Best practices for secure synchronization in smart grids

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Oct 6, 2021, 2:30-2:50p ET (Session #4)

NASPI North American SynchroPhasor Initiative

ADVA

ADVA solution capabilities in smart grids

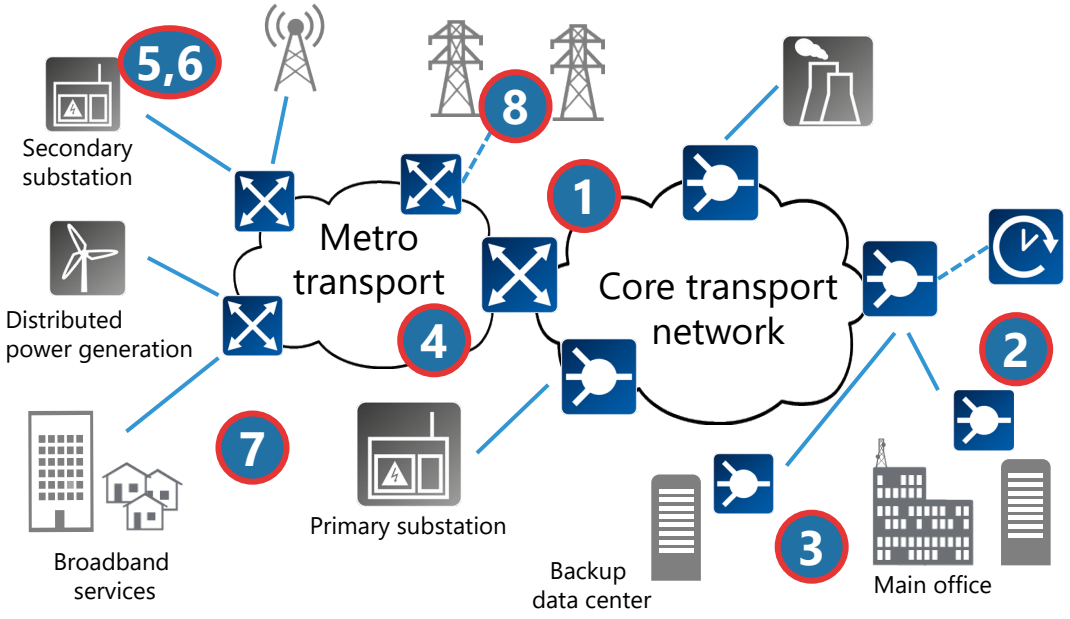
ADVA solution domains			
1.	Core transport	5.	Connecting substations
2.	Core synchronization	6.	Synchronizing substations
3.	Business continuity	7.	Broadband services
4.	Metro transport	8.	Monitoring power lines

Network modernization

- Security
- Sync
- Assurance
- IT/OT convergence

Communication services

- Residential
- Commercial
- Wholesale



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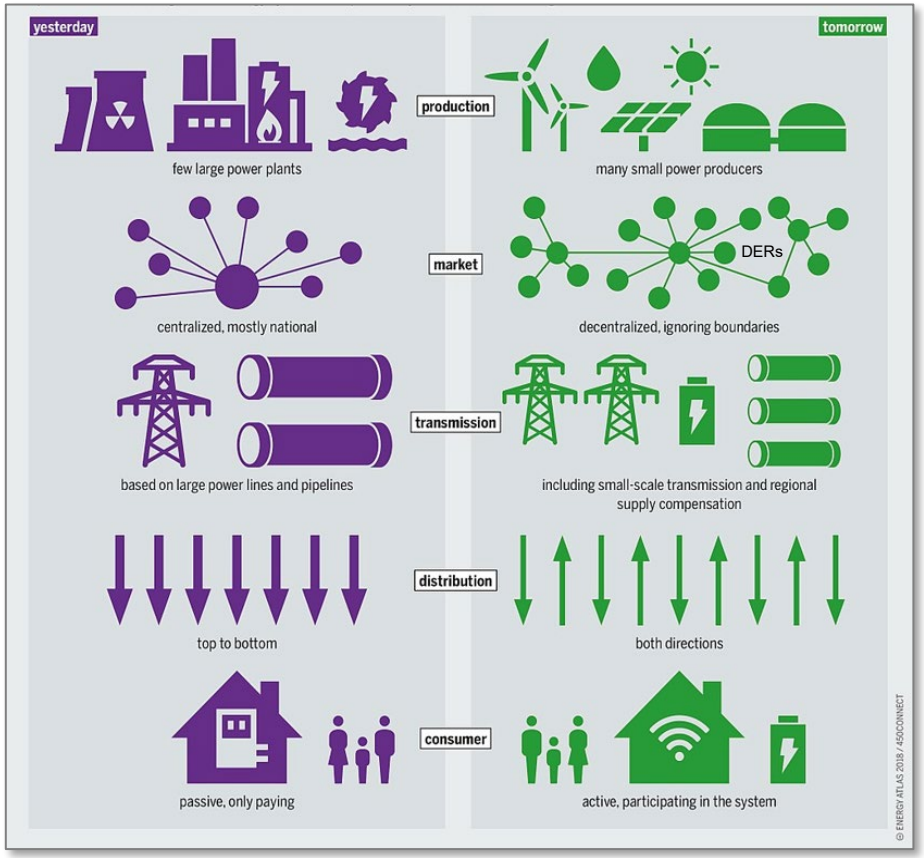
Tighter data timestamping accuracy requirements



Grid application	Timing requirements (minimum reporting resolution and 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
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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New gov-mandated aPNT* requirements

*assured **P**ositioning, **N**avigation & **T**iming**

Timing is a critical utility enabling **PN

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What is the aPNT mandate?

