## Experimentation and Validation Openness for Long-term evolution of VErtical inDustries in 5G era and beyond
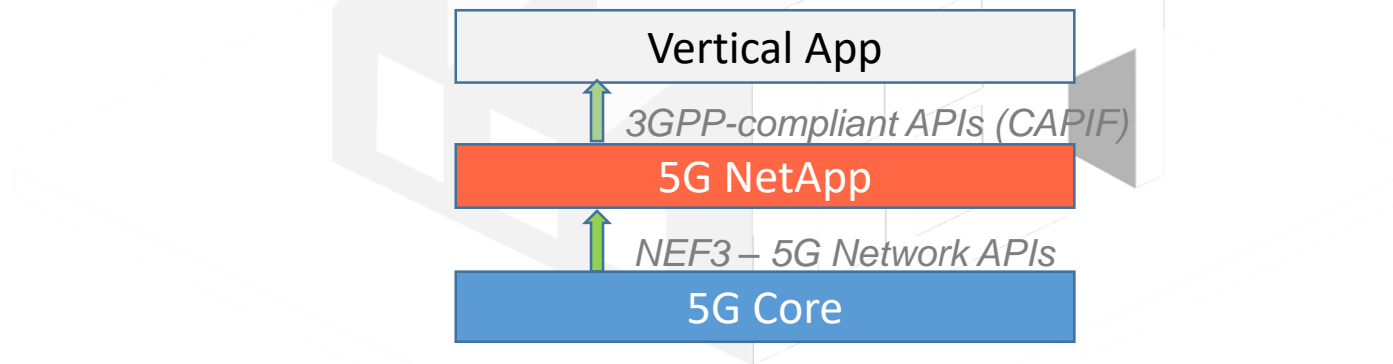
Regel G. Usach (UPV)

# EVOLVED-5G - Introduction

**E**xperimentation and **V**alidation **O**penness for **L**ong-term **E**volution of **V**ertical in**D**ustries in **5G** era and beyond

*The intense research work on 5G experimentation in Europe has reached the point where the evolved 5G capabilities, provided through a Service-Based Architecture (SBA), are to be exploited by third party innovators.*

*Key enabler for this openness is the realisation of **5G network programmability through standard APIs.***

Vertical App

*3GPP-compliant APIs (CAPIF)*

5G NetApp

*NEF3 – 5G Network APIs*

5G Core

*EVOLVED-5G aims to provide the means and tools for the development and validation of **5G NetApps** that consume and expose 5G business standard APIs, as well as Vertical Applications leveraging NetApps services (via those APIs) for the **Industry 4.0** sector*

# EVOLVED-5G Project Vision

Experimentation and Validation Openness for Long-term Evolution of Vertical inDustries in 5G era and beyond

EVOLVED-5G embraces the emerging NetApp ecosystem under a 2-fold scope:

- **To build an open experimentation facility for NetApp creation, validation, and certification.**

  *Developed NetApps will be validated in the **EVOLVE-5G Pilots** -Athens & Malaga 5G Platforms-, built upon 5G-PPP ICT-17 experimentation infrastructure from **H2020 5GENESIS** project*

- **To provide the means and the tools for long-term evolution of 5G-enabled vertical industries**

  **SDK** FOR NETAPP CREATION

  NETAPP **VERIFICATION & VALIDATION**

  NETAPP **CERTIFICATION**

  NETAPP ONLINE **PUBLICATION**

- **Moreover, EVOLVED-5G will provide innovative 5G-based FoF solutions benefiting from the use of NetApps**

# EVOLVED-5G Inspiration – NetApp vision

## The NetApp ecosystem:

- Request for a **separated middleware layer ->** it will simplify the implementation and deployment of vertical systems at large scale

- It responds to the same requestst triggered by the development of Vertical Application Enablers (VAE) by **3GPP SA6**

