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Advantages when combining CB with TSN

Using CB with TSN features

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Intention of this Slide Deck

The author would like to focus on the advantages when combining seamless redundancy (defined in CB) with TSN features.

This slide deck should provide some starting points for a discussion about the further process of CB and should help to make basic assumptions for the standardization process.

Used Terms for the CB Configuration

Active Sequence number window

- ***Start with 0** (open: or 1?)*

Use a fixed-size CB Tag

32 bit Sequence Number

	8-bit
	16-bit
32-bit	

Active Sequence Number

| 0 | 1 | 2 | ... | 255 | 0 |
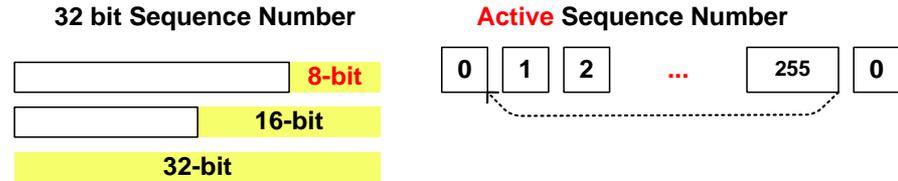
Acceptance Window for Filtering
"out-of-order" arriving frames

? — 3 — 2 — 1 — 0 → **CB**

Acceptence Window = 3

4 →
5 → Accept
6 →
?
7 → Discard
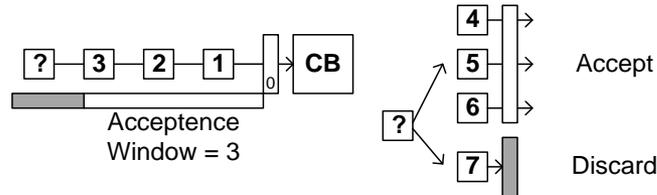
Duplicate Elimination Windows

to remember arrived frames

"old" is the history from the duplication windows

"new" is important for restore behavior after failure

2 | 3 | 4 | 5 | 6 | 7 | 8 | 9

old ← History-Knowledge about arrived Frames → new

Last received
Sequencenumber
SeqLast = 9

1st	SeqLast	9	true
2nd	-1	8	true
3th	-2	7	false
	-3	6	true
	...		
nth	-(m= n-1)	4 (n=6)	true

SeqLast - m

Discard

History

SeqLast

Accept
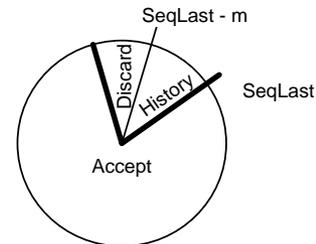
Identification of CB Circuits

| L2 | VLAN | Redundancy | Data | CRC |

optional

DA	SA	Prio	ID	?	SeqNr	?	...	CRC
1		1						
2								
		3						

Duplicate Elimination
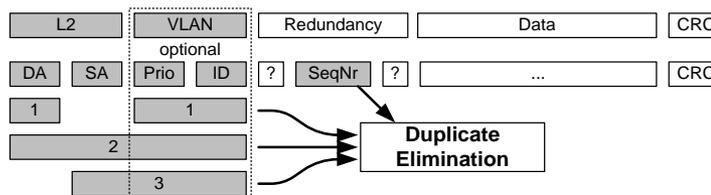
Forwarding of CB Frames

The first intention was to use VIDs for the separation of paths in one network, because VIDs enable to virtually separate the forwarding plane of the network.

[1] shows that one VID might be enough, depending on the target use-case. The previously presented use case with one VID (see [2]):


Bridge

Bridge with CB

Port with activated CB (for the shown circuit)

Port with configured forwarding

No CB Bridge
-> Listener doing CB
receives both duplicates!

