Achieving resilient and assured PNT in secure smart grids

Nino De Falcis, Sr Director, Sync Business Development Americas, Oscilloquartz

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NASPI North American SynchroPhasor Initiative

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Can your smart grid/substation timing survive the next cyberattack?

PNT* cyber threats are at an all-time high everywhere and are growing more sophisticated in tactics

*Positioning, Navigation & Timing. Timing is essential to enable P & N

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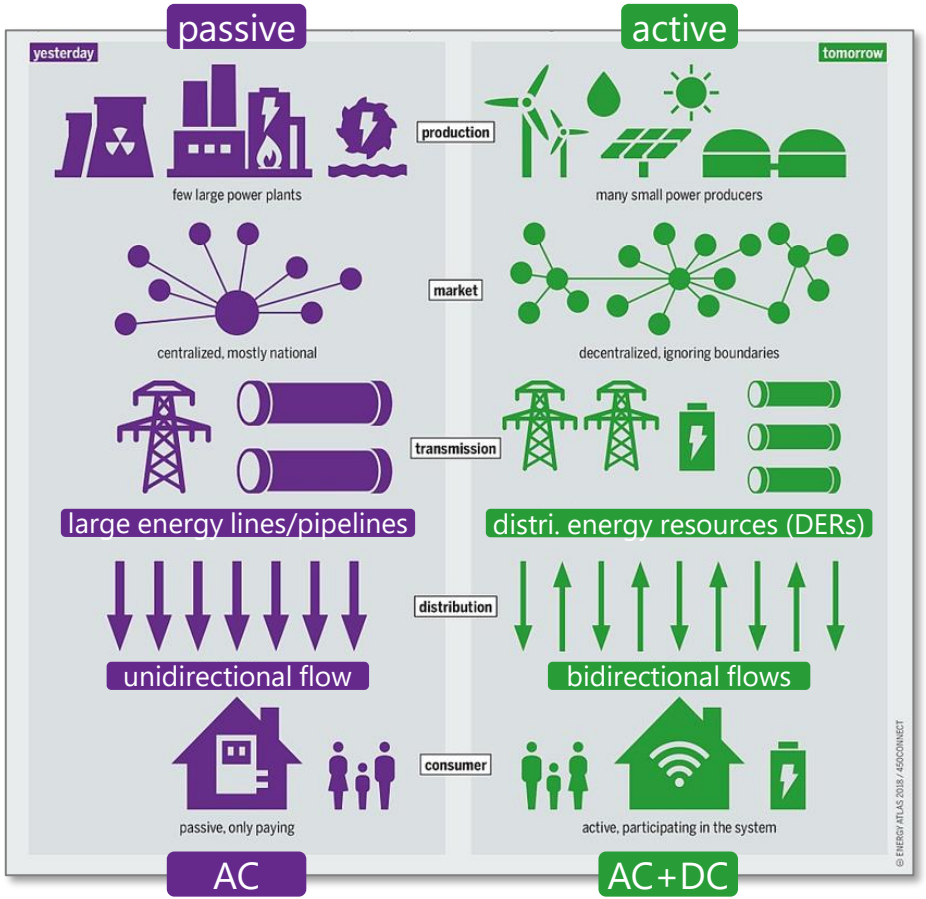
Tighter NTP-to-PTP data timestamping accuracy requirements



Grid applications	Timing requirements (min reporting resolution & accuracy relative to UTC)
Advanced time-of-use meters	15, 30, and 60 minute intervals are commonly specified (ANSI C12.1)
Non-TOU meters	Ongoing, with monthly reads or estimates
SCADA	Every 4-6 seconds reporting rate
Sequence of events recorder	50 µs to 2 ms
Digital fault recorder	50 µs to 1 ms
Protective relays	1 ms or better
Synchrophasor/phasor measurement unit (30 - 120 samples/second)	Better than 1 µs 30 to 120 Hz
Traveling wave fault location	100 ns
Micro-PMUs (sample at 512 samples/cycle)	Better than 1 µs
Substation communications protocols	
Substation local area network communication protocols (IEC 61850 GOOSE)	100 µs to 1 ms synchronization
Substation LANs (IEC 61850 Sample Values)	1 µs

source: NASPI Time Sync Task Force Report, 2017

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What is the resilient PNT?

