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@qualcomm

Brussels



Co-opetition, Innovation and Standardisation

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Delivering on the 5G vision

\$13.2 Trillion in goods & services by 2035*



* The 5G Economy, an independent study from IHS Markit, commissioned by Qualcomm

**Enhanced
mobile broadband**

**Massive
IoT**

Computer vision



Sensors



Head mounted display

Handheld terminal



**Ultra-reliable
low-latency**

Automated guided vehicle (AGV)



Wireless edge analytics



Industrial robot

AI-based camera detects hazards and alerts

V2V/V2I: Intersection assist, non-line of sight warning



Traffic light detects crossing and alert cars via I2V

C-V2X direct communication

Key for cars to act with immediacy

Evolving 5G for smart transportation

XR for closer collaborations at the work place



Six degrees of freedom

XR



Edge cloud for low latency, processing, content,...



Augmenting on-device processing and intelligence

Real-time insights

Days to market

Production estimate

37

2.3M

Distribution (K)



Orders (K)



Color swatches



360°

Emerging dedicated private networks for targeted needs



Shipping logs

Trip times

Cargo loads

Local management for low latency and protection of sensitive data

Real-time inventory

- ☐ Lumber
- ☐ Hardware
- ☐ Technology
- ☐ Manufacturing
- ☐ Produce
- ☐ Automotive
- ☐ Earth/Soil
- ☐ Retail

5G NR
Private network

On-premise compute and storage
Updating

Real-time asset tracking

At port (Days)

