5G NR – The Next Generation Wireless Access

Dr Stefan Parkvall
Senior Expert, Ericsson Research
IEEE Fellow

5G

Empowering people, transforming industries, advancing society

5G vision

Non-limiting access to information and sharing of data …

… anywhere and anytime …






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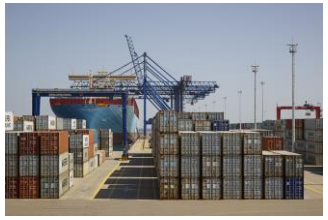
… for anyone and anything





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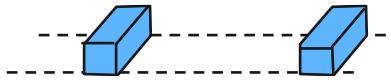
NR Rel-15 – what is it?

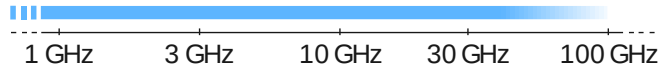
— 3GPP Rel-15 – first release of NR – completed in June 2018

NR characteristics – some examples

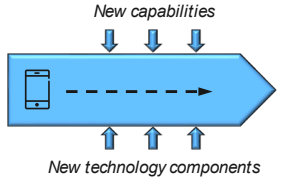
Ultra-lean design



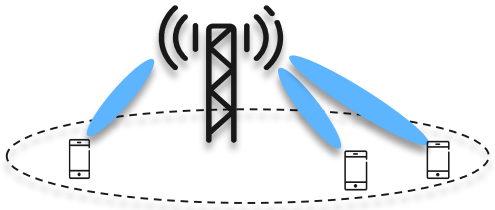
Wide spectrum range



Forward compatibility



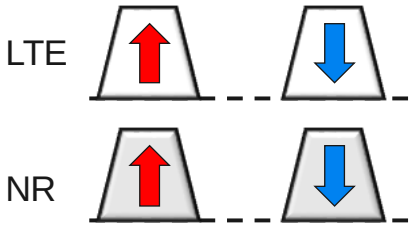
