OSCILLOQUARTZ
An ADVA Optical Networking Company

70 YEARS
TIMING EXCELLENCE

Recent Growth in Timing

WSTS 2019, San Jose, March 2019
Gil Biran

Precise synchronization has become essential

Distributed compute processes with critical infrastructures and the industrial Internet rely on precise time for coordination

Precise synchronization of **radio access networks** is fundamental for public and private mobile communication infrastructures

Positioning services for defense, aviation, seismology and many other applications need accurate time for precise localization

Financial transactions and certain **security applications** require trustworthy and precise time for auditable transparency

A growing number of applications requires an increasing precision in timing

Network synchronization – moderate cost, high impact

Sync failure → network outage

Synch investment (< 1% of network cost) is not creating direct service revenues, it is enabler (e.g. 5G).

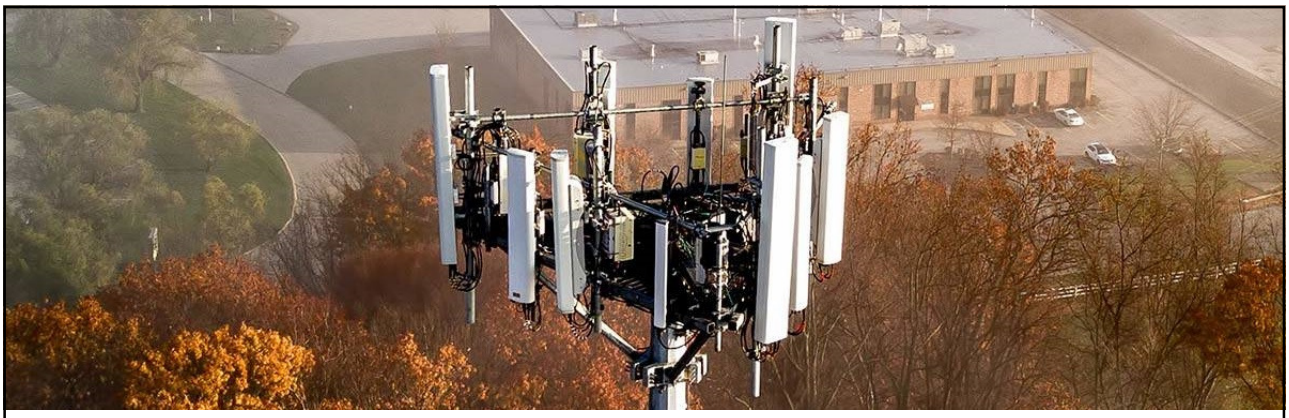
Inaccurate timing impacts service revenues by performance degradations, service outages or even catastrophic failures

- No compromises with timing accuracy
- Resilience by combining multiple sync technologies and suppliers
- Loose integration for agility, speed and vendor-neutrality

Lack of customer awareness – there is a high likelihood that sync accuracy is at risk

Tier-1 markets, applications and industry verticals

Radio access networks	Highly accurate phase and frequency synchronization for efficient use of spectrum	
	Timing distribution to remote-PHY devices in digital infrastructure deployments	Digital cable networks
Power utilities	Higher accuracy and uncompromised reliability for mission critical applications	
	Migration from NTP to PTP-based timing for increased time stamping accuracy	Financial trading
Data center infrastructure	Common and precise time basis for synchronization of distributed data bases	



Synchronization of radio access networks

Synchronization of radio access networks

Industry vertical	Incumbent fixed and mobile network operators
Compelling event	Introduction of LTE-TDD, migration to LTE-A and 5G
Product needed	Cesium Clock, Core, Edge and Access Grandmasters

Key players	Sync and RAN vendors
Solution needed	Scalable solution, clock accuracy, sync assurance
Outlook	Market will grow due to 5G, price pressure due to reduce ARPU, compensated by increase in volume

Radio Access Synchronization requirements

Fronthaul eCPRI: <100ns time sync

5G – positioning: <100ns time sync (cluster)

5G – CA, IoT: several 100ns time sync (cluster)