[1]: http://ieee802.org/1/files/public/docs2014/cb-nfinn-How-Many-VLANs-0214-v02.pdf
[2]: http://ieee802.org/1/files/public/docs2014/cb-kiessling-Details-0514-v01.pdf
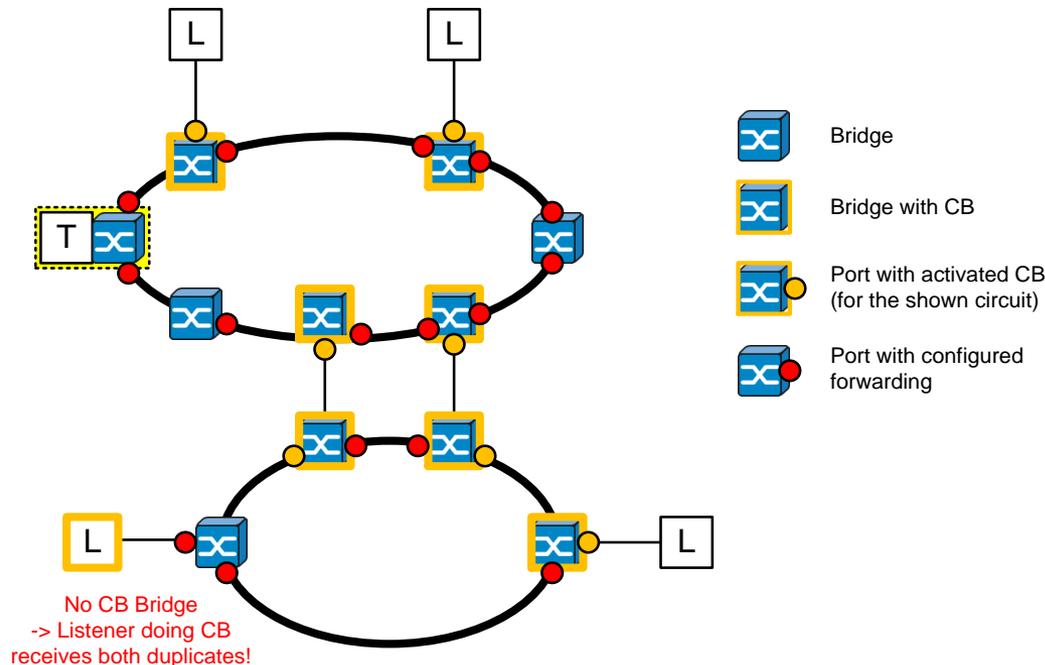
Forwarding of CB Frames

Two assumption are necessary for the 1-VID case

No "criss-cross" of forwarding paths in non-CB *("normal")* **bridges**
Intermediate Bridges at the "criss-cross" point can't distinguish between both circuits (*possible in the 2-VID case*) and forward frames along both paths, causing a duplication of frames.

CB functionality for duplicate elimination in "criss-cross" points
The Goal of the CB functionality is to do Duplicate Elimination. CB can avoid the forwarding of the "criss-cross" duplicated frames along the paths.

see picture from[1]:
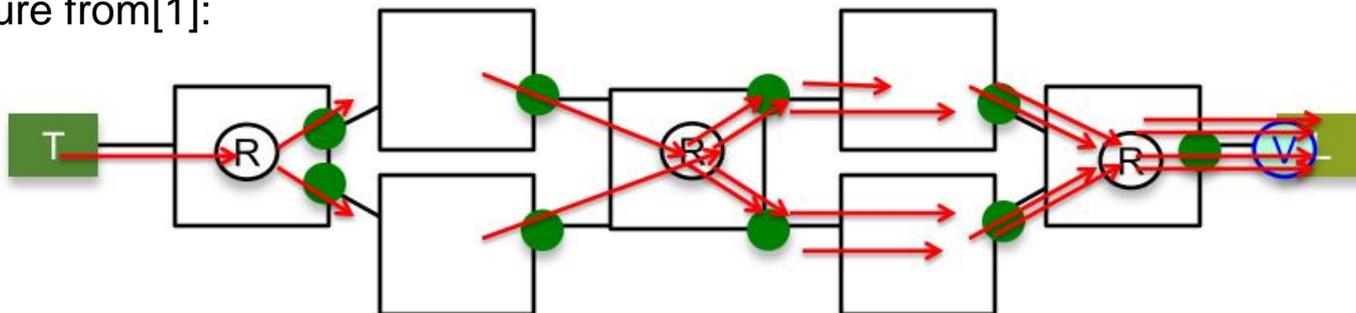
Forwarding of CB Frames

CB uses multiple (2 or more) paths simultaneously. The CB mechanisms must be configured / enabled at "criss-cross" points to avoid unintended frame duplication.

CB circuits must be identified by the CB mechanisms
- Based on using the **available L2 forwarding information (DA / SA / VID)**
- Optional: Mechanism like deep packet inspection

Configured Forwarding for redundant CB circuits
(redundant paths – not flooding and learning on loop-free topologies)
- Right name for a CB "connection": CB circuits *(or other names?)*
- Disjoint-paths for a good redundancy behavior
- Path Configuration: Manual or using Protocols *(e.g. using ISIS PCR)*
- CB enabled only at "merge" of circuits
  (not in every bridge for every stream – not CB aware bridges can forward frames)
  How to identify CB Bridges / How to do the configuration?

