Communication systems and networks – key enablers for digitalization of industry and society

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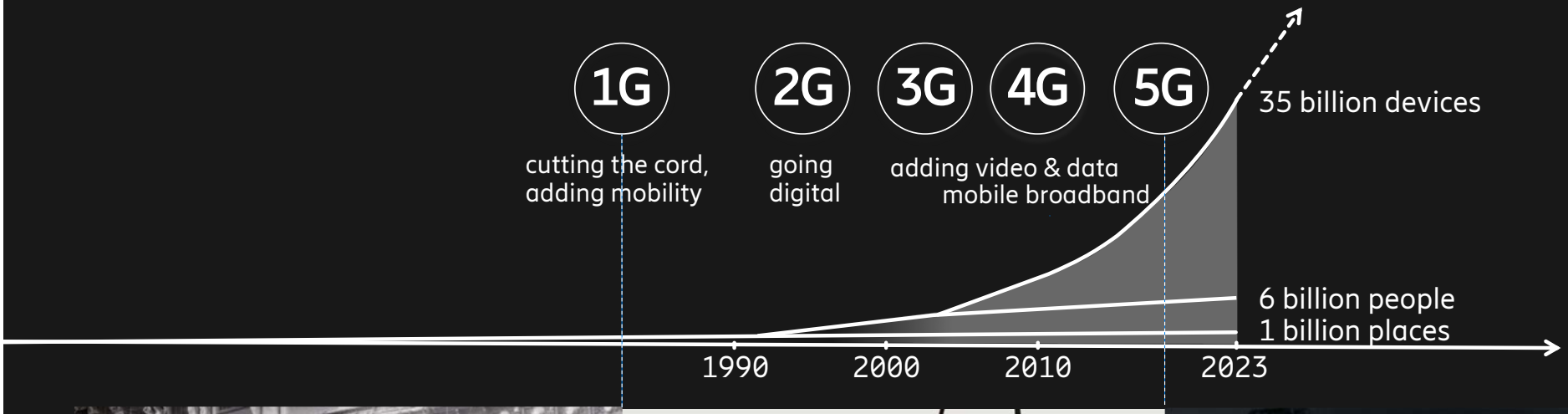
Magnus Frodigh | © Ericsson 2018 | 2018-05-30

The pace of change will ever be slower than today

5G – a foundation for digitalization

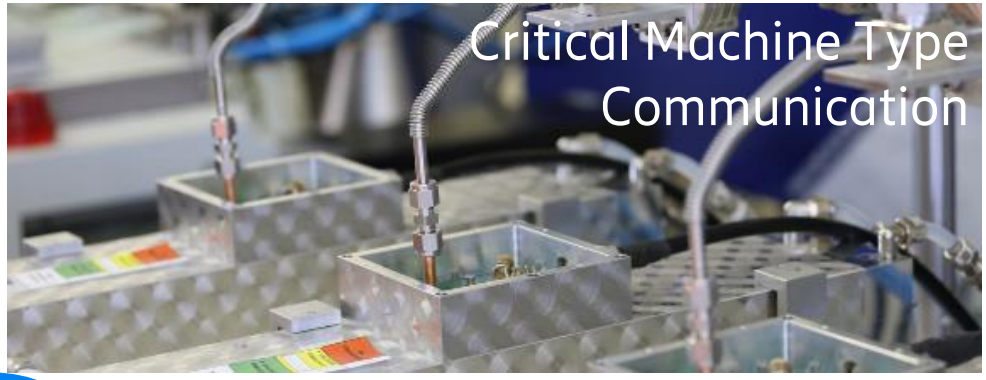


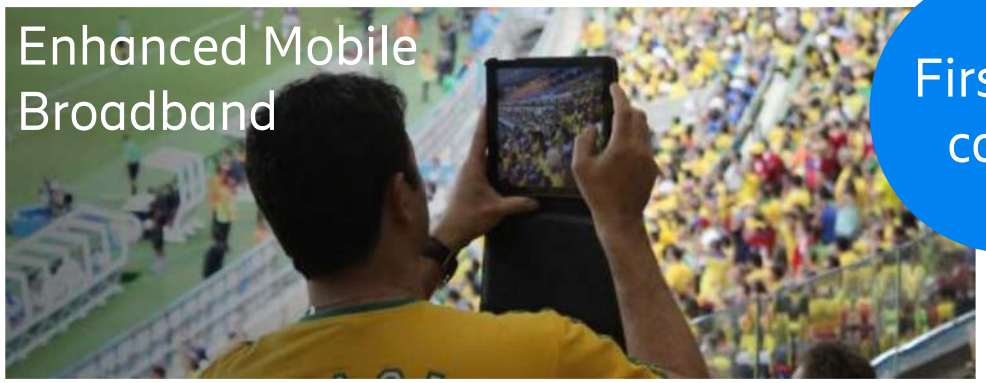
Telephony and mobile broadband

A digital infrastructure for industrial and societal transformation


5G
Empowering people,
transforming industries,
advancing society

5G starting with enhanced MBB and then enabling new evolved IOT use cases





First use cases

Anything that can be connected will be connected, smart and interactive

Cellular for Massive IoT

Smart cities | Smart agriculture | Smart manufacturing | Wearables | Waste management | Transport and logistics | Environment monitoring and prote

