Effizient mit 5G-Campusnetz

Wie Nokia seine eigene Produktion optimiert hat

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Global Head of Manufacturing Verticals

November 2023

Welcome to NOKIA
in Oulu and Chennai

5G
ready

WORLD
ECONOMIC
FORUM

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Factory Overview

Industry-leading manufacturing facilities of radio networking products/solutions

Oulu, Finland

- Produces over 1,000 4G and 5G base stations per day
- Campus (2021) ~ 17,600 sqm, employees (2021): ~ 470
- Facility expansion of additional 55,000 sqm (2025)
- ISO 9001, ISO 14001, and TL 9000 certifications

Chennai, India

- R&D and volume manufacturing
- Produces 2G/3G/4G/5G radio and core network products
- Campus (2021) ~ 141,000 sqm, employees (2021): ~ 3000+/shift
- ISO 9001, ISO 14001, ISO 27001 and TL9000 certifications

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Nokia Oulu conscious factory of the future leverages private 4G/5G for shop floor automation

Welcome to Nokia Oulu Factory
Advanced 4th Industrial Revolution Lighthouse
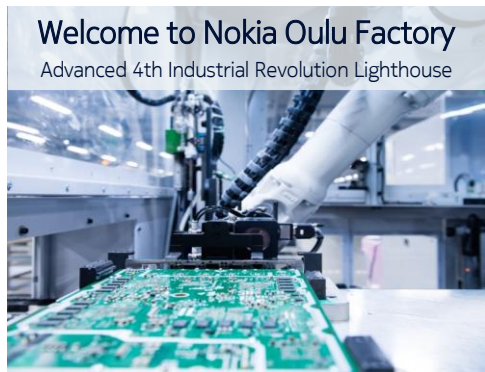
Nokia Conscious Factory @ Oulu

- New product introduction (NPI) factory, manufacturing 4G and 5G network equipment along multiple SMT production lanes
- Oulu as "Home of Radio" – Radio R&D incl. 6G
- Digitalization and automation since 2014 towards the conscious factory of the future
- Award-winning live lab, Industry 4.0 lighthouse

Use Cases & Private Wireless

- 100% of production area covered with 4G and 5G private wireless network including edge computing and redundancy
- Flexibility, mobility and reliability leveraged by use cases such as
  - Dynamic shop floor layout
  - Flexible robotics & real-time process mgmt.
  - Asset connectivity, monitoring and control
  - Cloud-based digital twin & virtualization

Business Benefits

- Optimized production layout change time
- Increased material feed operation efficiency
- Higher overall equipment effectiveness (OEE)
- Plus in product quality and manufacturing productivity
- Reduced prototype lead time and assembly defects

Press Release & Resources: https://www.nokia.com/about-us/news/releases/2019/07/03/nokias-digitalization-of-its-5g-oulu-factory-recognized-by-the-world-economic-forum-as-an-advanced-4th-industrial-revolution-lighthouse/
Video: https://youtu.be/I9gw7I0C-gE

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Nokia Chennai factory leverages private 4G for flexibility, mobility and reliability improvements

Nokia Factory @ Chennai
- High-volume factory, manufacturing 2G, 3G 4G and 5G radio and core network equipment along multiple SMT production lanes
- 42 000 sqm and 20 production areas connected in collaboration with local CSP

Use Cases & Private Wireless
- 100% of production area covered with a 4G private wireless network.
- 700 SIMs and 80% of the equipment connected
- Flexibility, mobility and reliability enabled by use cases such as
  - Connected robots and smart screw drivers
  - Positioning (HAIP) for asset tracking, monitoring and control
  - Digital truck management system
  - Augmented reality visualization for instant material information access ("Third Eye")
  - Cloud-based digital twin and virtualization

Business Benefits
- Increased material feed operation efficiency
- Eliminated 23 km walking distance per day
- Higher overall equipment effectiveness (OEE)
- Plus in product quality and manufacturing productivity

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Nokia AirScale and Enterprise Products

