Dependability Challenges for industrial 6G applications

Lelio Di Martino
Lelio.di_martino@nokia-bell-labs.com

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Future industrial applications need a network able to allocate and guarantee SLAs on demand

Reconfigurable Factory Floor Example

Challenge

- Frequent reconfiguration of the factory floor
  - Average of 900 changeovers / SMT line / month
  - 200-600 Eur for each new cable connection
  - Production batch: 2-3 hours
  - Quantities: 100s – 3 million pieces

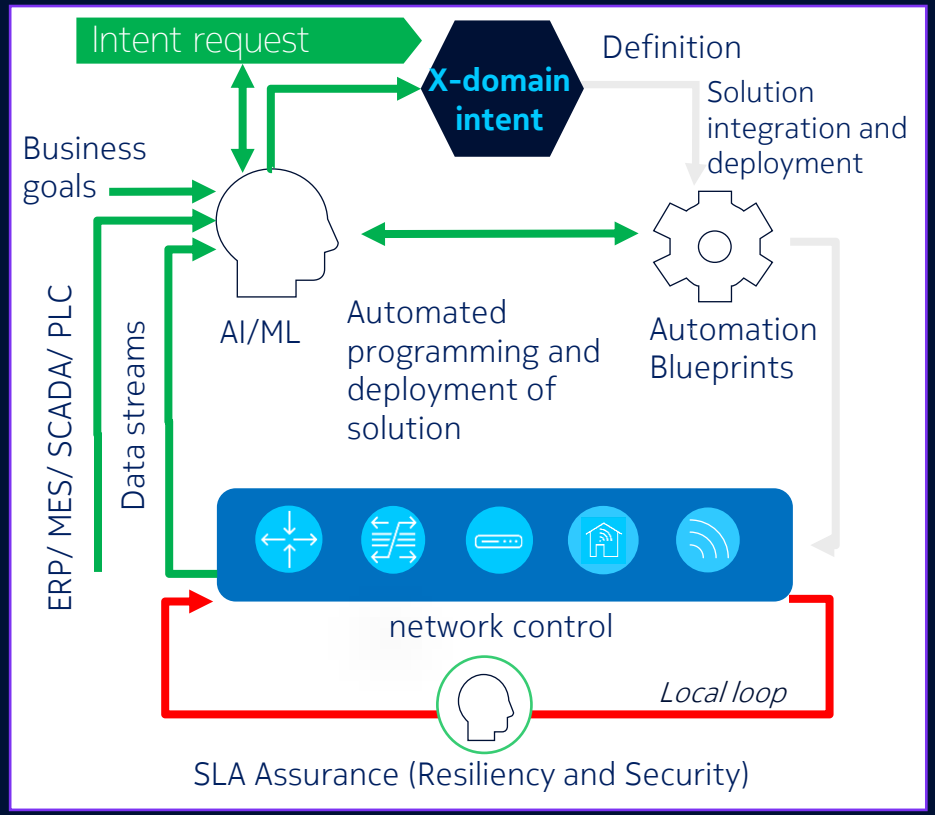
Open problems (selected)

- Use case specific SLA.
- SLAs require coordination with software layers (e.g., edge containers and orchestration) and network.
- Lack of deterministic behavior
- Mix of Low-latency traffic vs. high-bandwidth traffic
- Data-shower and uplink bandwidth

AI-driven Consumable Networks

Declaring the “why”, Inferring the “what”, and enforcing the “how”

0-programming network-as-a-service following business goals (i.e., mission)



The changing perspective of networks

"A way to improve availability is to install proven hardware and software, and then leave it alone" [Jim Gray 1991].

