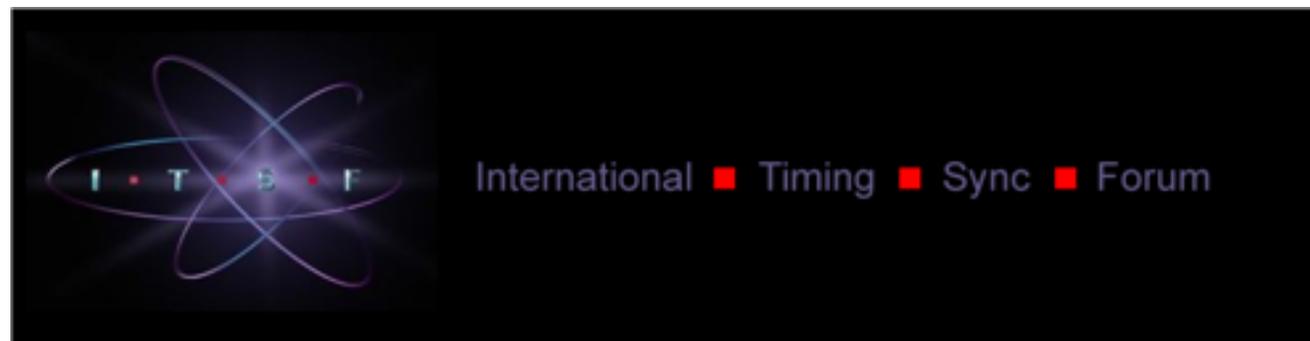


The background image for the title slide is a collage of technology-related elements. It includes a hand holding a compass, a satellite in orbit above a globe, a satellite dish, and a server rack. The text "Miffed at MiFID?" is overlaid in white on this background.

Miffed at MiFID?

The practical issues to be considered when auditing paper clocks in the real world...

Christian Farrow B.Sc. (Hons) MinstP
Technical Services Manager



Agenda



- Introduction
 - Financial Applications Requirements
- Audit process
 - Paper audits
 - Physical audits (where's the clock?)
- Findings
- Summary



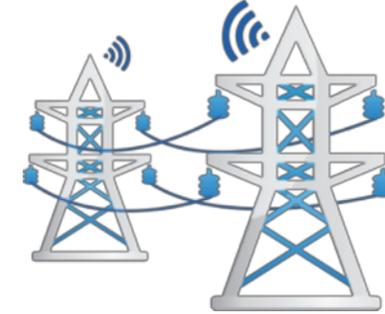
Time Enables ALL Infrastructures



Data Centers



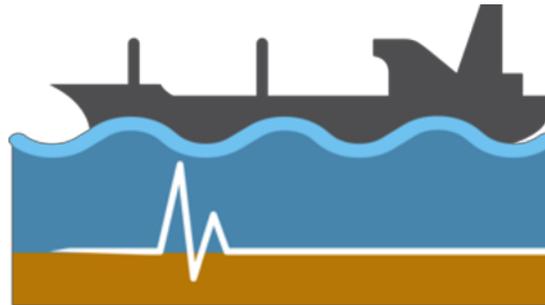
Enterprise Communications



Power Grid Communications



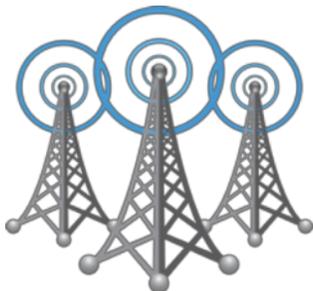
Wireline Communications



Seismic Exploration



Secure Communications



Cellular Communications



Financial Exchanges

Requirements Evolution: Financial Trading Regulations

- From 3rd Jan 2018 EU legislation – Markets in Financial Instruments Directive (“MiFID II”) - is in effect. Its scope includes the synchronisation of trading clocks to UTC and timestamping granularity:

Type of Trading	Granularity	Max. Divergence to UTC
Voice trading	1 s	± 1 s
All other trading	1 ms	± 1 ms
High frequency trading	1 μ s	± 100 μ s

- US regulation (SEC) Rule 613 (effective 2018): Synchronisation of business clocks to within 100 μ s of NIST clocks
- The aim is to prevent trading irregularities & provide an audit trail for “reportable events”

Requirements Evolution: Financial Trading Regulations



NPL Time
A resilient, traceable and certified time signal that completely eliminates reliance on GPS.

NPL Time[®] offers the financial sector a certified precise time signal, directly traceable to Coordinated Universal Time (UTC) and independent of GPS. The core implementation and additional metrics provide the user with underpinning timing capability for traceable timestamping, latency monitoring and synchronisation. The signal is fully compliant with the MiFID II RTS 25 timing traceability requirement.

Contact NPL Time[®] for more information

The resilient service* completely eliminates reliance on GPS and removes susceptibility to jamming, spoofing, urban canyon effects and solar storms. It reduces the costs associated with managing a complex assortment of timing devices and the need to access roof space to locate GPS antennas.

As the home of the UK's National Timescale, UTC(NPL), the caesium fountain, NPL, CsF2 - a primary frequency standard accurate to within one second in 158 million years NPL is perfectly placed to deliver precision timing services demanding customers.

Your MiFID II compliance clock is ticking...
Millisecond timestamping on market trades becomes a legal requirement on 3 January 2018

Find out how NPL Time[®] can help

Key benefits of NPL Time[®]

- Risk mitigation

IT - Nasdaq expands services in Europe, traceability reporting services in London

May 17, 2018 10:00 ET | Source: NASDAQ

MiFID II mandates clock synchronization for European exchanges and trading venues. Nasdaq now offers a Precision Time Protocol (PTP) service for its Nordic customers at the Vasby data centre and for its European customers in the Equinix LD4 data centre in London.

colt
NPL and Colt partner to critical timing service for compliance
by Colt Technology.
26 Apr 2018

London, 26 April 2018 – [Colt Technology Services](#) today announced its partnership with the National Physical Laboratory (NPL) to deliver precise timing capabilities to financial firms utilising [colocation services](#). This partnership will allow customers to quickly and easily comply with stringent MiFID II requirements, safe in the knowledge that the signal will be accurate to the granularity of the timing solution far exceeding the 100 microsecond level stipulated by the regulation under MiFID II. This offering will be available at Equinix facilities, located in Slough and London.

Finextra
ICE brings precise timing to UK data centre for MiFID II compliance
09 May 2017

In a high-frequency trading world where every microsecond counts, Intercontinental Exchange has struck a deal with the UK's National Physical Laboratory to ensure co-location customers at its data centre in Basildon get precise timing.

