

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n° 101016912



the Smart5Grid Stakeholder Forum

Starting soon

12 December 2023 14.30 CET

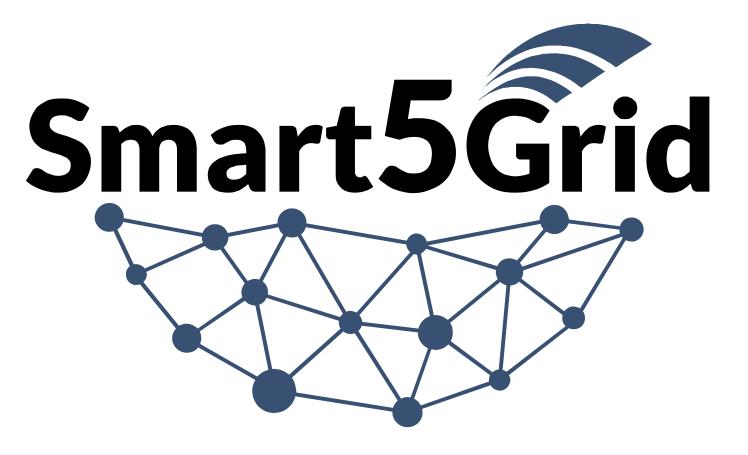


This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 101016912

the Smart5Grid Stakeholder Forum

Welcome

12 December 2023 14.30 CET



Demonstration of **5G** solutions for **SMART** energy **GRID**s of the future

The Smart5Grid Stakeholder Forum

Agenda



- Overview on Smart Grids, state of the art and needs
- State of the art of telecommunication in grids, a global DSO perspective
- Approaching 5G-based Edge-Cloud Computing
- Camara, toward Core API standardization
- The power of the Edge, virtualizing field devices and reducing latency
- Edge Orchestration: Capillary monitoring of the infrastructure and lifecycle management of network functions and services
- On private 5G networks and Network Applications as application functions
- The Smart5Grid platform to support developers
- Opportunities for innovators and developers
- Final Q&A



Overview on Smart Grids

State of the art and needs

e-distribuzione Riccardo Lama



State of the art of communications in energy grids

a global DSO perspective



Global dimension of Enel Grids







Countries

7

Lines

2M km

End Users

75.9 Mln



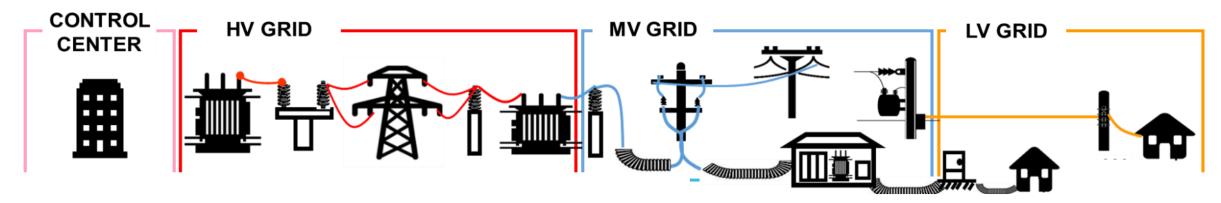




Telecommunication needs for the Grid

Grids Services





Control Center Services

- Telecontrol Networks
- WorkForce Management
- I/O vs TSO
- I/O vs other systems
- Energy producers monitoring
- Distribution
 Management System
- Energy Management System

HV Grid Services

- Status of Network
 Devices (digital and
 analog signals from HV
 Lines, MV Lines, Transf.,
)
- Digital and analog signals from Relay Protection
- Self Healing HV Lines
- Service from Substation Monitornig

MV Grid Services

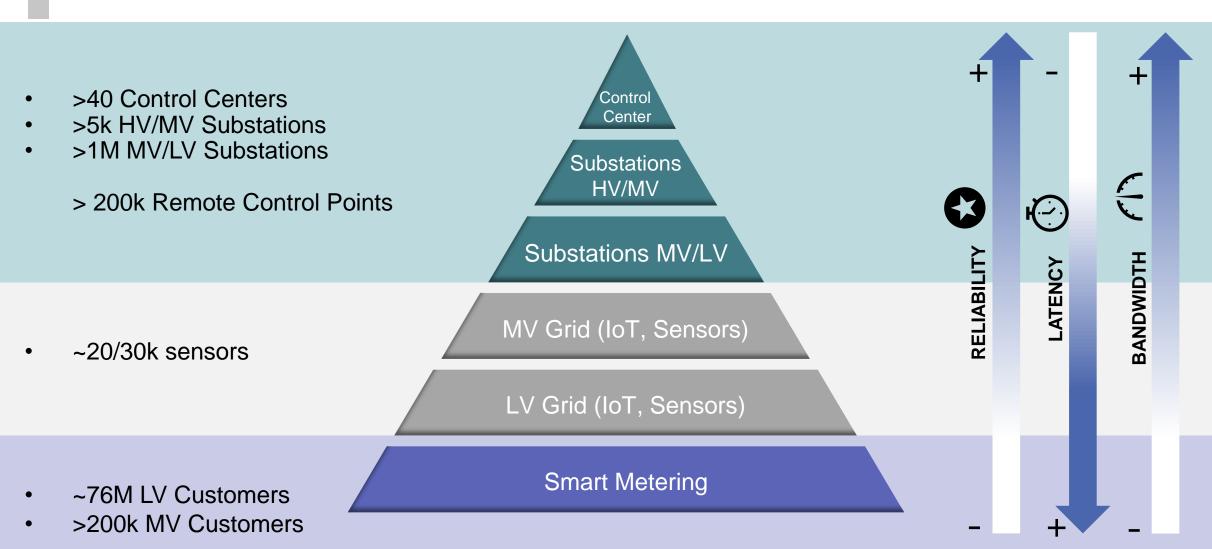
- **Grid Autumation** (FNC, FRG, LARS SHA, **SFS**)
- Status of Network
 Devices (digital and analog signals from RGDM, RGDAT, ...
- Grid Monitoring
- Smart Metering
- Device Management

LV Grid Services

- Smart Metering (meters)
- IoT and Sensors
- Field Operations

Telecommunication Features and Volumes



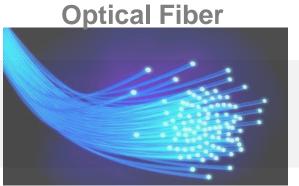


Connectivity Strategy of Enel Grids

The need for digitalization



Mobile Networks











		46	
Low Latency	***	***	
Bandwidth	***	***	
Reliability	***	***	
Scalability	***	***	
Flexibility	***	***	
Costs	€€€	€	





Approaching 5G-based Edge-Cloud Computing

Fostering the digital transition of the energy industry



Energy transition

Smart Grids
Flexibility

Islanding

Digitalisation

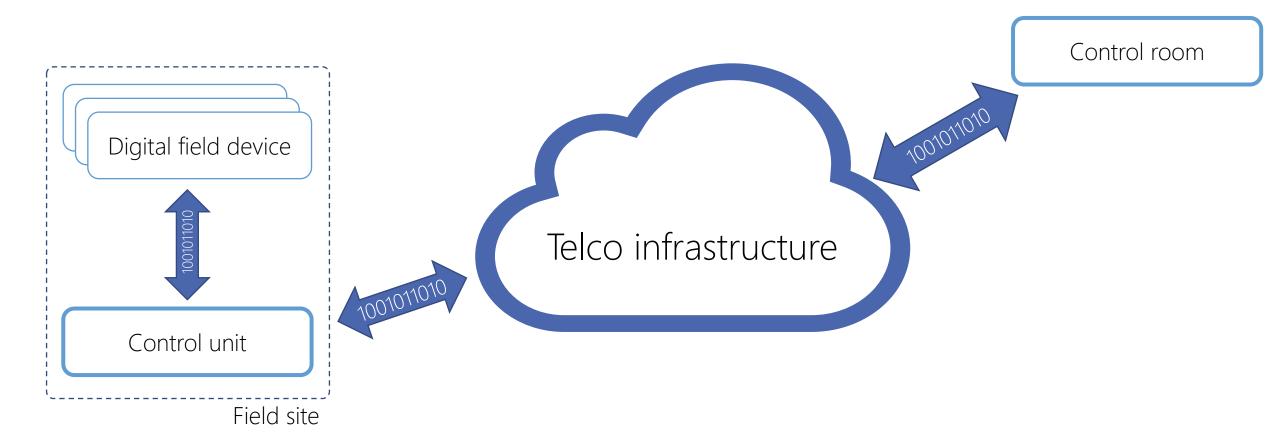
Distributed generation **Energy Storage**



Digitalisation: what kind?

