
# 5GROWTH - Industry 4.0 Low Latency services on a shared Transport Network

## 5GPPP-TB Industry 4.0 session

December 10, 2020

Paola Iovanna, Ericsson Research (TEI, Italy)

# Short Biography

Paola is a principal researcher at Ericsson Research in the area of transport network and systems for mobile networks

She leads research activities in the field of transport network architectures, control and management plane, and the interactions between the transport and radio segment. Relevant research topics recently covered are transport systems for 5G and beyond, including C-RAN transport solutions, convergence networks (radio and fixed access network), and on orchestration solutions for verticals applications. She is responsible in Ericsson Research of transport activity in a project for 6G

She has been leading a long-lasting cooperation with operator such as Telefonica and TIM, dealing with different research projects and realization joint PoCs and field-trials in the network operator premises. In the last years she has established a research cooperation with relevant customers working on Intelligent management of NFV/SDN networks for verticals support. In such framework she is proposing innovative solutions for transport architectures able to support verticals use cases in scenarios of convergent /shared networks.

Sha has also led several activities in the framework of many EU projects, such as 5G Crosshaul where was responsible of transport networks solutions for backhaul, fronthaul and midhaul; 5GTransformers where was WP responsible for solutions of orchestrating radio, transport and cloud resources in a VNF scenarios; 5Growth where she is responsible for COMAU pilot and she is proposing innovative solutions for controlled and low latency transport network, with the corresponding orchestrator functions to optimize transport, radio and cloud; 5G EVE where she is defining and realizing the infrastructure orchestrator for the Italian site (in TIM premises) able to optimize transport and radio resources.

During her research work she has generated 60 patent applications. She has matured a very good reputation at international levels, gained through the participation to several EU projects, the publication of more than 80 papers in internationally journals and conferences. In addition, she has made several experiences of lecturer in several University . In 2020 she has been rated among the influential women in Italian tech industry by the magazine Startup Italia.

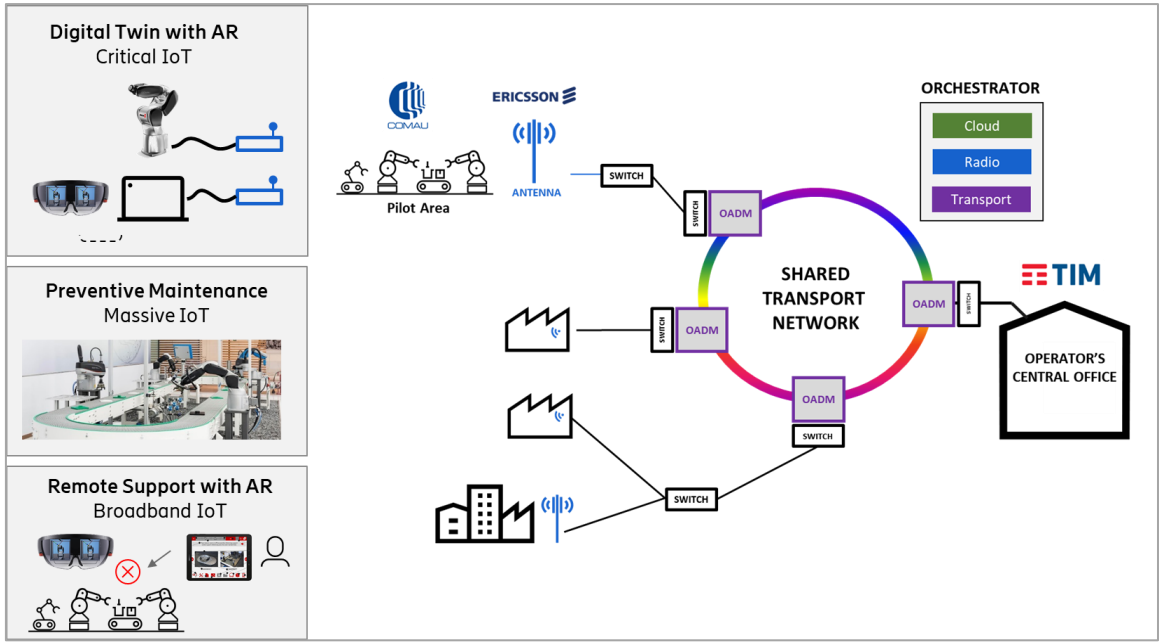
**Dr Paola Iovanna**

# 5GROWTH – Industry 4.0 Low Latency services on a shared Transport Network

**Scope and challenges-** Demonstrate by field trial approach the **key enablers** for the **factory of the future** to unlock new use cases and balance cost and revenues

- an industry-grade 5G communication, also supporting a low latency use case, on **a shared network** to reduce the total cost of ownership;
- a transport aware slicing to concurrently serve industrial use cases;
- novel optical transport technologies, to guarantee low latency and traffic isolation;
- an orchestration system for the automation of radio, **transport and cloud resources**

**5Growth Pilot in Italian site:** COMAU, Ericsson, TIM, Politecnico di Torino, Scuola Superiore S. Anna and Nextworks are deploying a joint pilot hosted in Automation Systems and Robotics floors of COMAU, in Turin. The pilot experiments a **shared network** based on a novel transport paradigm and 5G infrastructure, to support three mission-critical use cases: **digital twin, preventive maintenance**, remoted support with **augmented reality**.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# OUTLINE