AirScale Base Station: Multi-band radio + Baseband Units

AirScale Active Antennas

AirFrame Open Edge Servers
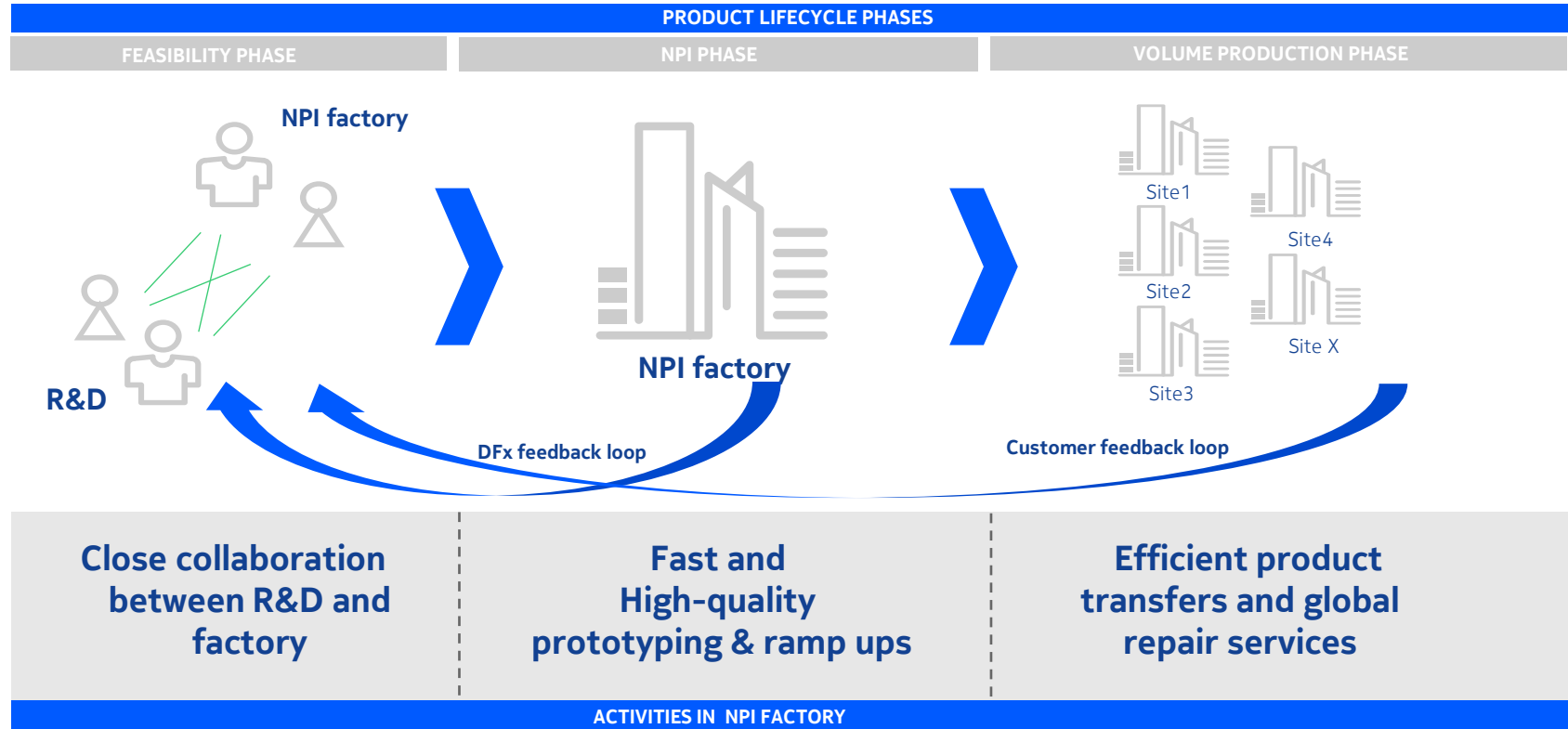
Nokia Enterprise

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NPI factory – strong manufacturing presence through entire product lifecycle

PRODUCT LIFECYCLE PHASES

FEASIBILITY PHASE	NPI PHASE	VOLUME PRODUCTION PHASE

NPI factory

R&D

NPI factory

Site1
Site2
Site3
Site4
Site X

DFx feedback loop

Customer feedback loop

Close collaboration between R&D and factory	**Fast and High-quality prototyping & ramp ups**	**Efficient product transfers and global repair services**

ACTIVITIES IN NPI FACTORY

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Powered by Nokia own technologies

