# Smart5Grid project

*Telco's perspective on Precise distributed generation monitoring at msec-level use case (Use Case 3) and Real-time wide area monitoring of cross-border power exchange use case (Use Case 4)*

The 5G Infrastructure Public Private Partnership

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

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

# Introduction 1/2

- *The "Framework"*

- *The "power grid" (networks of power plants, energy transmission towers, substations, poles and wires) can be assessed as the "largest machine in the world", as electricity is the most versatile controlled form of energy.*

- *For efficient transfer of electrical power, "smart grids" combine traditional grids with communication and information control technologies, targeting to achieve efficiency, cleanliness and security, and "reshaping" the modern landscape in energy transportation.*

- *The fast development of 5G, especially in verticals like the energy sector, will offer more opportunities for growth and market evolution, also providing options for innovation and investments.*

# Introduction 2/2

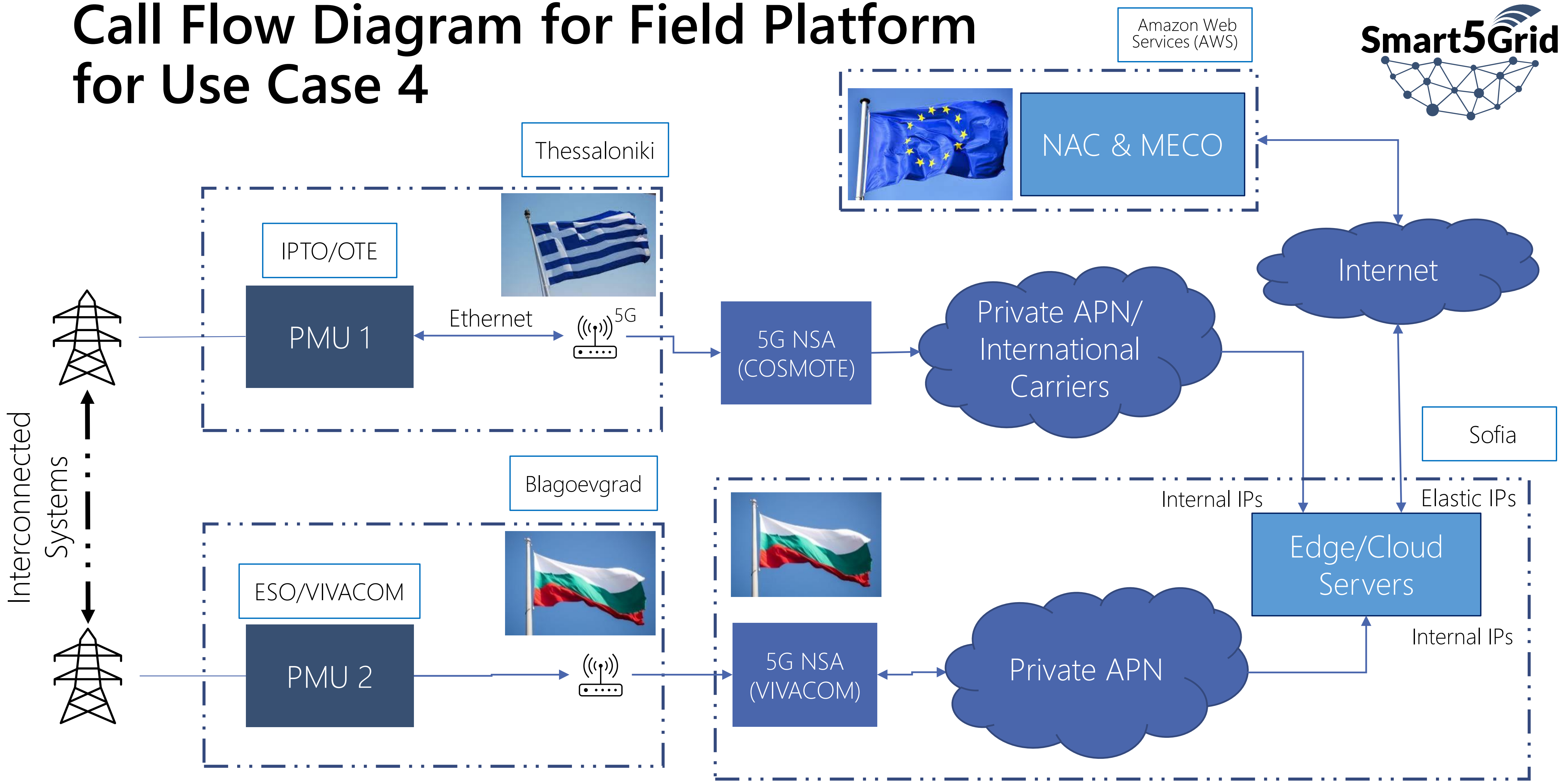
## *5G Challenges for the Energy Sector*

*5G networks will be an important ingredient for the development of smart grid technologies, especially allowing the grid to adapt better to the dynamics of renewable energy and distributed generation.*

*5G mobile networks will help to integrate previously unconnected devices to smart grids, for accurate monitoring and improved forecasting of their energy needs.*

