



Syncing the cloud - from T1 to TAP

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Agenda

- The rise of the data centre and general trends
- Time Apliance Project
- 5G O-RAN architecture and synchronization in white box environments
- Interfaces for bringing synchronization to applications

From T1 to TAP

A time check on Sync...

First T1 "leased line"
billed by AT&T

NTP

GPS

ATM/PWE3

PTPv2 2008

TAP

1960

1970

1980

1990

2000
G.Pactiming

2010

2020

First T1 lines deployed on
intercity trunks

**G.81x
(SDH)**



PRTC



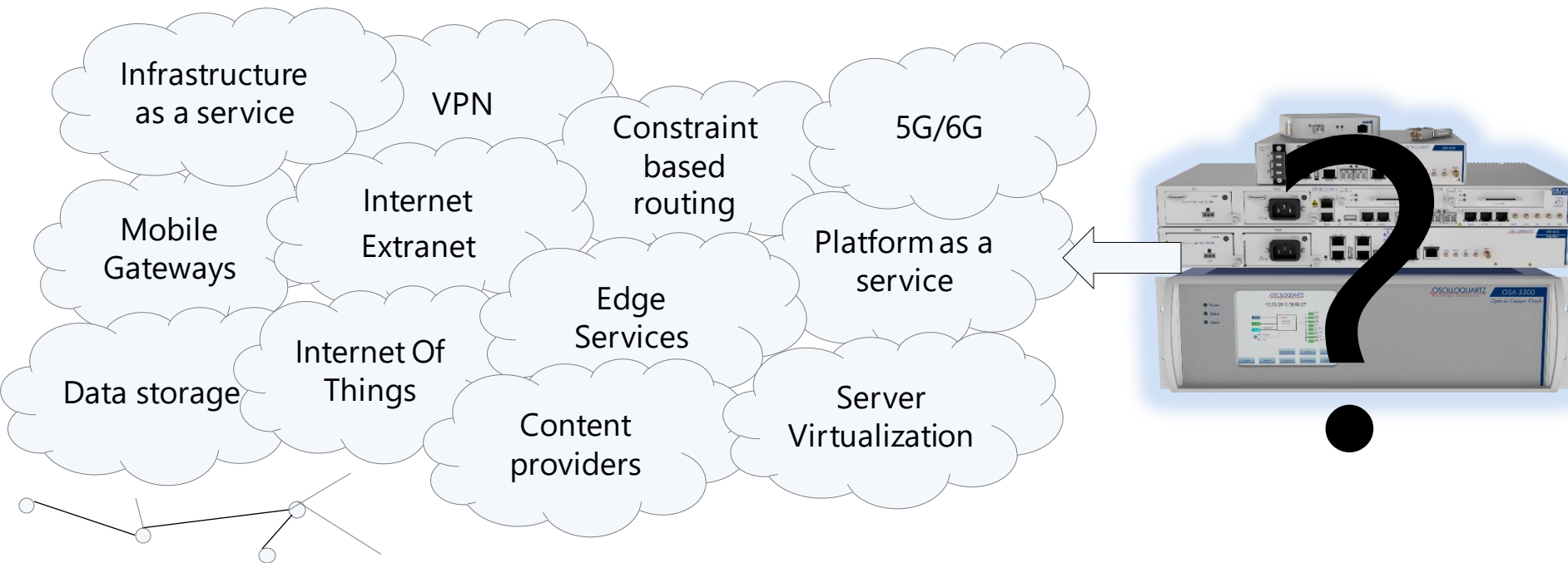
Telecom!
Can't you
behave like an
Ordinary clock?



From Telecoms (networks) to Data (centeric)

The Cloud needs sync...

And the cloud is in the Data Center/Mobile...



How to connect Sync to the cloud?

General Timing Trends and Cloud Trends

General:

Miniaturization



Consolidation



Cloud:

Scalability (synchronization management) \Rightarrow Explosive growth

Sustainability (efficiencies of scale) \Rightarrow Open Source (White Box)



The Cloud impacts the future of Synchronisation

Major sources of Time error

Ranking may vary...

Error Category	Error type	Solution
Antenna delay compensation	Offset; Hassle	Use PTP from antenna

Synchronization is a discipline

Time Appliance Project

Platform for cross-industry Sync with focus on DataCenters

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...



