P802.1ASds – Use Cases & Requirements

Presenter: Don Pannell, NXP

Co-Authors:
Alon Regev, Keysight
Ionel Ghita, Keysight
Olaf Mater, Marvell
Woojung Huh, Microchip
Vlad Lyalikov, Microchip

AVNU®
RELIABLE SYNCHRONIZED NETWORKING

Administration

This presentation is the collaborative work of the Presenter and Co-Authors that was performed in Avnu Automotive Work Group meetings.

This is not an official publication from Avnu.org, but permission was granted to use the Avnu template to show multi-company consensus on the items enclosed.

Consider this a starting point for discussing the needed gPTP mechanisms to support 10BASE-T1S half-duplex links.

OVERVIEW

What are the gPTP issues with 10BASE-T1S?

What are the goals of an acceptable P802.1ASds solution?

Summary of the gPTP issues of 10BASE-T1S

- 10BASE-T1S supports a point-to-point full-duplex mode
  - No change here as this is already supported by 802.1AS-2020
- 10BASE-T1S also support a multi-drop half-duplex mode
  - Supporting this use case is the Scope of P802.1ASds
- The multi-drop mode requires that the 802.3 Clause 4 MAC be in half-duplex mode regardless if PLCA (PHY Level Collision Avoidance) is enabled or not
  - gPTP cannot “see” the effects of PLCA, but it “sees” the effects of the half-duplex CSMA MAC – making this the focus of this work!

Summary of the Goals of P802.1ASds

- Be able to support gPTP on a “constrained” device (Bridge or End Station) where some 802.3 ports are full-duplex and some are half-duplex
  - A “constrained” device has a lower-end CPU with a fixed amount of RAM and ROM for the code space (as these resources are on-die & can’t be expanded)
  - This dictates the re-use of the existing gPTP code between full-duplex and half-duplex ports, as much as possible
  - New, complex mathematics algorithms (like using Sync for rate ratio) could extend the code beyond what can fit

Summary of the Goals of P802.1ASds

- Faster time to STD!
  - This dictates the need to minimize the changes to the existing gPTP state machines, as much as possible
  - New, complex mathematics algorithms (like using Sync for rate ratio) will take a long time to simulate and verify its correctness
  - We need to focus on solving the gPTP issues when a half-duplex MAC is used
  - Sync messages do not have any issues with half-duplex media
  - Pdelay messages DO have issues with half-duplex media – so we need to focus on and fix this issue only
    - A single Pdelay_Req gets multiple Pdealy_Resp's and drops asCapable stopping gPTP on the port
    - A solution was shown using unicast DA on Pdelay using BMCA & then how to get these unicast DAs
    - But this is not optimal for External Port Configuration – so work is needed here