Multi-antenna support



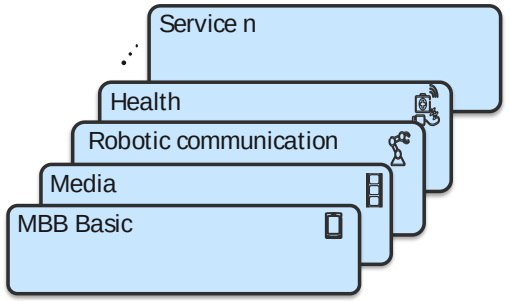
Low latency

NR characteristics – some examples

LTE – NR coexistence

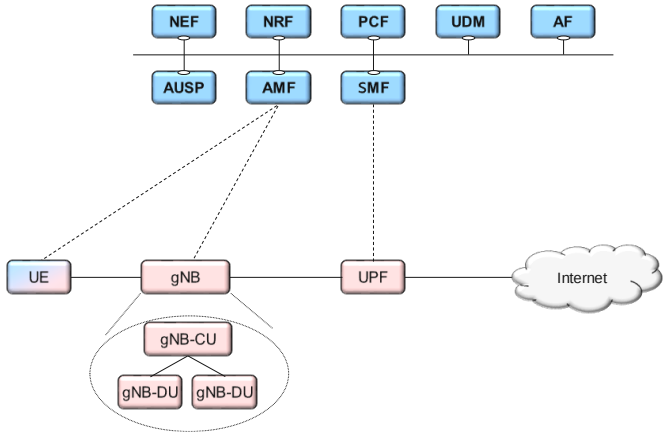


Network slicing



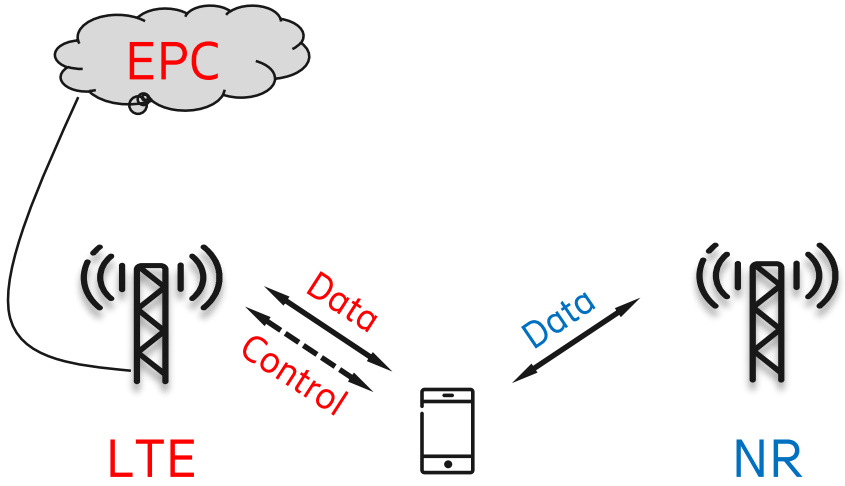
Modular architecture

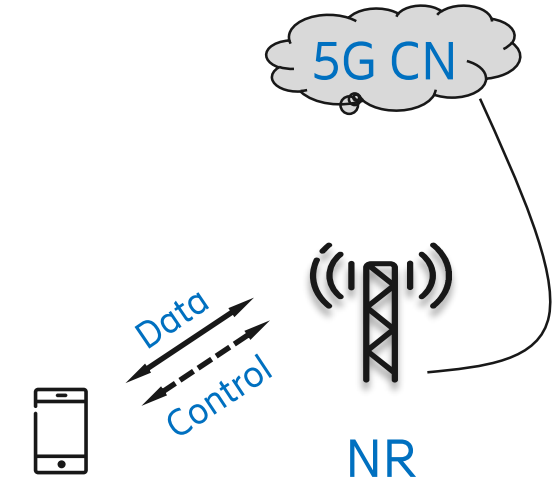
DU/CU split, CP/UP split



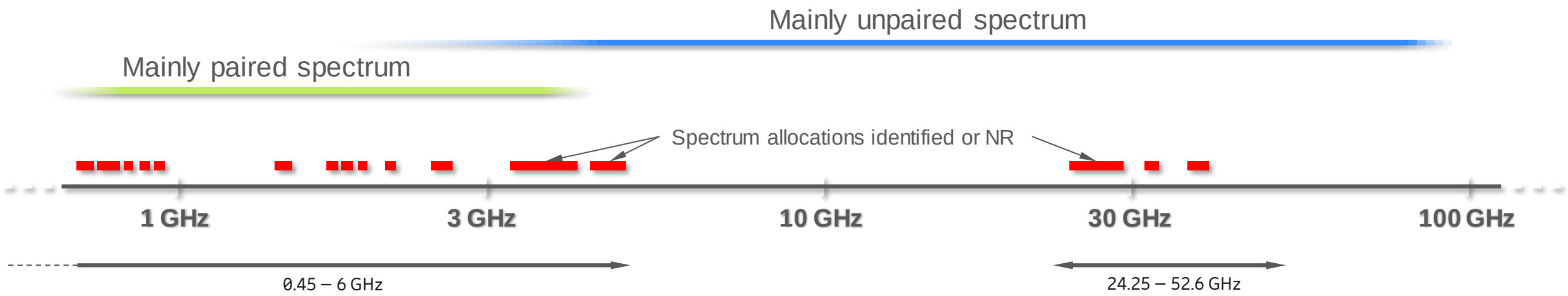
Architectural options

- Non-standalone NR (December 2017)
  - LTE handling initial access and mobility
  - NR is a "data rate booster"
  - Connects to EPC
- Stand-alone NR (June 2018)
  - NR handles initial access and mobility
  - Connects to 5G CN





5G spectrum



Frequency Range 1

Subcarrier spacing	15/30/60 kHz
Max carrier bandwidth	50/100/200 MHz

Frequency Range 2

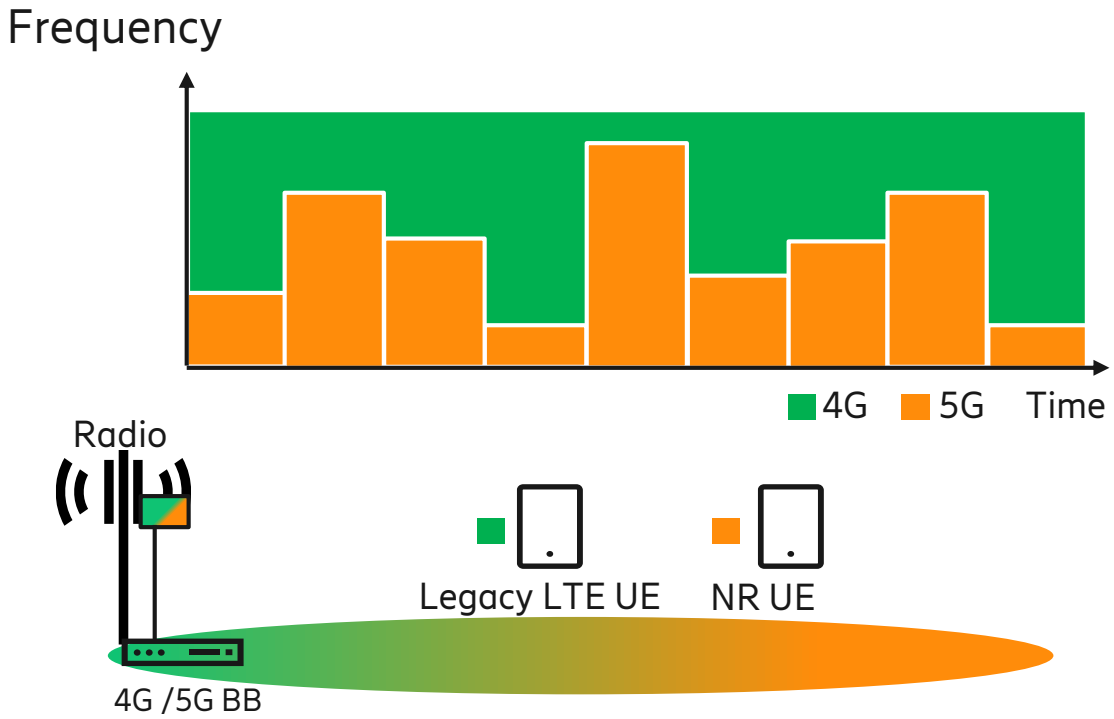
Subcarrier spacing	60/120 kHz
Max carrier bandwidth	200/400 MHz