Driven by US federal gov's executive order 13905 of Feb 2020

- **Protect** critical gov & industry infrastructure against PNT disruptions from GPS/GNSS jamming/spoofing & cyberattacks

- **Define** critical infrastructure under national security threats
  - Power grid
  - Finance
  - Transportation
  - Communications
  - Data centers

- **Use** published PNT assurance guidelines in progress & evolving
  - DHS Resilient PNT Conformance Framework *(IEEE P1952 Resilient PNT UE working group)*
  - NIST Cybersecurity Framework for PNT Profile (*NISTIR 8323*)

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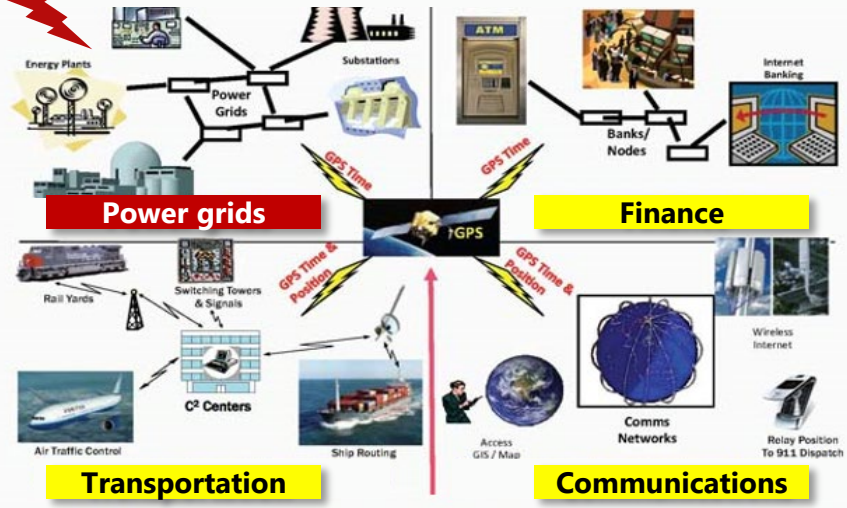
The problem in power grids

PNT cyberthreats

$1B/day in economic cost if 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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PNT cyberthreats & GNSS vulnerabilities

PNT cyberthreats

External GPS/GNSS level

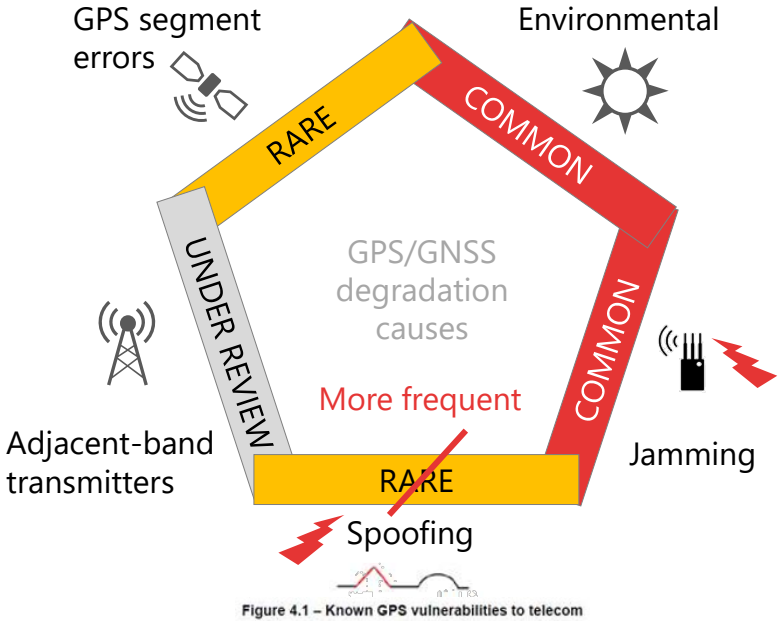
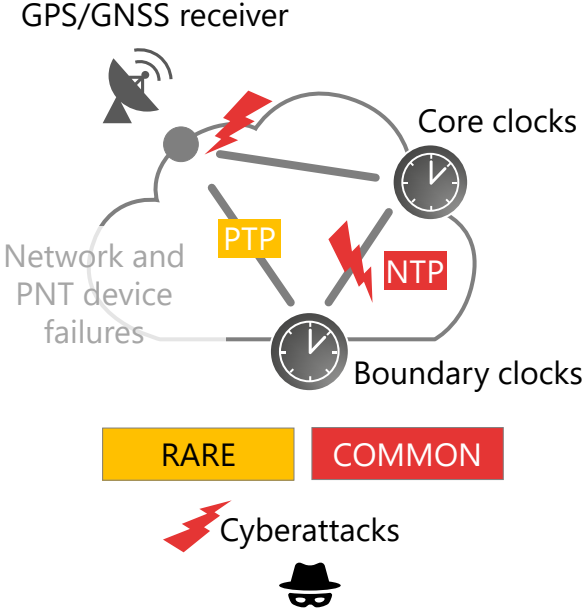


Figure 4.1 – Known GPS vulnerabilities to telecom

Internal network level



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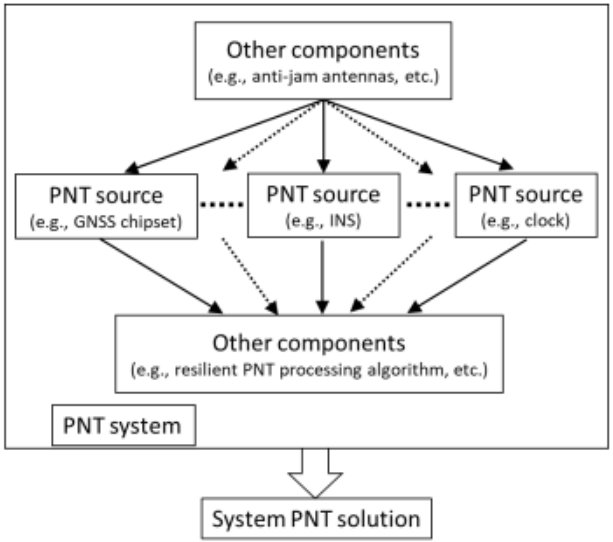
What are DHS' resilient PNT assurance guidelines?