Driven by US Federal Executive Order 13905 and UK & Euro Commissions

- **PNT** stands for **P**ositioning, **N**avigation & **T**iming, and Timing is essential to enable P & N
- **Protect** government/industry critical infrastructure against PNT disruptions from GPS/GNSS jamming/spoofing & other network timing cyberattacks

- **Deploy** resilient, self-survivable PNT systems thru assured PNT+ technology aPNT+™
- **Target** critical infrastructure under national security threats

Finance | Transportation | Communications | Data centers

- **Use** published resilient PNT guidelines &  standard in progress
  - DHS Resilient PNT Conformance Framework
  - NIST Cybersecurity Framework for PNT Profile NIST NISTIR 8323
  - IEEE P1952 Resilient PNT for User Equipment Standard working group IEEE SA P1952 PNT

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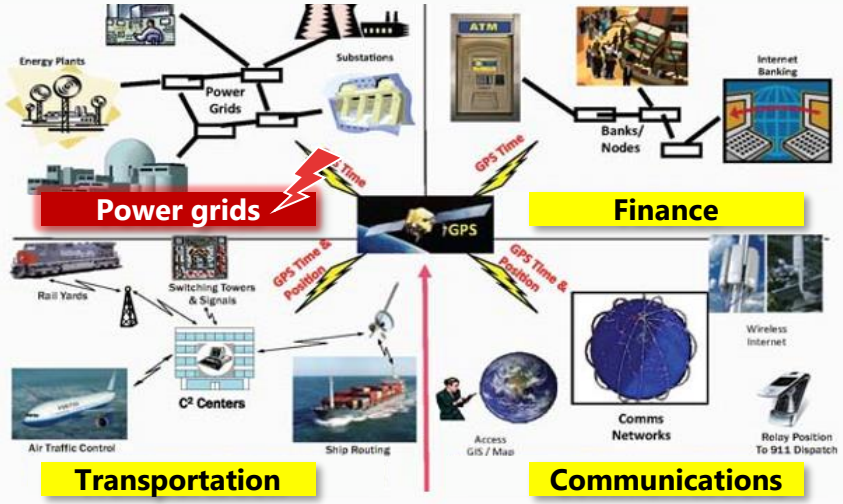
The problem in power grids

PNT
cyberthreats

$1B/day in economic cost if GPS/PNT is disrupted*

GPS & US critical infrastructure under national security threats



Homeland Security

All supported by

Data centers

*source: RTI & NIST 2019

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What are the PNT cyber threats & GNSS vulnerabilities?

PNT cyberthreats

External GPS/GNSS level

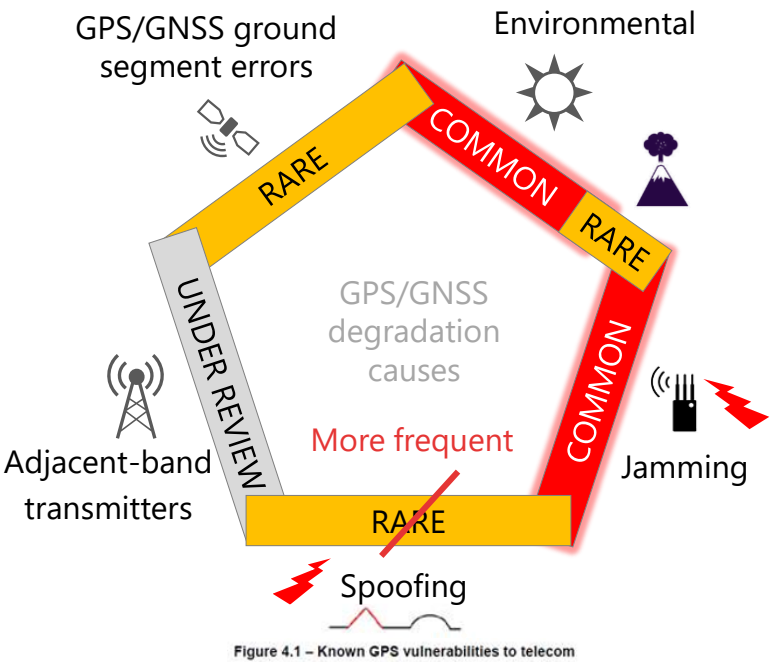
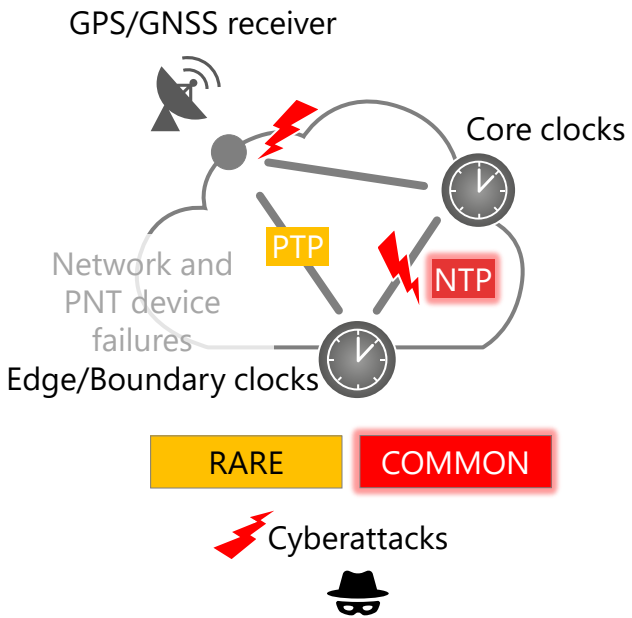