Ericsson spectrum sharing

— Gradually introduce 5G in 4G band based on NR device penetration

— Lowest cost 5G introduction:
Shared radio + share baseband + shared spectrum

— Smooth and fast network migration



5G spectrum bands and use cases

High Band

Extreme capacity layer (eMBB, Fixed Wireless, Ultra-reliable low latency)

- Large spectrum bandwidth available: very high capacity and data rates
- Limited coverage, partially compensated with Massive MIMO
- Latency <1ms at 26 GHz

Mid Band

Baseline capacity layer (eMBB, Massive IoT, Ultra-reliable low latency)

- Flexible for many uses case with higher throughput, wider spectrum, LTE refarming
- Latency: <3ms RTT at 3.5GHz

Low Band

Coverage layer (eMBB, Indoor, Massive IoT)

- Suitable for wide area coverage, deep indoor and mobility
- Data rates and capacity limited by spectrum bandwidth availability
- NR to provide shorter latency than in LTE-A

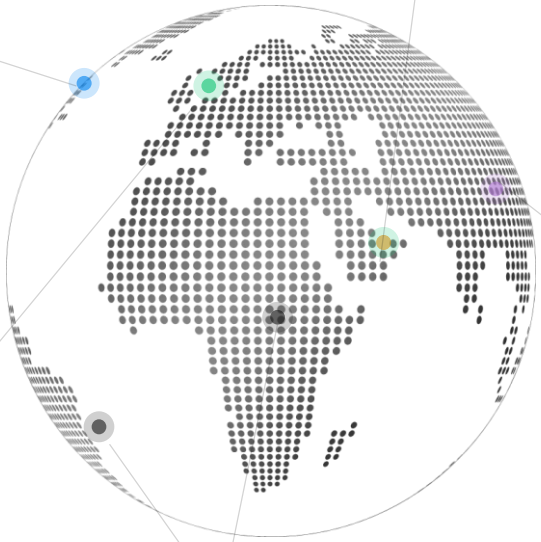
Initial NR focus per region

North America

- 2018 launches on mmWave
- Early 2019 low-band, mid-band
- Mobile broadband and FWA

Middle East

- 2018 launches on mid-band, with mmWave as second wave
- Mobile broadband and FWA



South America and Africa later

Europe

- Initial focus on mid-band
- Focus on industry use-cases
- Low-band NR for coverage
- High-band as capacity booster

