ePRTC in Datacenters – GNSS Backup as a Service (GBaaS)

Nir Laufer , VP PLM , Oscilloquartz

WSTS May , 2022

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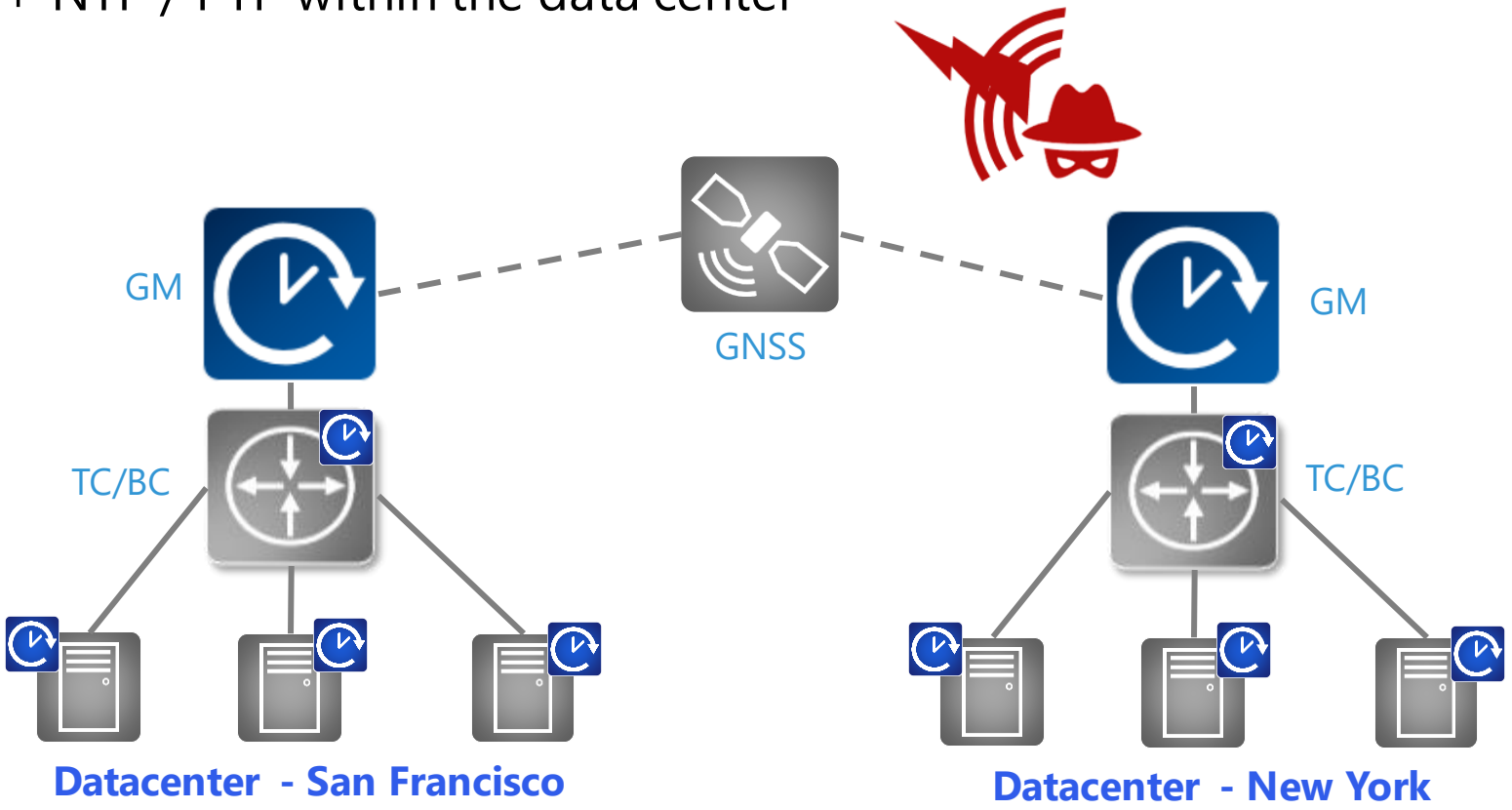
Why Synconization is needed in datacenters?

- Motivation: Improve data consistency management across distributed datacenters
- Tight time synchronization reduce the probability of records inconsistency and reduce the need to rollback unresolved records
- Common time across distributed datacenters is achieved by using GNSS as common reference + NTP / PTP within the data center



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GNSS vulnerabilities and threats

GNSS segment errors

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Technology

GPS error caused '12 hours of problems' for companies

By Chris Baraniuk
Technology reporter

4 February 2016 | Technology

System engineers were "called out of bed" over the problems

Several companies were hit by hours of system warnings after 15 GPS satellites broadcast the wrong time, according to time-monitoring company

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Science & Environment

Galileo sat-nav system still without service

By Jonathan Amos
BBC Science Correspondent

15 July 2019 | Share

Europe's satellite-navigation system, Galileo, remains offline.

The network suffered an outage on Friday due to what has been described as a "technical incident related to its ground infrastructure".

Engineers worked around the clock over the weekend but there is no update yet on when the service will resume.

The problem means all receivers, such as the latest smartphone models, will not be picking up any useable timing or positional information.

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Technology

Russia denies role in Israeli airport GPS jamming

27 June 2019 | Share

GPS signals have been unreliable for weeks, said officials

Russia has denied Israeli suggestions that it is behind disruption of GPS signals at Israel's Ben Gurion airport.

Since early June, GPS signals at the airport have been unreliable for pilots and planes using the location.

The missing navigational data has had a "significant impact" on airport operations, said Israel's Airports Authority.

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Russia suspected of jamming GPS signal in Finland

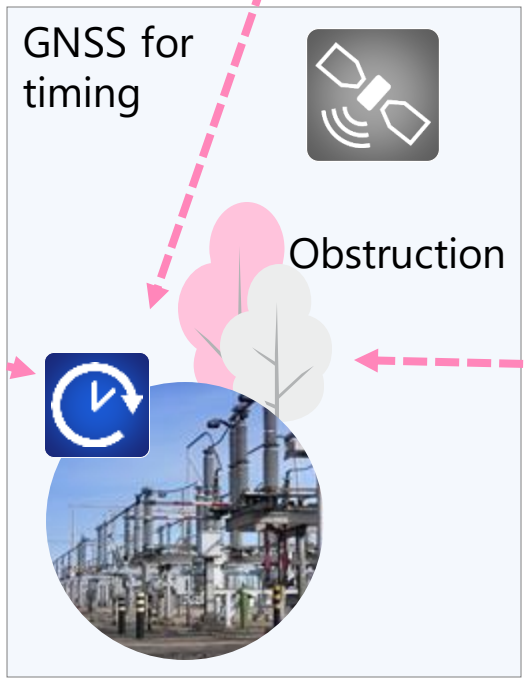
12 November 2018 | Share

Nato holds biggest military exercise since Cold War

Finnish Prime Minister Juha Sipila has said the GPS signal in his country's northern airspace was disrupted during recent Nato war games in Scandinavia.

Jamming and spoofing

ionospheric disturbance, solar activity



Interference with transmitters at adjacent bands

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What is the resilient PNT mandate/standard?

