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Building on TAP

sync resiliency for the cloud

Ken Hann; WSTS 2023; Vancouver

Agenda

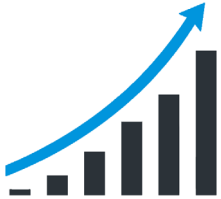
- Data centre / General trends
- Motivation for Synchronization with Software
  - Time Appliance Project
  - O-RAN architecture
- Software Synchronization and the virtual measurement
- Options; results; Interfaces;

General Trends

Miniaturization

Consolidation

Accuracy;
Resiliency;
Security



Cloud Trends

Scalability ➡ Explosive growth (synchronization management)

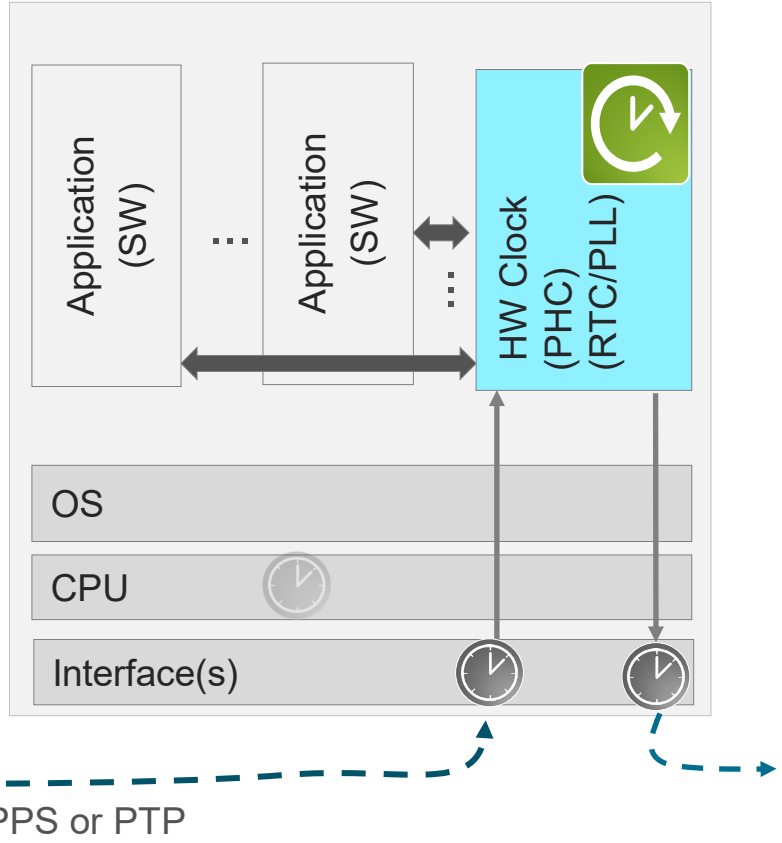
Sustainability ➡ Open Source (White Box) (efficiencies of scale)

New role of Software in synchronization

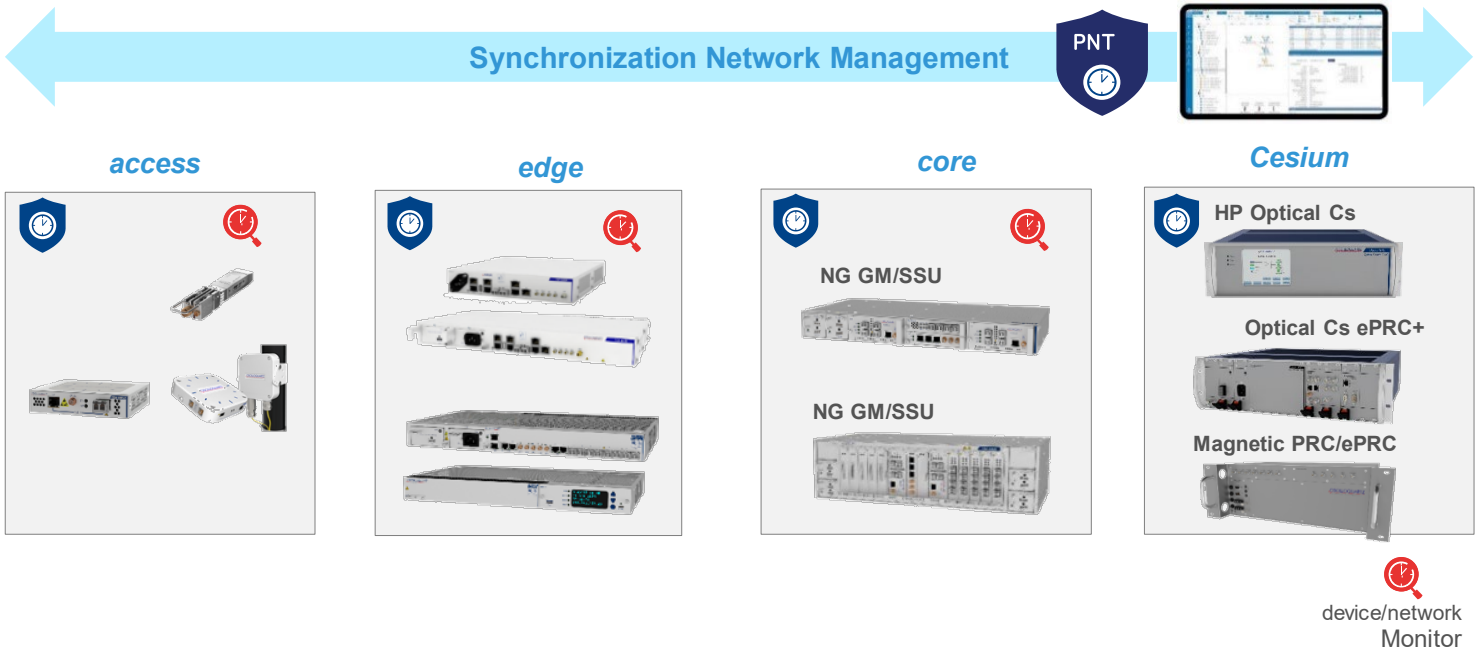
Clocks - Hardware with “soul”

