NPL

Time is Money

P&SC 24th April 2023

Dr Leon Lobo

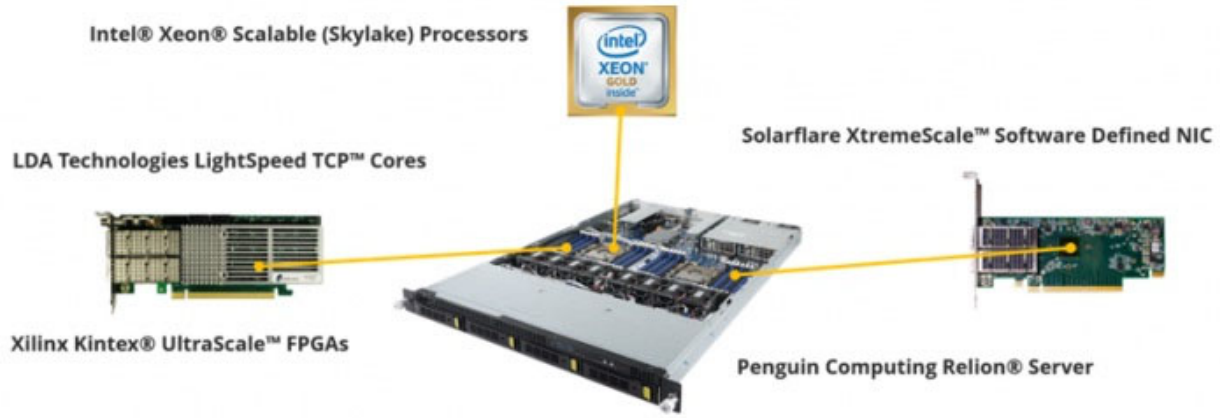
Rise of the machines

- Infrastructure synchronisation
- Ultra low latency networks and colocation
- Instrumentation
  - Timestamping
  - Flow/Health monitoring
  - Latency and network performance

- Algorithmic & High Frequency Trading
- Trading algorithms
  - Optimisation and playback
- Tick warehousing

- Regulation
  - Market clarity
  - Forensics and audit
  - Order of execution
  - Cross venue monitoring

100,000s transaction per second
Ultimate Trading Machine tick-to-trade 98ns (0.000 000 098s)



Race to zero


Japan
Norway/Finland
Ireland
Iceland
Greenland
Thule
Crise Fiord
Resolute
Nuuk
Shemya, AK
Alaska, USA
Iqaluit
Tuktoyaktuk
Canada

Government Office for Science

NPL

The Risk becomes a Financial threat

"What took a few days in August 2007 can unfold in a few minutes today given the amount of high frequency trading that now exists."

Andrew Lo Director of the MIT lab of financial engineering.

- The U.S. equity markets experienced the worst price decline and reversal since 1929 on May 6 2010. This has since been dubbed the "flash crash".
- The cost of the Flash Crash: confidence has been shattered and roughly $70bn has been pulled out of US equity funds since May 6.

A.4 Standards should play a larger role. Legislators and regulators should consider implementing accurate, high resolution, synchronised timestamps because this could act as a key enabling tool for analysis of financial markets

Financial regulation - EU

- Markets in Financial Instruments Directive II (MiFID II)
  - Traceability to UTC
  - HFT algo 100µs to UTC, 1µs resolution
  - Electronic 1ms to UTC, 1ms resolution

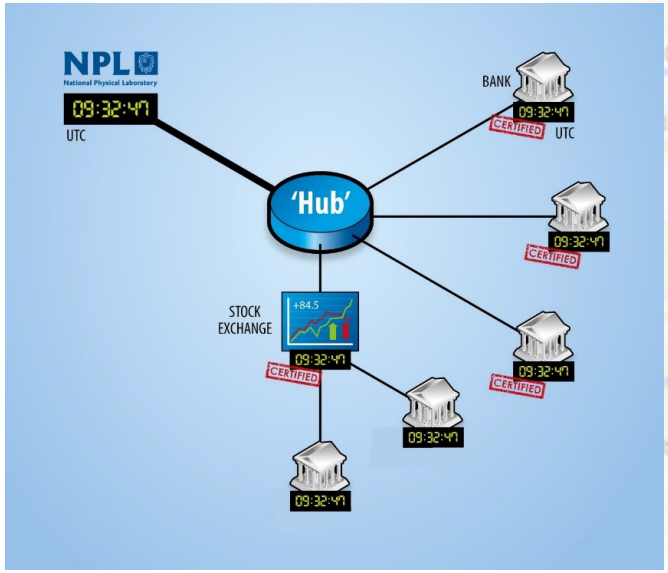
operators of trading venues and their members or participants are required to synchronise the clocks they use for any reportable events with UTC (Article 50 of Directive 2014/65/EU and Article 1 of Commission Delegated Regulation (EU) 2017/574)

3rd Jan 2018

Time as a Service (TaaS)

Traceable, Accurate, Available, Secure

NPLTime®



Traceability and MiFID II

- **Traceability** is a property of a measurement (including its uncertainties) that provides proof that the result obtained is an accurate representation of the reference
- The traceability chain is the unbroken chain of comparisons to a reference (with known uncertainties), in this case, UTC.

