



# Usage of IEEE 1588 Announce message for non-BMCA networks

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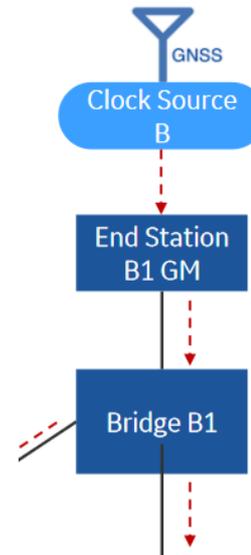
# Introduction

- IEEE 1588-2008 (and 802.1AS-2011) required Best Master Clock Algorithm (BMCA), to dynamically select the Grandmaster (GM) and configure paths
  - BMCA relies on Announce message
- IEEE 1588-2019 (and 802.1AS-2020) allows BMCA to be disabled (`externalPortConfigurationEnabled=true`)
  - Each port's state set by entity external to PTP (static or mgmt)
  - **Q: How is Announce useful for these non-BMCA networks?**
- This presentation attempts to answer
  - Focus is not on whether Announce should be optional in 1588

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# Some Non-BMCA Assumptions

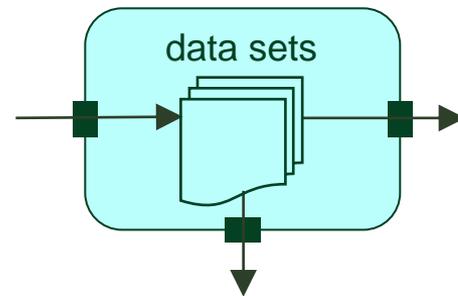
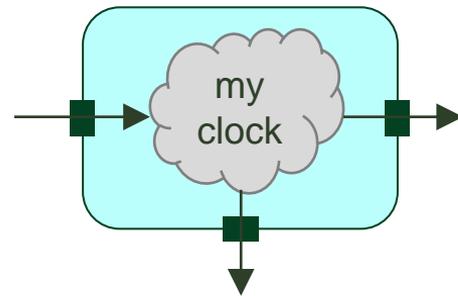
- From recent aerospace contribution
- Timescale is not always ARB
  - GM might be connected to global time source
- "PTP must natively address integrity."
  - Detection / mitigation of faults might not rely on centralized YANG-based management



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# Assumed 1588 Message Design

- Sync & Follow\_Up messages
  - Info directly related to syncing two clocks on a link (path)
  - Needs fast interval
  - Clock implementations can vary, so 1588 isn't very prescriptive on relay of this info
- Announce message
  - Info **not** directly related to syncing two clocks
  - Can use slower interval
  - Relay is specified through data sets



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# Presentation Flow

- First: Identify categories of info in Announce
  - Shown in red text
- Second: Describe how each category can be used for non-BMCA network

# Categories of Announce Info

# Fields

**Table 43—Announce message fields**

Bits							Octets	Offset
7	6	5	4	3	2	1		
header (see 13.3)							34	0
originTimestamp							10	34
currentUtcOffset							2	44
reserved							1	46
grandmasterPriority1							1	47
grandmasterClockQuality							4	48
grandmasterPriority2							1	52
grandmasterIdentity							8	53
stepsRemoved							2	61
timeSource							1	63

Each field is required by 1588, but for most, values can be constrained by 802.1AS or a TSN profile

E.g., if currentUtcOffsetValid always false, currentUtcOffset can be always 0 (ignored)

# Flags

Table 37—Values of flagField

Octet	Bit	Message types	Name	Description
0	0	Announce, Sync, Follow_Up, Delay_Resp	alternateMasterFlag	FALSE if the PTP Port of the originator is in the MASTER state. Conditions to set the flag to TRUE are specified in 17.2 and 17.3.
0	1	Sync, Pdelay_Resp	twoStepFlag	For Sync messages, if there is a Follow_Up message associated with the Sync message the twoStepFlag shall be TRUE, otherwise it shall be FALSE.  For Pdelay_Resp messages, if there is a Pdelay_Resp_Follow_Up message associated with the Pdelay_Resp message the twoStepFlag shall be TRUE, otherwise it shall be FALSE.
0	2	ALL	unicastFlag	TRUE, if the transport layer protocol address to which this PTP message was sent is a unicast address. FALSE, if the transport layer protocol address to which this PTP message was sent is a multicast address.
0	5	ALL	PTP Profile Specific 1	As defined by the applicable PTP Profile; otherwise FALSE.
0	6	ALL	PTP Profile Specific 2	As defined by the applicable PTP Profile; otherwise FALSE.
0	7			Reserved.
1	0	Announce	leap61	The value of timePropertiesDS.leap61.
1	1	Announce	leap59	The value of timePropertiesDS.leap59.
1	2	Announce	currentUtcOffsetValid	The value of timePropertiesDS.currentUtcOffsetValid.
1	3	Announce	ptpTimescale	The value of timePropertiesDS.ptpTimescale.
1	4	Announce	timeTraceable	The value of timePropertiesDS.timeTraceable.
1	5	Announce	frequencyTraceable	The value of timePropertiesDS.frequencyTraceable.
1	6	Announce	synchronizationUncertain (optional flag)	This is an optional flag. If this option is implemented, the flag shall contain the value of currentDS.synchronizationUncertain.