- HW Timestamping of Events
- Accuracy HW (~1ns)
- Accuracy SW (~1us)

- Huge vendor investment
- (ORAN; TAP;



Existing clocks/applications use Dedicated HW



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Software Synchronization

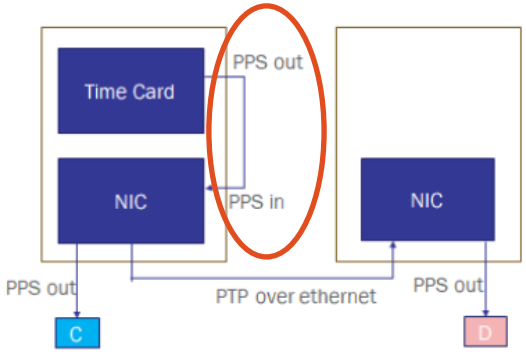
For Distribution?
Or
Local Application?

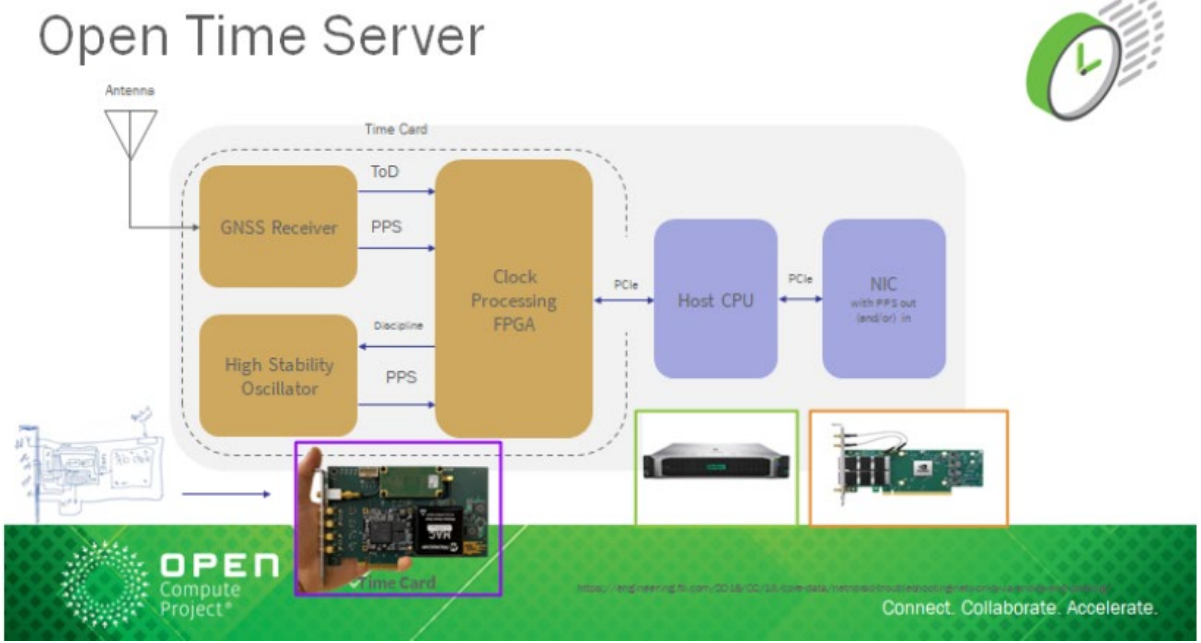
Datacenters - Open Time Server

= TimeCard + **Standard Server** + Standard NIC

- Interconnect via PCIe (using PTM)
- Optional PPS connections (pre-PTM)

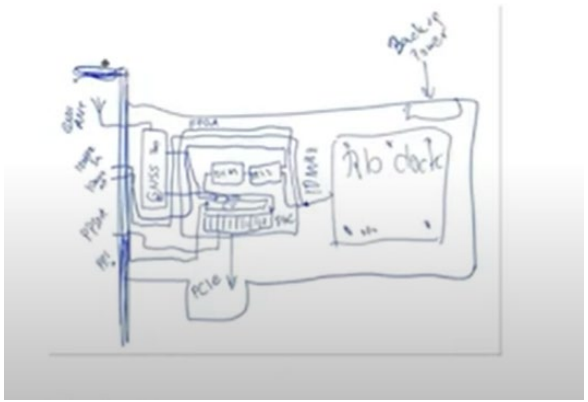
TAP use case:



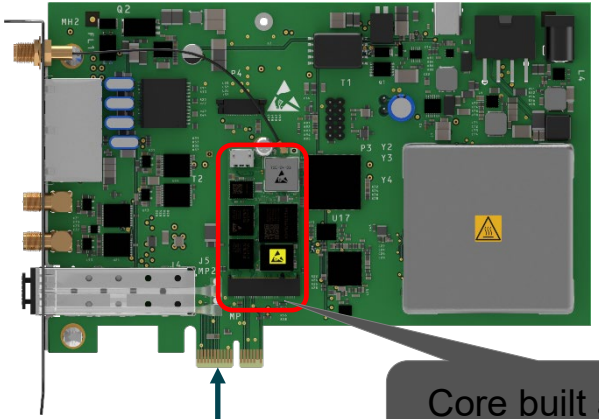


OSA PCIe TimeCard with M.2 module as core

Concept



Implementation



Core built as M.2 Sync Module

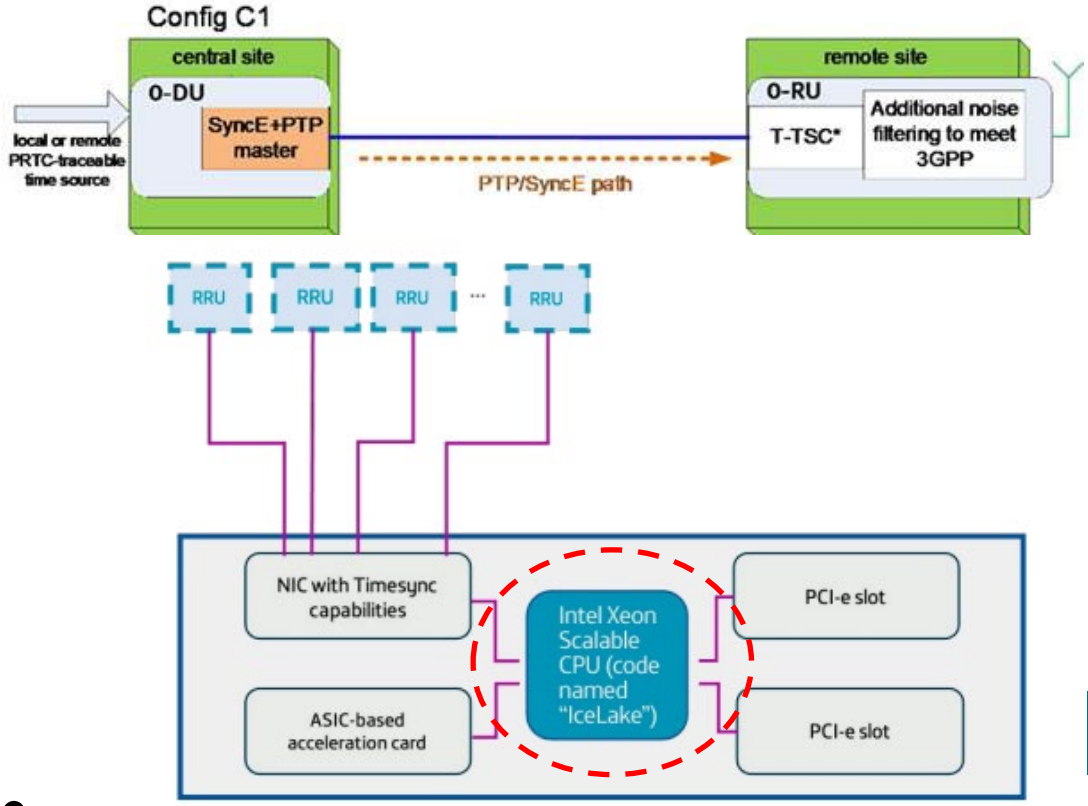
PCIe x 1

PCIe x1 (x2; x4)
SGMII x2

M.2 slot is commonly available and allows smooth sync add on

O-RU BASED ON WHITEBOX SERVER + NIC + ACCELERATOR

Telecoms - Open-RAN Architecture



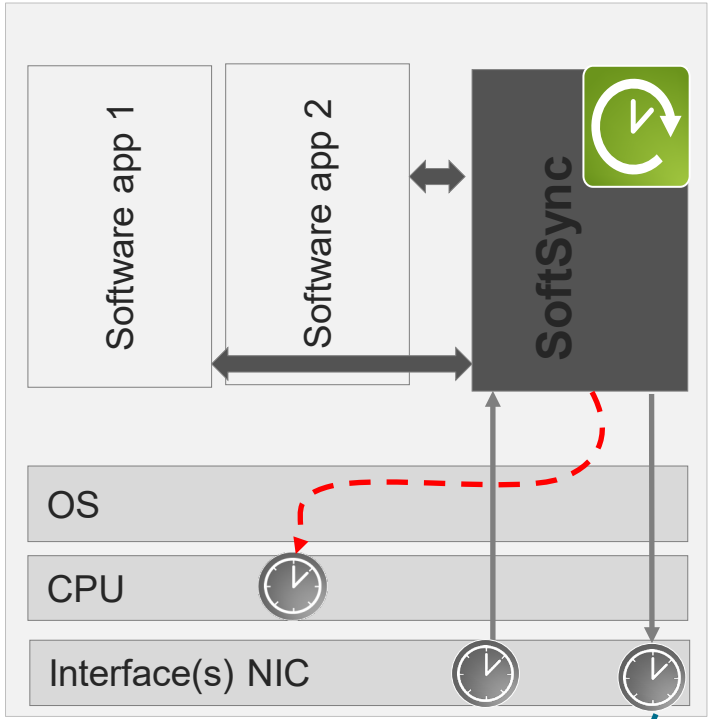
High accuracy sync over PCIe

Software Synchronization

HOW?

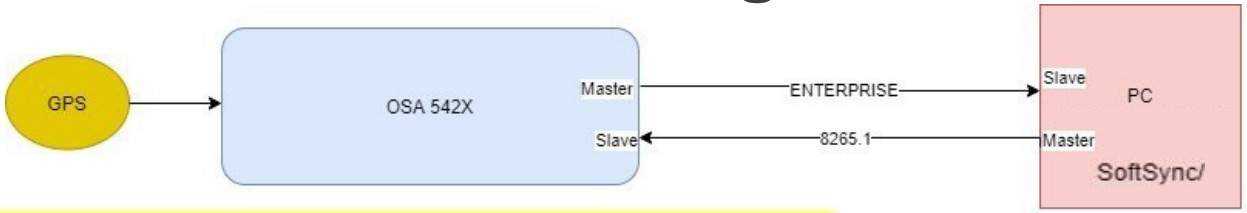
Whitebox server with SoftSync

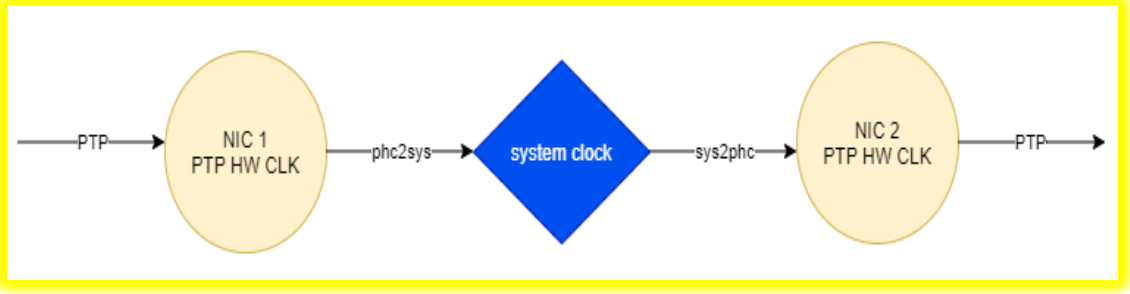
- HW Timestamping NIC (Intel)
- SoftSync PTP client on host machine
- Synchronizes OS with system APIs
- Performance ~ 100ns (Timestamping NIC)