Proven success in deployment of Industry 4.0 technologies at scale

Private wireless network to speed up NPI line re-layout and bring reliable connectivity to all assets

Flexible robotics to ensure high productivity and agility for continuous new ramp-ups

Cloud-based **Digital Twin** enabling real-time process management

Virtualization of new product introduction (NPI)

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Cloud-based **Digital Twin** enabling real-time process management

Virtualization of new product introduction (NPI)

- 100% factory floor connected
- 80% time reduction for floor plan layout changes
- Reduced time for system maintenance and network connectivity

- 100% improvement in logistics / material handling
- Increase in OEE in product assembly & test
- Provides reliable connectivity to AMRs and mobile assets

- 25%+ increase in productivity
- 50% improvement in product quality
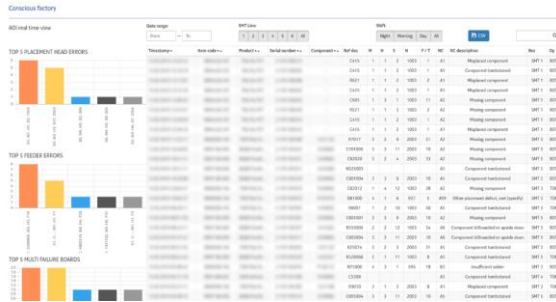- Enables rapid factory floor reconfiguration and asses their impact

- 50% reduction in prototype lead times
- 30% fewer assembly defects
- Use of AR to accelerate training of assembly workers
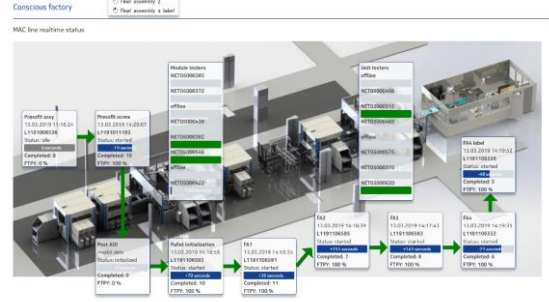
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Digital Twin of the production

Application examples

**Automated process error analytics**

- Real time process performance monitoring

- Automated analysis speeding up error detection and correction

- Various machines and data sources connected

Real time status of assembly line

- Status of each robot cell can be seen anytime from the dashboard

- Progress of the assembly process can be monitored real time

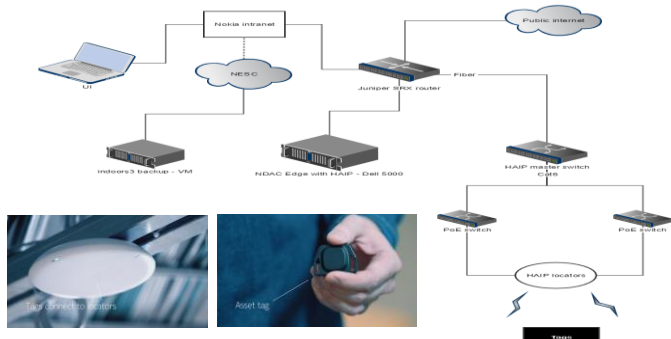- Visibility to individual product level enabled
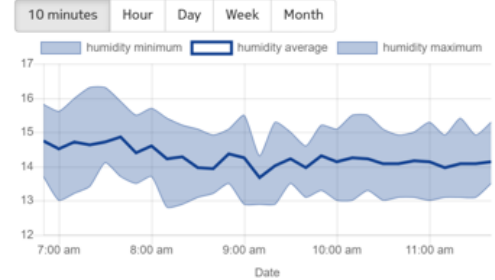
Production environment monitoring

- IoT sensor data utilized to monitor production environment

- Deviations in humidity and temperature levels can be observed

- Automated alarms can be triggered for maintenance staff

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High Accuracy Indoor Positioning System (HAIP)

HAIP Factory GUI

Area Covered – 4000 sqm

No. of Locators – 96, PoE Switches – 8, No. of Tags - 200

- Real-time, low latency, high precision tracking of key assets in factory and Hub
- Enabler for movable asset tracking and material pickup guidance
- Up to 30cm positional accuracy (typical <1m) with Angle of Arrival method
- High security of data due to Edge computing
- Open API for easy integration and use of location information in automated business workflows