Figure 4.1 – Known GPS vulnerabilities to telecom

Internal network level

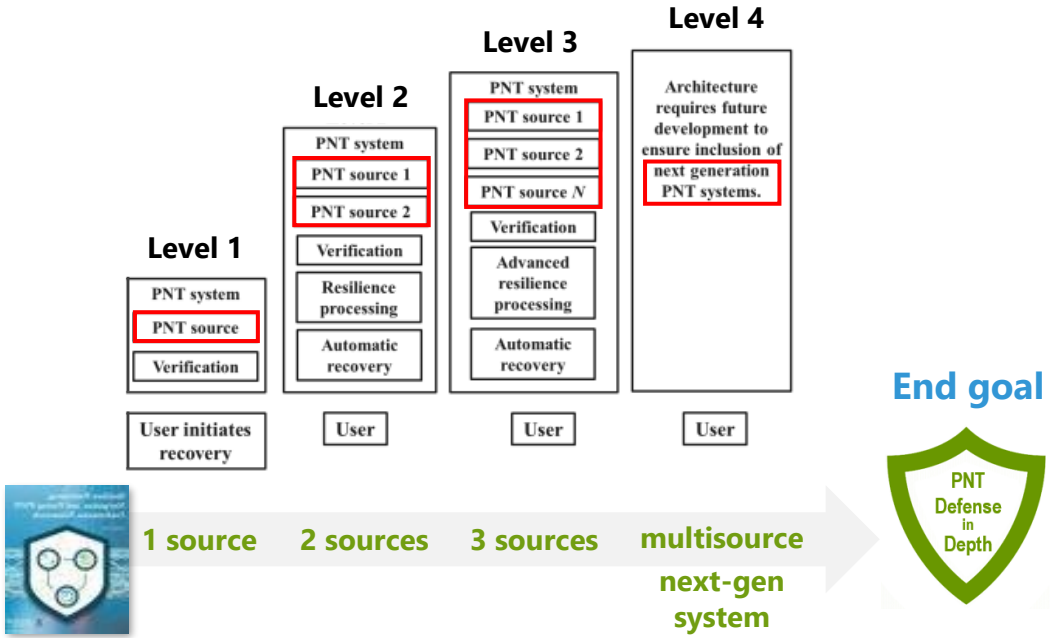


What are DHS Resilient PNT guidelines?

