



## Digitale onderstations: leer & ervaar!



11 april 2024

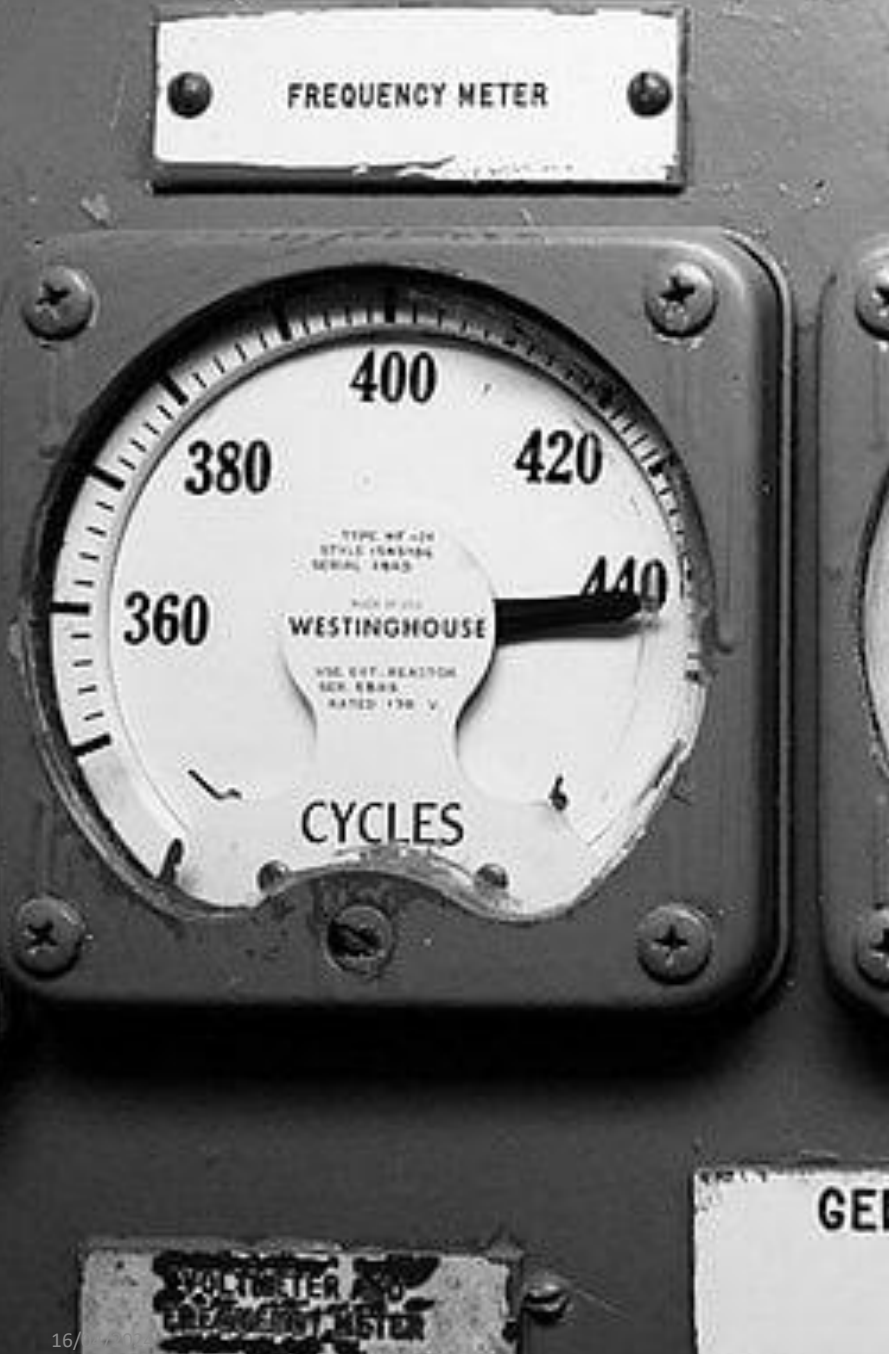
Hoe digitalisering de energietransitie versnelt | CIGRE B5 & D2

# Zero by Design - secure, resilient & traceable time

Christian Farrow B.Sc.(Hons) MIET MInstP

11/04/2024





14:35 4G LTE1 74%

← ↻ ☆ ⋮

English

I'm so sorry. I don't speak Dutch.

🔊 📄

Dutch

Het spijt me zeer. Ik spreek geen Nederlands.

🔊 📄 🗨️

+ New translation

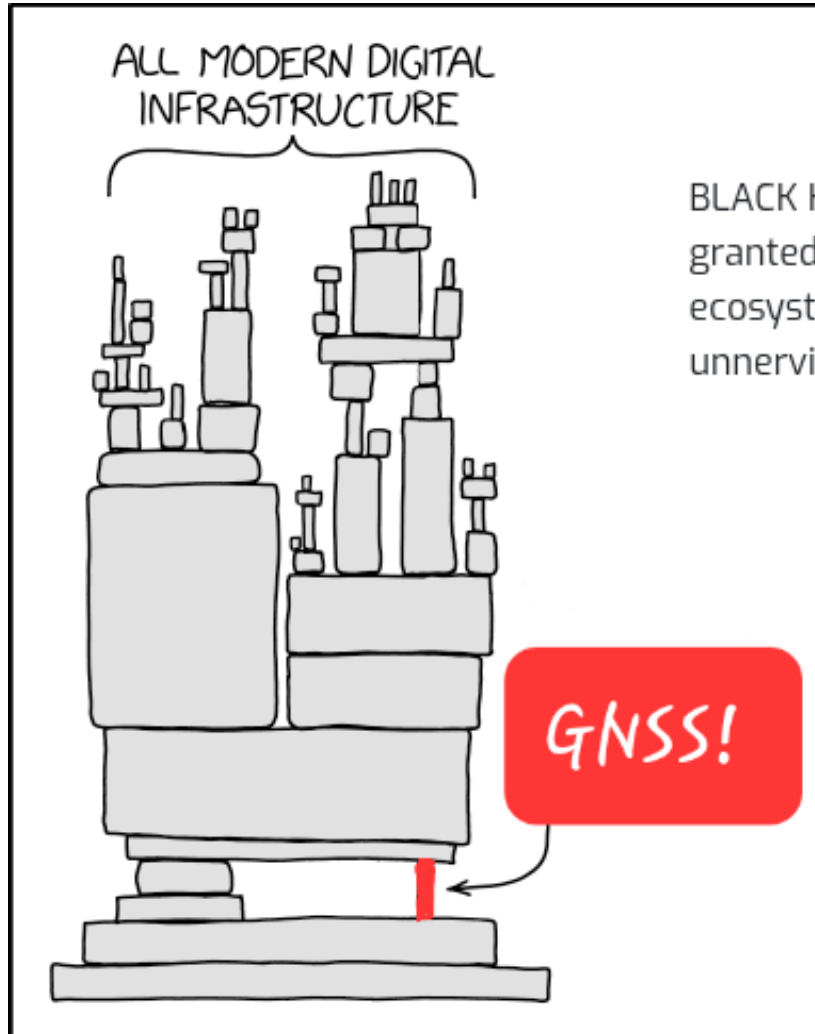


# Time underpins everything...

- Distributed Sensor Networks
  - Voltage, Current  
(and derivatives - Power etc.)  
Phase Angle, Temp, Battery SoC
- IT/OT Networks
  - NTP/PTP reference clocks  
Time-stamping of events
- GNSS clocks everywhere
  - *"Its biggest strength is its biggest weakness"*  
Phenomenal uptime, global availability