Technologies | Solutions | Business opportunities

Cellular IoT – technology characteristics

	Peak Throughput	Battery life	Voice	Mobility	Bandwidth	Coverage
Cat-M1	0.8/1 Mbps (300/375 kbps)	10+ year	Supported	Connected & idle mode mobility	1.4 MHz	160dB (+15dB)
NB-IoT	227/250 kbps (21/63 kbps)	10+ year	Not Supported	Idle mode mobility	200 kHz	164dB (+20dB)
EC-GSM-IoT	473/473 kbps (97/97 kbps)	10+ year	Not Supported	Idle mode mobility	200/600 kHz	164dB (+20dB)

Advanced antenna systems with beam tracking

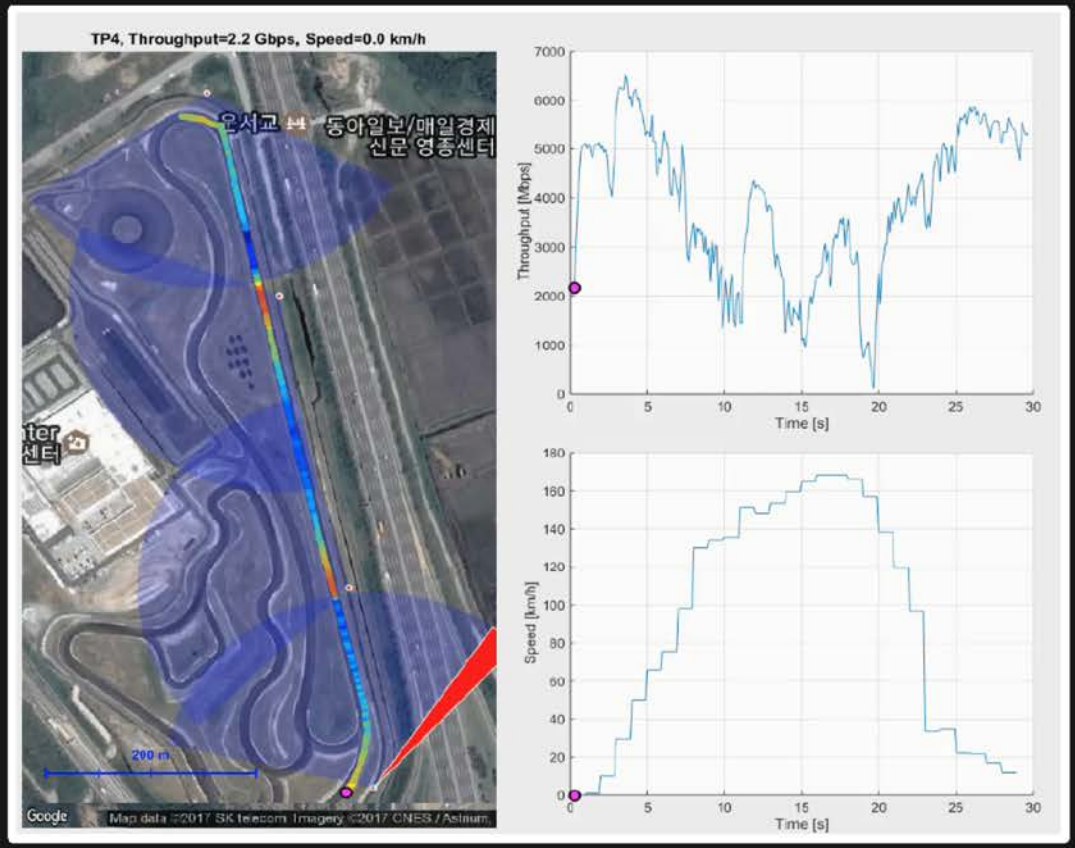
— Realistic use-case deployment

— Multiple transmission points with multiple beams

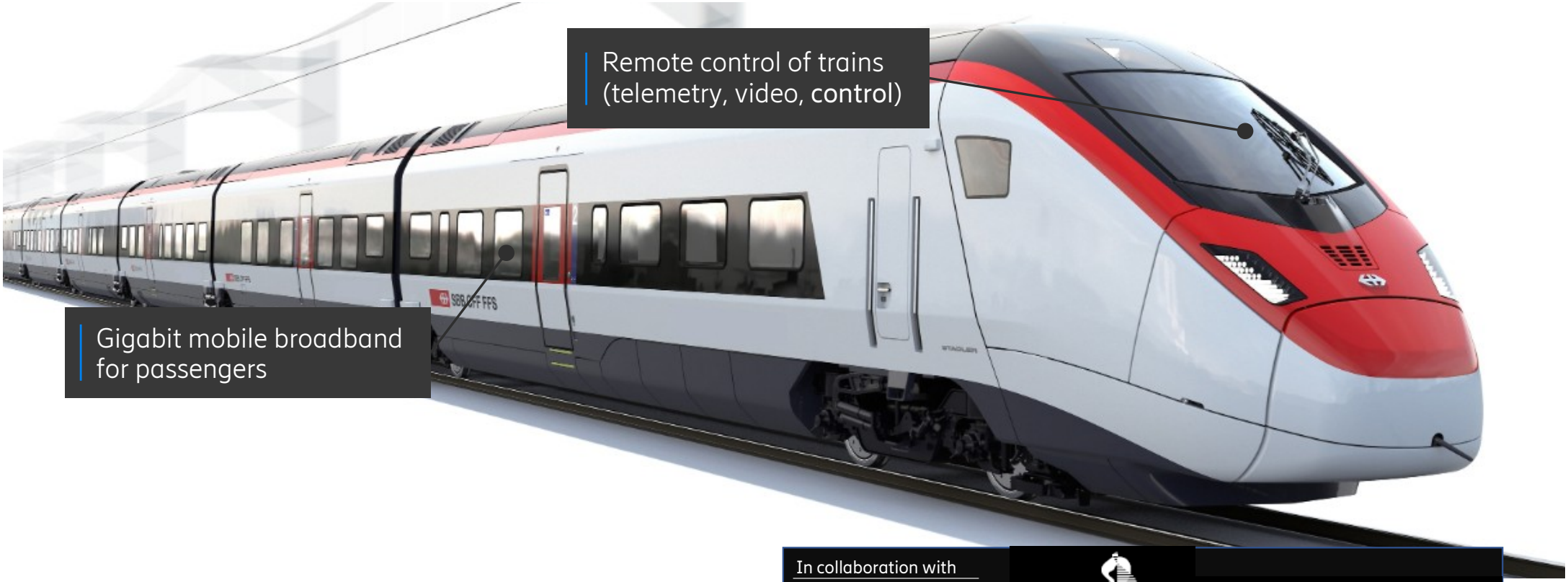
— High frequency (mmWave), 28 GHz

— High vehicle speed, 165+ km/h

— Seamless mobility with Gb/s performance



5G for serving multiple purposes



Technologies that drive industry changes

Machine intelligence

- Cognitive technologies and deep learning
- Responsible machine intelligence
- Capsule networks

Automation

- Model driven
- Automated life cycle management
- Autonomous systems

Radio evolution

- mm Wave and massive antenna technologies
