Study Committee B5-PS2

Protection & Automation, applications of emerging technology for protection, automation, and control B5-PS2.

10751 _2022

Defining an MV/LV Protection, Automation, and Control system based on 5G network

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Motivation

Observation

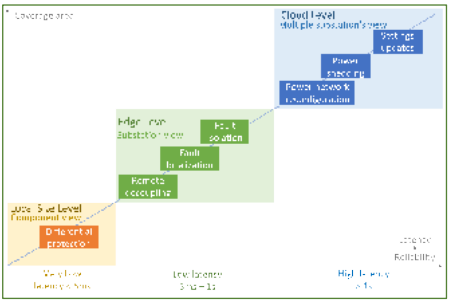
- Distribution grid PACs systems target high levels of **safety** and **reliability**, and address the need for better **state estimation**, **protection** and **control** schemes
- Protection scheme complexity increases with large **DER** integration.

Opportunity

- **Information and Communication Technologies (ICT)** are used in **Smart Grids** to manage the electric system.
- **5G**, alongside cutting **edge technologies and standards** can improve **communication performance : reliability, latency, interoperability, scalability, and power efficiency**.

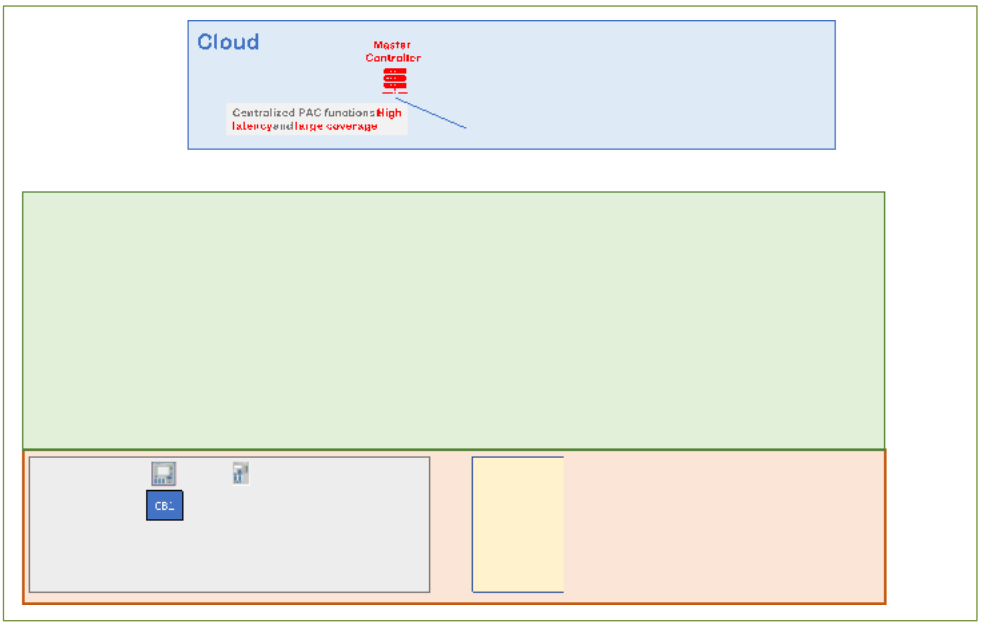
Solution

- Deploy PAC functions at different levels (**Local, Edge or cloud**).
- Propose a flexible **5G-base** communication architecture for **customized communication services** according to performance requirements demanded by PAC schemes.



Deployment of PAC functions at different levels

Method/Approach



Three-level PAC architecture

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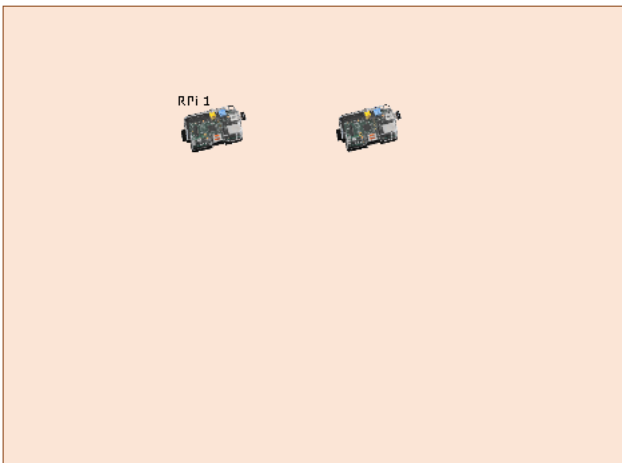
Experimental setup

We use an **all-in-one real-time grid simulator** from **Opal-RT**, allowing development and configuration of real-time controls, tests, measures, and application prototypes. We consider two protection relays from **ABB (RE_615 series)** and a Fault Passage Indicator from **Schneider (Flair 23DM)**. The grid devices are connected to the real-time simula

The used 5G network is **non-standalone (NSA)** compliant with **3GPP R15**. The 5G radio is an **Amarisoft callbox** operates in **TDD** band **n78** (**3500 MHz**) with a bandwidth of **20MHz**. The core network is **b<>com NSA core "WEF"**. The RAN and the Core are inter-connected using an optical fiber backhaul link.

User equipment (UEs) are **5G routers** from **Sierra Wireless** and **Advantech**. The **Raspberry 1 and 2** are used as **digital gateways** and connected to the 5G router through an **RJ45** cable.



5G-based PAC testbed

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Test results

The results show that the achieved **Avg_RD_D** is less than the maximum transmission time allowed by the French regulation (i.e., < **70 ms**). Regarding **Avg_NR_D**, it should be noted that the time of **100 ms** is obtained in a very reduced configuration with **two substations**. We estimate that with the same architecture using a permanent 5G link in a real scale configuration (eg: with **50 substations**), the average network reconfiguration delay will be reduced **from few minutes to few seconds**.

Perspectives

Short term:

- Compare the performance of our platform when using different communication technology : 5G and 4G.
- Build a field experiment based on a real distribution network.

Long term:

- Propose new smart grid applications that can be built on the proposed architecture.
- Compare the performance of our platform with a private and public 5G network
- Leverage the use of 5G network slicing to built more reliable communication network.