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Improvement for gPTP Gen 1 (IEEE 802.1 AS)

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Structure of this Presentation

1. **Problem with the Recovery of the Sync Tree**
   - **Topology with GM**
   - **Comparison to RSTP**
   - **Solution with Path Trace TLV**
2. **Limitations of the Path trace TLV**
3. **Proposal to solve the Problem**
   - **Using an Hop-Count like in RSTP**
   - **Routing for the Sync-”Tree”**
   - **Redundancy through multiple independent Sync-Path’s**

Stored GM Information

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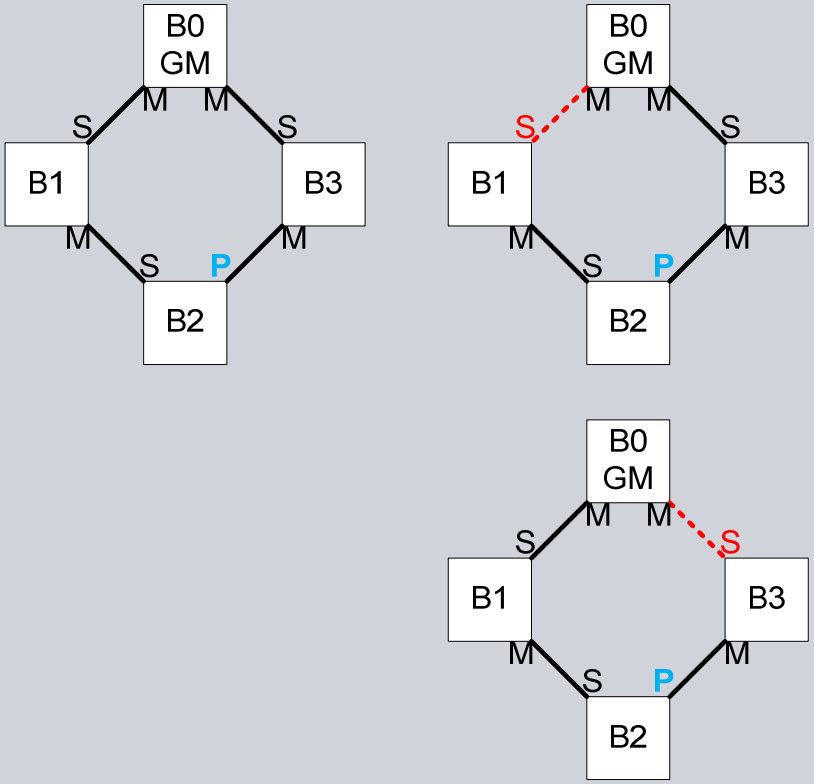
Ring-Topology with GM

Faster Reaction when using stored information

Ring with GM



1 Link is down

2 Slave Port without GM -> become GM

3 send new „GM“ B1 to B2

4 B2 receives „GM“ B1

5 B2 answers **after Timeout** with stored GM Info on P Port

6 B1 accept's old GM Info

1 Link is down

2 Slave Port without GM -> become GM

3 send new „GM“ B3 to B2

4 B2 receives „GM“ B1 on P Port

5 B2 answers **after Timeout** with stored GM Info on S Port

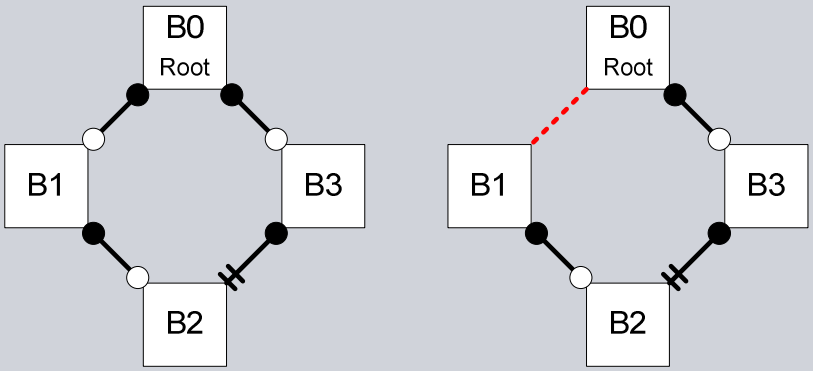
6 B3 accept's old GM Info

RSTP Topology

The BMCA described in this standard **…** is also equivalent to a subset of the Rapid Spanning Tree Protocol (RSTP) (IEEE 802.1 AS-2011 p68)

Same Ring-Topology with RSTP:

Ring with GM



○ Root-Port
● Designated Port
= Alternate Port

1 Link is down

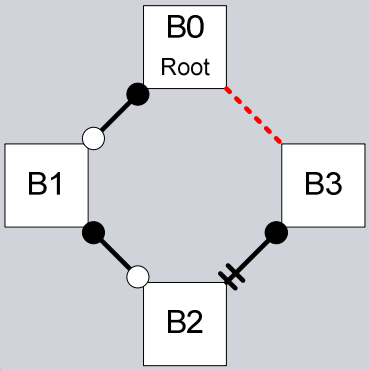
2 B1 expects to be Root Bridge

3 send B1 Root Information

4 B2 receives B1 is Root

5 B2 answers with stored Root Info of Alternate Port

6 B1 accept's „old" Root Bridge B0



1 Link is down

2 B3 expects to be Root Bridge

3 send B3 Root Information

4 B2 receives B3 is Root

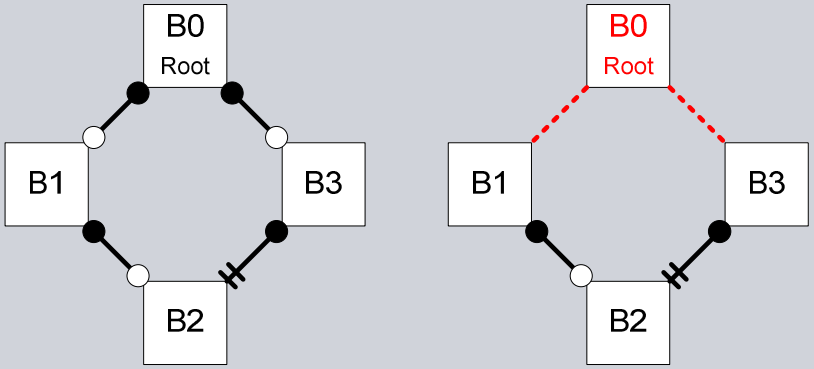
5 B2 answers with stored Root Info of Alternate Port

6 B1 accept's „old" Root Bridge B0

What happens when RSTP Root-Bridge fails?

Ring-Topology with stored RSTP Informations

Ring with GM



○ Root-Port
● Designated Port
= Alternate Port

1 Link is down

2 B1 expects to be Root Bridge
3 send B1 Root Information
4 B2 receives B1 is Root

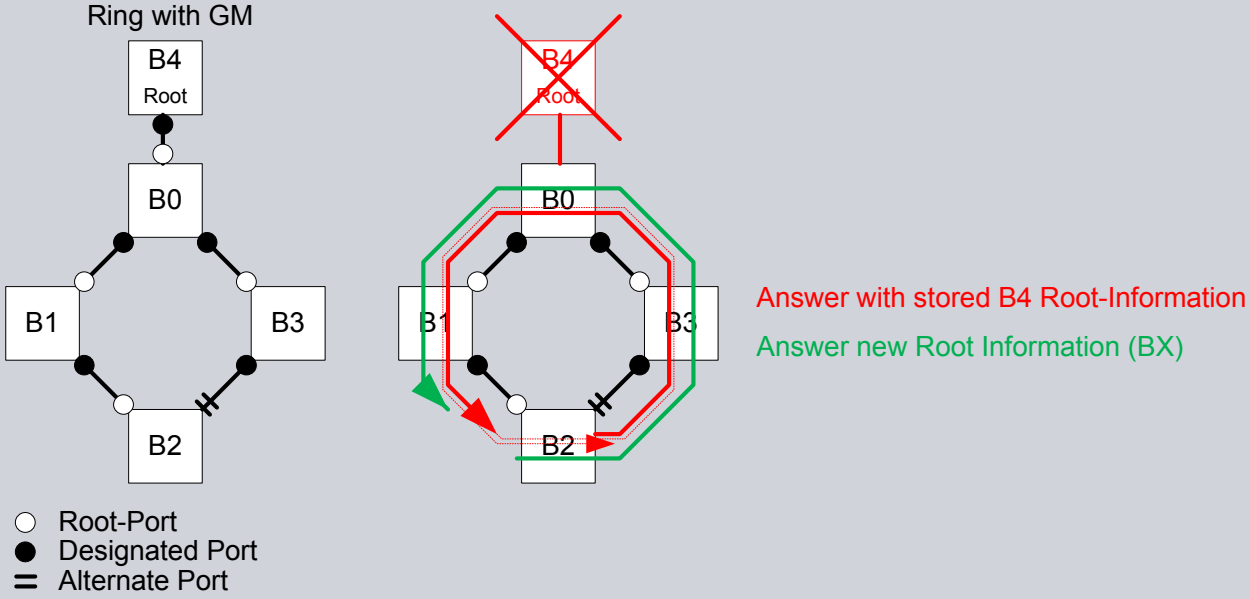
2 B3 expects to be Root Bridge
3 send B3 Root Information
4 B2 receives B3 is Root

Depending on time

5 B2 answers with stored Root Info of Alternate Port
6 B2 delets the stored Root Info of Alternate Port/Root Port

What happens when RSTP Root-Bridge fails?

