



EUCloudEdgeIoT.eu

# From Vision to Impact

MetaOS Project

## Enhancing Power Grid Resilience and Scalability through FLUIDOS: Leveraging Edge-to-Cloud Orchestration for Real-Time

### The Needs

The introduction of a massive number of renewable energy sources requires a highly monitored distribution grid that can coordinate energy producers and consumers in real-time. The emerging power grid architecture will rely on many measuring devices such as PMUs (Phasor Measurement Units) strategically positioned on the power grid to measure electrical quantities, with real-time data collection and synchronization carried out by PDCs (Phasor Data Concentrators). The synchronized data collected by PMUs and managed by PDCs serves as crucial input for the Grid State Estimation algorithm, which is the basis for real-time applications such as monitoring, control and protection of the grid, and offline applications such as archiving and offline analysis. Traditionally, PMUs have been deployed within the transmission grid. However, the evolving power grid demands a more comprehensive monitoring approach, including the distribution grid.

### The Problem

The introduction of PMUs into the distribution network brings about various challenges, including:

**Scalability:** The number of PMUs required for the power grid to be observable is significantly higher for the distribution case. While hundreds of PMUs are needed for the transmission network to be observable, the distribution network will require a number in the order of thousands. This implies the need to manage a massive number of distributed devices and their corresponding data flows.

**Resilience:** With thousands of devices in play, enhancing the resilience of the ICT infrastructure for data collection is crucial. For instance, managing faults or planned maintenance should be automated, as well as the possibility for the above devices when disconnected from the network and/or unable to access companion services running in the cloud.

### The company

As part of FLUIDOS project, the use case is developed by RSE, recognised in Europe as a non-profit research organisation with a wide and very successful role in integrating the national research programmes with the EU directives and plans.



### The solution

Traditionally, PDCs were monolithic applications running on dedicated hardware; however, with the increasing computational power available at lower costs, this is changing in recent years. Experimental efforts are underway to virtualize applications and utilize Kubernetes for orchestrating the deployment of PDCs and real-time analysis applications at the edge. This is aimed at reducing latency issues and improving resiliency, avoiding the need of operator physical assistance in case of outages, and paves the way for their usage within a FLUIDOS-based environment.

FLUIDOS creates a continuum of resources from the edge to the cloud and enables the displacement of workloads, such as data collection and analysis processes, based on specific scenarios (faults, reconfiguration, maintenance).

### Impact

The main features of the approach enabled by FLUIDOS are: FLUIDOS enables PDCs and analysis applications to continue functioning even if communication with control centres is interrupted by migrating PDC services to an adjacent node in case of fault.





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FLUIDOS can automatically orchestrate PDCs based on the latency between the node and PMUs, thereby improving the power grid state estimate or responding to faults.

The power grid is a critical infrastructure for the country and, as such, must be protected from any malicious attack, including the ones targeting monitoring and control services. FLUIDOS ensures service isolation from other applications on the hosting node with different usage permissions. It also leverages logging and anomaly detection capabilities, and provides survival capabilities in case a portion of the grid is disconnected from the main network, hence preserving its operations in case of a cyberattack.

## Recommendations for policy making

Sharing compute resources across the Cloud-edge-IoT continuum is an important factor for Europe's competitiveness to ensure continuous secured operations of critical infrastructures. New standards will arise from research project like FLUIDOS and will need to be implemented EU wide.



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