3

Location



Spools shipped



Camera



Capacity

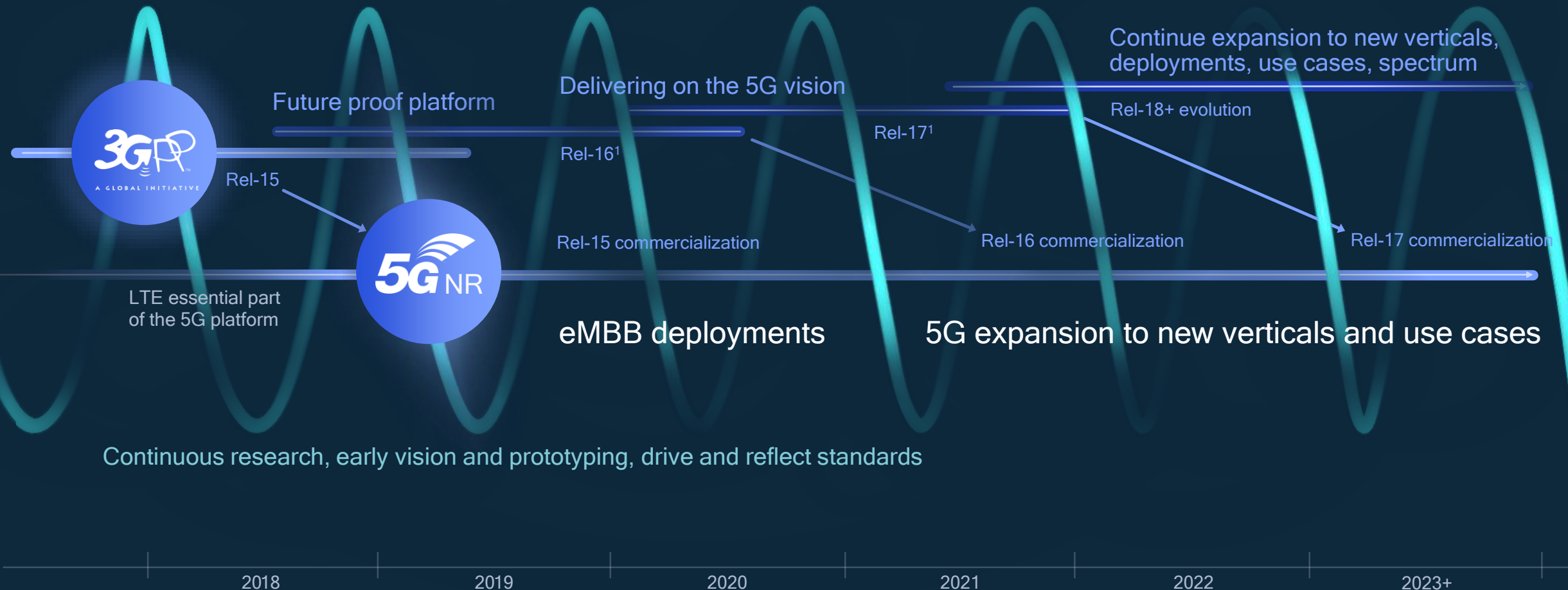


On-device intelligence

Seamless interworking with public network

AR-guided execution

Driving the 5G roadmap and ecosystem expansion



1. 3GPP start date indicates approval of study package (study item->work item->specifications), previous release continues beyond start of next release with functional freezes and ASN.1

Continued evolution to deliver on the 5G vision



Initial focus: eMBB – enhanced mobile broadband services



5G core network



5G NR IIoT with eURLLC



5G NR Cellular V2X



5G NR in unlicensed spectrum



Enhancements to 5G NR IIoT



Expand sidelink e.g., V2X reliability, P2V, IoT relay



Unlicensed spectrum across all use cases



Advanced channel coding



Sub-6 GHz with massive MIMO



LTE integration



5G broadcast¹



5G massive IoT²



Positioning across use cases



New spectrum above 52.6 GHz



NR-Light e.g., wearables, industrial sensors



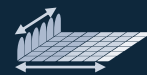
Centimeter accuracy e.g., IIoT with mmWave



Mobile mmWave



Scalable OFDM-based air interface



Flexible framework



eMBB evolution³



IAB – integrated access/backhaul



Continuation of Rel-15 projects, others⁴



Continued eMBB enhancements⁵



More capable, flexible IAB



Rel-15 deployment learning, XR, drones, others⁶

Rel-15

Established 5G NR technology foundation

Rel-16

Expanding to new use cases and industries

Rel-17: Likely candidates

Continued expansion and enhancements

1. Enhancing Rel-14 LTE enTV to meet 5G requirements; 2. eMTC/NB-IOT in-band 5G NR and connected to 5G core; 3. MIMO, power consumption, mobility, MR DC/CA, interference management and more; 4. Non-terrestrial networks, non-public networks (private networks), NR SON/MDT and more; 5. further improvements to capacity, coverage, mobility, power consumption, spectral efficiency; 6. mixed-mode multicast, small data transmission, multi-SIM, satellite, multimedia

Expanding 5G with the flexible framework

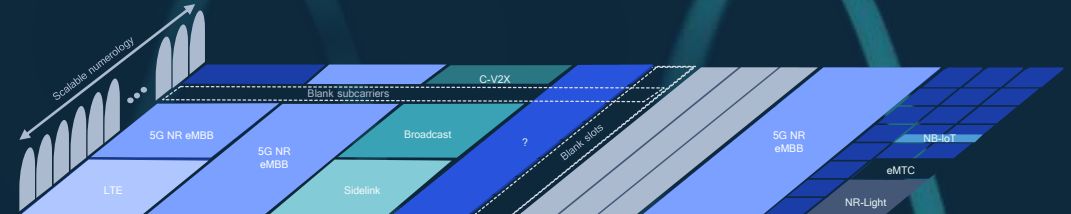
Early
vision

A unified future-
proof platform

Delivering on the
5G vision and expansion

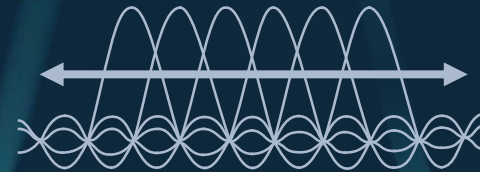


A flexible framework with
forward compatibility
Efficiently multiplex today's and
unforeseen services on same frequency

