Building an Independent Resilient Timing Service across your Datacentre Network

Chronos TECHNOLOGY

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Chronos: Sync & Timing Expertise since 1986

- Professional Services
- Training, Install/Commission & Support
- Network Sync Audits – Time & Timing
- Network Design & Test
- Consultancy

- ITU Standards Committee (SG15/Q13)
- Steering Groups – ITSF, WSTS & RIN

- R&D, product development
- Expert Advisory Groups (Blackett, RAEng)

- Resilient Synchronisation & Timing Solutions
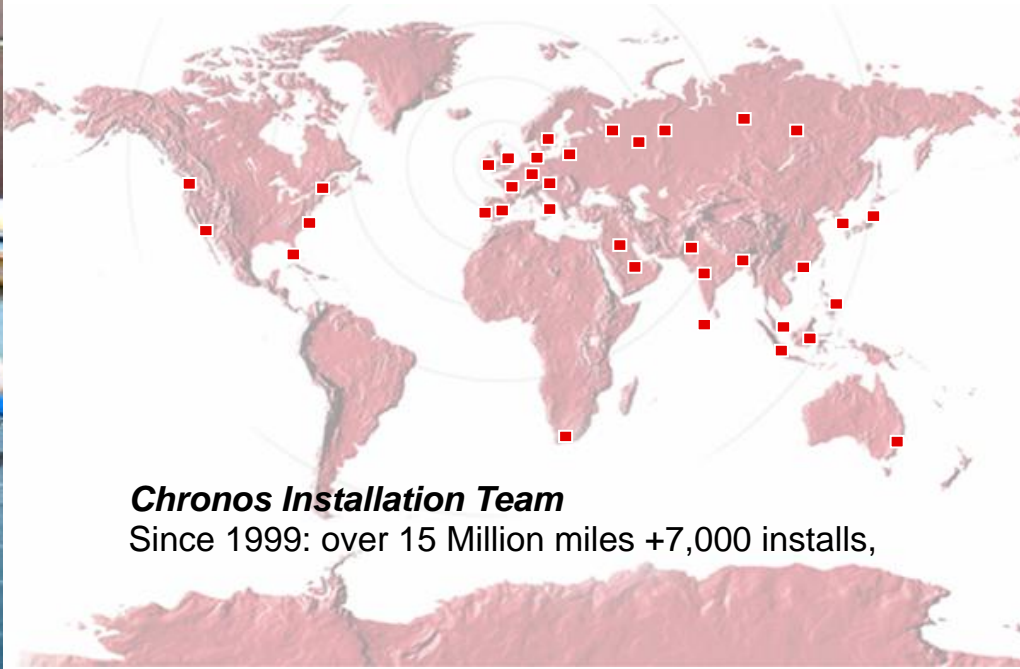- GNSS Vulnerability & Mitigation Solutions

- Markets
  - Telecom
  - Power
  - Financial Services
  - Defence & Security
  - Law Enforcement
  - Broadcast

Chronos Technology

- Global reach – installations + support
- *Extensive experience of how GNSS timing systems behave in the real world*

Chronos Installation Team
Since 1999: over 15 Million miles +7,000 installs,

Time – The Invisible Utility

- Time enables many industries, processes &
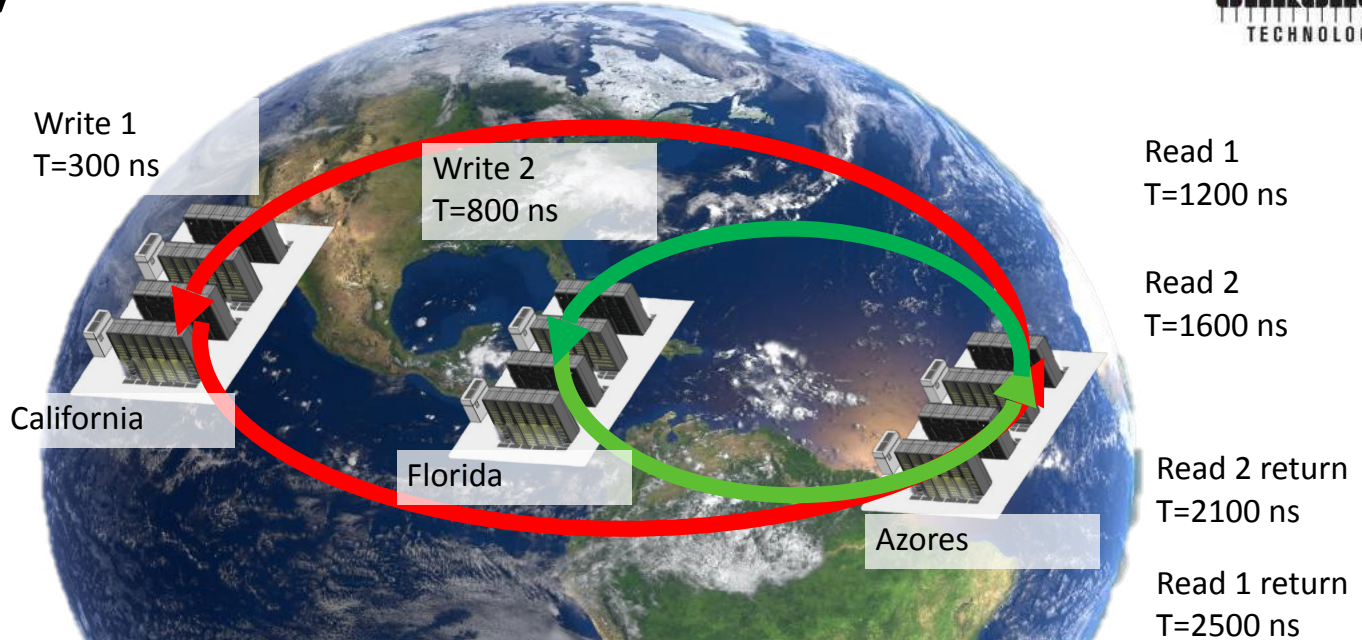
Why do we need accurate time?