Similarities between TSN and CB

TSN Streams are forwarded on paths between Talker and Listener

➢ No Flooding and learning for Streams *(MSRP pruned path)*

➢ States in the network for the Streams *(no longer stateless)*

TSN reserves resources in the bridges along the path for streams
(bandwidth by setting shapers, buffers, …)

➢ E.g. Shaper setting for the reserved Bandwidth at needed points

New: "Merge" of Streams in the network (enabling of CB)
"Merge" currently only for Listener – not for Talker

Forwarding along configured paths
Extension of the existing "Talker Pruning" functionality?

Similarities between CB and TSN

The (*optional*) CB serialization mechanism must be adopted to the CB circuit
- ➢ Difference in arriving frames from multiple paths
    - • Guaranteed max. and min. latency *(MSRP reservation and latency calculation)*
- ➢ Maximum Number of Frames per Interval *(TSpec of Streams)*

A robust CB duplicate elimination mechanism need to know the required size of the history knowledge for guaranteed duplicate elimination
- • Skew = Minimal Latency *(assumption for MSRP Gen 2)* and Maximum Latency
- • Traffic specification *(Maximum number of transmitted Frames during the Skew)*
- ➢ Both is available *(with MSRP Gen 2)* for TSN Streams

Reserved Traffic => Guaranteed functionality of CB!
Forwarded Bandwidth relies on CB – guaranteed duplicate elimination needed!

Summary of Assumptions

- **No "criss-cross" of forwarding paths in non-CB bridges**

- **CB functionality for duplicate elimination in "criss-cross" points**

- **CB circuits must be identified by the CB mechanisms**

- **Configured Forwarding for redundant CB circuits**

Related other CB Topics

CB intention is to use multiple paths. The result after the duplicate elimination can lead to an out-of-order delivery.

Different assumptions lead to different solutions for the following open problems in the CB draft:

- Serialization - Reordering of arriving frames
  - Arbitrary traffic
  - TSN Streams
- Reset behavior - loss of one path

Out-of-Order Delivery

Out-of-order delivery (*and duplication of information*) is possible during a network reconfiguration (change of the forwarding path - e.g. RSTP TC).
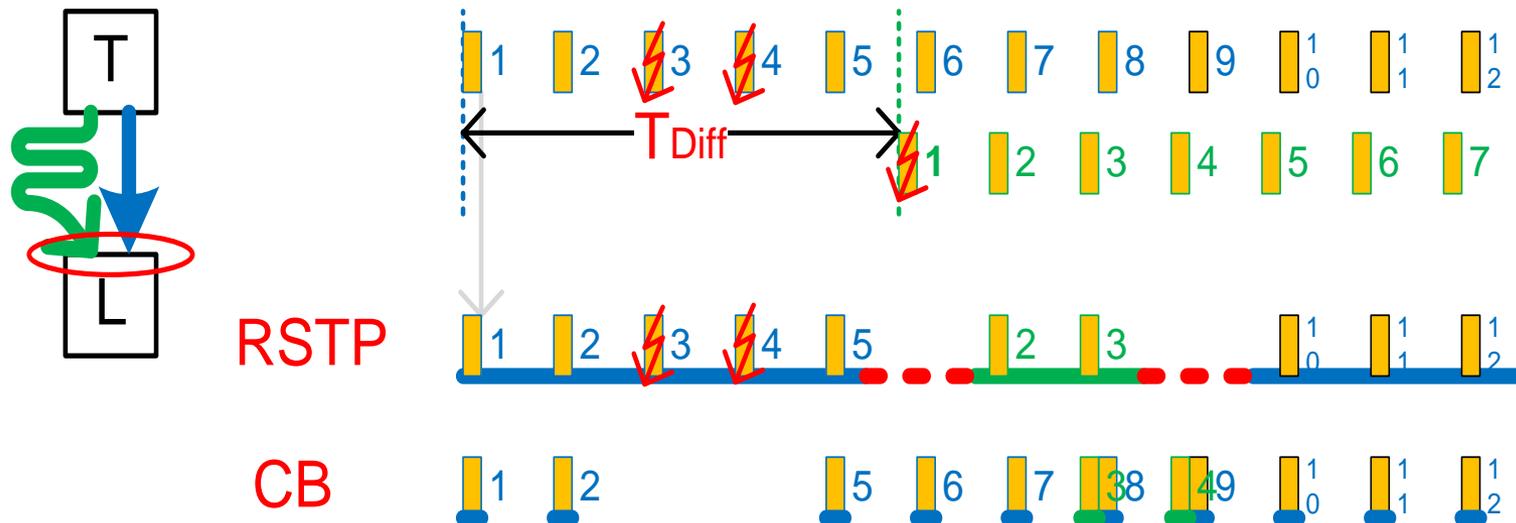
CB forwards the first arriving correct duplicate and filters the following duplicates.
The selection of the path is made for every frame individually.
A network reconfiguration can happen after every arrived frame.