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 & other cyberattacks

- **Define** critical infrastructure under national security threats
  - Power grid
  - Finance
  - Transportation
  - Communications (5G, broadcast, defense, etc)
  - **Data centers**

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

NIST NISTIR 8323

IEEE SA P1952 PNT

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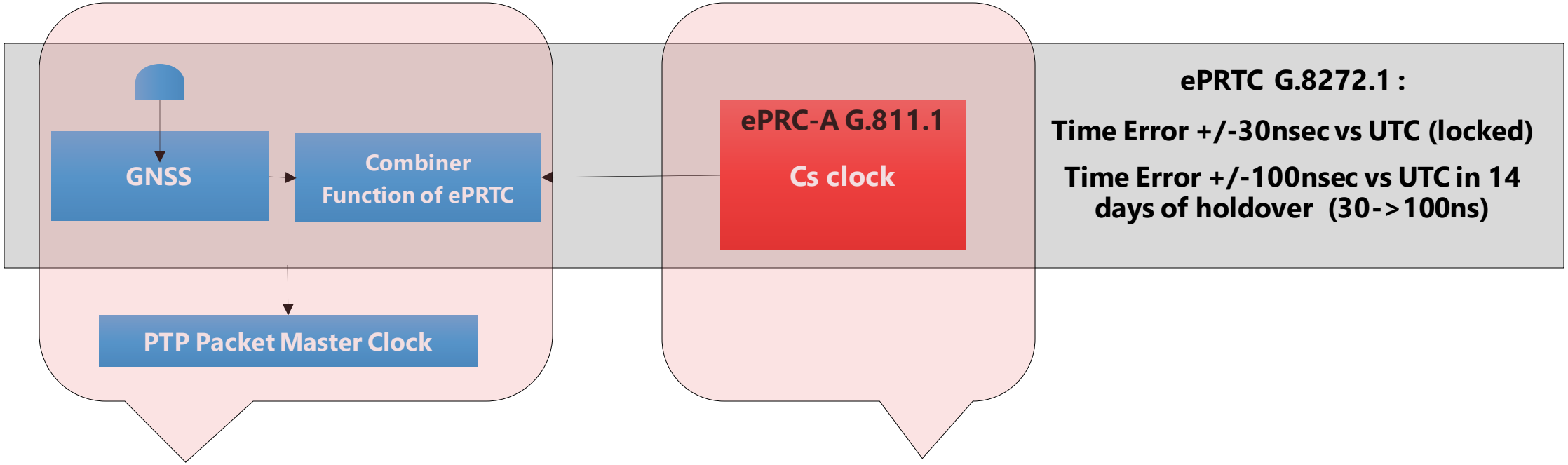
Typical ePRTC implementation



ePRTC combiner + PTP GM

Cesium Atomic clock

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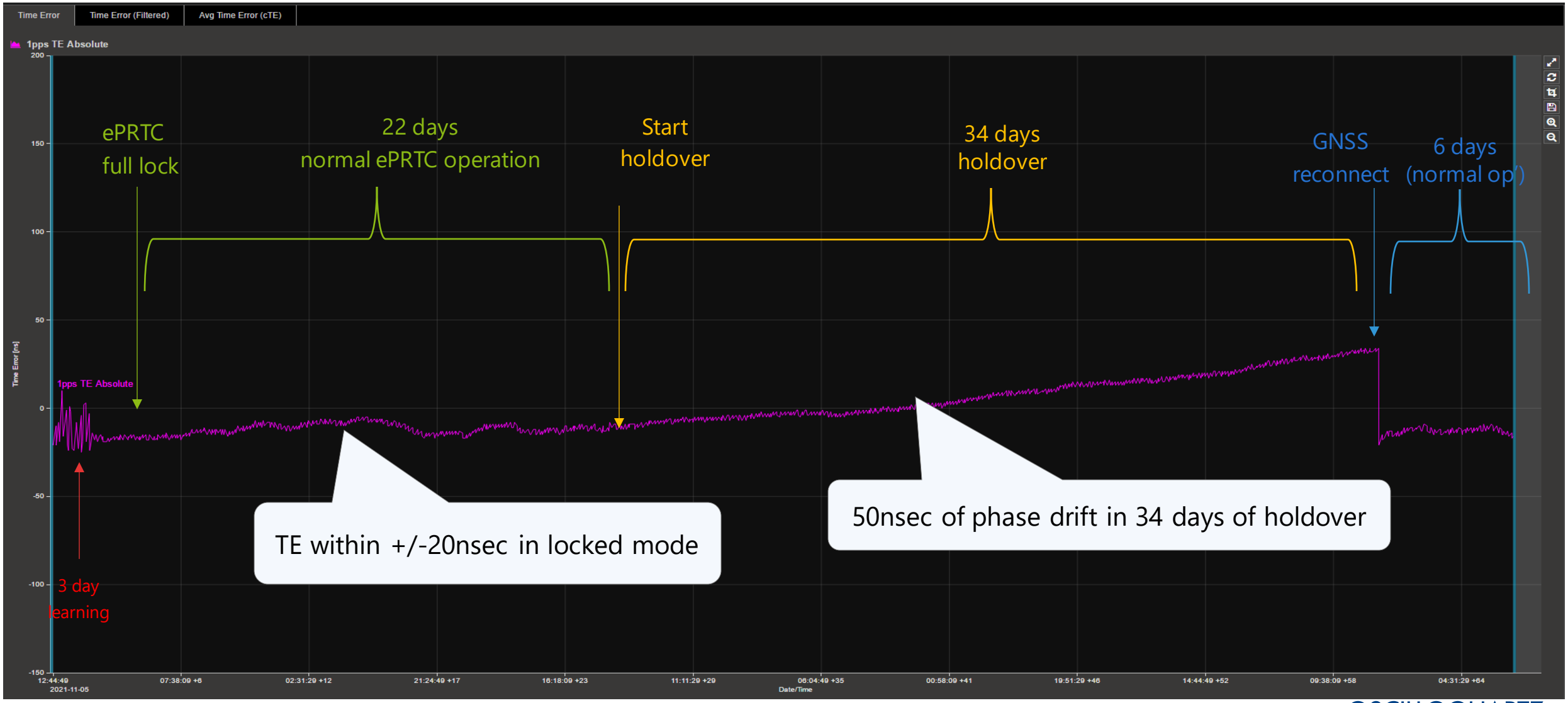
ePRTC lock and holdover results