DHS Resilient PNT Conformance Framework

Core functions

PNT Resiliency levels



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Secure smart grid/substation timing components

powered with trusted aPNT+ (assured PNT+) technology

PNT cyberthreats

2 COMPONENTS

Telecom connectivity

Grid protection

*Time-as-a-Service + GPS/GNSS-Backup-as-as-Service

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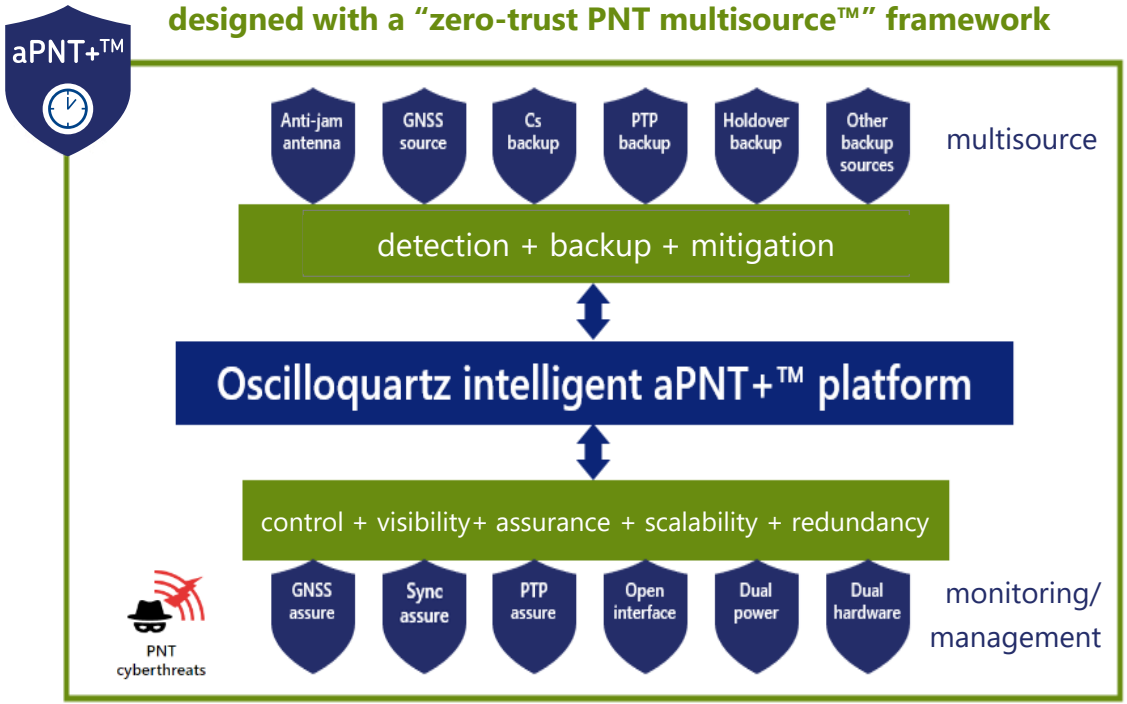
What's our trusted aPNT+ technology, & how does it work?