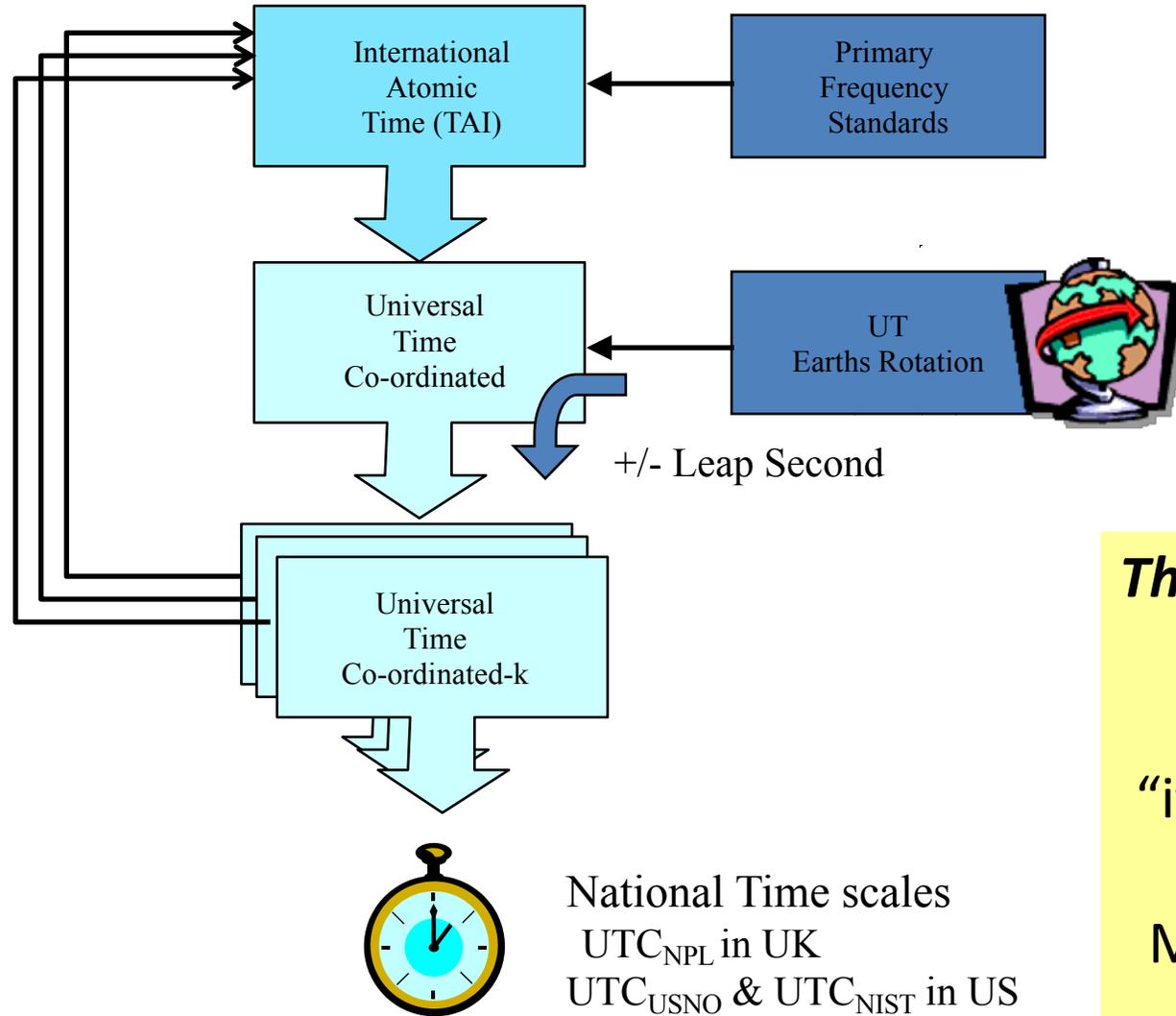
The rise of HFT has increased the need for synchronisation of trading systems and traceability to Coordinated Universal Time (UTC). With this in mind, from next January,

Requirements Evolution: Financial Trading Regulations



- **COMMISSION DELEGATED REGULATION (EU) 2017/574: Accuracy & traceability to UTC summary**
- **But what is UTC? Where do I get it?**

What is UTC? Where do I get it?



Things to note about UTC:

“it’s paper clock”
“it only exists in the past”

MiFID allows us to use &
test to UTC_{USNO}

From the ESMA MiFID II requirements:



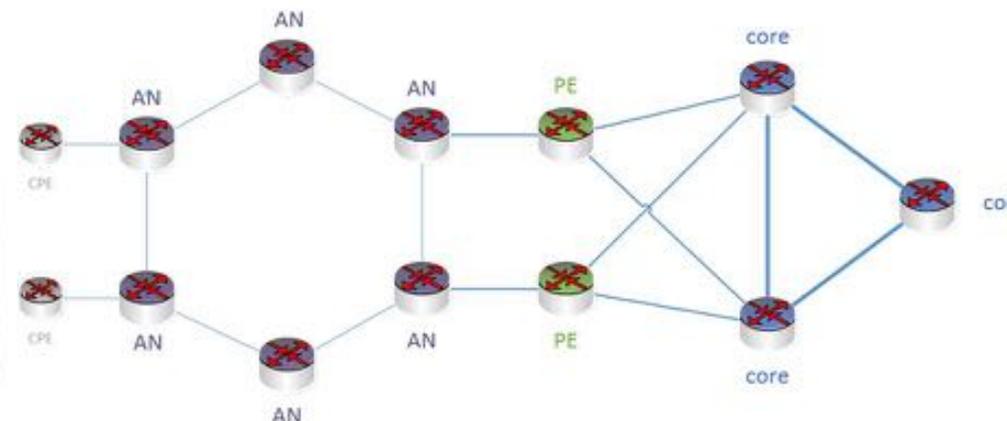
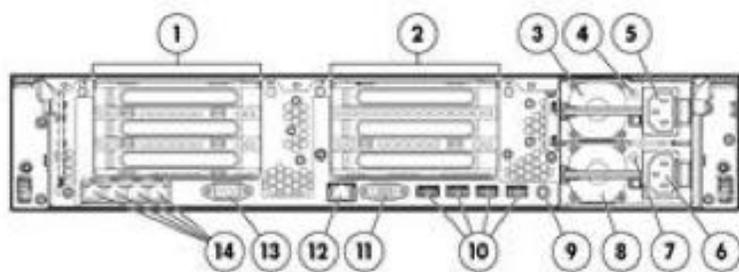
- *Establish a system of traceability to UTC, where such a system shall:
Demonstrate traceability to UTC by documenting the system design, functioning and specifications. This is to be accomplished by:*
- *Establish a system of traceability of their business clocks to UTC, including ensuring that their systems operate within the granularity and a maximum tolerated divergence from UTC as per RTS 25.
Evidence that their systems meet the requirements by documenting the system design, its functioning and specifications.*
- *Evidence that the crucial system components used:*
 - *meet the accuracy standard levels on granularity and maximum divergence of UTC as guaranteed and specified by the manufacturer of such system components (component specifications shall meet the required accuracy levels); and*
 - *that these system components are installed in compliance with the manufacturer's installation guidelines.*
 - *Identify the exact point at which a timestamp is applied and demonstrate that the point within the system where the timestamp is applied remains consistent.*

Firms shall conduct a compliance review of the traceability system at least once a year.

