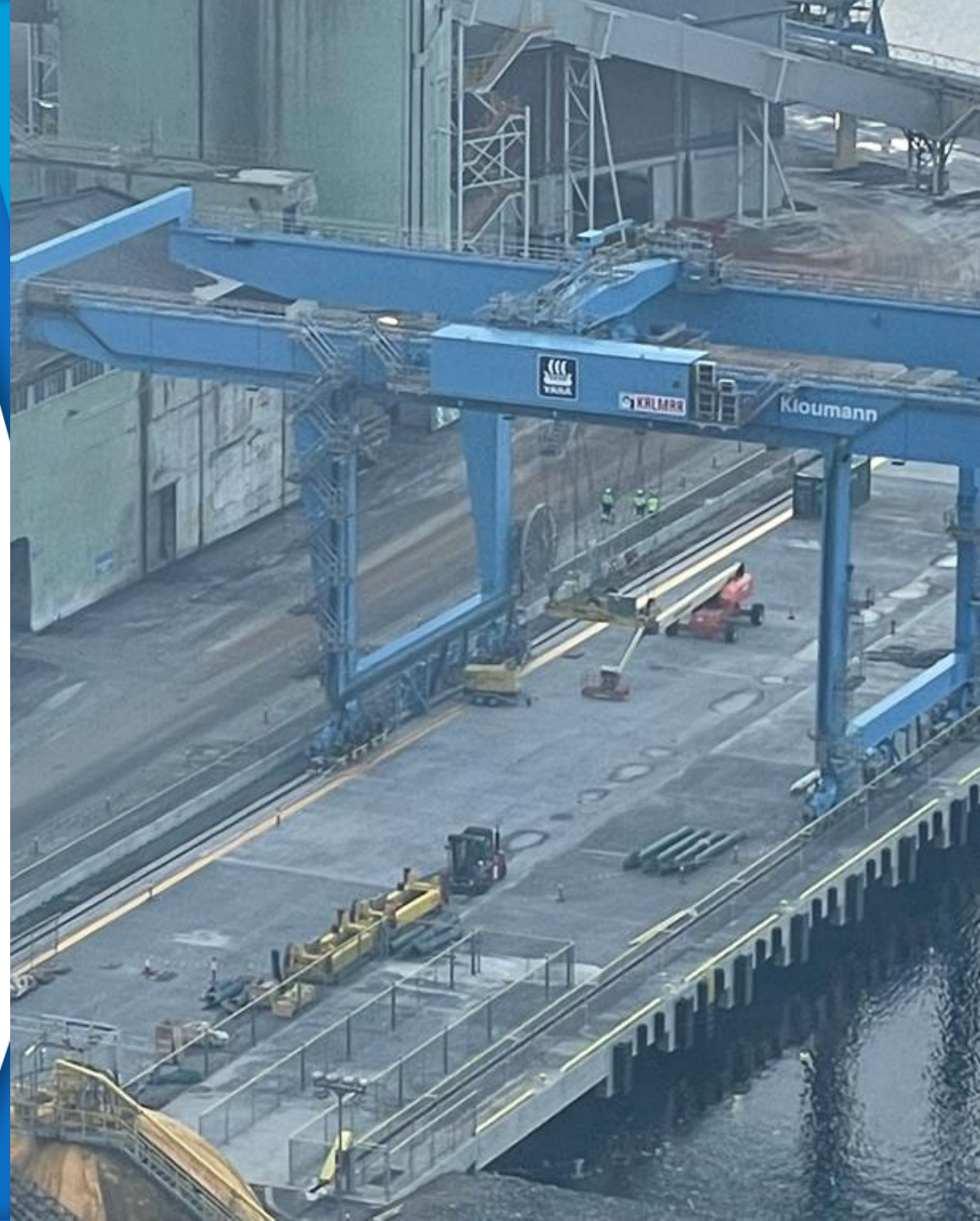


5G solutions, Smart Port at Yara Porsgrunn overview

Stig Myrland, Process System Manager at Yara Porsgrunn



Agenda

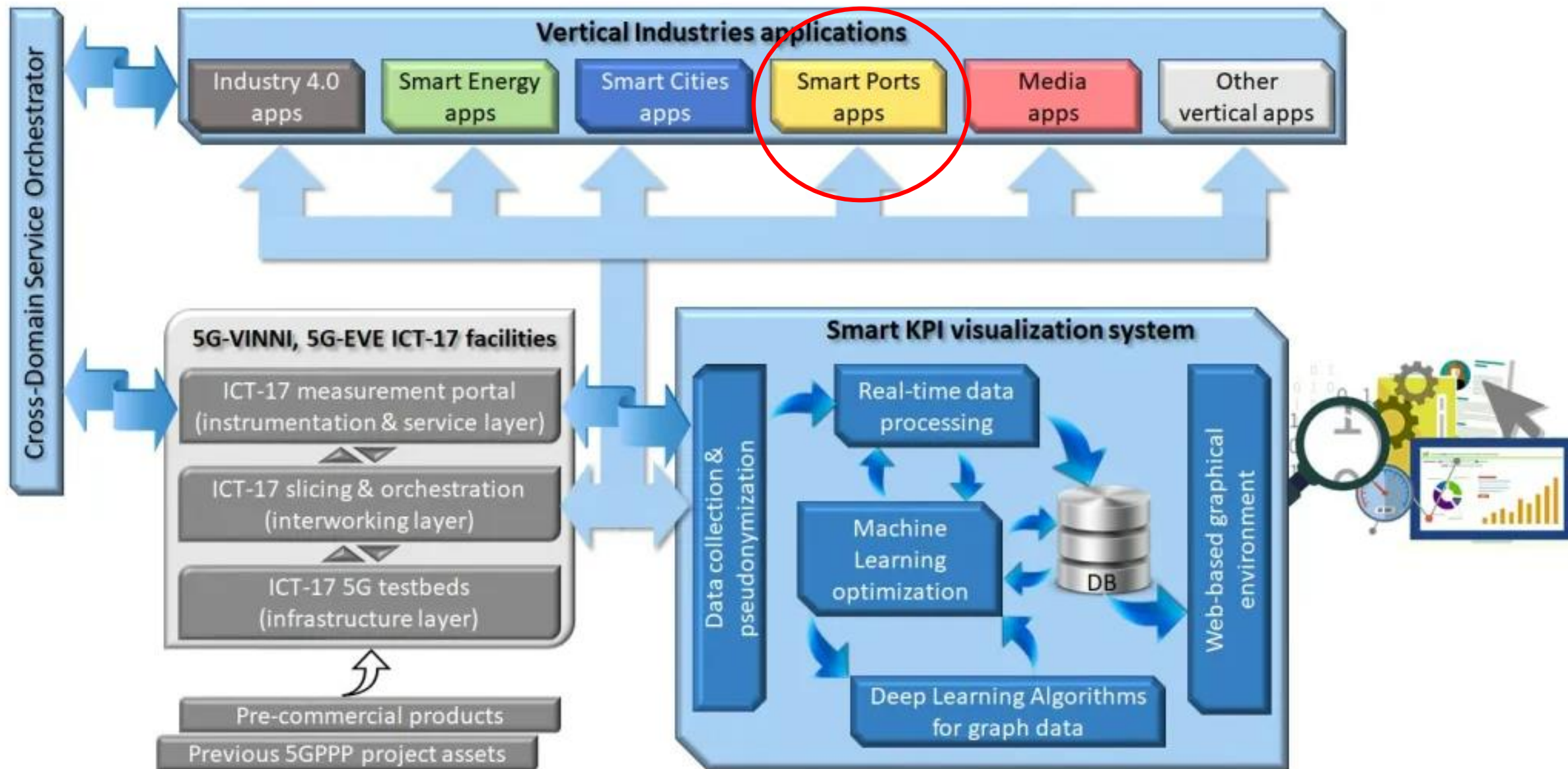
- EU project 5G - Solutions
 - Smart port
- Preliminary results
- Slicing and ROV over 5G (NTNU, YARA, Telenor)
- Why 5G?
- Summary

5G - SOLUTIONS FOR EUROPEAN CITIZENS






The "fifth generation" of telecommunication systems, or 5G, will be one of the most critical building blocks of the European digital economy and society in the next decade. Significant steps towards this strategic technology are being made at EU level, within the framework of the 5G Public Private Partnership, in view of validating the technology across domains.

