

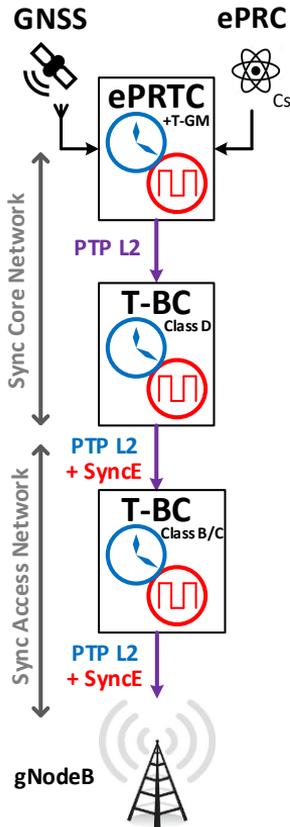


Obstacles on the way to time synchronization for 5G

and how to overcome them

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November 2022

Synchronization Concept for 5G



A1

Synchronization Sources

- national/regional capitals
- multiband-GNSS, ePRC and ePRTC

Synchronization Core Network

- PTP G.8275.1 Phase Profile FTS
- T-BC Class D → “distributed PRTC-A”

Synchronization Access Network

- PTP G.8275.1 Phase Profile + SyncE
- T-BC Class B/C

Synchronization Clients

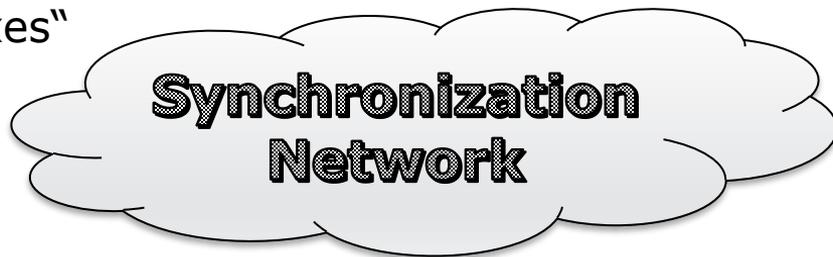
- gNodeB and others



Questions

Solution

- best „sync boxes“ or best overall solution?



Requirements

highest precision, availability and stability

- phase holdover?
- repair times?
- redundancy?
- GNSS outages (days/weeks)?