Ring-Topology with stored RSTP Information's



Looping limited by using a max. Hop-Count

Max. Hop-Count >=

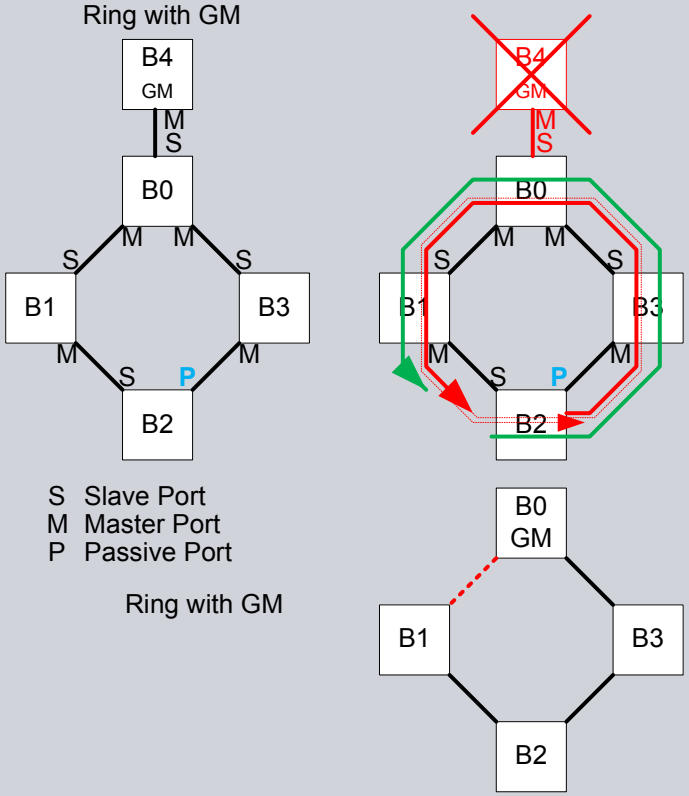
the longest possible way from the root in the network to each station

the longest possible loop (link-failure can separate them in a long line)

What happens in meshed network's ? More possible loops in the network.

What happens when GM-Bridge fails?

Ring-Topology with stored GM Information's



Answer with stored GM-Information

Answer new GM Information (BX)

1 Link is down – no GM Information

2 Timeout in Bridges B1 … B3
unknown sequence due to lokal timers

Assumption: Timer in B1 run's out first

3 B1 sends new „GM" B1 to B2 and B0

4 B2 receives „GM" B1

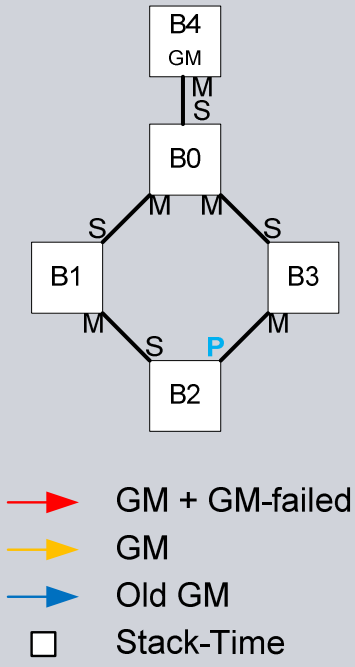
5 B2 answers with stored GM Info on P Port

6 B1 accept's old GM Info

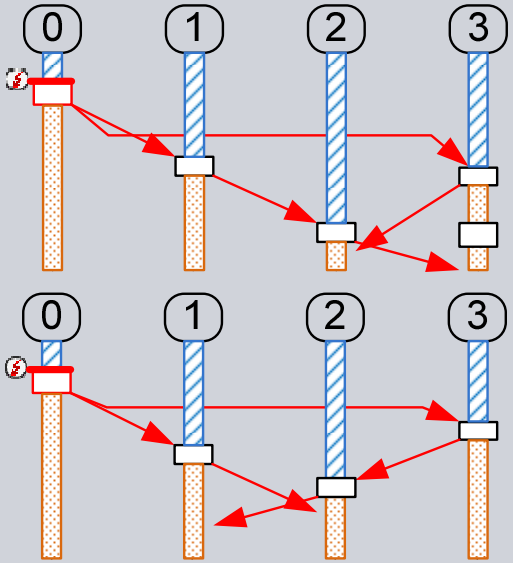
Currently solved with the **Path-Trace TLV**