NETWORK CONNECTIVITY USE CASES

Needed Single Domain Use Cases

Needed Multiple Domain Use Cases

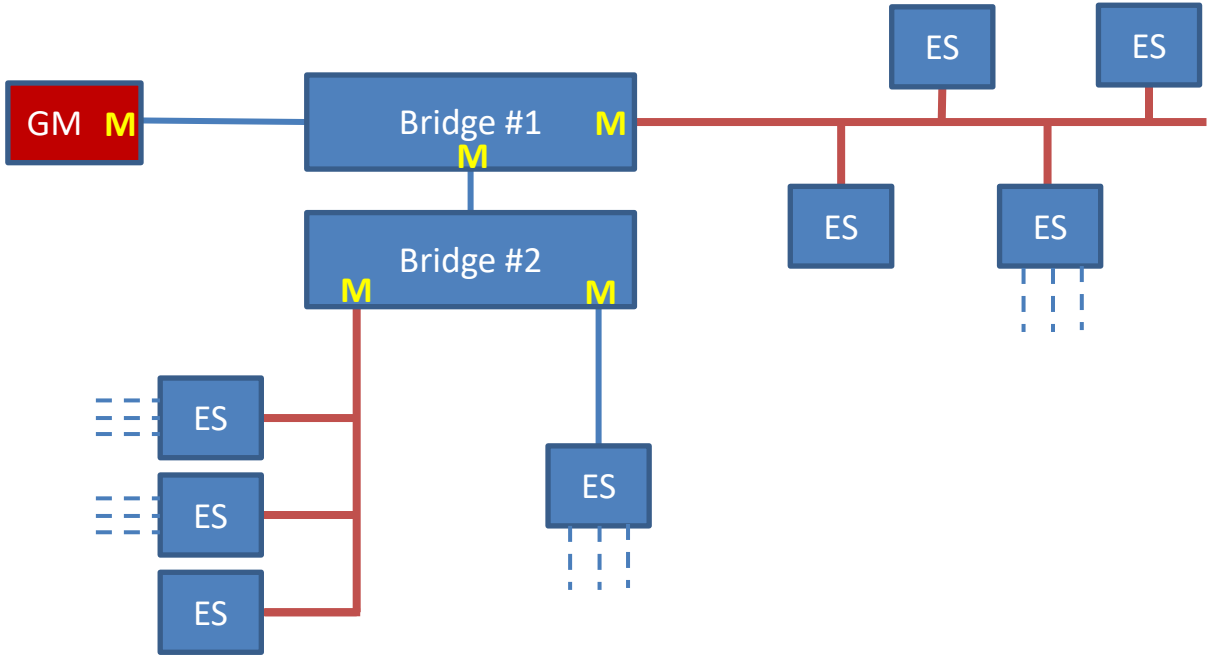
Single Domain use-cases with 10BASE-T1S

1. The gPTP GrandMaster is not directly connected to the multi-drop 10BASE-T1S shared media segments

2. The gPTP GrandMaster is directly connected to a multi-drop 10BASE-T1S shared media segment

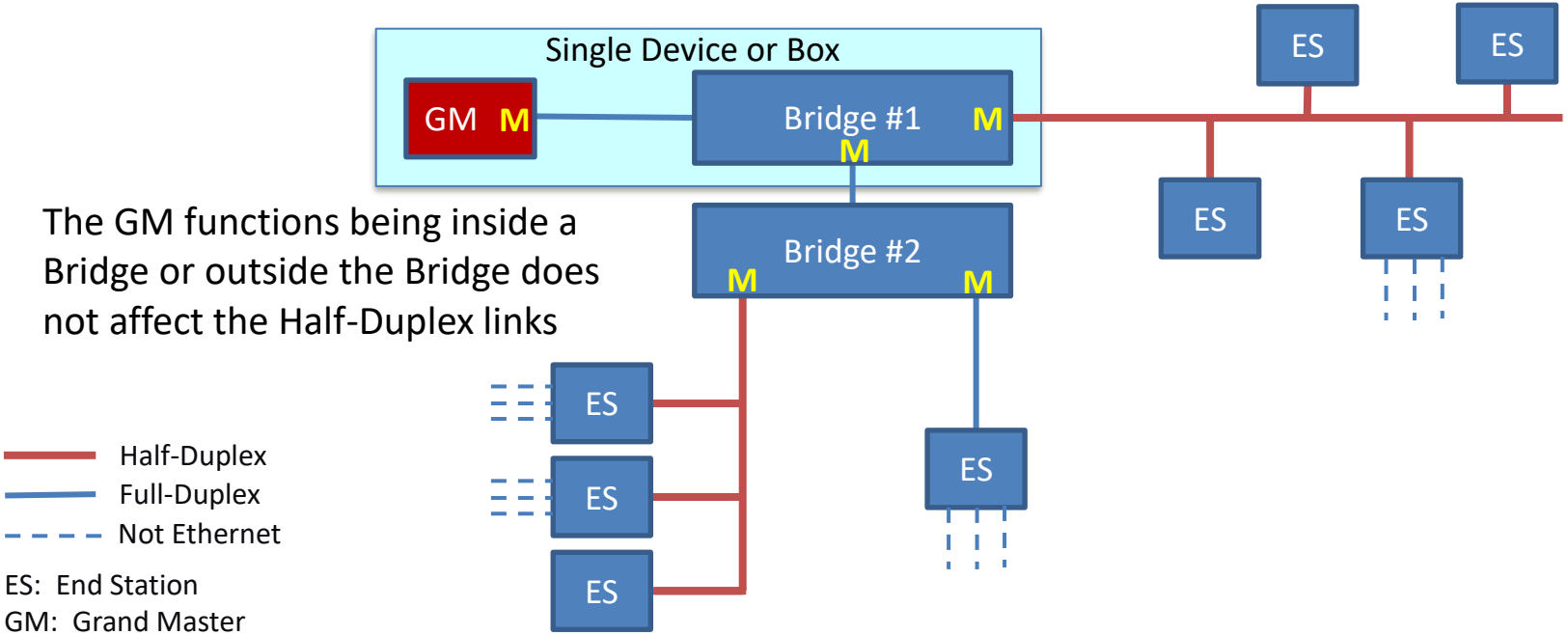
3. The multi-drop 10BASE-T1S shared media segment is the network (i.e., its stand-alone)

Case #1:
GrandMaster outside of 10BASE-T1S segments

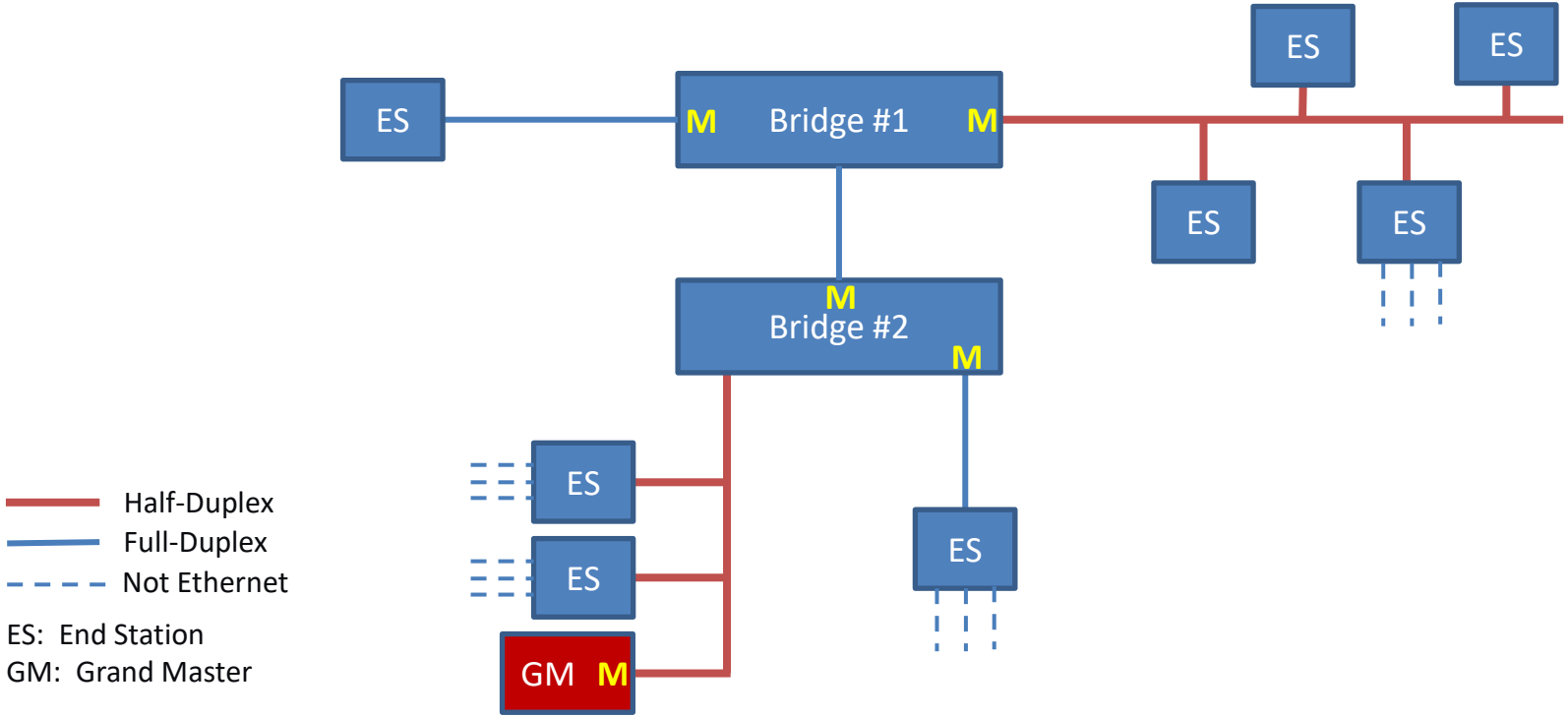


Case #1:
GrandMaster outside of 10BASE-T1S segments

The GM functions being inside a Bridge or outside the Bridge does not affect the Half-Duplex links