[Read More](#)

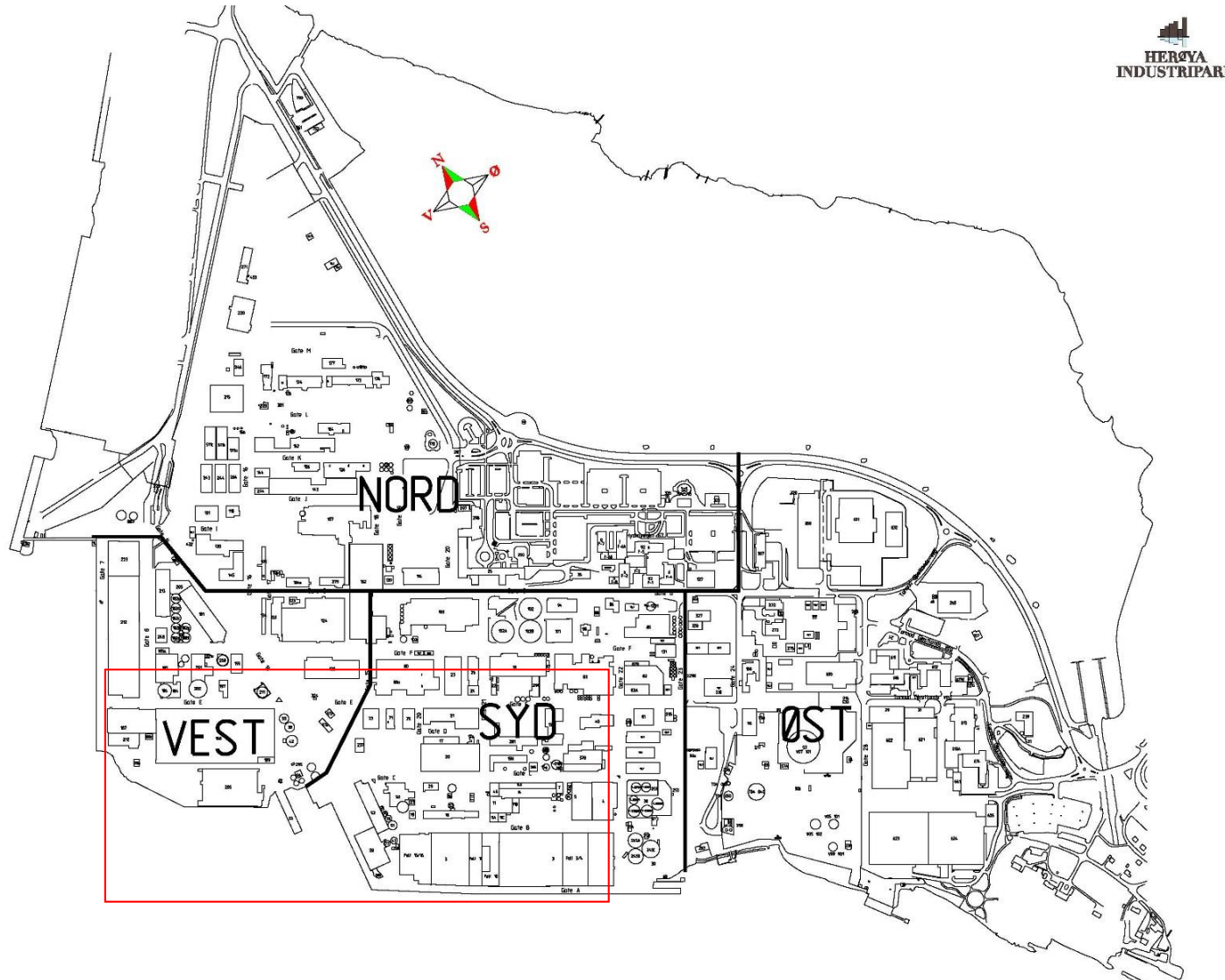




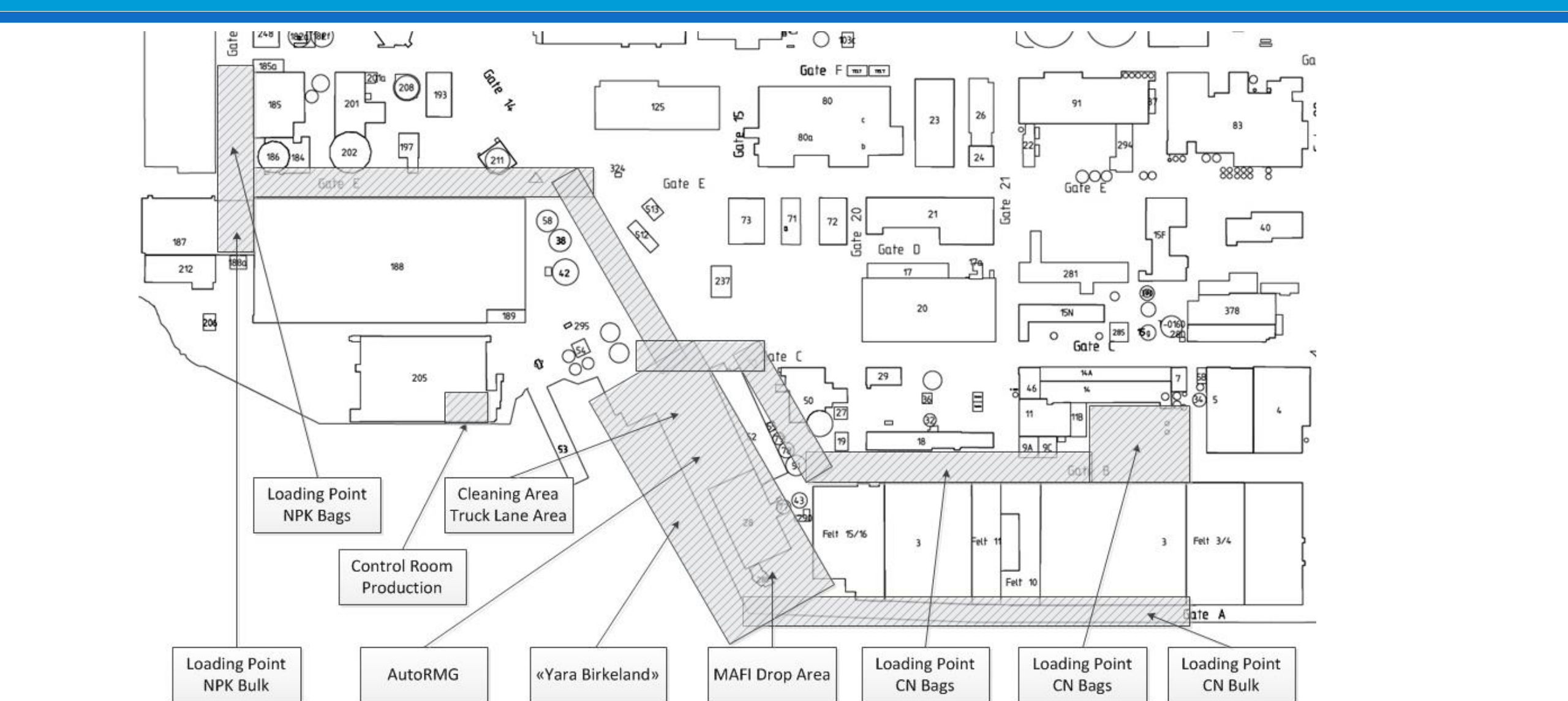
5G will give increased network performance

5G	Latency	Throughput	Connections	Mobility	Network Architecture
	1 ms E2E Latency	10G bps Per Connection	1,000K Connections Per km ²	500 km/h High-speed Railway	Slicing Ability Required
					