# Dependency



- With apologies to Randall Munroe <https://imgs.xkcd.com/comics/dependency.png>

## What Happens If Time Gets Hacked

Renowned hardware security expert raises alarm on the risk and dangers of cyberattackers targeting the current time-synchronization infrastructure.



**Kelly Jackson Higgins**  
Editor-in-Chief, Dark Reading

November 11, 2021

BLACK HAT EUROPE 2021 - London - Most people take time synchronization for granted, but it operates on what hardware security expert Adam Laurie calls a "fragile ecosystem." Laurie, a renowned hardware hacker, here today demonstrated an unnervingly simple way to alter time on a clock.



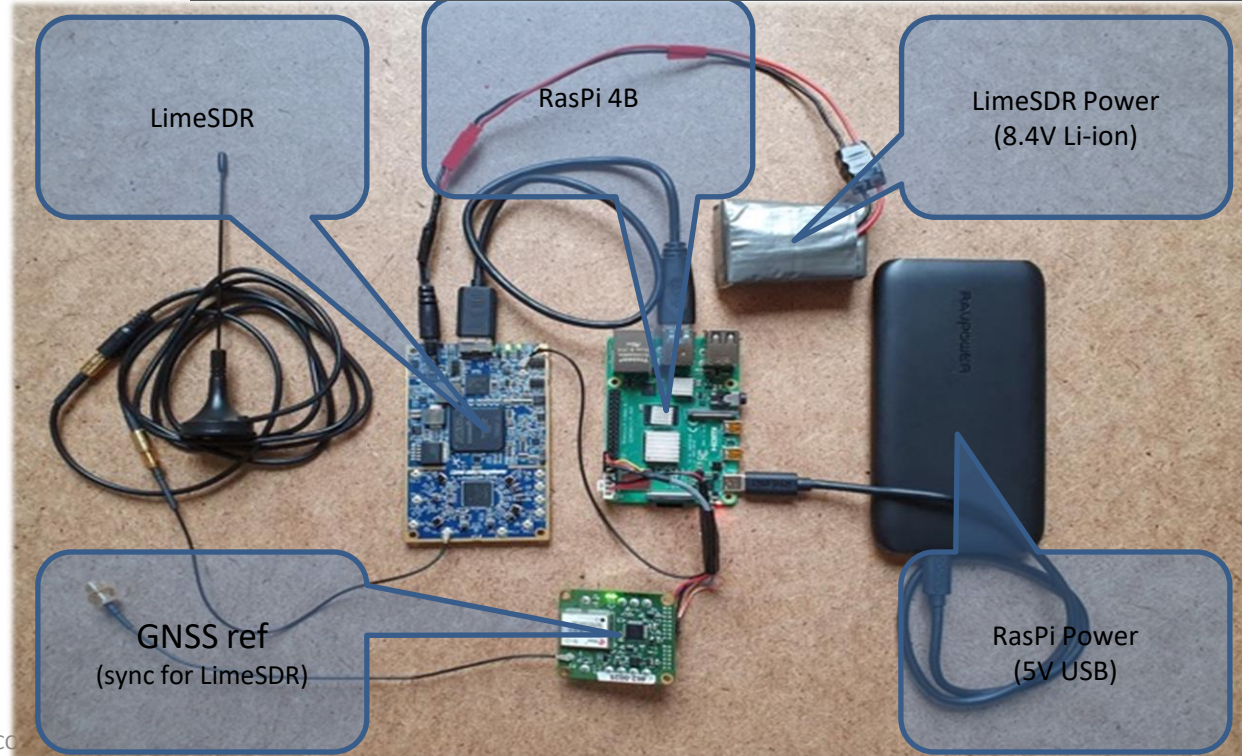
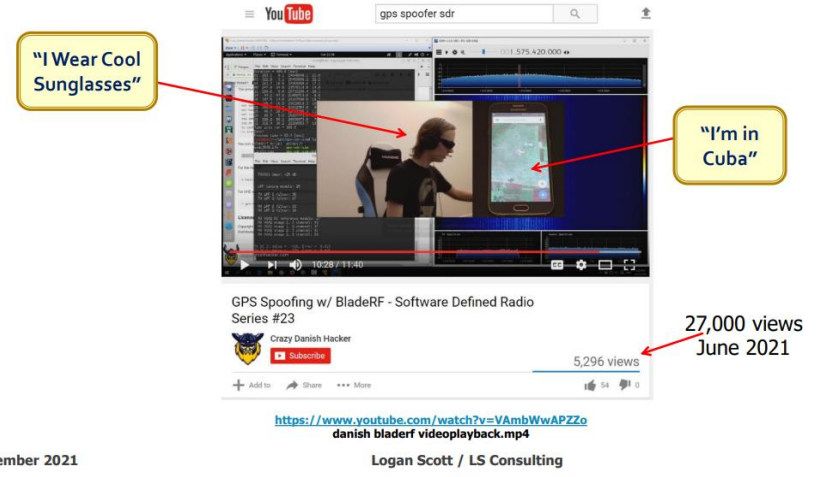
Adam Laurie's time-hacking demo at Black Hat Europe.



BLACK HAT EUROPE 2021 - London - Most people take time synchronization for granted, but it operates on what hardware security expert Adam Laurie calls a "fragile ecosystem." Laurie, a renowned hardware hacker, here today demonstrated an unnervingly simple way to alter time on a clock.

# Cyber Security for Time

- Not just threats from the network... GNSS RF signal inherently vulnerable
- Jamming (DoS) - Spoofing (MITM)
- Space-based attacks, Space Weather



# Cyber Security for Time

- Not just threats from the network... GNSS RF signal inherently vulnerable
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- Space-based attacks, Space Weather



LimeSDR

GNSS ref (sync for LimeS



12:06 4G

FCC investigates Amaz...