full 65 days run



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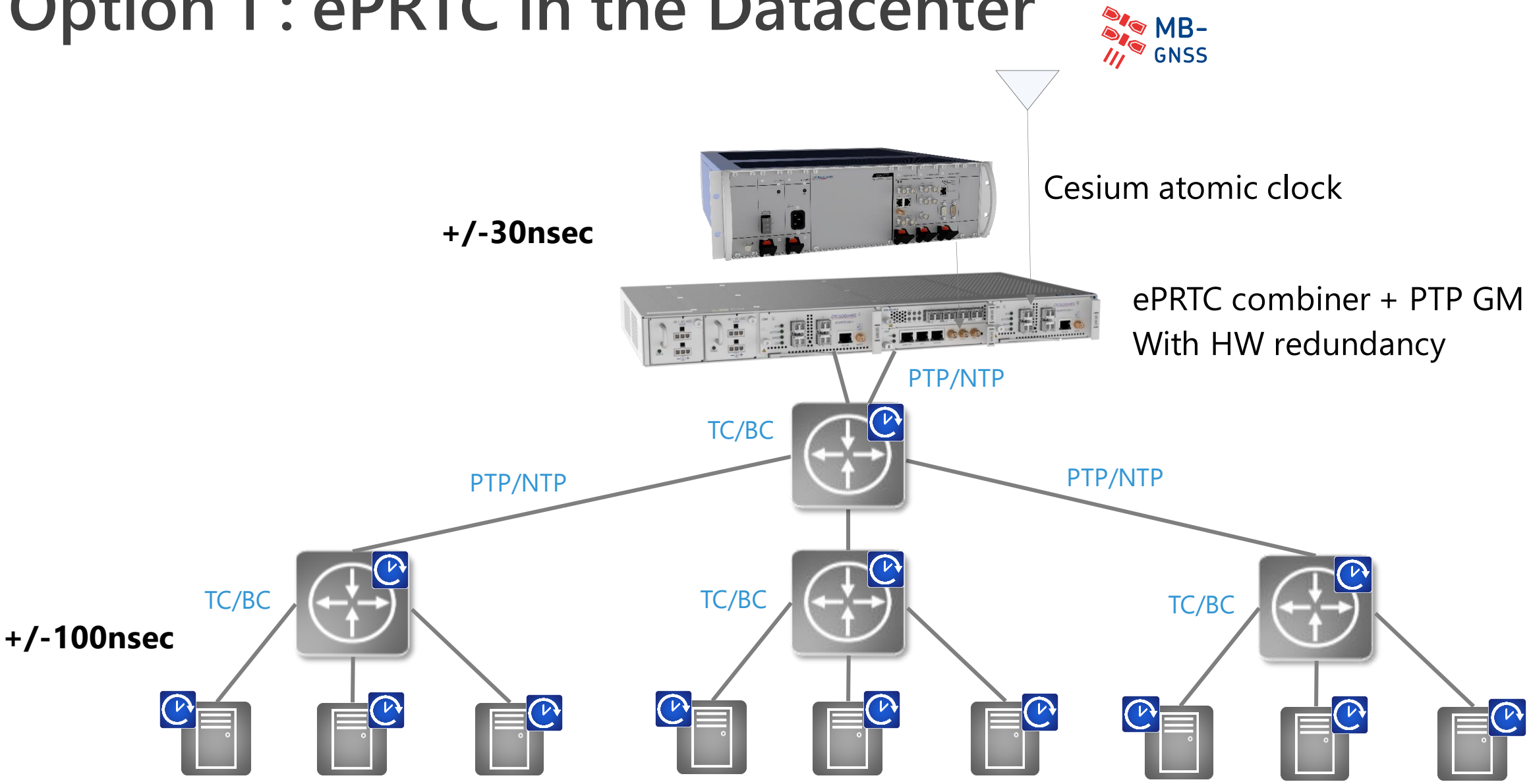
Option 1 : ePRTC in the Datacenter



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Option 2 : GNSS Backup as a Service (GBaaS)

