Best practices for resilient, NIST/UTC-traceable sub-μsec timestamping of financial trades

Business clock regulations | Resilient PNT mandate | NTP/PTP sync | Server with integrated PCIe GNSS PTP GM

May 11, 2022 (9:10-9:25a) | WSTS, Denver, CO | Nino De Falcis, Sr. Director, Sync Business Development Americas, Oscilloquartz

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Can Wall Street business trading clock survive the next cyberattack?

PNT* cyberthreats are at an all-time high everywhere and are growing in sophistication

*Positioning, Navigation & Timing | T enables P & N | aPNT+ (assured PNT

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Business clock regulations in financial trading
Client/Server/VM timestamping requirements

US FINRA CAT
- Trader clock accuracy: 50ms
- Exchange clock accuracy: 100µs
- Clock traceability: NIST (GNSS)
- CAT: consolidated audit trail archiving all trading orders in a central repository for regulatory compliance, with self-reporting accuracy deviations per CAT 2020-02

EU ESMA MIFID II RTS 25
- Exchange/Trader clock accuracy: 100µs
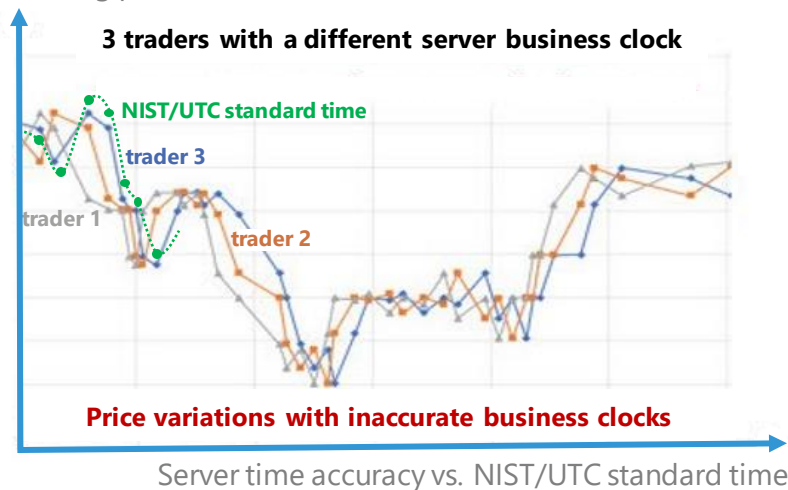- Clock traceability: UTC (GNSS)

COMMON

- Clock technology: NTP/PTP
- Clock compliance: proof of accuracy/deviation reporting thru stored client data logs
- Regulatory audits/fines: typ. up to 7 years of logged/archived data for forensics

vs. algo HFT accuracy target: 10-100's of ns for network/trade optimization measurements
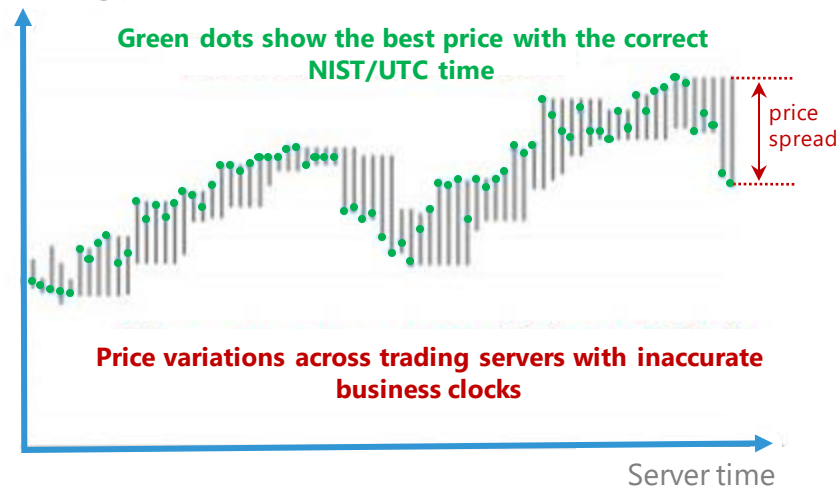
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Why time is money in financial markets

Trading price (line chart)

3 traders with a different server business clock

NIST/UTC standard time

trader 3

trader 1

trader 2

Price variations with inaccurate business clocks

Server time accuracy vs. NIST/UTC standard time

- **Trader 3**, whose server's time accuracy is tighter to NIST/UTC standard time, gets the best price/profit!

Trading price (candlestick chart)

Green dots show the best price with the correct NIST/UTC time

price spread

Price variations across trading servers with inaccurate business clocks

Server time

- If the time is off, the best price/profit is off too!

