



UTC via GNSS as a time source for telecommunication systems

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November 2020

Motivation

Frequency synchronisation:

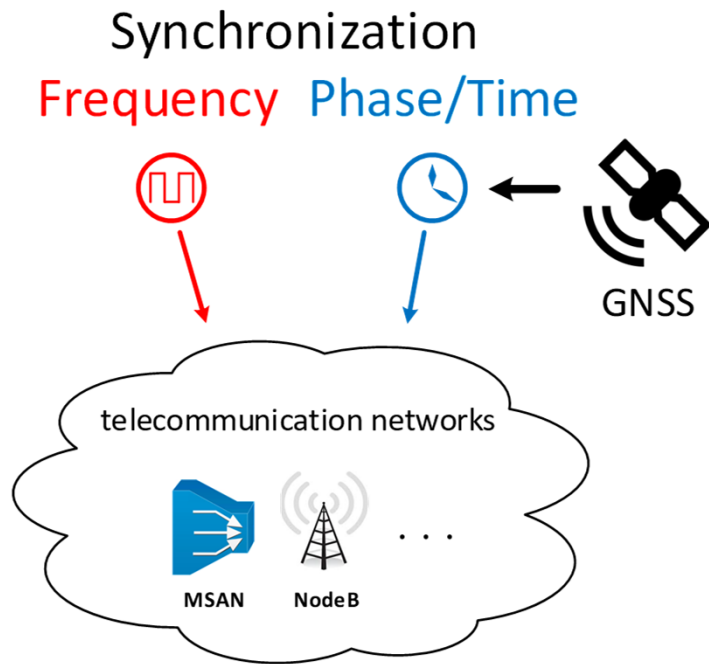
- for MSAN, 2G/3G NodeB and legacy equipment
- requirement for MSAN and RAN: SSU-A quality

Phase/Time synchronisation:

- requirement for 4G (LTE Advanced) and 5G (early implementations):
 - max. $\pm 1.1 \mu\text{s}$ network equipment budget i.e. $|TE|$ at NodeB input (acc. ITU-T Rec. G.8271.1)
 - Clock Class 6 or 7 acc. ITU-T Rec. G.8275.1
- requirement from regulator: max. deviation $\pm 1.5 \mu\text{s}$ from UTC at air interface

- **Synchronisation is critical infrastructure**
- **GNSS is currently the only available source for high precision UTC**

A¹



Short term concept for Phase Synchronization

Implementation:

- SyncE for frequency
- PTP (IEEE 1588v2 over Ethernet, FTS)