- Geo Mapping for High value assets
- Shortest route navigation to the asset location , locate and navigate to test equipment
- Integrate with Warehouse Smart Putaway/Picking application to guide operators to navigate during Putaway/Picking operations

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5G campus networks – a powerful enabler of higher efficiency

Some examples …

86%
Lead Time
Reduction

IT Infrastructure Setup
for new production line

23 Km
walk/day
elimination

Smart Material Delivery
(AGV, AIV)

31%
Labor time
reduction

Hardware Robotic
Automation

47K
Man hour
savings

Software Robotic
Automation (RPA)

25%
Increase in
automation rate

Flexible manufacturing

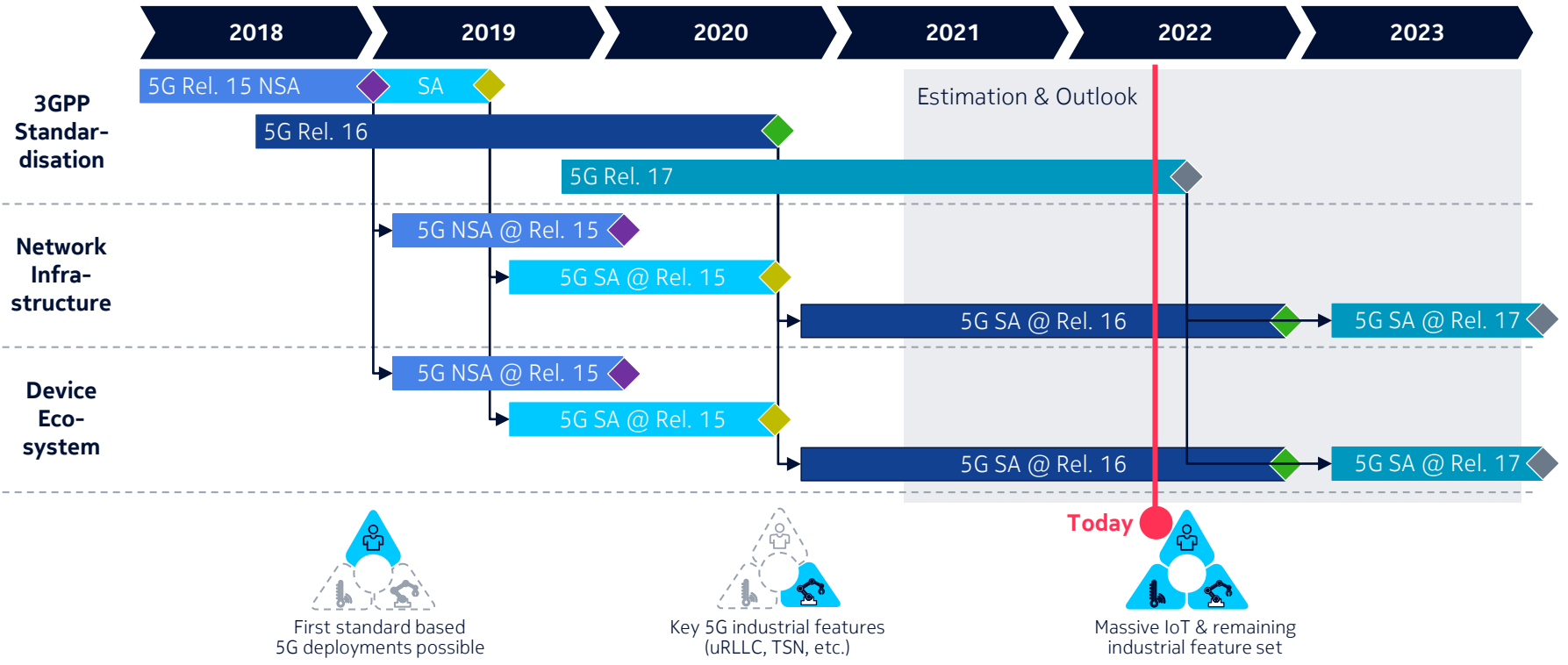**80%**
Connected
devices

Digital Twin Visibility

100+

Use cases deployed in