Core time base network

Single-digit number of locations for large operator

ePRTC enabled, TE ≤ ±**30ns**

Aggregation network

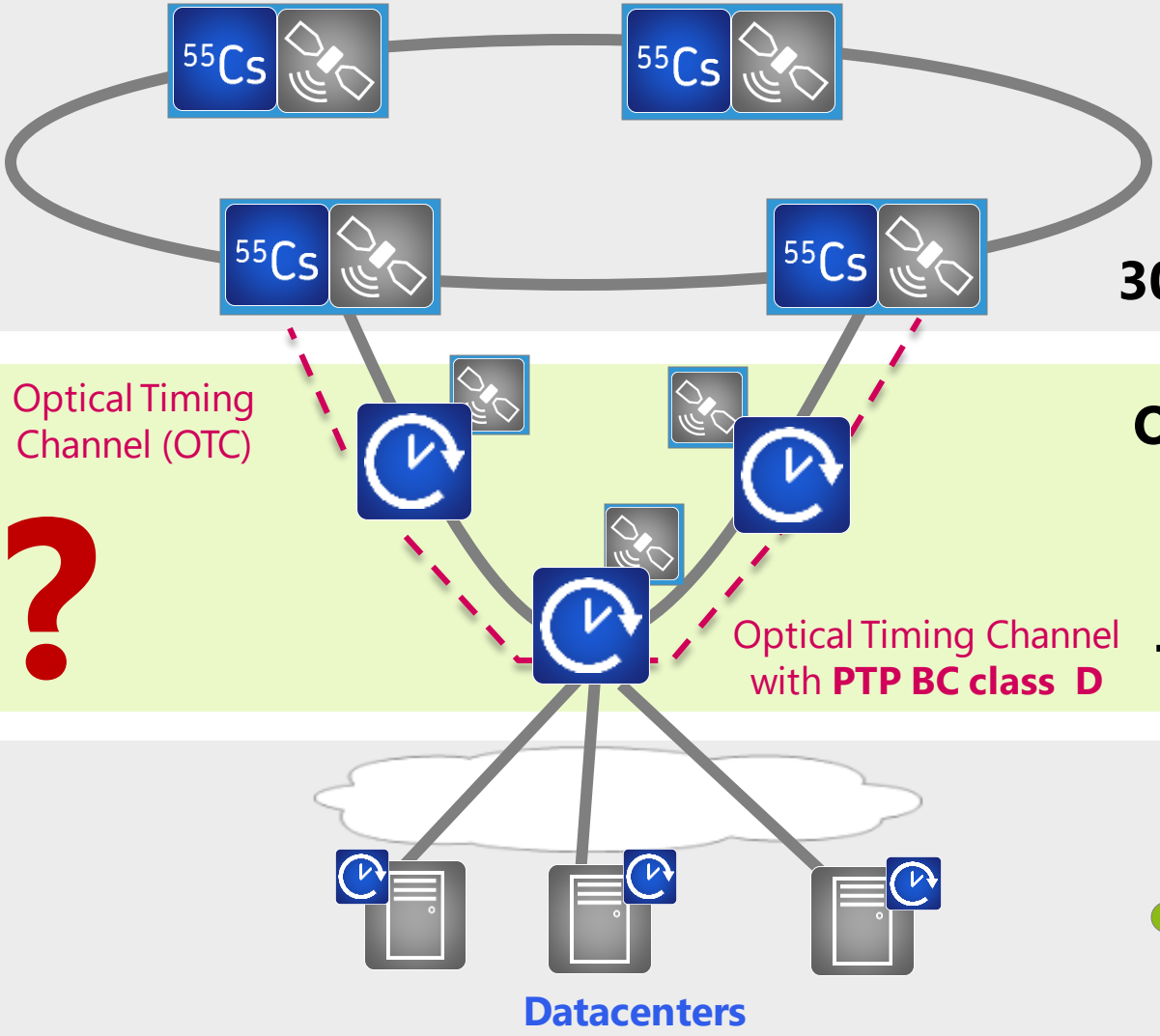
Hundreds of locations for large network

PRTC enabled, TE ≤ ±**100ns**

Feeders to end application

Thousands of locations for large network

TE ≤ ± **1100ns**



IEEE 1588 PTP

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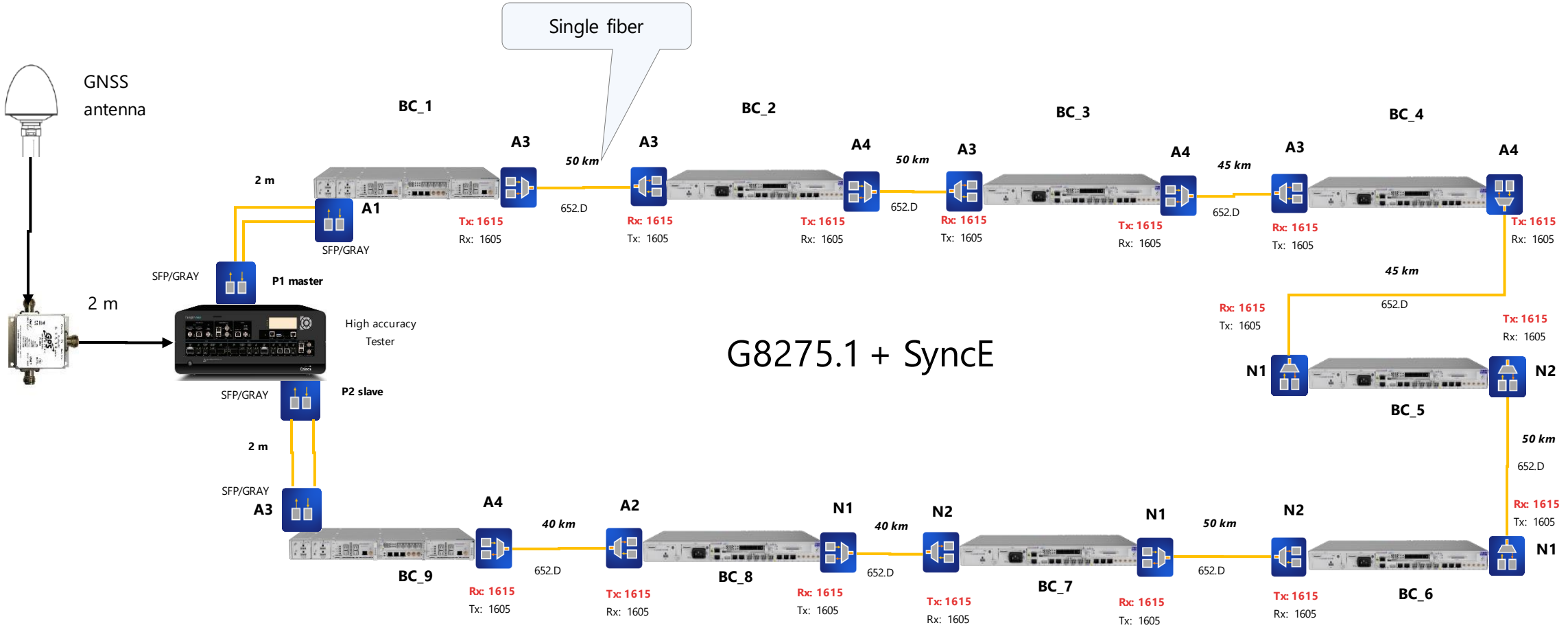
Time distribution : 9xBC Class D

Test setup: 9 x Class D BC's and 370 KM of fiber (single fiber)

Each BC class D (G.8273.2) adds up to 5nsec of max|TEL|



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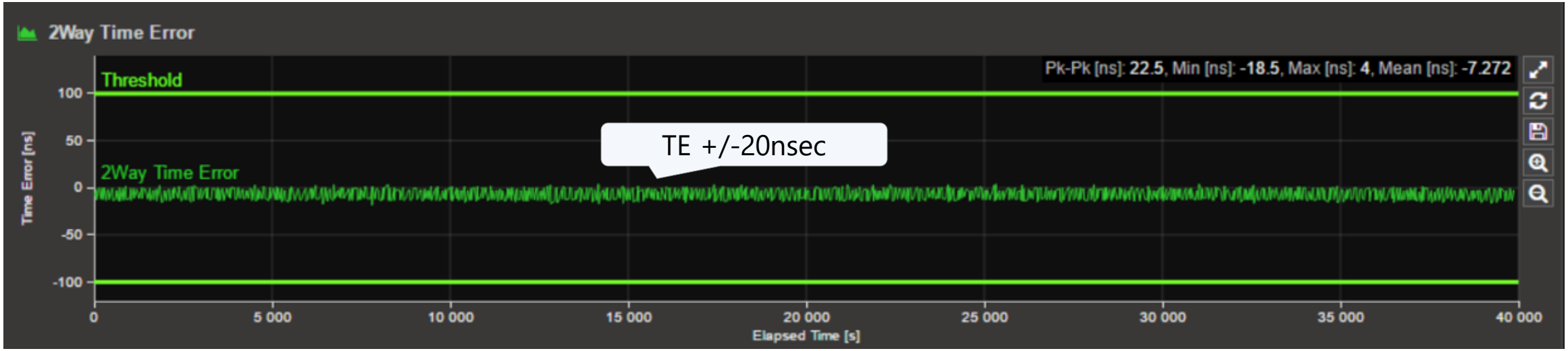
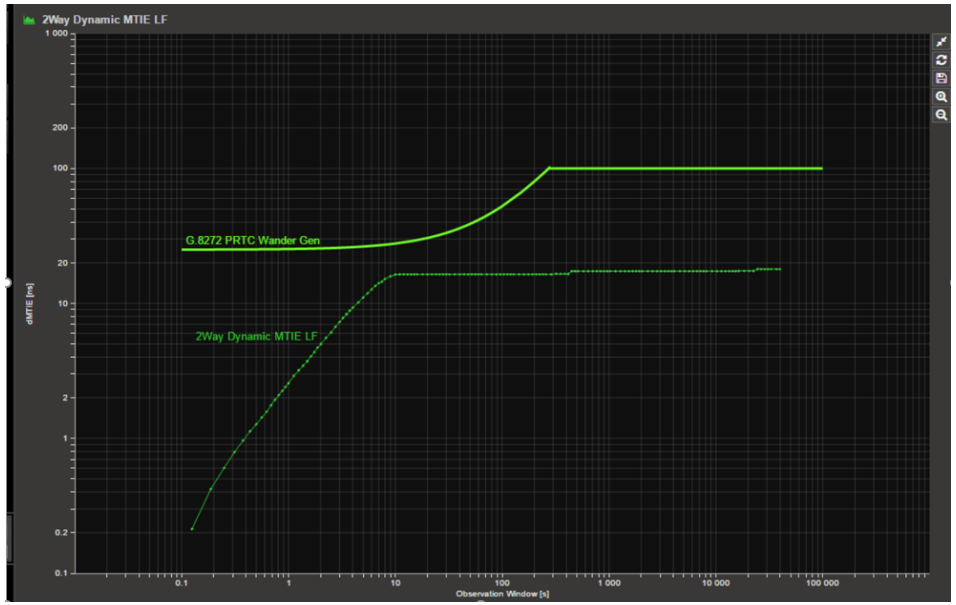
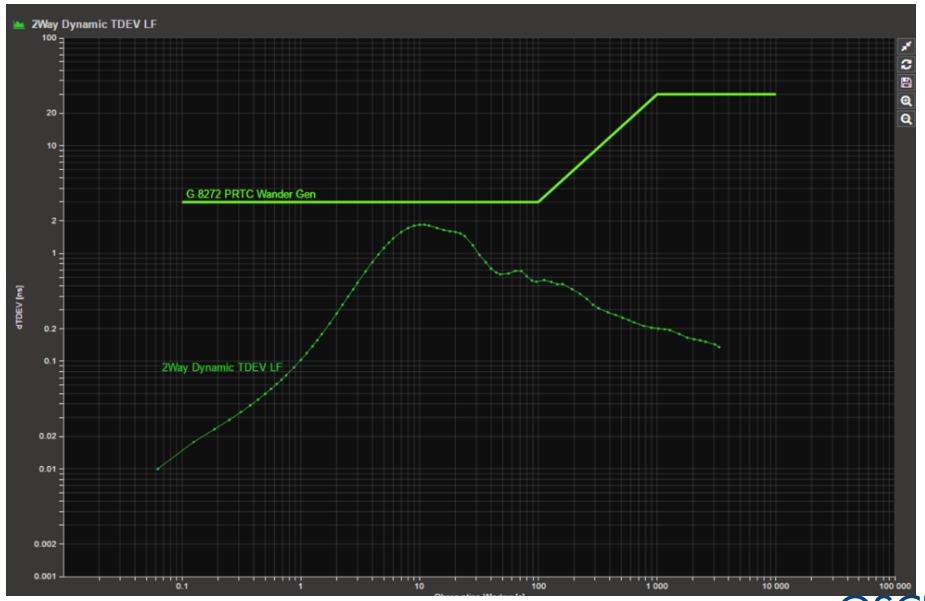
Time distribution : 9xBC Class D