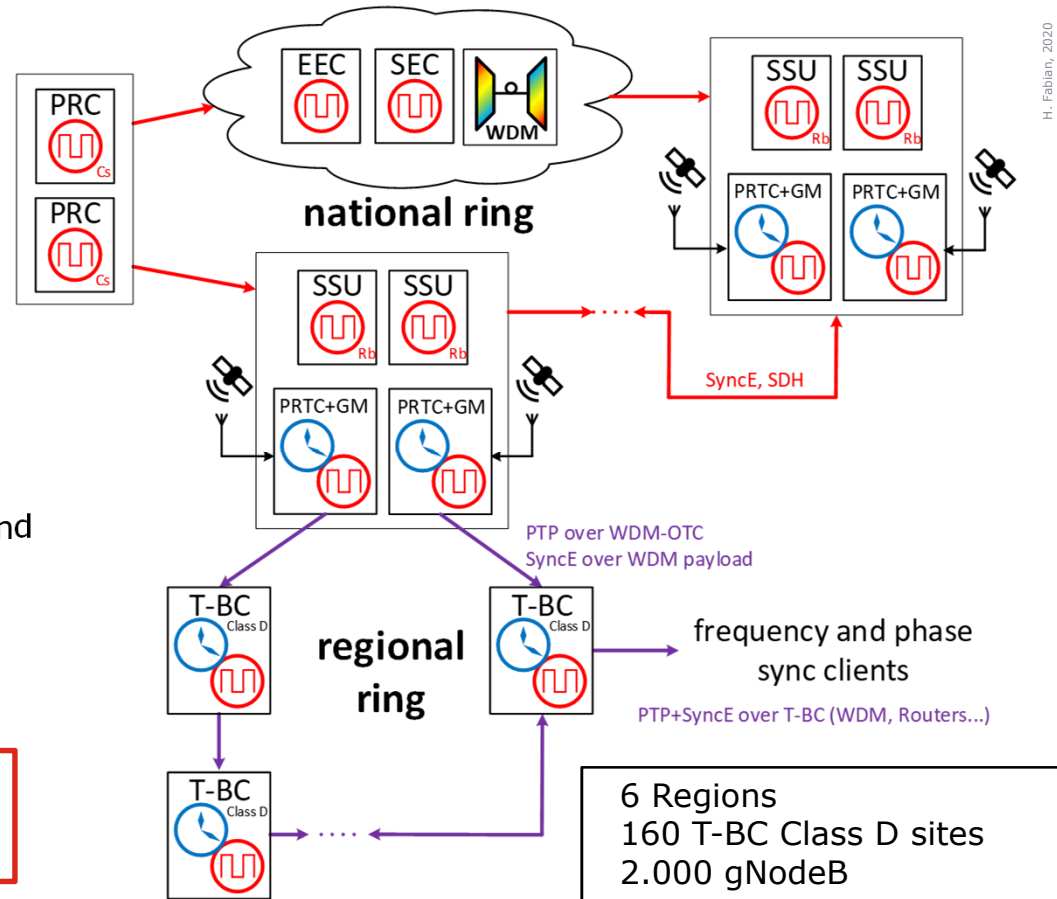
Resiliency and Quality

- separate frequency (Layer 1) and phase synchronization (Layer 2)
- Ring-Protection for Layer 1 frequency and Layer 2 phase synchronization
- <math>< 100 \text{ ns } |TE|</math> @ T-BC Class D site*
- <math>< 500 \text{ ns } |TE|</math> @ sync client input*