33 – 64%

of telco outages* due to untested configurations and corner cases

*1997-2023 data on telco failures

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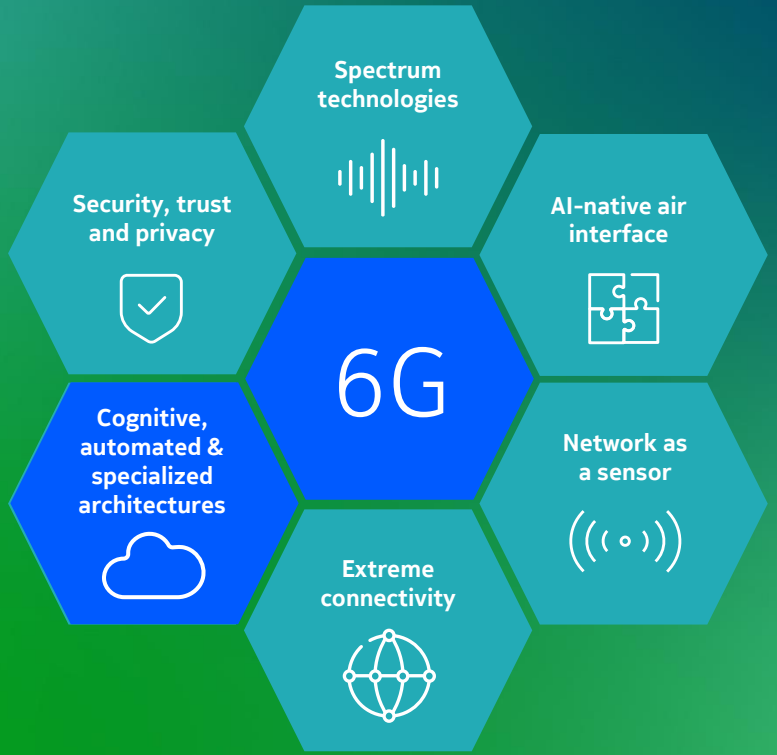
Bringing 6G future to life

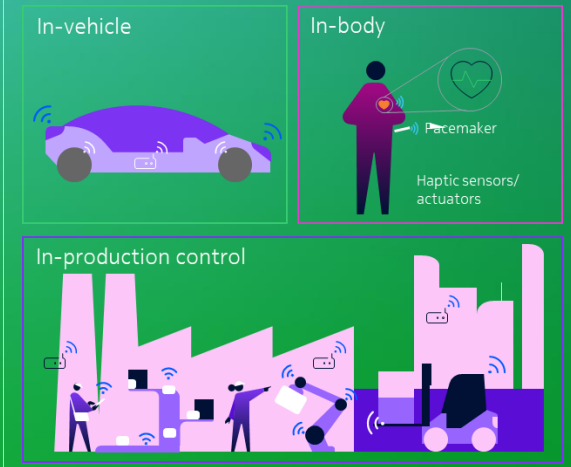
Six key technology areas and challenge for the 6G essential infrastructure



Network Building

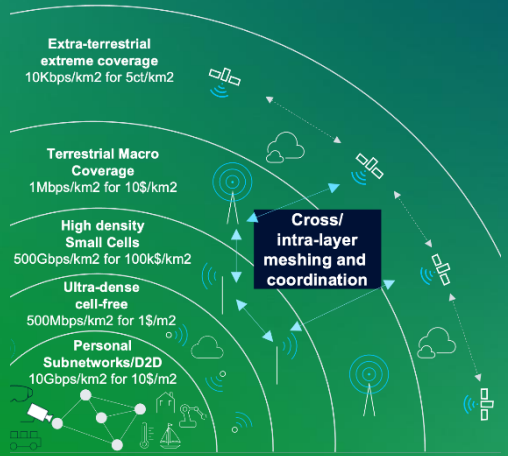
Network transformation requires new ways of building and integrating networks

Extreme specialized networks: each device matters!



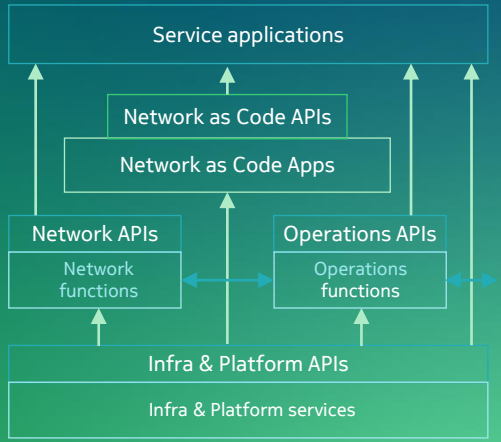
Highly engineered localized solutions for achieving mission-critical performance

Network of Networks



A hierarchy of collaborative network layers providing enhanced ubiquity and local capacity

