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Open Questions and further Details for a CB Solution

CB - Further Details

IEEE 802.3 Interim Session – Norfolk

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Intention of this Slide Deck

The author would like to focus the future work on CB and show technical options for further proceeding.

Some questions occurred during the last meeting and need to be clarified to get a common understanding of CB.

- What is with Out-of-order delivery?
- How to realize the Sequence number
- How to identify a CB connection (“Flow”/TSN Stream/…)

This presentation tires to provide some detailed information for the further proceeding of the CB standardization.

Agenda

This Presentation is divided in 2 major parts:

Open Questions

- What is with Out-of-order delivery?
- Is a 1-bit Duplication Windows enough?
- Will 1-VID work for the shown use-cases?

What Options should be considered for the CB Standardization

- Basic CB Mechanisms
- How to identify a CB connection (“Flow”/TSN Stream/…)
- What Parameters are needed to describe the CB Mechanism

CB and Out-of-Order Delivery

http://www.ieee802.org/1/files/public/docs2013/cb-nfinn-1CB-features-needed-0713-v01.pdf shows that a flakey link can cause an out-of-order delivery or loose of frames:

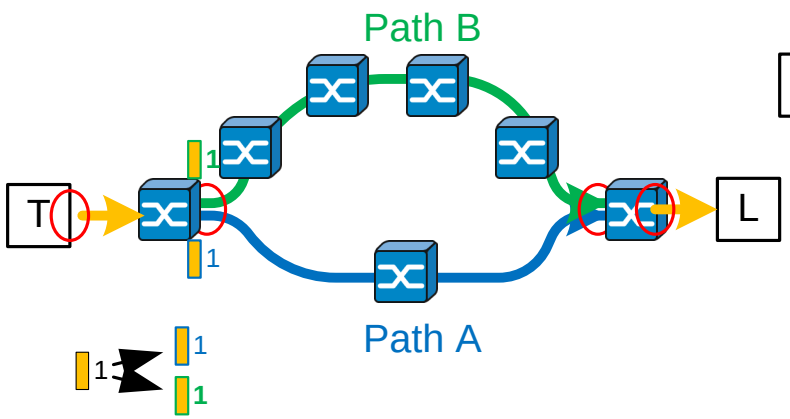
Sequence numbering: PRP

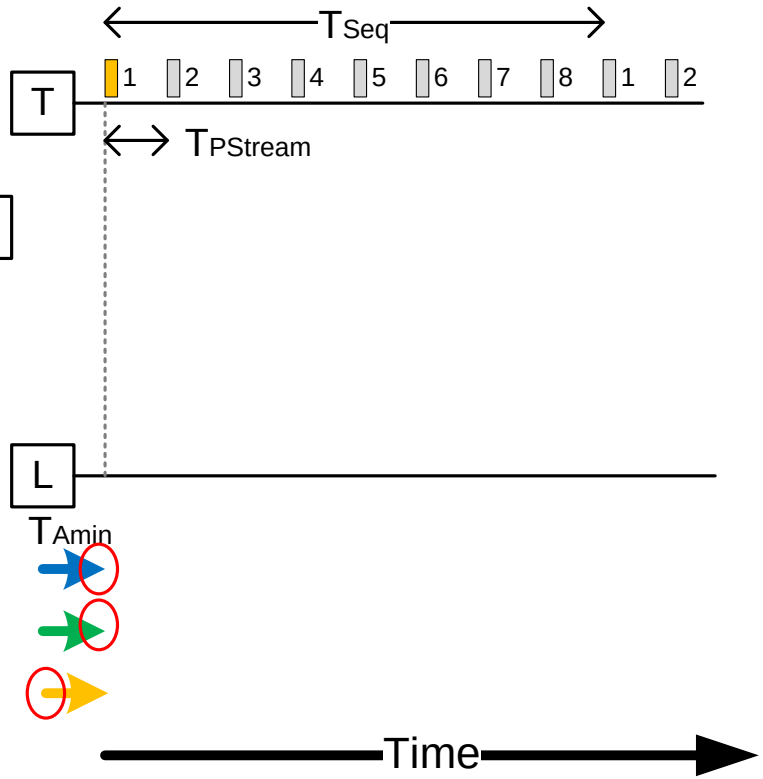
- On the bad side, if the difference in delivery time for the two paths is greater than the packet transmission interval for the stream, and if the faster path is flakey, then delivery is flakey.
  - A1 = sequence number 1 on path A. (B3) = dropped packet.
  - Arrival order at discard function: A2 B1 (A3) B2 A4 B3 (A5) B4 A6 B5 (A7)
  - Delivery to customer: A2 A4 A6, because A4 arrived before the missing B3.

- Using the same example as before:
  - Arrival: A2 B1 (A3) B2 A4 B3 (A5) B4 A6 B5 (A7)
  - Delivery: A2 B1 A4 B3 A6 B5

The described use case is shown in detail in the following slides, after showing the normal operation of CB.