Ensure procedures are put in place to establish a systems of traceability to UTC by documenting the system design, functioning and specifications and review such a system once a year.

Paper Audit – network design

- Network plans & drawings
- Specs/datasheets for all equipment that affects timing
- SLAs & Agreements for any Services provided by 3rd parties
- Logs/configs of all equipment
- Add some “Best Practice”



```

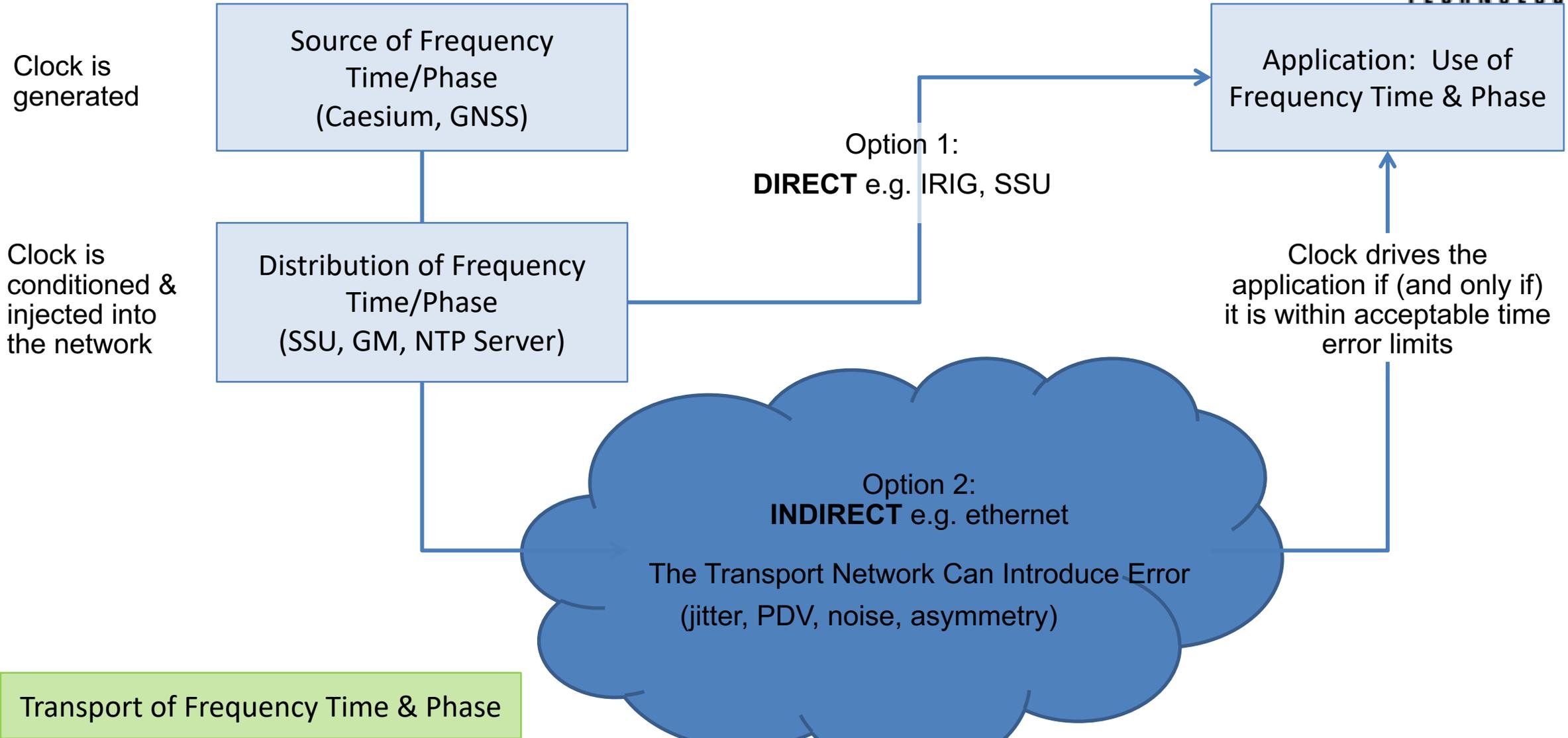
1 #ptp interface config
2 interface Ethernet1/x
3   speed 1000
4   ptp
5   ptp vlan 350
6   switchport mode trunk
7   switchport trunk allowed vlan 350,2100
8

```

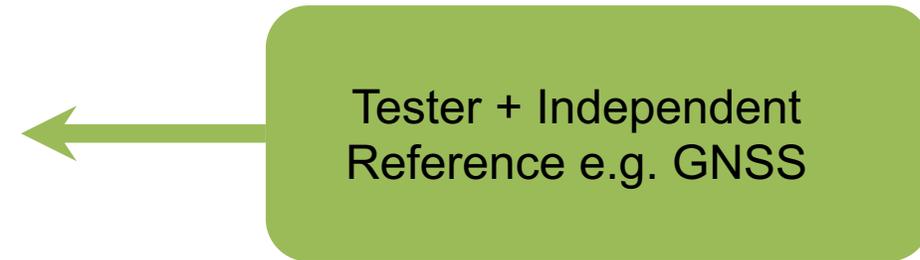
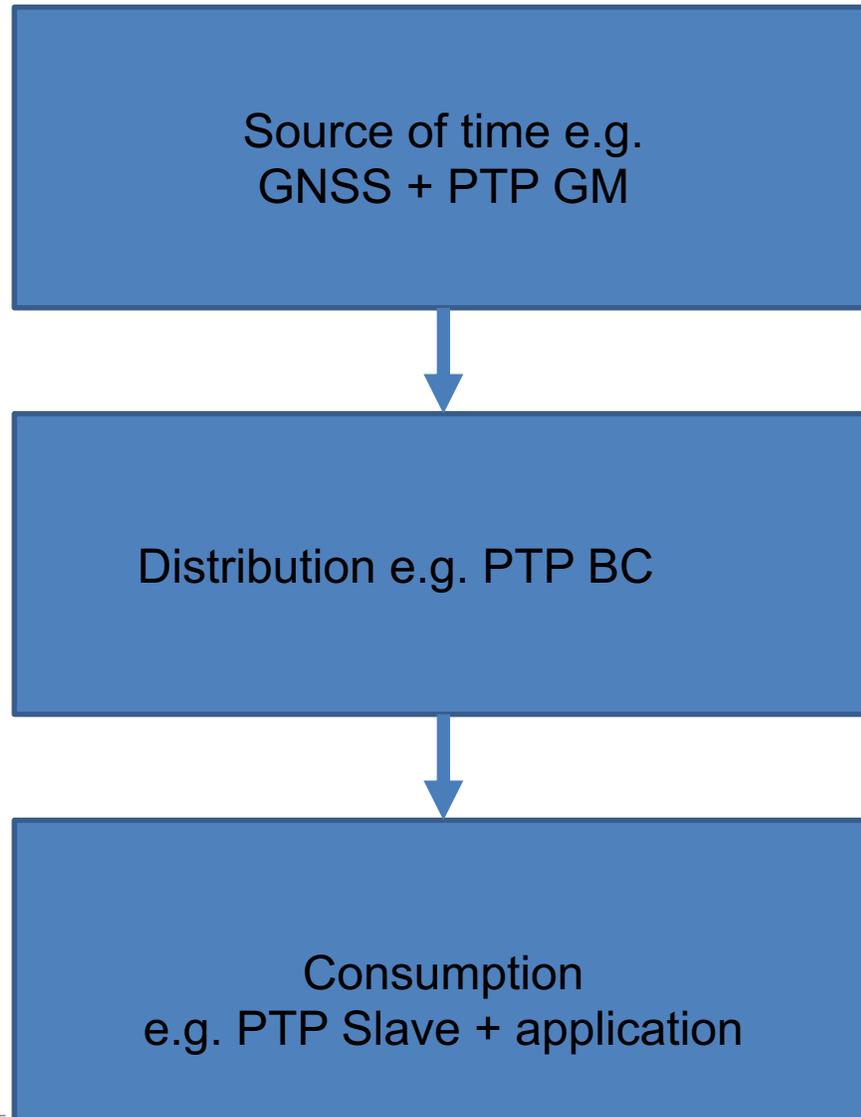
Auditing the clock + distribution...