- Multi-purpose, multi-characteristic radio
- Flexible spectrum assignment and utilization

Programmable networks

- Software defined networking
- Network abstraction
- Network slicing

Cloud technologies

- Distributed cloud and edge computing
- Micro services and DevOps
- Virtualization, containers

Programming language for packet forwarding – P4

Rapid development

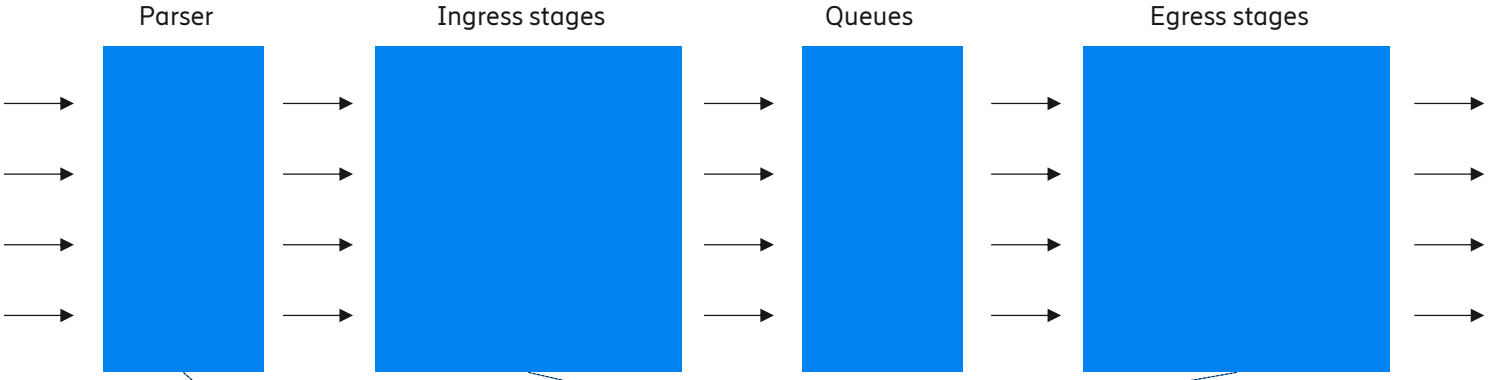
— high level language of programming packet processors

Platform independence

— independent of the specifics of underlying hardware

SDN compliance

— P4 works in conjunction with SDN control protocols




```
parser parse_ethernet {
        extract(ethernet);
        return select(latest.etherType) {
                0x8100 : parse_vlan;
                0x800 : parse_ipv4;
                0x86DD : parse_ipv6;
        }
}
```

Parser

— State machine
— Field extraction

```
table ipv4_lpm
{
        reads {
                ipv4.dstAddr : lpm;
        }
        actions {
                set_next_hop;
                drop;
        }
}
```

Match actíon

ipv4.dstAddr	action
192.168.0.0/16	drop
10.0.0.0/24	set_next_hop
10.0.1.0/24	set_next_hop

