



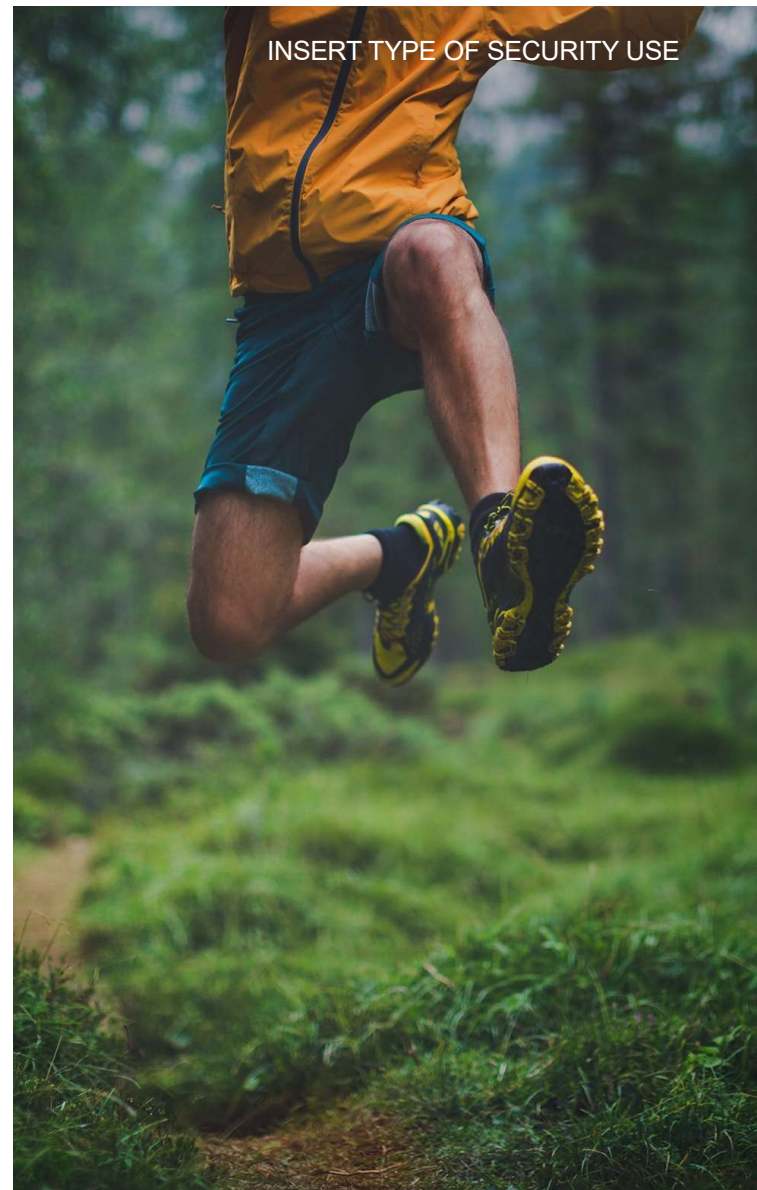
Synchronization Needs

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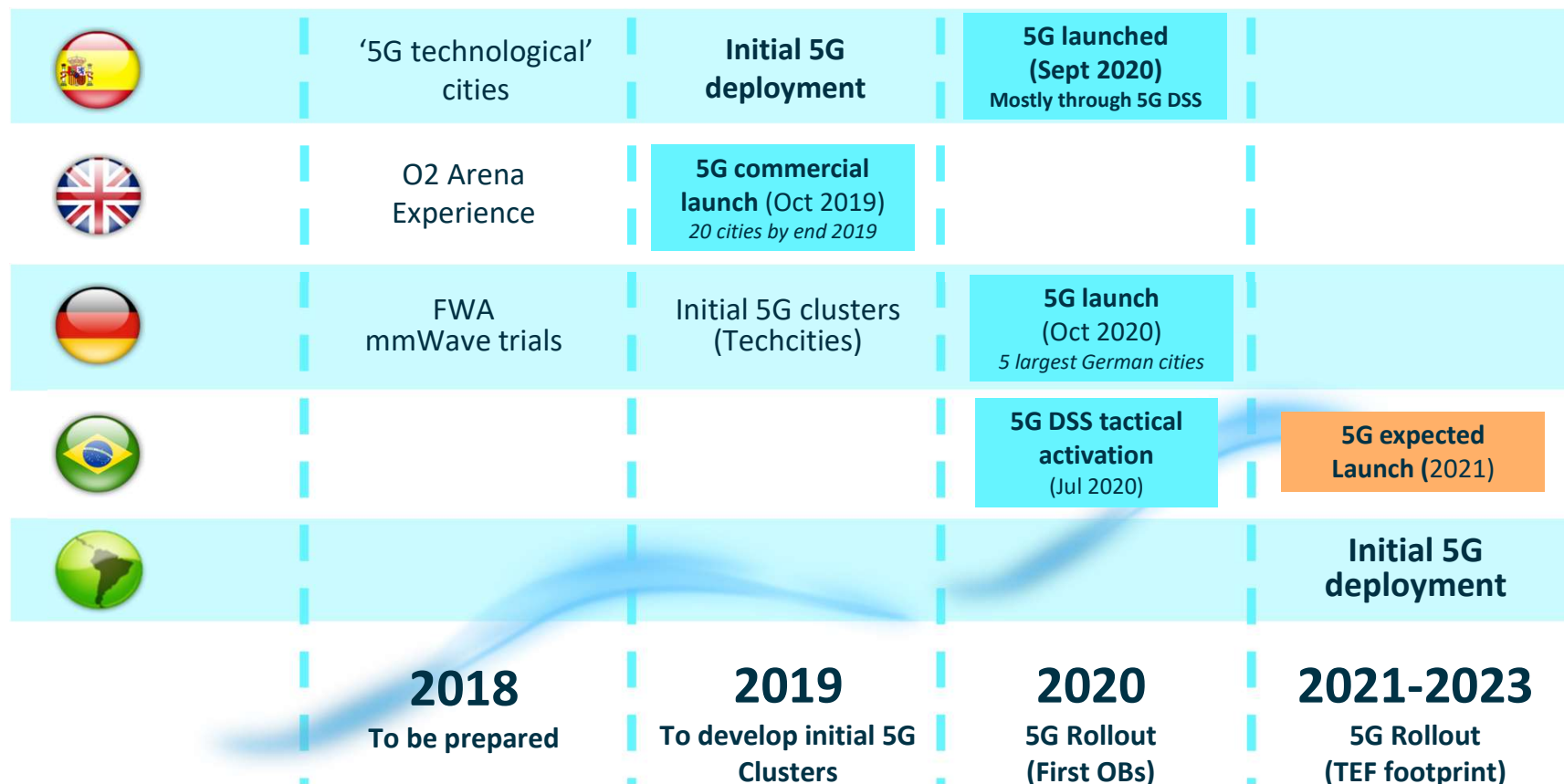
Telefónica S.A.
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INSERT TYPE OF SECURITY USE



5G deployments and launches in Telefónica

Managing the tempo of 5G deployments according to market needs and technology maturity.

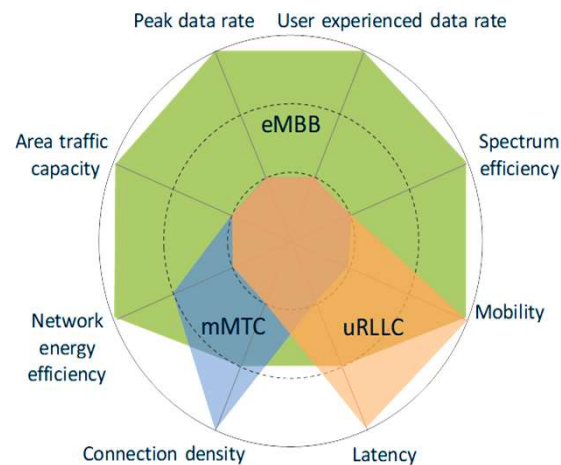


Introduction

5G networks are expected to support...