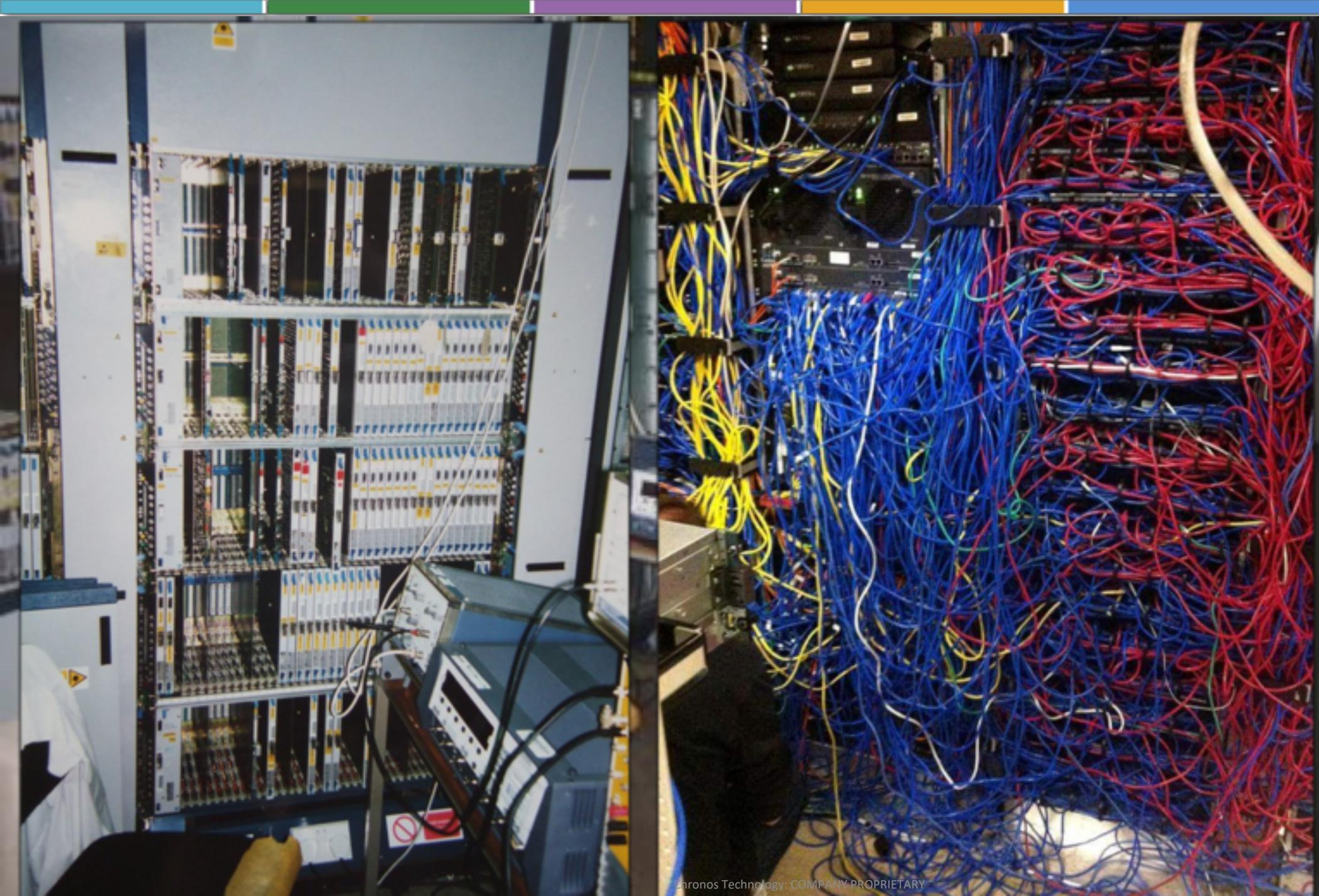
- Physical things:
 - UTC delivery: GNSS receiver, PTP GM
 - UTC distribution: PTP BC, PTP Slave
 - Network design – how all the above things are connected together
- Non-Physical things:
 - UTC: consumption: Trading application!

Timing: a simplified model



Auditing the clock...





TECHNO

FORTINET
FortiGate

Primary



Optional extra...?



NIC + PTP slave:

“sorry, we didn’t think we needed the 1PPS option”



Auditing the clock...

- Physical things:
 - UTC delivery: GNSS receiver, PTP GM
 - UTC distribution: ~~PTP BC, PTP Slave~~ ***no 1PPS (or other) clock O/P!***
 - Network design – how all the above things are connected together
- Non-Physical things:
 - UTC: consumption: Trading application!

No signal at pulse-per-second (PPS) output (PTP CLK connector)

The [redacted] data sheet at

[http://www.\[redacted\]/data_sheet_c78-707001.html](http://www.[redacted]/data_sheet_c78-707001.html)

describes a "IEEE 1588 PTP with pulse-per-second (PPS) output" feature, stating "Network administrators deploying IEEE 1588 PTP often find it challenging to measure the accuracy to which each device is synchronized. To assist in this effort, the [redacted] platform includes a 1-PPS output port that can be used to measure timing drift from the grandmaster clock."