DHS Resilient PNT Conformance Framework

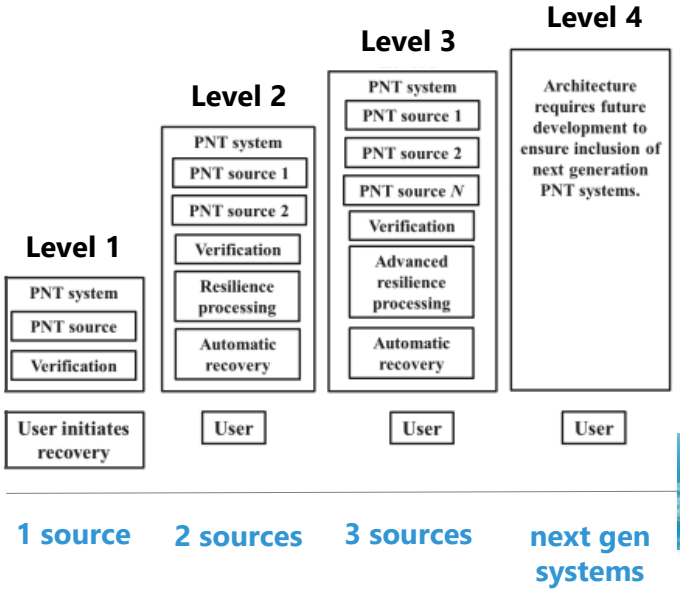
PNT Defense in Depth

Core functions

Functional diagram



PNT Resiliency levels



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What are NIST's cybersecurity assurance guidelines?

NIST Cybersecurity Framework for PNT Profile

PNT Defense in Depth

Goals

Framework

Core

- Guidance & controls

Implementation tiers

- Cybersecurity risk measurement & management practices

Profile

- Requirements & objectives alignment, including risk appetite & resources

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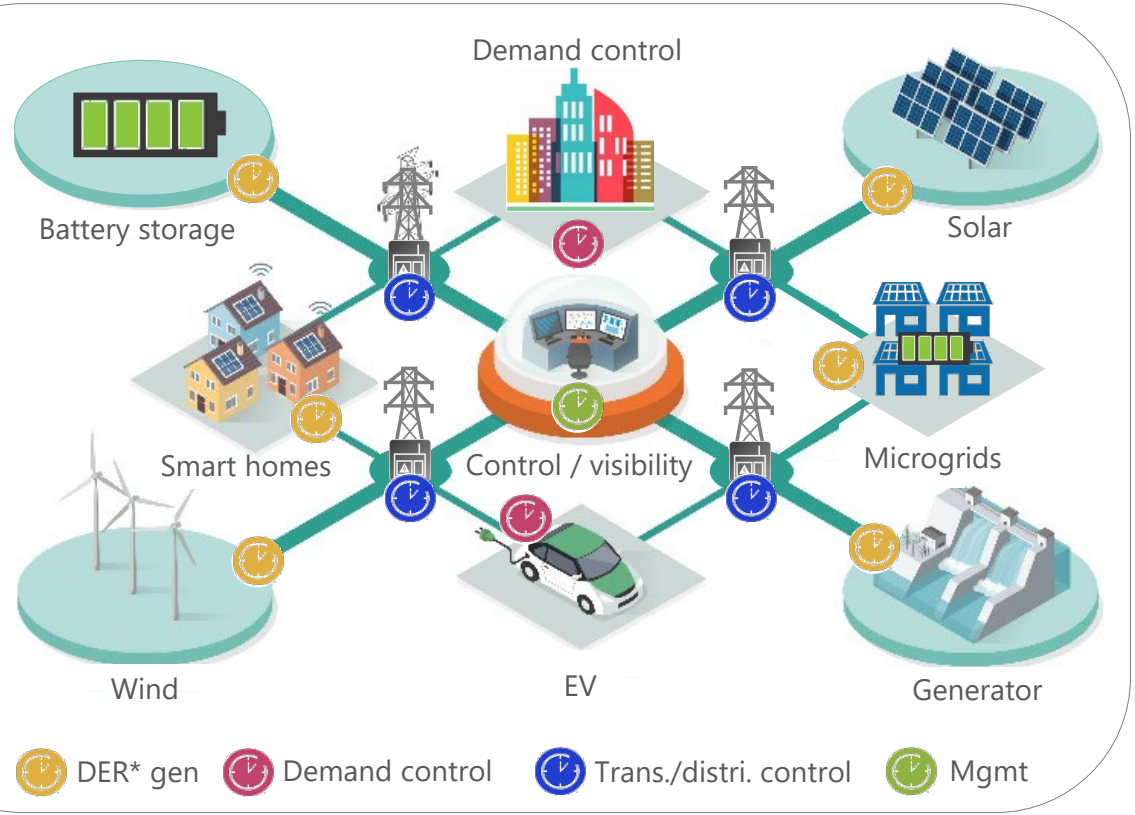
Visualizing secure smart grid sync with aPNT+ services

PNT cyberthreats

aPNT+™



*distributed energy resources

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Best practice aPNT+ framework with zero-trust PNT sources