Asia

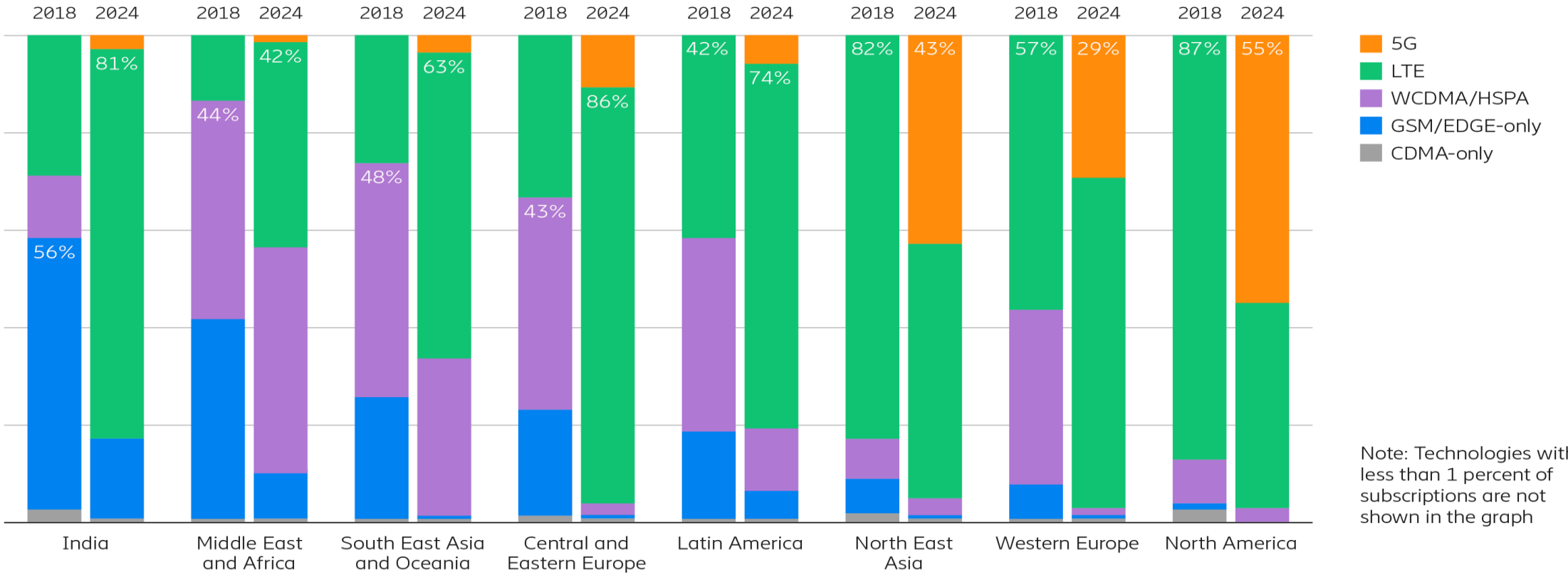
- Initial focus generally on mid-band, with high-band as second wave
- China taking lead in SA deployment
- Australia and Korea early movers with 2018 launches
- China and Japan driving volumes in 2020 with large scale rollouts

Forecast on subscriptions by region & technology

Ericsson Mobility Report – Special Edition World Economic Forum, Jan 2019

Rapid uptake of 5G – Driven mainly by US and NE Asia, and somewhat by Western Europe

Mobile subscriptions by region and technology (percent)

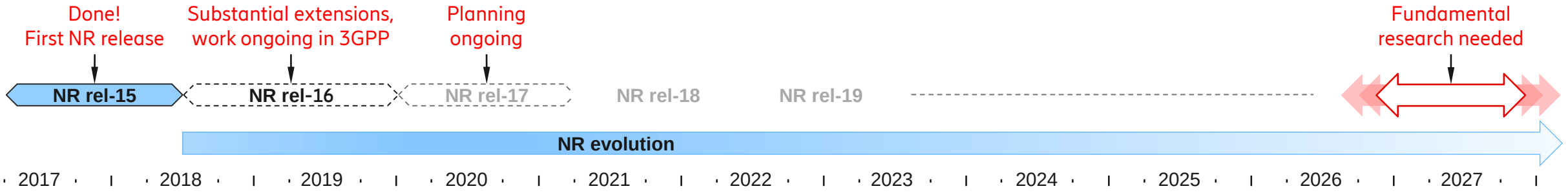


Note: Technologies with less than 1 percent of subscriptions are not shown in the graph

5G collaboration examples

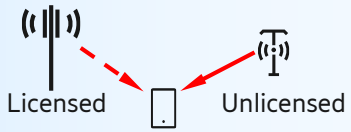
Beyond Rel-15

- First release concluded (Rel-15)
- Evolution of NR
  - Substantial extensions already in release 16
  - Continued evolution in subsequent releases
- New technologies beyond NR
  - Technologies implying a more fundamental step
  - May be part of “5G evolution” or “Beyond 5G”

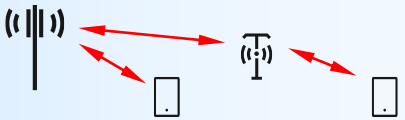


Some topics in NR Rel-16

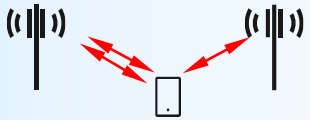
Unlicensed spectrum
LAA and stand-alone



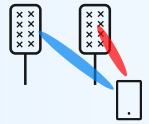
Integrated Access Backhaul
NR for backhauling



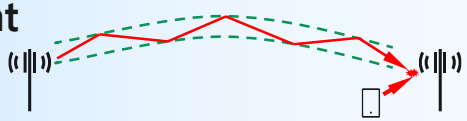
CA/DC enhancements
Faster SCell activation, signaling enhancements, ...