CB Transmission in the network



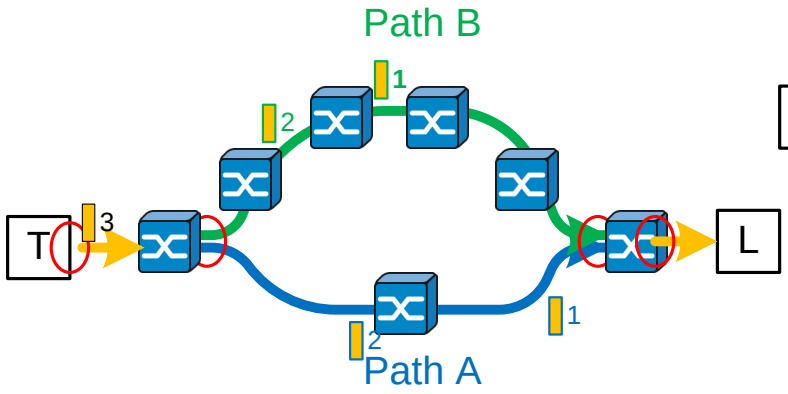


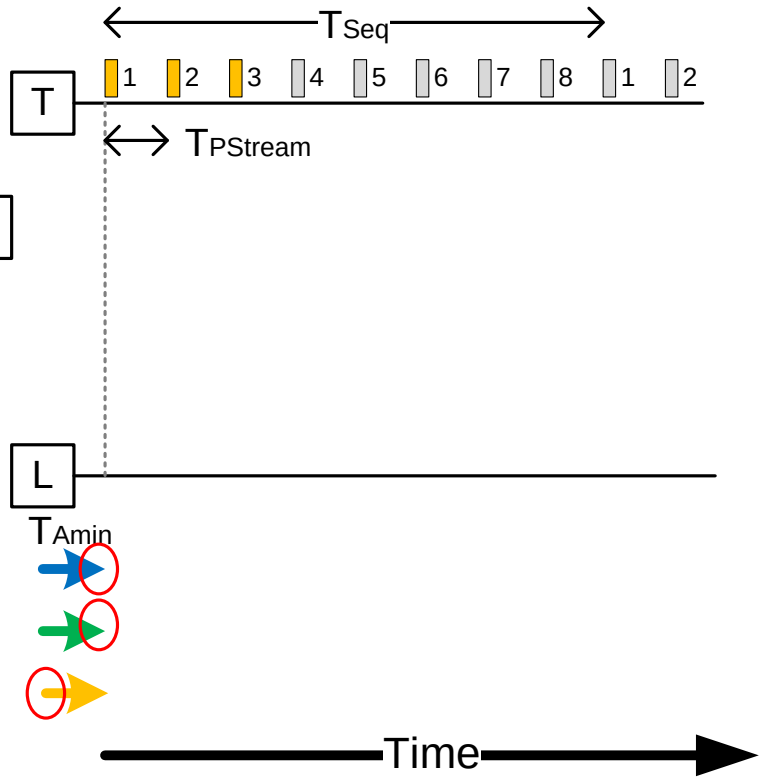
Frame Replication at the CB Bridge

- Same frame – **same DA-SA-VID**
- Same Sequence number (CB Tag)
- Send out on different Ports / Paths

(similar to Multicast forwarding)