Test results: **9 x Class D BC's and 370 KM of fiber meets ITU-T G.8272 requirements for PRTC-A clock.**





MTIE



TDEV

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Timing over …

Timing over …	Optimization methods	Time error
Layer 3 (Routed)	Small packet size	High (ms/µs)
Layer 2 (Switched)	VLAN with high priority	Middle (µs)
Layer 1 (OTN)	OTN buffer policing or inband transmission	Low (µs/ns)
Layer 1 (Transparent WDM)	Single fiber working	Lowest (ns)

Asymmetry

High

Low

OTC

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Node without OTC

The extract length of each of the fibers is unknown

The different between length of fibers can be few tens of meters over long distance connections -> creating significant asymmetry (~2.5nsec/m)

Optical line system

Intermediate site

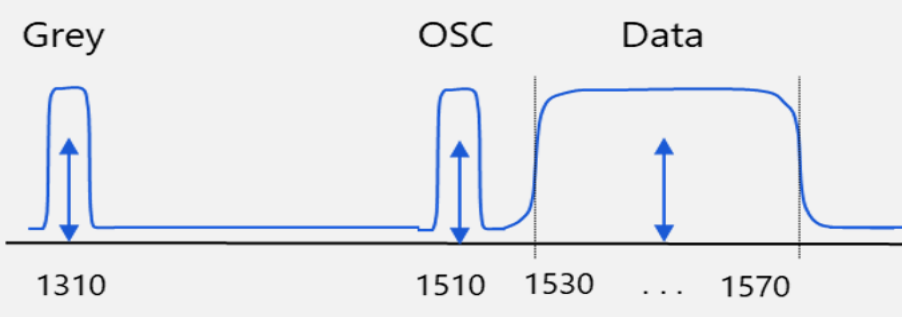
Terminal west

Terminal east

The inline amplifiers are directional and adding unknow delay which varies between generation of amplifiers , types and suppliers

Line terminal

Payload traffic



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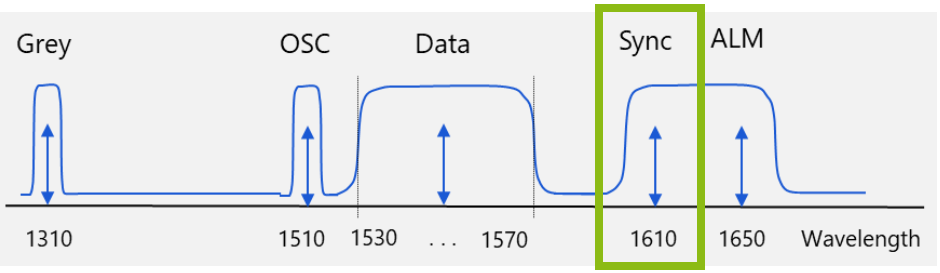
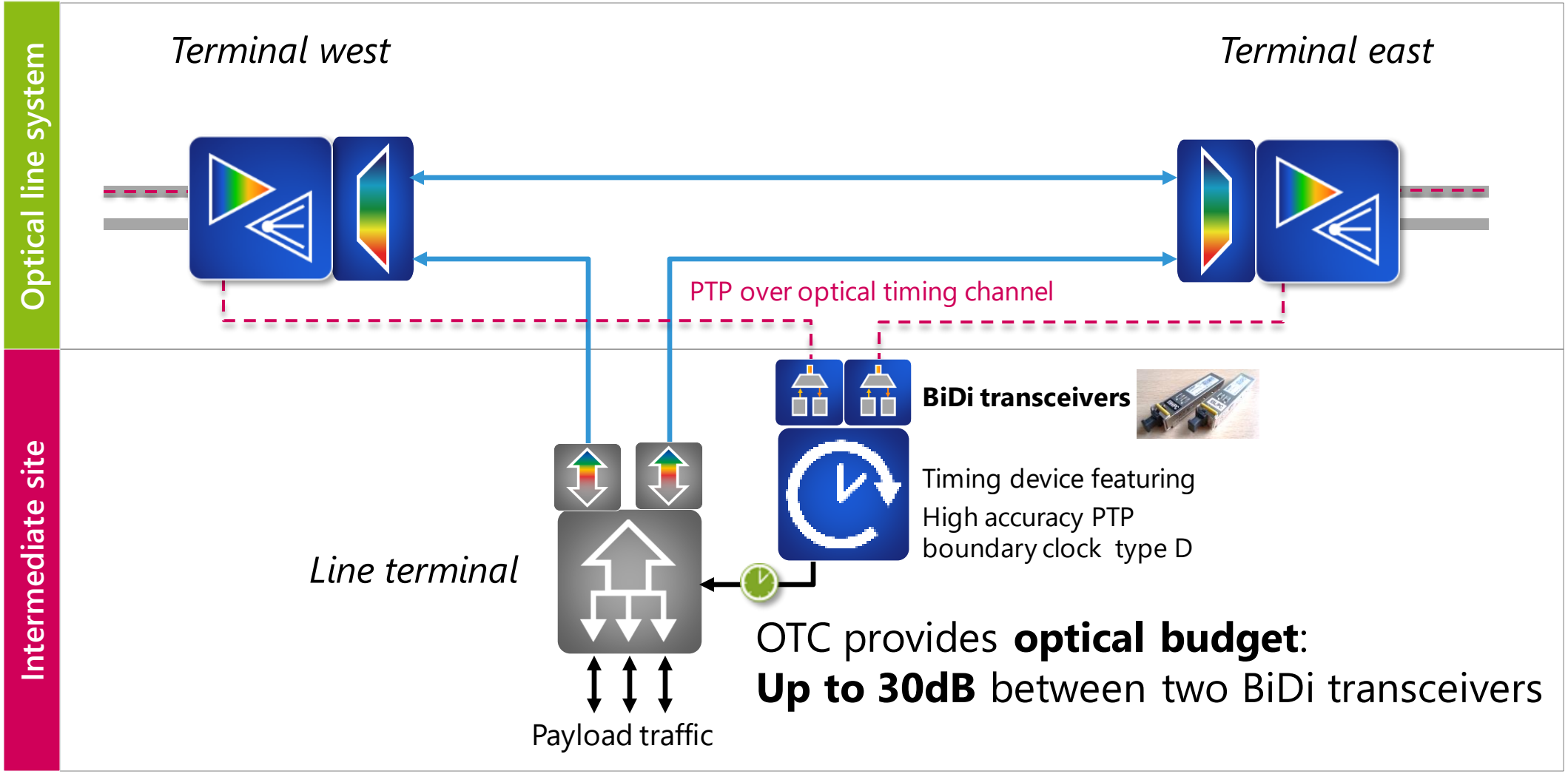
Node with OTC





