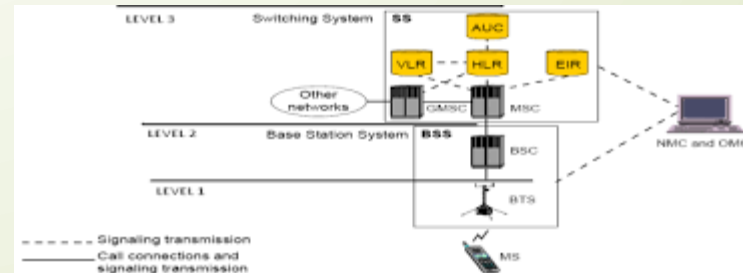


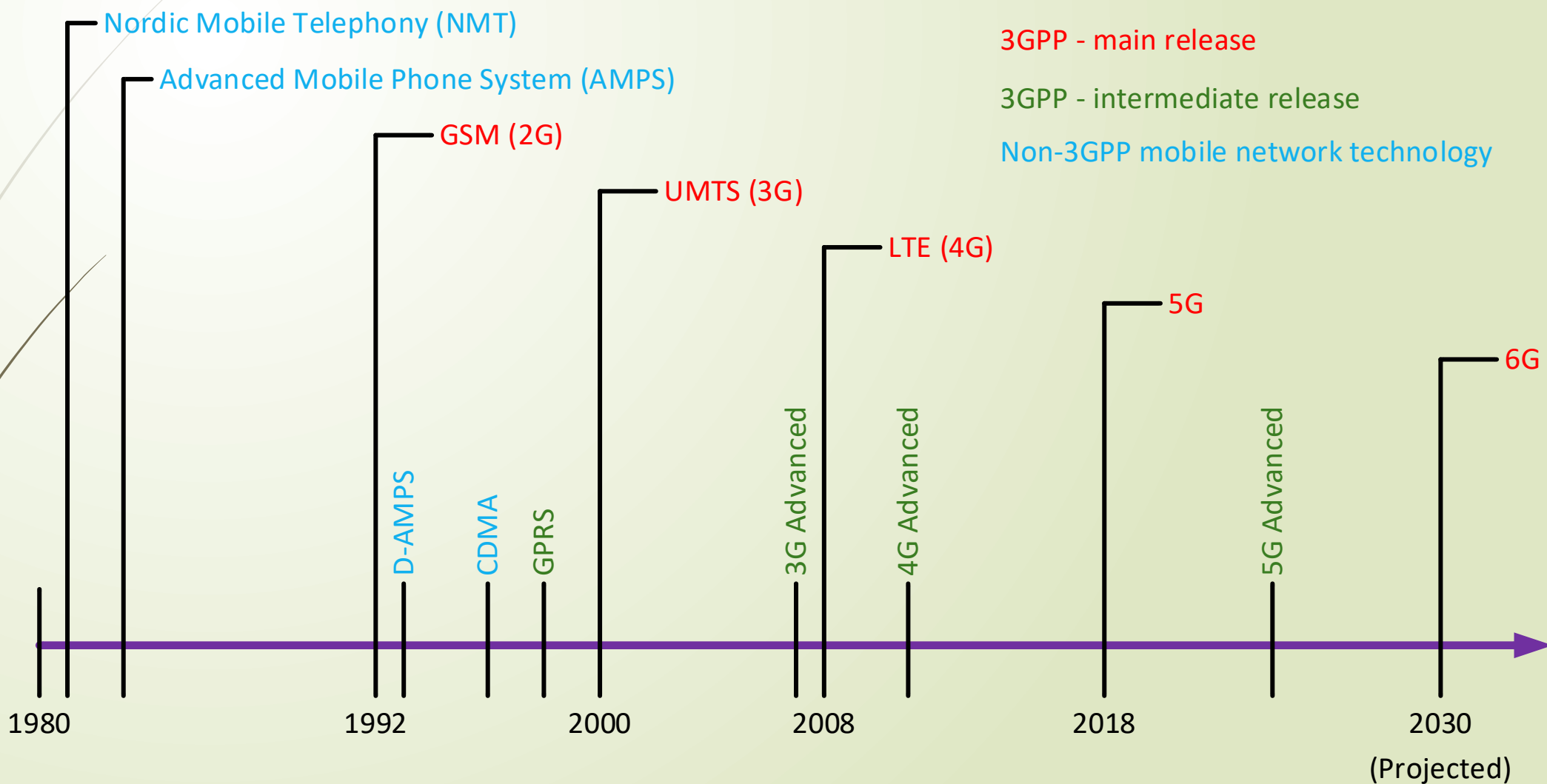
Ontwikkelingen in het Radio Access Network (RAN) voor Next-Gen mobiele netwerken

