

NGI



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NEXT-GENERATION IoT SOLUTIONS  
FOR THE UNIVERSAL SUPPLY CHAIN

# iNGENIOUS outcomes & lessons learnt

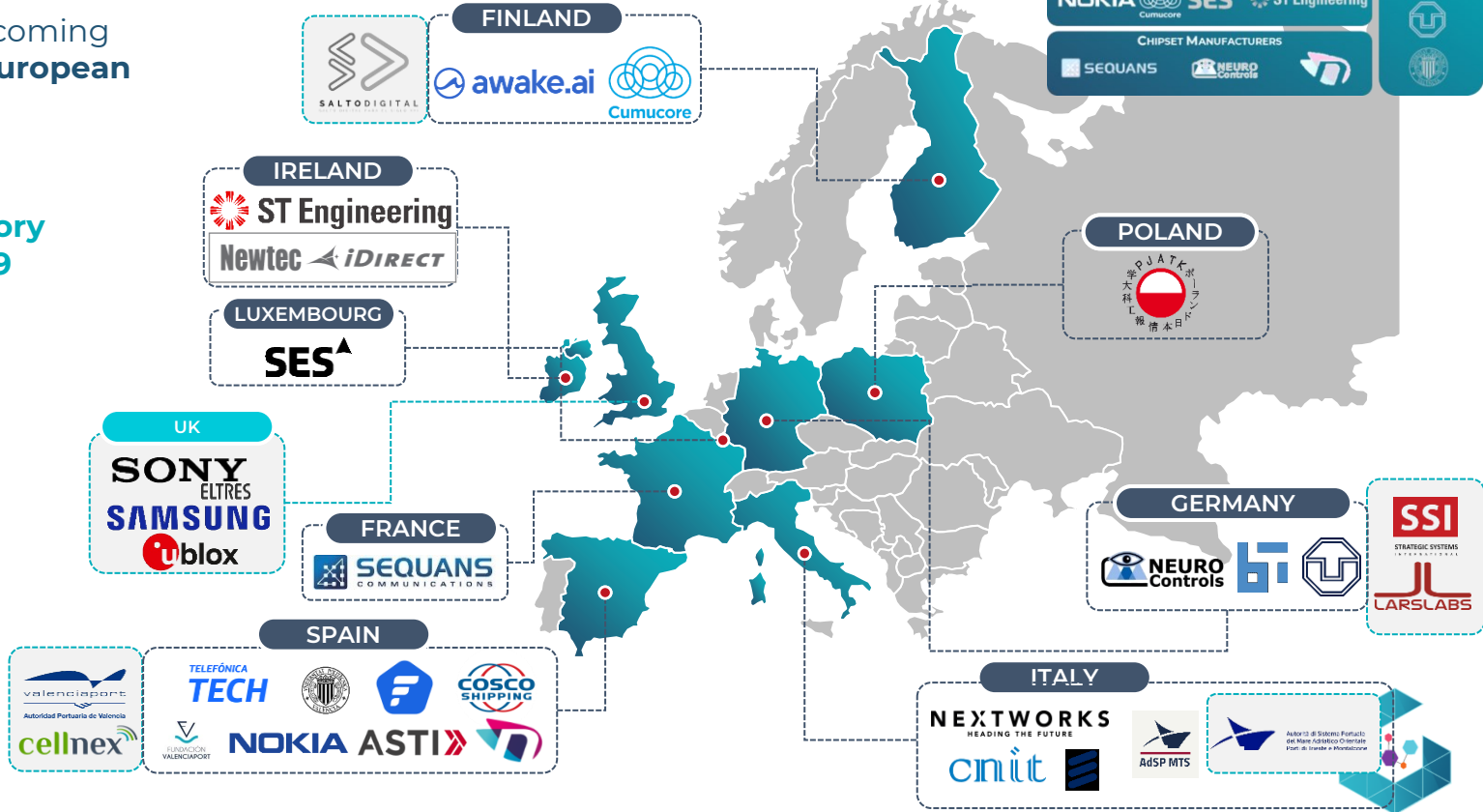
HiPEAC Workshop: "Next-generation IoT insights"