LTE	30~50ms	1000 Mbps	10K	350Km/h	Inflexible

Smart Port



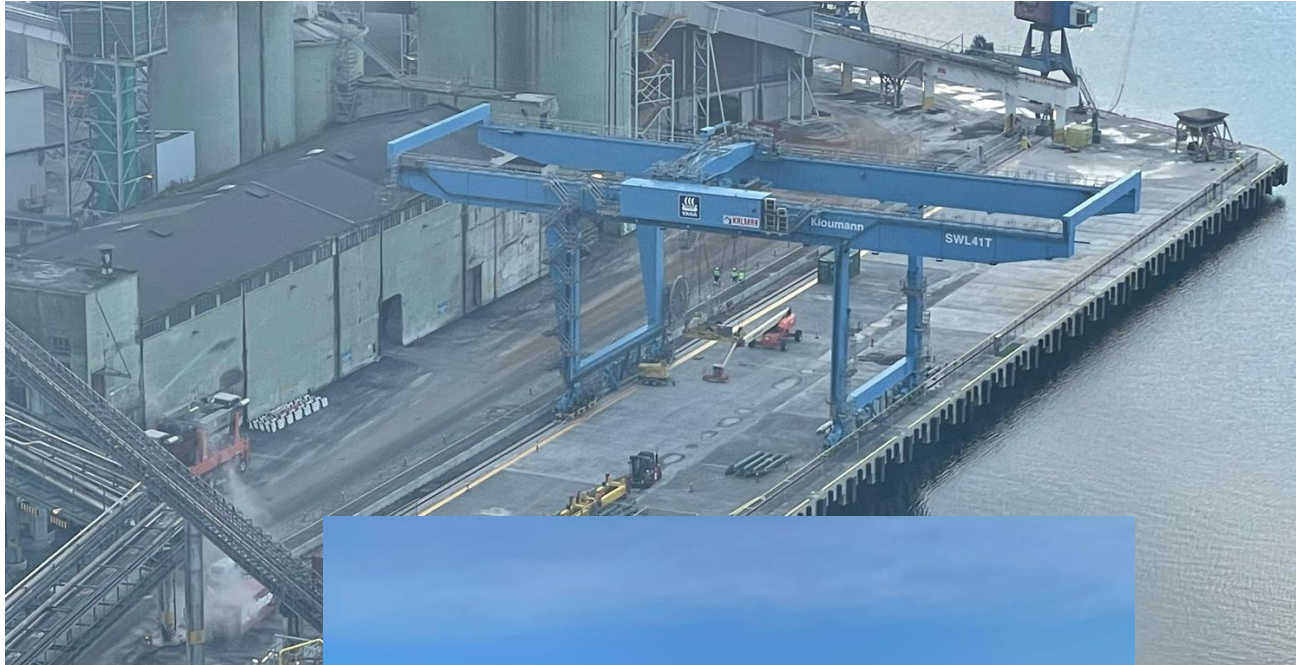
HERØYA
INDUSTRI PARK



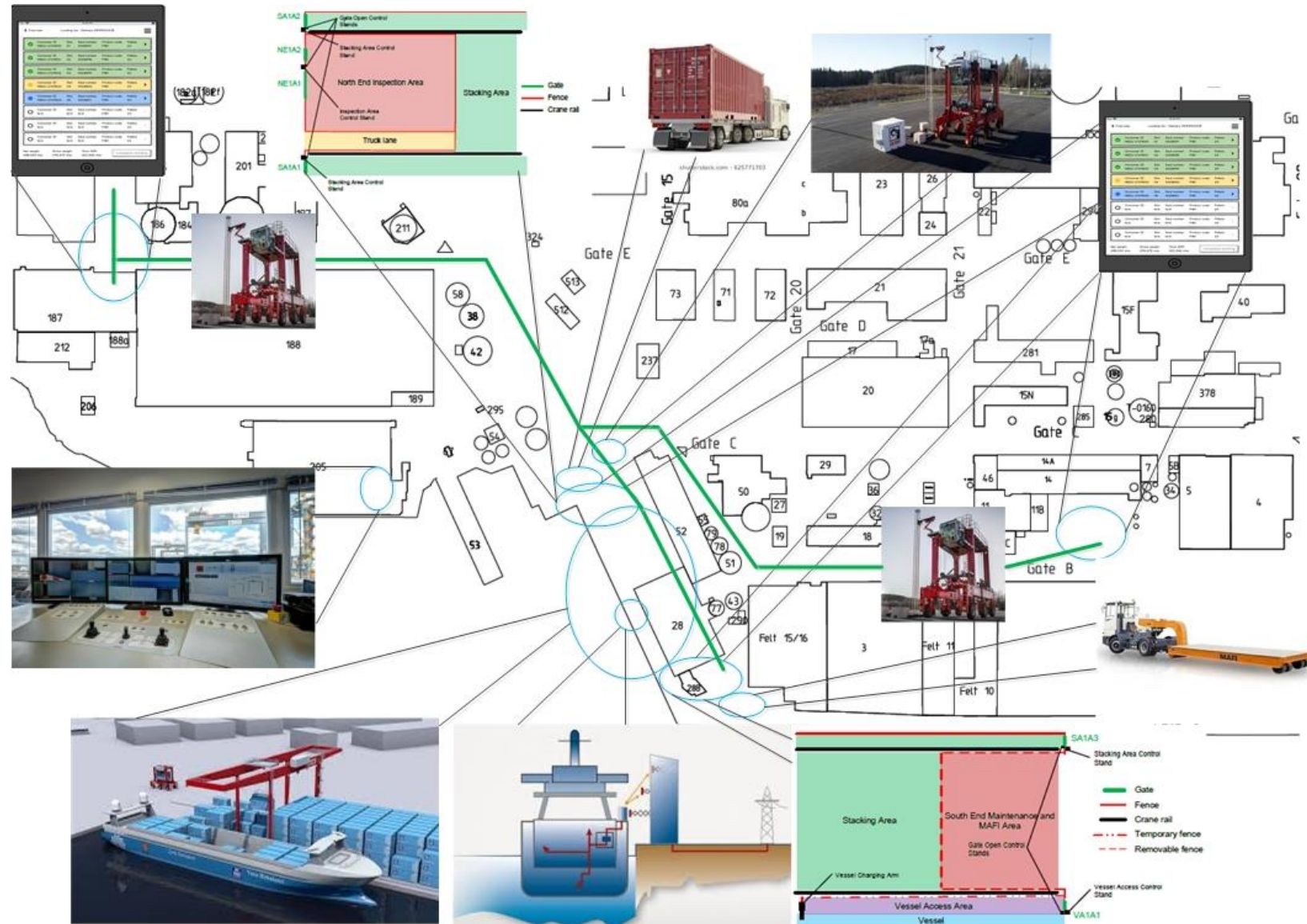
Smart Port – 5G setup



Smart Port – Main componets



Smart Port - Integrations



This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 856691

12/09/2022

10

Smart Port - Fully digitalized supply chain



IT'S ALL ABOUT
INTEGRATION
POWERED BY KONGSBERG





Yara Birkeland



Smart Port – Yara Birkeland



Smart Port – Yara Birkeland

Facts about Yara Birkeland

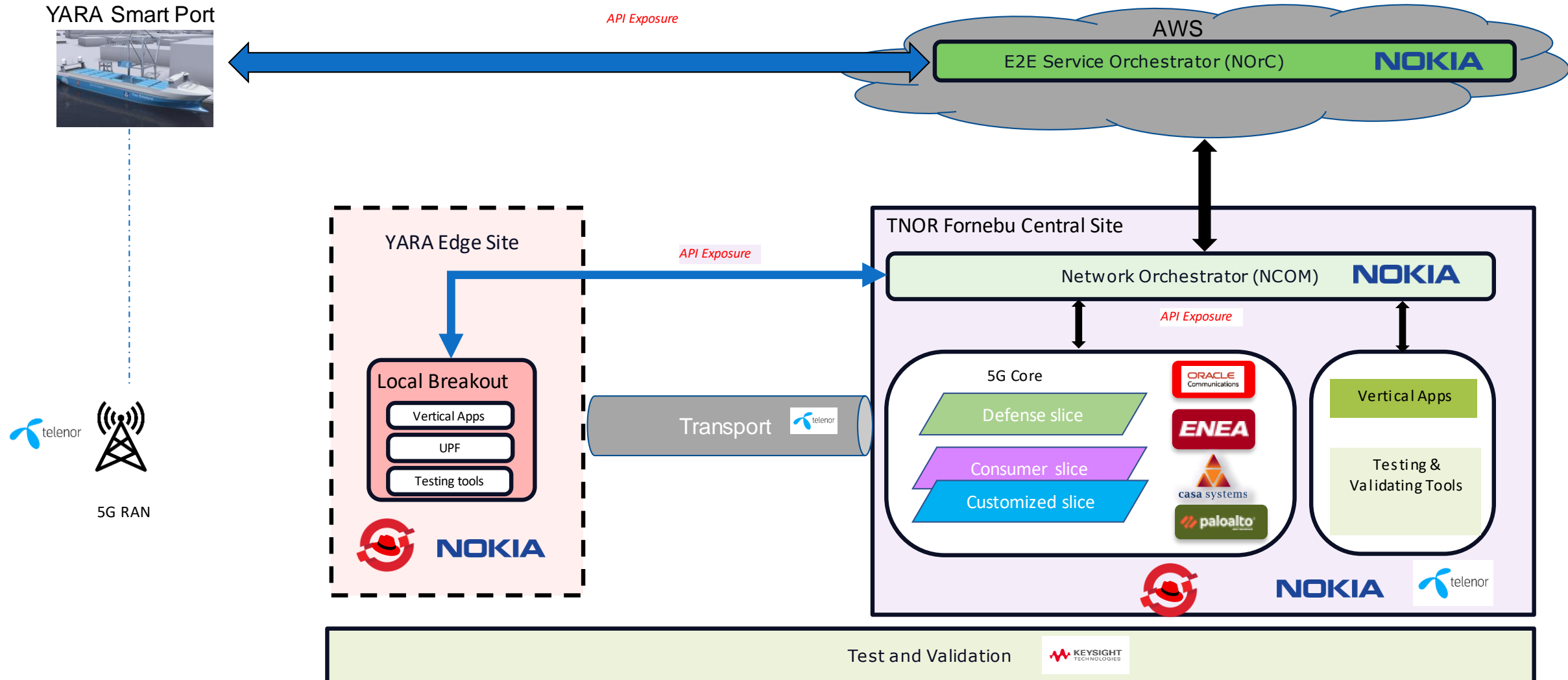
- Yara Birkeland is the world's first electric and autonomous container ship with zero emissions. The ship will transport fertiliser across the fjord from Yara's Porsgrunn plant to Brevik port and thereby replace 40.000 diesel truck loads per year and eliminate associated carbon emissions.
- The ship has been developed in collaboration between several Norwegian players. The technology company Kongsberg Maritime is responsible for the development and delivery of the Yara Birkeland technology, including sensors and integration required for remote control and autonomous operations, as well as electric propulsion, battery and control systems.