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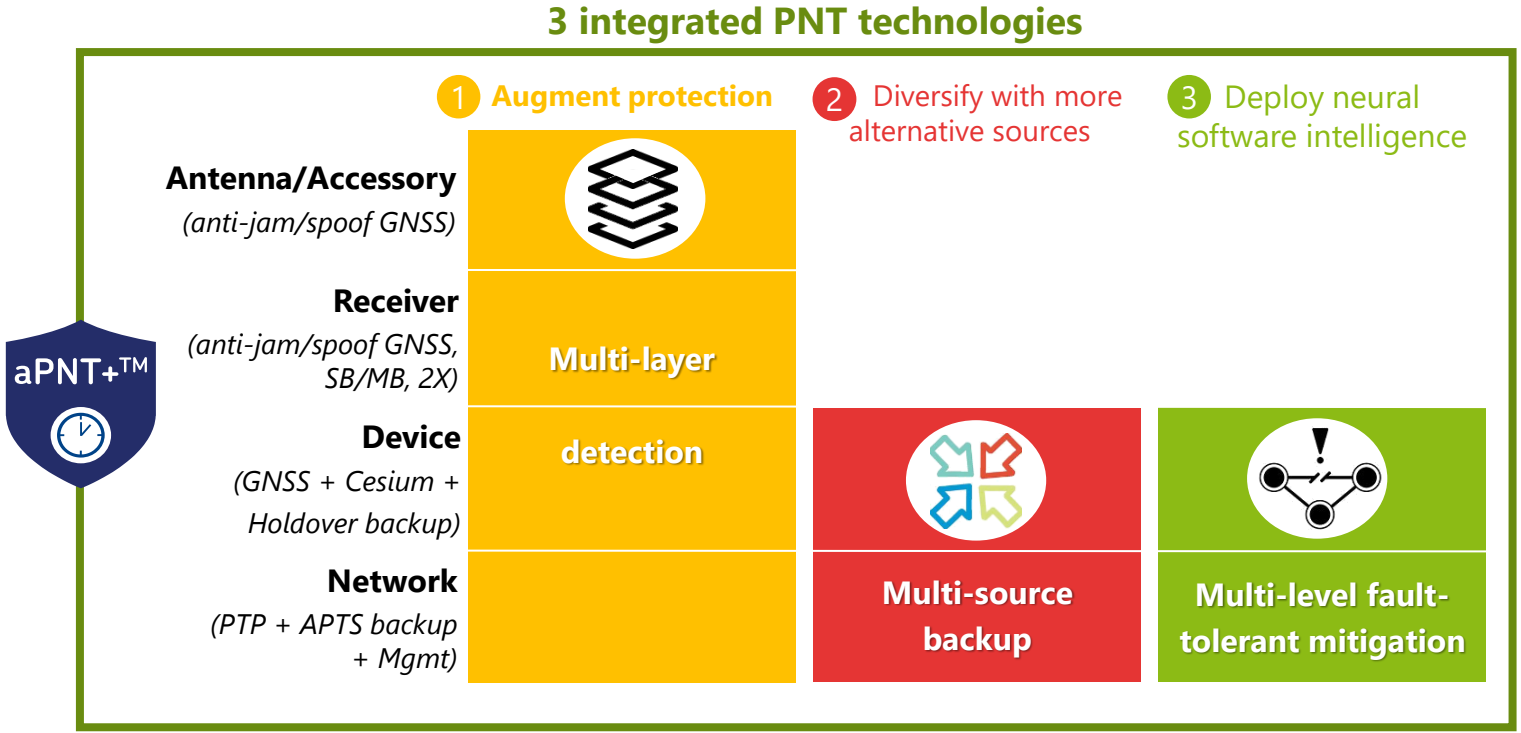
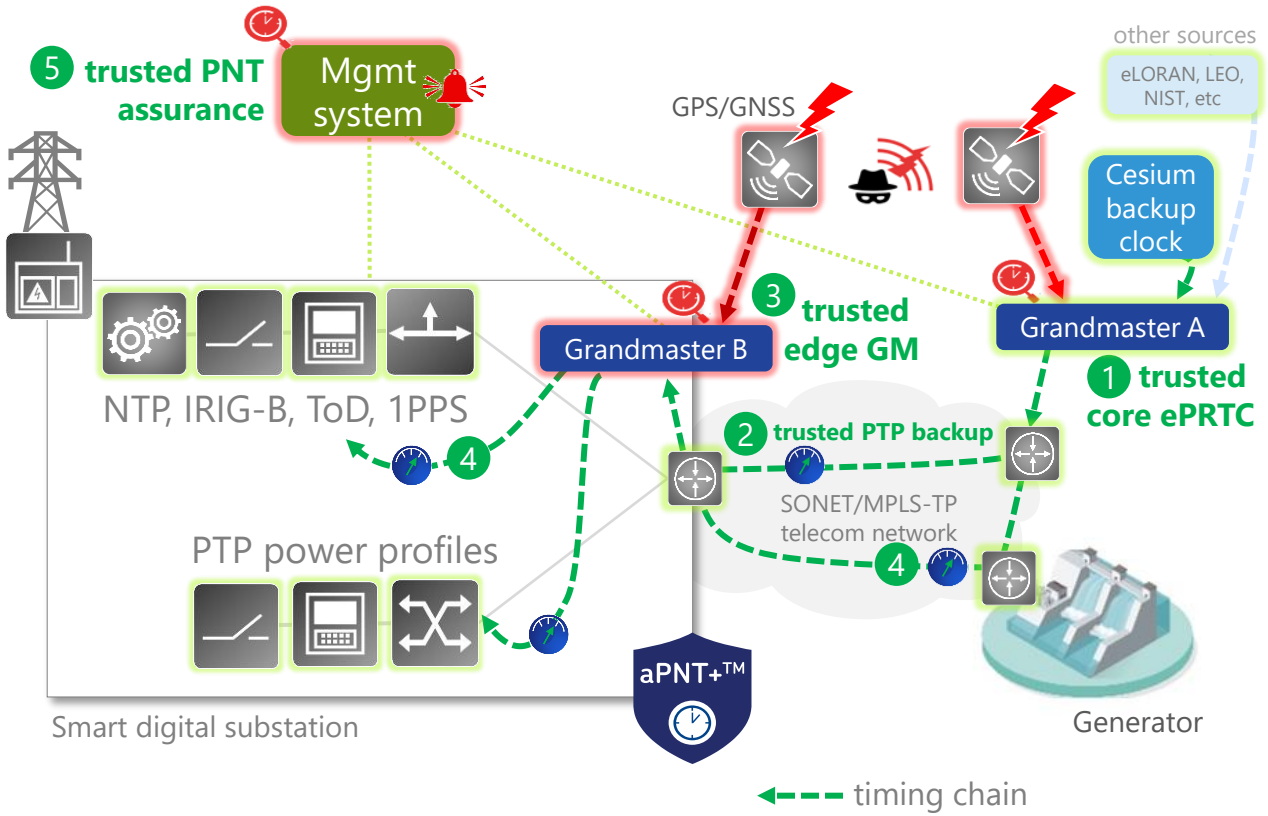
How does our “zero-trust PNT multisource” framework work?