Actual telecommunication model



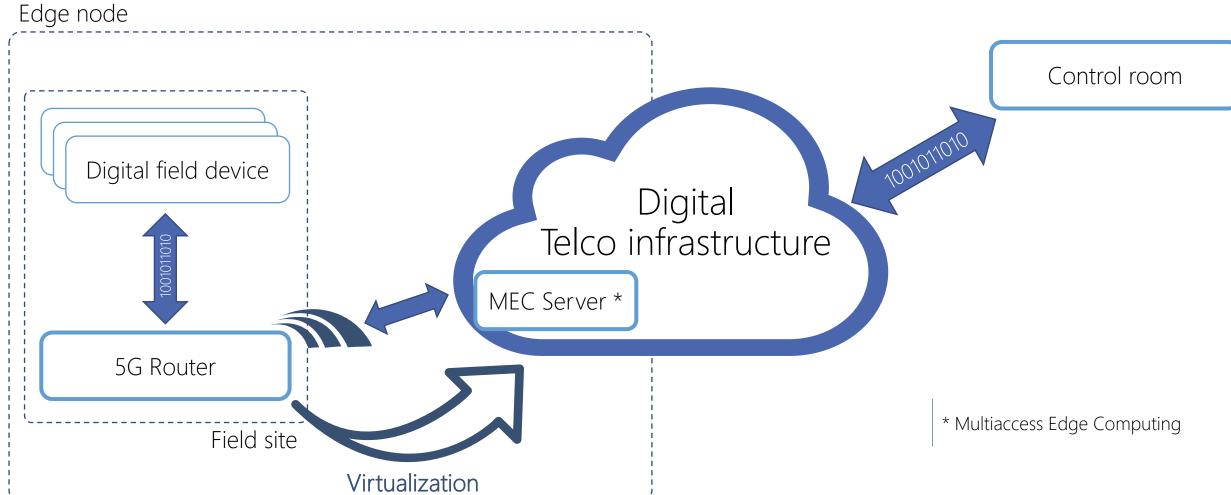




5G-based cloud edge computing

Digital telco paradigm shift





Smart5Grid overall concept



Smart5Grid
Open Experimental 5G Platform

Platform layer

Virtualization/Telco layer

Network App

Network App

Network App definition, modeling and implementation

Network Applications'
Open Service Repository

V&V Framework (Validation and Verification)

Energy layer





Network Applications: a way to simplify the 5G complexity

A simple Network Application



Network App Descriptor

microservice

Virtual Field device

microservice

Automation algorithm

microservice

Routing

microservice

Slicing

Computational requirements

Communication requirements

Other requirements



My core developments



Available from others



Demonstration of **5G** solutions for **SMART** energy **GRID**s of the future

The Smart5Grid project aims to investigate the potential of 5G-based Edge-Cloud Computation in the Energy industry, by introducing the concept of Network App for simplifying the 5G Complexity. The project testbeds are now available for third-parties' experimenters, fostering the creation of a new market-segment for Network Apps.



THE CONSORTIUM

24 EUROPEAN

PARTNERS

(50% SMEs)

COVERING 7 EU STATES **DURATION**

3 YEARS

(+4 MONTHS)

TERMINATING ON

APRIL'24

TOTAL BUDGET

8M€



the Smart5Grid Consortium

Coordinator











Tech Companies







Universities/Research institutions







DSOs



TSOs































*Linked third-parties of Enel Grids



Camara Toward Core API standardization

i2cat Andrés Cárdenas Córdova



CAMARA: <u>Toward Core API standardization</u>

Dr. Andrés Cárdenas Córdova

December 12, 2023



SMART energy **GRID**s of the future



AGENDA

- ☐ What & Why
- ☐ CAMARA Framework
- ☐ CAMAR System Architecture
- ☐ Roles of the Stakeholders
- Industry Impact
- ☐ Conclusions

WHAT IS CAMARA?

Brief overview:

- CAMARA is an open-source supported by Linux Foundation with the collaboration of the GSMA
- Its mission is to foster the definition, development, and validation of open and standardized APIs.
- CAMARA counts on an open and evergrowing community which gathers frontline industry stakeholders, including vendors, CSPs, Hyperscalers, solution integrators, and customers.
- CAMARA has adopted an open-source approach, based on using Apache 2.0 license for API definitions and reference implementations.





WHAT IS CAMARA?

Key aspects addressed by CAMARA:



Scaling

Apps, Products, or Services should be present in all relevant markets and networks globally.



Consistency

Verticals don't want APIs that work in a single network in a single country.



Simplicity

Telco Networks are complex, and every network is different.

Developers want simple and usercentric APIs.



WHY THE INITIATIVE?

Network Providers (MNOs)

- Need to evolve the Network Infrastructure and Services to All-software and Cloud-native solutions.
- Need to monetize the new set of sophisticated network and computing capabilities that enable enhanced characteristics for the next generation of services
- Prepare for new communication paradigms, with minimal human intervention, to interact with the physical and virtual infrastructures

- ➤ How to enable an smoothly integration between Vertical Industries and Network Providers (MNOs)?
- How to take advantage from this integration?



WHICH IS THE FRAMEWORK?

GSMA Open Gateway NaaS System is a framework of common network APIs designed to provide universal access to operator networks for developers.

MNOs

- Allows to expose and monetize telco capabilities to third party service providers in a programmatic manner through APIs.
- Allows to transform telco networks into programmable service platforms
- Represents a business opportunity to generate new revenue streams and monetizing investment in fiber, edge computing and 5G

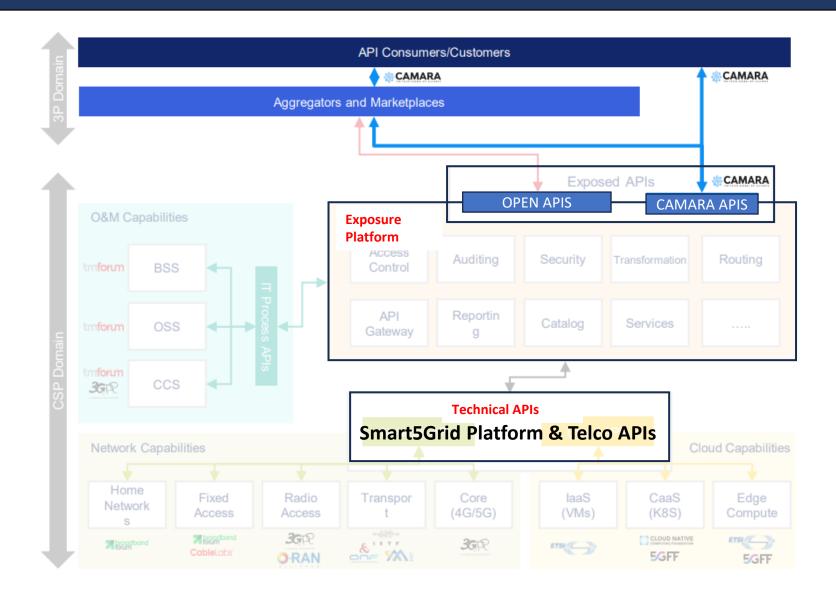
Verticals

- It releases them from the constraints of traditional over-the-top, best-effort service delivery approaches.
- New capabilities to provide enhanced user experiences and contribute to the digital ecosystem with new services





CAMARA ARCHITECTURE



	CAMARA APIs	Open APIs	Technical APIs
	Developer oriented, User Friendly	Service Management, Flexible, Extensible	Domain Specific Focus, Standardized, (FRAND)
	Single Place for Developers to use Telco APIs both for user and management activities	Interaction between CSPs and Aggregators to manage Products, Services, and Users	Multiple SDOs and initiatives that work to develop domain specific technical APIs



ROLE OF THE STAKEHOLDERS

Cloud Infrastructure

















Enhancing virtual 'Cloud' applications & services to enable Web3.0

Open Service (Northbound) Common Network APIs via CAMARA GitHub & GSMA Agreement Templates

Open Federation APIs (East West Federation & Interconnection) via GSMA Operator Platform Specifications & Agreement Templates















tmforum

Operate



Exposing network capabilities: Identity: 5G Capabilities: Al/Data: Privacy: Security

