Autonomous Edge 5G Private Network Requirements for Smart Factories

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Outline

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About us

- IPTO (Independent Power Transmission Operator) is responsible for the operation, maintenance and development of the electricity transmission grid in Greece with over 11.000 km of system covering the whole of mainland Greece and a great number of facility sites

- The operation and maintenance of such a system demands different services that can be mapped to Smart Grid and Industry 4.0 Use Cases:
  - Measurements' synchronization among sites
  - Real-time Information exchange between IPTO and high-voltage customers (power quality, trip signals etc.)
  - Equipment fault awareness and security at remote locations

- IPTO participates at different Industry 4.0 research projects, acting as the vertical user and participating at the integration, validation and field trials of novel Smart Factory solutions at its premises

Smart Factories: Definition, Objectives and Challenges

A Smart Factory is defined as a smart and reconfigurable network of interconnected sensors, machines, and production systems, which collect, exchange and analyze data in a unified and automated way.

Objectives

- Constant, real time awareness of operating status
- Equipment fault awareness and repair requirements
- Improved safety for personnel, local community and the environment
- Longer and Healthier equipment lifetime, thanks to intelligent predictive maintenance

Technology Challenges

- timing
- heterogeneity
- security and safety
- network infrastructure requirements
- network and service management
- Backwards compatibility with legacy equipment

Smart Factory Application Categories

- Preventive Maintenance:
  - Support of different type of low power sensors and protocols
  - Monitoring system and network able to transmit, process and store massive data

- Operation:
  - Strict timing requirements: including sensing time, transmission, and processing time
  - Zero-perceived downtime (availability), reliability, security, etc.

- Security:
  - CCTV monitoring demands streaming of high quality video
 - Alarms: high availability, security

Need for Private 5G Networks

- Private networks are designed and deployed for private use by governments or companies to optimize or enable business processes

- They offer:
    - Network control (flexible configuration, security and data privacy as network resources are dedicated to and under the control of the vertical user)
    - Resources allocation for the support of specific KPIs (e.g. demanding industrial applications)
    - Coverage at remote locations not supported by public networks
   - Support of independent architectures or integration to the public network

5G-VICTORI: Smart Factories Use Case
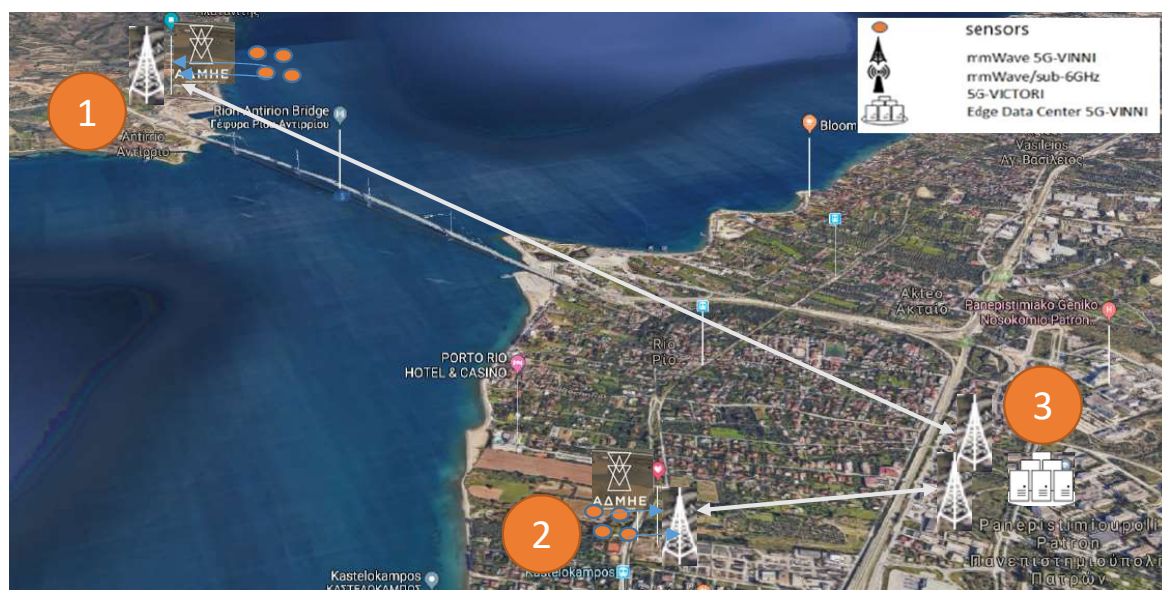
- The facility will interconnect two IPTO sites

