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PTP/ST 2059 Made Easy

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PTP Myths

- PTP is hard
- PTP doesn’t work
- PTP can cause network flooding and congestion
- PTP is the same as a Network Genlock

PTP Truths

- There are ways to do PTP wrong
- Some early implementations had bugs
- PTP is mature. V2 is from 2008
- PTP Is Not Unique to Broadcast
  - Scientific E.g. CERN
  - Finance High Frequency Traders and Stock Market
  - Telco (E.g. 5G)
  - Automotive
  - Cloud Datacenters
  - Electrical Utilities

Agenda

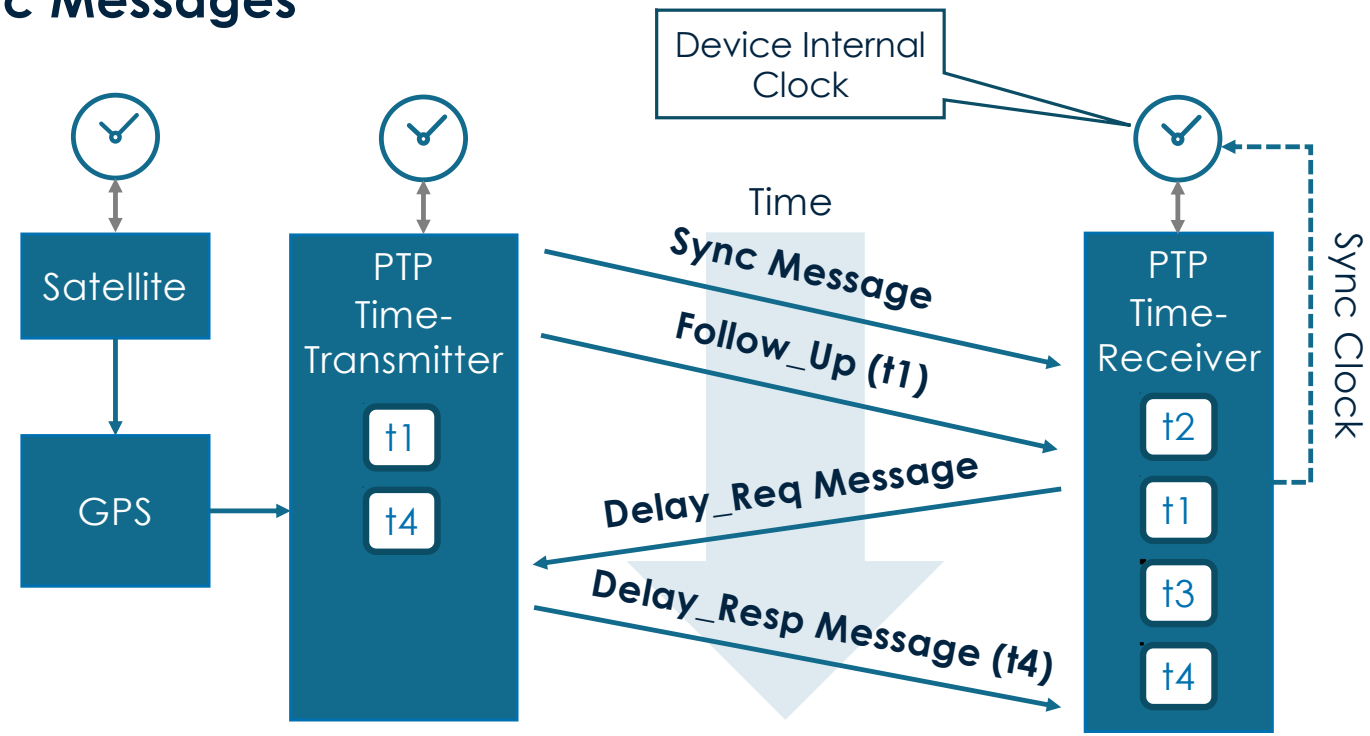
- PTP Basics
- PTP Best Practices
  - RP 2059-14
- PTP Guarantee

PTP Basics

PTP Messages

- "The time is" and "Now“ messages
  - Sync Message and Follow-up messages
- Measuring the "Now" message latency
  - Delay_Request and Delay_Response messages
- Determining the best GM message
  - Announce messages
- Management message
  - SMPTE TLV

PTP Sync Messages



PTP GM Selection Process

- One clock in every domain must be designated “GM”

- Each clock announces its attributes
  - If another clock is better, then clock goes into follower mode
  - If no better clock is found, then it becomes GM