31 maart 2026
KIVI mini-seminar
(on-line)

A brief journey through the technological development that brought us where we (think we) are today



The mobile communications network timeline



A high-level overview of capability per mobile network release

- GSM (2G): mobile user-oriented; voice, SMS
- GPRS (2.5G): mobile internet (albeit with very limited throughput)
- UMTS (3G): *usable* mobile internet, in combination with voice and SMS
- LTE (4G): large scale, high-speed mobile internet, smartphone, IoT, Telematics
- 5G: industrial applications; transport, factory, agriculture, autonomous driving, aviation / UAV, satellite integration
- 6G: mobile communication technology used in all aspects of society

The mobile network release cadence

- ▶ Starting from GSM (1992) a new mobile network (“G”) has been released appr. Every 8 – 10 years
- ▶ This duration (8 – 10 years) is the time it takes the global community to:
 - ▶ Define new functional requirements
 - ▶ Define fundamental architecture for the new mobile network
 - ▶ Set up a structure for the technical specifications
 - ▶ Define the standard (architecture, procedures, protocols)
 - ▶ Implement the standard into products (network equipment)
 - ▶ Install, test, integrate, release network equipment based on the new standard

Mobile network standardization: a continuous process

- The development of mobile network standards (“G”) overlaps:
 - A new “G” is released
 - Improvement of the previous “G” continues
- Likewise, mobile network standard deployment overlaps:
 - Operators deploy a new “G” in their network
 - The previous “G” continues to be operational
 - Operators support two or three network generations at the same time

Mobile network standardization: a multi-disciplined cooperation

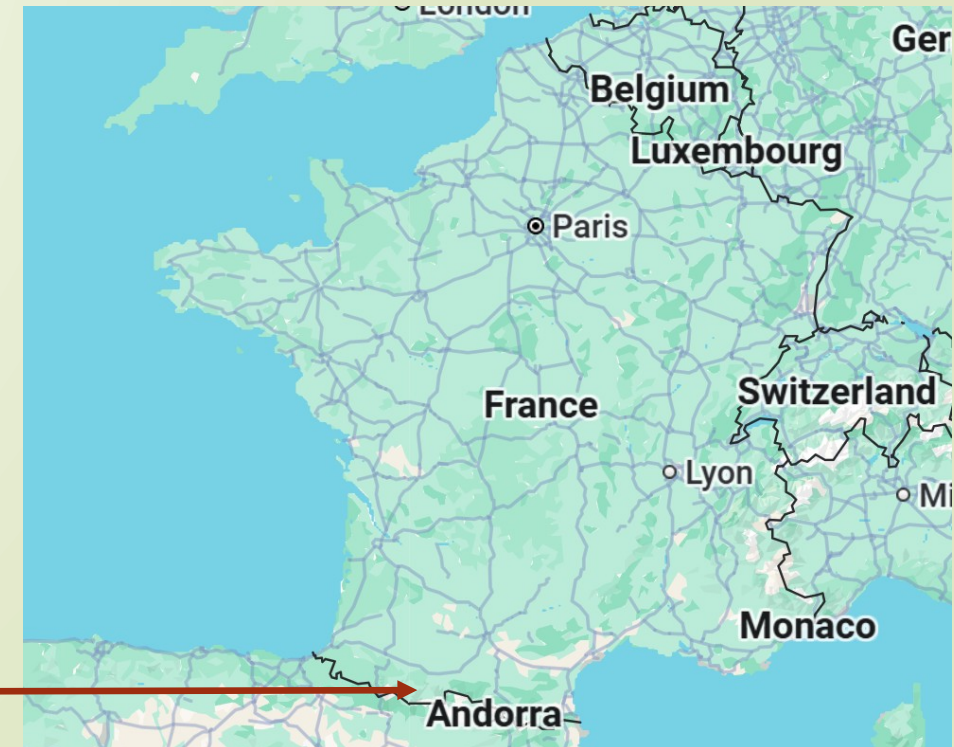
- Academia & research institutes: conducting fundamental research in communication technology
- Mobile network operators: developing a network standard that allows for operating a profitable communication business
- Equipment vendors: writing technical specifications based on which an end-to-end mobile communications network can be built
- Regulators etc.: governing the allocation of the frequency spectrum
- Industry organisations, e.g. GSMA: cooperation between operators for ensuring global compatibility, interworking, roaming agreements etc.
- And many more

Europe, the “bakermat” of global mobile communications

- 1982: Swiss based CEPT (European Conference of Postal and Telecommunications Administrations) starts the work on mobile communications
- 1989: France based ETSI (European Telecommunications Standards Institute) continues to work on GSM
- 1992: First release of GSM
- 1999: European, American and Japanese standardization organisations join forces and transform GSM into a global standard – 3GPP takes over ownership of the standard
- 2000 onwards: continuous development of mobile communications technology and networks standards (3G, 4G, 5G, 6G...)