Nuria Molner (Universitat Politècnica de València)

# Consortium

21 organisations coming from 8 different European countries

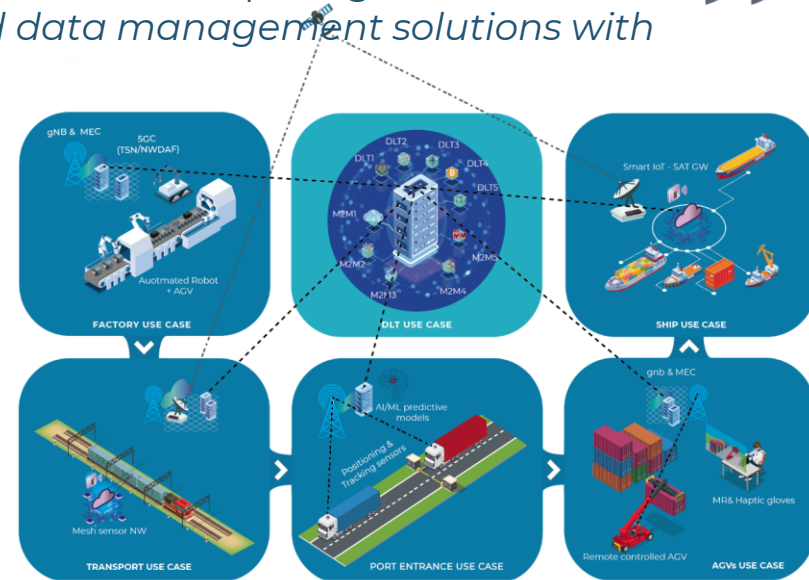
An external **Advisory Board** formed by 9 organisations will provide wider feedback from industrial and communications side



# Project Fact Sheet

“ **INGENIOUS aims to design and evaluate the NG-IoT solution**, with a particular emphasis on **5G** and the development of **Edge** and **Cloud** computing extensions for IoT in addition to providing smart networking and data management solutions with AI/ML. ”

- iNGENIOUS is built around **6 use cases** for the **supply chain management**.
- **PoCs (TRL 4)** and
- **demos (TRL 6)** experimentally **validated** in one **factory**, one **ship** and two **ports**
- **30 months project – 8 M€ budget**
  - 21 partners from 8 countries
  - October 2020 – March 2023



# Key Achievements

## FACTORY UC

**Enablement of 5G+ networks for industrial environments**, especially for centralized control of industrial robots.

### Demonstrated Innovations:

- **Improved utilization and on-demand adaptivity** of 5G network resources via end-to-end slice management
  - Enhancements to 5G core network with **ML-assisted E2E network slice support** in management and orchestration (MANO)
- More **efficient and robust wireless communication** through PHY/MAC flexibility
  - **Flexible PHY/MAC** in radio access network (RAN) and devices enabling **optimization of wireless channels**
- **New capabilities** enabled by smart/tactile APIs and **cost savings** by moving robot control operations to MECs
  - **API for smart and tactile IoT-control applications** running in nearby compute clouds (MECs)

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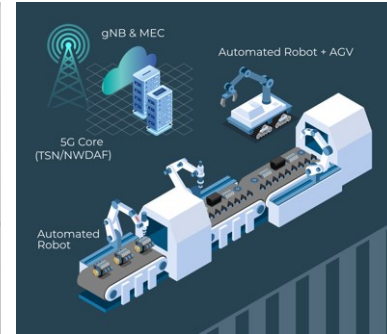
UC Partners:



**NEXTWORKS**  
HEADING THE FUTURE



**ASTI**



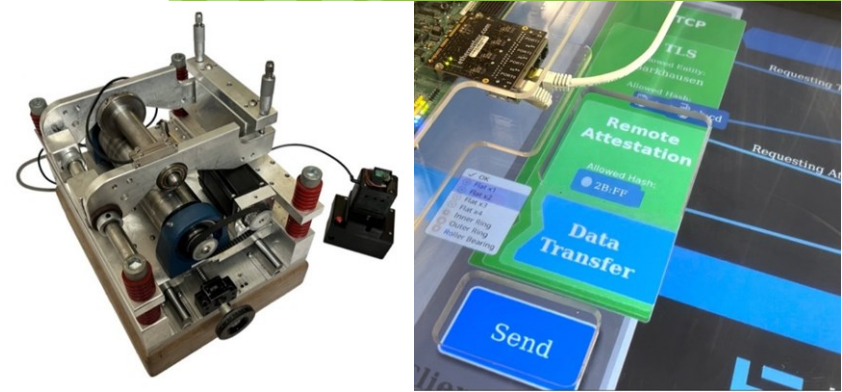
# Key Achievements

## TRANSPORT UC

**Monitoring of cargo train carriages** for defects and secure automatic reporting via IoT sensors.

### Demonstrated Innovations:

- Low-power vibro-acoustic **sensors prototype** for **automatic defect reporting** and **stronger communication and endpoint security** enable continuous monitoring enables **longer maintenance intervals** for train carriages, resulting in **cost savings** while **improving railway safety**
  - **Low-power vibro-acoustic sensors** continuously **monitor train axles for defects** using **neuromorphic classification**.
  - **Automatic real-time reporting** of detected defects during service via **terrestrial and satellite networks**.
  - **Communication** between and IoT sensors and control centre protected **Transport Layer Security (TLS)** through **remote attestation**.



UC Partners:



# Key Achievements

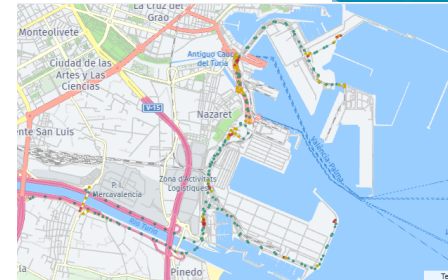
## PORT ENTRANCE UC



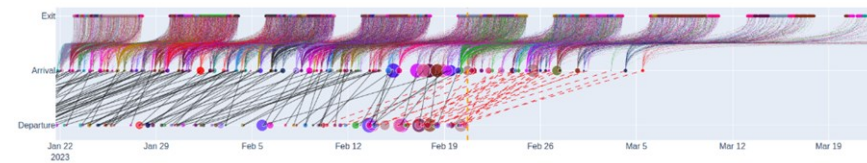
Enhance situational understanding of events in maritime ports and terminals.

### Demonstrated Innovations:

- **Commercial AI system for predicting port container traffic rates and predict and detect congestion rapidly** thanks to the real-time tracking of trucks inside the port areas
  - **Ingestion of online data sources** such as port community systems, vessel schedules, trucks entering/exiting through gates, and **IoT positioning sensors on trucks**
  - Development of **machine-learning (ML) models** able to **predict and optimize** the time spent by trucks inside the port facilities



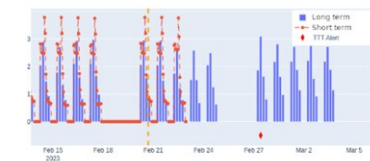
Simulated exit events



Number of container exits



Truck Turnaround Time



UC Partners:



# Key Achievements

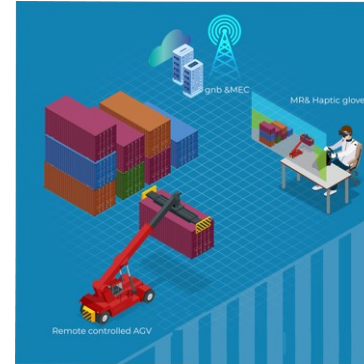
## AGV UC

**Improve driver safety** by allowing **automated guided vehicles (AGVs)** to operate in more scenarios, with humans assisting them via **remote control in few difficult situations**.