Problem with the RSTP Tree / Sync Tree

Ring-Topology with stored GM Information's

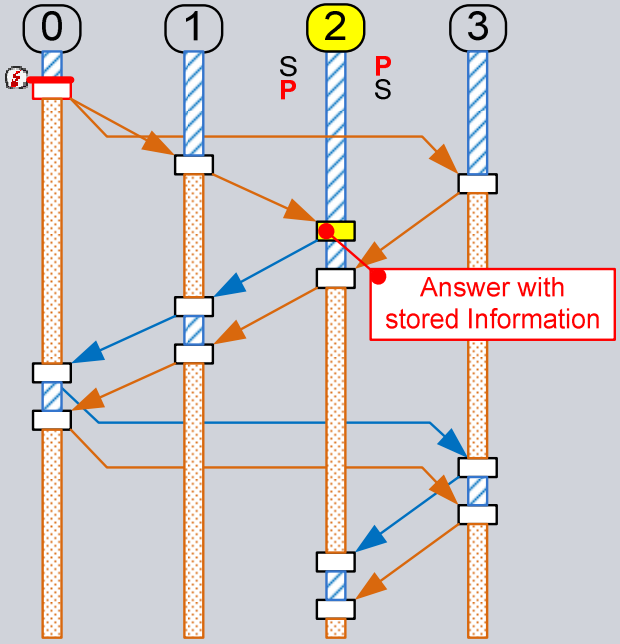


Wished Behaviour
new Information should renew
the old stored information



Deletion of the old stored information

Real behaviour
stored information dominates



Sharing of „wrong“ GM Information

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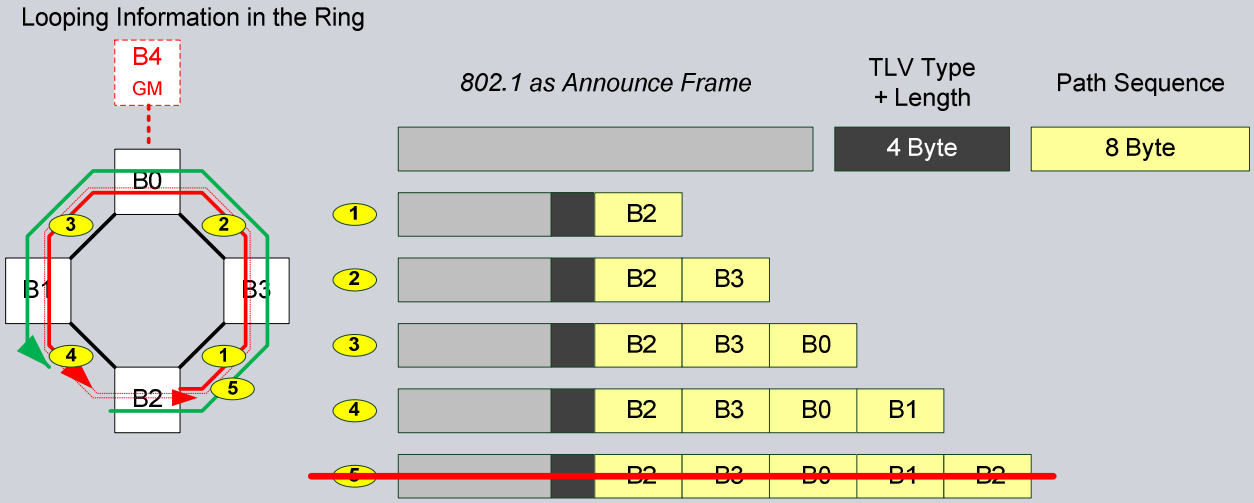
Current Solution with Path trace TLV

Ring-Topology with GM



The additional TLV must be able to carry the number of Clock IDs equal to the Hop-Count of the longest loop in the network (similar to RSTP Max. Hop Count)

If a frame includes the own clock ID in the path sequence, then the announce frame must be deleted.

