5G New Radio: Next Generation Radio Access Network

Wireless Network (SSY145)

Olalekan Peter Adare

&

Haitham Babbili

CHALMERS

2020-May-20

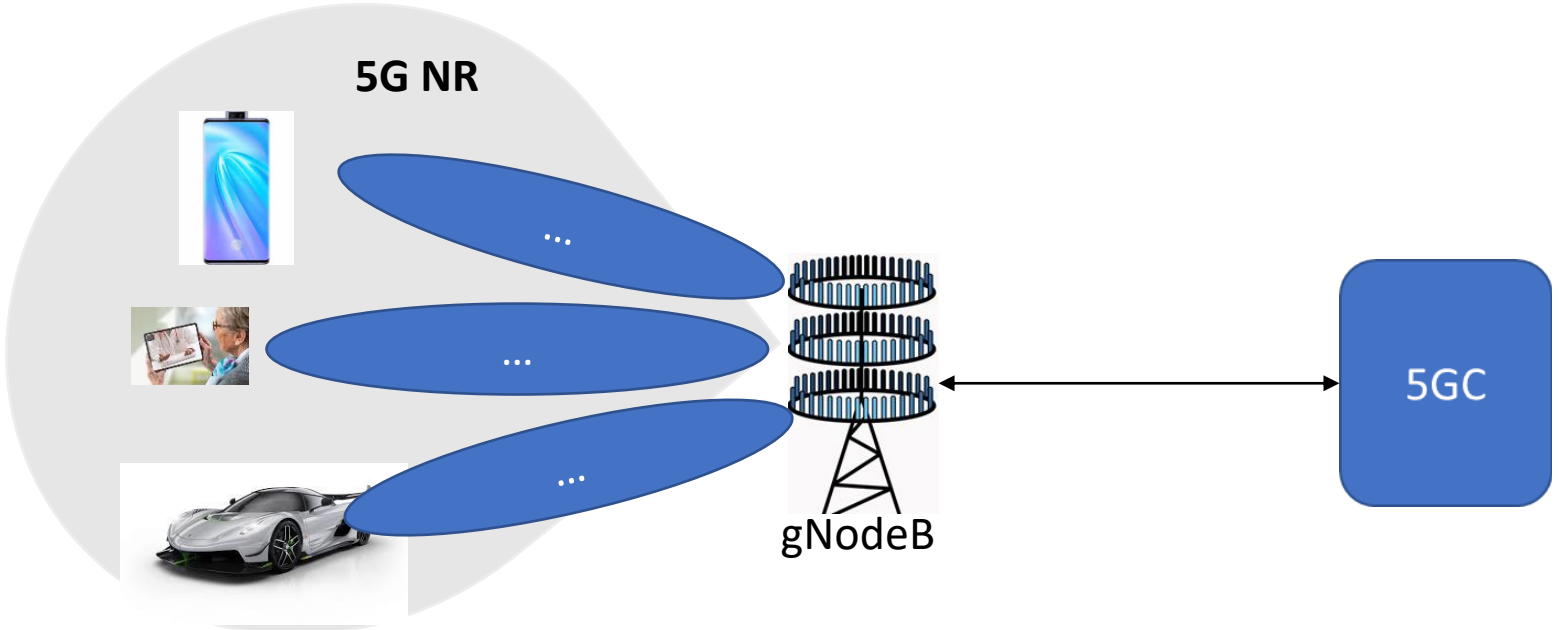
Content

- Introduction
- Background and New Challenges
- 5G NR
- 5G Standardization and Specifications
- 5G NR Requirements
- 5G NR Design
- 5G NR Services
- Spectrum Allocation in 5G NR
- 5G NR and 4G LTE Coexistence
- Benefits of 5G NR
- Conclusion