CB Transmission in the network

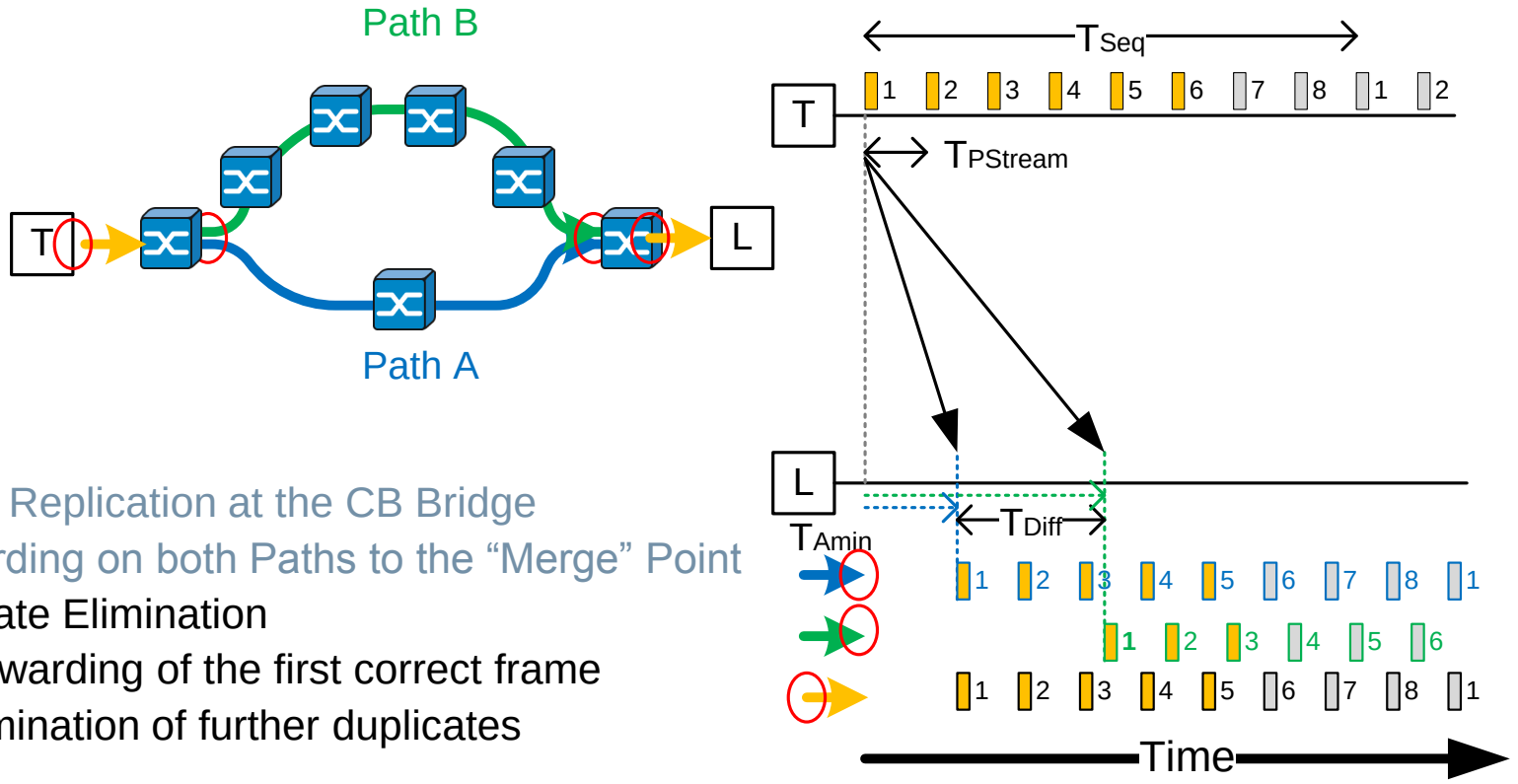




Frame Replication at the CB Bridge

Forwarding on both Paths to the “Merge” Point

CB Transmission in the network



Frame Replication at the CB Bridge

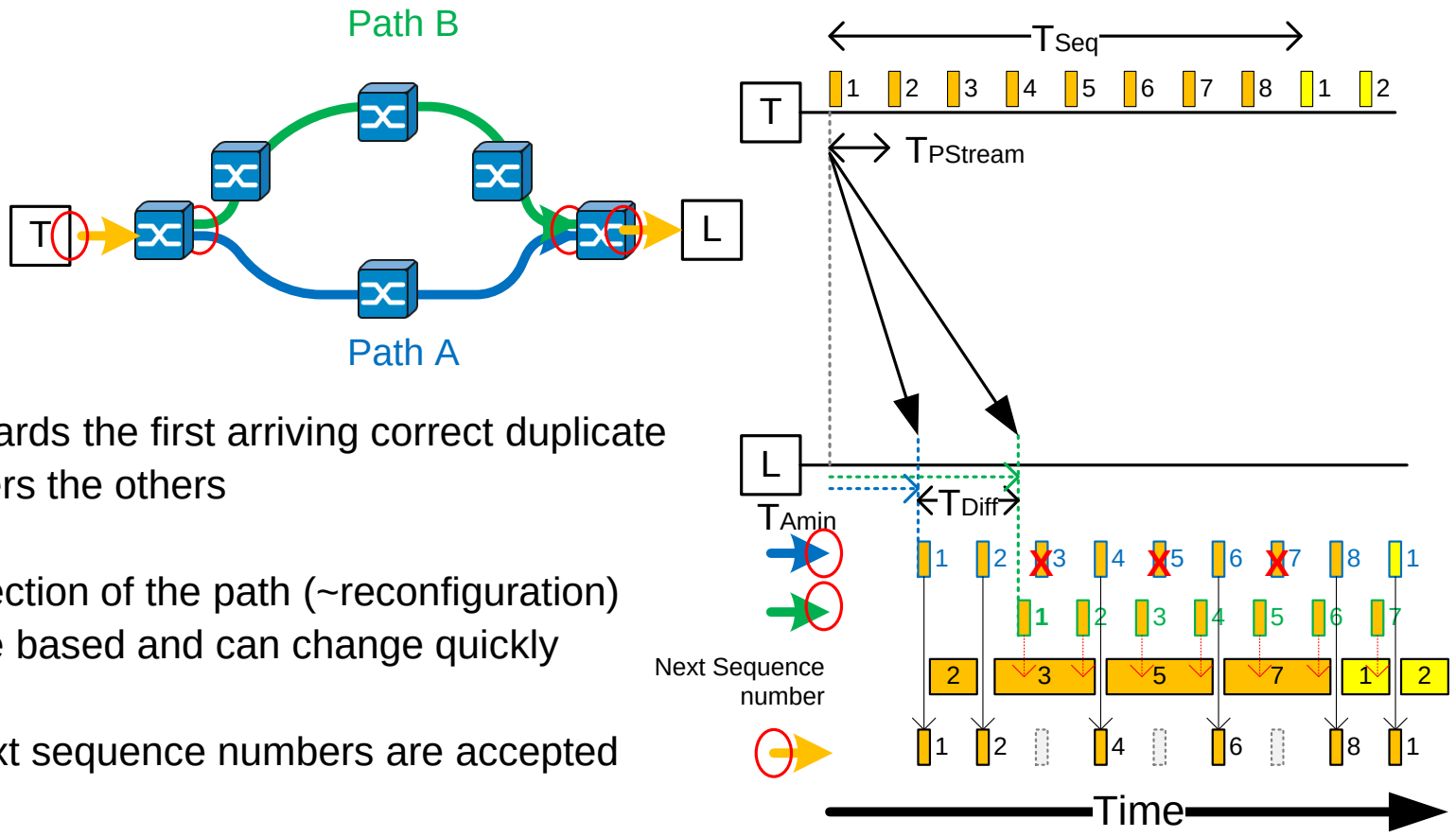
Forwarding on both Paths to the “Merge” Point

Duplicate Elimination

- Forwarding of the first correct frame
- Elimination of further duplicates

Consequences of a flaky path

when using a 1-bit duplicate elimination window



CB forwards the first arriving correct duplicate and filters the others

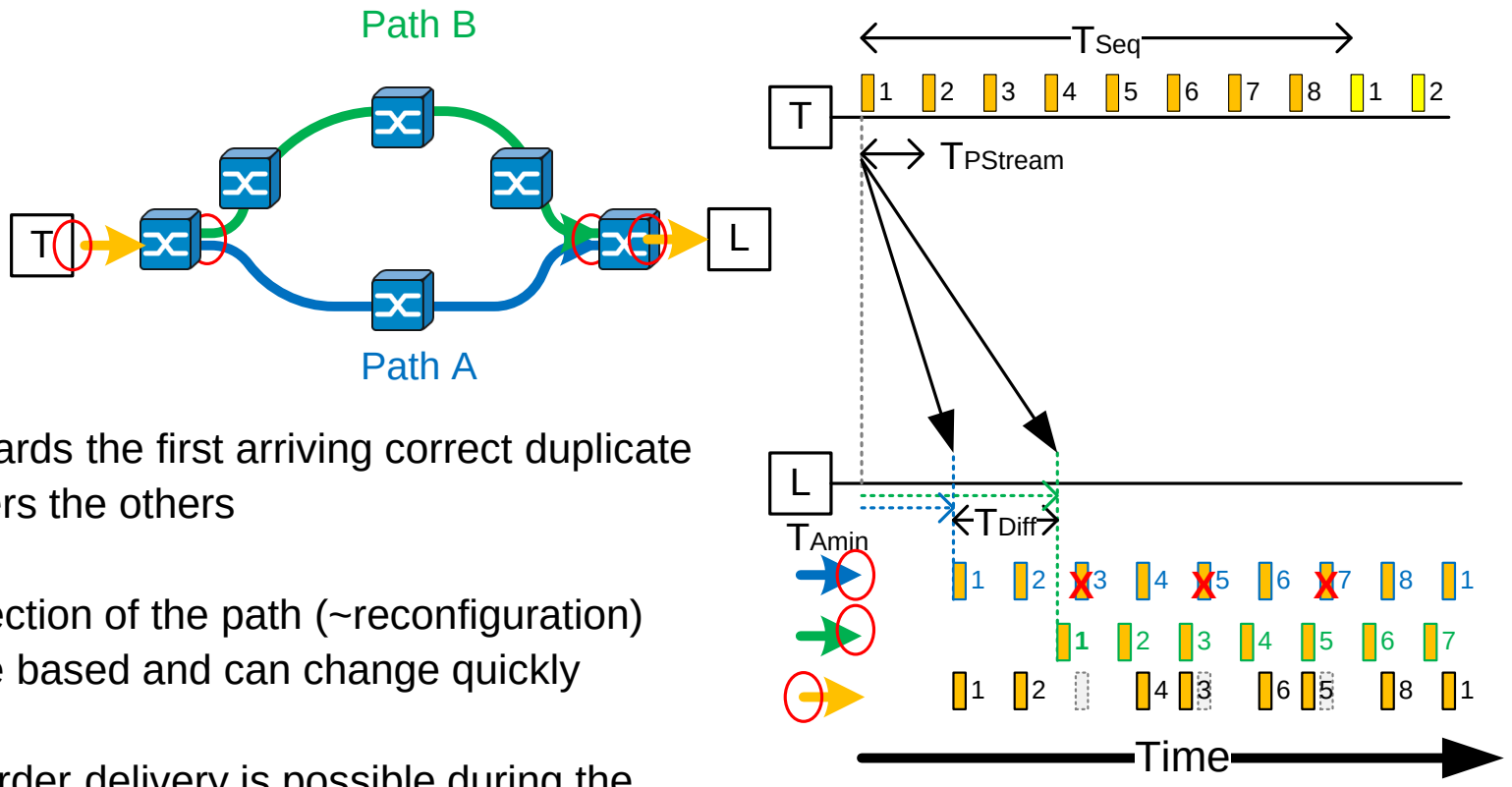
The selection of the path (~reconfiguration) is frame based and can change quickly

