5G or WiFi6?

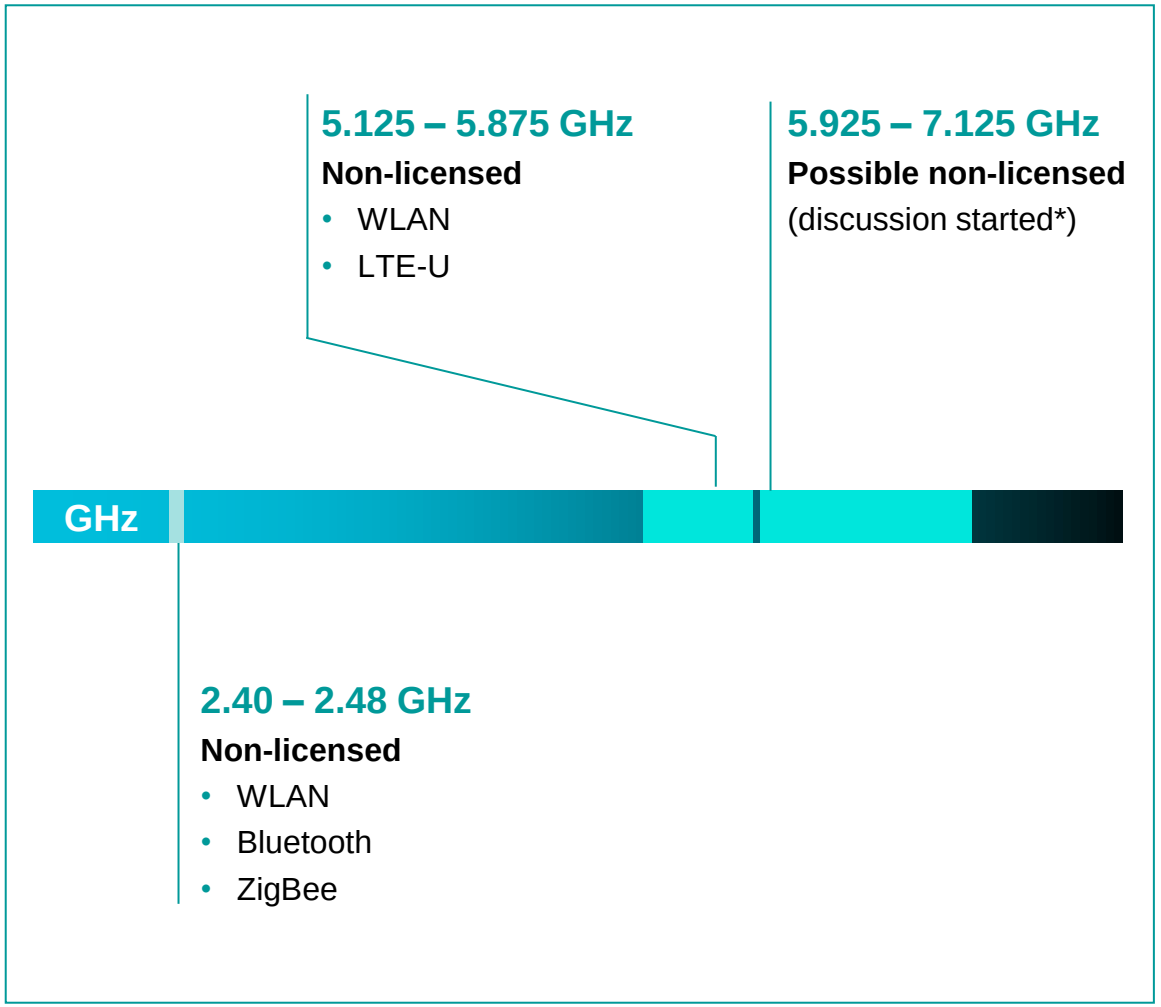
Styrk effektiviteten på dine industrielle applikationer

Agenda

WiFi 6
- Hvad kan WiFi 6
- Hvorfor er det godt for industrien med WiFi 6?

5G
- Hvad kan 5G i dag?
- Hvad betyder privat 5G?
- Hvad er fremtiden for 5G og industrien?

Used frequency spectrum of WLAN - WLAN to populate also 6GHz in the future



	Frequency (GHz)		
	2.4 GHz	**5 GHz**	**6 GHz***
Range	Up to 80 MHz	Up to 750 MHz	Up to 1,2 GHz
Pro	• Lower free space loss (attenuation) • Globally available and harmonized	• More channels • Less non-Wi-Fi interferer • Similar channels to use worldwide	• More channels • Would be released for Wi-Fi 6E and newer • Less Wi-Fi interferers
Con	• Crowded frequency • Many non-Wi-Fi interferer	• Some channels with other primary users where Wi-Fi needs to concede (radar) • Congestion increases	• Frequency at first only available in USA

*under discussion by FCC (USA) & ETSI (EU)

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Evolution of the IEEE 802.11 Standard - Wi-Fi standard is evolving to match new requirements

IEEE 802.11-1997

Released: 1997

Data rate:
max. 2 Mbps

Frequency:
2.4 GHz

Core features:
- FHSS (Frequency Hopping Spread Spectrum)
- DSSS (Direct Sequence Spread Spectrum)

IEEE 802.11a

Released: 2001

Data rate:
up to 54 Mbps

Frequency:
5 GHz

Core features:
- OFDM (Orthogonal Frequency Division Multiplexing)

IEEE 802.11g

Released: 2003

Data rate:
up to 54 Mbps

Frequency:
2.4 GHz

Core features:
- OFDM (Orthogonal Frequency Division Multiplexing)

IEEE 802.11n

Released: 2009

Data rate:
up to 600 Mbps

Frequency:
2.4 & 5 GHz

Wi-Fi 4

Core features:
- MIMO (Multiple-Input/Multiple-Output)

