PRIMMA

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ECOSYSTEM SERVICES

Accelerating Innovation in Logistics Together

March 19, 2026
Koen Mioulet,
Mark Beermann
& Anke Kuipers

Private networks Initiative for Major Logistic Hubs Market Alignment

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SMART VESSEL OPTIMIZER

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flow center of Excellence

duurzaam heids fabriek

Digitalzh

KROHNE
measure the facts

measure the facts

technology driven by KROHNE

KROHNE Group

Introduction

KROHNE Group

A leading international supplier of process measuring technology

- Founded 1921 in Duisburg, Germany
- 100% family-owned
- 2025 turnover: ~800 Mio. EUR (incl. joint ventures)
- > 4.100 employees
- > 400 employees in R&D
- 17 production and engineering companies in 12 countries
- Local presence in over 100 countries

Industries and Industry Divisions

Overview

Products

Flow measurement

- Complete product portfolio spanning over various measurement principles and applications
- For liquids, gases, steam
- Process safety and process optimisation, e.g. through build-in diagnostic functions
- Industry-specific solutions and services for the entire product life cycle

Products

Level measurement

- Comprehensive portfolio for continuous level and interface measurement or point level detection
- Transmitters, switches, indicators and accessories
- Contact or non-contact measurement of liquids, pastes, granulates, powders, solids, bulk goods etc.
- For standard or demanding applications with advanced requirements, hazardous areas and Functional Safety (SIL)
- Optimised performance and safety even in the most challenging applications, e.g.
  - high and low process temperatures/pressures
  - agitated, corrosive liquids
  - liquid-liquid interface
  - low-reflective, abrasive solids in dusty environments

Products

Pressure measurement

- Complete portfolio of transmitters, primary elements and accessories for pressure measurement
- Process instruments for pressure and differential pressure in a broad spectrum of applications with liquids, gases and steam
- Ceramic and metallic measuring cells, modular converter
- Full coverage of all materials and process connections
- Reliable, safe and cost-effective measuring points

Products

Temperature measurement

- Wide range of assemblies, sensors, transmitters and accessories for temperature measurement
- Broad variety of devices, configurations, materials and connections
- Standard, industry-specific and tailor-made designs for solids, liquids and gases
- For applications with high or cryogenic temperatures, high pressures and flow rates, confined space and moving surfaces
- Diagnostic functions for high process safety:
  - monitoring of isolation resistance
  - sensor drift
  - sensor breakage and short circuit
- Thermowells for aggressive media, high pressures and high flow rates

Products

Process analytics

- Extensive portfolio of analytic sensors for measuring pH, ORP, conductivity, TSS, turbidity, etc.
- Analytical sensors with integrated transmitter technology
- Measuring systems for single and multiple parameters
- Complete portfolio of assemblies and accessories
- From hygienic to Ex applications

Solutions

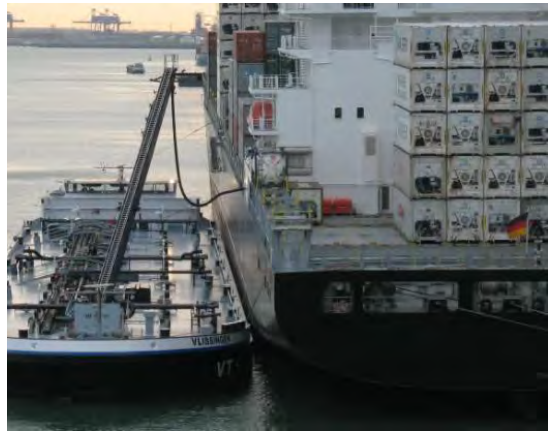
Flow metering Solutions

- Metering skids, control systems, analyser solutions
- Engineered flow solutions for process and custody transfer applications
- From metering systems to redundant sampling and prover solutions
- Dedicated solutions for wet gas and multiphase measurement

Solutions

Monitoring Solutions

- Process monitoring, analysis, validation and supervisory
- From stand-alone software installations to turn-key solutions including instrumentation
- Monitoring of critical processes on plants, pipelines and ships
- Visualisation, supervisory and reporting



Solutions

Wireless & remote metering Solutions

- Remote data transmission for special applications
- Direct access to remote measuring points
- Wireless communication of measuring signals and data
- For all distances and network sizes

Services
Overview

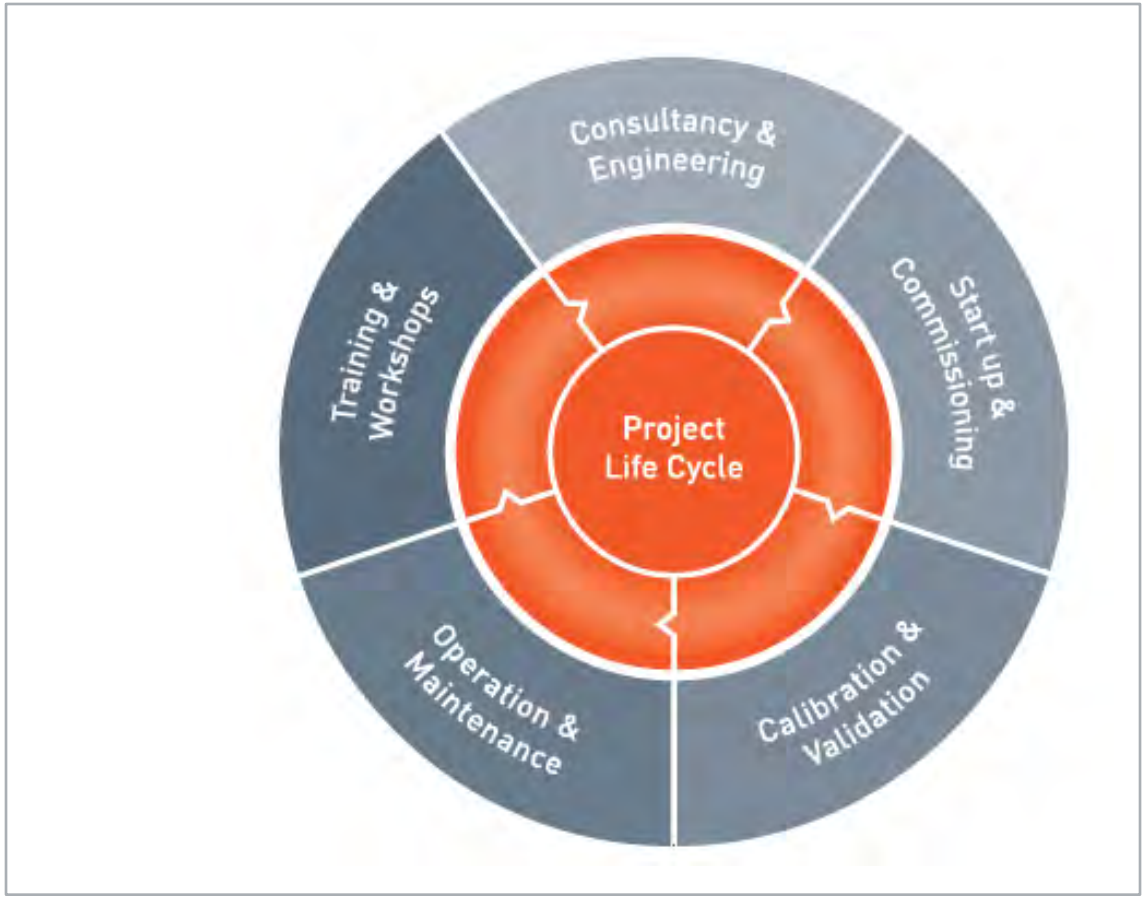
Consultancy and engineering: Pre-sales support starting at the planning phase through to final quotations and technical details

Start up and commissioning: Commissioning services including 24h telephone hotline as part of a Service Level Agreement

Calibration and validation: Periodic inspection, validation, recalibration and revamp service, including environmental and metrological certification

Operation and maintenance: Scheduled maintenance, emergency response, remote support and spare parts management

Training and workshops: Starting from online training courses through to tailormade in-house trainings

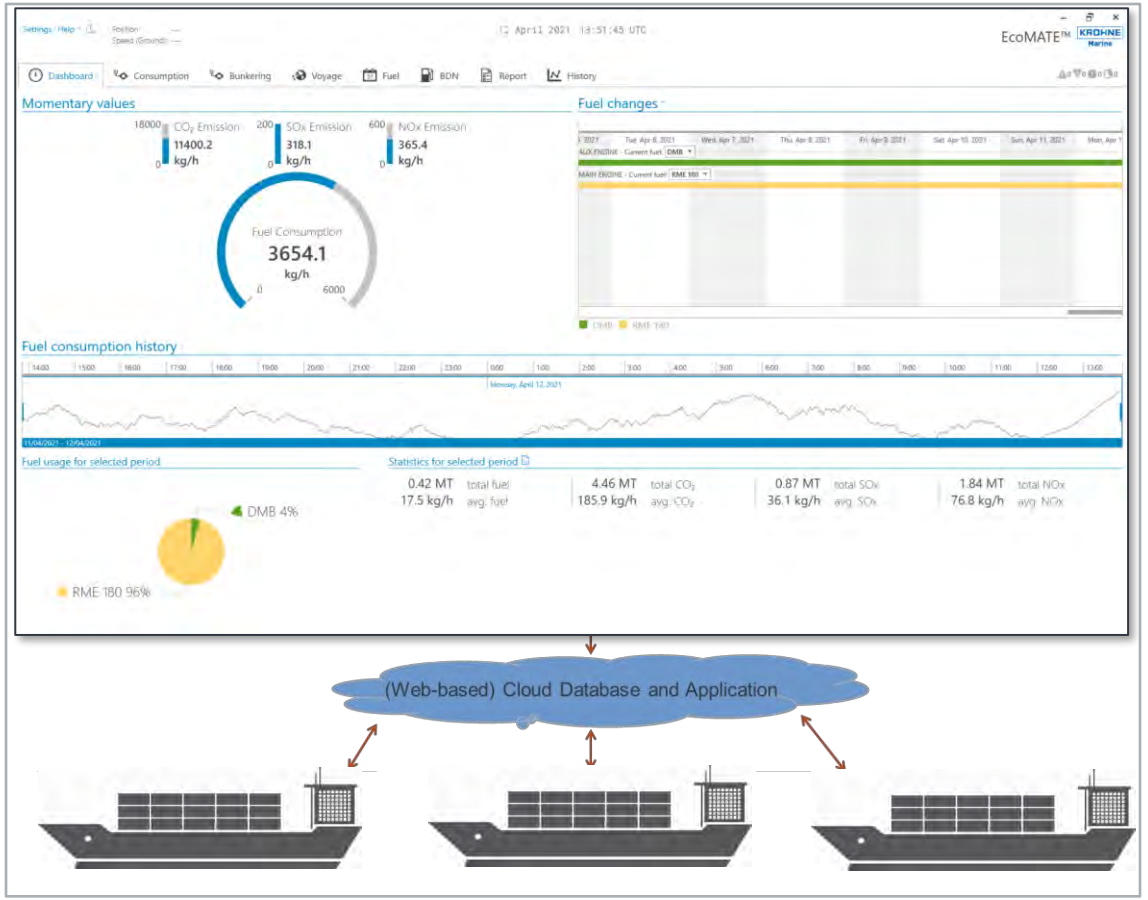


KROHNE Group

Pioneering Digitalisation: Cloud-based remote monitoring and reporting

EcoMATE

- Fuel consumption and emission monitoring system for ships
- Carbon emission monitoring, calculation and reporting: vessel-based annual reports with automated emission calculation (e.g. CO2)
- Cloud-based visualization of data from different vessels in a web interface for the operator
- Basic measurement: Coriolis flowmeters for measuring the fuel quantities in engine supply and return lines



KROHNE Group

Technology pioneer

New paths are created by walking them. KROHNE has always been a pioneer.

- **Technology:** many times, we have pioneered the industrial implementation of technologies that became standards in the process industries, for example electromagnetic flow measurement or FMCW radar level measurement
- **Internationalisation:** pioneering also means courage and foresight when entering new markets: in 1987, we were the second German company to found a joint venture company in Shanghai, China

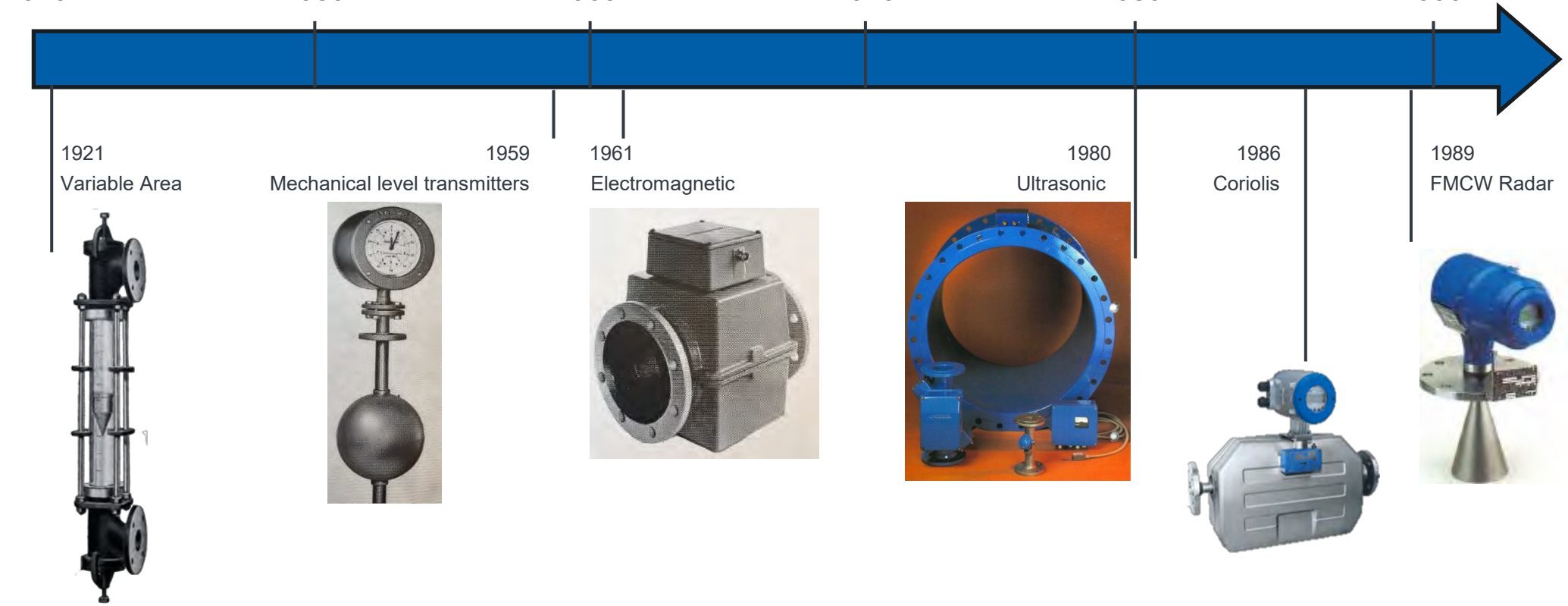
Many pioneering steps followed, and today we are a leading supplier of state-of-the-art technologies for process instrumentation, with local contacts in over 100 countries worldwide.

ACHEMA 1964: KROHNE presents the worlds largest EMF

2019: SAMSON and KROHNE introduce FOCUS-1, the first smart meter valve for flow, pressure and process control

KROHNE Group

Pioneering Technology: early industrialisation of technologies



KROHNE Group

Pioneering Internationalisation: Contacts Europe

KROHNE Group

Pioneering Internationalisation: Contacts worldwide

KROHNE Group

Pioneering Internationalisation: Production and engineering sites (1)

KROHNE Messtechnik GmbH
Duisburg, Germany

KROHNE Pressure Solutions GmbH
Minden, Germany

KROHNE Altometer
Dordrecht, The Netherlands

KROHNE Solutions
Breda, The Netherlands

KROHNE Ltd.
Wellingborough, UK

KROHNE S.A.S.
Romans-sur-Isère, France

KROHNE INOR Process AB
Malmö, Sweden

KROHNE Marine
Brevik, Norway

FOCUS ON
Dordrecht, The Netherlands

KROHNE Group

Pioneering Internationalisation: Production and engineering sites (2)

KROHNE Italy
Milan, Italy

KROHNE Inc.
Beverly, MA, USA

KROHNE Conaut
Embu, Brazil

CRK
Chengde, China

KMTS
Shanghai, China

SGAIC
Shanghai, China

KROHNE Marshall Ltd.
Pune, India

KROHNE Oil & Gas Malaysia
Selangor, Malaysia

KROHNE

measure the facts

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technology driven by KROHNE

Thank you for your attention!

KROHNE
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Flow Metering in the Age of IIoT and Intelligent Systems

Everything Digital, Everything Connected, Everything Out of Control?

Rutger Tromp
Jankees Hogendoorn

2016-03-19

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Why to go Digital?

1. **Understanding the Digital Revolution**

What technology is needed?

2. Understanding Digital Twins
3. Digital Products and Services

How to apply this technology?

4. Digital Infrastructure
5. Digital Threads

How to roll out this technology?

6. Closing discussion

Agenda

Understanding the Digital Revolution

Techno-social change in the 21st century

Social Change

Continuously growing world population.
Aging demographic structure in many regions.

Increased demand for **raw materials** (ores, chemicals), **water, F&B**.
Dwindling expert knowledge is compensated by **intelligent measurement** technology

Climate Change & Resource Scarcity

Change from oil to clean energy-
More efficient use of resources, including water

More accurate measurement technology enables **greater automation** and energy efficiency in production. **Energy transition** with gas, nuclear, solar, H2, carbon capturing & storage (CCS)

Rise in Technology and Digitalization

Autonomous, self-regulating and intelligent systems in all areas of life.

Increasing demand for **intelligent sensor technology** as a source of (measurement) data
Networking of systems and data via IoT

Rapid Urbanization

Worldwide migration to cities.
Growth of Megacities, especially in Africa and Asia.

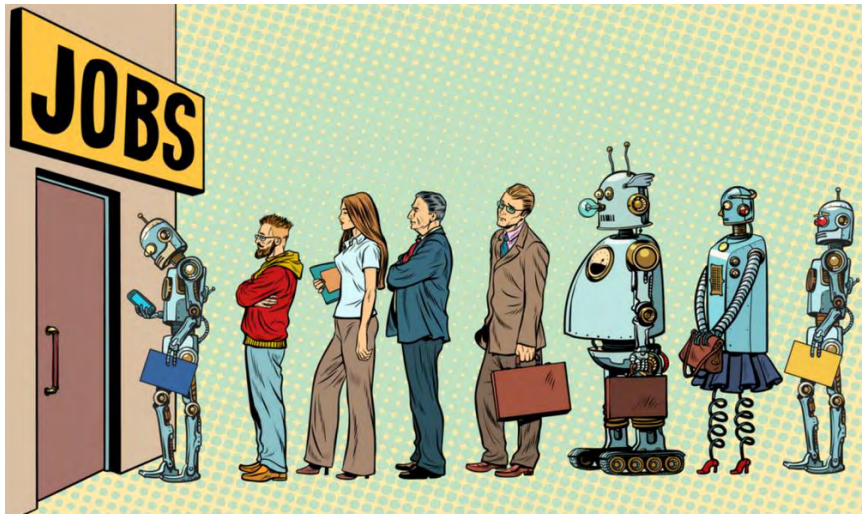
Smart cities with investments in **modern infrastructure**
Healthcare, transportation, **building automation, water & wastewater, F&B** offer best opportunities

Understanding the Digital Revolution

Techno-social change in the 21st century

Digital native

Digital first



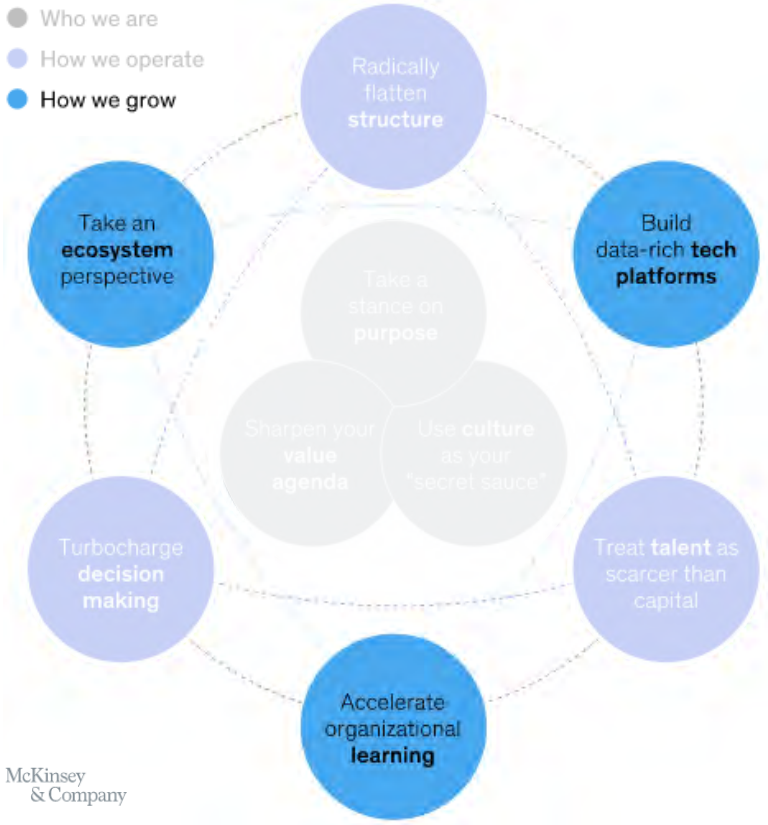
Human vs Machine

Understanding the Digital Revolution

A story with three sides: business, organizational, and technological contexts

Digital-powered business cases

Digital-powered organizations

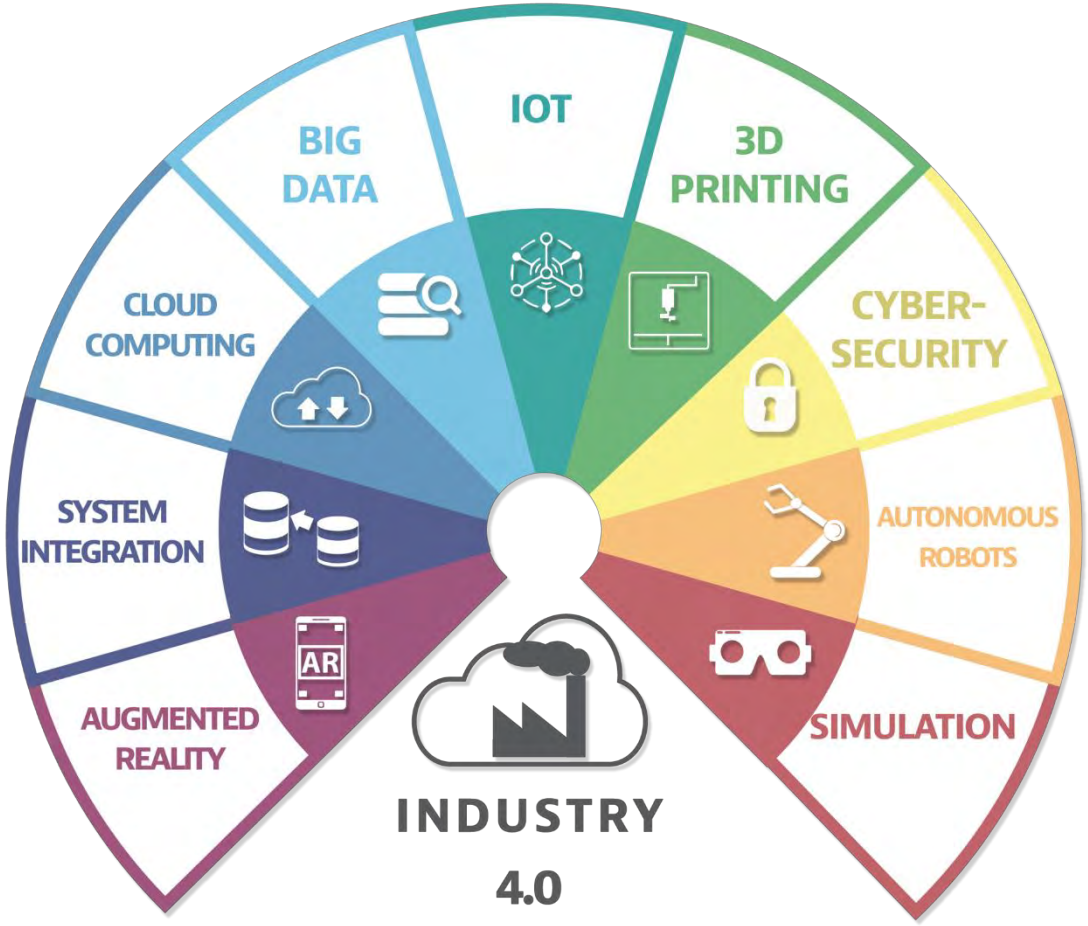


Digital-powered modeling tools

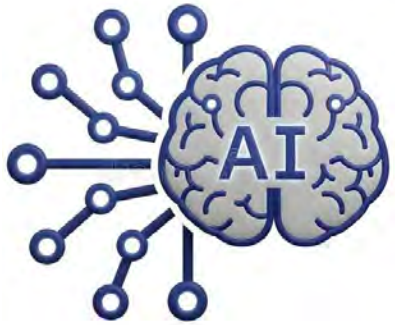
Digital Twin Modeling (2000s)

Understanding the Digital Revolution

Enter Industry 4.0 and beyond



+ Cognitive systems



+ Digital Twins

Why to go Digital?

