Key drivers for rail operators

Maintain **safety** as the highest priority

- Monitor assets to provide proactive maintenance
- Better control of trains
- Leverage video to detect anomalies
- Protect passengers with CCTV

Active reduction of carbon emission

- Extend lines to reach new areas
- Automate trains to increase their frequency
- Optimize use of all assets from an energy perspective

Make rail travel easier with **new services**

- Better passenger information with more accuracy and multiple channels
- Better on-board internet connection
- More data associated with ticket purchase

Digitization and automation

RAIL**LIVE!**

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The impact of digitization for rail operators networks

Increase the number of end points sensors

- Increase T2G connectivity (FRMCS, CBTC)
- More network endpoints with mix of wired and wireless connectivity
- Seamless service definition from end point to application
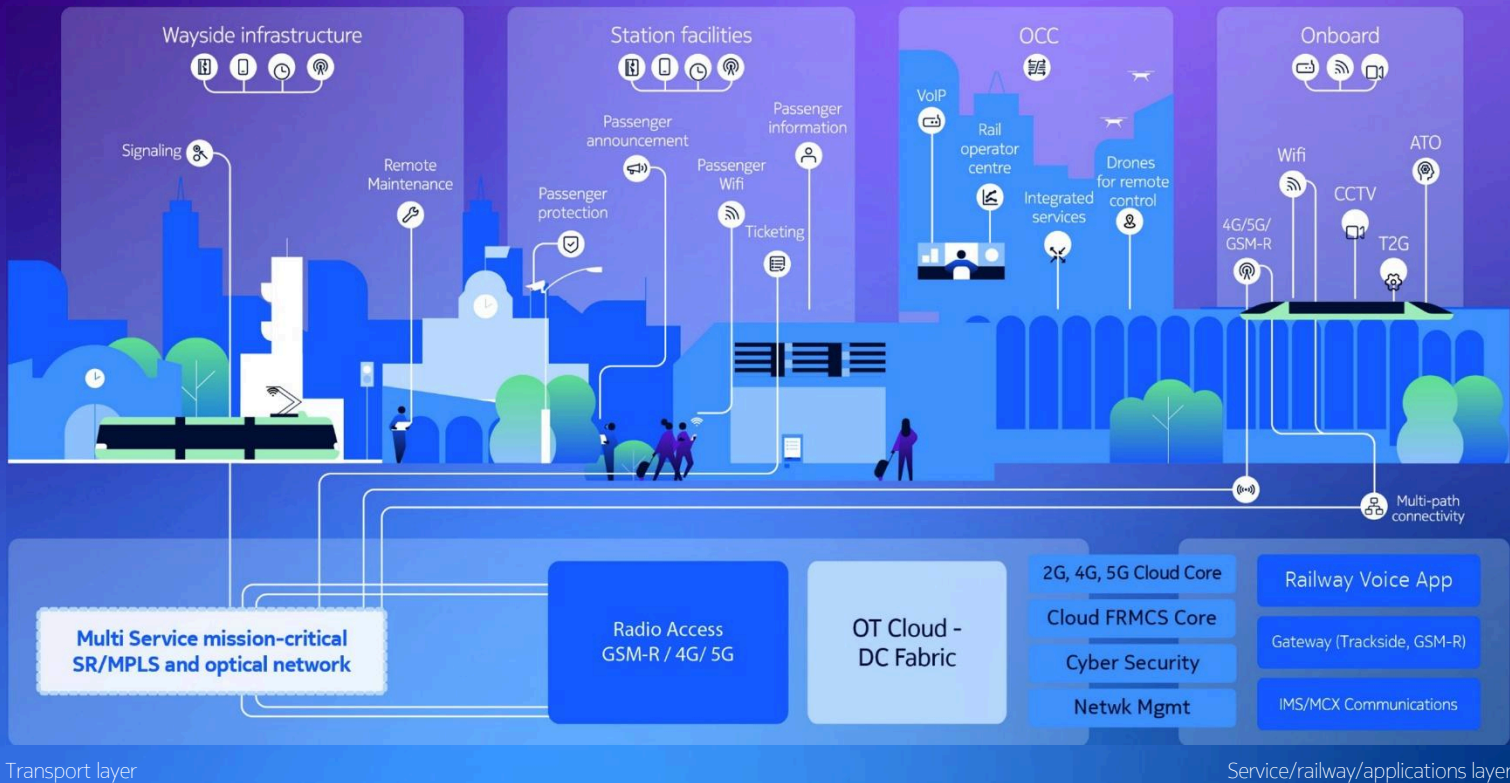
Facilitate data exchange

