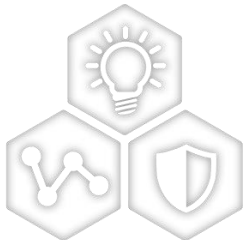


802.1AS use cases in 10B-T1S and improvement



A Leading Provider of Smart, Connected and Secure Embedded Control Solutions



SMART | CONNECTED | SECURE

Woojung Huh

IEEE Jan/2022 Interim TSN - 1/20/2022

AS updates for 10B-T1S

- **802.1ASds PAR**

- Amendment: Support for the IEEE Std 802.3 Clause 4 Media Access Control (MAC) operating in half-duplex

- **10B-T1S**

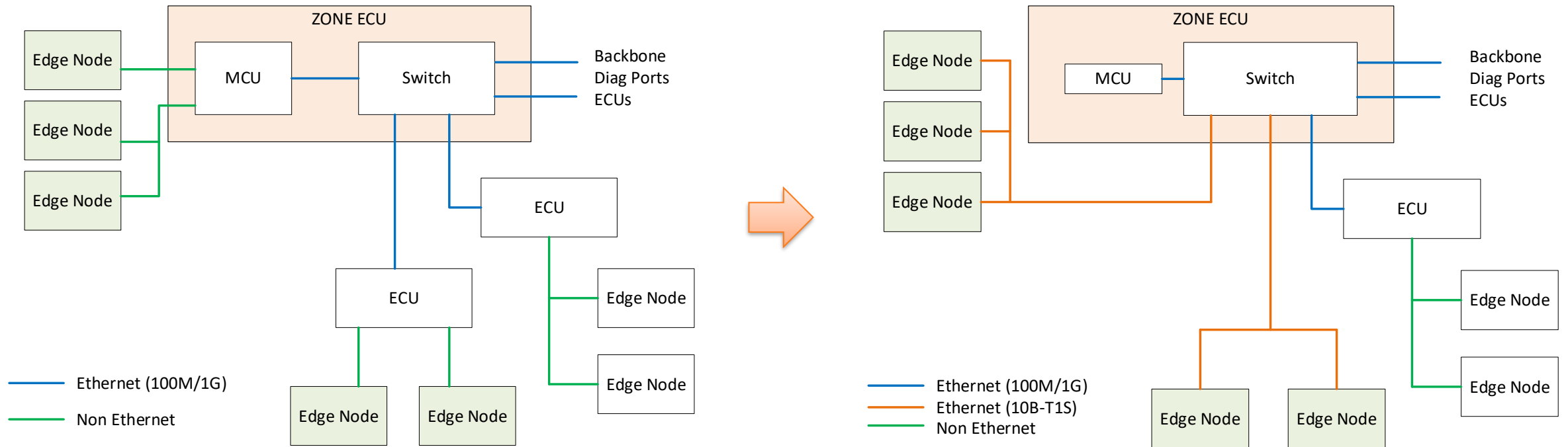
- 802.3cg CL147
- point-to-point full & half-duplex : CL147.7
- multidrop half-duplex : CL147.8
- Applications in Industrial Automation, AeroSpace, Medical devices, Automotive and more.

This presentation

- **Covers**
 - 10B-T1S multidrop use-case in Automotive
 - Single gPTP domain use-case
- **NOT Cover**
 - detail implementation
 - Hot-Standby

Application of 10B-T1S

- Convert legacy sensors/actuators traffic to 10Mbps
- Mainly communicate to high-performance CPU than between nodes
- Pre-configured harness