Trusted timing architecture in core stations & substations



1 **trusted core ePRTC:*** GNSS PTP grandmaster + independent optical Cesium backup clock with trusted PTP-verified feeds

2 **trusted PTP backup:** PTP L2 telecom profile with full on-path support - all switches with PTP-aware BC (if not, PTP L3 profile with partial/no path support)

3 **trusted edge GM:** GNSS PTP grandmaster with trusted PTP backup

4 **trusted timing monitor:** integrated multisource monitor, with analytics to compare, verify & select a trusted source

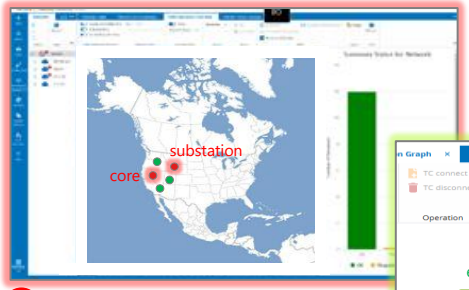
5 **trusted PNT assurance:** neural mgmt system for self-survivability, end-to-end control, visibility & trusted PNT

*enhanced primary reference time clock

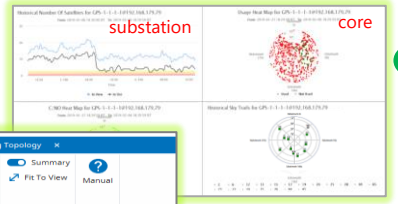
Trusted timing management functions in secure smart grids

Neural AI/ML intelligence for self-survivability, end-to-end control, visibility & trusted PNT