production
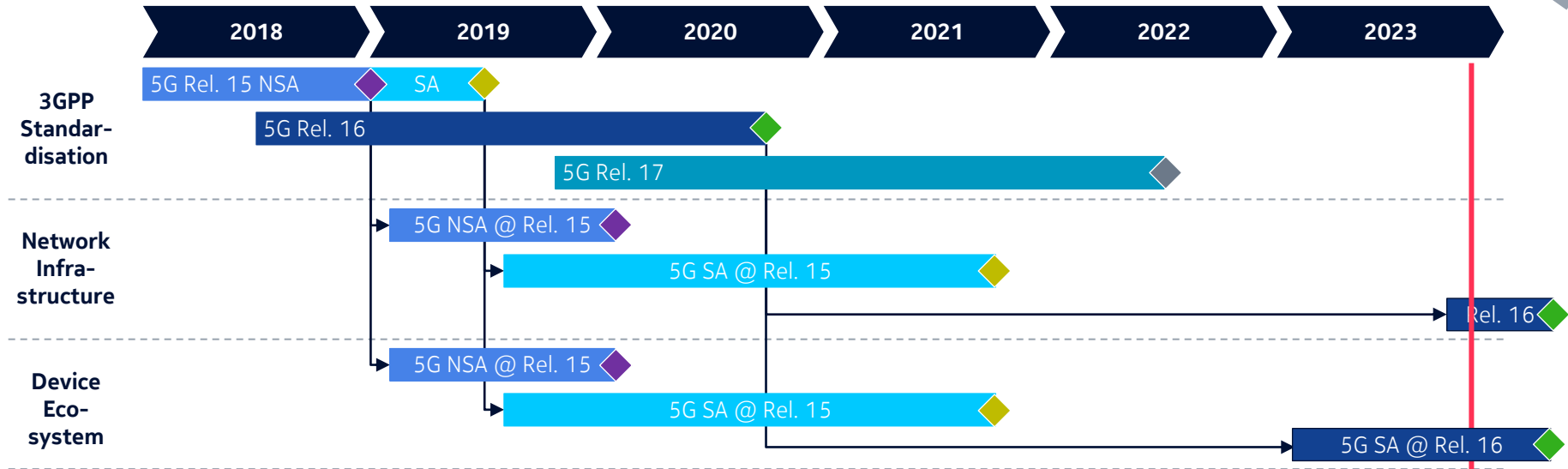
16%

OEE improvement overall
operations

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4G vs 5G vs WiFi vs …

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Private 5G wireless network design depends on 3GPP standardization, network infrastructure availability and device ecosystem – NSA vs. SA, Rel. 15, 16 & 17

| 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |

3GPP Standar-disation
- 5G Rel. 15 NSA — SA
- 5G Rel. 16
- 5G Rel. 17

Estimation & Outlook

Network Infra-structure
- 5G NSA @ Rel. 15
- 5G SA @ Rel. 15
- 5G SA @ Rel. 16 → 5G SA @ Rel. 17

Device Eco-system
- 5G NSA @ Rel. 15
- 5G SA @ Rel. 15
- 5G SA @ Rel. 16 → 5G SA @ Rel. 17

Today

First standard based
5G deployments possible

Key 5G industrial features
(uRLLC, TSN, etc.)