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What is the resilient PNT?

Driven by US Federal Executive Order 13905 and UK & Euro Commissions

- **PNT** stands for **P**ositioning, **N**avigation & **T**iming, and T is essential to enable P & N

- **Protect** government/industry critical infrastructure against PNT disruptions from GPS/GNSS jamming/spoofing & other network timing cyberattacks

- **Deploy** resilient, assured & self-survivable PNT systems

- **Target** critical infrastructure under national security threats

Power grids	Finance	Transportation	Communications	Data centers

- **Use** published resilient PNT guidelines & standard in progress
  - DHS Resilient PNT Conformance Framework
  - NIST Cybersecurity Framework for PNT Profile NIST NISTIR 8323
  - IEEE P1952 Resilient PNT for User Equipment Standard working group IEEE SA P1952 PNT

clock sources
multisource
next-gen system
resiliency levels

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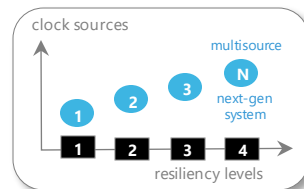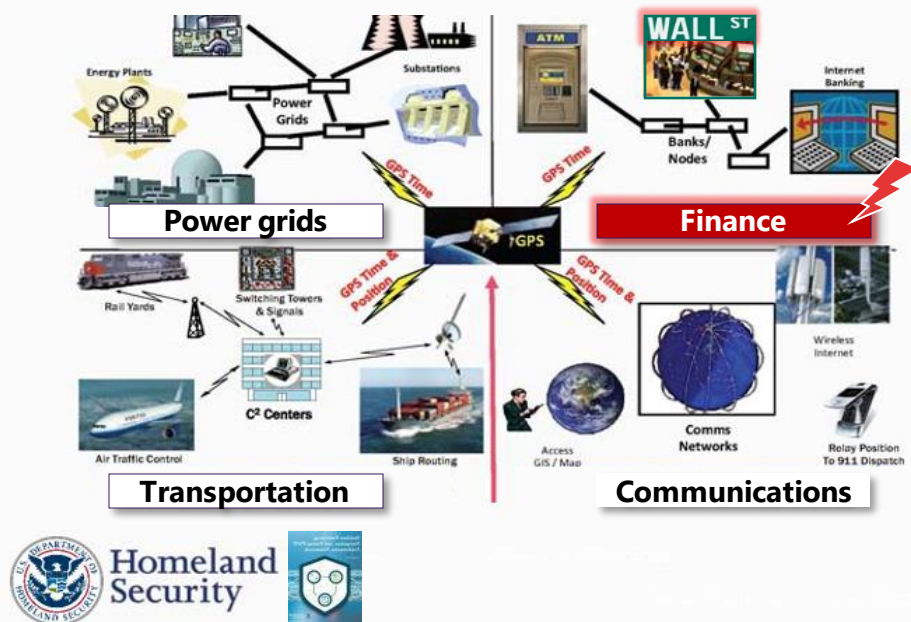
What's the problem in financial markets?

$1B/day in economic cost if GPS/PNT is disrupted*

GPS & US critical infrastructure under national security threats

Power grids

Finance

Transportation

Communications

Homeland Security

PNT cyberthreats

All supported by

Data centers

*source: RTI & NIST 2019

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What are the PNT cyberthreats & GNSS vulnerabilities?

PNT cyberthreats

External GPS/GNSS level

GPS/GNSS ground segment errors

Environmental

RARE

COMMON

RARE

UNDER REVIEW

GPS/GNSS degradation causes

COMMON

Adjacent-band transmitters

More frequent

RARE

Jamming

Spoofing
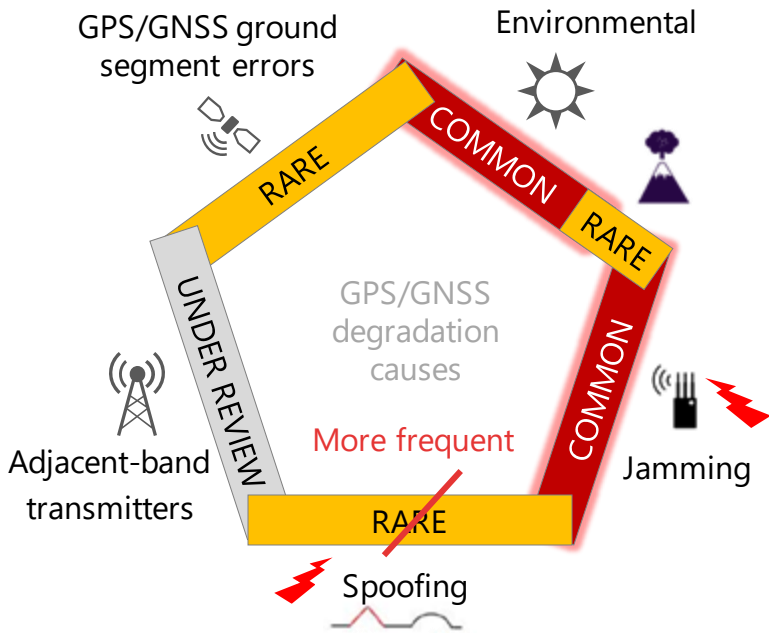
Figure 4.1 – Known GPS vulnerabilities to telecom