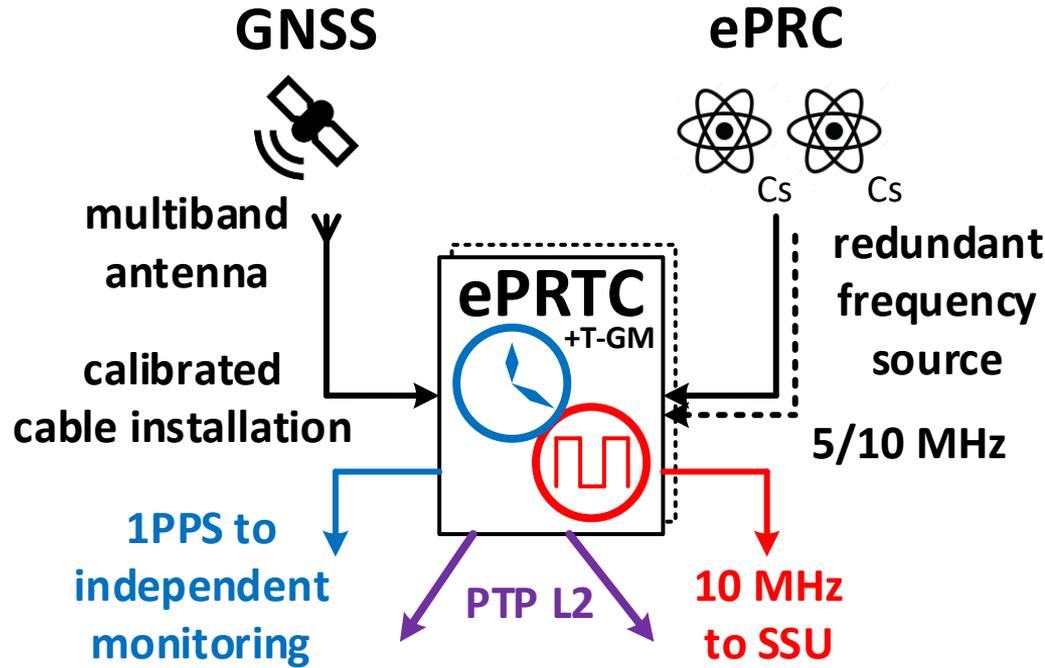
Tools & Skills

- inhouse competences?
- support/partners?
- NMS/WebGUI/CLI?

old-established principles

- SyncE in sync core network?
- frequency separate from phase/time?

Synchronization Sources: ePRTC



Time+Phase: GNSS

- re-use installed base?
- (new) calibrated antenna installation
- GNSS firewall?

Frequency: ePRC

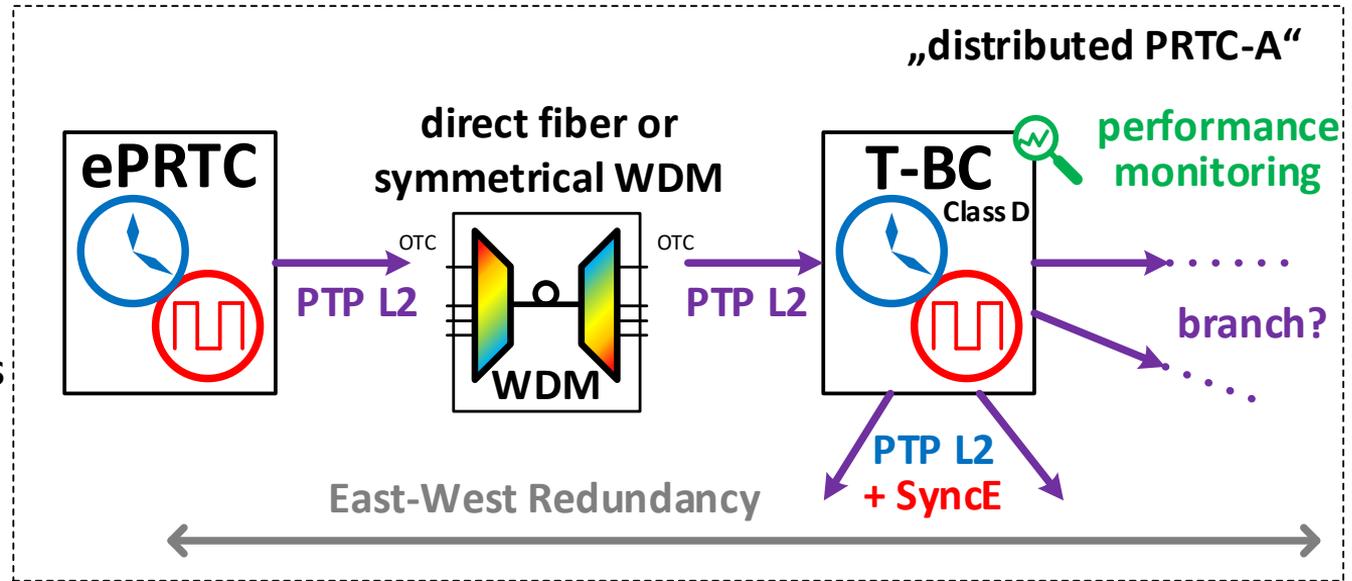
- holdover
- direct connection to atomic clock
→ redundancy?
→ different sites/rooms?