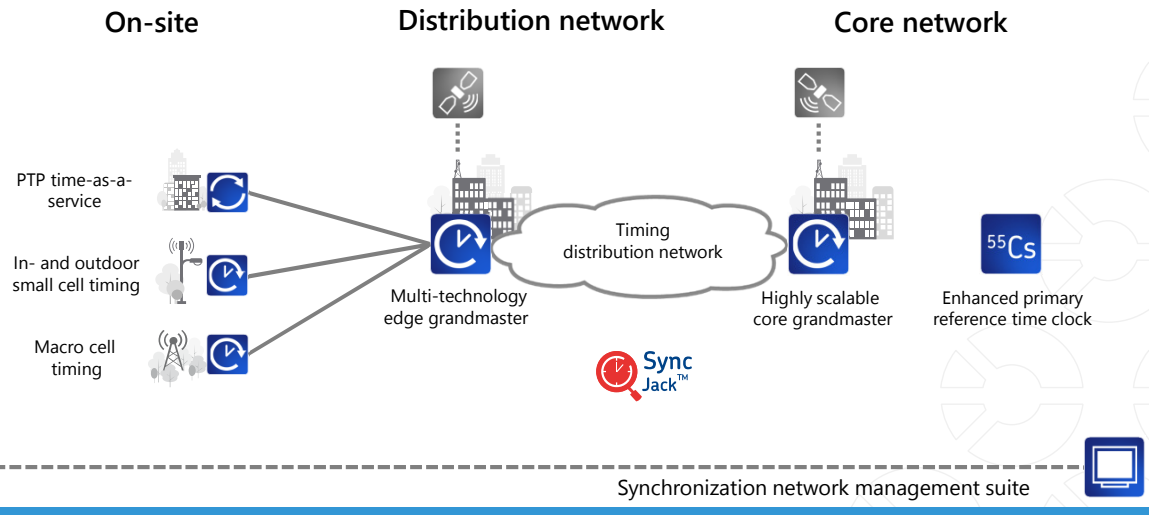
LTE Advanced CoMP, TDD: 1.5µs time synchronization

LTE – multicast: several µs time synchronization

3G TDD: 5µs time synchronization (large cells)

2G/3G – frequency synchronization

End-to-end network timing delivery



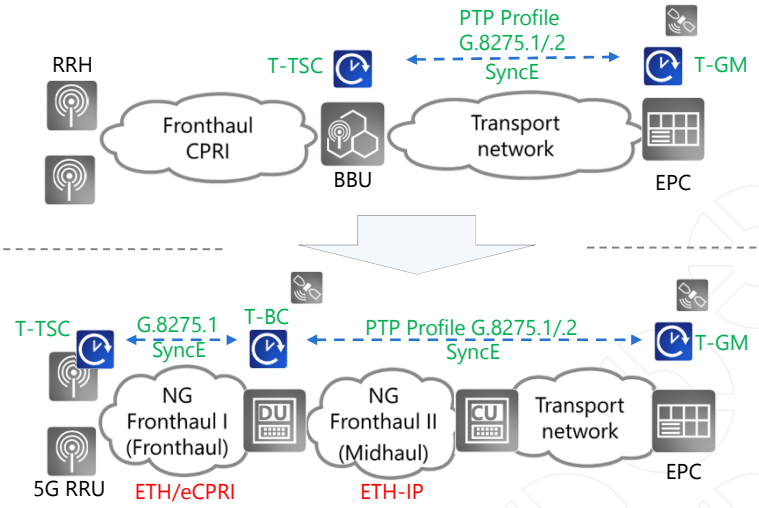
Assured precision timing – scalable phase and frequency synchronization