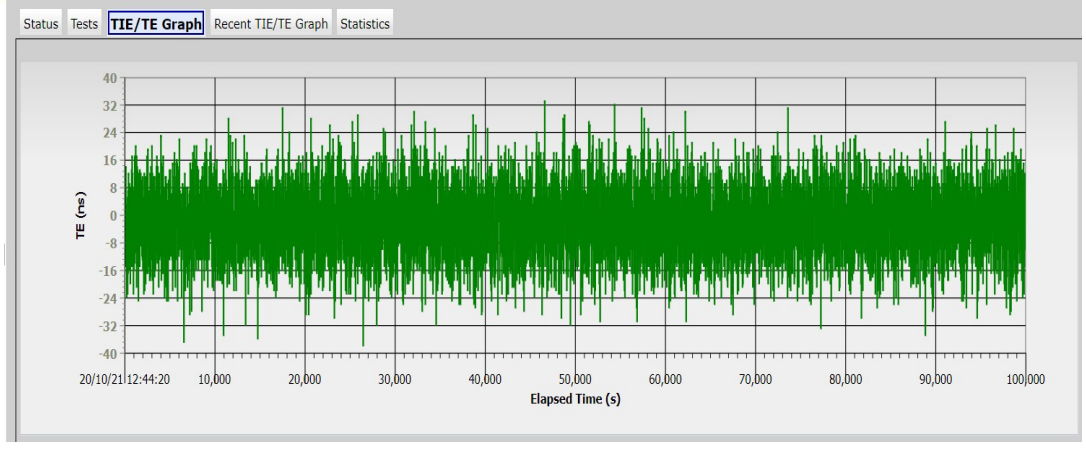
PPS or PTP

SoftSync Measurement using G.8265.1 Master



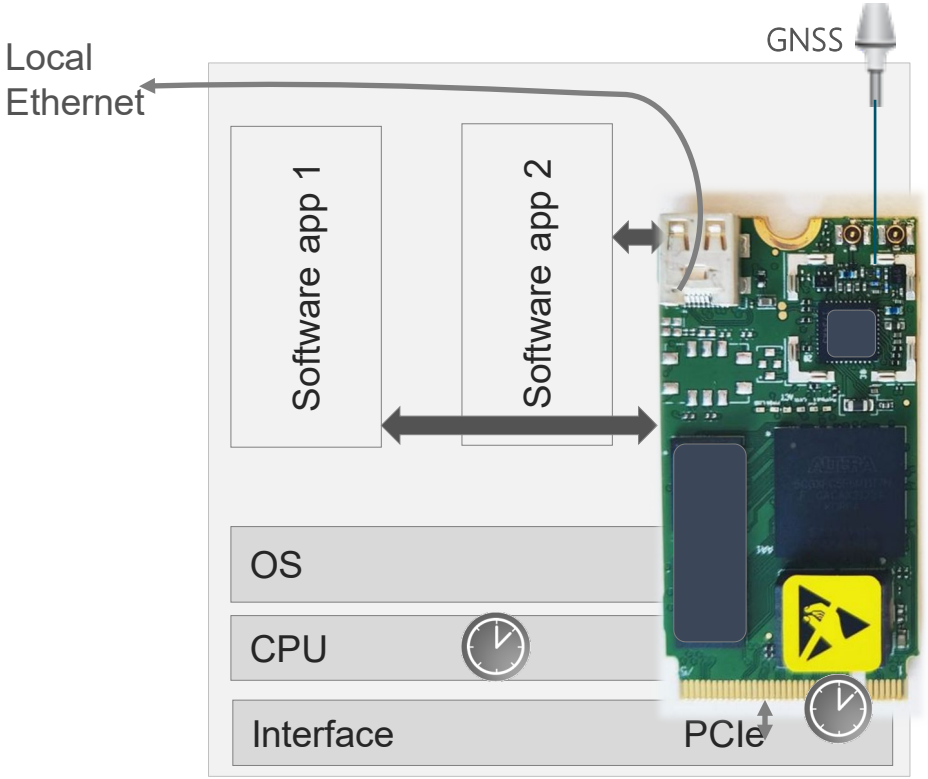


Back to Back

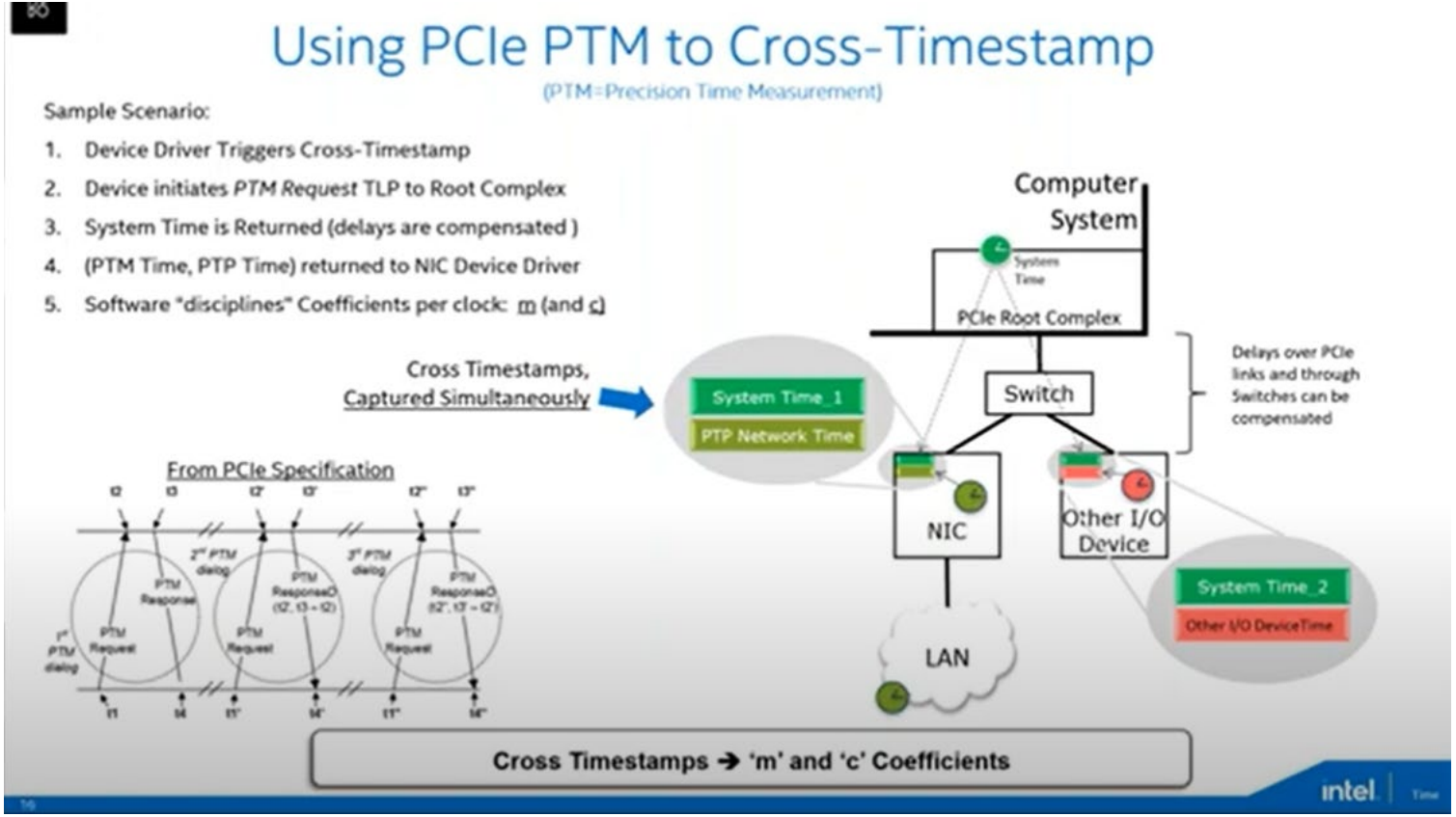


