

The Development of 5G: The Technological Challenges

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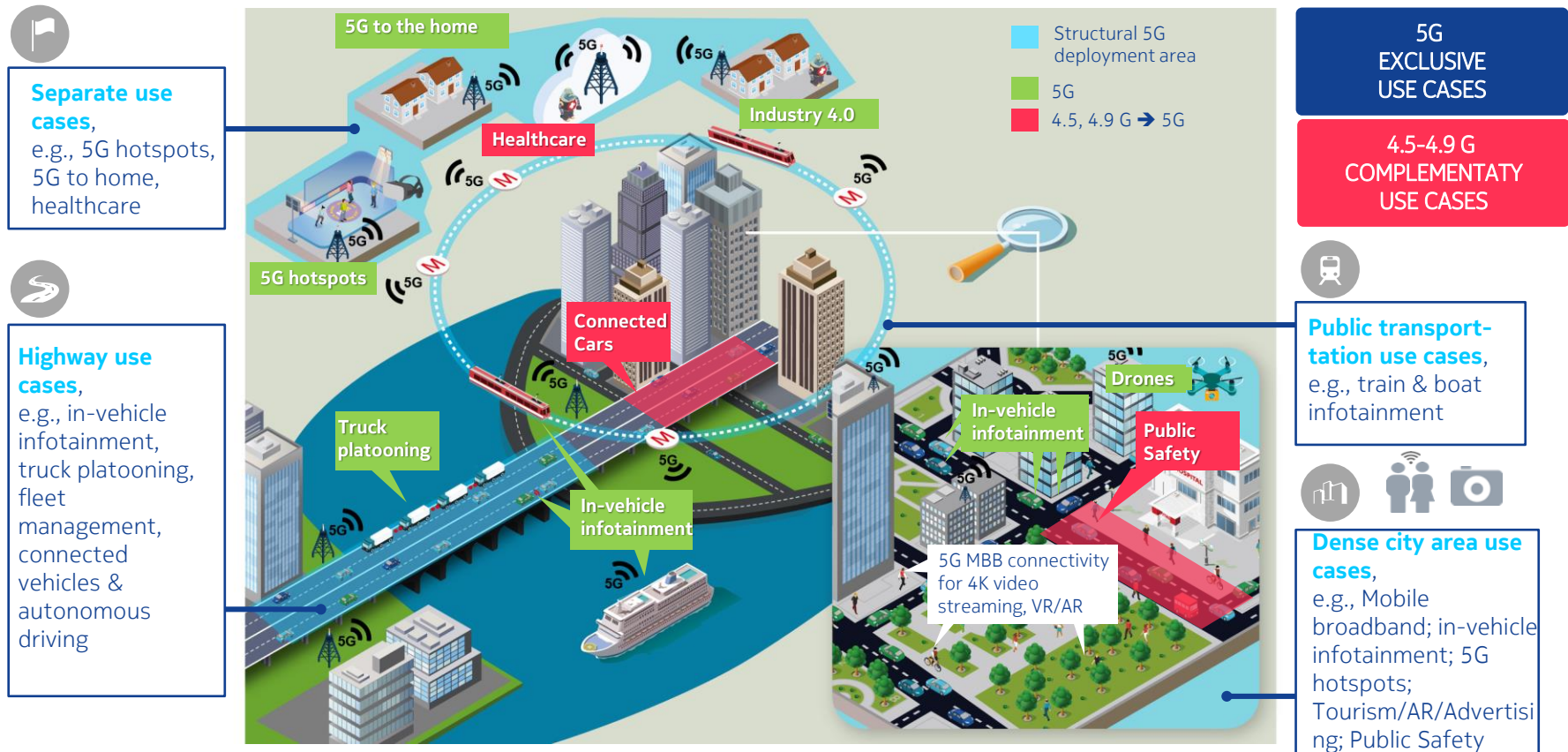
Application and 5G requirements

	Use cases	Application description	5G requirements
Immersive and interactive experience	5G to home	Fixed Wireless Access to homes (FWA) with low fiber penetration via 5G	Fiber-like speeds to multiple 10s of households from one site
	In Vehicle Infotainment	Video-driven mass infotainment inside fast moving public and private vehicles	Increased capacity (10/3 Gbps DL/UL) Lower latency for AR/VR (< 5-10ms)
	5G hot spots (overlay)	Virtual Reality streaming from event onto user devices on site at large scale	Ultra-High throughput 1-2Gbps; lower latency (<10 ms) required for AR/VR; very high capacity (>500 Users/cell)
Machine (Truck/Robot/Drone) as a Serve	Wireless Robotic Platforms	Robots for Logistic, Cleaning, Monitoring, Manufacturing (Industry 4.0) and Surgery	Ultra-reliable (failure rate <10 ⁻⁷) low E2E latency communication (5-25 ms)
	UAV Traffic Management	E2E fleet management for delivery drones: Traffic Management for UAV (TMUAV)	Ultra-low-latency and high reliability for safety/security. Increased uplink capacity (10 Gbps UL)
	Connected Vehicles	Truck platooning as an entry point into autonomous driving solutions	Ultra-low-latency and high reliability for extreme safety / security