- Technical Reasons
  - Distributed database access
  - Distributed sensor Networks
  - Radio Systems scheduling Tx/Rx (e.g. 5G)
- Regulatory Reasons
  - Legally traceable timestamps
    - e.g. EU MiFID II

Globally Distributed Database

Write 1
T=300 ns

Write 2
T=800 ns

California

Florida

Azores

Read 1
T=1200 ns

Read 2
T=1600 ns

Read 2 return
T=2100 ns

Read 1 return
T=2500 ns

- Must ensure Write 1 is perceived as occurring first in Azores

But who has the right Time?

- UTC is the global timebase
  - Usually delivered locally via a GPS receiver
  - GNSS constellations include GPS(US) GLONASS(Russia) GALILEO(EU) & BEIDOU(China)
  - GNSS receiver acts as a primary reference for time servers - NTP or PTP
  - Time Servers distribute time to applications

GNSS – the GPS success sto[ry]

- Originally US Military Missile-Guidance system
- FOC 27APR95

Using GNSS for Time

MEO Satellites:
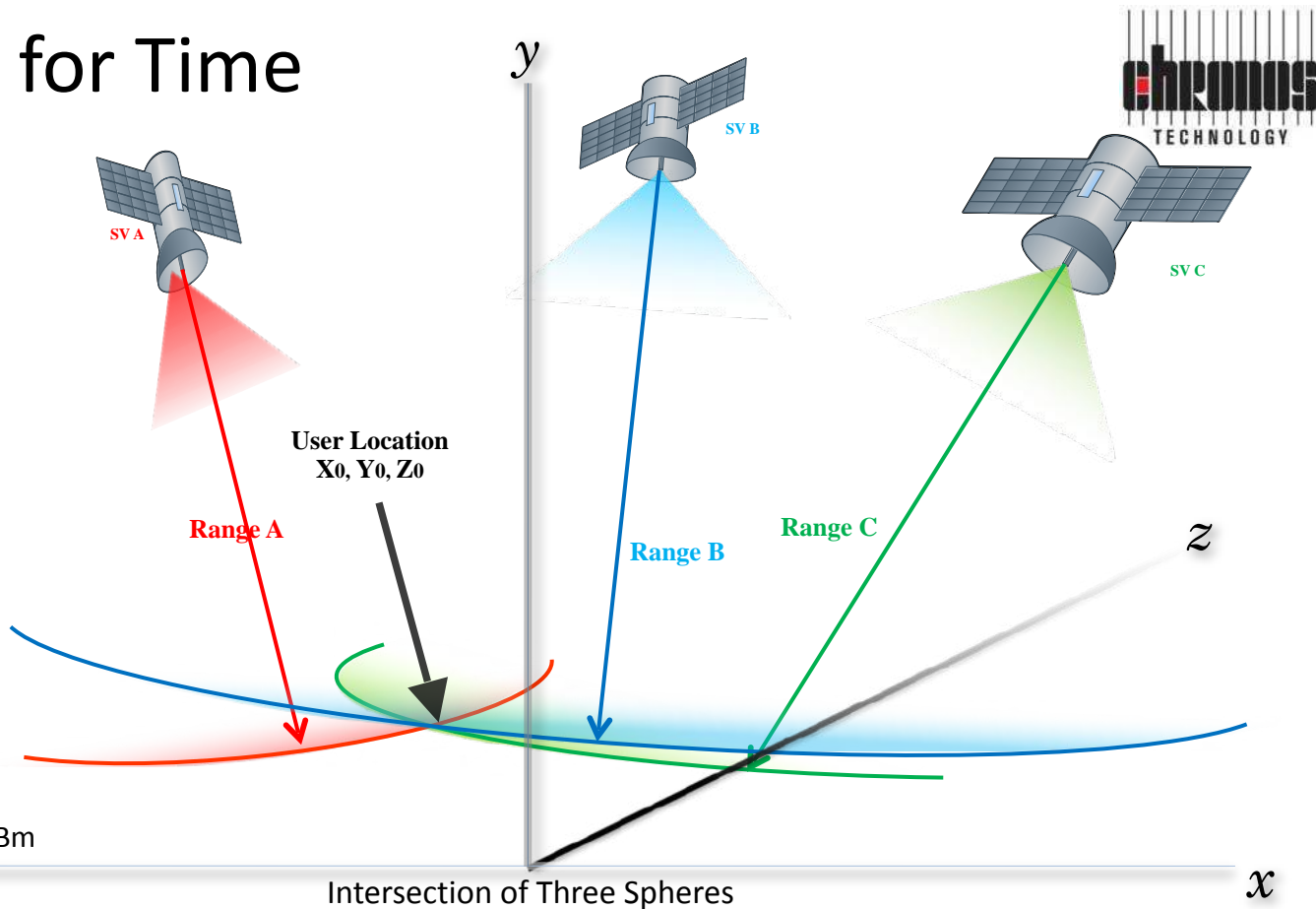BEIDOU – 21,150 km
GALILEO – 23,222 km
GLONASS – 19,100 km
GPS – 20,200 km