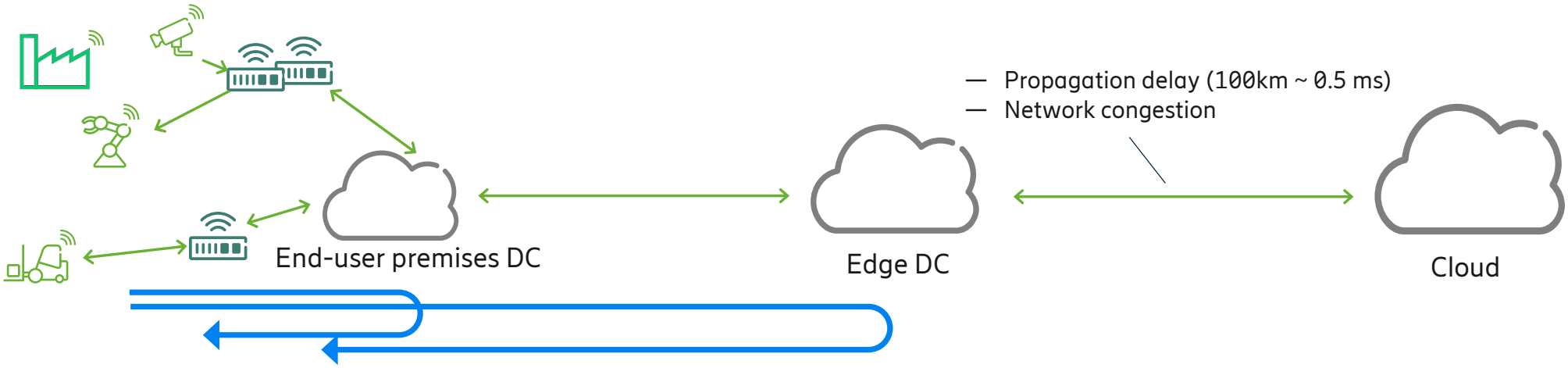
— Table lookup and update
— Field manipulation

The importance of edge computing

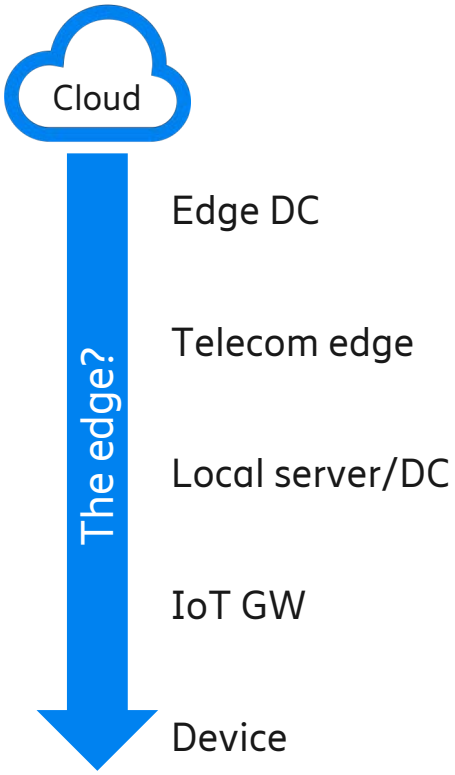
Edge computing pushes intelligence and processing capabilities closer to the end user or where the data originates or is needed

Drivers for edge computing

— Higher capacity services
— Lower latency services
— Legal/corporate/administrative domains



Where is the Edge?
It depends on who you ask



Data center companies	→ smaller sites in 2nd/3rd tier cities
Fixed and cable operators	→ central offices/exchanges, gateways/servers on business premises
Mobile operators	→ servers at cell-sites or aggregation points (also small cell indoor cells)
IT companies	→ servers at company sites
Mesh-network vendors/ service providers	→ gateways or access-points
IoT companies	→ localized controller or gateway for clusters of devices
Device and silicon vendors	→ smart endpoint (smartphone, car, raspberry pi)

Edge compute challenges

Application platform

— Common interface for deployment of 3rd party applications

— Orchestration and automated scaling of applications (e.g. application mobility between data centers)

Cloud platform & SDN

— Low platform overhead

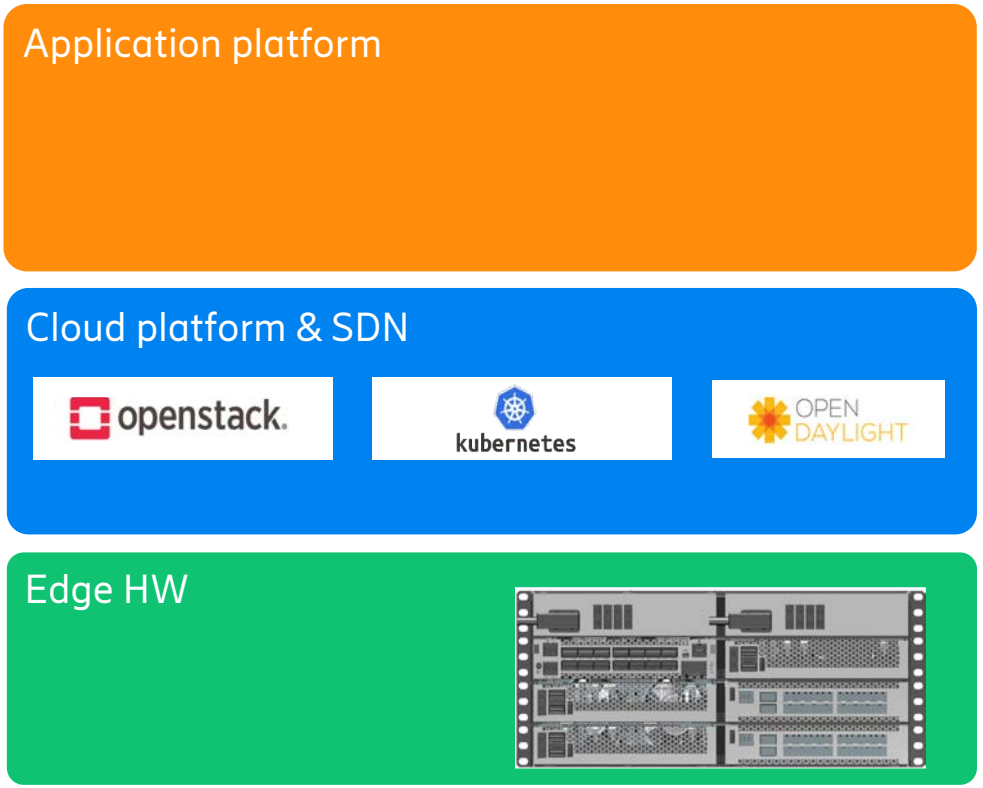
— Carrier grade performance, resilience, and security