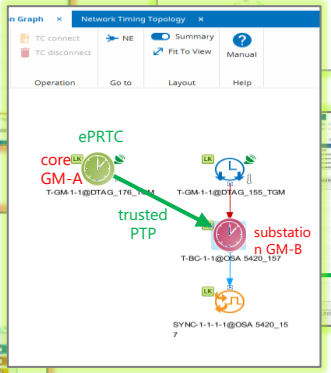
aPNT+™



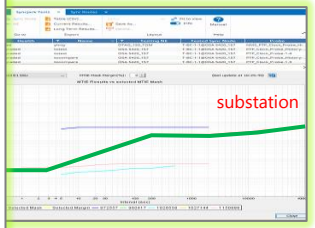
1 geolocation site A & B alert



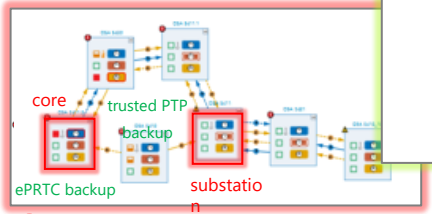
7 GNSS assurance analytics



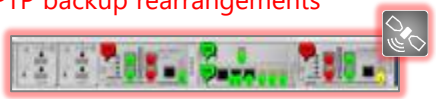
5 timing topology with ePRTC backup



6 PTP backup assurance



2 timing chain alert with ePRTC & PTP backup rearrangements

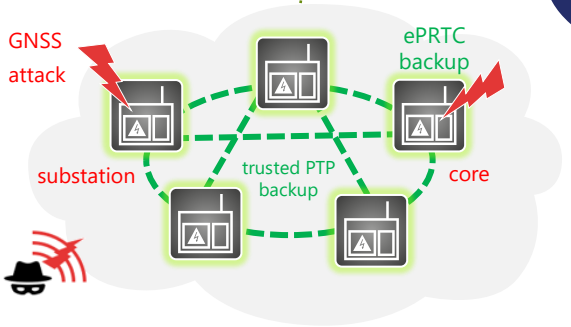


GNSS attack

3 core **GM-A** alert with ePRTC & PTP backup

4 edge substation **GM-B** alert with PTP backup

8 self-survivable timing chain with trusted PNT assurance



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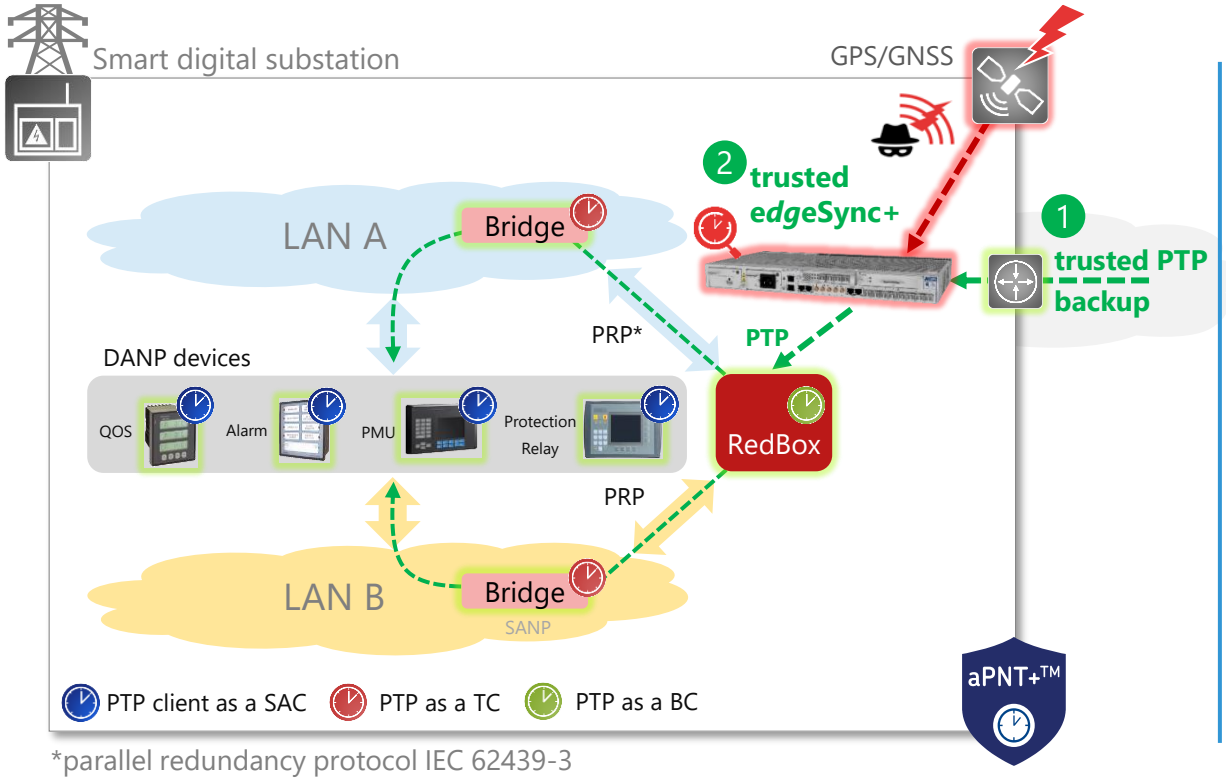
Trusted PRP intra-timing architecture in substations