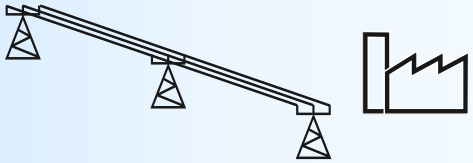
Multi-antenna enhancements
Multi-TRP, CSI reporting, ...



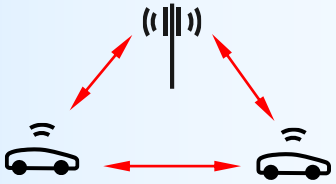
Remote Interference Management
TDD, athmosperic ducts, ~300 km



URLLC enhancements
PDCCH enhancements, ...



V2X
Sidelink, Uu enhancements, QoS, ...



Positioning
Combination of techniques

NR in unlicensed spectrum

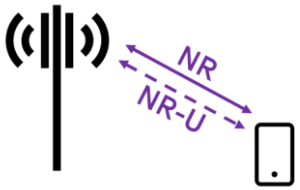
Frequency bands: 5 GHz and 6 GHz

Deployment

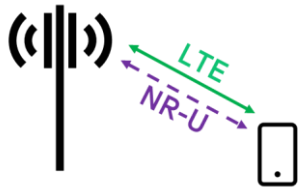
- Licensed-assisted access, NR + NR-U
- Licensed-assisted access, LTE + NR-U
- Stand-alone unlicensed operation

NR well prepared for unlicensed operation

- Flexible frame structure, ...
- Add LBT, also for initial access



NR + NR-U



LTE + NR-U

Stand-alone
unlicensed operation

Integrated access-backhaul

NR for wireless backhaul

— When wired backhaul not available

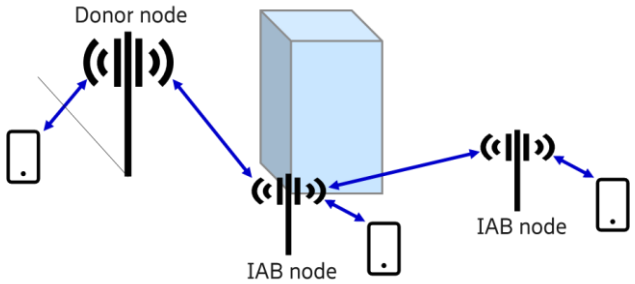
— For rapid deployment

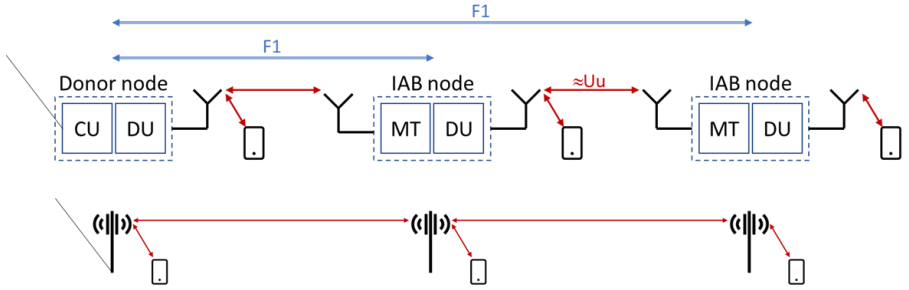
Focus on backhaul in mmw spectrum

— Both inband and outband backhaul

Based on specified CU/DU split

— Smooth migration to wired backhaul

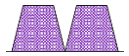
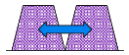
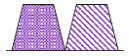
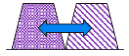




CA/DC enhancements

CA/DC scenarios

Carrier aggregation

Same numerology, in-carrier sched.		Rel-15
Same numerology, cross-carrier sched.		Rel-15
Different numerology, in-carrier sched.		Rel-15
Different numerology, cross-carrier sched.		Rel-16

Dual connectivity

MCG in FR1, SCG in FR2		Rel-15
MCG and SCG in FR1		Rel-16
MCG and SCG in FR2		Rel-16
MCG in FR2, SCG in FR1		Rel-16

Enhancements/extensions

- Early measurement reporting
- Signaling enhancements
- Faster activationfor Scells
- Faster activation of MCG CA or SCG
- Faster MCG recovery

RIM / CLI

Remote-interference management

— Inter-BS interference e.g. due to atmospheric ducts

Cross-link interference mitigation to support flexible resource adaptation.