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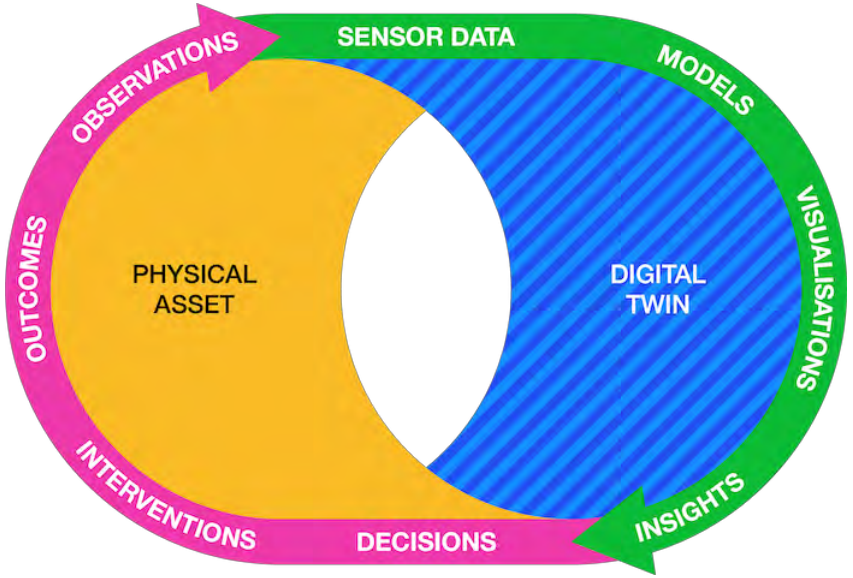
Understanding Digital Twins

A ‘nuts and bolts’ introduction

Philosophy: Integrate the physical and the digital into a cyber-physical world with unique new possibilities.

Method: Integrate data with modelling and simulation.

OF4400

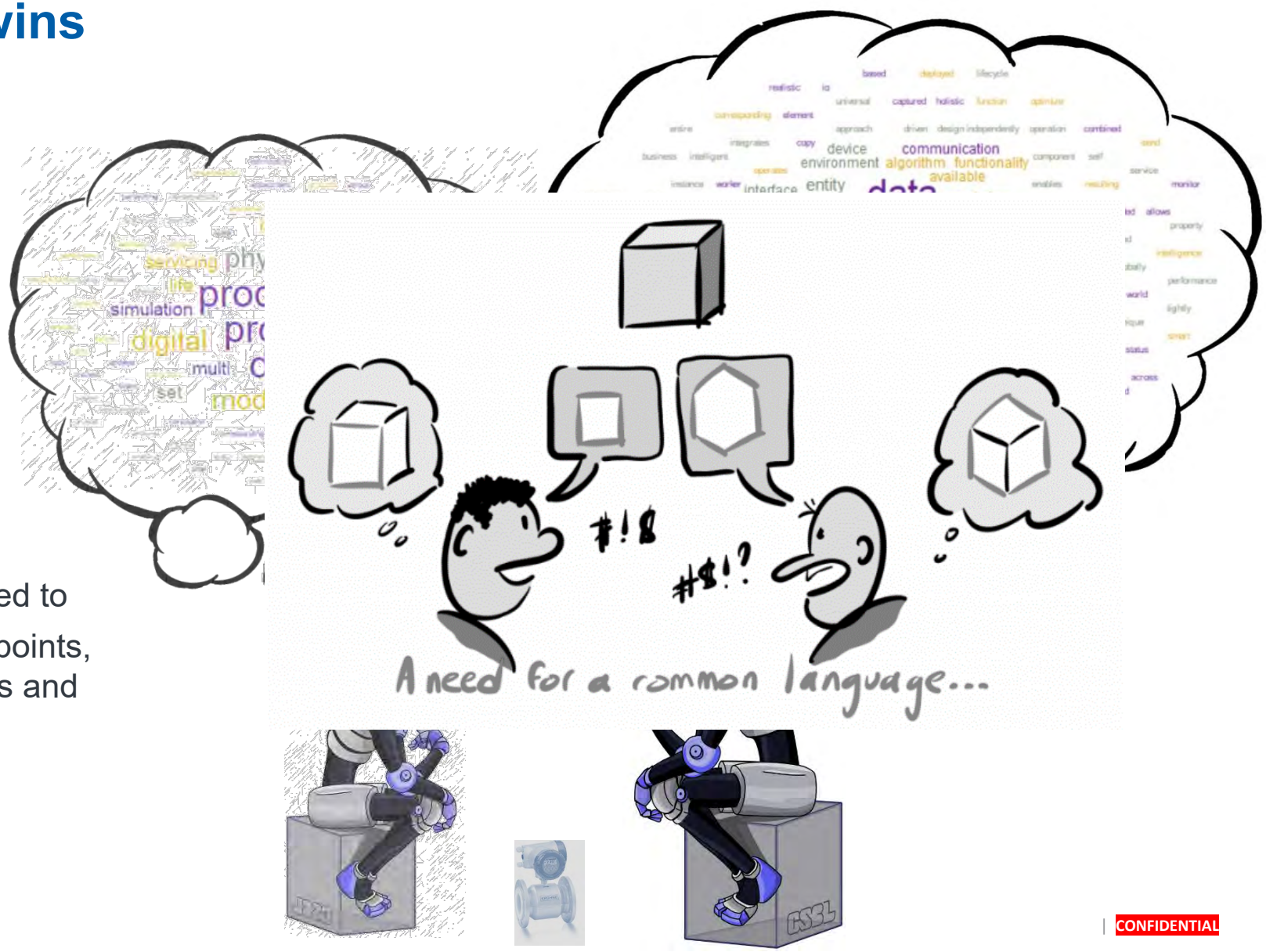


Digital Twin

Understanding Digital Twins

The viewpoint problem

- Immanuel Kant: “We see things not as they are but as we are.”
- We see digital twins not as what they are, but as what they can do for us, from our unique viewpoint.
- To get anywhere collaborating, we need to
  - be aware of these (conflicting) viewpoints,
  - communicate using shared concepts and terminology.



Understanding Digital Twins

The viewpoint problem

- Unfortunately, having shared terminology isn't that simple…
- Even something as fundamental as the definition of a 'digital twin' is plagued by the viewpoint problem.

HELLO GOOGLE, WHAT IS THE DEFINITION OF A DIGITAL TWIN?

KROHNE

Interesting question, here's what I could find:

- Wikipedia says …,
- IBM says …,
- McKinsey & Company says …,
- Amazon Web Services says …,
- Mathworks says …,
- Siemens says …,
- TNO says …,
- Fraunhofer-Gesellschaft says …,

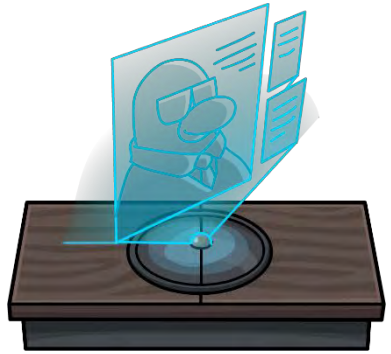
and hundreds more options.

Google

Understanding Digital Twins

The definition problem

- **Workaround:** a ‘soft’ definition for digital twins based on what, why and how…



What
A virtual representation of real-world entities and processes, synchronized at a specified frequency and fidelity.

Why
Use real-time and historical data to represent the past and present, and to simulate predicted futures.

Application dependent

How
Motivated by outcomes, tailored to use cases, guided by domain knowledge, and implemented in IT/OT systems.

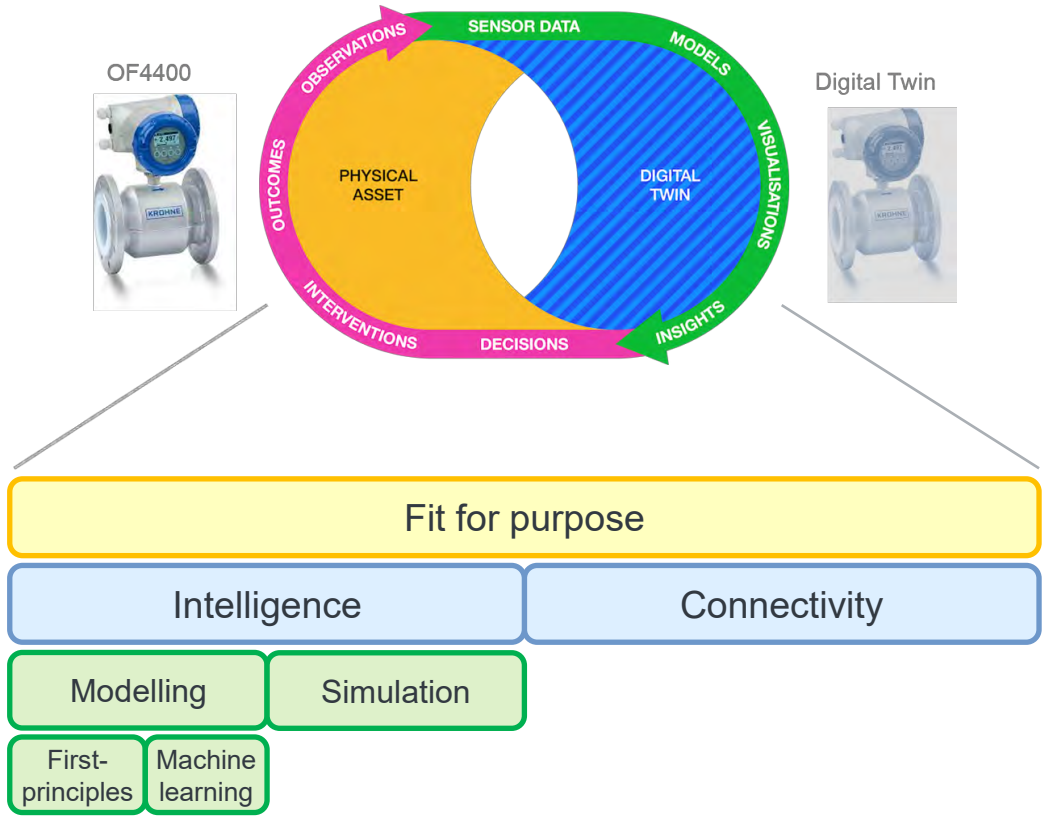
Universal

Reference: https://www.digitaltwinconsortium.org/

Understanding Digital Twins

The definition problem

- **Consequence:** Digital twin models always…
  - are fit for purpose, as the use case defines the form and the capabilities of the model.
  - involve synchronization with the entities and processes it mirrors (via IT/OT systems).
  - combine data, modelling and simulation.



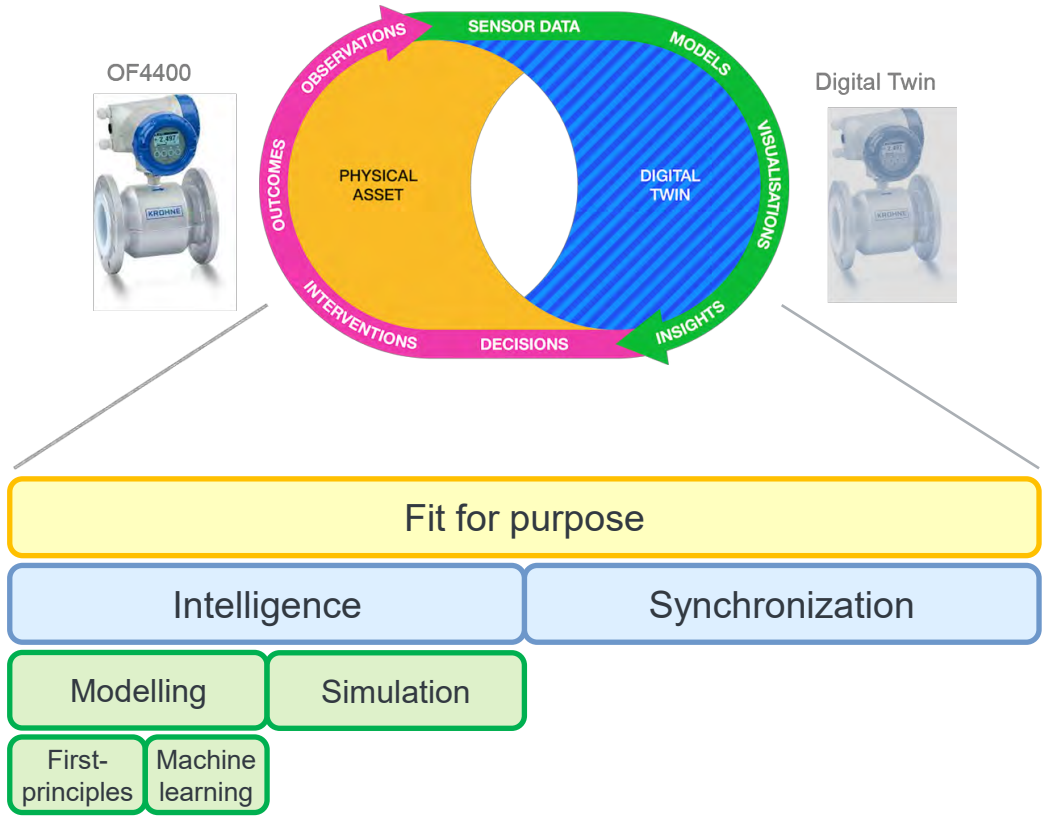
Understanding Digital Twins

The definition problem

- **Consequence:** Digital twin models always…
  - are fit for purpose, as the use case defines the form and the capabilities of the model.
  - involve synchronization with the entities and processes it mirrors (via IT/OT systems).
  - combine data, modelling and simulation.

- How to classify a model that is missing one of these components?

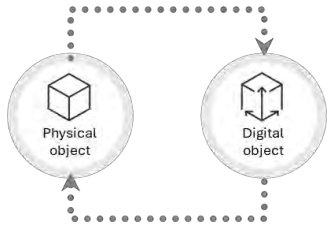
- Kritzinger (2018) says:
  - *"We can classify models on the degree at which automated synchronization exists between the model and the physical object."*



Understanding Digital Twins

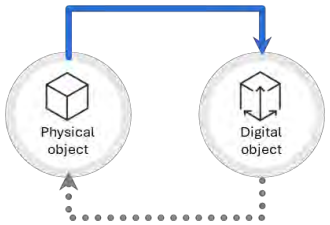
The classification problem

No automated synchronization



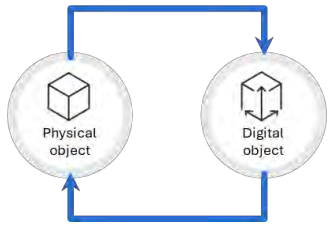
Digital Model
(i.e., static digital copy)

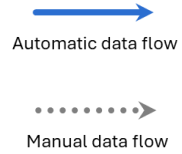
One-way automated synchronization from physical object to model



Digital Shadow
(i.e., real-time digital copy)

Two-way automated synchronization



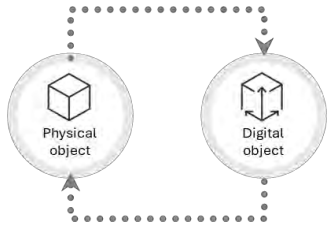


Digital Twin
(i.e., cyber-physical system)

Understanding Digital Twins

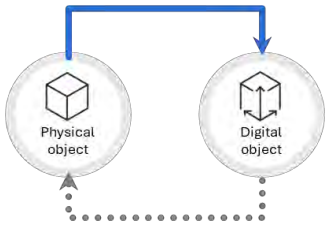
The classification problem

No automated synchronization



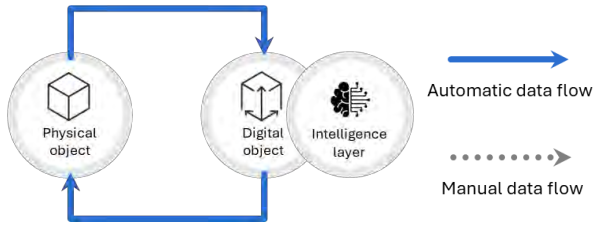
Digital Model
(i.e., static digital copy)

One-way automated synchronization from physical object to model



Digital Shadow
(i.e., real-time digital copy)

Two-way automated synchronization



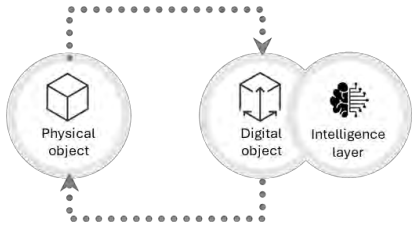
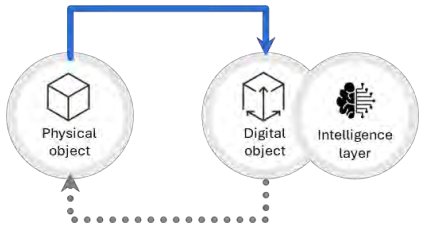
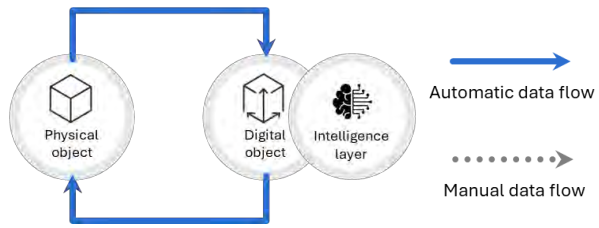
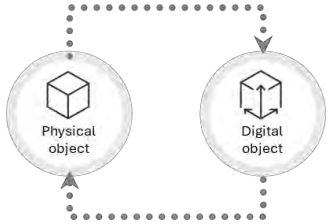
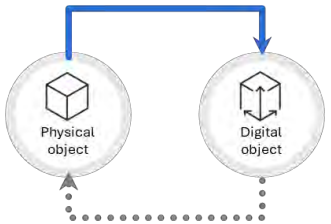
Digital Twin
(i.e., cyber-physical system)

Barbieri (2021) says:

- *"We should additionally classify models on the level of intelligence present in the model."*

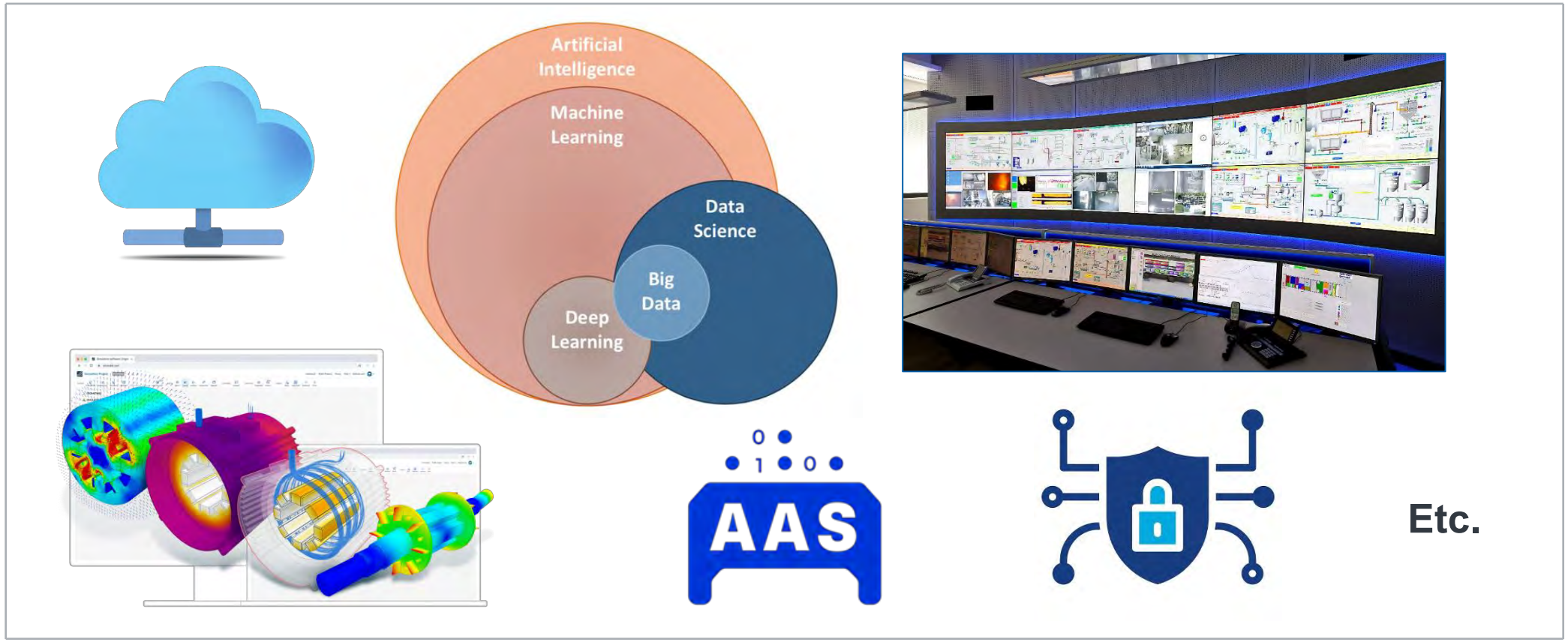
Understanding Digital Twins

The classification problem

	No automated synchronization	*One-way automated synchronization from physical object to model*	*Two-way automated synchronization*
Intelligence in model	 Virtual prototype (i.e., intelligent static digital copy)	 Pre-Digital Twin (i.e., intelligent real-time digital copy)	 Digital Twin (i.e., cyber-physical system)
No model intelligence	 Digital Model (i.e., static digital copy)	 Digital Shadow (i.e., real-time digital copy)	**Thank you, science!** **This helps. Kind of. Maybe. I guess…**

Understanding Digital Twins

The technology landscape complexity problem



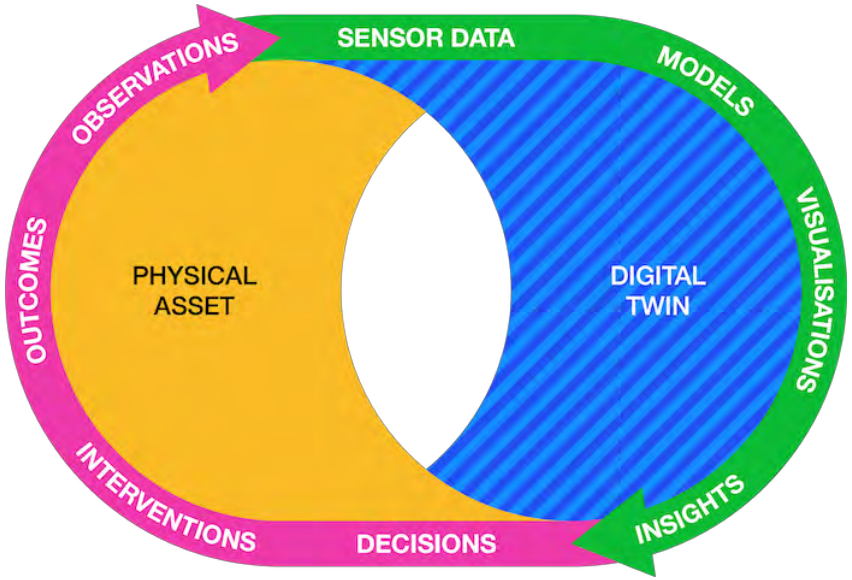
Understanding Digital Twins

The residency problem

Physical asset

We exactly know where this lives!

