802.1CB and Out-of-Order PDUs

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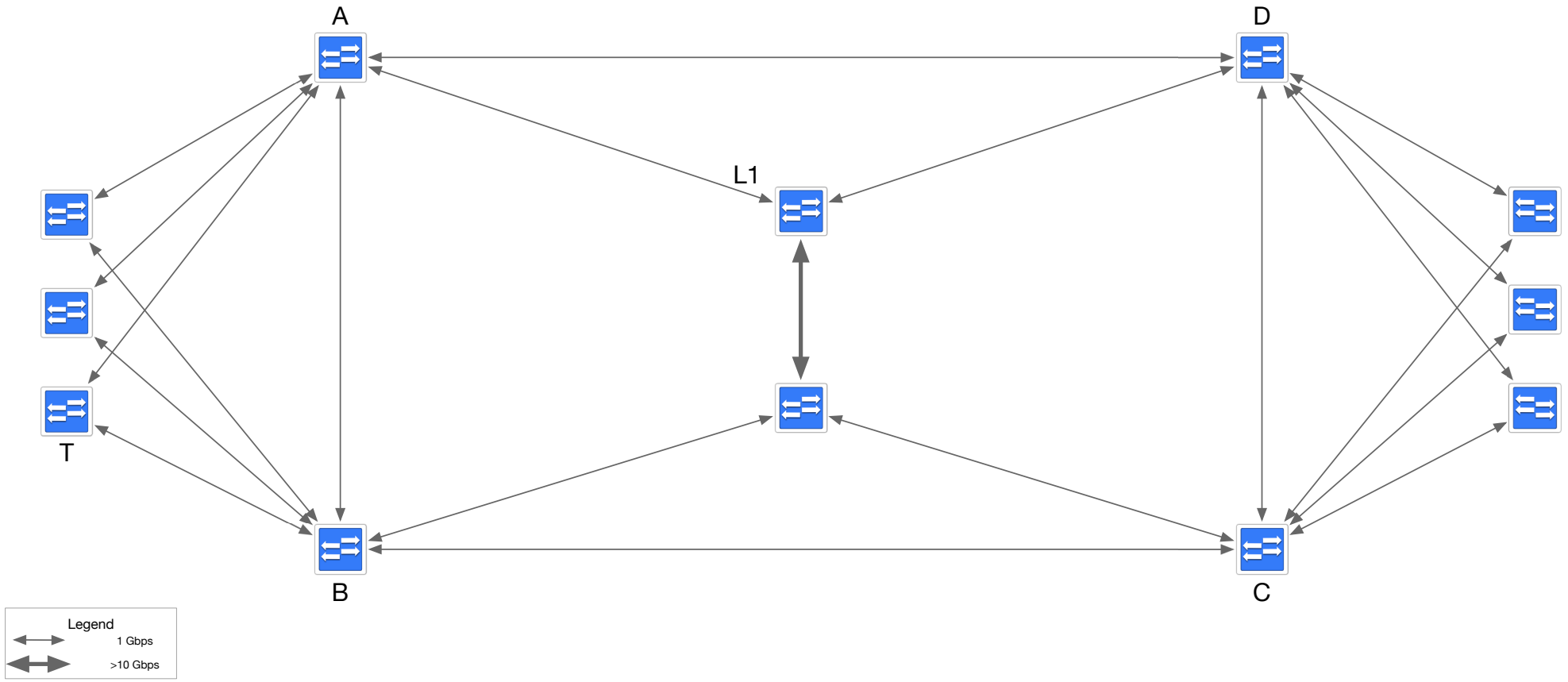
2020-06-02

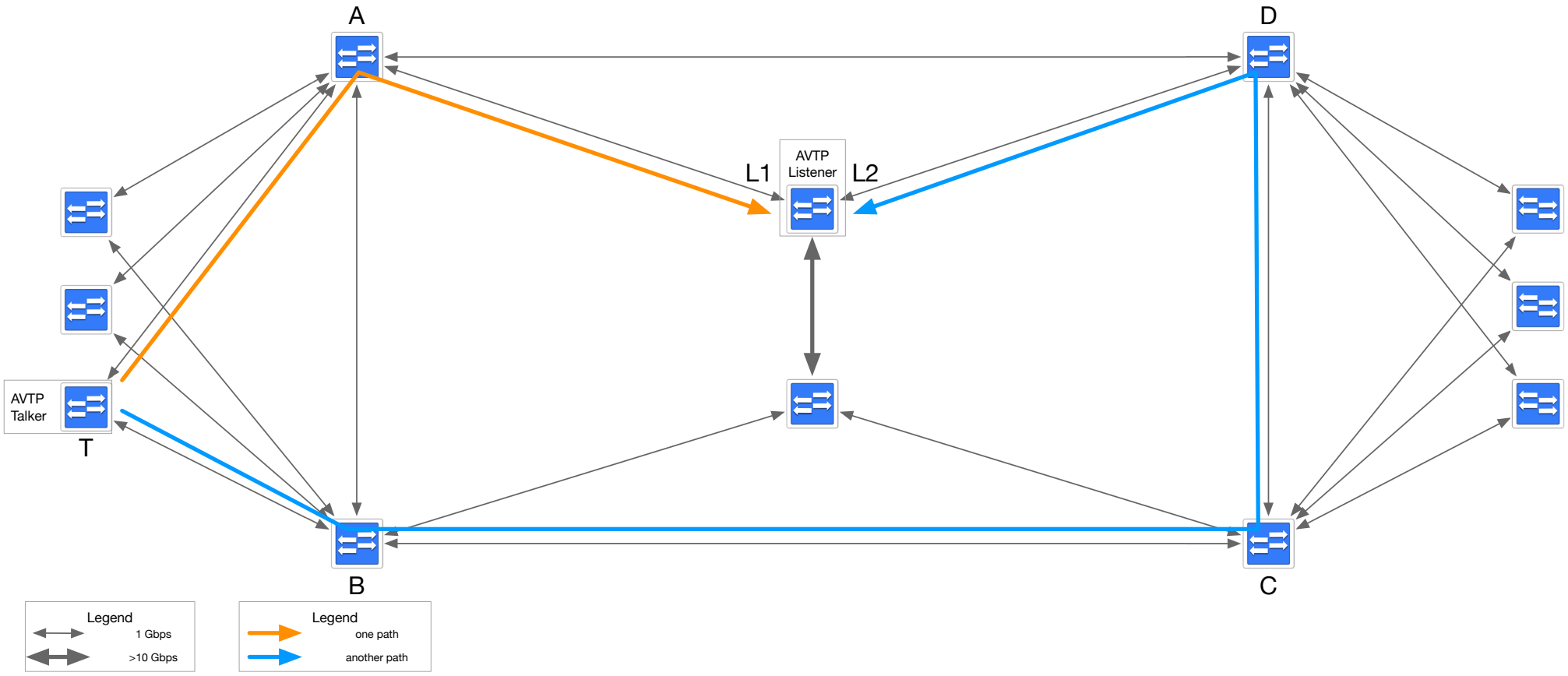
Revision History

Revision	Made By	Date	Description
0.1	Gordon Bechtel	2020-05-19	Initial Release
0.2	Gordon Bechtel	2020-05-26	Added details on sequence number reordering
0.3	Gordon Bechtel	2020-06-02	Added potential solutions for the out-of-order problem. Added notes from 26May2020 meeting, including note regarding sparse timestamping.