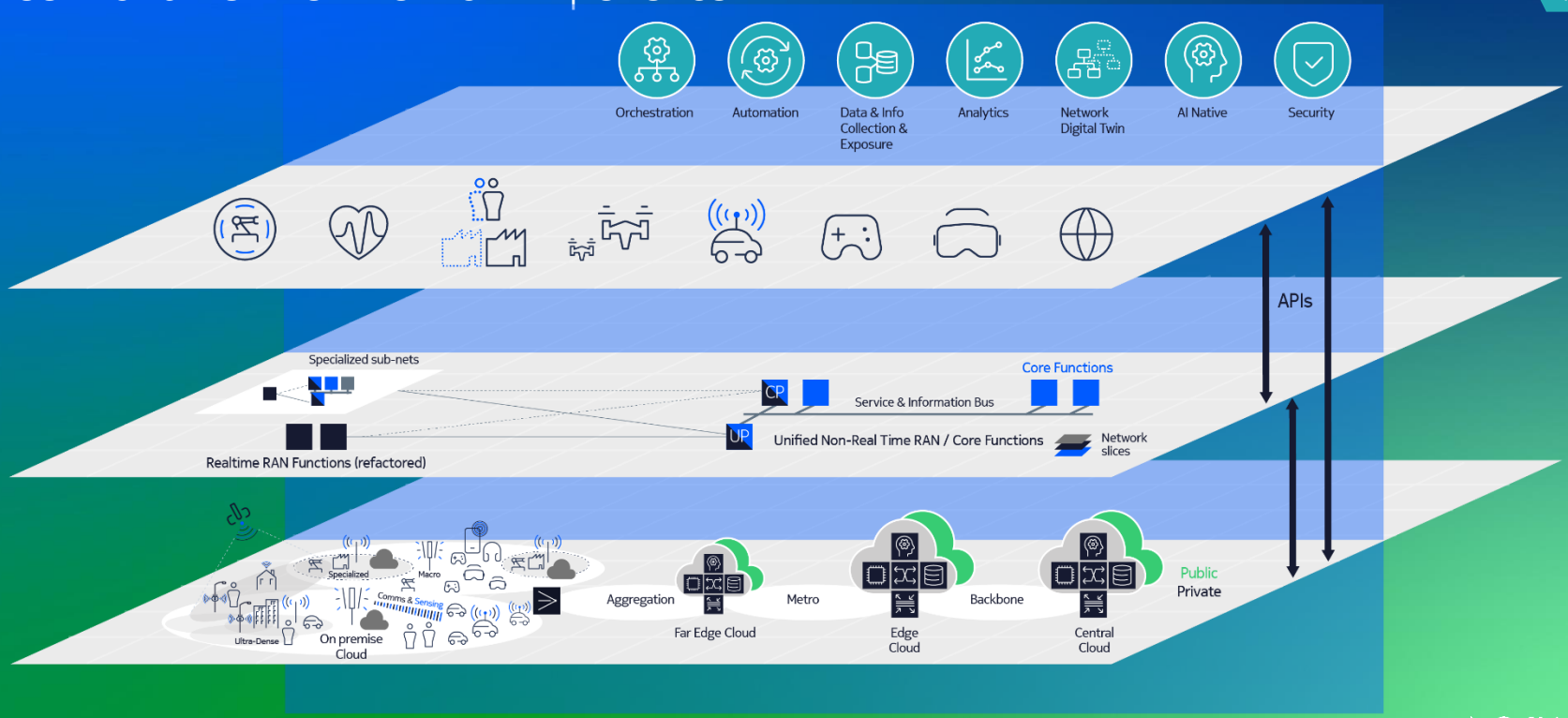
Network-as-a-Service enrichment



Enriching NaaS value via consumable, intent-based Network as Code APIs and AI/ML-based orchestration

