# A Preview of 5G-Advanced

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25. VDE/ITG Fachtagung Mobilkommunikation3. – 4. Nov. 2021, Osnabrück





On July 1, Nokia celebrated the 30-year anniversary of the world's first GSM call ever, which took place in its home country, Finland, in 1991.

# Timeline

Nokia view

		5G URLLC			5	5G	5G-Advanced						
							6G req.		6G study	6G sp	ecs	6G v2	
₽ F	R15	R16		R17		R18	R19		R20	R21		R22	
		5G comr deploy	5G commercial deployment			First ver 5G-Adv stand		Comme Deployn	rcial nent		First 3GPP 6G spec	6G Commerci Deployme	
	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	



## The evolution of 5G to 5G-Advanced The "four Es": Extension, Experience, Expansion, Excellence







## The dawn of 5G Advanced with Rel-18 Note: 3GPP final Rel-18 package will be agreed in Dec. 2021

#### Extension

- Service coverage enhancements
- Enhanced RedCap for sensors, video
- Sub-5MHz carrier for railways and smart grid
- Sidelink enhancements for vehicles, public safety, and extended reality

positioning methods for e.g. industrial

transactions and critical infrastructure

• Timing & synchronization aaS for e.g.

• 5G satellite networks

High accuracy and low cost

automation, IoT

• 5G drone support

Expansion

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#### Experience

- Extended reality (XR) optimizations
- Edge computing optimizations for e.g. Cloud gaming
- Mobility performance improvements for e.g. industrial and XR use cases
- Beamforming boost

#### Excellence

- Network energy savings
- Slicing enhancements
- AI/ML in radio, RAN, and core
- Centralized BB Unit resiliency
- Traffic splitting & steering



# Extension: wider reach and new segments

Extended support for UAVs, in-car communication, public safety, railway, and uplink heavy traffic types.

Global coverage via satellite for IoT and basic MBB.

The growth in number of IoT devices combined with extended MBB reach will increase the number of connected devices 2-3x fold.



- RedCap/IoT: 70% lower cost, 10y battery life, integrated with low-cost localization
- Bandwidth below 5MHz in dedicated FR1 spectrum
- PUSCH 2dB, RACH 5dB with dynamic power aggregation and enhancements for DFT-s-OFDM
- Sidelink relay enhancements and SL unlicensed
- IoT over NTN
- 5G UAV with reporting of flight path, flight parameters and drone identification



# Experience: eXtended Reality & more

- Augmented Reality (AR): adding virtual objects to real-world environments; devices: tablets, glasses
- Virtual Reality (VR): visual and audio scene combined with real-world locations; devices: usually Head Mounted Displays (HMDs)
- Mixed Reality (MR): adding haptics and interactions; devices: glasses, controllers

XR service requirements: up to 4k per eye with 90 fps, below 20ms latency, seamless mobility & high reliability



- Capacity MIMO performance boost with multicell uplink, +20% for high-speed mobiles
- Bounded latency not more than 20ms with high data rate
- Power XR-specific optimizations for devices
- Mobility reliability from 98.4% to 99.9%, close to 0ms HO break
- QoS fine-grained and synchronized service flows for optimized scheduling
- QoE XR-specific reporting of user quality perception
- Architecture split-rendering in edge and device



# Expansion beyond traditional communications

- Positioning with ultra-high accuracy below 10cm
- Positioning in out-of-coverage scenarios (incl. indoors)
- 5GS as timing backup/alternative for GNSS based applications offering same performance
- Time sync as a service for e.g. Smart grid, banking and points of sale, Media production & events, Sensors & testing, Consumer, Health & medicine.



- Positioning enhancements with carrier aggregation and carrier phase methods, lowcomplexity positioning, sidelink positioning
- Timing resiliency & sync as-a-Service with holdover times up to 24h, 250ns-1000ns sync accuracy
- Timing service with specific KPIs (e.g. accuracy, interval, coverage area)



# 5G operations excellence

- Lower cost and higher efficiency through smart orchestration and management
- Improved network resiliency
- More efficient handling of highly diverse traffic streams with different QoS requirements over RAN and CN.



- Network energy savings as part of any new feature to be developed
- Study of power models & dedicated network energy saving features
- Al enablers in radio, RAN and core
- Centralized BB Unit (gNB-CU) resiliency\*
- Multi-Access PDU sessions\*
- Support for service function chaining\*
- Slicing enhancements\*



# AI promises and challenges

#### Promises

- Make difficult-to-solve problems tangible
- Performance gains over "traditional" implementations
- Flexibility and adaptability to different scenarios and deployments
- Continual performance improvements



#### Challenges

- Framework for inter-operable AI/ML training and inference
- Comparability and explainability of solutions and performance
- Performance requirements & capabilities
- Conformance and device testing
- Data privacy



# AI/ML in 5G-Advanced





# The future starts now

Examples only

Video

High quality video

Digital twins

Digital twin of an object (e.g. an engine)

5G



Data communication & control

#### 5G - Advanced

XR, a fully immersive user experience while on the move

Digital twin at a larger scale (e.g. a vertical farm)

Provide precise location & timing services that complement GNSS

6G

Holographic

Digital twin of cities and even humans with real-time synchronous updates

Network with a 6<sup>th</sup> sense

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### Six key areas for 6G research in the next decade



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## Main take away



#### Evolution

5G-Advanced evolves the 5G system (5G NR & 5GC) to its fullest capabilities

#### **Backwards Compatibility**

5G-Advanced maintains backward compatibility to 5G

#### Timing

First version of 5G-Advanced Standards excepted for end 2023 with products hitting markets by mid 2025

## Myths

5G-Advanced is characterized by the enhancements from Rel-18 onward, it is not defined by the one main feature.

#### Market longevity

5G-Advanced will have min 5years of market significance

#### G (R)evolution

5G-Advanced will be followed by 6G, which will not be constrained by the 5G basic design.



