National Physical Laboratory

UTC Traceable Time for the Financial Sector using PTP

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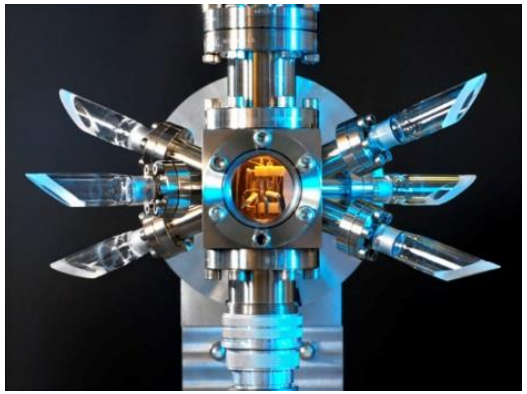
Overview

- Introduction to the NPL*Time*® service
  - Financial sector timing requirements
  - NPL solution
- Tests at NPL
  - Loopback system
  - Service monitoring
- Trial of NPL*Time*®
  - Results
- Conclusions

Clocks & time dissemination at NPL

Primary frequency standard
Caesium fountain CsF2

Optical clocks
Sr, Sr+ and
Yb+



Time Scale:

- 4 active hydrogen masers
- 5 caesium clocks

The Time from NPL:

- MSF 60kHz radio signal
- NTP
- GPS common view
- NPL*Time*®

Introduction to the NPL*Time*® service

NPL*Time*® takes advantage of the UK national timescale UTC (NPL) to disseminate a time signal via fibre optic link directly to customers in the city of London

IEEE 1588 v2 (PTP) is used to provide end users with resilient and certified timing and synchronisation of systems to a high level of accuracy

Time signal is independent of GPS

SLA is 1 µs to UTC (NPL) with
99.9% availability

Financial sector requirements

- **Core requirements**
  Common clock
  Traceable
  Resilient
  Secure

- **Functional requirements**
  Timestamping
  Synchronisation
  Latency monitoring
  Network performance
  Audit requirements

NPL*Time*® benefits

- Risk mitigation
- Simplicity of implementation
- Maximises confidence in data timing
- Maximises benefit realisation of localised PTP infrastructure upgrades
- Provides both absolute time and sync across implementations
- NPL*Time*® SLA available everywhere

NPL-Telehouse fibre link

NPL*Time*® CsDU

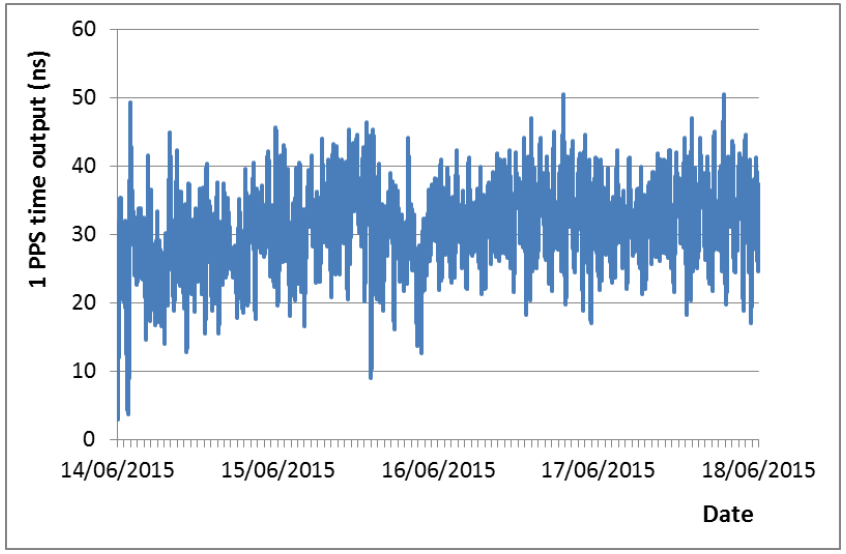
Caesium Clock Disciplining Unit:
PXI chassis + Timing card + Cs clock