Orbital period: 11-14hrs

Power output: 20-265W

Received signal: -125dBm to -130dBm
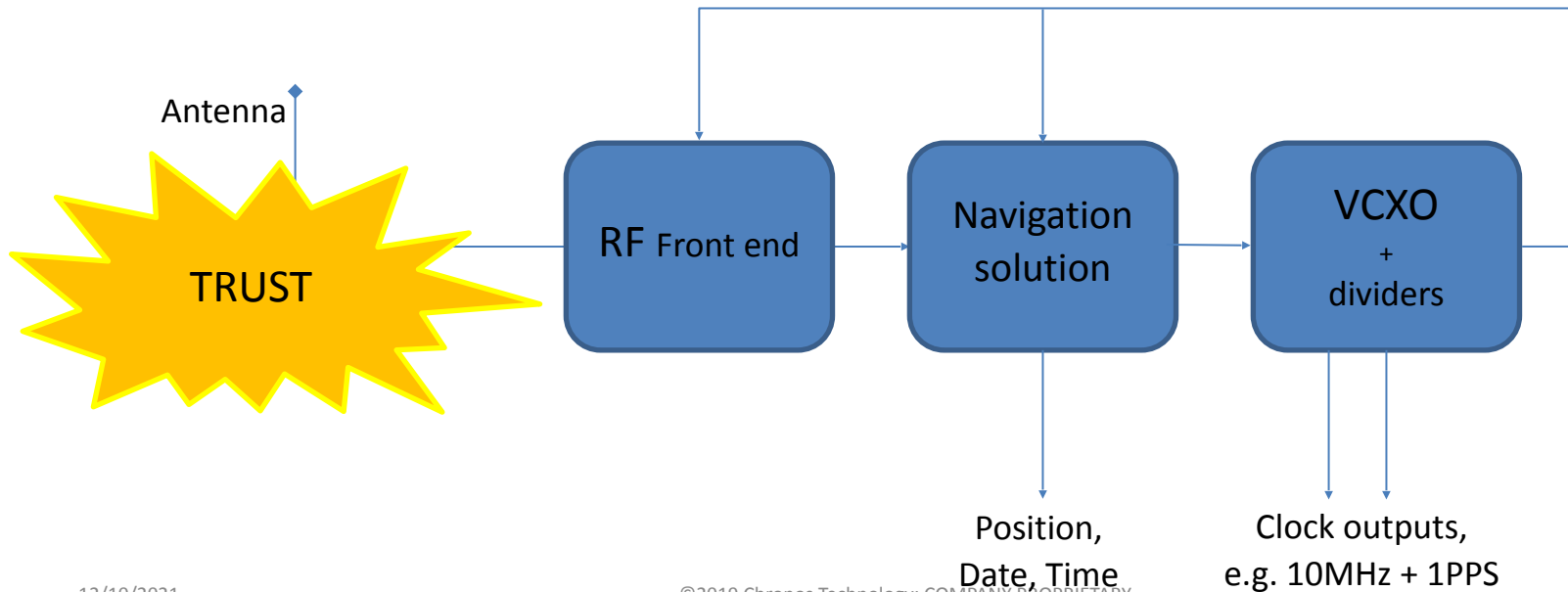
SV A

SV B

SV C

y

User Location
X0, Y0, Z0

Range A

Range B

Range C

z

x

Intersection of Three Spheres

Receiver Clock (timing) errors add a 4th unknown, hence 4 satellites require for precise fix

GNSS timing receiver – simplified view

- Uses the navigation solution to steer/control a local oscillator
- Timing output ultimately controlled by the RF signal input

Antenna

TRUST

RF Front end

Navigation solution

VCXO + dividers

Position, Date, Time

Clock outputs, e.g. 10MHz + 1PPS

Jamming now a civilian activity

- Privacy concerns have lead to an explosion of "GPS Jammers"
  - Business/Fleet vehicle tracking
  - Offender tracking
  - Freight Tracking
  - High-value cars fitted with trackers

  - "Privacy Jammers" for sale on the internet
    - Some also jam GSM/3G/4G/WiFi/Bluetooth etc.

  - Personal privacy – criminal activity – organised crime

Jamming now a civilian activity

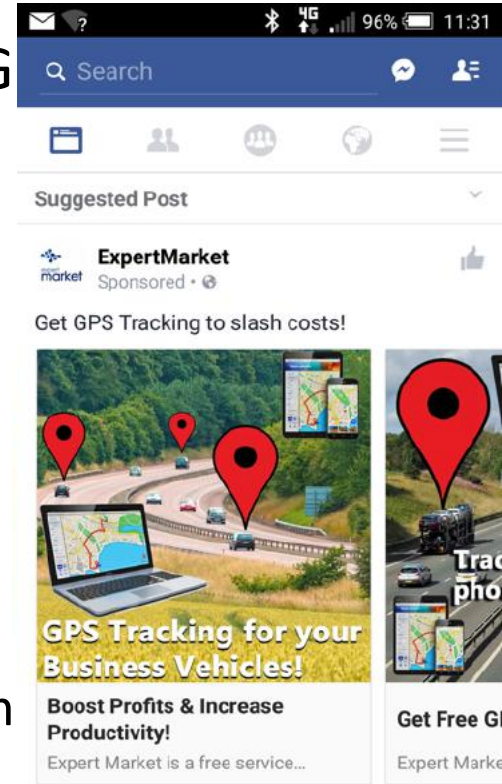- Privacy concerns have lead to an explosion of "G
    - Business/Fleet vehicle tracking
    - Offender tracking
    - Freight Tracking
    - High-value cars fitted with trackers

    - "Privacy Jammers" for sale on the internet
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    - Personal privacy – criminal activity – organised crim

Spoofing now a civilian activity

- Spoofing now trivial with COTS hardware & open-source software
    - Raspberry Pi + SDR + github code + electronics

- Increased use of location services has lead to widespread awareness of "Location Spoofing" techniques

Of the receivers we tested

- Some failed and needed power off/on reset
- Some failed catastrophically needed to be re-flashed

LimeSDR

RasPi 4B

LimeSDR Power (8.4V Li-ion)

GNSS ref (sync for LimeSDR)

RasPi Power (5V USB)
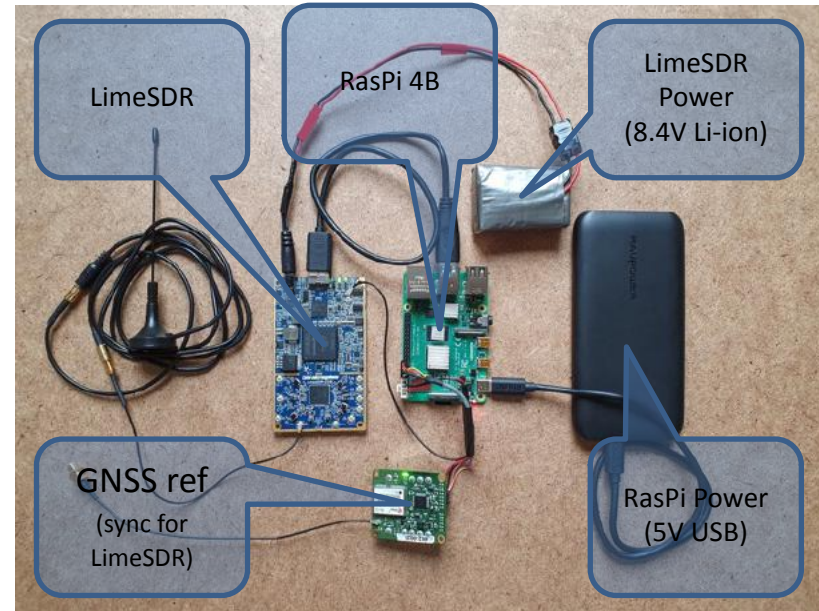
But how common is it?

