Can We Make PTP Bullet Proof?

Oregano Systems
A Meinberg Company

The Best Master Clock Algorithm

A proven way to **ALWAYS** provide a reference, why bother?

- ▲ Fully **autonomous** process
  - ▲ Triggered only if current Grandmaster **fails** or a "**better**" GM enters the network
- ▲ All devices in a network will always select the **same** best Grandmaster

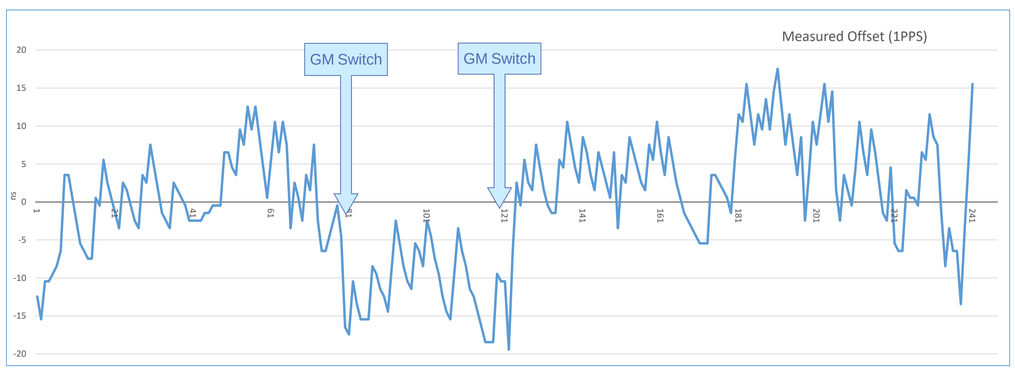
- ◀ Master Election takes **time**
  - ◀ **Hold over** performance of all end devices is critical
- ◀ What if the auxiliary PTP GM is not working?
  - ◀ GM(s) in stand-by have to be monitored separately
- ◀ Triggered **only** by Announce messages

- ▼ **Loss** of PTP event messages **remains undetected**
  - ▼ PTP event messages are manipulated within network elements!
- ▼ **Quality** of time information is **not taken into account**

Redundant Synchronization at the End Node

Use **multiple** time references simultaneously

- ▲ Process several PTP feeds independently from each other
- ▲ Multiple PTP instances attached to distinct PTP ports
  - ▲ Distinct physical ports
  - ▲ 1 shared physical port
- ▲ Time stamps have to be drawn from a common clock
  - ▲ Independent hardware time stamping modules
  - ▲ Independent control loops
- ▲ Redundant Synchronization allow to select one PTP feed to adjust the clock
- ▲ Selection Criteria
  - ▲ Availability … All messages are received correctly
  - ▲ Consistency … All messages are exchanged at their respective expected rates
  - ▲ Accuracy
    - ▲ BMCA
    - ▲ Quality of time information using statistical information, …..



Undetected Error Conditions and Attack Scenarios

They do **exist** and some of them are quite **nasty**…

Unreliable Time Information

- ◀ **No** time information altogether
  - ◀ Transient or permanent failures
- ▼ Poor **Quality**

Wrong time information

- ◀ **Misconfigured** devices
  - ◀ PTP is **always** a multi-vendor deployment …
- ▼ Deliberate **attacks**

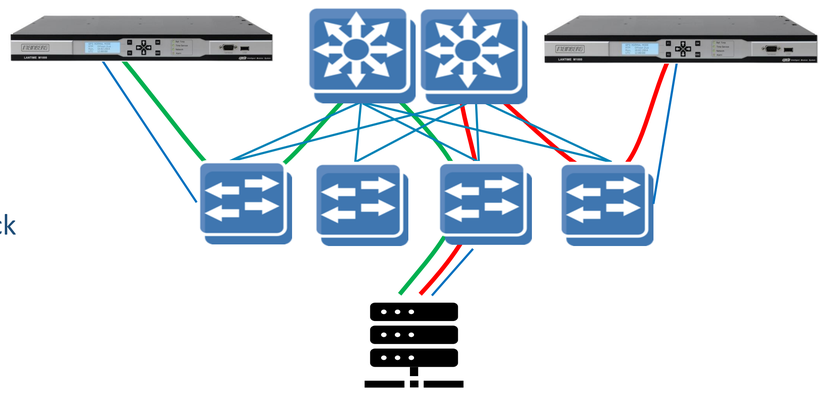
- ▼ PTP DoS – Denial of PTP Service
  - ▼ Swamp all nodes with PTP packets
- ▼ **Pose** as the VERY BEST Master
  - ▼ **Take** over the network
  - ▼ **Tamper** with time (introduce jumps, slew time, …)
  - ▼ **Stop** sending time information while still sending Announce messages
- ▼ Man in the **middle/ time delay** attack
  - ▼ **Delay** packets (unidirectionally and/or randomly)
- ▼ **Tamper** with the GNSS Reference
  - ▼ Jamming
  - ▼ Spoofing