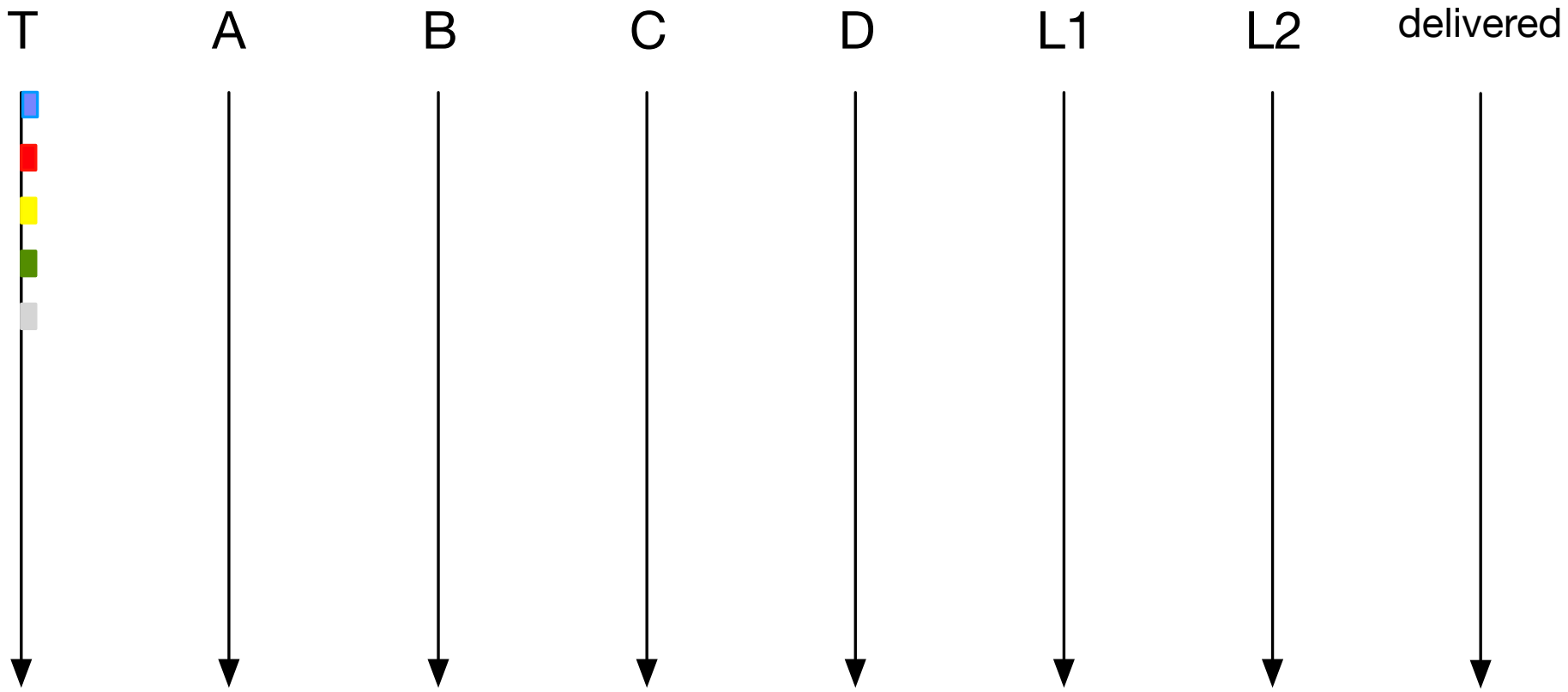
Example Topology



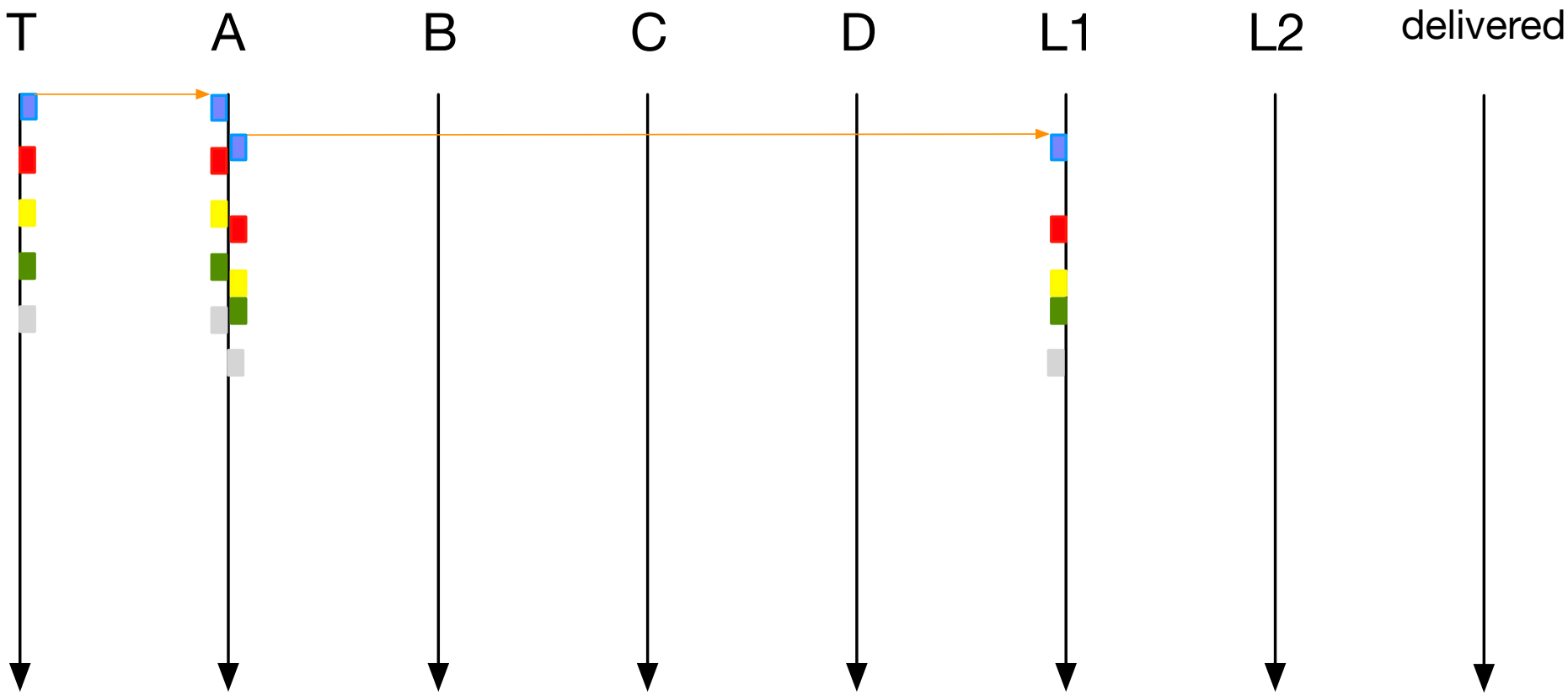
Example of Redundant Paths



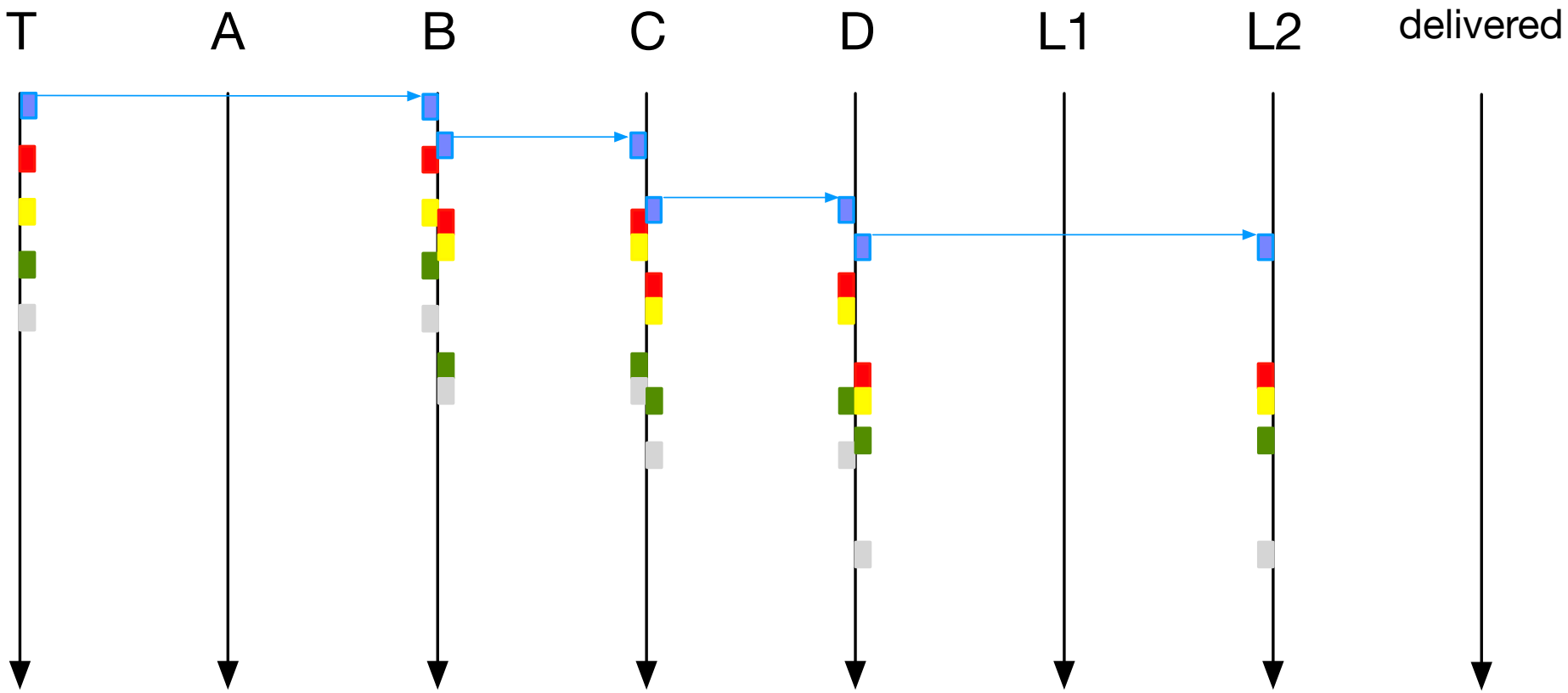