IEEE 802.11ac

Released: 2012

Data rate:
up to 6933 Mbps

Frequency:
5 GHz

Wi-Fi 5

Core features:
- Channel bonding up to 160 MHz

IEEE 802.11ax

Release: 2020

Data rate:
up to 9608 Mbps

Frequency:
2.4 GHz & 5 GHz
Wi-Fi 6E: 6 GHz

Wi-Fi 6

802.11 Timelines

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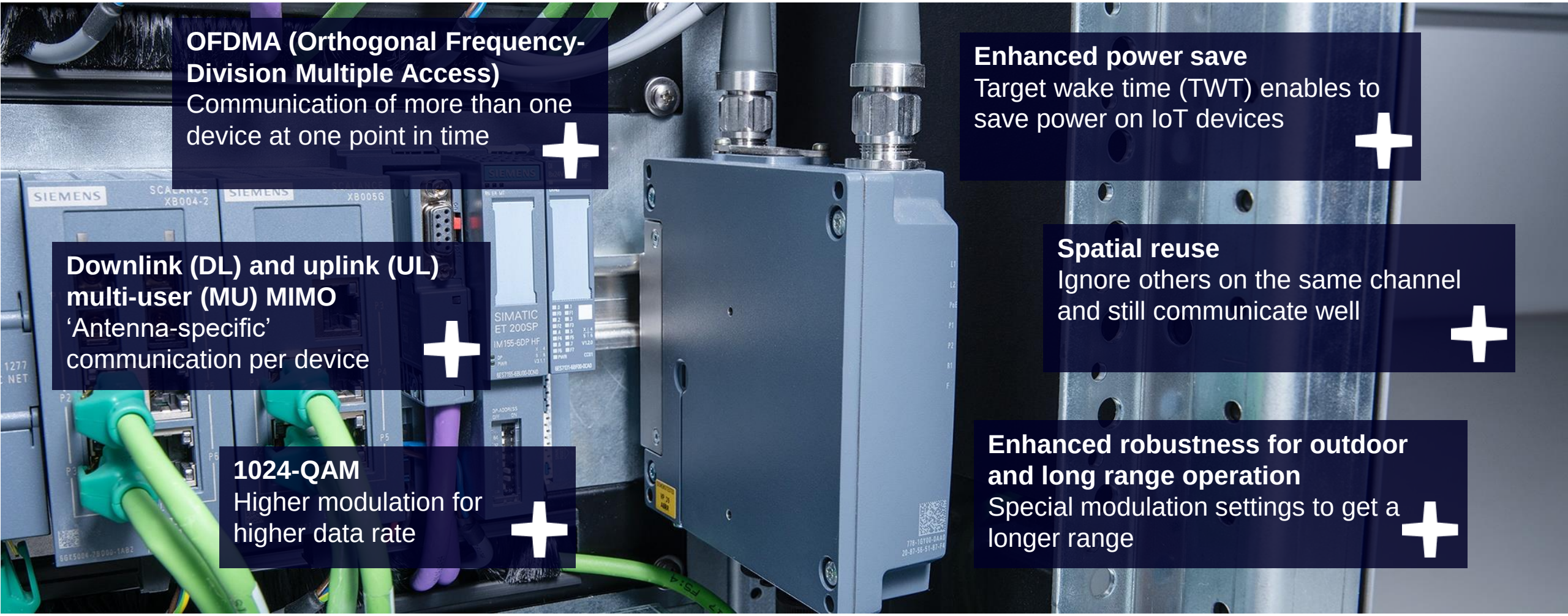
Features of IEEE 802.11ax Standard
First Wireless LAN Standard with main focus on efficiency



OFDMA (Orthogonal Frequency-Division Multiple Access)
Communication of more than one device at one point in time

Downlink (DL) and uplink (UL) multi-user (MU) MIMO
‘Antenna-specific’ communication per device

1024-QAM
Higher modulation for higher data rate

Enhanced power save
Target wake time (TWT) enables to save power on IoT devices

Spatial reuse
Ignore others on the same channel and still communicate well

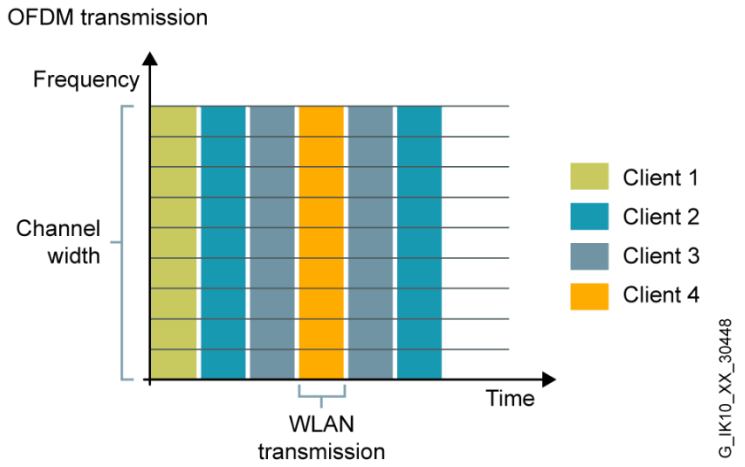
Enhanced robustness for outdoor and long range operation
Special modulation settings to get a longer range

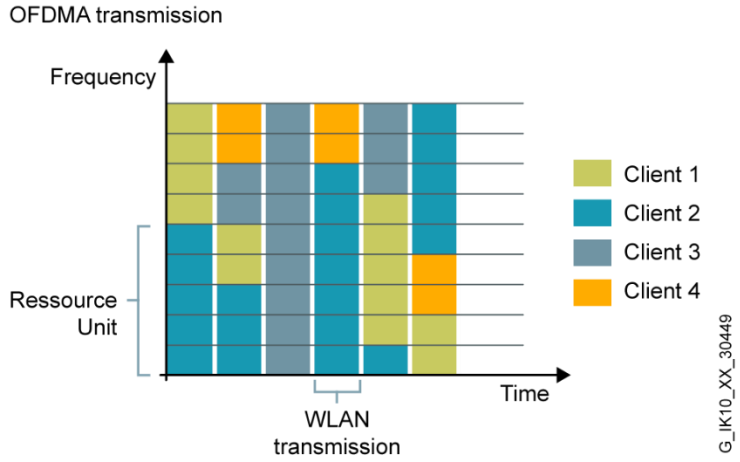
Core Feature: Multi-user operation with OFDMA
Improvement of communication fairness and latency

Predecessor IEEE 802.11 standards enabled one device to speak at one given time within a wireless channel.

IEEE 802.11ax divides one channel into up to 9 “subchannels” (so called Ressource Units, RUs) which can be used in parallel.

The Access Point can speak per RU to one WLAN client. At uplink several clients can speak at the same time to the Access Point. This makes communication more efficient and decreases latencies.





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Latency and roaming on IEEE 802.11ax

What‘s not in the standard?