### Demonstrated Innovations:

- **Immersive driving system with 5G networks with remote operator** controlling in unknown situations that cannot be handled by the AGV on its own
- **Latency for receiving video and sending control commands** over 5G has been confirmed adequate
  - **AGVs** equipped with **5G modems** and **360° cameras**
  - **Mixed reality (MR) cockpit** with 5G video streams for immersive remote driving experience from a **safe indoor cockpit**
  - **Haptic input devices** with **real-time sensory feedback** for more precise controlling AGVs

UC Partners: NOKIA



# Key Achievements

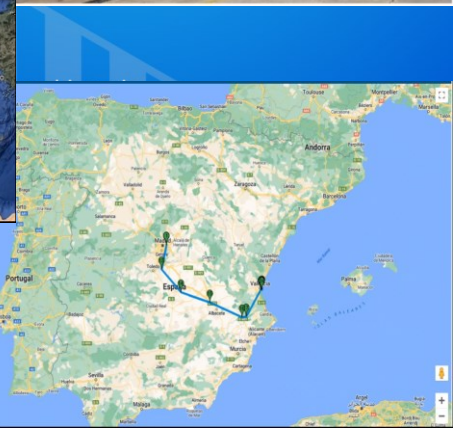
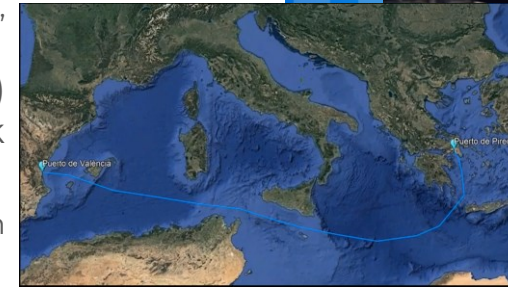
## SHIP UC



End-to-end tracking of assets in shipping containers.

### Demonstrated Innovations:

- **Sensorized container** for continuous monitoring and awareness of the goods as they pass through the supply chain
  - **Real-time/periodic monitoring** of predetermined parameters (temperature, humidity, GPS, movement, bumps, etc.)
- Sea (shipped **Valencia-Piraeus** and vice versa) and terrestrial (train **Valencia-Madrid** and truck Madrid-Valencia) real-time connection
  - Uses **satellite backhaul** from the IoT RAN when **sailing** on the sea
  - Uses **terrestrial IoT connectivity** when ship approached the port and while on land