Path trace TLV in an industrial ring

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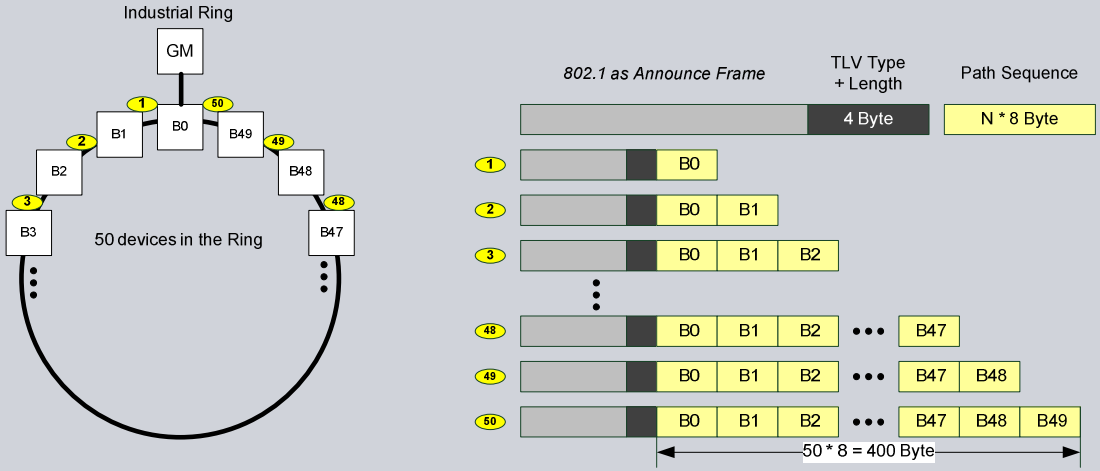
Ring-Topology with GM



The additional header must be able to carry the number of clock Identities equal to the Hop-Count of the longest loop in the network (similar to RSTP Max. Hop Count). Industrial Rings support a huge number of devices in the ring (64 / 128 Devices).

Restrictions:

TLV is optional

TLV can get very long (e.g. *64**8-Byte + 4 Byte Header = >516 Byte) in big networks.

Every time aware system must **check** if the own clock Identity is in one of the positions in the TLV before the frame is accepted

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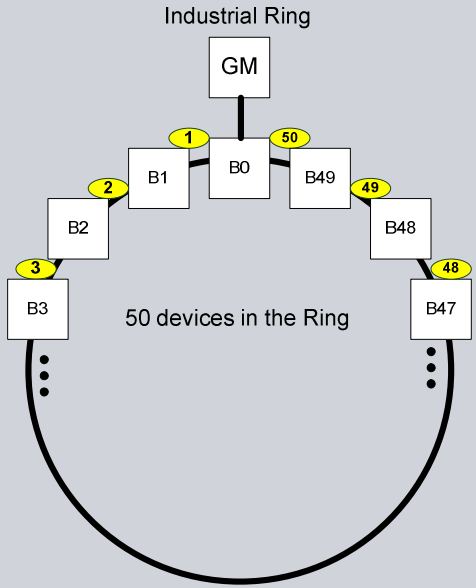
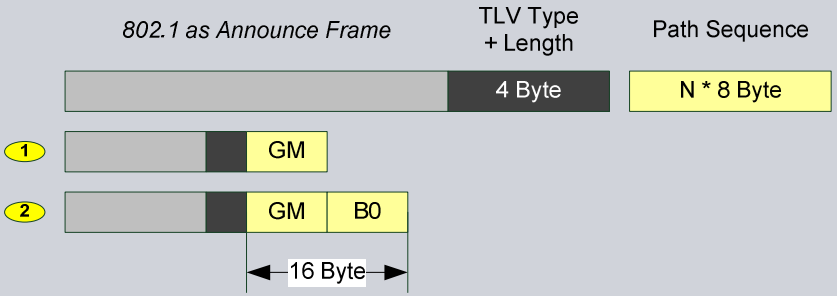
Proposal 1: Optimized Path trace TLV

Optimization for the Path trace TLV





Only the GM and devices with >2 Ports must enter there clock Identity in the path Sequence.

TLV stays short **in rings** (4 Byte + 4 Byte Header = >516 Byte).

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Proposal 2: Using a Hop-Count

Use the BMCA and the Sync Tree with a max. Hop-Count

- RSTP like behaviour of the Sync Tree
- Looping frames are limited
- Value for max. Hop-Count must be configured