- Scheduling algorithm to trigger frames at the Access Point
- Fast roaming is not improved and could take up to seconds

→ No reliable, predictable worst case latency for an industrial application!

iFeatures from Siemens to improve the Standard

- Improvement for a fast roaming
- Reduced latency with deterministic cycles
- Application-appropriate treatment of all client devices

→ Reliable, predictable worst case latency for an industrial application!

iFeatures are needed for reliable and real-time automation solutions

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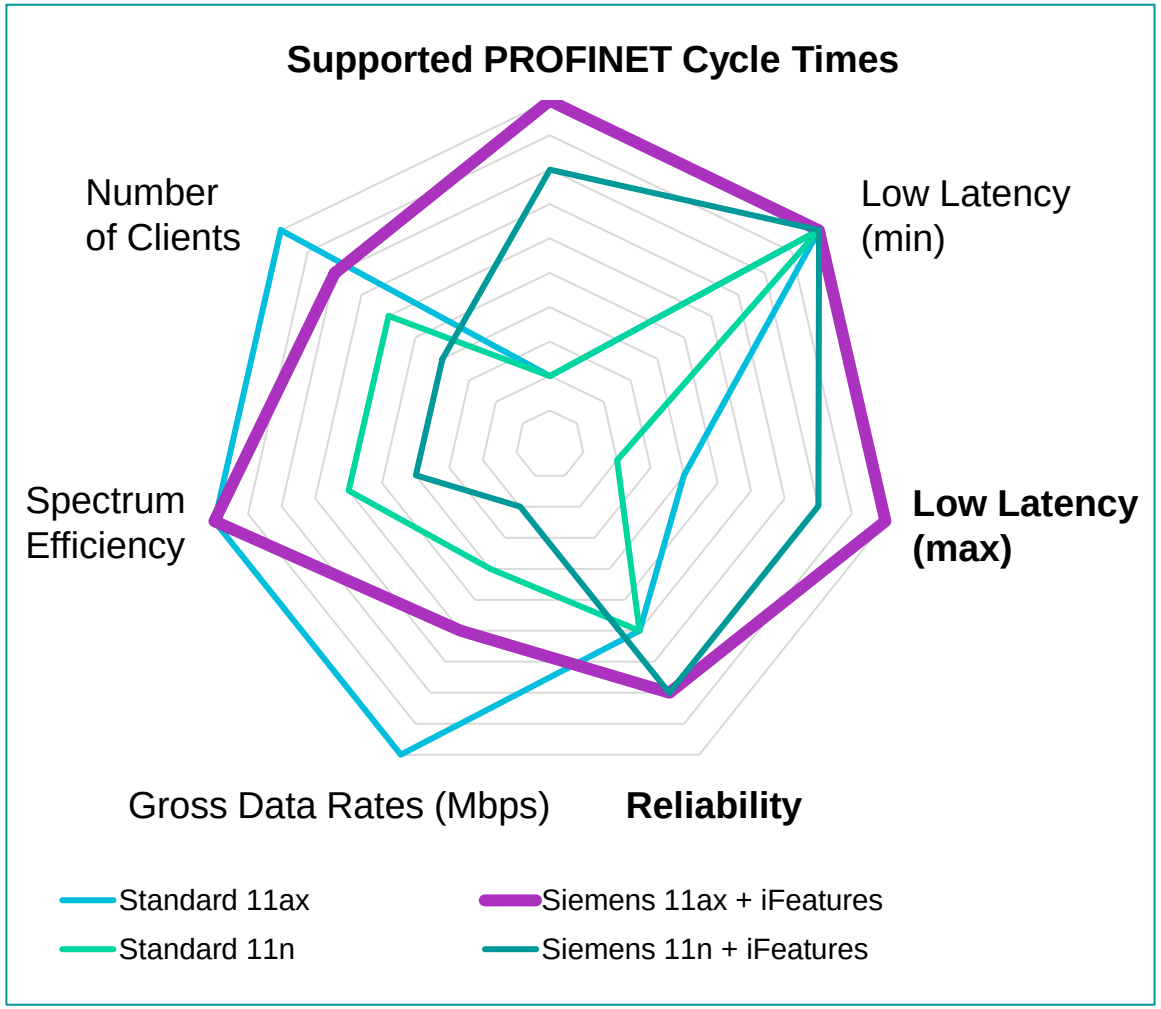
iFeatures from Siemens will improve the WiFi 6 standard



Must have for automation applications:

- Known worst case latency, e.g. to avoid interruption of automation protocols like PROFINET and OPC UA
- High reliability to assure uptimes and maximize the production output

Lower priority for automation applications:

- Highest data rates as they do not guarantee the quality of your service
- Highest number of clients since most industrial applications do not require it

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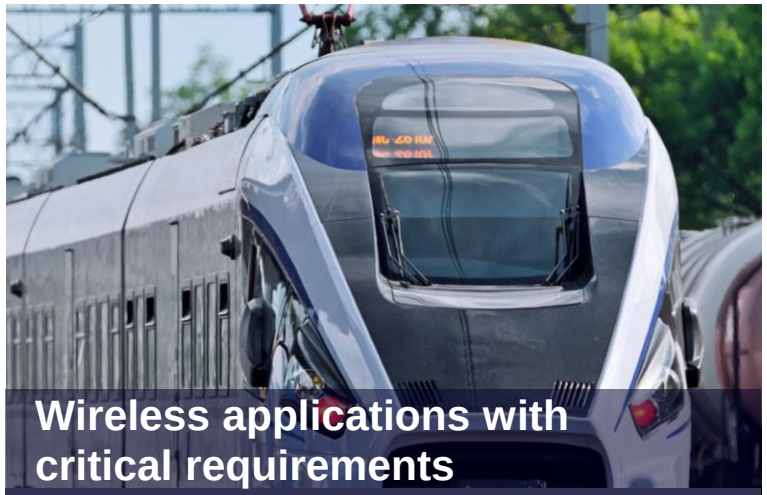
Use cases for Industrial Wireless LAN

Wireless networks in industrial applications

- Overhead monorails
- Automated guided vehicle + Automated mobile robot systems (AGVs + AMRs)
- Intralogistics (rack feeder, shuttle)
- Retrofitting with wireless networks

Cyclic and reliable communication



Wireless applications with critical requirements

- Public transport (e.g. train to ground)
- Amusement park rides
- Ski lifts, big wheels, fun rides
- Safety applications (with Safety Integrity up to Level SIL3 according to IEC 61508)

Emergency stop for safety applications

Portfolio for harsh environments – indoor and outdoor

- Oil & Gas industry
- Seaport applications and container terminals
- Mine shafts and tunnel networks

Industrial approvals and enhanced environmental conditions (EEC)

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The right Industrial Wireless Solution for each of your applications!