- Both facilities lie at each side of the Rio-Antirrio canal separated by 4 km of sea

- Data from various sources are combined through a private 5G network for:
  - Preventive maintenance and
  - Monitoring of critical infrastructures

- A submarine fiber cable will be used to transport measurements from the Antirrio site ①

- A mmWave connection will be used for the connection of Rio site ② with the Cloud system hosted at the University of Patras ③

Diversity in requirements for the different applications

- Monitoring of Critical Infrastructures

- Preventive Maintenance
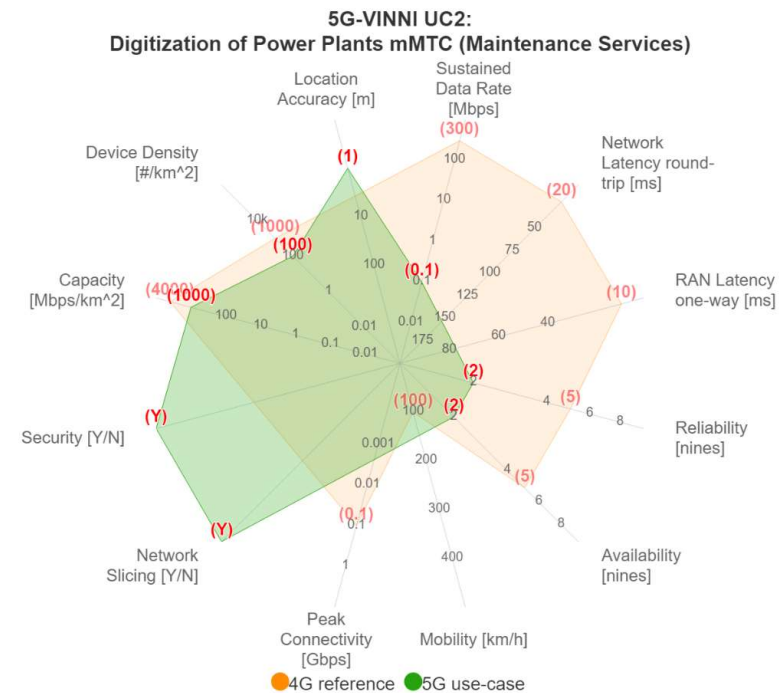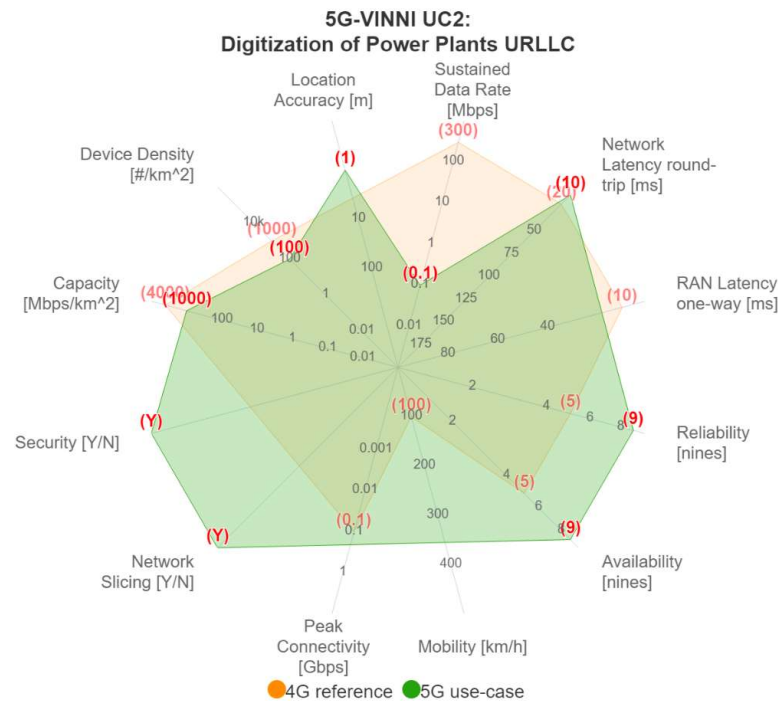
Use Case Key Challenge

Currently a monolithic IoT and network solution is used in IPTO. We can choose between two different setups.