Earth Networks

Source: White Paper, The Ecosystem for Open Gateway NaaS API Development, GSMA, 2023

Customers/ 3rd Parties

- Consume abstracted, aggregated and enriched APIs exposed by the MNOs.
- Consume service-oriented APIs and servicemanagement oriented APIs

MNO/ Internal APIs

- Technology-specific APIs defined by standardization bodies (3GPP, GSMA, TM Forum, ETSI), etc.
- How IT capabilities are to be operated and managed for NaaS provision
- Design and guide of the implementation of modular and standardized APIfication of the IT system



ROLE OF THE STAKEHOLDERS

CAMARA

Define (additional) APIs and roadmap to sync across MNOs and CSPs

Creation of Technical Steering Commitee (TSC) for Project harmonization

Homogenization on the API lifecycle Management

Documentatio of API versioning available globally for ensuring federation through CSPs and MNOS



CONCLUSIONS

- CAMARA is leading a paradigm shift with great impact on the industry landscape.
- CAMARA requires a collaborative workspace that brings together incumbent telco standards bodies with IT and cloud communities, industry associations and open-source projects.
- Verticals can take advantage from the NaaS system to evolve their bussiness models reducing their devops procedures.
- Vertical's applications can work dynamically adapting their services to the context of the users.
- Allows the development of user-centric services.



THANK YOU!

IP monitoring for Smart Grids

Italian Demo | Olbia



Power plant operators' safety monitoring

Spanish Demo | Barcelona

frequency control

Bulgarian Demo (Southern region)

Greek-Bulgarian Demo | (Cross-border)



The power of the Edge

Virtualizing field devices and reducing latency





Michalis Rantopoulos



UC#4 –Real-Time Wide Area Monitoring- Overview

- The **scope** of UC#4 is the real-time monitoring of a geographical wide area where cross-border power exchanges take place.
- The interconnection flow between Greece and Bulgaria is monitored leveraging the advantages that the 5G communications infrastructure provides.
- > To achieve the enhancement of the interconnected power system operation, live monitoring of the interconnected power system flows is of vital importance.
 - For that reason the PMU-PDC scheme will be used, enabling high data number and granularity.
 - Phasor Measurement Units (PMUs) measure grid current and voltage by amplitude and phase at several substations (nodes) of the transmission power system. The high-precision time synchronization of the measurements from different substations allowing better monitoring of system's state and detection of dynamic events. The PMUs are located in Thessaloniki and Blagoevgrad regions and will be used as the monitoring process of the RSC
 - A virtual Phasor Data Concentrator (vPDC) will be developed for the data gathering process according to C37.244 standard.
- The utilization of 5G contributes to the connectivity between the PMUs and the vPDC offering its low latency and high reliability, fulfilling the critical constraints of this UC.

Smart5

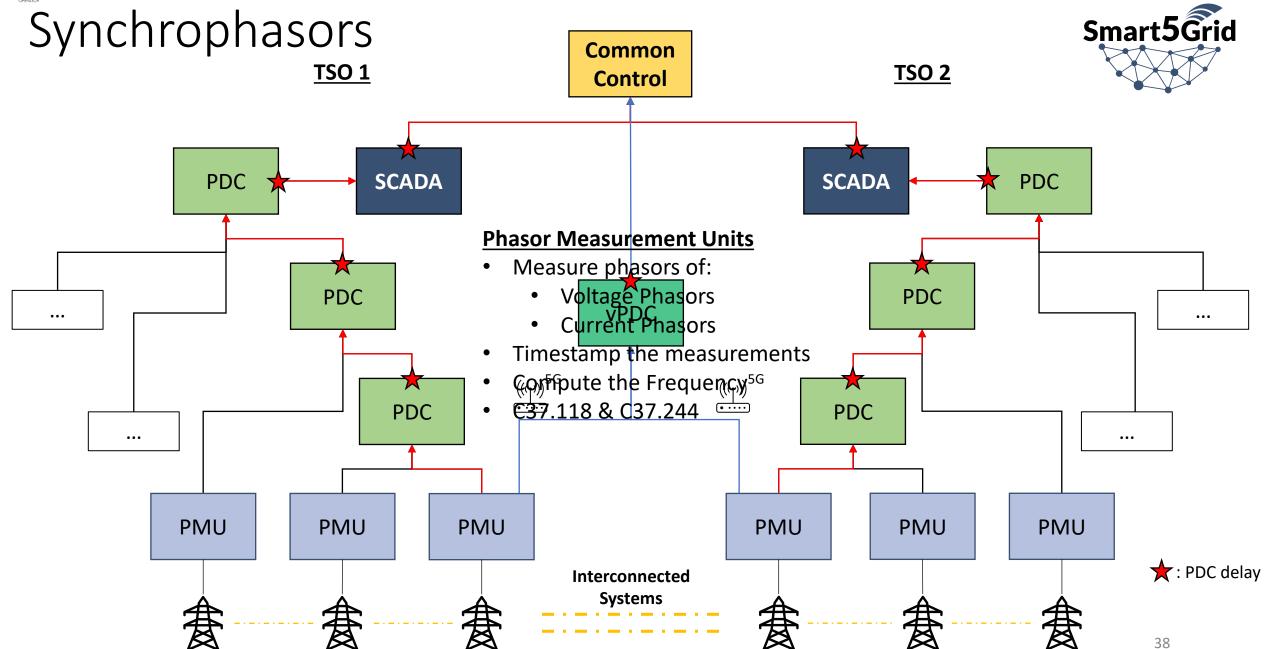


UC#4 –Real-Time Wide Area Monitoring Overview

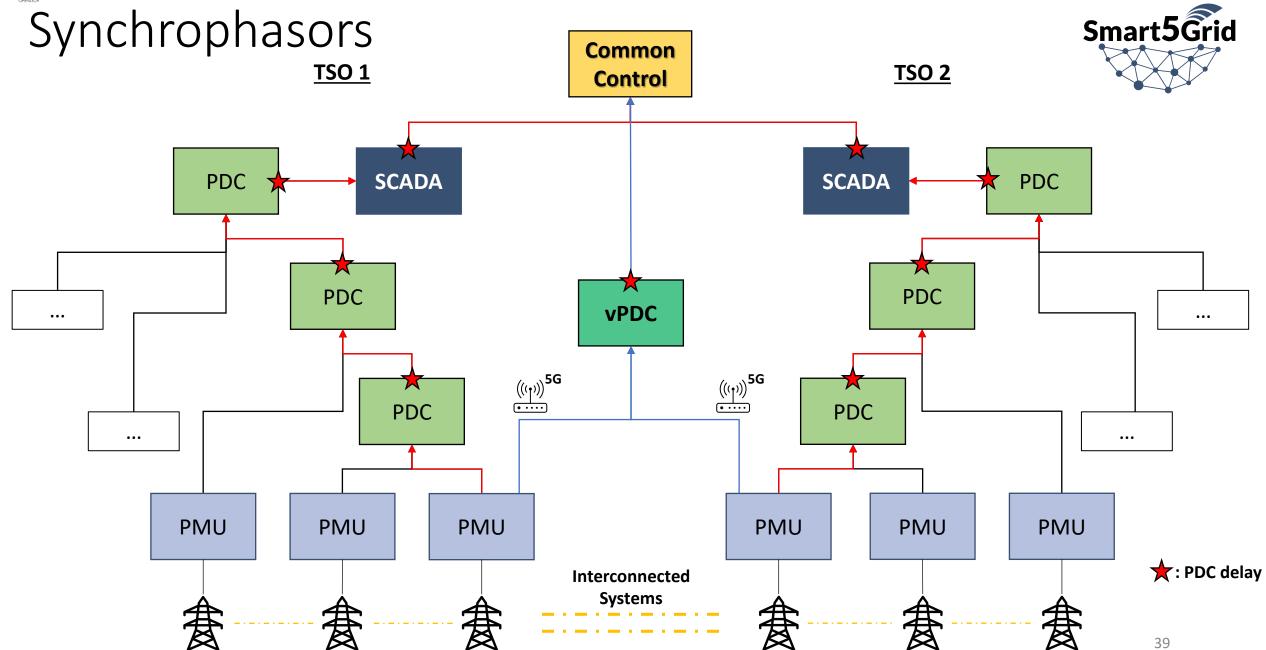


- The **scope** of UC#4 is the real-time monitoring of a geographical wide area where cross-border power exchanges take place.
- The interconnection flow between Greece and Bulgaria is monitored leveraging the advantages that the 5G communications infrastructure provides.
- > To achieve the enhancement of the interconnected power system operation, live monitoring of the interconnected power system flows is of vital importance.
 - For that reason the PMU-PDC scheme will be used, enabling high data number and granularity.
 - Phasor Measurement Units (PMUs) measure grid current and voltage by amplitude and phase at several substations (nodes) of the transmission power system. The high-precision time synchronization of the measurements from different substations allowing better monitoring of system's state and detection of dynamic events. The PMUs are located in Thessaloniki and Blagoevgrad regions and will be used as the monitoring process of the RSC
 - A virtual Phasor Data Concentrator (vPDC) will be developed for the data gathering process according to C37.244 standard.
- The utilization of 5G contributes to the connectivity between the PMUs and the vPDC offering its low latency and high reliability, fulfilling the critical constraints of this UC.