5Growth vision

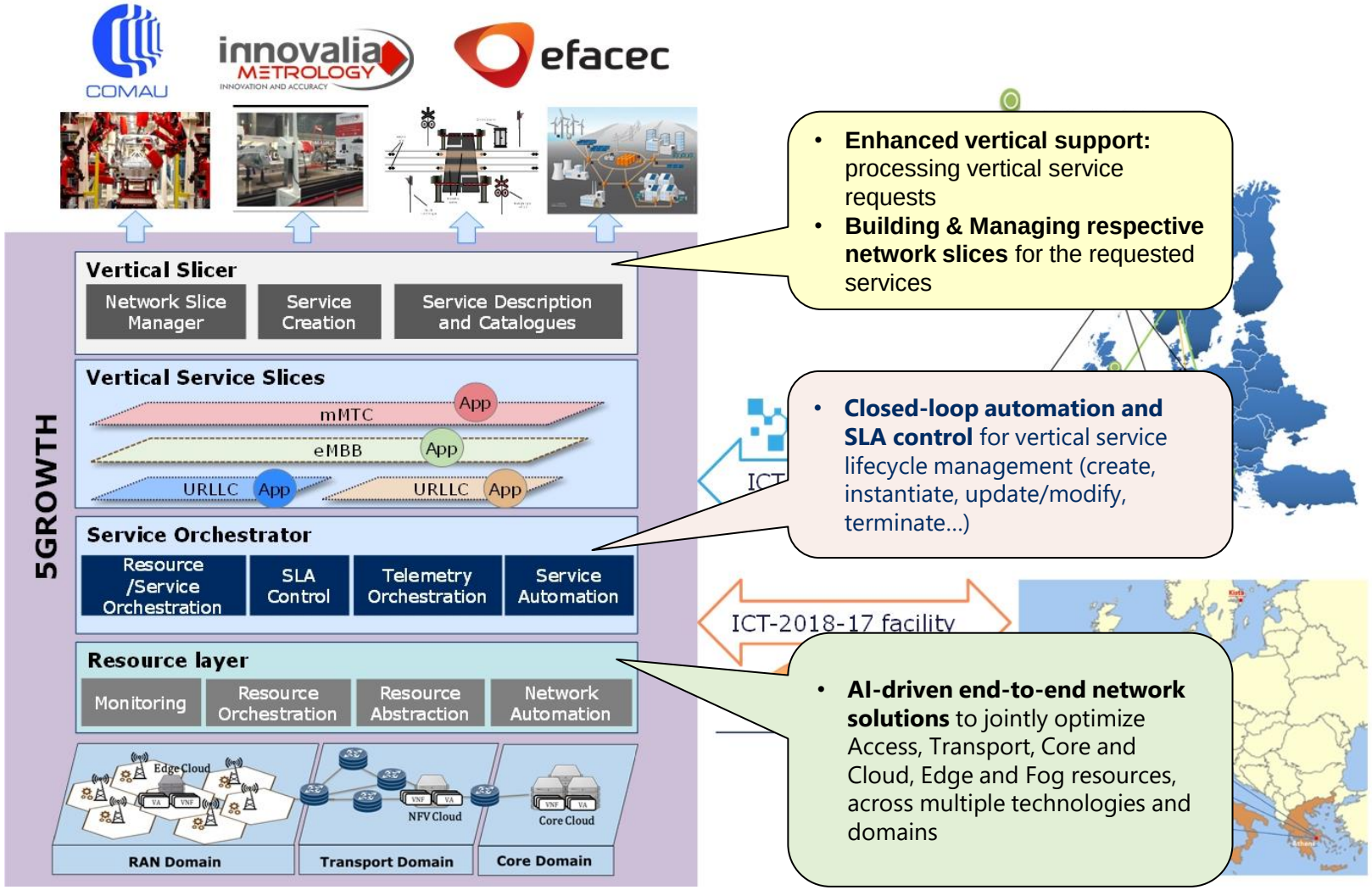
Industry 4.0 Low Latency services on a shared Transport Network

- Motivation
- Qualifying elements
- Pilot

Conclusion

# 5Growth Vision

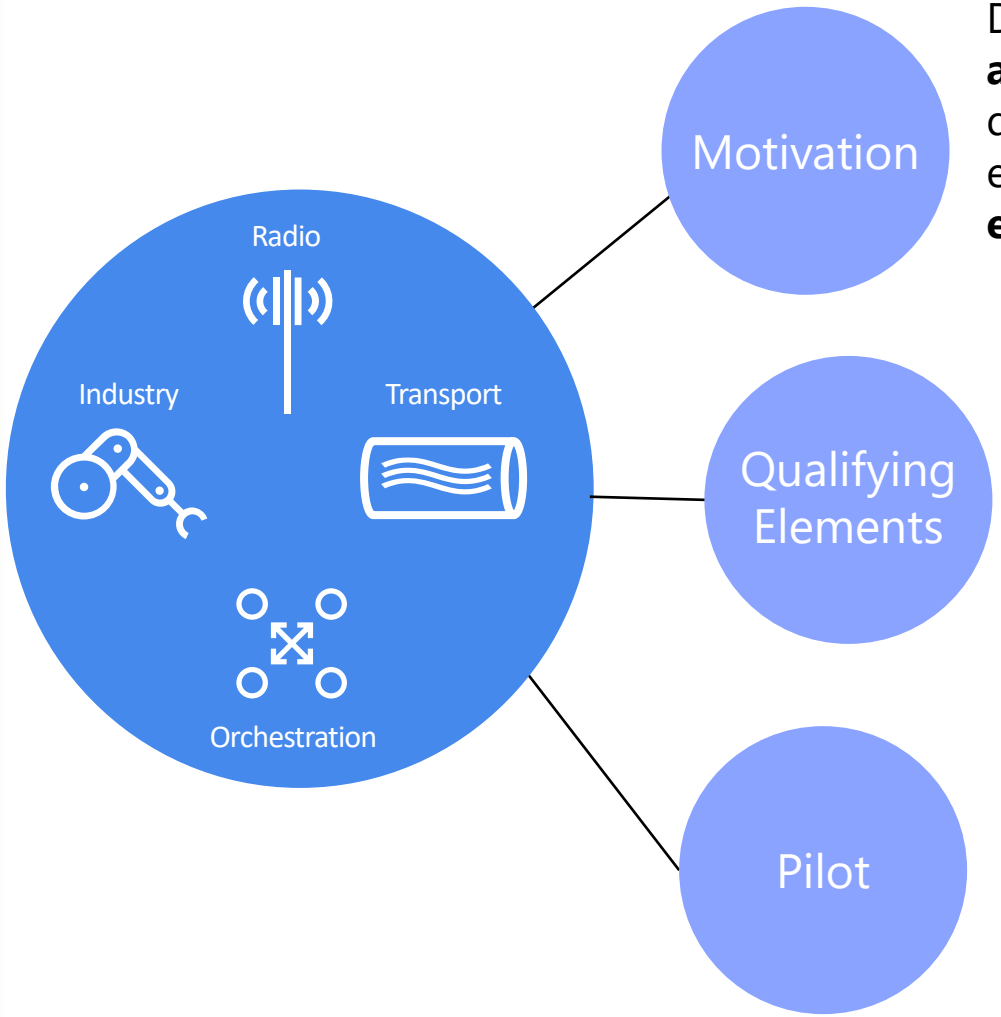
To empower vertical industries, such as **Industry 4.0, Transportation, and Energy** with an **AI-driven Automated and Shareable 5G End-to-End Solution**