3 building blocks

Strategies	Anti-threat protection	Alternative sources	AI/ML sw intelligence
Antenna/Accessory *(GNSS/Mcode/eLoran)*			
Receiver *($GNSS_{SB/MB}$/Mcode/etc)*	**Multi-layer**		
Device *(GNSS/Cs/holdover/etc)*	**detection**		
Network *(PTP/APTS/mgmt)*		**Multi-source backup**	**Multi-level fault-tolerant mitigation**

aPNT+™

PNT cyberthreats

DHS PNT resiliency level 0 1 2 3 4 **Enhanced 4**

Augmented Resilience + Robustness + Cybersecurity

PNT Defense in Depth

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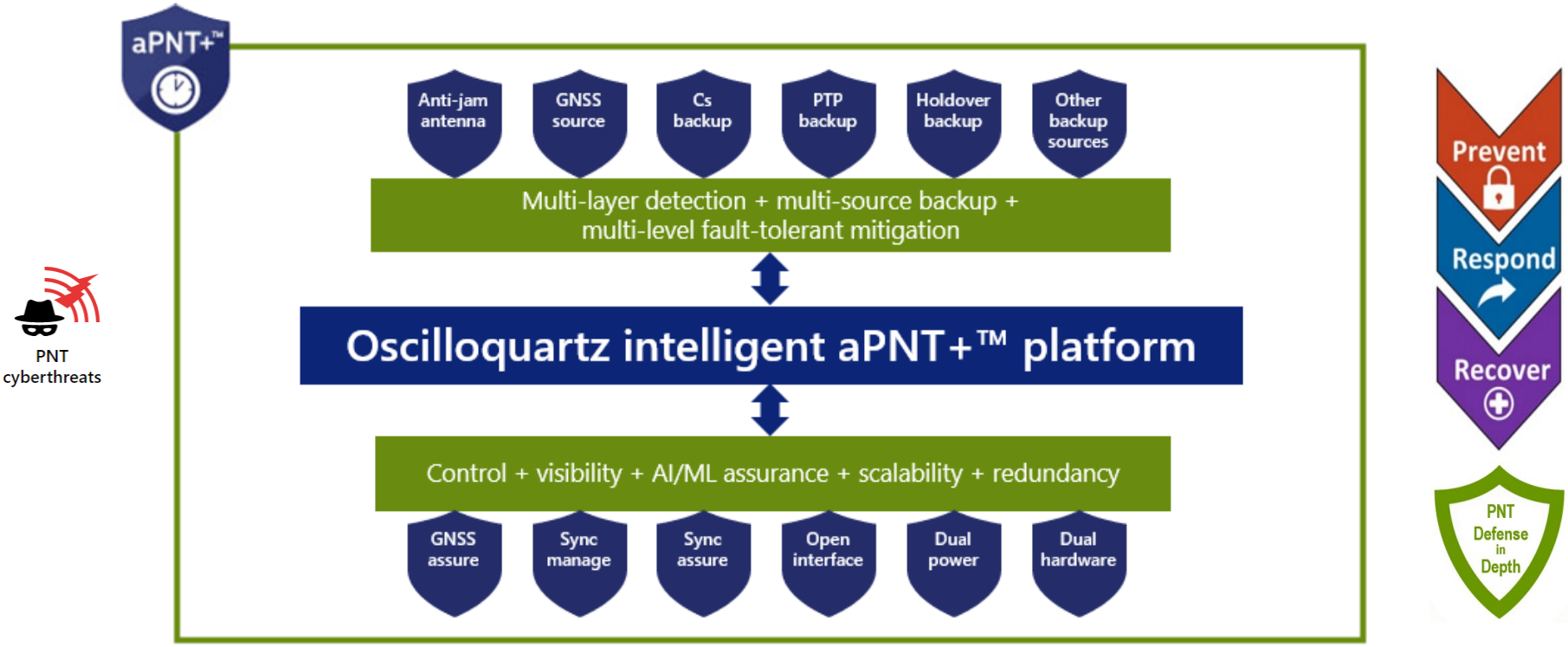
aPNT+ technology with built-in aPNT+ framework



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Best sync architecture strategies with aPNT+ technology

Level 1 resiliency

Problem

User **level 0** PNT disruptions

GPS

SB (single band)

Grandmaster - basic GPS SB receiver

User

Solution

User **level 1** PNT resiliency

GNSS (multi-constellations - GPS, Galileo, etc.)

SB or MB (multiband L1/L2/L5)

MB-GNSS

Grandmaster - GNSS SB/MB receiver

User

- MB to mitigate jam/spoof event
- SB with 2 receivers, fixed & nav mode, to detect spoof event
- Smart anti jam/spoof software
- Holdover clock: OCXO or Rb

Optional

- Anti-jam antenna
- In-line anti-jam/spoof accessory

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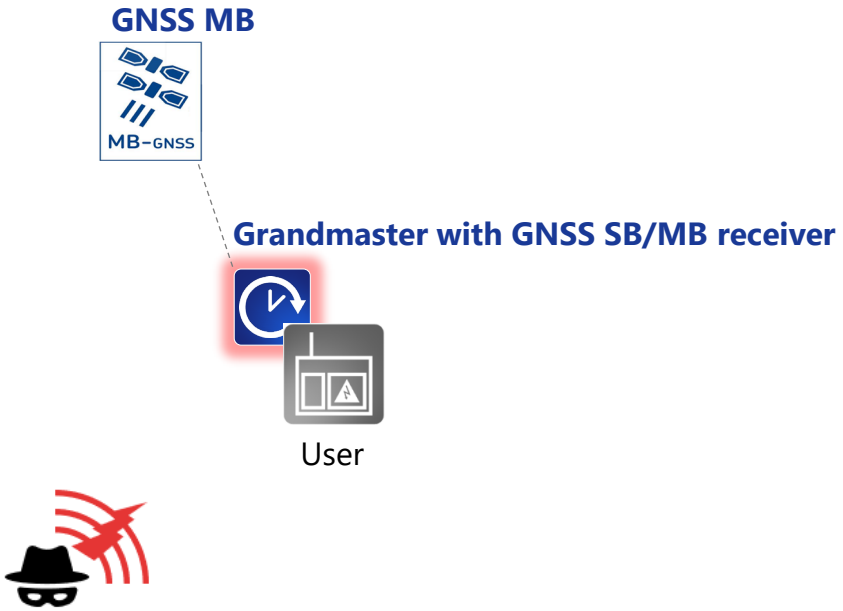
Best sync architecture strategies with aPNT+ technology

