

The background is a vibrant, abstract graphic. It features a central bright white light source from which numerous colorful rays emanate, creating a sunburst or starburst effect. The rays transition through a spectrum of colors including yellow, orange, red, and various shades of blue and green. Overlaid on this are several large, semi-transparent, wavy shapes in similar color tones, giving the overall image a sense of motion and energy.

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The bridge to possible

PTP Troubleshooting on Nexus 9000 switch

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BRKDCN-3005



Agenda

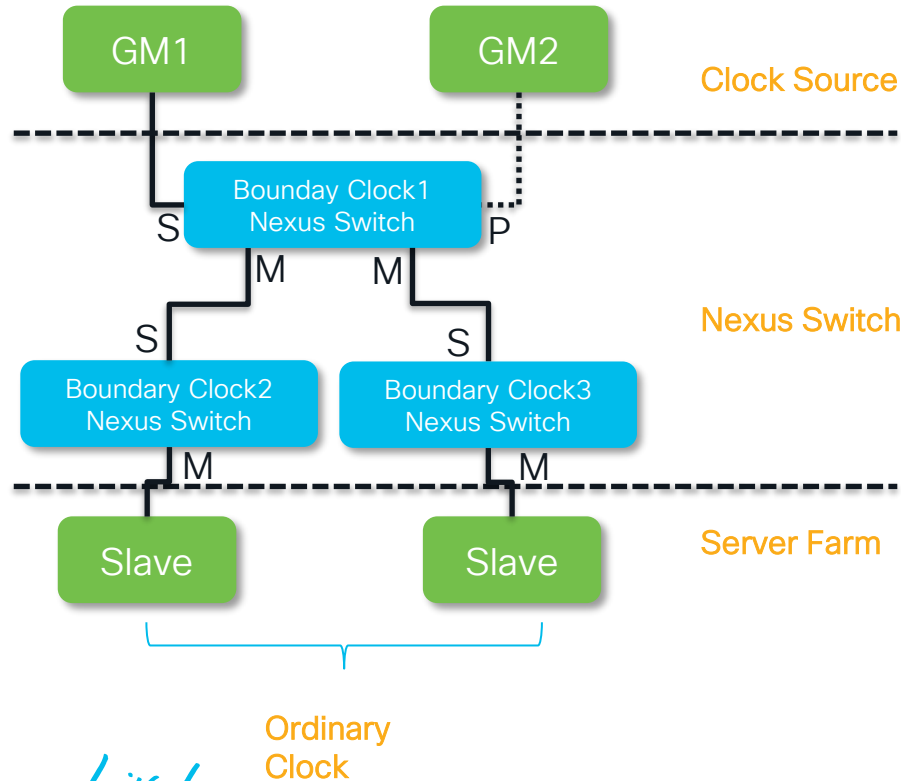
- PTP Basics
- Troubleshooting & Debug Commands
- Common Issues

PTP Basics

Why need PTP?

- Financial Market – Trading System
- IPFM – Audio/Video Sync
- NDI Telemetry – HW Telemetry
- ERSPAN type III, TTAG

Nexus switch with PTP Diagram



- **Grandmaster Clock(GMC)**

1. The clock at the top of the hierarchy
2. Reference time for entire network

- **Boundary Clock(BC)**

1. Accurately deliver time to other devices
2. Intermediate Clock
 - “M” – Master role interface
 - “S” – Slave role interface
 - “P” – Passive role interface