From 4G eNB to 5G gNB synchronization evolution

4G: RRH connected over CPRI with in-band synchronization

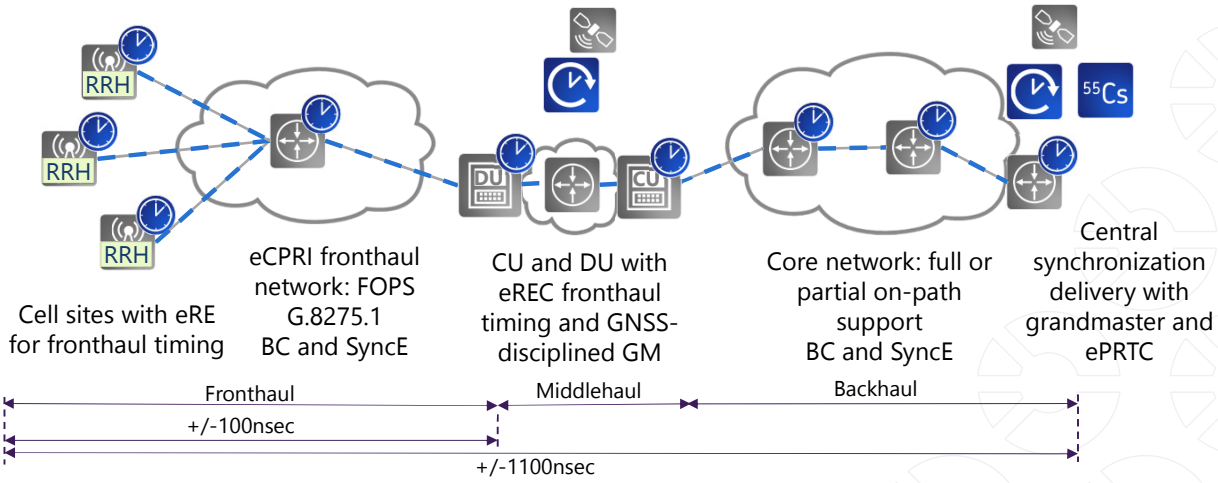
5G: gNB with Ethernet connectivity and DU/CU using PTP for accurate timing

RRU connected over eCPRI with PTP synchronization



BBU is further split into DU/CU with very stringent timing requirements

5G Synchronization architecture eCPRI fronthaul



Emerging synchronization architecture for most stringent timing requirements

Digital cable network synchronization

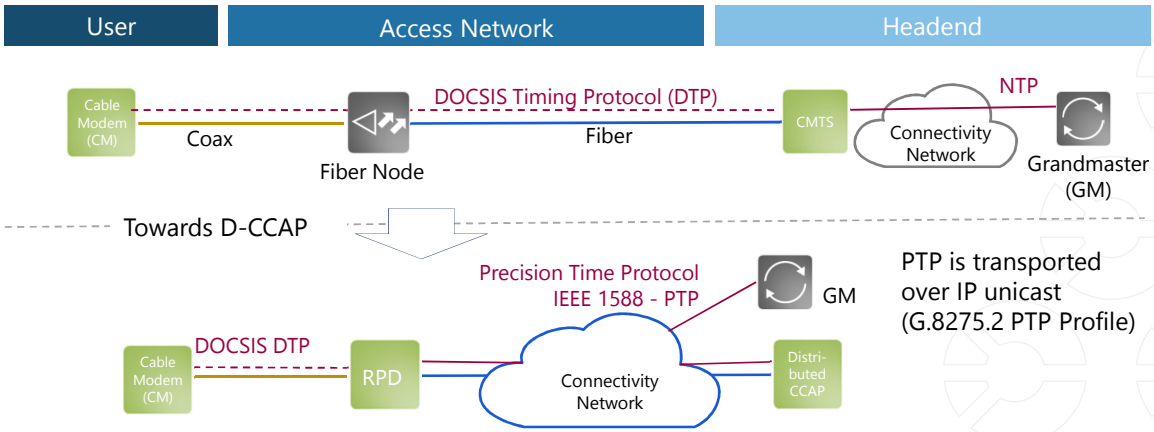
Digital cable network synchronization

Industry vertical	MSOs and cable network operators
Compelling event	DOCSIS 3.1 migration to digital RPD cable access infrastructure
Product needed	Core and Edge Grandmasters, Access Grandmaster for TaaS

Key players	Sync vendors
Solution needed	Cable labs interoperability, compact and cost effective
Outlook	Multi Service Operators are forced to move to DOCSIS 3.1 in order to survive by lower cost of business services, mobile backhaul and TaaS to follow