- **Develop the 5Growth platform** to create, provision and manage the vertical services with AI-driven innovations
  - Leverage on the 5GPPP Phase 2 project 5G-TRANSFORMER platform
- **Interaction with ICT-17 Platforms** to provide E2E Solution
  - Via standard Interfaces
  - Develop adaptations to each platform

# Industry 4.0

## Low Latency services on a shared Transport Network




Demonstrate **a shared network** to support **any future industrial application**, including the low latency ones, without requiring a dedicated network. A **shared transport** enables new use cases and ensures the balance between cost and revenues while supporting the **extreme performances** comparable to dedicated infrastructure

A **novel shared optical transport**, to guarantee low latency, high throughput, and traffic isolation. An orchestrator to concurrently optimize **radio, transport and cloud** by extending the **slicing** technique to be "**transport-aware**".

A pilot at the **Comau** (FCA) factory, in collaboration with **TIM**, experiments a novel transport network paradigm, starting from three mission-critical use cases: **digital twin, preventive maintenance**, remoted support with **augmented reality**.

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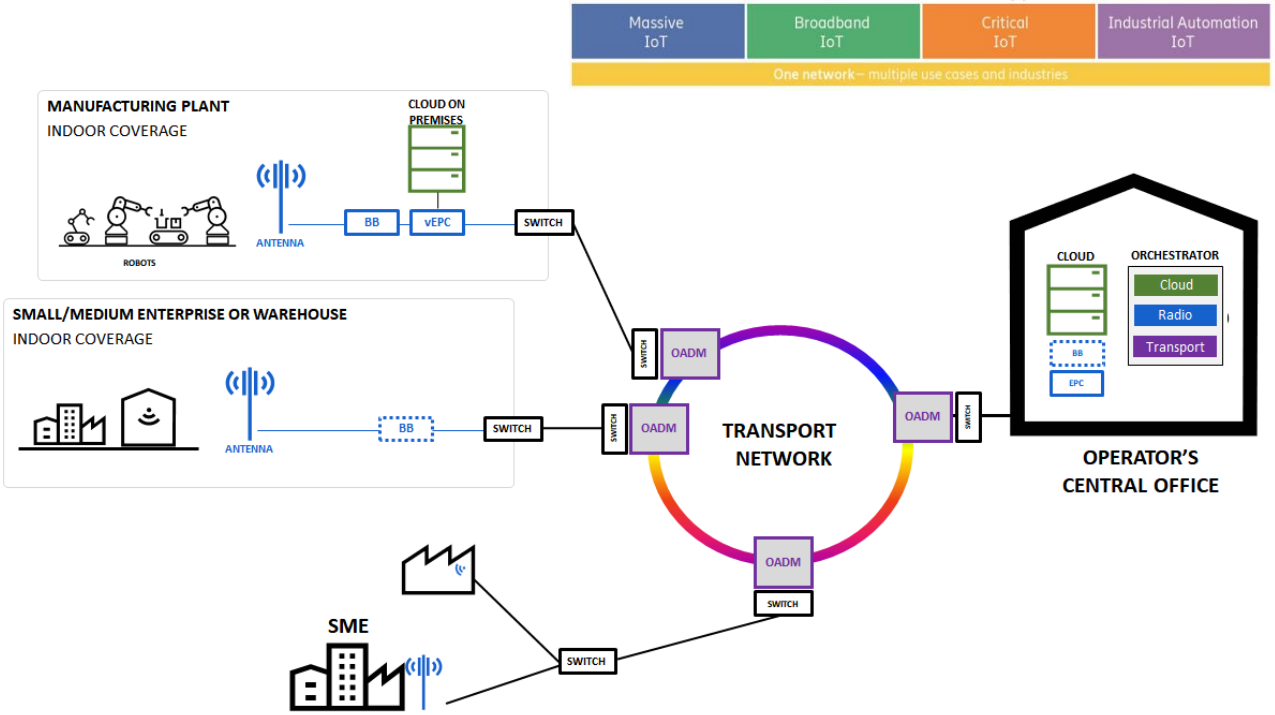
# Motivation for a shared network

- To support critical use cases in industrial applications, like the ones demanding low latency in manufacturing, the current approach is to provide 5G coverage with **a standalone dedicated (non-public) network**, entirely **installed at the vertical premises**.

- Small and Medium Enterprises (**SME**) could prefer leveraging on a **non-public network connected with an operator's network** which provides part of the radio infrastructure, like the core functionalities.