- The ship was built at Vard's shipyard in Brattvåg, Norway. Massterly, a joint venture undertaken by the Norway-based Wilhelmsen group and the Kongsberg group, has operational responsibility for Yara Birkeland from its monitoring and operations center in Horten, Norway. State-owned Enova has supported the development of Yara Birkeland with NOK 133.5 million.
- Yara Birkeland will be put into operation in 2022. Initially, it will start a two-year trial period to become autonomous and certified as an autonomous, all-electric container vessel.

The diagram illustrates a 5G testbed architecture. It features a central **5G Vinni 5G core** with an **API App**. The core is connected to a **Base station** (26GHz) and a **5G Transmitter** (3.5GHz). The core also connects to a **Nordic connect** cloud and an **Internet** cloud. The architecture is divided into several regions:

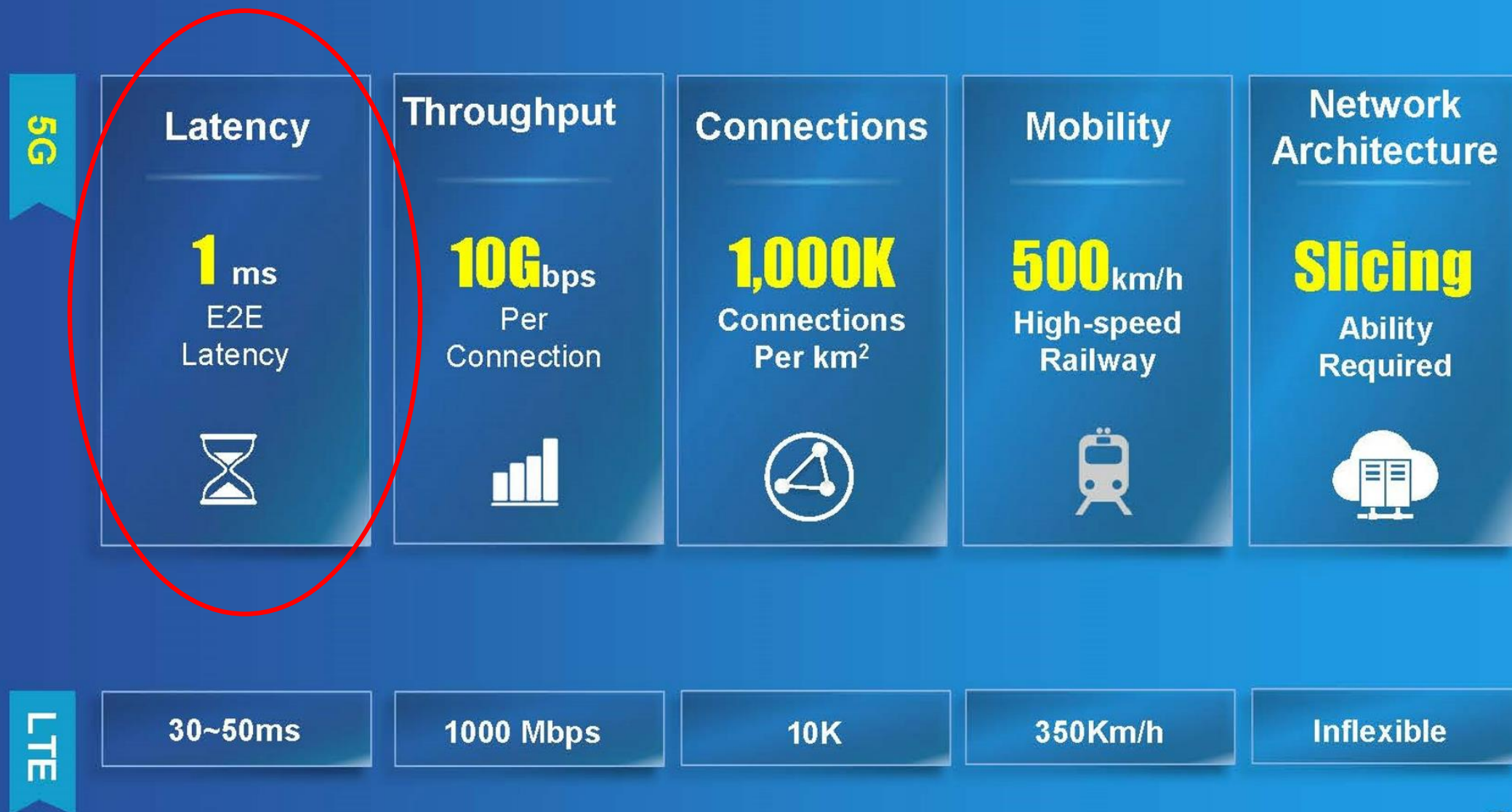
- Kongsberg:** Includes **TB data transfer**, **AZURE**, and **SQL data sync**.
- Yara Porsgrunn LAN:** Includes **5G Test server**, **DLC/PSS server**, and **SQL data sync**.
- Yara production network:** Includes **5G Test PC**, **PSS client**, and **5G Test server**.
- Nuro games:** Includes a **Server** and a **VPN Gateway**.
- NTNU:** Includes a **Server** and a **VPN Gateway**.

Other components include **CAR**, **5G Modem**, **PLC**, **4K camera (5G)**, **DLC Tablets**, **5G test equipment**, **Antenna**, **Straddler**, **Autonomous bus**, and **5G Vinni 5G core** with an **API App**.