Level 2 resiliency

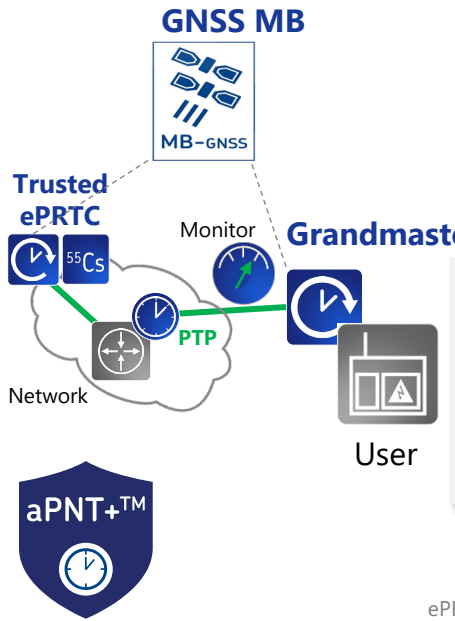
Problem

User **level 1** PNT disruptions



Solution

User **level 2** PNT resiliency



- Same config as level 1 resiliency

PLUS

- **PTP network time backup from ePRTC source**
- **PTP network time monitor**, with threat alarms

ePRTC - enhanced Primary Reference Time Clock

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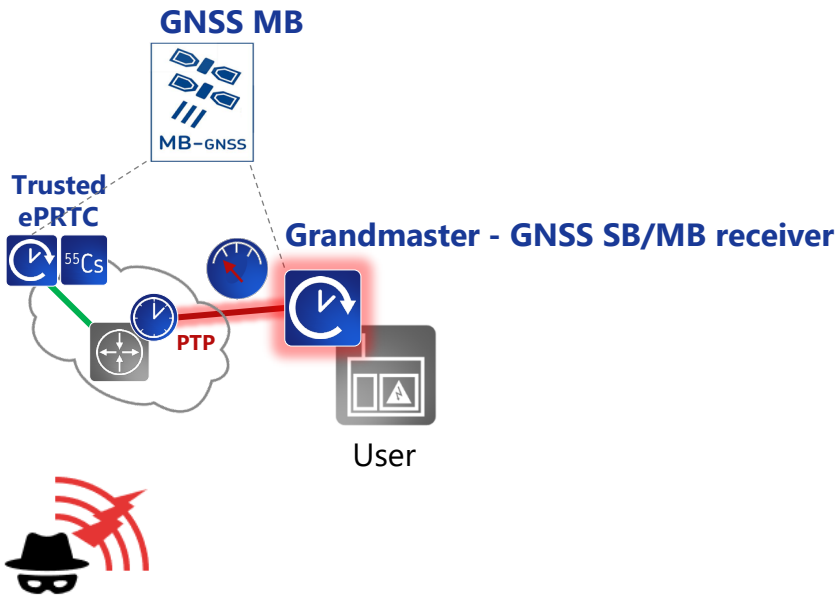
Best sync architecture strategies with aPNT+ technology

Level 3 resiliency

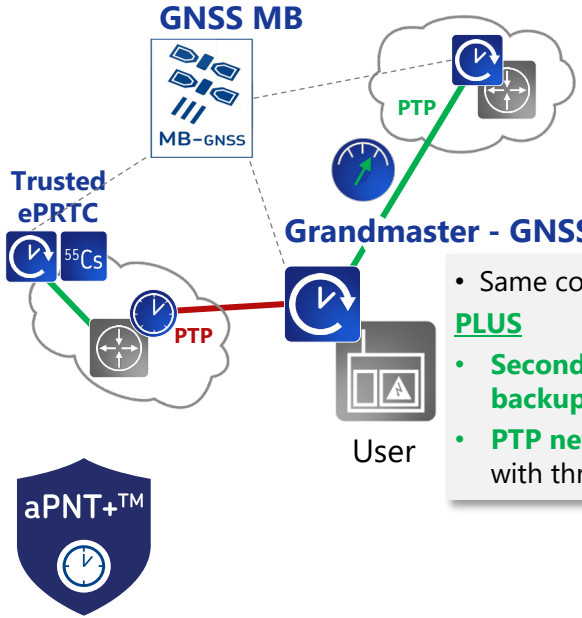
Problem

User **level 2** PNT disruptions



Solution

User **level 3** PNT resiliency



- Same config as level 2 resiliency

PLUS

- **Secondary PTP network time backup**
- **PTP network time monitor**, with threat alarms

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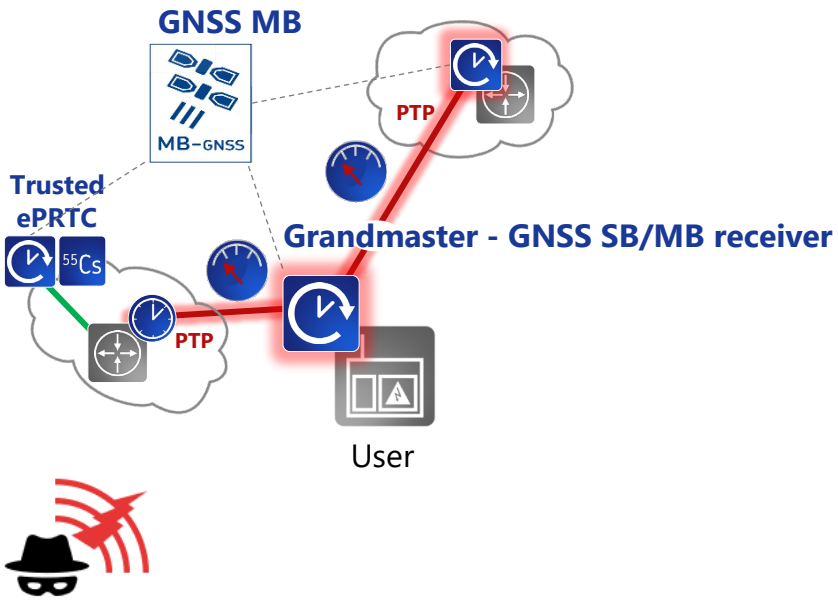
Best sync architecture strategies with aPNT+ technology