Reordering of arriving frames

The current Draft includes a re-ordering of frames (for a CB connection).
Frames must be stored and released in the original order.

This is a new feature – RSTP and MSRP allow a out-of-order delivery during the reconfiguration of the network (change of the forwarding path).
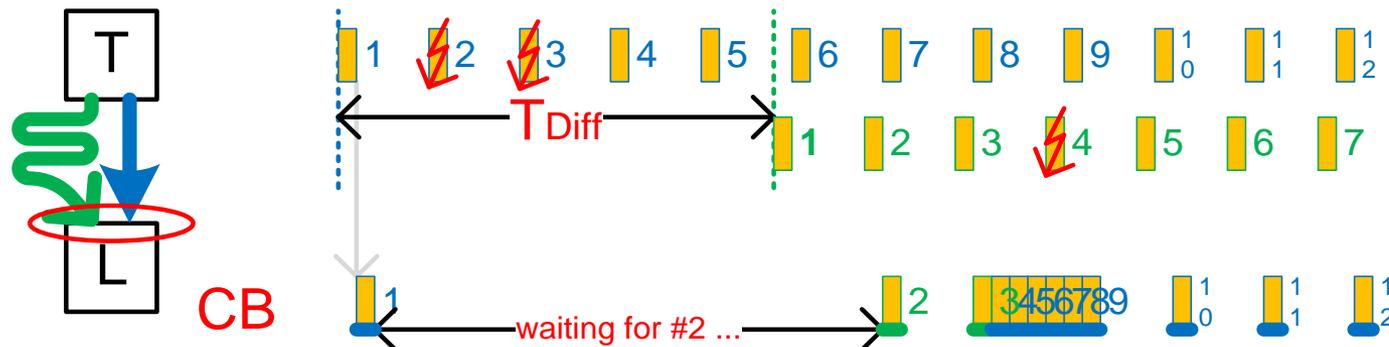
- How long must the frames be stored? How many?
  Failure: Release stored frames after timeout ? = loss of frames
 (if frame #2 never arrives …)

Streams have a maximal latency and maximal number of frames / interval.

Reordering for Streams

Streams are periodic, every arriving frame must be delayed until it's duplicate should be arrived to **retain the stream characteristic** in failure cases.
The Skew can be estimated using the maximum guaranteed latency.
(*using MRSP Gen 1 - minimal latency was suggested to be included in MSRP Gen 2*)
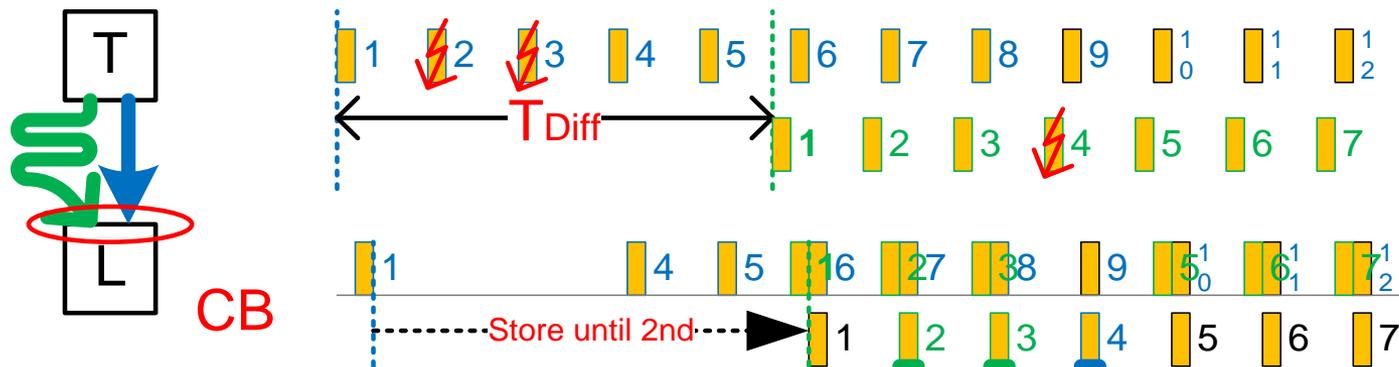