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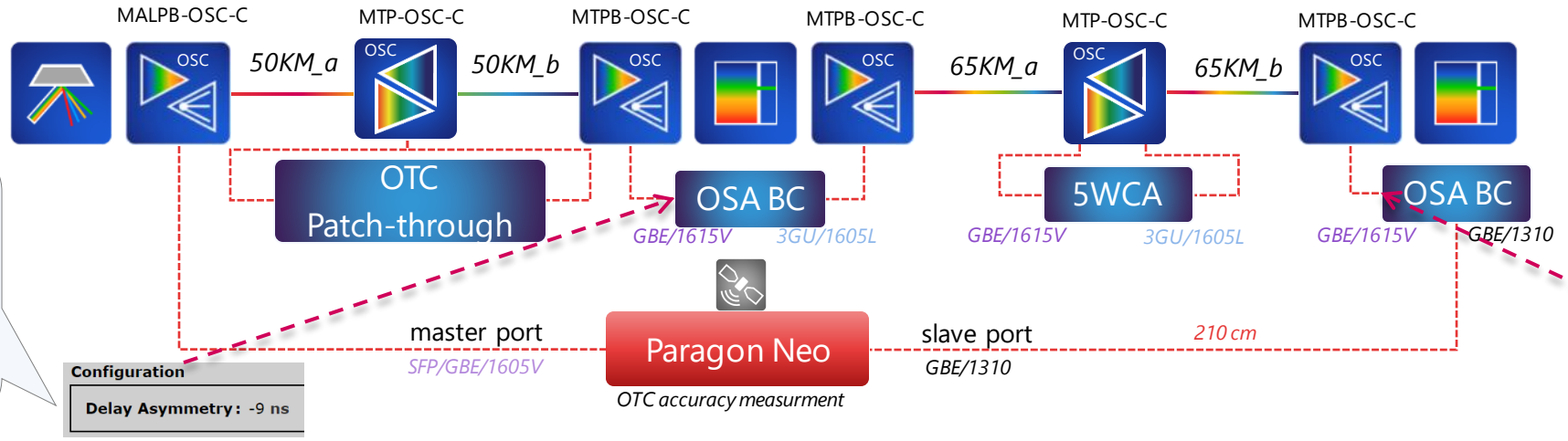
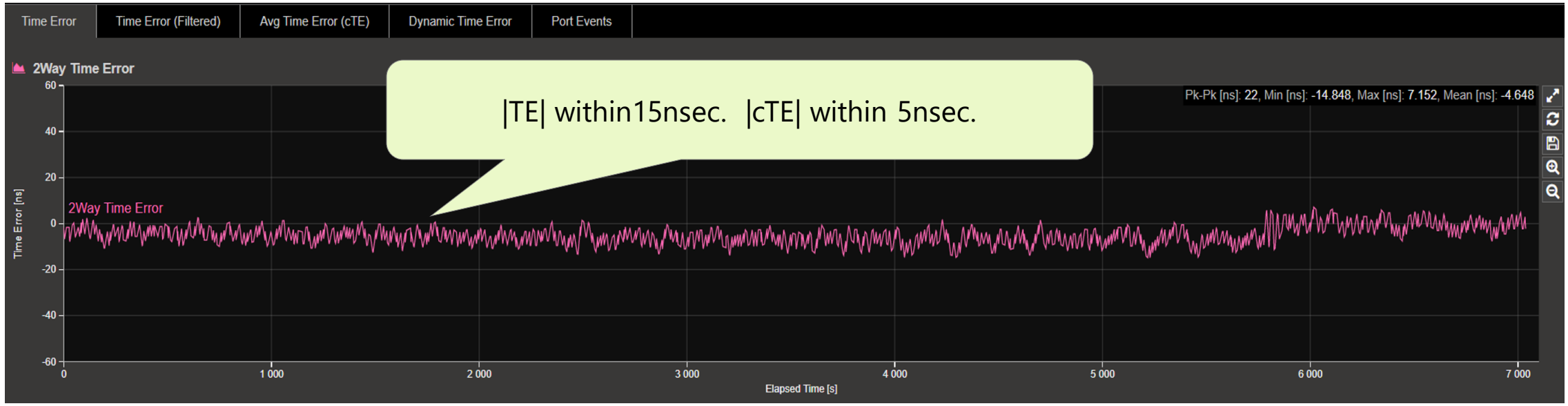
Know (fixed) asymmetry is configured on the BC port



$$cTE \approx \frac{100km}{2} * -10nm \frac{18ps}{nm\,km} = -9000ps = -9ns$$

$$cTE \approx \frac{130km}{2} * -10nm \frac{18ps}{nm\,km} = 11700ps = -11.7ns$$



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Summary

- Datacenters require stringent phase and time synconization
- Accurate synchronization reduce the probability of records inconsistency and reduce the need to rollback unresolved records
- “GNSS everywhere” is subject to GNSS vulnerabilities (jamming /spoofing etc’)
- ePRTC’s can be used to mitigate these risks
- Sub 100nsec accuracy can be delivered from core ePRTC sites to datacenters sites using optical timing channel combined with BC class D

ePRTC and GBaaS enable robust synchronization in datacenters

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Thank you

Pls contact me in case you have any comments or questions : nlaufer@adva.com

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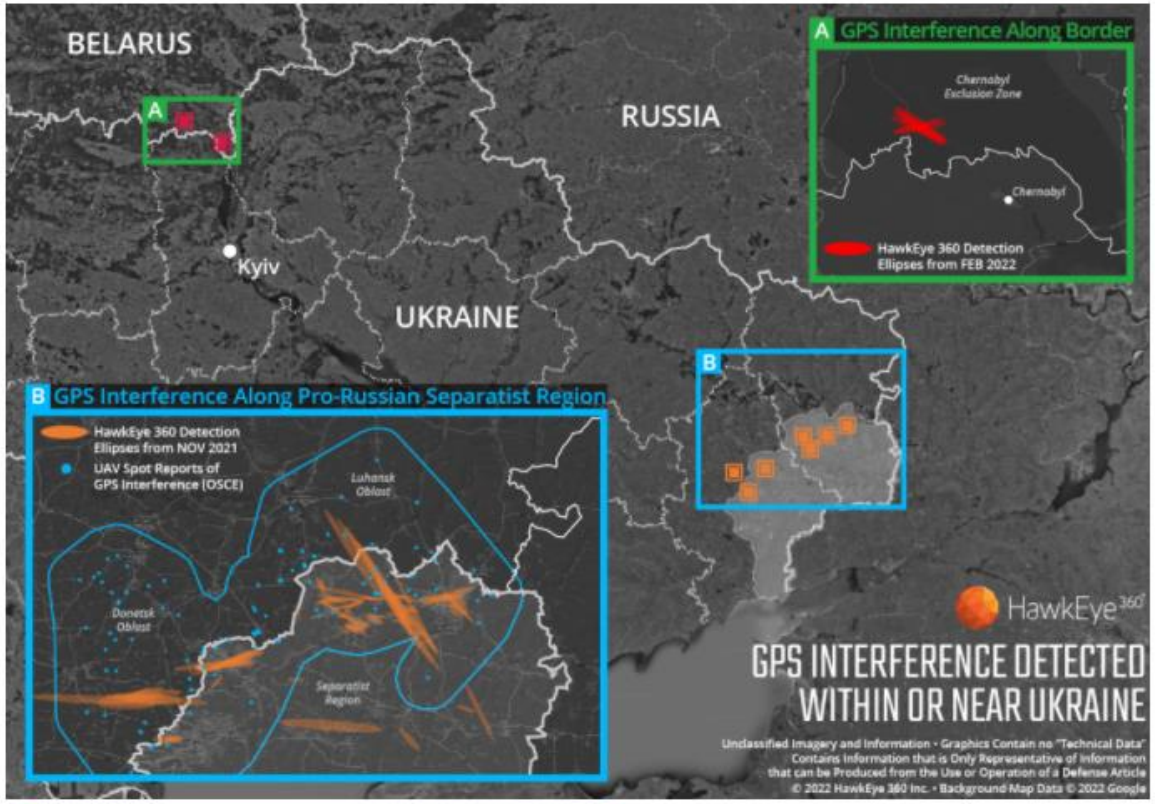
Why assured PNT?