Example PDUs and Timing on Network



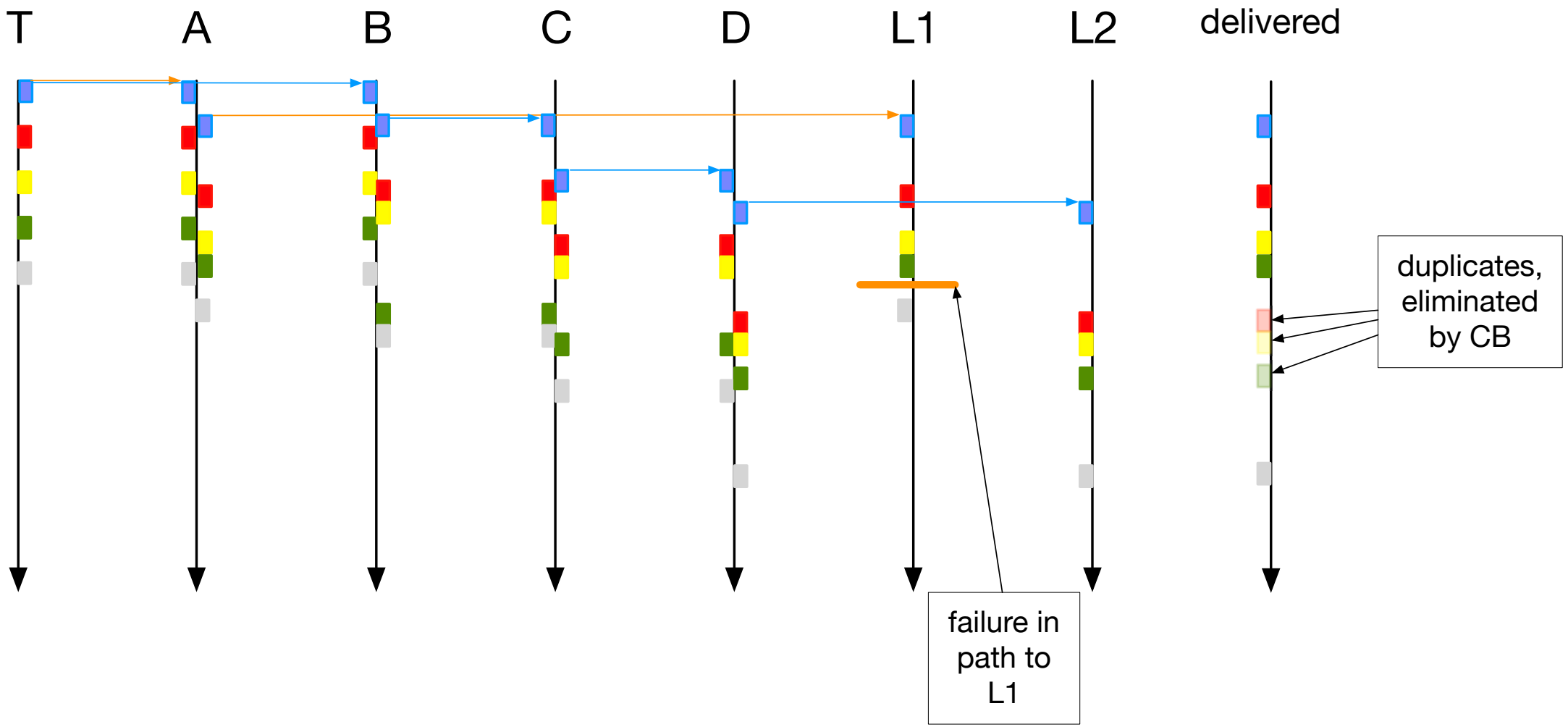
Orange Path



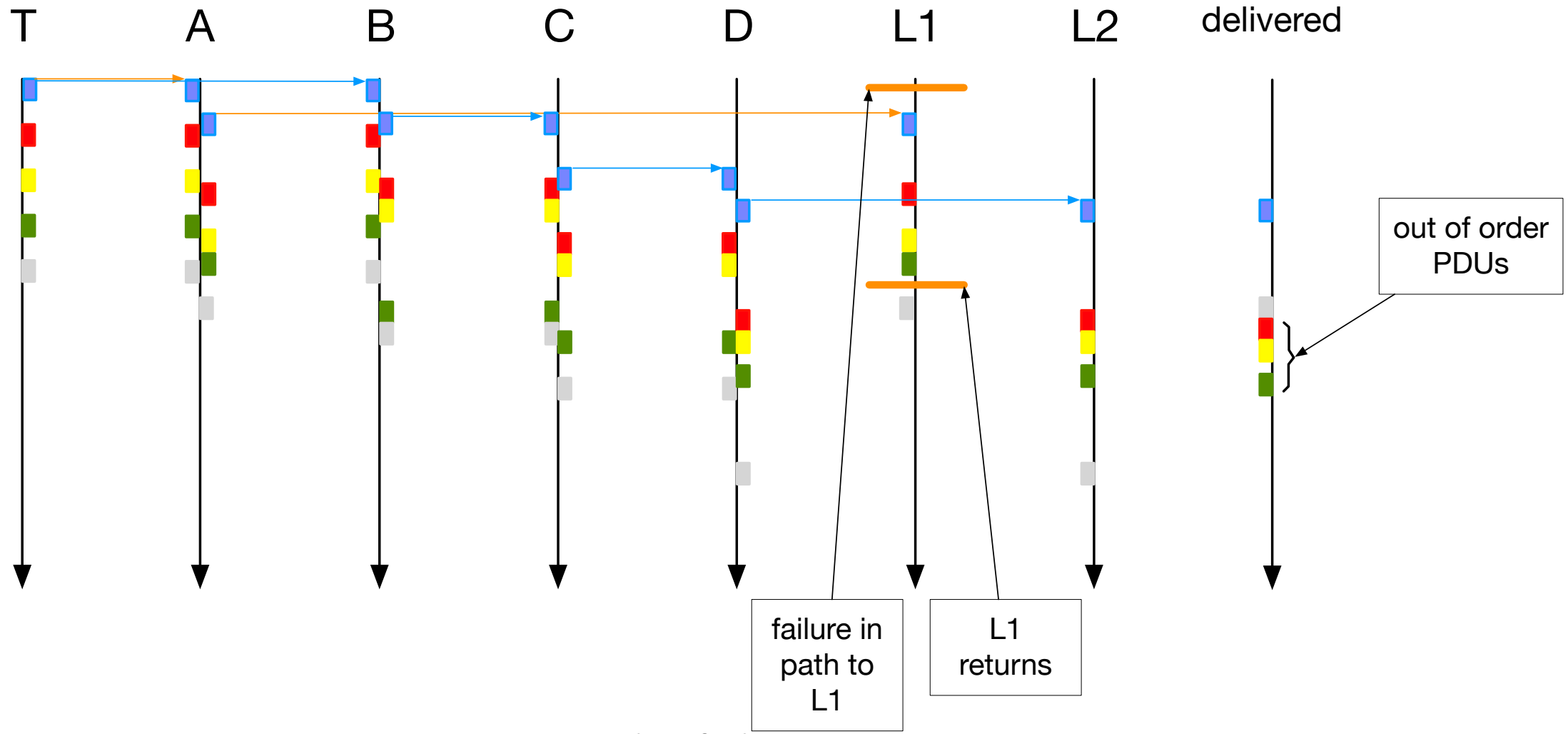