Third-party Standalone

Vertical App / NetApp / 5G Network APIs / 5G Network

Third-party Non-Standalone

Vertical App / Business APIs / NetApp / 5G Network APIs / 5G Network

Vertical App ➡ 5G ➡ *5G-Enabled Vertical App*
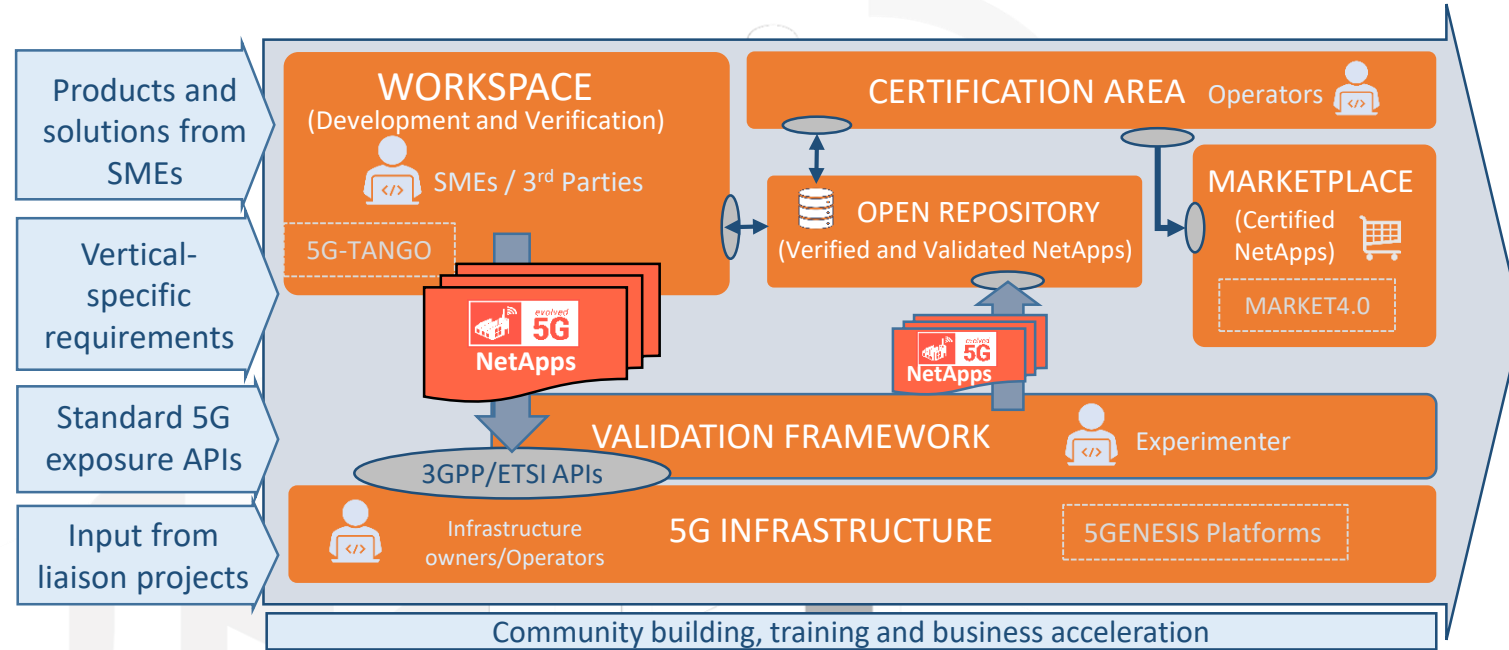
# EVOLVED-5G Overall View

**11 SMEs grouped in 4 Industry 4.0 –related pillars bring their vertical Apps**

**The Project targets 5G NPN for the Industry 4.0 sector with FoF-specific Use Cases**

**5G-enabled vertical Apps with the aid of NetApps that consume 5G core Northbound APIs**

**NetApp dev environment from 5GTANGO, Validation framework from 5GENESIS And Marketplace design from MARKET 4.0**

Products and solutions from SMEs

Vertical-specific requirements

Standard 5G exposure APIs

Input from liaison projects

## WORKSPACE
(Development and Verification)

SMEs / 3rd Parties

5G-TANGO

NetApps

## CERTIFICATION AREA    Operators

## OPEN REPOSITORY
(Verified and Validated NetApps)

## MARKETPLACE
(Certified NetApps)

MARKET4.0

NetApps

## VALIDATION FRAMEWORK    Experimenter

3GPP/ETSI APIs

Infrastructure owners/Operators

## 5G INFRASTRUCTURE

5GENESIS Platforms

Community building, training and business acceleration

## SDK
Open Software Development Kit for verticals to exploit 5G functionality and 5G performance gains through 3GPP standard APIs