Only next sequence numbers are accepted

Path B is useless – the redundant transmitted information is not used to prevent single frame errors

Consequences of a flaky path

when using a n-bit duplicate elimination window (e.g. n=8-bit)



CB forwards the first arriving correct duplicate and filters the others

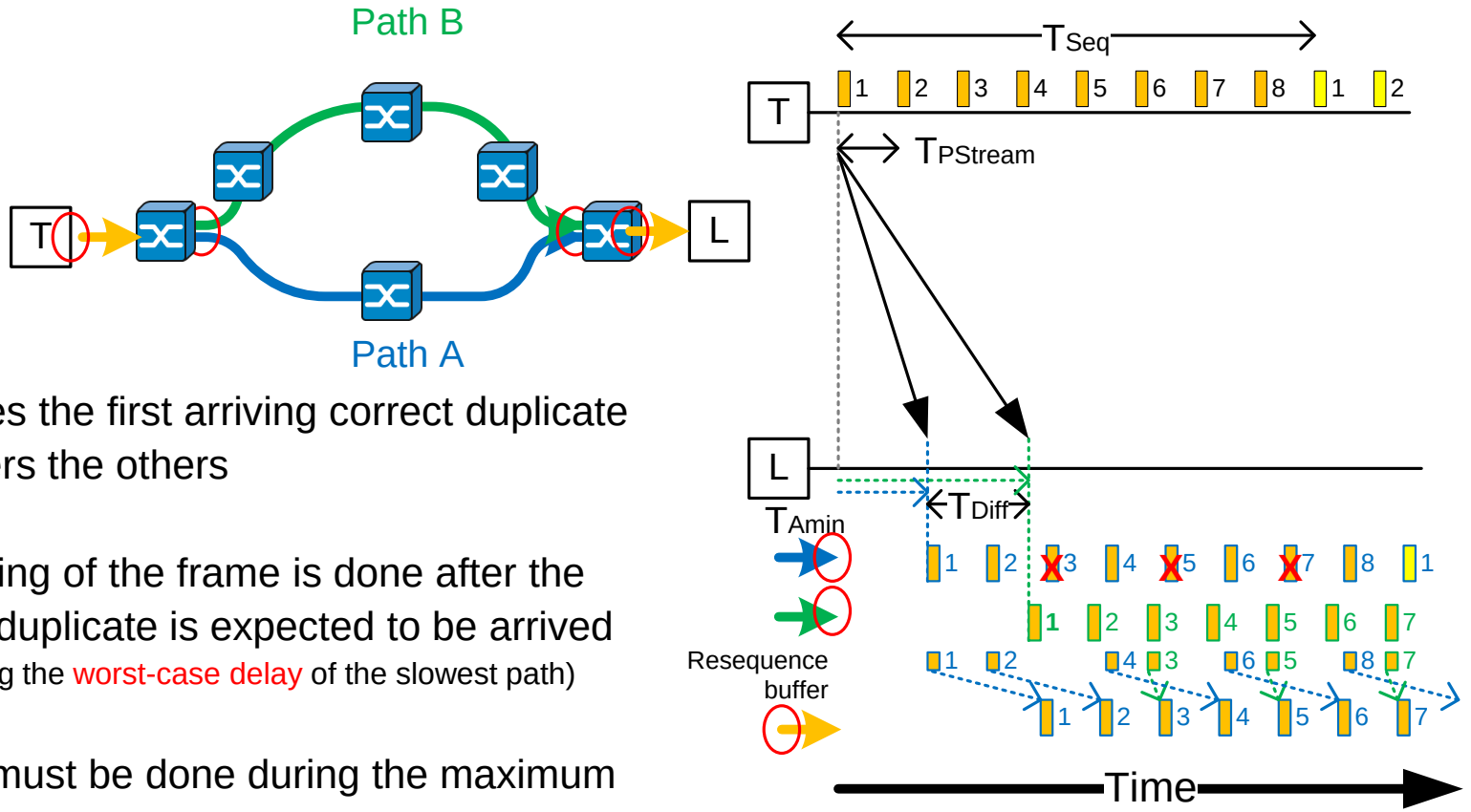
The selection of the path (~reconfiguration) is frame based and can change quickly

Out-of-order delivery is possible during the reconfiguration of the network (e.g. RSTP TC)