Blue Path



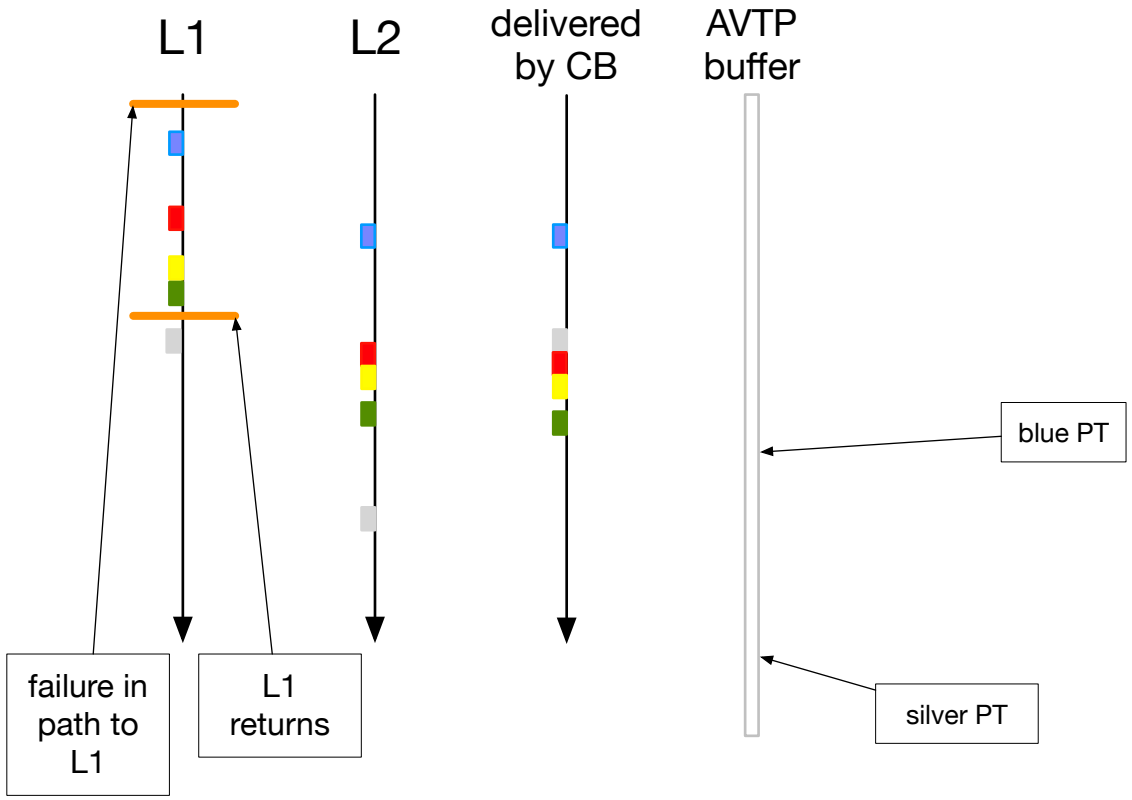
Delivery: Short Path Failure



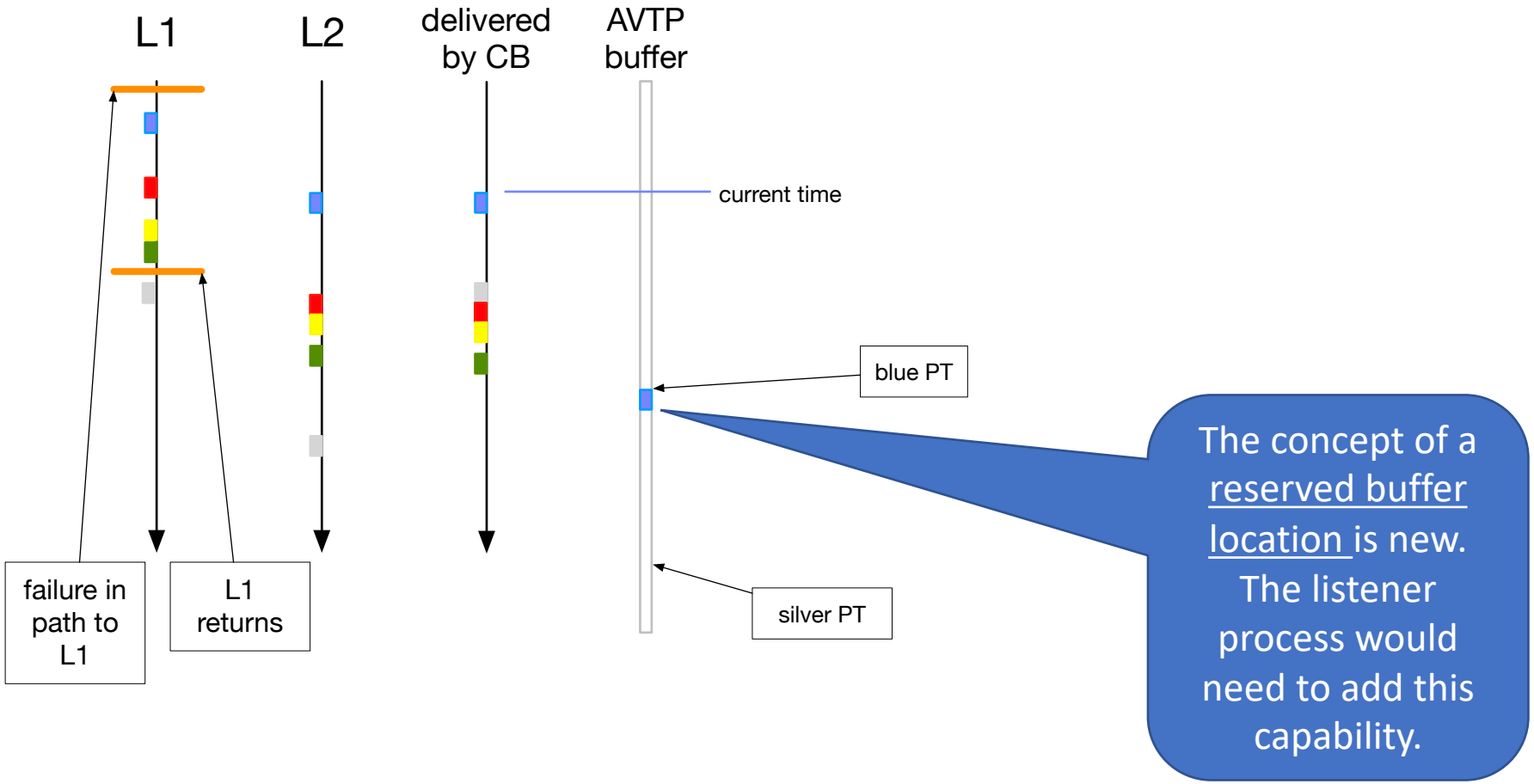
Delivery: Short Path Fails and Returns