Source: Various on-line sellers

## FCC investigates Amazon over alleged marketing of wireless signal jammers - NBC



Dana A. Goward

President, Resilient Navigation & Timing Foundation; Proprietor, Maritime Governance, LLC

March 25, 2024

**What's New:** The Federal Communications Commission (FCC) says it is taking action to enforce the law against marketing, selling, and using wireless jammers, including those that target GPS/GNSS. While reports do not mention anything about spoofing, it is against the law also

"I'm in Cuba"

27,000 views  
June 2021

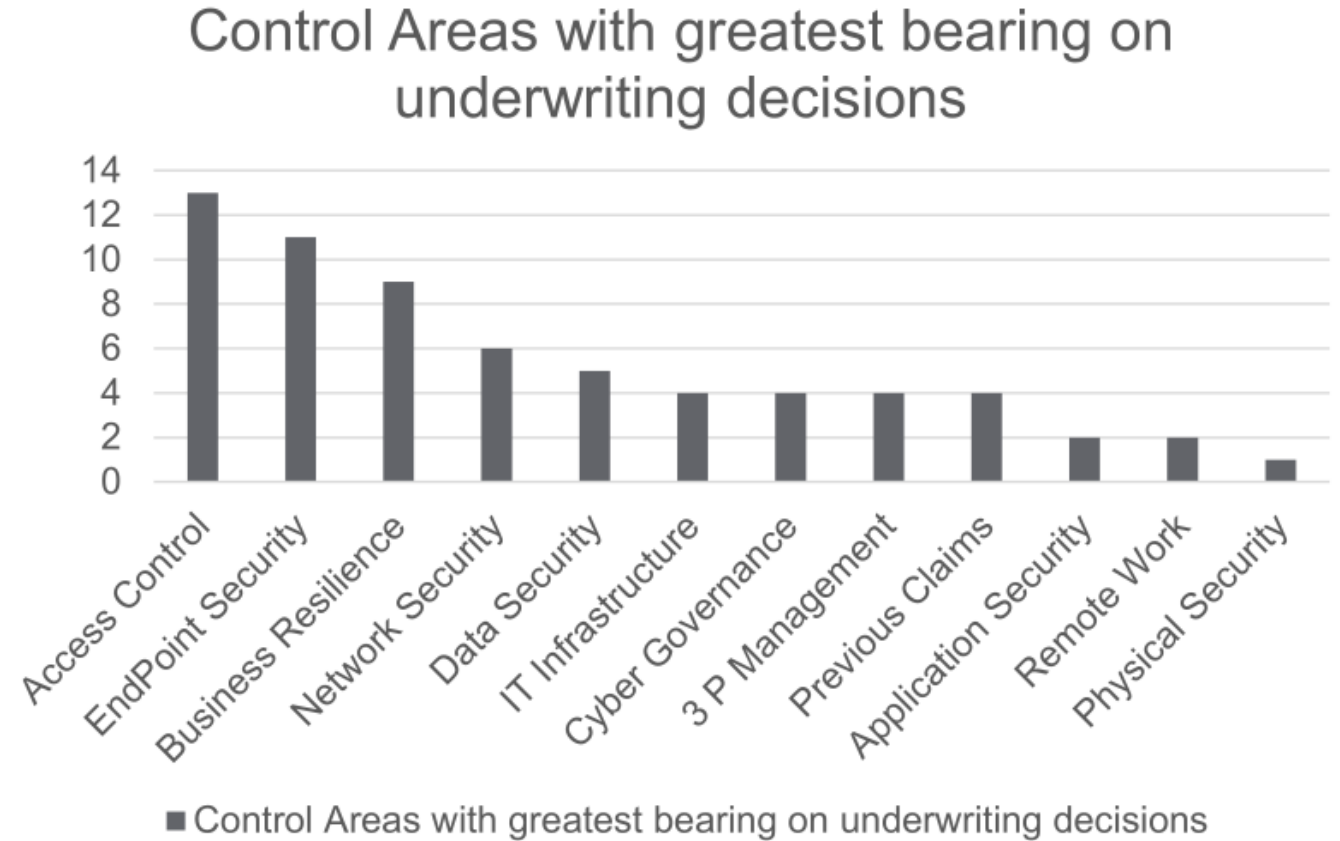
LimeSDR Power (8.4V Li-ion)

RasPi Power (5V USB)

# AON 2023 report

- "Access Control"

Insurers closing their books for cyber-insurance!



2021-22 was the worst year ever for Losses, with the books virtually closing to new policies towards the end of 2022..Source AON 2023

