Benefits for Electrical Utilities of using micro-PMUs on MV grids

Distributed Generation penetration trend is strongly impacting most of **Electrical Utilities** all around the world; grid complexity is increasing consequently and **DSOs** are now facing new challenges such as unpredictable bidirectional power flow, MV harmonic pollution and grid management revolution.

The **QEd**, an all-in-one hardware platform from **Gridspertise**, is able to enhance the classic substation Protection and Control equipment performances thanks to its embedded **Micro-PMU**.

What is QEd?

QEd is the Gridspertise hardware platform intended to **virtualize** all the classic devices usually installed in **electrical substation** such as RTUs, Protection relays, Modems, Routers and Data meter concentrator.

Thanks to its multi-purposes concept QEd is the **keystone** to merge **OT** and **IT** ecosystems to maximize the resiliency and efficiency of the Grid while simplifying maintenance operations.

- Multi-feeder Protection Relay and BCU
- **Virtual Smart Meter** data concentrator
- Embedded 3G/4G modem and Router
- Remote Management and Diagnostic cloud platform
- **Embedded micro PMU**

What is a PMU?

A **phasor measurement unit** (**PMU**) is an edge device used to estimate the magnitude and phase angle of an electrical phasor quantity (such as voltage or current) using a common time source for synchronization. (usually provided by GPS or IEEE 1588 Precision Time Protocol). PMUs can calculate **electrical phasors** starting from voltage/current waveforms thanks to their high-sampling capability combined with time-synchronization feature. The resulting measurement is known as a **synchrophasor**. These time-synchronized measurements are important because if the grid's supply and demand are not perfectly matched, frequency imbalances can cause stress on the grid, which is a potential cause of power outages. Although PMUs are commonly used for **HV applications**, they can now help utilities to manage DER penetration in the MV grid as well.

Why DSOs need PMUs for MV grid?

Because of the **increasing DER penetration** many **DSOs** are now facing new challenges in terms of **harmonic pollution**, grid management and grid stability. Due to the high presence of inverters the electrical parameters in such grids are no longer perfectly sinusoidal as voltages and currents contain components both in high frequency (up to hundreds of kHz) as well as in low frequency (lower than the frequency of the grid).

Voltages and **currents** turn out to be no longer periodic but **almost periodic** (very long fundamental periods) due to intermodulation between fundamental frequencies produced by individual power conversion electronic systems (inverters).

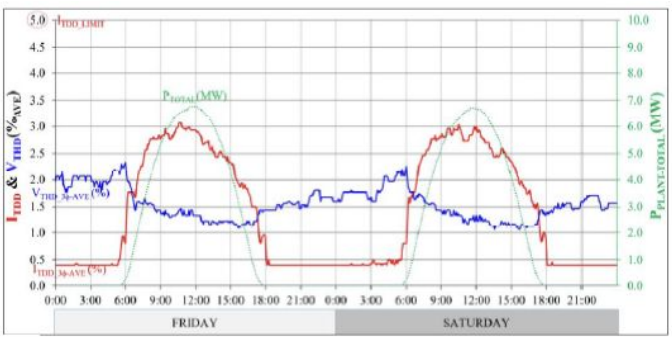

Figure 1 - Harmonic pollution example

When it comes to RES and DER a new approach to grid management is crucial; micro PMUs can be a solid help for Utilities to manage unintentional islanding and grid reconnection providing high-accuracy measurements to timely detect any early phases of islandings. Therefore, micro PMUs can also be used to measure the frequency in the grid with unmatched accuracy; this helps engineers in analyzing fast dynamic events which is not possible with traditional SCADA measurements (generating one measurement every 2 or 4 seconds). Grid resiliency can be enhanced thanks to micro PMUs: synchronized real-time measurements help Utilities to deal with high-impedance earth faults and identify with unmatched accuracy the exact fault location.

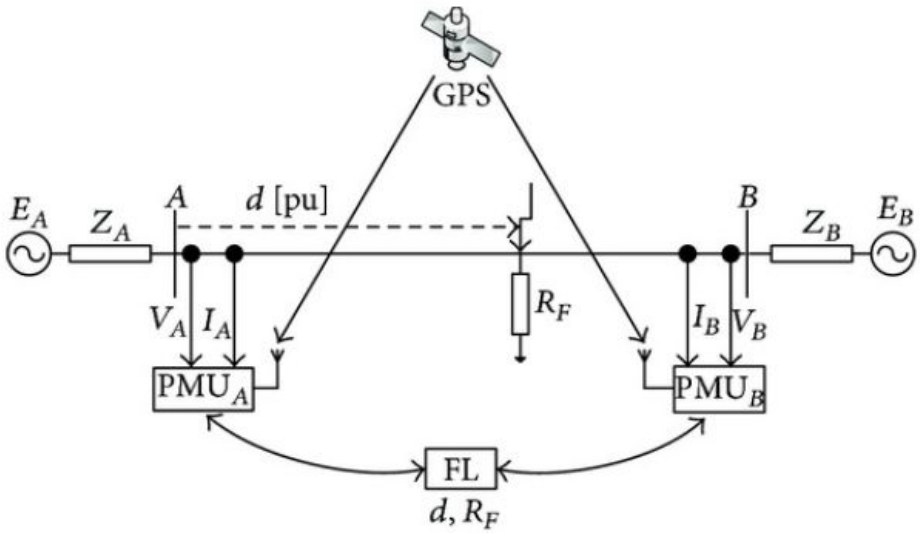

Figure 2 - Fault location calculation criteria

Finally **grid stability management** can take advantage of micro PMUs to calculate the Virtual Inertia of the grid and explore new operating system to maximize existing infrastructures capabilities

Takeaways: 5 main benefits for Electrical Utilities

- **Power system automation**: being able to perform high-accuracy; frequency monitoring micro PMUs can help Utilities managing unintentional islanding and main grid reconnection.
- **Real-time grid State Estimator for Volt/VAR optimization** and advanced dynamic congestion management to unlock Flexibility market.
- **Support real-time load shedding/curtailment techniques** to maximize demand-response efficiency and avoid any grid collapse.
- **Increase power grid reliability** by early fault detection and accurate fault location calculation.
- **Synchronized time stamping of micro PMUs** can be used for Security improvement through synchronized encryptions like trusted sensing base. (cyber attack recognition by verifying data between the SCADA system and micro PMU data).