- **Ordinary Clock(OC)**

1. Only 1 port in PTP diagram

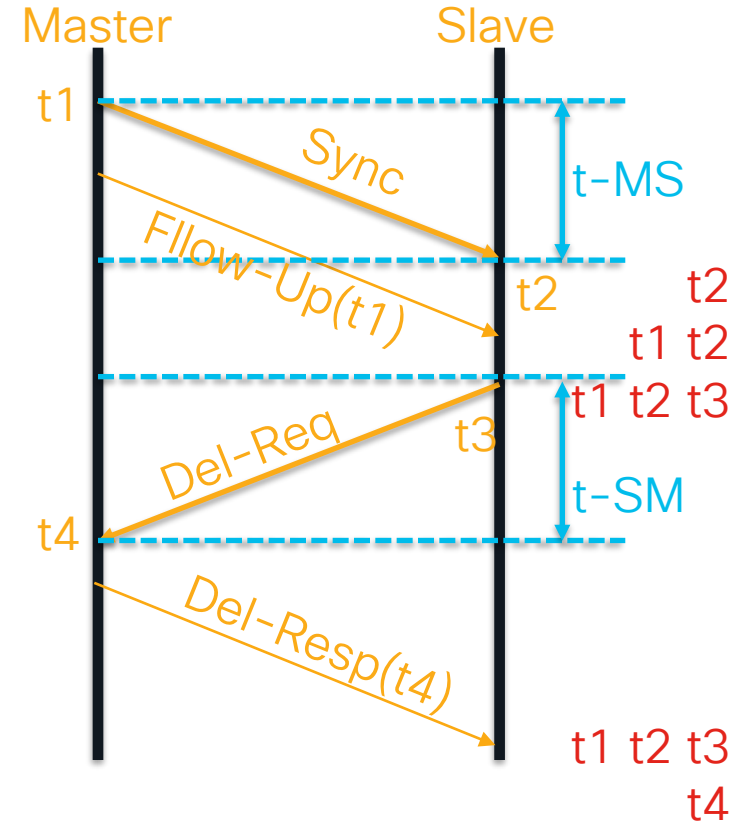
PTP Operation and Mean Path Delay Calculation

- It uses Sync, Delay-Req, Follow-Up, Del-Resp event messages (mcast or ucast) to communicate timing info(one or two-step)
 - “t1” is Master timestamp when Sync leaves.
 - “t2” is Slave timestamp when receives Sync
 - “t3” is Slave timestamp when Del-Req leaves.
 - “t4” is Master timestamp when receives Del-Req
- Mean Path Delay calculation

$$\text{MPD} = ((t2 - t1) + (t4 - t3))/2$$

$$\text{Offset} = t2 - t1 - \text{MPD}$$

Slave uses 4 timestamps to compute difference of time



Best Master Clock(BMC) Algorithm

- The general comparison algorithm is based on comparisons of attributes with the following rules:
 1. Priority1: User configurable absolute priority(lower values takes precedence)
 2. Class: Attribute defining clock's traceability
 3. Accuracy: Defines the accuracy of a clock
 4. Variance: Attribute defining the precision of a clock
 5. Priority2: User configurable variable(lower values takes precedence)

BMCA determines the master clock device, all above info is included in "Announce" message

```
nexus# show ptp clock
PTP Device Type : boundary-clock
PTP Device Encapsulation : NA
PTP Source IP Address : 1.1.1.1
Clock Identity : ac:7a:56:ff:fe:17:a9:bf
Clock Domain: 24
Slave Clock Operation : Two-step
Master Clock Operation : Two-step
Slave-Only Clock Mode : Disabled
Number of PTP ports: 3
```

Priority1 : 255

Priority2 : 255

Clock Quality:

Class : 248

Accuracy : 254

Offset (log variance) : 65535

Configurable

PTP BCMA

Switch1 Announce Message

Ethernet II, Src: Cisco_17:a9:bf (ac:7a:56:17:a9:bf), Dst: IPv4mcast_01:81 (01:00:5e:00:01:81)
Internet Protocol Version 4, Src: 1.1.1.1, Dst: 224.0.1.129
User Datagram Protocol, Src Port: 320, Dst Port: 320
Precision Time Protocol (IEEE1588)
 0000 = majorSdold: Unknown (0x0)
 1011 = messageType: Announce Message (0xb)
 0000 = minorVersionPTP: 0
 0010 = versionPTP: 2
 messageLength: 64
 domainNumber: 24
 minorSdold: 0
 flags: 0x0008
 correctionField: 0.000000 nanoseconds
 messageTypeSpecific: 0
 ClockIdentity: 0xac7a56ffe17a9bf
 SourcePortID: 4
 sequenceId: 38881
 controlField: Other Message (5)
 logMessagePeriod: 1
 originTimestamp (seconds): 0
 originTimestamp (nanoseconds): 0
 originCurrentUTCOffset: 37
 priority1: 0
 grandmasterClockClass: 248
 grandmasterClockAccuracy: Accuracy Unknown (0xfe)
 grandmasterClockVariance: 65535
 priority2: 255
 grandmasterClockIdentity: 0x3c510effe44c783
 localStepsRemoved: 1
 TimeSource: INTERNAL_OSCILLATOR (0xa0)