Flowmeter



Digital Twin

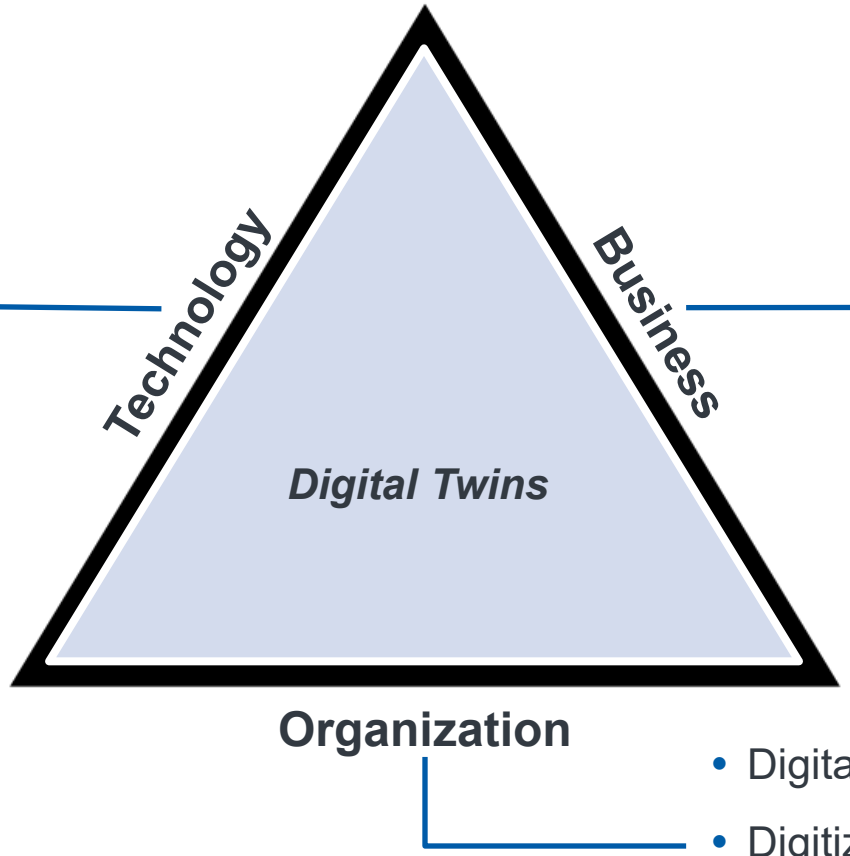
Digital asset

Can we know exactly where this lives?

Understanding Digital Twins

A story with three sides: business, organizational, and technological contexts

- Real-world entity or process
- Virtual representation
- Data that connects the two



- Data-enriched products and services
- Digital products and services

- Digitalization – Everything Digital
- Digitization – Everything Optimized
- Digital transformation – Everything Connected

Why to go Digital?

1. Understanding the Digital Revolution

What technology is needed?

2. Understanding Digital Twins
3. **Digital Products and Services**

How to apply this technology?

4. Digital Infrastructure
5. Digital Threads

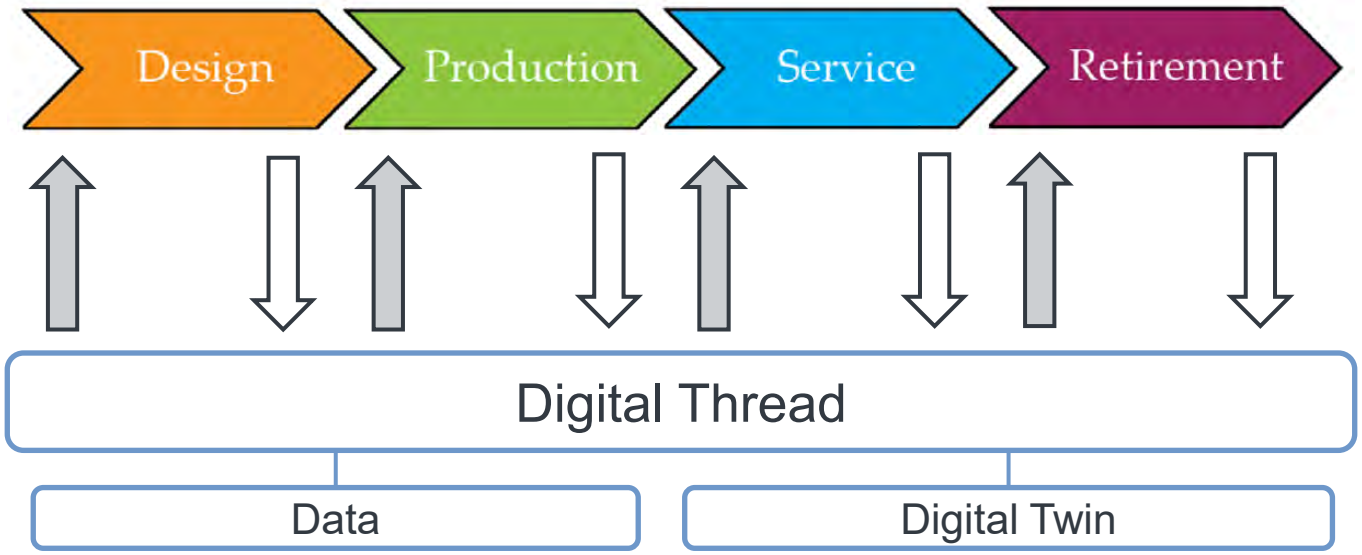
How to roll out this technology?

6. Closing discussion

Agenda

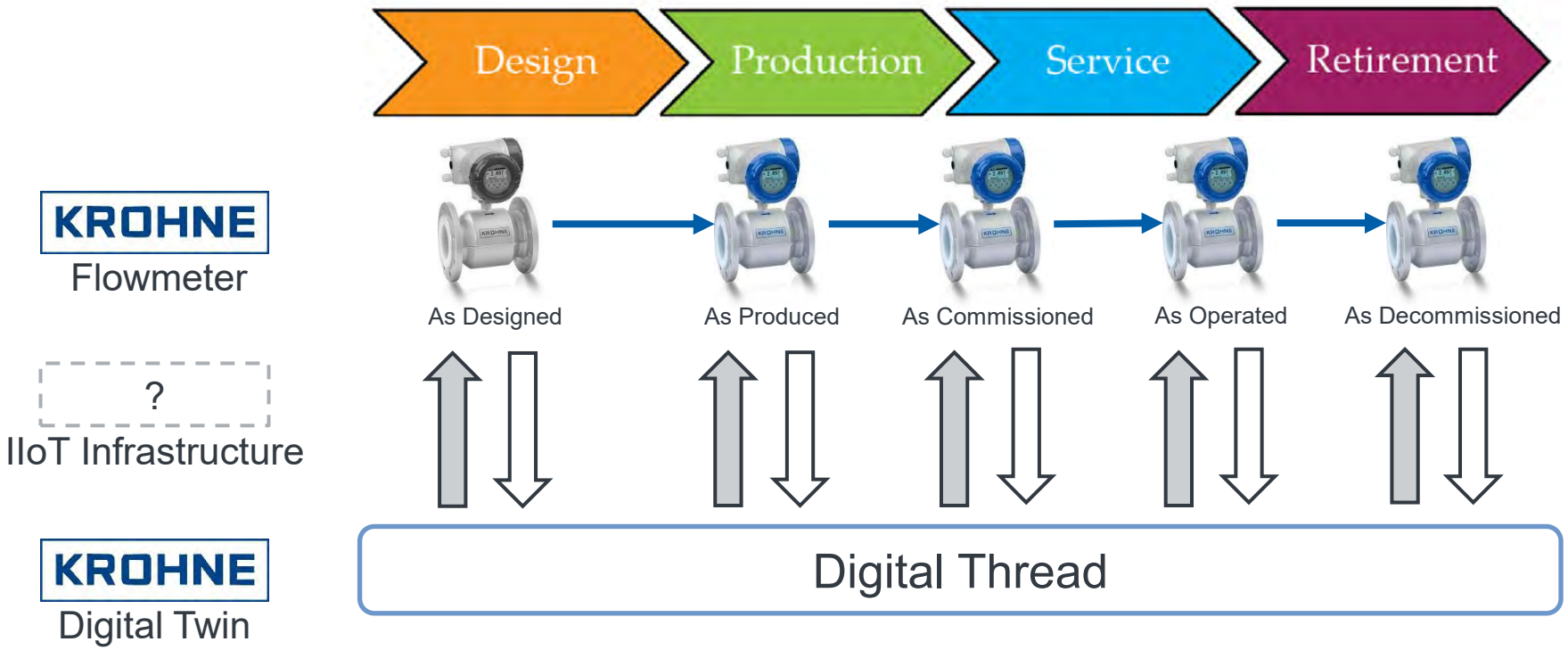
Future Products and Services

Digital Twin-enhanced Products and Services



Future Products and Services

Digital Twin-based Product Lifecycle Management



KROHNE
measure the facts

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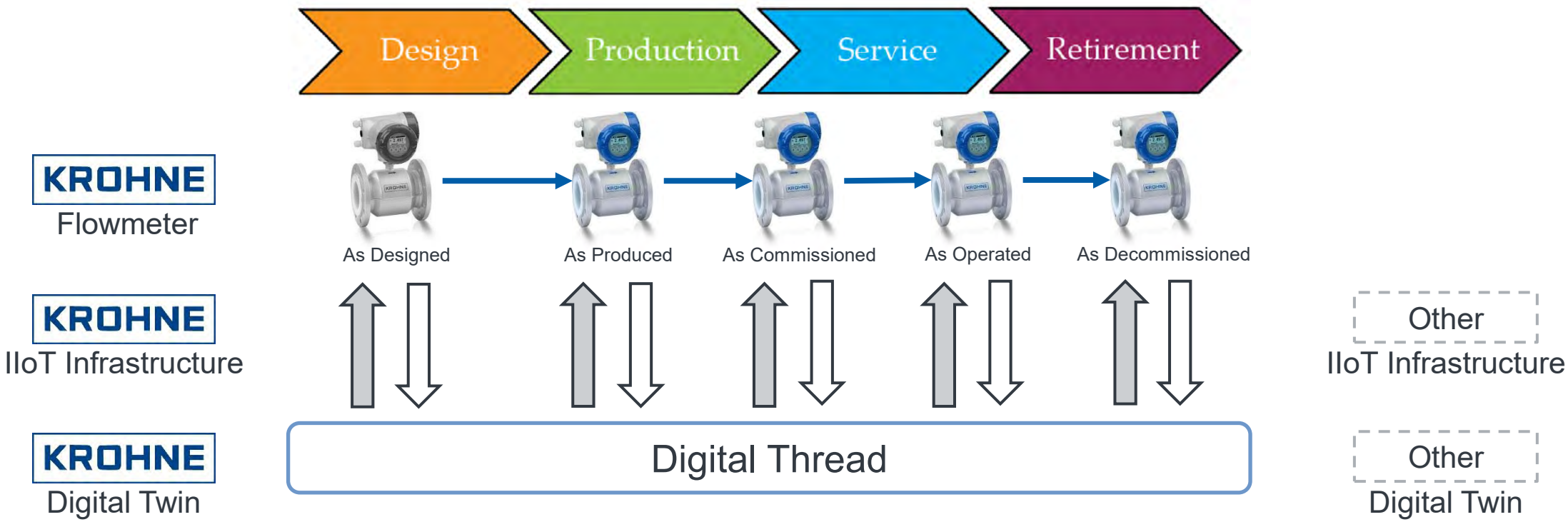
Agenda

Digital Infrastructure

- IIoT Infrastructure contains many features and components.
- IIoT Infrastructure is a hot topic
  - Rapid technology developments
  - Streamlining industrial standards
  - Emerging (EU) regulations
    - Digital Product Passport
    - Cyber Resilience Act (CRA)
- Adoption in industry poses quite some challenges
  - Onsite connectivity limitations
  - Legacy system integration
  - Vendor interoperability
  - Workforce skill gap
    (e.g., mixing of IT and OT knowhow)
  - Safety-critical control system operation
    (e.g., dual data secured paths via gateways)
  - Scalability from pilot to entire plant
  - Etc.

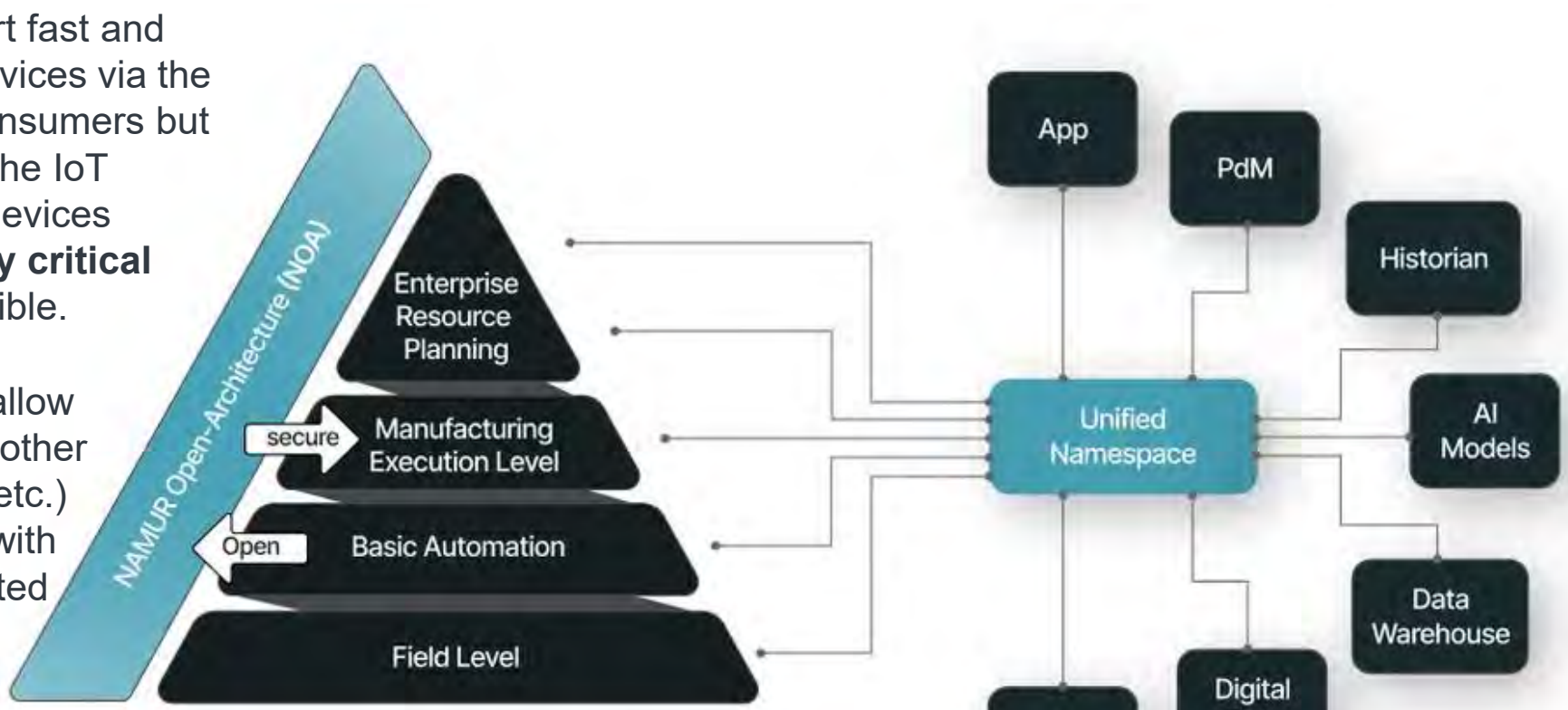
Digital Infrastructure



Digital Infrastructure

- **Open architectures** support fast and open data flow from field devices via the IoT infrastructure to data consumers but tightly restrict data flow via the IoT infrastructure into the field devices (push-pull / pub-sub). **Safety critical** components are not accessible.

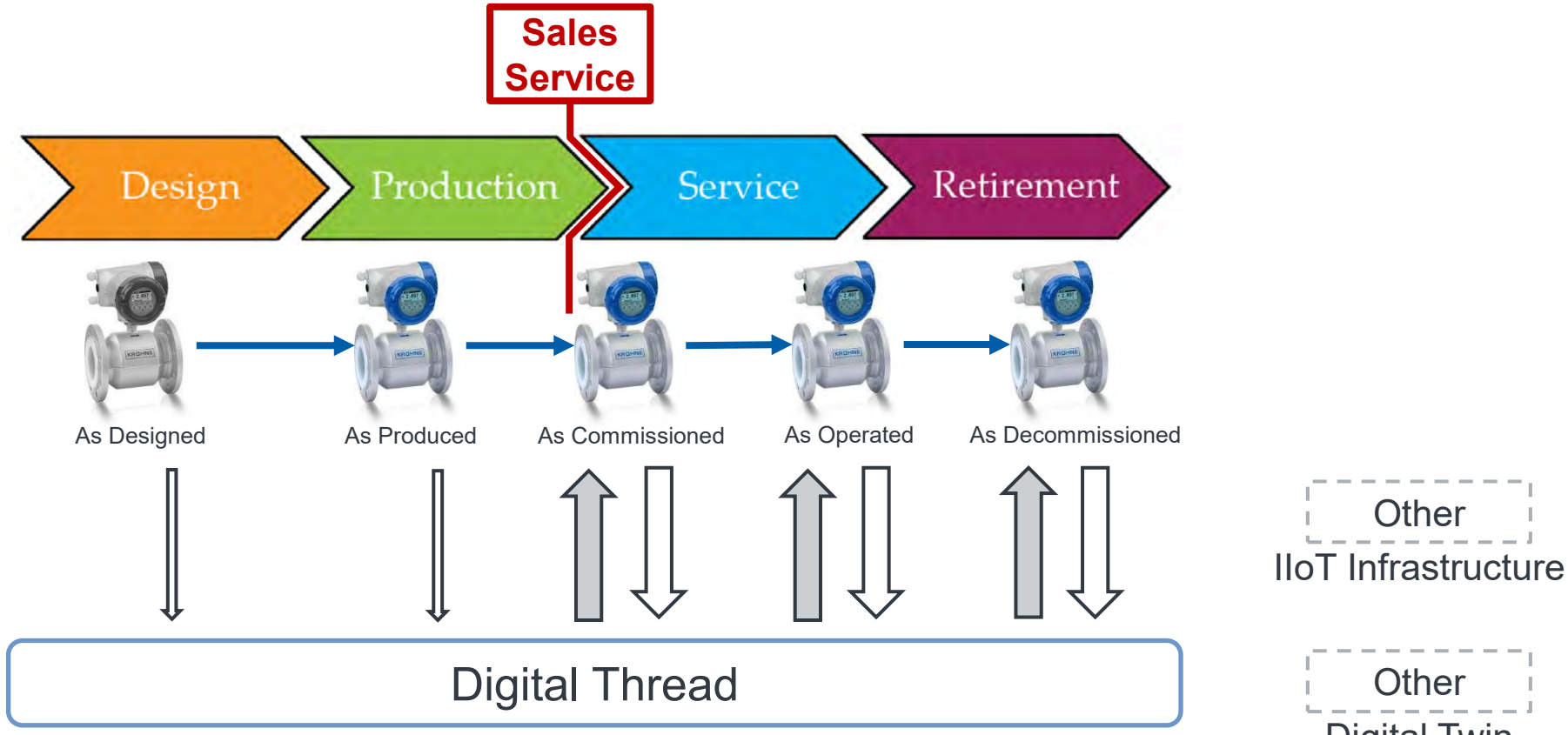
- **Authentication controls** allow many actors (dashboards, other IoT systems, digital twins, etc.) to simultaneously interact with a field device but each limited to its own predetermined **read/write access level**.



- Multiple dedicated digital threads can coexist and ‘pull’ data at the same time. But not all will be created equal in terms of the scope of data available.

