NOKIA

5G e o futuro da conectividade

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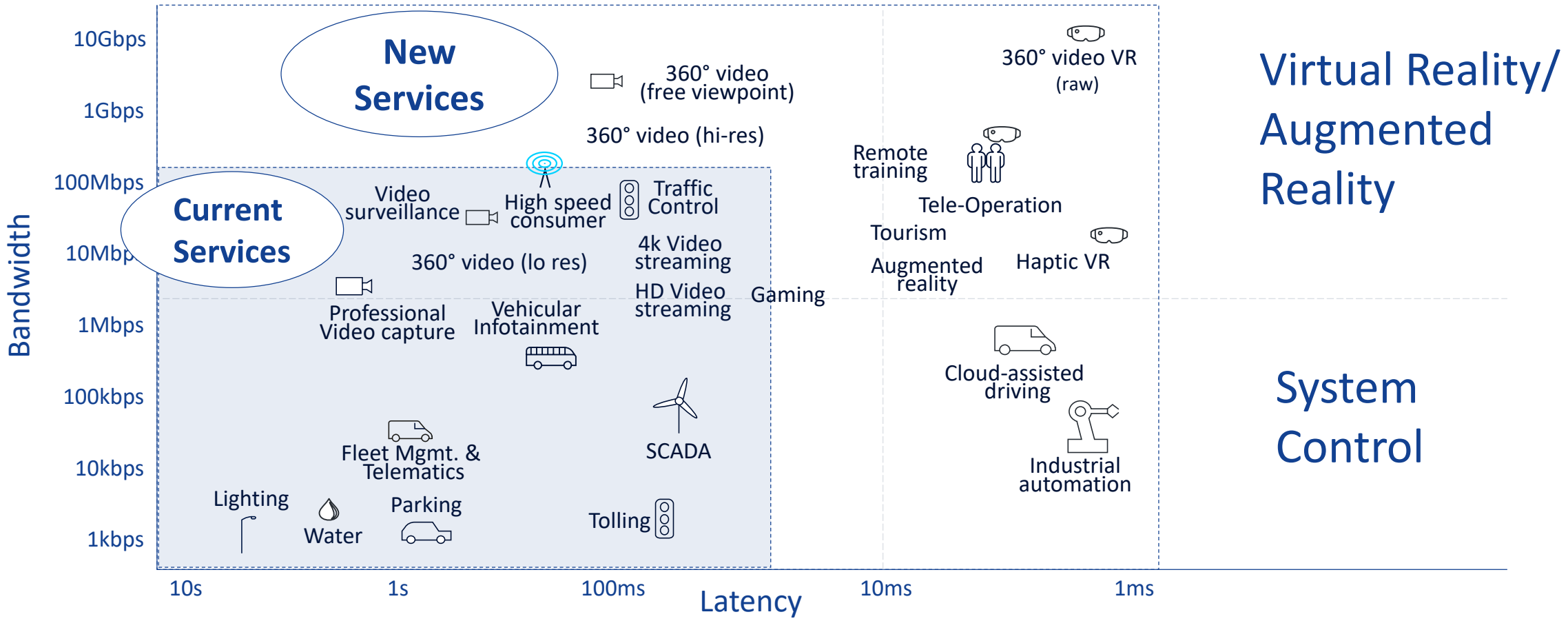