## CERTIFICATION
Ecosystem with a set of certification programs to securely isolate the operator's tools and allow a wider openness of the workspace and the validation facility to third parties
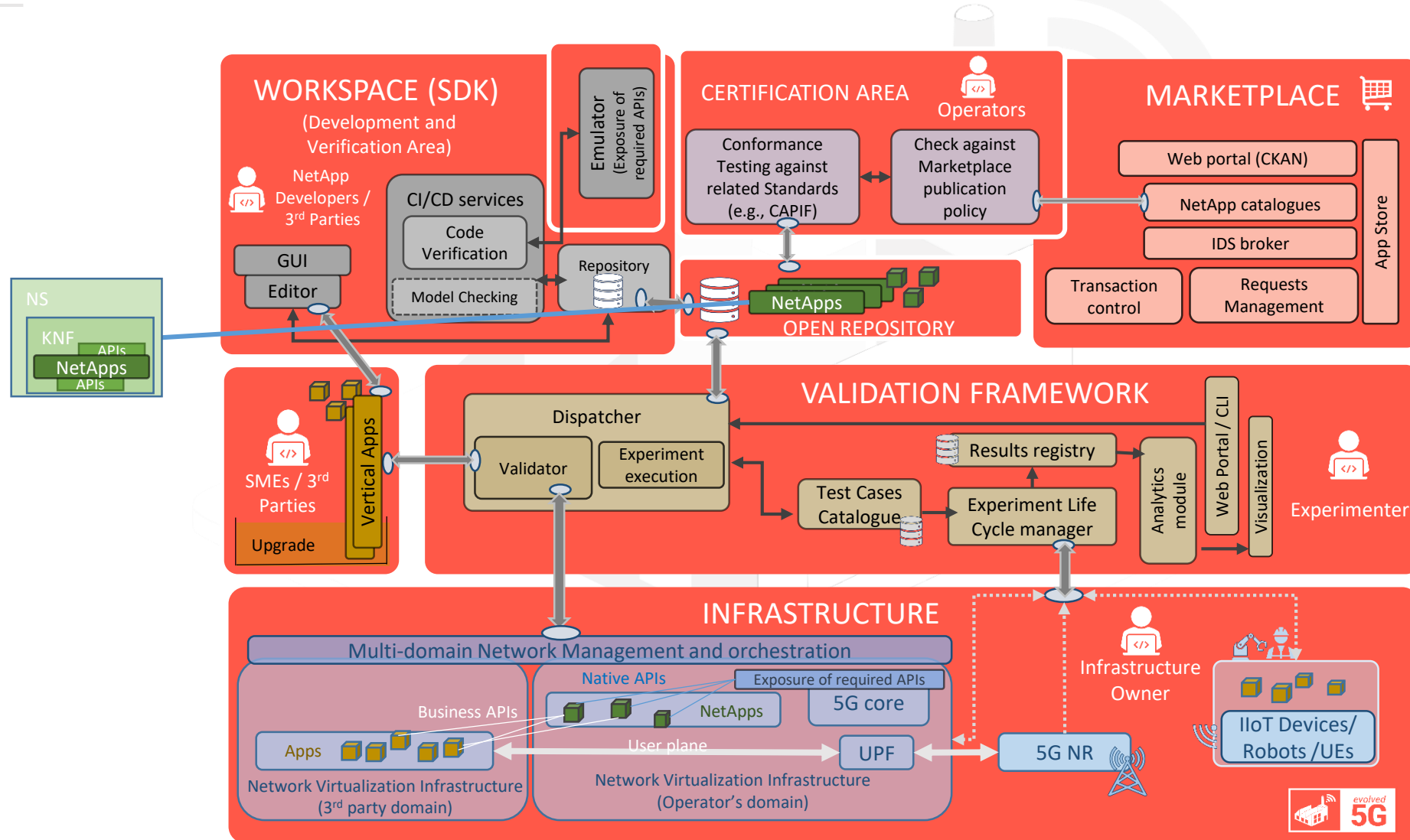
## VERIFICATION & VALIDATION
Test complete network services in multi-domain environments, automation in the validation process, and vertical- to network-level measurement campaigns
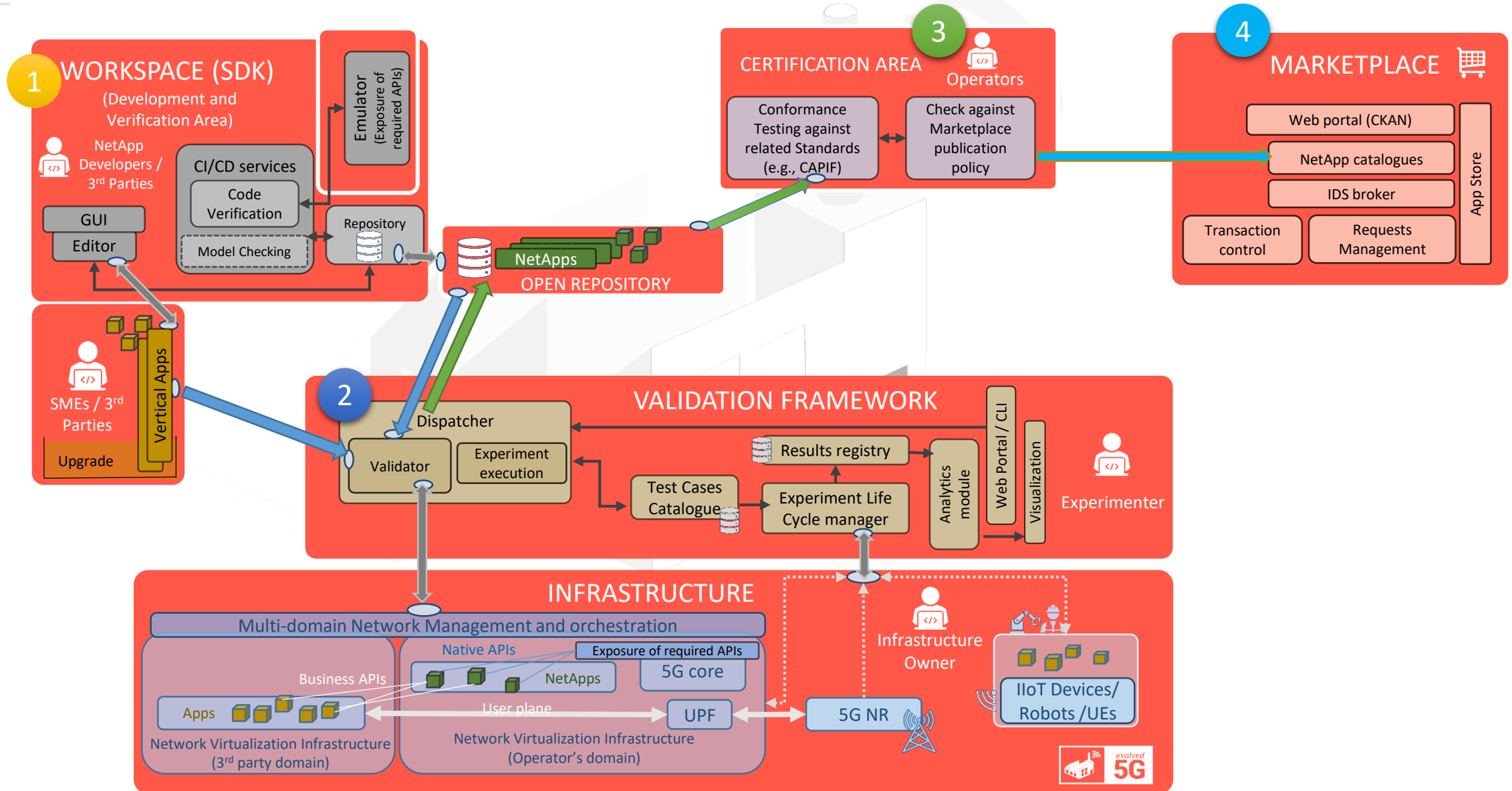
## PUBLICATION
Active online NetAPP store where verticals can interact with, publish, search, discover, acquire and deploy Data Services