Whitebox server with PCIe / M.2 interface

- GNSS input
- Local Ethernet Port (PTP)
- No offset between GNSS and Ethernet
- PCIe port



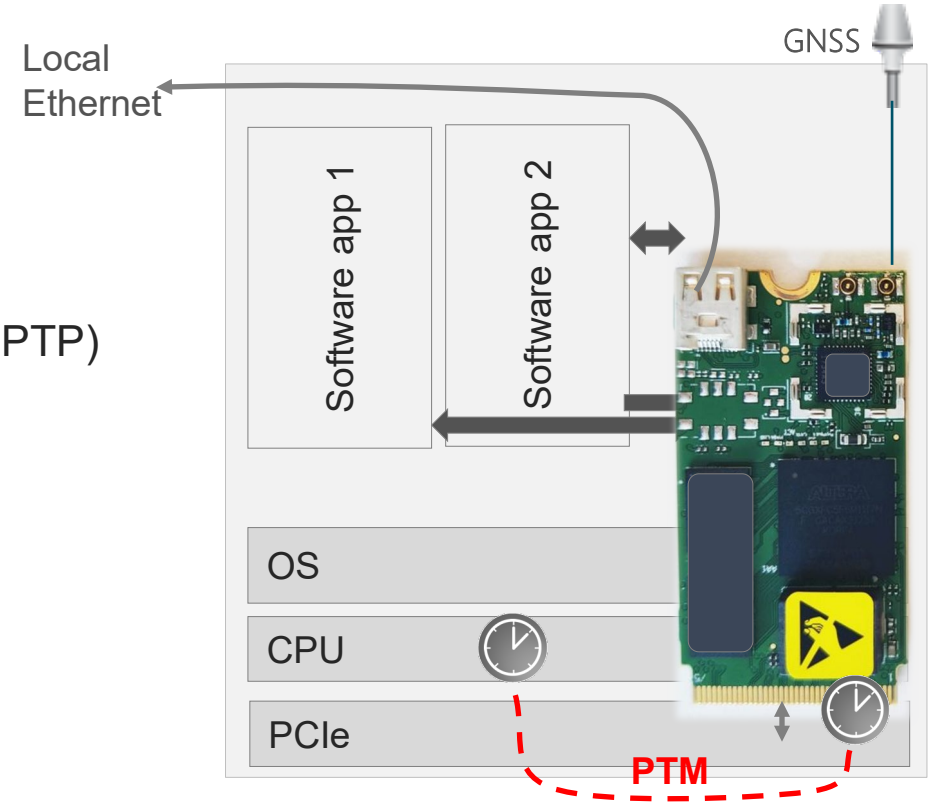
Synchronization over PCI-e (PTM)