Smart Port – 5G architecture



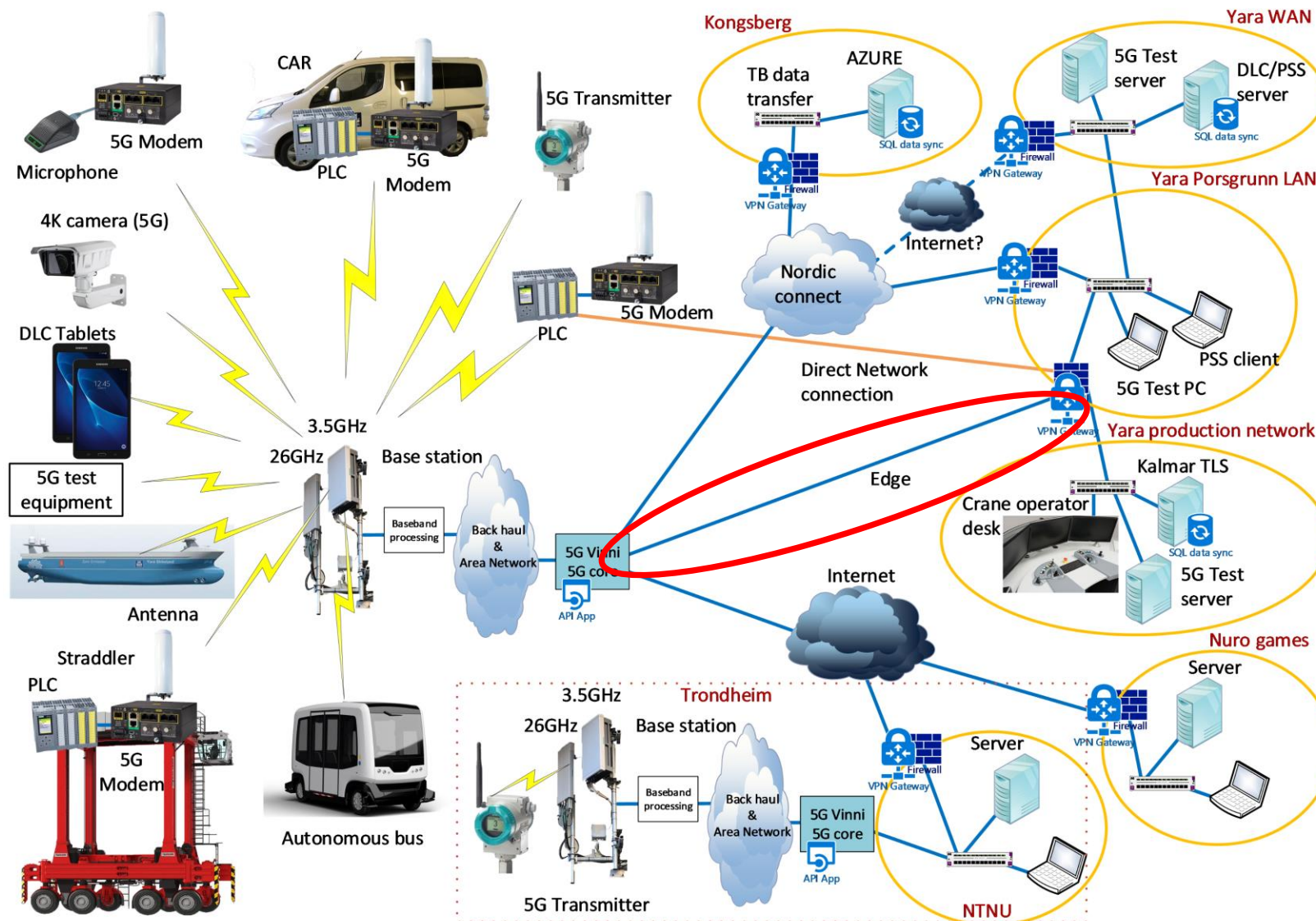
5G will give increased network performance



Low latency

- Will make 5G capable to do real time applications
- Makes it possible to have more or less deterministic communication
- Will support autonomy in a good way
 - Continuous and efficient movement
- Demands a local breakout from 5G
 - Travel distance is key for low latency
- Not possible in NSA 5G, demands Standalone 5G

Smart Port – Topology drawing

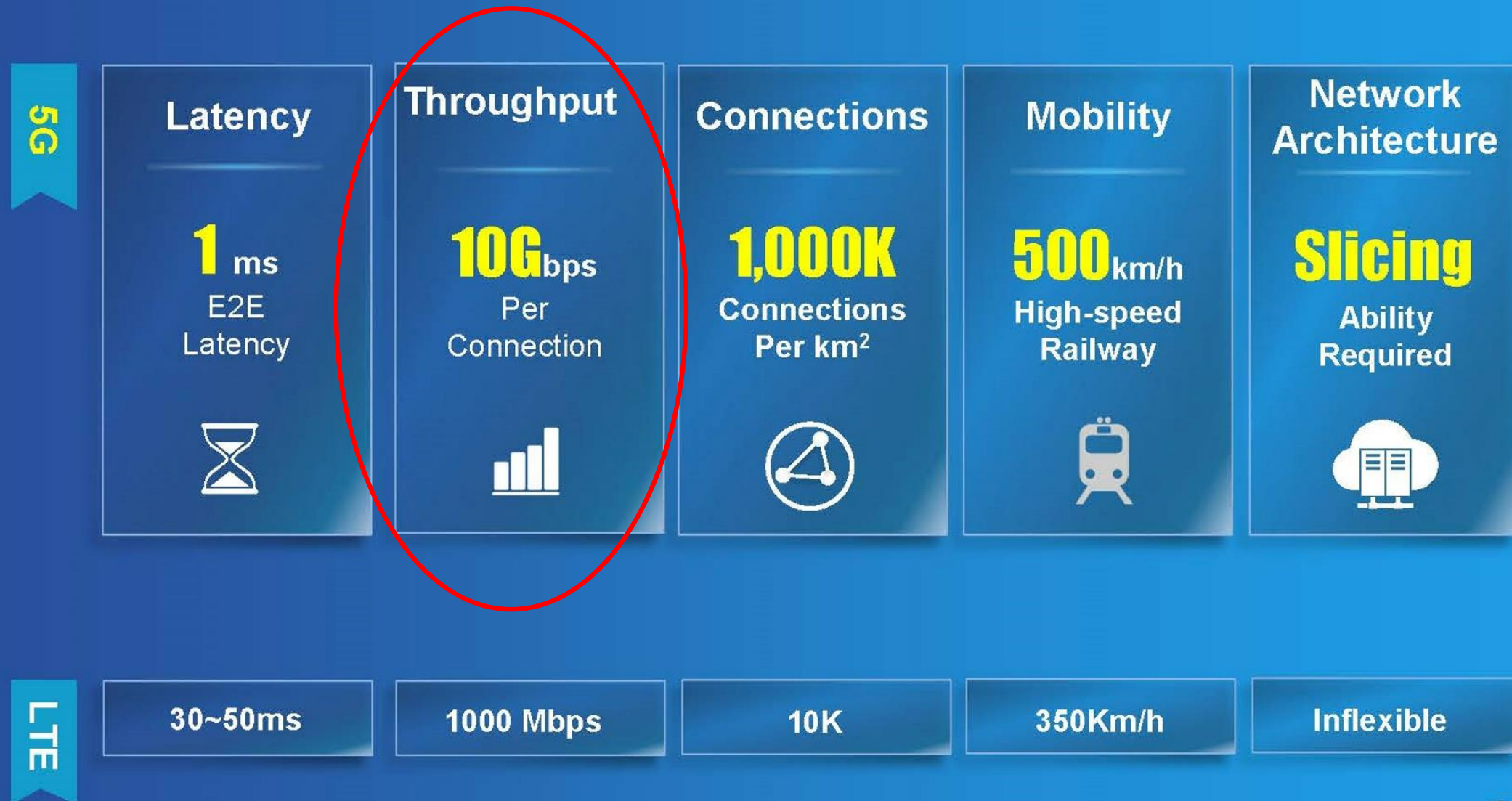


This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 856691

12/09/2022

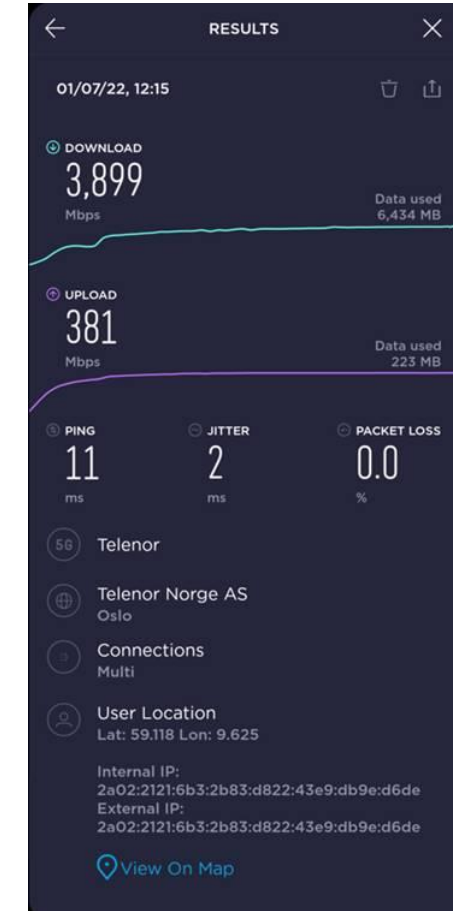
20

5G will give increased network performance



Up and download speed

- 5G promise extreme speed
 - Screen dump shows results from our precommercial 26GHz 5G net
 - Download almost 4 Gbps
 - Upload at approx 380 Mbps
- Upload is more demanding than download
 - End user equipment have low power compared to 5G antenna
- But still, impressive results
 - A limited number of industrial use cases demands more
 - One of our use case demands UL at 500 Mbps
- Public users demands high download speeds
 - Streaming of video
- Industrial users demands high upload speeds
 - Data / video from field to control room or cloud