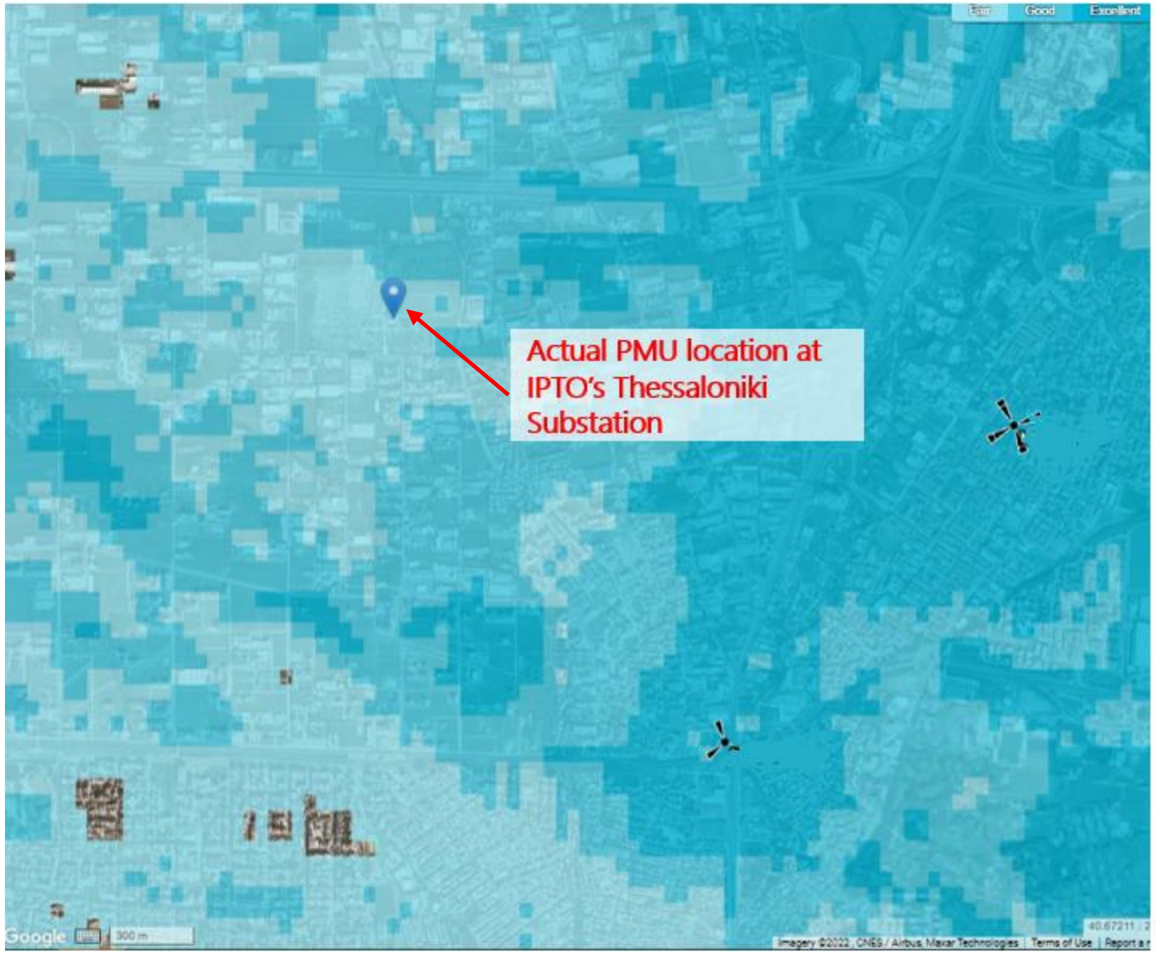
- *Managing of energy demand will become more efficient and will implicate for less investments.*
- *The smart grid will allow for: (i) easier balance of the energy loads; (ii) reduction of electricity peaks and; (iii) reduction of energy costs.*
- *From the perspective of power supply, 5G is expected to enable better efficiency, observability and controllability of the power system, especially at the distribution side.*
- *Energy suppliers will be able to collect and store power grid related data at much faster rates, ensuring secure and stable power supply, while risk mitigation and fault management will become simpler and more straightforward.*

