Real-time Monitoring and Situational Awareness in Active Distribution Networks

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Managing Uncertainties in Power Networks

In traditional power systems, the main **sources of uncertainties** are represented by the **loads**.

Majority of the control and operational problems are solved in the **planning (years)** or **dispatching (day)** stages.
Managing Uncertainties in Power Networks

Massive deployment of distributed energy resources → large uncertainties come from sources

Control and operational problems are solved in the planning (years), dispatching (day) and real-time.

Real-time visibility of distribution network is needed.
Observability of Active Distribution Networks

As distribution networks become more “active” operational security of the overall grid requires ADNs and TNs to interact tightly.

“Lack of visibility affects AEMO’s ability to accurately assess the operational limits of the power system.”

Source: Luigi Vanfretti
Smart Meters

Voltage Profile

Current Profile

Current Profile
Smart Meter Data Analytics

LV Network Mapping and Line Parameter Estimation

Phase A Load Profiles

Power in Watts

Leaf Nodes (Consumers)
Smart Meter Data Analytics

Solar Disaggregation and Shadow Detection

[Diagram of sunrise and sunset tracking over the course of a year, with annotations for sunrise, sunset, panel sunrise, and panel sunset.

[Diagram of a solar edge sun path plot, showing the path of the sun across the sky at different times of the day and night.]
Are Smart Meters the ultimate solution?

Phasor Measurement Units (PMUs)
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Applications of Phasor Measurement Units (PMUs):

1. T&D interaction
2. State Estimation
3. Fault Detection
Efficient Fault Location in Distribution Networks

Current Technology: Fault Indicators

- 1 device per few km
- Precision of a few hundreds of meters to kms
- Can take hours

Grid/Guard

- 1 device at the substation
- Precision of a few meters
- 1-5 minutes
Efficient Fault Location in Distribution Networks
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