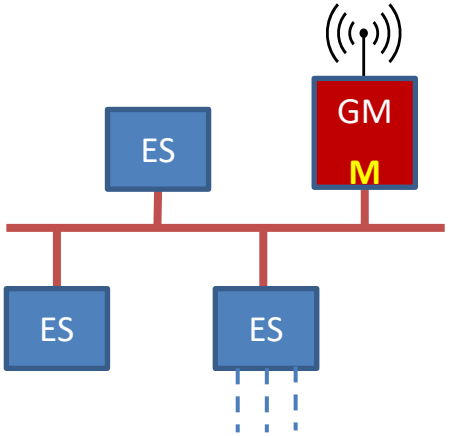
Case #2:
GrandMaster connected to 10BASE-T1S



Case #3:
10BASE-T1S is the Network

Examples are:

- Hospital smart beds
- Elevator shafts
- …



Half-Duplex
Full-Duplex
Not Ethernet

ES: End Station
GM: Grand Master

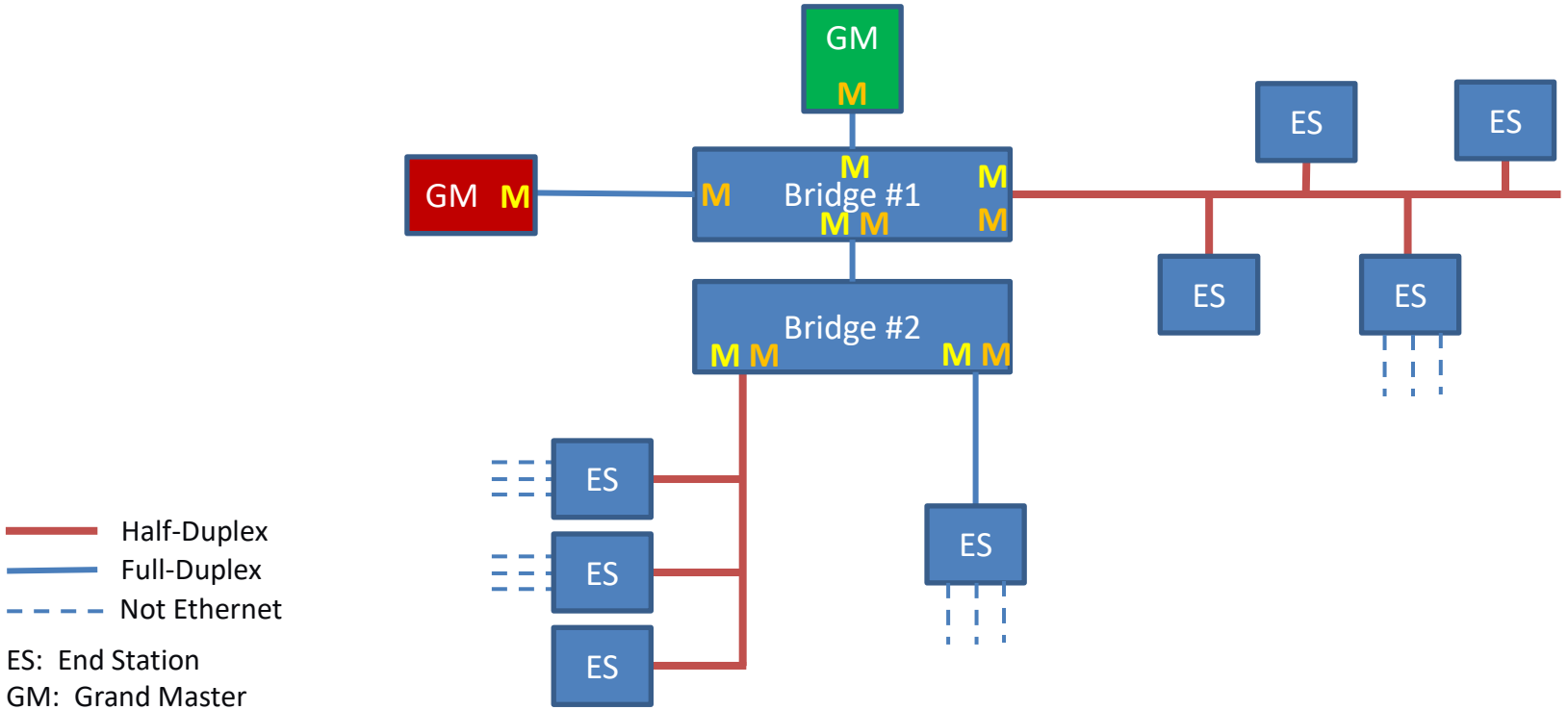
Multi domain use-cases with 10BASE-T1S

4. The gPTP GrandMaster is not directly connected to the multi-drop 10BASE-T1S shared media segments