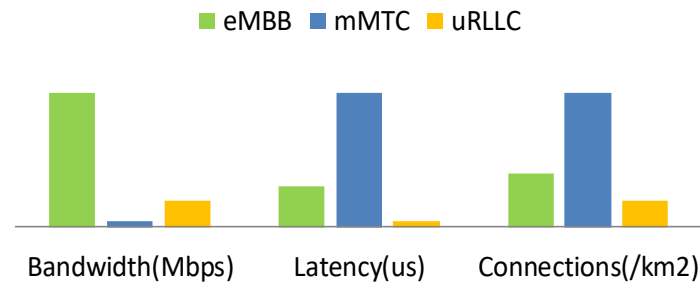
A hyper-connected society with:

- **very high data rate** access
- **very low latency**
- **wider coverage** for an **increasing number** of almost **permanently connected** devices.



ITU-R Categorization of 5G services

Different *slices* for different needs



eMBB = enhanced Mobile Broadband
mMTC = massive Machine-Type Communications
uRLLC = ultra-Reliable Low-Latency Communications

Requirements

For each RAN technology

Requirements vary for each RAN technology:

- Any TDD based RAN technology requires phase and time synchronization
 - In our context, this applies to 5G and some LTE.
- Any FDD-based RAN technology, which requires tight coordination between neighbouring cellsites also requires phase and time synchronization.
 - LTE-A (Advanced) features such as eICIC (enhanced inter-cell interference cancellation) and CoMP (Coordinated Multi-Point).
- Any other RAN technology (2G, 3G and LTE-FDD with no advanced features) only requires frequency synchronization.

Application (3GPP release)	Frequency: Physical / Air Interface	Phase Requirement
2G / 3G	15 ppb / 50 ppb	N/A
LTE - FDD		N/A
LTE - TDD		$\pm 1.5 \mu\text{s}$ small cell
LTE-A		$\pm 5 \mu\text{s}$ macro cell
5G Basic Services		$\pm 1.5 \mu\text{s}$
5G Fronthaul		$\pm 1.5 \mu\text{s}$
		± 32 to 130 ns

Not only precision, but also availability, robustness and security.

Available Technologies - Frequency & Time Sync

Two options can provide what is required for future 5G networks.

		Frequency Sync	Time & Phase Sync
Network Protocols / Technologies	SDH/PDH	Yes	No
	SyncE	Yes	No
	PTP IEEE1588v2	Yes	Yes
	GNSS	Yes	Yes

GNSS is vital for Time/Phase sync, as the best solution is based in a combination of GNSS + terrestrial technologies.

However, GNSS is sensible to some disturbances:



Solar flares



Jammers



Police / Military activity

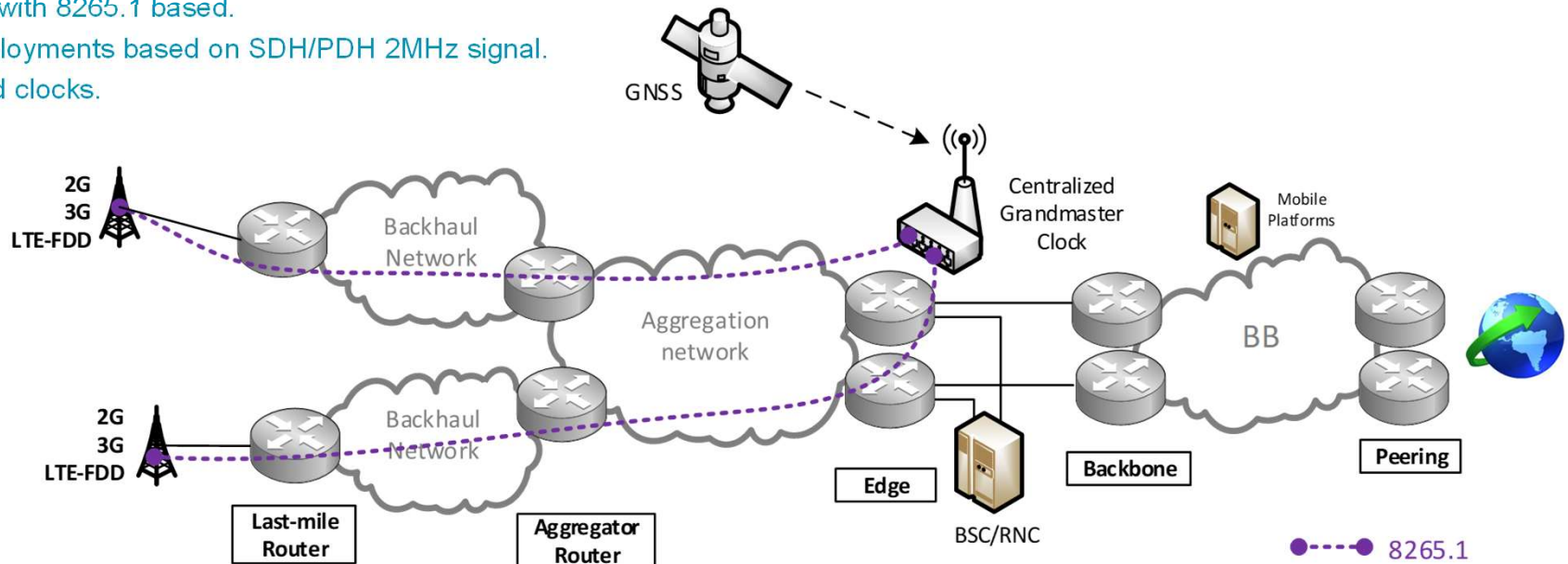


GNSS might have issues when sync is required for indoor sites (installation, permits).

Synchronization Implementation – Existing & Legacy

Allows Frequency Synchronization

- Required for 2G, 3G and LTE-FDD non-Advanced features.
- 1588 PTP with 8265.1 based.
- Earlier deployments based on SDH/PDH 2MHz signal.
- Centralized clocks.



BSC/RNC = Base-station Controller / Radio Network Controller

Synchronization Implementation – Ongoing Evolution

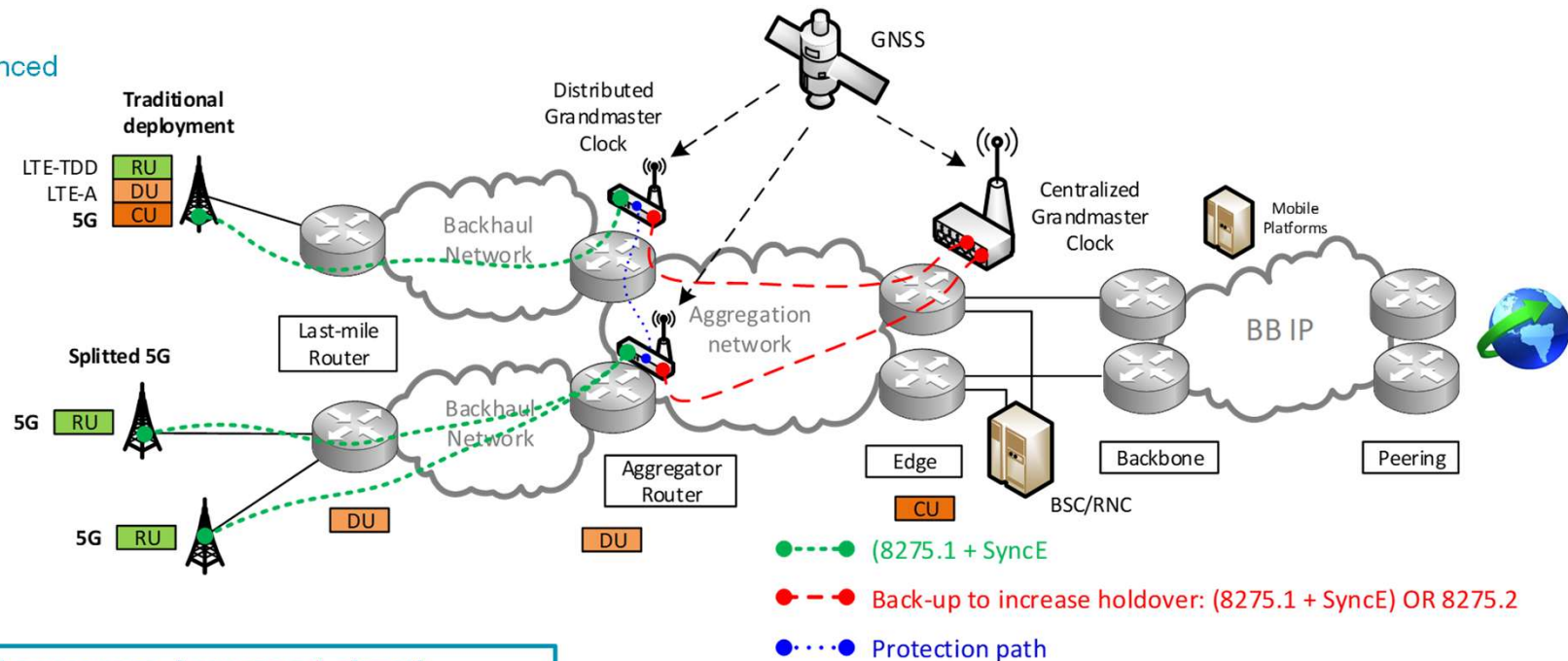
Allows Frequency and Time&Phase Synchronization