- Larger bandwidth everywhere for CCTV
- Larger DC for central data store (Data Lake)
- AI-capable data center infrastructure with scalable architecture

Secure data

- Ensure 99,999% availability
- Zero-trust in access
- Secure data everywhere
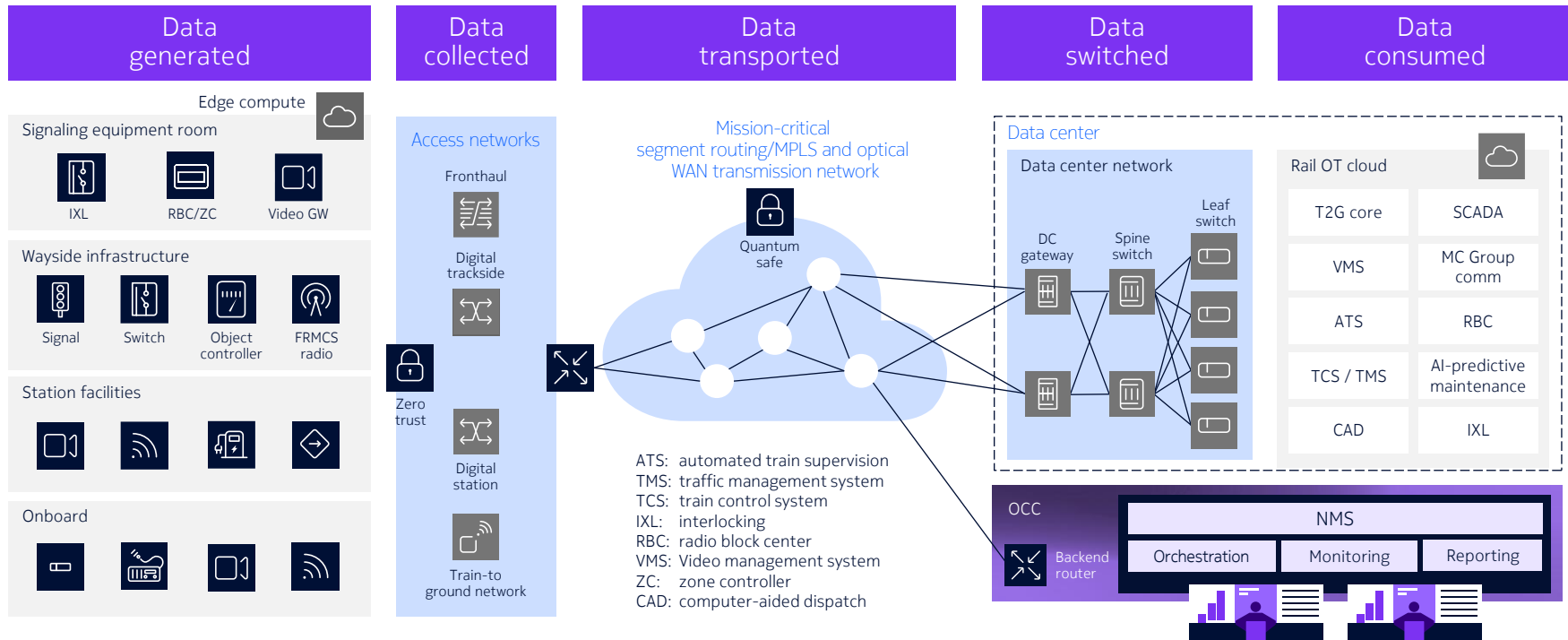- Opened but secured data-lake for ecosystem interaction

Large, reliable, flexible network and DC

RAIL LIVE!