MiFID II requires traceability at the timestamp, NOT the timing source

Toward international regulatory convergence

- **UTC** traceability for business clock synchronisation
- Traceability at the **timestamp** (as an ideal scenario)
- Tiers of traceability mandated as per market requirement

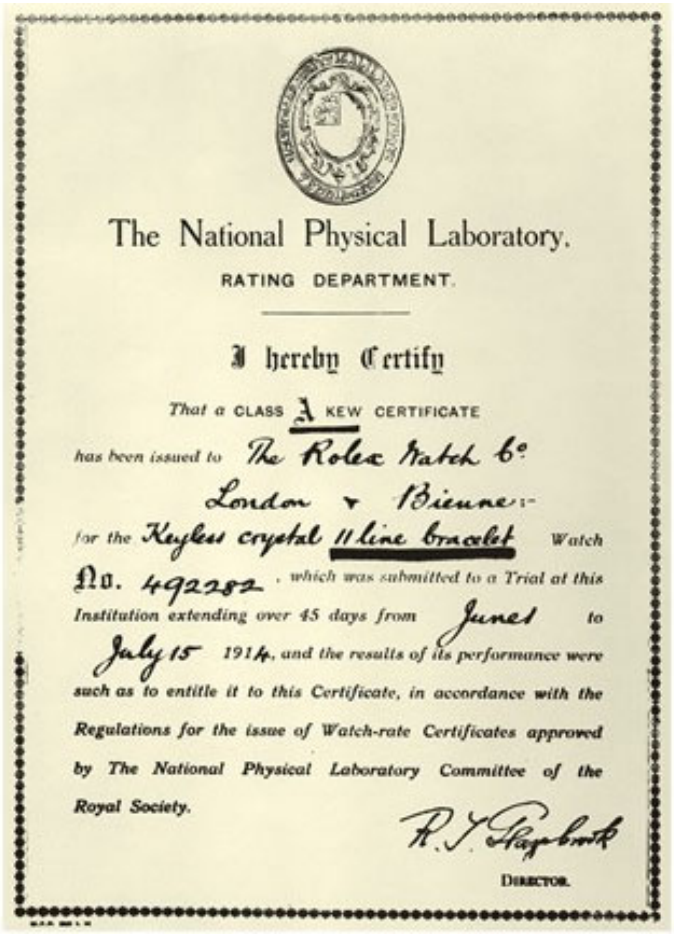
IOSCO/MR/01/2020

Madrid, 16 January 2020

International Organization of Securities Commissions
Organisation internationale des commissions de valeurs
Organização Internacional das Comissões de Valores
Organización Internacional de Comisiones de Valores
المنظمة الدولية لهيئات الأوراق المالية

IOSCO recommends synchronising clocks used for timestamping with UTC

A century on…



The National Physical Laboratory.

RATING DEPARTMENT.

I hereby Certify

That a CLASS A KEW CERTIFICATE has been issued to The Rolex Watch Co London & Bienne for the Keyless crystal 11 line bracelet Watch No. 492282, which was submitted to a Trial at this Institution extending over 45 days from June 1 to July 15 1914, and the results of its performance were such as to entitle it to this Certificate, in accordance with the Regulations for the issue of Watch-rate Certificates approved by The National Physical Laboratory Committee of the Royal Society.

R. T. Glazebrook

DIRECTOR.

NATIONAL PHYSICAL LABORATORY

Teddington Middlesex UK TW11 0LW Telephone +44 20 8977 3222

NPL*Time*®

SAMPLE CERTIFICATE

The certificate provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, unless permission for the publication of an approved extract has been obtained in writing from the Managing Director. It does not of itself indicate the subject of calibration any attributes beyond those shown by the data contained herein

FOR:	COMPANY ADDRESS
SERVICE PROVIDER	PROVIDER NAME
PROVIDER REFERENCE	xxxxx-xxxxx
DESCRIPTION:	NPL*Time*® is a resilient precision time dissemination solution providing direct access to Coordinated Universal Time (UTC) on fibre networks, offering UTC traceable time, certified on installation at the customer's site by the National Physical Laboratory, the UK's UTC lab responsible for managing the UK's timescale. This document certifies the signal at the end point installed by the SERVICE PROVIDER as validated by NPL as NPL*Time*® with the following SERVICE LEVELS.
SERVICE LEVELS	Accuracy to UTC: <1µs Availability: 99.99%
DATE OF INSTALLATION:	31/01/2014

NPL Reference: xxxx-xxxx — Page 1 of 1

Date of Issue: 31/01/2014 — Signed: — (Authorised Signatory)

Checked by: P Whibberley — Name: L Lobo — on behalf of NPLML

Resilient Time for the Future

npl.co.uk/ntc

ntc@npl.co.uk

Dr Leon Lobo
Head of the National Timing Centre
leon.lobo@npl.co.uk