Level 4 resiliency

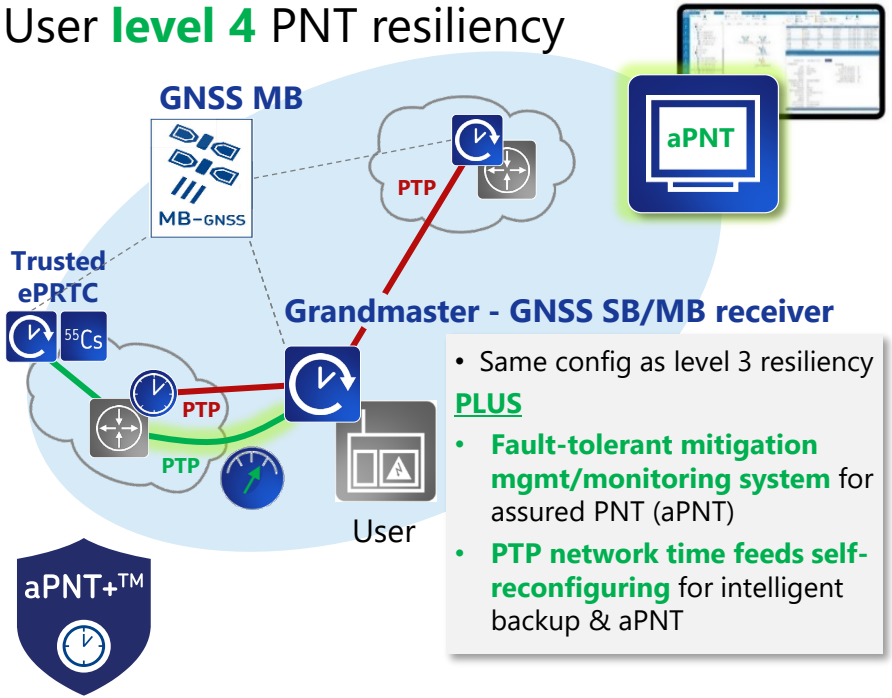
Problem

User **level 3** disruptions



Solution

User **level 4** PNT resiliency



- Same config as level 3 resiliency

PLUS

- **Fault-tolerant mitigation mgmt/monitoring system** for assured PNT (aPNT)
- **PTP network time feeds self-reconfiguring** for intelligent backup & aPNT

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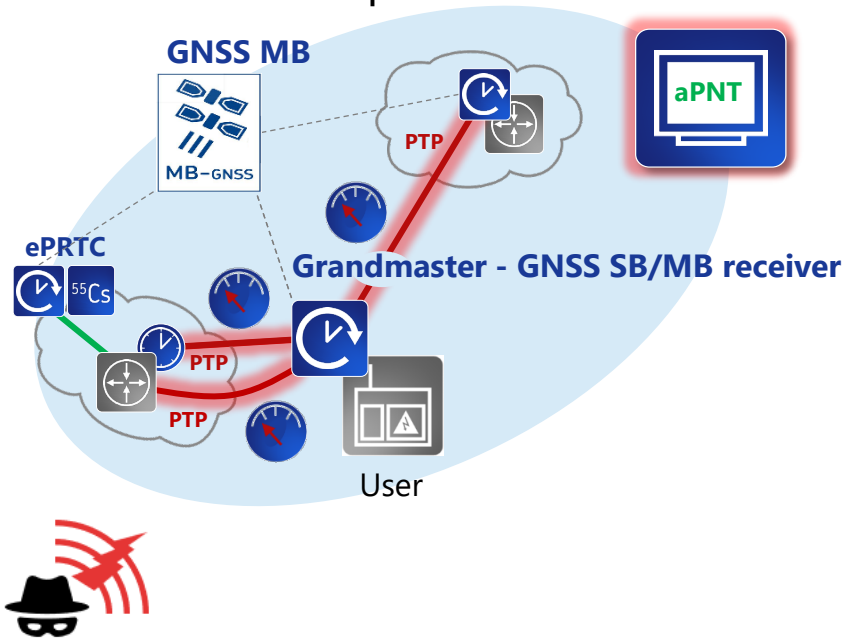
Best sync architecture strategies with aPNT+ technology

