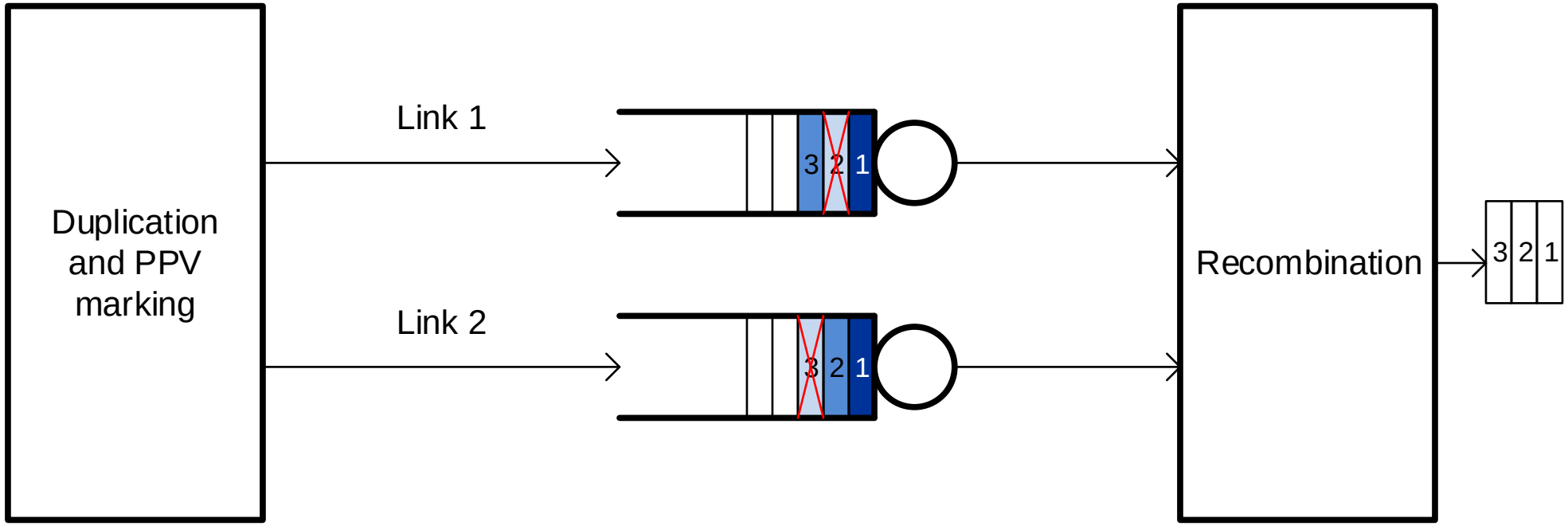


802.1CB AND SRS – EFFECTIVE FRAME REPLICATION FOR TSN

- Treat high and medium PPV packets as guaranteed in ATS (low as non-guaranteed)
  - As any packet is medium on at least one link, every critical packet is received within the delay limit if
    - both links are up
    - no packet is corrupted
- If a link is down or a medium PPV packet is corrupted there is still a chance that some extra critical traffic with low PPV goes through the other link if the traffic there is smaller than allocated (low PPV packets might go through)
  - The medium and low PPVs can be extended to PPV ranges to further represent the importance of packets
- The latent error detection function is updated to take into account the possibility of losing low PPV packets



802.1CB AND SRS PUTTING ALL TOGETHER



- Total capacity demand is L*(1+r)
  - L is the total load, r is the ratio of very critical traffic
- The solution can be generalized to more redundant paths and more traffic classes

SUMMARY

- A lot of analysis and simulations have been performed on SRS, more results to come

- Combination of SRS with TSN solutions have benefits, e.g., more efficient bandwidth usage and dimensioning, which is valid for
  - Combination of SRS with 8201.Qcr ATS
  - Combination of SRS with 802.1CB FRER