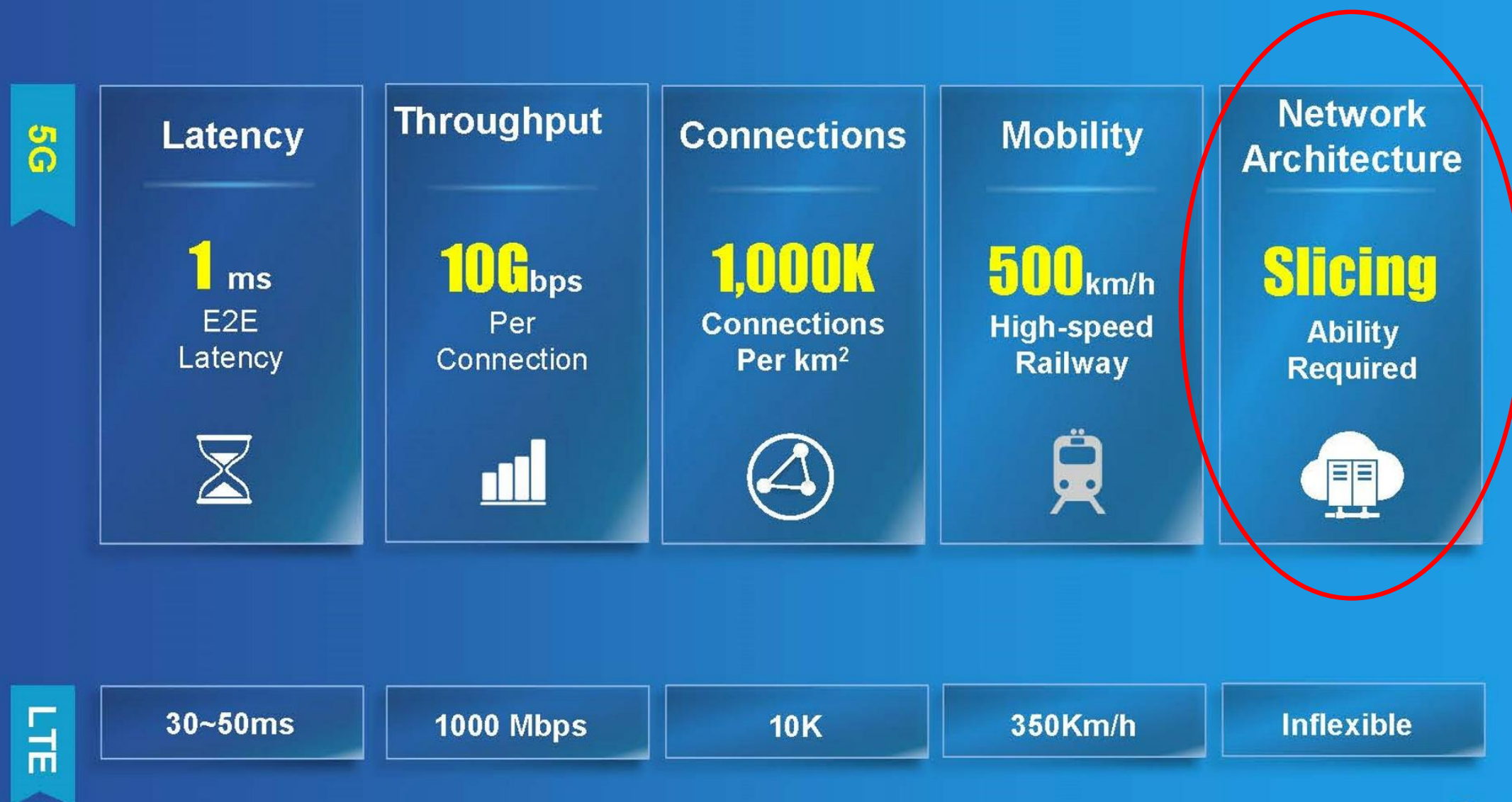
The diagram illustrates a 5G testbed architecture. At the center is the **5G Vinni 5G core**, which connects to various components. On the left, a **Base station** (26GHz) and a **5G Transmitter** (3.5GHz) are connected to **5G Modem** units, which are in turn connected to a **CAR** and a **Straddler** (PLC). A **5G test equipment** (red circle) is connected to an **Antenna**. The core connects to an **Internet** cloud, which then links to several regional networks: **Kongsberg** (AZURE, TB data transfer, SQL data sync), **Yara Porsgrunn LAN** (5G Test server, DLC/PSS server, SQL data sync), **Yara production network** (5G Test PC, PSS client, 5G Test server, Kalmar TLS, Crane operator desk), **Nuro games** (Server, VPN Gateway), and **Trondheim** (5G Vinni 5G core, API App, Base station, 5G Transmitter). The diagram also shows **Nordic connect** and **Direct Network connection** paths.

Up and download speed 3.6GHz

- Example result Smart Port



5G will give increased network performance



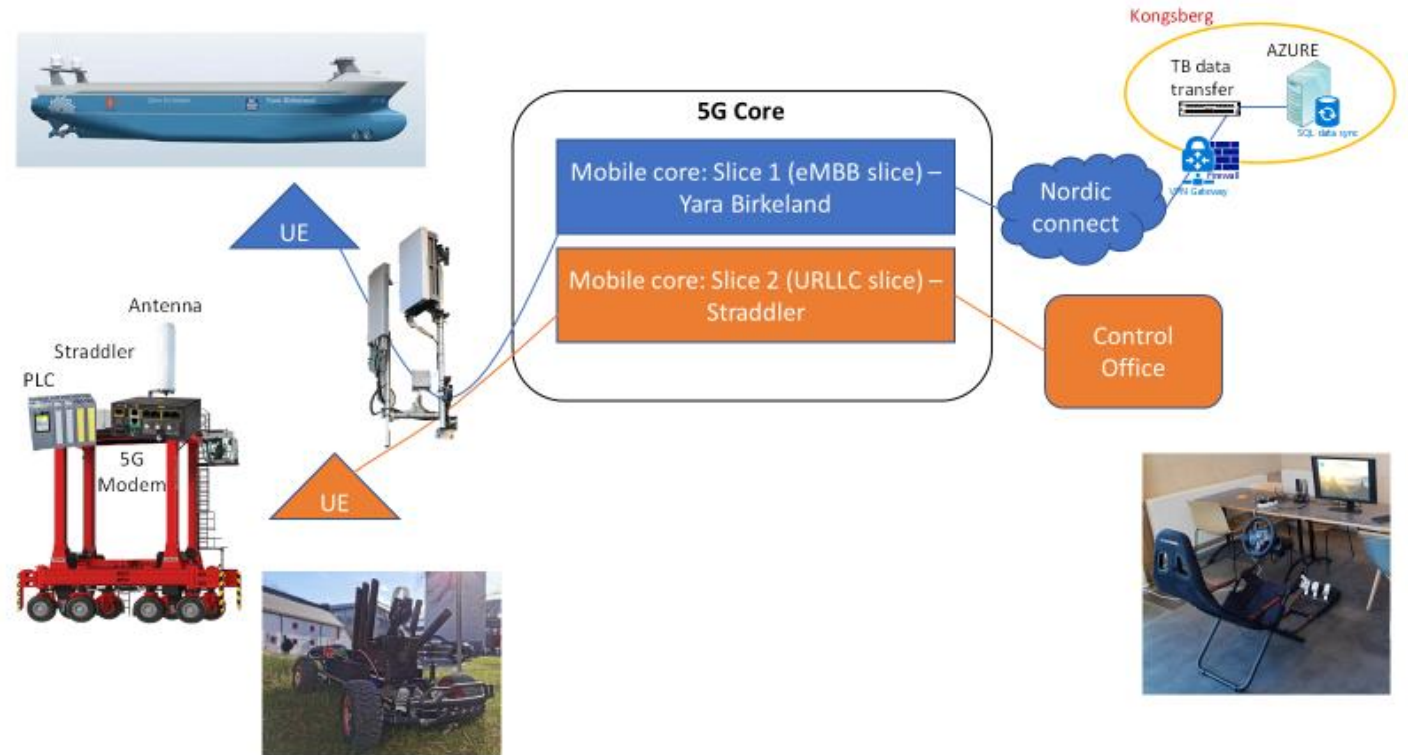
Slicing (capacity prioritization)

High speed upload link on 26.6 GHz system:

Require >500 Mbps upload speed to upload diagnostic data from the autonomous operation of the Birkeland Vessel within the available timeslot. Therefore, eMBB.