	IEEE 802.11n iFeatures (Wi-Fi 4)	IEEE 802.11ax iFeatures (Wi-Fi 6)	Private 5G for the Industry
Cyclic and real-time communication over wireless	✓	✓	✓
Emergency stop for safety applications	✓	✓	✓
Data privacy	✓	✓	✓
Spectrum	unlicensed	unlicensed	licensed
Scalability of architecture	Scalable from **small to medium** size	Scalable from **small to larger** size	Full solution from **medium to campus-wide**

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Industrial
5G
&
Industrial
WLAN
!

The evolution of cellular networks in Industry – from the first commercial network to the network of the future.

1G

Released: 1979

Standards:
NMT, AMPS & TACS

Capabilities:
Analog voice

0.0024 Mbit/s Industry Impact

No impact on industrial applications

2G

Released: 1991

Standards:
GSM & CDMA

Capabilities:
- Digital voice
- Encrypted communication
- Limited roaming
- SMS & MMS

Extensions:
- GPRS (2.5G)
- CDMA2000 (2.5G)
- EDGE (2.75G)

0.064 Mbit/s Industry Impact

- Remote control/Telecontrol
- Text messages from and to remote machines

3G

Released: 2002

Standards:
UMTS & EV-DO

Capabilities:
- Mobile broadband
- Locating services
- Multimedia streaming
- Seamless global roaming

Extensions:
HSPA+ (3.5G)

42 Mbit/s Industry Impact

- Video monitoring
- Remote Access to machines (e.g. for teleservice)
- Remote Condition Monitoring

4G

Released: 2009

Standards: LTE

Capabilities:
- High Speed mobile Internet
- IP-based packet switching
- HD multimedia streaming
- Seamless global roaming

Extensions:

Feature extension through new category/releases

1,000 Mbit/s Industry Impact

- Mobile service Technicians
- Service via smart phone
- Wireless Backhaul

5G

Released: 2019

Standards: 5G

Capabilities:
- Private networks (local use frequency)
- (I)IoT Ready
- Massive Machine Type communication
- Ultra-low-latency
- Ultra-high reliability
- Millimeter wave support

Extensions:

Feature extension through new categories/releases

10,000 Mbit/s Industry Impact

- Autonomous Logistics Autonomous Machines
- Assisted Work
- Wireless Backhaul
- Edge Computing
- Mobile Equipment

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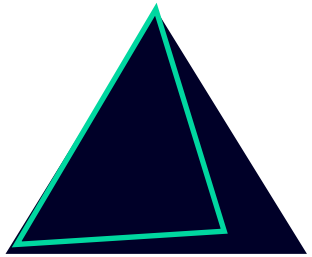
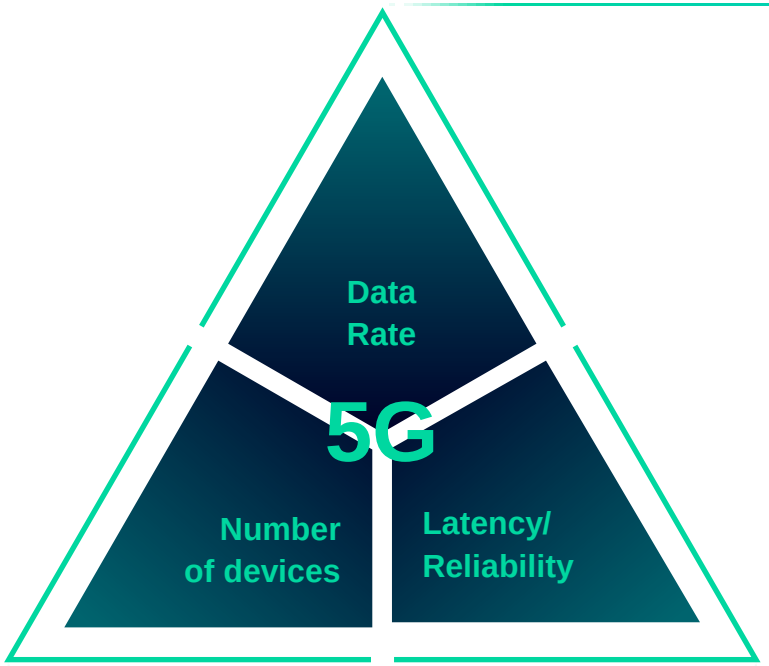
5G fulfills various network requirements

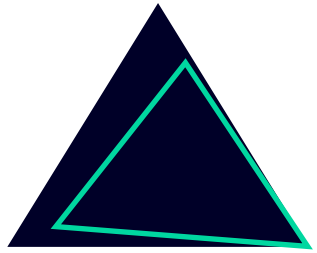
Enhanced Mobile Broadband (eMBB)

10 to 20 times faster than 4G



Public Profile (Telco Provider)





Industrial Profile (I4.0 Factory)

Massive Machine-Type Communications (mMTC)

Connect 1,000,000 devices per km²

Ultra-reliable low-latency communications (URLLC)

Reliability 99.999% | Latency of 10 ms

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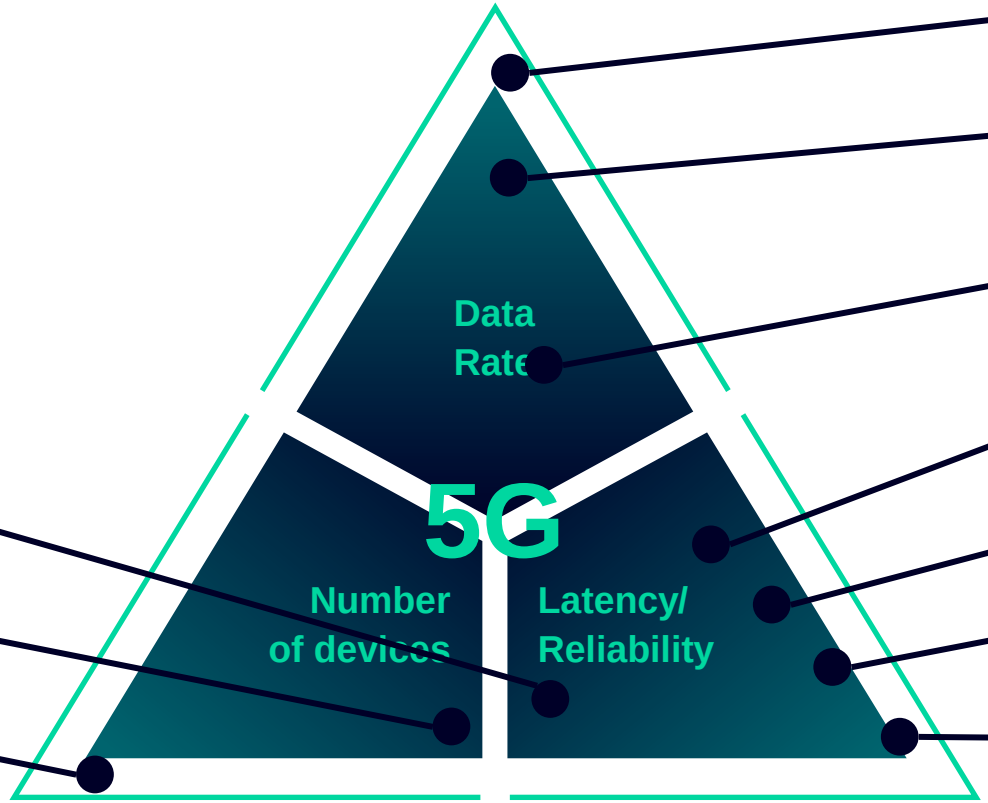
Classification of applications according to network requirements

