SUNSEED

Sustainable and robust networking for smart electricity distribution

Project Grant agreement number: 619437

SUNSEED

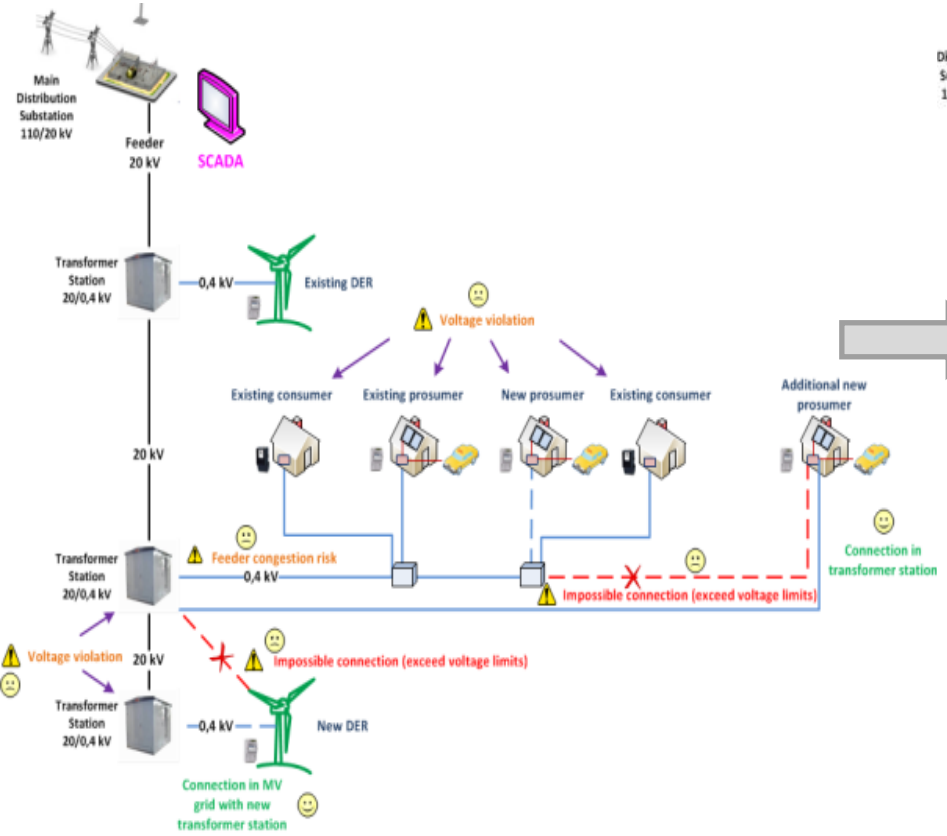
Project overarching objectives

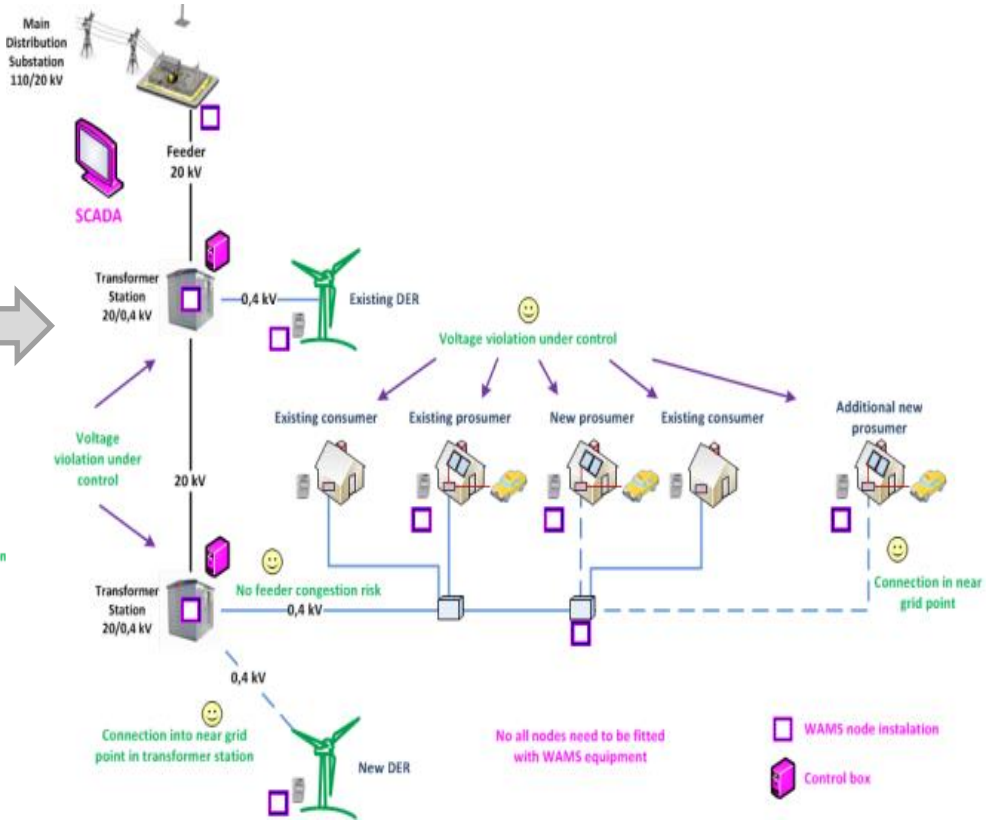
Motivation

1. Changing nature of the Consumers (households or industry) -> Prosumers
   - energy generators from renewable sources
     - photovoltaics, wind, cogeneration
   - manageable loads
2. Utilities are „blind“ in distribution grid
   - real-time monitoring is needed

Project Grant agreement number: 619437

Motivation (cont.)