Internal network level

GPS/GNSS receiver

Network interference

Boundary clock

PTP

NTP

Client clock

RARE   COMMON

Cyberattacks

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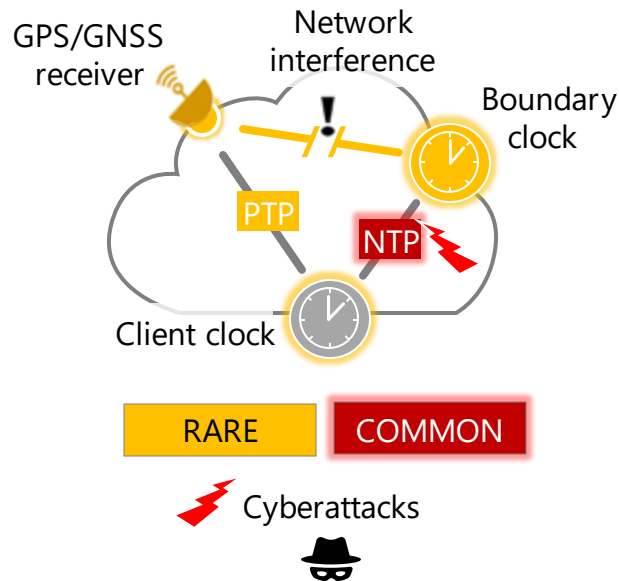