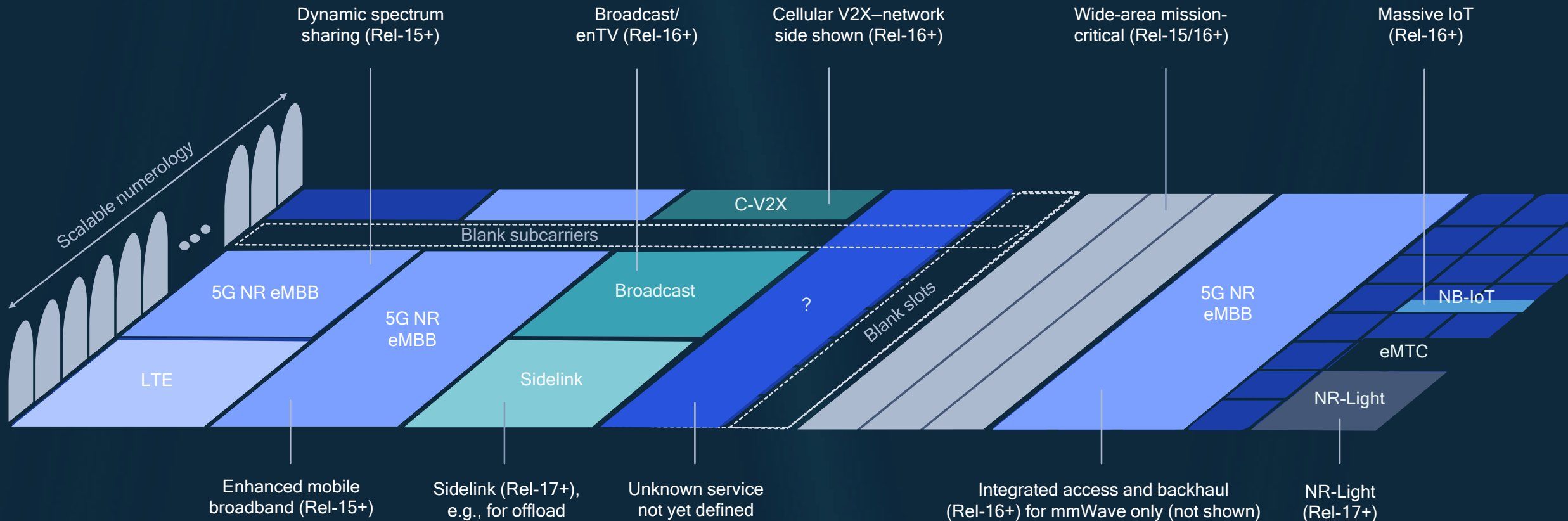


Flexible slot-based framework

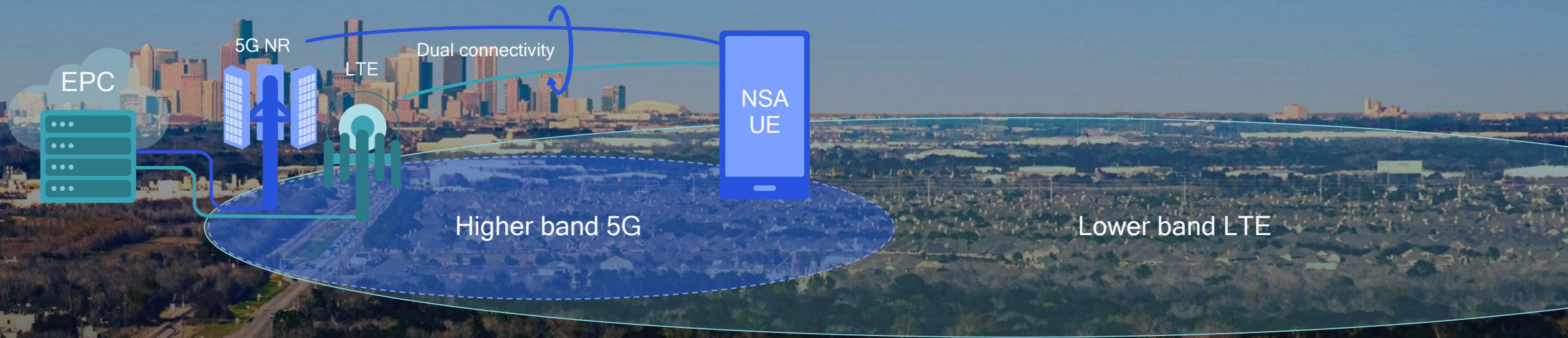
Scalable OFDM-based air interface