Project Grant agreement number: 619437

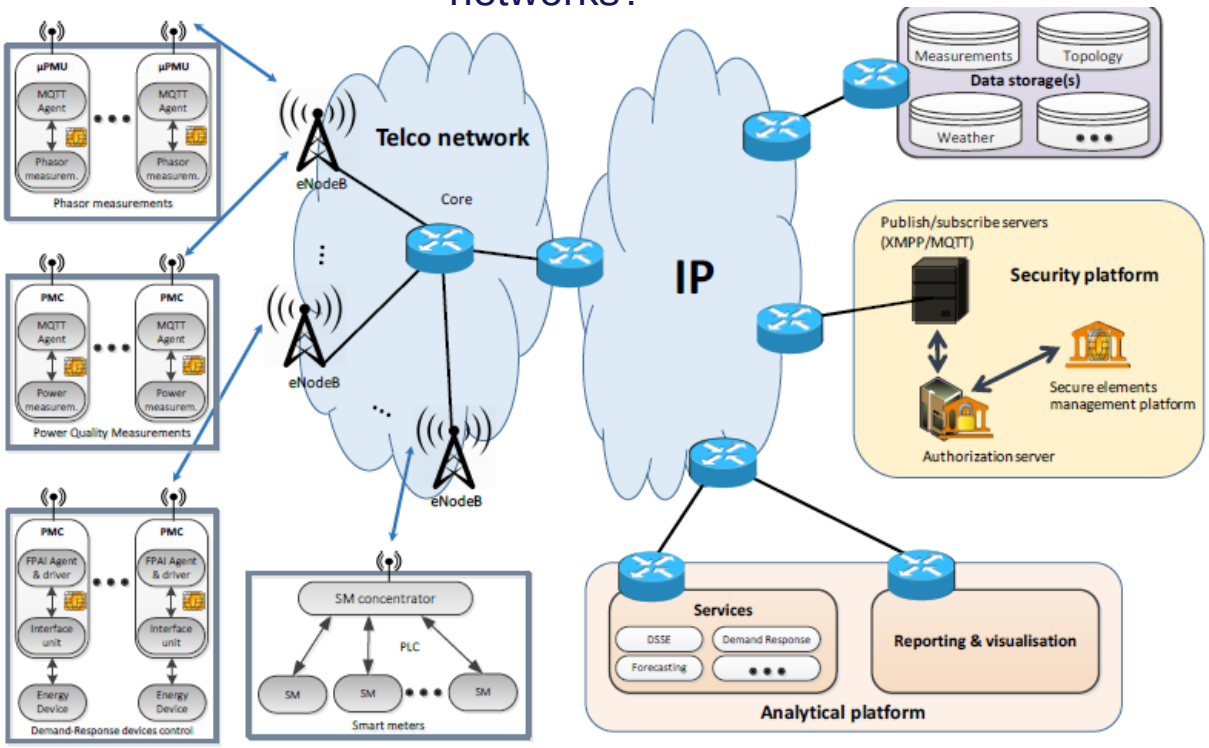
Motivation (cont.)

3. Manage risks related with network operation
   - voltage violations, congestions, …
4. Increasing hosting capacity of additional DER into existing grid without additional reinforcements
5. Offering new services for customers
6. More efficient network operation
   - increasing network observability, controllability and management
7. Utilisation of already present comm. networks from both energy and telecom operators.
   - converged communication infrastructure for future smart energy grids offering open services.

Project Grant agreement number: 619437

Project tries to answer:

If the infrastructure of telecom operators is suitable for future needs of smartgrid networks?



How to implement cheap smartmeters, which can make precise and frequent measurements (1/s) and send data securely?

What infrastructure is necessary for optimizing energy distribution network?

Objectives

- SUNSEED objective is to produce a set of guidelines how to overlap, combine and interconnect, i.e. converge, DSO and telecom communication networks for dense DEG (distributed energy generation) smart energy grids as an evolutionary development.
- SUNSEED proposes to design, deploy, test on field trial and evaluate the best of breed solution to converge DSO and telecom communication networks to support dense, highly available, resilient smart grid, with smaller total cost of ownership (TCO), shorter deployment time frames (telecom network reuse) and openness to new smart grid network operators.

Objectives (1/2)

1. Development of business models that include integration of existing DSO and telecom communications infrastructures
2. Implementation design guidelines for integration/cooperation of existing DSO and telecom communications infrastructures
3. Advanced metering and control node, to act as WAMS (wide area measurement system) node
4. High-level design guidelines for reengineered communication solutions using standard and advanced communication techniques

Objectives (2/2)

5. High-level design guidelines for reengineered communication solutions using standard and advanced communication techniques
6. Develop analytical tools software solutions combining data from energy and communication networks
7. Set up a large scale field trial (approximately 1000 smart meters and WAMS nodes), as proving ground of objectives, involved technological solutions, models, algorithms and test their operation, availability and scalability in large heterogeneous smart grid environments.