# Call Flow Diagram for Field Platform for Use Case 4



# 5G Network Coverage at Thessaloniki site

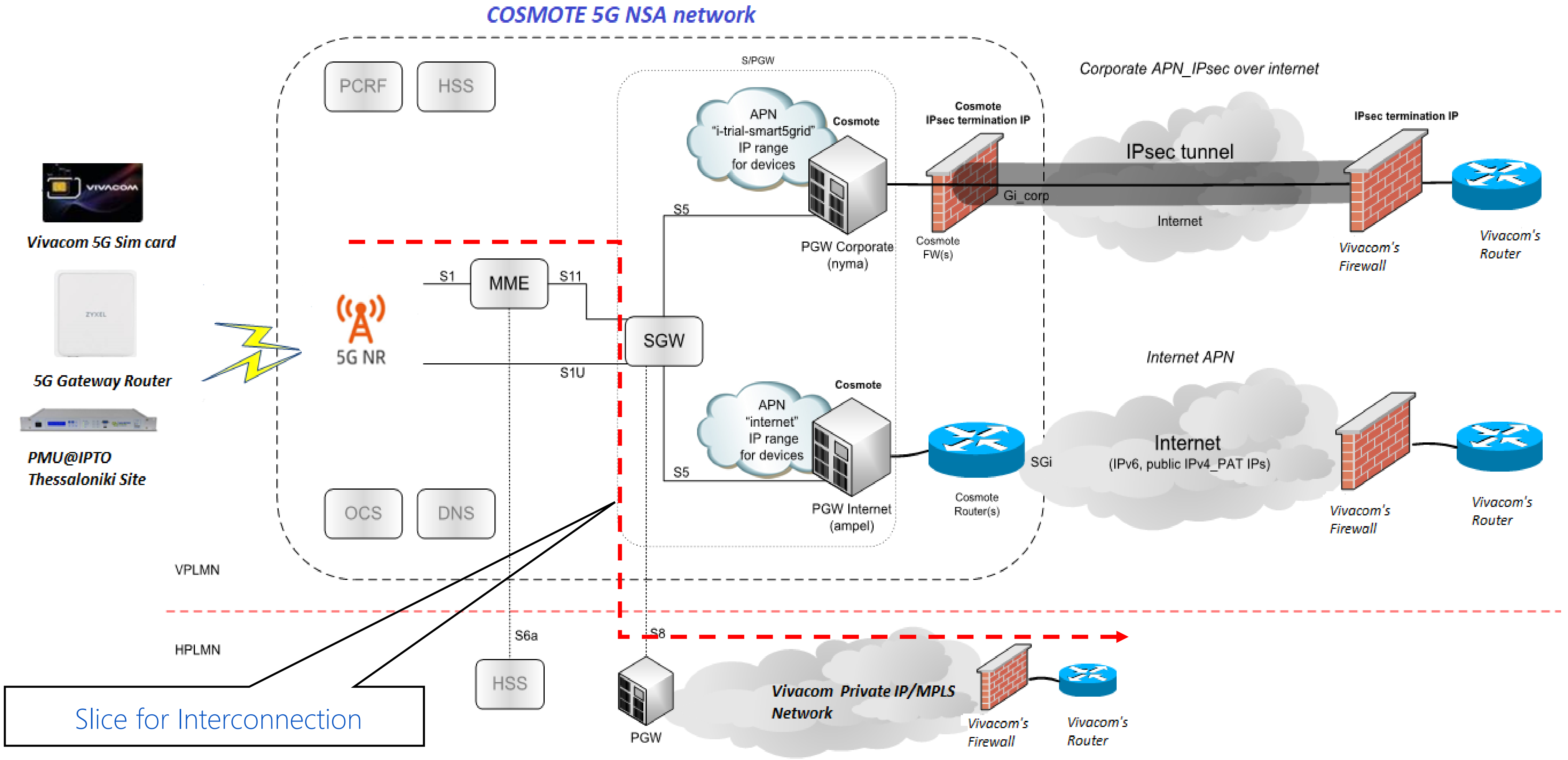
Greek Side




- *Exact PMU location has "Fair Outdoor" predicted coverage i.e., placed Outdoors at certain height (2m) above ground*
- ***Site survey** by IPTO/OTE must be performed to fine tune the 5G coverage*
- *Open communication with COSMOTE's Access Network Department to fine tune Radio Parameters*