## Cyber Threat Intelligence Services

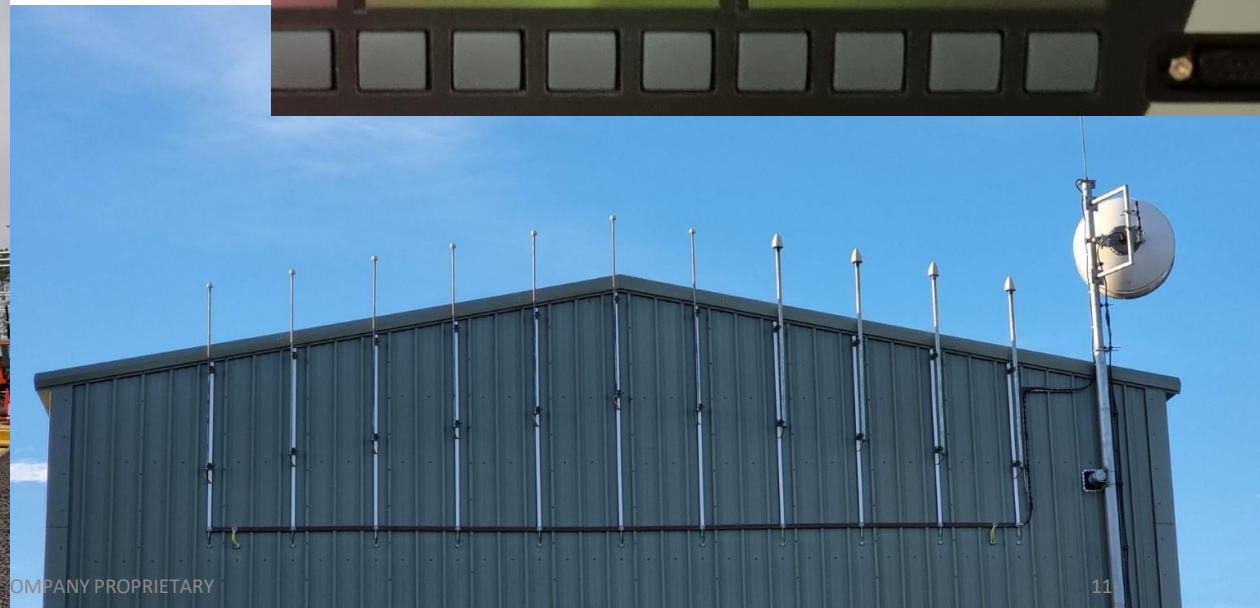
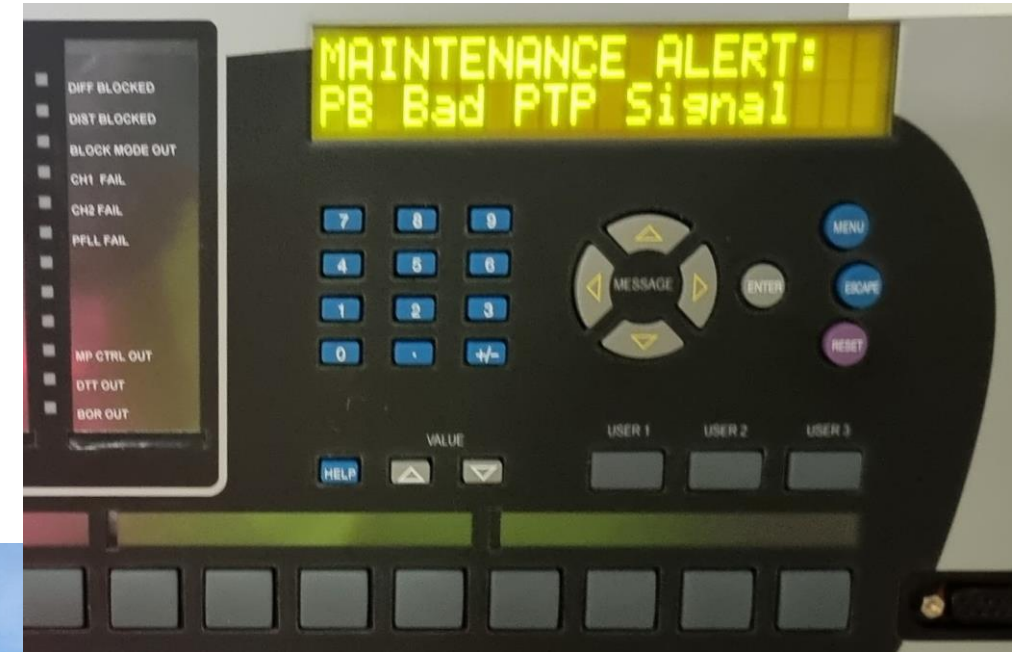
### What is Cyber Threat Intelligence?

Cyber Threat Intelligence helps identify online threats and business risks to individuals and organizations. We tailor our Cyber Threat Intelligence engagement to your organization's needs, leveraging tactical and strategic intelligence and turning

Credit: AON 2023 report:  
<https://www.aon.com/2023-cyber-resilience-report/>

# Case Study: GNSS Antenna Proliferation

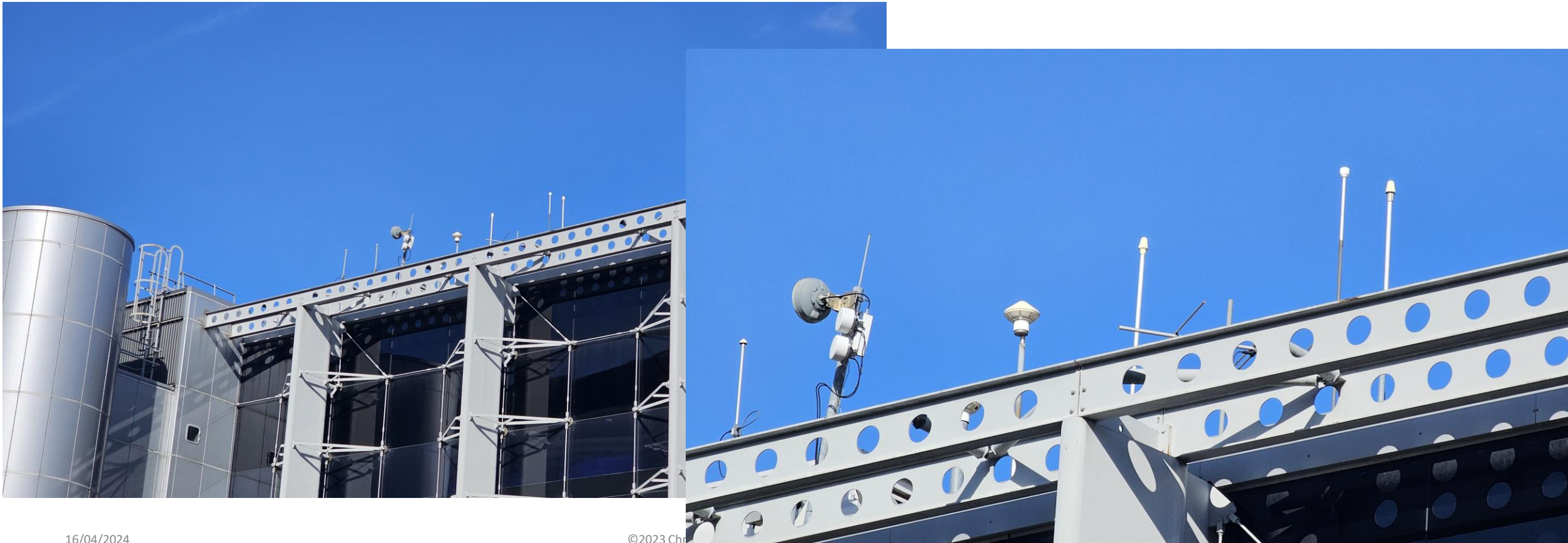
- "Digital Substation"
  - GNSS proliferation driven by
    - Redundancy, "rack-based" functionality
    - Incompatible PTP profile or lack of support - *C37-238-2011 or -2017 or 61850-9-3 or (S)NTP*





# Data-centre antennas (proliferation?)

- Cloud compute (+ some flavours of edge compute also?)  
*"It's secure, it's in the cloud" - there's no such thing!*



# Resilient Timing: Best Practices

- Own your own timescale
- Trust no one
- Test Everything



# Resilient Timing: Best Practices

- Own your own timescale
  - Bring some trusted sources/autonomy in-house
- Trust no one
  - Be careful accepting timing from outside sources
- Test Everything
  - Test & Monitor permanently