Expanding 5G with the flexible slot-based framework



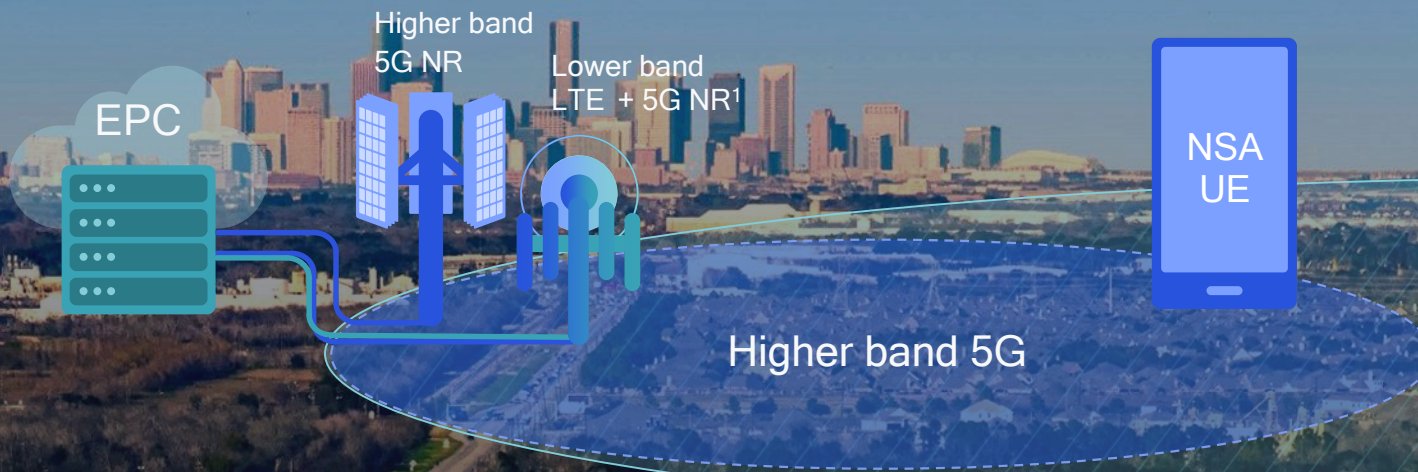
Accelerated 5G to 2019 with non-standalone mode