Digital Threads

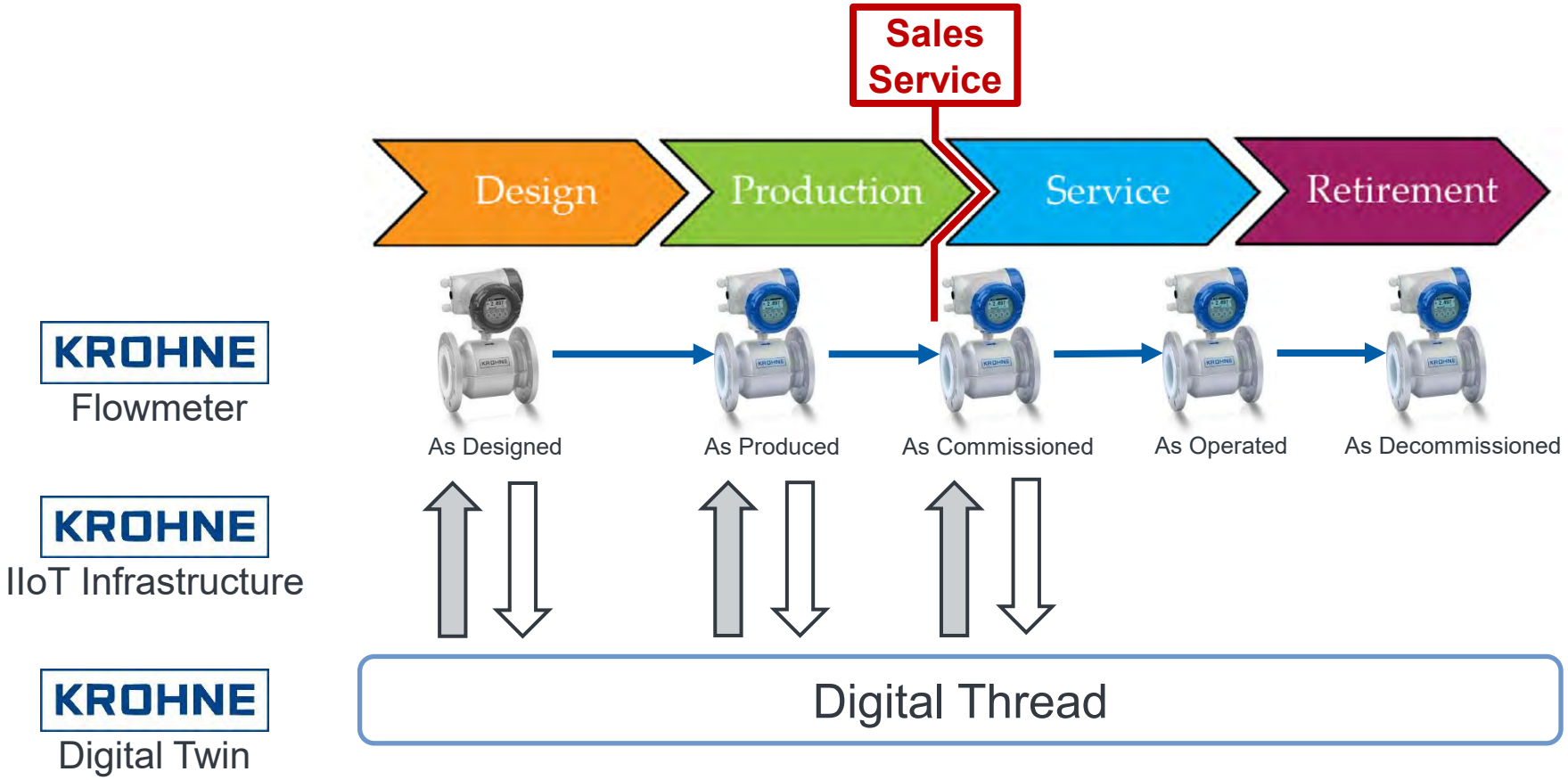
Co-creation vs. Isolation



Suboptimal case 1: 3rd Party Isolated

Digital Threads

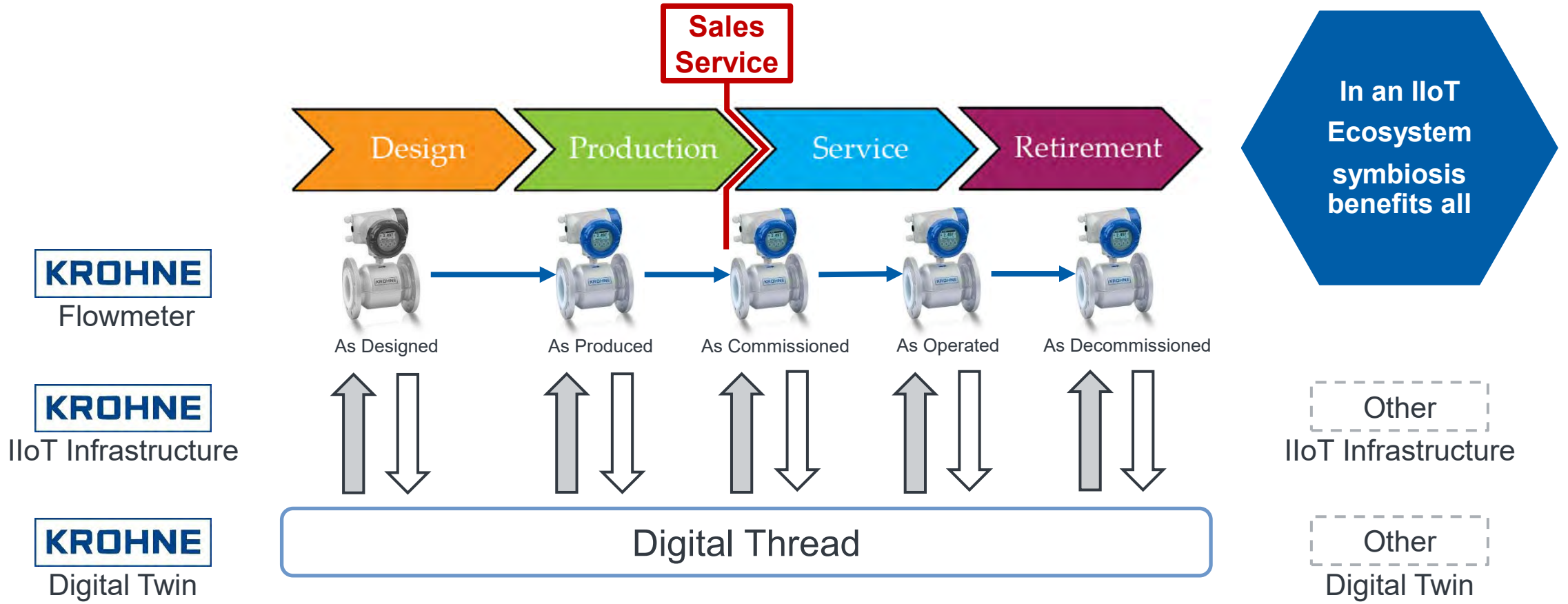
Co-creation vs. Isolation



Suboptimal case 2: KROHNE Isolated

Digital Threads

Co-creation vs. Isolation



Optimal case: co-creation

Why to go Digital?

1. Understanding the Digital Revolution

What technology is needed?

2. Understanding Digital Twins
3. Digital Products and Services

How to apply this technology?

4. Digital Infrastructure
5. Digital Threads

How to adopt this technology?

6. **Closing discussion**

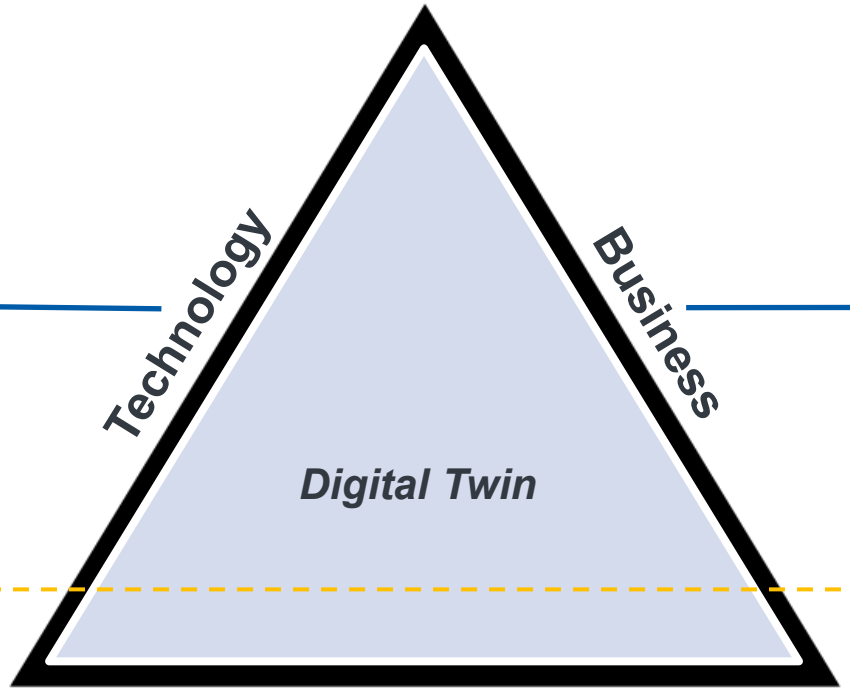
Agenda

Closing Discussion

Digital twins – a story with three sides: business, organizational, and technological contexts

- Flowmeter (Field Device)
- Digital Infrastructure
- Digital Tread

KROHNE



- Data-enriched products and services
- Digital products and services

KROHNE

You

- Digitalization – Everything Digital
- Digitization – Everything Optimized
- Digital transformation – Everything Connected

How can we further support you to help you reach your organization's digital transformation goals?

KROHNE

measure the facts

measure the facts

technology driven by KROHNE

Thank you for your attention!

Contact details

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Flow Division Innovation

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The Netherlands

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ULWIMO
ULtimate WIreless MObility

ECOSYSTEM SERVICES

About ULWIMO

Koen Mioulet
Enterprise Wireless

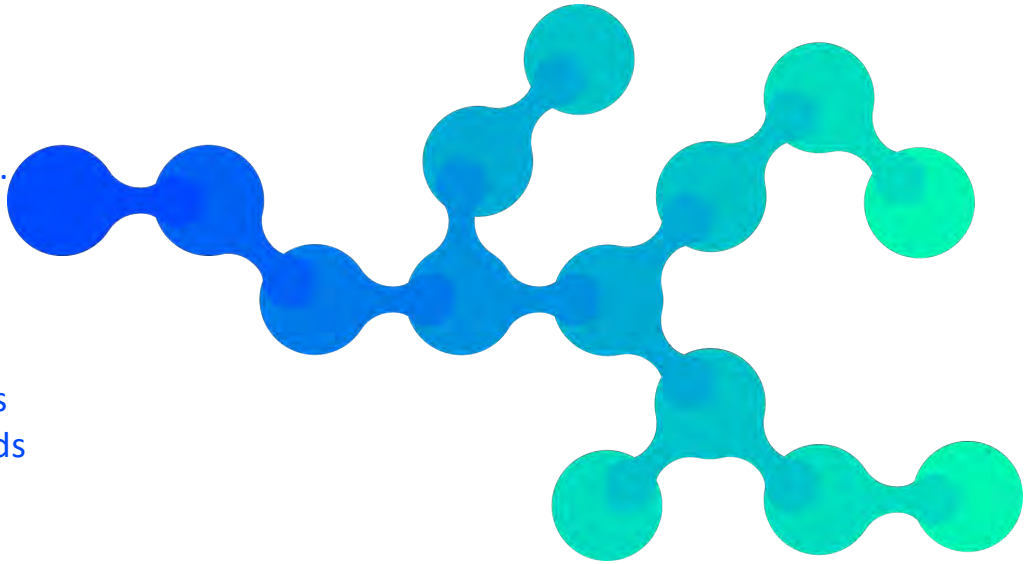
We believe in connection

About Ecosystem Services

Ecosystem Services (ES) connects people, ideas, and organizations to foster collaboration and drive innovation. We specialize in building and enhancing ecosystems in (mobile) connectivity and digitalization, enabling organizations to break silos and work towards shared goals.

With a strong track record, including leading the Dutch program at the MWC Barcelona for 10 years, ES brings together public and private leaders to address challenges and create impactful solutions. Through visionary programs and hands-on facilitation, we ensure that collaboration leads to tangible results.

"Those who want to remain relevant tomorrow must collaborate intensively today."



Mark Beermann
Anke Kuipers

ECOSYSTEM SERVICES

PRIMMA

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Agenda 19 March 2026

Start At KROHNE

10:00 Welcome and introduction for the day by Ulwimo & Ecosystem Services and Techbinder – Bram van den Boom

10:05 Presentation by Krohne

11:00 Tour at production facilities at Krohne

11:45 Leave to Duurzaamheidsfabriek

12:00 Lunch at Duurzaamheidsfabriek - Dordrecht

Welcome and opening remarks

13:00 Opening by Daniel Wortel – MD Duuzaamheidsfabriek
Brief overview of PRIMMA – Koen Mioulet and Mark Beermann
Looking back to MWC and morning visit – Koen and Mark

13:20 Setting the stage: main challenges and trends in wireless networks and QoS
Deployments of private networks, trends and market – Koen Mioulet
Transition from 4G to 5G at ECT - Hans van der Sluijs

13:50 Use cases and mapping of requirements to solutions
Use cases from ports already deployed - Koen
How to map use case requirements – Koen

14:30 break

14:45 Workshop / breakout sessions
Workshop on mapping use case requirements to wireless solutions using a canvas – Team PRIMMA
Presenting and discussing the results of the workshop

15:45 Quality Asssurance & operational excellence for advanced use of private networks
Relevance of KPI's for private networks – Saul Friedner and Daniel Mai of Siemens
Methods to ascertain network performance for critical operations - Ilya Samokhin from Viavi

16:30 Wrap-up, conclusions, take-aways and next steps
Wrap of the day
Agenda of the follow-ups of PRIMMA
Introductions of the demo's – Bram van den Boom

16.50 Networking in the demo environment
Informal networking with all participants on the ground f loor, with Technbinder**, PhoneCam, Soply, PubliXR and Frontier / Peplink**

Introduction & opening by Duurzaamheidsfabriek

Daan Wortel / Bram van den Boom

Introduction of the participants

Consultants
Ecosystem
End users
EU (end user) equipment
Fiber Solutions
Education / Students
System Integrator
Operator / Service providers
Solutions
Startups

Deal

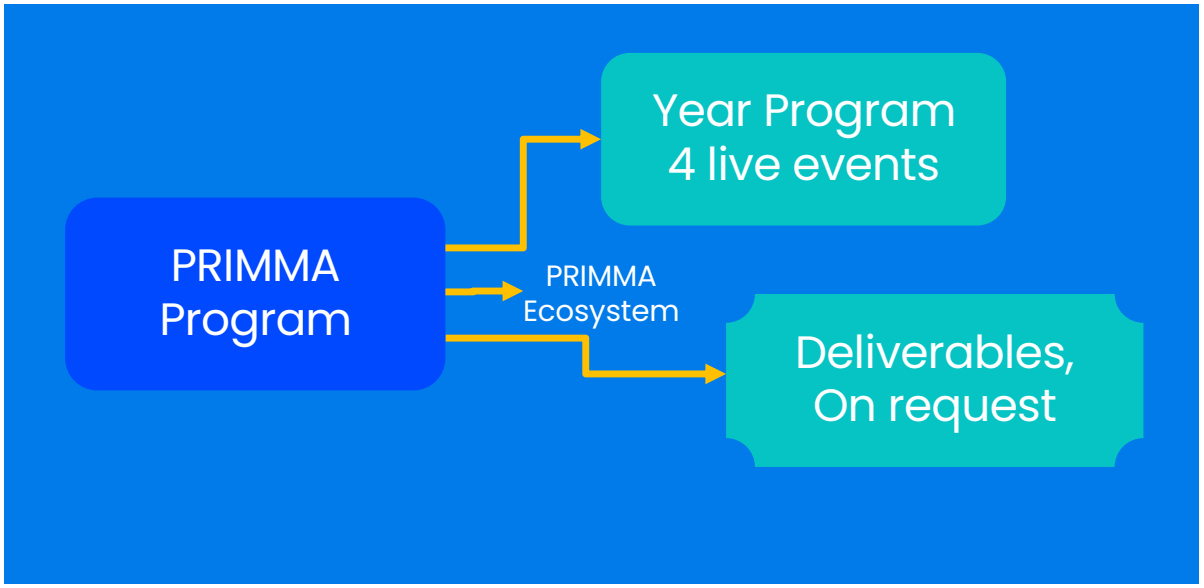
Connecting partners for impact

Thom de Rijke

Brief Overview PRIMMA
Koen Mioulet,
Mark Beermann


Private 5G
for process automation and
innovation in
Airports, seaports and
(large) logistics hubs

The Ecosystem Journey and Ecosystem outputs



NTT DATA Druid

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The PRIMMA Ecosystem Journey & Deliverables

Realised

Phase 1 (Realised) :

Round Table 1

Inspiring, touchpoints,
Opportunities & challenges
Define activities

Round Table 2

Introducing the workgroup, program
Go/ no go for continuation

2 Online Sessions (optional)

Inspiration &
Learning to work as an ecosystem

4 In Person Working sessions

Inspiration locations
Knowledge sharing
Co-creation
Innovate

Set-up for 2027 programme

1 **Continuation of the annual journey & bringing the ecosystem together**

2 **Realisation of the deliverables together on request**

Creation of Deliverables
Based on the priorities and input from the participants and using what is already available
On request

Deliverables as
- Whitepapers
- Best practices (Fieldlabs)
- Policymaking feedback
- Etc.

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Year program 2026 (subject to change)

- 4 events (1 per quarter) at inspiring locations with participation of all digital ecosystem roles
- Program co-created with partners with focus on use cases, solutions and technology
- Work on deliverables on basis of collaborative participation and separate budget

Joining PRIMMA now means becoming part of a movement that builds future-proof logistics infrastructure and capabilities.

Join PRIMMA →

*In March PRIMMA will organize a knowledge mission Private Networks as part of the NL program during Mobile World Congress Barcelona.

Drechtsteden, March 19, 2026

At Drechtsteden initiatives like Smart Port and Dealdrechtsteden are leading the way to collaborate with the local private and public communities aimed at innovative maritime solutions like:
- Digital connectivity, IoT/Sensing.
- Qos Assurance and SLA Management,
the number one unique selling point of private networks. The event includes presentations and demonstrations of innovative use cases.

Port of Valencia, April 21-22, 2026

Port of Valencia is the largest port of the Mediterranean see and leading in the digital developments with private networks.

In April the Container Terminal Automation Conference in Valencia will taken place, that we will visit combined with a meeting session and a tour in the Valencia port.

Belgium Airport, September 2026

In Belgium, the ecosystem is well developed with many impressive deployments of private 5G already. An overview will be given at an airport. In addition to allowing further optimisation of the airport's operations, the 5G technology will also enable to accelerate digital innovations and facilitate the integration of future technologies.

NL Logistics, November 2026

PRIMMA provides public bodies with a strategic platform to align policy with market needs,. This session will further explore public-private cooperation with existing cross-sector logistic communities and association in the logistics sector. To help shape the regulatory and innovation landscape for next-generation logistics.

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Opportunities for Participants

- Accelerate innovation and digitalization agendas
- Help shape logistics and connectivity strategies
- Gain access to forward-looking technologies and peers, also in additional verticals

Joining PRIMMA now means becoming part of a movement that builds future-proof logistics infrastructure and capabilities.

Join PRIMMA →

Major logistic hubs
As a major logistics hub, joining PRIMMA connects you to a powerful ecosystem of public and private partners accelerating private network adoption. Benefit from:

- **Faster innovation** through shared use cases and tested solutions
- **Regulatory guidance** to navigate complex national and EU frameworks
- **Collaboration** with telecom, IT, and logistics leaders shaping industry standards.
- **Greater visibility** as a digitally advanced, future-ready logistics hub.
- **Working with peers** on developing role models and best practices.

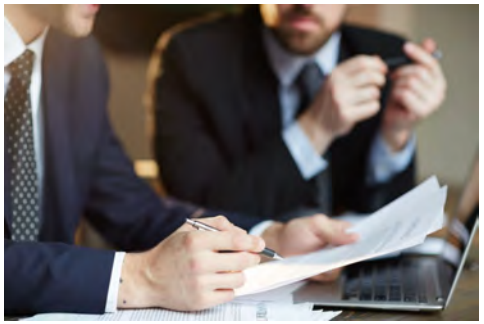
Be part of the coalition, building the digital infrastructure of tomorrow.

Research and innovation

PRIMMA offers researchers and innovation actors access to real-world testbeds, cross-sector collaboration, and high-impact experimentation opportunities. Contribute to future-proof logistics innovation, shape emerging standards, and strengthen your applied research impact, all within a trusted, public-private ecosystem.

Network & Tech Providers

PRIMMA connects providers to high-value logistics hubs and key decision-makers, enabling faster piloting and scaling of private network solutions. Through collaborative use case development, real-world field labs, and active involvement in policy discussions, partners gain regulatory insight, market credibility, and the opportunity to shape scalable, standards-based innovations in a strategic sector.



Government and Regulators

PRIMMA provides public bodies with a strategic platform to align policy with market needs, support economic growth, and ensure secure, future-ready infrastructure. Through cross-sector collaboration, knowledge sharing, and early engagement with real-world use cases, we help shape the regulatory and innovation landscape for next-generation logistics.

Looking back to MWC 2026

Koen Mioulet,
Mark Beermann

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NLMWC26 Knowledge Mission Private Networking

Private Networks Innovation

Your 2-day Knowledge Mission Experience

	WEDNESDAY, MARCH 4	THURSDAY, MARCH 5
08:30	Morning Kickoff	
09:00	Use cases, technology, deployments	Innovation in logistics: Visit to Port of Barcelona
12:30	Lunch & Networking	Lunch & Networking
13:00	Use cases and solutions System integrators	Visit to the container terminal BEST
17:00	Network drinks at NL Pavilion	Closing drinks at location

Partners

NTT DATA peplink VIAVI Solutions

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NLMWC26 Knowledge Mission Private Networking
Day 1, Wednesday, March 4, the MWC expo

Viavi Solutions

Frontier / Peplink

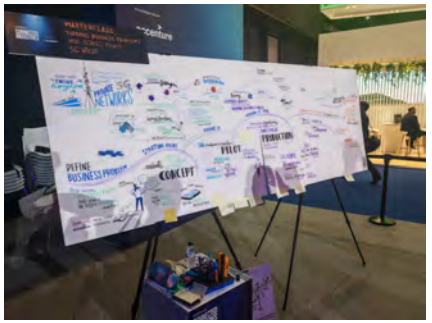
SES

Ericsson

NL Pavilion / Eurofiber

Huawei

NTT Data



GSMA

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NLMWC26 Knowledge Mission Private Networking
Day 2, Thursday, March 5, Port of Barcelona and BEST

At Port of Barcelona

Boat tour in Port of Barcelona

Visit to to Terminal operator BEST

Looking back
morning visit to Krohne

Koen Mioulet,
Mark Beermann

Setting the stage: main challenges and trends in wireless networks and QoS

Deployments of private networks, trends and market – Koen Mioulet

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Accelerating Innovation in Logistics Together

March 2026
Koen Mioulet,
Mark Beermann
& Anke Kuipers

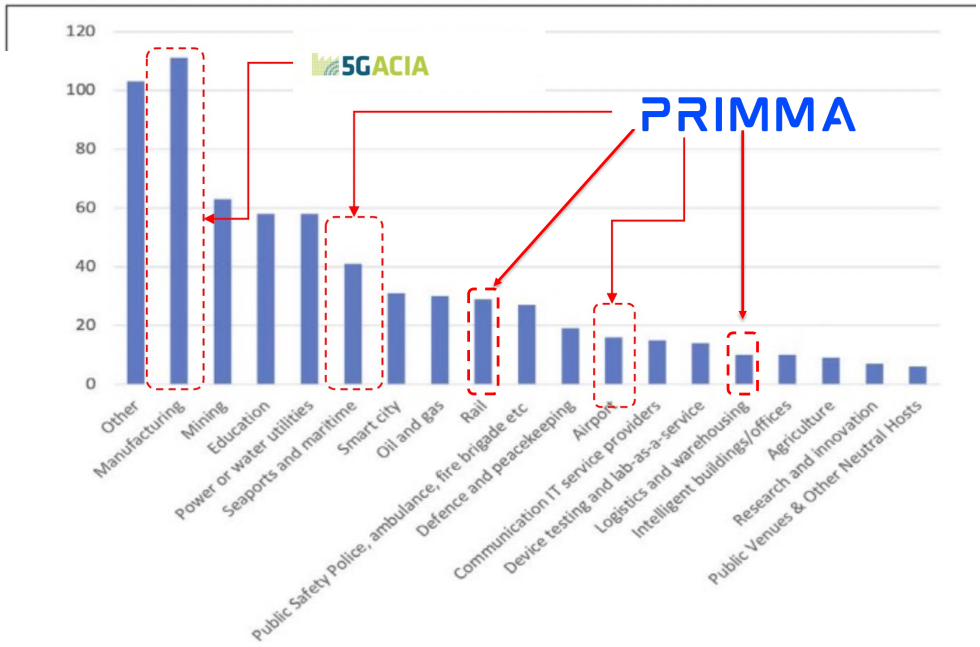
PRivate networks Initiative for Major Logistic Hubs Market Acceleration

Offer to join the coalition and program Initiated by Ulwimo and Ecosystem Services


Private 5G
for process automation and
innovation in
Airports, seaports and
(large) logistics hubs

Why Major logistic hubs?

Figure 3: Number of identified customers deploying private mobile networks (trial and commercial) by sector (base: 656 organisations)



The above graph from the 'Global supplier's association (GSA)' shows the amount of private mobile projects currently being deployed in each sector. Showing also where the room is for growth and the motivation for our initial choice for major logistic hubs.