# Interconnection Scenario – Roaming

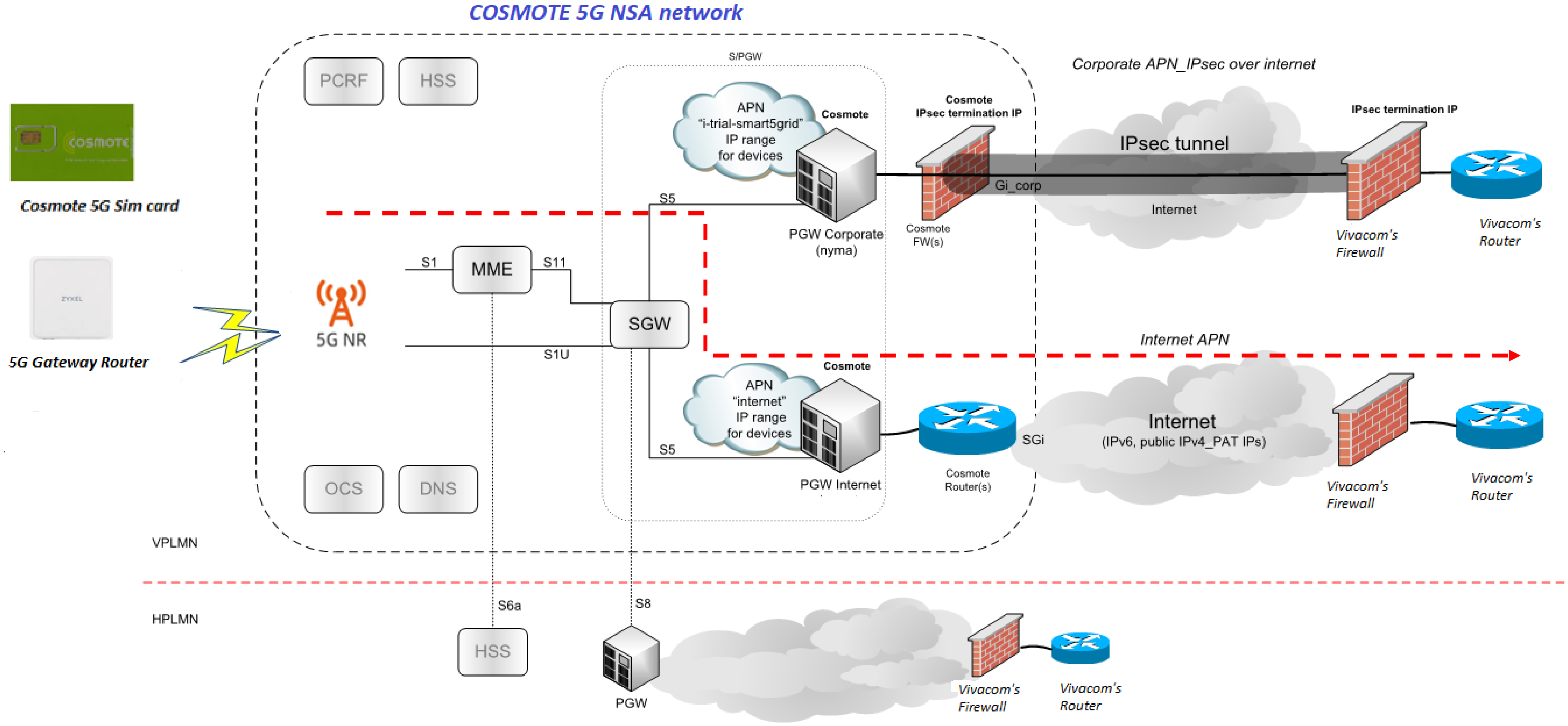
Greek Side




- 5G Commercial Roaming activated between COSMOTE and VIVACOM, thus making this scenario feasible
- Considered as Optimal Routing for Interconnection between IPTO site and EDGE/CLOUD server since all data are kept 'locally'
- Involvement of International Carriers for the Interconnection path
- IPX/GRX Dedicated Packet Backbone for Roaming Control and User Plane Traffic responsible

# Initial Testing

Greek Side




- *5G SIM card from COSMOTE installed in the 5G Gateway Router to test the connectivity of the Router with 5G network.*
- *Commercial APN 'internet' used by COSMOTE subs.*
- *PMU was not connected to the Gateway Router.*
- *Laptop with iperf client was connected to the 5G Gateway Router*