3GPP headquarter: Sophia Antipolis (“city of wisdom”)

ETSI/3GPP



What about the radio frequency usage

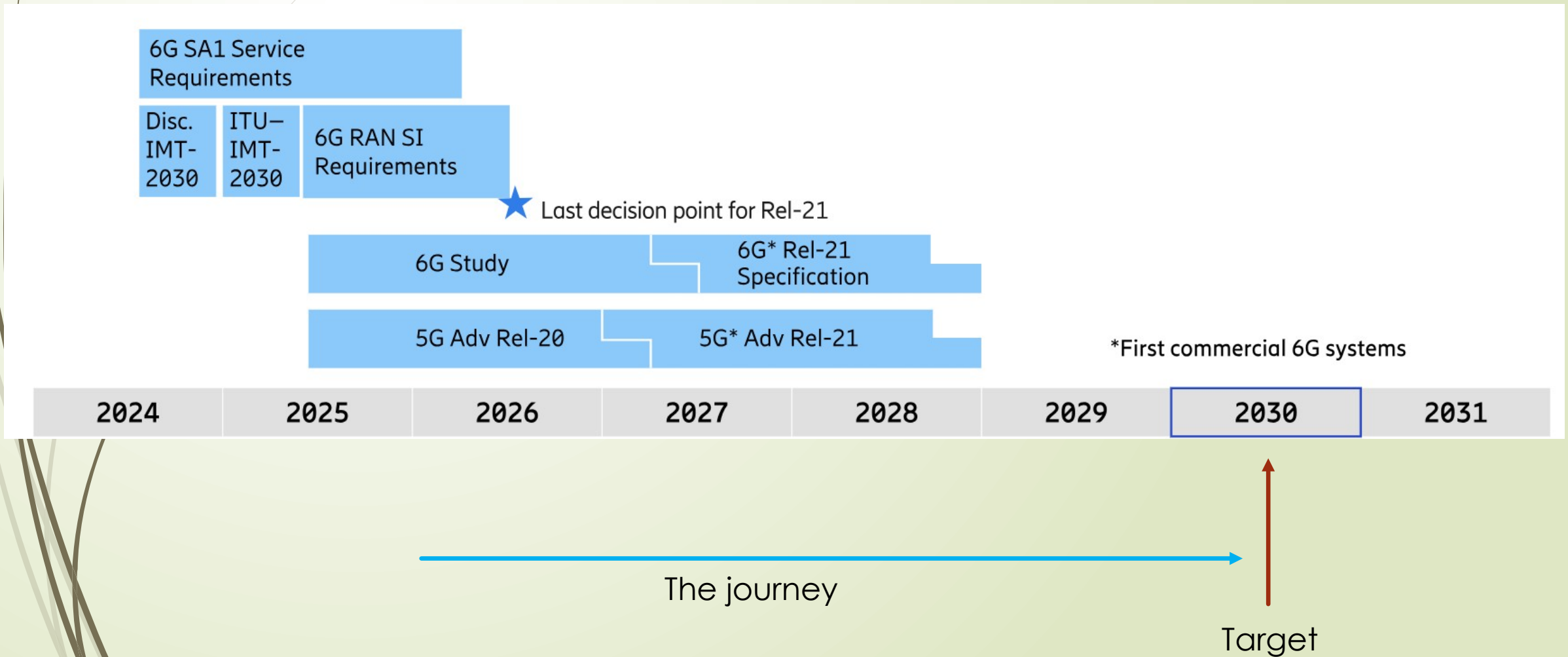
GSM → 5G

- GSM: 450 MHz, 900 MHz, 1800 MHz, 1900 MHz
 - UMTS: 2 GHz
 - 4G: 850 MHz - 2600 MHz
 - 5G (FR1): 450 MHz - 7125 MHz
 - 5G (FR2): 24 GHz - 71 GHz
-
- Higher frequencies allow (generally) for higher data throughput
 - At higher frequencies, more bandwidth available
 - But higher frequencies have shorter range

Envisaged frequency use in 6G

- ▶ 6G may operate in frequency bands that are currently used by previous network generations
- ▶ Millimeter wave: 30 GHz - 300 GHz
- ▶ Sub-Tera Hertz: 300 GHz - 1 THz
- ▶ Frequency usage in future networks (6G and beyond) not yet defined

Where are we now?



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