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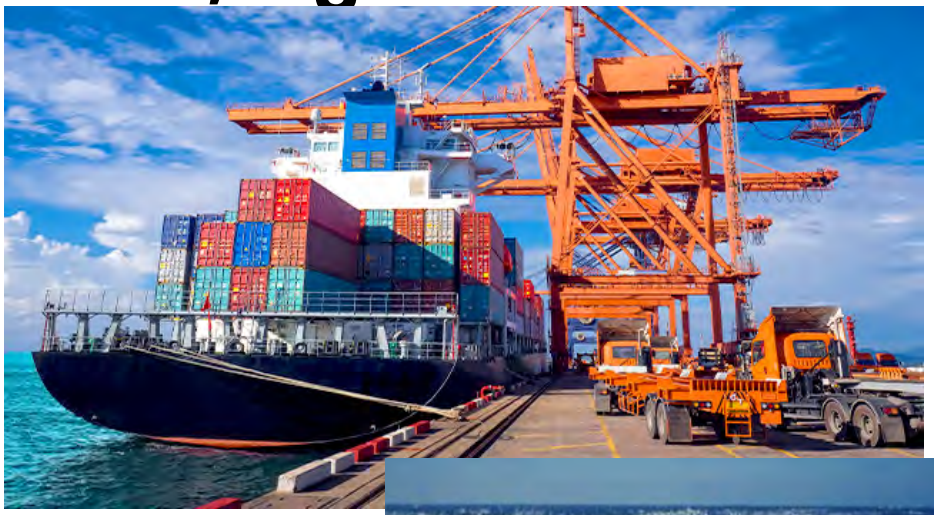
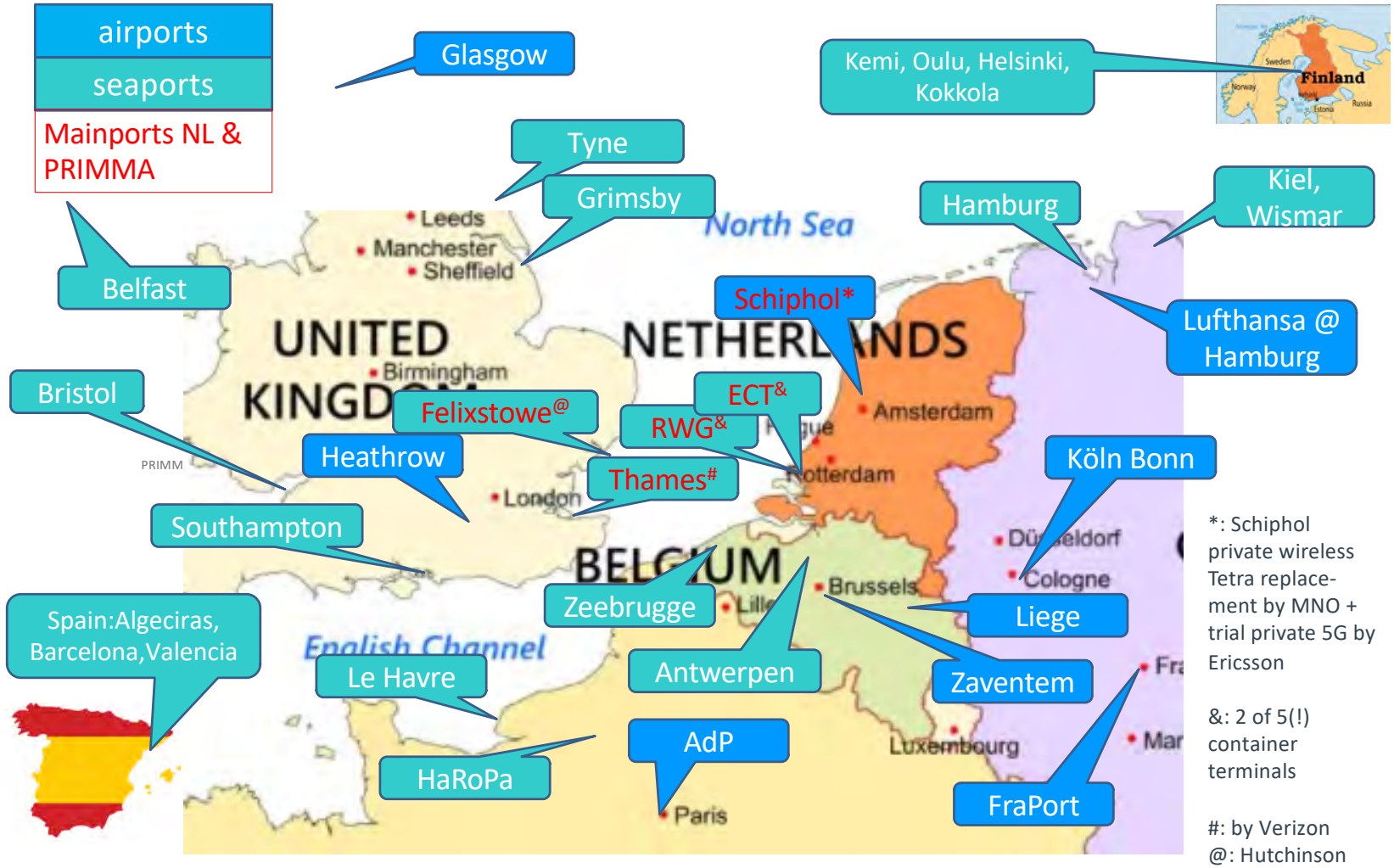
Use cases in (air)ports operations, logistics



Mainports NW Europe with active private wireless roll out; 25+ !



Jan'26 PRIMM

*: Schiphol private wireless Tetra replace-ment by MNO + trial private 5G by Ericsson

&: 2 of 5(!) container terminals

#: by Verizon

@: Hutchinson

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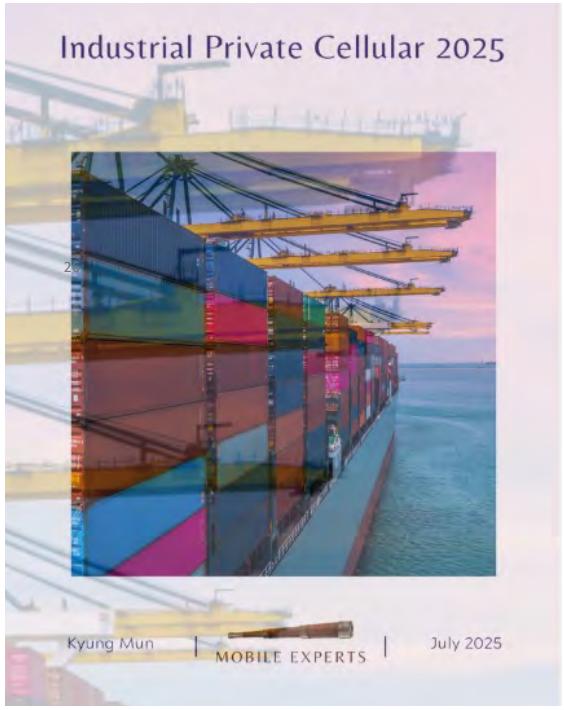
Miscellaneous sources and diverging stats

GSA: **1900** private networks
Counting >100K projects
Counting customers, not deployments

Mobile experts: **3000+** networks



Berg insight: **4700** pvt networks

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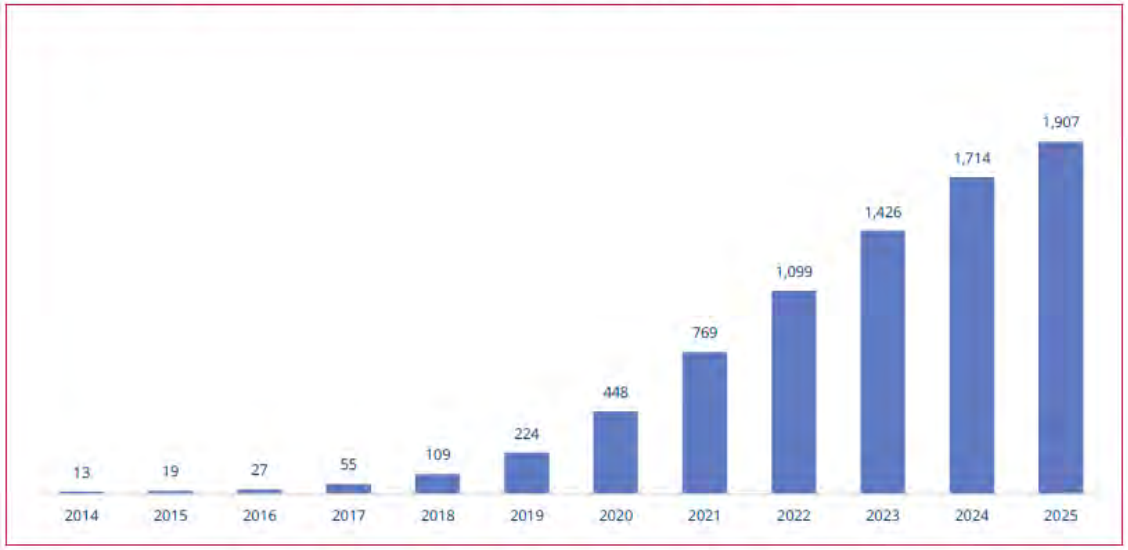
GSA Market totals and additions

Figure 1. Private mobile network customer references of more than €100,000, by year announced

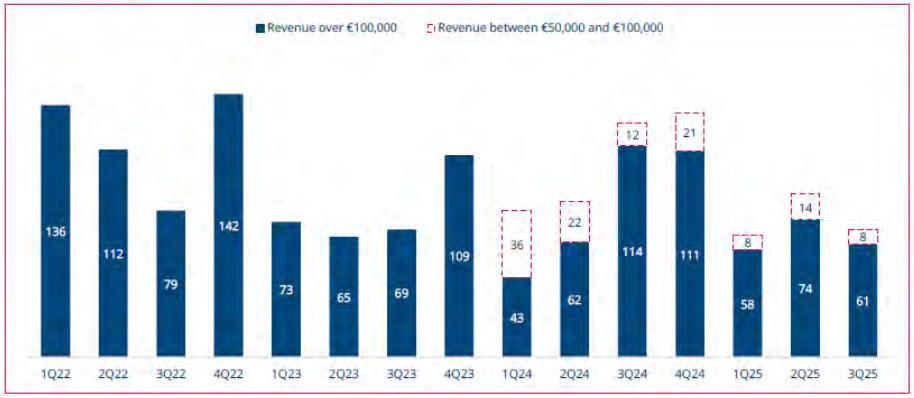


GSA counts **1900** customers per E ’25
Steadily rising, not spectacularly accelerating

Difference with other stats:

- GSA counts projects > 100K (as off ‘24 > 50K)
- GSA counts customers, may have multiple sites or roll outs

Figure 3. Net private mobile network customer references additions per quarter



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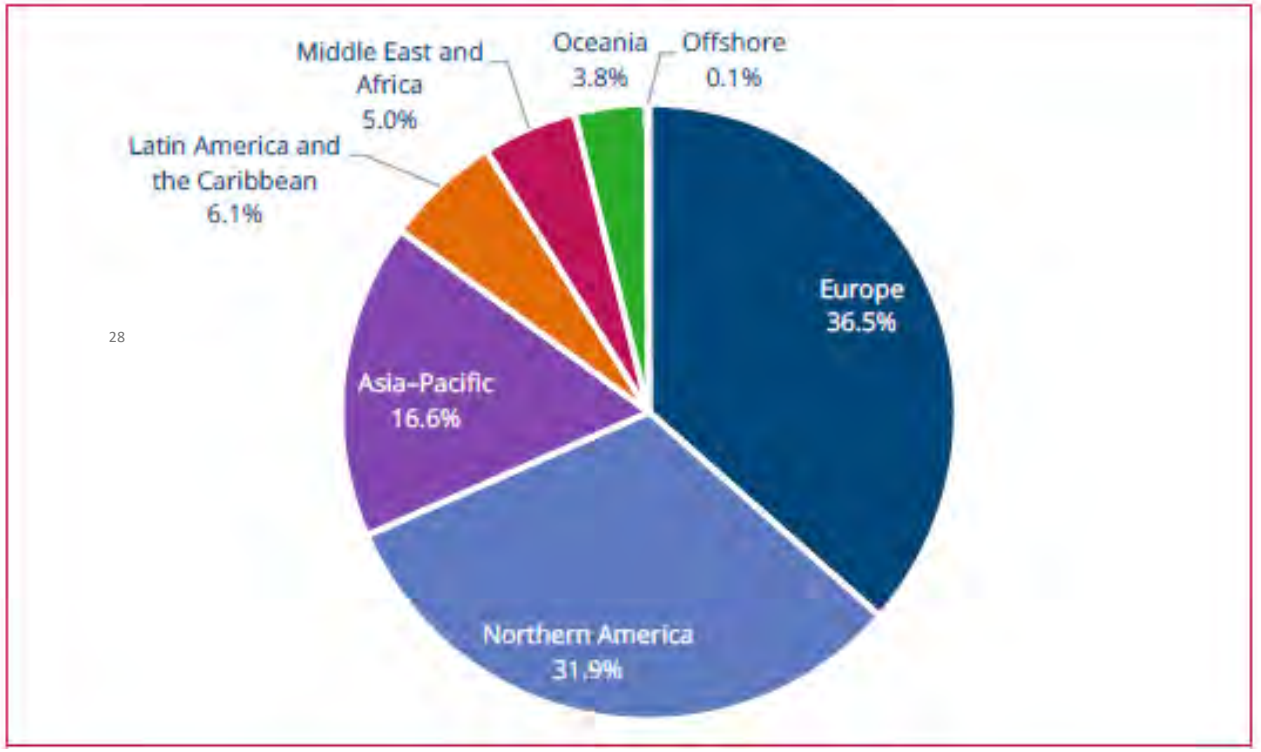
Pvt wireless deployment across continents

EU and USA are leading
Not in the least due to availability of spectrum



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Interested? More?

url: www.primma.org
@: info@primma.org

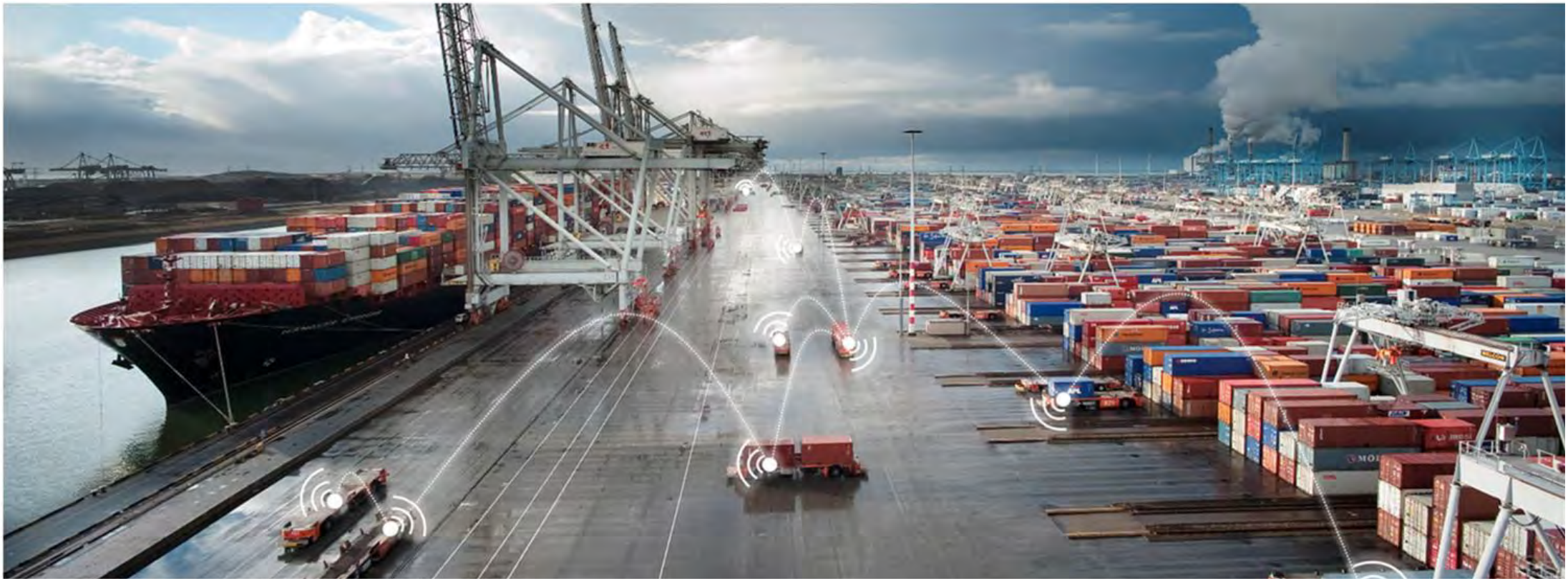
Setting the stage: main challenges and trends in wireless networks and QoS

Transition from 4G to 5G at ECT – Hans van der Sluijs

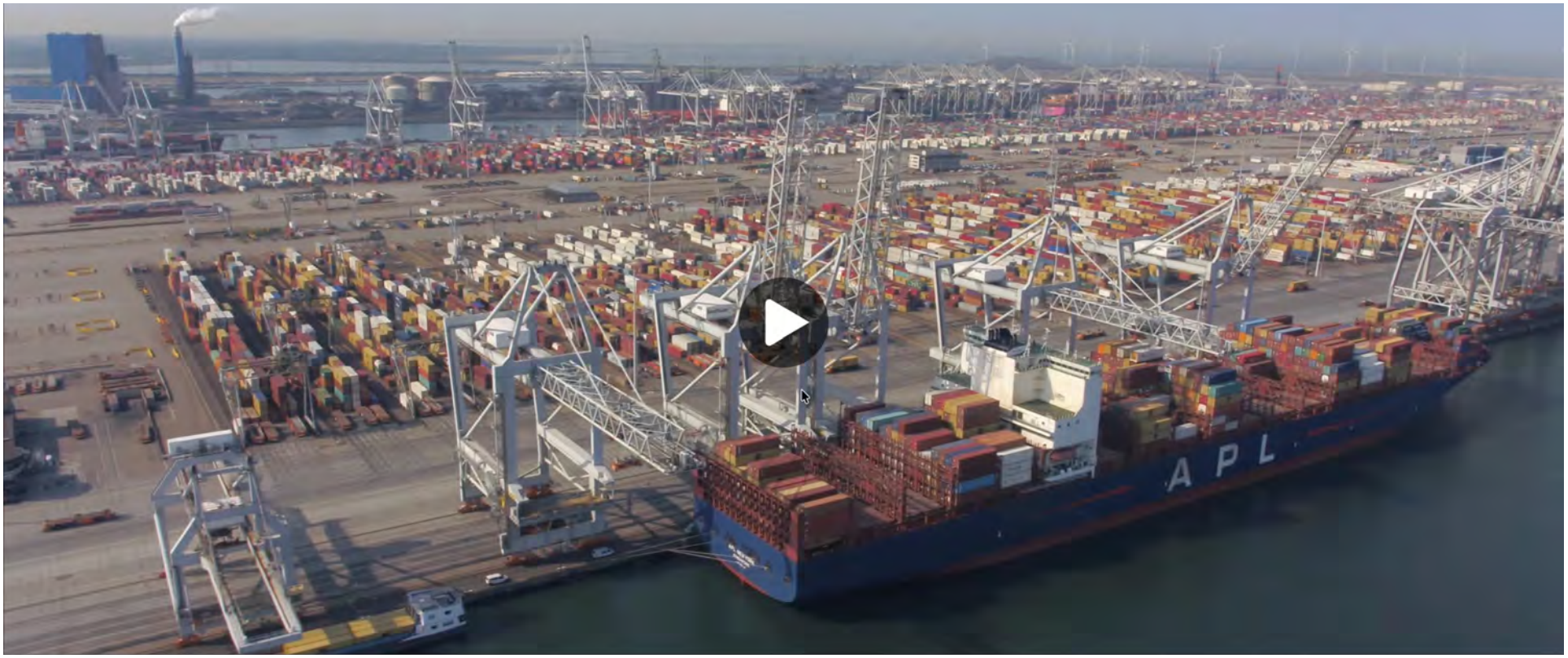
5G Connectivity needs on ECT Rotterdam Container Terminal

Ardin van Mourik / Hans van der Sluijs

Project Manager ECT / consultant LTE - 5G



A short introduction to ECT Rotterdam



Watch video here: https://youtu.be/dKUQFR80f3U

ECT LOCATIONS @ MAASVLAKTE

Delta
Terrain: 3 km^2
Quay: 4.9 km

Euromax
Terrain: 1 km^2
Quay: 1.5 km

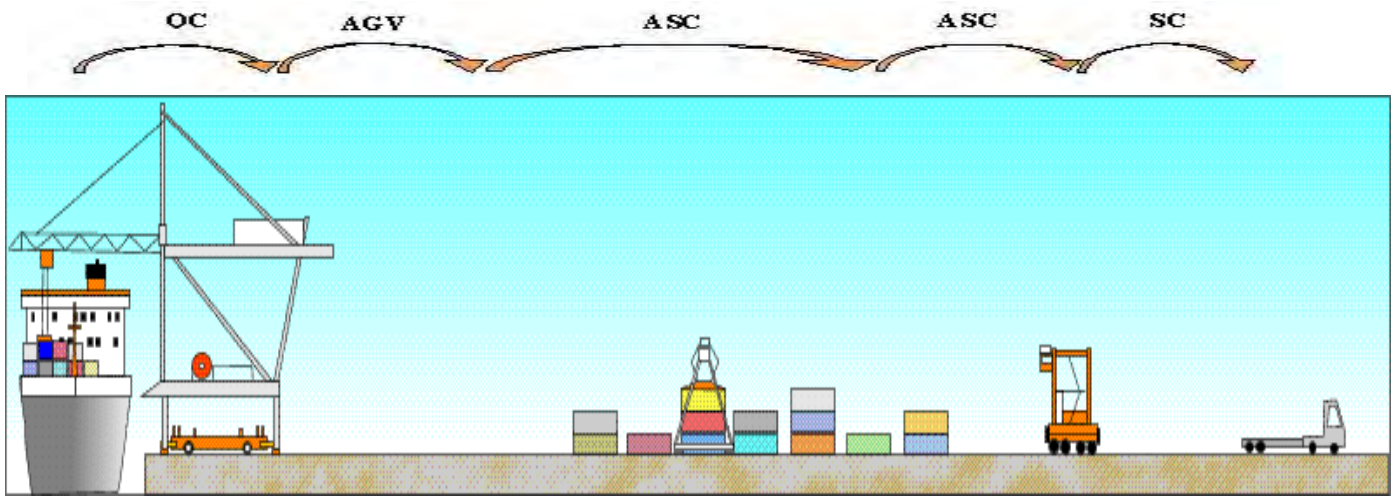
Hutchison Ports ECT Rotterdam Terminal

ECT Delta Terminal

ECT Euromax Terminal

- Founded in 1966
- 1800 employees (24x7x364)
- 7 million TEU per year (~ 50% PoR)
- 4 hinterland terminals (Duisburg, Willebroek, Moerdijk, Venlo)

A normal day at the office..



- **30** Deep sea vessels
- **70** Feeder vessels
- **135** Trains
- **225** Inland vessels
- **21.000** Trucks

Numbers per **week** at DT/EMX terminal

QC - Manned: Wired / Tetra

AGV - Unmanned: 5G

ASC – Unmanned: Wired / 5G

SC - Manned: Tetra / 5G

(M)TT - Manned: Tetra / 5G

Personel: Tetra / Wi-Fi / 5G

Connections in the port - Wired or wireless?