Holdover solution at Telehouse hub:
Failover to Cs clock in the event of fibre failure

Records the 1PPS time difference between NPL*Time*® Primary clock and the Cs clock

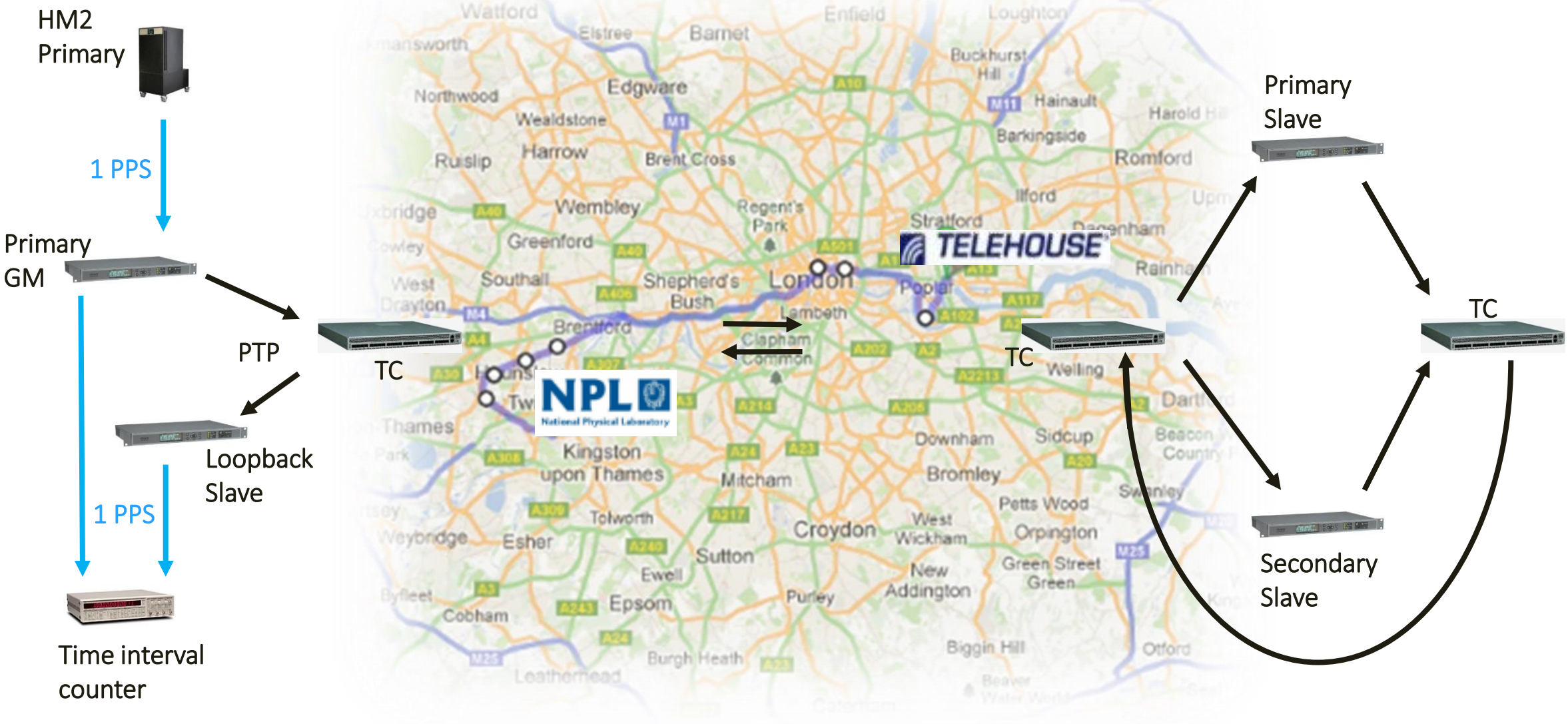
Calculates and writes a frequency adjustment to the Cs clock to correct the time offset

Time output resolution is limited by the PTP time server.