"Zero Trust"  
&  
"Secure by Design"

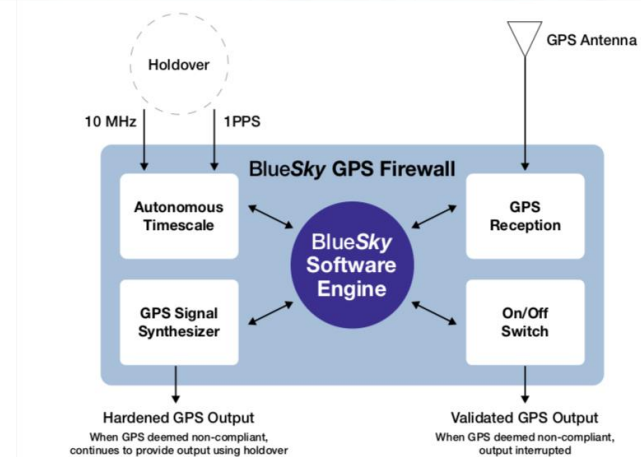
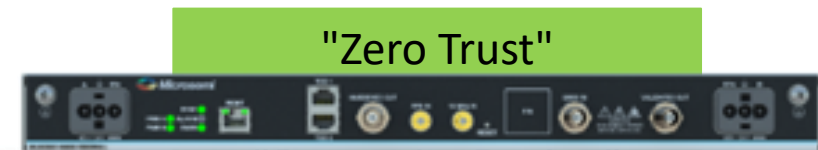
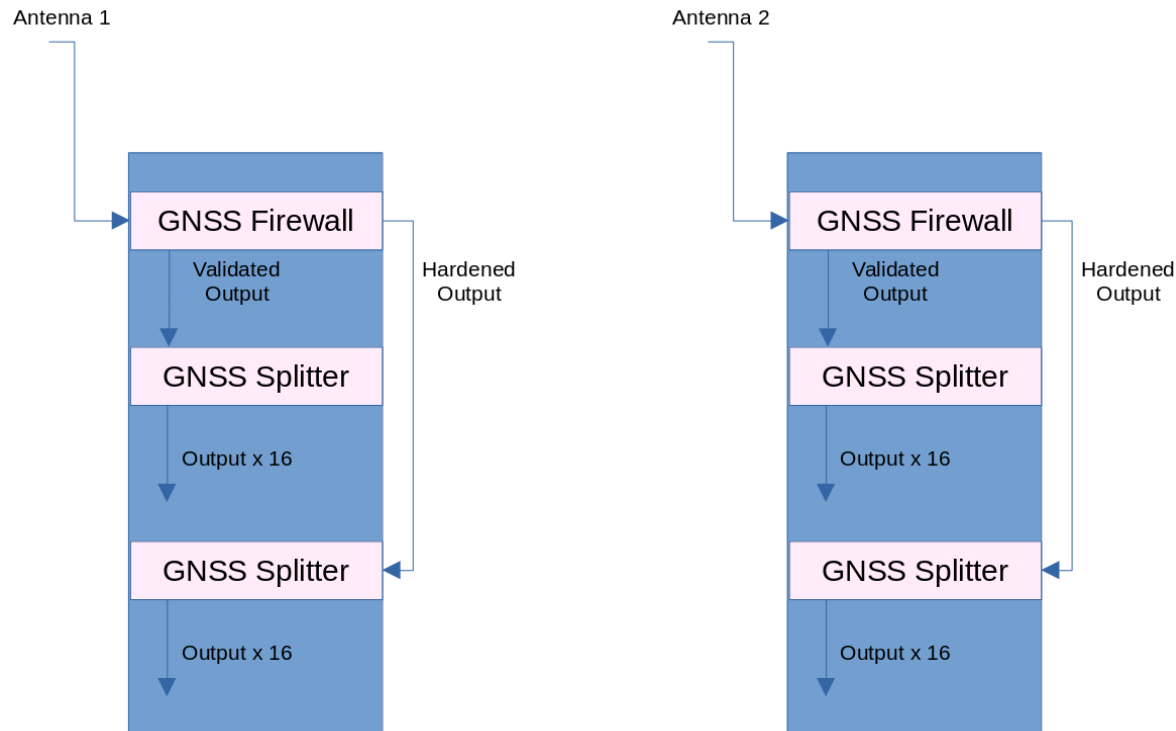


ISO/IEC 27001 and 27002  
ISO/IEC 15408  
IEC 62443  
ISO/SAE 21434  
ETSI EN 303 645  
NERC/NIST CSF/Cyber Essentials



# Case Study: GNSS antenna nonproliferation (!)

- Single antenna (x 2) (*GNSS over fibre?*)  
GNSS Firewall + GNSS signal distribution inside building –  
splitter output drives existing system(s) directly



# Evolution of ITU reference clocks

- Initially Frequency only (Plesiochronous International Digital Links!) -  $1 \times 10^{-11}$
- Later Frequency + (Traceable) Time/Phase - 100ns or 30ns error to UTC
- Better (x10) frequency -  $1 \times 10^{-12}$
- Frequency + Time/Phase + "**tuned holdover**" - <100ns error to UTC for 14 days (>40 days under study)
- GNSS independence "Coherent Network" - (inter)national lab style, geographically distributed architecture