— Platform support for HW accelerators (GPUs , FPGAs)

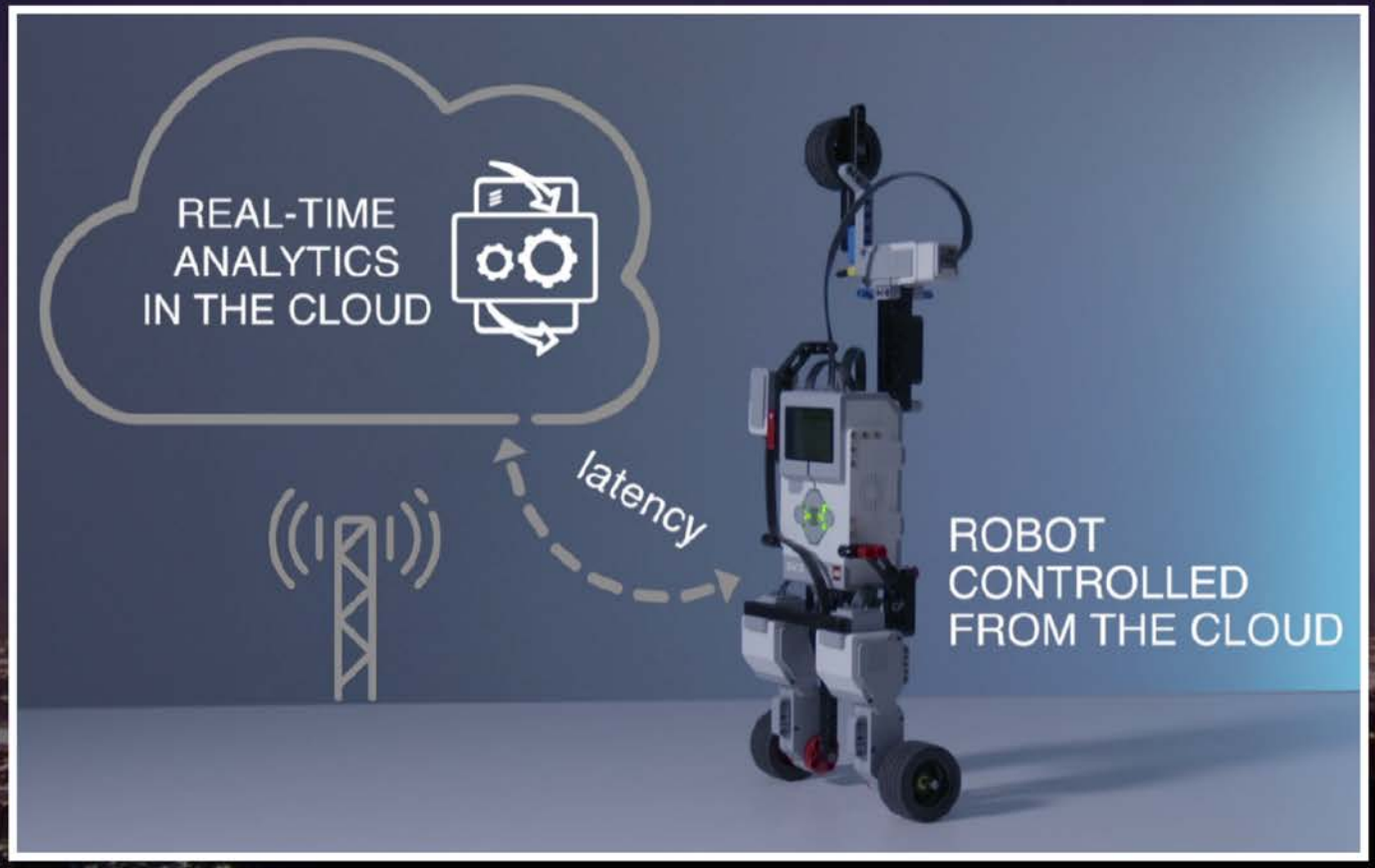
— Joint orchestration of networking and compute

Edge optimized HW

— Low footprint and environmentally hardened for non-DC sites



Balancing robot
Cloud based solutions that work



Mixed reality example

Mixed reality is the integration of digital information with the user's environment in real time.