Monitoring:

- independent from NMS

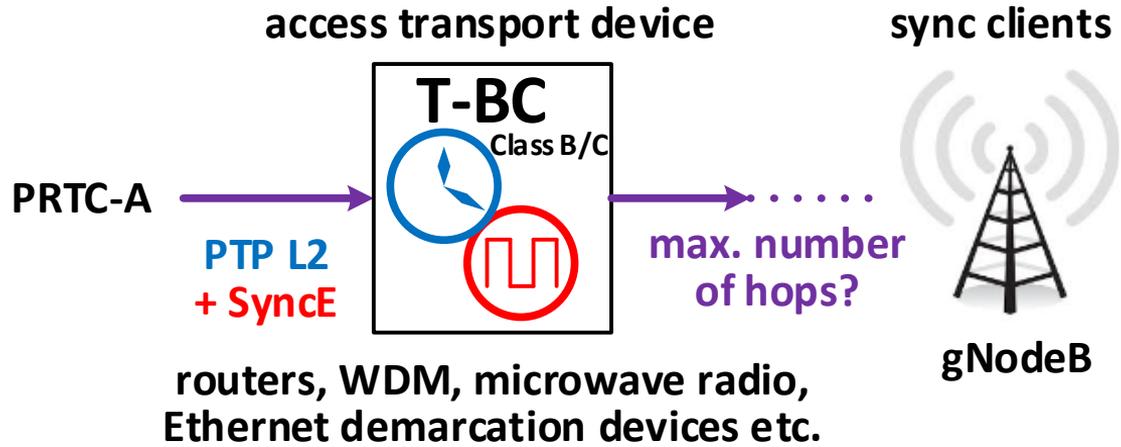
Synchronization Core Network

- PTP transport between T-BC Class D?
- East-West or ring protection
- existing transport routes → branches?
- in-service performance monitoring



- SyncE only at output

Synchronization Access Network

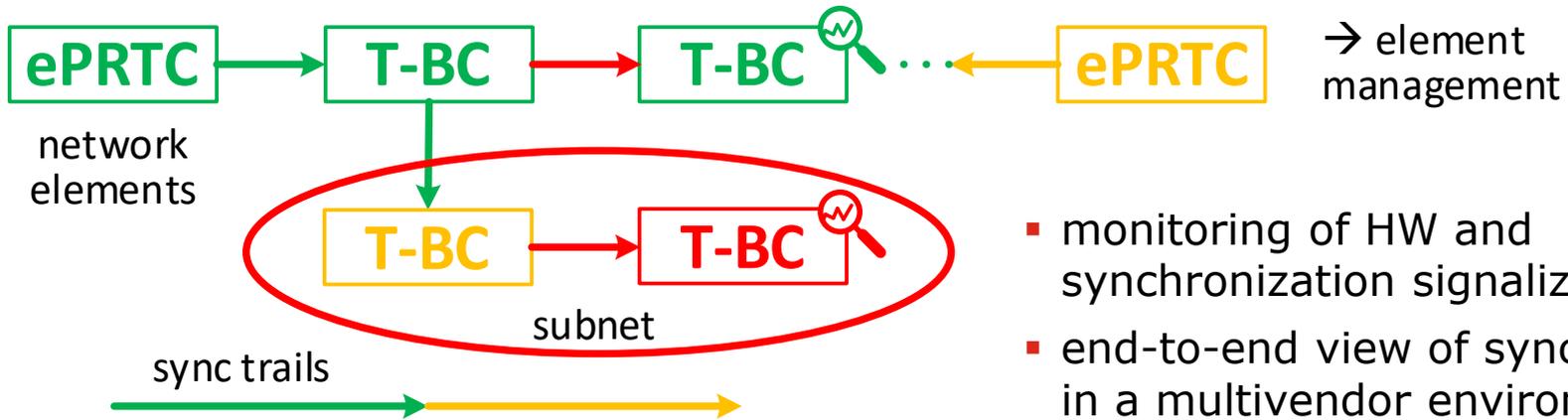


- T-BC Class B/C + SyncE in every node → swap installed base?
- calculation of worst-case time error → max. number of T-BC hops
- redundancy in access network?

- sync fault root cause analysis in multi-vendor/technology network?
- repair times end to end?