Wired OT Equipment

- 60 Quay Cranes
- 190 ASC Stacking Cranes
- 6 Rail Cranes

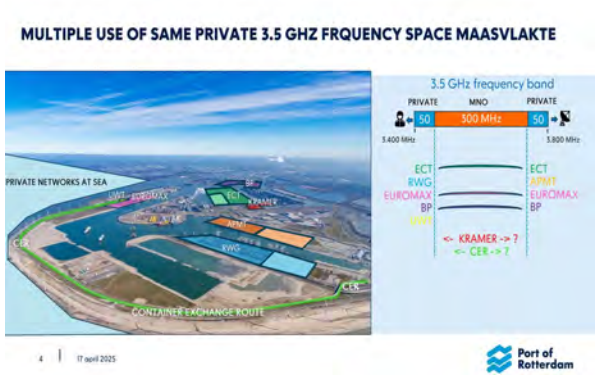
Wireless 4G LTE / 5G Network

- 382 Modems unmanned verhicles
- 83 Modems manned verhicles
- 38 Handhelds & TOD laptops

TETRA Network

- 900 Hand- & Carsets / Dispatch terminals

Challenges of a 5G network at ECT Rotterdam



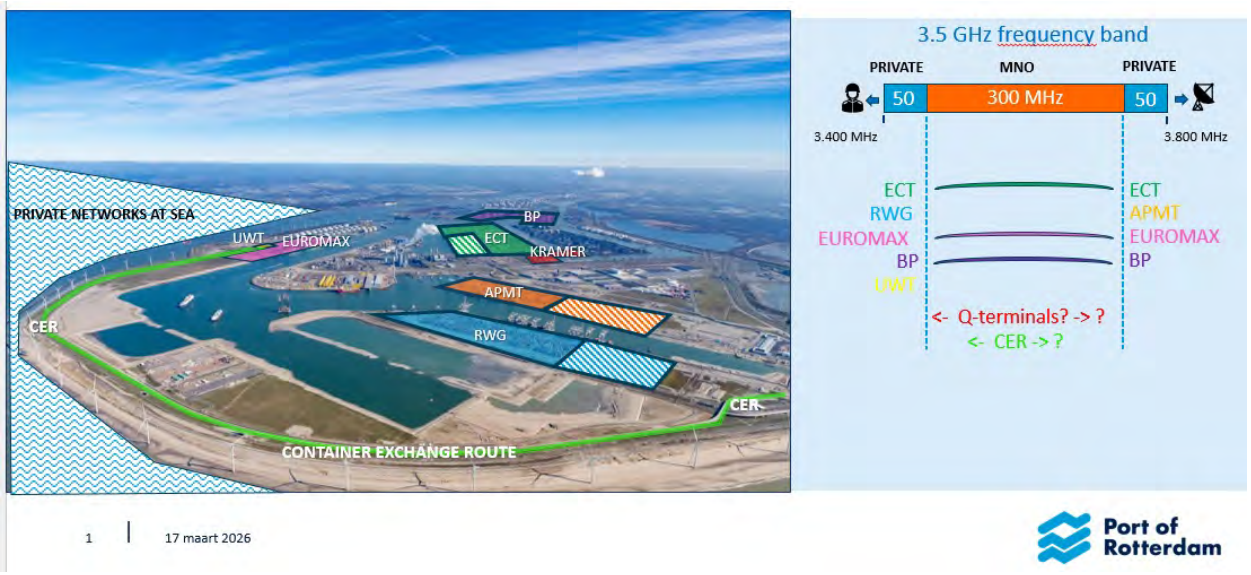
5G Connectivity needs on ECT Rotterdam Container Terminal

Competing with neighbouring 5G networks

The governmental regulations require that each private 5G network may only service the area of their own terminals (Perceel Gebonden Network)!
Thus all companies located in the area have to share the available limited spectrum:
3420-3450 MHz and 3750-3800MHz!

Introducing coordination on / uniqueness off:

- MCC: Country Codes NL: 204 or 999
- MNC: 2 or 3 digit Network codes
  (204)95/96/97; ECT: (999)875 / 951
- PCI and mod 3 of Antenna site
- Azimuth and downtilt of RRUs antennae
- Frame configuration
- ERP Power on premise borders



Migration to a new 5G network

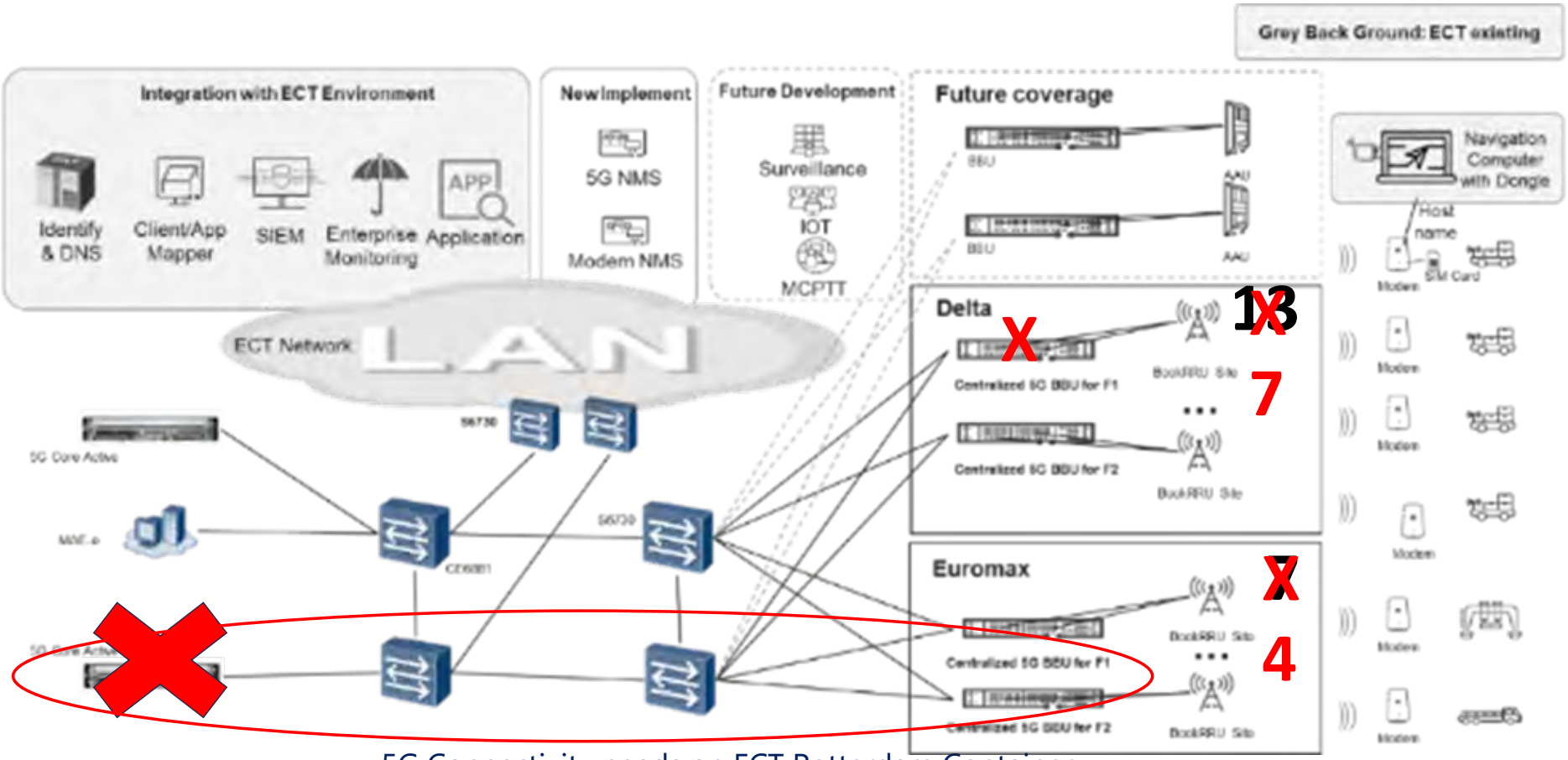
The ECT terminals must be equipped with a **single** private 5G SA network serving **both terminals**. This network provides connectivity to unmanned AGVs, manned trucks, and portable devices such as PDAs and laptops.

ECT's operations are fully reliant on this infrastructure, therefore a **stable** (**on premise**) wireless network with very **high availability** and **redundancy**, **no single points of failure**, **low latency** with sufficient and adjustable / expandable bandwidth is essential.

ECT therefore requested a 5G SA network with the following MRs:

- Very High Availability of 5G network (24/7 99,997% 16m unplanned)
- Ability to Prioritize Traffic Types (QoS / preemptive)
- Low Latency of the network (<200 ms t.o.t. no jitter / no packet drop)
- Very High Capacity / Throughput Requirements (400kbps/1,6Mbps)
- Comply to Requirements of RDI (PGN)
- To be fully operational by the end of September 2026

N-1 redundancy in design of 5G network



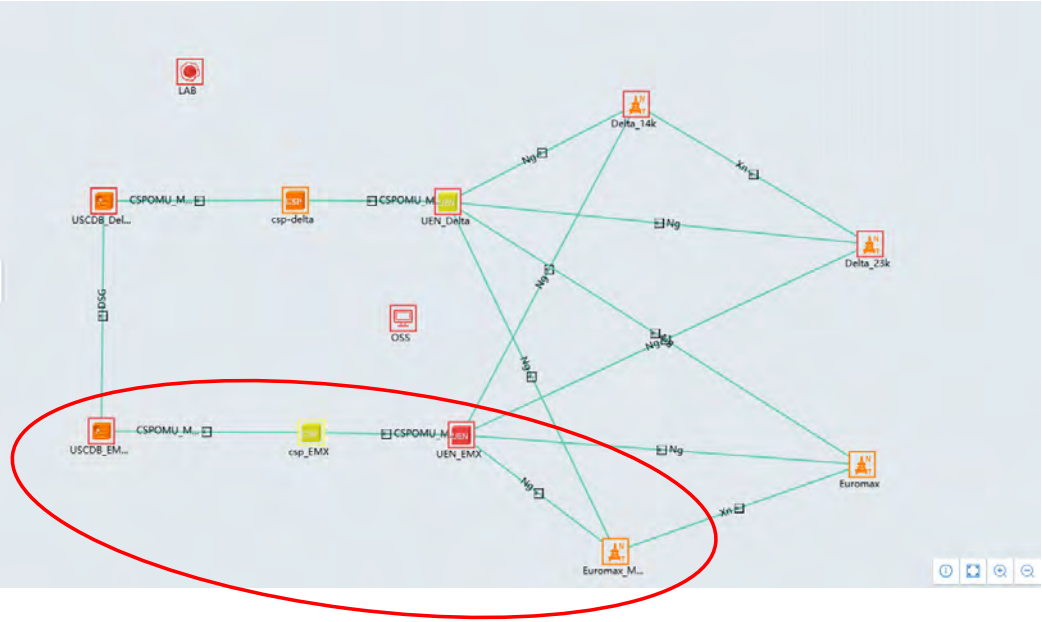
5G Connectivity needs on ECT Rotterdam Container Terminal

Monitoring tools for Core/RAN/CPE/Spectrum

- Huawei - MAE monitoring for CORE, RAN and network;
- Peplink - InControl2 for CPE performance;
- Rohde & Schwartz - ROMES for spectrum monitoring;
- SolarWinds – Network performance monitoring;
- Network Control - Availability dashboard.

Monitoring tools for Core/RAN – Huawei MAE

- Huawei - MAE monitoring for CORE, RAN and network

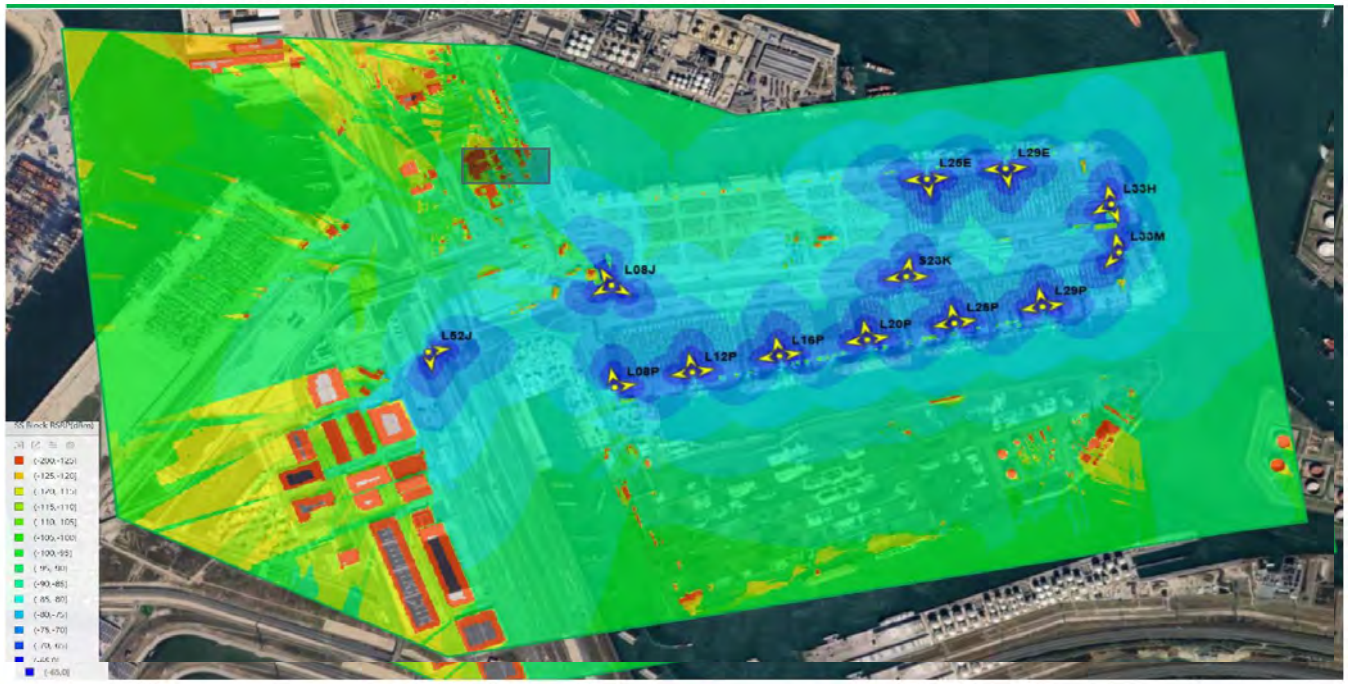


Monitoring tools for CPE – Peplink Incontrol2

- Peplink - InControl2 for CPE performance

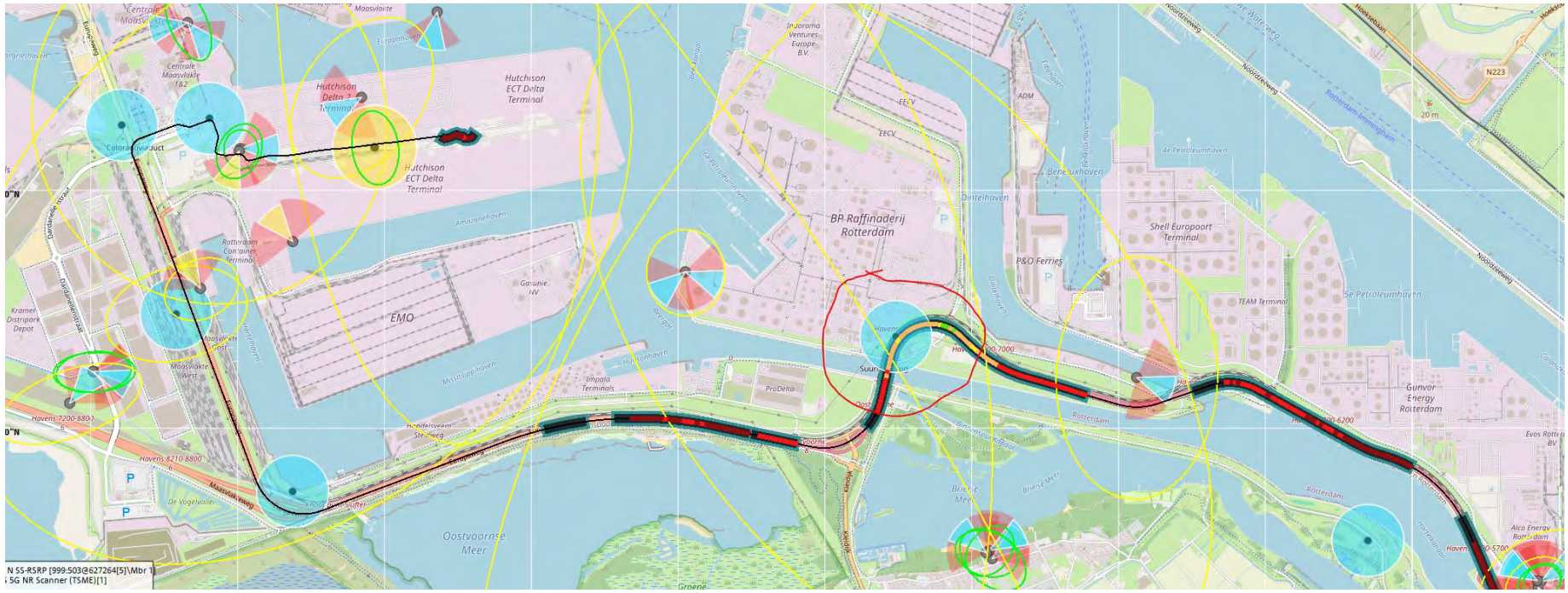
Monitoring tools for Spectrum / Rohde & Schwartz

- Huawei – Network Modeling -> ROMES for spectrum monitoring



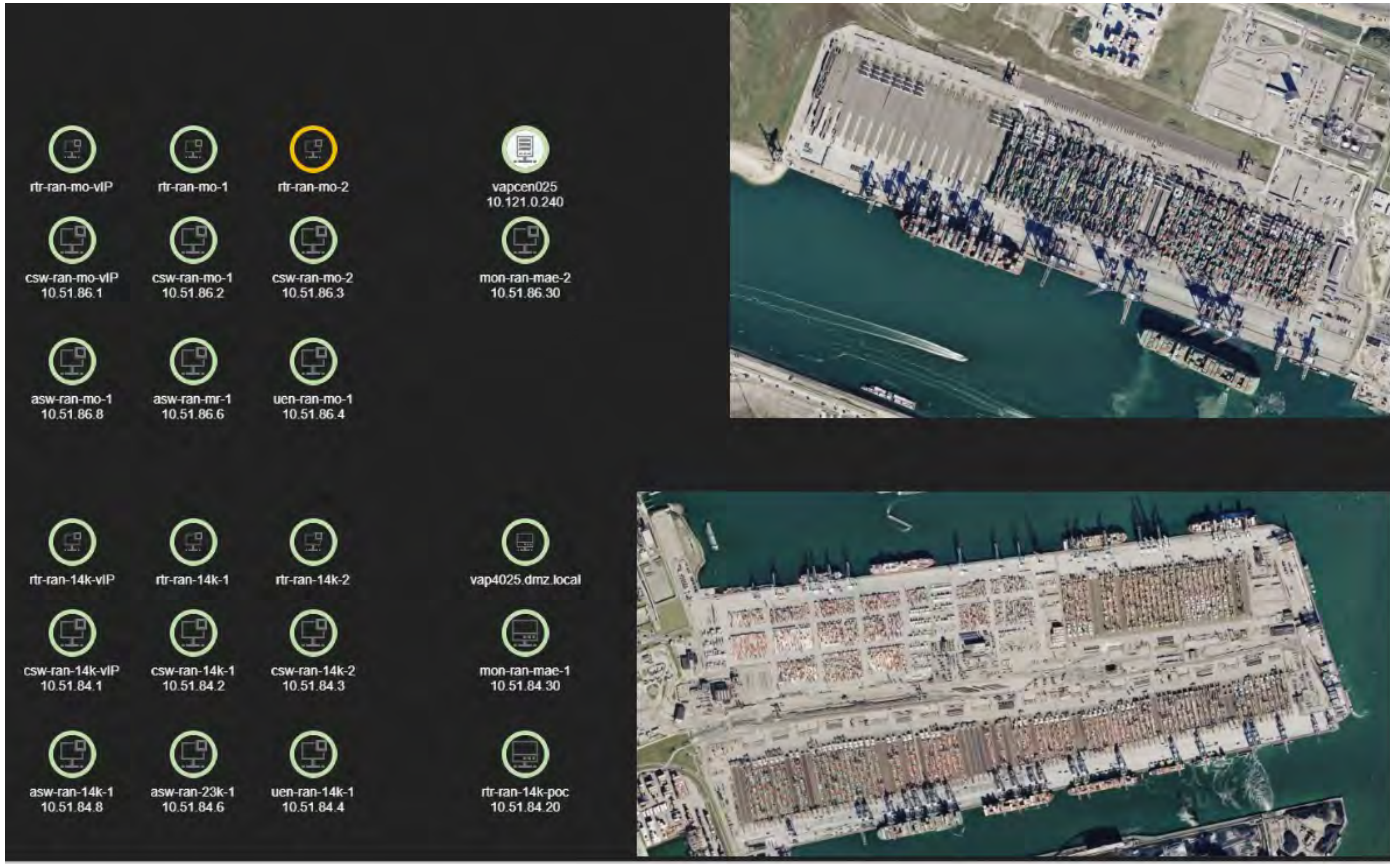
Monitoring tools for Spectrum / Rohde & Schwartz

- Rohde & Schwartz - ROMES for spectrum monitoring



5G Connectivity needs on ECT Rotterdam Container Terminal

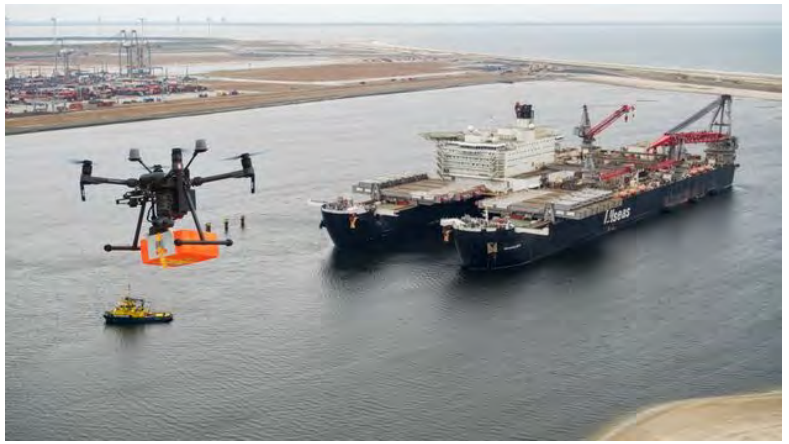
Network availability monitoring – SolarWinds



5G Connectivity needs on ECT Rotterdam Container Terminal

5G Use Cases in the future?

- **Maintenance support use cases**
  - Equipment manuals and drawings
  - PLC updates and configuration
  - Overall Equipment Effectiveness (OEE)
- **Streaming video use cases**
  - Remote Controlled QCs (Back-Up)
  - Drone Inspections/Surveillance
  - Introducing Autonomous Equipment
- **Voice communication**
  - Replacement TETRA Network / MCX



Questions?