SUNSEED

The consortium

SUNSEED

1. Sustainable and robust networking for smart electricity distribution (FP7)
2. Project duration: 1 Feb 2014 – 30 Apr 2017
3. Coordinator: Telekom Slovenije
4. Budget: 4.745.054 EUR
5. EU funding: 2.990.000 EUR
6. Nine partners from six countries are participating: Slovenia, Netherlands, Denmark, United Kingdom, France and Germany

The consortium

1. Telekom Slovenije
2. Elektro Primorska
3. Jožef Stefan Institute
4. Elektroservisi
5. TNO
6. Aalborg University
7. Gemalto SA
8. Gemalto M2M
9. Toshiba Research

SUNSEED

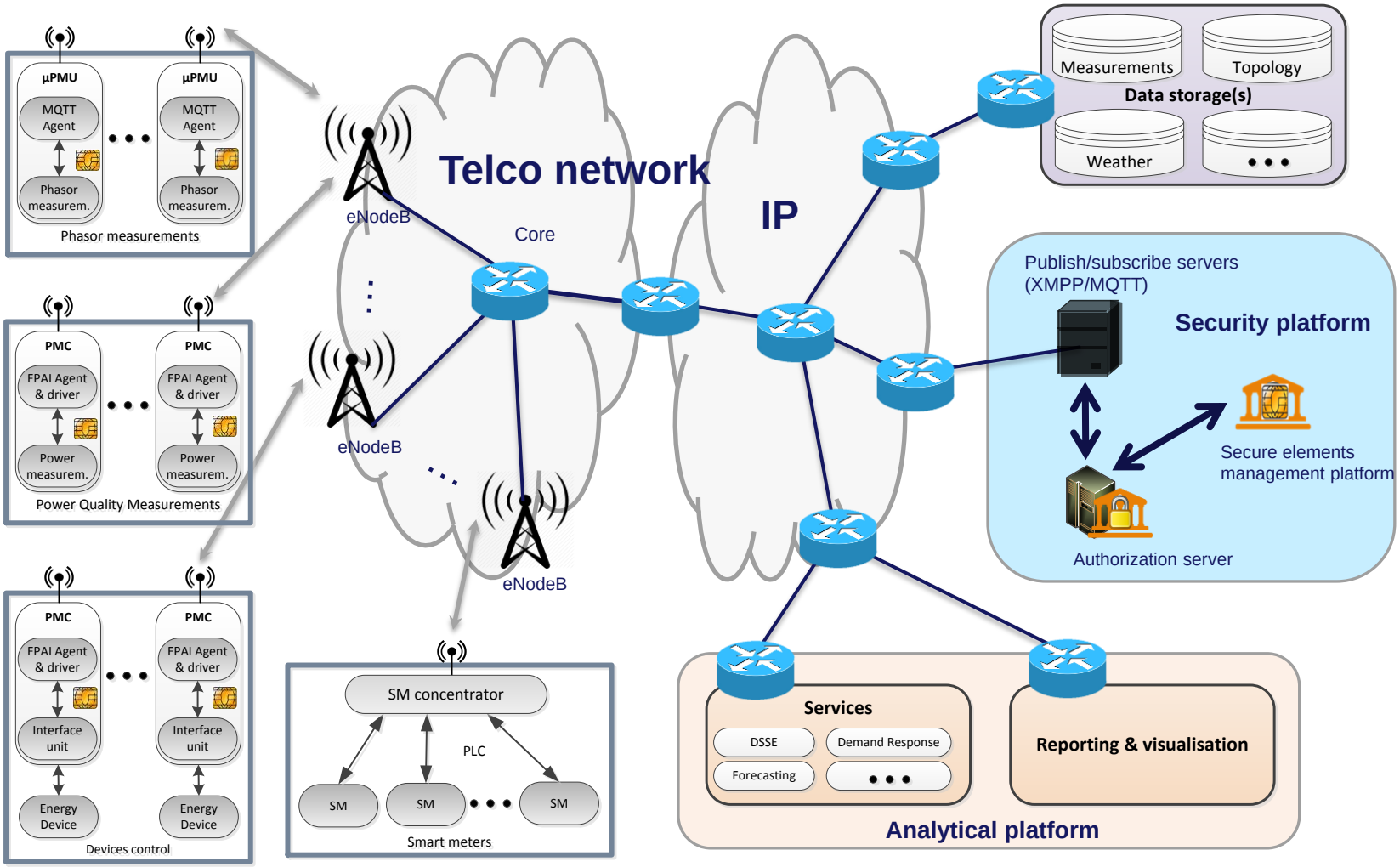
The main lessons learned and barriers to innovation deployment

Large scale field trial

1. Four different areas at the utility Elektro Primorska (industrial, rural, remote, urban)
2. Operating region with nearly 1000 of communication nodes (smart meters and WAMS devices)

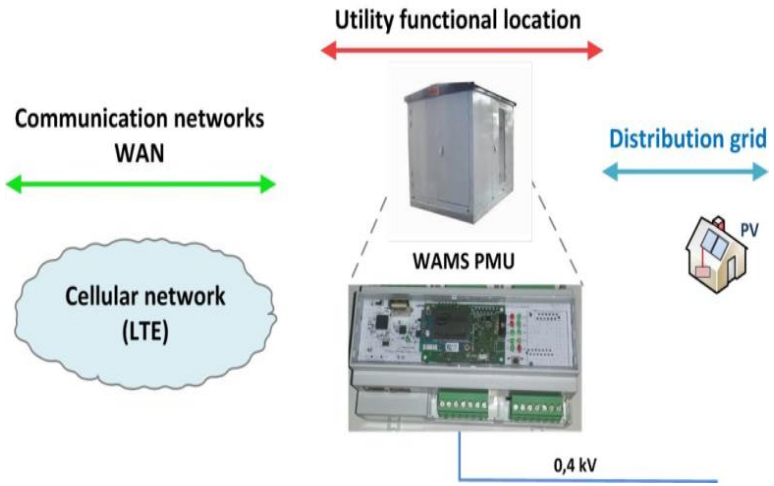
Terrain map of SUNSEED field trial locations in Slovenia (Kromberk). Power line network with DEG locations and LTE radio coverage.