But how common is it?

Google

gps spoofing reports

🔍 All   📰 News   ▶ Videos   🖼 Image

About 793,000 results (0.47 seconds)

Spoofing, is an intelligent form of interfer
false location. During a **spoofing** attack a
signals into the target receiver. For exam
make a smartphone believe it's on Mount

https://www.septentrio.com › insights › what-s
What is GPS Spoofing and how to

https://www.linkedin.com › pulse › thousands-
Thousands of GNSS jamming an
2 Dec 2020 — Aviation association Eurocontr
disruption in 2019, an all-time high. Jamming
Mediterranean, likely due to electronic warfar
and elsewhere in the region

https://safety4sea.com › cm-understanding-gp
Understanding GPS spoofing in s
31 Jan 2020 — Concerning the incident, a ma
contacted the US Coast Guard Navigation Ca

https://www.csoonline.com › Security ▾
What is GPS spoofing? And how
7 May 2019 — Instead of showing the accura
were in Buckingham, England, in the year 20

https://www.cs.ox.ac.uk › files › gps ▾ PDF
On the Requirements for Success
by NO Tippenhauer · Cited by 440 — In 2001
interfer- ence with the civilian GPS signal is a
practical spoofing ...

People also ask

Ghost ships, crop circles, and soft gold: A GPS mystery in Shanghai

15 Nov 2019 — On a sultry summer night in July 2019, the MV Manukai was arriving at the port of Shanghai, near the mouth of ...

/ https://www.thedrive.com › chinas-...

China's Mysterious Spoofed GPS "Crop Circle" Has Something ...

19 Nov 2019 — China's Mysterious Spoofed GPS "Crop Circle" Has Something Interesting At Its Center. Something appears to be physically ...

📶 https://radionavlab.ae.utexas.edu › i...

Mystery GPS 'Crop Circles' in Shanghai

Mystery GPS 'Crop Circles' in Shanghai. December 2019: Researchers at the Center for Advanced Defense Studies (C4ADS), a nonprofit ...

sports

ask

oofing still work?

S be detected?

someone is spoofing their location?

GPS spoof Pokemon go?

iPhone GPS?

spoof in Pokemon Go 2021?

c.co.uk › news › technology-47786246 ▾
s 'extensive Russian GPS spoofin
Thousands of incidents have been logged of R
rt suggests.

ritimeglobalsecurity.org › media ▾ PDF
nd Spoofing of Global Navigation
intermeasures. 8. APPENDIX A: Reporting of
problem reporting. 9. Galileo incidents repor

sworld.com › spoofing-in-the-black-sea-... ▾
the Black Sea: What really happe
Between June 22-24, a number of ships in the
their GPS-derived position, and found themse

net.com › Topic › Security ▾
ms Russia a pioneer in GPS spoo
- C4ADS concluded that GPS spoofing attack
egic threat and are now at high risk of prolifera

ed.co.uk › article › russia-gps-spoofing ▾
Putin, Russia is spoofing GPS sign
- C4ADS's report focussed on GPS spoofing
ology used in Crimea and Syria. "GPS spoofin

To protect Putin, Russia is spoofing GPS signals on a massive scale

27 Mar 2019 — To protect Putin, Russia is spoofing GPS signals on a massive scale ... Russian-linked electronic warfare ...

🌐 BBC News app · *Installed*

BBC NEWS   ## Study maps 'extensive Russian GPS spoofing' - BBC News

2 Apr 2019 — Study maps 'extensive Russian GPS spoofing' · Russian President Vladimir Putin has a bubble of spoofed GPS signals ...

🔭 www.nbcnews.com ⚡

Russia 'spoofing' GPS to keep drones away from Putin, report says

26 Mar 2019 — Russia manipulates global navigation systems by sending out false location data to civilian ships or other ...