On the front panel of the [redacted] is a coaxial mini DIN connector labeled PTP CLK. My understanding is that this is the 1-PPS output port referenced in the data sheet.

I have configured the network switch to enable PTP, have connected a PTP grandmaster, etc. and am attempting to observe the signal output by the PTP CLK connector using an oscilloscope. I am not observing any pulses being output by this connector.

How do I enable this PTP CLK connector?

Other Network Infrastruct...

Everyone's tags (1)

1588 PTP [redacted]

I have this problem too

 cgk2 [redacted]  Beginner

02-04-2016 04:04 PM

After discussing this issue

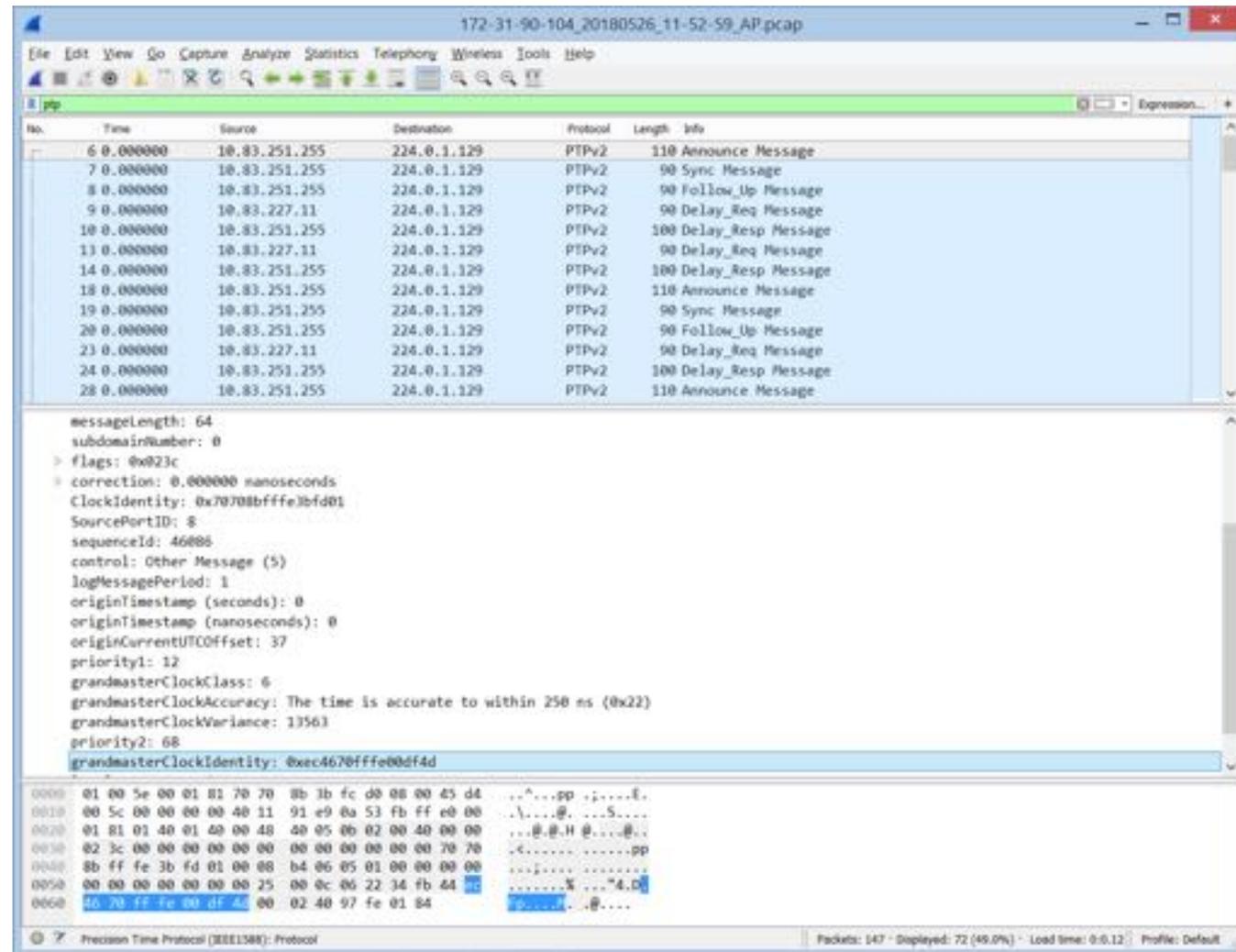
After discussing this issue with a [redacted] TAC engineer, I learned that while this PTP CLK connector is present on [redacted] [redacted], and [redacted] (front panel names), there is no software support for this connector at this time. There is also no time frame for [redacted] to support this PTP CLK connector.

There is no clock to audit

- *Turn up on site and nothing to measure!*
- Add test slave – compare output
- Mirror port - capture PTP packets
- SECURITY hampers the audit process
- GNSS receivers calibrated
- Packet captures all OK
- Test slave 1PPS $\sim 10\mu\text{s}$
 - Agrees with other work

PTP packet capture

- Security policy/paranoia hampers capture!
 - Request “mirror port”
 - Announce Message: GM ID, UTC-TAI offset
 - Message rates etc. as expected
 - Two-step, Layer3 (UDP/IP)
 - Sync: 2Hz Del_Req/Resp: 0.5Hz
 - Announce: 0.5Hz



172-31-90-104_20180526_11-52-59_AP.pcap

No.	Time	Source	Destination	Protocol	Length	Info
6	0.000000	10.83.251.255	224.0.1.129	PTPv2	110	Announce Message
7	0.000000	10.83.251.255	224.0.1.129	PTPv2	90	Sync Message
8	0.000000	10.83.251.255	224.0.1.129	PTPv2	90	Follow_Up Message
9	0.000000	10.83.227.11	224.0.1.129	PTPv2	90	Delay_Req Message
10	0.000000	10.83.251.255	224.0.1.129	PTPv2	100	Delay_Resp Message
13	0.000000	10.83.227.11	224.0.1.129	PTPv2	90	Delay_Req Message
14	0.000000	10.83.251.255	224.0.1.129	PTPv2	100	Delay_Resp Message
18	0.000000	10.83.251.255	224.0.1.129	PTPv2	110	Announce Message
19	0.000000	10.83.251.255	224.0.1.129	PTPv2	90	Sync Message
20	0.000000	10.83.251.255	224.0.1.129	PTPv2	90	Follow_Up Message
23	0.000000	10.83.227.11	224.0.1.129	PTPv2	90	Delay_Req Message
24	0.000000	10.83.251.255	224.0.1.129	PTPv2	100	Delay_Resp Message
28	0.000000	10.83.251.255	224.0.1.129	PTPv2	110	Announce Message

```

messageLength: 64
subdomainNumber: 0
> flags: 0x023c
  correction: 0.000000 nanoseconds
  ClockIdentity: 0x70708bfffefbf401
  SourcePortID: 8
  sequenceId: 46086
  control: Other Message (5)
  logMessagePeriod: 1
  originTimestamp (seconds): 0
  originTimestamp (nanoseconds): 0
  originCurrentUTCOffset: 37
  priority1: 12
  grandmasterClockClass: 6
  grandmasterClockAccuracy: The time is accurate to within 250 ns (0x22)
  grandmasterClockVariance: 13563
  priority2: 68
  grandmasterClockIdentity: 0xec4670fffe00df4d
  
```

0000 01 00 5e 00 01 81 70 70 8b 3b fc d0 00 00 45 d4 ..^...ppE.