Massive IoT & remaining
industrial feature set

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Private 5G wireless network design depends on 3GPP standardization, network infrastructure availability and device ecosystem – NSA vs. SA, Rel. 15, 16 & 17
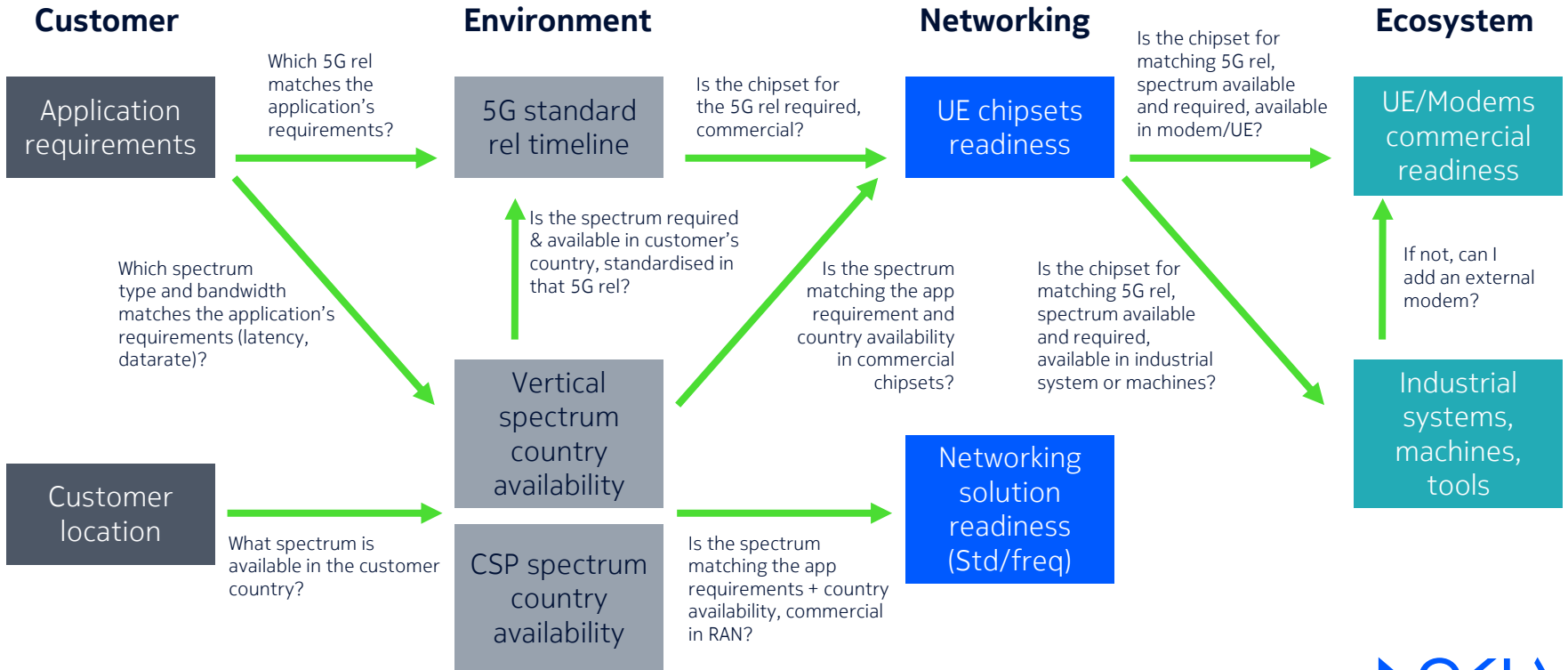

Today - indicative

	2018	2019	2020	2021	2022	2023

3GPP Standar-disation
- 5G Rel. 15 NSA ◆ SA ◆
- 5G Rel. 16 ◆
- 5G Rel. 17 ◆

Network Infra-structure
- 5G NSA @ Rel. 15 ◆
- 5G SA @ Rel. 15 ◆
- Rel. 16 ◆

Device Eco-system
- 5G NSA @ Rel. 15 ◆
- 5G SA @ Rel. 15 ◆
- 5G SA @ Rel. 16 ◆

First standard based
5G deployments possible

Today

Key 5G industrial features
(uRLLC, TSN, etc.)

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Private 5G for industrial readiness

Complex equation - key factors and multiple interdependencies

Customer **Environment** **Networking** **Ecosystem**

Application requirements

Which 5G rel matches the application's requirements?

5G standard rel timeline

Is the chipset for the 5G rel required, commercial?

UE chipsets readiness

Is the chipset for matching 5G rel, spectrum available and required, available in modem/UE?

UE/Modems commercial readiness

Which spectrum type and bandwidth matches the application's requirements (latency, datarate)?

Is the spectrum required & available in customer's country, standardised in that 5G rel?

Is the spectrum matching the app requirement and country availability in commercial chipsets?

Is the chipset for matching 5G rel, spectrum available and required, available in industrial system or machines?

If not, can I add an external modem?

Vertical spectrum country availability

Customer location

What spectrum is available in the customer country?

CSP spectrum country availability

Is the spectrum matching the app requirements + country availability, commercial in RAN?

Networking solution readiness (Std/freq)

Industrial systems, machines, tools

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