Whitebox server with PCIe / M.2 interface

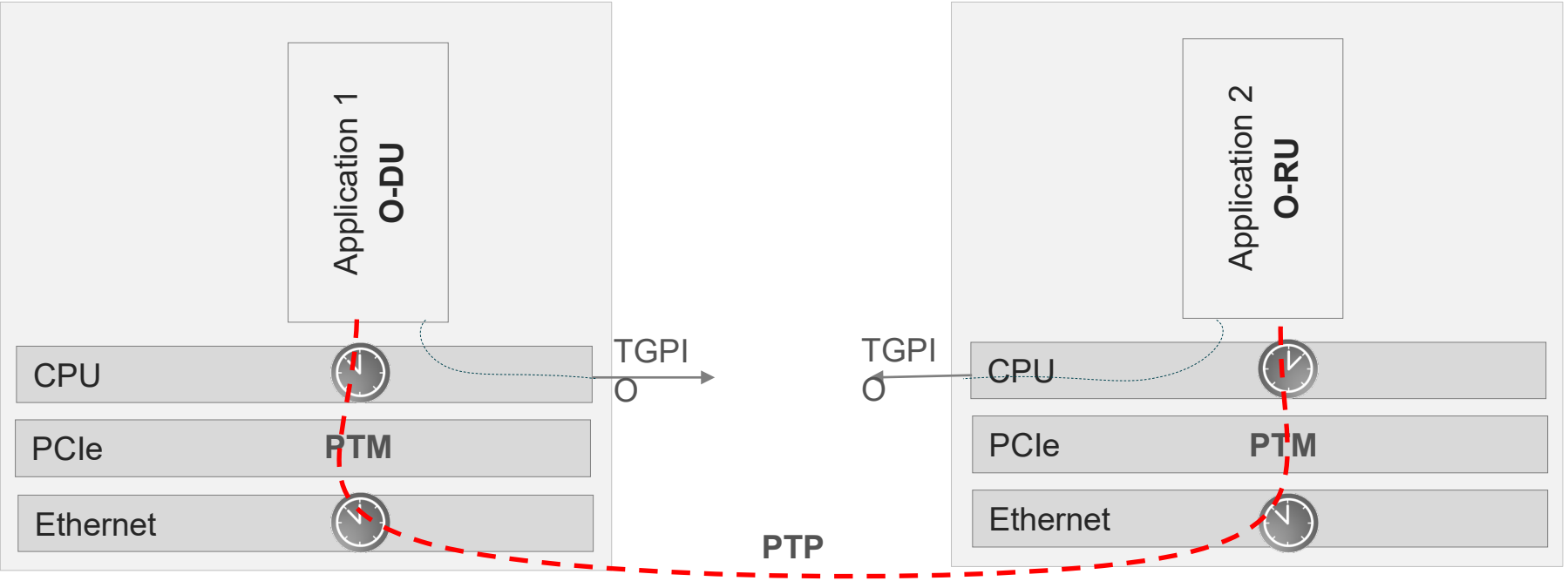
- PTM support on PCIe
- PCIe <-> CPU ~10ns
- CPU <-> OS ~ 1ns

- No offset between GNSS and Ethernet (PTP)
- Class C BC possible
- PTM becoming available



SYNCHRONIZATION OF VIRTUALIZED APPLICATIONS E.G. O-RAN

Infrastructure synchronized by SW



What Other Applications?

Conclusions

1) Highest Accuracy applications requires dedicated HW

2) Sync on COTs Server (TAP; O-RAN)
- Available today ~100ns (e.g SoftSync)
- PTM enables ~10ns accuracy (also for virtulized sw)
- PCIe = Timing interface

3) M.2 Sync Module = small footprint PCI-e

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Back-up slides

Measuring system clock

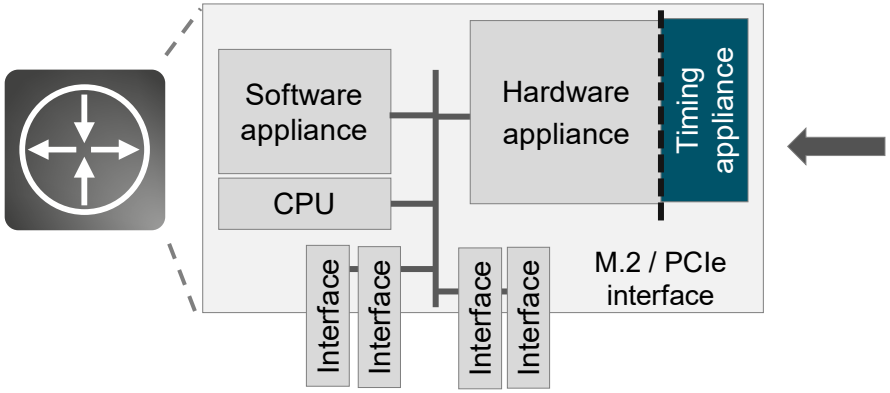
1. CPU clock Stability (measuring a moving target)
2. Time Aware GPIO pins
3. PTM capable PCIe interfaces to PHCs
4. Use of calibrated SoftSync Application
5. Other mechanisms?

May be simplier to maintain a known offset

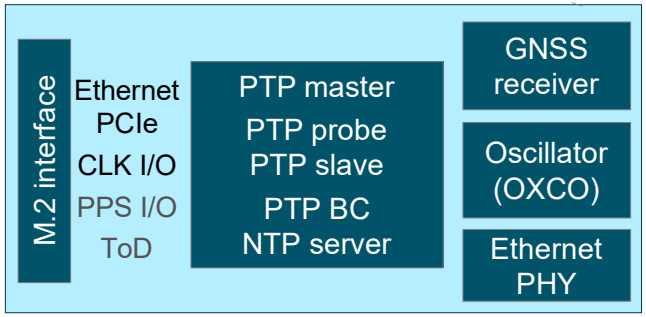
While M.2 Sync Module natively supports PCIe…