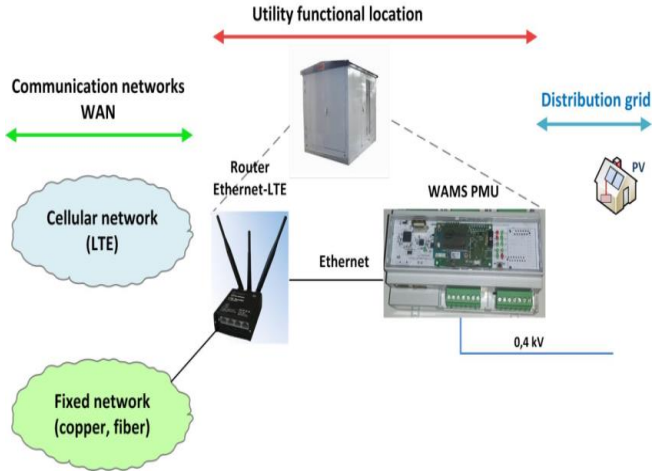
Terrain map of SUNSEED test region in Slovenia (Tolmin). Power line network with DEG locations, UMTS radio coverage andx DSL customer locations.


µPMU
MQTT Agent
Phasor measurem.
Phasor measurements
PMC
FPAI Agent & driver
Power measurem.
Power Quality Measurements
Interface unit
Energy Device
Devices control
Telco network
Core
IP
eNodeB
SM concentrator
PLC
SM
Smart meters
Measurements
Topology
Data storage(s)
Weather
Publish/subscribe servers (XMPP/MQTT)
Security platform
Secure elements management platform
Authorization server
Services
DSSE
Demand Response
Forecasting
Reporting & visualisation
Analytical platform

Communication access scenarios (WAMS)

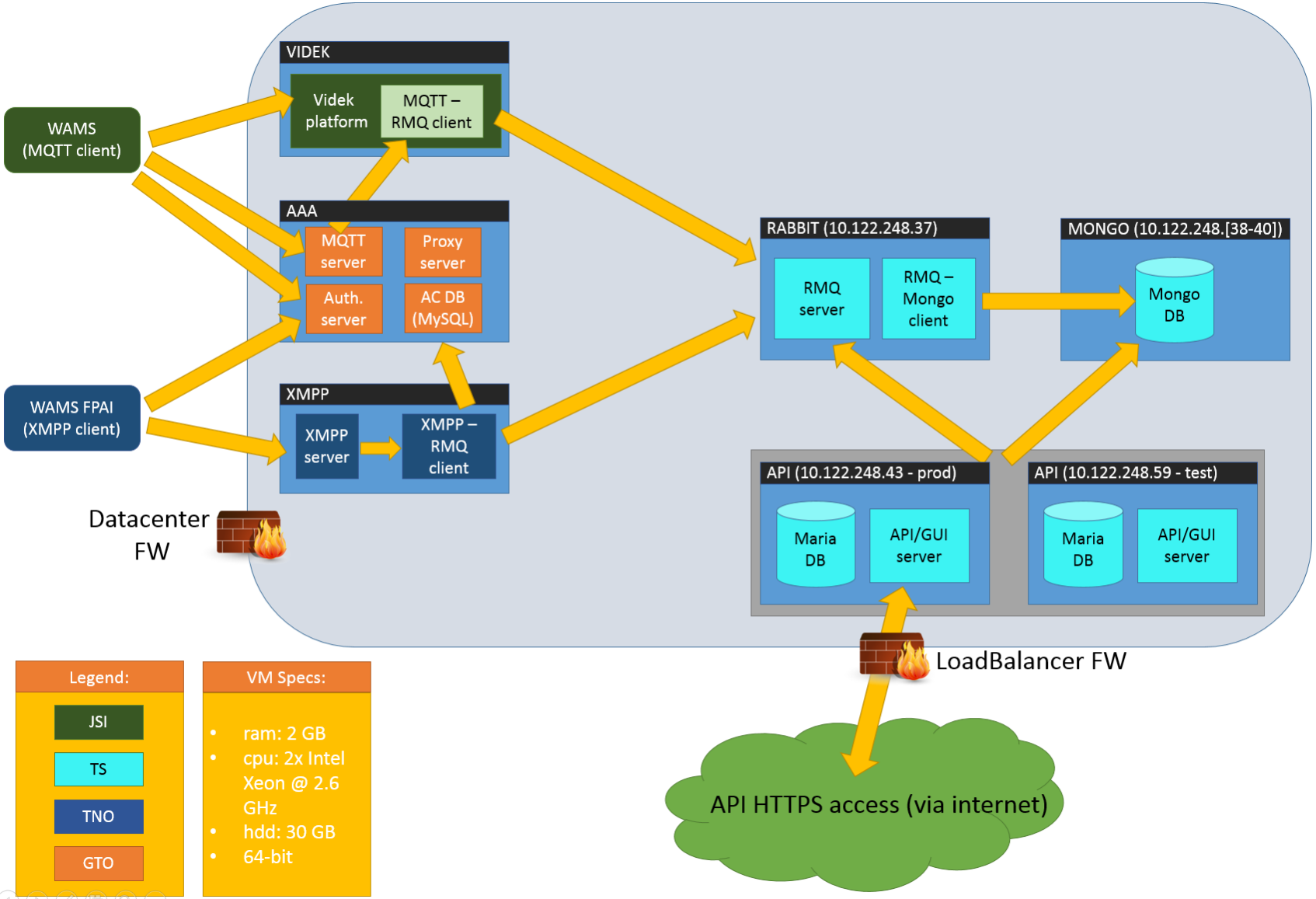
1. WAMS node with built-in LTE modem
2. WAMS node with external LTE modem/router