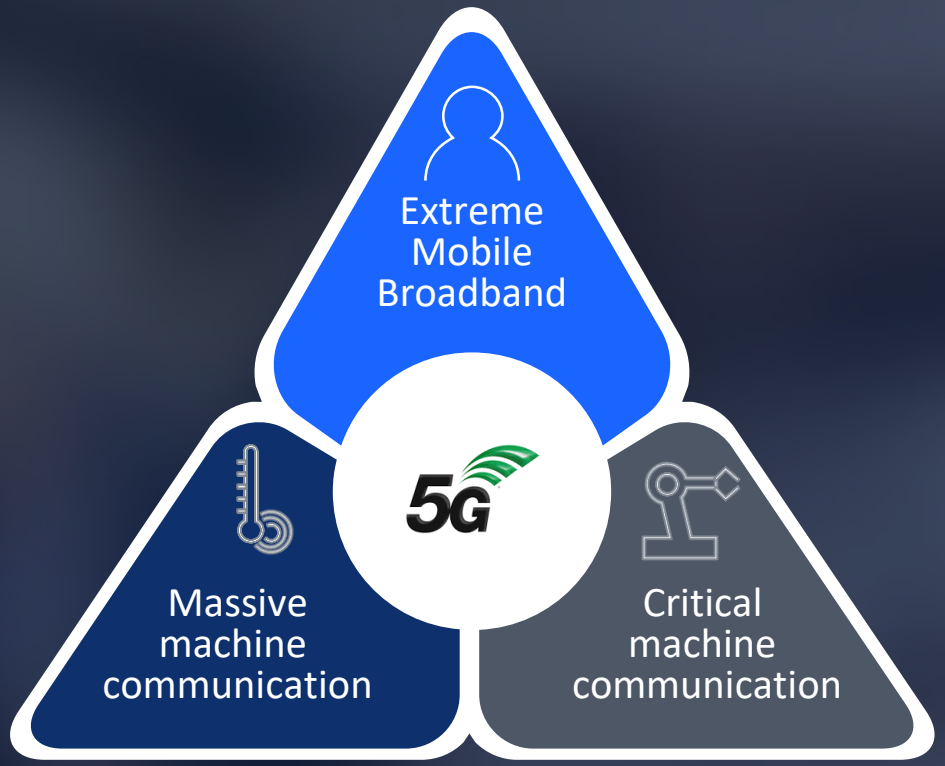
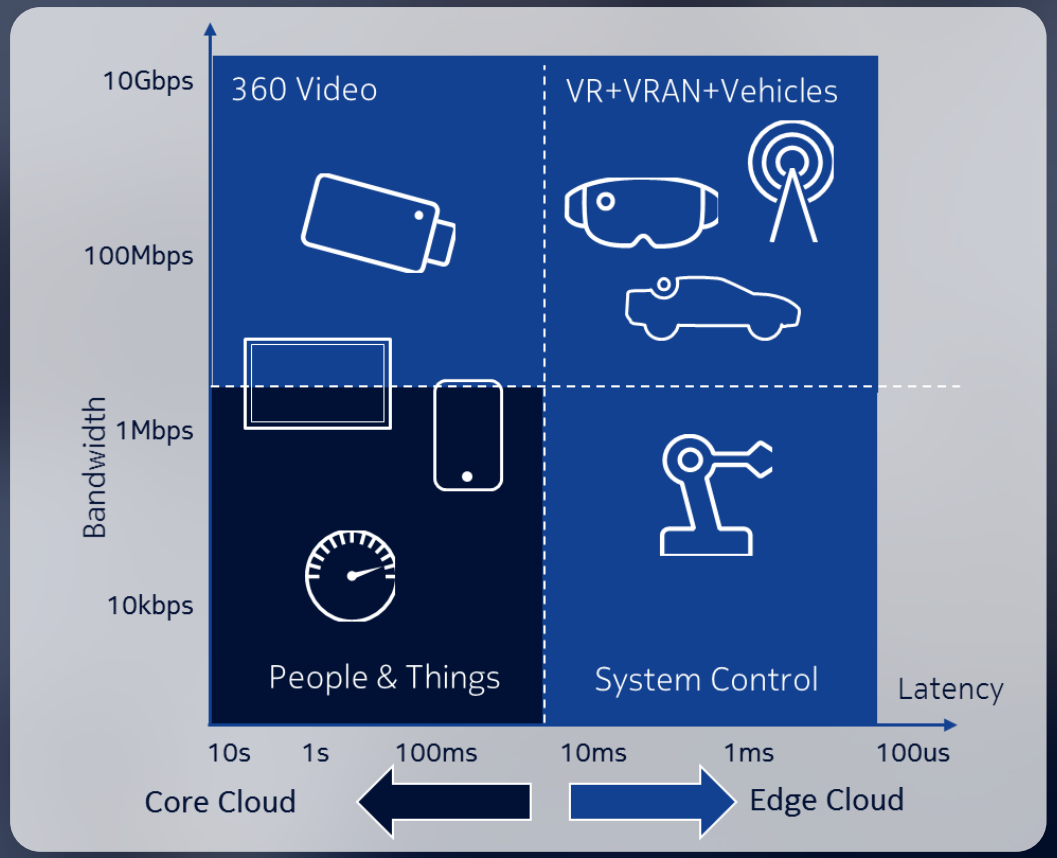
Service Requirements