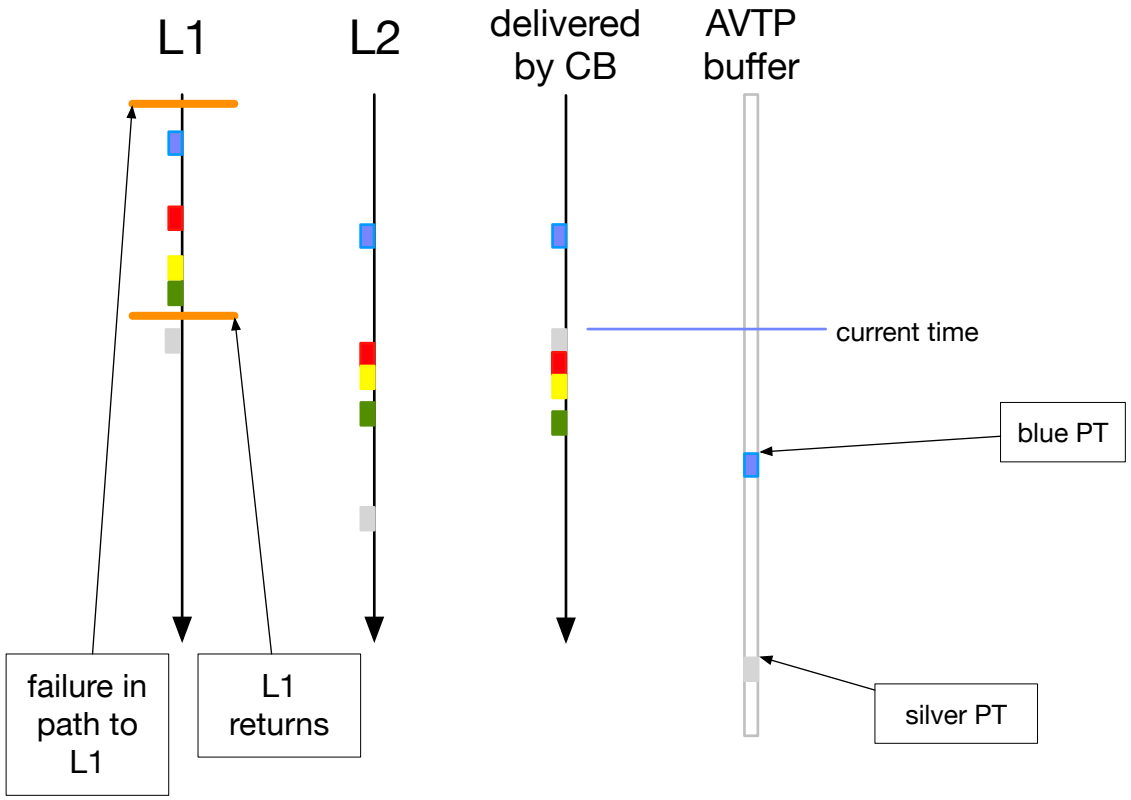
Use AVTP Presentation Time to Handle the Problem (With Some New Processing)



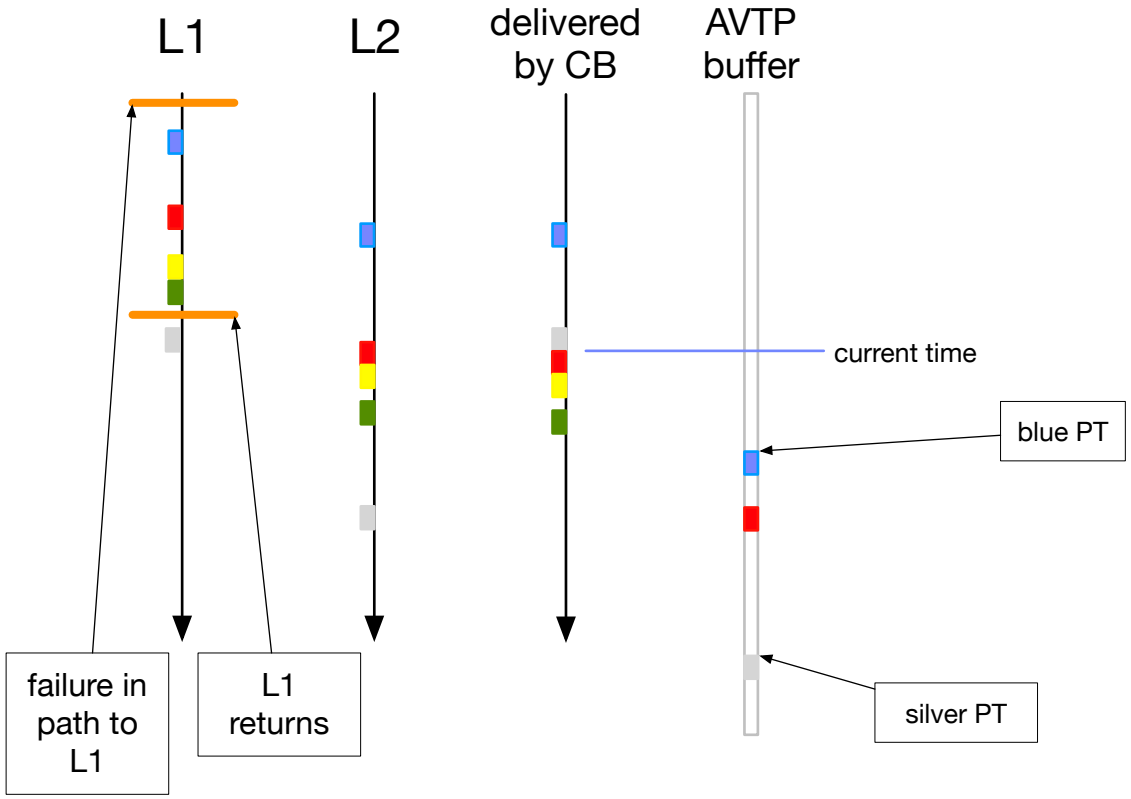
