SUCCESS CASE 28.2024

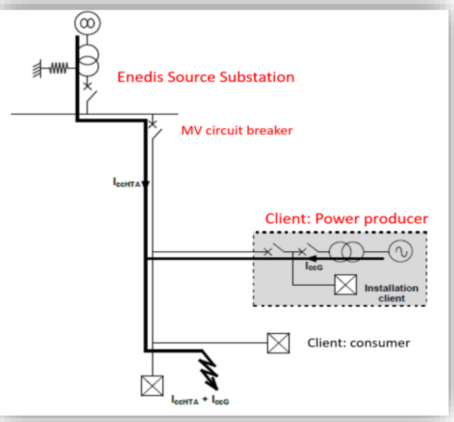
TELEACTION WITH 5G

USING 5G TO REPLACE WIRED TECHNOLOGIES AND ENSURE LOW LATENCY CONNECTIVITY TO SMARTGRID ANTI-ISLANDING SYSTEMS.

THE CHALLENGE

Enedis deploys systems called *Teleaction* (or *TAC*) to secure the connection of large renewable energy producers to the electrical network connected by a medium voltage (MV) line (20 kV) with an operating power above 5 MVA. The TAC system consists of two remote circuit breakers: one on the producer's side and the other at the electrical substation to which the producer is connected by an MV line. The control system ensures that, in the case of a fault detected by the network, the generator is automatically disconnected as soon as the circuit breaker on the electrical substation side is open. **This prevents the emergence of situation known as *islanding*** where a portion of the MV electrical grid is still producing power for itself (the power producer can equilibrate the request locally) while the DSO is supposed to have cut the network (*see diagram below*).

The operation of TAC requires reliable connectivity between the two devices performing the automatic control, ensuring a transmission delay of less than 50ms at any time. A connectivity with this level of performance is traditionally achieved with a dedicated copper or fiber link. Such links are expensive and the implementation usually requires several months. In addition, telecommunication companies are phasing out copper technologies, while fiber coverage is still insufficient in rural areas. This is why 5G cellular connectivity is considered as a potential replacement solution.



WHY 5G CONNECTIVITY?

5G improves the performance of previous generations of cellular technologies, especially in terms

For more information about the project, please contact:
EMMANUEL.VILLALTA@ENEDIS.FR

of latency and reliability, which are crucial for this use case. These improvements are linked to technological evolutions introduced on cellular networks with 5G:

- **Scheduling** (scheduler controls with multiple access to the radio medium) in 5G URLLC which allows for improved latency.
- **Network-slicing** which allows reserving resources to guarantee the stability of the performances and in particular the latency on the radio interface (5G NR) as in the core of network (5G Core).
- **Simultaneous connectivity of the same equipment to several 5G cells/antennas** which improves reliability in case of failure, disruptions, or performance drop on one of the cells.

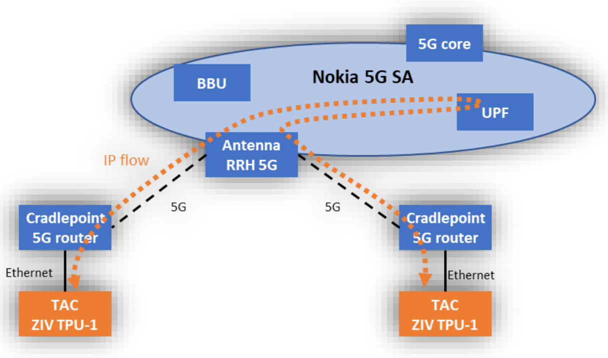
With 5G, the enhancement of cellular network performances introduces the possibility of replacing the use of wired connectivity to connect TAC devices. Indeed, even with 5G connectivity on both the producer and source station sides, the latency should remain below the 50ms threshold required by the Teleaction system.

FROM A SUCCESSFUL EXPERIMENTATION ...

Enedis decided to tackle this challenge by experimenting with this use case through the **5G3E project** and with the collaboration with Nokia and Orange. The EDF R&D site at Les Renardières was selected as the lab environment to perform this experimentation as it provides a "full-scale" electrical distribution network with HV/MV substations and photovoltaic (PV) power production. The objectives of the experimentation phase of the use case "Teleaction with 5G" were multiple:

- Validate the **correct operation** of the TAC **on 5G connectivity**.
- Measure **5G performance** (latency) and the stability of this performance.
- Demonstrate the **differentiating characteristics of 5G compared to 4G** in the use case.

To get as close as possible to 5G SA performance, a temporary private 5G standalone infrastructure was set up with Nokia and Orange’s collaboration (*see figure below*).



The average end-to-end latency measured with 5G is 28ms and allows for a comfortable margin compared to the 50ms required for the use case. This should allow accommodating additional delay on a less favourable public 5G network (concurrent access to spectrum, more centralized 5G core infrastructures).

The experiment also confirmed that 4G performances (latency and jitter) are not suitable to meet the 50ms requirements in a constant and reliable way.

...TO A FIRST TRIAL IN PRODUCTION ENVIRONMENT

The promising results of the experimentation motivated a **field trial with an EDF PV power generation facility** located near Fos-sur-Mer in the South of France and **connected to the Enedis production grid**.

Orange cellular network is used as 5G connectivity between the TACs devices installed at the PV farm substation and the one in the nearest HV/MV substation. Managed cellular routers (already deployed by Enedis for other use cases) have been upgraded with 5G modules to cope with production requirements (cybersecurity hardening, industrial rugged form factor). Before enabling the new 5G TAC systems, **several optimisations were performed** to improve latency stability on both 5G end-devices and the Orange network: enforcing specific spectrum bands to cope with power-saving strategies, firmware updates, scheduling optimization, etc.

The system is now live for more than 6 months. **The average network latency is 33ms (one-way) and remained below the 43ms threshold 99% of the time**. This level of stability performance is good but not fully satisfying. Some remaining issues (modem power cycles, multi-site 4G/5G dual carrier, …) have been identified to reach a 99,99% reliability target.

Additional performance improvements should be achieved with **future 5G standalone B-to-B connectivity services** (expected in 2025) to avoid instability caused by 4G/5G dual attachment and further improved performance with edge network functions.