# Initial Testing - Results

## Greek Side

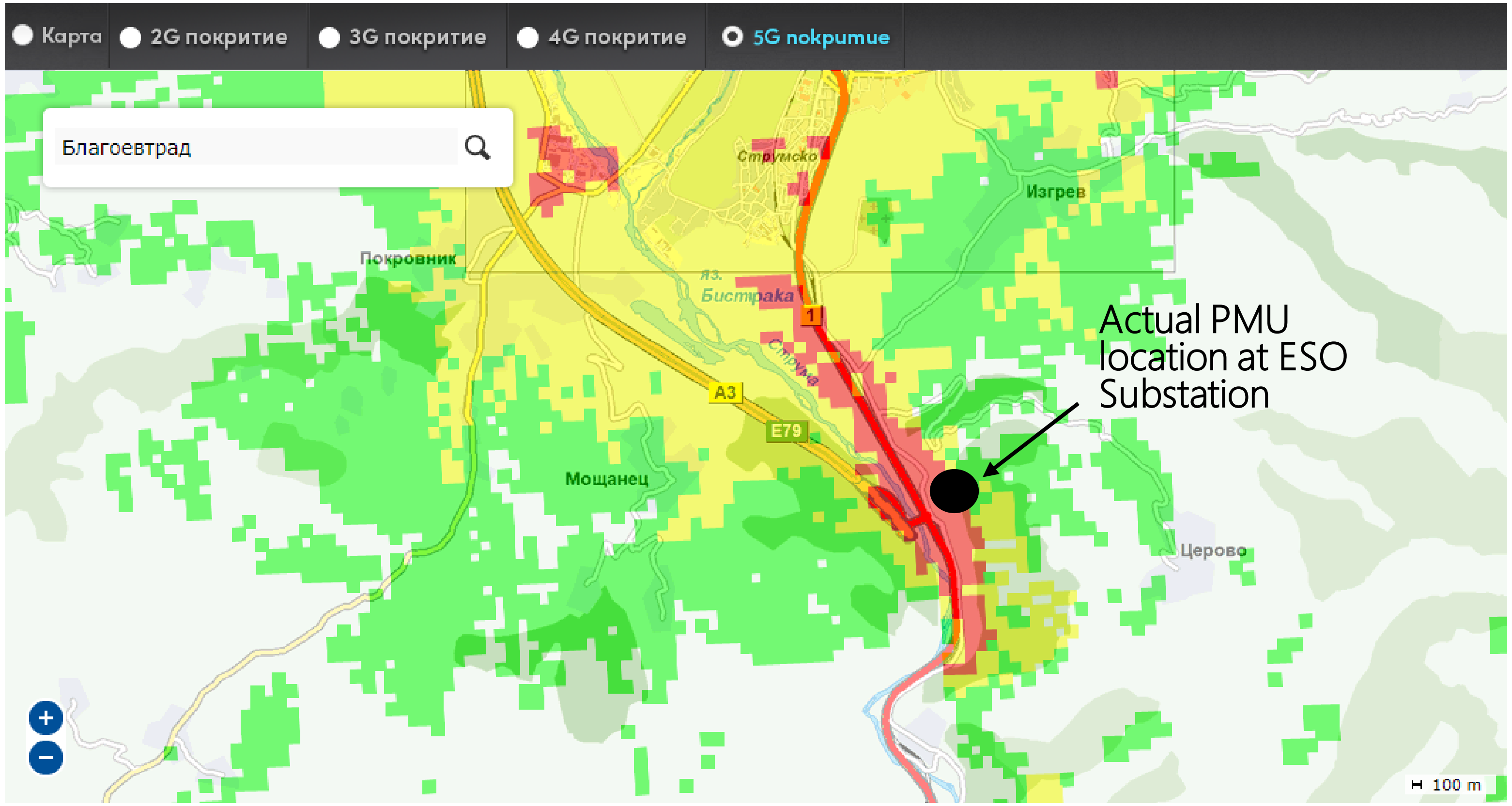
```
root@ipto:/usr/bin# iperf3 -s -V -p 3000
iperf 3.0.11
Linux ipto 4.4.0-121-generic #145-Ubuntu SMP Fri Apr 13 13:47:23 UTC 2018 x86_64 x86_64 x86_64 GNU/Linux
-----------------------------------------------------------
Server listening on 3000
-----------------------------------------------------------
Time: Fri, 03 Jun 2022 12:23:08 GMT
Accepted connection from 109.178.137.205, port 2547
      Cookie: BrodimasDLap.1654258990.195999.63aae
[  5] local 10.20.30.217 port 3000 connected to 109.178.137.205 port 2435
Starting Test: protocol: UDP, 1 streams, 8192 byte blocks, omitting 0 seconds, 10 second test
[ ID] Interval           Transfer     Bandwidth       Jitter    Lost/Total Datagrams
[  5]   0.00-1.00   sec   104 KBytes   852 Kbits/sec  53.205 ms  0/13 (0%)
[  5]   1.00-2.00   sec   136 KBytes  1.11 Mbits/sec  22.405 ms  0/17 (0%)
[  5]   2.00-3.00   sec   120 KBytes   983 Kbits/sec  12.919 ms  0/15 (0%)
[  5]   3.00-4.00   sec   128 KBytes  1.05 Mbits/sec  12.739 ms  0/16 (0%)
[  5]   4.00-5.00   sec   136 KBytes  1.11 Mbits/sec  11.972 ms  0/17 (0%)
[  5]   5.00-6.00   sec   120 KBytes   983 Kbits/sec  12.436 ms  0/15 (0%)
[  5]   6.00-7.00   sec   128 KBytes  1.05 Mbits/sec  20.140 ms  0/16 (0%)
[  5]   7.00-8.00   sec   128 KBytes  1.05 Mbits/sec  20.887 ms  0/16 (0%)
[  5]   8.00-9.00   sec   128 KBytes  1.05 Mbits/sec  17.782 ms  0/16 (0%)
[  5]   9.00-10.00  sec   128 KBytes  1.05 Mbits/sec  14.148 ms  0/16 (0%)
[  5]  10.00-10.14  sec  16.0 KBytes   949 Kbits/sec  13.590 ms  0/2 (0%)
- - - - - - - - - - - - - - - - - - - - - - - - -
Test Complete. Summary Results:
[ ID] Interval           Transfer     Bandwidth       Jitter    Lost/Total Datagrams
[  5]   0.00-10.14  sec  1.25 MBytes  1.03 Mbits/sec  13.590 ms  0/159 (0%)
CPU Utilization: local/receiver 0.1% (0.1%u/0.0%s), remote/sender 0.9% (0.6%u/0.3%s)
```

*Features*

- *IPTO has managed to establish a first call from its Headquarters in Athens -> VIVACOM's EDGE/CLOUD server via COSMOTE's 5G NSA network*
- *Public Internet was used as the Backbone network*