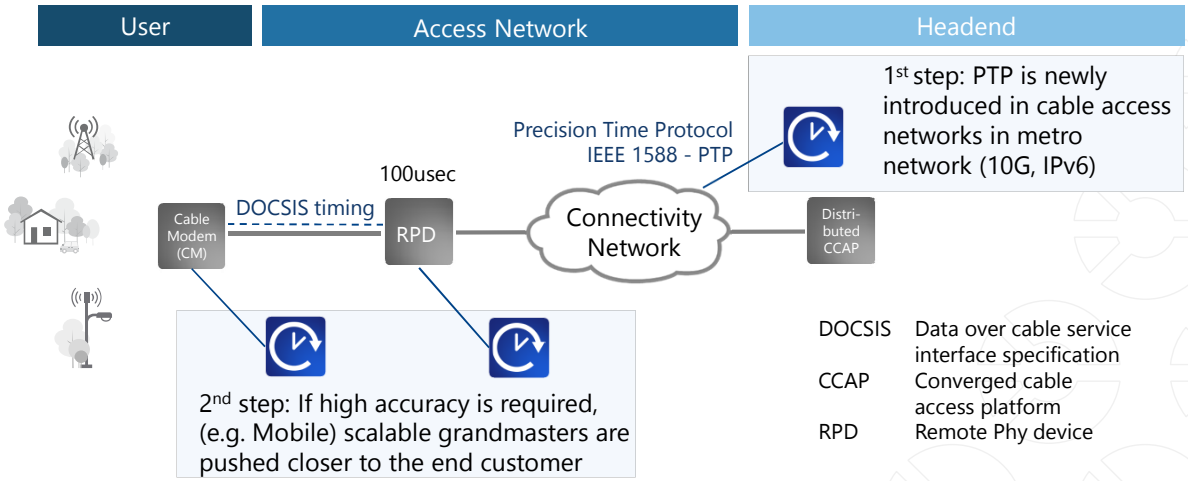
12

General synchronization requirements



From DTP in legacy DOCSIS to IEEE 1588 PTP in DOCSIS 3.1

Distributed access architecture in cable networks



IEEE 1588 PTP for cost-efficient synchronization from central grandmaster

Power utilities synchronization

Synchronizing for energy companies

Industry vertical	Energy utility companies
Compelling event	Stringent timing requirements at substations due to the shift to power grid networks
Product needed	Cesium Clock, Core and Edge Grandmasters

Key players	General and power specific sync vendors
Solution needed	Power profile, IRIG-B and Semi rigid solutions, GNSS and sync assurance
Outlook	Although the very slow rate of progress, next generation power grid networks will drive the shift from NTP and IRIG-B to PTP, will take 10+ years

Synchronization accuracy requirements

PTP 1µs

NTP 1ms

IRIG 1s

Fault localization
Synchrophasor: voltage/current with accurate phase

SCADA: supervisory control and data acquisition
Frequency measurement
Event recorder

Bulk metering
Customer premises metering

Challenges

Increasing accuracy

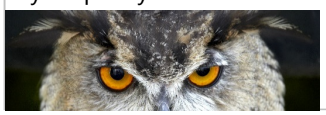
With moving from 1ms to 1µs time accuracy, NTP needs to be replaced by PTP

GNSS vulnerability

GNSS outages need to be mitigated with network-based synchronization delivery

Lack of visibility

As synchronization in power networks is mission critical, real-time information about sync quality is vital



Standardization

IEEE 1588 necessary for IEC 61850 substation automation and IEEE C37.118 synchrophasor

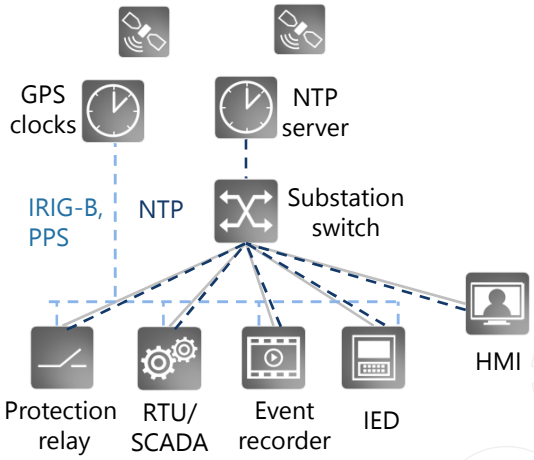
IEC International Electrotechnical Commission

Substation synchronization - today

- IRIG and PPS provide time information
- GNSS as highly accurate local time reference