Put Blue PDU in it's "Reserved" Spot in Buffer



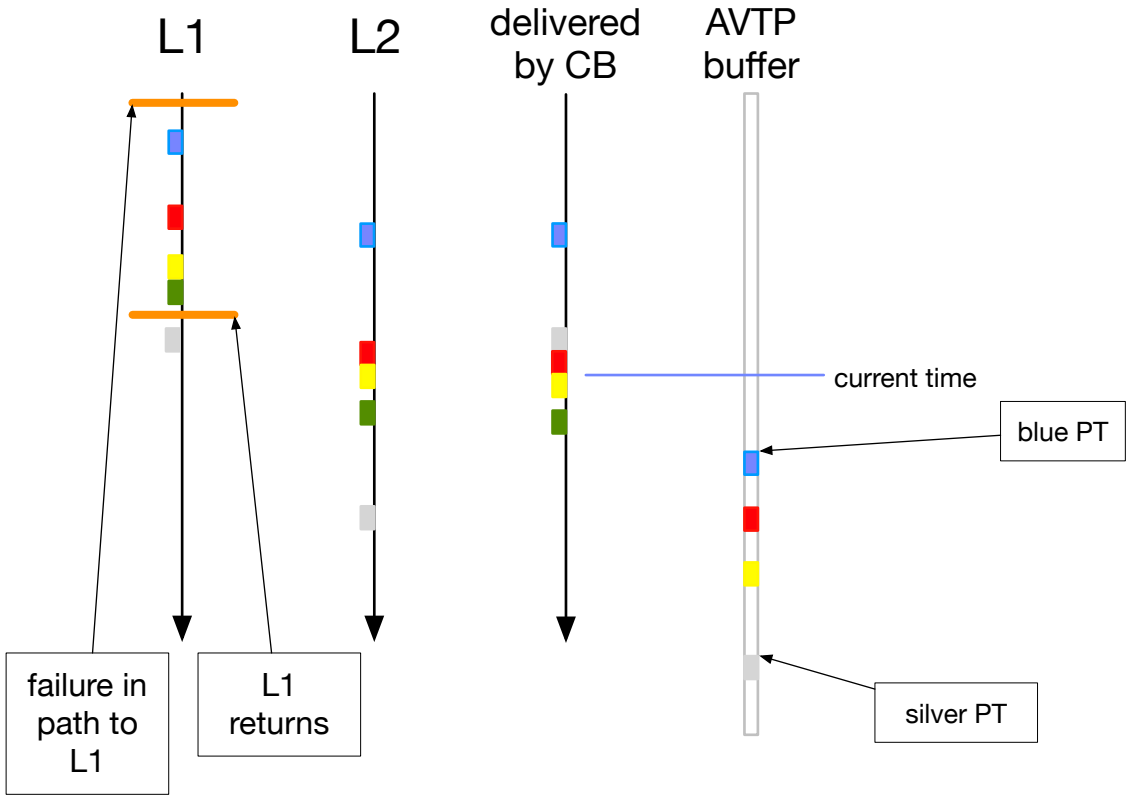
Same for Silver, even though it's Out-of-Order