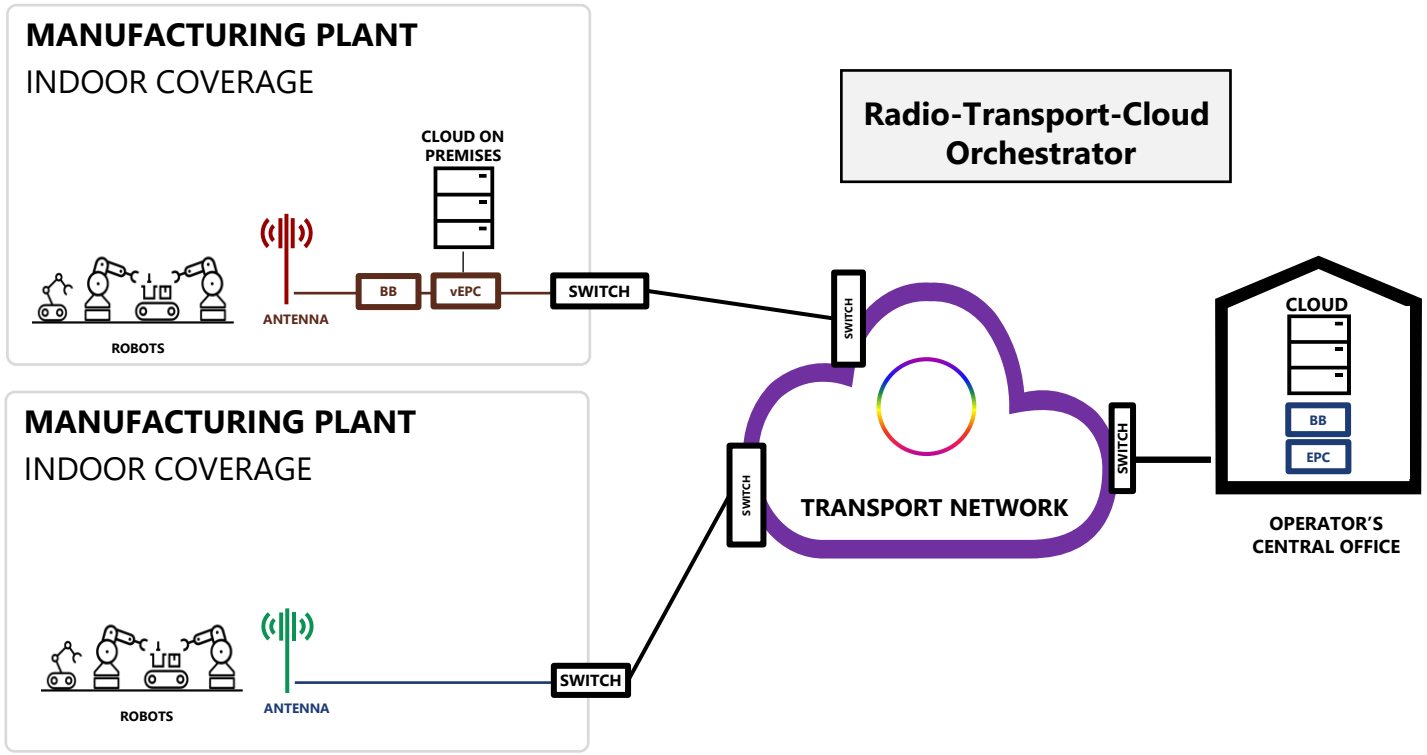

- The challenge is to define a solution to **serve even the critical use cases** over a **shared network** supported by an **appropriate transport layer to reduce the TCO** while preserving the required performances.

- The shared network will also allow **centralizing cloud farms** from the vertical premises to a remote locations like, for example, in a central office of a mobile network operator or in a data center.

# Qualifying elements for shared network

Shared transport network able to guarantee low and controlled latency, and high throughput performances

5G slicing transport aware able to cross optimize transport, radio and cloud

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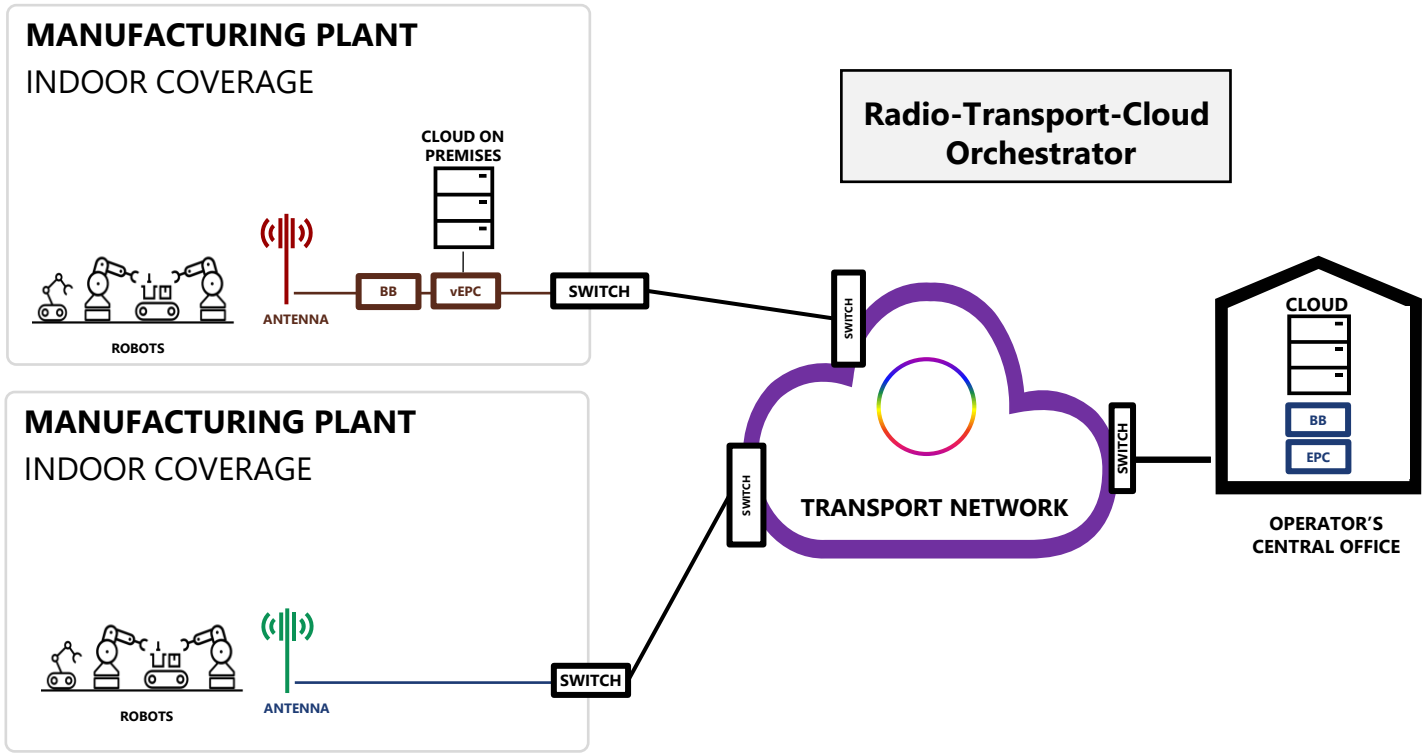