Enhanced level 4 resiliency

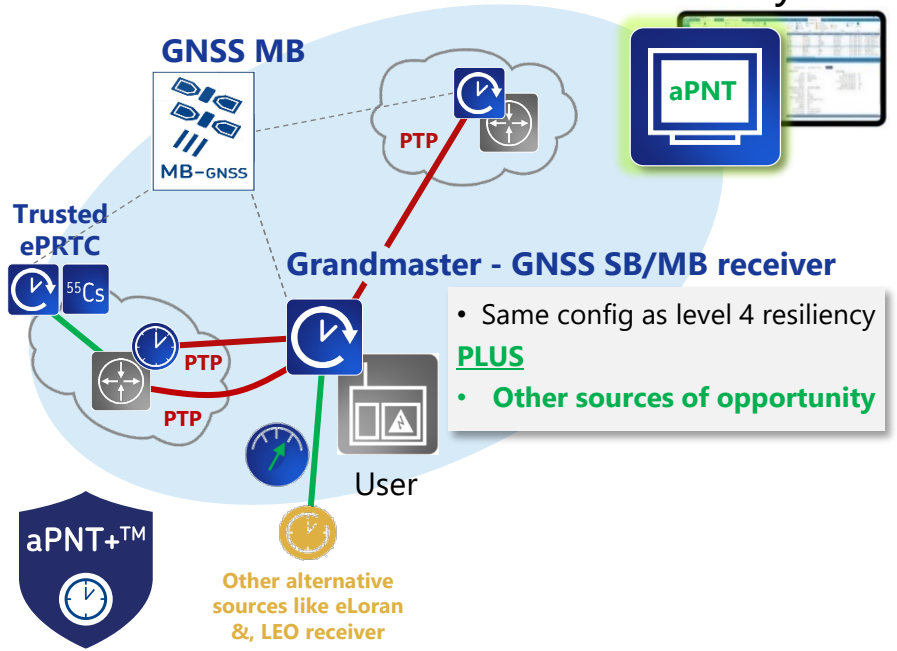
Problem

User **level 4** disruptions



Solution

User **enhanced level 4** PNT resiliency



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Typical sync product deployment with aPNT+ technology

Sync manage

Intelligent network sync control, visibility & scalability

Open interface

GPS/ GNSS

Anti-jam antenna option, mitigating jam/spoof from low elevation

Anti-jam antenna

GNSS assure

Multiband + multi-constellation GNSS receiver

GNSS source

Dual power

Redundant, hot swappable PSU

Dual hardware

5430/40 product

aPNT+™

GNSS PTP Grandmaster

Extended Crystal/Rubidium holdover backup

Holdover backup

Like eLoran or LEO receiver

Other sources

ePRTC – enhanced independent Cesium clock backup

Cs backup

PTP backup with APTS from remote peer GNSS PTP GMs like ePRTC

PTP backup

Smart GNSS jam/ spoof detection with SyncJack monitor

Sync assure

PNT cyberthreats

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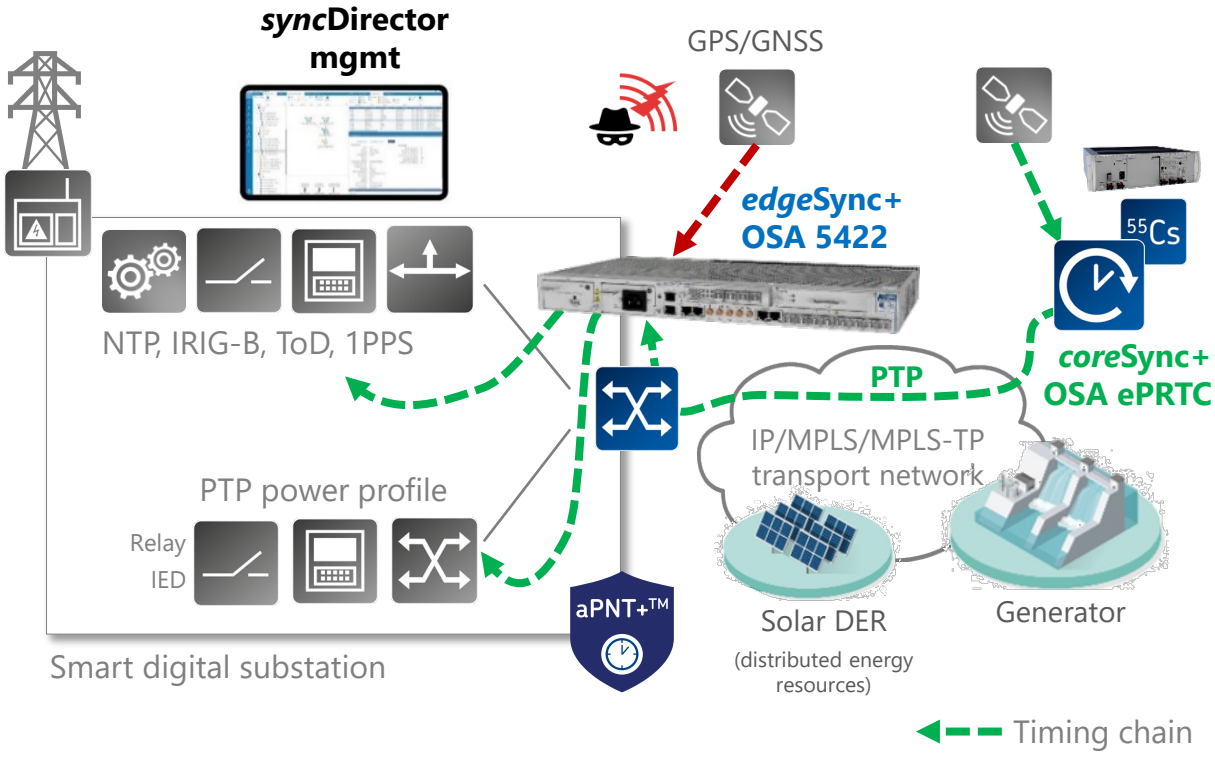
Trusted sync architecture for core sites & substations



***core*Sync+:** OSA 5422 GM* time server, combining GNSS + OSA Cesium clock, providing trusted & verified PTP network feeds