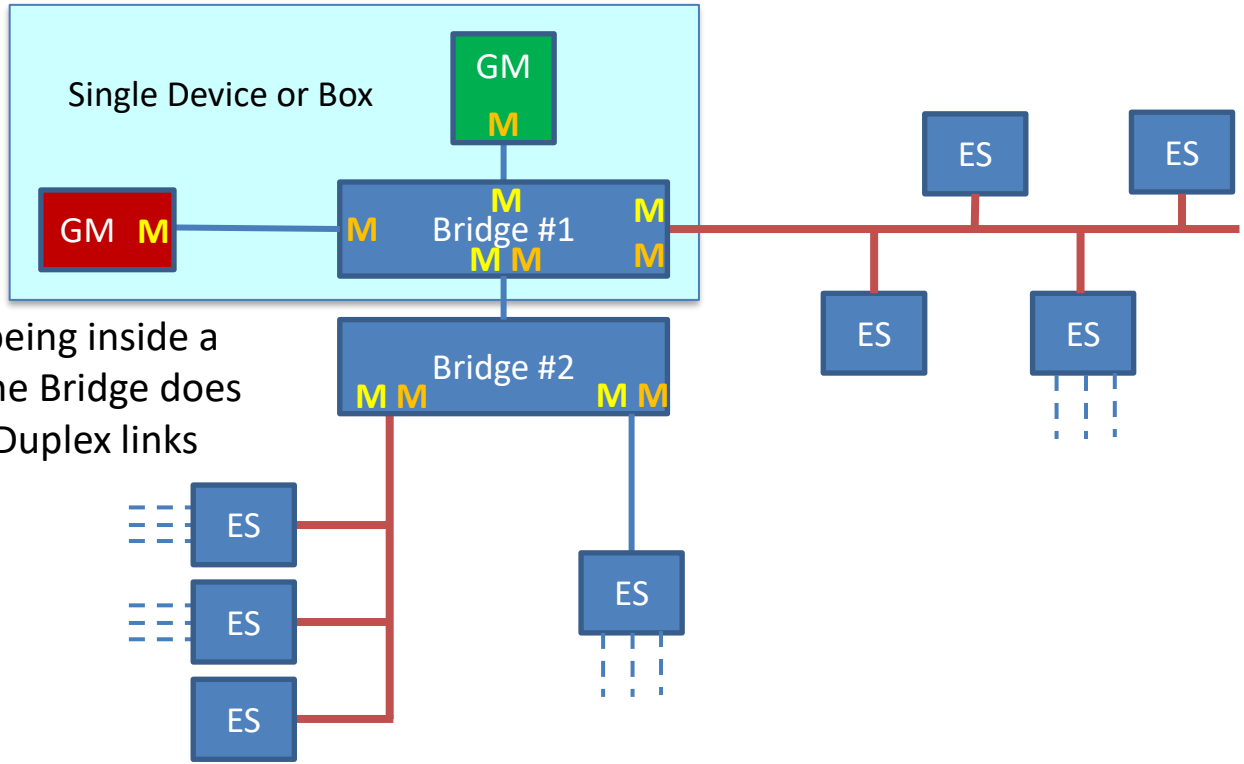
5. The gPTP GrandMaster is directly connected to 1 or more multi-drop 10BASE-T1S shared media segments

6. The multi-drop 10BASE-T1S shared media segment is the network (i.e., its stand-alone)

Case #4a: GMs outside of 10BASE-T1S segments

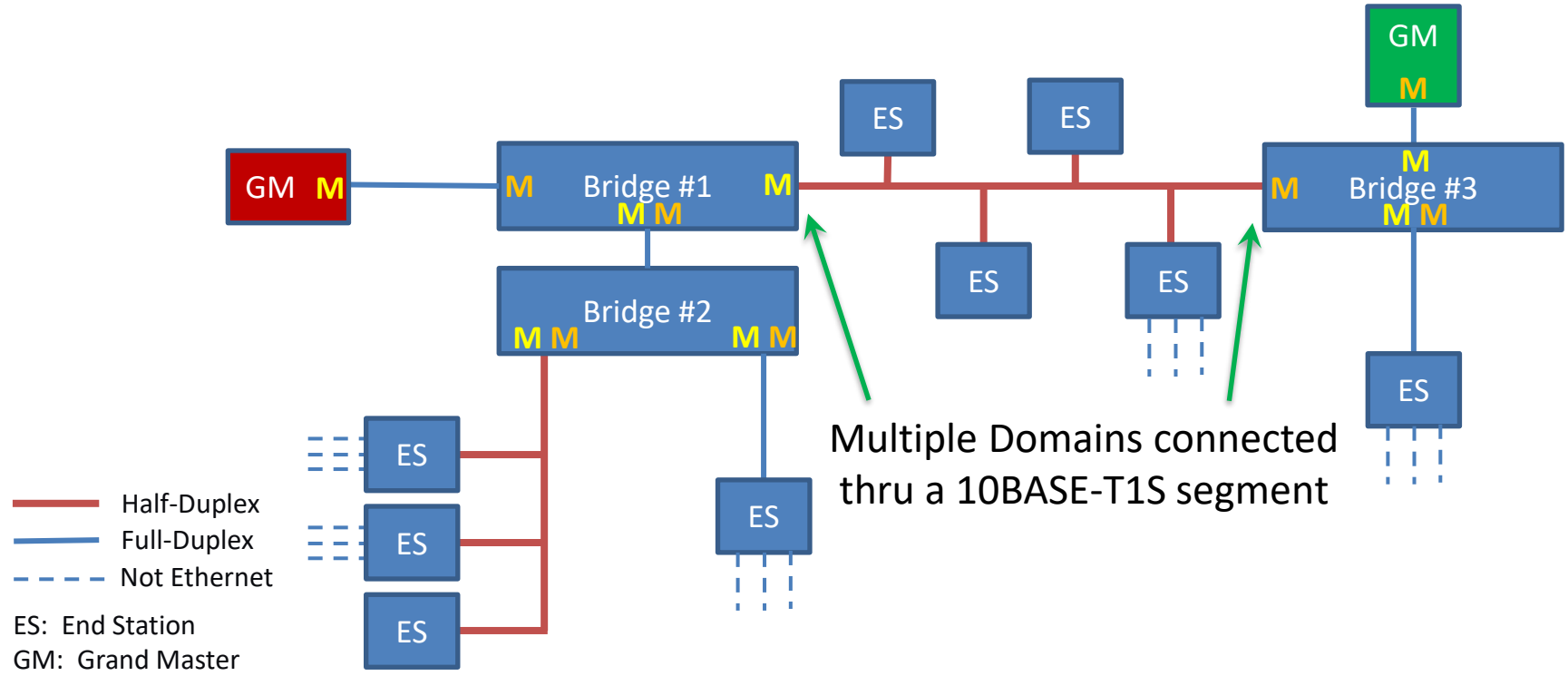


Case #4a: GMs outside of 10BASE-T1S segments



The GM functions being inside a Bridge or outside the Bridge does not affect the Half-Duplex links