Network Management System

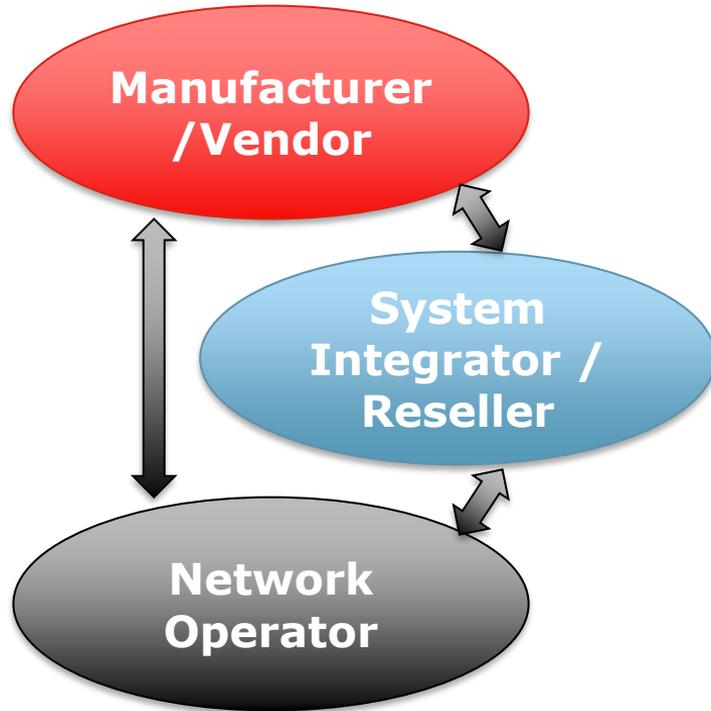
- graphical view of topology and status/alarms



- synchronization is critical infrastructure!
 - fully functional and absolutely stable NMS

- monitoring of HW and synchronization signalization
- end-to-end view of sync trails in a multivendor environment
- automatic performance monitoring with threshold cross alarms

Organization/administrative challenges



- expert / staff reduction in every company
 - increasingly difficult processes (type approval / operation / upgrade)
- small operators /small invest
 - communication to vendor on the same level?
 - how to put enough pressure on the manufacturer to fix bugs and solve problems?
- support needed
 - manufacturer/vendor
 - system integrator
 - academic/industry partners

Summary

- Synchronization for 5G: highest precision, availability and stability
- Best overall solution (HW, architecture, operation, trouble shooting)
- Know-how and skills: in-house or external
- Tools: NMS, performance monitoring etc.
- Development options for future requirements

Acronyms and Abbreviations

1PPS	...	1 Pulse Per Second	ITU	...	International Telecommunication Union
10GE	...	10 Gigabit Ethernet	ITU-T	...	ITU Telecommunication Standardization Sector
5G	...	fifth generation technology standard for cellular networks	L2	...	OSI Layer 2
CD	...	Chromatic Dispersion	NMS	...	Network Management System
Cs	...	Cesium (oscillator)	NZDSF	...	non-zero dispersion shifted fiber (G.655)
cTE	...	constant Time Error	OSI	...	Open Systems Interconnection (ISO/IEC 7498)
EEC	...	Ethernet Equipment Clock	OTC	...	Optical Timing Channel
ePRC	...	Enhanced Primary Reference Clock	PRC	...	Primary Reference Clock
ePRTC	...	Enhanced Primary Reference Time Clock	PRTC	...	Primary Reference Time Clock
FE	...	Fast Ethernet (100 Mbit/s)	PTP	...	Precision Time Protocol (IEEE 1588v2 1988)
FTS	...	Full Timing Support (G.8275.1)	SSM	...	Synchronization Status Message
FW	...	Firmware	SSU	...	Synchronization Supply Unit
GE	...	Gigabit Ethernet	SW	...	Software
GM	...	Grandmaster	SyncE	...	Synchronous Ethernet
GNSS	...	Global Navigation Satellite System	T-BC	...	Telecom Boundary Clock
GPS	...	Global Positioning System	T-GM	...	Telekom Grandmaster
HW	...	Hardware	TE	...	Time Error
IEEE	...	Institute of Electrical and Electronics Engineers	ToD	...	Time of Day
			UTC	...	Coordinated Universal Time
			WDM	...	Wavelength Division Multiplexing



Thank you

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