Migration to Ethernet

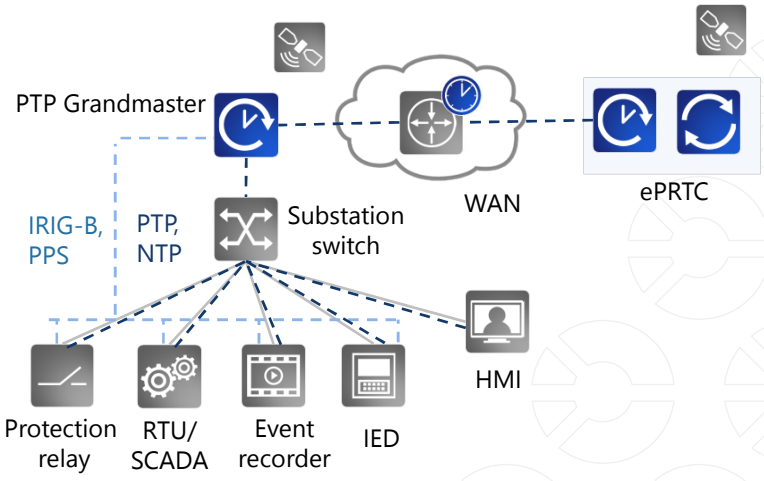
- Network Time Protocol (NTP) provides msec precision to appliances
- GNSS time reference



Presently applied solutions neither meet accuracy nor availability requirements

Substation synchronization - tomorrow

- Precision Time Protocol for **sub-µs timing accuracy**
- Converging PTP, NTP and IRIG-B into **single PTP solution**
- Mitigating GNSS outages with network-based backup for **highest availability**
- Assuring business continuity by **monitoring sync quality**



Highest accuracy and best availability with satellite **and** network based timing

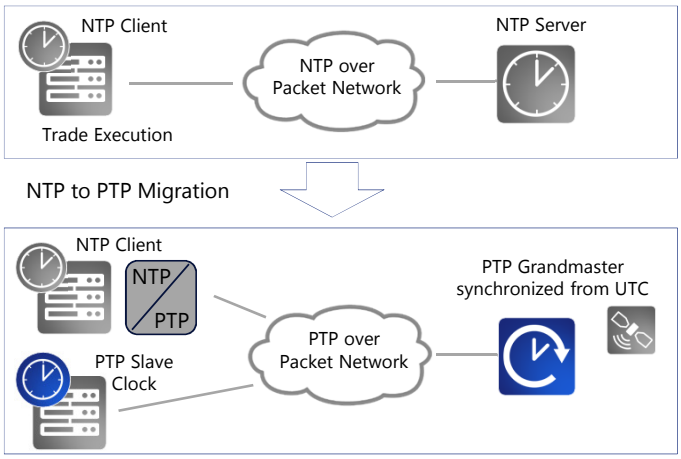
Time stamping in financial trading

Time stamping in financial trading

Industry vertical	Financial institutions, exchanges, trading venues
Compelling event	Support for MiFID II and SEC 630 time stamping accuracy
Product needed	Cesium Clock (TaaS providers)
	Core and Edge Grandmaster and PTP slave (HW and SW)

Key players	Sync vendors
Solution needed	End to End with HW based PRTC/ePRTC and HW or SW based PTP clients, sync performance monitoring and long term logging
Outlook	Higher margin business with increase demand for accuracy

NTP to PTP migration in finance



Objective:

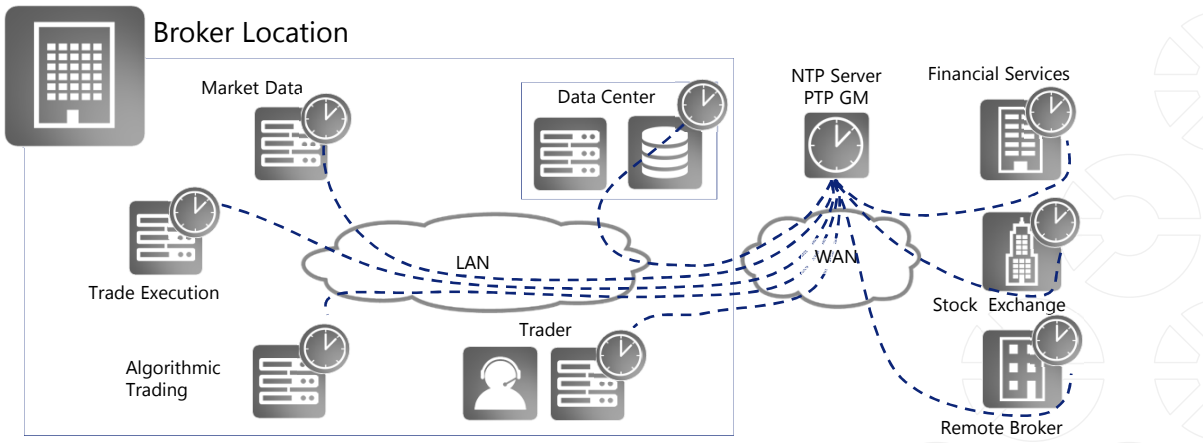
- Leverage PTP accuracy
- Protect investment with existing NTP clients