15

Security

- Physical Access controls are extensive

- Private or Isolated networks

- …but
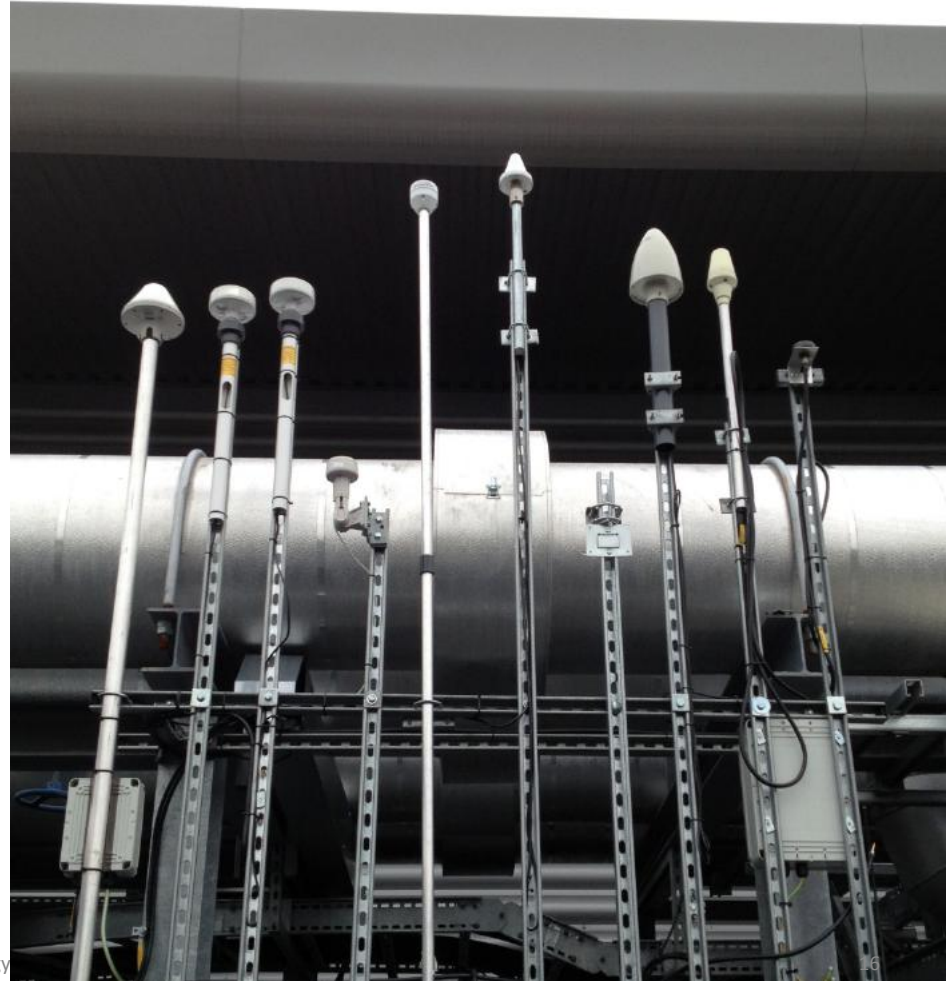
Precise Time for Datacentres

Time As A Service

1. Secure Time Traceability
   - Detect spoofing, jamming

2. Time Resiliency
   - Survive outages

3. Time Distribution

Time Traceability: **Secure GNSS**

Time Resiliency: **Atomic Clock Backup**

Trusted Time™: **PTP/NTP**

Financial Transactions

Streaming **Virtual Meetings** **Database Access**

Data Center
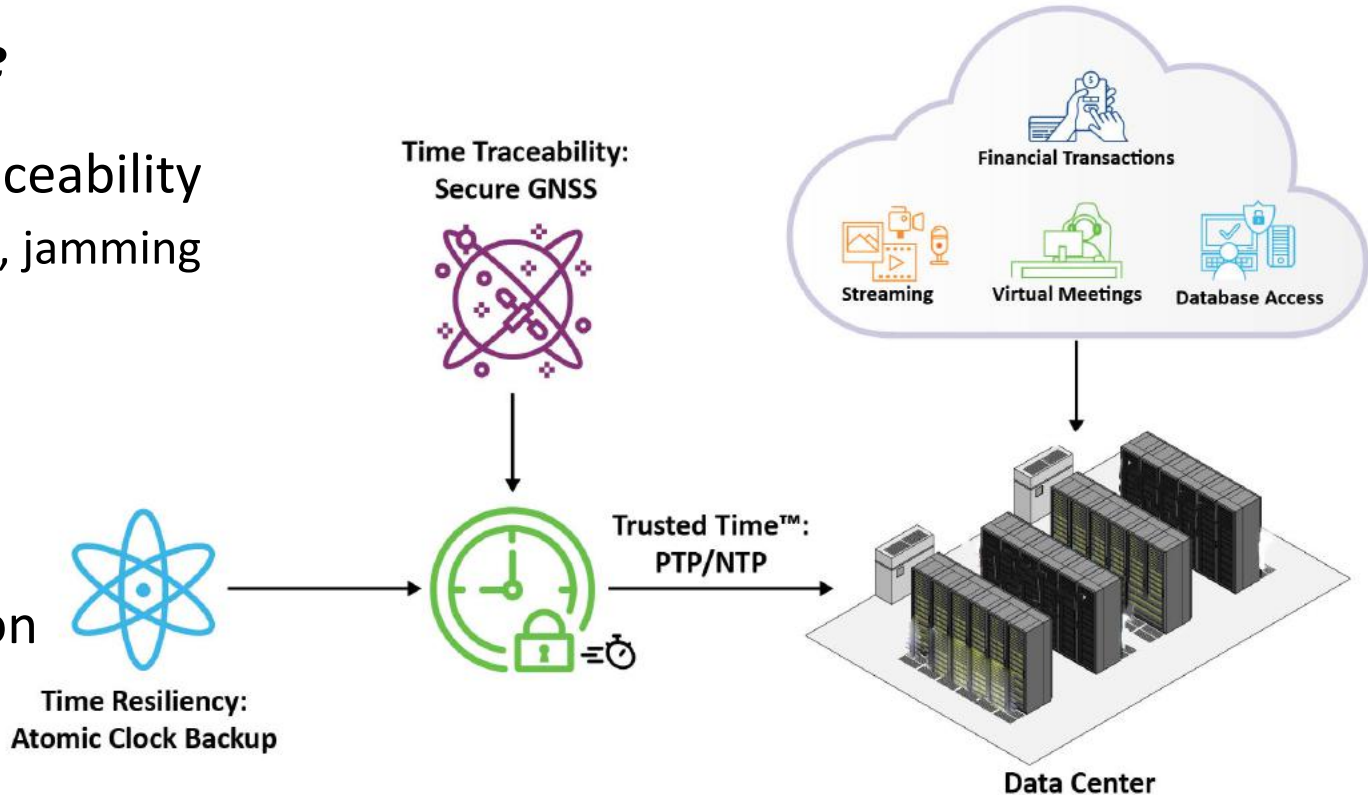
GNSS vulnerable
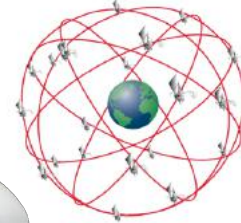
Live Sky
(not secure)

Existing GNSS receivers

©Chronos Technology – COMPANY PROPRIETARY

GNSS Firewall

Live Sky
(not secure)

Hardened Output
(secure and resilient
using atomic holdover)

Validated Output

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GNSS Firewall

or
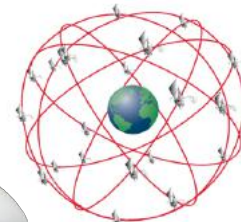
Optional
(inside)

Live Sky
(not secure)

Hardened Output
(secure and resilient
using atomic holdover)

Validated Output

Holdover
(resilient)