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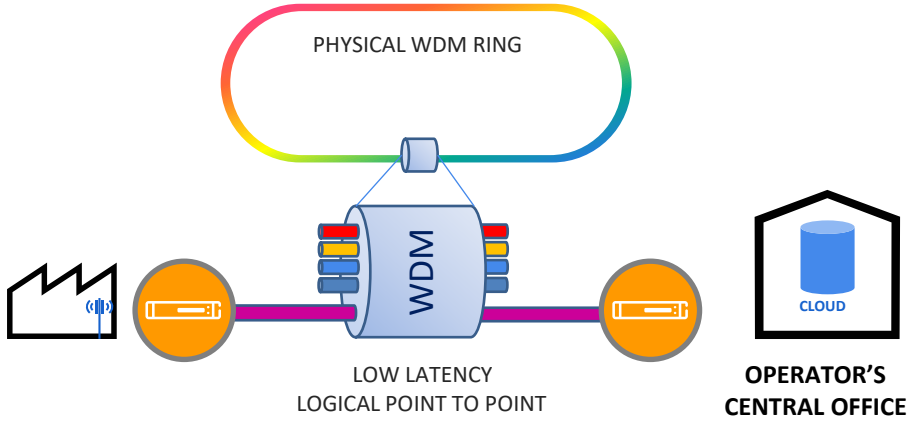
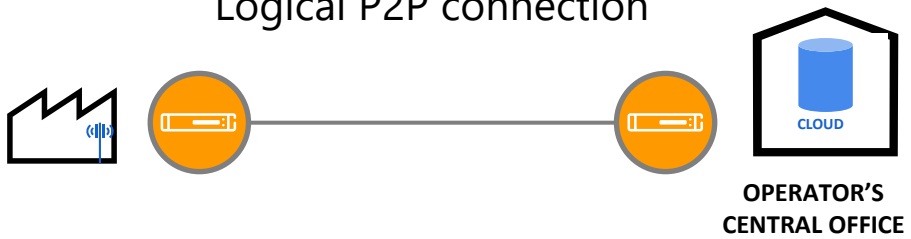
# A Shared Transport Network based on Optical Technologies

- Optical technology assures **high bandwidth, low and controlled latency**
- WDM assures hard **segregation of the traffic**
- Preferred topology is a ring to facilitates add/drop connectivity and protection, anyway alternative topology such as tree (e.g. in case of PON) are supported
- WDM with up & down transmission on the same branch of the ring enables a **logical P2P connection** between central office and antenna site that facilitates controlled and very low latency
- Possibility to **combine WDM with L2-L3** switching to manage granularities lower than wavelength and to increase flexibility in dynamic configuration

Optical channel over physical WDM ring




Logical P2P connection



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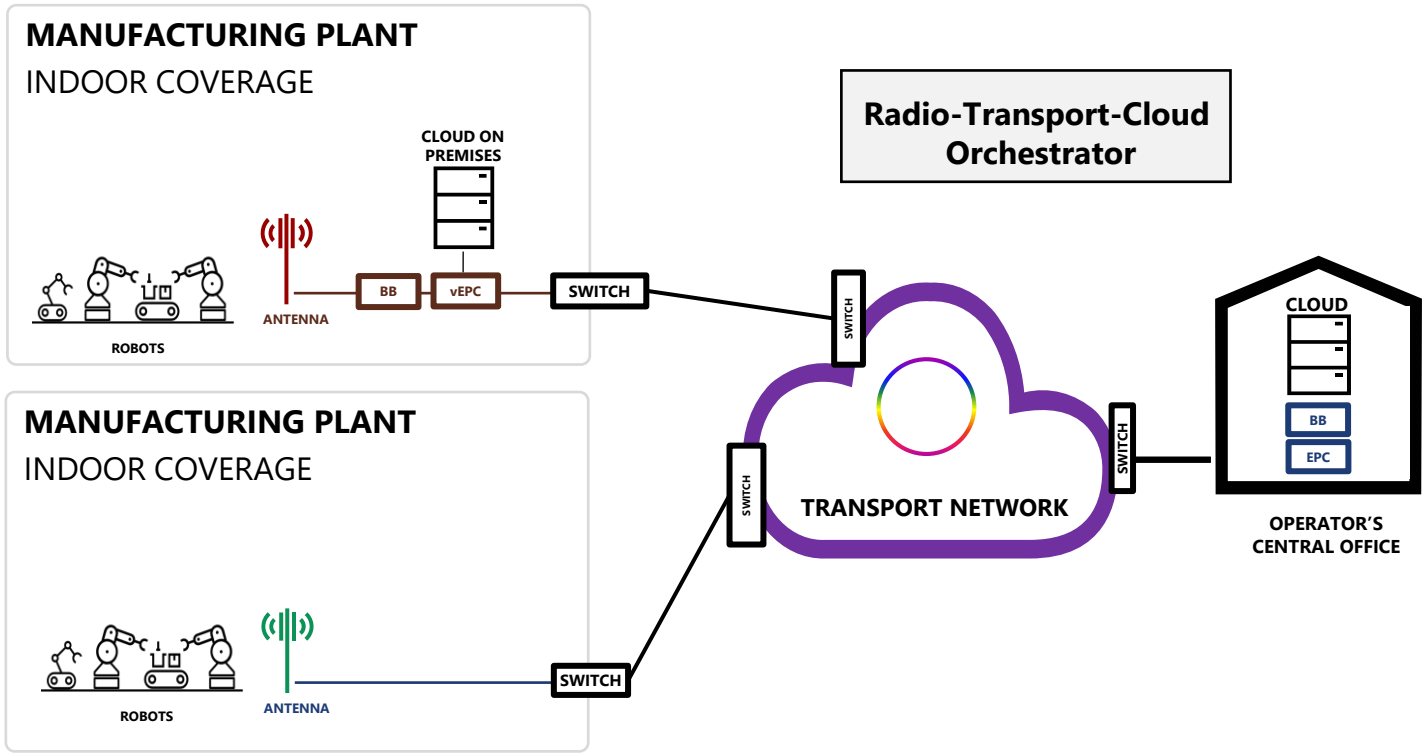