Advantage vs. Legacy Solutions

Real-time Wide Area Monitoring

Direct communication between vPDC - PMUs

5G networks

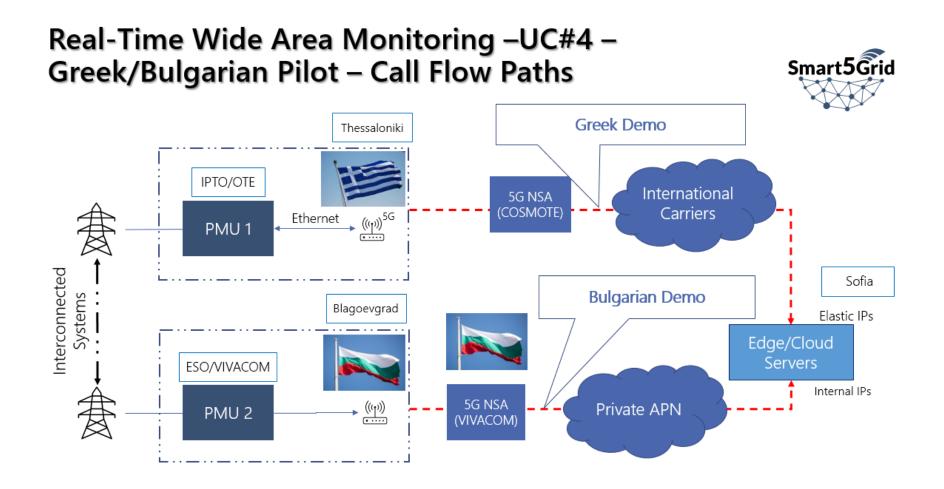
Previous generations of wireless networks

Optical fiber (wired networks)



Smart5Grid's Observations for Real-Time Wide Area Monitoring

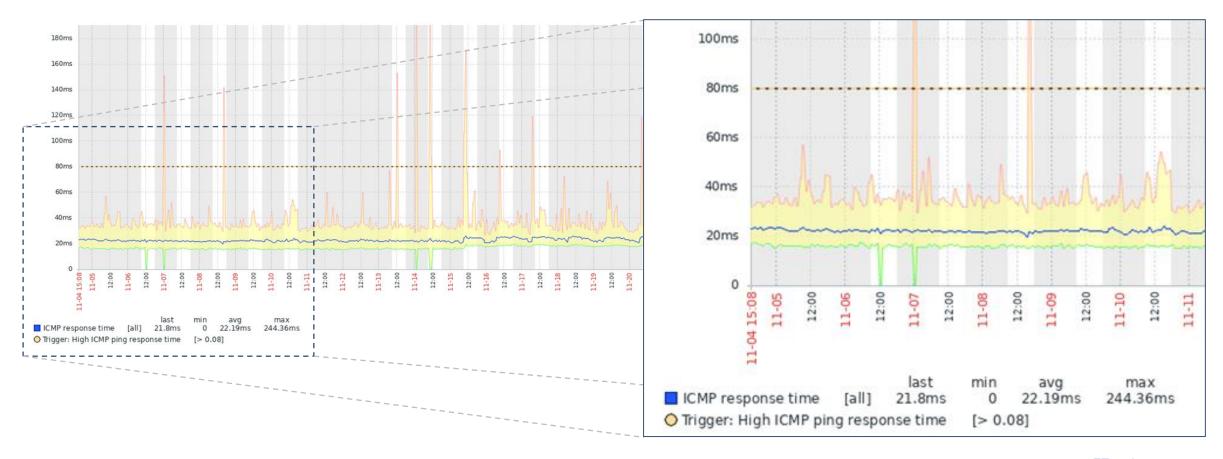
Local (Blagoevgrad PMU) vs 'Remote' (Thessaloniki PMU) Interconnection





Comparative Measurements from Field Locations – Bulgarian Demo

Effect on Latency from Interconnections of Blagoevgrad PMU





Comparative Measurements from Field Locations – Greek Demo

Effect on Latency from Interconnections of Thessaloniki PMU

Absence of Measurements due to Human Intervention Error locally





Comparative Measurements from Field Locations – Observations

- No significant Delay inside COSMOTE's mobile Network in the RAN + transmission Side till the data reach the S/GW server
- When trying to interconnect through the Roaming Scenario the effect on Latency lies primarily on the GRX Interconnection Side, since User Plane Data follows the usual Roaming Data Path
- Bulgarian Demo the data are handled 'locally' with a clear better performance of Latency
- Future improvement test the Greek Demo with a COSMOTE sim card, instead of a roaming VIVACOM and measure the effect on Latency





This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n° 101016912

the Smart5Grid Stakeholder Forum

Coffee break

We will be back at 15.30



Edge Orchestration

Capillary monitoring of the infrastructure and lifecycle management of network functions and services



Michalis Dalgitsis



NearbyOne

Edge Orchestration: Capillary monitoring of the infrastructure and lifecycle management of network functions and services

December 2023

Motivation



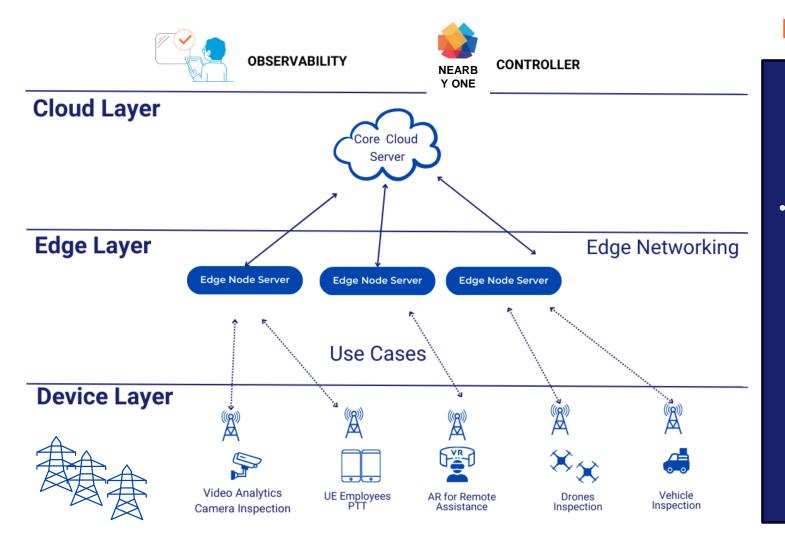


The smart grid paradigm poses **new challenges to communication networks** requiring a flexible and orchestrated network, slicing, and millisecond-level latency.

To transform today's power distribution grids into 'evolved' smart grids that feature online monitoring data and to enable efficient, fast, and secure operation, power distribution companies need **new tools** that will allow them to monitor and operate the distribution network and to maintain and increase reliability and Quality of Service (QoS).