— Cross-link interference measurements at a UE

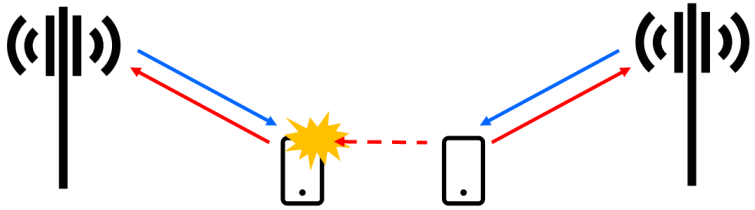
— Network coordination mechanisms including exchange of intended DL/UL configuration

Remote interference

e.g. due to atmospheric ducts

Cross-link interference

dynamic/uncoordinated TDD



URLLC enhancements

New use cases

— Factory automation
— Transport industry, include remote driving
— Electrical power distribiution

Areas

— PDCCH enhancements (compact DCI, PDCCH repetition, increased PDCCH monitoring capabilities)
— UCI enhancements (enhanced HARQ feedback, CSI feedback enhancements)
— PUSCH enhancements (mini-slot-level hopping and retransmission/repetition enhancements)
— Uplink inter-UE Tx prioritization
— Enhanced “grant-free” transmission

NR V2X

Complementing LTE V2X for advanced V2X use cases

— Vehicles platooning, extended sensors, advanced driving, remote driving, ...

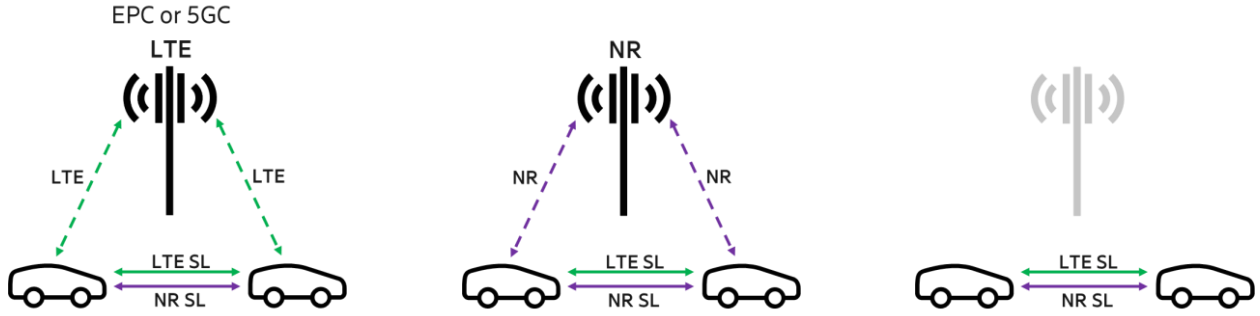
Objectives

— Ensure current NR radio-interface support for relevant V2X use cases

— Introduce NR sidelink (direct vehicle-to-vehicle link)

  — In-coverage, partial-coverage, and out-of-coverage

  — Sidelink controlled by NR or LTE



NR Positioning

Regulatory requirements

— Horizontal accuracy: 50 m

— Vertical accuracy: 5 m

Preliminary requirements for commercial services

— Horizontal accuracy: 3 m [indoor] / 10 m [outdoor]

— Vertical accuracy: 3 m [indoor/outdoor]

Combination of different techniques

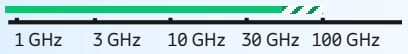
DL-based positioning
- DL-TDOA
- DL-AoD

UL-based positioning
- UL-TDOA
- UL-AoA

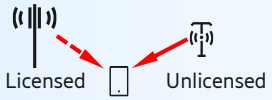
DL/UL-based positioning
- RTT-based positioning
- E-CID-based positioning

Possible topics in Rel-17

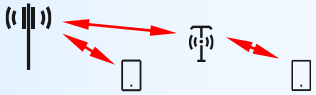
- **Above 52.6 GHz**



- **Unlicensed, 5-6 GHz, 60 GHz**



- **IAB enhancements**



- **MIMO enhancements**

- **Non-terrestrial access**

- **Drone enhancements**

- **Multicast/broadcast**

- **Public safety**
  (No separate WI/SI needed)