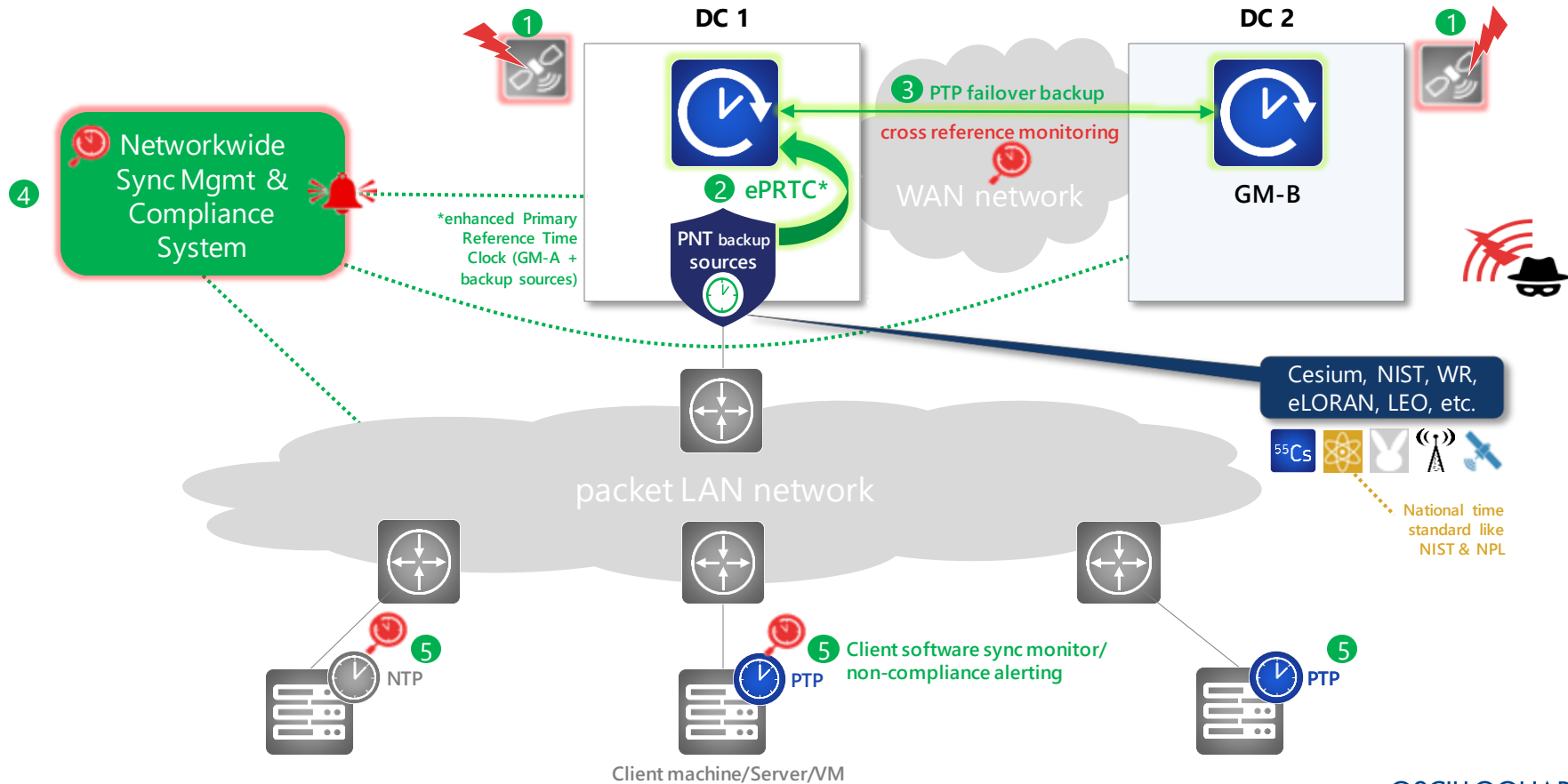
Redundant single GPS/GNSS source timing architecture
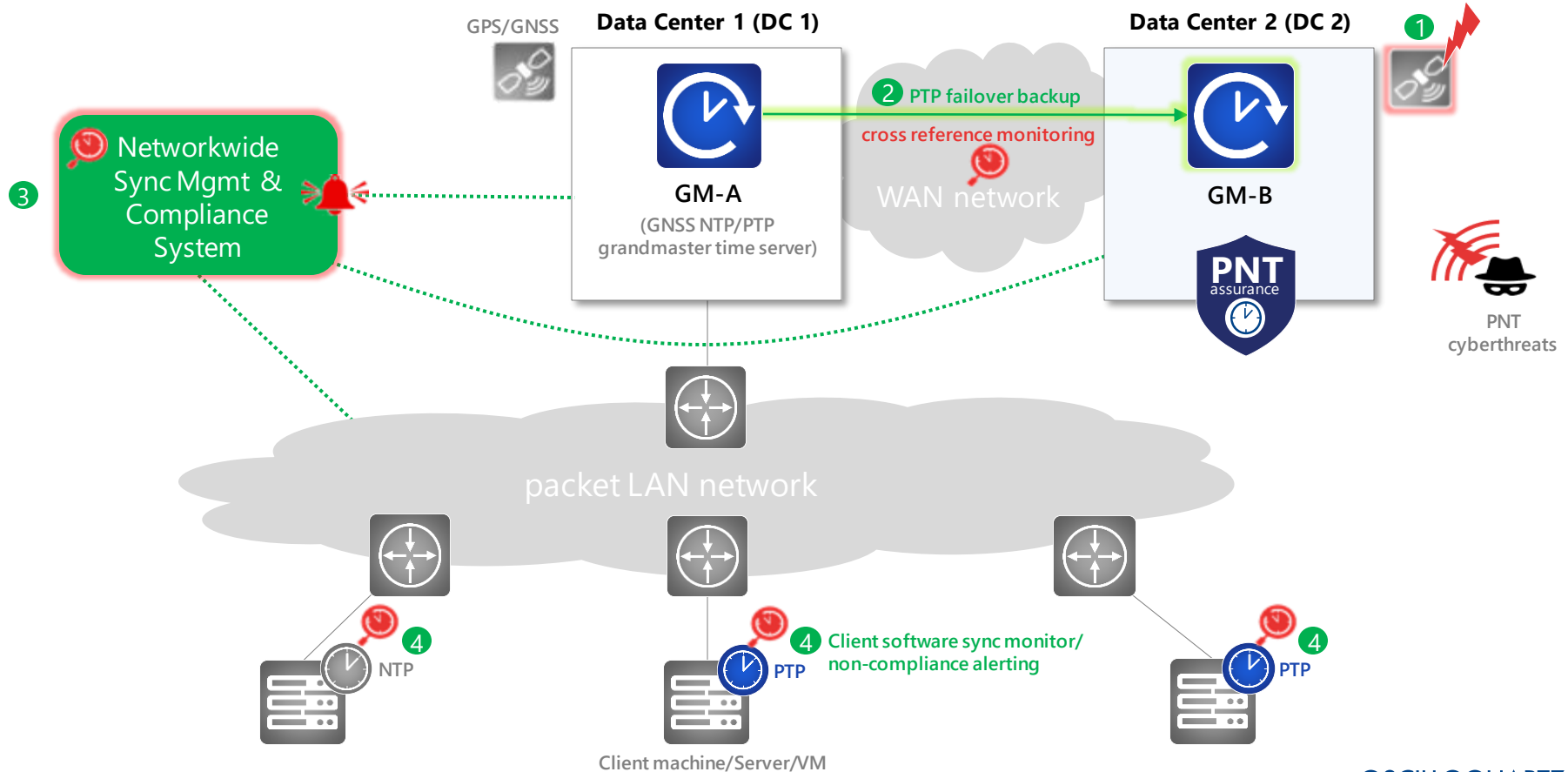
"Zero-trust multisource backup" timing architecture