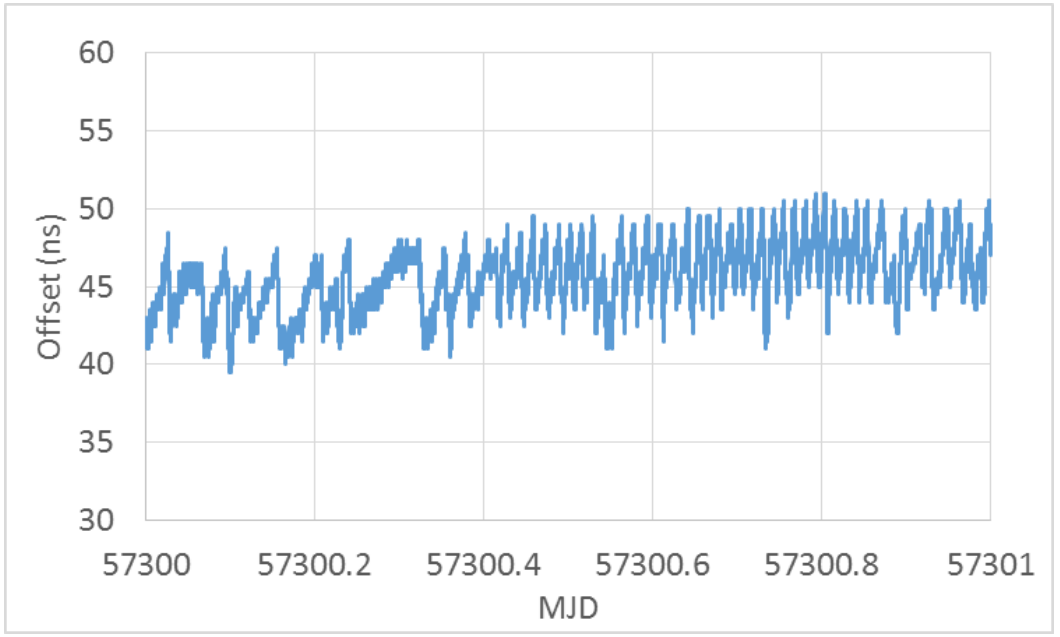
CsDU 1 PPS – Primary clock 1PPS

Loopback


HM2
Primary
1 PPS
Primary
GM
PTP
TC
Loopback
Slave
1 PPS
Time interval
counter
TELEHOUSE
NPL
National Physical Laboratory
TC
Primary
Slave
TC
Secondary
Slave