Resilient Timing Deployment models

Time Server with GNSS firewall features inside

MAC

SyncServer

Firewall for timing protection of "legacy" products

TimePictra with BlueSky

Optional MAC

Optional Cesium
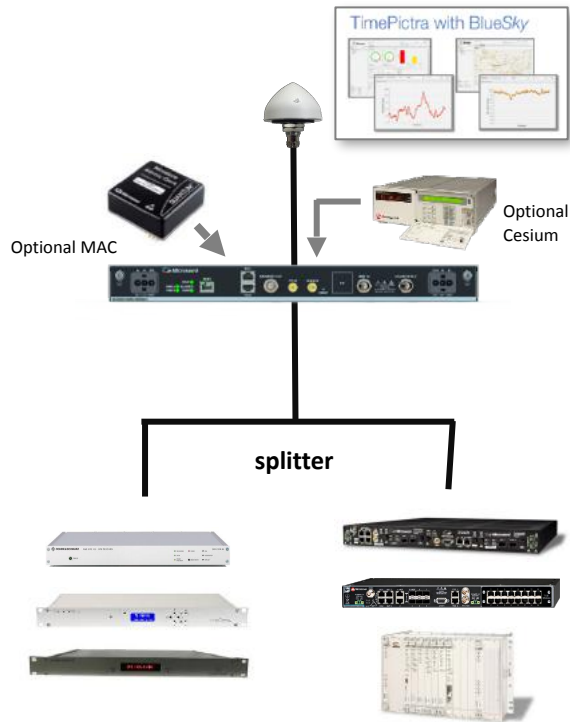
splitter

Firewall for PNT protection of Critical Infrastructure

TimePictra with BlueSky

Optional MAC

Optional Cesium

Critical Infrastructure Equipment requiring GNSS

Support for Galileo

or

Optional
(inside)

Live Sky ↓ and

**Reception/Anomaly
Detection**

GPS
TIME

or

GALILEO
TIME

→ Hardened
Output (**GPS format**)

Validated
Output (**all bands**)
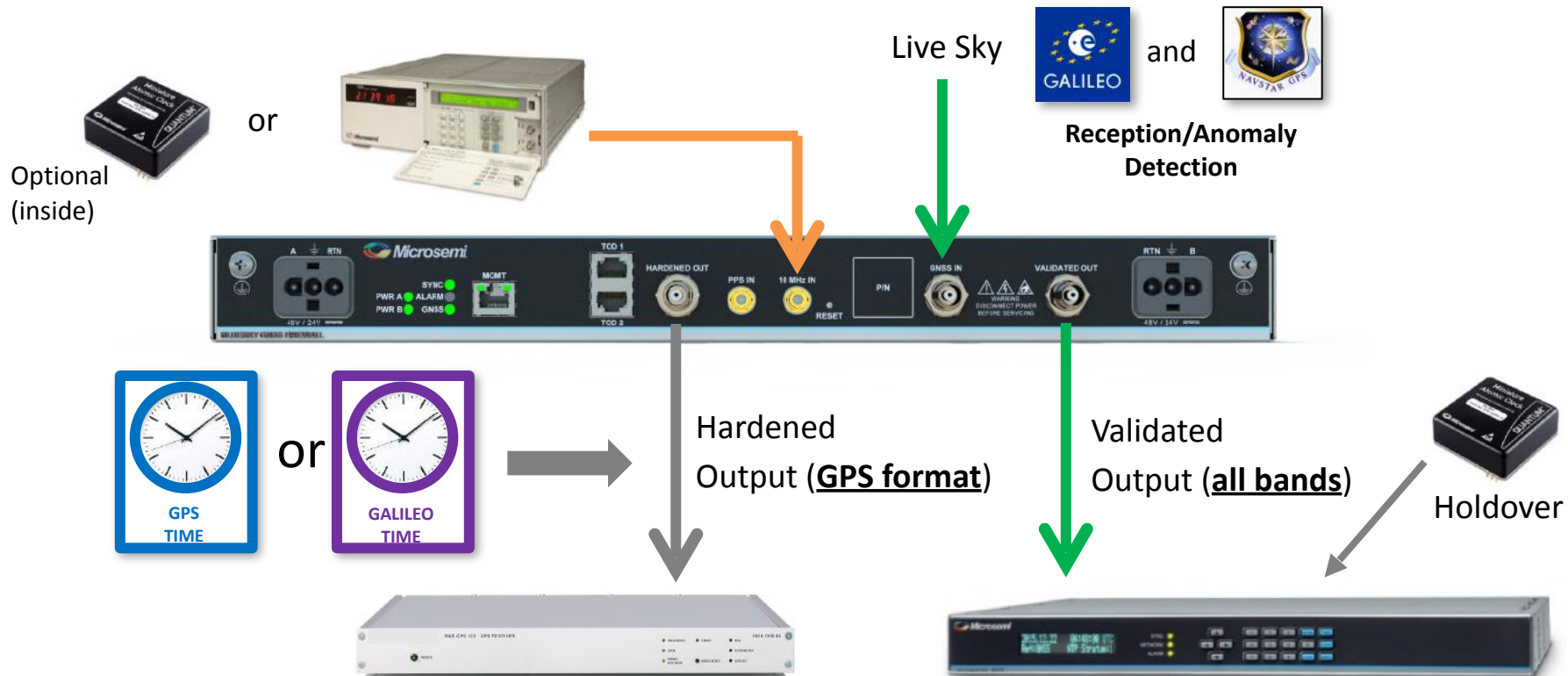
Holdover

Reliability

- Redundancy/Resiliency

- Network architectures that support multi-node virtual PRTC (vPRTC) technology

- PTP (multi profile) and NTP support
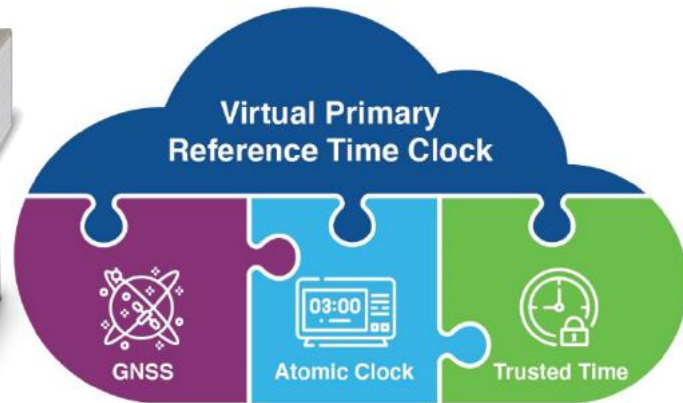
ePRTC