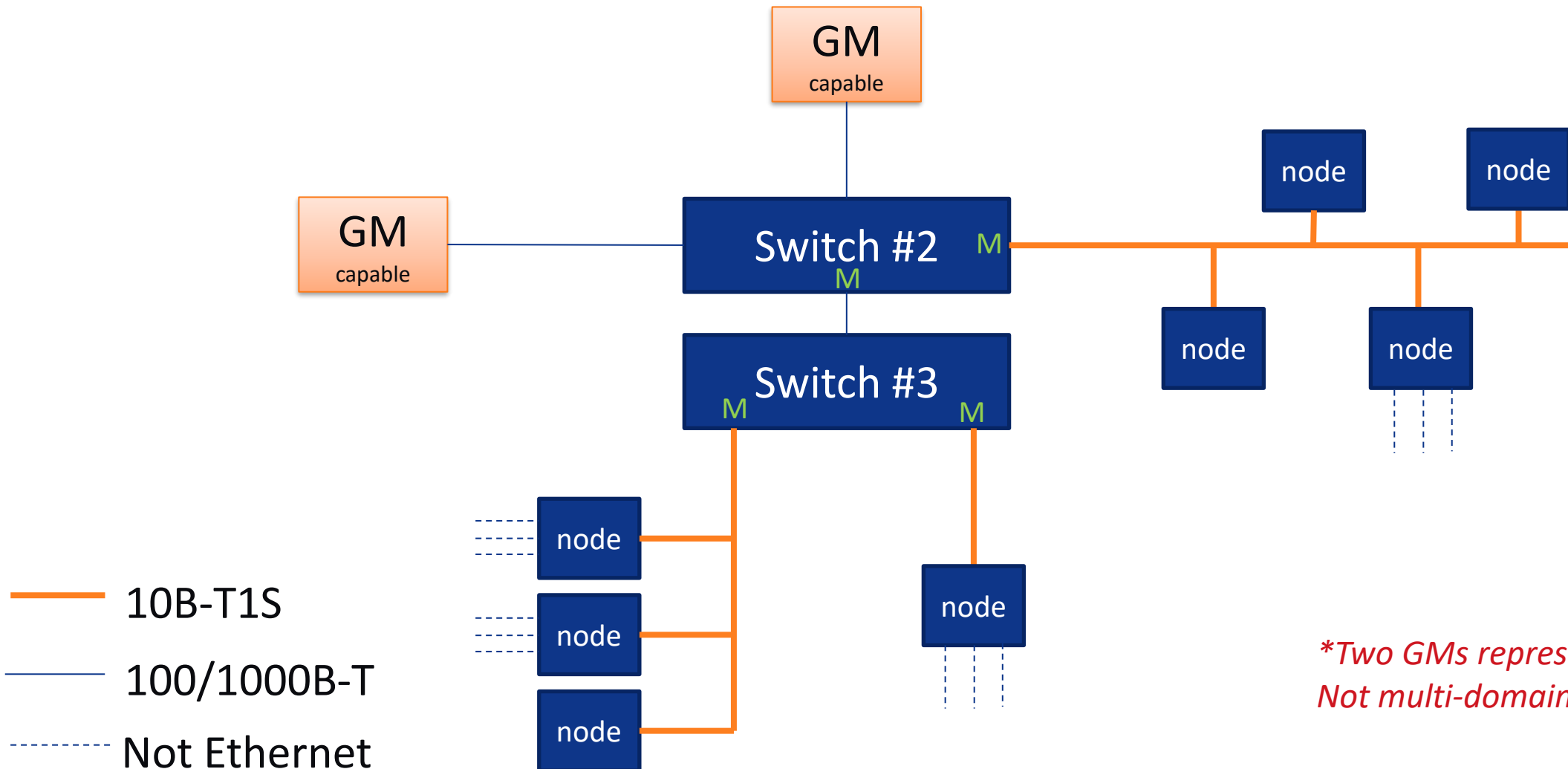
10BASE-T1S in AUTOSAR - <https://www.youtube.com/watch?v=4smu4FF-Iso>

The 10BASE-T1S OA3p Interface - <https://standards.ieee.org/content/dam/ieee-standards/standards/web/documents/other/eipatd-presentations/2021/d2-01.pdf>