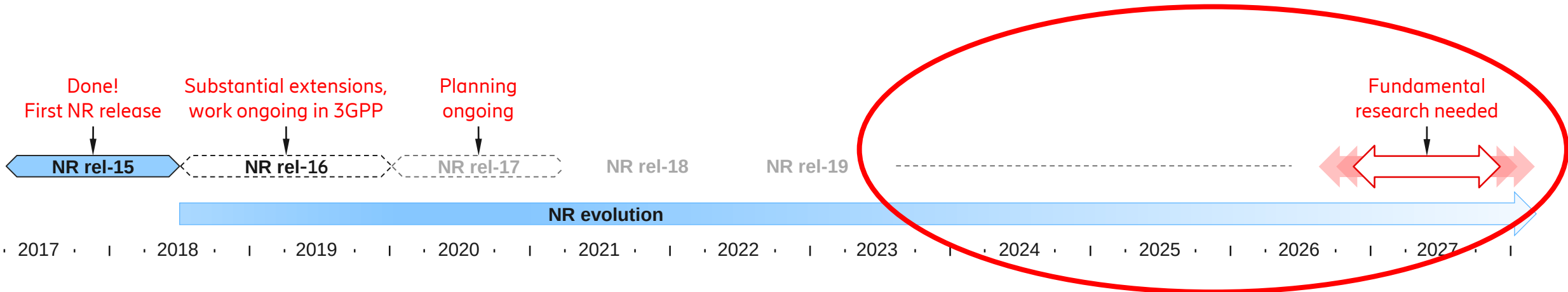
- **NR MTC for industrial sensors**

- **SON/MDT**

What about the longer time perspective?

Long-term NR evolution

- First release concluded (Rel-15)
- Evolution of NR
  - Substantial extensions already in release 16
  - Continued evolution in subsequent releases
- New technologies beyond NR
  - Technologies implying a more fundamental step from NR
  - May be part of "5G evolution" or "Beyond 5G"



High-level 5G vision still valid

Non-limiting access to information and sharing of data …

… anywhere and anytime …



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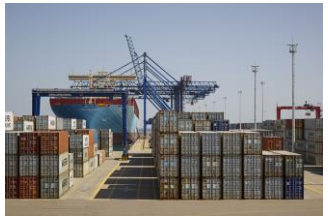
… for anyone and anything





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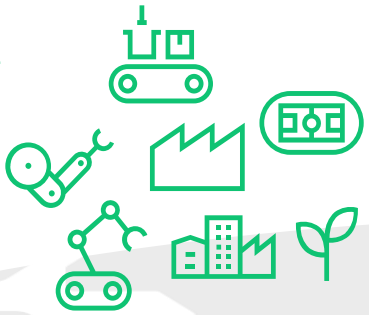
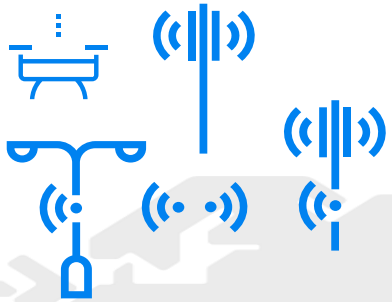
5G evolution and beyond

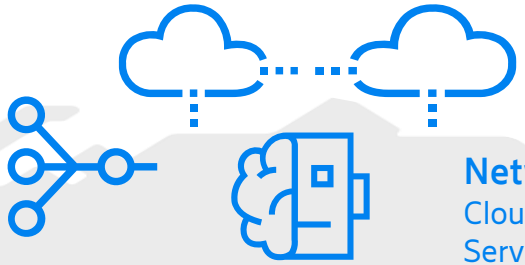
New use cases
Manufacturing and industrial IoT
Automotive and ITS
XR (AR/VR/mixed reality/...)
Fixed wireless access



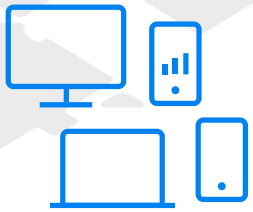
Radio access
Higher frequencies
Integrated access and backhaul
New topologies and mesh
Energy efficiency



Networking
Encryption compatible network optimizations/Collaborative
Artificial Intelligence / Machine Learning
Intelligent SON- oriented