*) in faultless condition

Time and Phase Source

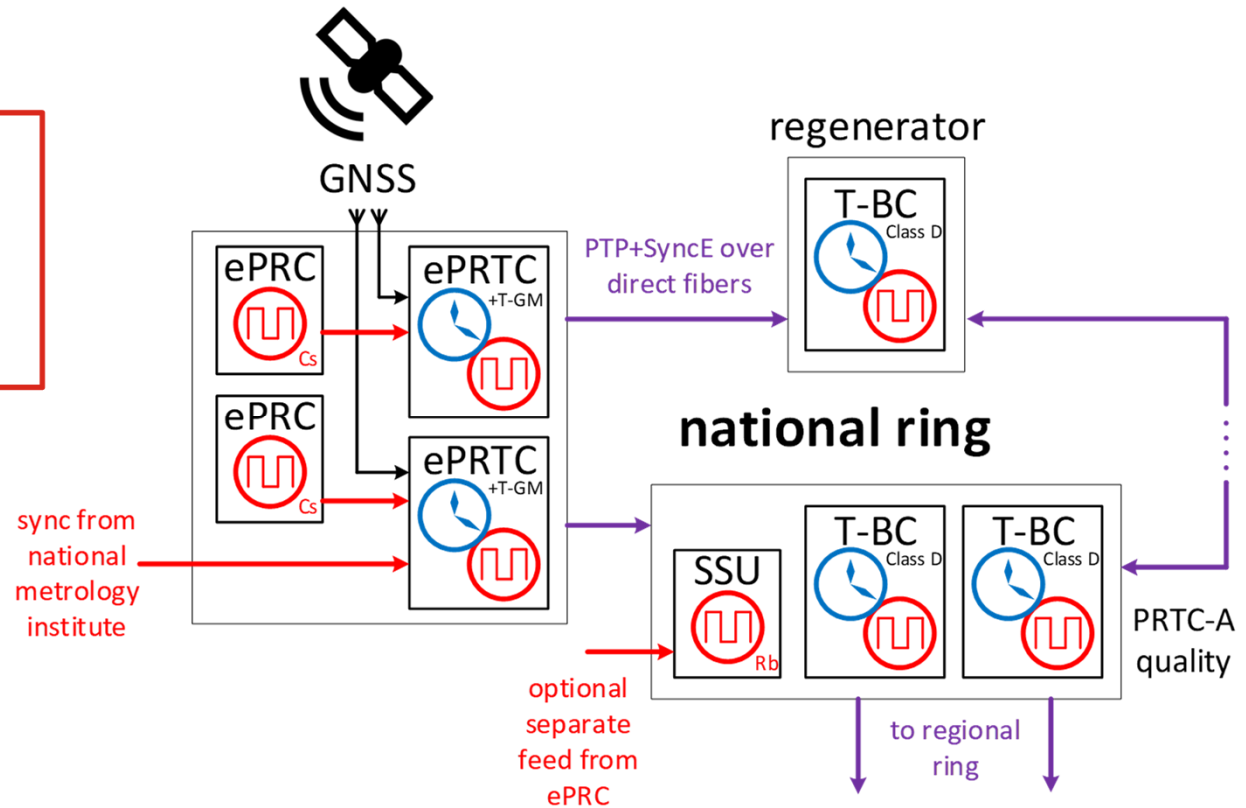
- GNSS receivers in regional capitals



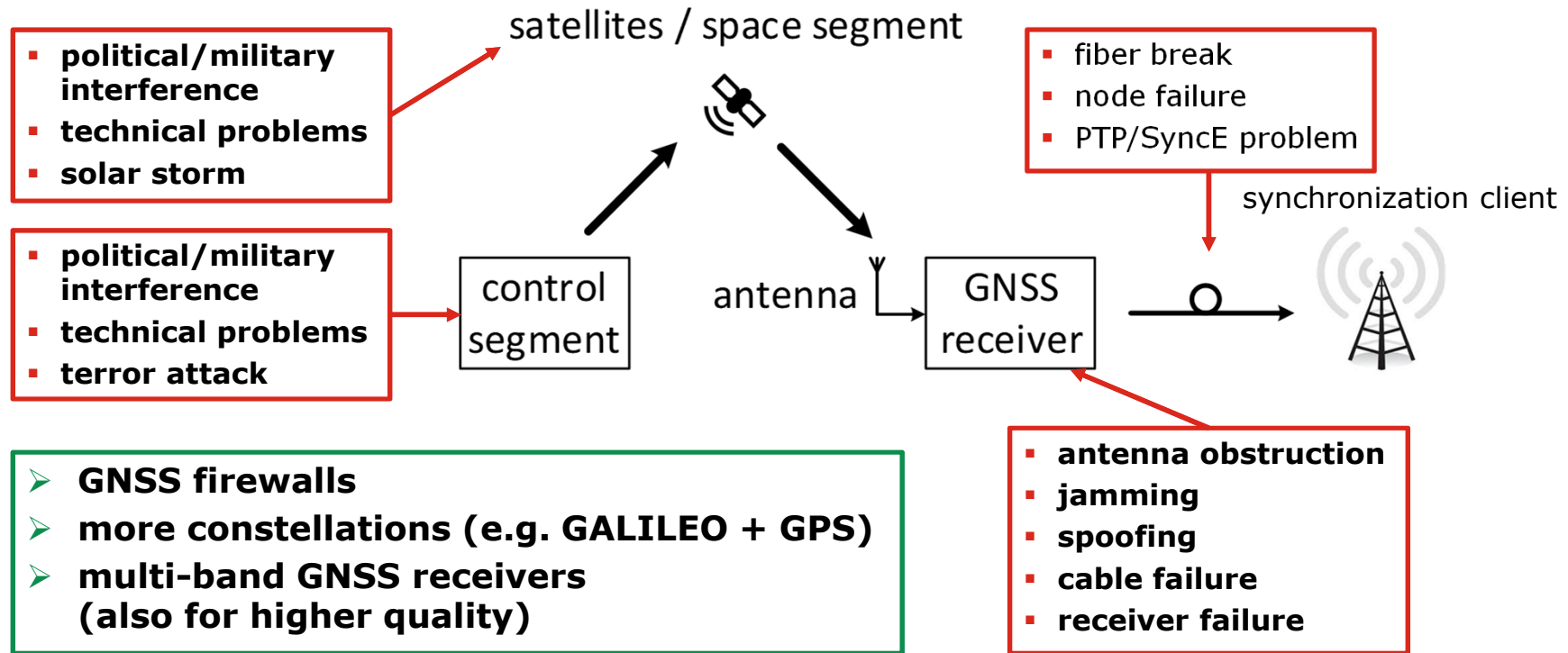
Long Term Concept for Frequency-, Phase- and Time-Synchronization

H. Fabian, 2020

**two redundant
GNSS receivers for
whole national
synchronization
network**



Challenges with GNSS, PTP, SyncE...



Acronyms and Abbreviations

4G	...	fourth generation technology standard for cellular networks	OTC	...	Optical Timing Channel
5G	...	fifth generation technology standard for cellular networks	PRC	...	Primary Reference Clock
Cs	...	Cesium (oscillator)	PRTC	...	Primary Reference Time Clock
EEC	...	Ethernet Equipment Clock	PTP	...	Precision Time Protocol (IEEE 1588v2 1988)
ePRTC	...	Enhanced Primary Reference Time Clock	RAN	...	Radio Access Network
FTS	...	Full Timig Support (ITU-T G.8275.1)	Rb	...	Rubidium (oscillator)
gNodeB	...	5G 'Next Generation Node B'	SDH	...	Synchronous Digital Hierarchy
GNSS	...	Global Navigation Satellite System	SEC	...	Synchronous Equipment Clock
GPS	...	Global Positioning System	SSM	...	Synchronization Supply Unit
IEEE	...	Institute of Electrical and Electronics Engineers	SSU	...	Synchronization Status Message
IP	...	Internet Protocol	SyncE	...	Synchronous Ethernet
ITU	...	International Telecommunication Union	T-BC	...	Telecom Boundary Clock
ITU-T	...	ITU Telecommunication Standardization Sector	T-GM	...	Telekom Grandmaster
LTE	...	"Long-Term Evolution" → 4G	T-TC	...	Telecom Transparent Clock
MPLS	...	Multiprotocol Label Switching	T-TSC	...	Telecom Time Slave Clock
MSAN	...	Multi-service access node	TE	...	Time Error
NodeB	...	3G/4G/5G base station	UTC	...	Coordinated Universal Time
			WDM	...	Wavelength Division Multiplexing





Thank you

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