Single domain 802.1AS use-cases in 10B-T1S

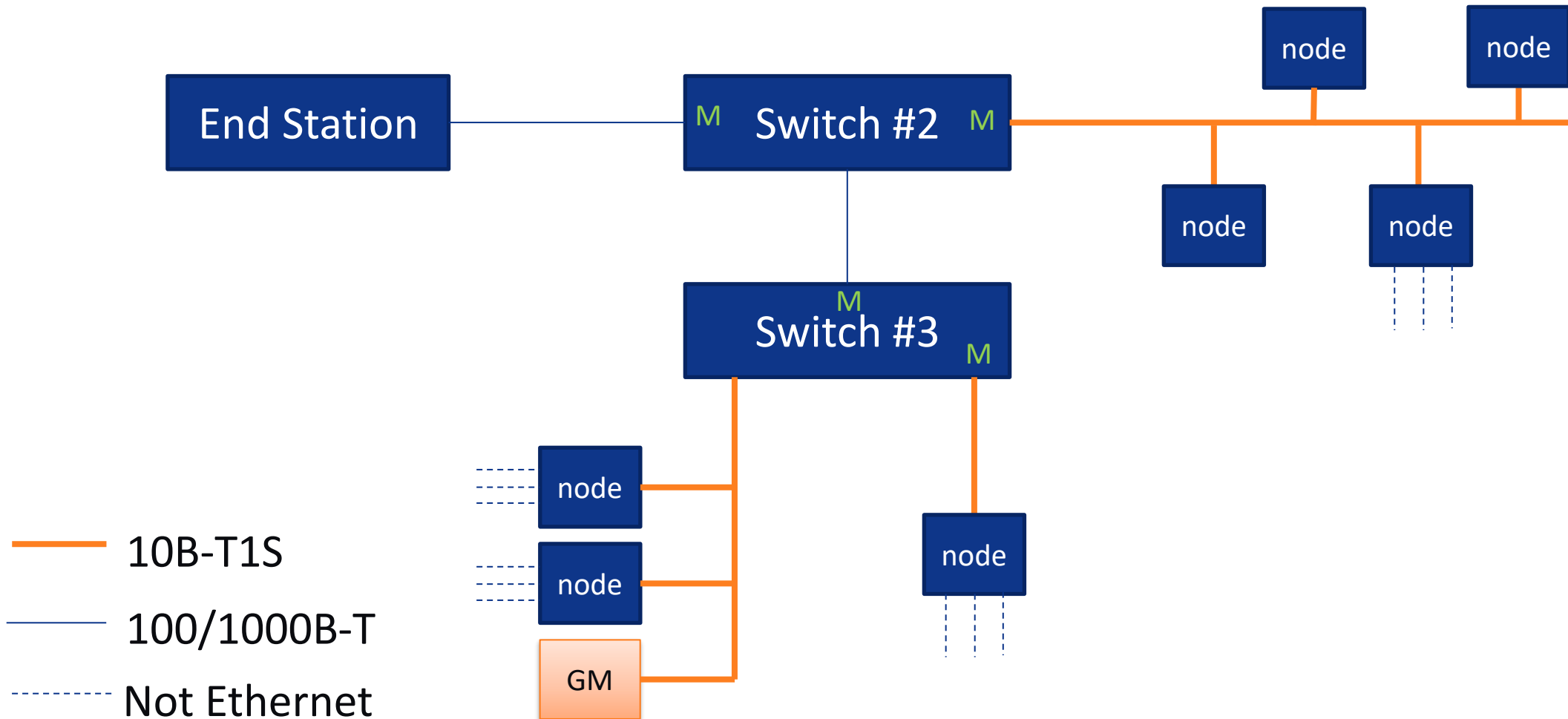
- 1. GMs outside of multi-drop 10B-T1S**
- 2. A GM in multi-drop 10B-T1S**
- 3. A GM in point-to-point 10B-T1S**
- 4. GMs in multi-drop 10B-T1S**
- 5. Only 10B-T1S with Switch**
- 6. Multi-drop 10B-T1S without Switch**