Switch2 Announce Message

Ethernet II, Src: Cisco_2b:ec:ff (ac:4a:67:2b:ec:ff), Dst: IPv4mcast_01:81 (01:00:5e:00:01:81)
Internet Protocol Version 4, Src: 1.1.1.1, Dst: 224.0.1.129
User Datagram Protocol, Src Port: 320, Dst Port: 320
Precision Time Protocol (IEEE1588)
 0000 = majorSdold: Unknown (0x0)
 1011 = messageType: Announce Message (0xb)
 0000 = minorVersionPTP: 0
 0010 = versionPTP: 2
 messageLength: 64
 domainNumber: 24
 minorSdold: 0
 flags: 0x0008
 correctionField: 0.000000 nanoseconds
 messageTypeSpecific: 0
 ClockIdentity: 0xac4a67ffe2becff
 SourcePortID: 4
 sequenceId: 28
 controlField: Other Message (5)
 logMessagePeriod: 1
 originTimestamp (seconds): 0
 originTimestamp (nanoseconds): 0
 originCurrentUTCOffset: 37
 priority1: 255
 grandmasterClockClass: 248
 grandmasterClockAccuracy: Accuracy Unknown (0xfe)
 grandmasterClockVariance: 65535
 priority2: 255
 grandmasterClockIdentity: 0xac4a67ffe2becff
 localStepsRemoved: 0
 TimeSource: INTERNAL_OSCILLATOR (0xa0)

PTP Common Verification

```
nexus# show ptp clock
```

PTP Device Type : boundary-clock

PTP Device Encapsulation : NA

PTP Source IP Address : 1.1.1.1

Clock Identity :3c:51:0e:ff:fe:44:c7:83

Clock Domain: 24

Slave Clock Operation : Unknown

Master Clock Operation : Two-step

Slave-Only Clock Mode : Disabled

Number of PTP ports: 1

Priority1 : 0

Priority2 : 255

Clock Quality:

Class : 248

Accuracy : 254

Offset (log variance) : 65535

Device role: GMC, BC, or TC

MAC address of Bridge

Domain ID

BC mode, one-step or two step

Number of ports enabled PTP

BMCA attributes

PTP Common Verification

```
nexus# show ptp parent
```

MAC address of itself

Parent Clock:

Parent Clock Identity: 3c:51:0e:ff:fe:44:c7:83

Parent Port Number: 0

Observed Parent Offset (log variance): N/A

Observed Parent Clock Phase Change Rate: N/A

Grandmaster Clock:

Grandmaster Clock Identity: 3c:51:0e:ff:fe:44:c7:83

Grandmaster Clock Quality:

Class: 248

Accuracy: 254

Offset (log variance): 65535

Priority1: 0

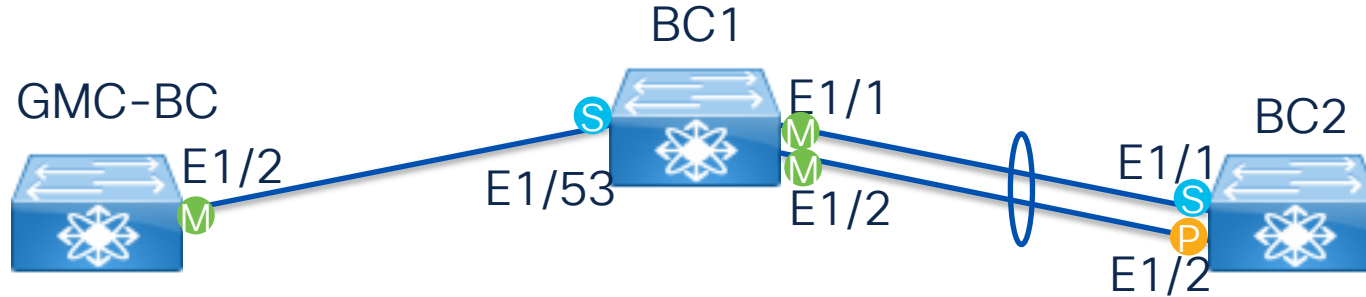
Priority2: 255

MAC address of GM clock

Troubleshooting & Debug commands



PTP Troubleshooting



3c51.0e44.c783

GMC-BC# show ptp brief

PTP port status

Port	State
Eth1/2	Master

ac7a.5617.a9bf

BC1# show ptp brief

PTP port status

Port	State
Eth1/1	Master
Eth1/2	Master
Eth1/53	Slave

ac4a.672b.ecff

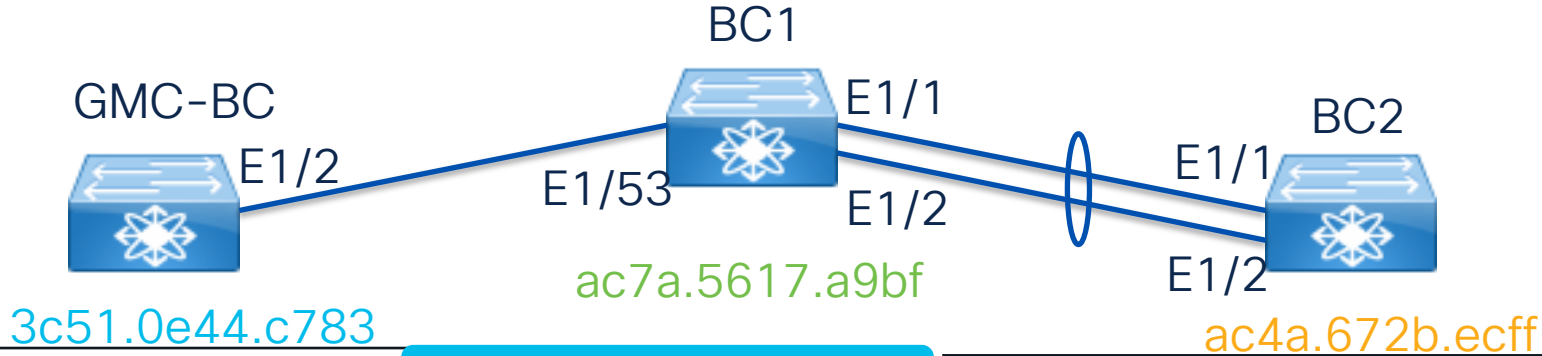
BC2# show ptp brief

PTP port status

Port	State
Eth1/1	Slave
Eth1/2	Passive

E1/1, E1/2 calculated individually

PTP Troubleshooting



BC2# show ptp parent

Parent Clock:
Parent Clock Identity: ac7a:56:ff:fe:17:a9:bf
Parent Port Number: 0
Observed Parent Offset (log variance): N/A
Observed Parent Clock Phase Change Rate: N/A

Parent IP: 1.1.1.1
Grandmaster Clock:
Grandmaster Clock Identity: 3c:51:0e:ff:fe:44:c7:83

Upstream BC MAC

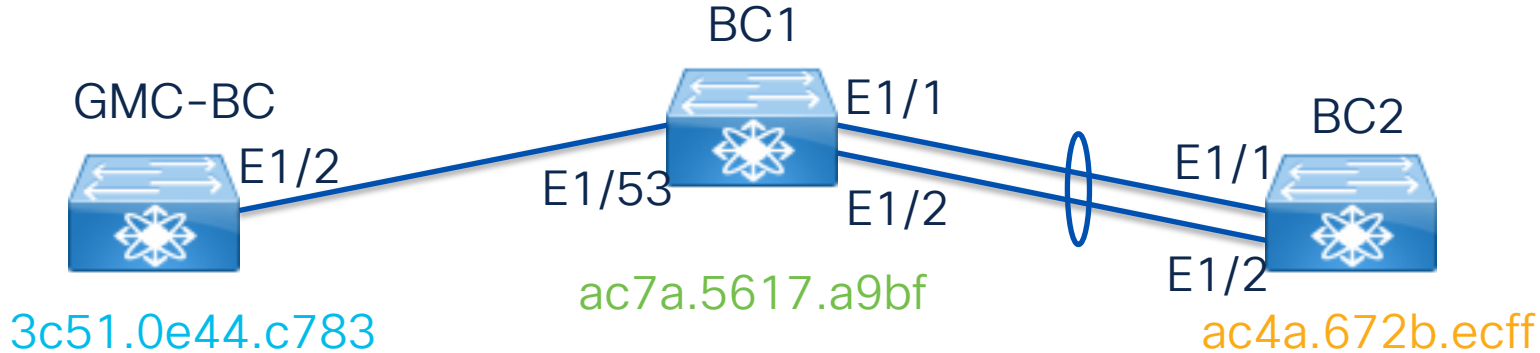
GMC is not upstream BC

BC1# show mac-address table

VLAN	MAC Address	Type	age	Secure	NTFY	Ports
-----+-----+-----+-----+-----+-----						
G	-	ac7a.5617.a9bf	static	-	F	F sup-
eth1(R)						