Smart City Applications and Requirements

	Use cases	Application description	5G requirements
Connected Cars	Autonomous Driving Assistance	Real Time support for Assisted Driving – traffic indications, warnings, map updates, etc.	High Tput DL in high density traffic scenarios (~10Mbps / vehicle); Increased location positioning accuracy
	Fleet mgmt. & Remote Vehicle monitoring	Tracking of fleet vehicles, including real time remote vehicle diagnostics, location, driver behavior, etc.	Low Tput, Low to Medium Latency
	Vehicle to Pedestrian Notification / Warnings	Pedestrian awareness of vehicles (e.g. intersections)	High density (e.g. intersections), Low V-to-P latency (< e2e 100ms)
Public safety	Mobile / Static Video Surveillance	High resolution UL camera video surveillance, remote control (zoom, pan, etc.). Includes offender identification, Missing Person, etc.	Very-High UL Tput and Overall Capacity , driven by camera resolution & units / cell (e.g. 15-20Mbps per camera). Very Low latency for high resolution offender identification
	Emergency Responder (ER) Support	Combined with surveillance, video feed and tactical information available to Emergency Responders	High DL Tput (~15Mbps / responder), with high reliability and low E2E latency communication (<50ms e2e)
Health Monitoring	Remote Out-patient Monitoring	Remote patient monitoring for out-of-premises care, includes wearables, tele-medicine	Very-low-latency and high reliability for safety/security; increased UL Tput (~20Mbps)
	Connected Emergency Vehicles	Embarked mobile tele-medicine for remote/nomadic diagnostics, access to patient files, etc.	High QoS via enhanced Tput for 2-way video (~10-20Mbps UL & DL) ; Very-low-latency and high reliability for safety

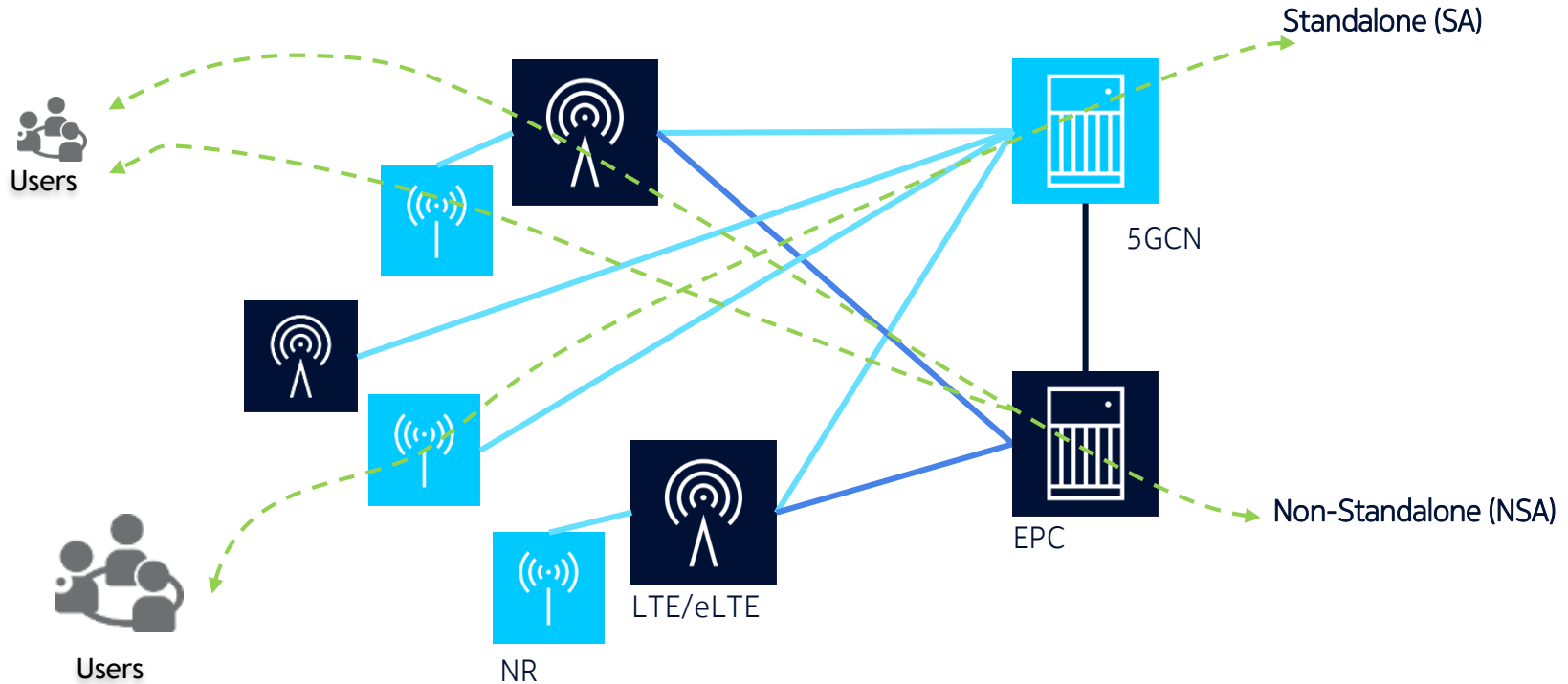
5G deployment areas and use cases requiring 4.5, 4.9 and 5G connectivity