Large number of use cases
- connecting remote workers
- assisting with complex tasks
- more efficient warehousing and logistics
- enhanced learning outcomes
- real-time data & analytics visualization

Any reshaping idea that can be tried will be tried and trigger change

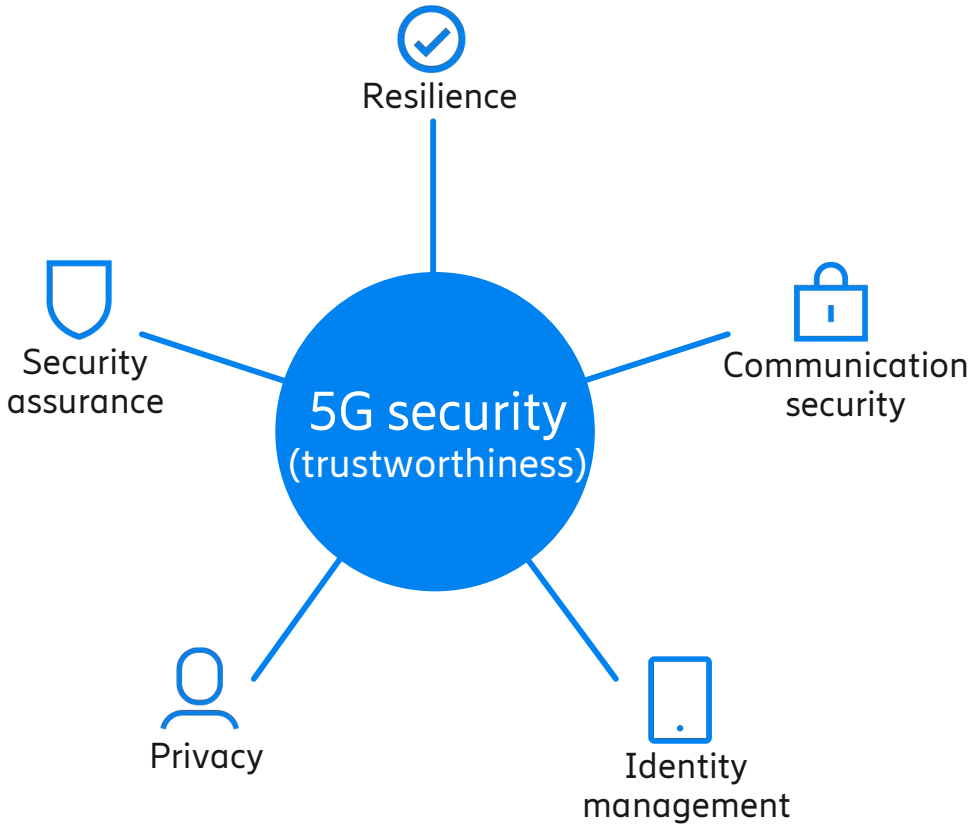
video
— mixed reality

An evolving security landscape

Building trustworthiness in 5G

Five properties contributing to trustworthiness of 5G systems

Standardization, system design principles, implementation considerations, security monitoring, build security for 5G



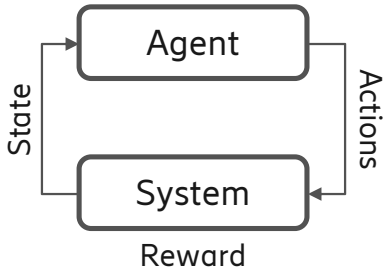
Machine Intelligence for next generation systems

Real-time

— Intelligent decision making on live data
— Network edge, IoT sensors and more
— 5G: ultra-low latency

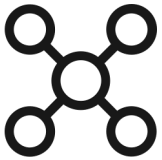
Beyond games and simulations

— Reinforcement Learning
— Safe exploration
— Simulators + live systems



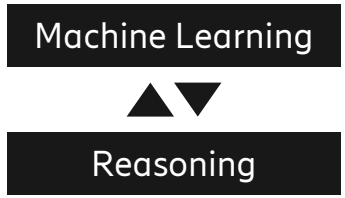
Distributed & decentralized

— From data center to network edge
— Distributed learning
— Local vs. global decisions