HawkEye 360 Detects GPS Jamming Along Ukraine Border Prior to Russian Invasion

By **Anusuya Datta** - 03/04/2022 3 Minutes Read



HawkEye 360 detected GPS jamming along Ukraine border. Photo courtesy of HawkEye 360

https://www.he360.com/hawkeye-360-signal-detection-reveals-gps-interference-in-ukraine/

on 17th March 2022

WAR IN UKRAINE

EASA warns of intensifying GPS jamming incidents linked to war in Ukraine

VICTORIA BRYAN

European aviation safety authorities have warned of risks from increased incidents of GPS jamming, following Russia's invasion of Ukraine.

The jamming or spoofing of Global Navigation Satellite System (GNSS) signals has been observed by aircraft in various phases of flights, the European Union Aviation Safety Agency (EASA) said in a safety information bulletin (SIB) published on March 17, 2022.

EASA said that in certain cases the jamming and/or spoofing forced aircraft into "re-routing or even to change the destination due to the inability to perform a safe landing procedure."

GPS is the most well-known type of GNSS, which is where satellites are used for positioning data. GNSS is a common way for commercial aircraft to navigate to waypoints in the air and can also be used to position for landing. Loss of GNSS data could also trigger issues with terrain avoidance and wind shear alerting systems, EASA said.

MOBILITY

Russia responsible for GPS jamming in Europe, French air safety official claims

Finnish carrier Finnair reported GPS interference in flights over the Baltic sea near Kaliningrad in March • Copyright AXEL SCHMIDT / AFP

By **Tom Bateman** • Updated: 01/04/2022

Russia is to blame for recent GPS jamming incidents that have affected aircraft over Finland, the Baltic Sea and near Russia's Kaliningrad exclave, a top French air safety official has said.

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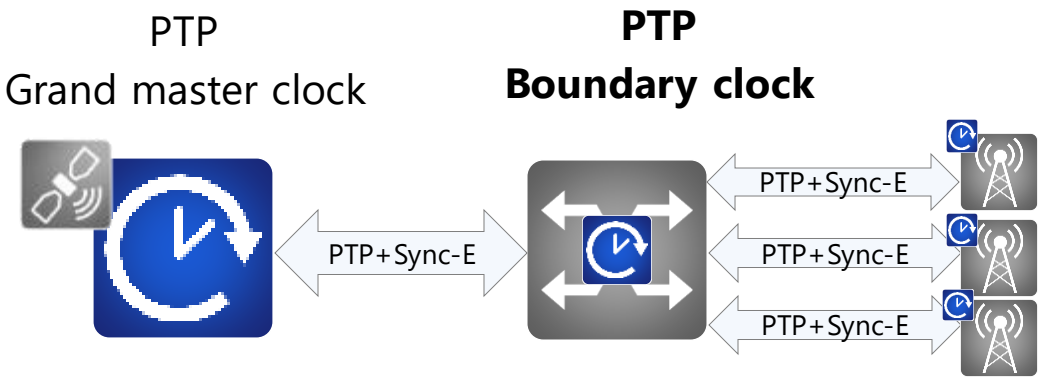
PTP Boundary clock classes

ITU-T BC Classes are defined in G.8273.2

BC main functions:

- Select best available master (BMCA)
- Filter input jitter (PTP/Sync-E)
- Regenerate PTP to distribute time to subtended devices



T-BC Class	max|TE| (ns)	max|TEL| (ns)	Constant Time Error (ns)	MTIE (ns)	TDEV (ns)
A	100	-	±50	40	4
B	70	-	±20	40	4
C	30	-	±10	10	2
D	FFS	**5**	FFS	FFS	FFS

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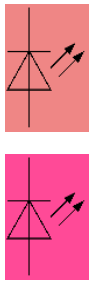
Chromatic dispersion creates asymmetric delay

Asymmetric delay results in a deterministic time error

λ_1 = 1.605µm

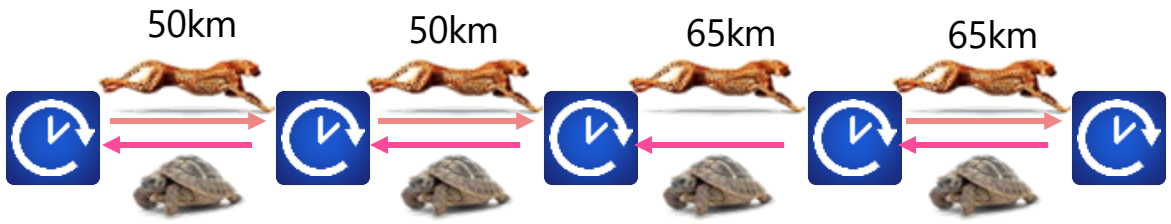
λ_2 = 1.615µm



100km of fiber with dispersion of 18ps/(nm km)