8275.1 + SyncE

Required for LTE-FDD Advanced features, LTE-TDD and 5G.

Needed for both deployment types.

- Current: monolithic hardware.
- Future: split hardware options.



Full coverage, increased signal holdover (99,999%? availability), resiliency, security, cost effectiveness.

BSC/RNC = Base-station Controller / Radio Network Controller

Required Performance

For different radio applications

Achievable

- Time error between RU-DU, RU-GMC and inter-RU (i.e., same DU).

Tech / Application	Time-error	
RU-GMC (DU-GMC)	+/- 1.5 μ sec (+/- 1.1 μ sec)	<i>Absolute</i>
Intra-band non-contiguous CA	+/- 130 nsec	<i>Relative</i>
Inter-band CA	+/- 130 nsec	<i>Relative</i>
Coordinated Multi-Point (CoMP)	+/- 130 nsec	<i>Relative</i>
Intra-band contiguous Carrier Aggregation (CA)	+/- 65 nsec	<i>Relative</i>
MIMO / Transmit Diversity (Cat A+)	+/- 32 nsec	<i>Relative</i>

- Latency between RU-DU.

Segment	Latency
RU-DU	< 100-150 μ sec one-way

Note:

Variations of these requirements might be found among different RAN Vendors.

Technological Gap

Tech / Application	Time-error	
High-Accuracy Positioning Services (same DU)	10 nsec	<i>Relative</i>
Self-driving / Autonomous car	< 5 nsec	<i>Relative</i>

Why ROOT?



ROLLING OUT OSNMA FOR THE SECURE SYNCHRONIZATION OF TELECOM NETWORKS

ROOT wants to experimentally assess the benefit introduced by Galileo authenticated signals in the specific context of the synchronization of 5G telecommunication networks

A Mix of Experts



Telefonica

ROOT Targets

01

Reference 5G architecture

Increase the resilience of telecom networks, proposing enhanced synchronization architectures for 5G networks

02

RF interference countermeasures

Assess performance of new multi-frequency Galileo receivers, OSNMA enabled, to monitor intentional interference

03

Prevent network cyberattacks

Experimentally assess secure solutions able to mitigate specific cyberattacks to the distribution of time synch over the network

04

Experimental test campaign

Quantify improvements introduced by reliable synch mechanisms built upon the combination of OSNMA and secure network synch distribution

05

Business perspectives

Launch a successful market entry of the ROOT solution

06

Increase awareness

Foster the introduction of Galileo OSNMA for the synchronization of the next generation of telecommunication networks

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