Low latency requirement to support Real time applications:

In order to control straddle carriers in real time, the system need to react quickly in a predictable way. The latency needs to be low and repeatable. The performance needs to be guaranteed when the network is loaded and capacity is shared with other traffic. Therefore, (URLLC).



NTNU student project in cooperation with Yara og Telenor

Machine control – remote steering of vehicle over Telenor's commercial NSA 5G network



- Service requirements
 - Device-to-Device VPN network over 5G
 - eMBB video uplink from vehicle and downlink to control unit
 - URLLC – signaling uplink from control unit and downlink to vehicle for steering, speed, and brakes
- Live pilot May 2021
 - Drive test Trondheim from Tyholt to NTNU (2.0 km)
 - Verified that it is possible to steer vehicles over 5G
 - Average speed 9,23 km/hour
 - Median video latency 124 ms
 - Median signaling latency 34 ms
 - Video [Slik fjernstyres bilen over Telenors 5G-nett! \(online.no\)](https://www.online.no)

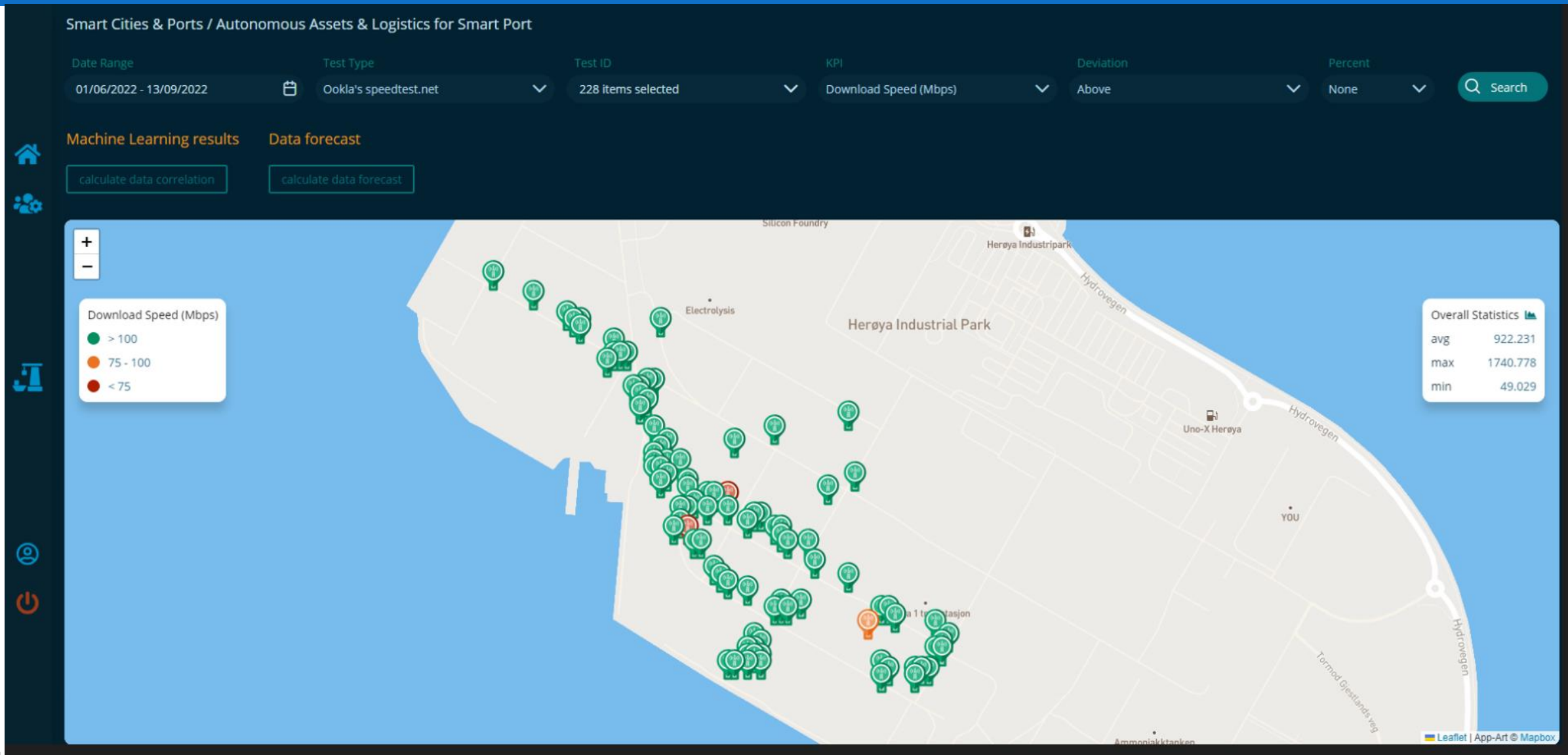
Source:

Jon Ola Landgraff, Lars Markus Lerdahl, Karsten Sedal Slagstad, Aksel Digre Søbstad 2021:
Fjernstyring av kjøretøy over 5G/4G. Bachelor oppgave Ingeniørfag. NTNU