- Uses a steered Caesium for much better holdover

- Much smarter GNSS interference monitoring

- 30ns to UTC while locked

- Up to 100ns in holdover for 14 days

Time error Δx (t)
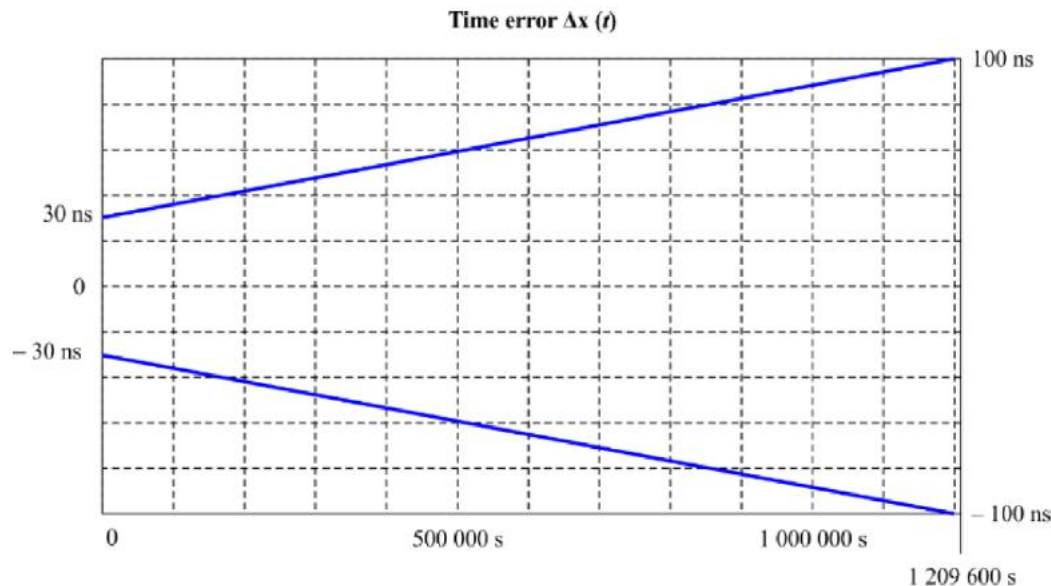
HP-BC

- G.8273.2 tried to cater for all applications of boundary clocks
- Different metrics used to classify different types
- Headline for class D is 5ns using filtered averaged Max TE
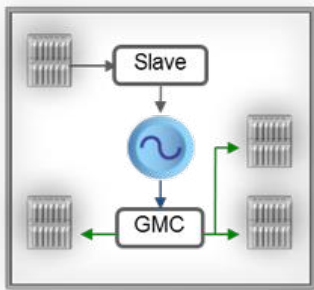
Boundary Clock

Parameter	Conditions	Class A	Class B	Class C	Class D
Max |TE|	Unfiltered, 1000s	100ns	70ns	30ns	-
Max|TE_L|	0.1Hz low-pass filter,1000s	-	-	-	5ns
cTE	Averaged over 1000s	50ns	20ns	10ns	-
dTE_L MTIE	0.1Hz low-pass filter, Const. temp, 1000s	40ns	40ns	10ns	-
	0.1Hz low-pass filter, Var. temp, 10000s	40ns	40ns	-	-
dTE_L TDEV	0.1Hz low-pass filter, Const. temp, 1000s	4ns	4ns	2ns	-
dTE_H	0.1Hz high-pass filter, Const. temp, 1000s	70ns	70ns	-	-

"Virtual PRTC" - vPRTC
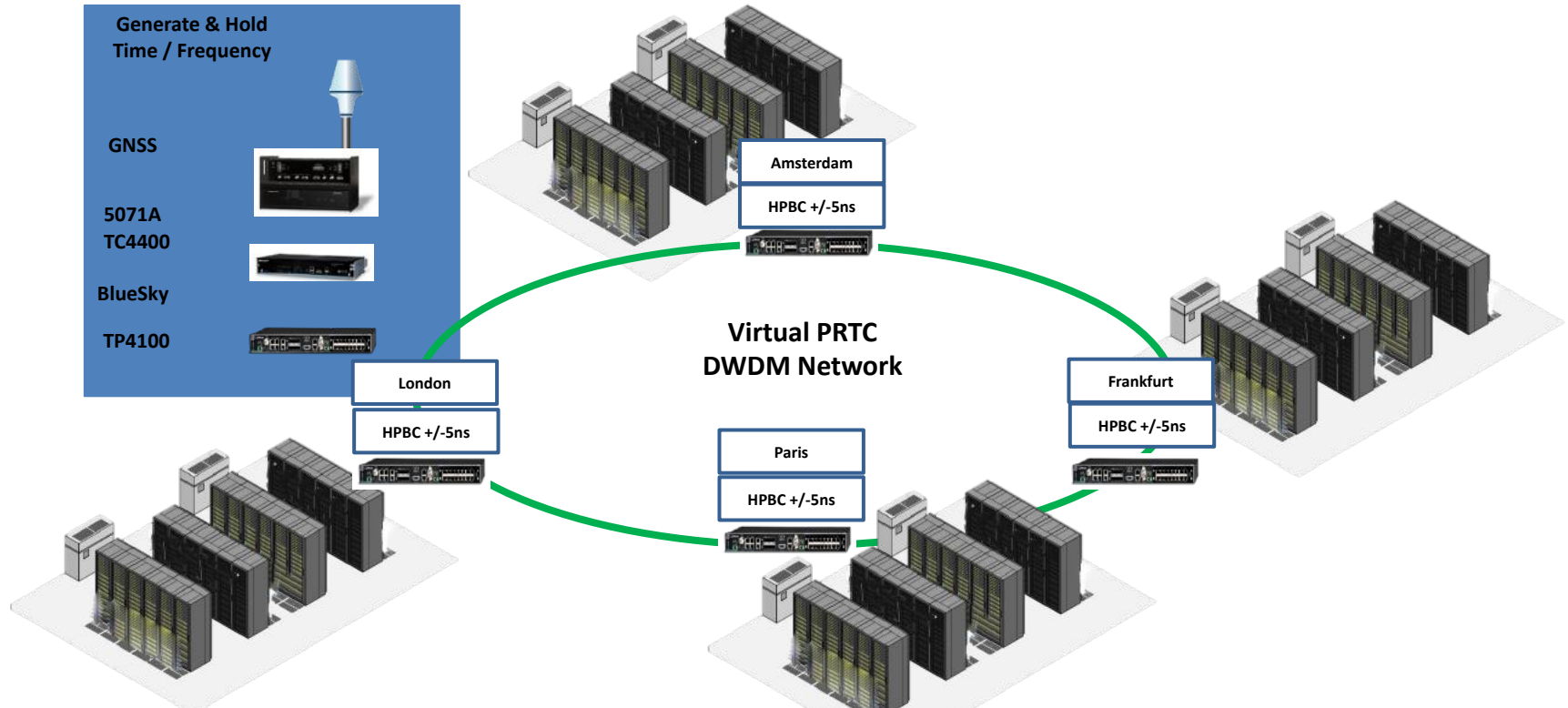
Solutions for Data Center Timing