Devices & Hardware
Co-operative transmission / D2D
Zero energy
Zero cost

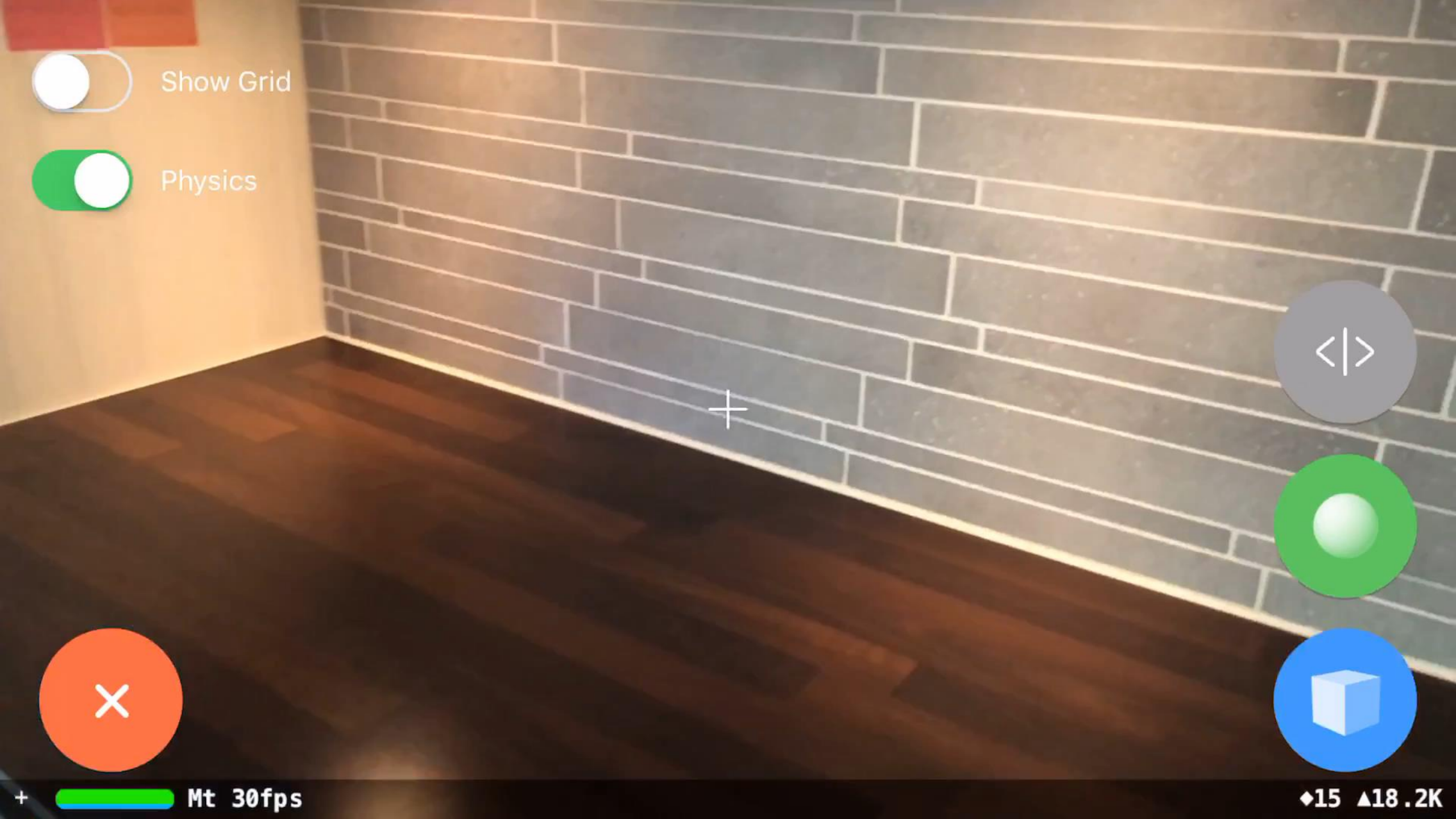


Network Implementation
Cloud based
Service based
AI
Open source
Network service mesh

Integrated connectivity and edge compute

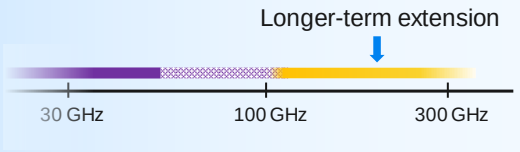
Zero-touch

Trusted networking

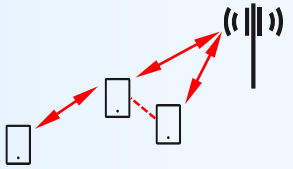

Show Grid
Physics
Mt 30fps
♦15 ▲18.2K

Some possible long-term technologies

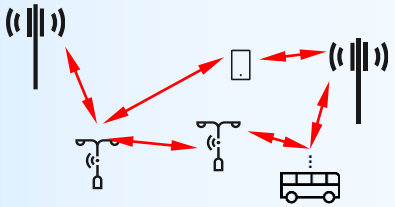
Expansion beyond 100 MHz
Reevaluate waveform



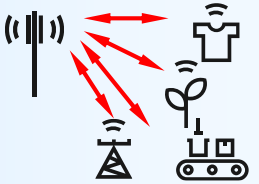
Device cooperation
Relaying, co-operation
Especially for future IoT applications



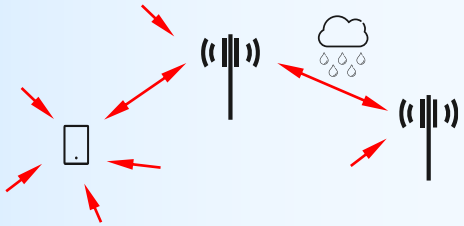
Flexible network topologies
Multi-site, multi-hop, mobile relays, ...
all under network control



Massive IoT
"zero cost", "zero energy", ...



Cellular as a sensor
Communication signals for
sensing the environment



Cloud-native RAN
Scalable, stateless, ...

Summary

— 5G NR evolution has started
  — First steps ongoing in rel-16
  — Scope of rel-17 soon to be discussed