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Nokia solutions for railway

Wayside infrastructure
- Signaling
- Remote Maintenance

Station facilities
- Passenger announcement
- Passenger protection
- Passenger Wifi
- Passenger information
- Ticketing

OCC
- VoIP
- Rail operator centre
- Integrated services
- Drones for remote control

Onboard
- Wifi
- CCTV
- ATO
- 4G/5G/ GSM-R
- T2G
- Multi-path connectivity

Multi Service mission-critical SR/MPLS and optical network

Radio Access GSM-R / 4G/ 5G

OT Cloud - DC Fabric

- 2G, 4G, 5G Cloud Core
- Cloud FRMCS Core
- Cyber Security
- Netwk Mgmt
- Railway Voice App
- Gateway (Trackside, GSM-R)
- IMS/MCX Communications

Transport layer

Service/railway/applications layer

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End-to-end, mission-critical transmission network for rail
Seamlessly connecting sensors, data, systems and software

Data generated

Edge compute

Signaling equipment room
- IXL
- RBC/ZC
- Video GW

Wayside infrastructure
- Signal
- Switch
- Object controller
- FRMCS radio

Station facilities

Onboard

Data collected

Access networks

Fronthaul

Digital trackside

Zero trust

Digital station

Train-to ground network

Data transported

Mission-critical segment routing/MPLS and optical WAN transmission network

Quantum safe

ATS: automated train supervision
TMS: traffic management system
TCS: train control system
IXL: interlocking
RBC: radio block center
VMS: Video management system
ZC: zone controller
CAD: computer-aided dispatch

Data switched

Data center

Data center network

Leaf switch

DC gateway

Spine switch

Rail OT cloud
- T2G core
- SCADA
- VMS
- MC Group comm
- ATS
- RBC
- TCS / TMS
- AI-predictive maintenance
- CAD
- IXL

OCC

Backend router

Data consumed

NMS

Orchestration | Monitoring | Reporting

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Minimizing network downtimes for improved train service

Physical design

- Ensure network path divergence
- Avoid common mode failures with fiber inventory
- Interaction WDM/MPLS

Logical design

- Ensure redundancy protocols from core to access
- Ensure Industrial Ethernet integration

Software quality

- Rely on trusted and measured software quality
- Compare software lifecycle to avoid frequent upgrades

Mission-critical products

- Fully redundant (data and control plane) hardware
- Hitless failover
- In-service software update

Easy HW operations

- Front access for all components on routers
- Fanless or Modular and accessible Fan and fan filters

Monitor - Automate

- Easy root cause detection and trouble shooting
- Failure anticipation via reports and thresholds
- Automation and Digital twin for human error reduction.