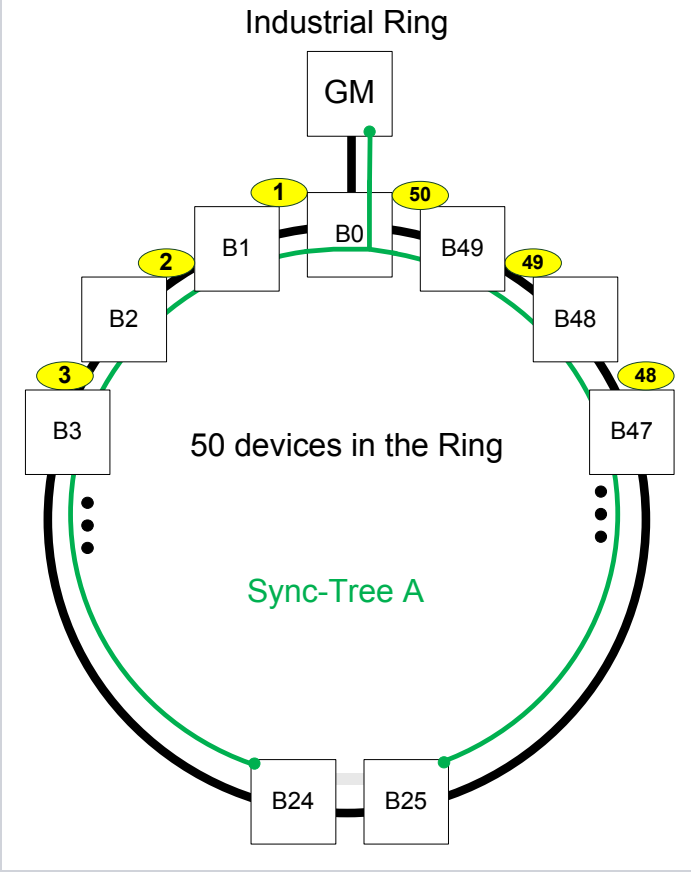
No long TLV is needed, looping may happen but is limited to the defined max. hop-Count.

Time aware systems only need to check if the hop-count is bigger than there maximum value (up-counting) or if the value is zero (down-counting).

Restrictions:

Value must be configured correct and is individually for every network. Changes are needed when extending the network.

Looping is only limited and not completely prevented.



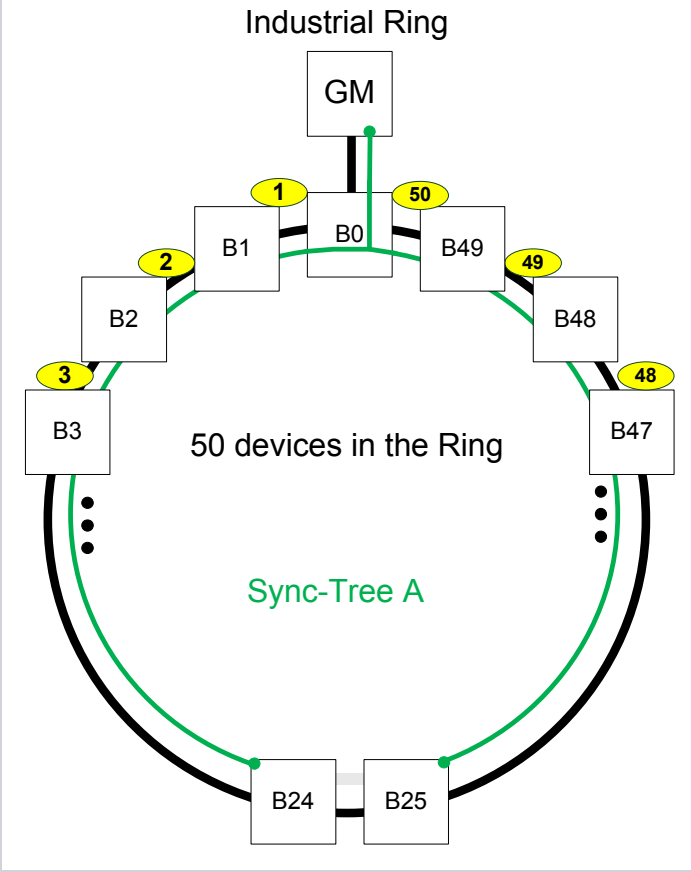
Proposal 3: Deletion of stored Information

Use the BMCA and the Sync Tree with a deletion information

Time aware systems need to delete the stored information

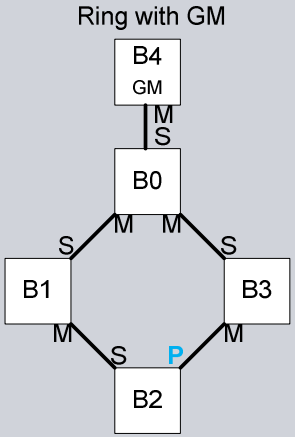
Restrictions:

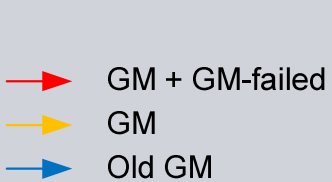
Deletion mechanism with new “deletion” Information in the announce frame