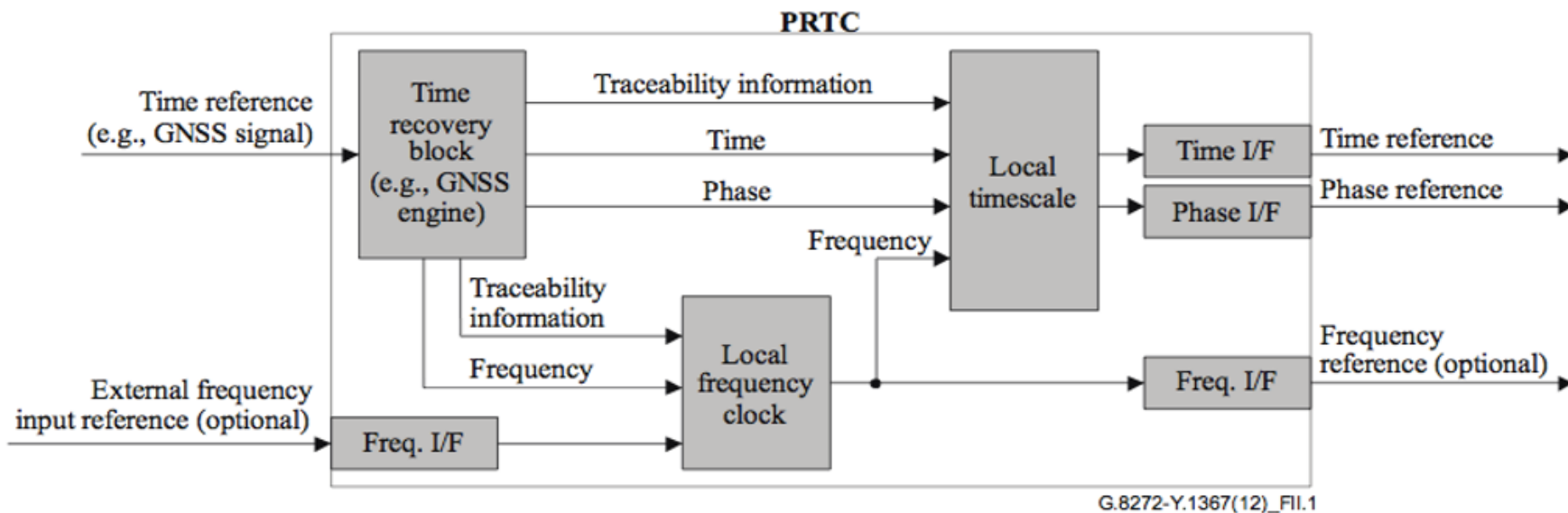


Figure II.1 – PRTC functional model

# Evolution of ITU reference clocks

The image shows a screenshot of the ITU website. At the top, the ITU logo is on the left, and the tagline "Committed to connecting the world" is in the center. On the right, the "Sustainable Development Goals" logo is visible. Below the header, a navigation bar includes "About ITU", "Radiocommunication", "Standardization", and "Development". A secondary navigation bar lists "Events", "Publications", "Membership", and "News". The main content area features a large digital clock graphic with green numbers on a dark background. A white article preview box is overlaid on the clock, containing the title "New ITU clock concept for more resilient synchronization networks", the date "13 Mar 2024", and a brief description of GNSS systems. To the right of the article, there is a "Subscribe to our newsletter" form with an email input field and a reCAPTCHA widget. The bottom of the page shows a date "10/07/2024" and a URL fragment "G.8200-G.8299: Synchronization, quality and availability targets". On the far right, a vertical sidebar contains a "Join ITU" button, a search icon, a user profile icon, a "SHARE" button, and a language selector with "Русский" selected.

**ITU** Committed to connecting the world

SUSTAINABLE DEVELOPMENT GOALS

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The UN specialized agency for ICTs Events Publications Membership News

Home > News > New ITU clock concept for more resilient synchronization networks

## New ITU clock concept for more resilient synchronization networks

News · 13 Mar 2024

ITU News

Global navigation satellite systems (GNSS) provide precise timing for synchronization networks that are critical to mobile telecoms and data centres, power supply and smart grids, railway and road transport, and security and public safety.

Long disruptions to GNSS could be catastrophic without solutions to maintain precise timing. These solutions are provided by ITU standards, assuring network operators and regulators that precise time will keep ticking.

Common causes of GNSS disruptions:

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10/07/2024

G.8200-G.8299: Synchronization, quality and availability targets

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SHARE

Русский

# Evolution of ITU reference clocks

Clock Type	ITU-T Recommendation	Date
PRC – Primary Reference Clock	G.811	1976 – CCITT Orange Book
PRTC - Primary Reference Time Clock	G.8272	2012
ePRTC – Enhanced Primary Reference Time Clock	G.8272.1	2016
ePRC – Enhanced Primary Reference Clock	G.811.1	2017
cnPRTC – Coherent Network Primary Reference Time Clock	G.8272.2	2024