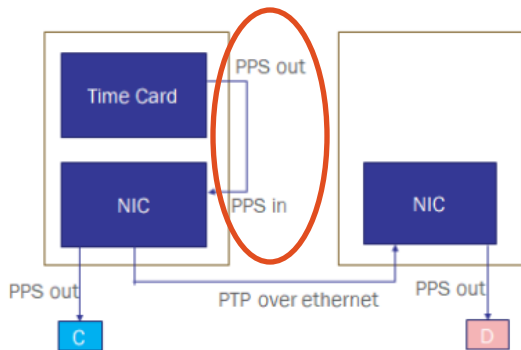
2) Promote openness in **Timing Appliances** and interfaces through open-source implementations

Open Time Server

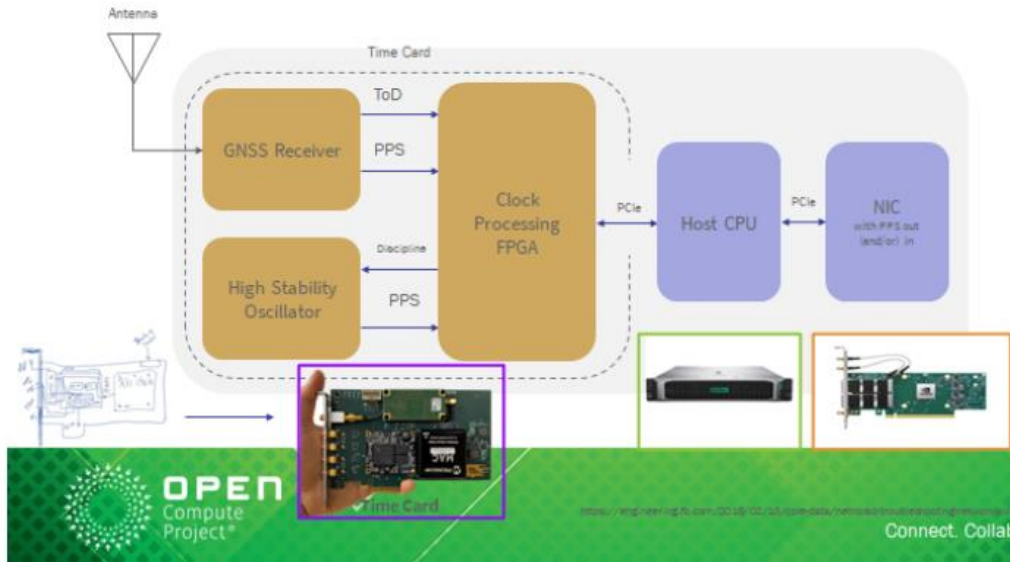
= TimeCard + Standard Server + Standard NIC

- Interconnect via PCIe (using PTM)
- Optional PPS connections (to ensure high accuracy)

TAP use case:

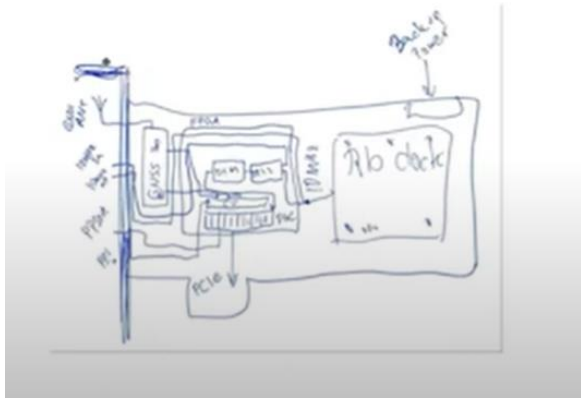


Open Time Server

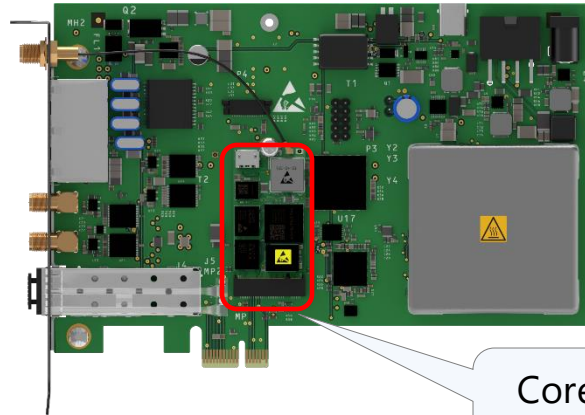


PCIe TimeCard with M.2 module as core

Concept



Implementation

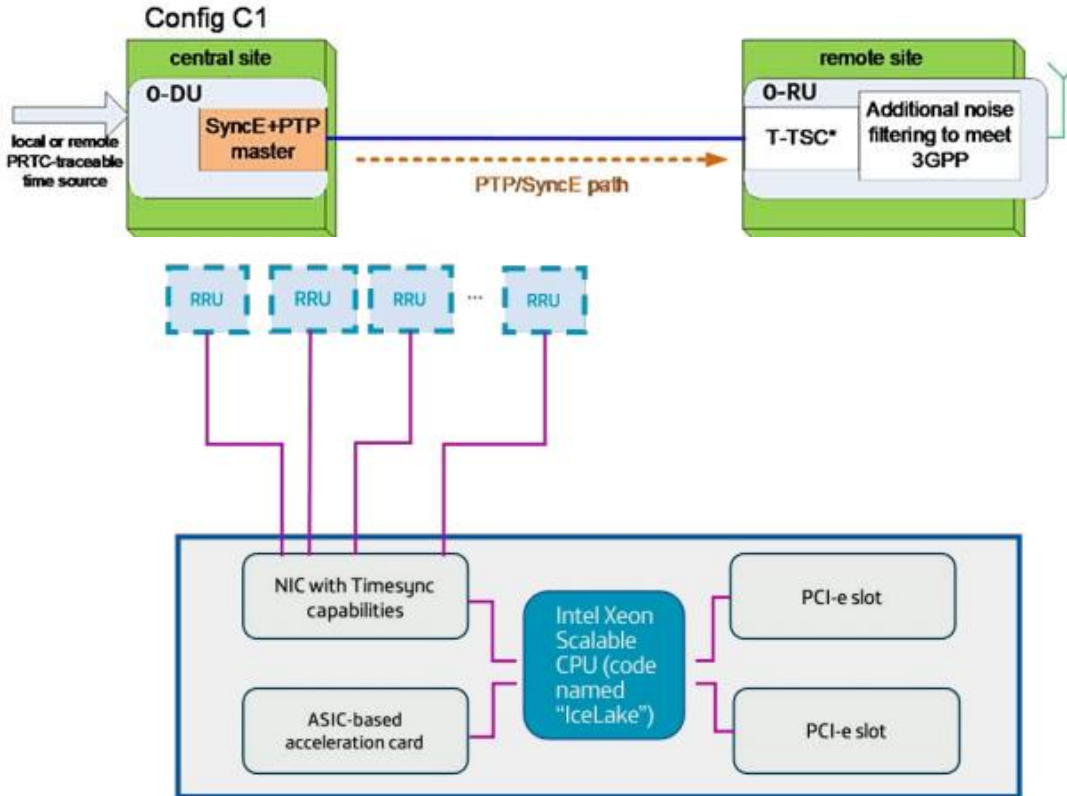


Core built as M.2
Sync Module

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

Open-RAN Architecture Config C1

O-DU based on whitebox server + NIC



PCI-e is becoming a sync interface

Synchronization over PCI-e (PTM)

Precision Time Measurement

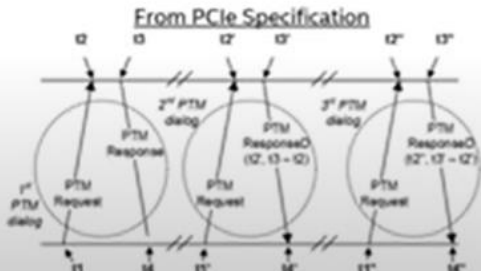
Using PCIe PTM to Cross-Timestamp

(PTM=Precision Time Measurement)