Factory and Process Automation



- Augmented Reality
- Remote Access & Maintenance
- Human Machine Interface (HMI)
- Automated Guided Vehicles (AGVs)
- Mobile Robots
- Industrial Safety
- Closed Loop Control (Factory Automation)
- Closed Loop Control (Process Automation)
- Remote Control
- Massive Wireless Sensor Networks

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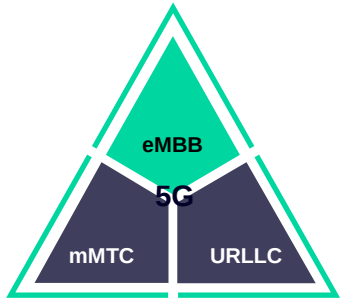
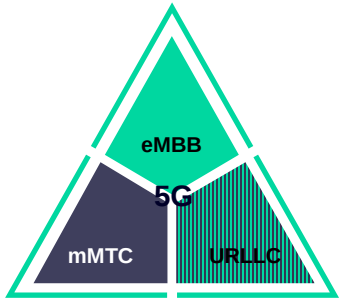
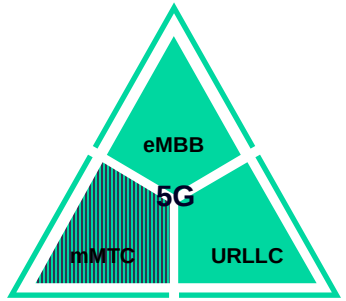
Why can we only start with Release 16 in Industry?



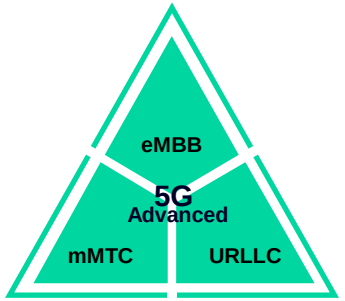
Release 15
Available: Dec. 2018



Release 16
Available: July 2020*



Release 17
Available: June 2022*



Release 18
Planned: Q2/2024*

Data rate / Area traffic capacity (20 Gbps)	Complete	Complete	Complete	Complete
Spectrum efficiency (3 x 4G)	Complete	Complete	Complete	Complete
Network Energy efficiency (100x 4G)	Complete	Complete	Complete	Complete
Connection density (1,000,000 / km^2)	Partially	Partially	Complete	Complete
Latency (<10 ms)	None	Partially	Complete	Complete
Reliability (99.999% under 10 ms)	None	Partially	Complete	Complete
Mobility (handover/ roaming with 500 km/h)	Complete	Complete	Complete	Complete
Localization (Phase 1: 1 meter accuracy)	None	Partially	Partially	Complete
Non-public networks (Private Networks)	None	Partially	Complete	Complete
Industrial IoT (TSN Support)	None	Partially	Partially	Complete
Network slicing (Multiple networks on shared network)	Complete	Complete	Complete (+ more)	Complete (+ more)
SideLink (Direct Communication between end-devices)	None	Partially	Partially	Complete

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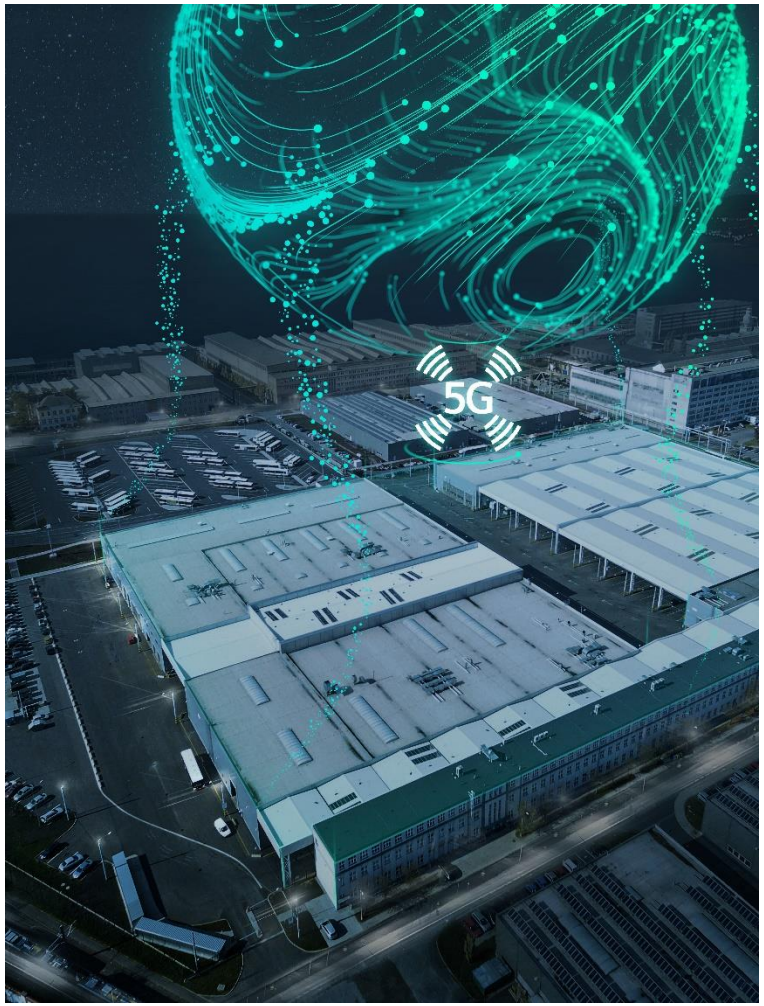
Possible benefits for Industrial 5G

Feature / Function		Benefit
• Enhanced Mobile Broadband (eMBB) → Release 15	>	• High data rates with global, wide-area network coverage (e.g. for augmented reality applications)
• Ultra-Reliable Low-Latency Communication (URLLC) → Release 16	>	• High reliability and unprecedented low latency fulfilling the needs of mission critical industrial applications (e.g. safety communication via wireless).
• Massive Machine-Type Communication (mMTC) → Release 17	>	• Support of high number of connected devices per unit area (around 1.000.000 devices per km2), enabling extreme user end-device density (e.g. for massive sensor networks in the process industry).
• Private networks with private industrial frequencies for local use (with URLLC and Release 16)	>	• Setup of interference free wireless networks, fulfilling the needs of mission critical applications. • Maximum data privacy as data stays on premises. • Full network ownership.