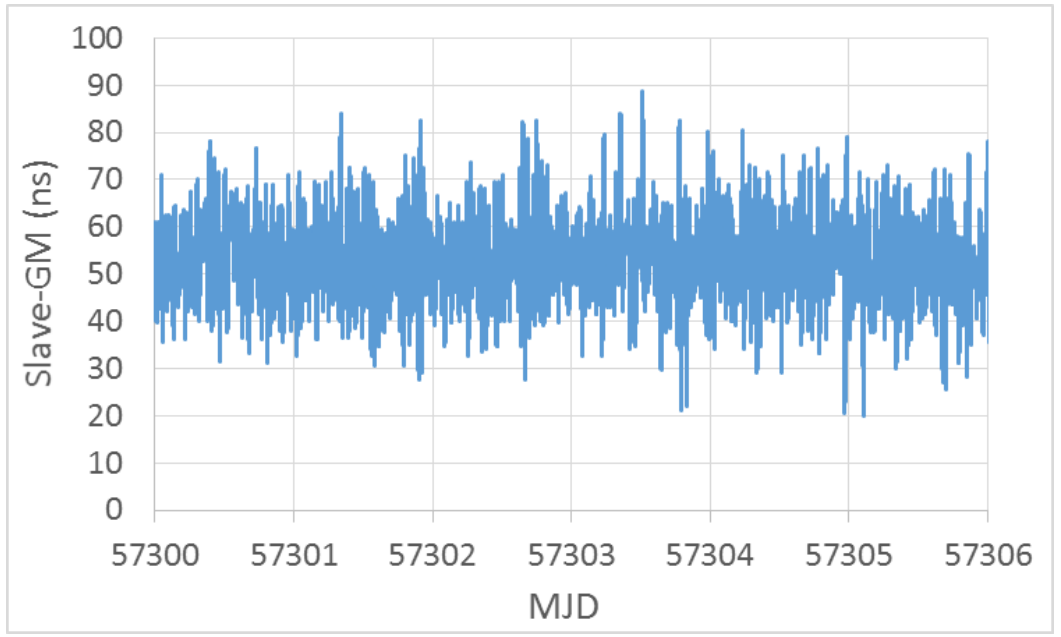
Results at NPL

Time difference between primary GM and backup GM, 1 PPS



- Redundancy monitoring
- HM4 steered to maintain 100ns offset

Loopback slave measured against Primary GM, 1 PPS



- Client endpoint simulation
- Compared directly with GM

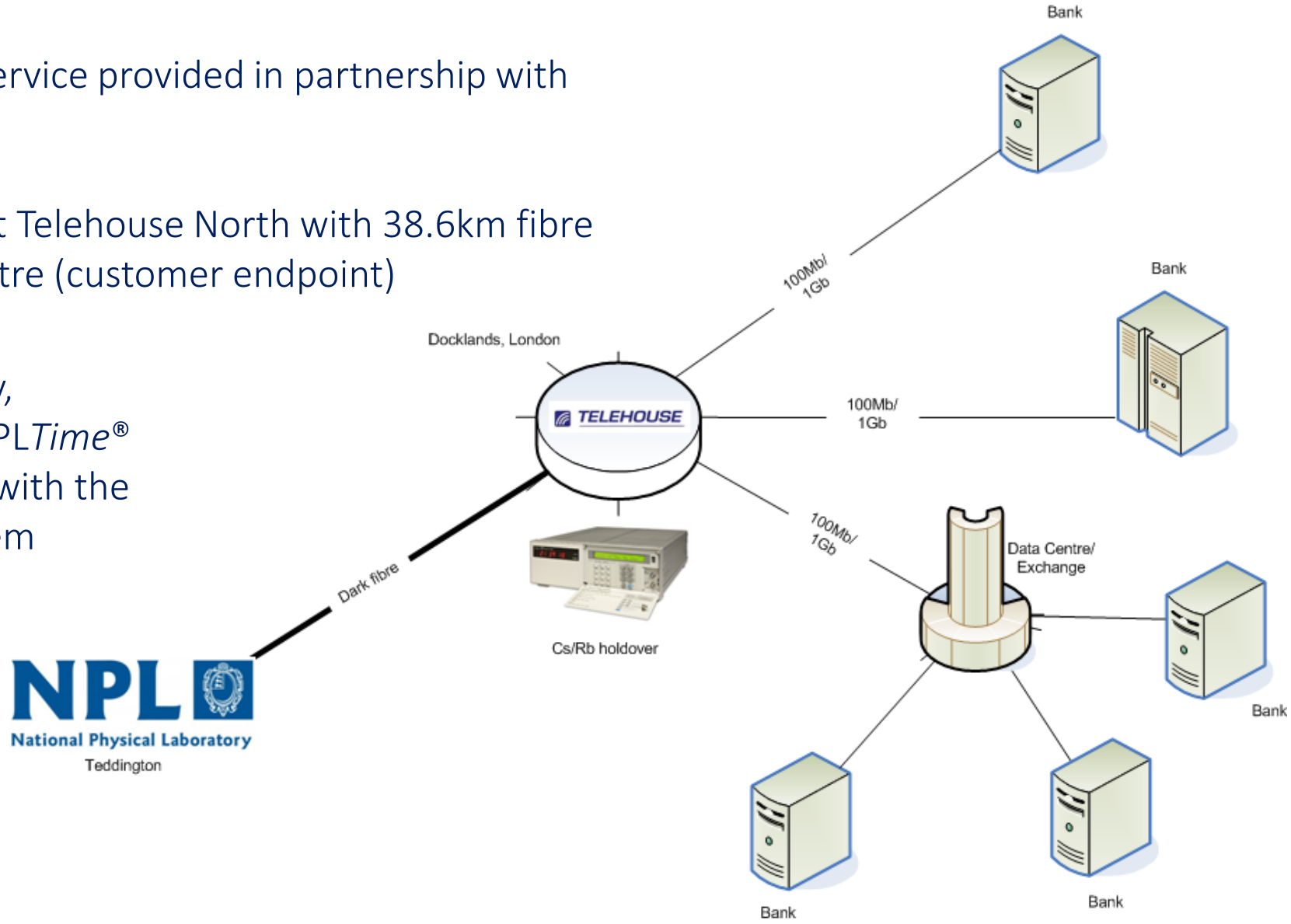
Trial with 3rd Party Customer

3 month trial of the NPL*Time*® service provided in partnership with TMX Atrium