1) Upload all measurements from 1 and 2 to the cloud system located at 3, where they will be stored and processed by our legacy monitoring application Great for preventive maintenance applications:
- Sufficient storage and computational power
- No real-time constraints

OR

2) Install our legacy monitoring application in one of two sites (1 or 2) and proceed to local processing Great for time critical applications:
- No need to store historical measurements
- Reduced network latency
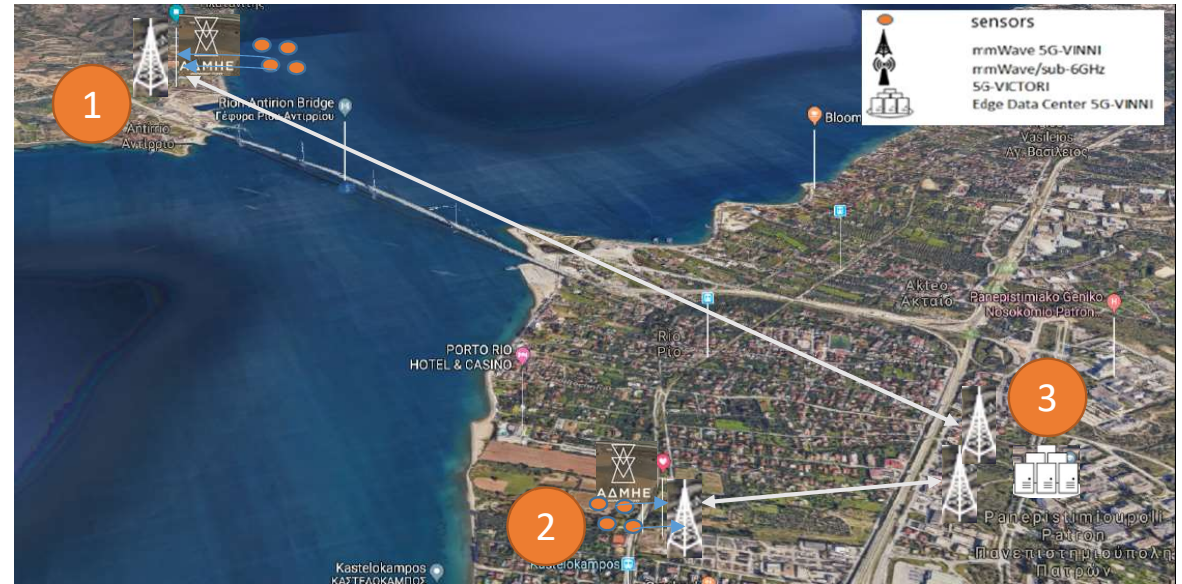
Problem

We want to support both types of applications at the same time

sensors

mmWave 5G-VINNI
mmWave/sub-6GHz
5G-VICTORI
Edge Data Center 5G-VINNI

Use Case – Solution Approach

- Change of legacy monitoring system with a **scalable IoT solution**, parts of which can be executed on the cloud or at the Edge according to the application needs.

- Deployment of **Edge infrastructure** able to host the IoT solution and other facilitating services

- Use of **different Network slices** customized per application

UiTOP

Key Features

- Cloud-hosted (Public, Private or Hybrid), multi-tenant solution

- Containerized micro-services based architecture, with processes overload & prioritization mechanism

- Core and optional modules enable flexible packaging to satisfy the different IoT providers' needs