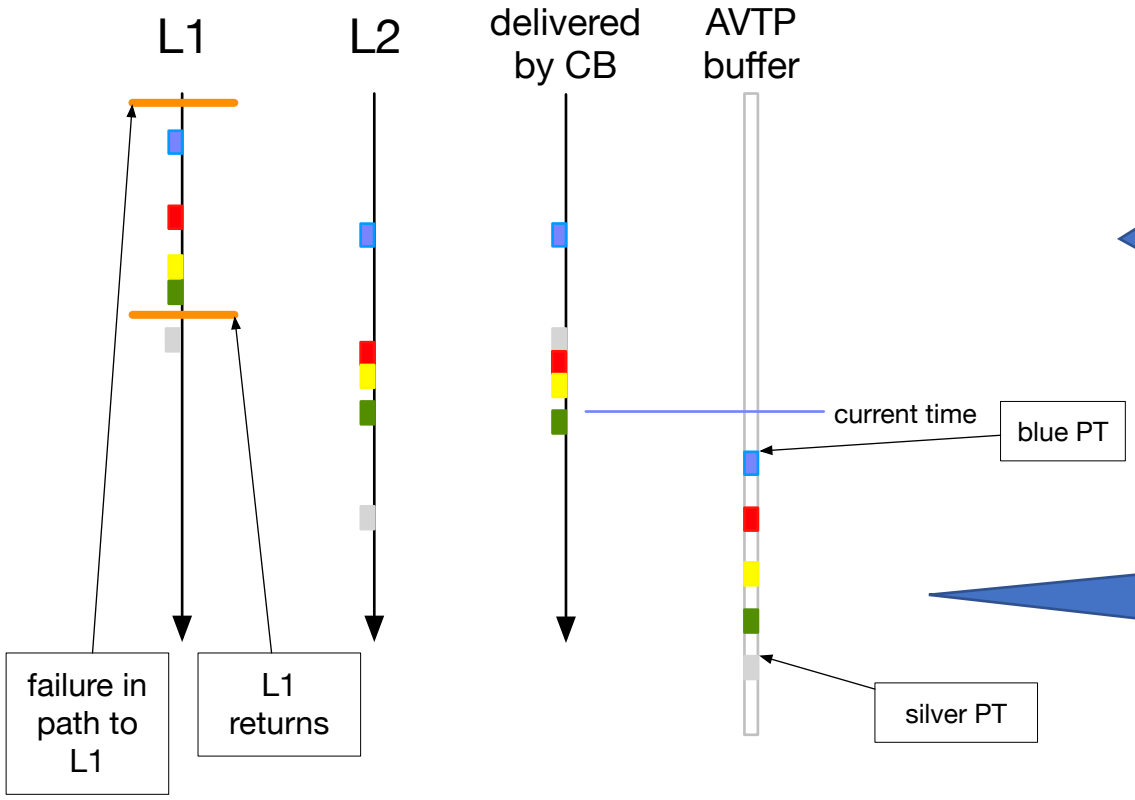
Same for the Red PDU



…And Yellow


L1
L2
delivered by CB
AVTP buffer
current time
blue PT
silver PT
failure in path to L1
L1 returns

…And Finally Green



Note: Sparse timestamping will make this operation difficult. Recommendation: Don't use sparse timestamping in applications using redundant streams.

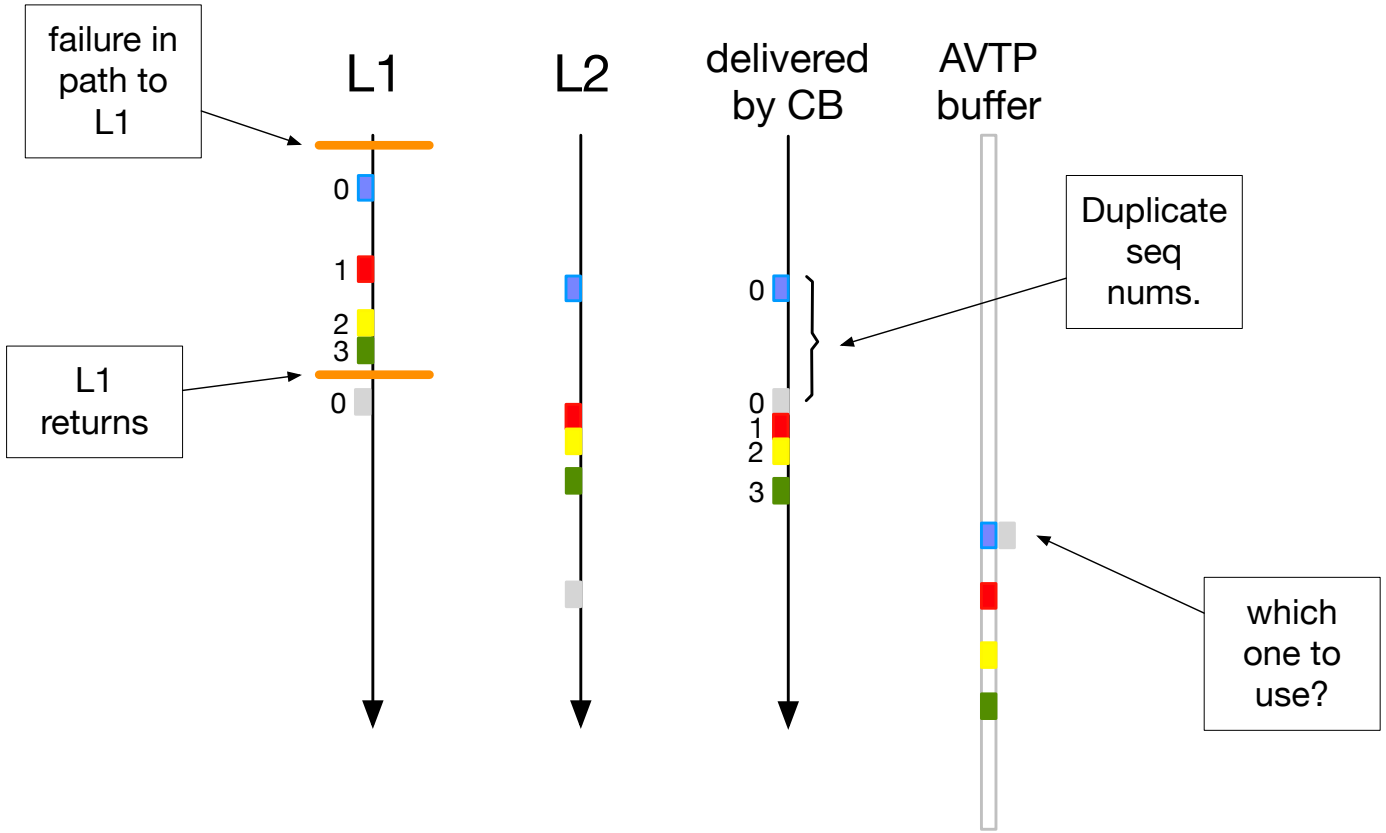
The PDUs are back in order and on-time for distribution to the listener application.