Expand coverage with lower bands

Expand 5G coverage

- Dynamic Spectrum Sharing (DSS)
- 5G FDD in low bands



Multiple spectrum options

For private 5G networks



Licensed spectrum by mobile operators

Operators can allocate spectrum in a specific area



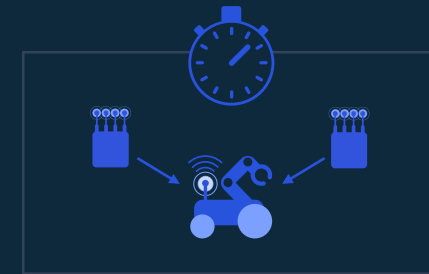
Unlicensed spectrum with async sharing

NR-U with asynchronous sharing work for many applications



Dedicated regional spectrum

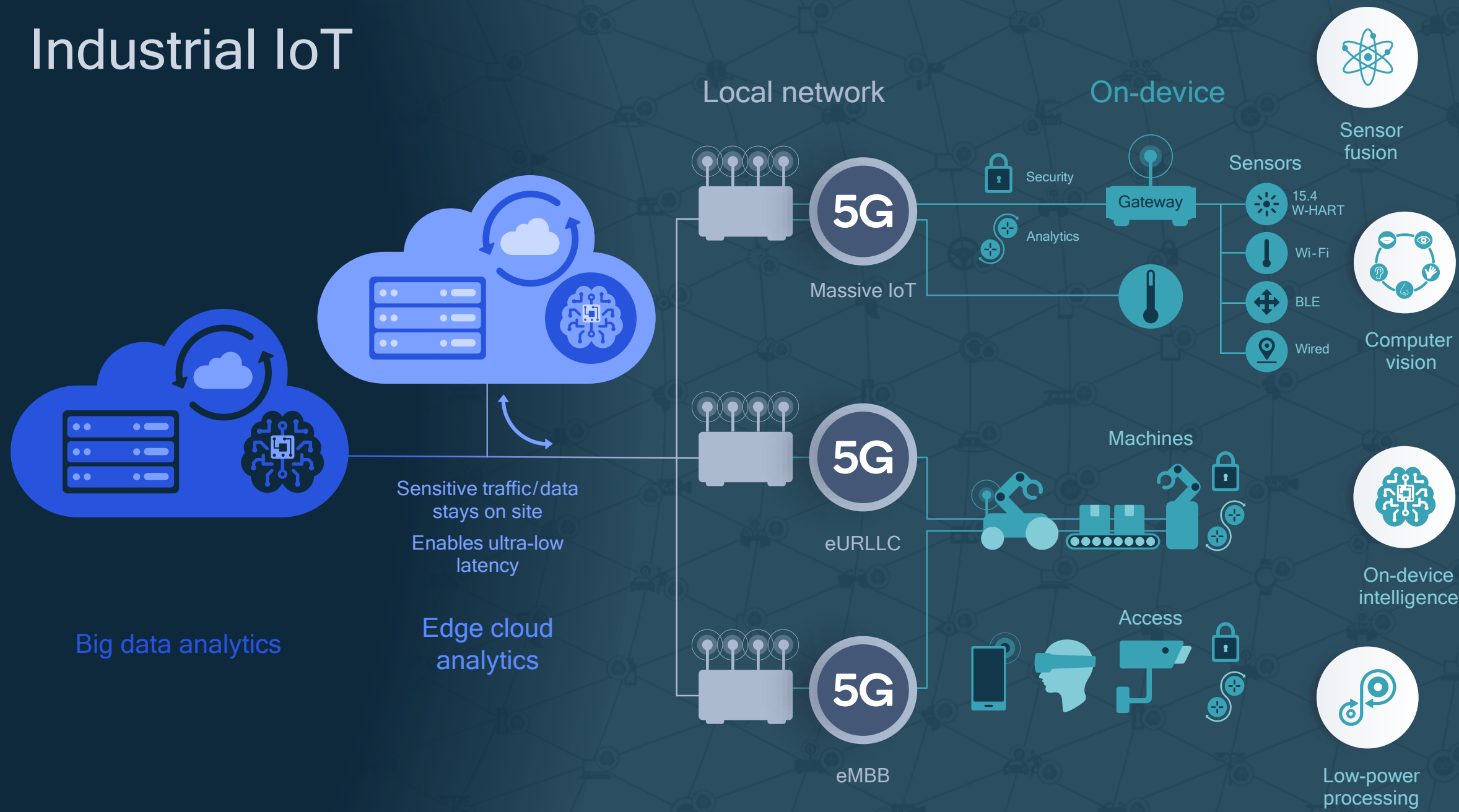
Regional spectrum such as 3.7GHz in Germany for IIoT