Machine Learning + Reasoning

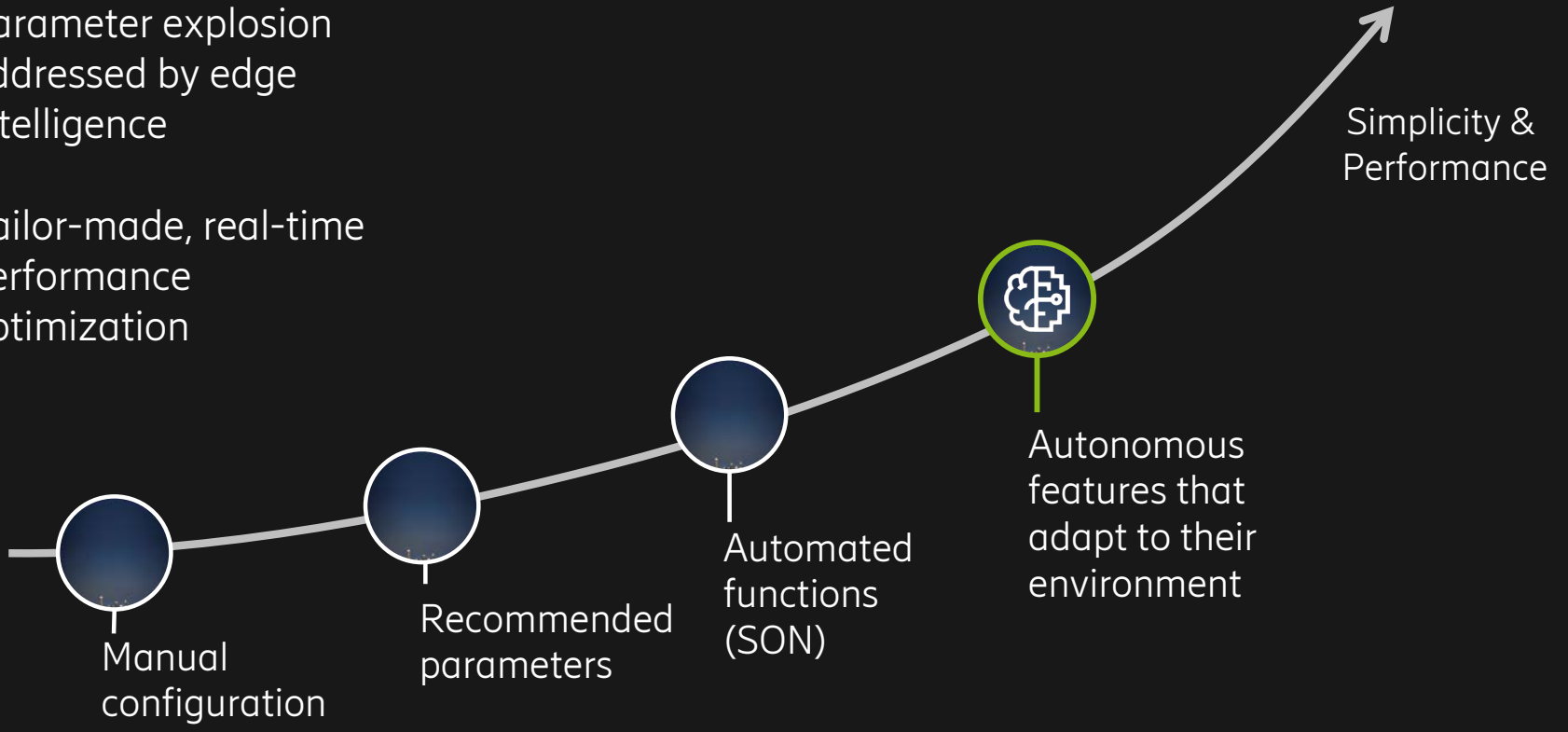
— Extract high-level knowledge from ML
— Validation and explanation
— Use ML to guide Reasoning



Machine Intelligence is key for managing network complexity

Parameter explosion addressed by edge intelligence

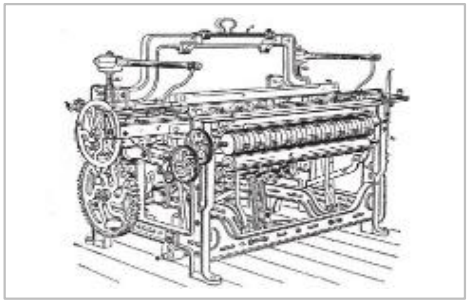
Tailor-made, real-time performance optimization

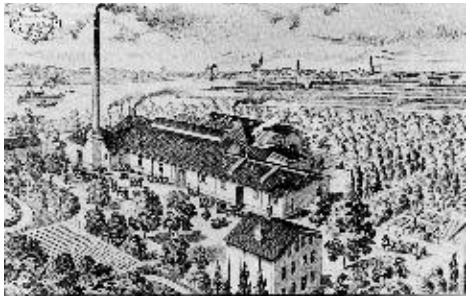


Digital doesn't respect boundaries – regardless of the industry, digitalization will uncover inefficiencies and create value.