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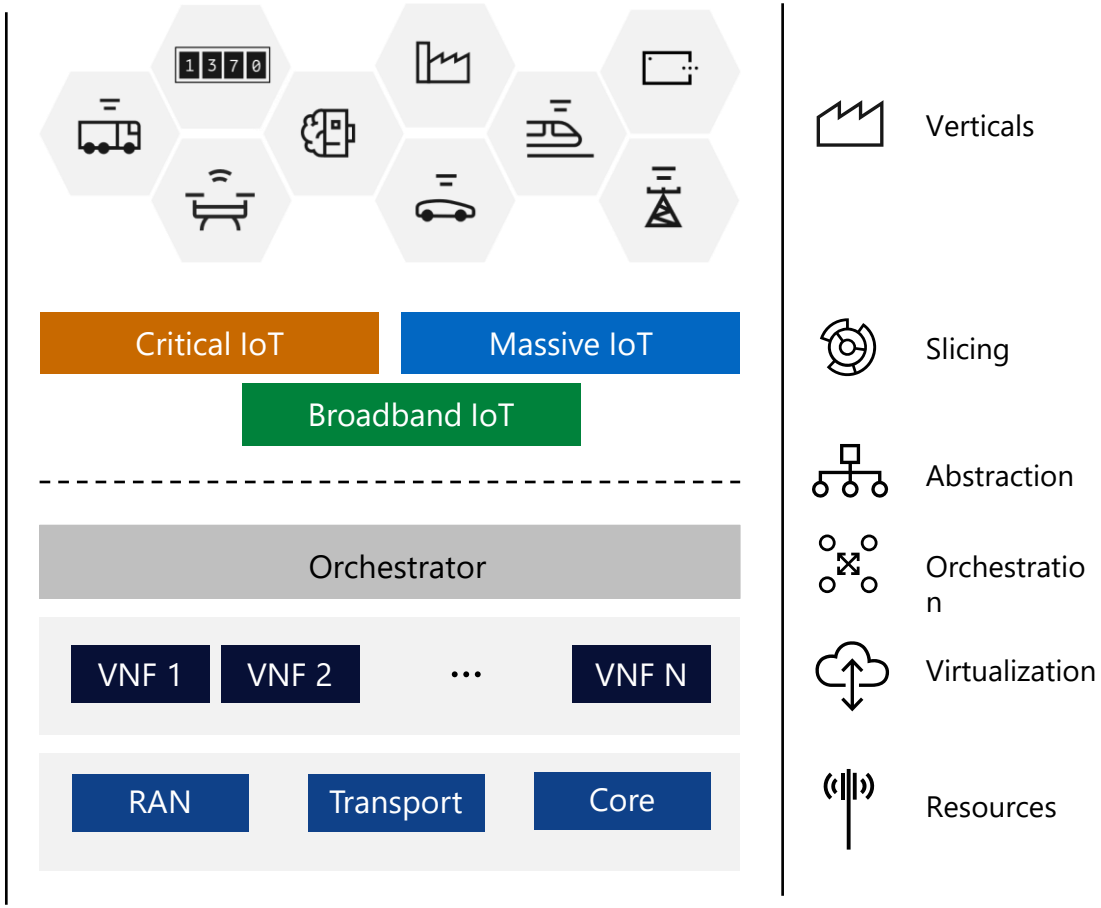
# Transport-aware 5G Slicing
# Cross-optimization of transport, radio and cloud

- E2E QoS of vertical uses cases shall be aware of transport deployments connecting VNFs
- An **orchestrator** concurrently optimizes radio, transport and cloud by extending the slicing technique to be "transport-aware".
- Extend the current ETSI MANO NFV orchestrator architecture by using an abstract view of the radio-transport resources with the scope to:
  - enabling cross optimization radio and transport by correlated placement of VNF functions
  - simplifying the E2E services by exposing SLA parameters of the vertical services (e.g. latency, bandwidth, etc.)
  - decoupling service from infrastructure layer