N/A in 802.1AS (tx 0, rx ignore)

N/A

N/A in 802.1AS (tx 0, rx ignore)

N/A in 802.1AS (tx 0, rx ignore)

time offset

GM quality

path quality

# TLVs (1 of 2)

Table 52—tlvType values

tlvType values	Value (hex)	TLV defined in subclause
Reserved	0000	—
MANAGEMENT	0001	15.5.2
MANAGEMENT_ERROR_STATUS	0002	15.5.2
ORGANIZATION_EXTENSION	0003	14.3
REQUEST_UNICAST_TRANSMISSION	0004	16.1
GRANT_UNICAST_TRANSMISSION	0005	16.1
CANCEL_UNICAST_TRANSMISSION	0006	16.1
ACKNOWLEDGE_CANCEL_UNICAST_TRANSMISSION	0007	16.1
PATH_TRACE	0008	16.2
ALTERNATE_TIME_OFFSET_INDICATOR	0009	16.3
Reserved	000A-1FFF	
In the 2008 edition, these values were assigned to options not present in this edition. To avoid conflict with 2008 implementations, these values shall not be used for other purposes.	2000, 2001, 2002, 2003	
Experimental values (see 4.2.9)	2004-202F	
Reserved	2030-3FFF	

N/A

N/A (Signaling for unicast)

fault detection (loop)

time offset

# TLVs (2 of 2)

Table 52—tlvType values

ORGANIZATION_EXTENSION_PROPAGATE	4000	14.3	
ENHANCED_ACCURACY_METRICS	4001	16.12	— path quality
Reserved for assignment by the IEEE 1588 Working Group for TLVs that propagate	4002-7EFF		
Experimental values (see 4.2.9)	7F00-7FFF		
ORGANIZATION_EXTENSION_DO_NOT_PROPAGATE	8000	14.3	— N/A (Signaling)
L1_SYNC	8001	Annex L	
PORT_COMMUNICATION_AVAILABILITY	8002	16.9.2.1	— N/A (Signaling for unicast)
PROTOCOL_ADDRESS	8003	16.9.2.2	
SLAVE_RX_SYNC_TIMING_DATA	8004	16.11.4.1	— N/A (Signaling for monitoring)
SLAVE_RX_SYNC_COMPUTED_DATA	8005	16.11.4.2	
SLAVE_TX_EVENT_TIMESTAMPS	8006	16.11.5.1	
CUMULATIVE_RATE_RATIO	8007	16.10	— N/A
PAD	8008	14.4	— N/A
AUTHENTICATION	8009	16.14	— N/A (PTP security for all messages)
Reserved for assignment by the IEEE 1588 Working Group for TLVs that do not propagate	800A-FFEF		
Reserved	FFF0 – FFFF		

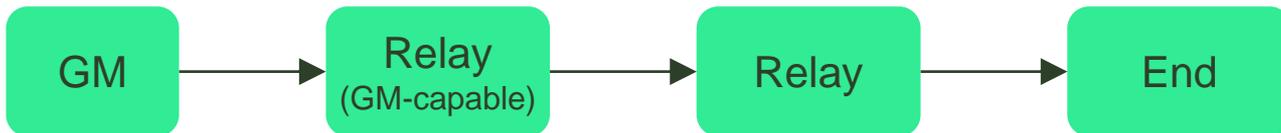
All TLVs are optional from 1588 perspective (up to profile to require)

# Non-BMCA Use of each Category

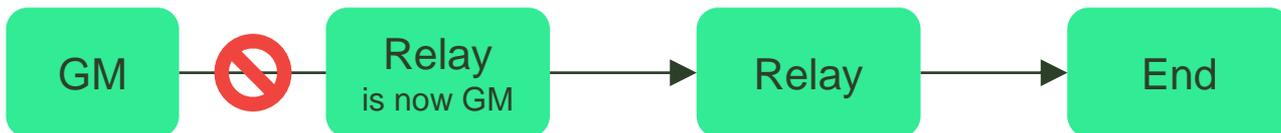
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# GM Identity

- In non-BMCA network, can GM change?
  - Yes
- Example
  - Step 1: Everything fine



- Step 2: Link fault



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# GM Identity

- Do you want end instances to detect this fault?
  - Likely Yes
  - Can impact quality of time, especially when fault is spurious
    - Risk of "flapping" between original GM and relay GM
- When reporting / logging fault, do you want to use unique ID for the new GM?
  - Likely Yes
  - Can be used to locate the fault(s)

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# GM Identity

- Announce is the only way to identify the current GM
  - grandmasterIdentity in Announce provides unique ID
  - sourcePortIdentity in Sync is upstream master port, not GM