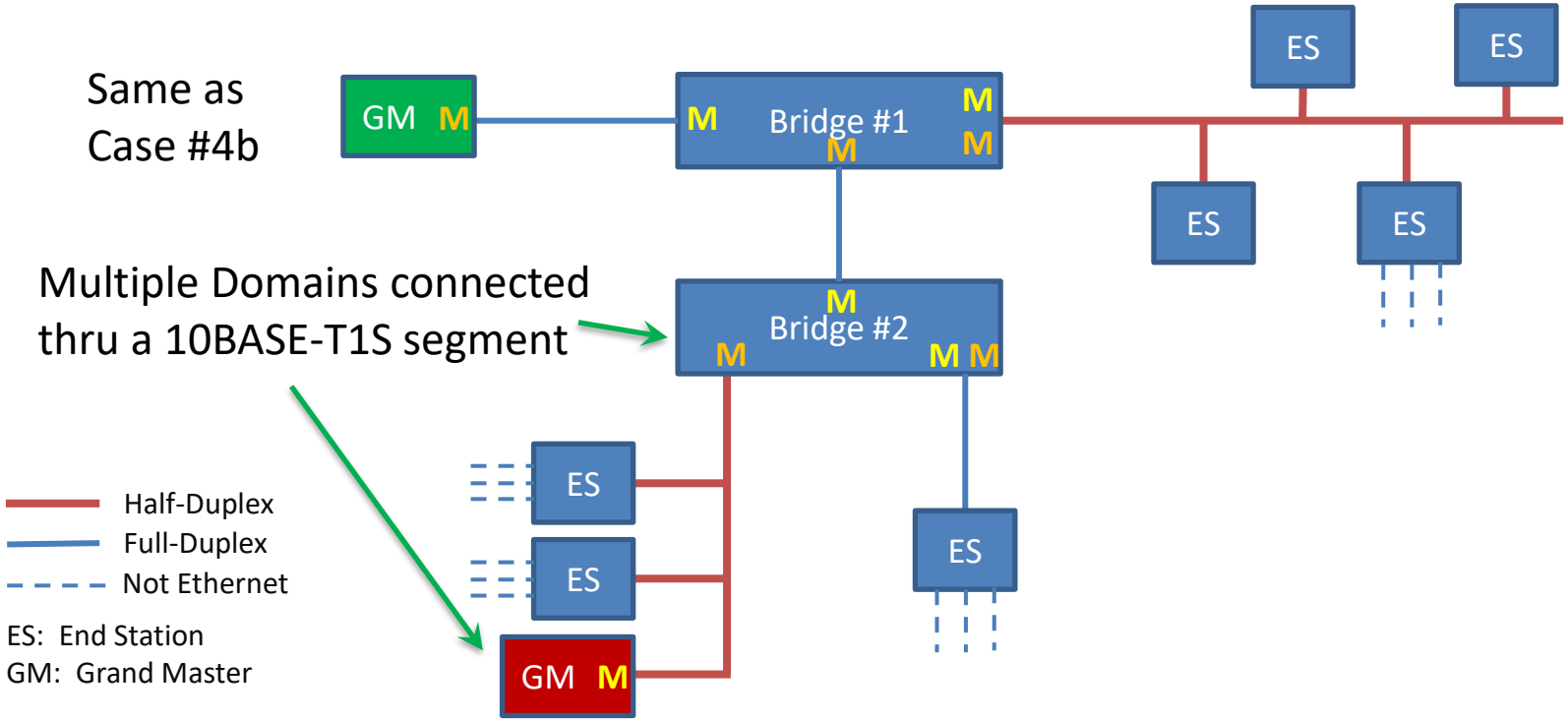
Case #4b: GMs outside of 10BASE-T1S segments



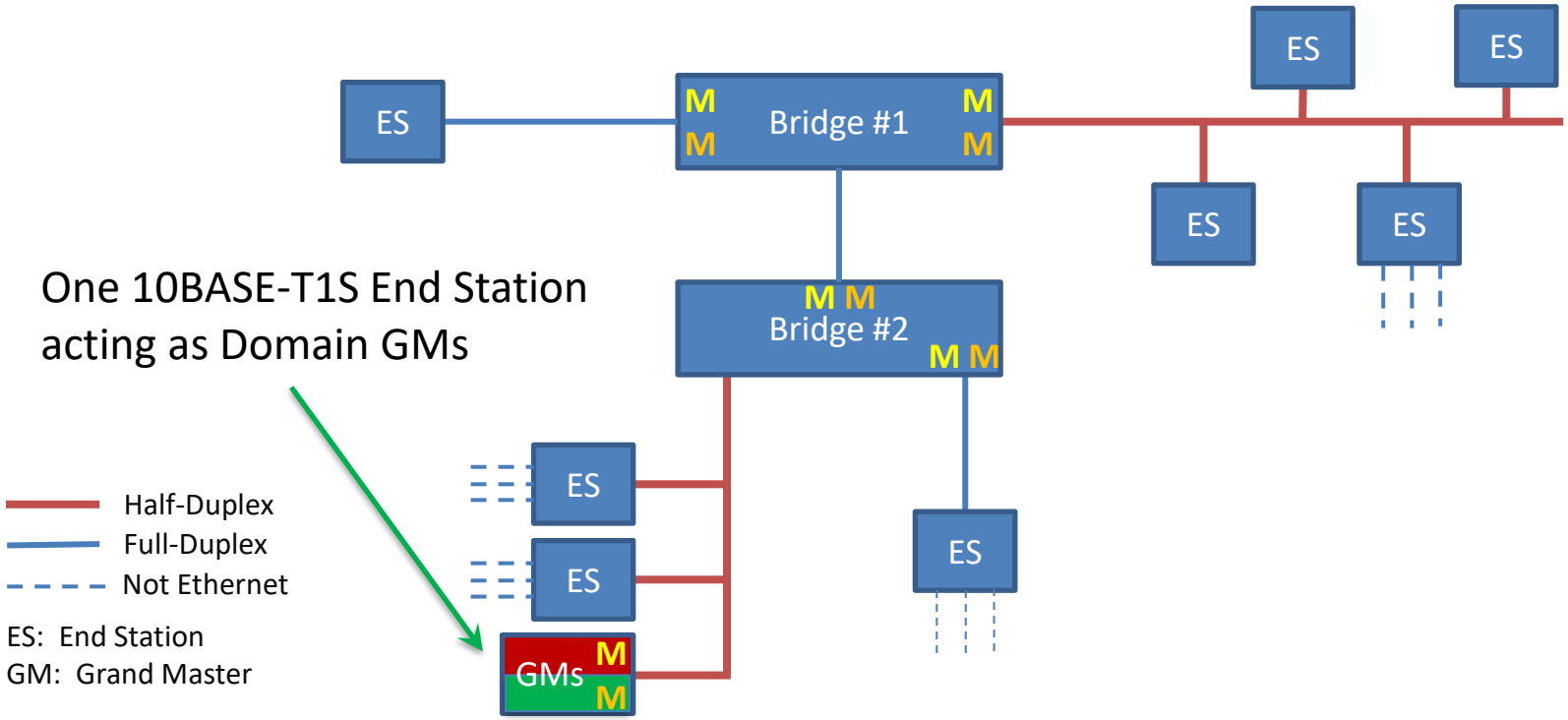
Case #5a: GM(s) on 10BASE-T1S segment(s)