# 5G Network Coverage at ESO Blagoevgrad Site

Bulgarian Side

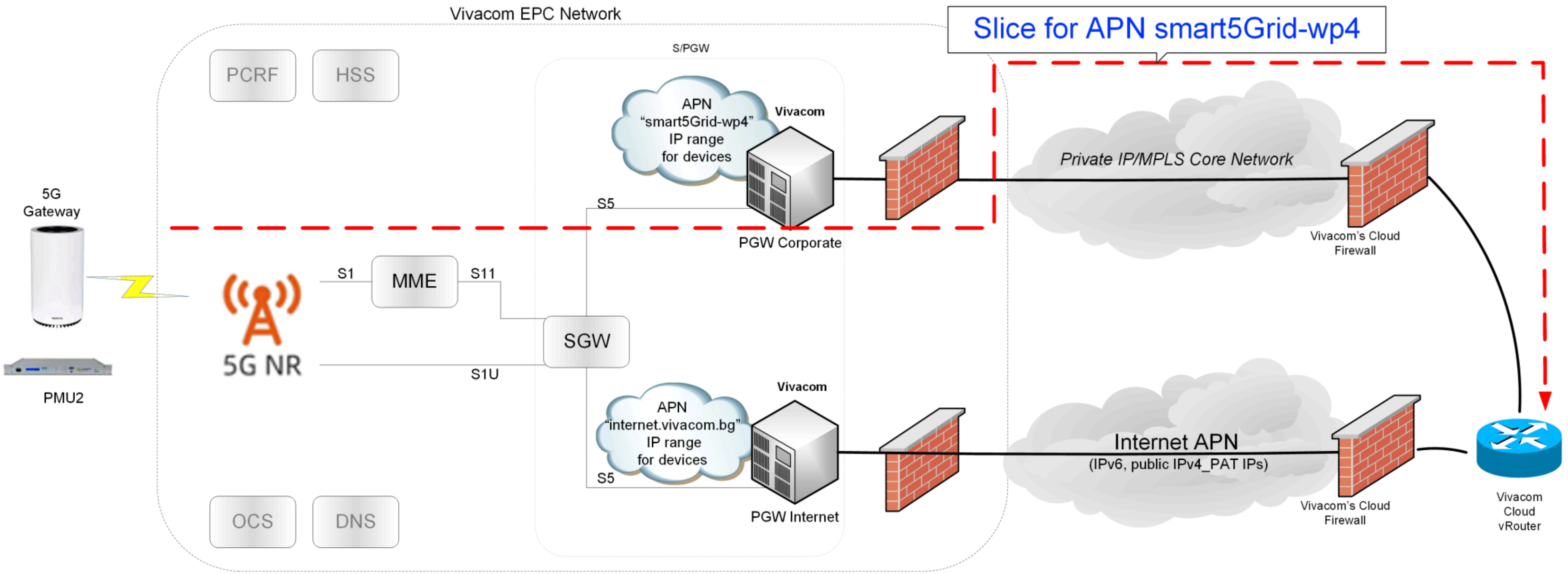



- *Exact PMU location has "Good Outdoor" predicted coverage*
- ***Site survey** by ESO/Vivacom can be performed if needed to fine tune the 5G coverage*

| Coverage | Signal strength | Color code |
|---|---|---|
| No coverage | X ≤ - 110 dBm | White |
| Fair (outdoor) | - 110 dBm < X < - 100 dBm | Green |
| Good | - 100 dBm < X < - 80 dBm | Yellow |
| Very Good | X ≥- 80 dBm | Red |