DC 1
DC 2

① PTP failover backup
cross reference monitoring

③ PTP failover backup

② ePRTC*

Networkwide Sync Mgmt & Compliance System

④

*enhanced Primary Reference Time Clock (GM-A + backup sources)

PNT backup sources

WAN network

GM-B

Cesium, NIST, WR, eLORAN, LEO, etc.

National time standard like NIST & NPL

packet LAN network

⑤ NTP

⑤ PTP

⑤ Client software sync monitor/ non-compliance alerting

⑤ PTP

Client machine/Server/VM

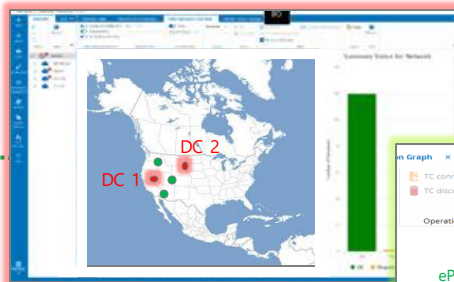9

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Secure networkwide sync mgmt & compliance system

Neural AI/ML intelligence for self-survivability, end-to-end control, visibility, resilient & assured PNT
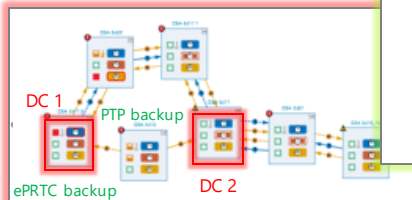

Networkwide Sync Mgmt & Compliance System

9 API for client data logs
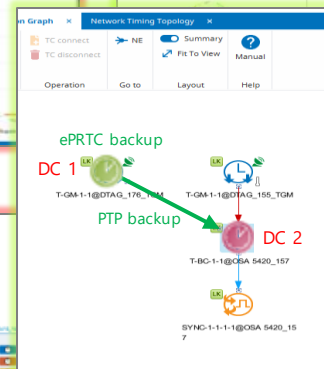
Financial analytics tool vendors like Splunk/Pico

PNT assurance

1 geolocation DCs 1 & 2 alert

2 timing chain alert with ePRTC/ PTP backup rearrangements

3 DC 1 GM-A alert with ePRTC/PTP backup to DC 2

4 DC 2 GM-B alert with PTP backup from DC 1 ePRTC

5 timing topology with ePRTC/PTP backup

6 PTP backup assurance to DC 2

7 client sync monitor/ compliance assurance

8 vendor-agnostic GNSS analytics/assurance

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Secure multisource client software sync architecture

DC 1

GM-A

ePRTC

PNT backup sources

PTP

DC 2

GM-B

GNSS NTP/PTP grandmaster time server)

packet LAN network

Switch with PTP asymmetry optimization
- Full on path support with PTP-aware class D BC (~5ns impact)

Client software sync monitor/ non-compliance alerting

PTP

Server/Client machine/VM

internal clock

app 1

app 2

client sync

processor

smartNIC

PTP timestamped packets

with HW timestamping assist

Accuracy

100's of ns

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Server with embedded PCIe GNSS PTP GM for HFT applications

DC 1

GM-A

ePRTC

PNT backup sources

DC 2

GM-B

GNSS NTP/PTP grandmaster time server)

PTP

packet LAN network

PTP backup

Embedded PCIe GNSS PTP GM
- PTP master/slave/BC
- PTP monitor
- Holdover clock
- PPS+ToD

Server 1

internal clock

app 1   app 2

processor

PCIe

Server 2 (or more)

internal clock

app 1   app 2

processor

client sync

smartNIC

PTP over Ethernet

sub 100ns

HFT accuracy

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Thank you

Questions? Contact us at info@adva.com