***edge*Sync+:** OSA 5422 GM time server with GNSS source + PTP backup for aPNT

***sync*Director mgmt:** intelligent OSA ENC management system for full sync control, visibility & aPNT

*grandmaster

Best sync practices for trusted PNT assurance

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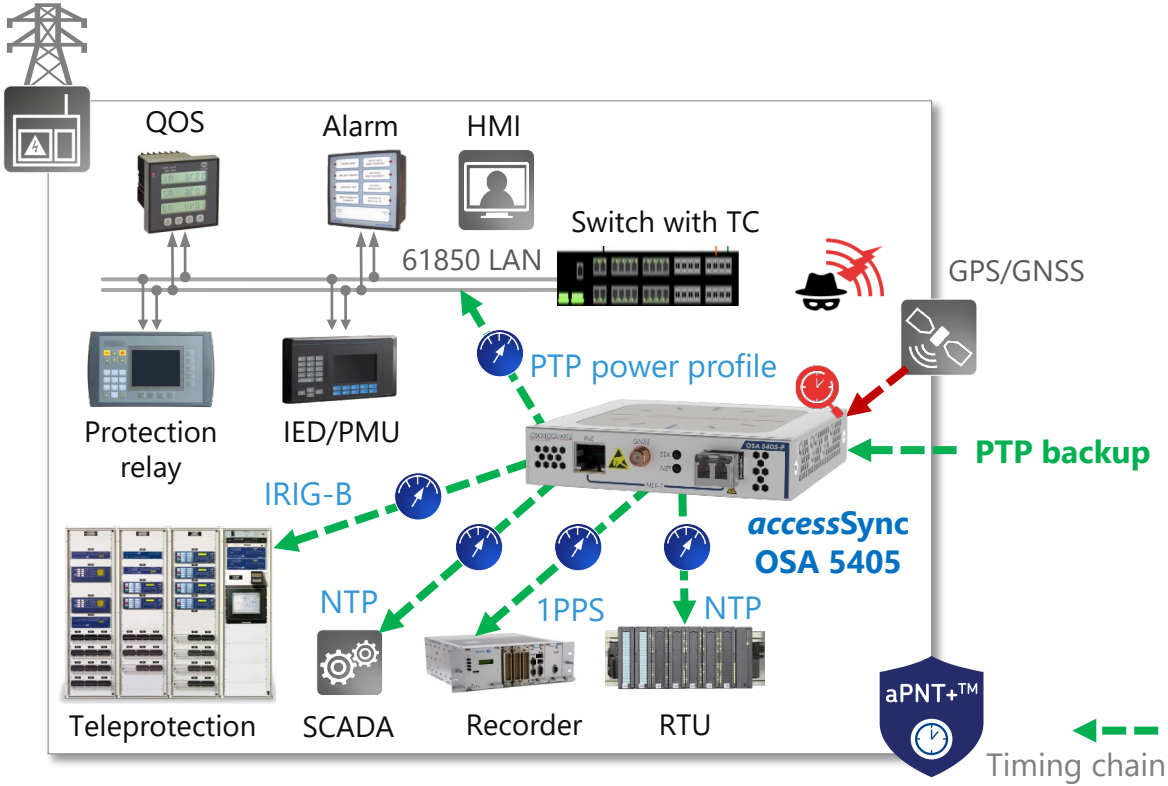
Trusted intra-sync architecture for substations



PTP backup: PTP network backup feeds from remote peer PTP GMs typ. in data centers

accessSync: OSA 5405 GM time server with PTP profile & legacy interfaces

SyncJack: smart monitor, with GNSS anti-jam/spoof & sync quality monitoring capabilities

GM: grandmaster

Best substation intra-sync practices for trusted PNT assurance

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Innovative aPNT+™ product solutions

Ensemble Sync Director - AI/ML-assisted network management for complete control and visibility

access*Sync™
1-64 clients

OSA 5401
SFP SyncPlug

OSA 5405-I/O/P

edge*Sync™
8-64/128-1024 clients

OSA 541x

OSA 5412

edge*Sync™+ (PRTC/ePRTC)
128-1024 clients

OSA 5420/21

OSA 5422

core*Sync™ (PRC/ePRC/PRTC/ePRTC)
128-2048 clients

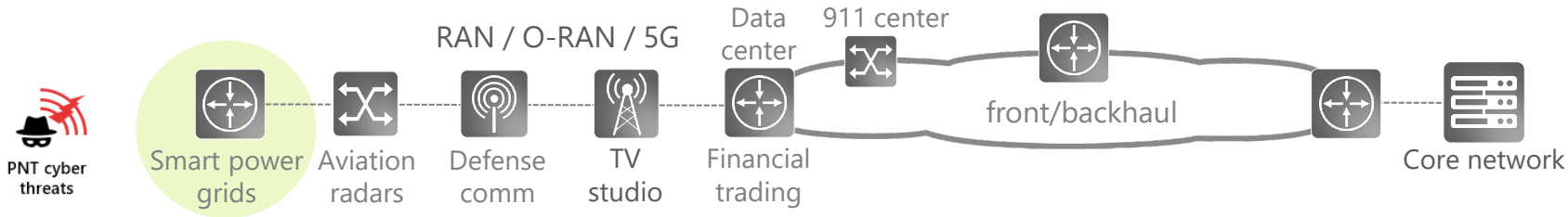
OSA 5430 and 5440 NG GM/SSU/ePRTC

OSA 3350 Cs ePRC+

3230B Cs PRC/ePRC

*1/10G PTP, NTP, SyncE, BC, slave, APTS, TDM, BITS, G.826x, PPS, TOD, CLK, IRIG, LPN, PTP multi-profiles, etc.

Sync Jack™ device/network Monitor



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Takeaways

- ADVA's solution capabilities in smart grids
- Tighter PTP timing requirements in distributed smart grids
- New resilient PNT requirements for national infrastructure security threats
- New aPNT+™ technology
- Trusted smart grid sync architectures:
  - ✓ Core sites: GNSS + Cesium backup + network PTP backup + legacy interfaces
  - ✓ Substations: GNSS + network PTP backup + legacy interfaces
- Innovative aPNT+™ product solutions
- Bonus: sync planning guide for smart grids - click here

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Thank you

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