The distribution hub is located at Telehouse North with 38.6km fibre cross connect to Slough datacentre (customer endpoint)

The aim is to assess the accuracy, stability and availability of the NPL*Time*® service and make a comparison with the current time dissemination system within the customer Estate

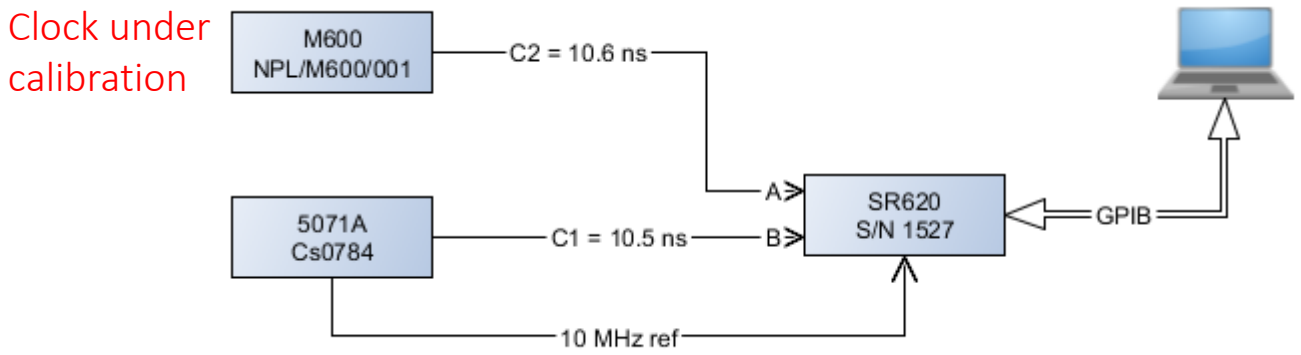
SLA <1µs offset to UTC(NPL)
99.9% availability



Portable Cs Clock calibrations : 1 PPS

Caesium clock calibrations were used to determine the time offset to UTC(NPL)