Single server – whole data center – complete region

Secure Time Traceability

- BlueSky™ GNSS Firewall Hardware or Software

Time Resiliency

- Atomic Clocks

Time Distribution

- **SyncServer and Grandmasters**

TP4100

S600

But h... s

Screenshot 1 (08:54):

EUROPE

Examples include time over fiber, enhanced long-range navigation (eLORAN), and broader use of low Earth orbit (LEO) satellite net-works, along with the use of inertial or dead-reckoning technology for dynamic platforms. All of these solutions offer improved resilience or robustness when implemented properly.

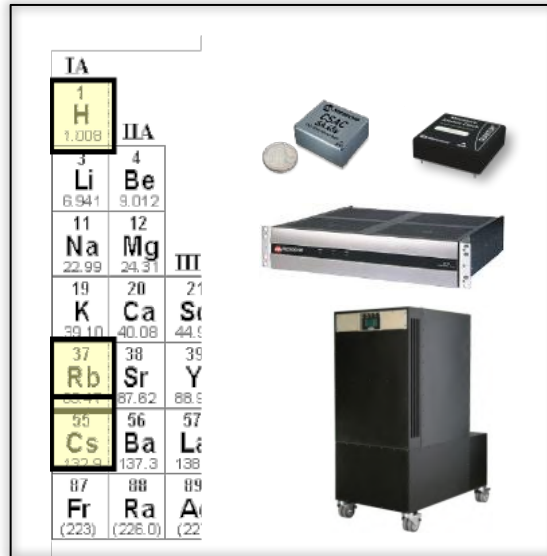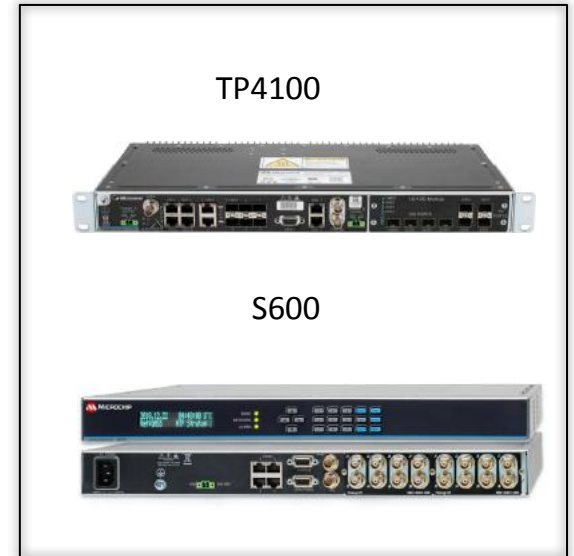Improving the resilience of our GNSS-dependent infrastructure is no longer optional; the rising incidence of real-world threats makes it essential. Improving GNSS resilience and solving dependencies based on quantifiable evidence will help ensure a safer world driven by precise and reliable use of PNT services.

This is not an unsolvable problem. We just need to act.

This article originally appeared on EE Times.

Read also:

Screenshot 2 (08:42):

EETimes EUROPE

Opinion

Need for Resilient PNT Has Never Been Greater

🕐 August 18, 2021   Guy Buesnel

Users of GNSS positioning, navigation and timing data must now deal with a growing spectrum of threats to their systems.

Share this:

Real-world instances of Global Navigation Satellite System (GNSS) jamming and spoofing have been steadily increasing in recent years. High-profile incidents include spoofing attacks on hundreds of commercial ships in the Black Sea and repeated GNSS jamming affecting commercial aviation in Norway.
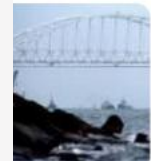
Background (Google search "gps spoofing reports"):

Google

gps spoofing reports

About 793,000 results (0.4...

Spoofing, is an intelligent false location. During a s... signals into the target re... make a smartphone belie...

https://www.septentrio.com
What is GPS Spoofi...

https://www.linkedin.com
Thousands of GNSS...
2 Dec 2020 — Aviation ass... disruption in 2019, an all-tim... Mediterranean, likely due to... and elsewhere in the region

https://safety4sea.com
Understanding GPS
31 Jan 20... — Concerning... contacte... the US Coast Gu...

https://www.c...line.com
What is GPS spo...
7 May 2019 — Instead of sl... were in Buckingham, Engla...

https://www.cs.ox.ac.uk
On the Requirement...
by NO Tippenhauer · Cited... interfer- ence with the civilia... practical spoofing ...

People also ask

chronos TECHNOLOGY
...poofing ...cale
...is spoofing ...sian-linked
...e Russian ...News
...ssian GPS ...Putin has a
...ep ...port says

Summary

- Requirements to deploy precise, traceable time are increasing
- Security of time systems is paramount
- Auditing & Testing of time systems is a must

- Use GNSS firewalls & vPRTCs to bring time under your own control and into your whole network

- The SMART Data Centre offering should be...

Virtual Primary
Reference Time Clock

GNSS   Atomic Clock   Trusted Time
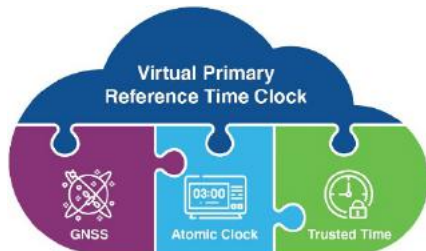
Space, Power, Cooling AND TIME

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