Use cases and mapping of requirements to solutions

Use cases from ports already deployed – Koen


Recap port of Barcelona visit
Port Authority | container terminal
MWC'26, MB/KM
Deployment model, usage, KPI's
Interactive session
KPI's of network relative to use cases

Barcelona Port Authority deployment model

- PA orchestrated the service, wrote RFQ, went out for tender
- Due to (no) private spectrum, MNO's replied
- PA selected bidder, drafted SLA with KPI's
  - Orange contractor
- Service in operation in 2024
- PA uses it herself for customs, environmental monitoring, geo location and vessel control, surveillance
- Tenants are welcome to use the service as well yet
  - To be contracted with Orange directly
  - PA is not the 5G service provider
  - Orange even uses own FO, not that of PA; so PA clear of legal disputes

The port geography

Competing with Ports of Algeciras, Valencia
No petrochemical
Cruise ships & ferries
Close to downtown
=> Relocating ‘heavy’ users
Electrification programme

The 5G service in Barcelona port

5G CONNECTIVITY

- EVOLVABLE 5G NETWORK
- 100% OUTDOOR + INDOOR COVERAGE+ 2 NAUTICAL MILES
- INTERCONNECTION WITH "RESCAT" READY FOR ROAMING NACIONAL
- NETWORK AVAILABLE TO THIRD PARTIES VIA THE CONTRACTOR

Location Map

Delivery **MAY** 2024

Hybrid Private Network

5G

As a Service (IaaS)

The current use cases of 5G

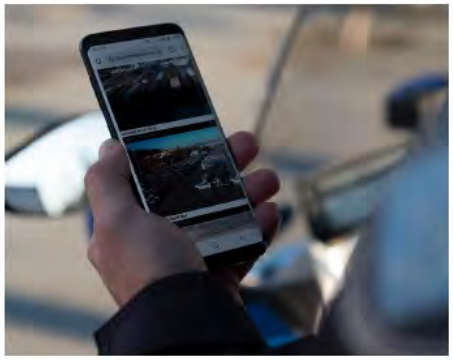
Railway Digital Twin

5G Hydrogeology

Smart Buoys

Firefighters

The Drone



All only one

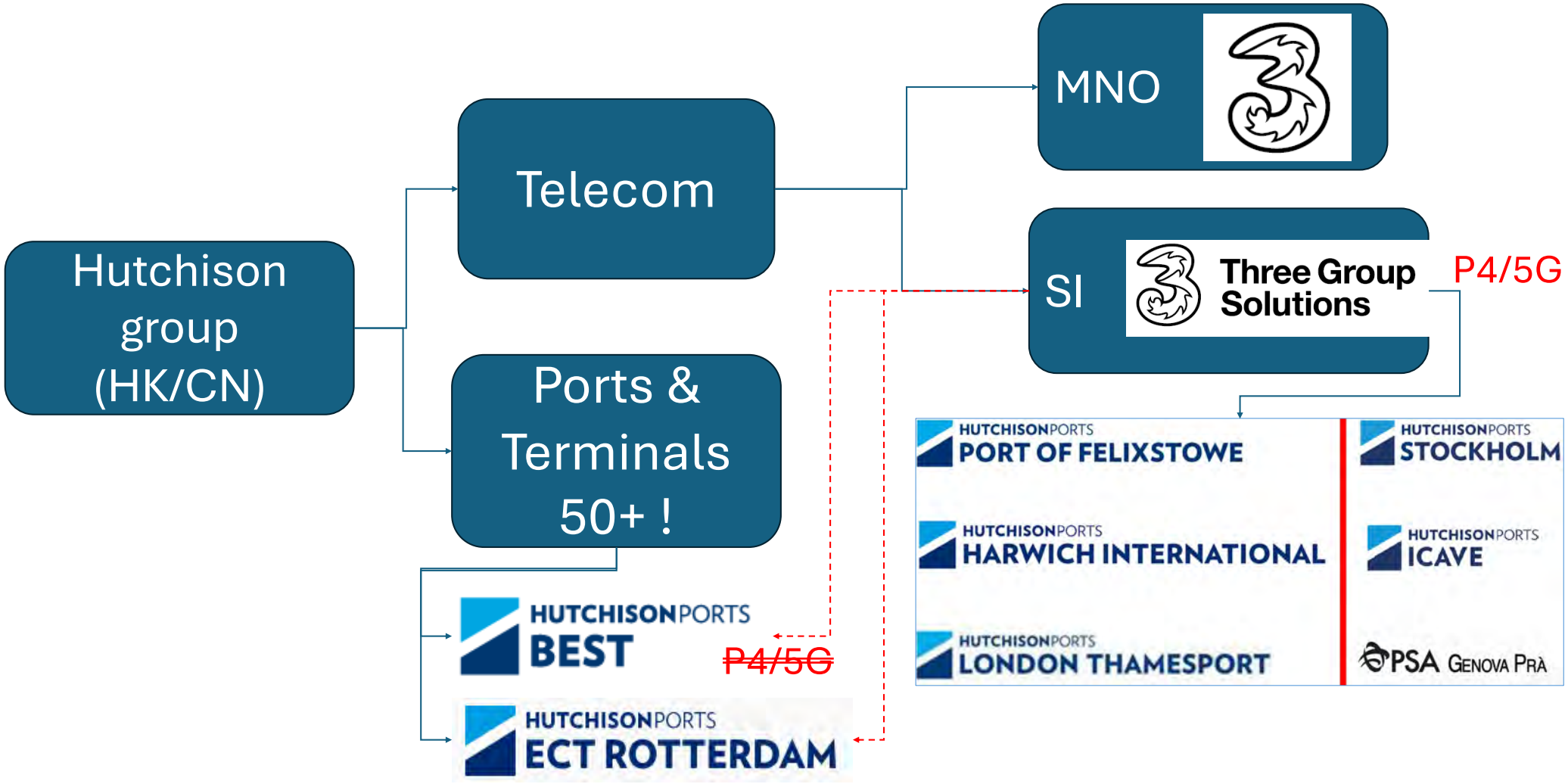
PIONEERS

5G MARITIME FOR INTELLIGENT VESSEL LOCATION, POWERED BY PIONEERS

This project aims to validate the location of ships in real time and with great precision, obtaining image data that complements the information from current port geolocation systems (AIS and radar geoposition system).

Experimenting, piloting, developing, incubating

Visit to ‘BEST’ container terminal



BEST Container terminal operations

- Quay cranes
- Stacking cranes
- RTG’s
- Trucks
- AGV’s

Telecoms:

- Fibre
- WiFi
- Port’s 5G !

Necessity to automate ports/terminals

Global Container Port Automation: Market

USD 4.5B
Market size 2023

USD 14B
Projected by 2030 (CAGR ~14-18%)

KPI IMPACT: AUTOMATED vs MANUAL

+8–15%
Crane moves/hr — vs manual benchmarks

–20–40%
Labour cost/TEU — reduction vs non-automated

–30–50%
Damage & incidents — across all automated facilities

–30–60%
CO2 per TEU — electrified terminals vs diesel

Source: Graham Wilde, Three Solutions; 3rd parties

The Port of Felixstowe – 3.3m containers move through the port every year

29	300	83	Up to 200
Quay Cranes	Trucks	RTGs	ATs

All use cases require 5Mbit/s UL and 10Mbit/s DL per device, <50ms latency

99.9% availability

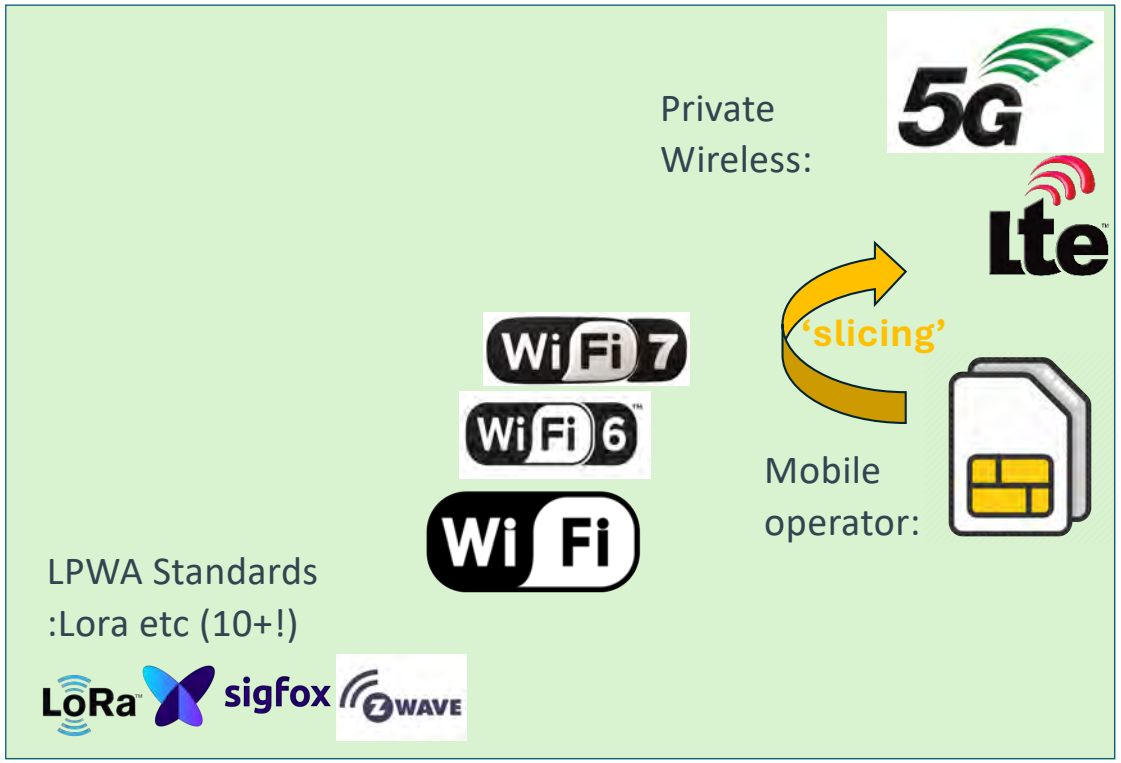
Three Group Solutions


Interactive session
Matching user requirements &
wireless network alternatives
KPI’s of network relative to use cases
Lstelcom | Siemens | Viavi

Relative position and performance of P5G vs common propositions in enterprise wireless

⇑ Level of QoS

Guaranteed

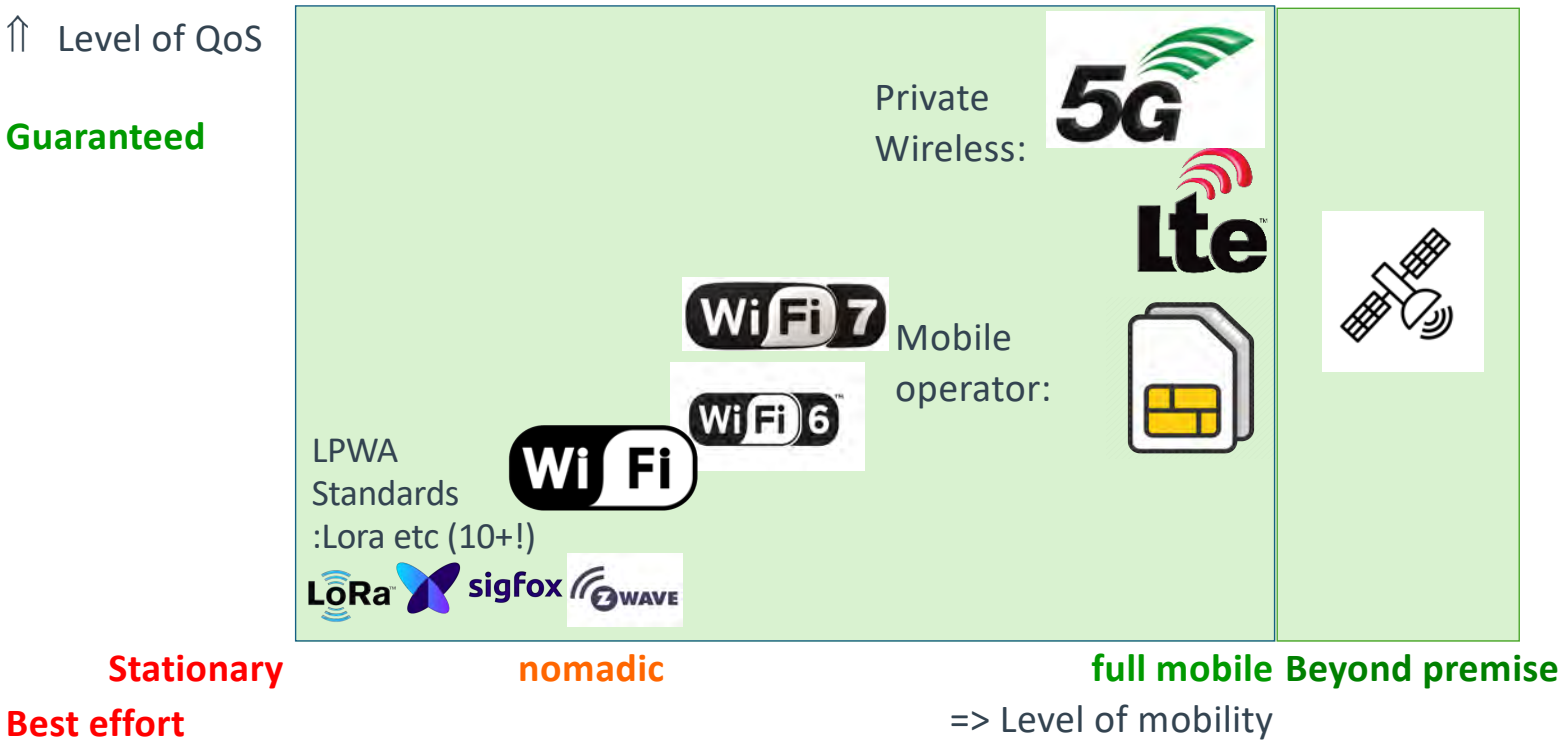


Best effort

Stationary **nomadic** **full mobile**

=> Level of mobility

Relative position and performance of P5G revisited for Sat

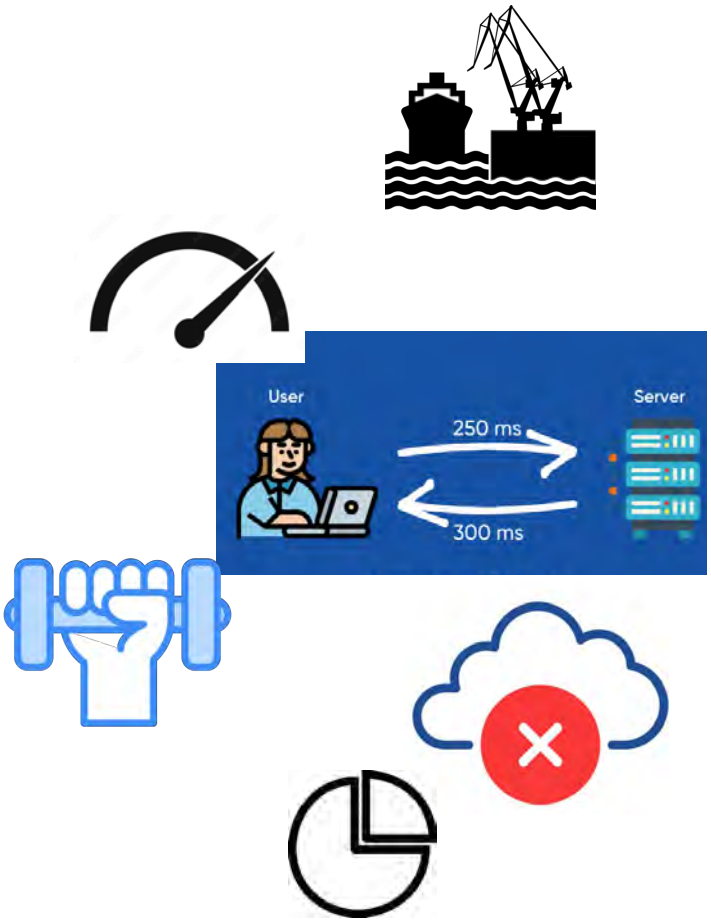


Use cases wireless in ports and logistics

- Remote Crane control
- Video crane operation
- AGV and AMR steering
- Drone control
- Predictive maintenance
- Telemetry
- Sensor data gathering
- Worker tablets
- Workers AR/VR support
- Video surveillance, perimeter control
- Trunked voice, PMR, walkie talkie

Critical KPI's for wireless port/logistics use-cases

- ❑ Coverage area, uncovered remote area's
- ❑ Device density
- ❑ Speed (data throughput)
- ❑ Latency (delay)
- ❑ Jitter (variation in delay)
- ❑ Robustness, availability (99.99…%)
- ❑ Service restoration, outage duration
- ❑ UL/DL ratio



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Matching usage and (type of) network

	LPWAN: LoRa, Sigfox etc	Wifi 6 (7,8)	Mobile operator subscription	Mobile operator slice	Private 4/5G	Satellite	Tetra, DMR, porto's
Autonomous Crane control, AGV's, AMR's							
Video controlled remote crane operation							
Drone control, drone surveillance							
Predictive maintenance,							
Telemetry , Sensor data							
Worker tablets, Workers AR/VR							
Video surveillance, perimeter control							
Trunked voice, PMR, walkie talkie							

Use cases and mapping of requirements to solutions

How to map use case requirements – Koen Mioulet

Break

Workshop / breakout sessions

Workshop on mapping use case requirements to wireless solutions using a canvas – Team PRIMMA

Presenting and discussing the results of the workshop

PRIMMA

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Matching usage and (type of)

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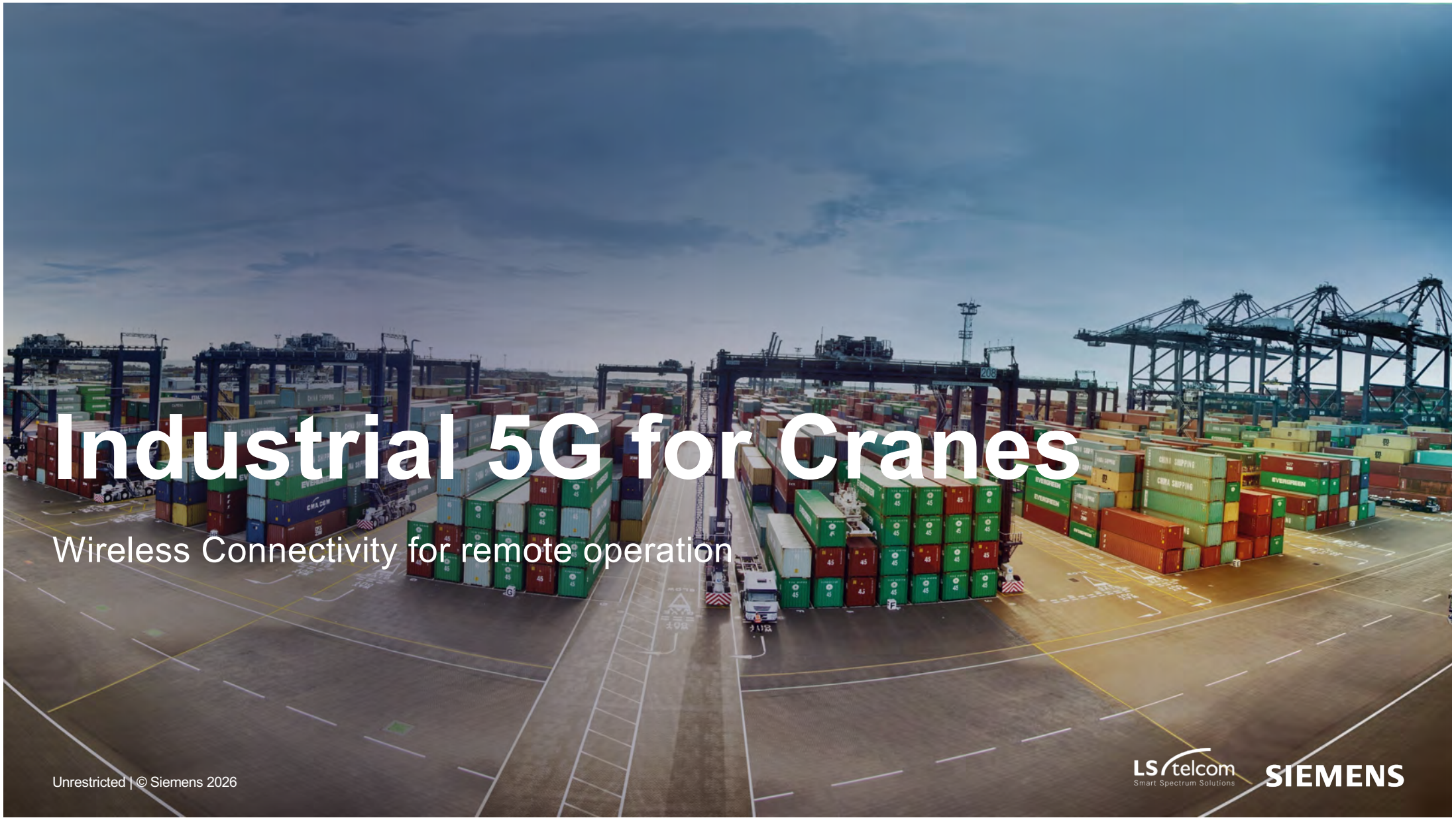
Worker tablets, Workers AR/VR							
Video surveillance, perimeter control							
Trunked voice, PMR, walkie talkie							

Quality Asssurance & operational excellence for advanced use of private networks

Relevance of KPI's for private networks – Saul Friedner and Daniel Mai of Siemens



Industrial 5G for Cranes

Wireless Connectivity for remote operation

LS telcom Smart Spectrum Solutions

SIEMENS

Industrial 5G for Cranes

Saul Friedner
Director, Spectrum Services and Business Development
LS telcom UK

Daniel Mai
Director Industrial Wireless Communication
Siemens AG

LS telcom – Accredited Solution Partner of Siemens for Private 5G Networks

- Provision of a comprehensive and powerful offering for private 5G applications – from consulting on specific use cases, licensing, planning and dimensioning to the complete implementation of the 5G network
- Private 5G wireless technology from Siemens supports a wide range of applications and cross-sector applications – developed and produced in Germany

Solution Partner
Automation Drives
SIEMENS

LS telcom Smart Spectrum Solutions SIEMENS

LS telcom @ Siemens

SIEMENS

- Global sales network
- Industry expertise and sector knowledge
- Specialized solutions and services for industry requirements

SIEMENS

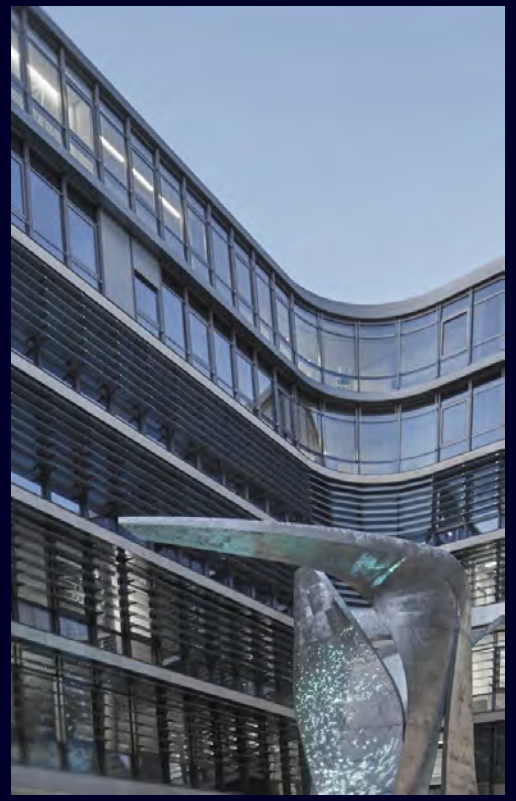
- 5G Core
- 5G Radio Access Network (RAN)
- Radio Units
- User Equipment (UEs)

LS telcom Smart Spectrum Solutions

- Spectrum Regulation, Licensing & Management
- Spectrum Monitoring
- Private Wireless & Professional Mobile Radio

LS telcom Smart Spectrum Solutions

- Software for radio network planning
- Airborne measurements
- Network realization / implementation



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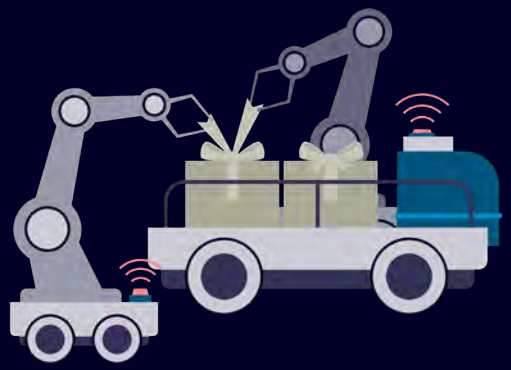
Why KPIs matter more in Private Networks

- Private networks optimised for operational performance rather than subscriber best efforts
- Objectives include deterministic performance, operational reliability, predictable latency and guaranteed throughput



Private 5G is ideal for industrial / enterprise environments, so KPIs offer

- Safe and reliable remote crane control
- Low latency and secure communications to safety critical devices/equipment

Key KPI Targets

- Latency <10 ms
- Reliability >99.999%
- Packet loss <10^-5
- Availability >99.99%
- Handover success rate >99.5%

Network KPIs

Performance KPIs

Service KPIs

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KPIs inherently maximise productivity and efficiency and derive deployment costs

Private 5G Use Case Drivers

Different industrial use cases prioritise different KPIs.