5G and edge fabric for Smart Grids





Benefits

- TCO reduction: Lower costs using traditional and modular server and edge computing solutions.
- Breaking down data silos: The utility will have one common network model that all departments work from to ensure reliable planning, operation, and protection of the power grid.
 - Inherent Observability: The Edge
 Platform provides telemetry on a normalized format to be directly injected into the maintenance system

NearbyOne brings a new 360° approach

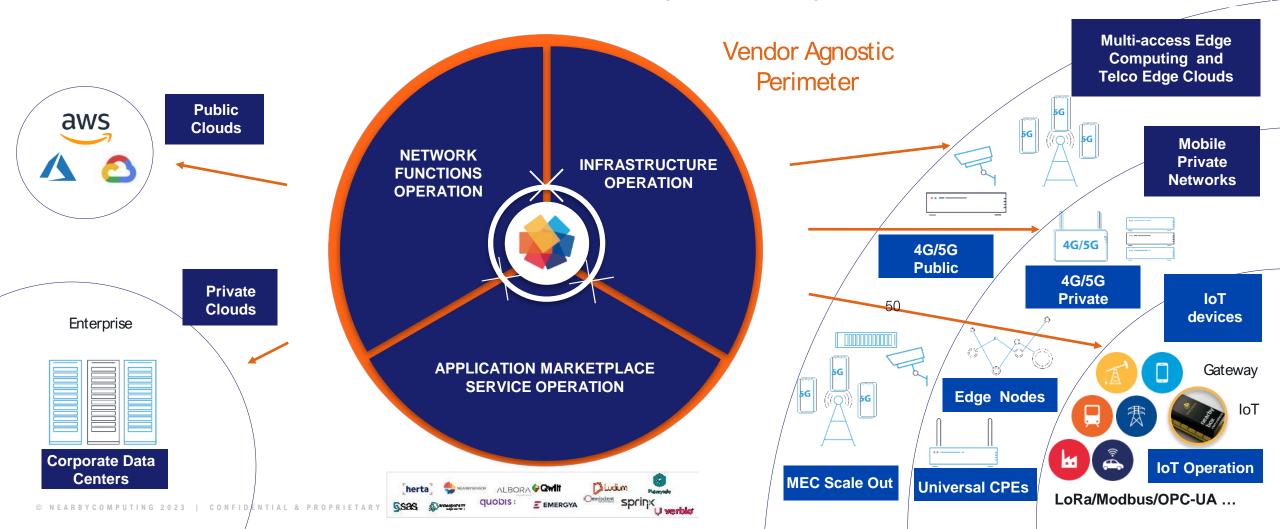


Holistic

For the frictionless, centralized management of different types of devices and SW components from a single platform

Adaptive

Automatically adapts to the wide variety of situations that take place at the Edge thanks to intelligence-driven decisions.

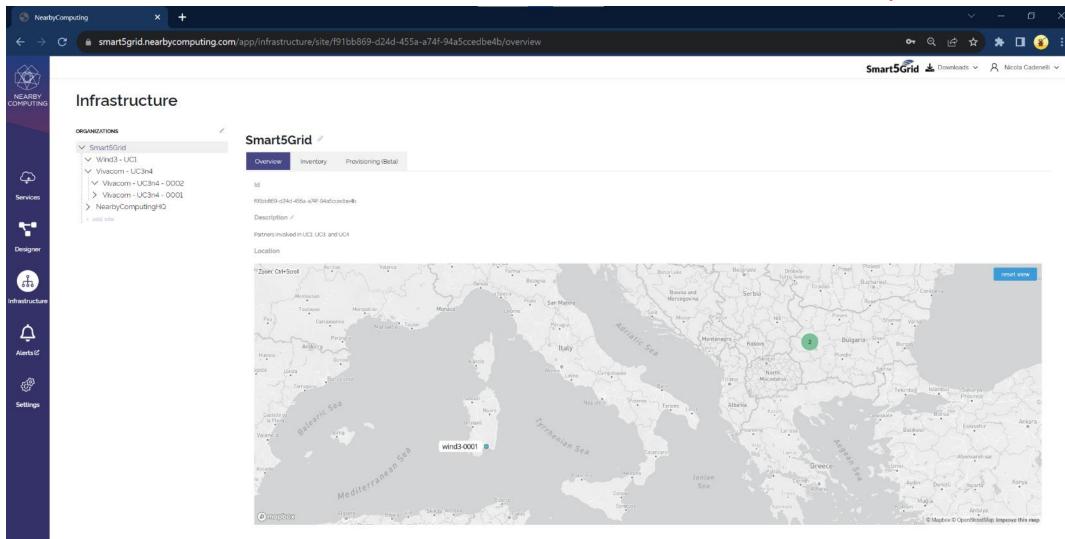


NearbyOne as Smart5Grid Network App Controller

© NEARE



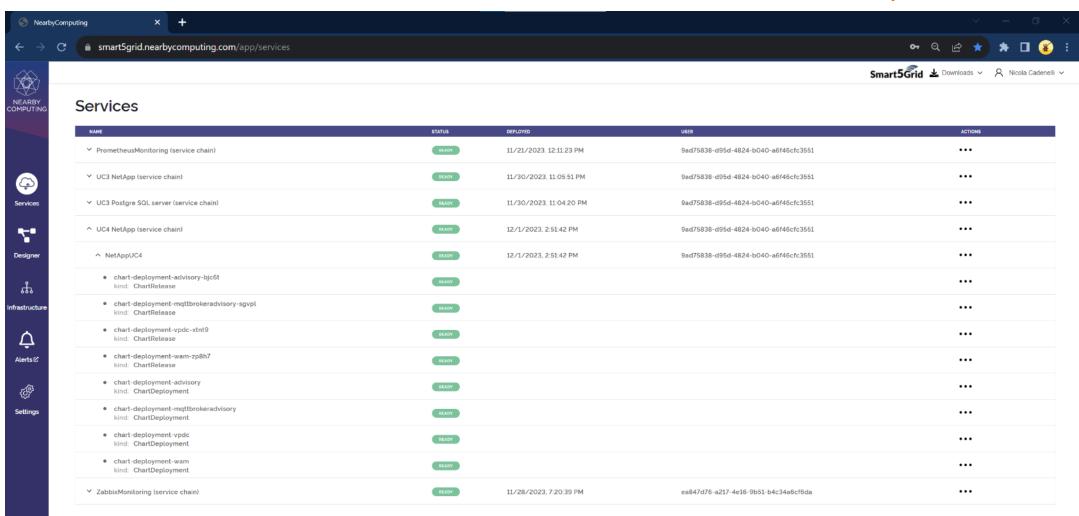
One instance to monitor infra and services in different countries and different partners



NearbyOne as Smart5Grid Network App Controller



One instance to monitor infra and services in different countries and different partners



High Level Features



□Unified Configuration Management

- Friendly configuration of multiple vendor NFs via API or UI
- Deployment of defined configurations across clusters
- Unified management of NFs (CNFs, VNFs), Physical Infrastructure

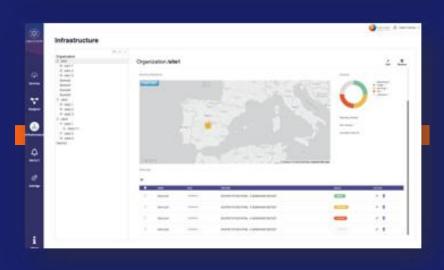
□ Lifecycle Management

- Rollout and Rollback (automatic or manual) of new software versions
- LCM of software and hardware (may require extensions to support additional OEMs)

□ Observability

- Full Observability Stack as a Service, powered by standard open source components
 - Prometheus/Thanos/Grafana
 - ELK
 - SNMP/AlertManager/WebHooks
 - Jaegger / OpenTelemetry
 - Alerta
- Unified and Extensible Alarming platform

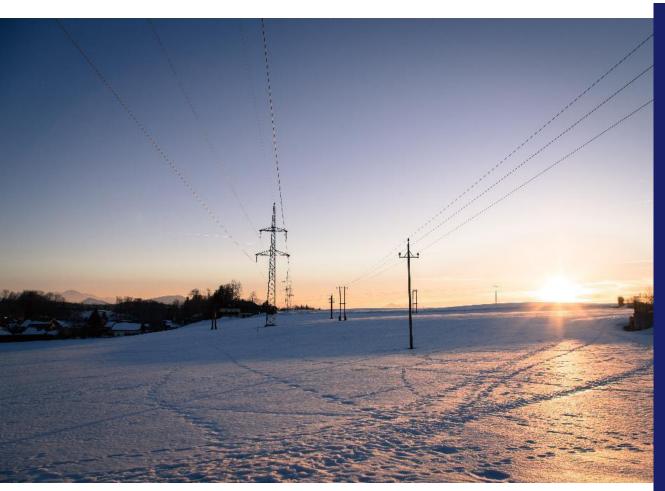




Real Use Cases: Smart Substations







BENEFITS

☐ MONITOR AND SECURE SUBSTATIONS

High-resolution 3D sensors combined with AI will support workers during maintenance, avoiding reaching live parts of the power grid.