It can be extended to other applications

Generic architecture of a network device

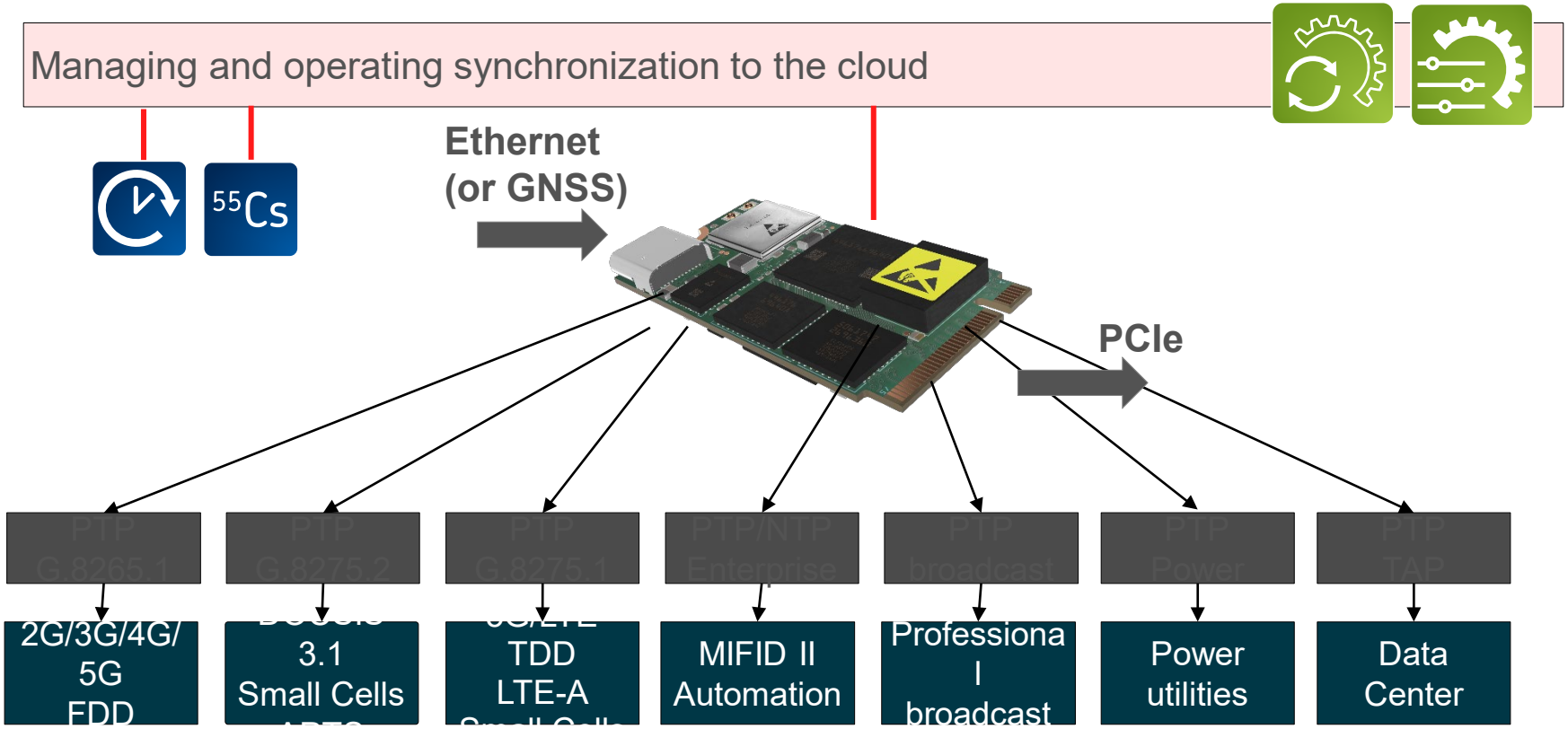


M.2 Sync Module



M.2 provides sync to host devices

M.2 Sync Module synchronize many applications



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Time Appliance Project

Open Compute Project https://www.opencompute.org/

Mission

1) Create specifications and references for **Data Center Timing** appliances, applications and networking infrastructure:
   - Open Time Server
   - DC profile coming...

2) Promote openness in **Timing Appliances** and interfaces through open-source implementations

RANKING MAY VARY…

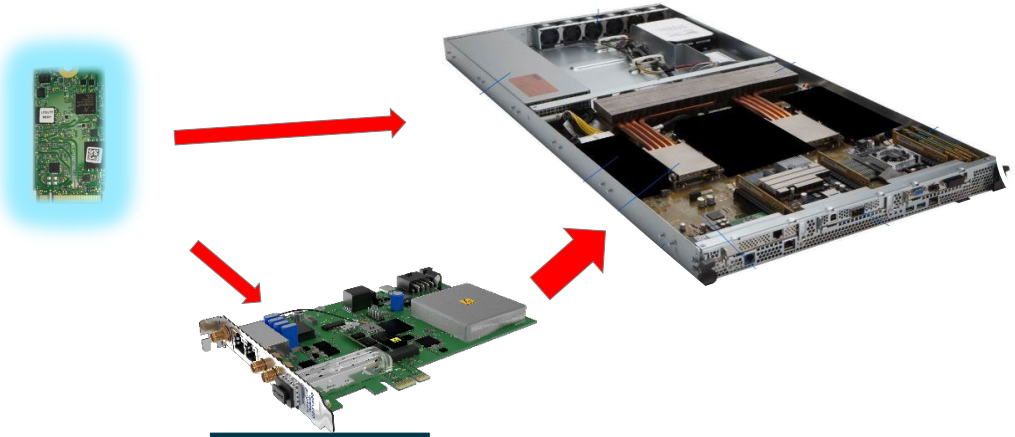
Major sources of Time error

Error Category	Error type	Solution
Antenna delay compensation	Offset; Hassle	Use PTP from antenna
PTP over non-sync network	Risk	High packet rate; Evaluate; Monitor; Pray...
PTP over PCI-e (Soft Sync…)	Temporal	PCI-e with PTM support; (PPS connection)
GNSS outages	Risk; Bomb	Backup; Multiband GNSS; Spoofing mitigation;