Way forward:

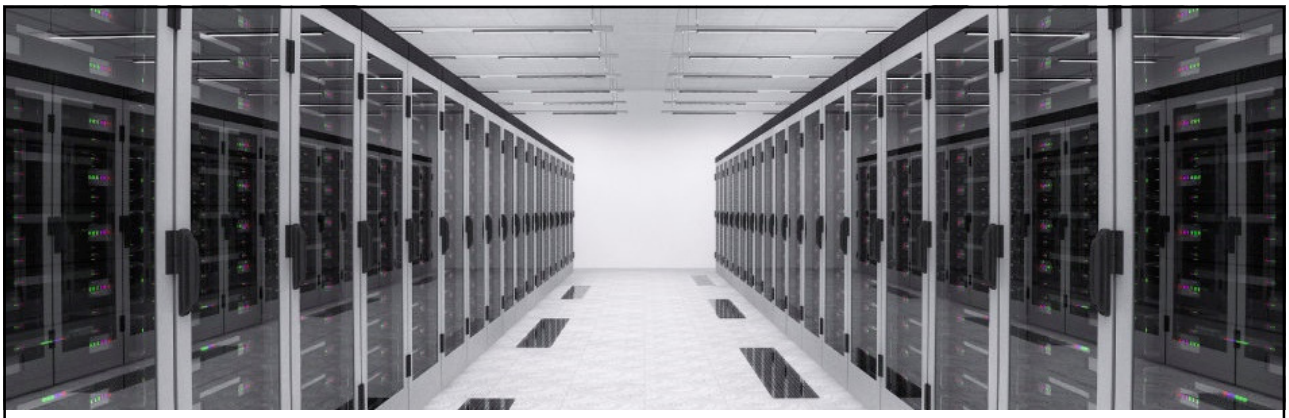
- NTP/PTP gateway
- Enhancing NTP with precise sync signal (1PPS)
- Upgrading legacy appliances with SFP GM
- Sync soft client

NTP migration as initial step – upselling with high precision clocks, sync assurance

Timing in financial trading networks



Any component of the trading system needs time information



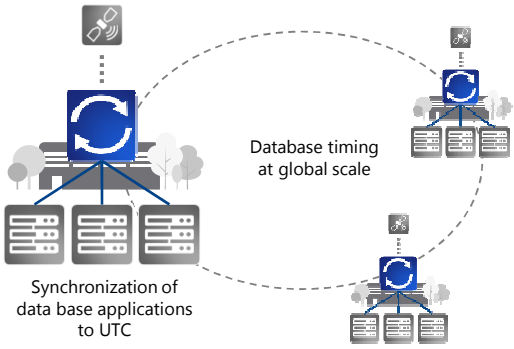
Data centers and distributed data bases

Real-time data base synchronization

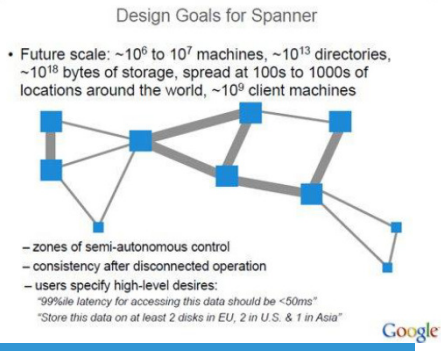
Industry vertical	Internet content and cloud service providers
Compelling event	Distributed, real-time data base offering, GNSS backup
Product needed	Cesium Clock
	Edge Grandmaster, ePRTC like solution

Key players	Sync vendors, self development
Solution needed	ePRTC integration, Full solution and Scalability
Outlook	Large market that will keep growing due to the high demand of timing and fast growth of the ICP