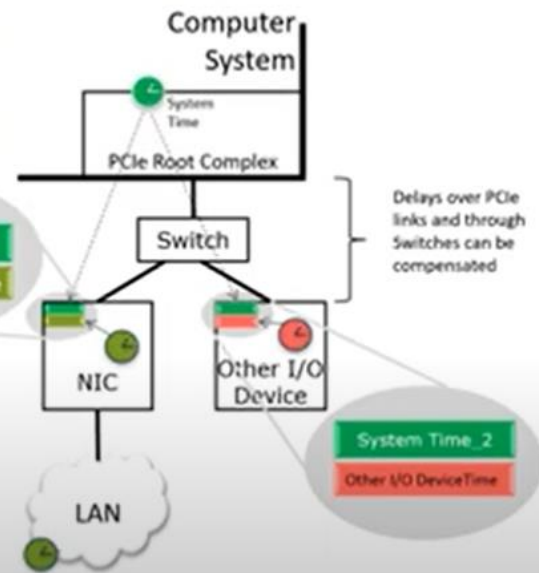
Sample Scenario:

1. Device Driver Triggers Cross-Timestamp
2. Device initiates *PTM Request* TLP to Root Complex
3. System Time is Returned (delays are compensated)
4. (PTM Time, PTP Time) returned to NIC Device Driver
5. Software "disciplines" Coefficients per clock: m (and c)

Cross Timestamps,
Captured Simultaneously



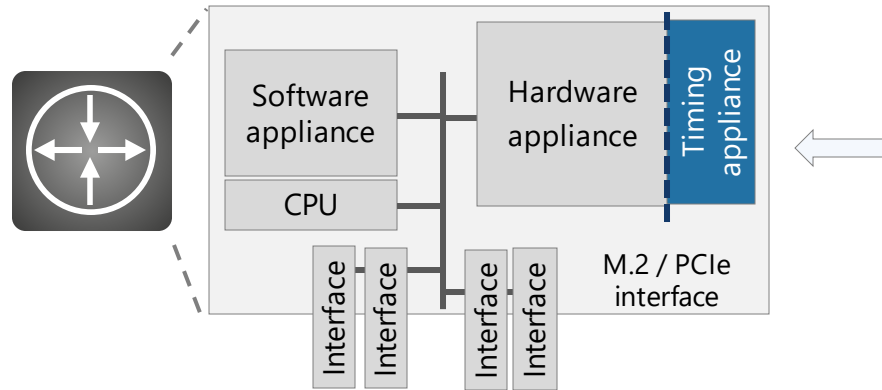
Cross Timestamps → 'm' and 'c' Coefficients



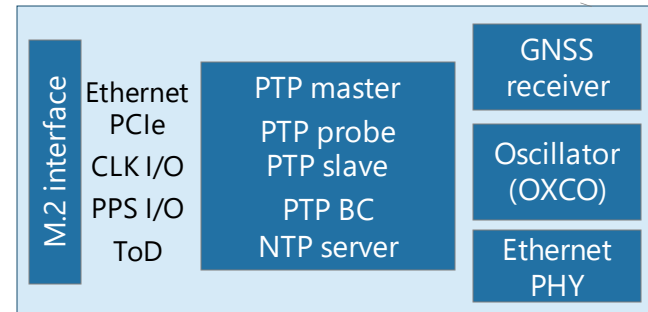
While M.2 Sync Module natively supports PCIe... It can be extended to other applications



