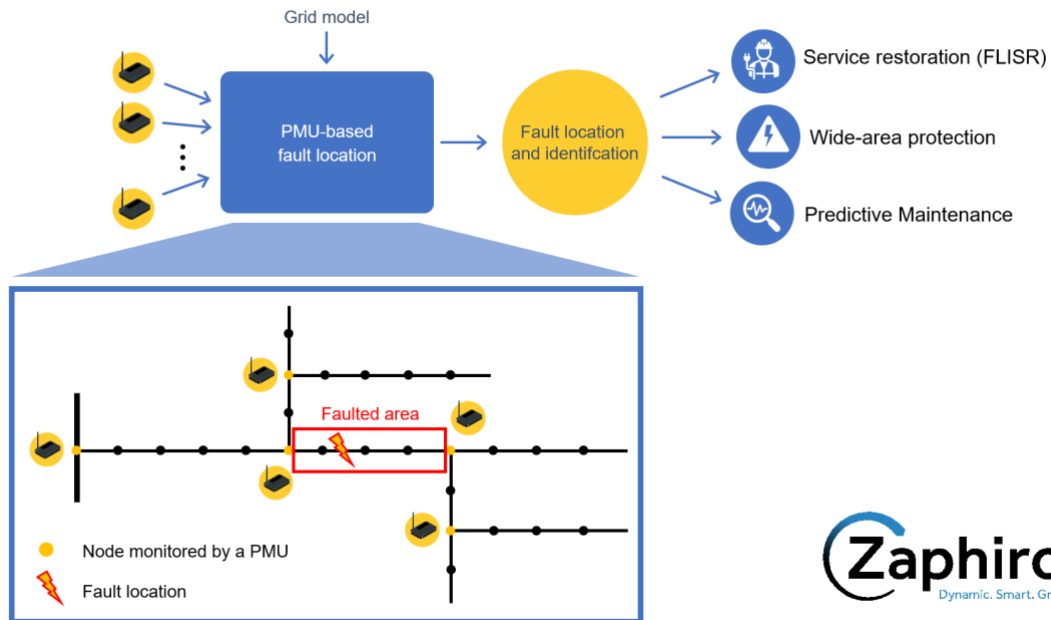
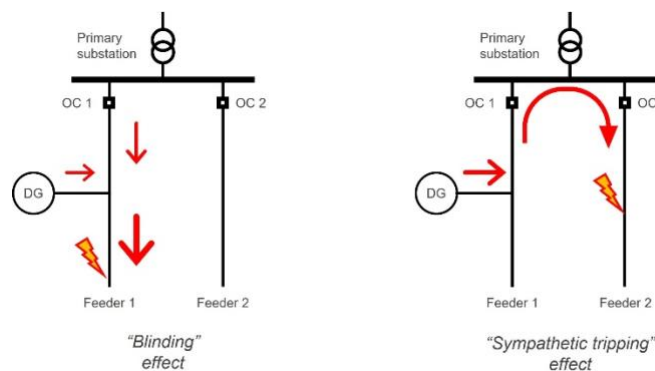


# Improving Fault Location and Identification using Time-Synchronized Phasor Measurements



Reduction of downtime for electricity consumers and avoidance of grid infrastructure damages have always been a top priority for distribution grid operators. Today, with frequent severe weather events and aging infrastructure, the grid is under increasing risk of fault-related customer interruptions. At the same time, electrification of customer equipment to reach net-zero is putting pressure on utilities to minimize power disruptions. Furthermore, the integration of high-capacity Distributed Generators (DGs) is causing trouble for over-current (OC) protection devices and/or fault location algorithms to correctly identify faults due to their contributions to fault currents as shown below.



In this context, distribution utilities are looking for solutions to help them minimize interruption time for end-users and grid infrastructure damage during fault events; in the industry, this is called Fault Location, Isolation and Service Restoration (FLISR).

One of the biggest challenges in a FLISR system is the correct identification and location of faults. The performance of a fault identification and location solution can be measured according to the following criteria:

- 1) Accuracy – Refers to the size of the grid portion flagged as faulted;
- 2) Sensitivity – Refers to the minimum fault current that can be detected;
- 3) Reliability – Refers to the capability of providing the correct fault location while not triggering false alarms, i.e., not detecting faults in healthy grid areas;
- 4) Speed – Refers to the capability to locate and isolate faults as fast as possible. This is fundamental when protections fail and reactive measures need to be taken quickly to avoid irreversible damage.

In practice, the solution must be able to guarantee satisfactory performance regardless of:

- 1) The type of faults (i.e. earth and intra-phase shorts involving one or multiple phases)
- 2) The system neutral grounding (i.e. solidly grounded, compensated, or isolated)
- 3) The grid operating conditions (e.g. generation/load levels, grid configuration etc.)

Conventional fault location techniques using local relays and Fault Passage Indicators (FPIs) measurements are usually not sufficient to give satisfactory performance for modern utilities. More specifically, they suffer from low sensitivity in the case of high-impedance faults, low sensitivity when dealing with intermittent faults, and low reliability in the presence of high-capacity DGs. The accuracy of such methods is proportional to the number of installed devices, i.e. the more devices the more specific the identified area. Speed is affected by the capabilities of the used technology (i.e. LED flashing FPIs vs. FPIs and relays with communication capabilities).

The use of time-synchronized measurements for fault location and identification presents several advantages:

- 1) They improve sensitivity for high-impedance faults by adapting triggering thresholds using pre-fault grid operating conditions provided by time-aligned synchronized phasor measurements.
- 2) They improve sensitivity when dealing with intermittent faults, as the systems is constantly recording fault signals as opposed to using threshold-based triggers only.
- 3) They improve reliability in the presence of DGs, by enabling the use of differential methods that account for the currents of each individual area delimited by time-synchronized measurement devices such as Phasor Measurement Units (PMUs).

Zaphiro proposes a novel fault detection and location technique based on time-synchronized current measurements and only one voltage measurement at the substation. The solution can detect and locate faults with high fidelity, under all grid operating condition, neutral groundings, and fault types. By leveraging synchrophasors, Zaphiro's solution is highly sensitive to high-impedance faults, takes into account DG contributions to fault currents, and accurately locates self-extinguishing (or intermittent) faults.

*Learn more about our work at: [www.zaphiro.ch](http://www.zaphiro.ch)*