Real-time data base synchronization



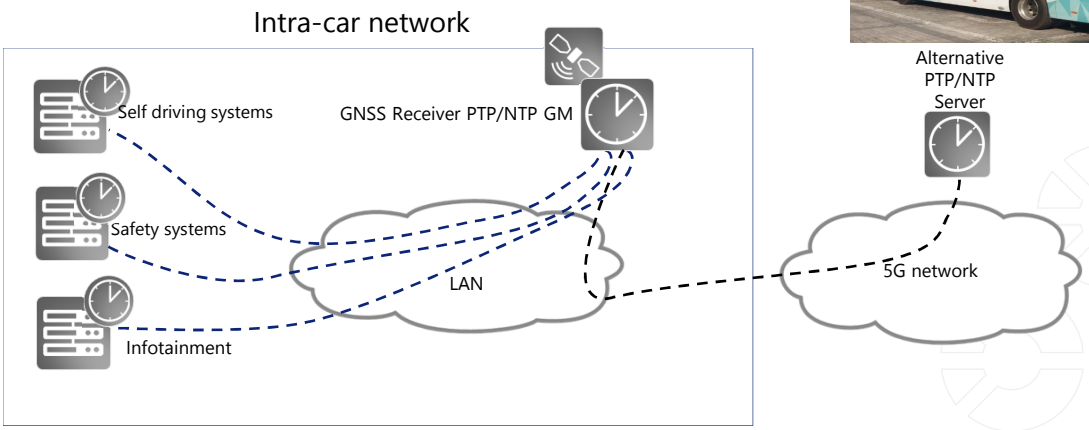
- Establishing consistency among stored data
- Continuous harmonization of data over time
- File synchronization, distributed file systems, mirroring
- Synchronized cloud data bases
  - Google Spanner
  - Amazon Dynamo
  - Azure Cosmos



Establishing data consistency between data bases locally and globally

Where are we going from here?

Timing for Self Driving Cars



Any component of the Self Driving Car needs time information

From Connected Cars to Connected Cows…

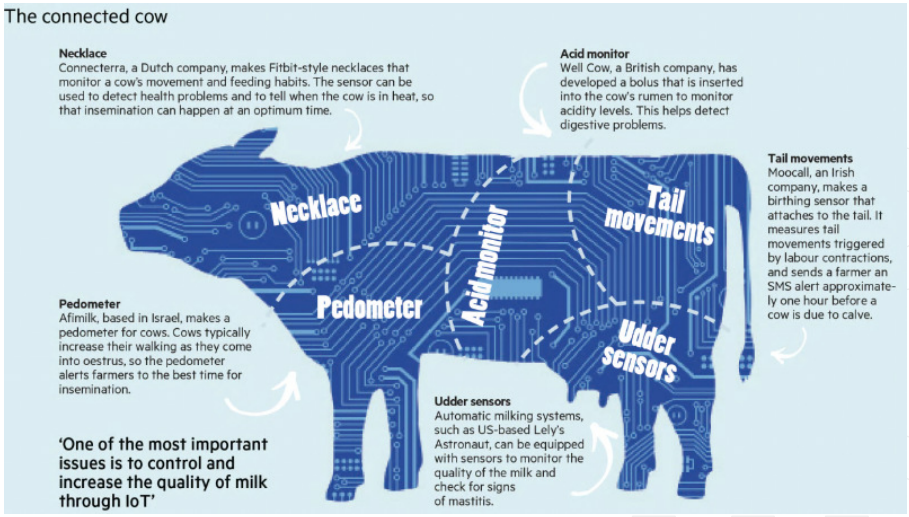
Coverage

Small Cells

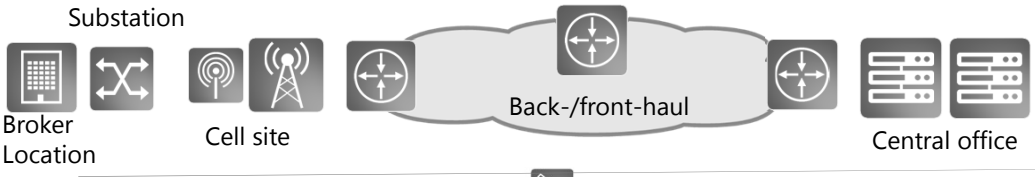
Low Power

Synchronization

Rural IoT



So what is the common need for all these cases?



SFP-based cell site PTP grandmaster

Cell-site grandmaster with integrated dual-GNSS receiver

Edge/ core grandmaster featuring 1/10GE interfaces

Atomic cesium clock for highest precision and longest holdover

ePRTC solution

Many ways to enhance accuracy of time distribution

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Thank you