CB may cause Out-of-order delivery
This can be prevented by a resequence mechanism

Consequences of a flaky path

when using a resequence function



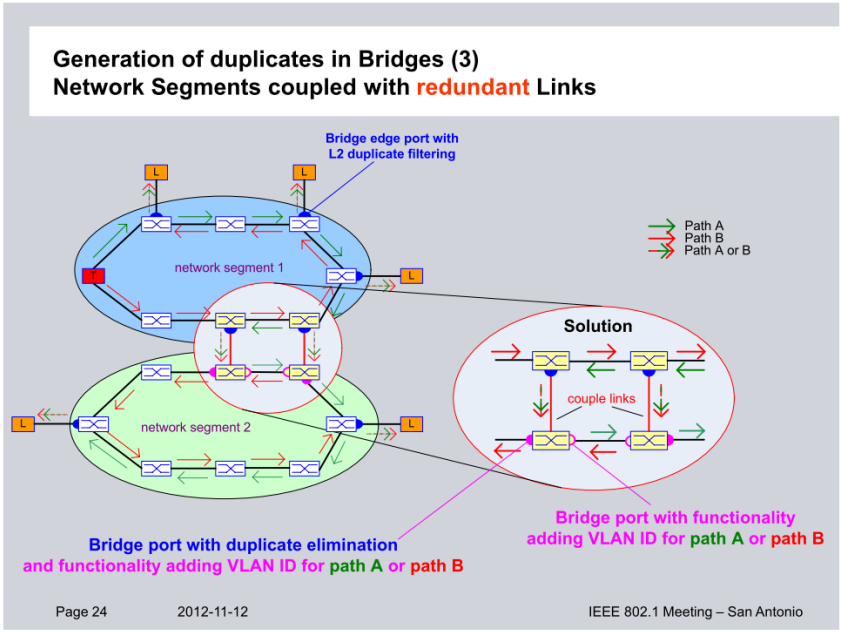
CB stores the first arriving correct duplicate and filters the others

Forwarding of the frame is done after the slowest duplicate is expected to be arrived (considering the worst-case delay of the slowest path)

Storing must be done during the maximum latency difference of the paths

CB with 1-VID

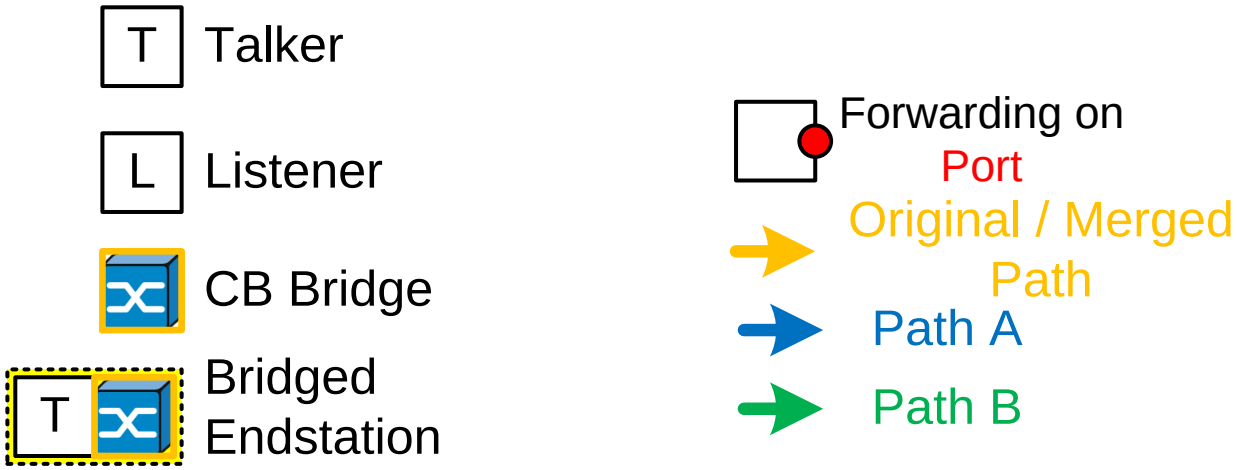
Multiple CB Use Cases where shown in the past for the 2-VID solution.
The following Use Case will be demonstrated with a 1-VID solution:



http://www.ieee802.org/1/files/public/docs2012/new-goetz-jochim-Seamless-Redundancy-1112-v03.pdf

CB with 1-VID

The following Symbols are used to demonstrate the use case:



The **Blue** and **Green** color of the path shows the independent forwarding in the network
But: Frames on both paths are exact duplicates
(Same DA, Same SA, Same VID, Same CB-Tag, …)

The **Orange** color is used to show that just one of the duplicates is transmitted on this path

CB with 1-VID
Paths in the Network

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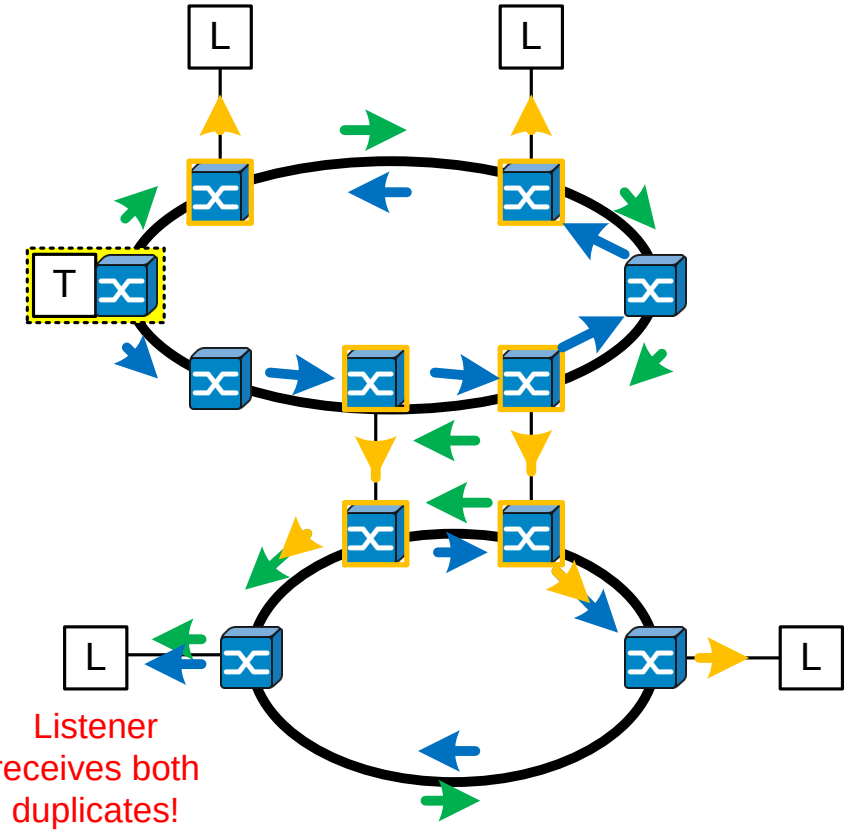
Paths in the network with redundant segment coupling using CB Bridges:



CB with 1-VID
Forwarding in the Network

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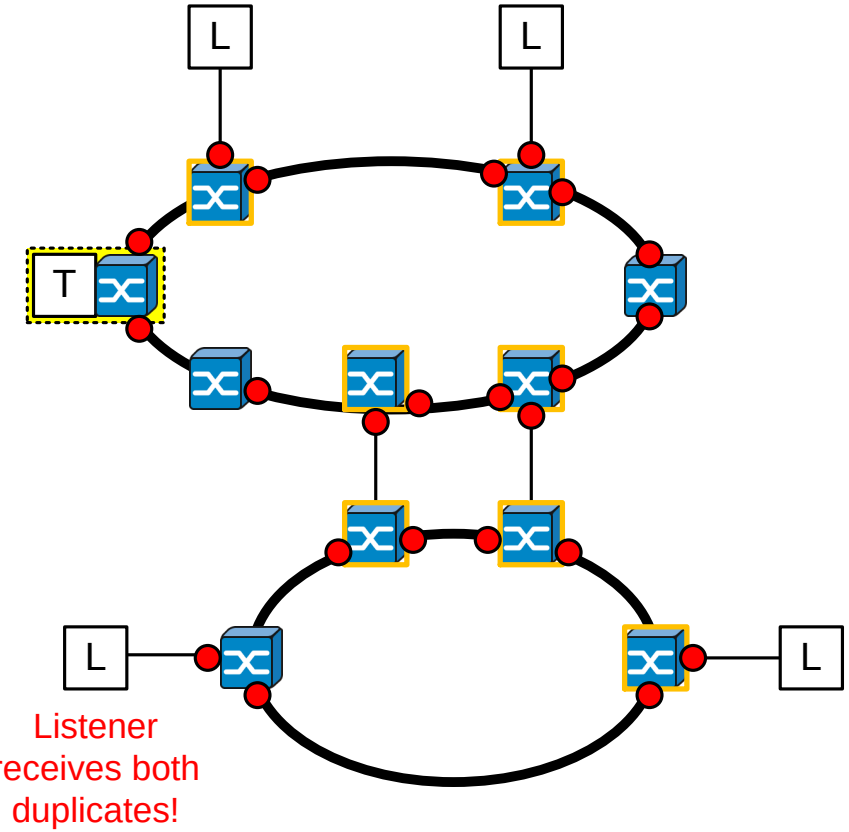
Forwarding in the network with redundant segment coupling using CB Bridges:



CB with 1-VID
Forwarding in the Network

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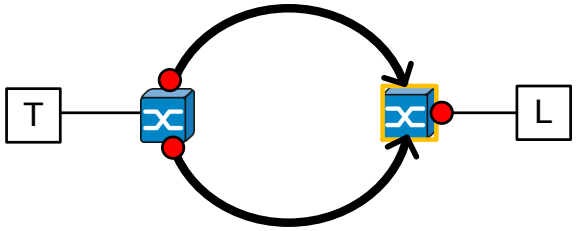
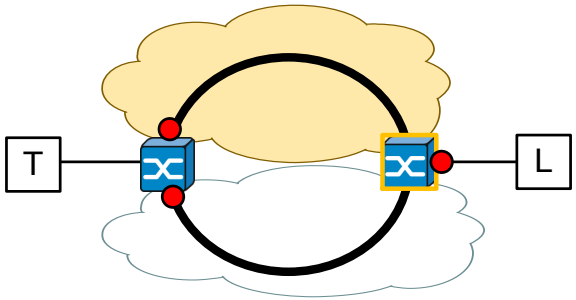
Routed Paths must ensure that there are no loops in the path!

Shared Links double the Bandwidth (if no CB Bridge is used – see next slide with CB Bridges)

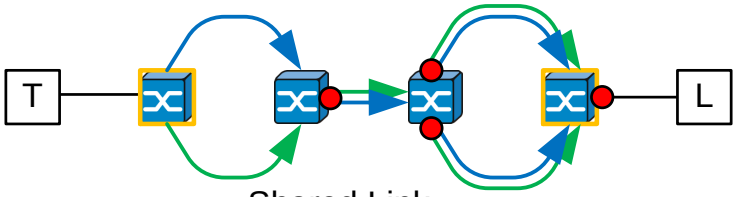


Normal Bandwidth

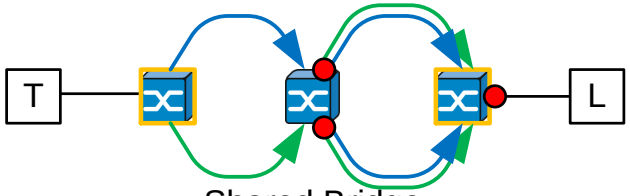


Seperated Paths

Doubled Bandwidth



Shared Link



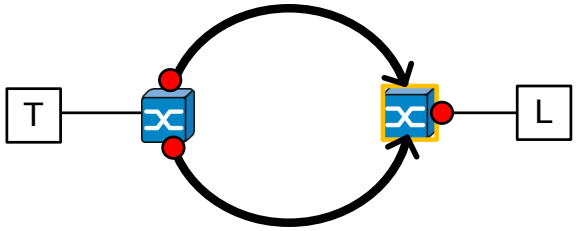
Shared Bridge

A 2-VID Solution can always distinguish frames from Path A and Path B
(after a Shared Bridge / Link)

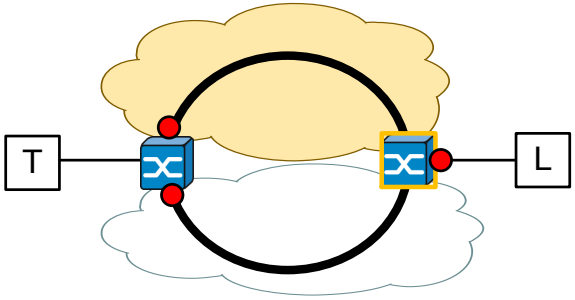
CB with 1-VID
Forwarding in the Network

Routed Paths must ensure that there are no loops in the path!