Arriving frames with an higher sequence number must be stored to be able to switch to the fast path again and avoid loss of frames. *(see Frame 4)*

Temporary loss of one path

CB and a temporary loss of one path (*optional re-ordering of frames not shown*):
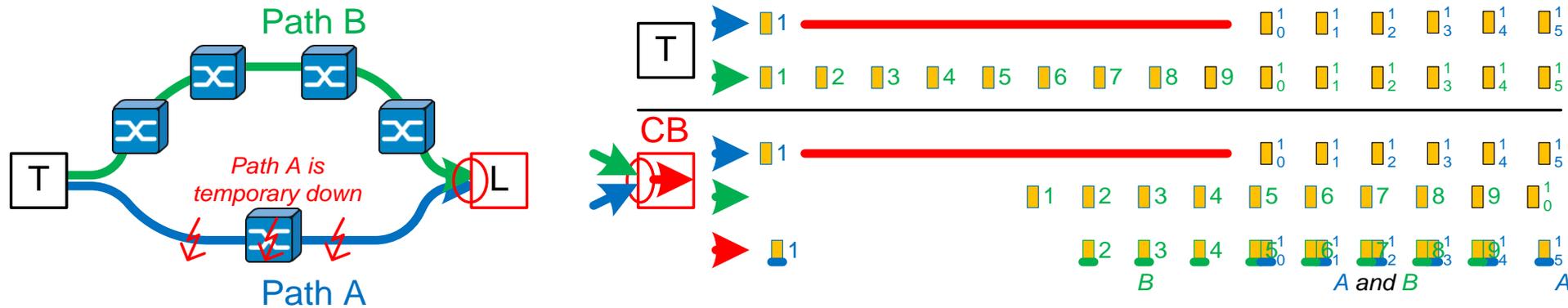
The CB Bridge at the merge point receives both streams and "switch" between the path. The current sequence number is known.

The CB functionality can recognize the "**gap**" in the sequence *(between 1 and 10)*.

Other bridges along the forwarding path only forward the frames.

What happens if CB is activated on a path?

Temporary loss of one path

Same Example with CB in the forwarding bridge of Path A:
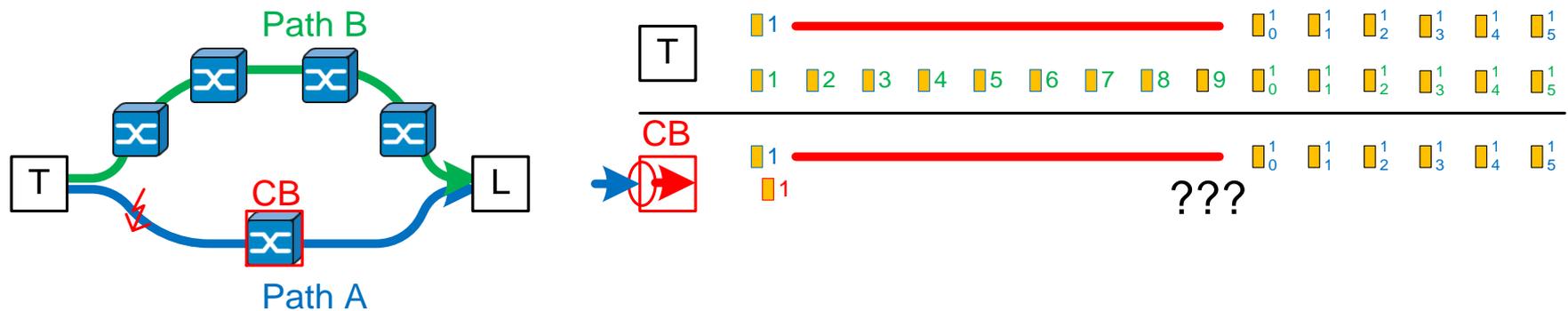
The CB Bridge in Path A receives only one duplicate.

No frames arrive for some time … the path A is repaired and the bridge is confronted with a **jump** in the sequence number …

Accept the big jump in the sequence number and continue?
Discard the frames and wait for the next sequence number?