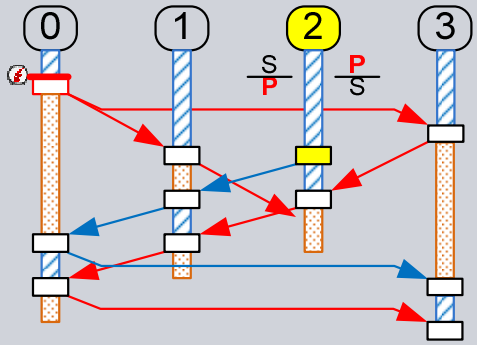
Proposal 3: Deletion of stored Information

Ring-Topology with stored GM Information's



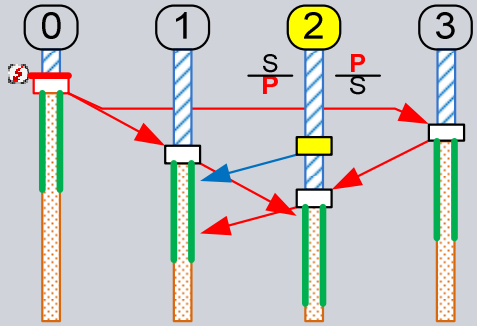


Timer can influence the behaviour



Timer Event

„Guard“-Timer to remind the deletion of the GM



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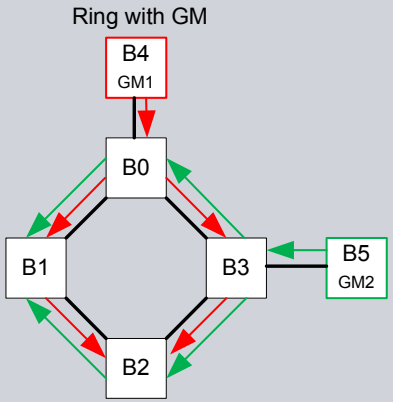
Proposal 4: Time-Out for GM Information

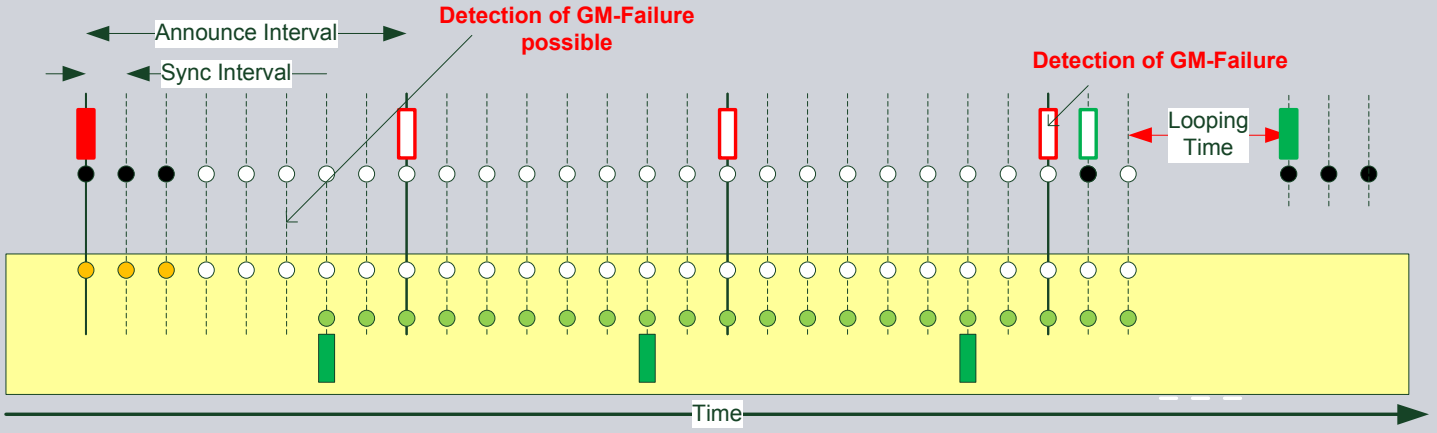
Ring-Topology with stored GM Information's

Delete the stored GM Information after e.g. 3 Sync Interval without sync-messages from GM



Announce-Message GM1
Sync-Message GM1
Announce-Message GM2
Sync-Message GM2
Sync-Message

GM Information included in Sync-Messages



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4. **Proposals for gPTP Gen 2**

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Solution in gPTP Gen 2

Current Requirements for the Sync-Path:

- Loop-free path from the GM to every device
- P2P Forwarding of Information
- Shortest Path from GM preferred