0010 00 5c 00 00 00 40 11 91 e9 0a 53 fb ff e0 00@.....S.....

0020 01 81 01 40 01 40 00 48 40 05 06 02 00 40 00 00 ...@.H@....@...

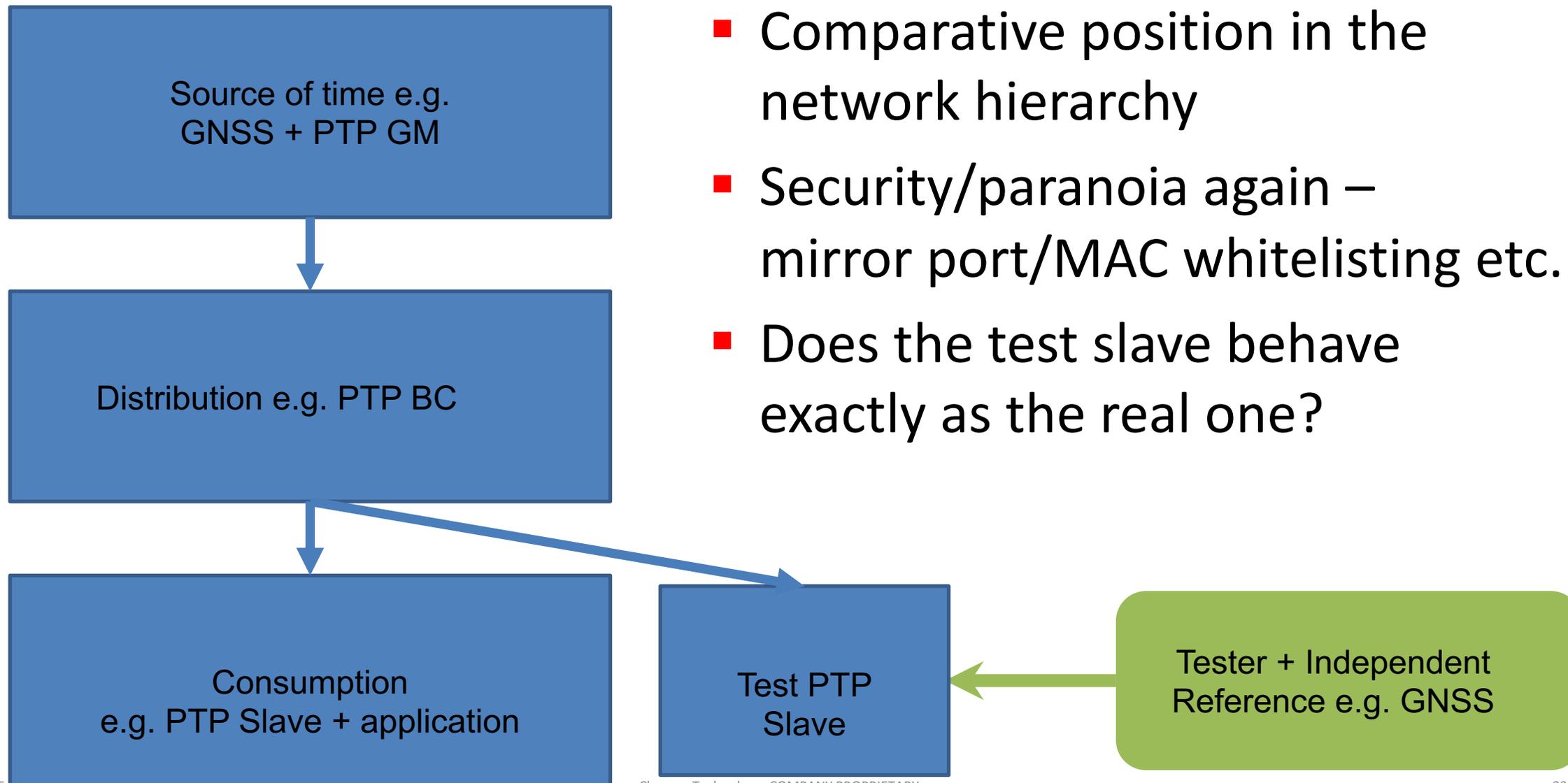
0030 02 3c 00 00 00 00 00 00 00 00 00 00 00 70 70 <.....pp

0040 8b ff fe 3b fd 01 00 08 b4 06 05 01 00 00 00 00S....."4.D

0050 00 00 00 00 00 00 25 00 0c 06 22 34 fb 44 00S.....@...

0060 46 70 ff fe 00 df 4d 00 02 40 97 fe 01 84S.....@...