■ AUTOMATIC POWER GRID FAULT DETECTION

Monitor the power grid remotely and detect failure locations along lines reducing operation costs.

□REAL-TIME WIDE AREA MONITORING

Aggregate and control data of 1000s of Medium and High Voltage decentralized Renewable Energy Sources and their inverters.

□ REAL-TIME WIDE AREA MONITORING

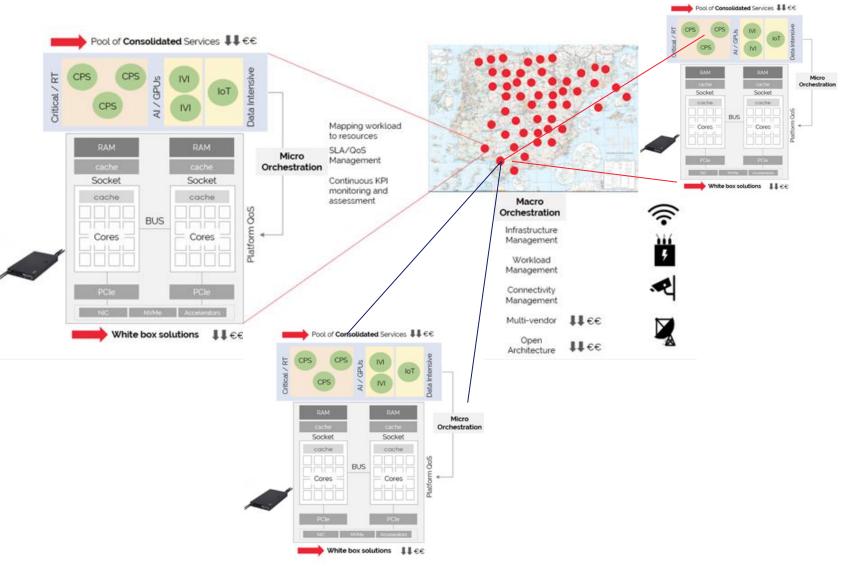
From Distributed Energy Resources at Medium Voltage levels operated by DSOs to High Voltage levels operated by TSOs, as well as inter-TSO cross-border Regional Security Coordination.

Real Use Cases: Virtualized Substations



COMPUTING





BENEFITS

□CRITICAL LOW-LATENCY (2 ms) PROTECTION AND SCADA SERVICES

Provide guaranteed performance and reproducible QoS to critical protection services thanks to the offered microorchestration and custom provisioning profile to set BIOS settings (Hyperthreading, CPU frequencies, caches, etc) and more.

QCOLLOCATION WITH ANCILLARY SERVICES

Other services can be deployed without impacting the performance of critical services.

□MICRO&MACRO ORCHESTRATION FROM A SINGLE-PANE OF GLASS

Monitor and manage multiple sites from one remote dashboard. Plan upgrades rollout using blue/green or canary deployments





Get in touch for more information Thank you

Contact
Michalis Dalgitsis
Research Engineer
michail.dalgitsis@nearbycomputing.com

Nicola Cadenelli, PhD Senior Solution Architect ncadenelli@nearbycomputing.com

Angelos Antonopoulos, PhD
R&I Director
aantonopoulos@nearbycomputing.com





On private 5G networks

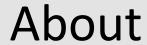
and Network Applications as application functions



Nicola di Pietro







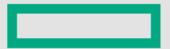


a Hewlett Packard Enterprise acquisition



is active in the field of mobile core networks

- Part of Hewlett Packard Enterprise
- Headquarters: Bolzano Vicentino (VI), Italy



Hewlett Packard Enterprise

We develop fully virtualized 4G/5G mobile core networks and related solutions both for public and private networks

12/12/2023 Smart5Grid Stakeholder Forum 58





Why 5G?

Designed around services

Business-to-business technological revolution

Infrastructural: not only a support but an actual enabler to new production systems and services

New customers other than traditional mobile network operators, i.e., the vertical industries





Some vertical sectors:

Automotive
Utilities
City management
Healthcare
Smart manufacturing
Government and public safety



Private 5G: Not Only National Operators

It is becoming common practice for common businesses to have their own 5G. From nation-wide public networks to a plurality of "small" private, customized networks



Based on the availability of frequency for lease to private entities, the mobile network operator's role remains prominent!





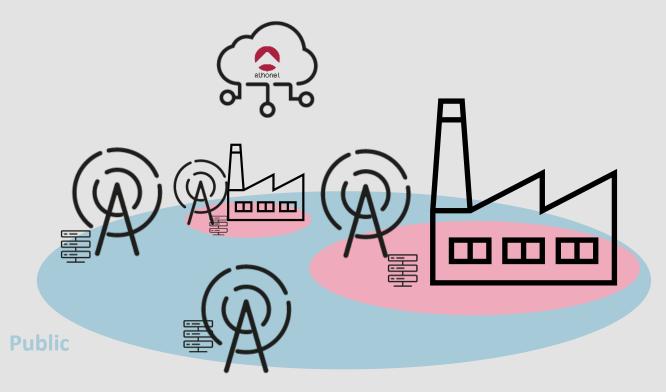


Private 5G for 3GPP: Non-Public Networks

Standalone NPNs

Public Network Integrated NPNs (via network slicing)





Private



Benefits of Private vs. Public 5G

- Localization of data for privacy/security
- Optimized radio coverage via ad hoc deployment for the owner
- Reduced latency because of local deployments
- Reduced uncertainty of network operations and reduced service disruption
- Control of the owner over network elements





5G Network Capability Exposure

Certain control-plane 5G functionalities are accessible to third parties (e.g., Network Applications) via Application Functions (AFs) and exposed interfaces. AFs can:



Retrieve event notification

(loss of user connectivity, user mobility, message delivery, etc.)



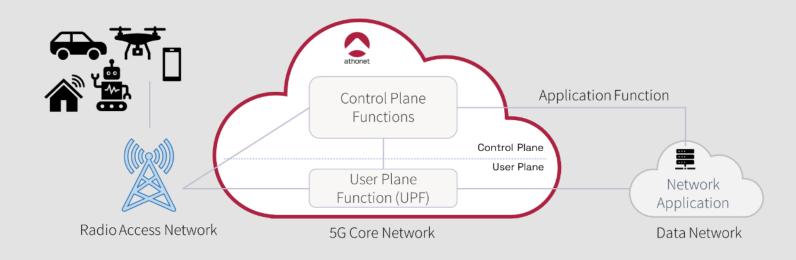
Trigger device actions (device activation, feedback message, etc.)



Retrieve network analytics

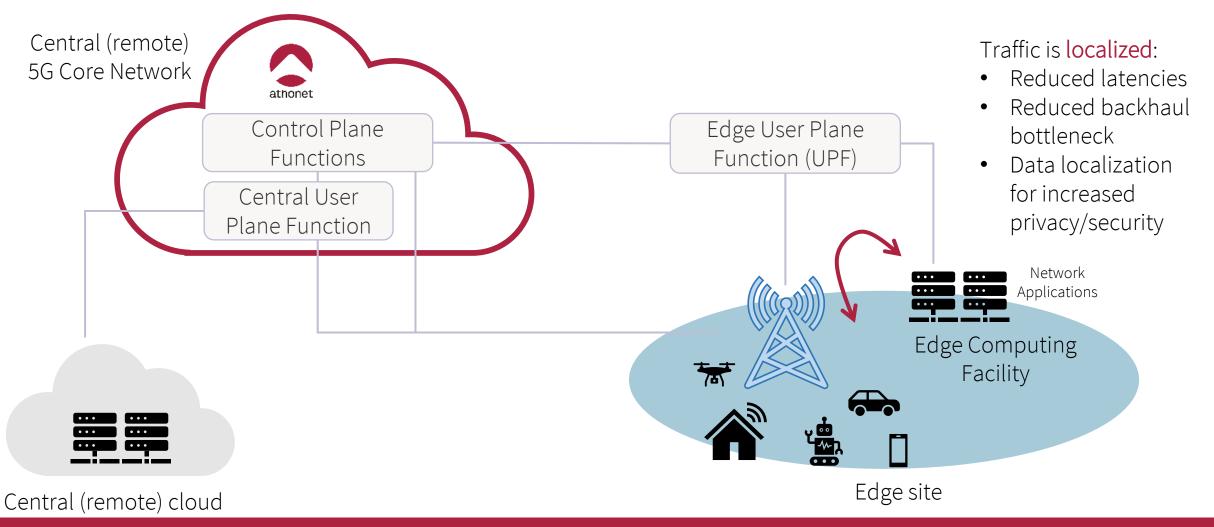


Configure network parameters (routing, QoS, etc.)