5G NR

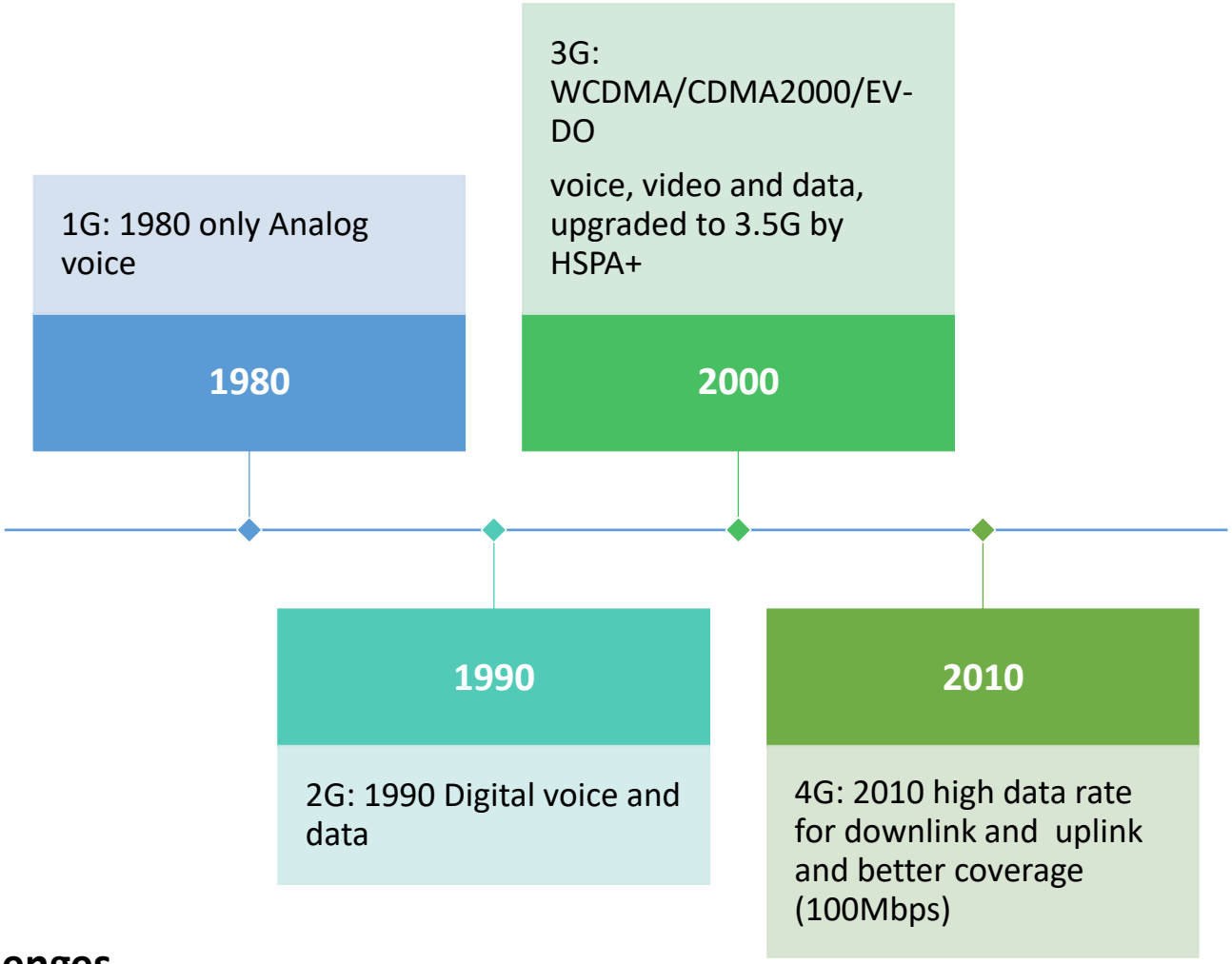
Introduction: What is 5G NR?

- In mobile communication, the air interface is the frequency link between UE and base station in mobile communication
- 5G New Radio (NR) is access air interface of the 5G Network
- An OFDM-based, unified, and more capable air interface
- It will offer varying services, use cases, deployment scenarios and diverse spectrum
- Possibility of operating from low to very high frequency bands: 0.4 - 100GHz
- It will interwork with 4G LTE and Wi-fi for seamless user experience



5G NR

Background & New Challenges



Challenges

Ultra-high data rates (> 1Gbps) ↔ Ultra-large Connections (>1million) ↔ Ultra-low latency (<1ms)