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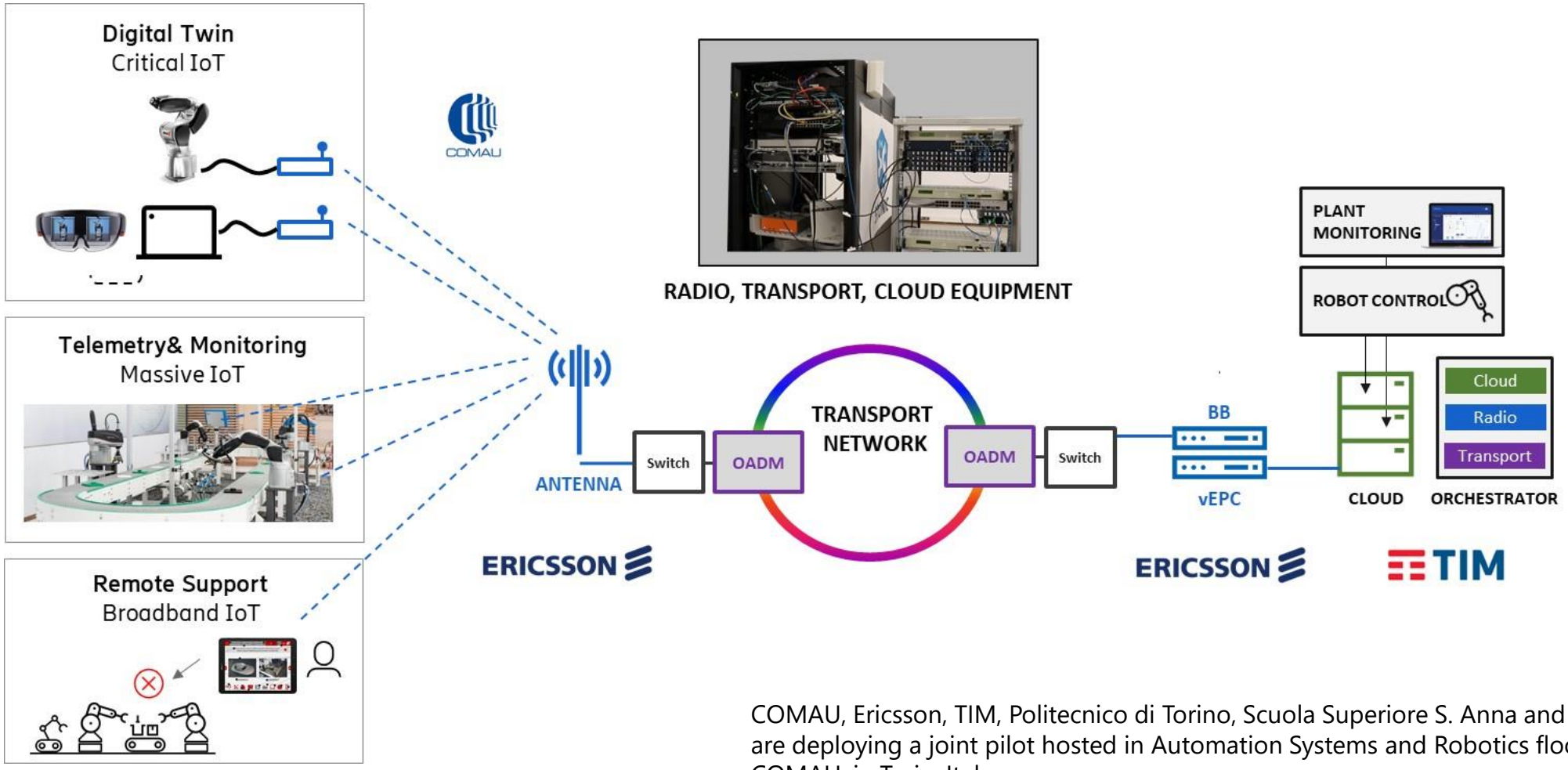
# Pilot details



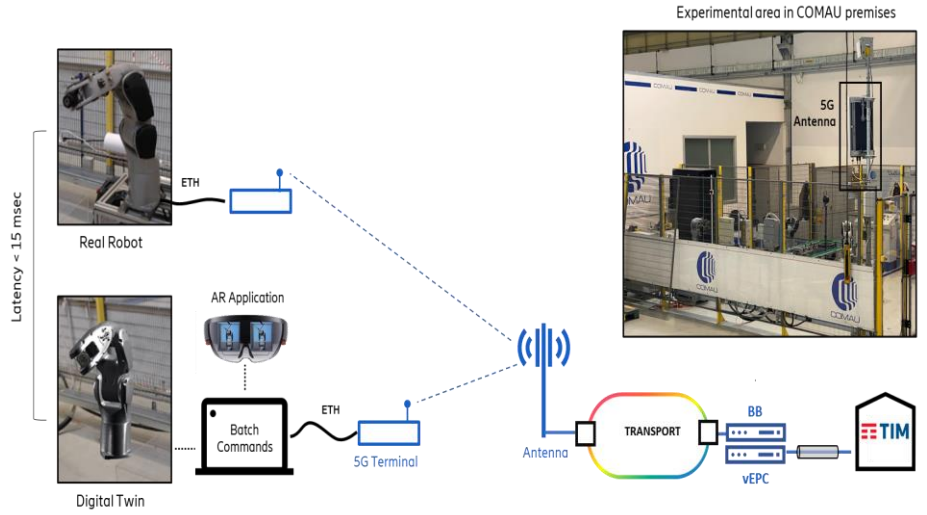

COMAU, Ericsson, TIM, Politecnico di Torino, Scuola Superiore S. Anna and Nextworks are deploying a joint pilot hosted in Automation Systems and Robotics floors of COMAU, in Turin. Italy .