CB eliminates Duplicates

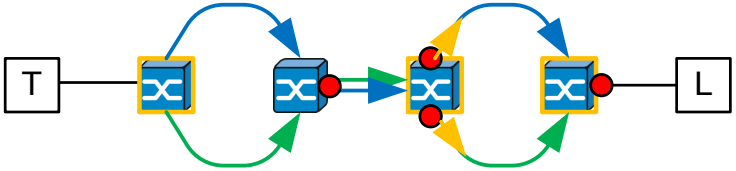


Normal Bandwidth

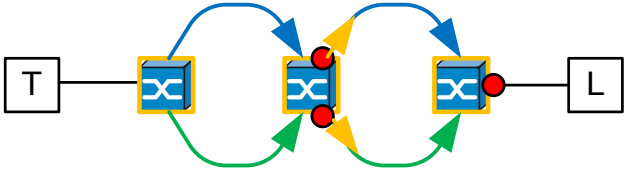


Seperated Paths

Duplicate Elimination



Shared Link



Shared Bridge

No need to distinguish frames from Path A and Path B when using CB Bridges

(Duplicate Elimination before a Shared Bridge / Link)

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Basic CB Mechanisms

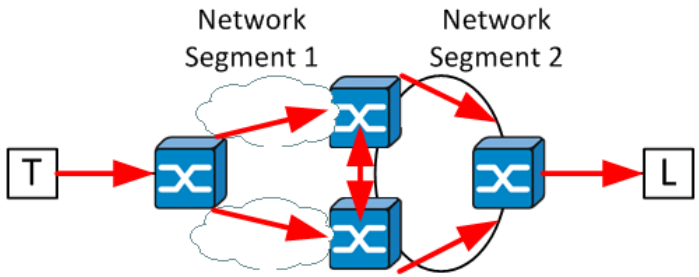
There are four different functions that are needed for CB:

- Insertion of the CB Tag in the frame (Sequence number, Tagging)
- Replication (using the Multicast behavior in the 1-VID case)
- Duplicate Elimination (Filtering of duplicates)
- Deletion of the CB Tag in the frame (CB Tag removal)

Basic CB Mechanisms

Merge (Duplicate Elimination) and Sequence Number Discard are two function and should exist independent

We have shown in many presentations that a CB bridge should be able to redundantly couple network segments. (coupled rings in e.g. http://www.ieee802.org/1/files/public/docs2012/new-goetz-jochim-Seamless-Redundancy-1112-v01.pdf)



Use cases exist where the CB Merge functionality **without** a sequence number discard functionality is needed in a Bridge!

Network Segments show why the sequence number removal should be done only at the end.

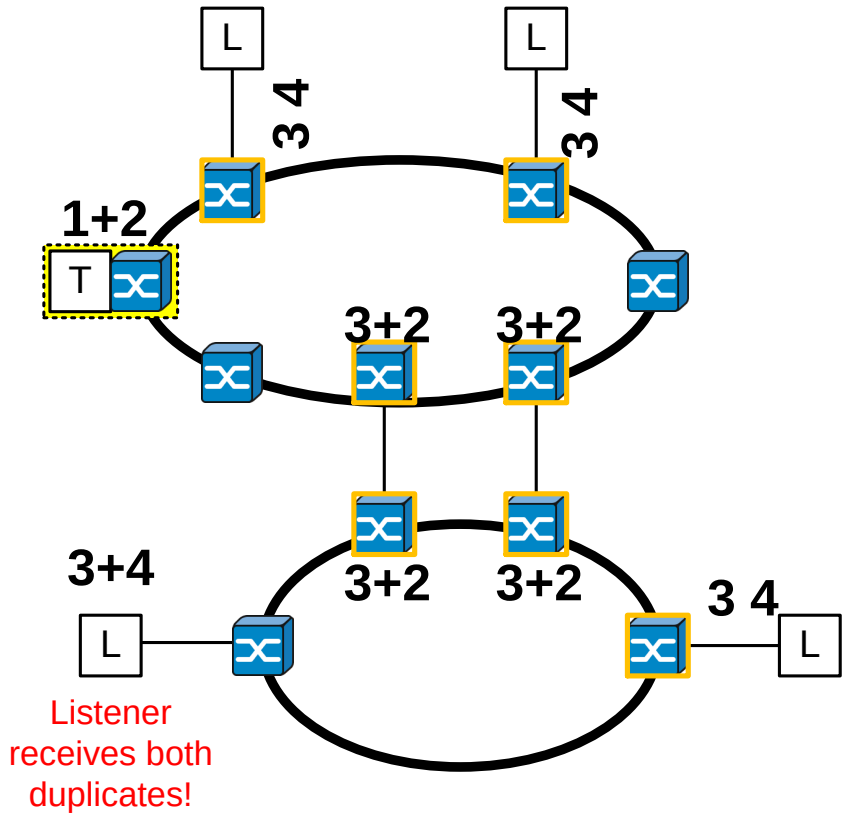
Basic CB Mechanisms

Mechanisms in the example use case

1. Insertion of the CB Tag in the frame (CB Tagging)
2. Replication
3. Duplicate Elimination
4. Deletion of the CB Tag in the frame (CB Tag removal)

Duplicate Elimination (3) must be based on the same sequence number!