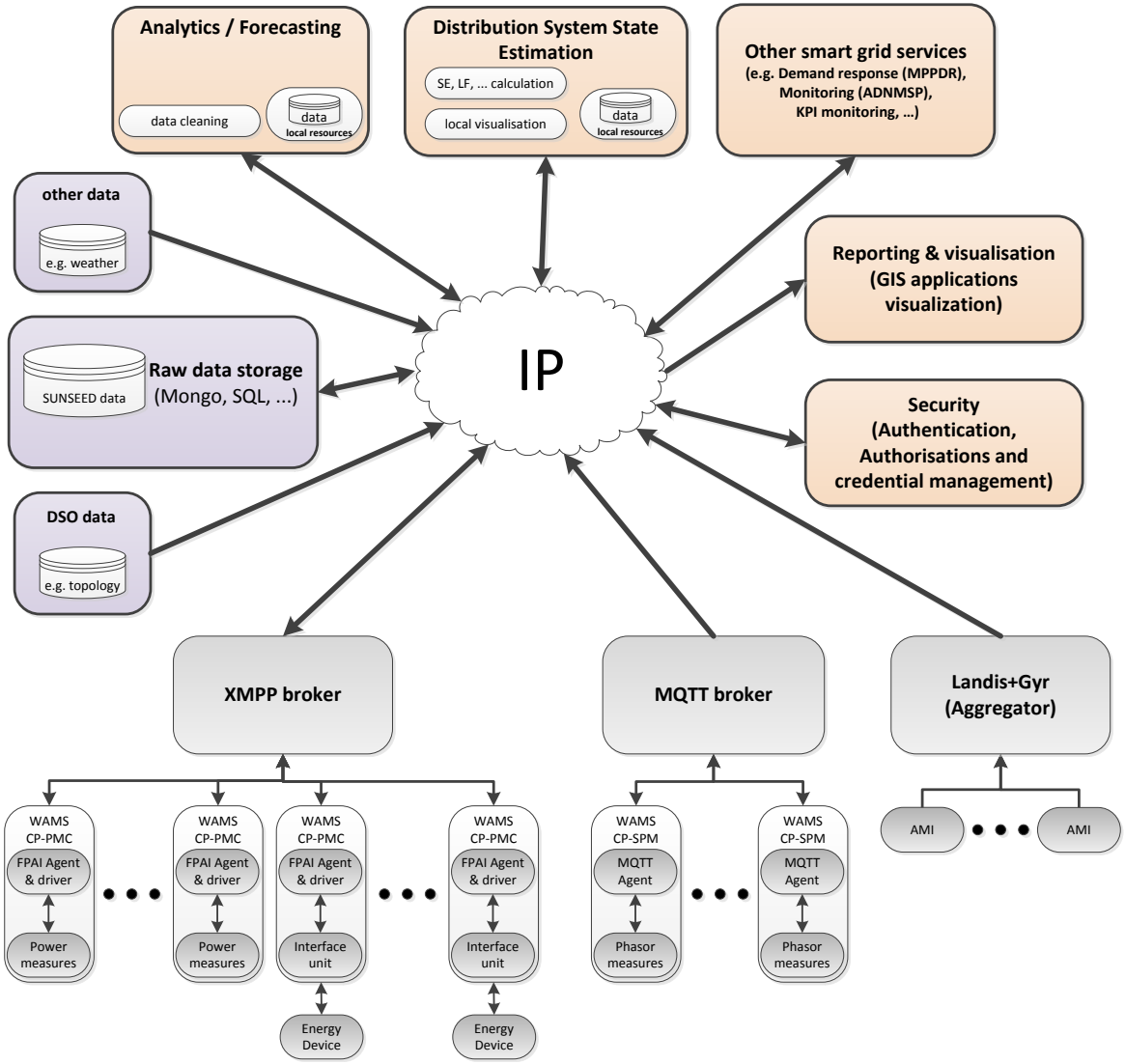




Project Grant agreement number: 619437

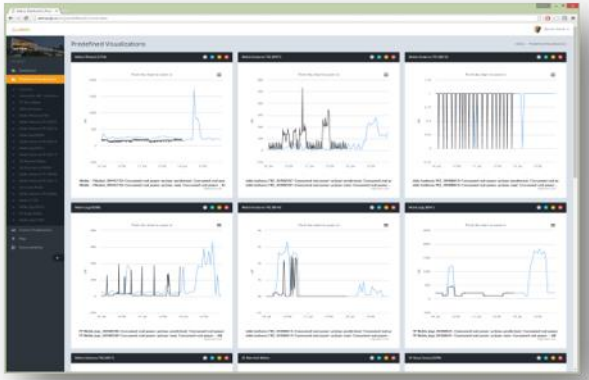
Data Flow

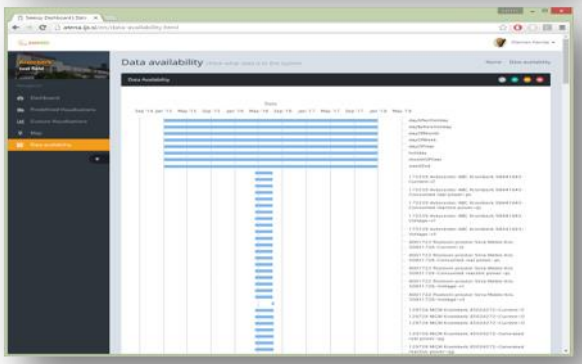

VIDEK
Videk platform
MQTT – RMQ client
WAMS (MQTT client)
AAA
MQTT server
Proxy server
Auth. server
AC DB (MySQL)
XMPP
XMPP server
XMPP – RMQ client
WAMS FPAI (XMPP client)
Datacenter FW
RABBIT (10.122.248.37)
RMQ server
RMQ – Mongo client
MONGO (10.122.248.[38-40])
Mongo DB
API (10.122.248.43 - prod)
Maria DB
API/GUI server
API (10.122.248.59 - test)
Maria DB
API/GUI server
LoadBalancer FW
API HTTPS access (via internet)
Legend:
JSI
TS
TNO
GTO
VM Specs:
ram: 2 GB
cpu: 2x Intel Xeon @ 2.6 GHz
hdd: 30 GB
64-bit