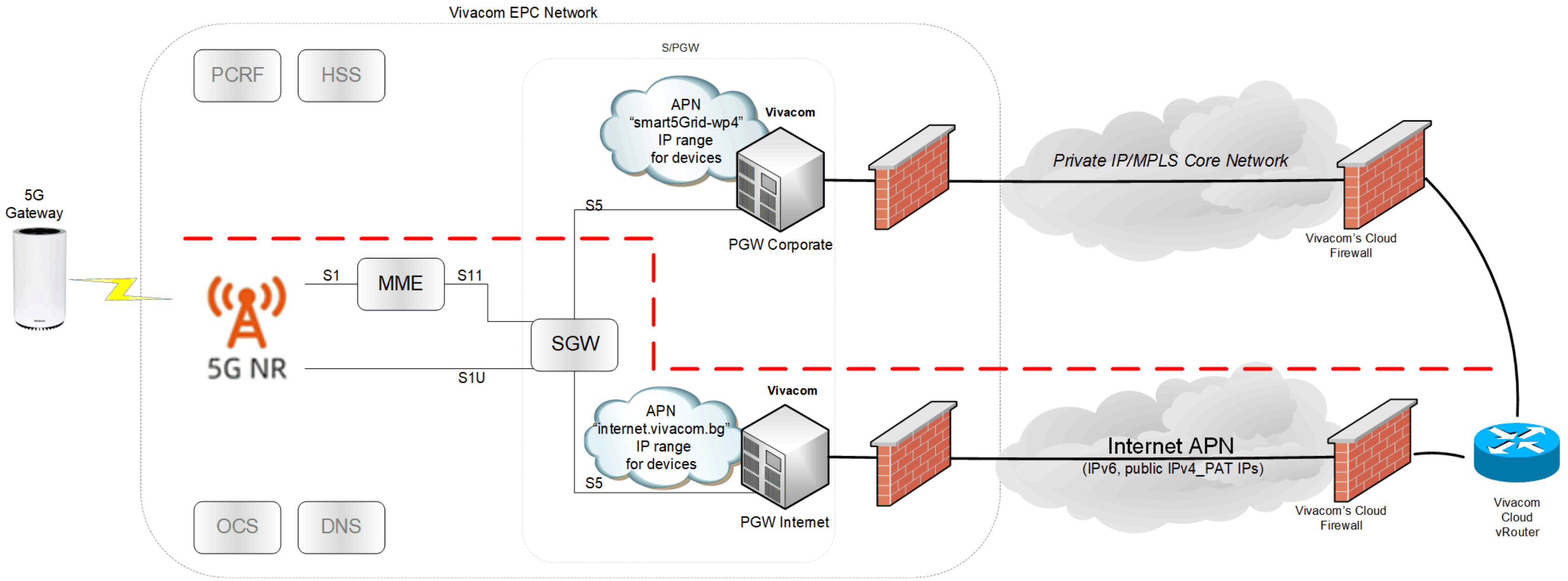
# Interconnection scenario

## Bulgarian Side



# Initial Testing

Bulgarian Side



# Objective of UC#3

Millisecond level precise distributed generation monitoring (+control*)

- Real-time RES production monitoring
- Real-time RES production monitoring and control - demonstrated in T 3.4 HIL demo
- Predictive maintenance enabler for renewable wind assets
- First time in Bulgaria 5G is leveraged for an application in energy sector