Value map for latency & bandwidth



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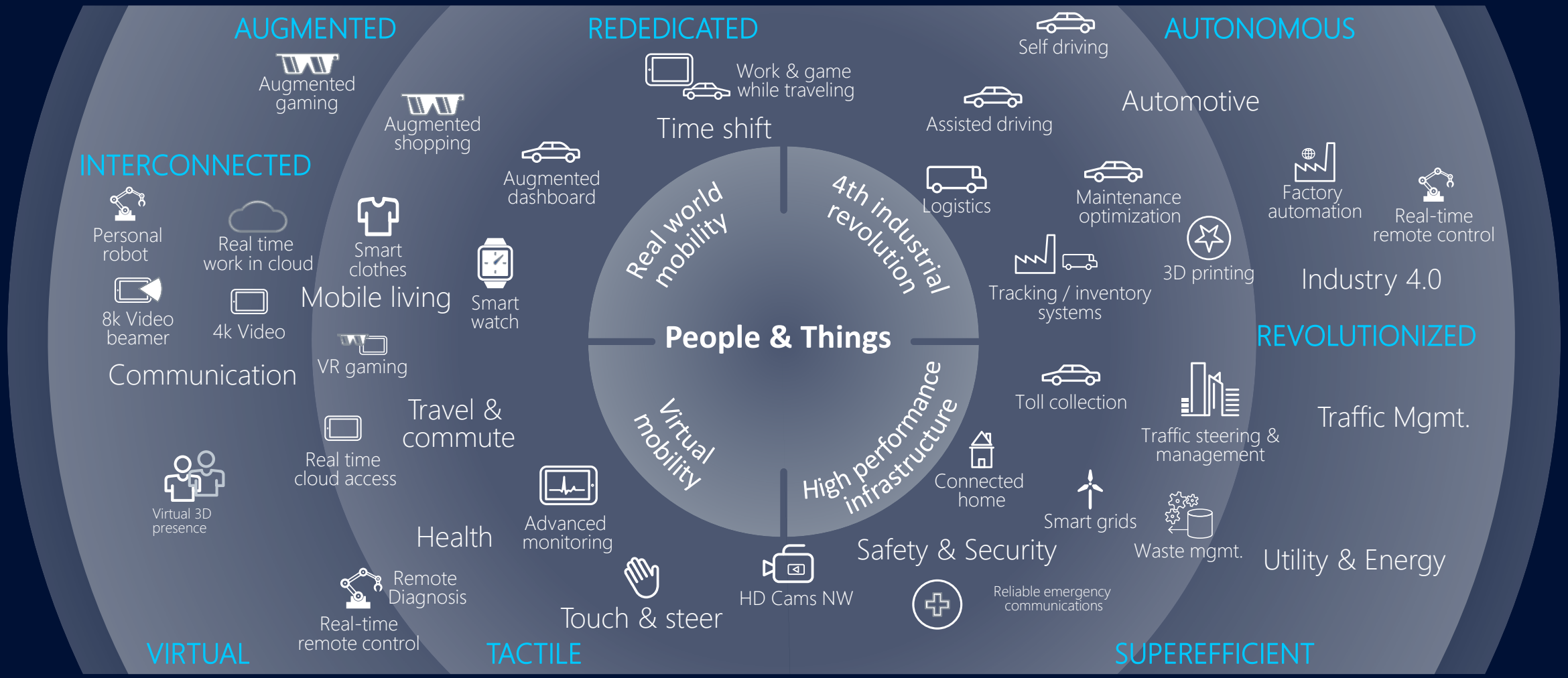
Explosion of possibilities: new performance levels of people and things



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Industry 4.0 - Nokia applies Industrial IoT in own factories and warehouses to increase productivity. Result: +27% in productivity

Digital Twin
Simulate, train and optimize physical assets, processes and systems within a virtual factory

Asset Management and Analytics
Monitor machine conditions to derive maintenance necessity and process optimizations

Enhanced Maintenance
Support, train and advise staff remotely by using augmented reality technologies

Indoor & Outdoor Positioning
Locate, track and manage items, people and any kind of asset along the whole supply chain

Smart Product
Embed IoT functionality into any kind of product to go beyond factory footprint

Connected worker
Increase health and safety for workers through real-time monitoring and "smart garments"

Cloud Robotics
Move intelligence from the shop floor to the cloud for easier machine communication

In-Car Delivery
Overnight delivery directly into the car or truck to enable digital inventory and smart delivery

Energy Management
Optimize energy consumption based on occupancy and actual energy usage

Video Analytics for Manufacturing
Quality management, security and safety and automated lifecycle management in production

Private Network
Secure, low-latency and private network infrastructure for Industrial IoT use cases

Factory in a Box
Optimize production and ensure business continuity through modular factory containers

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Nokia Conscious Factory of the future is available already today