PRC/ePRC - Frequency only, Caesium clock

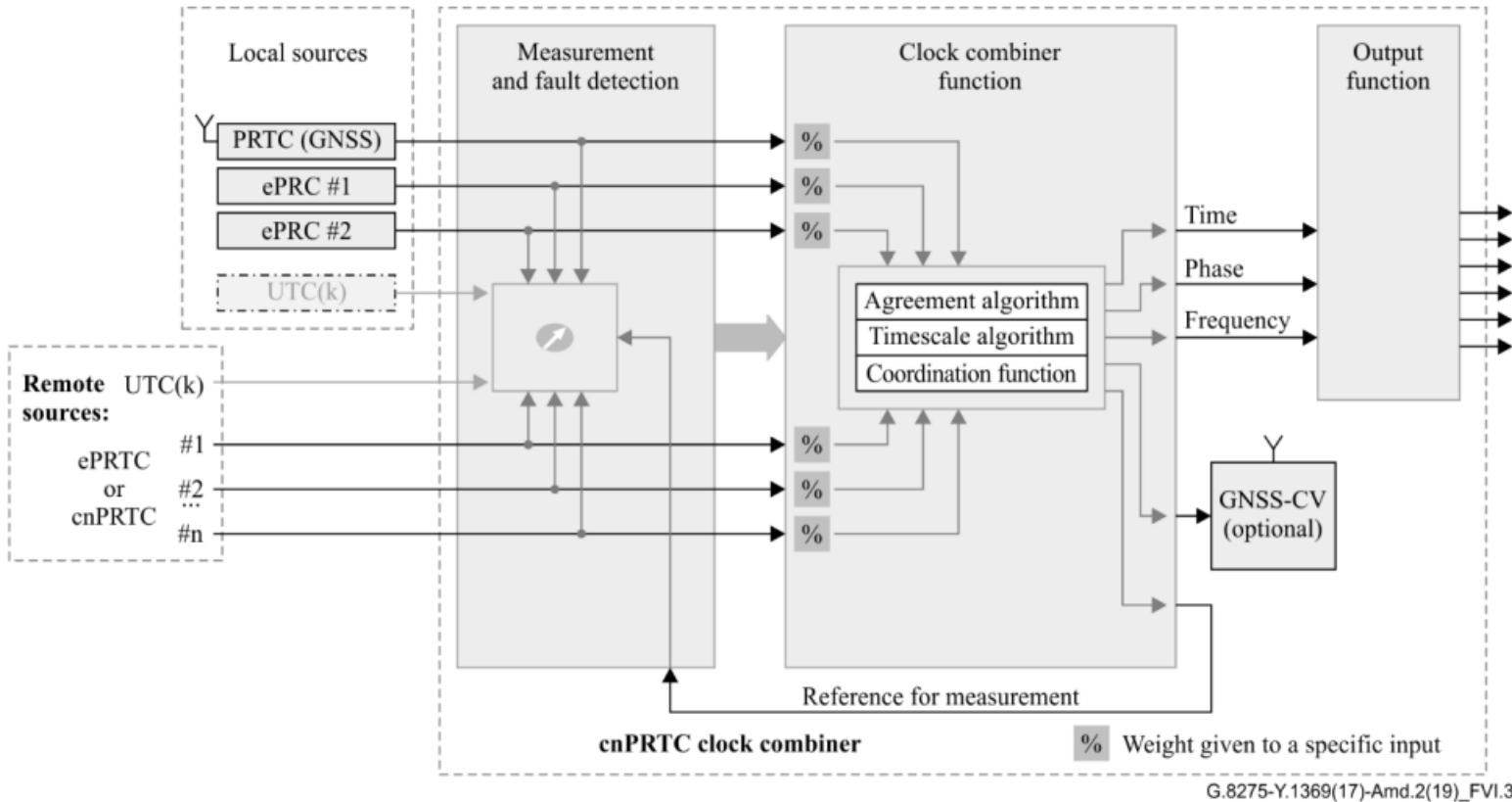
PRTC-A – single band GNSS

PRTC-B – multi-band GNSS (ionospheric delay compensation)

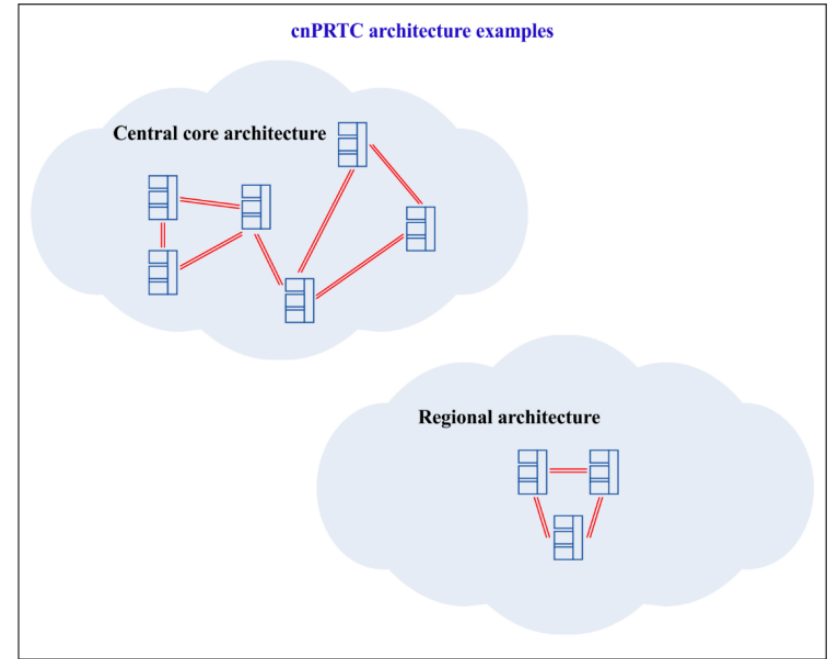
ePRTC – clock combiner GNSS + Caesium

cnPRTC – ePRTC with PRTC-B meshed at the network layer

# cnPRTC



**Figure VI.3 – Coherent network PRTC functional block diagram**

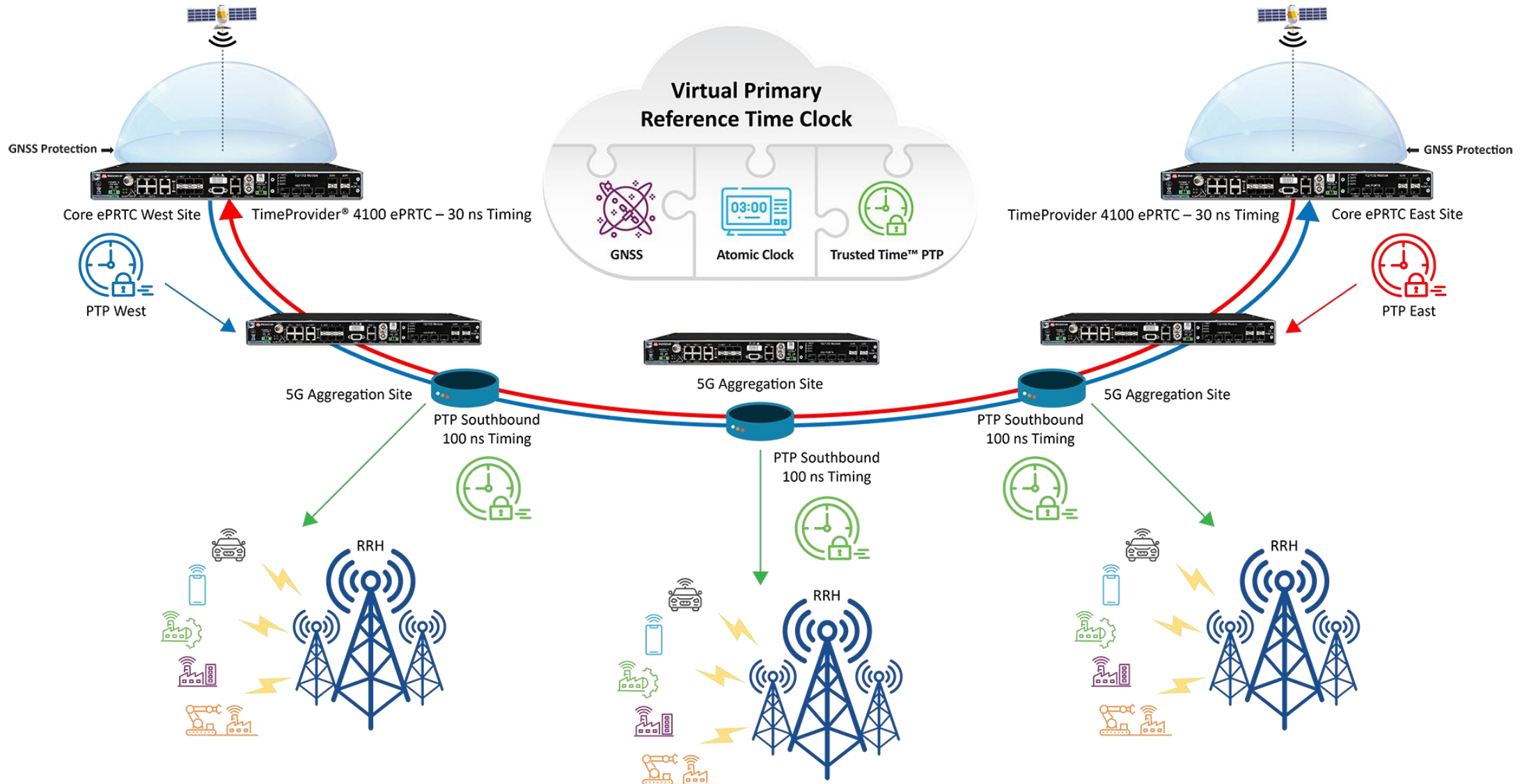


**Figure VI.1 – Coherent network PRTC architecture examples**

"Resilient Primary Clock concepts acc. to ITU-T with measurement results", Helmut Imlau, ITSF 2022, Düsseldorf