*parallel redundancy protocol IEC 62439-3

1 trusted PTP backup: network time backup from an upstream *core*Sync ePRTC+

2 trusted *edge*Sync+: OSA 5422 GNSS grandmaster with PTP backup as a master SAC

Key PRP timing concepts

- PRP mode not applicable to PTP frames (but applicable for NTP)
- RedBox: redundancy box in 2 LANs
- DANP/SANP: doubly/singly attached node in PRP
- DAC/SAC: doubly/singly attached clock in PRP
- TC/BC: transparent/boundary clock

Best PRP substation timing architecture practices for trusted aPNT+

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Our timing product range by best-fit/cost application

Ensemble *Sync* Director™

aPNT+™

accessSync™

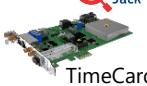
OSA 5401
SFP SyncPlug

OSA 5405-I/O/MB/P

OSAinside™

OSA 5400

SyncModule



TimeCard

OSA SoftSync
Linux

edgeSync™

OSA 541x

OSA 5412

edgeSync+™

OSA 5420/21

OSA 5422

coreSync™

OSA 5430 NG GM/SSU

OSA 5440 NG GM/SSU

coreSync™

OSA 3350 optical Cs ePRC+

3230B Cs magnetic PRC/ePRC

device/network
Monitor

PNT cyber threats

Smart power grids

Aviation radars

Defense comm

TV studio

O-RAN/edge DC

Financial trading

Data center

911 center

front/backhaul

Ground station

Core network

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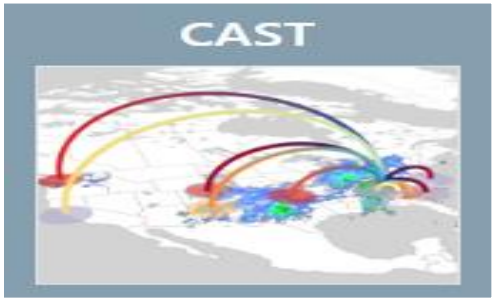
DOE use case: CAST (center of alternative sync & timing)

Website: https://darknet.ornl.gov

Secure, resilient & assured timing architecture: zero-trust multisource GPS/GNSS backup

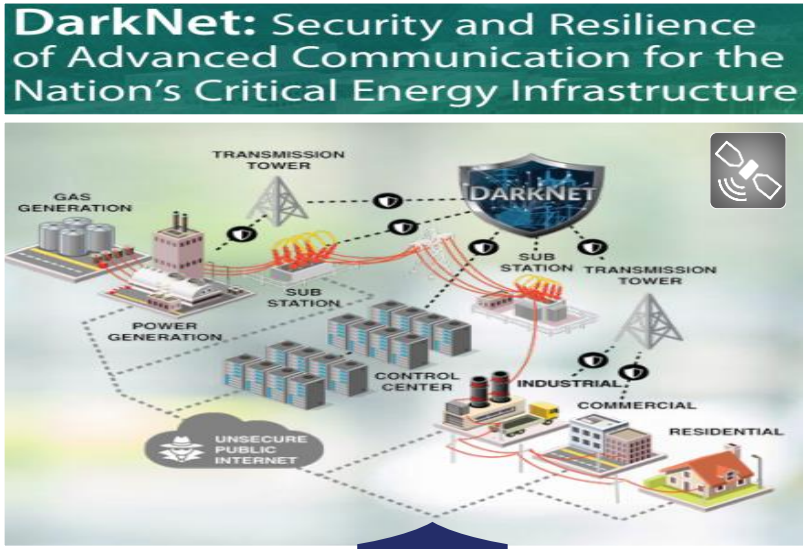


Team members participating in CAST

U.S. DEPARTMENT OF ENERGY

OAK RIDGE National Laboratory

The CAST team provides nation-wide timing as a service to support US critical infrastructure and the power industry.



PNT cyber threats

Best practices in resilient and assured timing architecture

aPNT+™

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Thank you

Have questions? Contact me at ndefalcis@adva.com