2014

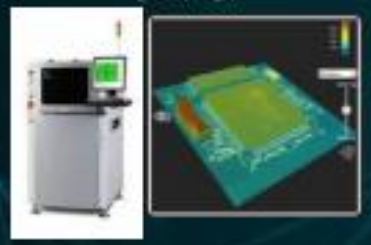
CNC

Filter Auto-tuning

Latest generation SMT

2015

SPI & next generation 3D AOI



Dream Cell concept

3D printing

2016

Modular Automation line Concept

Multiscrew feeding & fixing

Standalone production automation

2017

VR / AR utilization

Autonomous vehicle

Intelligent SMT material flow

2018

Video Analytics

Digital Twin

5G OTA

Conscious warehouse

Conscious Factory

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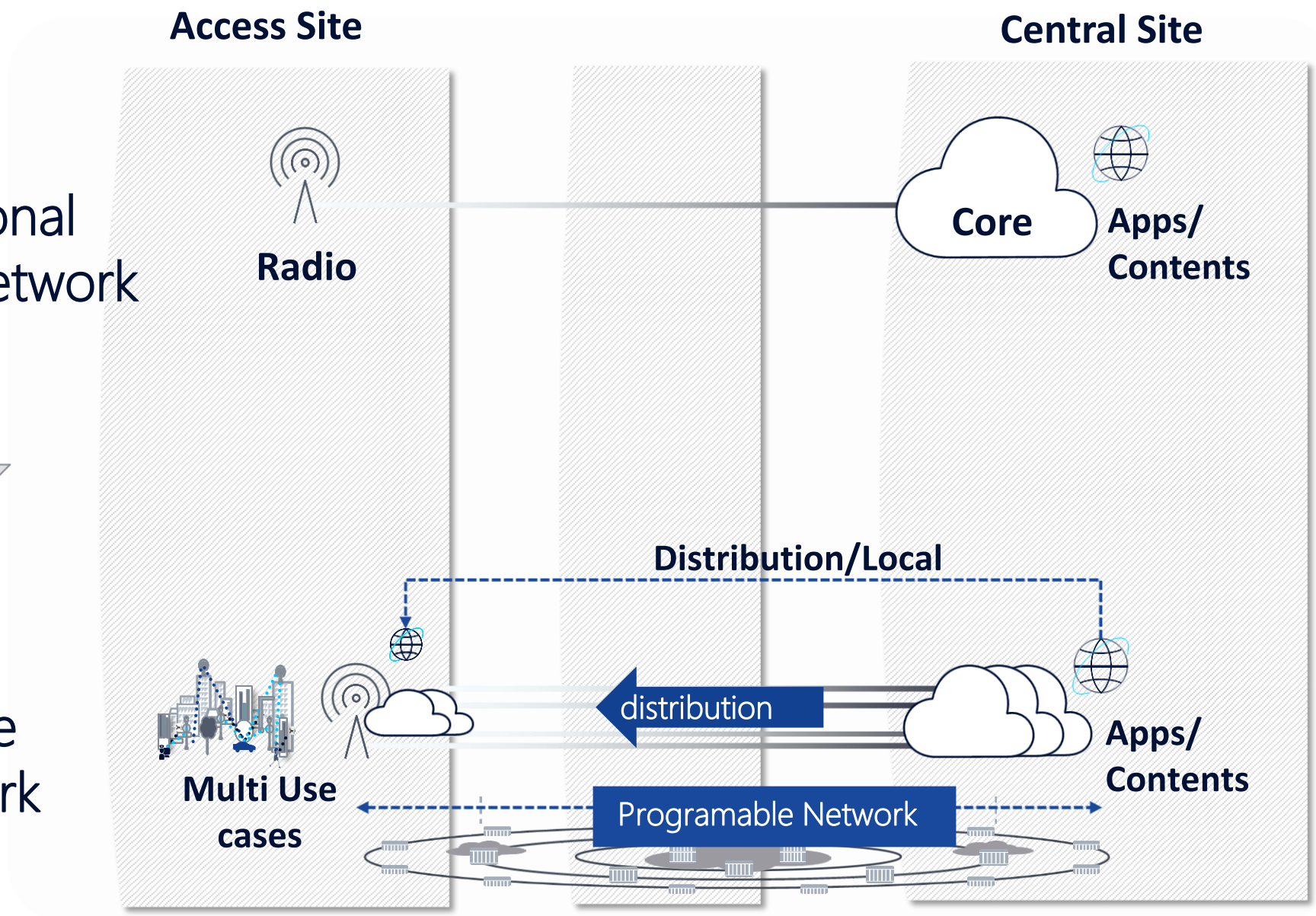
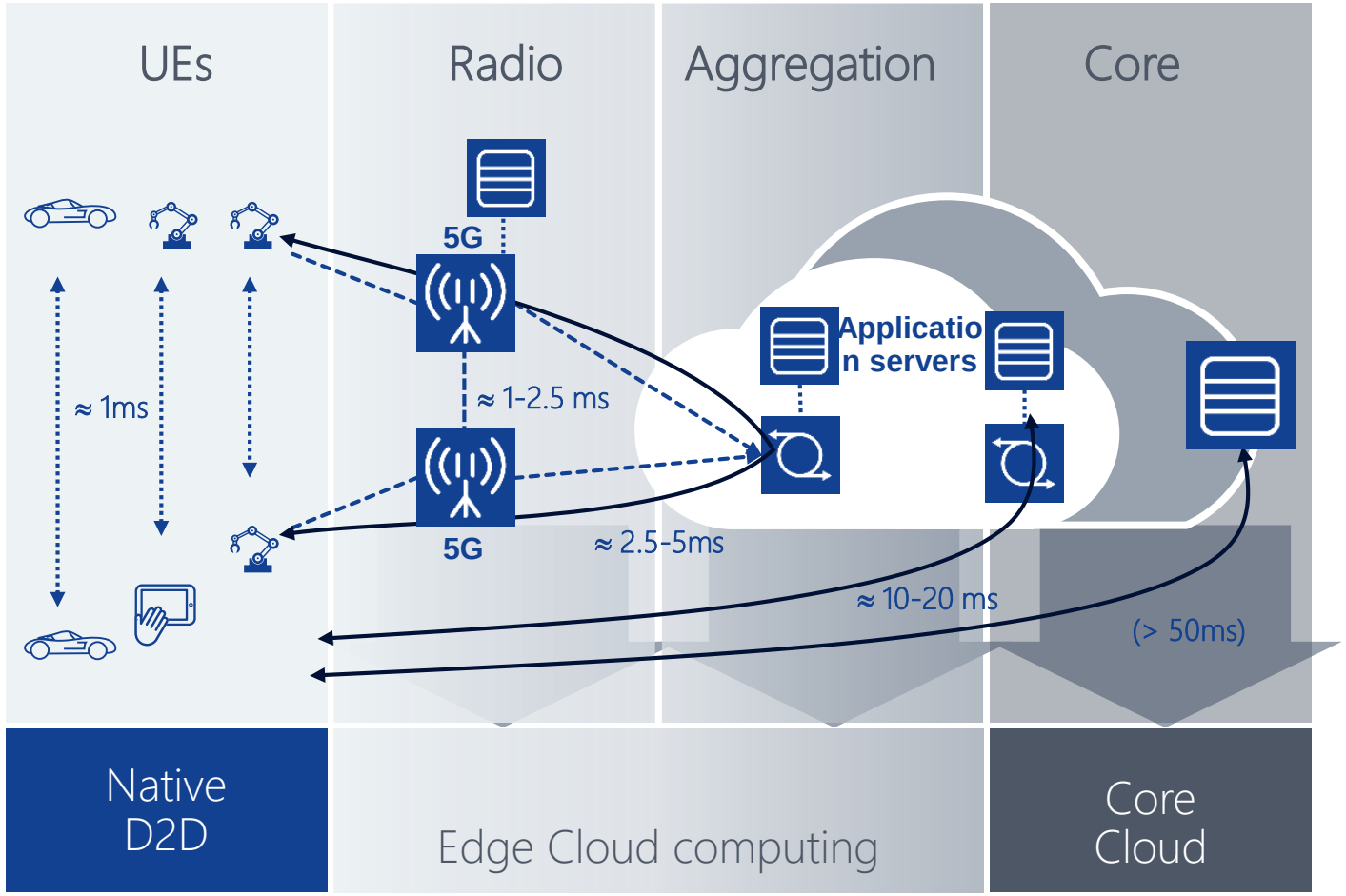
Tradicional Mobile Network