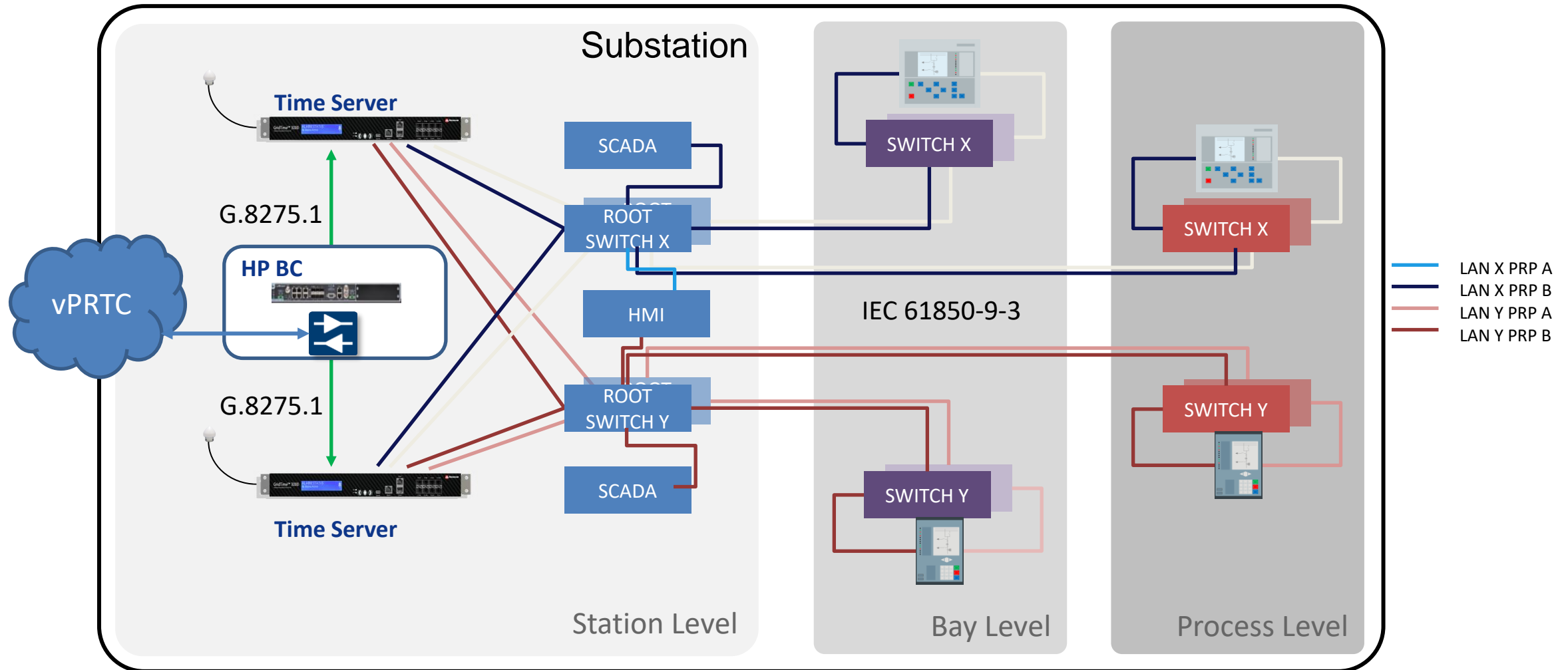


# "The Network is The Clock" - vPRTC



# "The Network is The Clock" – vPRTC to substation

Digital Substation Clock PTP Utility/ Power Profile Output to SS IED  $\leq 1 \mu\text{s}$



# Utilise Telecom Network to provide *YourOwnTime*<sup>TM</sup>

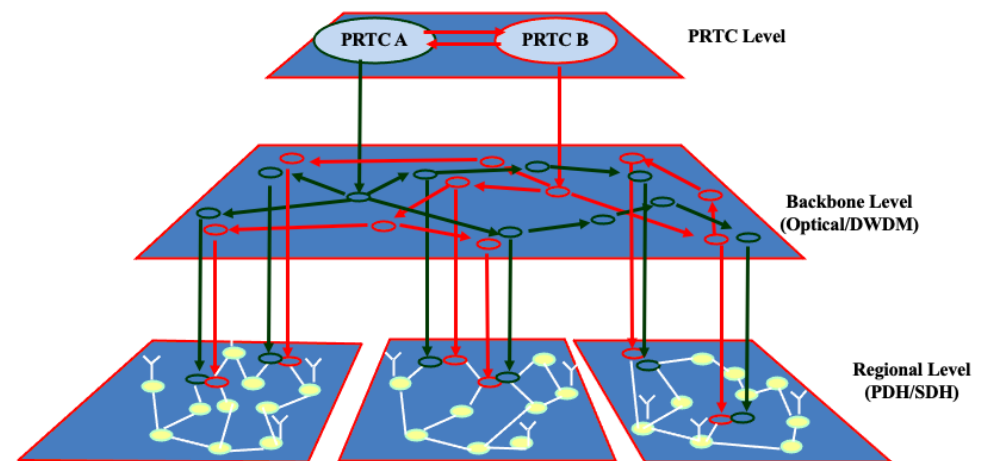
- New ePRTC clock specifications\* networked via dedicated fibre (DWDM/OTN etc.) & HP-BC can provide ~5ns of error to UTC across the whole network

\* ITU G.8272.1 - GNSS+Cs <100ns error to UTC 14 days

- Every substation that has Telecom optical network access can have access to *YourOwnTime*<sup>TM</sup>

- *YourOwnTime*<sup>TM</sup> can be primary or a backup to be used if GNSS interference is present

## Network Sync – Layered Model



# Resilient Time: Summary

"Zero Trust"  
&  
"Secure by Design"

- Resilience increasingly means security, availability & autonomy for time
- ITU-T vPRTC telecom network architectures can supply resilient & trusted time everywhere – if business silos can be overcome!
- "GNSS Firewall" features appearing in newer GNSS receivers – but don't forget the "legacy" installed base!



## Digitale onderstations: leer & ervaar!



11 april 2024

Hoe digitalisering de energietransitie versnelt | CIGRE B5 & D2

# Thank you for your attention

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