Cs clock measured against UTC(NPL) before and after measurements at Slough



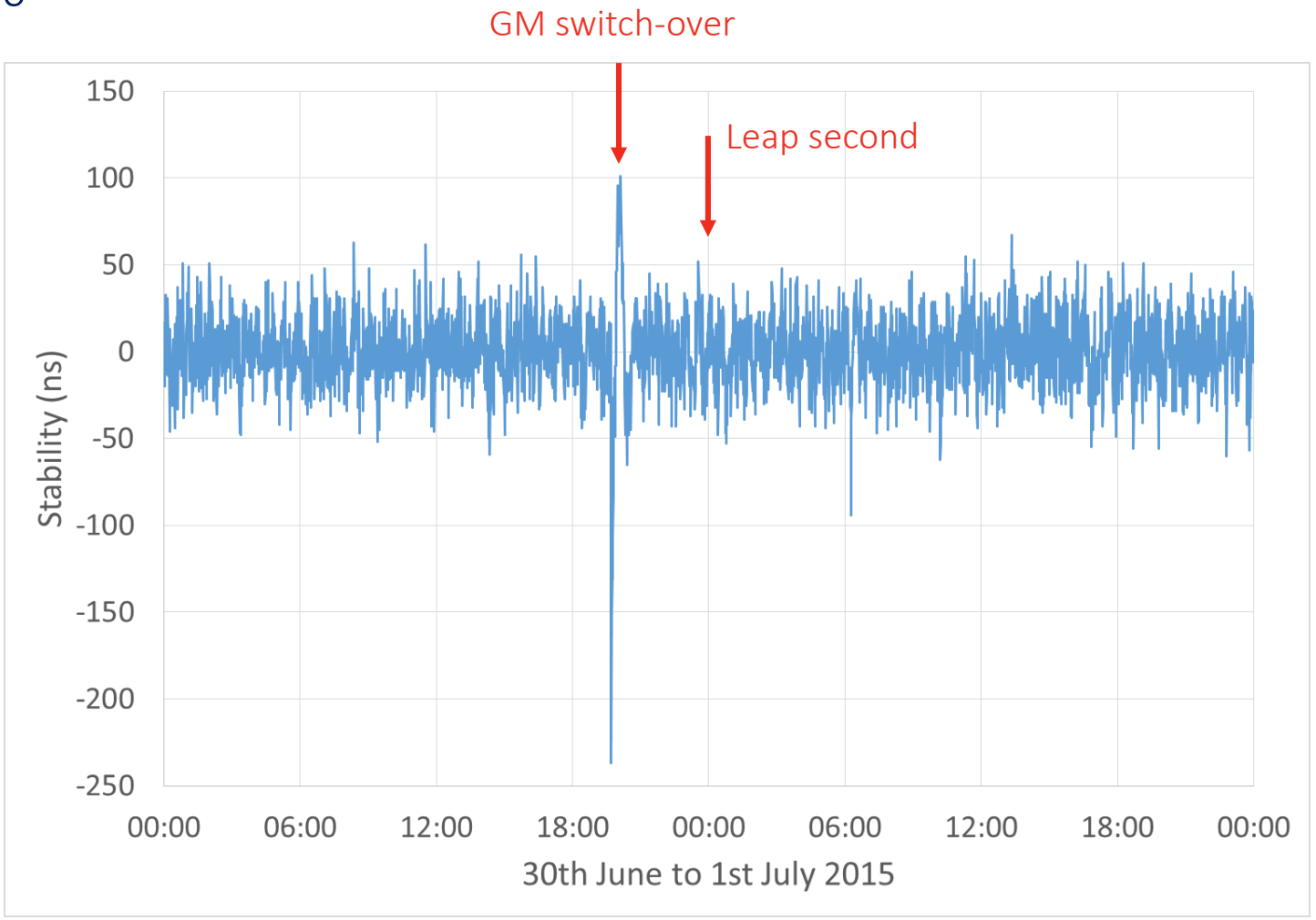
Date	MJD	Offset from UTC(NPL) at Slough
20th May 2015	57162.7554	+105.4 ns
15th June 2015	57188.7910	+110.2 ns
22nd July 2015	57225.8513	-7.8 ns
26th August 2015	57260.8105	+9.5 ns
29th September 2015	57294.8331	-7.9ns

Leap second

Leap second added 30/06/2015 11:59:60
PTPv2 Announce message
No deviation observed