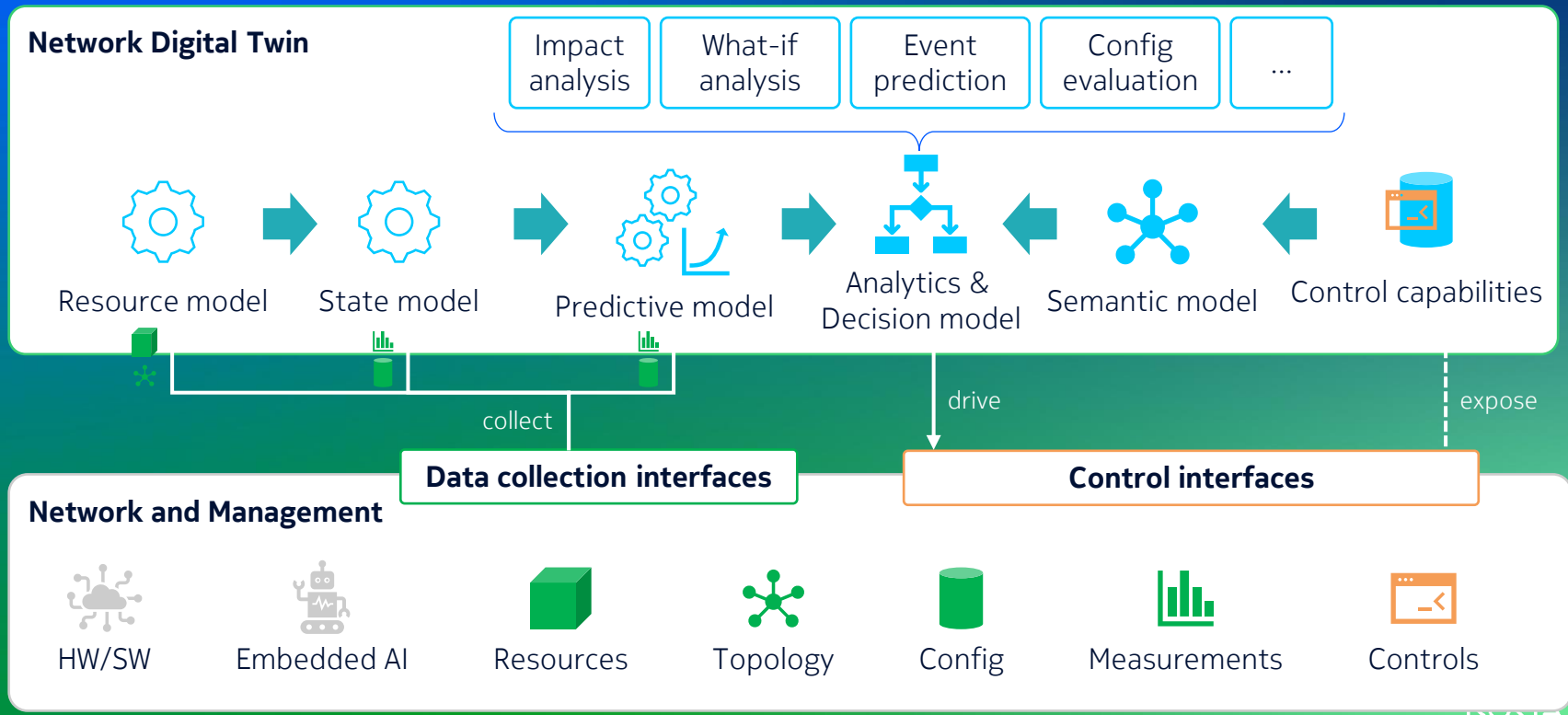
Cognitive, automated and specialized architectures