Future Network



Latency evolution with 5G

Low End-to-End latency enables a new generation of latency-critical services

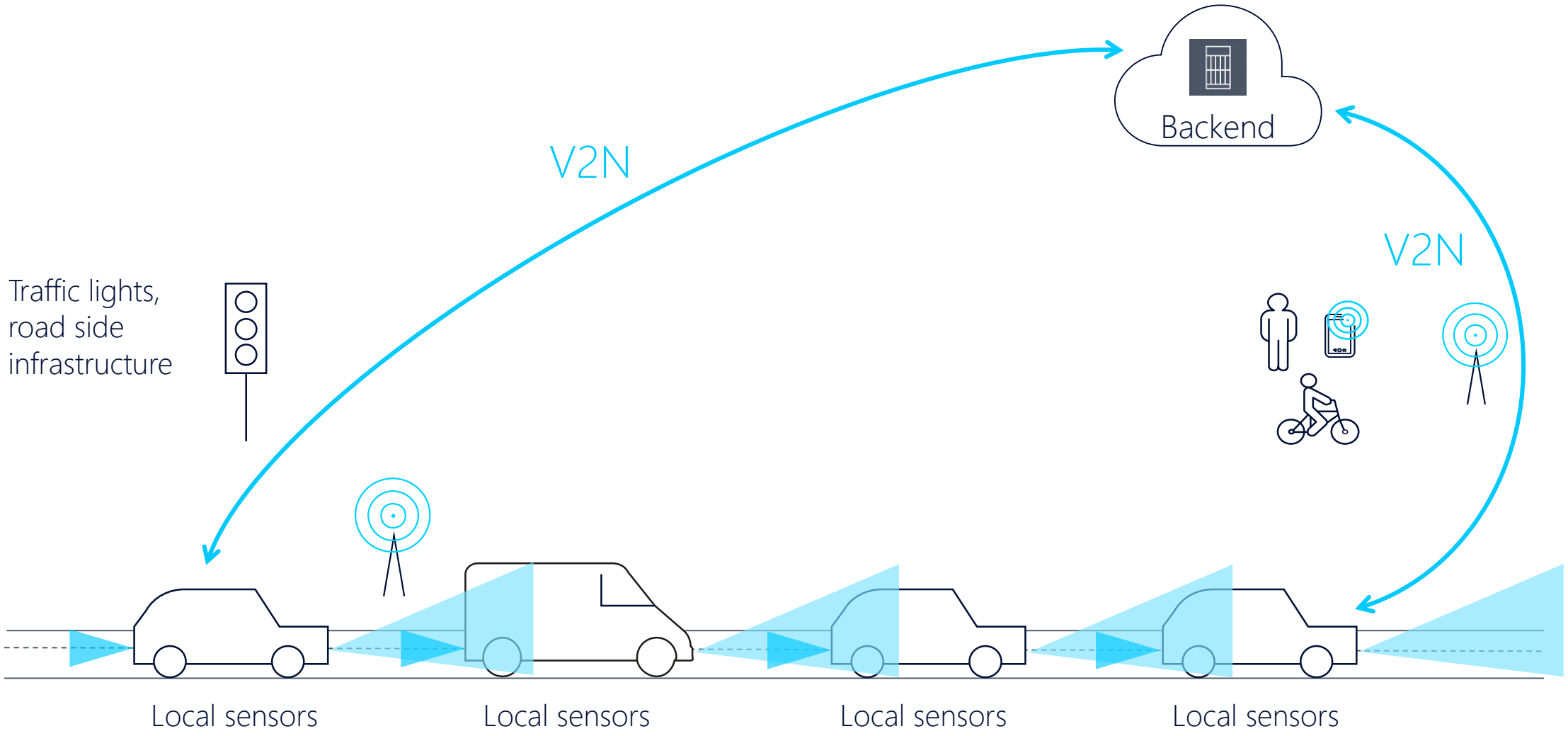


Moving
virtual networks

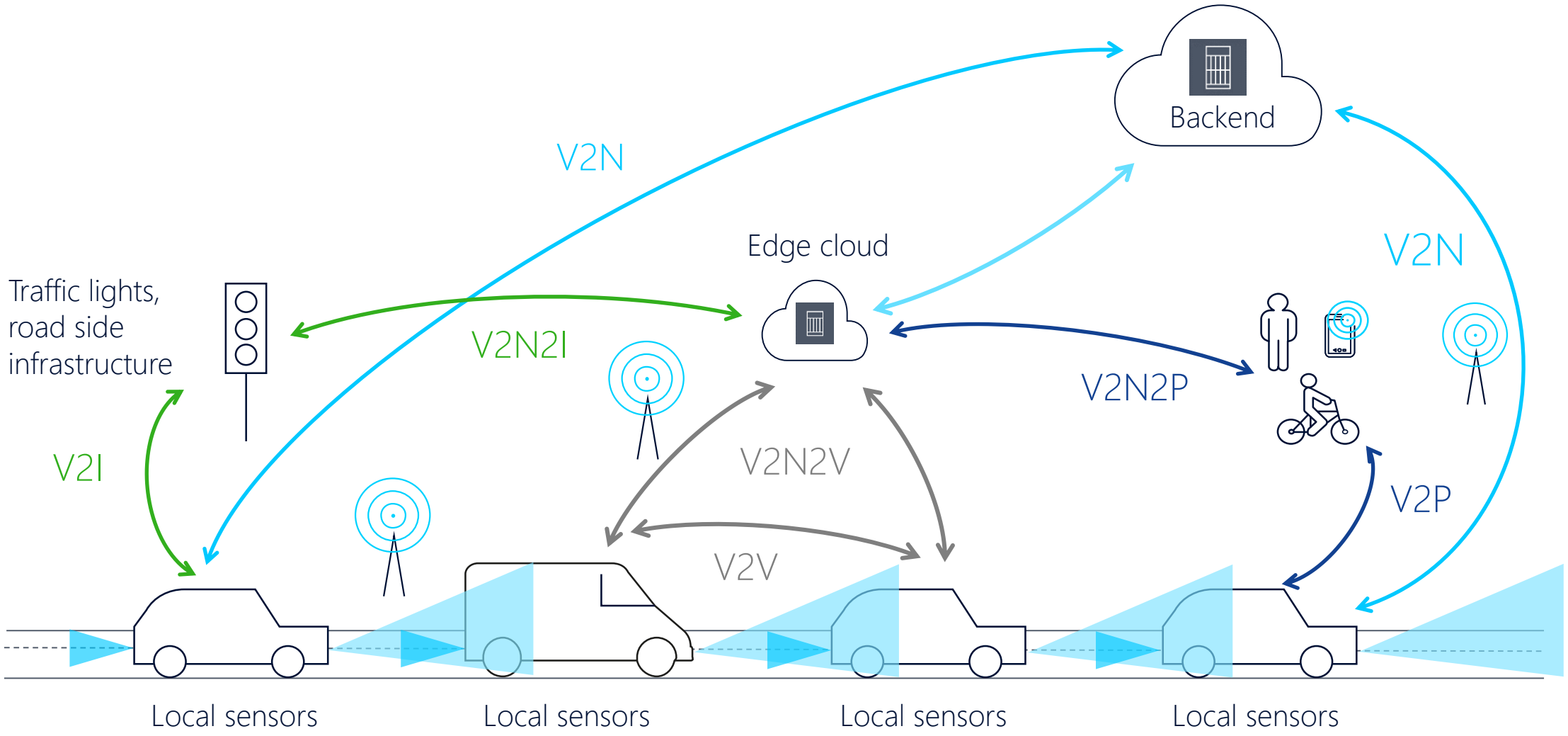
Mission-critical
services, e.g. in V2X or industrial applications