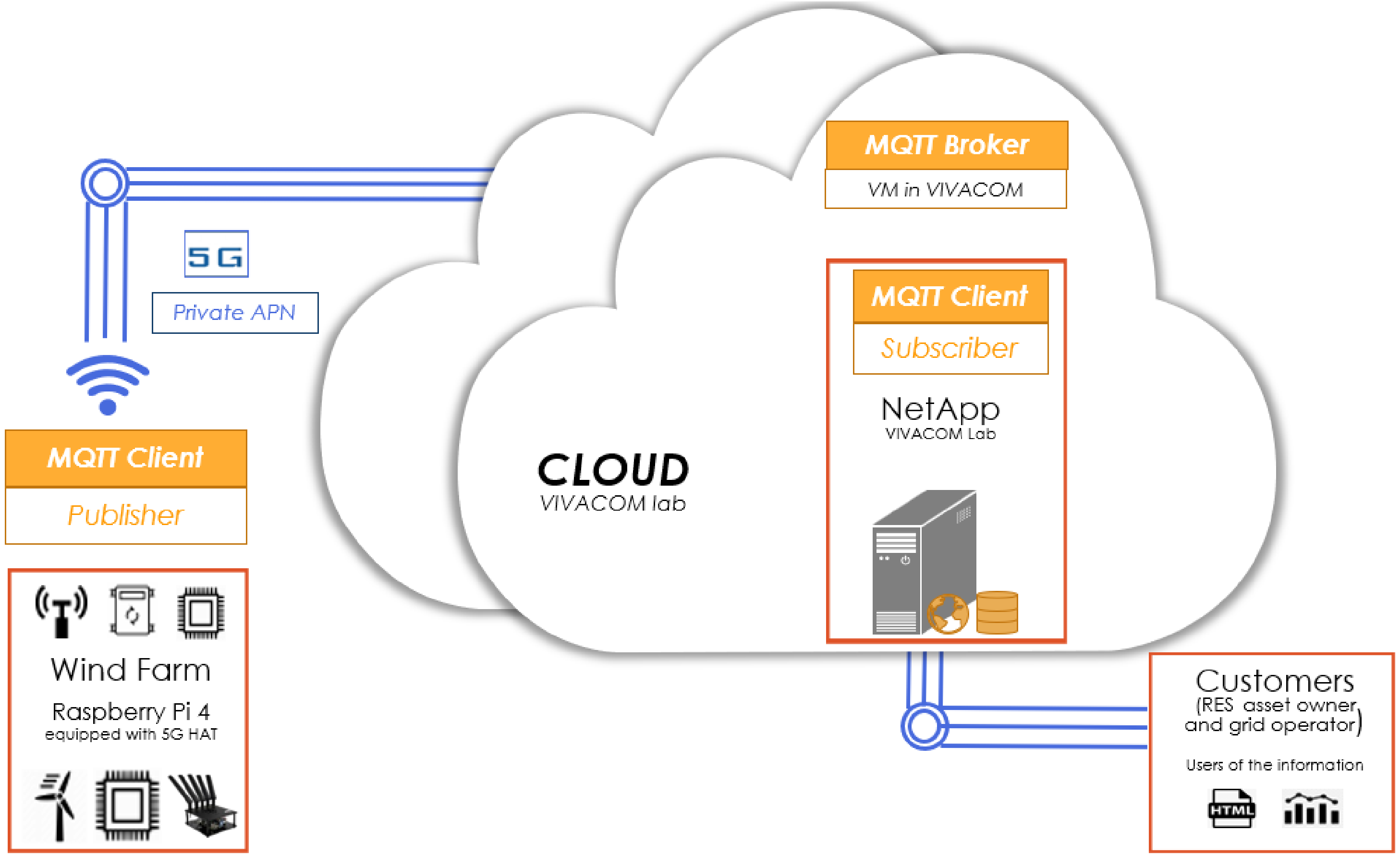
# Problem Statement

UC 3- Millisecond level precise distributed generation monitoring

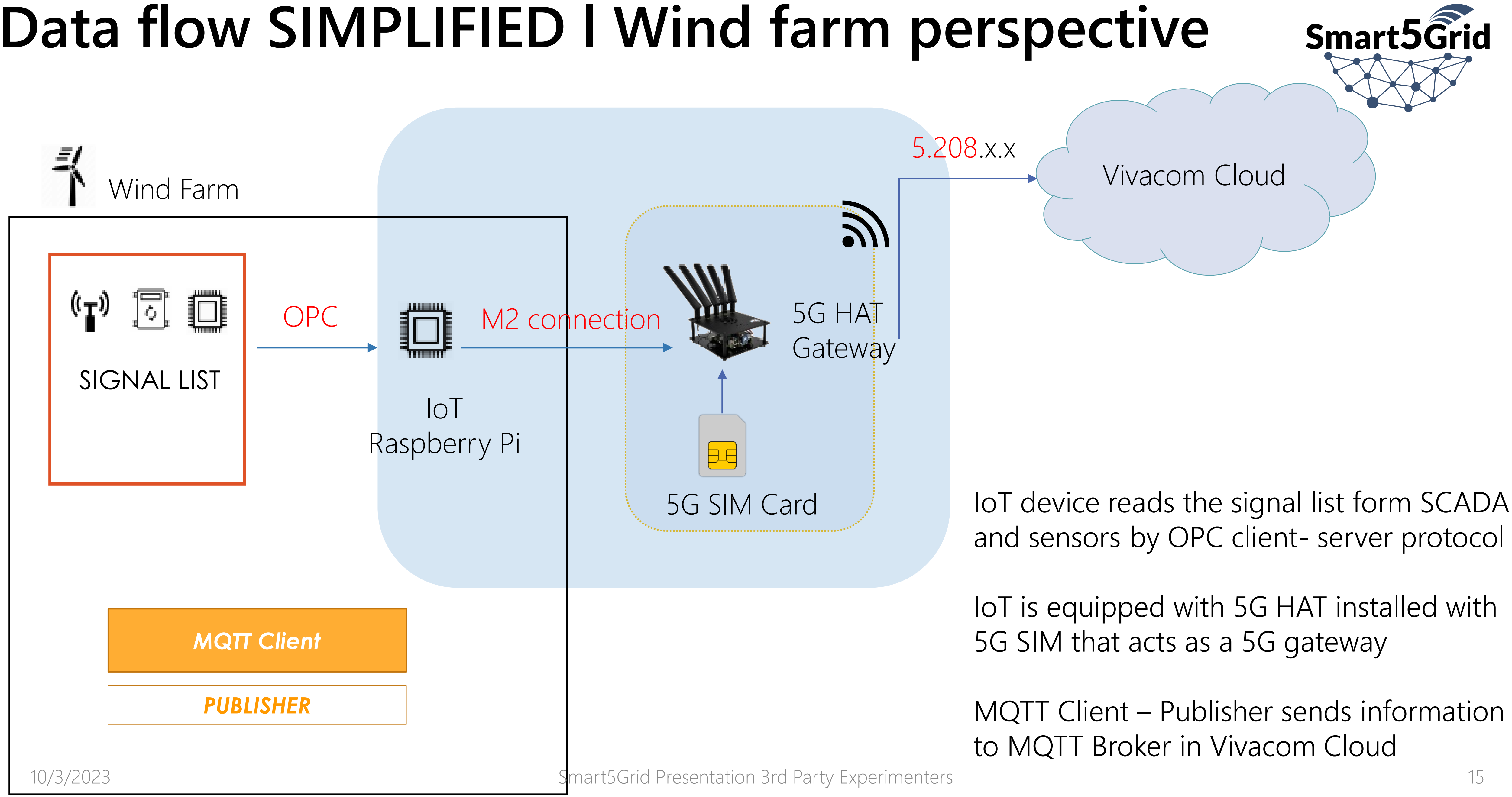
- ❑ Increased penetration of distributed RES and decarbonization of energy sector drives a challenging Energy sector Transformation,
- ❑ High stochasticity introduced by RES provokes issues in real-time operation, rendering necessary the introduction of new flexibility services,
- ❑ Most of the communication technologies used for the communication between the RES assets and the power grid are still wire-bound,
- ❑ The massive digitalization of energy sector aimed to facilitate energy systems transformation, requires a stable, fast, agile and reliable communication infrastructure and telco solutions.

# Call Flow Diagram of Use Case 3

- Demonstration of an ultra-reliable and with low-latency 5G network in the energy domain in the laboratory environment, replicating the on-the-field implementation which is not yet in place
- MQTT protocol will be used for the IoT data exchange between the Raspberry Pi4 equipped with 5G HAT module and the server hosting the NetApps, which is in the VIVACOM cloud
- MQTT Broker, UC3 NetApp and NAC all installed in one virtual machine in Vivacom cloud



# Data flow SIMPLIFIED I Wind farm perspective




IoT device reads the signal list form SCADA and sensors by OPC client- server protocol

IoT is equipped with 5G HAT installed with 5G SIM that acts as a 5G gateway

MQTT Client – Publisher sends information to MQTT Broker in Vivacom Cloud

Smart5Grid

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

# Thank you

Wishing all the best for our common success!