Clock ID comes from Gateway MAC

PTP Troubleshooting



```
BC1# show ptp parent
```

```
Parent Clock:  
Parent Clock Identity: 3c:51:0e:ff:fe:44:c7:83  
Parent Port Number: 4  
Observed Parent Offset (log variance): N/A  
Observed Parent Clock Phase Change Rate: N/A  
Parent IP: 1.1.1.1  
Grandmaster Clock:  
Grandmaster Clock Identity: 3c:51:0e:ff:fe:44:c7:83  
.....
```

Upstream BC is
GMC

PTP Troubleshooting

GMC-BC

GMC-BC# show ptp clock

PTP Device Type : boundary-clock
PTP Device Encapsulation : NA
PTP Source IP Address : 1.1.1.1
Clock Identity : 3c:51:0e:ff:fe:44:c7:83
Clock Domain: 24
Slave Clock Operation : Unknown
Master Clock Operation : Two-step
Slave-Only Clock Mode : Disabled
Number of PTP ports: 1
Priority1 : 0
Priority2 : 255
Clock Quality:
 Class : 248
 Accuracy : 254
 Offset (log variance) : 65535
Offset From Master : 0
Mean Path Delay : 0
Steps removed : 0

BC1

BC1# show ptp clock

PTP Device Type : boundary-clock
PTP Device Encapsulation : NA
PTP Source IP Address : 1.1.1.1
Clock Identity : ac:7a:56:ff:fe:17:a9:bf
Clock Domain: 24
Slave Clock Operation : Two-step
Master Clock Operation : Two-step
Slave-Only Clock Mode : Disabled
Number of PTP ports: 3
Priority1 : 255
Priority2 : 255
Clock Quality:
 Class : 248
 Accuracy : 254
 Offset (log variance) : 65535
Offset From Master : 168
Mean Path Delay : 168
Steps removed : 1

BC2

BC2# show ptp clock

PTP Device Type : boundary-clock
PTP Device Encapsulation : NA
PTP Source IP Address : 1.1.1.1
Clock Identity : ac:4a:67:ff:fe:2b:ec:ff
Clock Domain: 24
Slave Clock Operation : Two-step
Master Clock Operation : Two-step
Slave-Only Clock Mode : Disabled
Number of PTP ports: 2
Priority1 : 255
Priority2 : 255
Clock Quality:
 Class : 248
 Accuracy : 254
 Offset (log variance) : 65535
Offset From Master : -8
Mean Path Delay : 1008
Steps removed : 2

Number of hops from GM

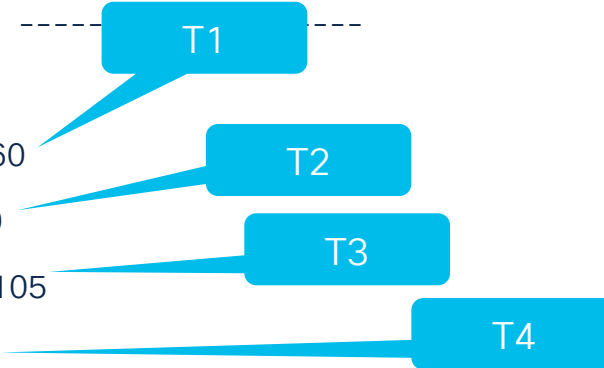
Advanced Debugging Skill

- Observe PTP control plane packet counter

BC1# show ptp counter inter e 1/1

PTP Packet Counters of Interface Eth1/1:

Packet Type	TX	RX
Announce	597681	25
Sync	4765963	160
FollowUp	4765960	160
Delay Request	18	1195105
Delay Response	1195105	18



Advanced Debugging Skill

- In order to debug PTP interface role selection, show cli and debug cli are useful

BC1# show system internal ptp info announce-pkts

2023 Mar 08 04:30:27.935430: E_PTP_ANN_PKT_EV[TX] I/f Eth1/2 (0x1a000200): MSG:Announce TS:0 V:2
LEN:64 D:24 UC:0 2S:0 UTCVAL:0 PTPTS:1 TT:0 FT:0 SRC:ac:7a:56:ff:fe:17:a9:bf-0x4 COR

Direction and interface

R:0 (0x0) SEQ:96dd (38621) Int:1; TS:0 s 0 ns; UTC_OFF:37 TM_SRC:a0 STEP:1 PRIO1:0 PRIO2:255