Same as
Case #4b

Multiple Domains connected
thru a 10BASE-T1S segment



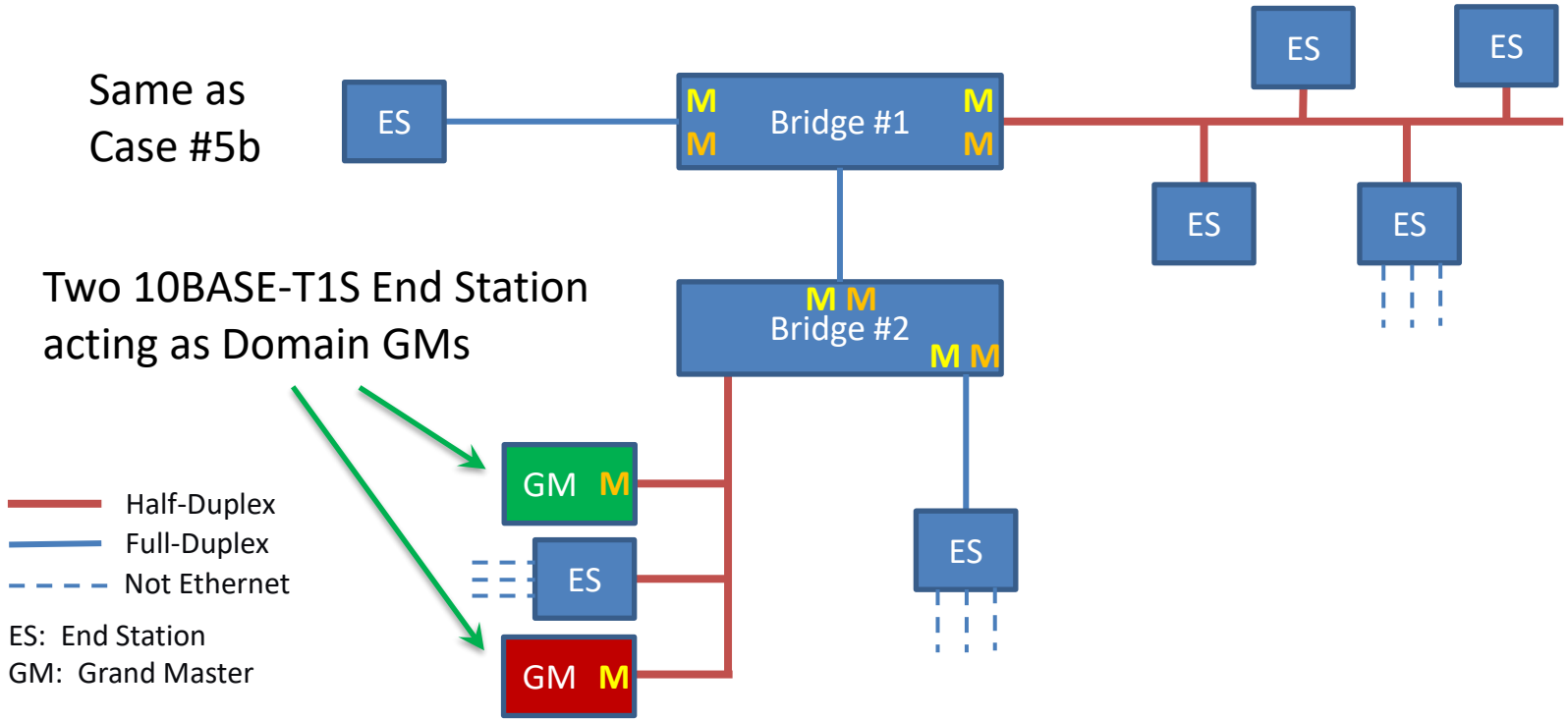
Case #5b: GM(s) on 10BASE-T1S segment(s)



Case #5c: GM(s) on 10BASE-T1S segment(s)