Case #1. GMs outside of multi-drop 10B-T1S

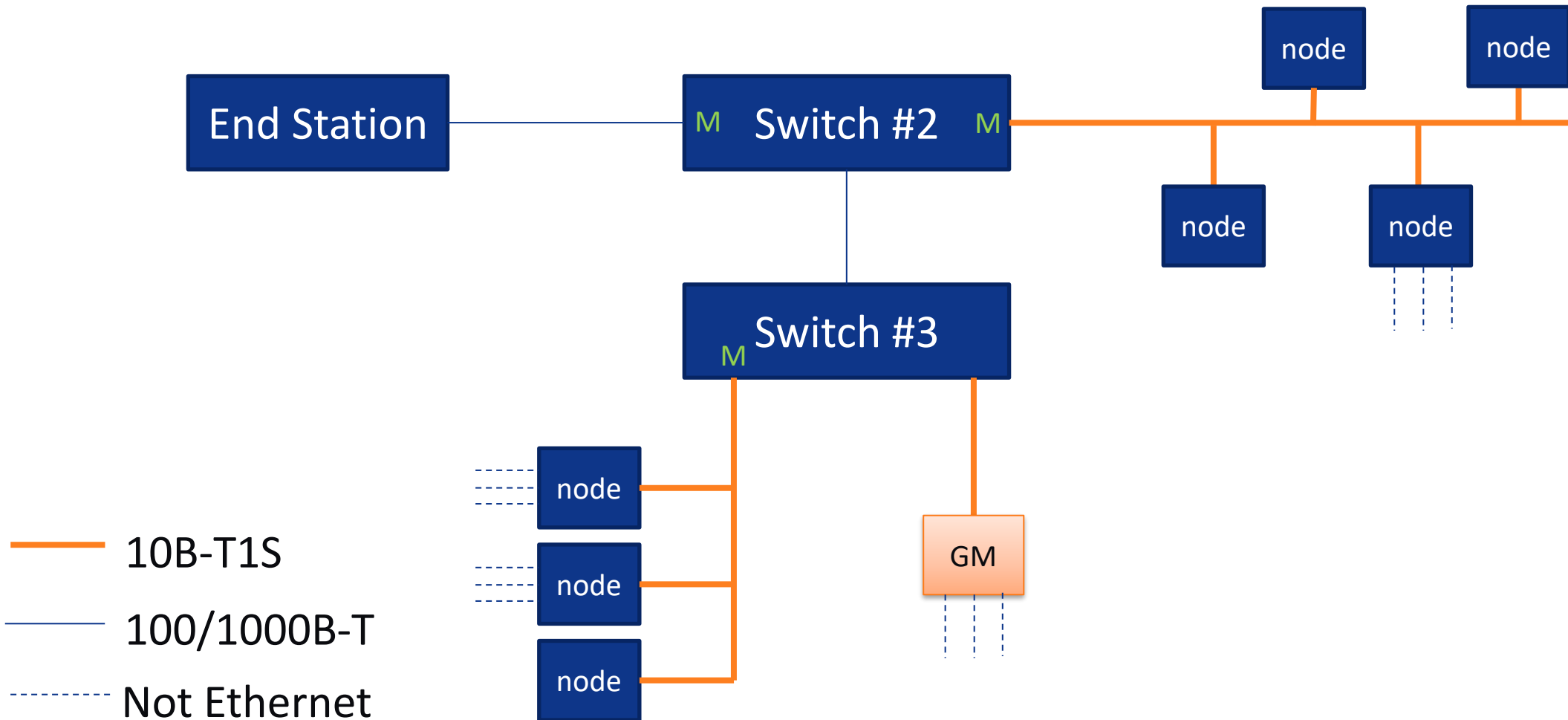


**Two GMs represent BMCA-capable.
Not multi-domain*

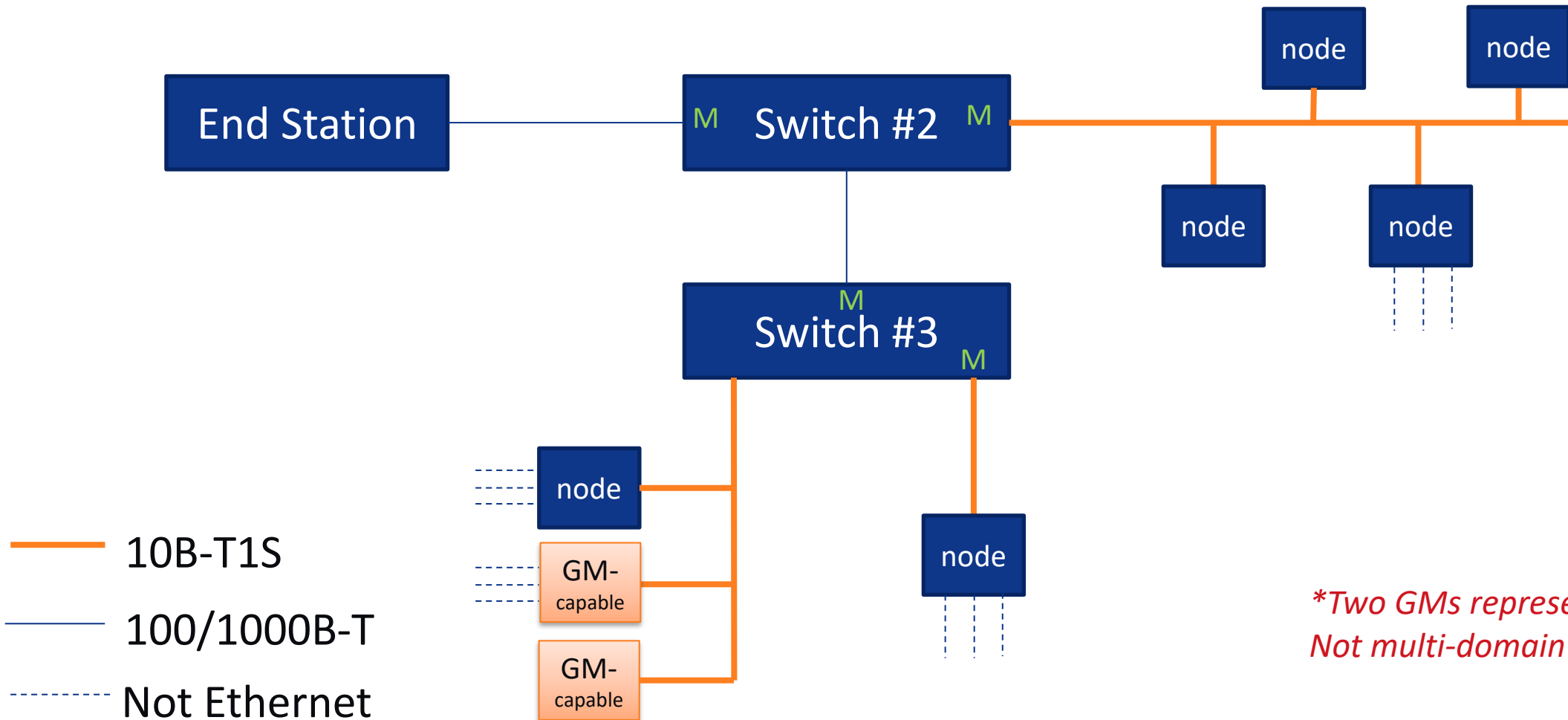
Case #2. A GM in multi-drop 10B-T1S



Case #3. A GM in point-to-point 10B-T1S

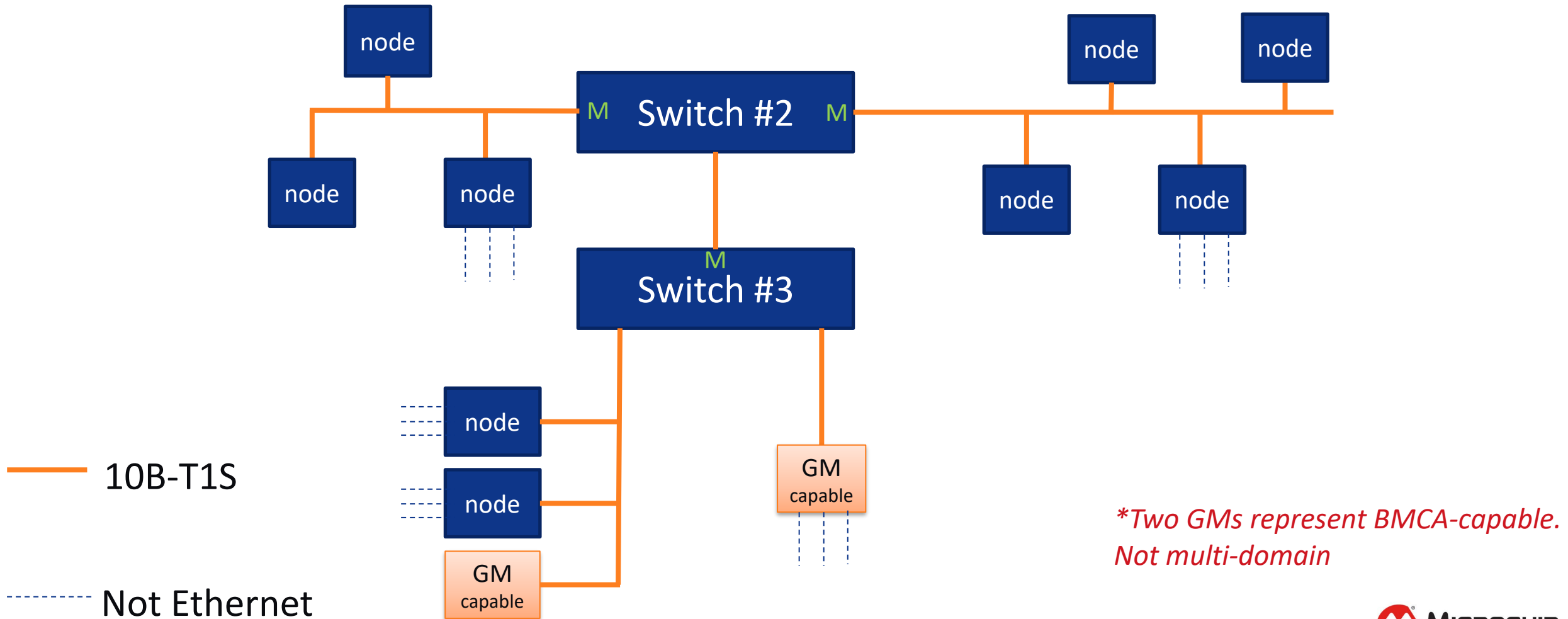


Case #4. GMs in multi-drop 10B-T1S

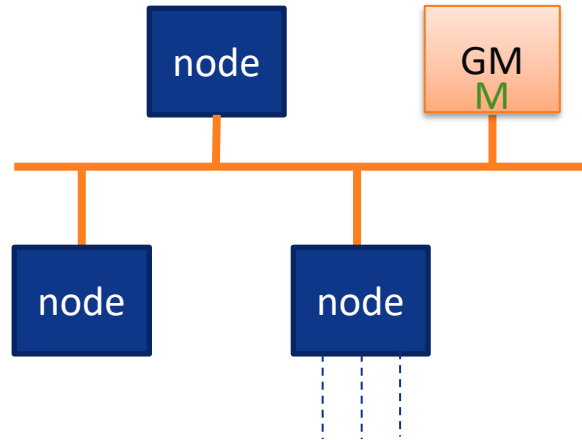


**Two GMs represent BMCA-capable.
Not multi-domain*

Case #5. Only 10B-T1S with Switch



Case #6. Multi-drop 10B-T1S without Switch



— 10B-T1S
- - - Not Ethernet

Common use-case in Automotive

- **“Case 1. GMs outside of multi-drop 10B-T1S”**
 - Applications for 10B-T1S is mostly interaction with sensors/actuators
 - Sensors/Actuators traffics will be processed in high performance ECU in Switch or backbone connected to faster speed network
 - GM could already exist in in full-duplex point-to-point environment such as AV system
 - Multidrop nodes may not have an accurate clock as GM-capable

Common use-case in Automotive

- Single domain
 - Assume that legacy networks can be merged into single gPTP domain in a 10B-T1S segment
 - Guess that time subdomains on right picture can be converted into a single domain
- Multi-domains can be handled in Switch with high-speed network if needed.
- Start with simple scenario of single-domain first