Generic architecture of a network device

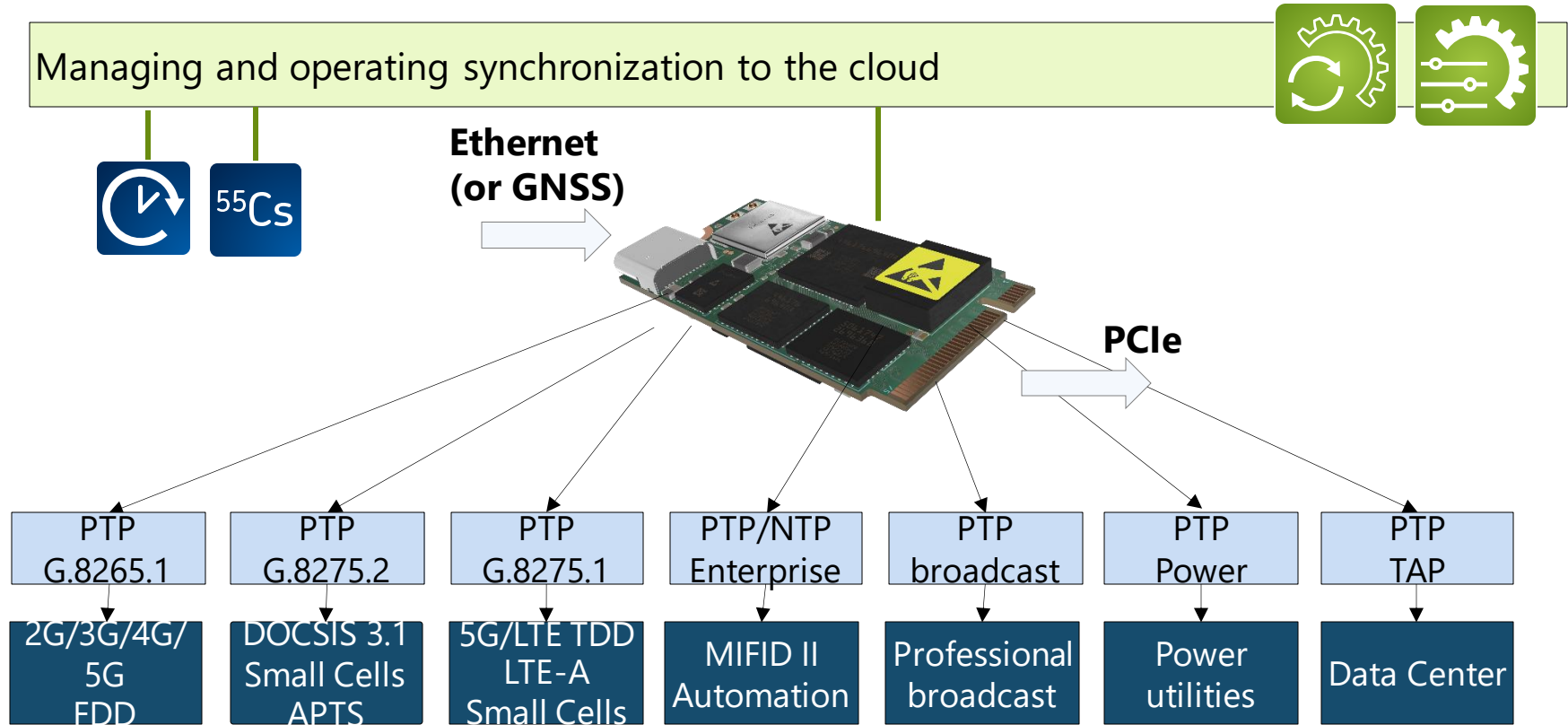


M.2 Sync Module



M.2 provides sync to host devices

M.2 Sync Module synchronize many applications



Conclusions

- 1) General move from Transmission centric to Data centric
 - Explosive growth of "the Cloud"
 - Cloud Services need high accuracy Sync (TAP; O-RAN)
- 2) Cloud HW based on COTs Server (TAP; O-RAN)
 - PCIe becoming a high performance Timing interface
- 3) M.2 Sync Module proposed as a flexible solution for PCI-e and other applications



Thank you

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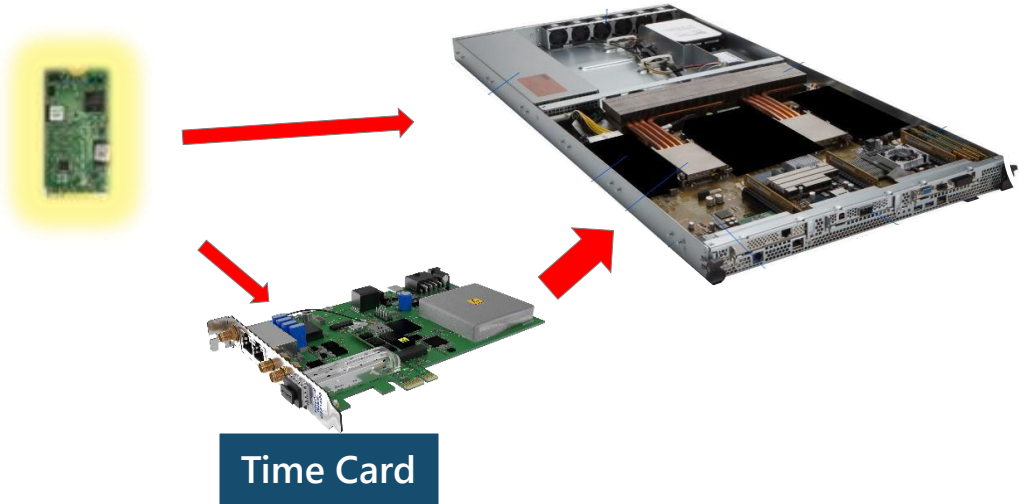
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Back-up slides