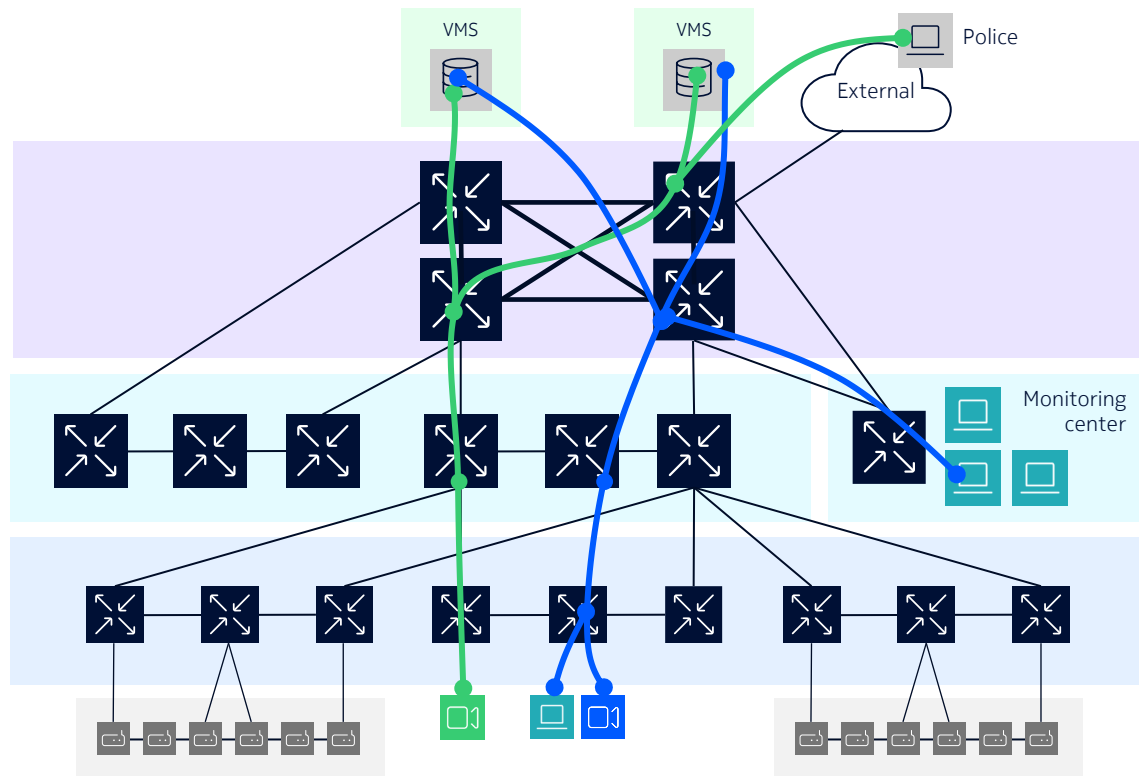NOKIA

Providing segmentation to applications
Adapt network to applications

Highlights

- Individually adapt network to each application need

- Converged network allows lowest possible TCO

- Accommodate all service types to ensure future proof solution

- Quick integration of any new applications
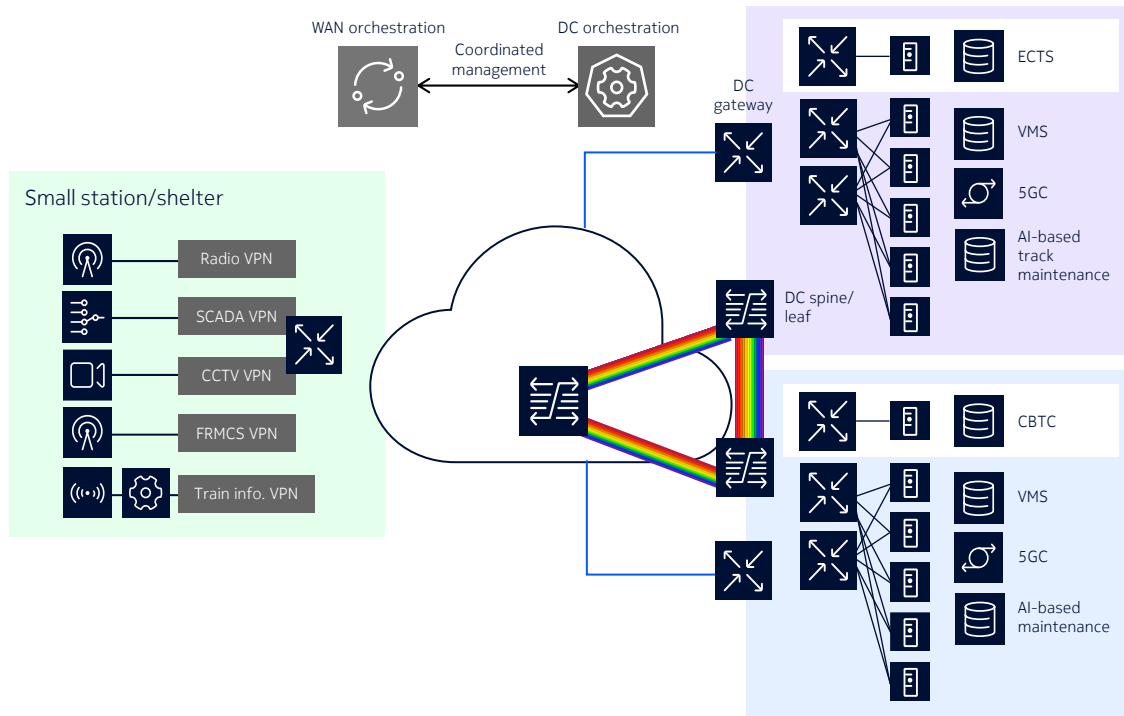
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Scaling networks for CCTV

Highlights

- CCTV growth is still ongoing to protect people and assets

- Video requires multiple storages and monitoring sites (internal and external)