Ports
Multi use case environment with focus on safety, reliability and availability

AGVs
Key focus on safety, low latency, availability and handover

Video analytics
Key focus on mainly throughput

Infrastructure design and deployment criteria

Cost, SLAs and management

Tracking of KPI metrics for continuous improvement

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Why Wireless?

Mobile Robots working together

They need low latencies
to synchronize their tasks

Emergency stops

Latencies and reliability are key to make sure that
a machine really stops instantly when
an emergency stop has been pressed

Augmented workforce

High bandwidths are needed to
provide high data rates for handheld
devices on the shopfloor

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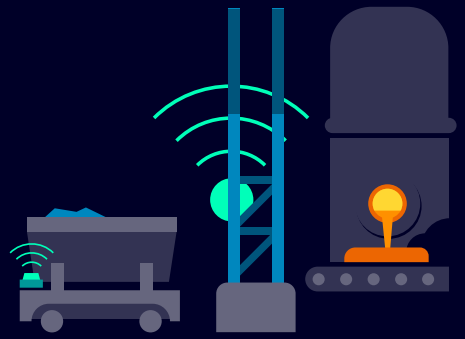
Special requirements on the shop floor

Harsh environment



Reliability is king

Optimal coverage

Guaranteed Latencies, Deterministics

High uplink data rates

Industrial protocols

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Applications with private Industrial 5G networks

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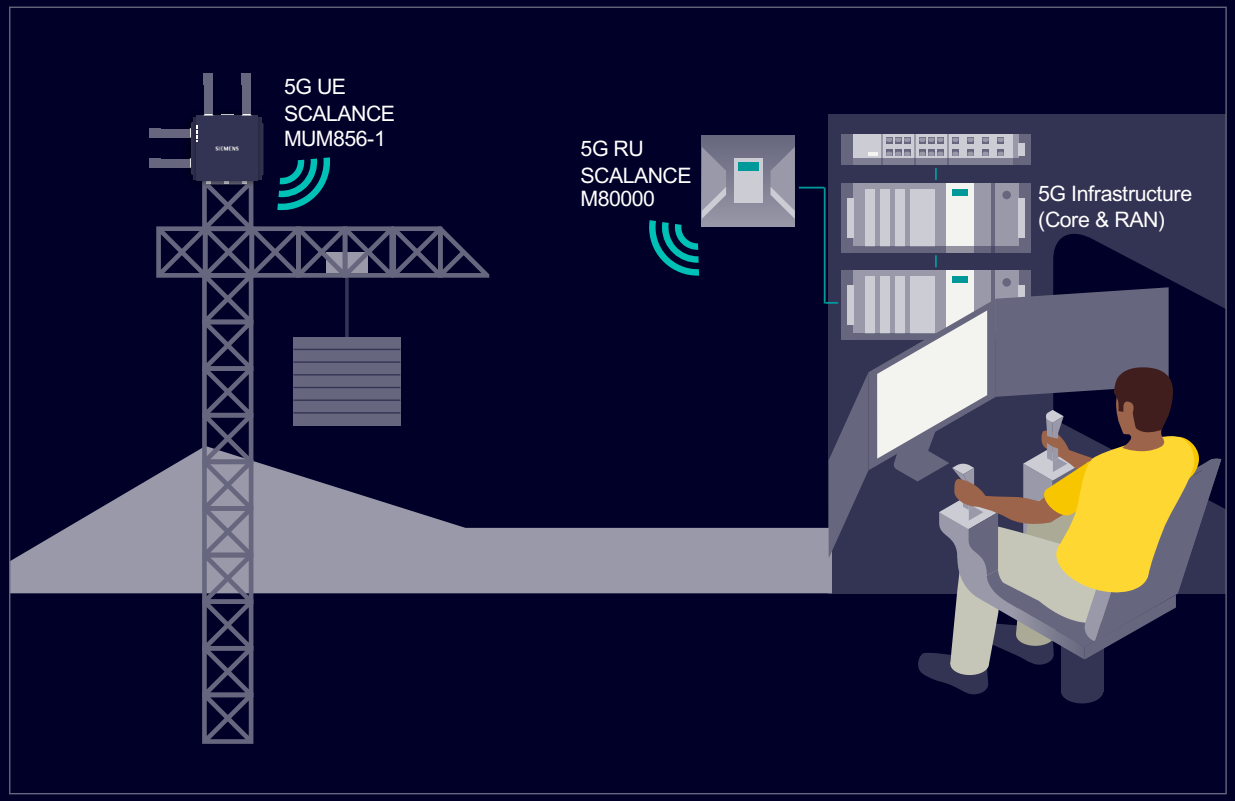
Reliable connectivity for remote operation of mission-critical applications
Remote Operation of Cranes



- Reliable, deterministic communication with high bandwidth enables remote operation of cranes
- Low-latency connectivity enables realistic user experience for the operator (real-time video stream & machine feedback)
- One technician can operate several cranes from an ergonomic working station just by switching from one instance to another

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Reliable connectivity for (intra) logistics applications

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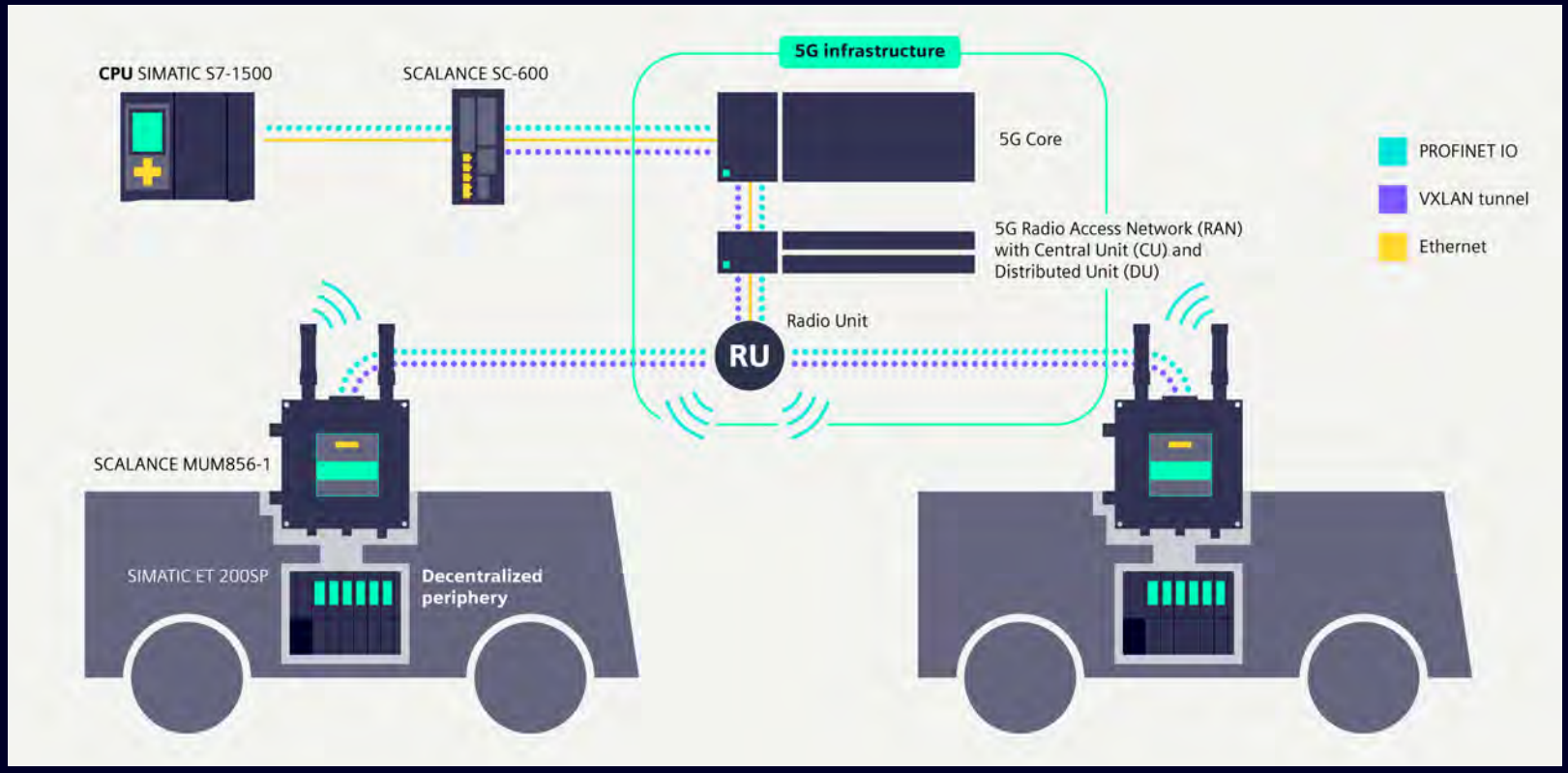
Reliable connectivity for (intra) logistics applications



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Additional use cases for Private 5G Networks

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 Hub: forwarding of the radio signal into a cell* Radio Units (RUs): transmission of the radio signal
User Equipment (UEs)	Connection of end devices to 5G network

*optional, for extension of cell coverage

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Private Industrial 5G solution

- Focus on ease of use for OT personel
- Tested End-to-End interoperability with automation equipment
- Freely adjustable upload/download capacities (TDD patterns) to e.g. enable video streaming
- Traffic profiles with different QoS
- PROFINET / Layer-2 communication
- OT Cybersecurity compliance (NIS2, IEC 62443, CRA)
- Different Radio Units to cover various private spectrum allocations
- Rugged product design, UEs with different IP classes and certifications, broad antenna portfolio
- 5 years warranty, 10 years product availability, 10 years spare part availability

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Quality Assurance & operational excellence for advanced use of private networks

Methods to ascertain network performance for critical operations – Viavi

XEdge

Network Assurance for Smart Ports

Continuous Monitoring for Private LTE / 5G Deployments

Ilya Samokhin| VIAVI Solutions | March 2026

Ports Are Going Private 5G — But Who Watches the Network?

No Visibility

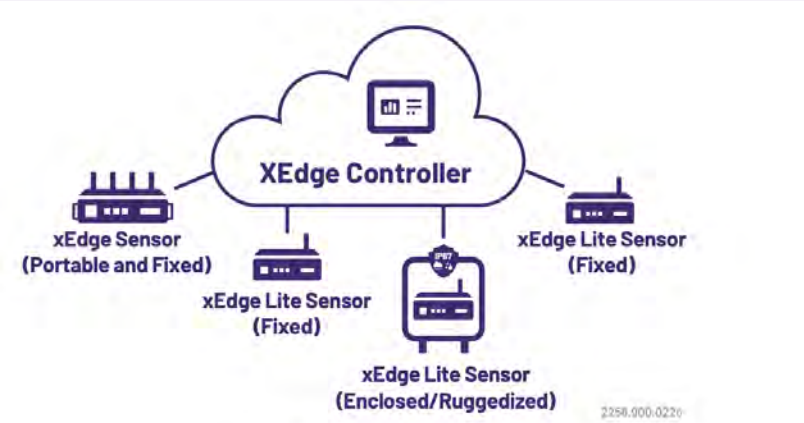
MNO tools don't cover private networks. Port IT teams lack RF expertise.

SLA Uncertainty

Integrators deploy and leave. Who validates ongoing network quality?

Mission-Critical Ops

AGVs, RTG cranes, and safety systems need guaranteed connectivity.



XEdge Sensor Deployment

XEdge: Always-On Network Intelligence

Software-driven sensor platform by VIAVI Solutions. Monitors 4G/5G networks 24/7 — fully automated, no RF expertise needed.

200+

KPIs Collected

RF, throughput, latency

4

Operators at Once

Multi-carrier DAS

24/7

Autonomous

No manual intervention

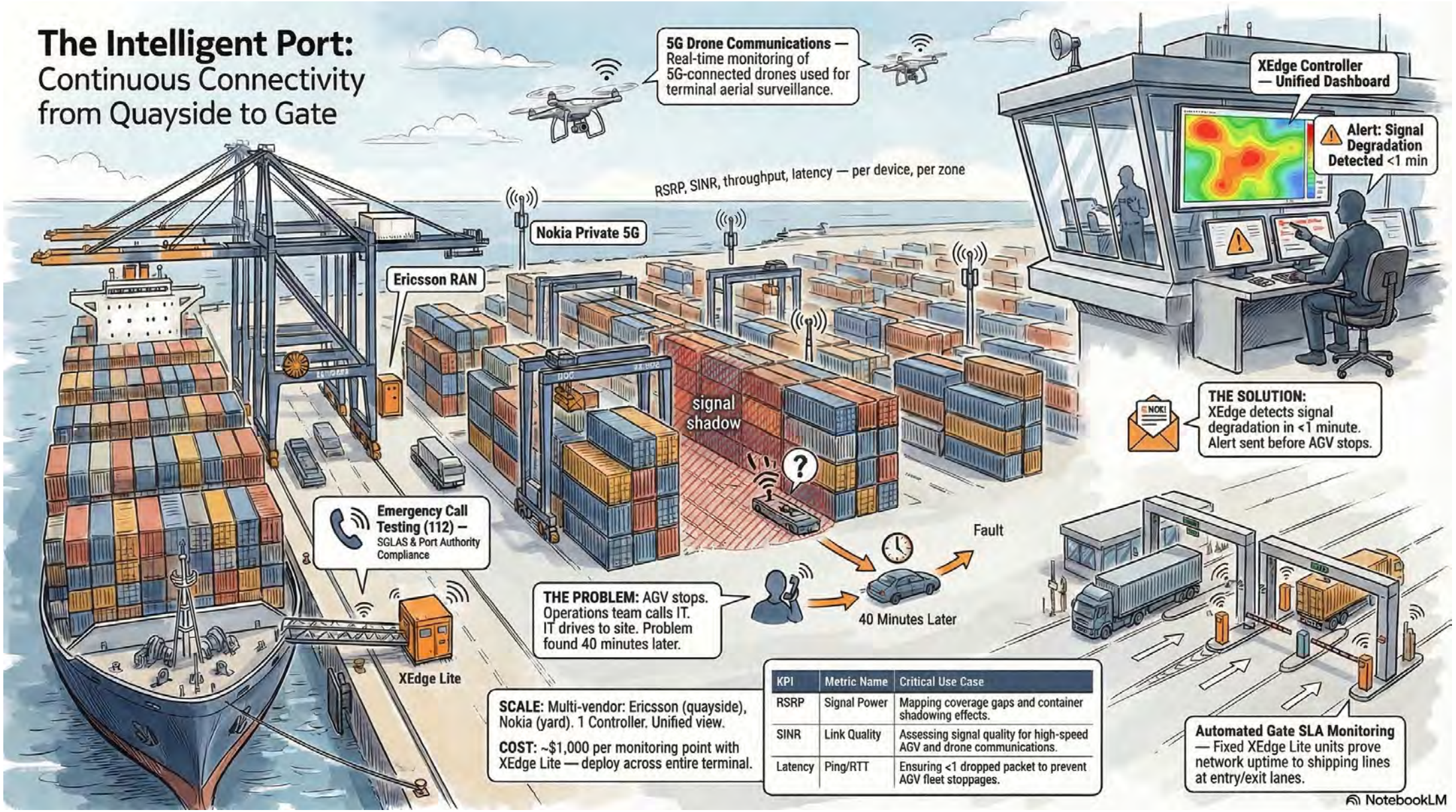
Speed, ping, iPerf, HTTP, YouTube QoE

REST API: ServiceNow, Splunk, Grafana

Alerts: SMS, email, API webhook

GPS heatmaps, geo-fencing, walk tests

VIAVI



KPI	Metric Name	Critical Use Case
RSRP	Signal Power	Mapping coverage gaps and container shadowing effects.
SINR	Link Quality	Assessing signal quality for high-speed AGV and drone communications.
Latency	Ping/RTT	Ensuring <1 dropped packet to prevent AGV fleet stoppages.

XEdge Lite - Mass Deployment for Ports

Low Cost

sensors

5–15x cheaper than alternatives

- **Size:** Palm-sized (567g)
  Easy to mount anywhere in the terminal
- **Power:** PoE+ or 12V DC
  <20W — use existing port infrastructure
- **Connectivity:** LTE + 5G NR (sub-6)
  NSA & SA, 1 modem
- **Outdoor:** IP67 enclosure option
  $200 add-on for quayside deployment

Controller software: centralized dashboard for all sensors. On-prem or cloud.

VIAVI

Port Use Cases

AGV / Autonomous Vehicles

Validate low-latency connectivity for automated guided vehicles across terminal zones

Crane & RTG Operations

Monitor network at quayside and yard crane positions, alert on degradation

SLA Validation

Prove integrator/MNO SLA compliance with continuous automated evidence

Safety Systems

Ensure reliable connectivity for emergency calls, man-down alerts, and safety IoT

Coverage Mapping

GPS heatmaps across berths, yards, and gate areas — identify dead zones

Security Testing

Validate network segmentation between OT/IT when using private 5G

VIAVI

Private 5G ≠ Secure by Default

In public networks, devices are isolated from core infrastructure. In private 5G, devices share the same IP space as your SCADA and OT systems.

Public MNO Network

- ✓ Devices isolated by architecture
- ✓ No route to core/OT systems
- ✓ NAT + GTP tunneling enforced
- ✓ Security = operator's problem

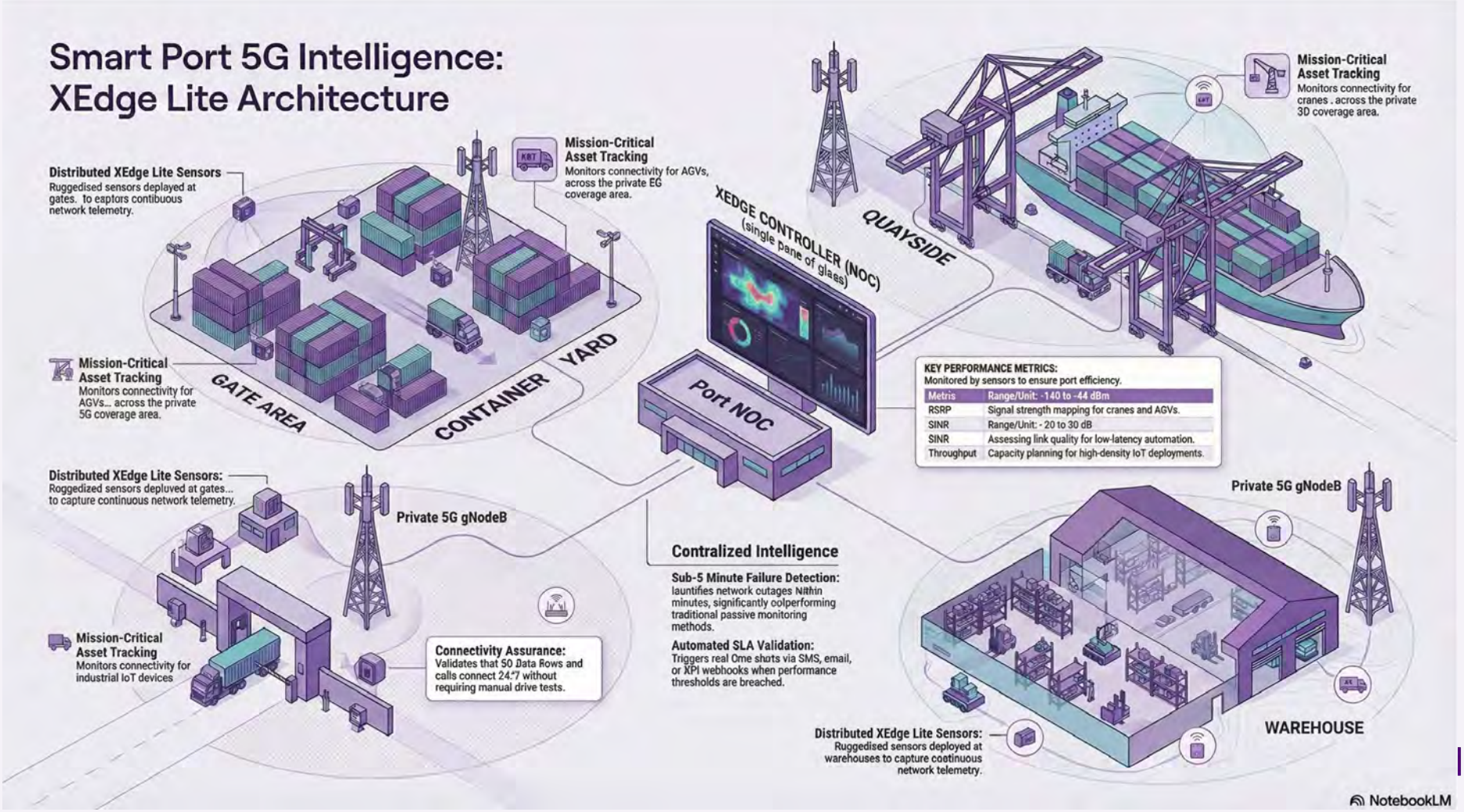
Private 5G in Your Port

- ✗ Devices on same IP space as OT
- ✗ Direct route to SCADA / cranes
- ✗ Segmentation depends on config
- ✗ Security = YOUR problem

XEdge validates that your firewall rules and segmentation actually work — from the device perspective.

VIAVI

How XEdge Deploys in a Port



Let's Talk

1

Site Assessment

We map your port layout and identify optimal sensor locations

2

Pilot Deployment

5–10 XEdge Lite units, 30-day proof of value with live data

3

Scale to Production

Full terminal coverage with centralized monitoring

Ilya Samokhin| ilya.samokhin@viavisolutions.com | viavisolutions.com/xedge

Wrap-up, conclusions, take-aways and next steps

PRIMMA

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Year program 2026 (subject to change)

- 4 events (1 per quarter) at inspiring locations with participation of all digital ecosystem roles
- Program co-created with partners with focus on use cases, solutions and technology
- Work on deliverables on basis of collaborative participation and separate budget

Joining PRIMMA now means becoming part of a movement that builds future-proof logistics infrastructure and capabilities.

Join PRIMMA →

*In March PRIMMA will organize a knowledge mission Private Networks as part of the NL program during Mobile World Congress Barcelona.

Drechtsteden, March 19, 2026

At Drechtsteden initiatives like Smart Port and Dealdrechtsteden are leading the way to collaborate with the local private and public communities aimed at innovative maritime solutions like:
- Digital connectivity, IoT/Sensing.
- Qos Assurance and SLA Management,
the number one unique selling point of private networks. The event includes presentations and demonstrations of innovative use cases.

Port of Valencia, April 21-22, 2026

Port of Valencia is the largest port of the Mediterranean see and leading in the digital developments with private networks.

In April the Container Terminal Automation Conference in Valencia will taken place, that we will visit combined with a meeting session and a tour in the Valencia port.

Belgium Airport, September 2026

In Belgium, the ecosystem is well developed with many impressive deployments of private 5G already. An overview will be given at an airport. In addition to allowing further optimisation of the airport's operations, the 5G technology will also enable to accelerate digital innovations and facilitate the integration of future technologies.

NL Logistics, November 2026

PRIMMA provides public bodies with a strategic platform to align policy with market needs,. This session will further explore public-private cooperation with existing cross-sector logistic communities and association in the logistics sector. To help shape the regulatory and innovation landscape for next-generation logistics.

Networking in the demo environment

Informal networking with all participants on the ground floor, with **Techbinder, PhoneCam, Soply, PubliXR and Frontier / Peplink**

Live demonstrations

FRONTIER EU

SMART VESSEL OPTIMIZER

PUBLIXR

SOPLY

PhoneCam™

Powered by:

TECHBINDER

ULWIMO
ULtimate Wireless MObility

ECOSYSTEM SERVICES

flow center of Excellence

duurzaam heids fabriek

Digitalzh

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