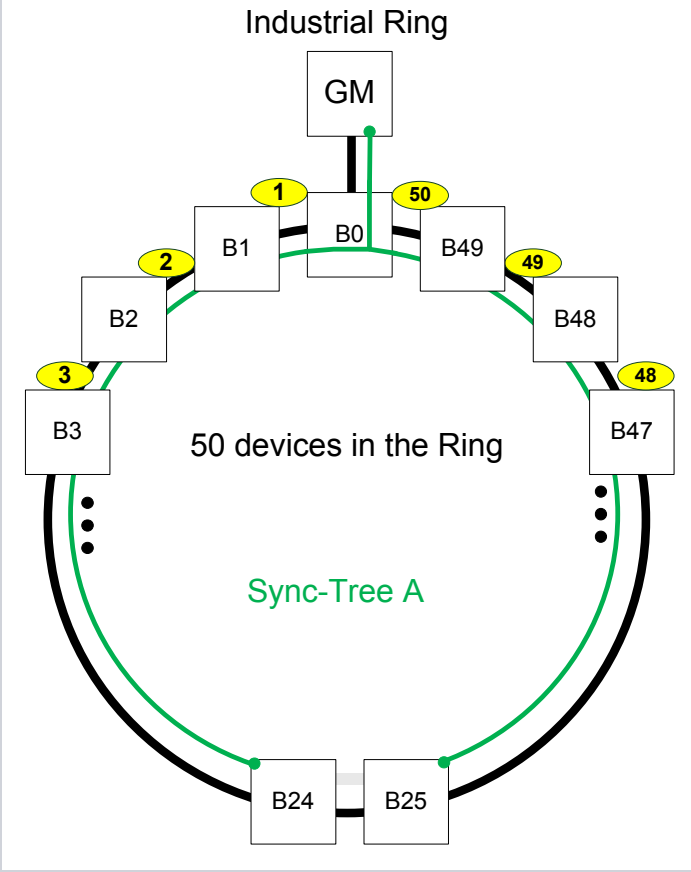
AVB **Gen 1** includes:

- RSTP for a loop-free network
- loop-free Sync-Path using BMCA

AVB **Gen 2** will include:

- Routing Mechanisms ISIS-SPB-PCR
  - IS-IS for getting the topology of the network
  - SPB for loop-free routing in the network

Can we use a routed path for the Sync-Tree in TSN?



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Possible additional benefit from Routing

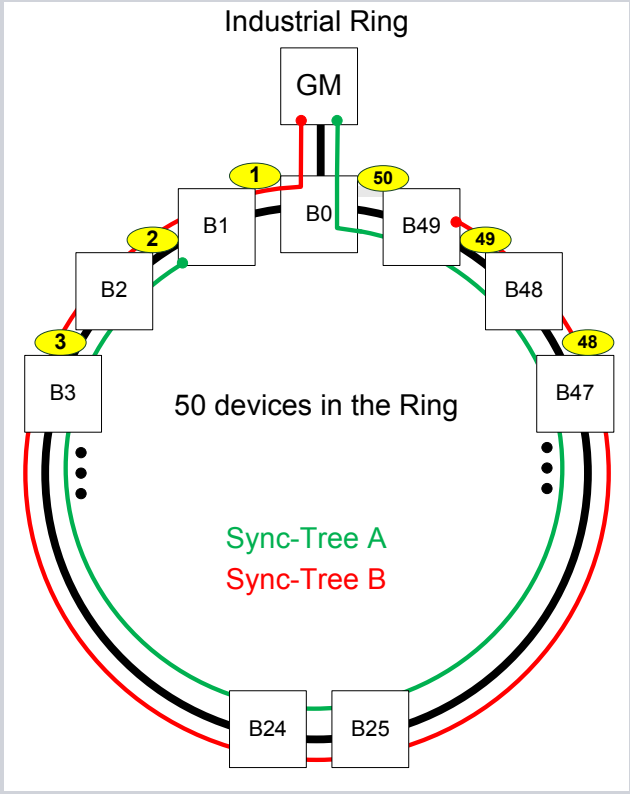
Is the Time-Sync Path critical?

Sync is essentially for low latency applications:

- Schedule of Frames
  - Buffer resources (Congestion avoidance)
  - Time of reception
    (Industry: Fail-Safe Applications)

- **TABS** will only work with correct time-sync
  - Legacy Frame Forwarding (Non-TAB time)
  - Waste of Bandwidth
  - Guaranteed Low Latency (TAB-time)

Can we use redundant routed path's for the Sync-Tree?



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Thank you for your attention!

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