- Network allows centralized storage

- Design knowhow and node capabilities are key to improve availability and reduce bandwidth
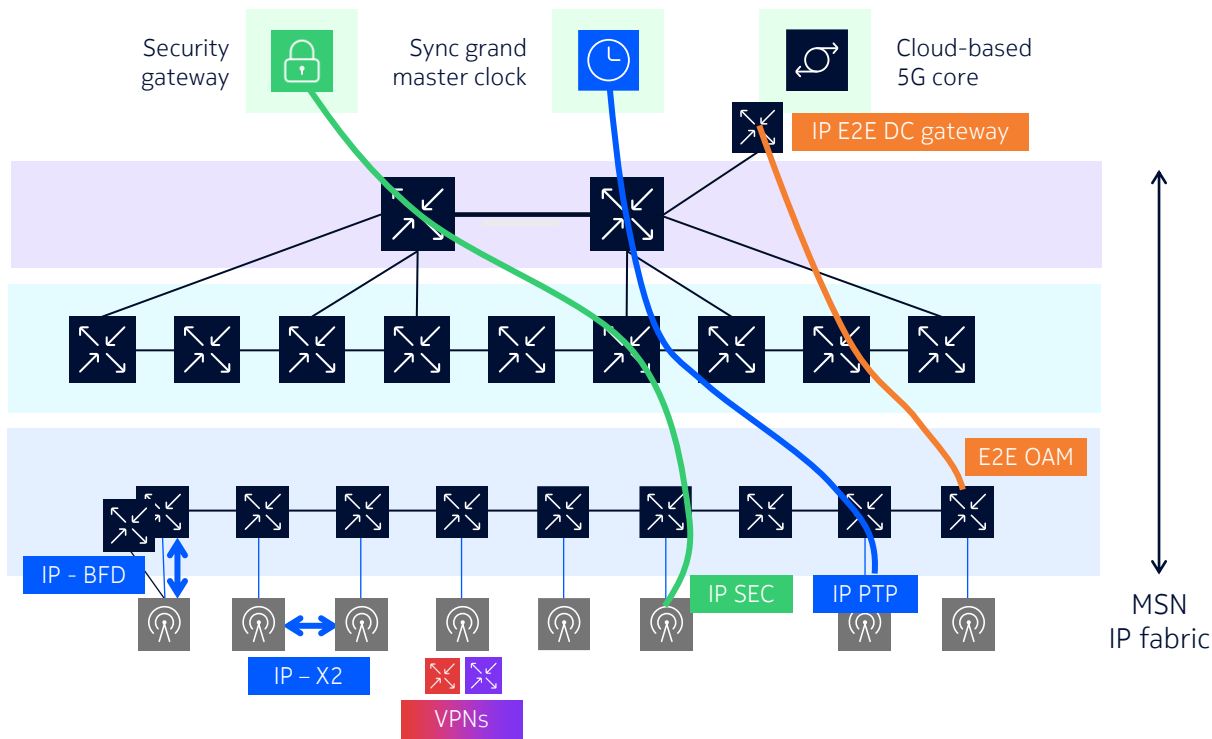
Building the OT cloud
Robust flexible and programable cloud infrastructure

Highlights

- Build a solid data center foundation to host cloud native applications

- Bring high level of redundancy with close MSN interaction

- Bring flexibility to the infrastructure in order to leverage virtualization environment

- Scalable flexible and reliable DC architecture to cope with critical application growth and cloudification

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Finally, why is IP/MPLS needed for FRMCS/5G?

Security gateway

Sync grand master clock

Cloud-based 5G core

IP E2E DC gateway

E2E OAM

IP - BFD

IP SEC

IP PTP

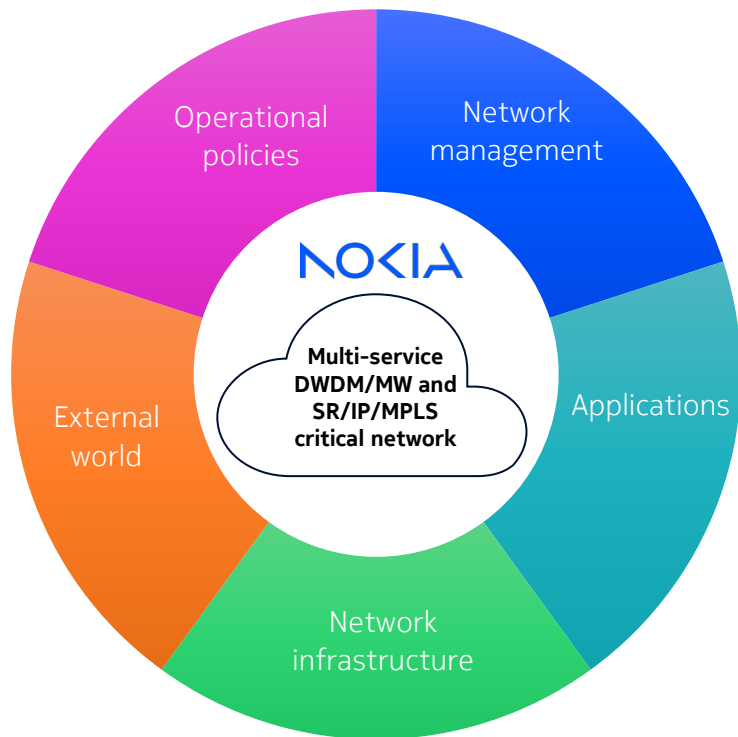IP – X2

VPNs

MSN IP fabric

Highlights

- 3GPP requires an IP fabric for 5G backhaul

- Availability, roaming, slicing, OAM for Service Level Agreements are all IP-based