$$cTE \approx \frac{100km}{2} 10nm \frac{18ps}{nm\ km} = 9000ps = 9ns$$

Same east-west wavelength



Time error from chromatic dispersion: **19ns**

Constant and deterministic

Impact of chromatic dispersion can be efficiently compensated

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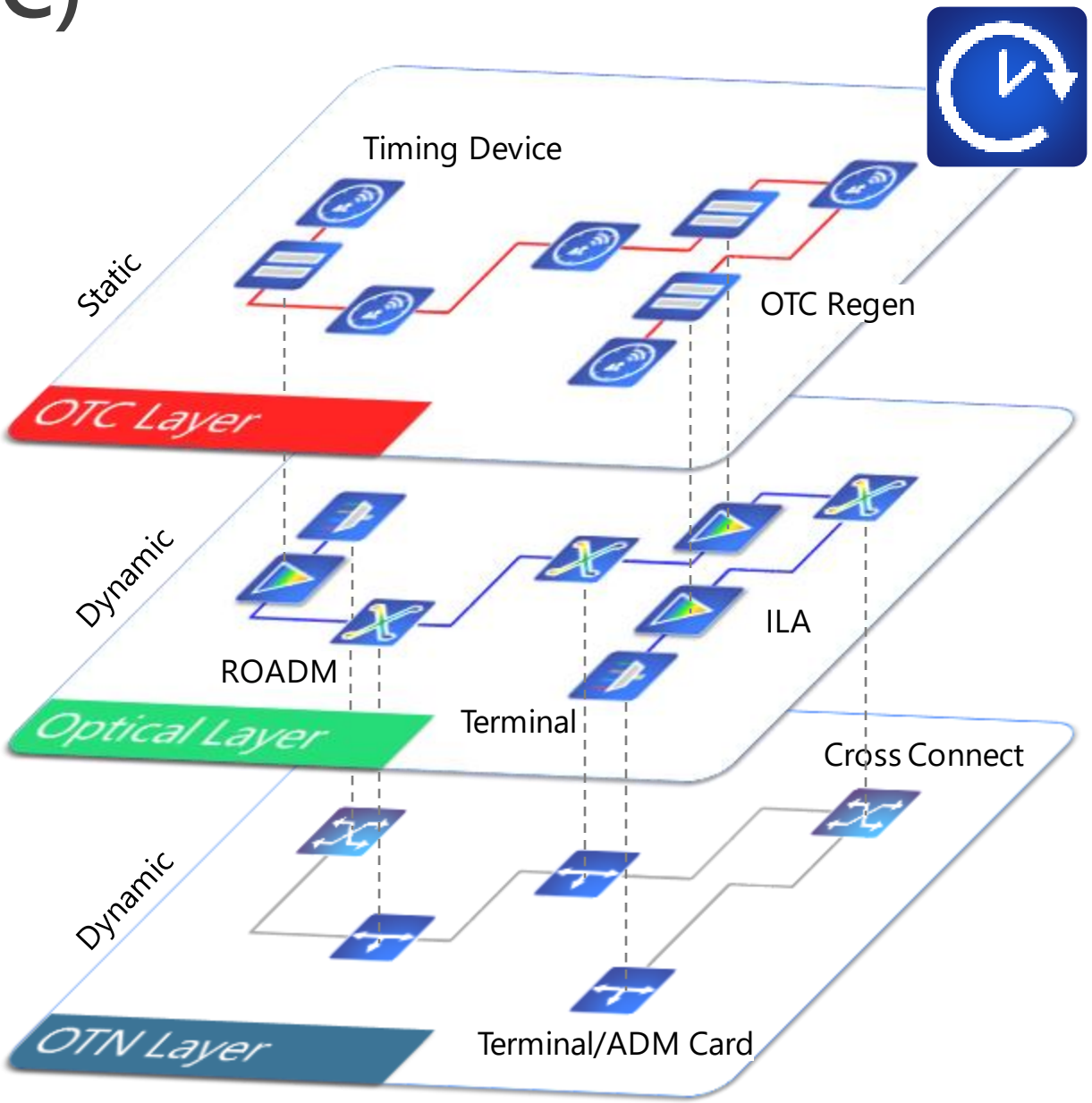
Optical Timing Channel (OTC)

The **Optical Timing Channel** (OTC) achieves **high-accuracy time distribution** by **PTP** (IEEE 1588) via Gigabit Ethernet **over dedicated wavelengths** on a **single fibre**

OTC has **minimal constant link asymmetry** due to bidirectional transmission on a single fiber.

OTC is **independent from other layers** (IP, Ethernet, OTN, reconfigurable optical layer) practically **eliminating dynamic time errors**

OTC **does not change optical network engineering rules** and is just an overbuilt to the optical transport layer



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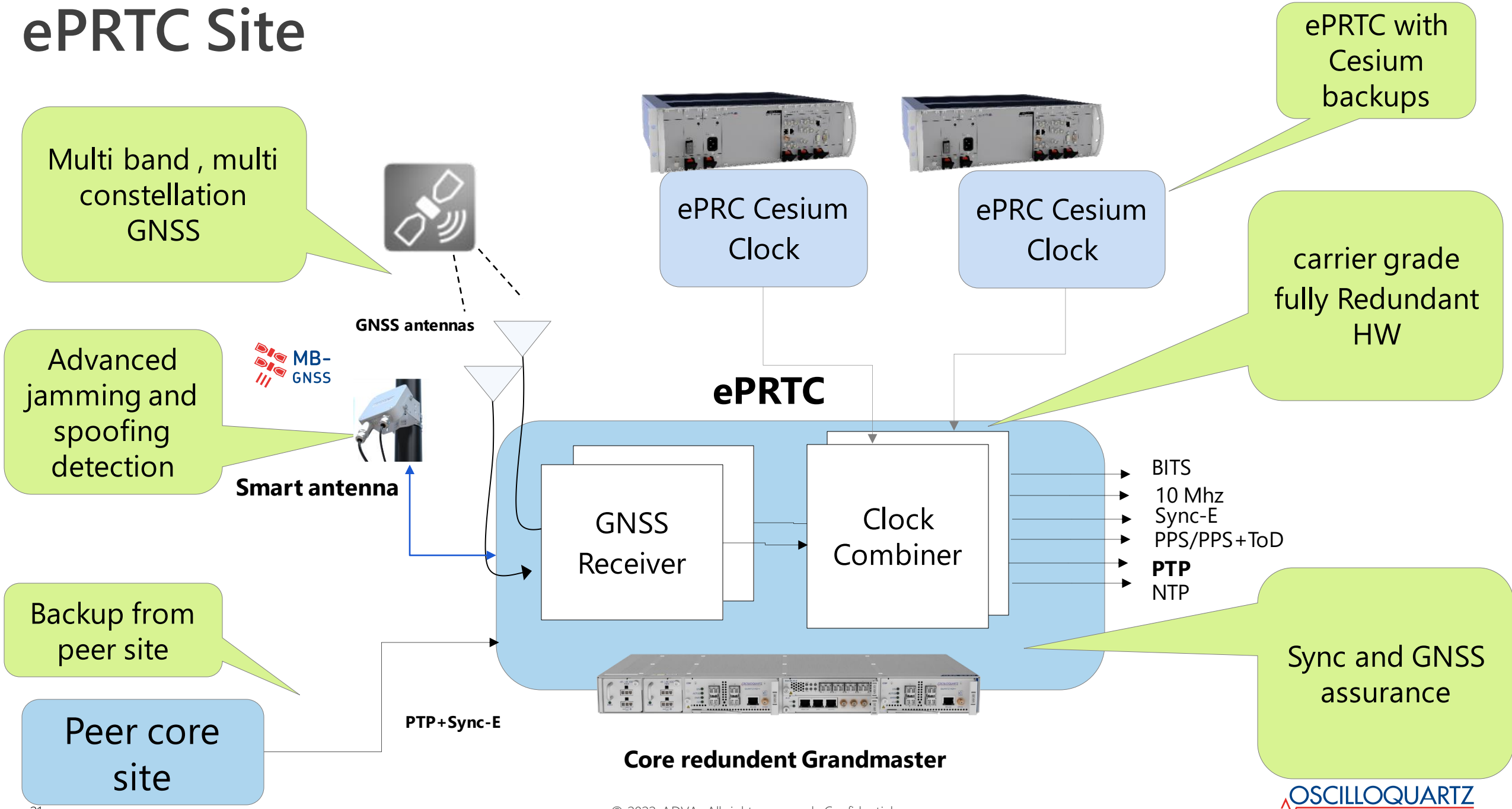
ePRTC Site



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