Unlicensed spectrum with synch sharing

Synchronized sharing can provide reliability and eURLLC for IIoT

Industrial IoT



Enhanced network communication

Faster access to cloud for in-vehicle experiences, car OEM services and telematics



New direct communication

V2V, V2I, and V2P communications for latency-sensitive use-cases, e.g. collision avoidance



Massive Internet of Things

Deeper coverage to connect road infrastructure (e.g. sensors and traffic cameras)



V2N



V2N



Road hazard warning

V2I



RSU

Speed harmonization



V2V



Smart city



Sensors



Utilities



Connected car services



In-vehicle experiences



Road safety



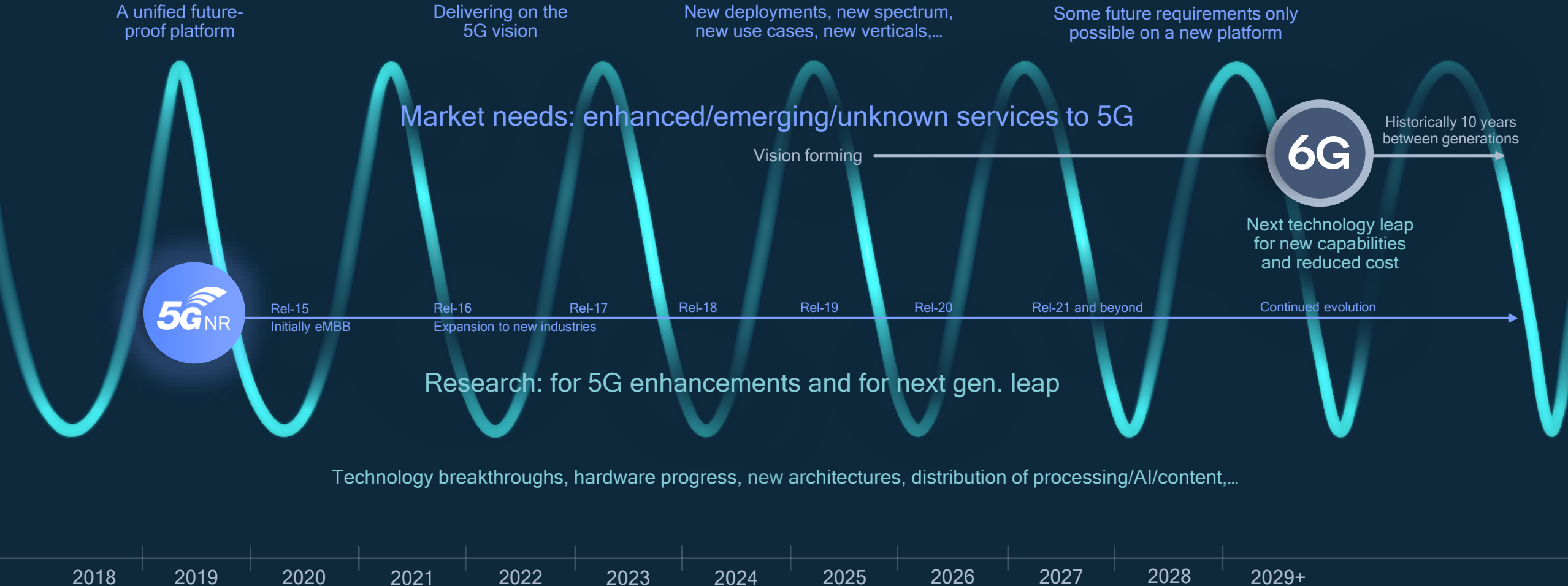
Transportation efficiency



Connected road sensors





Evolution to 5G NR supports smart transportation use cases

Policies that preserve investment in standards are key





Thank you

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