Analytics / Forecasting
data cleaning
data
local resources
Distribution System State Estimation
SE, LF, ... calculation
local visualisation
data
local resources
Other smart grid services
(e.g. Demand response (MPPDR), Monitoring (ADNMSP), KPI monitoring, ...)
other data
e.g. weather
Reporting & visualisation (GIS applications visualization)
SUNSEED data
Raw data storage
(Mongo, SQL, ...)
IP
Security (Authentication, Authorisations and credential management)
DSO data
e.g. topology
XMPP broker
MQTT broker
Landis+Gyr (Aggregator)
WAMS CP-PMC
FPAI Agent & driver
Power measures
WAMS CP-PMC
FPAI Agent & driver
Power measures
WAMS CP-PMC
FPAI Agent & driver
Interface unit
Energy Device
WAMS CP-PMC
FPAI Agent & driver
Interface unit
Energy Device
WAMS CP-SPM
MQTT Agent
Phasor measures
WAMS CP-SPM
MQTT Agent
Phasor measures
AMI
AMI

Short Term Load Forecasting

- Data sources:
  - Smart meters
  - Batched stream - once per day, resolution 15min
- Model characteristics:
  - Prediction horizon: 1h – 24h
  - Algorithm: on-line linear regression
  - Evaluation: depends heavily on the type of consumer (can not capture stochastic processes);
- Result:
  - Forecasted profiles for all measurements
  - At each new record, for the next 24 hours
- Potential usage:
  - Used by state estimation as „up to date“ pseudo measurements

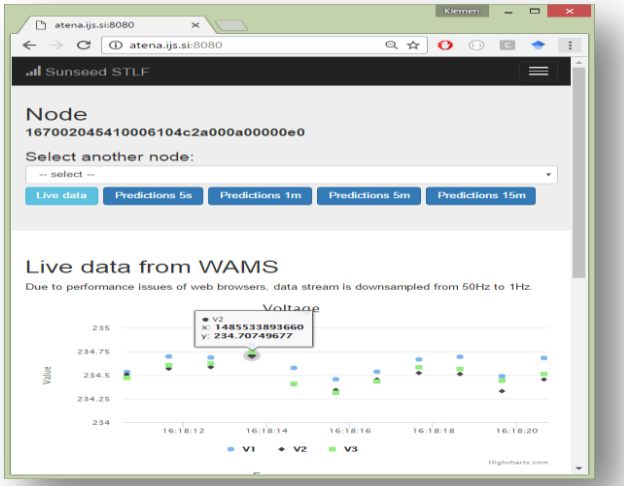


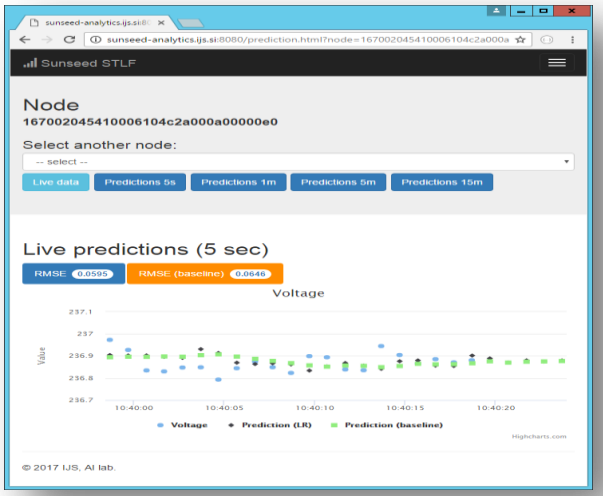


Project Grant agreement number: 619437

Very Short Term Load Forecasting

- Data sources:
  - 16 WAMS nodes
  - high resolution (50Hz), different measurements (via ActiveMQ)
- Model characteristics:
  - Prediction horizon: 5s – 15min (Voltage)
  - Algorithm: truly streaming model, very robust (restart, saving), linear regression and moving average (baseline)
  - Evaluation: baseline only slightly improved (stochastic process)
- Result:
  - Very short term predictions based on high velocity WAMS data
- Potential usage:
  - Used by autonomous load management module