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



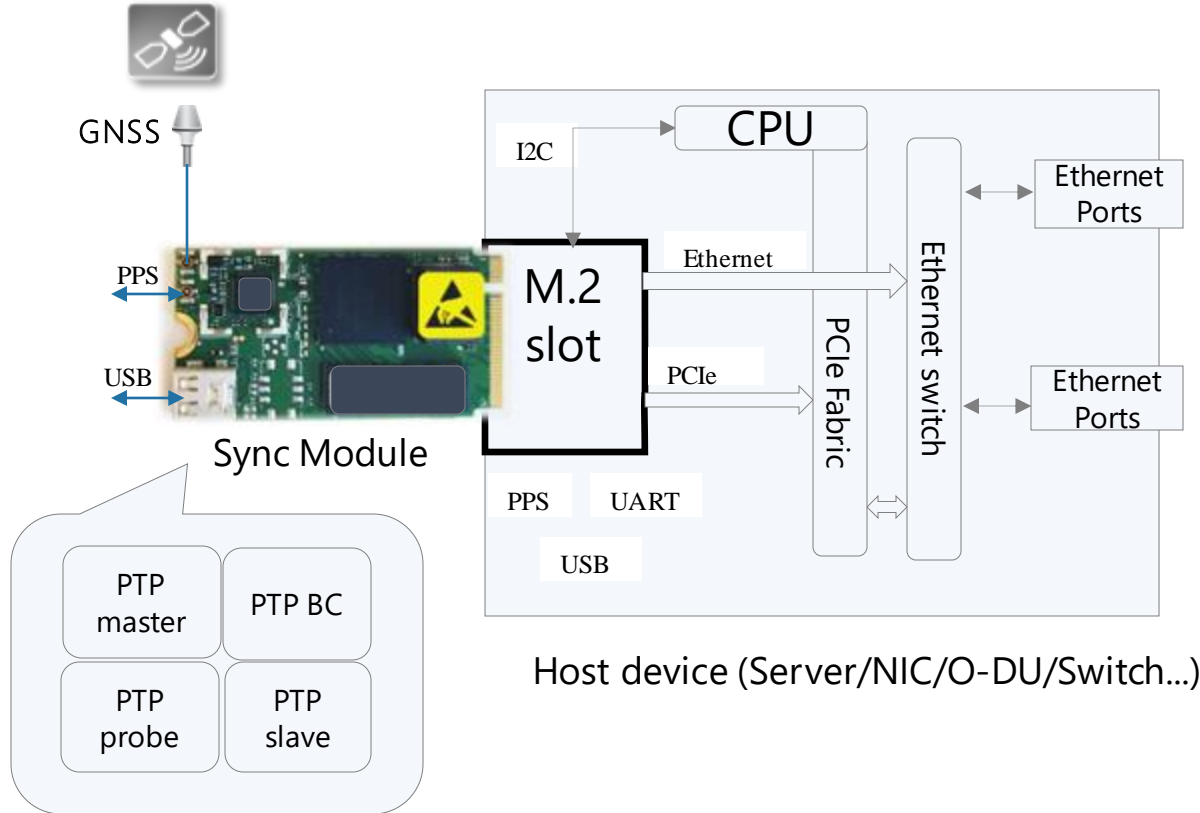
- Low-power, solution
- Easily integrated into systems due to M.2 interface
- Extended temperature range -40°C to +85°C components

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

While M.2 natively supports PCIe...

It can be extended to other applications



TimeCard