# EVOLVED-5G Architecture

# EVOLVED-5G Architecture & NetApp overall validation flow



**① WORKSPACE (SDK)** (Development and Verification Area)

NetApp Developers / 3rd Parties

- GUI Editor
- CI/CD services
  - Code Verification
  - Model Checking
- Repository
- Emulator (Exposure of required APIs)

SMEs / 3rd Parties
- Vertical Apps
- Upgrade

**OPEN REPOSITORY** — NetApps

**③ CERTIFICATION AREA** — Operators
- Conformance Testing against related Standards (e.g., CAPIF)
- Check against Marketplace publication policy

**④ MARKETPLACE**
- Web portal (CKAN)
- NetApp catalogues
- IDS broker
- Transaction control
- Requests Management
- App Store

**② VALIDATION FRAMEWORK**
- Dispatcher
  - Validator
  - Experiment execution
- Test Cases Catalogue
- Results registry
- Experiment Life Cycle manager
- Analytics module
- Web Portal / CLI
- Visualization
- Experimenter

**INFRASTRUCTURE**
- Multi-domain Network Management and orchestration
- Native APIs
- Business APIs
- Exposure of required APIs
- NetApps
- 5G core
- Apps
- User plane
- UPF
- Network Virtualization Infrastructure (3rd party domain)
- Network Virtualization Infrastructure (Operator's domain)
- Infrastructure Owner
- 5G NR
- IIoT Devices/ Robots /UEs

7

# EVOLVED-5G - FoF Use Cases for Industry 4.0

*EVOLVED-5G will provide solutions in the following areas making use of EVOLVED-5G framework:*

Miaxed Reality assisted manufacturing

IoT/M2M-based remote monitoring platform

L7-aware whitebox switch with dynamic SFC & TSN support

Haptic-driven console for industrial Surface repairing

AI-based video analyzer for industrial and robotics

Security information and event management system

Intent-driven chatbots for precise maintenance

ML-driven anomaly detection system for industrial processes

Blockchain data brokerage engine

AI-driven logistics robotics fleets

L7-aware whitebox switch with dynamic SFC & TSN support

*EVOLVED-5G contributes towards **Industry 4.0** and the **Fabric of the Future** (FoF)*

Thank you