- All clocks use same selection algorithm
  - Called “BMCA”
  - All clocks will reach same conclusion with same set of data

BCMA

Decision rules

1. Priority 1 (P1) – User set
2. Clock quality
   (E.g. class and accuracy - GPS lock, freerun)
3. Priority 2 (P2) – User set
4. Other random stuff

Getting PTP Through the Network

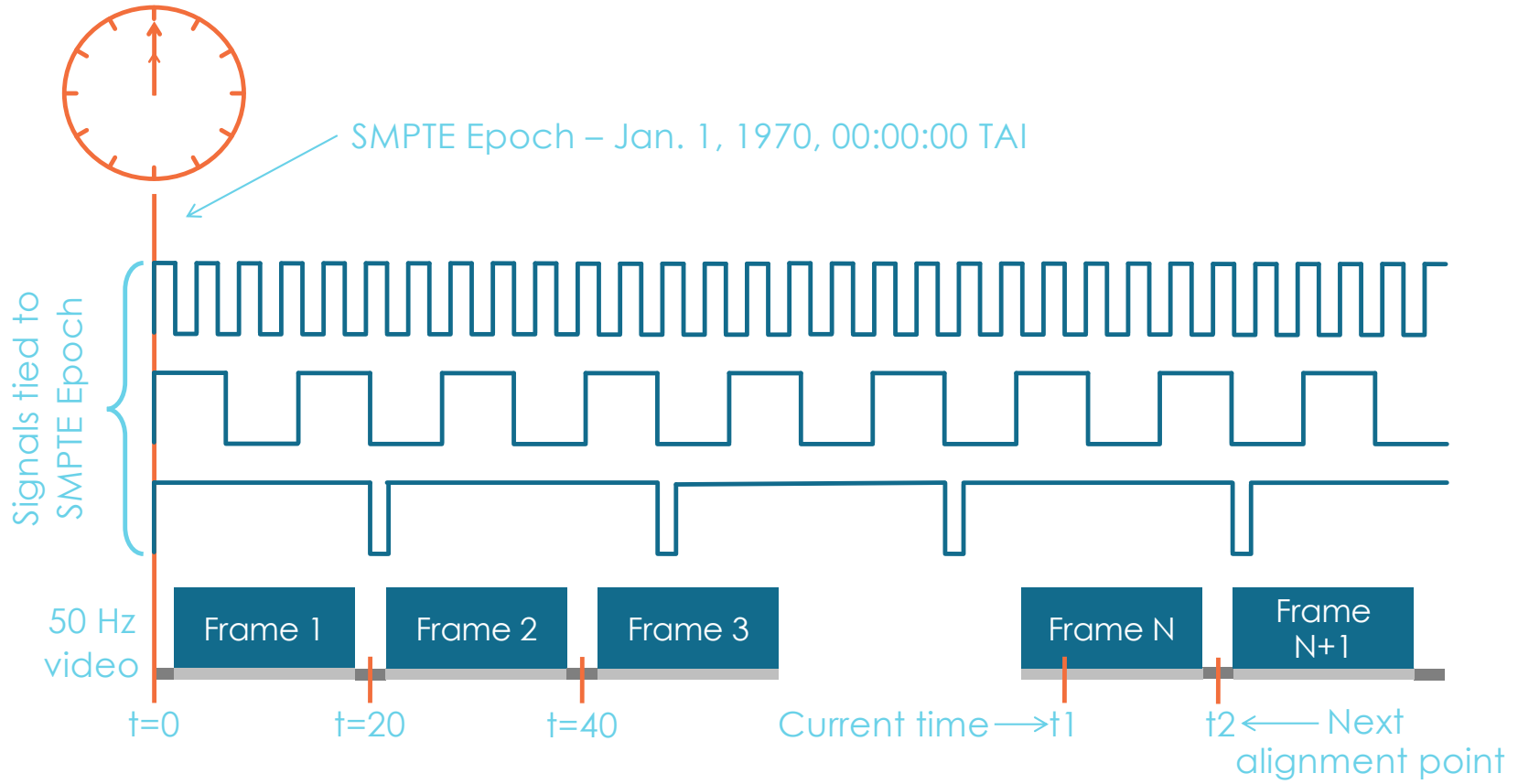
- Boundary Clocks Switches
  - Regenerate Time

- Transparent Clock Switches
  - Pass the messages but update time field

PTP vs Network Genlock

- Network Genlock goal is a known phase at a given time
- PTP gets time to all devices
  - ST 2059-2 is profile for PTP
- ST 2059-1 is generating phase from time
- PTP is not a Network Genlock. ST 2059 is