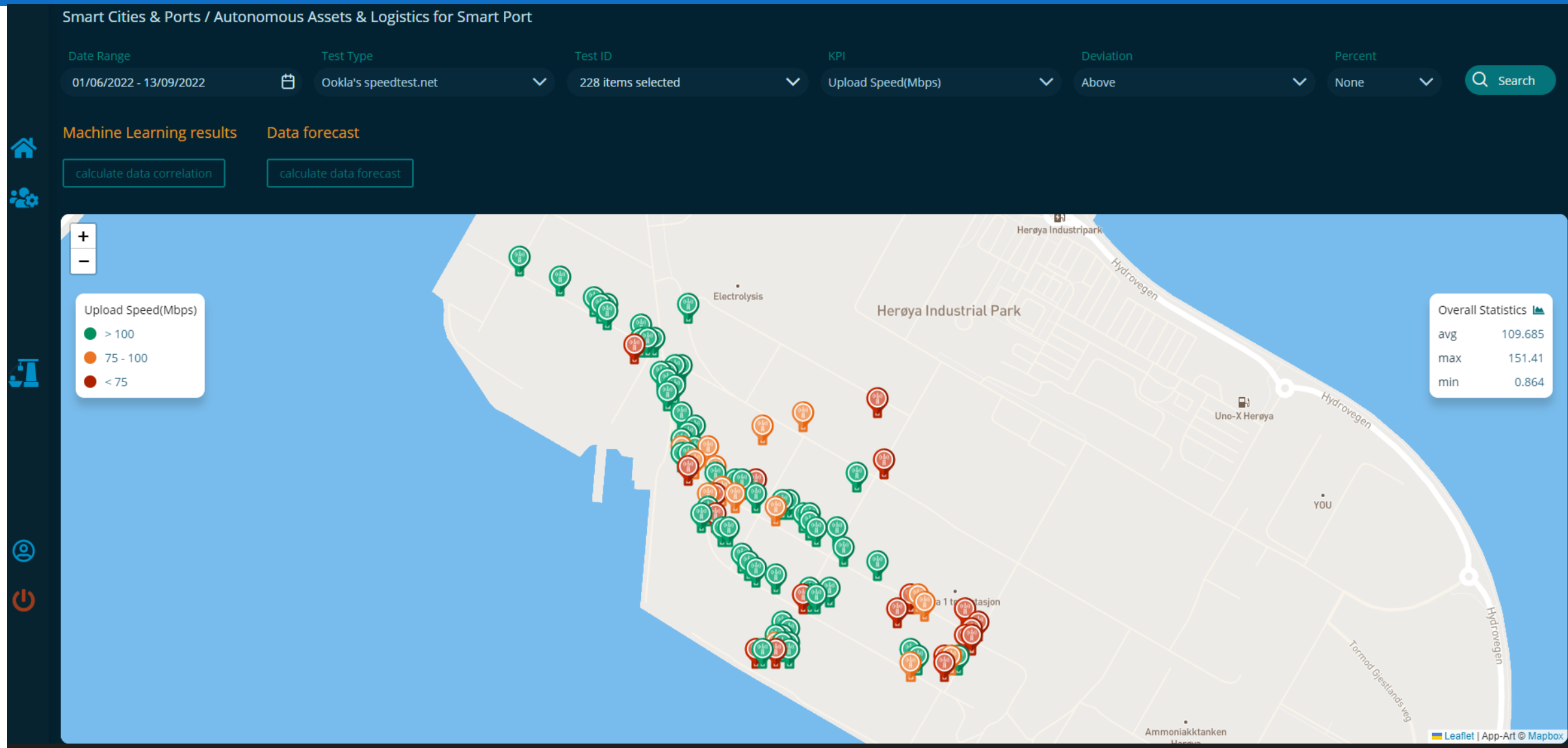
1

Sensitivity: Internal

Outdoor coverage – Download speed



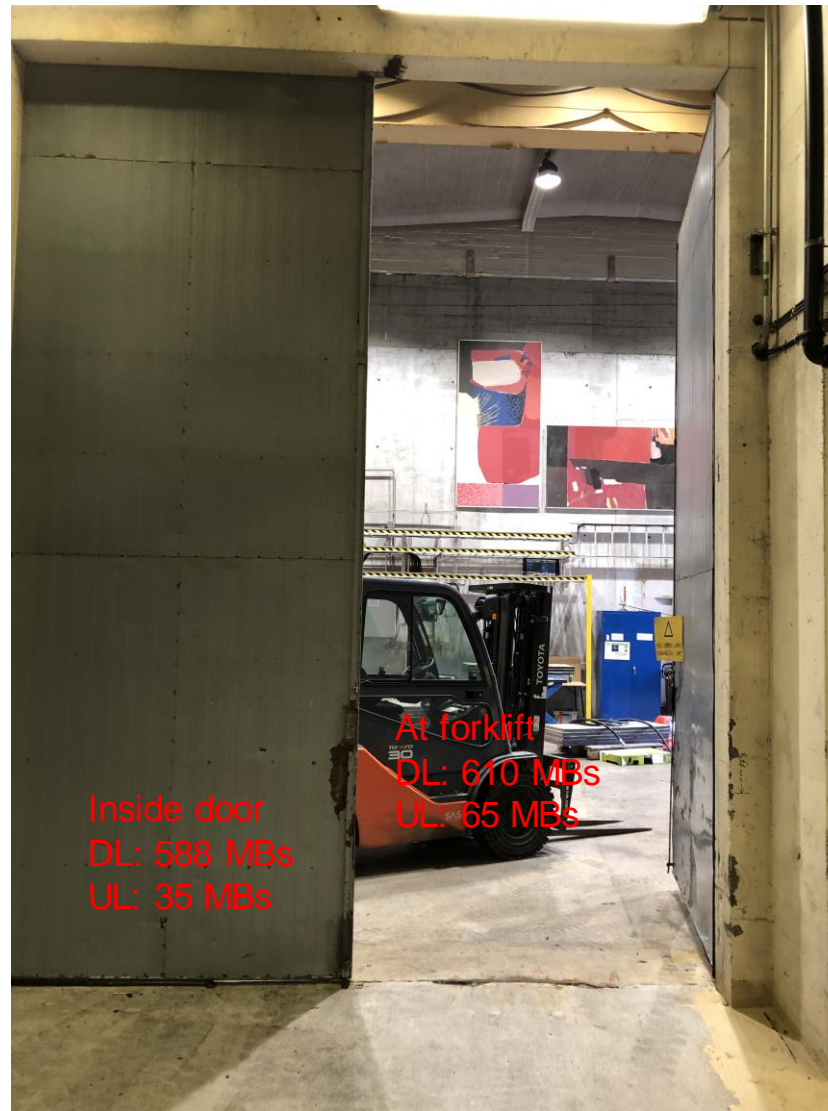
Outdoor coverage – Upload speed



Indoor coverage from outdoor RAN's



Indoor coverage from outdoor RAN's



Indoor coverage from outdoor RAN's



Indoor coverage from outdoor RAN's

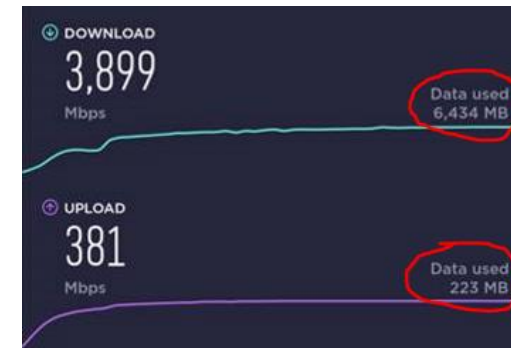


Challenges for 5G in Industrial environments

- Steel reinforced concrete buildings
 - Demanding for outdoor coverage
- Steel reinforced concrete walls
 - Blocks 5G signals and reduces indoor coverage
- Speed
 - Industry demands upload speed
 - End user equipment have low power compared to 5G antenna
- Wireless instrumentation
 - Limited 5G / NB compatible alternatives
 - Instrument vendors still not onboarded
- Accurate positioning
 - Still not part of 5G technology

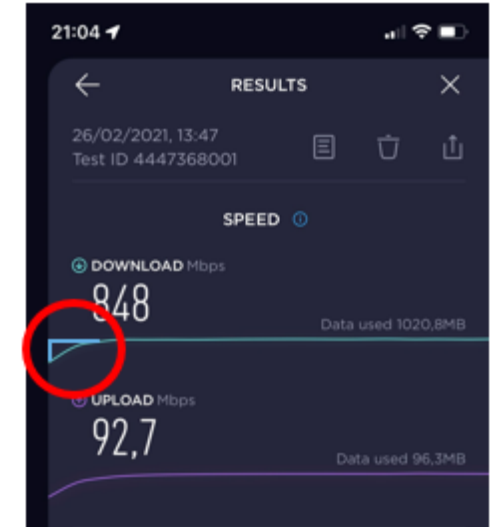
Why 5G?

- Less infrastructure with commercial 5G systems than with the use of WiFi
 - Lower CAPEX for the industry partner
 - A project does not need to invest in infrastructure if 5G coverage is present
 - Infrastructure cost kills the business case of many smart projects
 - Cost is moved from CAPEX to OPEX
 - Break even WiFi / 5G need to be investigated
- The telecom companies might limit the success of 5G with their pricing model
 - My kids included data will be used by 1 single speed test
 - Increased capacity -> Better video quality -> Increased data consumption
 - Can the 5G technology compete fiber + WiFi in homes and offices?
- 5G might replace several wireless communication platforms
 - WiFi
 - Wireless Sensors (Narrowband IoT)
 - Walkie Talkie solutions
 - Emergency networks
- 5G promise more accurate positioning
 - Can 5G replace GPS and DGNSS over time?



Why 5G?

- What about functional safety? Will 5G be an alternative solution?
 - Will the availability be sufficient for autonomous solution with safety level intact?
- Always networked
 - 5G standalone will give end users the feeling that they are always connected
- Autonomy and edge computing in 5G network
 - 5G with appropriate design can keep local functions running while central parts are down
 - Increased availability of critical functions
 - Telecom can deliver edge computing at site on customer need and request
- One network only, is it smart?
 - What if it fails?
 - Our 5G stopped due to an earth fault of the cooling system
- What about cyber security?
 - Will 5G create a back door into production networks?



Cyber security



This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No. 856691

12/09/2022

37

Summary

- 5G have the potential to be an enabler for the industry
- Shorter execution time of projects with infrastructure / coverage at the site
- Steel reinforced concrete
 - Indoor and outdoor coverage is a challenge for the 5G technology
- Upload speed is more important than the download speed for industrial users
- Availability of 5G compatible instruments (Narrowband IoT)
 - Battery lifetime 5-10 years to compete with Wireless HART
- Cyber security.... A critical factor
- Is 5G the network of the future for the industry / Smart Ports?
- Maybe

Yara Birkeland at the Smart port