- This is why all mobile network operators are using IP/MPLS for backhaul

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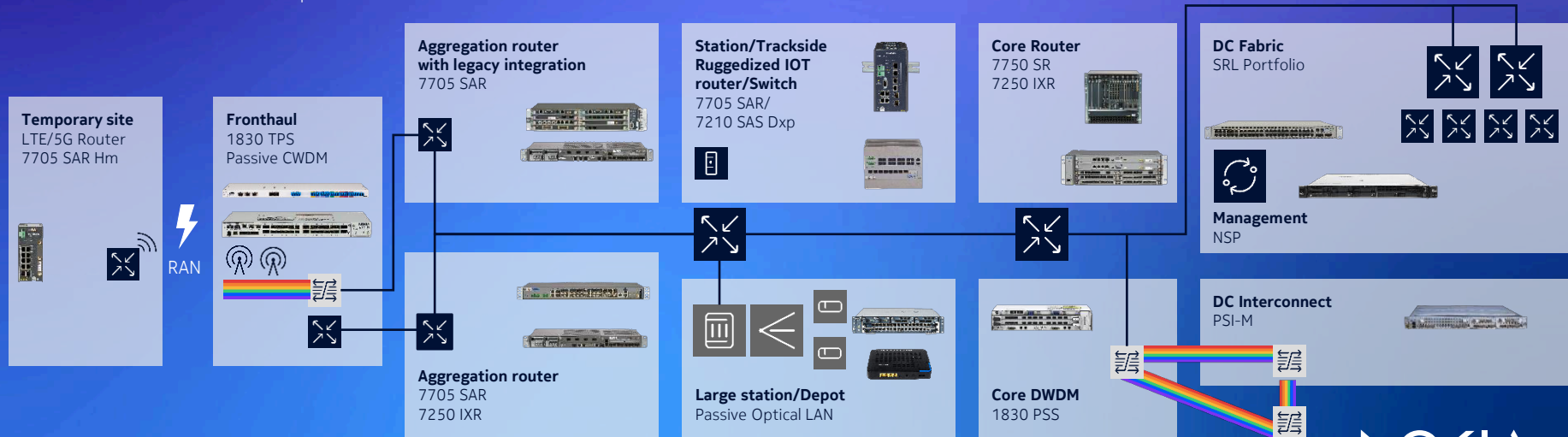# End-to-end cyber security toolkit in action
Increasing pressure of safety/security

Highlights

- Protecting critical networks is requiring multiple tasks and solutions

- Protecting is not delegating tasks to the products

- Protecting requires constant monitoring and adaptation

- The network is a first level of defense for applications

- The network contributes to safety standards and regulator cybersecurity directives (NIS-2 EU, IEC 62443, ER-ISAC, NERC CIP, IEC 63452 ...)

Network Infrastructure Portfolio for Railways

Zero trust

FRMCS ready

Quantum-safe

Automation

OT Cloud

Facilitated operations

Maximized availability

RAN

Temporary site
LTE/5G Router
7705 SAR Hm

Fronthaul
1830 TPS
Passive CWDM

**Aggregation router
with legacy integration**
7705 SAR

Aggregation router
7705 SAR
7250 IXR

**Station/Trackside
Ruggedized IOT
router/Switch**
7705 SAR/
7210 SAS Dxp

Large station/Depot
Passive Optical LAN

Core Router
7750 SR
7250 IXR

Core DWDM
1830 PSS

DC Fabric
SRL Portfolio

Management
NSP

DC Interconnect
PSI-M

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Proven experience of robust-cyber secured-large metro and mainline networks

Smooth integration of any fixed or mobile applications

A leader and trusted long-term partner of railways

Networks become one of the most critical assets for railway operations. Nokia demonstrates a focused approach to answer the associated challenges.

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