Achieving Network Genlock/Synchronization



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PTP Best Practices

Upcoming RP 2059-14

PTP Best Practices

Network Architecture/Topology

BP#1 - Solid Network and PTP Foundation

PTP Network Architecture/Topology

BP#2 - Use Boundary Clock Everywhere that you can

BP#3 - Use Only PTPv2 and Avoid PTPv1

BP#4 - All GMs must have the same time

BP#5 - Each site should have their own active GM

BP#6 - PTP links between both ST 2022-7 sides

PTP Best Practices

PTP Configuration

BP# 7 - Use ST 2059-2:2021 Profile Default Values

BP# 8 - Set the PTP Domain 1-126 (not 0 or 127)

BP# 9 - “Leader/TimeTransmitter only” on All Media Node facing ports

BP#10 - Devices at the same level have same P1 and different P2

BP#11 - Enable ST 2059-2 TLV messages

Commissioning and Operation

BP#12 - Do proper Commissioning

BP#13 - Implement a PTP monitoring solution

PTP Best Practices

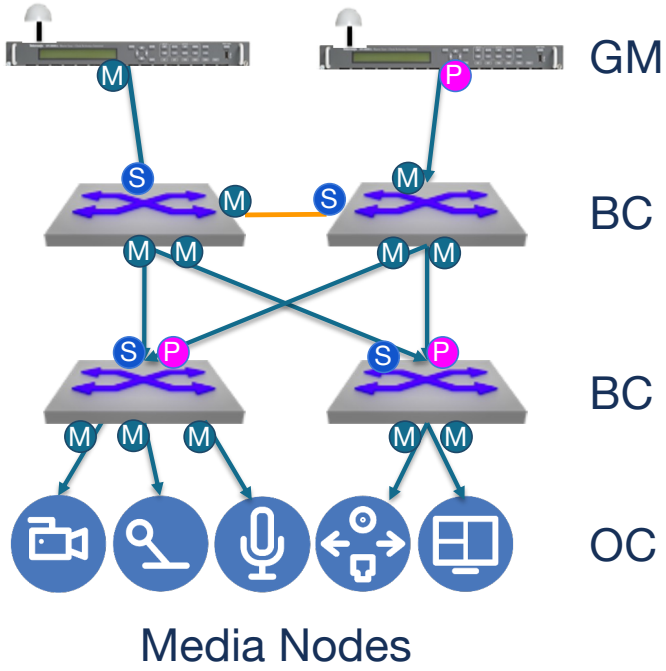
Security Best Practices

- BP#14 - Protect Management Interfaces (GUI And API)
- BP#15 - Boundary Clocks And Leader/Timetransmitter Only
- BP#16 - Management Messages
- BP#17 - Protecting GNSS System
- BP#18 - Monitoring System

Best Practices for PTP Network Architecture/Topology

BP#2 - Use Boundary Clock Everywhere that you can

- Switches connected to Media Nodes MUST be BC
  - Isolation between Media Nodes
  - Greatly reduces Media Node processing
  - Security
- Simplicity, easier to debug and design
- No multicast complexity for PTP
- Consistent Configuration on all Leafs



BP#3 - Use Only PTPv2 and Avoid PTPv1

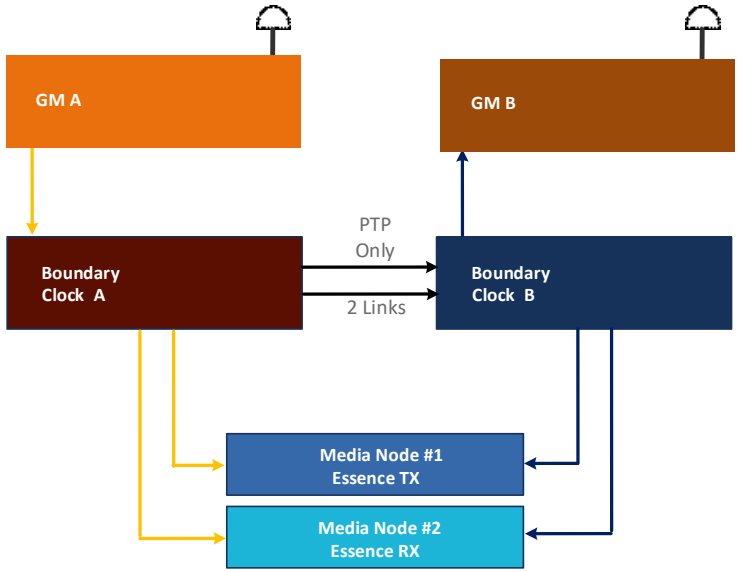
- Avoid PTPv1 if you can
  - Most devices can be configured for PTPv2
- If you can't avoid PTPv1, try to keep it in its own PTPv1 network
- May need device to bridge between PTPv1 and PTPv2