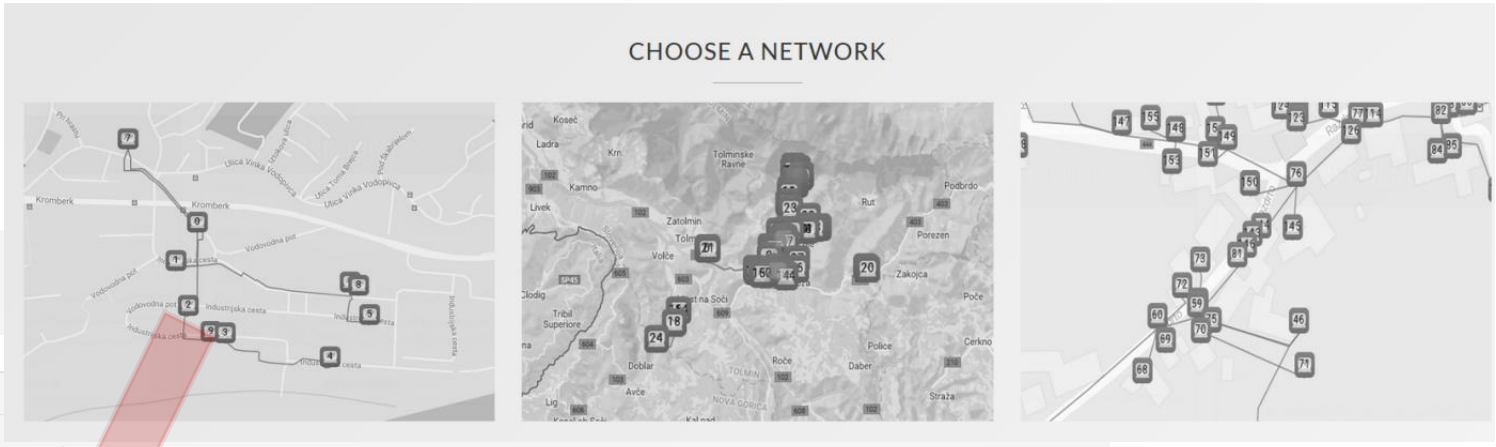




Project Grant agreement number: 619437

WAMS measurements visualization

Real time:
20ms interval



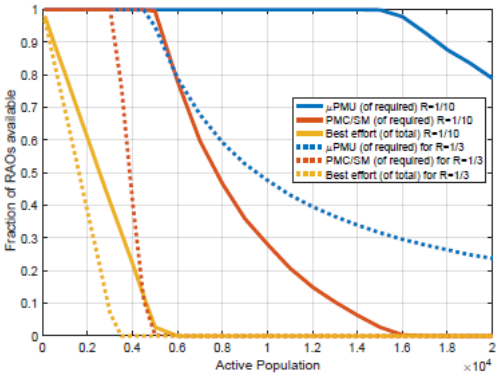
Used for DSSE (Distribution System State Estimation)

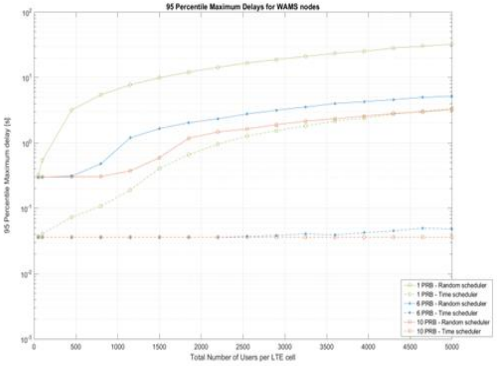
Three phases!

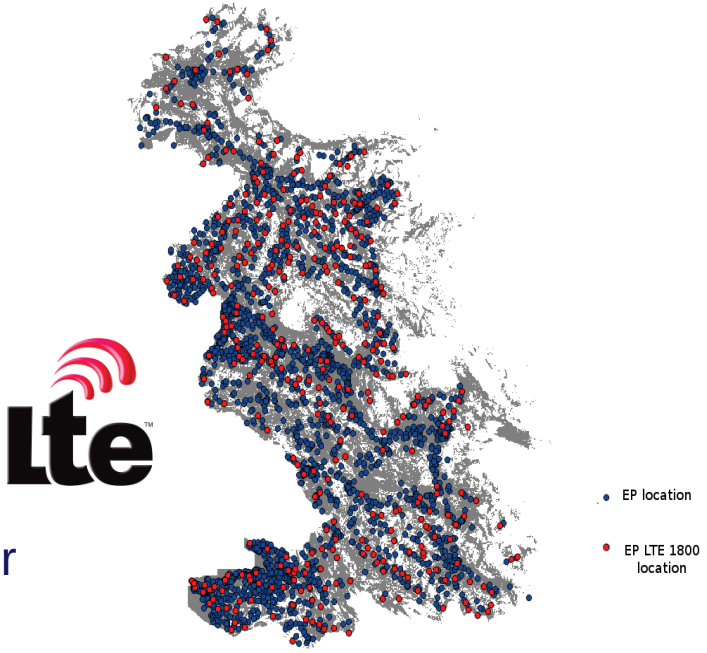
To obtain full observability!

Project Grant agreement number: 619437

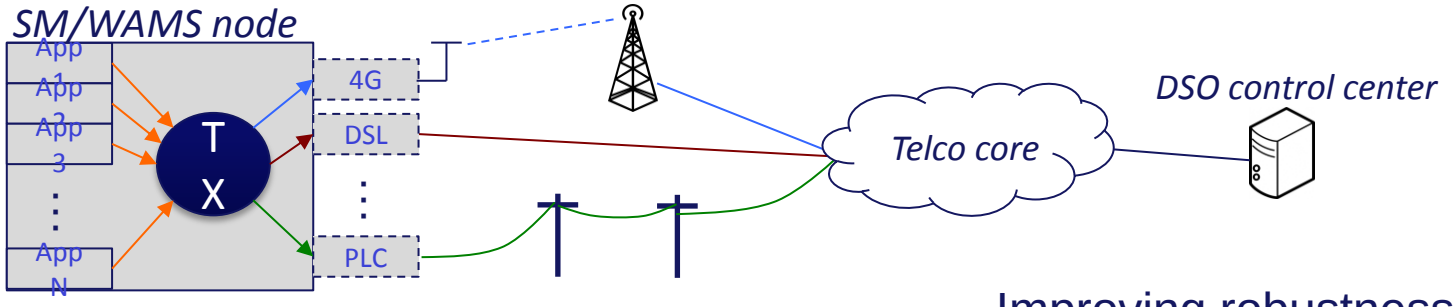
Analysis to optimize distribution and data network