CLASS:248 ACC:fe LOG_VAR:ffff GM:3c:51:0e:ff:fe:44:c7:83

Attributes

2023 Mar 08 04:30:27.935256: E_PTP_ANN_PKT_EV[TX] I/f Eth1/1 (0x1a000000): MSG:Announce TS:0 V:2
LEN:64 D:24 UC:0 2S:0 UTCVAL:0 PTPTS:1 TT:0 FT:0 SRC:ac:7a:56:ff:fe:17:a9:bf-0x0 COR

R:0 (0x0) SEQ:96dd (38621) Int:1; TS:0 s 0 ns; UTC_OFF:37 TM_SRC:a0 STEP:1 PRIO1:0 PRIO2:255

CLASS:248 ACC:fe LOG_VAR:ffff GM:3c:51:0e:ff:fe:44:c7:83

Advanced Debugging Skill

BC2# debug ptp bmc interface eth1/1

2023 Mar 8 07:01:25.247218 ptp: ptp_bmc_calc_Erbest(): * Selected Erbest of port 'Eth1/1' (0x1a000000) is Clock ID: ac:7a:56:ff:fe:17:a9:bf Port: 0

2023 Mar 8 07:01:25.247254 ptp: ptp_bmc_calc_Ebest(): * * Selected Erbest of port 'Eth1/1' (0x1a000000) as Ebest (Clock ID: ac:7a:56:ff:fe:17:a9:bf Port: 0)

2023 Mar 8 07:01:25.247282 ptp: ptp_bmc_state_decision_all(): Current D0 Clock ID: ac:4a:67:ff:fe:2b:ec:ff Port:0

2023 Mar 8 07:01:25.247308 ptp: ptp_bmc_state_decision_all(): Current Ebest Clock ID: ac:7a:56:ff:fe:17:a9:bf Port:0

ANN1 is local announcement, ANN2 is remote one

2023 Mar 8 07:01:25.247346 ptp: GM ids are NOT same; ANN1 [port id: 0xac:4a:67:ff:fe:2b:ec:ff] :: ANN1 Attr [prio1 255 cls 248 acc 254 var 65535 prio2 255 steps 0 time-src 152] ANN2 [port id: 0x3c:51:ef:fe:44:c7:83] :: ANN2 Attr [prio1 0 cls 248 acc 254 var 65535 prio2 255 steps 1 time-src 160]

Advanced Debugging Skill

- PTP bad correction is a common issue in field
- A random bad correction is hard to be analyzed without data
- Traditional log capture method is impossible for PTP bad correction issue
- “Auto-log” feature offers convenience

Advanced Debugging Skill

BC1# show system internal ptp corrections

PTP past corrections

Slave Port	SUP Time	Correction(ns)	MeanPath Delay(ns)	MasterTimestamp (sec, nsec)	Slave Timestamp (sec, nsec)	Sync-SeqID	PTPLC ts_corr(ns)
Eth1/53	Tue Mar 7 07:00:33 2023 442043	13269016	168	1678172433 449331992	1678172433 436063144	57414	0
Eth1/53	Tue Mar 7 07:00:33 2023 187152	13268792	168	1678172433 198736912	1678172433 185468288	57413	0
Eth1/53	Tue Mar 7 07:00:32 2023 937967	13268552	168	1678172432 948072568	1678172432 934804184	57412	0
Eth1/53	Tue Mar 7 07:00:32 2023 687108	13268320	168	1678172432 696366112	1678172432 683097960	57411	0
Eth1/53	Tue Mar 7 07:00:32 2023 586990	-140221544	168	1678172432 445647208	1678172432 585868920	57410	0
Eth1/53	Tue Mar 7 07:00:32 2023 337414	-140221784	168	1678172432 194201400	1678172432 334423352	57409	0
Eth1/53	Tue Mar 7 07:00:32 2023 87570	-140222008	168	1678172431 942953128	1678172432 83175304	57408	0

Identify bad correction

Advanced Debugging Skill

BC1# show system internal ptp bad-corrections

PTP past corrections

Slave Port	SUP Time	Correction(ns)	MeanPath Delay(ns)	MasterTimestamp (sec, nsec)	Slave Timestamp (sec, nsec)	Sync-SeqID	PTPLC ts_corr(ns)
Eth1/1	Fri Mar 3 07:35:53 2023 588262	-4323068	976	1677828929 55999548	1677828929 60323592	30	0
Eth1/1	Fri Mar 3 07:35:53 2023 337453	-4310992	976	1677828928 805571968	1677828928 809883936	29	0
Eth1/1	Fri Mar 3 07:35:53 2023 87116	-4298824	976	1677828928 554563664	1677828928 558863464	28	0
Eth1/1	Fri Mar 3 07:35:52 2023 837437	-4286688	976	1677828928 303745520	1677828928 308033184	27	0