BP#4 - All GMs must have the same time

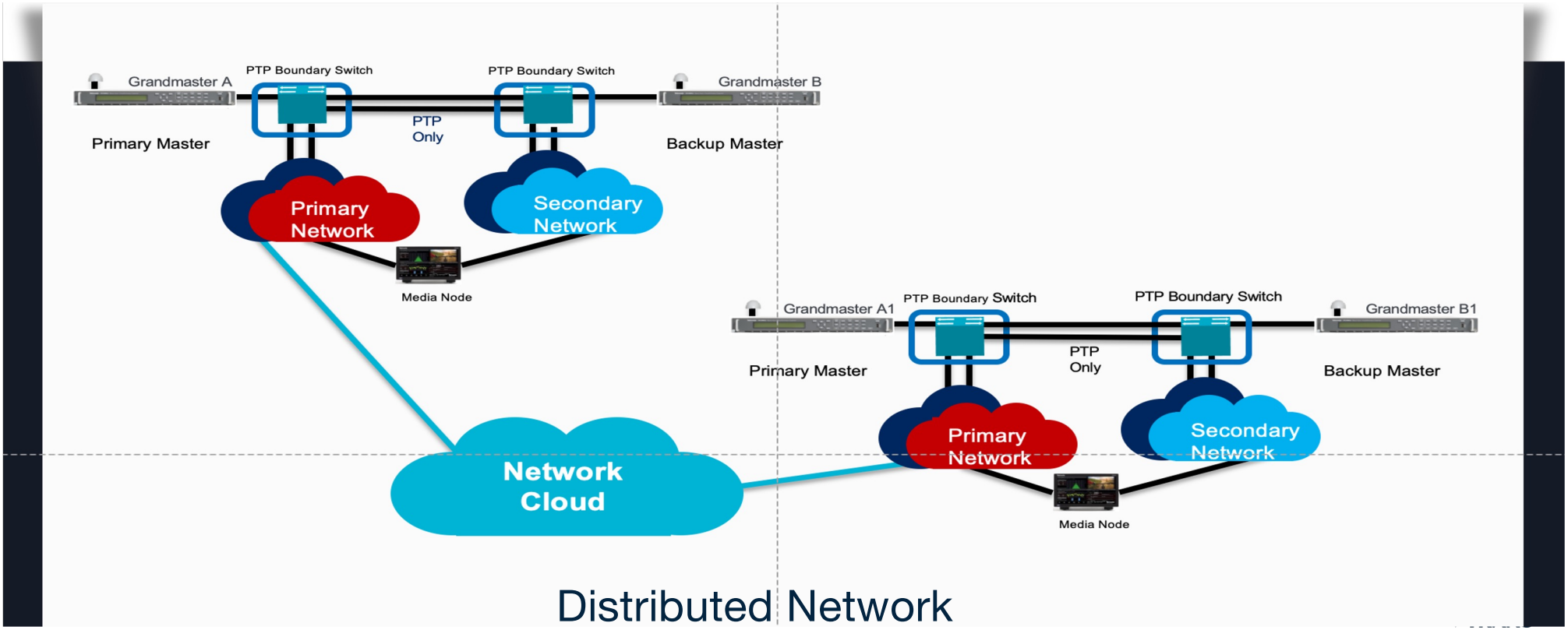
Why?