Need for an Unified Network Experience

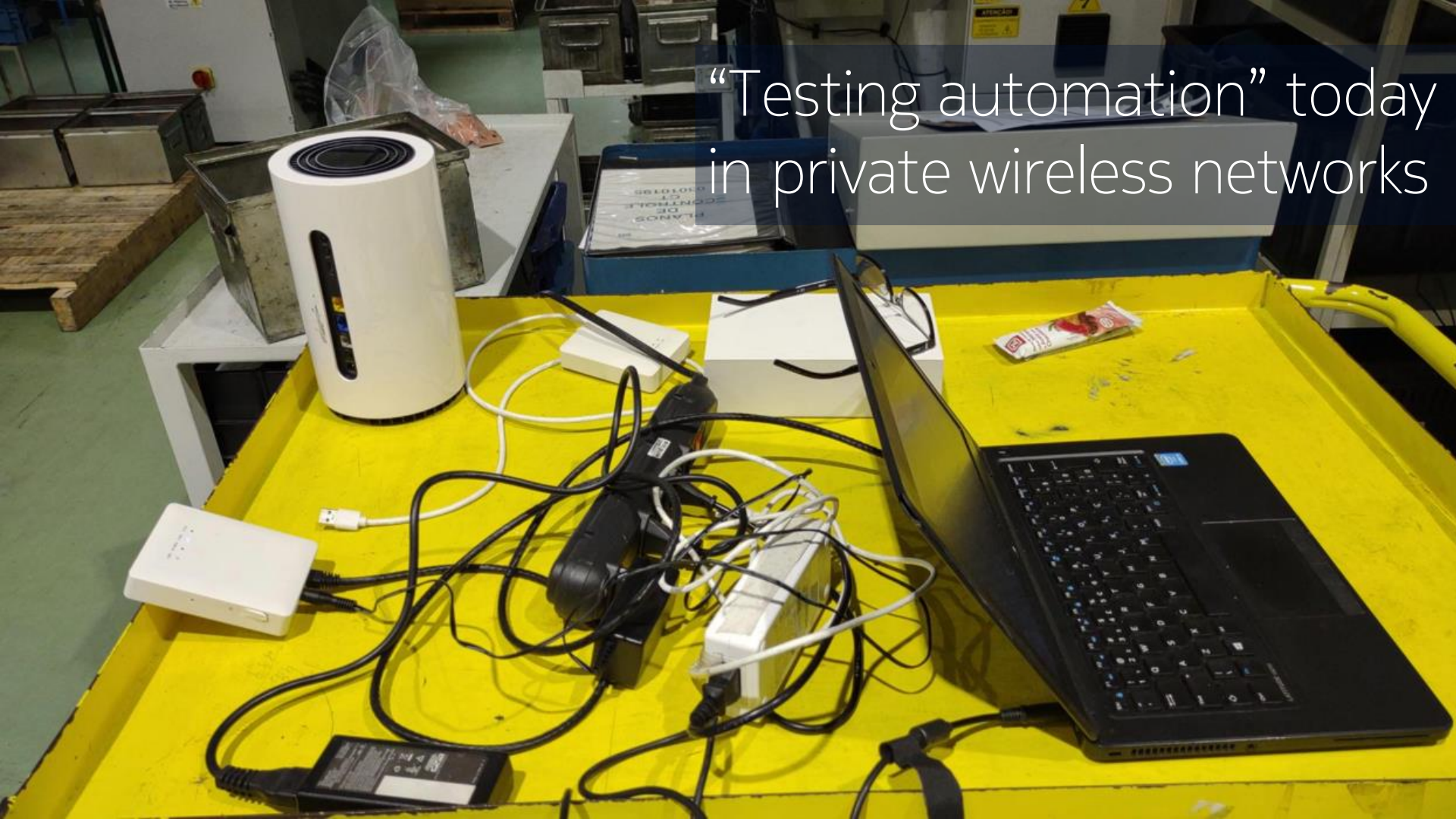


Network Digital Twin: brains for customized network capabilities

… learning, orchestrating and automating every action the network makes



Continuous network SLA validation via network digital twins



“Testing automation” today in private wireless networks

Cost of Testing and Troubleshooting new network features

40–70%

of the total delivery cost

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Sample of Today's network complexity

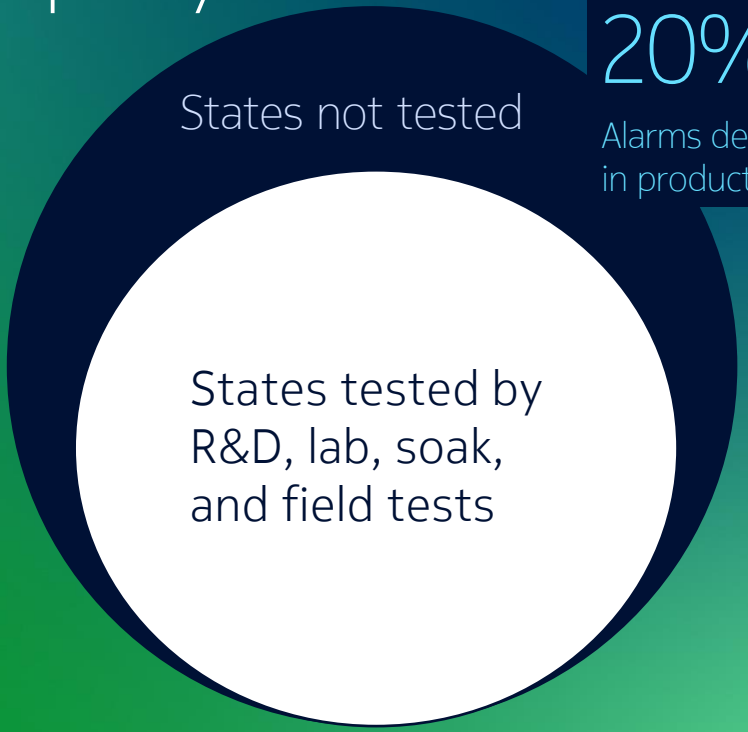
a typical node has:

70 000 different parameters

average number of Alarm types: **9 000**

5 000 different counters

with information residing on multiple and diverse platforms and databases,



20%

Alarms detected only in production time

Almost infinite combinations of vendors, configurations and customer requirements

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Building a digital twin of the network: continuous modeling

Network Digital Twin use case with high accuracy

Continuous modeling of the network performance in remote areas (difficult to access) to assess SLAs