Same as
Case #5b

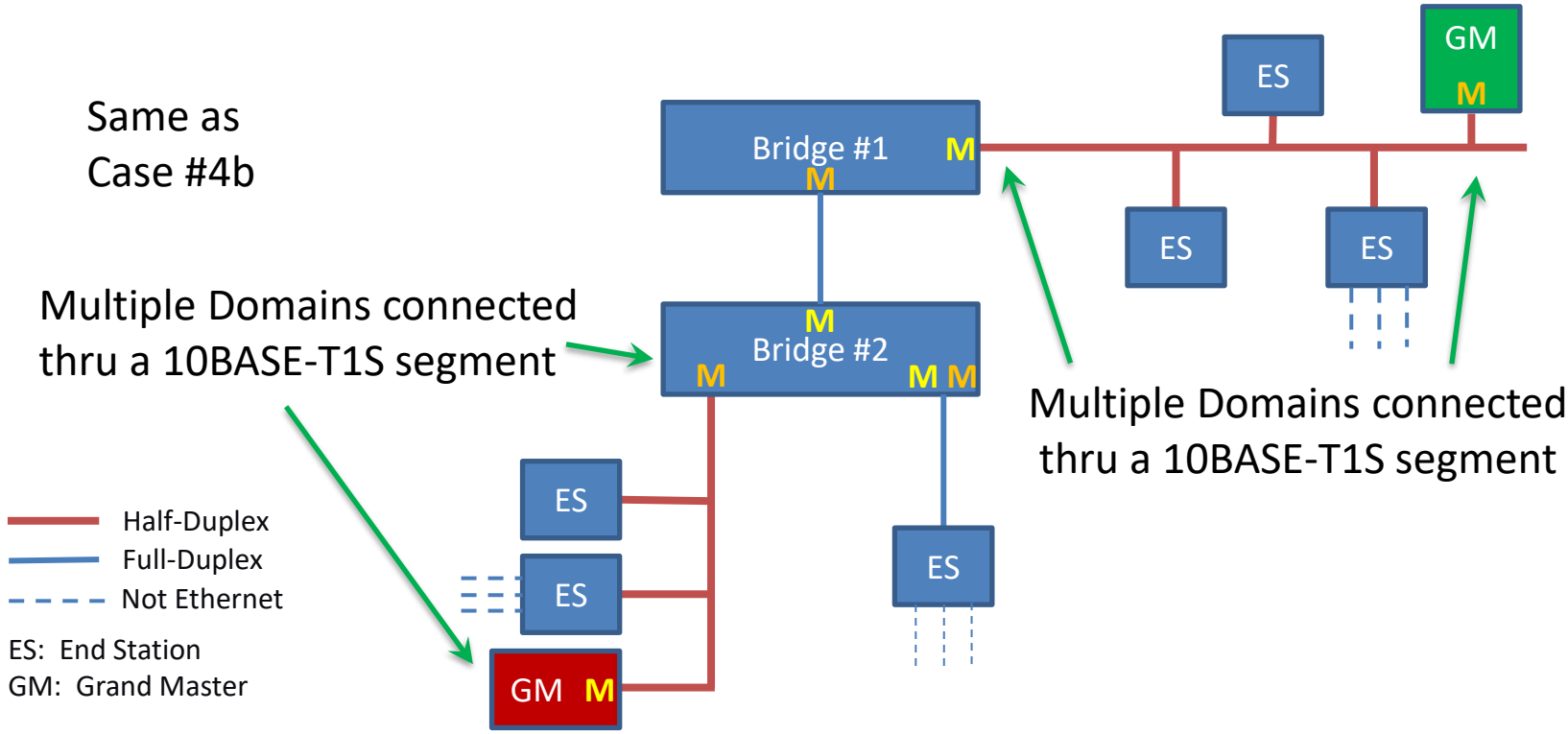
Two 10BASE-T1S End Station
acting as Domain GMs



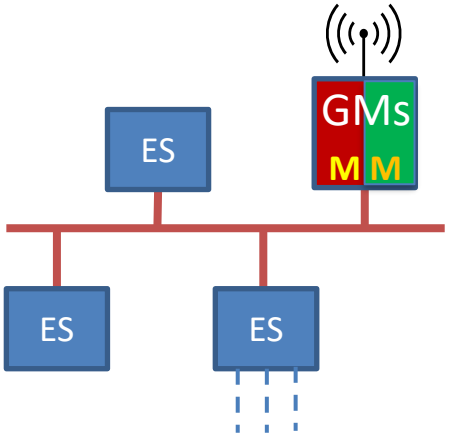
Case #5d: GM(s) on 10BASE-T1S segment(s)

Same as
Case #4b

Multiple Domains connected thru a 10BASE-T1S segment



Case #6a: 10BASE-T1S is the Network

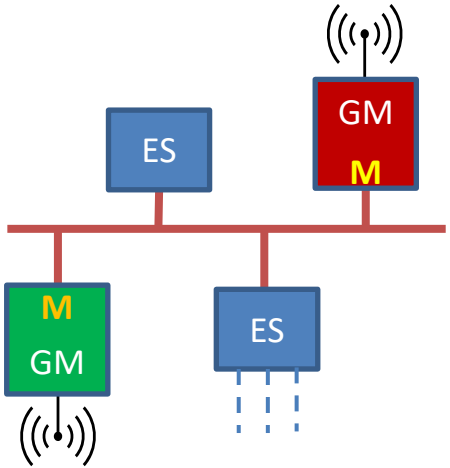


Half-Duplex
Full-Duplex
Not Ethernet

ES: End Station
GM: Grand Master

Case #6b: 10BASE-T1S is the Network

Same as
Case #6a

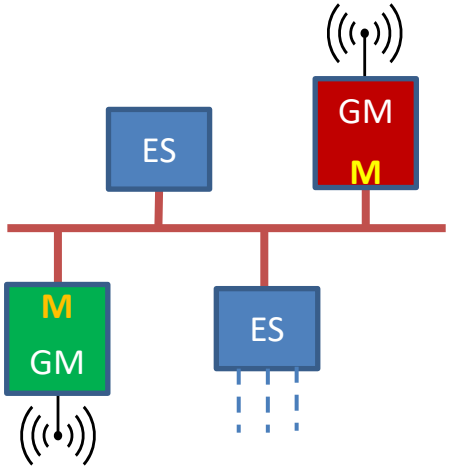


Half-Duplex
Full-Duplex
Not Ethernet

ES: End Station
GM: Grand Master

Summary of the Topologies

As far as the half-duplex links are concerned, all the above use-case appear to boil down to this simplified model



Half-Duplex
Full-Duplex
Not Ethernet

ES: End Station
GM: Grand Master

Are there other use-cases that would change this simplified model?