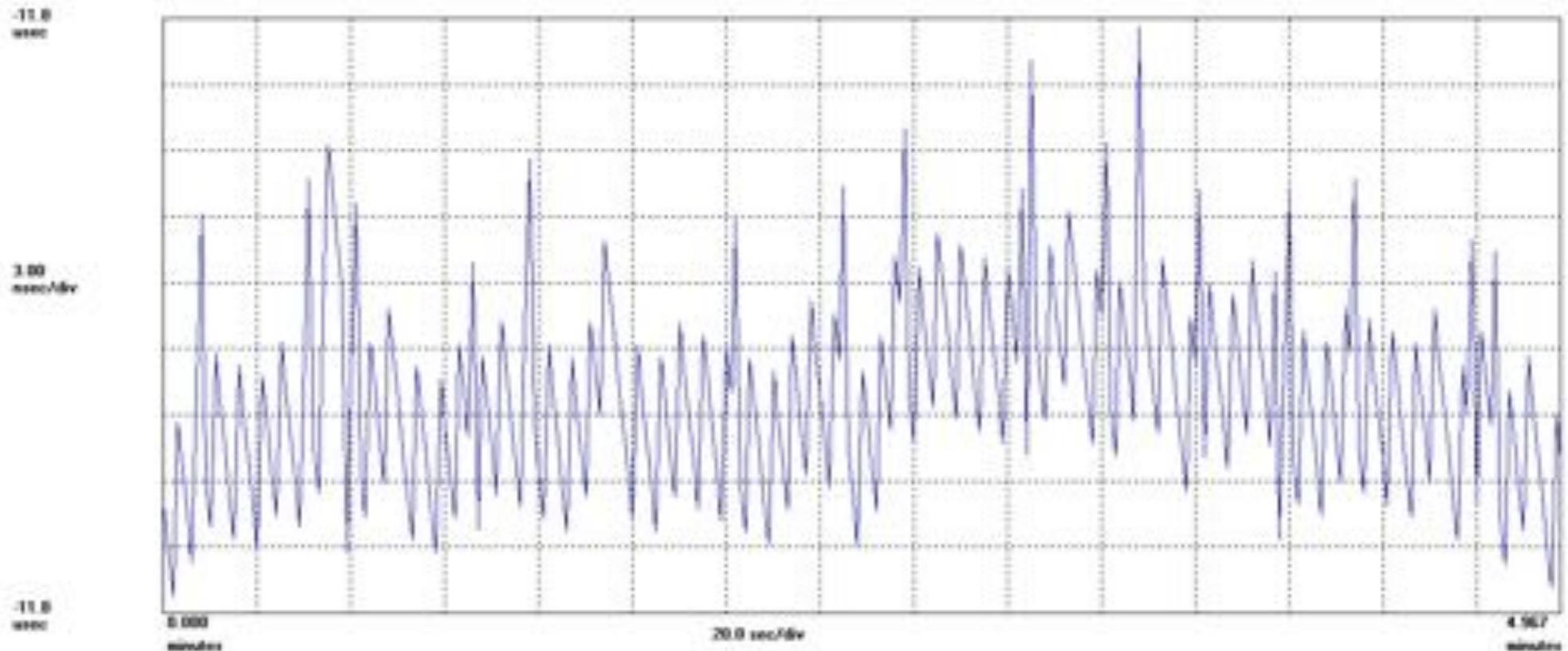
Surrogate PTP slave



Surrogate PTP slave



Symetrix TimeMonitor Analyzer
Phase deviation in units of time: $F_s=1.000$ Hz; $F_m=1.000000$ Hz; 2018/06/02 11:17:14
SyncWatch Phase: Samples: 200; StartPC: 2018/06/02 11:17:13; MeasChan1: Input PPS; RefChan: CSAC; Local time: UTC Offset: 0:00



Findings

- GNSS 1PPS output confirms:
 - Cable delay not set at all
 - ~500ns error – “standard” 100m cable drum used
 - Questionable install?
 - GNSS GM manufacturer states
“probably no need to set cable delay compensation”
- PTP Packet capture confirms:
 - GM Identity + network performance
- Test Slave confirms:
 - Approximate/Achievable performance

Summary

- 1PPS outputs!
 - Telecom learned this lesson already
- BREXIT the new focus – MiFID is “done”
 - money/resource was allocated 2016/17
 - difficult to get commitment now it seems the “MiFID compliance” box has already been ticked
- If/when the regulator imposes penalties on traders this may change...
- Meaningless requirements need to be updated

A collage of images including a hand holding a compass, a satellite dish, a globe, and server racks, all set against a blue background.

Thank you for listening, any questions?