What about Sequence Numbers?

- If the AVTP stream is not using presentation time (tv = 0), how to re-order PDUs? Or if the stream is using sparse timestamping.
- Sequence numbers are our only option, within the AVTP framework.
- How well will that work? What are the limitations?
  - A short sequence number could cause problems. How short is too short?

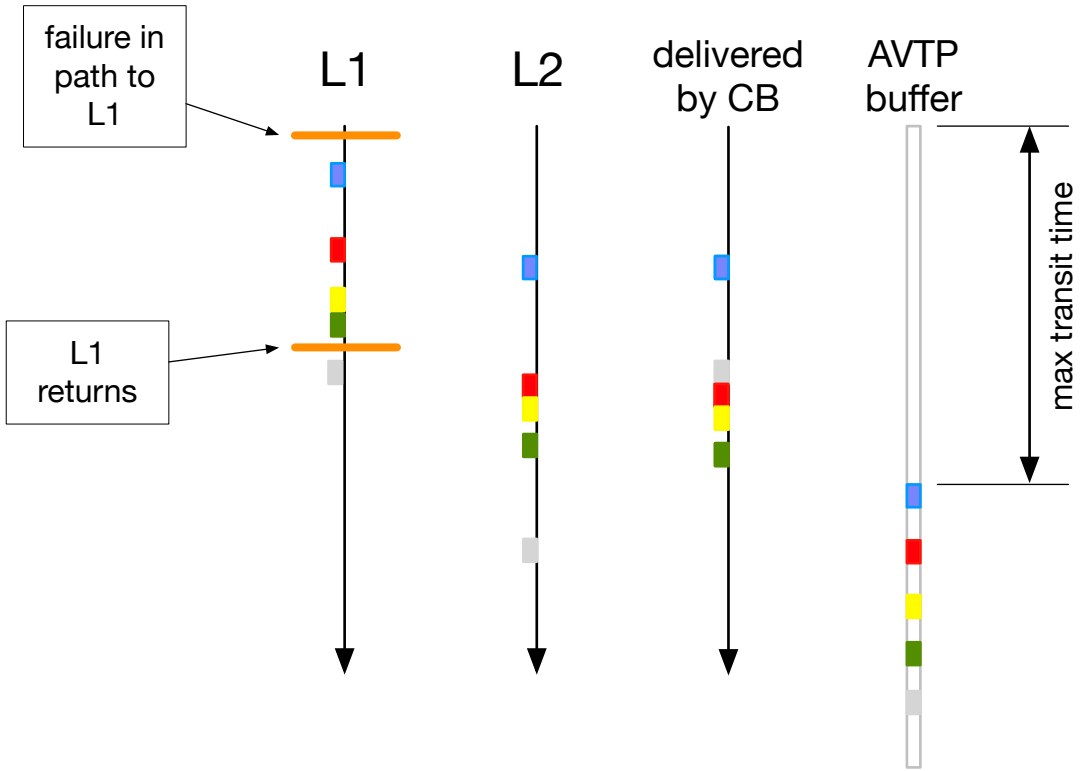
2-bit Sequence Number Example: Too Short!

For this example, assume the sequence number is 2 bits long…



Sequence Number Can't Repeat Within the Delay Difference between Paths

- The worst-case delay difference is typically the max transit time.
- This occurs if the short path is zero and the long path is as long as possible.



As long as the sequence number doesn't repeat during the max transit time, all PDUs can be resolved.

Important Point: The Listener MUST still buffer in order to complete reordering of PDUs. It can't simply pass PDUs because PT isn't used.

Example Calculations

$$R_M = \frac{seqnumsize \times PayloadBytes \times 8}{MTT}$$

where R_M is the max data rate possible for a stream with a particular PDU, sequence number size and Max Transit Time combination.

Seq Num Size	Payload Bytes	MTT	Note	R_M
256	1468	2ms	Raw video, full Ethernet frame, class A	1.503 Gbps
256	1468	15ms	Raw video, full Ethernet frame, class C	200.4 Mbps
256	1468	50ms	Raw video, full Ethernet frame, class B	60.13 Mbps

We have a problem. For instance, raw 24bit, 1080p, 60fps video has a 2.98Gbps rate. It won't fit.

Potential Solutions (in no particular order)

- Use the IP encapsulation of AVTP described in Annex J of 1722-2016. Utilize the 32-bit encapsulation sequence number to complete re-ordering.
  - The AVTP listener must recognize the UDP encapsulation format
  - Gordy: Is this mapping a layer violation?
- Have the 802.1CB elimination point pass the resulting PDU stream as a single member CB stream – complete with the CB R-TAGS and their 16-bit sequence number – to the AVTP listener.
  - The AVTP listener must recognize the CB stream tag, utilize the CB seq number to help with re-ordering and eliminate the tag before passing along the PDU.
  - Gordy: Is this a layer violation?
- Create a new AVTP header with a larger sequence number
- A combination of presentation timestamps (when using sparse timestamping) and sequence numbers.

ToDos

- Need to add expanded explanations of each solution
- Need to make a specific recommendation for updating the standard.