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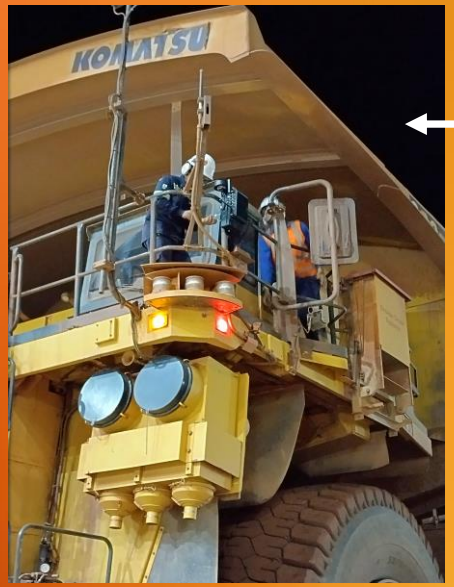
Network Digital Twin example application

Continuous testing application in open-pit autonomous mines

- Semi-Automated generation of a network digital twin
- Network demands/SLA capability Map for autonomous trucks and autonomous drillers

SLA capability heatmap



Digital Twin Black Box

- Network SLA capability Map
- Operations (Truck and Autonomous driller) KPIs and Network KPI real-time / predictive correlation
- Zero-time drive tests

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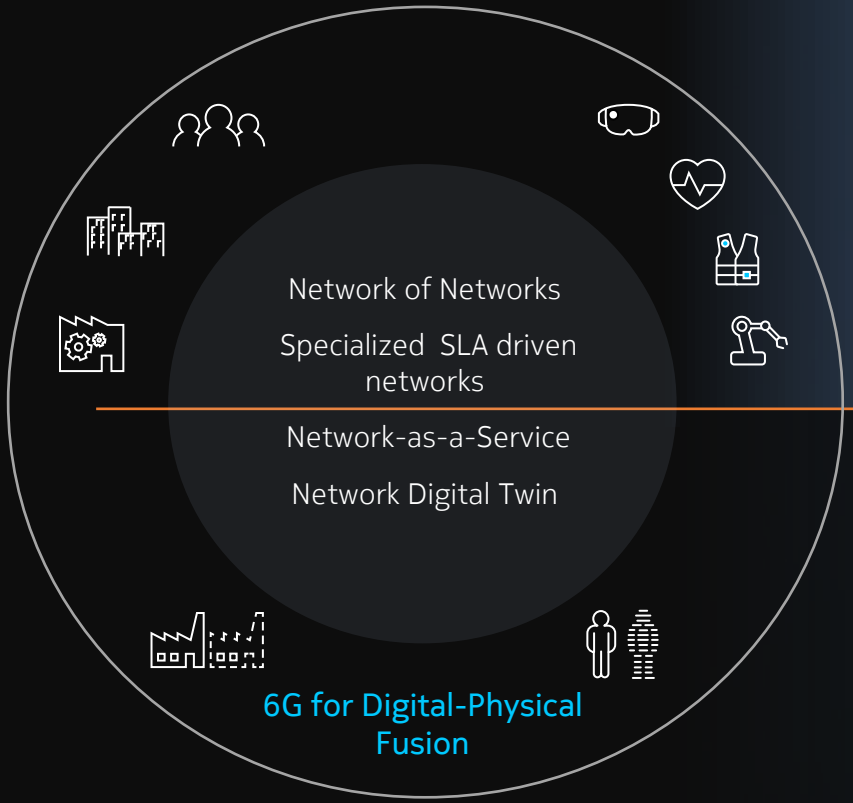
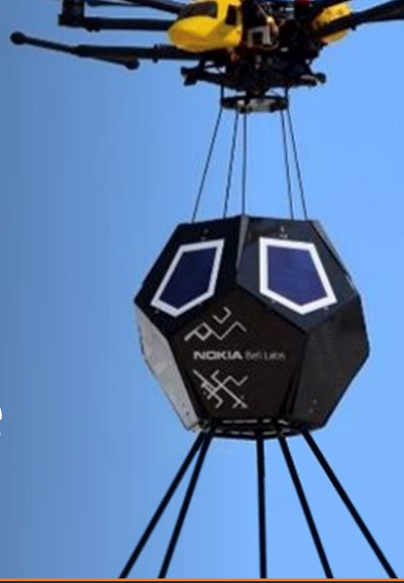
Conclusions



Network is changing perspective



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Thank you