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# GM Quality: Possible Usage

- Does non-BMCA profile mandate that all GMs have exact same quality?
  - Likely No
    - Even if all GMs must be within a min requirement
- If fault causes change from high-quality GM to min-quality GM, do we want to know in report / log?
  - Maybe
- If profile specifies algorithm to select among GMs to mitigate fault, is quality needed?
  - Yes (definitely)

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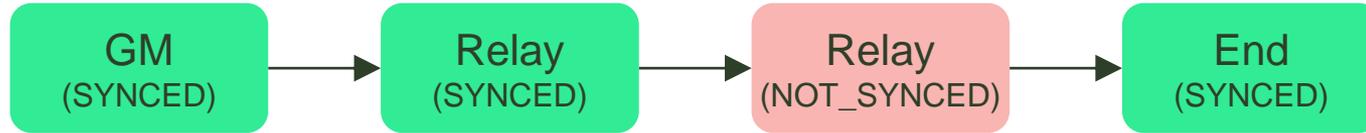
# GM Quality: Info in Announce

- grandmasterClockQuality.
  - clockClass: enumeration that answers questions like...
    - Is GM synced to primary reference?
    - If not, is GM in holdover?
    - Is GM using holdover upgrade option?
  - clockAccuracy: from "within 1ps" to ">10s" (enumeration)
  - offsetScaledLogVariance: variance of local clock
- timeSource: source of GM's time (e.g., GNSS, NTP)
  - E.g., If GM's time came through gateway from a CAN node, and that info is useful, timeSource would be the place to specify
- ptpTimescale: PTP (global TAI date/time) or ARB (arbitrary, e.g., zero at power on)
- timeTraceable, frequencyTraceable: Traceability of timeSource (boolean)

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# Path Quality

- P802.1ASdm/D0.7 ptplInstanceState example



- Is End truly synced? No
  - Local knowledge is insufficient
  - Sync state must be propagated
    - Otherwise, no way for downstream instances to know when the upstream path is not synced

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# Path Quality

- Fix: 1588 Announce synchronizationUncertain flag
  - Designed to propagate sync state down path
  - Currently unused by 802.1AS
- Could add support to P802.1ASdm as

```
currentDS.synchronizationUncertain =  
parentDS.synchronizationUncertain |  
(PtpInstanceSyncStatusDS.ptpInstanceState != SYNCED);
```

- Arguably in scope because it makes sync state actually work...



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# Path Quality

- Is a single bit sufficient?
  - Arguably No
- 1588's Enhanced Accuracy Metrics TLV
  - Propagates static, dynamic, and transient metrics along path
    - Similar to those discussed in IEC/IEEE 60802
  - Some profiles exploring use of TLV for enhanced BMCA
  - Currently unused by 802.1AS
- Usage for non-BMCA network similar to GM quality
  - Use to log metrics for fault diagnosis? Maybe
  - Use to decide between multiple paths to mitigate fault? Yes

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# Fault Detection (Loop)

- Is portState misconfiguration possible for non-BMCA?
  - Yes (Murphy's Law)
  - Can result in a loop (i.e., network traffic grows to 100%)
  - No protection without Announce
- stepsRemoved can detect in N loops
  - Increments each hop
  - Detect misconfiguration when reach maxStepsRemoved
- Path Trace TLV detects in 1 loop
  - Append instance's ID on transmit, check for own ID on receive
  - Mandatory in 802.1AS

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# Fault Detection (802.1ASdm Hot Standby)

- Split functionality of current P802.1ASdm draft uses Announce to avoid timing loops
  - Described in comment #42 on D0.7
  - If the GM of a domain is lost, the new root of the sync spanning tree will transmit priority1 of 255 in Announce
  - This results in gmPresent set to false in downstream instances (i.e., they free-run)
  - If GMs of both domains are lost, this avoids a timing loop

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# Time Offset

- Often need offset from domain's primary timescale
  - Not related to BMCA at all
  - Applies to timescale PTP (TAI) or ARB
- UTC offset is built into Announce
  - If you display a date/time to a human, you need UTC offset
  - GM uses leap59/61 flags to indicate leap sec well in advance
    - How leap sec is applied (e.g., smear) is up to profile

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# Time Offset

- Additional offsets use

## Alternate Time Offset Indicator (ATOI) TLV

- Can use 0, 1, or >1 ATOI TLVs
  - Each TLV includes name and key (numeric ID)
- Includes fields for discontinuities (e.g., daylight savings time)
- Example: ARB GM can use to send "here's local time zone for display to a human, but don't use for control systems"
- FYI: AUTOSAR has similar offset TLVs in Follow\_Up

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# Profile Specific

- If profile needs specific info in the preceding categories...
  - Announce's fields and flags are designed for extension
    - E.g., Profile-specific value for timeSource, or clockClass
  - Profile-specific TLV can be appended to Announce

Thank You