Therefore the CB Tag must be in the frame from the 1st CB Bridge until the last CB Bridge.



Suggestions for CB

Make CB flexible - Different Applications require different Settings

- One 32-bit Sequence number Tag for compatibility
- Limit the sequence number - “active windows” during setup of path
  (Active Sequence number size)
- Acceptance Windows for Filtering “out-of-order” arriving frames
  (for robustness - handle failures like in AFDX)
- Duplicate Elimination Windows (capability to filter duplicates)

New Requirement from CB

- Information about Max/Min Latency
  (to guarantee Duplicate Elimination – also discussed as requirement for buffer size calculation)
- Reset functionality of the sequence number
  (needed during setup / re-setup –> CB Control Plane Protocol)

Options to identify a CB connection

Flexibility for 802 based solutions - Openness for other network technologies

Suggestions for CB

Active Sequence number size

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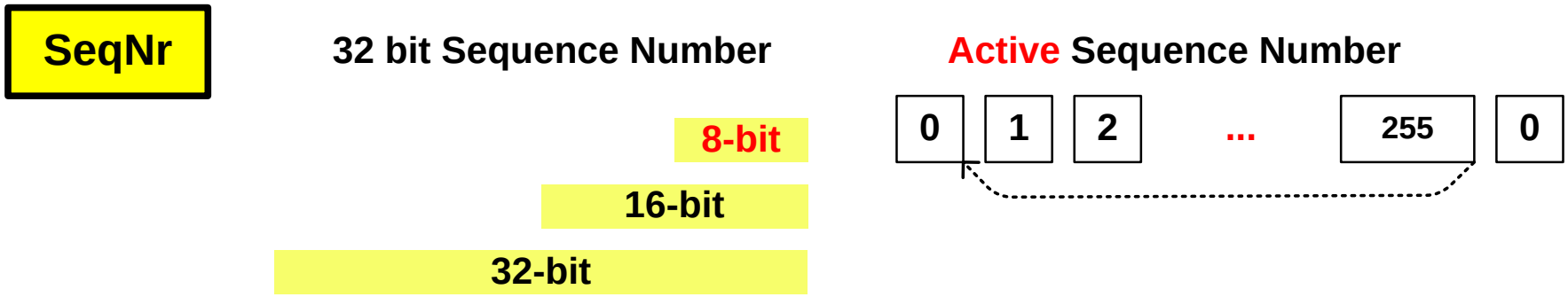
Sequence Number in the TAG (with CB Ethertype)

Possible solutions to fulfill different Requirements:
Different (active) Sequence number size



Option to setup the active sequence number size (8/16/32/… bit)
from the Control Plane Interface – and read out the maximum possible value

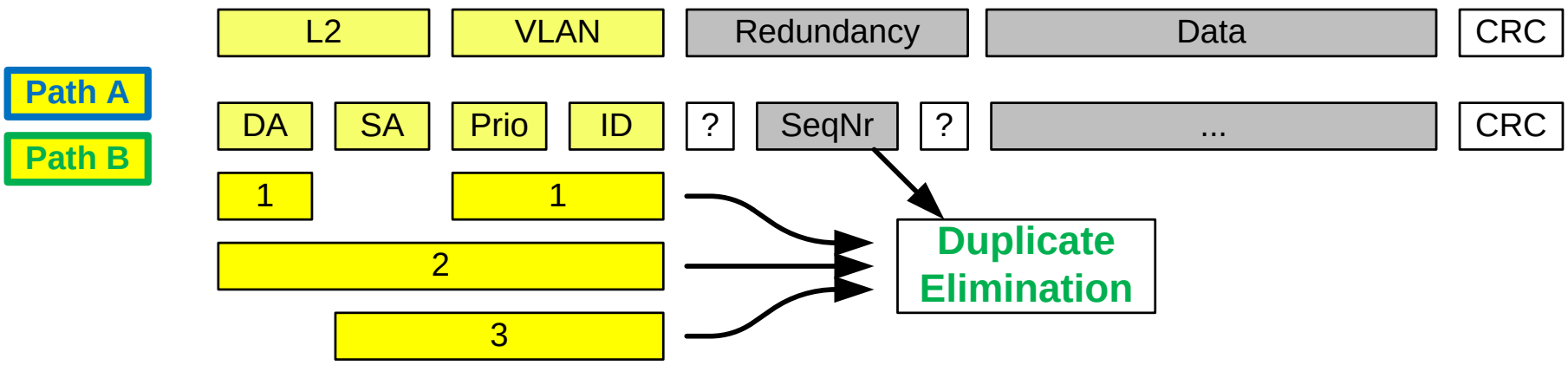
Option to reset the current state of the Duplicate Elimination function during (re-) setup/reservation of the path

Suggestions for CB

Identification of a CB connection (Stream, Flow, …)

We have discussed at least 3 options to identify an Layer 2 “flow” (redundant CB “stream”, flow, …).

1. DA + VID (for TSN Streams)
2. DA + SA + VID (General Use Case)
3. SA + VID (PRP compatibility)



If VLAN is not used, then all information without VID (DA / DA + SA / SA)

Suggestions for CB

Setup of a CB Connection

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Steps for setting up a CB Connection

1) Setting up the forwarding paths
2) Resource Reservation along the paths for guaranteed delivery
   (e.g. TSN Stream Bandwidth Reservation)
3) Min. and Max. Latency Calculation
4) CB Settings based on the Latency Difference and Application
   - Size of the active Sequence Number
   - Size for duplicate Elimination
   - Acceptance Window for robustness
   - Method of CB Connection Identification
   - **… others?**

5) Signaling to start the transmission

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Summary

CB should be as flexible as possible to cover multiple use cases

A 1-VID solution with routed (nailed up) paths work

Four basic functions of CB

- The CB Tag belongs to the End-to-End connection
- Duplicate Elimination and Replication can happen multiple times

Multiple Options to identify a CB Flow

Flexibility for a 802 solution – openness for other protocols

Diagnostic for the CB functionality needed

Similar to the TSN diagnostic information during the setup of the reservation

Configuration of CB Data Plane from Control Plane

TSN principle – use a protocol (control plane) to establish an efficient L2 forwarding (data plane)