Coexistence of public and private 5G networks to enable high-performance industry-campus networks

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Industrial Wireless networks need a private frequency band

Advantage of wireless network ownership in OT:

- self-management guarantees flexibility in production
- Qualified IT-experts with OT-knowledge on-site
  → 24/7 support and maintenance of the network
- QoS based on dedicated network for industrial use
  → support ultra-reliable and low-latency communication

Maximum data privacy and security:

- Data stay on-premises
- Protection of trade secrets, production data and patents

Private networks combined with private spectrum ensure optimal data privacy

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Which 5G infrastructure is right for your Industrial Automation?

Public

Private

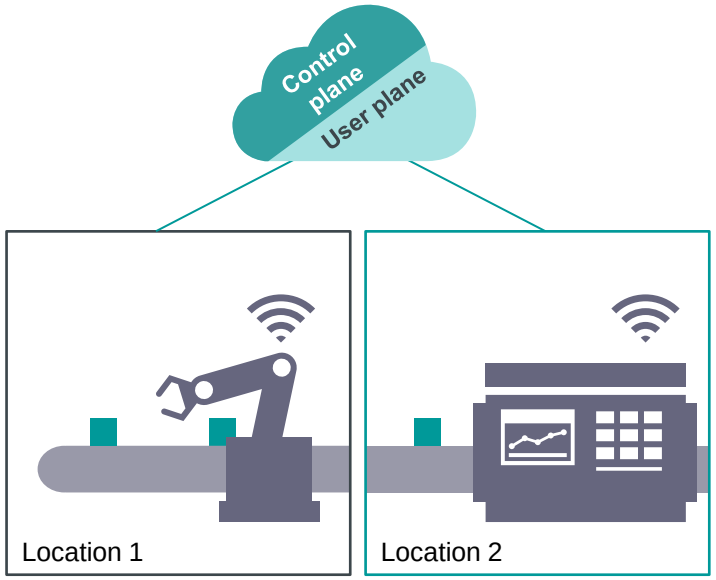
Public deployment[1]

Flexibility: Very limited, depends on provider

Privacy: Insufficient w/o additional precaution

QoS: Not guaranteed

Network: Depends on implementation of provider



Used frequency: 3,4 … 3,7 GHz (Public)

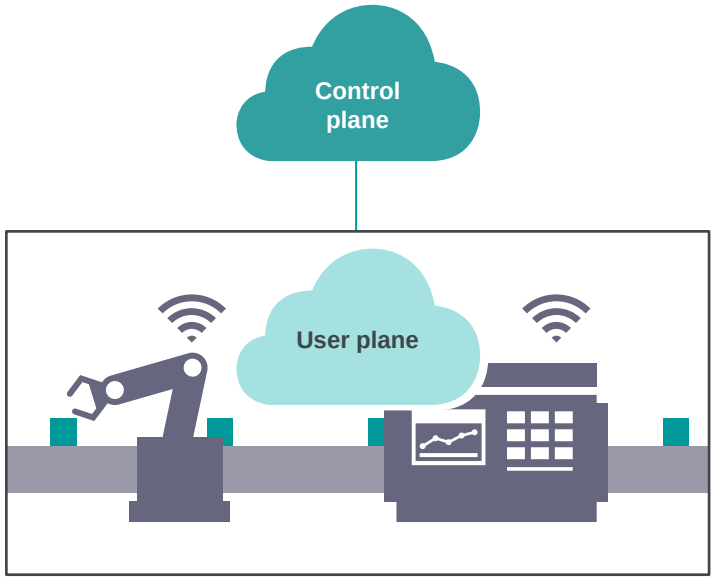
Semi public deployment[1]

Flexibility: Limited, depends on provider

Privacy: UEs are visible outside

QoS: Best effort

Network: This scenario is one possible way of slicing, depends on provider



Used frequency: 3,4 … 3,7 GHz (Public)

Local, private deployment

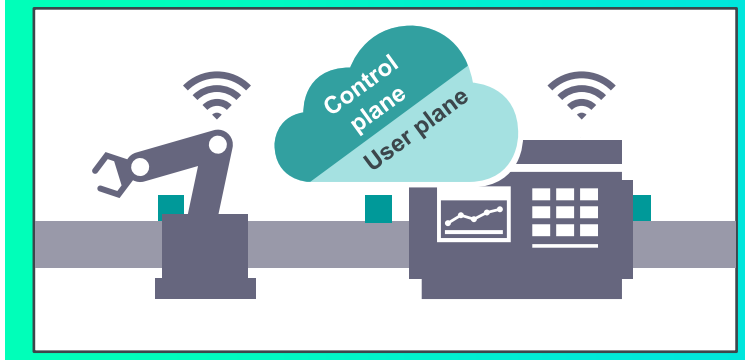
Flexibility: Unlimited

Privacy: Optimal

QoS: Optimal

Network: This scenario is only possible with access to spectrum

Industrial 5G



Used frequency: 3,7 … 3,8 GHz (Private)[2]

[1] Depends on the implementation of the provider, most likely variants are shown

[2] Based on German spectrum model

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Private Industrial 5G solution

5G Core	Management of 5G network incl. UEs and data traffic
Radio Access Network (RAN)	Central Unit (CU): control of the radio network Distributed Unit (DU): conversion of the radio signal Radio Units (RUs): transmission of the radio signal
User Equipment (UEs)	Connection of end devices to 5G network

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Siemens Private 5G Infrastructure based on Release 15

Setup in the Siemens Automotive Center

Radio Unit
Active radio device connected to the distributed unit, responsible for converting the digital radio signal into an analog

5G Core
The Core manages the complete network including connected User Equipment (UEs) and data traffic

Central Unit (CU) & Distributed Unit (DU)
The CU controls the radio equipment, the DU translates the network traffic into a digital radio signal which is send and received by radio units.