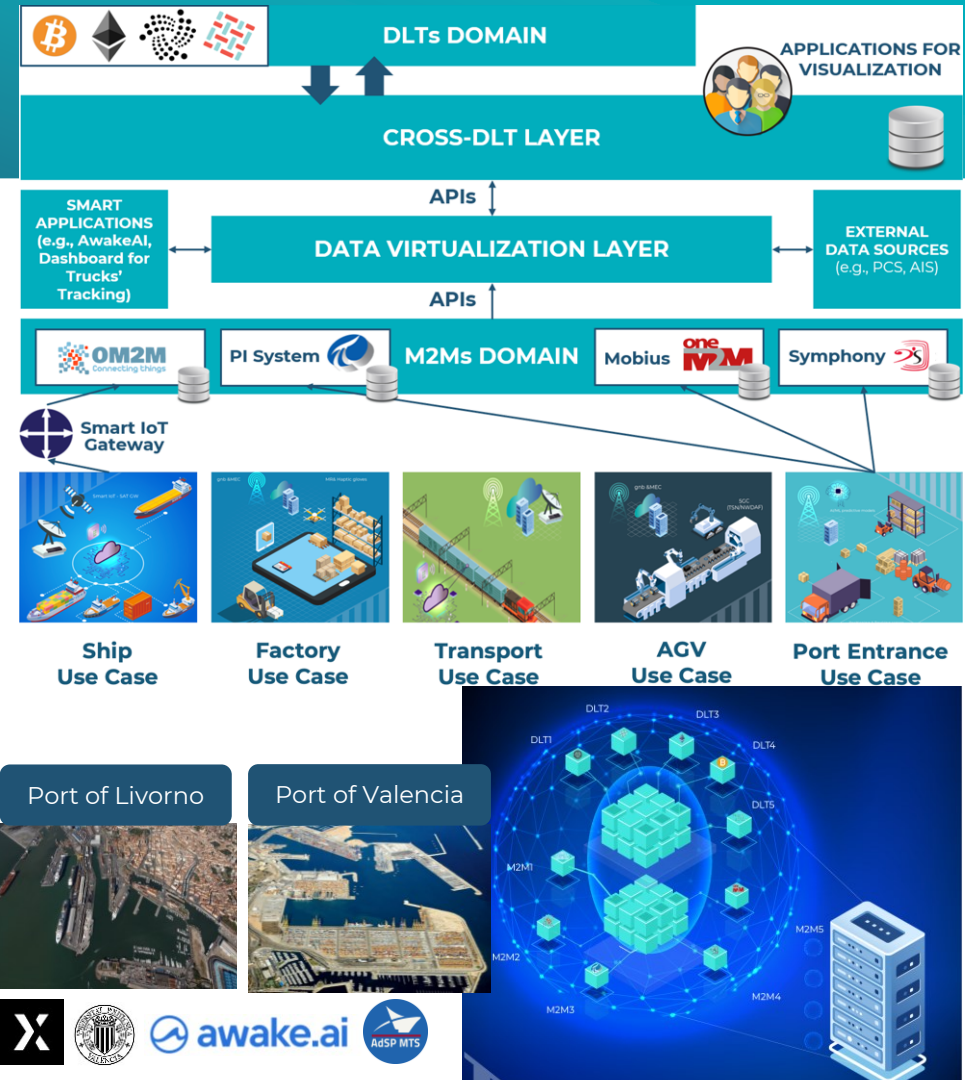


UC Partners:    **SES**<sup>^</sup>  **ST Engineering**  
 



# Key Achievements

## DVL/DLT UC












Provide **interoperability layer over separate IoT solutions** for unified data access and new cross-sector applications.

### Demonstrated Innovations:

- Existing and heretofore **incompatible M2M, data management, and DLT solutions are made interoperable**
  - Data Virtualization Layer** to federate machine-to-machine (**M2M**) platforms as well as **external data sources** (e.g., the Port Community System)
  - Cross-DLT layer** to federate **DLT networks**, which store **immutable records** of supply-chain events.
- IoT-driven applications: **end-to-end asset tracking**

# Key Achievements

## SME Success Stories

- Creation of **new products** & services:
  - **Cloud-based analytics services** for maritime traffic prediction  **awake.ai**
  - **Low-power ML-enabled sensors** for transportation health monitoring  **NEURO Controls**
- **Evolution of existing** innovative **products**:
  - **5G Rel-15 modem** component to make IoT devices 5G capable 
  - **5G-Core Network**, Slice Management module, NWDAF, 5GLAN and TSN network functions  **Cumucore**
- **Acquisition of SMEs** by big companies:
  - **ASTI Mobile Robotics** 
- **Collaboration Agreements** outside the Project
  - **Fivecomm** 
  - **Cumucore**  **Cumucore**
  - **+ Sequans** 
  - **+ Nextworks**  **NEXTWORKS**  
HEADING THE FUTURE



# Lessons Learned

- Demos in **real environments**: maritime ports and industrial areas
  - Have to be prepared (much) **in advance**: Prepare carefully the timings & **field requirements**
  - Early **integration** & Previous **lab tests**
- Not all countries have similar **laws**:
  - in some **licenses** are easier to get
  - Help of a national partner for the request in domestic **language**
- Working as a **true team** pays off
  - Fast **communication**
  - Willingness to **find solutions** to the problems
  - 1 **partner withdrawal** but still **no delays in delivery** of UC work and demos



# STAY UPDATE AND GET INVOLVED!



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# Thank you

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