Deviation due to a planned switch-over of NPL Grand Master clocks, Teddington

Plot taken from Management server data

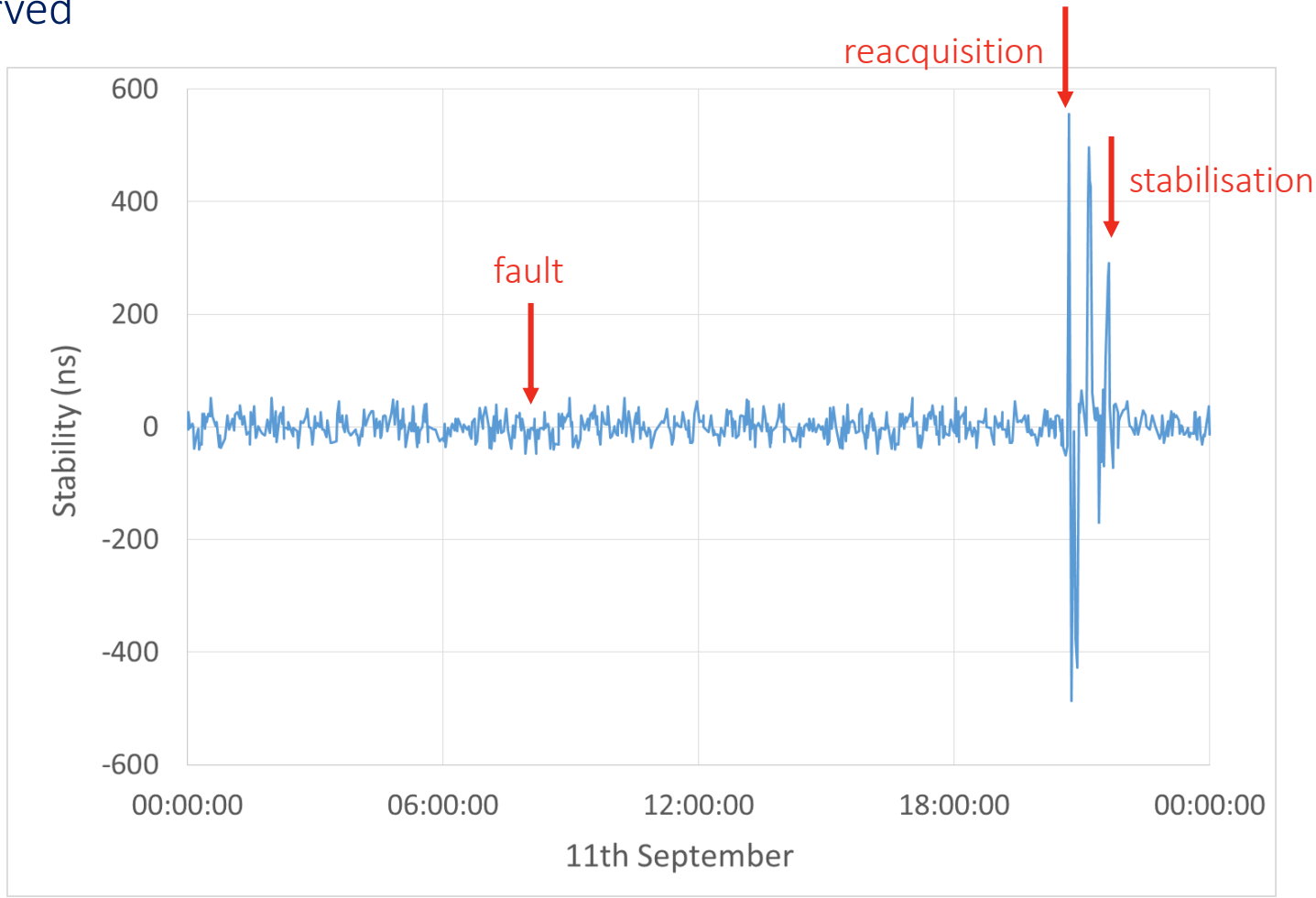


Fibre breakage

Fibre failure NPL (Teddington) – Telehouse hub 08:03
Failover to CsDU so no deviation observed

Fibre path restored:
Reacquisition of reference 20:40
Stabilisation to reference 21:39

Plot taken from management server data



Conclusions

- PTP timing provided by the NPL*Time*® is within the service SLA
  - maximum 1µs deviation from UTC(NPL), 99.9% availability
- Measured remotely by the NPL*Time*® management platform
- Measured directly by a calibrated caesium clock
- Initial deviations from the SLA were resolved by hardware changes
- Resiliency of the service tested through key events
  - Leap second
  - Fibre breakage

Summary of NPL*Time*®

- Certified by the National Physical Laboratory at the user
- Compliant with MiFID II RTS 25
- Continuously monitored by NPL
- No reliance on GPS or internet time
- Eliminates susceptibility to GPS vulnerabilities
- Uses fibre optic links, ensuring maximum resilience and security
- No roof access required
- Built in redundancy