- Core and optional modules can be executed on the cloud or at the edge
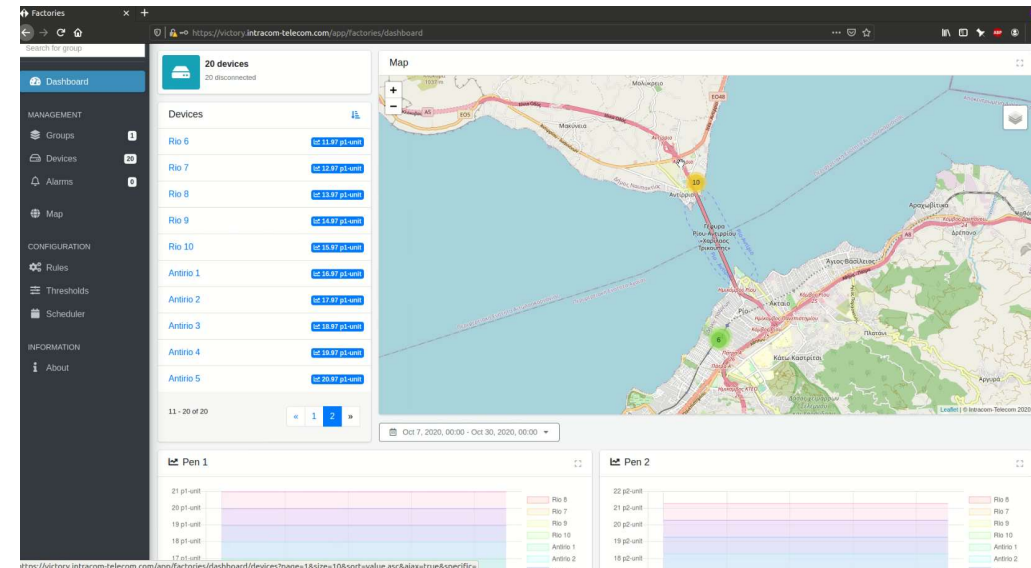
Snapshot of customized UiTOP GUI

Patras 5G Autonomous Edge

Patras 5G Autonomous Edge, is a mobile box, containing everything from the 5G New Radio and 5G Core, Network and Service Orchestrations including a Virtualized environment based on Openstack technology.
http://wiki.patras5g.eu/5g-autonomous-edge

Patras 5G Autonomous Edge solution

Key Features

- Virtualized Hardware
- Network Orchestration (OSM)
- Service Orchestration (Openslice)
- 5G New Radio (Indoor Range)
- Monitoring Services (Grafana, Prometheus, Netdata)
- EdgeXFoundry for IoT gateway functionality

Autonomous Edge can support the orchestration and execution of different Network and Application services including the UiTOP modules

Preventive maintenance Applications

- This set of applications focuses on gathering data from many sensors, store them and use them for preventive maintenance activities
    - Measurements from low cost and legacy sensors with no latency requirements
    - Cleansing of measurements, alleviation of network congestion (data fusion techniques at the edge)
    - Data processing, visualization, storage and reports at UoP data center
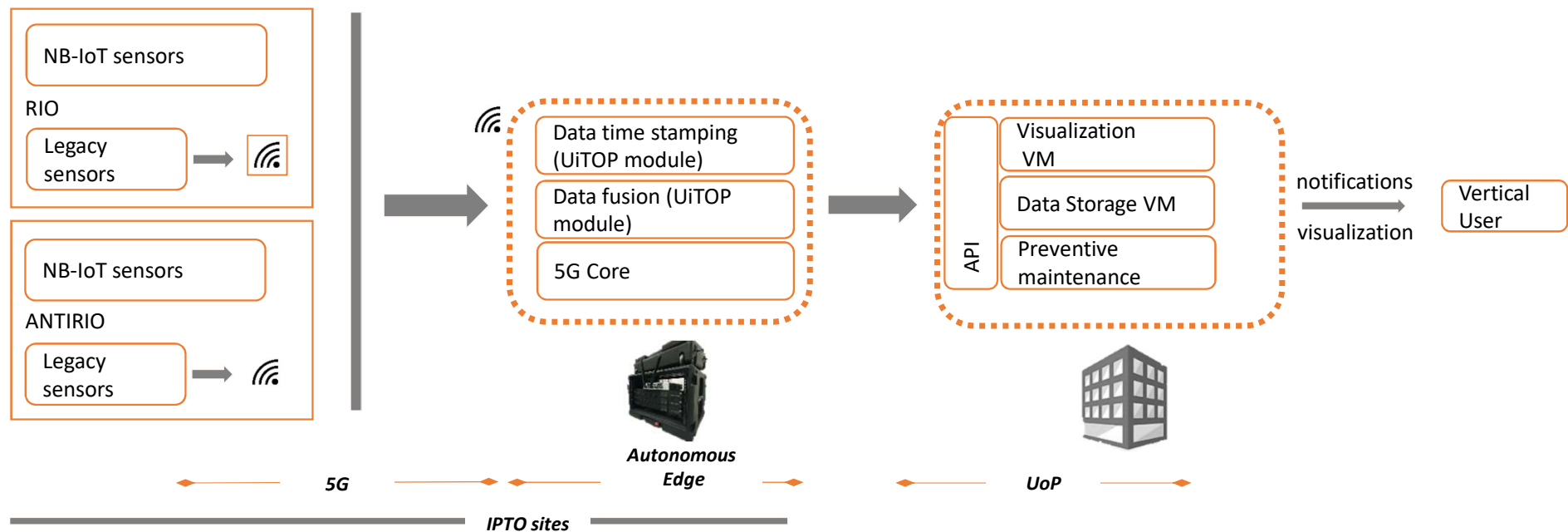
Monitoring of critical infrastructures