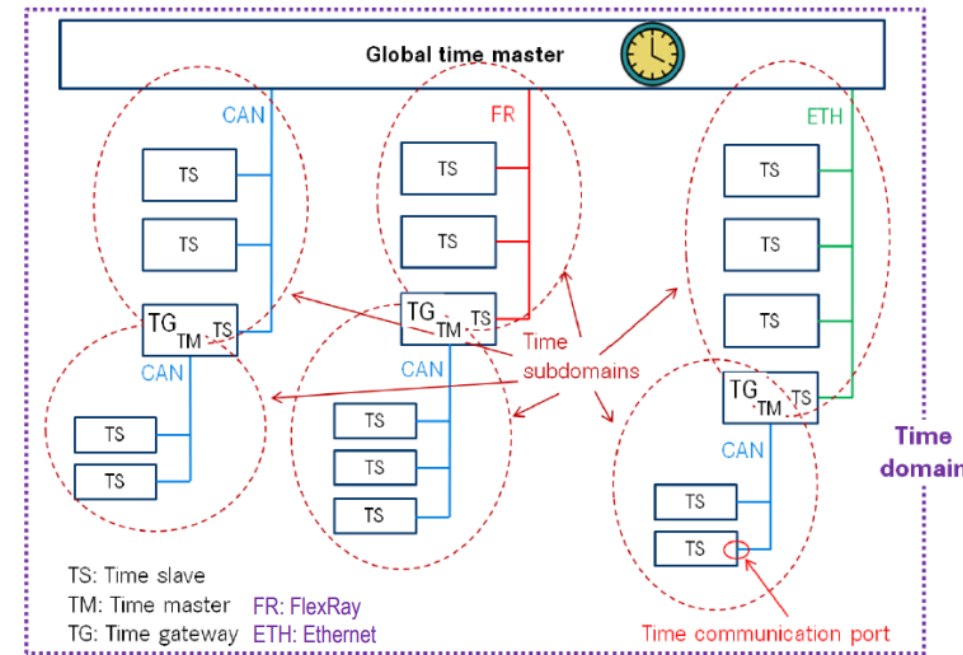


Figure 3: Terminology Example

Possible Issues supporting 802.1AS in 10B-T1S

- **Collision in media**
 - Collision can happen in half-duplex
 - Collision may cause unexpected delays
 - Interval may not be guaranteed because of collision (and delay)
 - May miss syncInterval, pdelayReqInterval and announceInterval
 - No hard restriction of Interval margin, however, some test may fail
 - Timestamping in half-duplex
 - P802.3da CL90 adds TSSI for 802.3cg CL147 (10B-T1S) & CL168 (10B-T1M) half-duplex
 - 90.4.3.1.1 adds *“When using the half-duplex mode of operation, multiple TS_TX indications may be produced for a single MA_DATA.request as a result of collisions on the media.”*
- **Multicast in mixing segment (multidrop)**
 - PTP messages deliver to multiple devices
 - Message expects a single response, but could get multiple responses

How to avoid collision

- **802.1Qbv**
 - MAC solution
 - <https://www.ieee802.org/1/files/public/docs2017/tsn-cgunther-802-3cg-multidrop-0917-v01.pdf>
 - Not all MAC supports Qbv (especially End Station)
 - 802.1AS should run first before Qbv is configured
- **PLCA**
 - PHY solution
 - Need interaction between PHY and MAC
 - 802.3 CL148. optional in half-duplex multidrop mode
 - Avoid collision but cause another issue

Propagation delay measurement

- **Use current 802.1AS CL11 full-duplex pDelay mechanism**
 - Multicast PTP message doesn't work well with multi-drop
 - Possible changes in StateMachine to support multi-drop
 - By using UNICAST address
 - Another mechanism/update*
- **Introduce a new MD pDelay mechanism**
 - Like 802.1AS CL12 for 802.11
- **Another way**
 - OpenAlliance Topology Discovery measures cable length. (measurement precision < 15cm, it is < 1nSec.) – there may be extra compensation factor such as temperature
 - Static method like setting min & max linkDelay like combining cable length with mathematical method
 - However, G.1.2 of 802.1DG D1.4 describes needs of pDelay message, especially neighbor rate ratio.