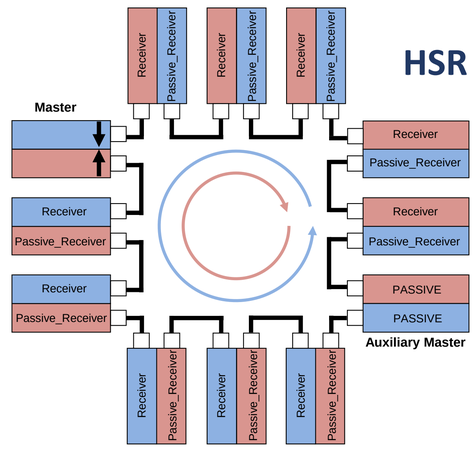
Let's secure PTP and be done with it!?

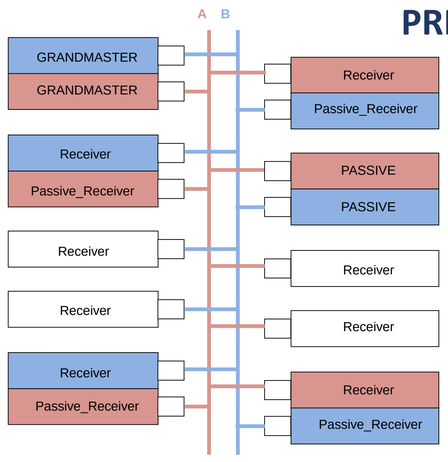
- ◀ Standard encryption techniques (MACSEC, IPSEC) may significantly deteriorate the accuracy
  - ◀ **Dedicated** devices required for the **whole** network!
  - ◀ There is no need to encrypt PTP, time is no secret …

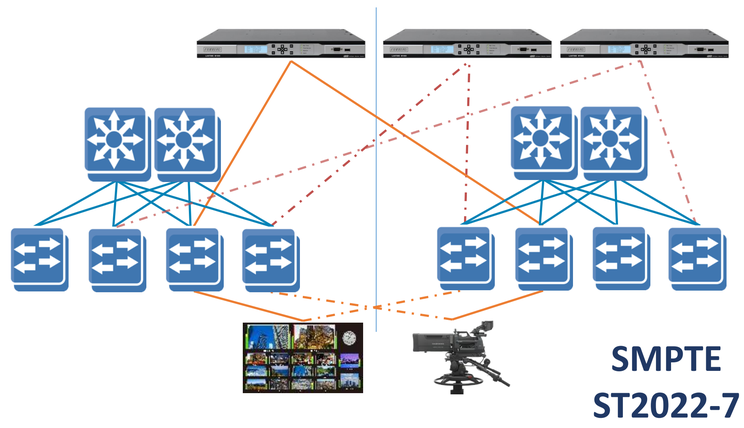
Make Use of Redundancy Whenever Possible

Multiple network paths, **Multiple** networks, **Multiple** references, ….