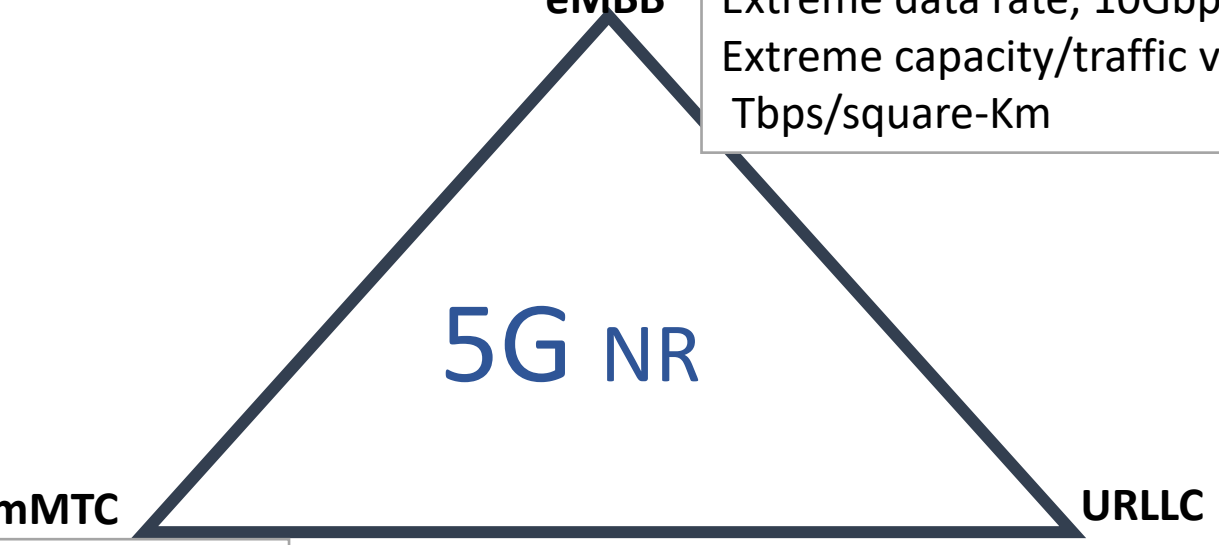
Network Evolution is needed to fulfill these requirement → 5G NR

5G NR: Scaled for diverse uses

eMBB
Enhanced Mobile Broadband

mMTC
Massive Machine Type Communication

URLLC
Ultra-reliable and Low-latency Communications



Extreme data rate, 10Gbps peak
Extreme capacity/traffic volume
Tbps/square-Km

Ultra-high density
1million/square-Km
Optimized IoT
Low-power and low-complexity

Ultra-low latency < 1ms
Highly reliable (99.999%)
Highly secured

5G NR

5G Standardization and Specifications

- **3GPP** Release 15 in 2018 gave the basic requirements for 5G NR. This became the baseline for Releases 16 and 17.
- 3GPP proposed practical deployment scenarios
- **Non-Standalone (NSA)** : 5G NR relies on 4G LTE network for its control/signaling information. Data access is handled by the 5G NR network

  Intended for earlier commercial use and smooth upgrade to full 5G network
- **Standalone (SA)** : This is 5G without 4G LTE.

Here, data, control/signaling are handled end-to-end by the 5G network

5G NR

5G NR Requirements

- High data rate in the order of ~Gbps
- Increased bandwidth efficiency
- Support for many new use cases
- Support for large number of device connection
- Latency of 1ms, or less
- Energy efficiency and battery lifespan optimization
- Scalable and customizable network

…….

5G NR

5G NR Design

- Basically, to increase data rate, there should be an increase in bandwidth and the modulation schemes.

Key Design Parameters are:

- **Flexibility** : use wide range of frequencies, deploys different technologies and depends on the physical layer components (gNB, 5GC)
  - Technology: high order modulation, massive MIMO with flexible channel state information, variable numerologies, and frame structure timing sequence
- **Ultra lean design**: reduce the ”always-on” reference signals
  - Improve power efficiency
  - Reduce network operator expenses
  - Reduce interference in high traffic load situation
  - Reduced number of reference signals since beamforming is being used
- **Forward compatibility**: 5G NR must support a wide range of use cases, (V2V,D2D, AR,VR…) and some new cases are under review. This means it must offer support for future wireless access technologies

5G NR

5G NR Services

eMBB:

- Service in 5G NR that require high data rate like high resolution video, virtual and augmented reality, and live steaming.
- Depends on the physical layer: The various technologies at the layer are high modulation orders, high bandwidth, carrier aggregation, cell densification, massive MIMO, mmWave and spectral localization

mMTC:

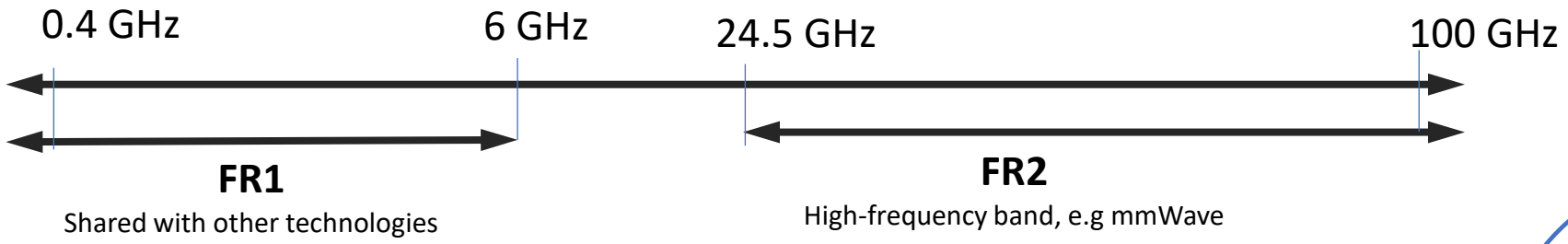
- support higher volume of IoT for services like smart city, tracking and sensing
- Requires high connection density, better power efficiency and longer battery lifespan
- Narrowband internet of things (NB-IoT) is a good fit mMTC. It also helps to manage the possibility of having more mMTC devices than the network can initially support.

URLLC:

- services that are latency-sensitive and highly reliable. (<1ms & 99.999%) e.g. remote driving
- Requires QoS priority different from that of the mobile broadband service. It is given a higher QoS priority than normal mobile services
- Achieved by reducing system over-head in terms of channel access, user schedule, allocation of resources, grant-free based uplink transmission, and advanced channel coding schemes.

5G NR

Spectrum Allocation in 5G NR



- Frequency bands for 5G NR are separated into two different frequency ranges.
  - FR1: sub 6GHz (450MHz – 6GHz) : wider coverage, lower bandwidth (100MHz)
  - FR2: 24.5GHz to 52.5GHz: shorter coverage but higher bandwidth (400MHz)
- 5G NR use compensation of FR1 and FR2 which mean better coverage and high bandwidth
- 5G NR spectrum use license , unlicensed, and shared spectrum
- 5G NR uses both TDD and FDD as duplex technology:
  - Dynamic TDD, used mostly in FR2 range. TDD and FDD is used in FR1 range.
  - Self-contain structure is faster switching time
  - Better spectrum utilization and guaranteed bandwidth

5G NR

5G NR and 4G Coexistence

- Frequency spectrum is limited so the system needs to utilize it in an efficient way, by sharing the spectrum.
- **Static Sharing:** good for user but not for spectrum efficient
- **Dynamic Sharing(DSS):** based on flexible design of the physical layer
- DSS minimizes the collision between 5G and 4G technologies
- Coexistence between 4G and 5G can be consider as flexible re-farming

5G NR

Benefits of 5G NR

- More data rate per user (peak 10 Gbps)
- Hyper-densification (1m/square-km)
- Increased capacity and network coverage
- Optimized for IoT
- More reliable and low latency system e.g. mission-critical services like remote driving, sensing, telemedicine, tracking etc.
- New Intelligent interconnection of devices e.g. V2X, D2D etc

5G NR

Conclusion

- 5G NR is the access air-interface for the 5G network
- 5G NR focuses on eMBB, mMTC and URLLC services
- The key technologies include spectrum flexibility, ultra lean design, carrier aggregation, advanced coding and massive MIMO.
- 5G NR can co-exist with 4G LTE seamlessly
- 5G NR offers better coverage for mobile services in urban, suburban and rural areas.
- 5G NR is the foundation for future mobile communication technologies.

5G NR

THANK YOU

Olalekan Peter Adare & Haitham Babbili