BMCA in 10B-T1S

- **Don't see any problem to run current BMCA in 10B-T1S**
- **ANNOUNCE message to all nodes in multi-drop**

Things to consider in 10B-T1S

- **Delay**

- PLCA can cause variable delay at Tx path (MAC -> PHY -> Media)

- **Accuracy**

- 10Mbps Low MII clock (2.5MHz) could be challenging to meet 40nSec granularity

- **Vendor may have proprietary solution**

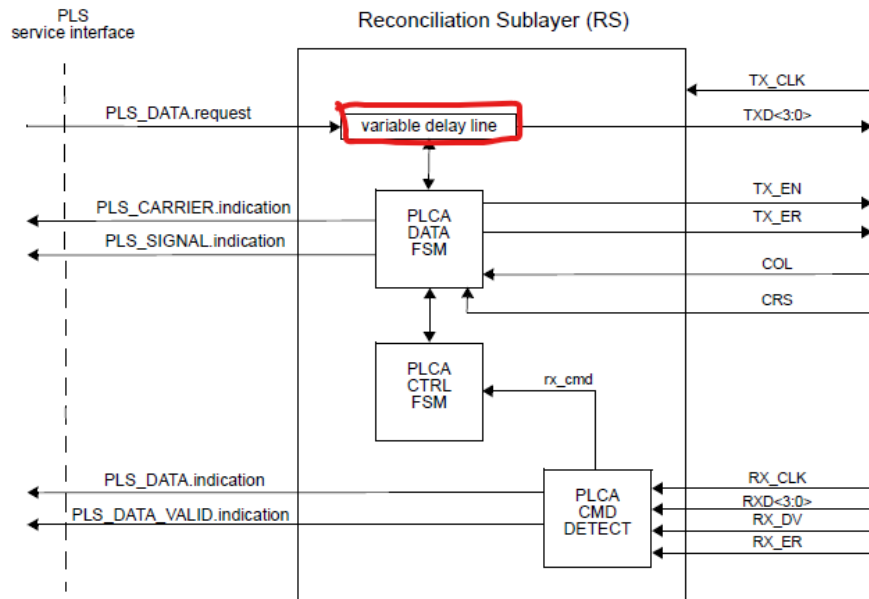


Figure 148-2—PLCA functions within the Reconciliation Sublayer (RS)

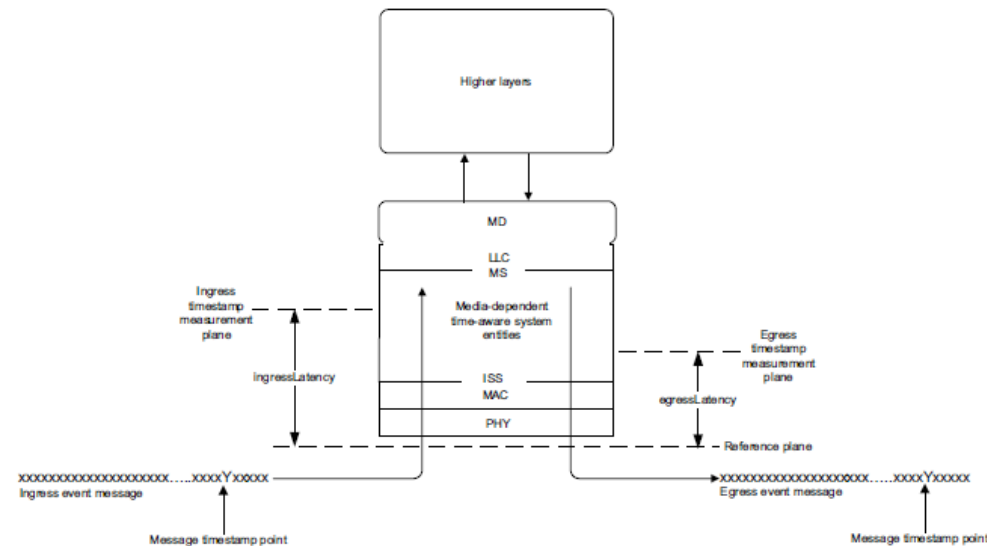


Figure 8-2—Definition of message timestamp point, reference plane, timestamp measurement plane, and latency constants

Summary

- **To support 802.1AS in 10B-T1S**
 - Timestamp on 10B-T1S PHY or on MAC with Half-duplex support
 - Collision Avoidance is needed
 - Hardware-supported media sharing will be needed for deterministic behavior
 - New propagation delay measurement will be needed
 - Solutions to overcome variable delay and accuracy issue
- **Future Experiment Plan**
 - Experiments with PLCA
 - Experiment a new propagation delay measurement
 - Experiments with different number of nodes in multi-drop mode

Thank you