Finding bottlenecks and improvements in data transfer and end-to-end delay for massive number of nodes



Improving robustness with multi-access communication

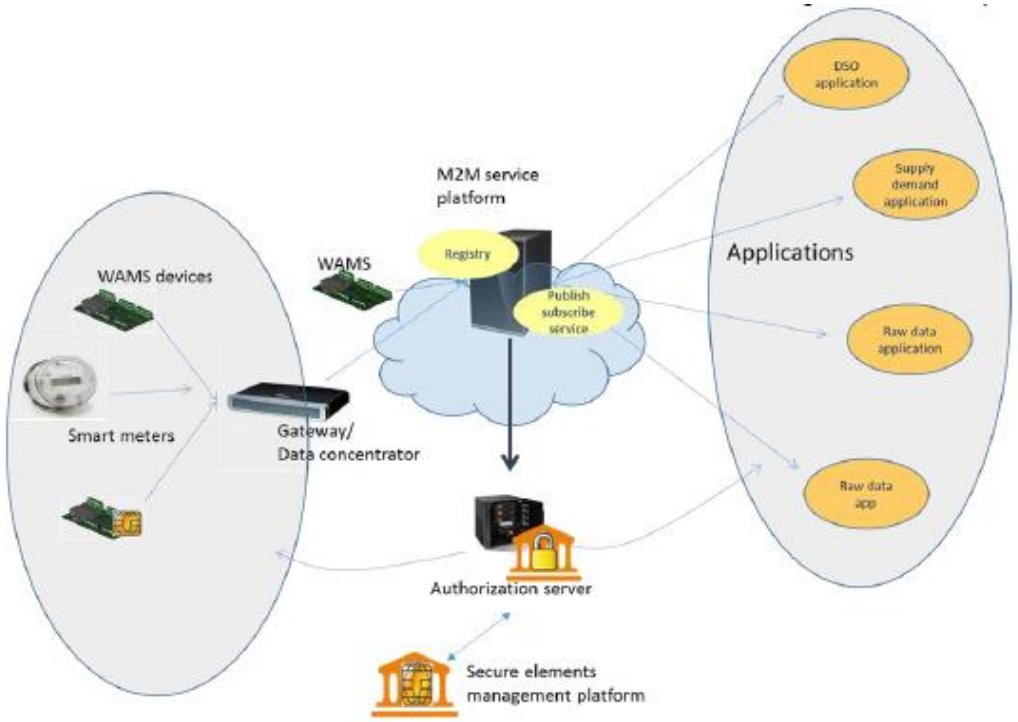
Project Grant agreement number: 619437

Security Solution

High level goal: **Secure smart grids communications**

Problems addressed:

1. Enhance protection of credentials stored in the WAMS to prevent device cloning
2. Fine Grain authorization management
3. Dynamic credentials distribution.
4. Make life simple for application developers



Project Grant agreement number: 619437

SUNSEED – final status

1. Successful final project review in Nova Gorica on June 20th/21st 2017
2. Excellent results, very good partner cooperation
3. 1200 pages of deliverables in last year of project
4. Project budget was exceeded by less than 5%

SUNSEED – problems encountered and solved

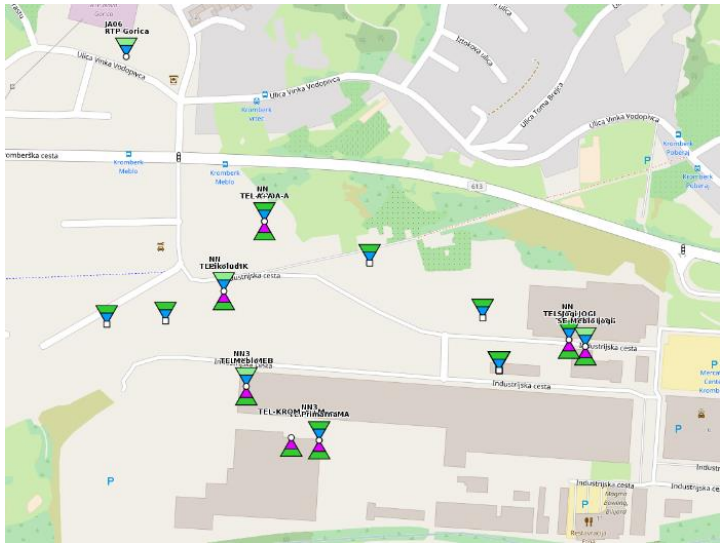
- Late delivery of WAMS devices
- Time consuming installation of WAMS devices on locations
- Key personnel (10 employees) left TS (main coordinator and scientific coordinator as well as several consecutive WP2 leaders – including 6 PhD employees). Similar problem was at ES.
- For these reasons project was prolonged for 3 months, which meant that we had to prepare amendment to specify all changes in the DoW.
- Regardless of all those problems we reached all project objectives and we were also able to organize additional project workshop.

SUNSEED

Deployment prospects of the most promising solutions

SUNSEED – exploitation

- Monetizing WAMS devices
- More flexibility towards power users
- Possible telco services for power distribution network providers
- Telco Services for providers of water and gas
- Monetizing GIS solution
- IoT in mobile network
- 5G for further network optimization



Project Grant agreement number: 619437

Thank you!