Advanced Debugging Skill

- Auto-log enables capability to capture bad correction log in backend – No performance impact

switch# test system internal ptp auto-log correction-limit 1000

Set a threshold of correction to trigger if switch starts log collection. In this case, it's 1000ns

switch# test system internal ptp auto-log file-max-count 5

Maximum Auto-log files quantity

switch# no test system internal ptp auto-log file-rollover

Disable Auto-log rollover

switch# test system internal ptp auto-log

Start Auto-log in backend

Advanced Debugging Skill

- In case any bad correction occurs, Auto-log created in bootflash

```
switch# dir bootflash:
```

```
4096   Mar 08 04:02:27 2023  ptp_autolog/
```

```
swtich# dir ptp_autolog
```

```
136318   Mar 08 04:02:35 2023  auto_ptp_dbg_log_1.log
```

```
134421   Mar 08 04:02:36 2023  auto_ptp_dbg_log_2.log
```

```
104854   Mar 08 04:02:37 2023  auto_ptp_dbg_log_3.log
```

```
301786   Mar 08 04:02:39 2023  auto_ptp_dbg_log_4.log
```

```
32075    Mar 08 04:02:34 2023  auto_ptp_dbg_log_5.log
```


Advanced Debugging Skill

- T1,T2,T3,T4 info included in Auto-log file

```
04:02:35 307325 ptp_calc_mean_path_delay t1/m sec 1678248155 ns 305634912 t2/s sec  
1678248155 ns 305635076 t3/ds sec 1678248155 ns 306286548 t4/dm sec 1678248155 ns  
306286720 diff corr 0 ns
```

```
04:02:35 307335 ptp_calc_mean_path_delay t4_1_ns 651808 t3_2_ns 651472 del_ns 336  
mpd_ns 168
```

```
04:02:35 307381 Delay ns 168 updated
```

```
04:02:35 307387 Delay 0 sec 168 nsec; mean path delay 168 nsec
```

$$\text{MPD} = [(t2 - t1) + (t4 - t3)]/2 = [(305635076 - 305634912) + (306286720 - 306286548)]/2 = 168\text{ns}$$

$$\text{Offset} = t2 - t1 - \text{MDP} = -4\text{ns}$$

Useful Clis:

show running-config ptp

(show PTP running config)

show ptp brief

(show PTP port states)

show ptp counters all

(show PTP message counters)

show ptp clock

(show PTP BC properties)

show ptp clock foreign-masters record

(show GM preproperties)

show tech ptp

(combines all the above and more)

debug ptp bmc/errors/pkt etc...


Common Issues



GM Active/Standby Role Switchover

1. Understand GM switchover workflow
2. “show system internal ptp info announce-pkts” is helpful

2023 Mar 17 02:28:01.901100: E_PTP_ANN_PKT_EV[RX] I/f Eth1/53 (0x1a006800):
MSG:Announce TS:0 V:2 LEN:64 D:24 UC:0 2S:0 UTCVAL:0 PTPTS:1 TT:0 FT:0 SRC:3c:51:0e:f
f:fe:44:c7:83-0x4 CORR:0 (0x0) SEQ:1567 (5479) Int:1; TS:0 s 0 ns; UTC_OFF:37 TM_SRC:a0
STEP:0 Prio1:0 Prio2:255 CLASS:248 ACC:fe LOG_VAR:ffff GM:3c:51:0e:ff:fe:44:c7:83



See if Standby GM offers
better attributes

PTP Unaccepted under Port-channel

1. PTP protocol is running in physical interface individually, it's not as same as other common protocol.

```
nexus(config)# inter po 100
```

```
nexus(config-if)# ptp
```

```
^
```

```
% Incomplete command at '^' marker.
```

BC Switch cannot Sync GM Time

1. Check PTP domain consistency
2. Check “PTP vlan <id>” enabled or not
3. Check PTP priority configuration

```
nexus#show running-config ptp
```

```
ptp source 1.1.1.1
```

```
ptp priority1 128
```

```
ptp domain 24
```

```
nexus(config)# show ptp clock
```

```
Clock Domain: 24
```

```
Priority1 : 128
```

```
Priority2 : 255
```