Synchronization is a discipline

How to interface to a WhiteBox Card or Server

Module
M.2 interface to Host



Embedding timing expertise in 3PP network devices

Introduction- M.2 SyncModule

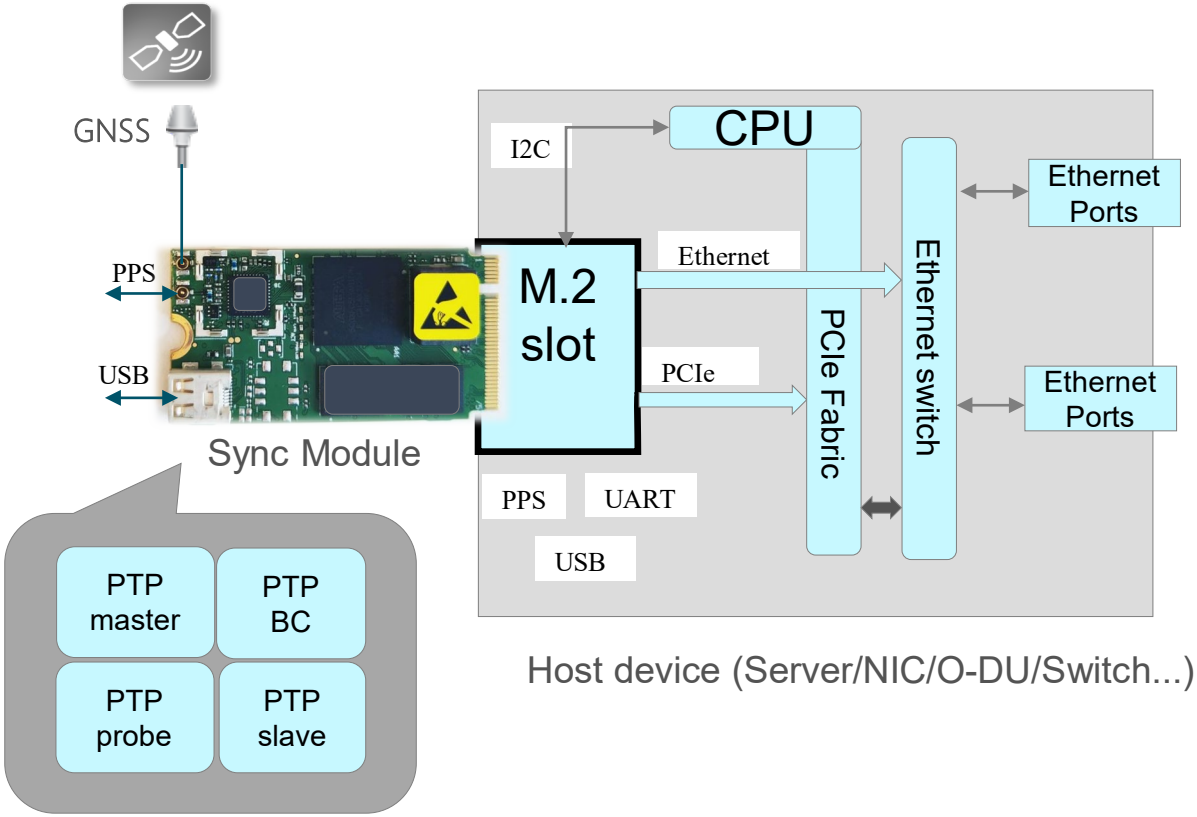
- Low-power, solution
- Easily integrated into systems due to M.2 interface
- Extended temperature range -40°C to +85°C components

Comprehensive sync capabilities

- IEEE 1588 PTP grandmaster/boundary/slave clock
  - Up to 64 unicast clients at 128pps
  - Multiple PTP profiles
  - PTP profiles conversion
- GNSS receiver
- NTP server
- PTP input as backup to GNSS (APTS)
- Sync probe
- Sync-E In/Out
- OCXO based holdover

IT CAN BE EXTENDED TO OTHER APPLICATIONS

While M.2 natively supports PCIe…



TimeCard

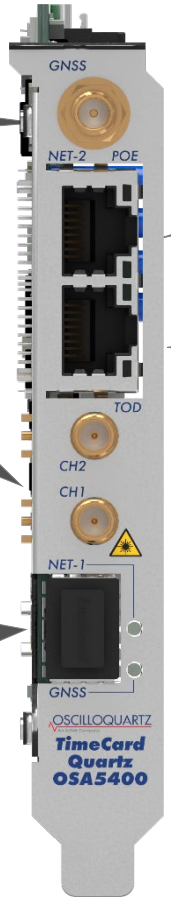
GNSS antenna input

100M/1G copper +PoE Output

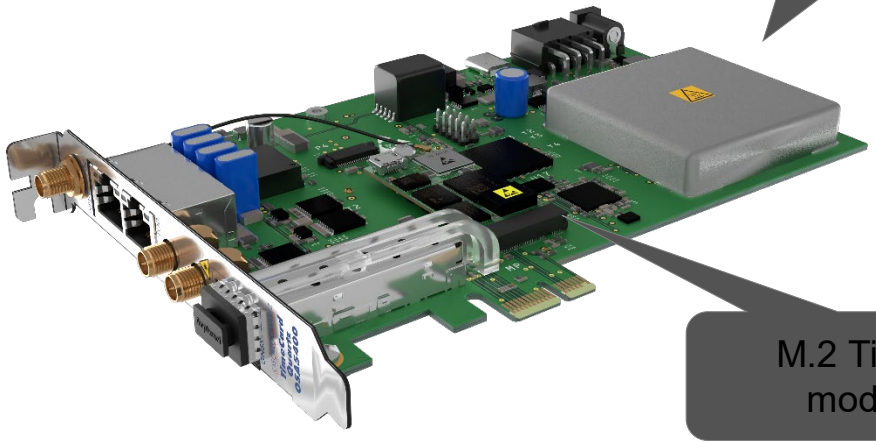
PPS+TOD (HW ready)

CH1/CH2 I/O (PPS/CLK)

1G Fiber



Qz/HQ+/HQ++/Rb options - extended holdover



M.2 Timing module

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Using Smart Antenna to help with cabling