Failure over has no large jump in time

Link between GM

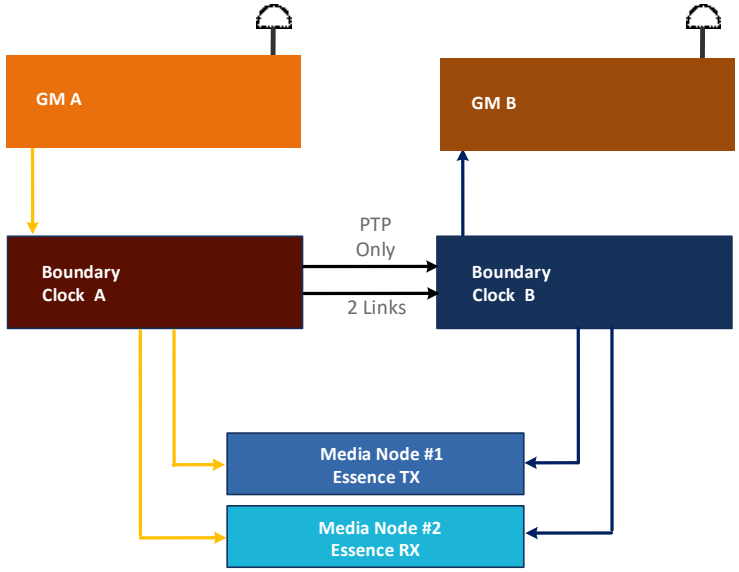


BP#5 - Each site should have their own active GM



BP#6 - PTP links between both ST 2022-7 sides

- Network **MUST** converge to a single GM during failure events
- Do NOT want a 100% air gapped networks
- Need at least 2 PTP links between the ST 2022-7 sides



Best Practices for PTP Configuration

BP#7 - Use ST 2059-2:2021 Profile Default Values

- New version of ST 2059-2:2021
  - www.smpte.org
  - Same as AES-R16

- Announce Interval 0 (1 message per second)
- Announce Timeout 3
- Sync Interval -3 (8 messages per second)
- Delay Request Interval -3 (8 messages per second)

BP#8 - Set the PTP Domain 1-126 (not 0 or 127)

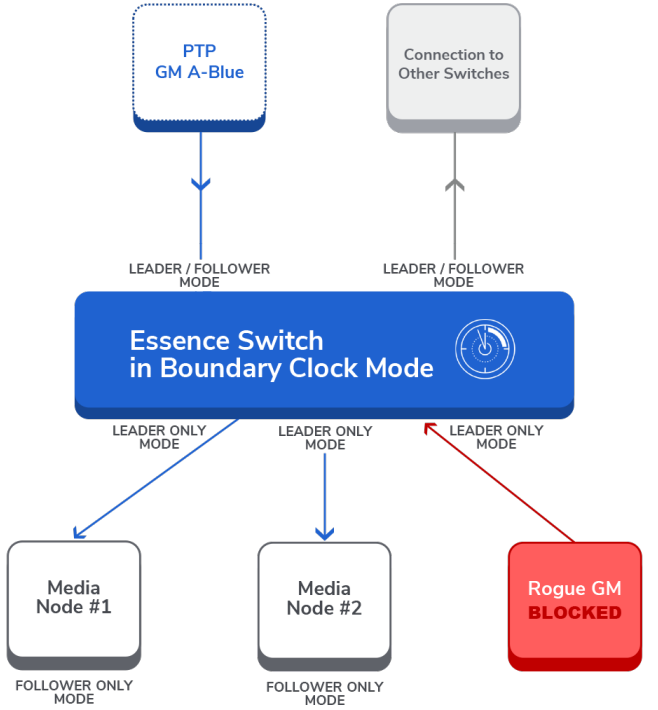
- Domain value ranges from 0 to 127
- Default Values for
  - ST2059-2 =127
  - AES67 and IEEE1588 = 0

- NOT recommend using default values
- Why?
  - Want unconfigured device to “fail” hard

BP#9- “Leader/TimeTransmitter only” on All Media Node facing ports

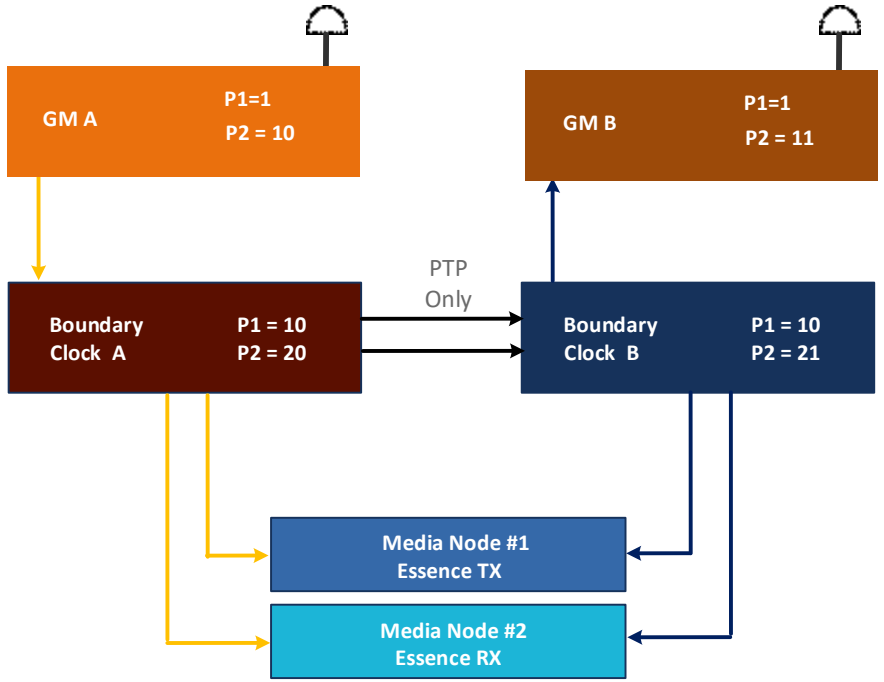
- Prevents a BC port from taking part in BMCA
- Limits the role of the port to be Master / Leader
- Prevents unauthorised end-points taking over
  - Rogue end points
  - Badly configured end-points