PTP State cannot Converge

1. Check if COPP drop PTP message unexpected

```
nexus# show policy-map interface control-plane
```

```
class-map copp-system-p-class-redirect (match-any)
```

```
  match access-group name copp-system-p-acl-ntp
```

```
  match access-group name copp-system-p-acl-ntp-l2
```

```
  match access-group name copp-system-p-acl-ntp-uc
```

```
.....
```

```
dropped 52348948 bytes;
```

```
  5-min violate rate 34563 byte/sec
```

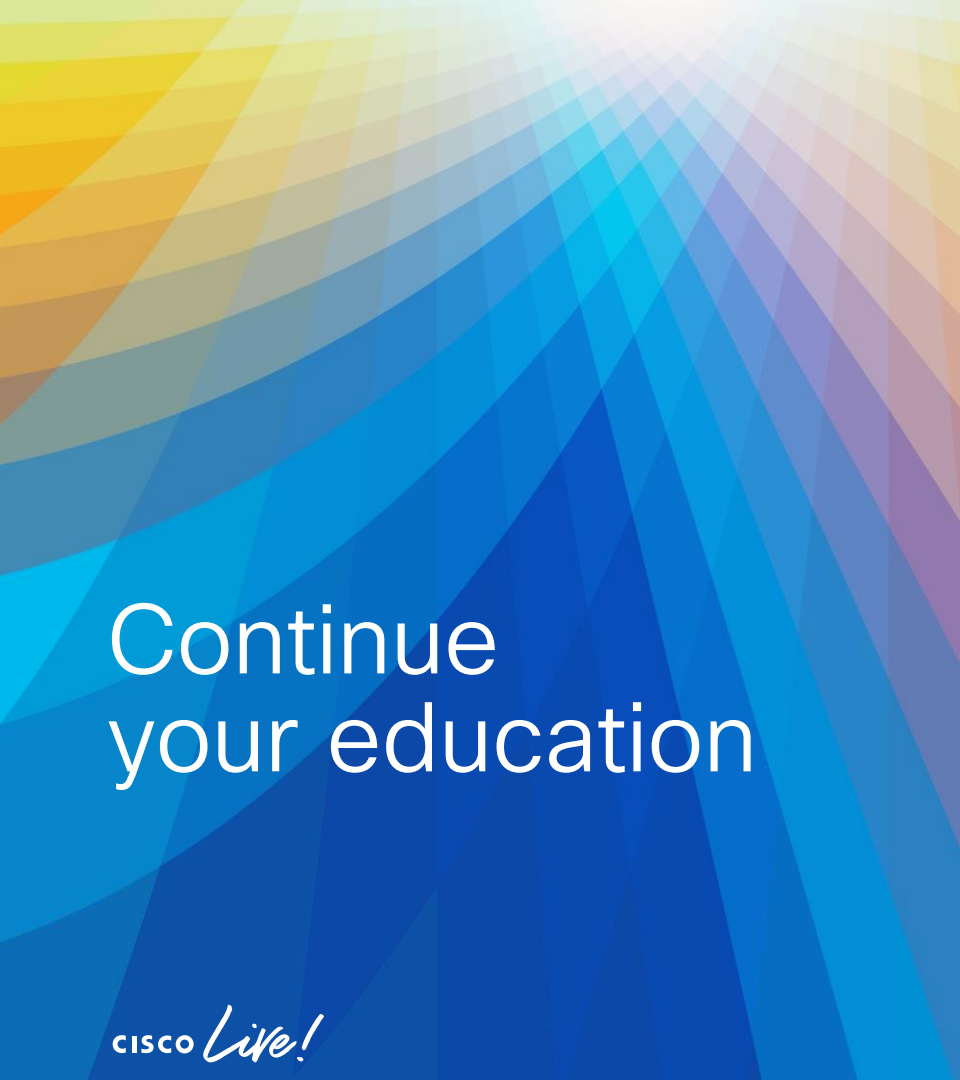
```
  violated 64345 peak-rate byte/sec
```

Best way to figure out congestion

- Ethalyzer
- SPAN

Best Practice

1. Before deploy PTP or troubleshoot PTP, **read configuration guide first**
2. “show tech ptp” is always necessary to any kind of PTP issue
3. Don't forget “Auto-log” in case of bad-correction issue



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