- This set of applications addresses time critical events, security & control-related actions
  - Measurements from HV cable sensors (e.g. oil pressure), video from FHD cameras and motion capture sensors
  - Local data time stamping and data correlation (at Rio facilities)
  - Real-time operational and security-related control actions at the edge
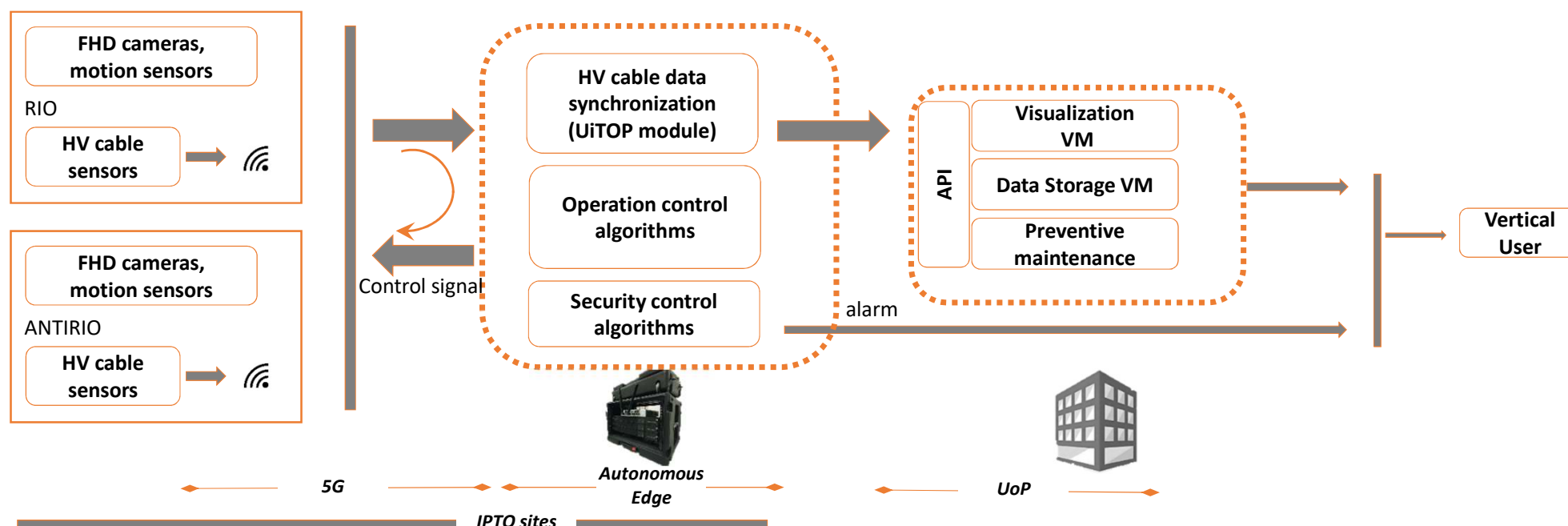
Findings

With the integration of a Private 5G network:

- The vertical industry does not rely on a public network operator for the on-premise communications and is the only responsible for the operation, and maintenance of the network

- The vertical industry can control the network resources to support specific services KPIs. With proper resource allocation, services with different requirements can be supported simultaneously

- The use of virtualized hardware, wireless communications, and Network and Service Orchestration, leads to a flexible, easily managed, expandable and cost-effective solution

- Data privacy is ensured, as communication are performed through private channels. This is very important when dealing with sensitive information collected from Smart Factories

Thanks for your attention!

5G-VICTORI Project
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