Central cloud based	> 50 ms latency
Mobile Edge LTE	≈ 10 ms
5G Edge	≈ 2,5 ms
5G D2D	≈ 1 ms

Cellular vehicle communications- the current state



Cellular vehicle communications – the evolution



NOKIA Bell Labs

Inventing the Future X Network

1925

Creation of Bell Labs
The engineering departments of the American Telephone and Telegraph Company (AT&T) and Western Electric were consolidated into Bell Telephone Laboratories. Their mission was to research and design communication technologies for the rapidly expanding telephone network and to explore fundamental areas of science that could shape the future of the industry. Over the years, many cornerstone technologies of modern society have been invented at Bell Labs and 8 Nobel Prizes have been awarded to its researchers

1930's

NOBEL PRIZE
1937
Electron Diffraction
Demonstrating wave nature of matter

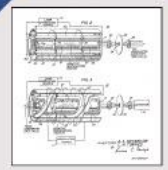
1940's

1948
"A Mathematical Theory of Communications"
By showing that all communications channels – of any type – have a fundamental capacity limit, Claude E Shannon founded the field of information theory

1950's

1954
Solar cells

NOBEL PRIZE
1956
Transistor
To replace the vacuum tube, Bardeen, Brattain and Shockley created a working point-contact transistor. This basic building block for all digital products is the foundation for our information society



1958
LASER
In their 1958 paper, Schawlow and his brother-in-law Townes described in detail a proof of concept for the LASER. The laser enables a wide variety of applications: fiber-optic communications, digital storage, barcode scanners, precision surgery and industrial cutting tools

1960's

1962
Telstar
Transatlantic live TV broadcast via satellite

1970's

1973
UNIX and C Language
Thompson and Ritchie's elegant design made it an immediate hit with the programming community when it was released in 1974. UNIX would later on become the Internet's foundation

1976
Fiber Optic Network
First demonstration of 45 Mbit/s transmission

NOBEL PRIZE
1977
Electronic Structure of Magnets and Glasses

NOBEL PRIZE
1978
Cosmic Microwave Background Radiation
Pioneering work on radio communications using the Holmdel Horn Antenna provides support for the Big Bang Theory

1978
Commercial Cellular Network
Invention of the cellular concept and creation of the first commercial network

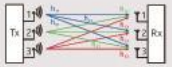
1980's

1980
Demonstration of DSP
Large-scale integrated circuit for digital signal processing

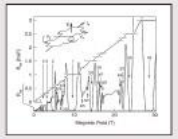
1995
Commercial DWDM
Pioneering work on wavelength multiplexing in optical fibers

1990's

1995
Integrated ADSL Chip
After co-inventing ADSL technology, follow-up innovations like vectoring continued to generate world records for high speed data transfer over copper telephone lines, fueling the Internet



1998
Wireless MIMO Spatial Multiplexing
Invention of wireless transmission based on multiple spatial paths



NOBEL PRIZE
1998
Fractional Quantum Hall Effect
Discovery of a novel collective quantum fluid state of matter

NOBEL PRIZE
1997
Laser-Based Cooling and Trapping of Atoms
To understand the fundamental limits of materials and matter

2000's

2006
Software Defined Routing
Predecessor of Software Defined Networks (SDN)

NOBEL PRIZE
2009
CCD
Boyle and Smith's picture phone research realized the enormous potential of the Charge Coupled Device as an imaging device, leading to the invention of the digital photo, video cameras, scanners, satellite surveillance and ultra-sensitive astronomical telescopes

2009
Coherent 100G Optics
Invention of the future of high speed optical communications with coherent processing

2009
World's first standard compliant LTE call

2010's

2011
lightRadio Cube
First demonstration of building block of future small cell wireless networks