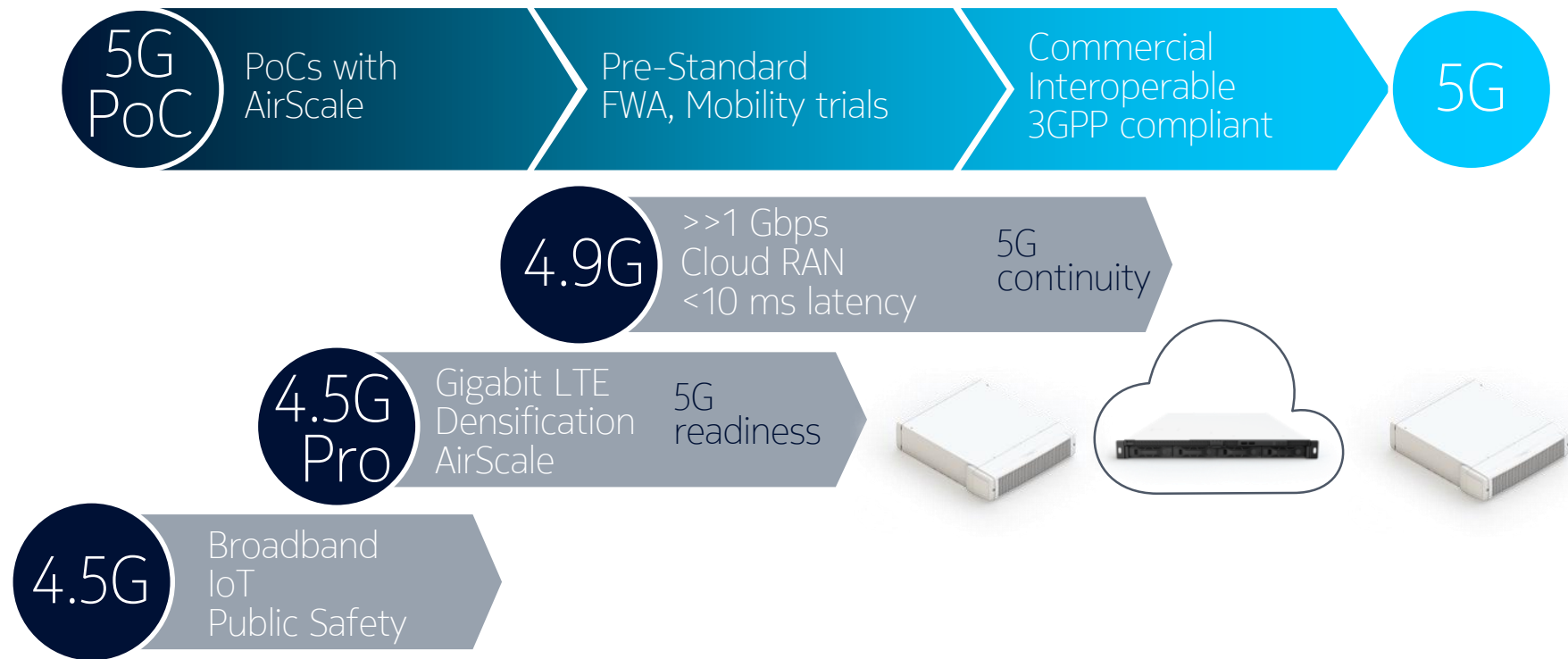
Example of long term migration options

4.5, 4.9 and 5G systems

2020-2025



The path to 5G with stepwise evolution in LTE and 5G



Conclusions

Nokia is investing heavily to drive PRODUCT and TECHNOLOGY leadership and enable long term COMPETITIVENESS

Nokia's INNOVATION and IN-HOUSE technology development will ENABLE carriers to embark on path to 5G with time to market LEADERSHIP

Nokia welcomes the Italian Government tender and is COMMITTED to realize pre-commercial 5G tests and trials jointly with stakeholders

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