- Should not be used for fabric connectivity



BP#10 - Devices at the same level have same P1 and different P2

- All devices at the same level in the PTP hierarchy have the same P1 value and a different P2 value
- Devices at different level in the PTP hierarchy have different P1 values



BP#11 - Enable ST 2059-2 TLV messages

- Used by Media Nodes to generate Drop Frame Timecode
- Management messages sent from the GM

Why since I don’t use Timecode?

- Avoid issues in the future

Best Practices for Commissioning and Operation

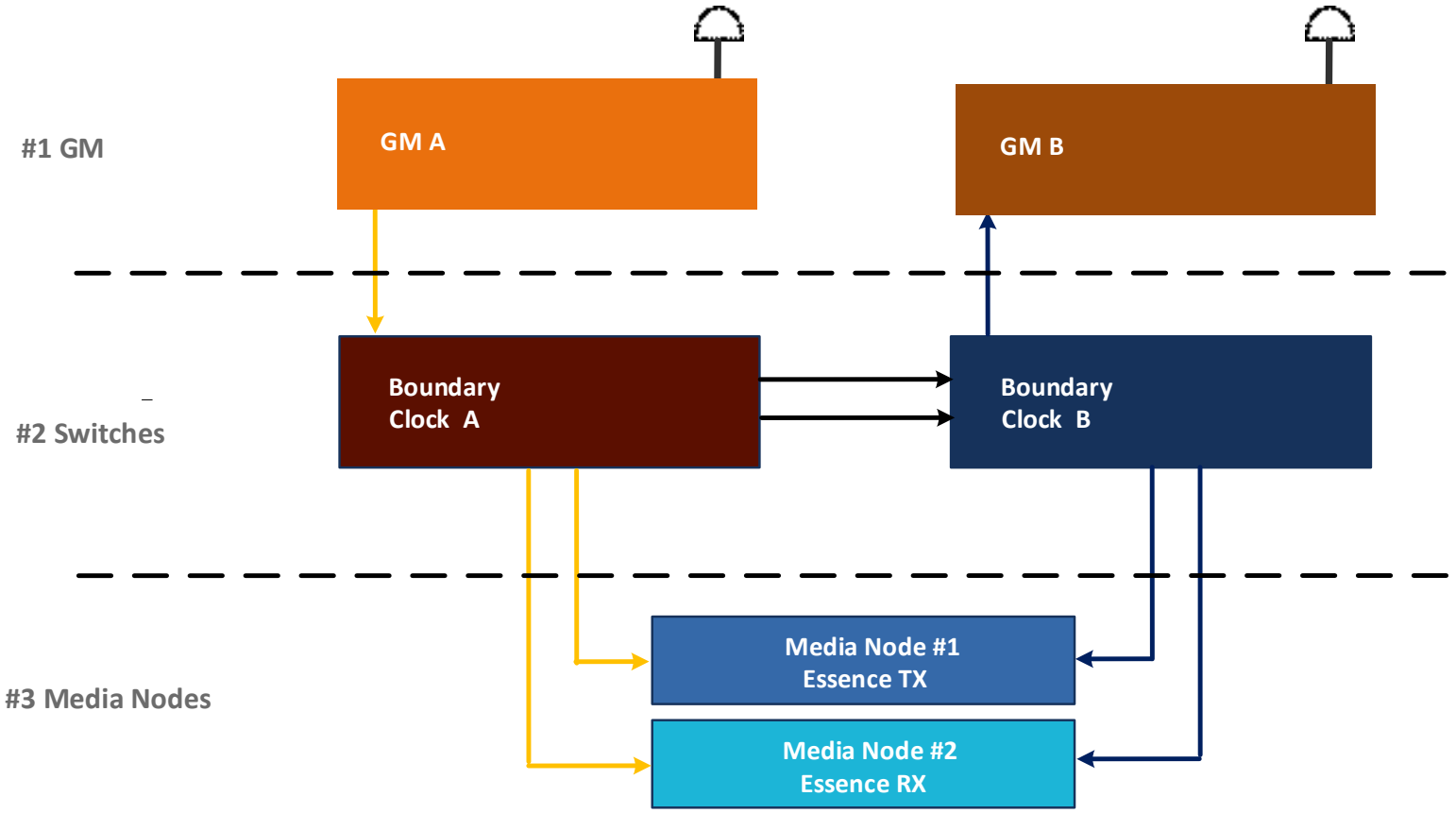
BP#12 - Do proper Commissioning

- Now that you have designed and built your system, you need to verify that it is working properly

- PTP can appear to be working properly, when in reality it is not

- Issues can be
  - Design
  - Device features
  - Configuration