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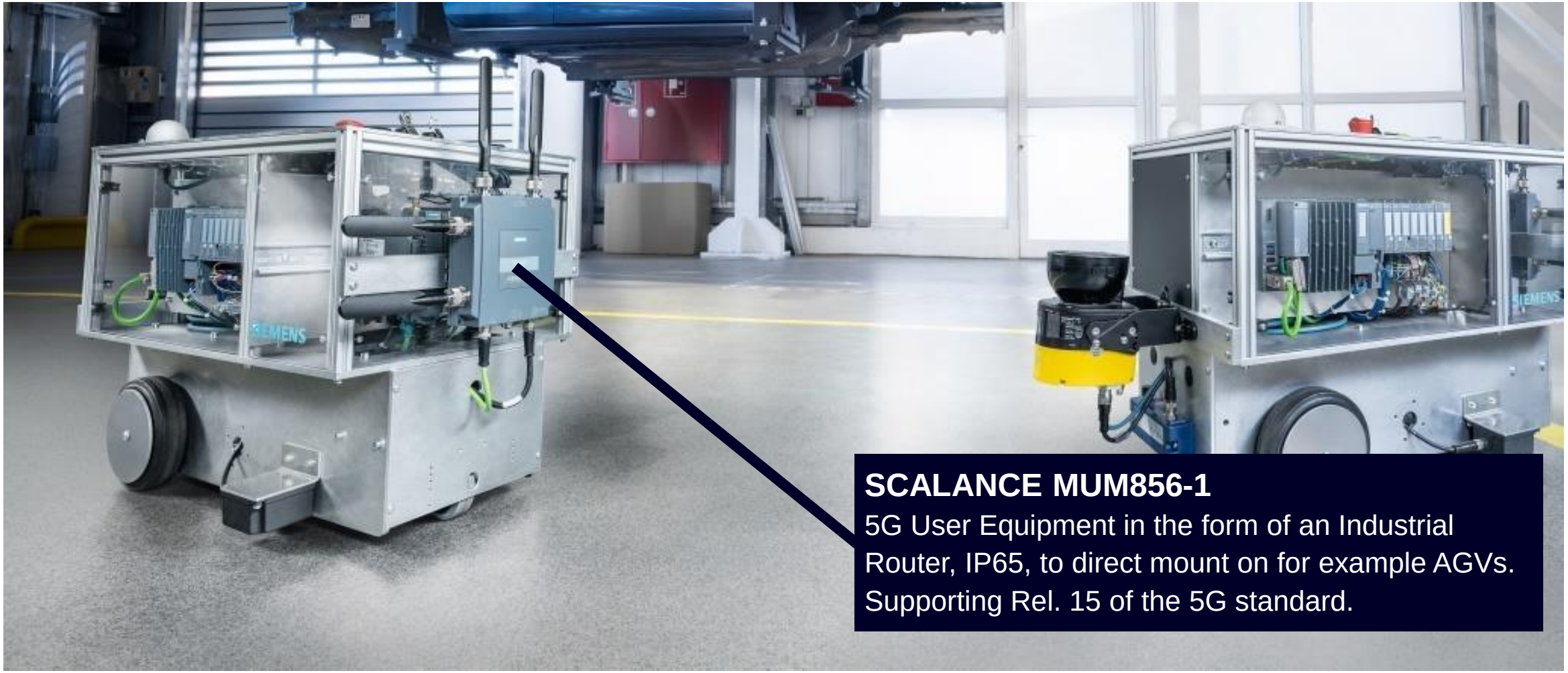
Siemens Industrial 5G End Devices based on Release 15

SCALANCE MUM856-1 direct mounted on a SIMOVE AGV



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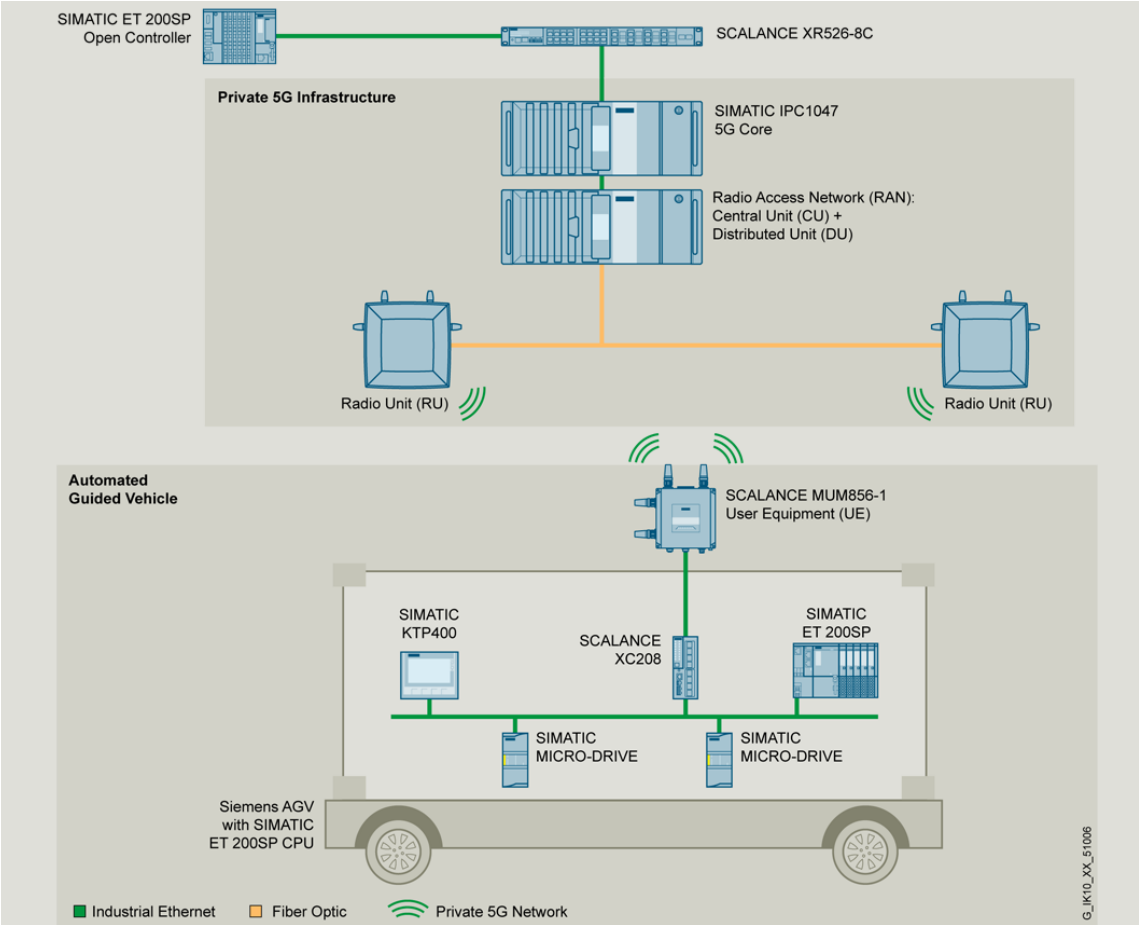
5G Use Cases
Connection of automated guided vehicle system to a private 5G network