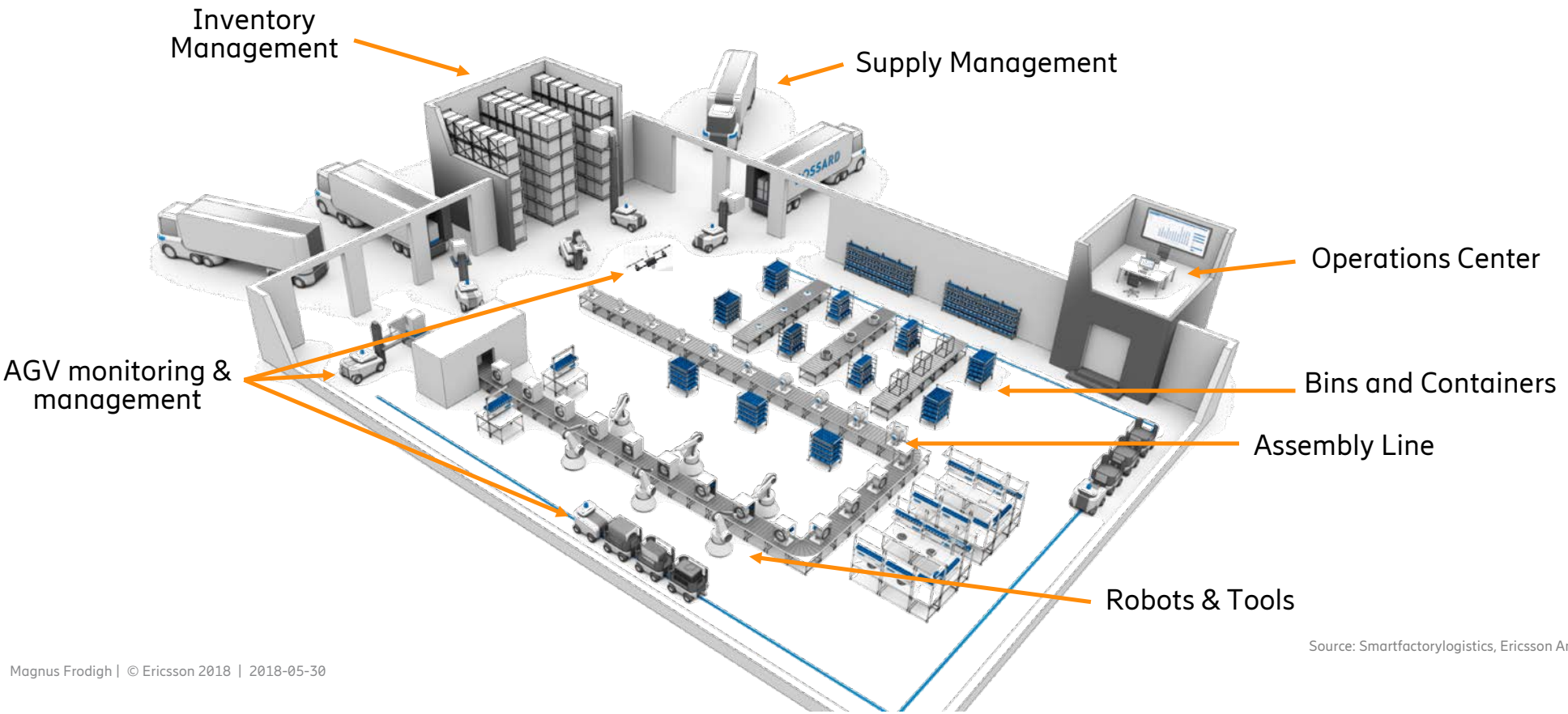
From industry 1.0 to 4.0

1784	1870	1969	Now
First mechanical loom	First assembly line	First PLC	Industry 4.0
1	2	3	4
Mechanization Water power Steam power	Mass production Assembly line Electricity	Partial automation Computer	Full automation Wireless connectivity Information processing Virtualization of control



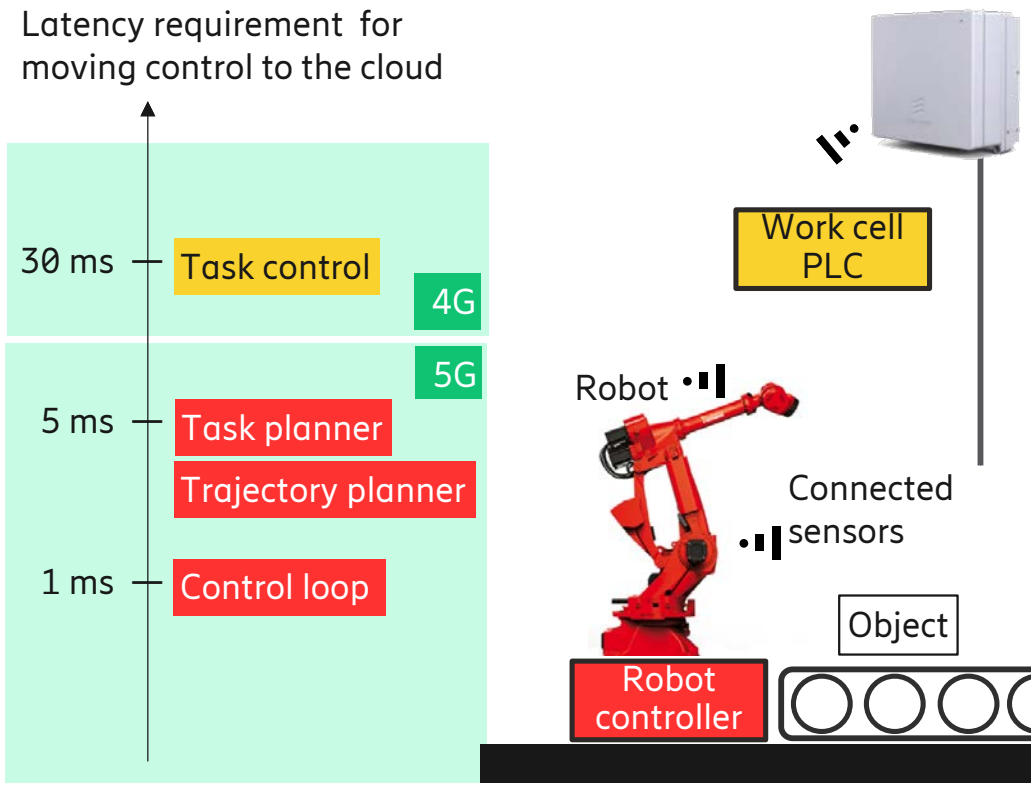


One-stop shop floor solution



Source: Smartfactorylogistics, Ericsson Analysis

Industry-grade cellular connectivity



Findings and learnings

5G for industries

—Foundation for Industry 4.0

—4G & 5G technologies proven superior in industry environment

—Multi-purpose shop floor solution

—Provides global solutions for global players

The three basic foundations going forward

5G