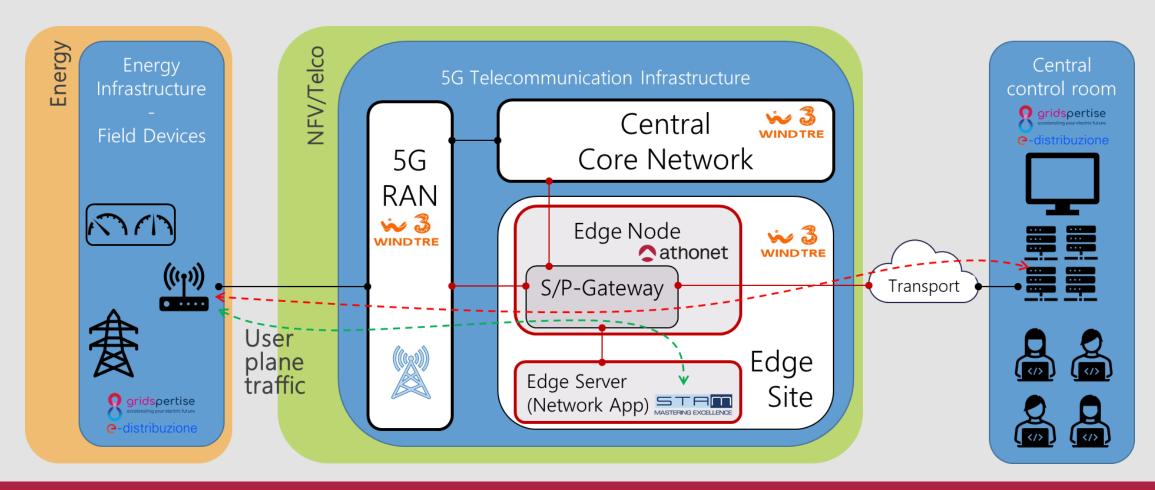


Hybrid Deployments and Edge Computing





Smart5Grid's Use Case 1 - PNI NPN





In Conclusion



Private 5G is a reality!

It is becoming common practice for common businesses to have their own 5G



Millions of networks?

Athonet alone has hundreds 4G/5G active licenses right now.



Capability Exposure

Network Applications have control capabilities over the 5G network



thank you for your attention

Visit our website <u>www.athonet.com</u> or follow us on Linkedin



The Smart5Grid platform to support developers



ubiwhere Hélio Simeão

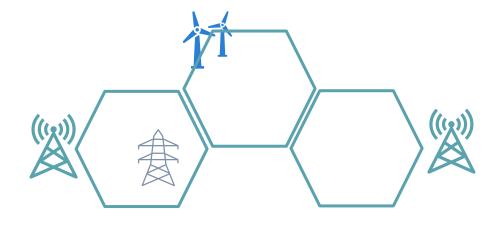
Let's catch up

When operating critical infrastructure, security is paramount.



"The **latency** and **bandwidth** advantages of 5G are part of enabling a number of these use cases, but considering that human lives are at stake, the **security** enhancements of 5G networks over 4G should not be overlooked. Among the key enhancements:

- ➤ Encryption: (...) 5G networks encrypt the user's **identity** and **location** during the **authentication process**.
- > Improved Authentication: (...) support for pre-shared keys, certificates, and tokens, (...).
- Network Slicing: (...) **Breaches** impacting **one virtual network** will not necessarily mean all the other slices are **compromised**. (...) prevent **unauthorized access** across these **virtual networks**."

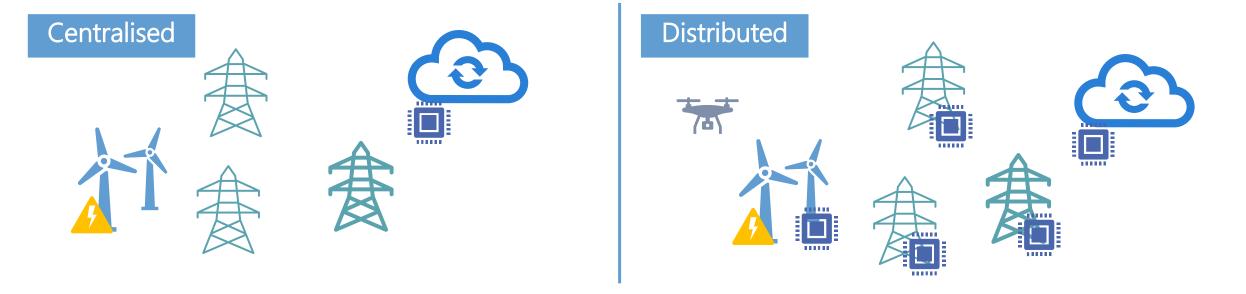


"State of the Edge Report 2023", Linux Foundation

Let's catch up

Edge applied in the Energy domain – Paradigm shift

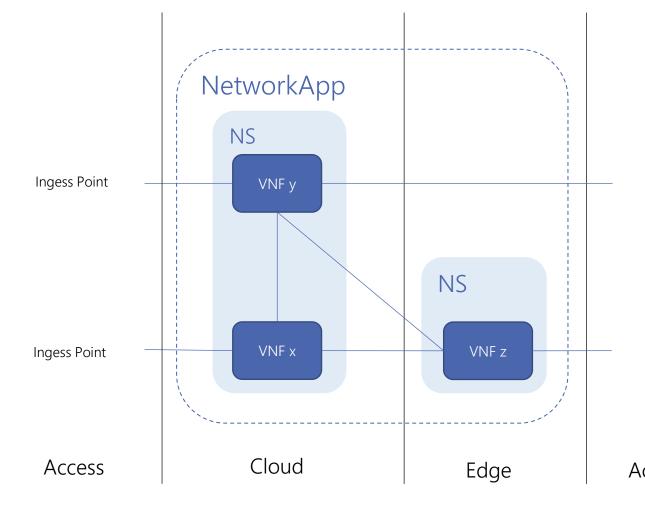




"(...) Edge solutions need to work with **legacy OT** and **modern protocols**, they need to integrate **AI/ML**, and they need to **deploy** and **monitor solutions** across a large / **heterogeneous set of edge nodes**. The idea of lift/ shift all edge data and sift/act from the cloud doesn't always **scale**, can be **expensive**, and doesn't often meet **latency** needs."

Let's catch up

Smart5Grid NetworkApp: means to an end..



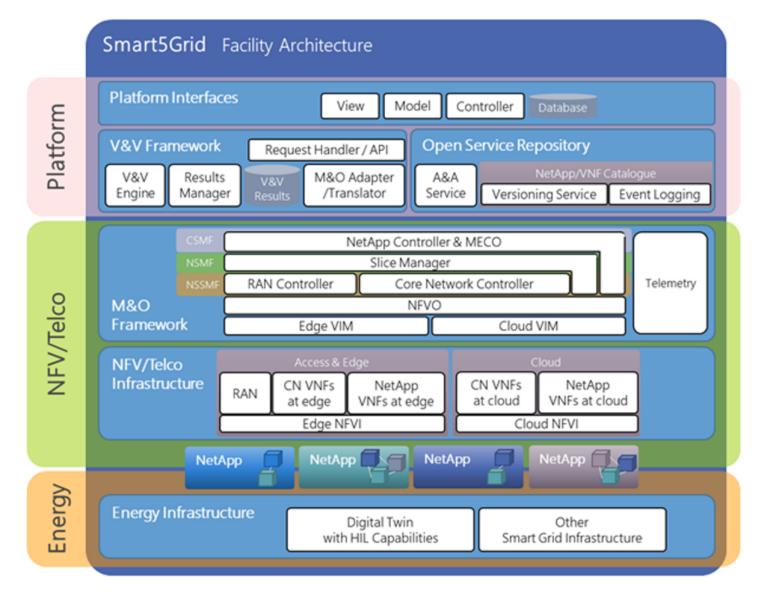


- ✓ Facilitate developers to define vertical applications
- ✓ Abstract the complexities of the network, reducing the level of networking expertise required
- ✓ Promote reutilization of Software Functions
- ✓ Micro-services Architecture
- ✓ Efficient use of resources (typically scarce at the edge)
- ✓ Cloud-Edge continuum
 Access

Smart5Grid platform

Hello World!