NOBEL PRIZE
2014
Fluorescence Microscopy
Ground-breaking work on sub-wavelength optical microscopy leads to super-resolution microscopy at cellular level

2014
XG-FAST
First demonstration of 10 Gbps over copper telephone wires

2015
GreenTouch
International consortium delivers new technologies to improve energy efficiency in wireless networks by more than 10,000X

2015
Optical MIMO-SDM
Pioneering work on utilizing the spatial dimension in fiber, showing greater than 10X increase in optical network capacity

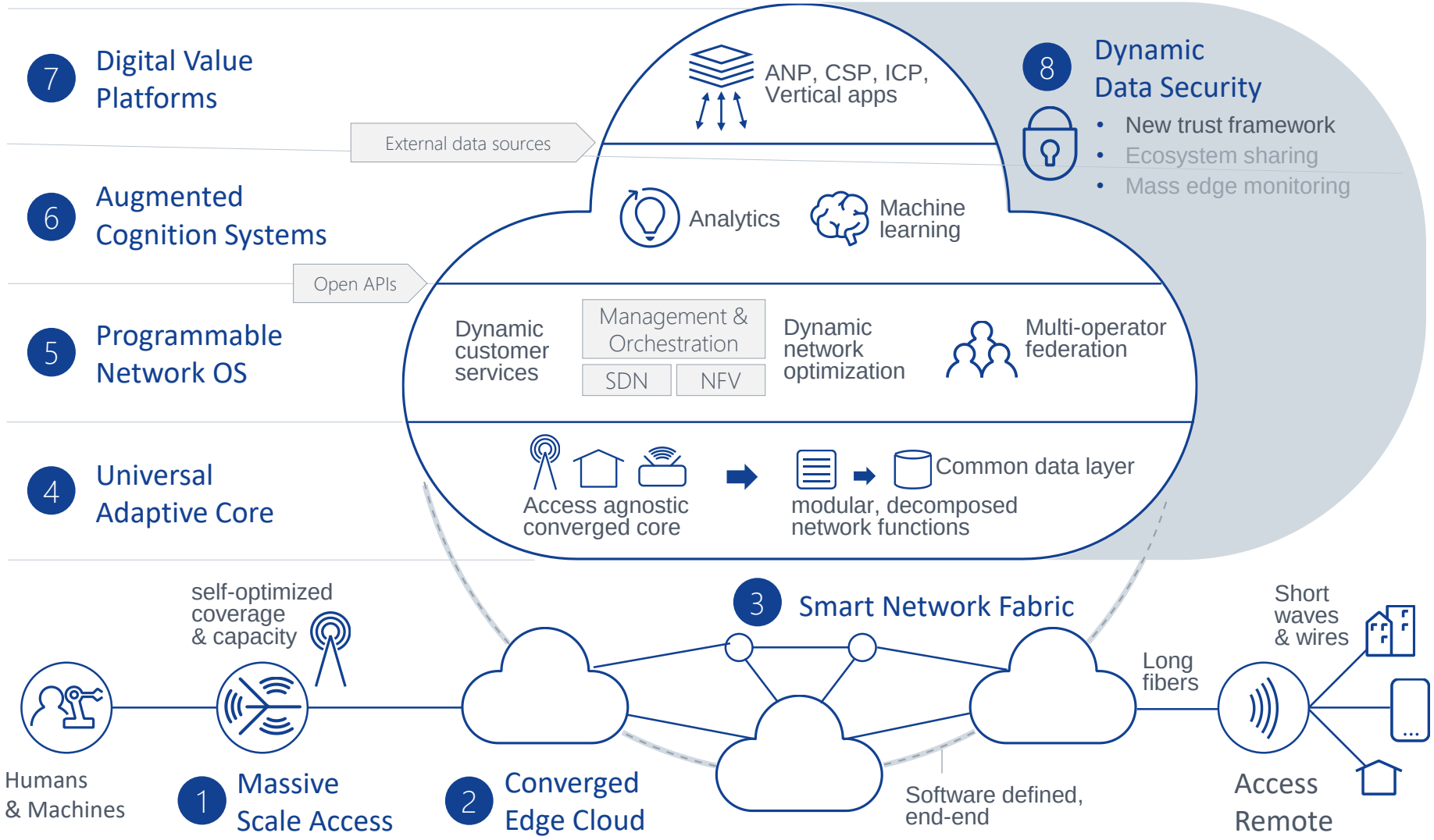
2015
The Future X Network: A Nokia Bell Labs Perspective
First Nokia Bell Labs book written

2016
5G Massive Connectivity
First demonstration of 1M simultaneous, ultra-low latency connections in a single cell for 5G and IoT

The Future

Nokia Bell Labs continues to solve the great industry challenges, producing disruptive innovations for the next phase of human existence

Nokia Future-X network



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