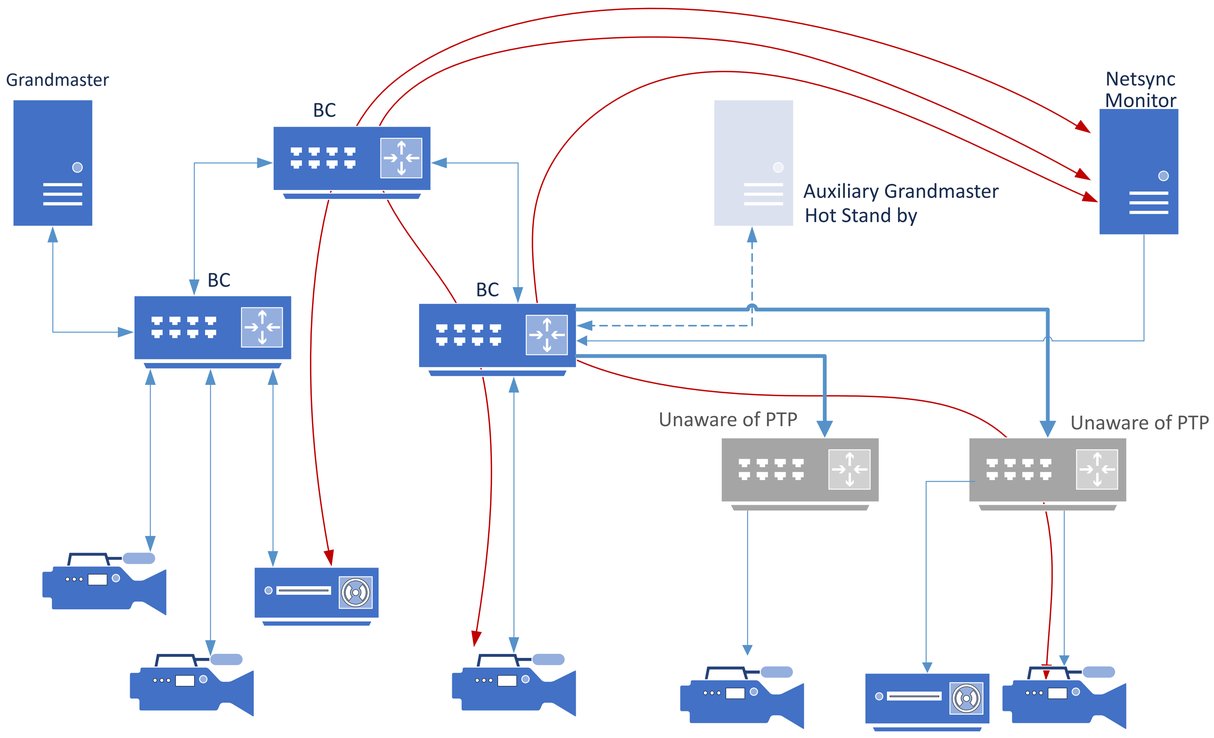




PTP Monitoring

Its tedious, but the **ultimate** key to success

- ▲ Use **all** available channels/methods
  - ▲ **Both** in-band and out-of-band
- ▲ PTP V2.1 offers several cool methods
  - ▲ Receiver Event Monitoring, Enhanced Sync Accuracy Metrics, Performance Monitoring
- ▼ Do **not** rely on the PTP Receiver data alone: Its view of the world is very **limited**
- ▲ Monitor both during deployment and operation (24x7)

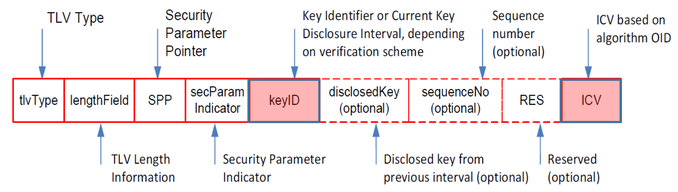


Highly Resilient PTP Time Transfer in a Nutshell

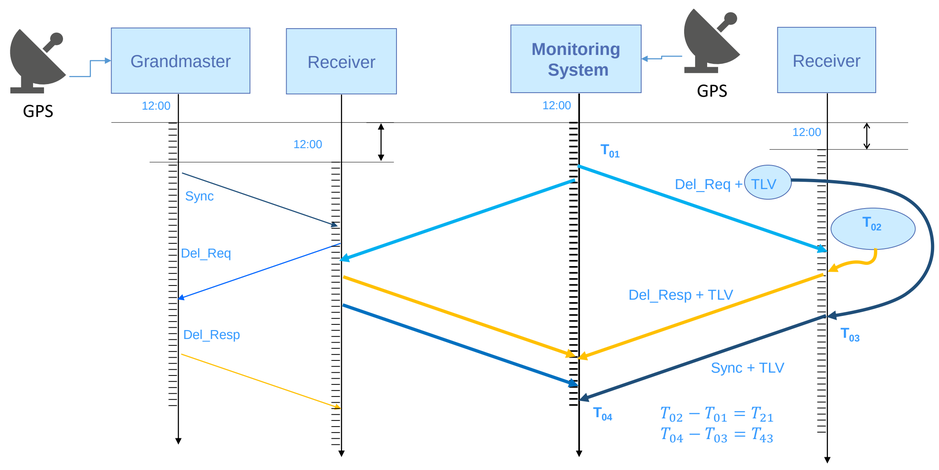
A **multi-pronged** approach at work

- ▲ Provision a **sufficient** number of primary references
  - ▲ Ideally not collocated
- ▲ Deploy modern GMs capable of detecting GNSS based attacks
- ▲ Make use of existing network **redundancy**
  - ▲ Redundant paths in networks
  - ▲ Fully redundant networks
  - ▲ HSR – High availability Seamless Redundancy
  - ▲ PRP – Parallel Redundancy Protocol

PTP V2.1 Security TLV



- ▲ Deploy PTP Security (This is **NOT** the one-size-fits-all solution!)
- ▲ **Most** error/attacks can be **prevented**
- ▲ **All** Errors/attacks can be **detected**



▲**Monitor, Monitor, Monitor, Monitor, Monitor, Monitor, Monitor …**

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