"Write once, deploy everywhere"

Use validated technology

Test your Network Appplication

Free testing environment

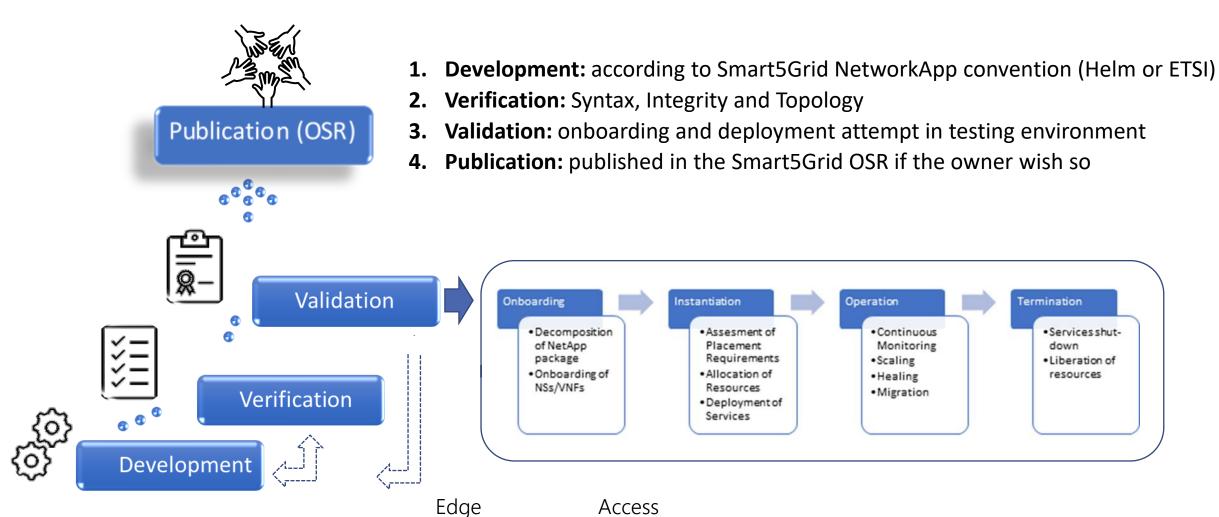
Get immediate feedback

Access our User Guide

Smart5Grid platform

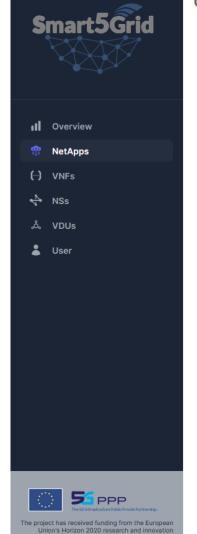
How can we help developers?





Smart5Grid platform

User Interface (Open Service Repository - OSR)



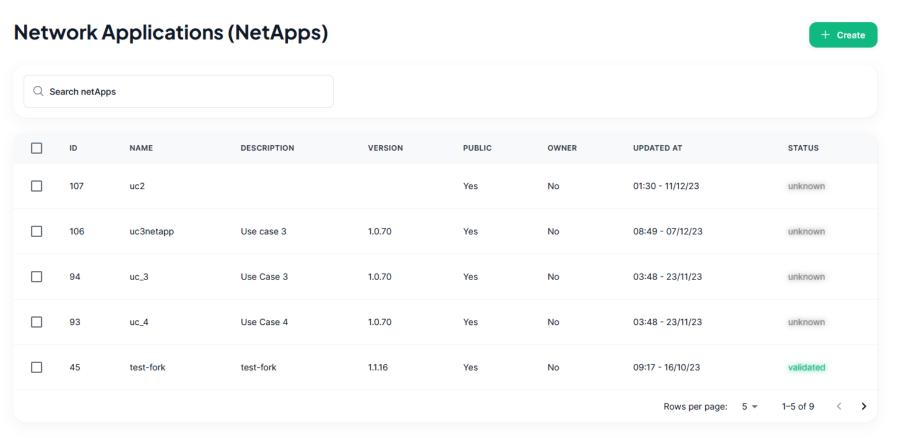
programme under grant agreement no 101016912

OSR platform









Smart5Grid Open Experimentation Platform Key takeaways



- "Write once, deploy everywhere" Network Apps
- Free testing environment
- Build and Certify your Network App
- Support line to experts from software, telco and energy domains



Opportunities for you!



Key features of Network Apps

Fostering the integration of the Core Network features

- Simplifying 5G complexity
- Focus on the core developments
- Combining multiple microservices to realize complex applications

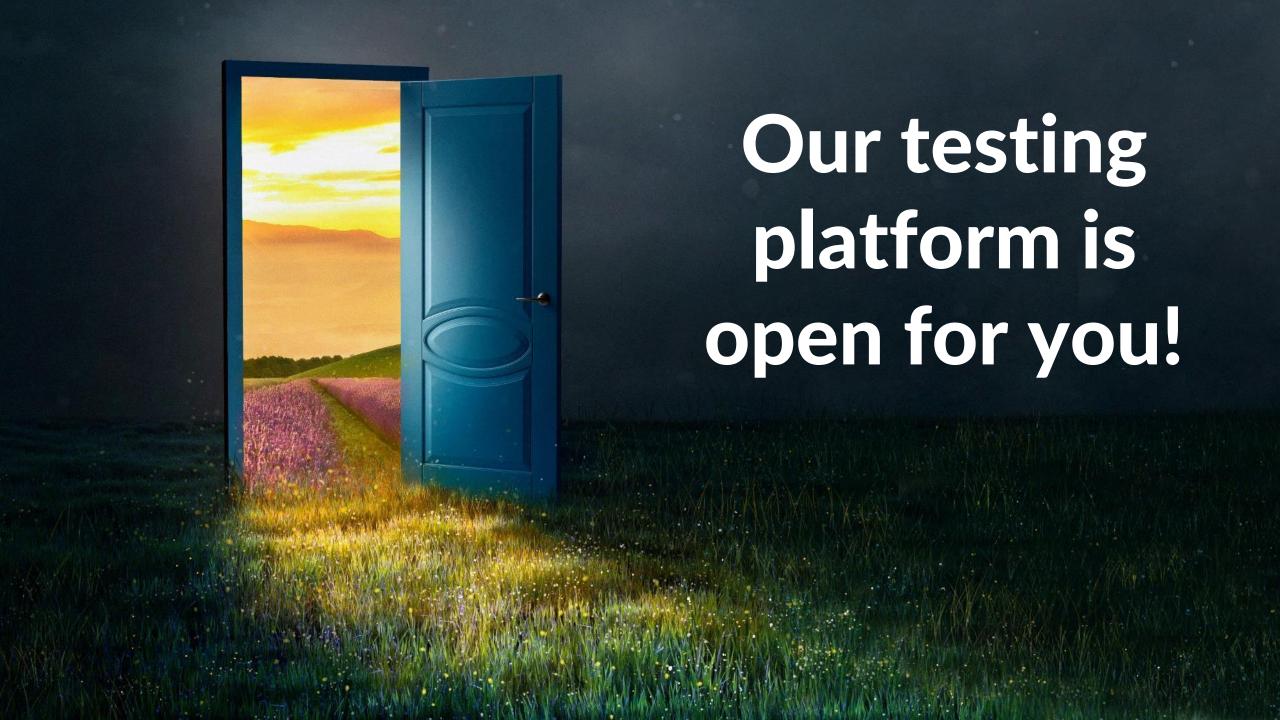
Orchestration and operation

- Centralized management
- Scalability and replicability
- Leveraging on a flexible infrastructure

Accelerating the implementation

- Open Service Repository as a single access point for developers
- Integrated Verification and Validation feature for test automation

Smart5 Grid





all the tools you need are here!











Our first stakeholder's implementation

Virtualization of a 3D safety monitoring tool in Private 5G edge cloud





Open Discussion

Bring your valuable feedback!

Conclusions

Main project elements and key results









NFV automatic testing and validation framework



Four advanced 5G real-life demonstrators



Roadmap for third party experimentation



Contact support desk



Liaison and Interaction with 5G-PPP Program







Final event to be announced soon Join us in Brussels

Join us! Follow us! Like us!



smart5grid.eu 🛩 in f 🔂 🗅











This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n° 101016912

the Smart5Grid Stakeholder Forum

Thank you!