Christian Farrow

Technical Services Manager

Christian.Farrow@chronos.co.uk

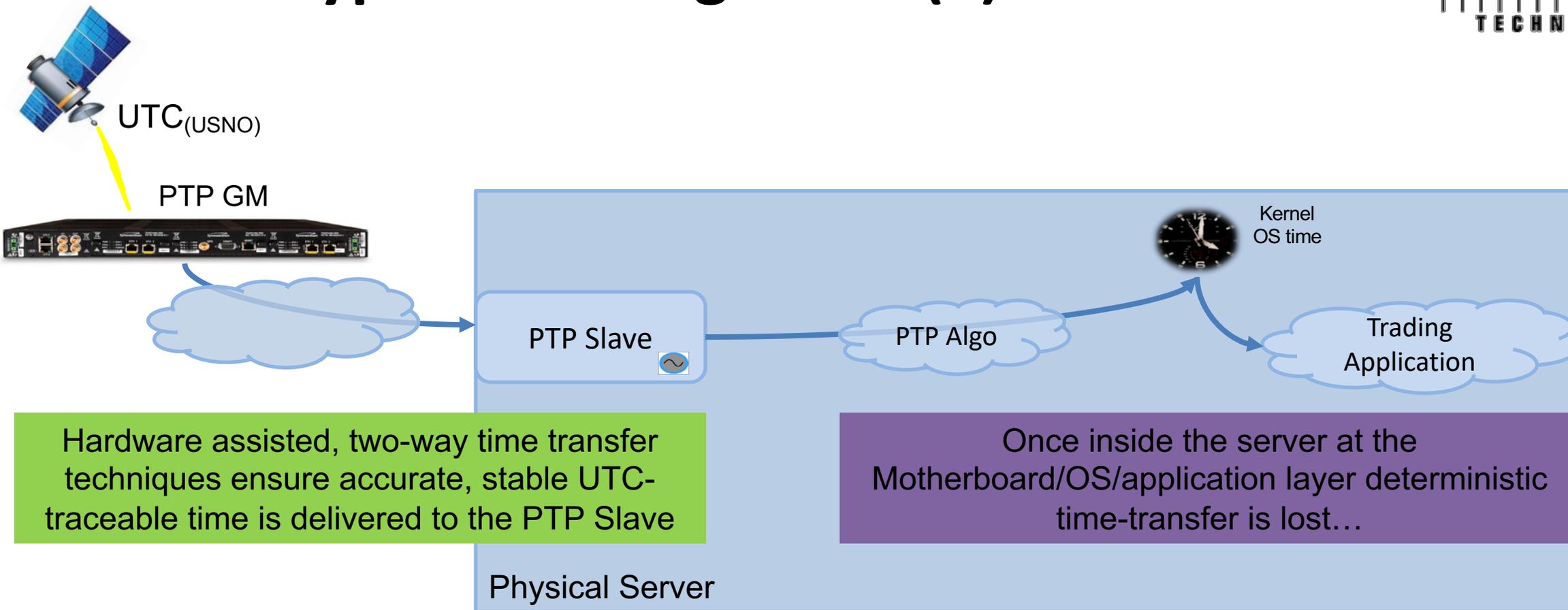
www.chronos.co.uk



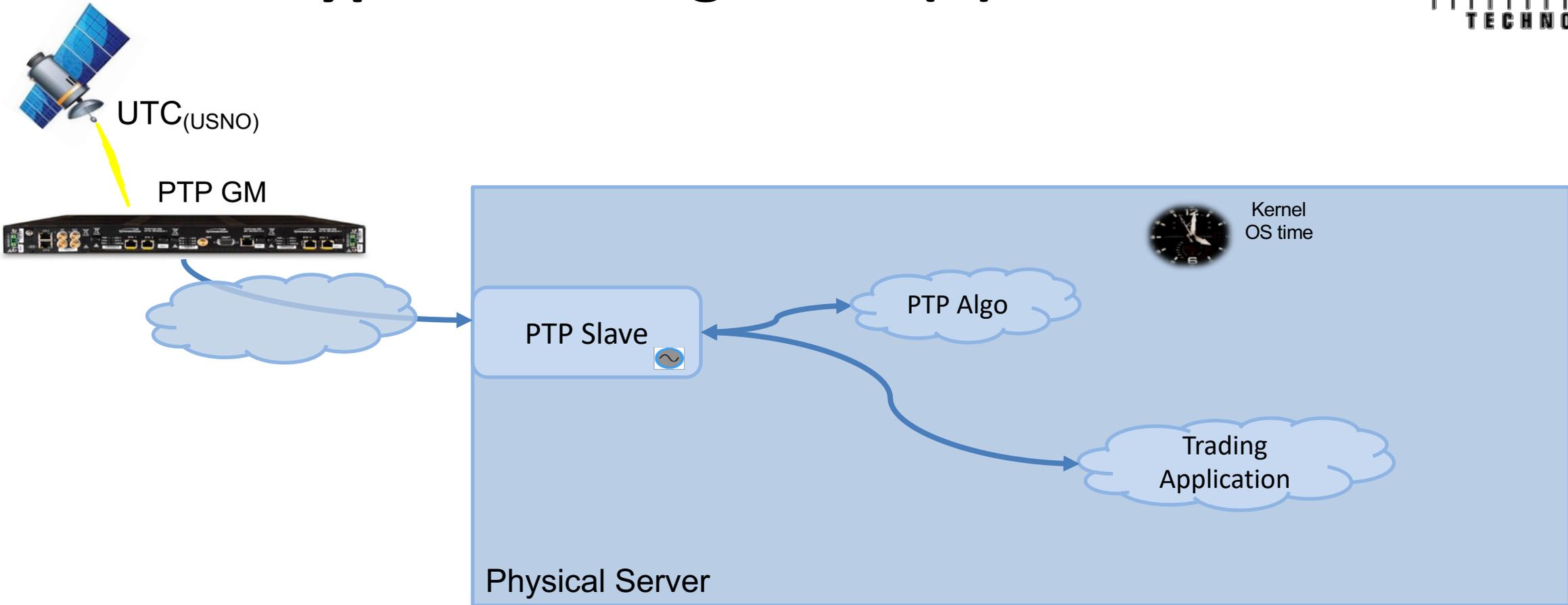
A horizontal banner image with a collage of technology-related elements. From left to right: a hand holding a silver analog compass over a background of binary code; a large satellite dish antenna; a satellite in orbit above a view of Earth from space; a red and white telecommunications tower; and a close-up of server racks in a data center.

Reference Slides

Typical Trading Clock (a)

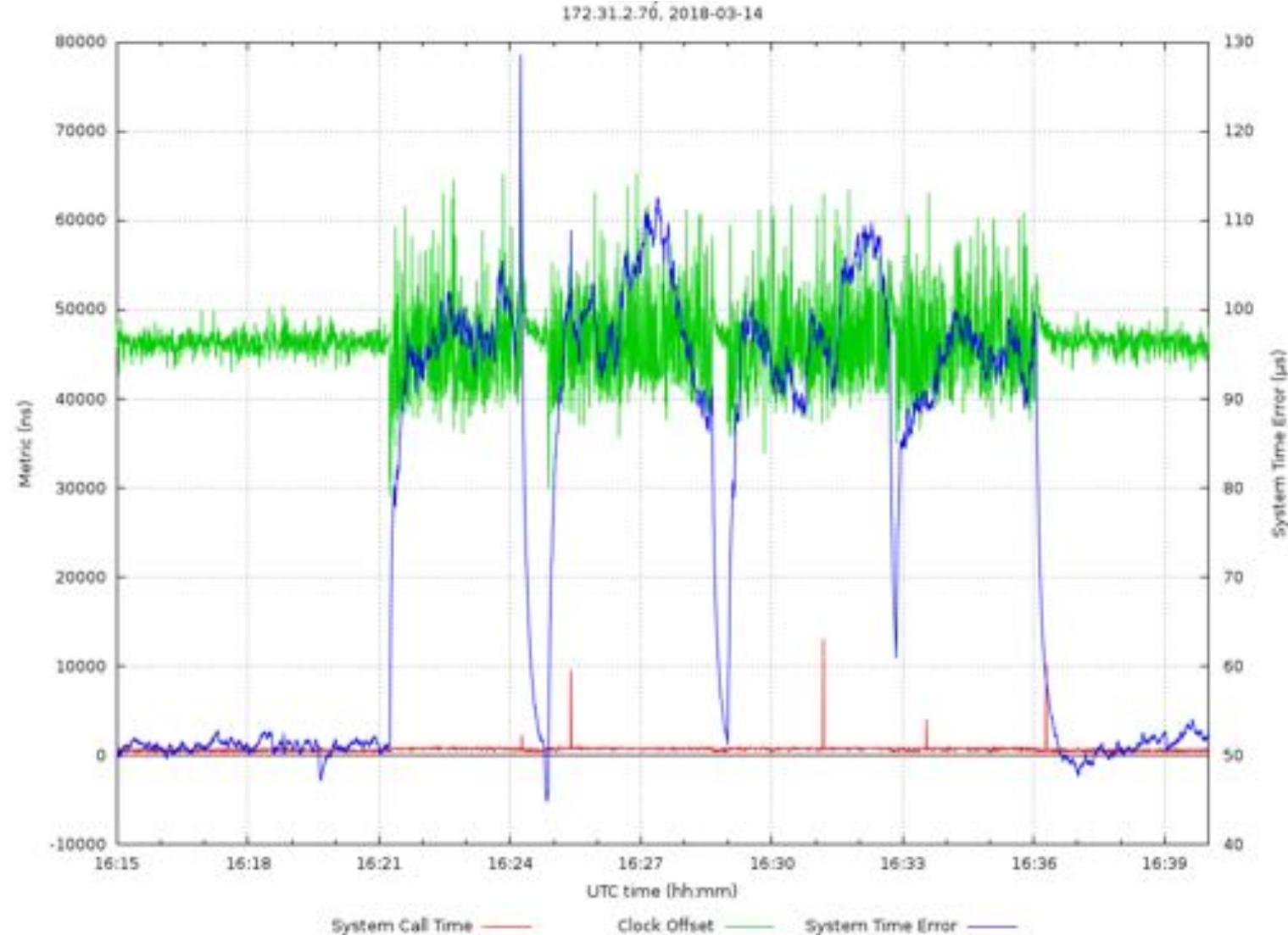


Typical Trading Clock (b)



Profiling the application space

- Lab test plots



Profiling the application space