  - Implementation bugs

Elements of a PTP System



- Separate Checklists for GM, Switches, and Media Nodes
- List of items to check/verify
  - *There are a lot of items*
- Pass/Fail Criteria for each item

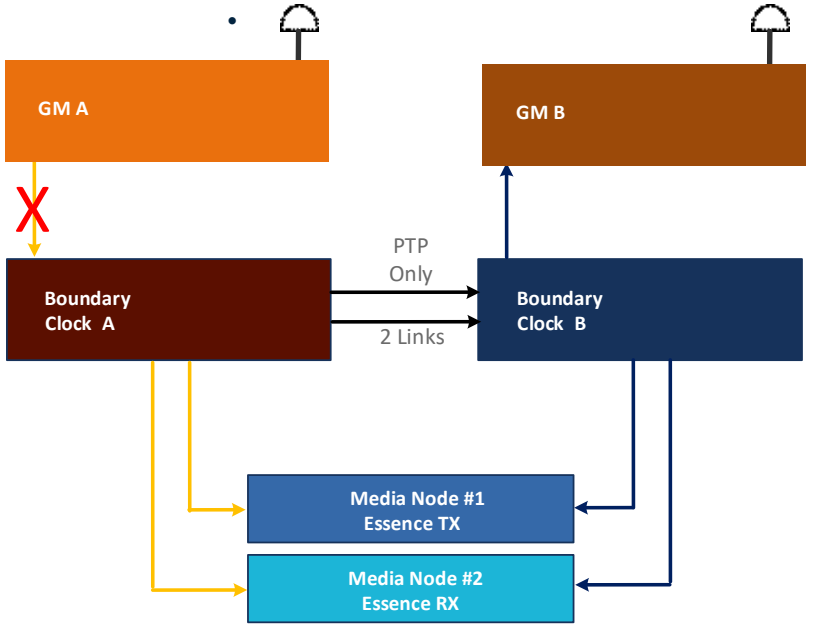
- Commissioning Period
  - Monitor for 24-48 hours
  - pcap for monitoring period

- Tools
  - Device GUI and API
  - WireShark .pcap captures
  - T&M

Redundancy, Failover and Power-up Testing

- Understand expected behavior
  - Detailed transient behavior. This includes
    - Port state change
    - Timing of the changes

- **Change of GM should not impact the Media Node output**
  - Check for glitches or change in output phasing at the Media Nodes



BP#13 - Implement a PTP monitoring solution

- Monitor critical parameters
  - GM ID
  - Locked status
- Detect changes in the system