# Use case description

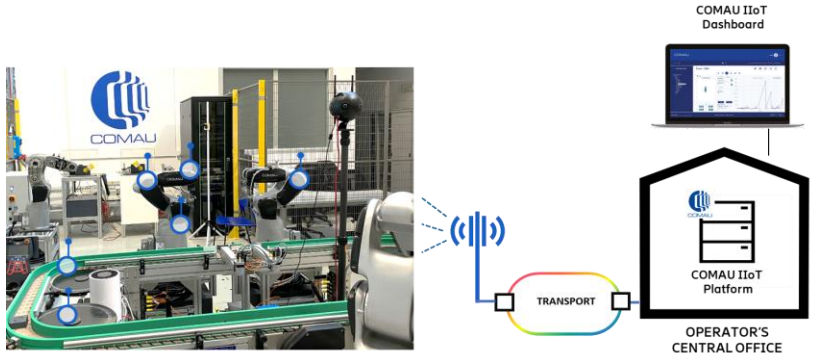
**Digital Twin** (Ultra-Reliable Low-Latency Communications) is a powerful, new, digital environment that perfectly mirrors the manufacturing line, thus facilitating the **optimization** of **complex processes** and **production scenarios**.

A robot is remotely controlled by a computer. Robot  status and position is sent in real time from the robot controller, which estimates the actual position of the robot via the encoders installed on the axes motor, to a computer that builds the digital replica and feeds an AR device with information for a supervisor who is in front of the real robot.

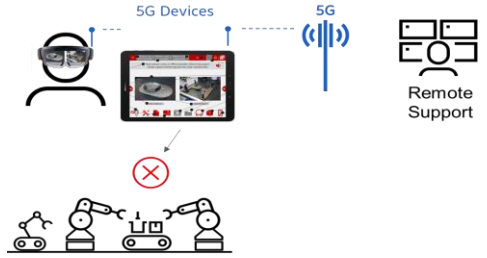
The robot and the computer are connected via 5G, demanding a latency **lower than 15 ms** to have a synchronized alignment of the robot with its virtual replica.




**Monitoring & Telemetry**, (massive Machine-Type Communications)
In the pilot UC, mMTC is used to connect multiple sensors with a remote digital platform that continuously supervises the factory and assumes immediate decisions to prevent avoidable failures.




**Remote Support and Digital Tutorial**, (enhanced Mobile BroadBand).
A technician , to repair a fault, on the factory floor can use a tablet or augmented reality glasses, connected via 5G, to reach and expert, located geographically far from the factory. The expert has the "full picture" of the fault and can provide remote support to the in-field technician.  The technician can also access to step-by-step digital tutorials. The main objective of the UC is to reduce the Mean Time to Repair (MTTR).

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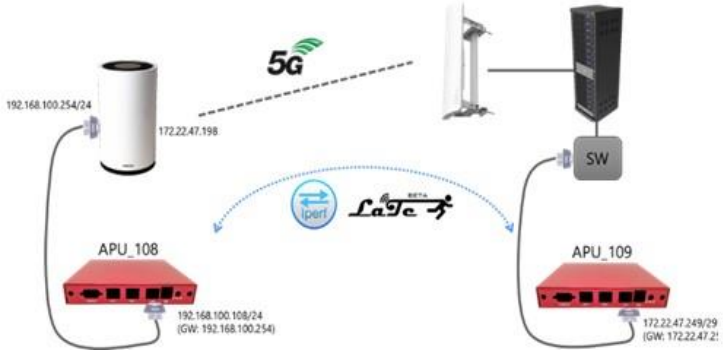
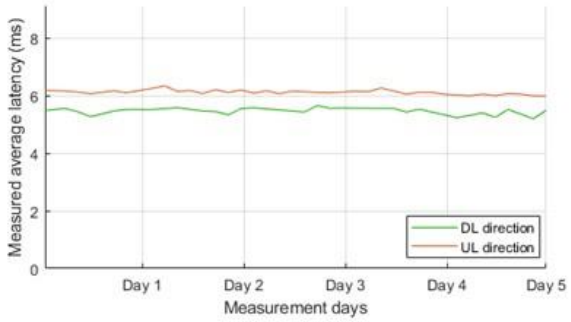
# Test Campaingn on pilot

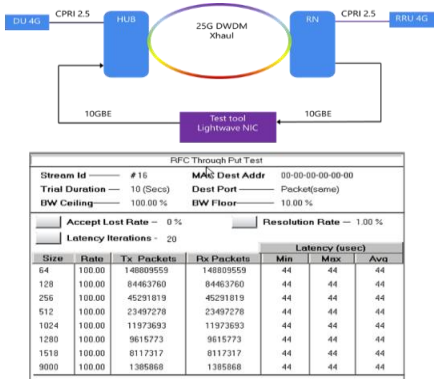
**Radio contribution** results an average downlink (DL) latency of around 5.38 ms with an average throughput of 844 Mbps and an average uplink (UL) latency of 6.07 ms at 61.12 Mbps.
Results obtained with suitable tuning between throughput and latency allows to support also low latency use case




**Transport contribution** over and optical ring of 8.8 km. Latency is essentially due to the fiber span (44 µs over the 8.8 km of fiber) , processing (switching and framing) is below the instrument precision (1 µs).

Therefore, the **contribution of transport latency to the overall E2E latency is negligible** as it is more than two order of magnitude below the radio contribution.



# Conclusion

5Growth H2020 EU Project experiments in a Pilot for Industry 4.0 in Comau and TIM premises relevant use cases for factory of the future by three relevant use cases: Digital Twin (URLLC); Monitoring & Telemetry (massive Machine-Type Communications), Remote Support and Digital Tutorial, (enhanced Mobile BroadBand).

Shared network unlocks new use cases for  Industry 4.0 and extend to SME critical use case support

Qualifying elements for shared networks are

- Suitable transport network to assure low and controlled latency
- 5G slicing transport aware that includes a suitable abstraction view of transport and radio network to optimize the resource usage by smart placement of the VNF

Measurements on pilot demonstrated:

- The E2E radio infrastrucutre can sopport the use cases  in terms of latency that is complaint for URLLC
- The transport network can support low latency requirements in a geographical area  (e.g. length of 15 km) and  provides deterministic latency on the order of microseconds that is one order of magnitude less than URLLC E2E delay (1ms)
- The slicing tranasport aware mechansim supports concurrently the three use cases enabilng optimization of the radio, trasnport and cloud resources

















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