Task
- Reliable connection of stationary and mobile participants to private industrial 5G networks

Solution
- SCALANCE MUM856-1 with its IP65 enclosure enables the connection of different participants to private 5G networks
- Rugged design enables the mounting outside of the control cabinet and on stationary and mobile participants in harsh industrial environments

Benefits
- Benefitting from the advantages of 5G technology in private industrial networks
- Flexible utilization of a device for both public and private 5G networks – depending on configuration
- Compatible with private third-party 5G networks* (e.g., Nokia, Ericsson)



Please note that the SCALANCE MUM856-1 can be replaced by the SCALANCE MUM853-1 depending on the environmental and deployment circumstances

* Smooth integration in private third-party networks is not guaranteed; use in Nokia and Ericsson networks has been tested successfully

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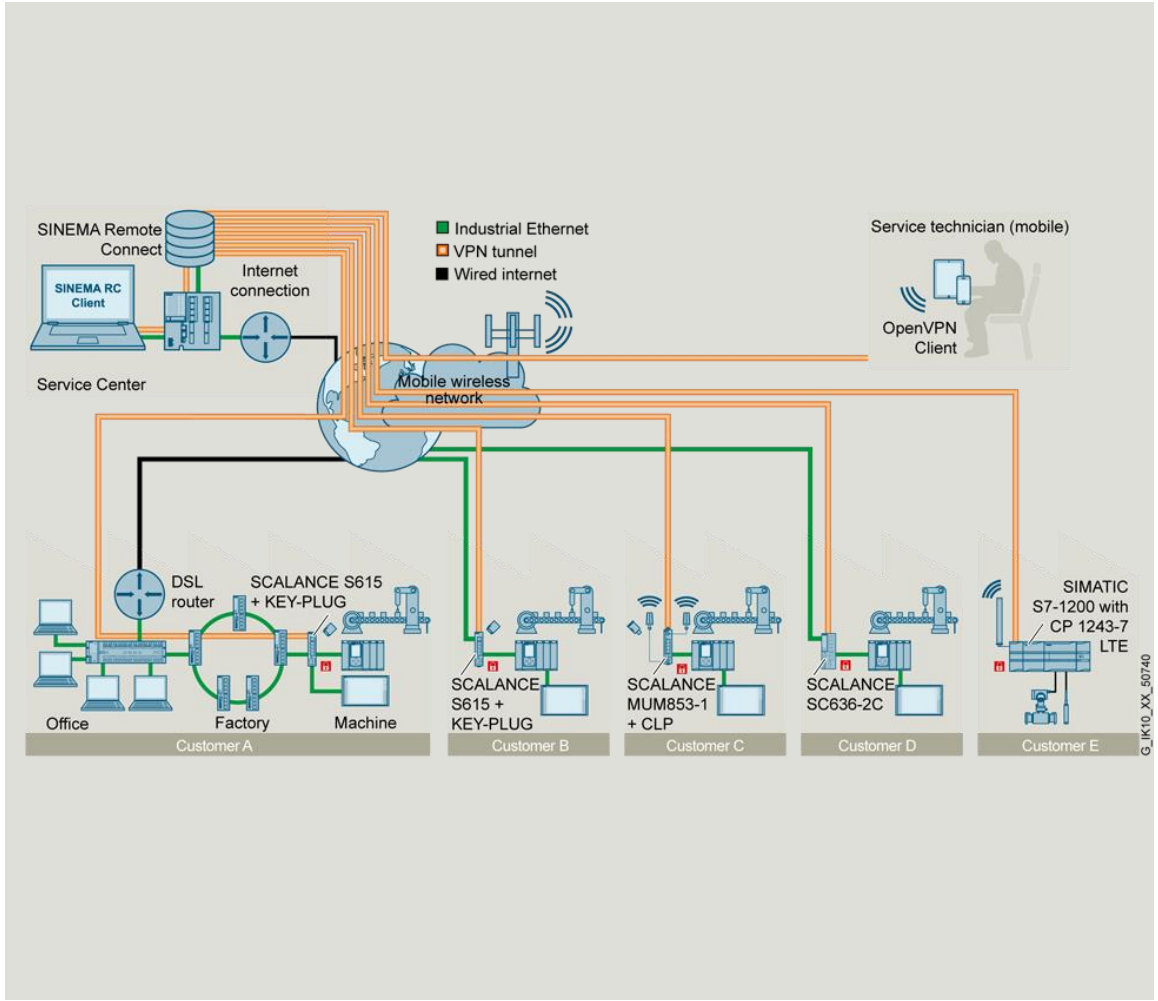
SCALANCE M with SINEMA Remote Connect
Secure connection of remote machines via VPN

Task
- Easy and secure remote maintenance of machinery and larger installations – also with the latest 5G mobile communications technology
- Connection of stationary and mobile participants over 5G to an existing SINEMA Remote Connect server

Solution
- SCALANCE MUM856-1 with its IP65 enclosure enables the connection of stationary and mobile participants to public 5G networks and offers SINEMA Remote Connect support
- User-friendly setup of devices with routing/ NAT information in SINEMA Remote Connect
- Access to machinery/ installations is secured by security mechanisms (OpenVPN) and integrated stateful inspection firewall

Benefits
- Realization of data-intensive applications with high bandwidth
- Can be used without specialized IT knowledge
- Transparent IP communication
- Prevention of manipulation and unauthorized access through secure data transmission and authentication
- Seamless technology – proven workflow is maintained
- Cost savings – same remote maintenance system in all networks
- Cell protection concept (defense in depth) also with 5G



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Global connectivity solution for factories
Simple plantwide connectivity throughout the factory

Task

- Providing wireless connectivity on the shopfloor, including brownfield installations
- Simple integration of new /additional devices in an existing shopfloor environment

Solution

- Installation of a private 5G Infrastructure provides a reliable wireless connection to devices in the field.
- Legacy devices can be easily connected through the state of the art technology of 5G with an Industrial 5G router
- With Industrial 5G various applications within one network can be supported

Benefits

- Easy way to add connectivity in brownfield scenarios
- Smart Design to facilitate easy handling by OT personal
- Simple and fast deployment of new end devices
- Scalability of the system leaves room for future adaptions

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