- RP 2059-15
  - Standardize parameters and encoding to monitor

- IEEE 1588 V2.1 adds monitoring features

- Monitoring data collector

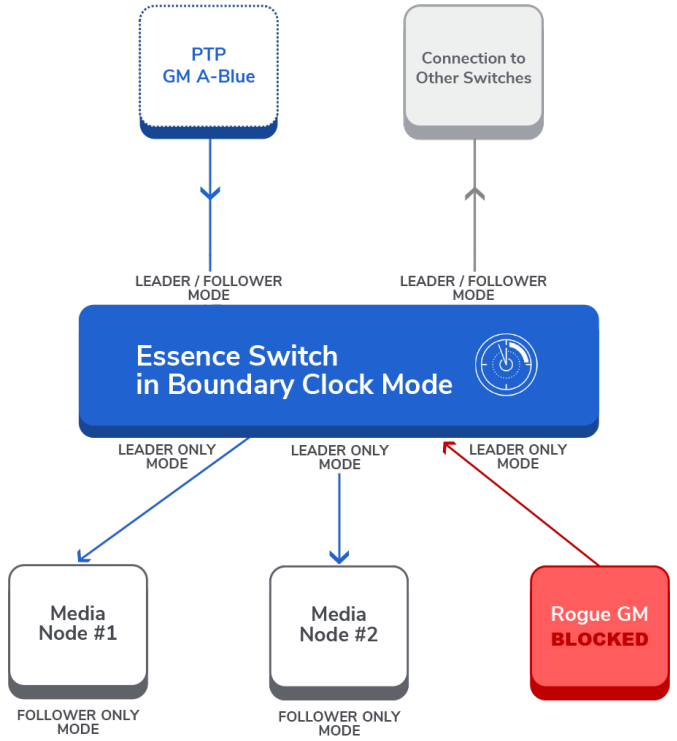
PTP Security Best Practices

BP#14 - Protect Management Interface GUI And API

- Strong password
- Secure login
- GM and switches are most critical

BP#15 - Boundary Clocks And Leader/Timetransmitter Only

- "Leader/Master/TimeTransmitter " is not defined in IEEE 1588:2008 (V2.0)
- Added as optional feature in 1588:2019 (V2.1)



BP#16 - Management Messages

- Restrict management messages to only the features necessary for the system
- Restrict the use/distribution of multicast management messages
- Stop distribution of multicast Management Response messages
  - SMPTE Profile ST 2059-2 requires management message responses be unicast
    - Unpatched PTP4L is not ST 2059-2 compliant

BP#17 - Protecting GNSS System

- Two antennas
  - One per ST 2022-7 side
- Dual band and multiple constellations
- Use anti-jamming and spoofing antenna
  - Horizontal protection
- Backup/Alternative time sources
  - NTP
  - Iridium time as a service
  - ATSC 3.0 time service
  - Freerun during event
    - Local atomic clock or high quality oscillator

BP#18 - Monitoring System

- Detect
  - Changes to the system time
  - Disruptions or Degradations in the time distribution
  - Interruptions of the time distribution

- SMPTE RP 2059-15 “YANG Data Model for ST 2059-2 PTP Device Monitoring in Professional Broadcast Networks”
  - https://pub.smpte.org/doc/rp2059-15/
    - Hard to find of the SMPTE Website
  - Free to SMPTE Members

PTP Guarantee

The Whitcomb Consulting PTP Guarantee

If you follow the PTP Best practices and have PTP issues,
Whitcomb Consulting will debug your PTP issues for free!

Fine Print

- The client must follow PTP Best practices. These include:
  - VSF VidTrans 2025 PTP Made Easy
  - "PTP/ST 2059 Best Practices developed from PTP deployments and experiences - IP Oktoberfest 2020"; and
    - www.youtube.com/watch?v=izJe1rnpaKc
  - "PTP Security Best Practices for the Broadcast and Professional Media Industries" WSTS 2022
    - https://wsts.atis.org/wp-content/uploads/2022/05/07-Leigh-Whitcomb.PTP-Security-Best-Practices-for-the-Broadcast.pdf
- The client must have taken and passed the SMPTE Summer Bootcamp 2024
- The client must use tier-1 switches and equipment
- The client must provide full documentation on the network
- Whitcomb Consulting must be given remote access to:
  - All switches and Media Nodes
  - A PTP capture device on the switches
- The free debugging is limited to 10 hours
- If it is determined that the client did not follow all the best practices, the client agrees to pay Whitcomb Consulting for the debugging at Whitcomb Consulting's current hourly rate

The Whitcomb Consulting Free PTP Review

If you follow the PTP Best practices,

Whitcomb Consulting will review your PTP design for free!

Fine Print

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    - https://wsts.atis.org/wp-content/uploads/2022/05/07-Leigh-Whitcomb.PTP-Security-Best-Practices-for-the-Broadcast.pdf
- The client must have taken and passed the SMPTE Summer Bootcamp 2024
- The client must use tier-1 switches and equipment
- The client must provide full documentation on the network
- The free review is limited to 0.5 hours

Summary

- Topics
  - PTP Myths and Truths
  - PTP Basics
  - PTP Best Practices
    - RP 2059-14
    - Boundary Clocks And Leader/Timetransmitter Only
- Whitcomb PTP Guarantee
- There are ways to do PTP wrong however if you follow this presentation, it will work well
- PTP is easy!

Thank you

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