MODES OF OPERATION

Conceptual modes that need to be supported (as of today):

- Plug-and-Play
- External Port Configuration

Plug-and-Play on 802.3 Half-Duplex Links

- A working single-domain solution for Plug-and-Play was demonstrated in: https://www.ieee802.org/1/files/public/docs2017/tsn-cgunther-802-3cg-multidrop-0917-v01.pdf
- Propose to use the mechanisms described there as a starting base-line for optional Plug-and-Play support on 802.3 half-duplex links

Slide 9 from the Linked Presentation:

802.1AS ON MULTIDROP? YES

Can 802.1AS (gPTP) run on a multidrop network? Yes!

Here's the steps, assuming the timing Master for the multidrop segment will never change* (i.e. it is the port on the attached switch):

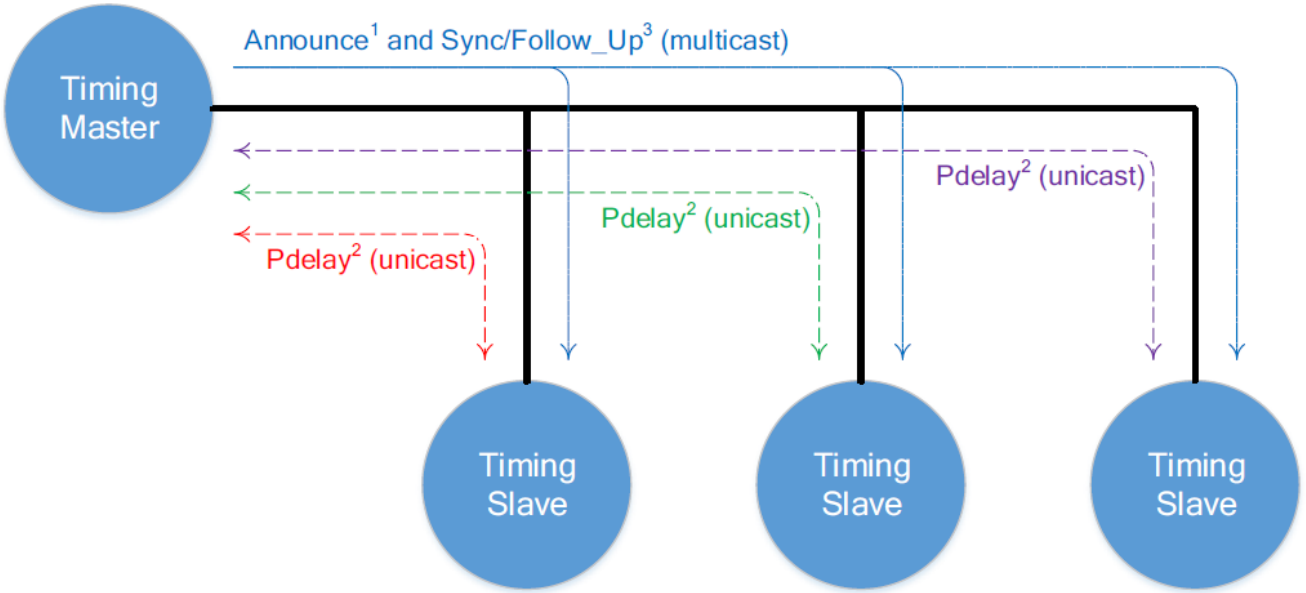
1. Master Announces itself to the network which allows Slave(s) to learn the Master's MAC address.
2. Slave(s) run Pdelay in unicast mode with the Master. Collisions will be handled appropriately. If the wire lengths are so short that the propagation delay is negligible it may be possible to skip Pdelay measurements in an engineered network. Slave(s) only need to track propagation delay to the single Master.
3. There is no need for the Master to run Pdelay propagation calculations against the Slave(s); therefore, Master does not need to track multiple delays.
4. Master transmits Sync & Follow_Up messages using the standard multicast address.
5. Slave(s) calculate current time by adding propagation delay (calculated by Pdelay) to the Master's gPTP time ('*t1*' from the Sync's Follow_up packet).

* Note: I believe the assumption about a 'dedicated' Master is not actually required if all nodes transmit Announce packets and the BMC algorithm chooses the Master node; the procedure described above will still work.

Slide 10 from the Linked Presentation:

802.1AS ON MULTIDROP, PACKET EXCHANGES

The following diagram illustrates the packet exchanges detailed on the previous slide. In order to synchronize time, Slaves wait for (1) Announce which also contains the Timing Master MAC address, then run (2) Pdelay, then finally process (3) Sync/Follow_Up.



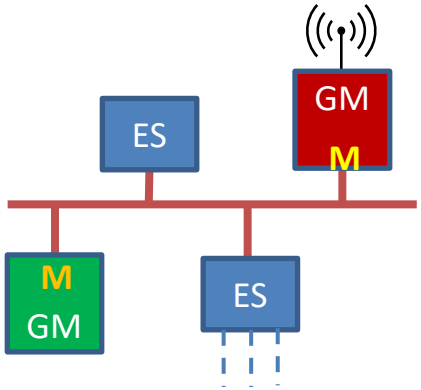
External Port Config on 802.3 Half-Duplex Links

- Need to solve the Pdelay unicast DA issue
  - Are these addresses “known” by configuration?
  - Are they “learned”? By Announce?
  - Impact of an End Station’s gPTP on shared media
    - As it may need to know about more than one GM
- Next steps: Work out proposed mechanisms

SUMMARY

- All proposed solutions need to work on all the use cases described above

  That appears to boil down to the simplified half-duplex link segment shown:



- We plan to bring solution suggestions for External Port Config at a future meeting

QUESTIONS?
COMMENTS?
CONCERNS?

Thanks!