

Two Witnesses to Every Fault

Locating faults from fault current and from the meters that went dark, and saying whether the two agree

PRODUCT	Grid Data Enhanced Analytics
AUDIENCE	Distribution operations, reliability engineers

The patrol is where the minutes go

When a feeder locks out, the clock starts. Customers call. The control room pulls up what it knows. A crew heads out to find the fault, and on a long feeder with many laterals, rough terrain, or poor road access, the patrol can take longer than the repair.

Every minute of that patrol lands in the utility's reliability numbers and in its customers' patience. Often the surest way to shorten restoration is a better answer, before the crew rolls, to one question: where is the fault?

Why fault location is hard

Utilities usually have more than one kind of evidence about a fault. The trouble is that each kind has blind spots, and the two are rarely compared.

Fault current alone can be ambiguous. Protective devices and SCADA capture the fault current the feeder saw. That evidence is valuable, but on a branched feeder it can point to more than one candidate location, and it is only as good as the network model behind it. A wrong conductor, an outdated tap, or a missing switch in the model moves the answer.

Dark meters alone can mislead. AMI meters report events such as last gasp when they lose power and power restored when it returns. A map of which meters went dark shows the outage footprint in detail. But AMI communications are imperfect. A collector outage or a backhaul problem can silence a whole cluster of meters that still have power. Treat that silence as an outage, and a crew drives to a street where the lights are on.

The two views live in different places. The control room sees SCADA. The AMI team sees meters. Somebody in the middle compares them by phone, if there is time. Nobody formally states whether the two stories match.

Principles of a good approach

Use independent evidence. Locate the fault from measured fault current, and separately from which meters went dark. Two methods that rely on different data fail in different ways, which is exactly why they are worth having together.

State whether they agree. When both point to the same section, the crew can go straight there with confidence. When they disagree, that is a finding in its own right: the model may be wrong, a communications

problem may be hiding in the meter data, a protective device may have operated unexpectedly, or there may be more than one fault. Either way, the operator should be told.

Model the communications network on its own. Meters sit on the electric network and on the AMI communications network at the same time, and the two do not line up. When the communications network is modeled separately, a cluster of silent meters behind one collector reads as a communications fault, not an outage. The line crew stays on the real fault, and the communications team gets the right ticket.

Use the meter events, not only the reads. Last gasp and power restored events carry timing and state that interval reads alone do not.

Put it on the map. The answer belongs on the connectivity model, where the operator and the crew can see the candidate section, the affected meters, and the devices around them.

Reliability indices from the same evidence

The same events that locate a fault also define an interruption. IEEE 1366 sets out the standard reliability indices that regulators and utilities use:

- **SAIDI:** the average total outage duration per customer served.
- **SAIFI:** the average number of sustained interruptions per customer served.
- **CAIDI:** the average time to restore service for customers who were interrupted.
- **MAIFI:** the average number of momentary interruptions per customer served.
- **CEMI:** the share of customers who experienced multiple interruptions.

Many utilities compute these in a separate reporting process, from manually reconciled outage records, long after the fact. Computing them from the source data, per feeder, per substation, and system-wide, means every number traces back to the events behind it. That makes the indices defensible in front of a regulator. It also makes them useful for planning: CEMI and MAIFI surface the customers and feeders that keep getting hit, even when system-wide averages look fine.

What it looks like in practice

Grid Data Enhanced Analytics (GDEA) joins the utility's GIS connectivity model, live SCADA telemetry and events, and AMI reads and events into one live picture. It locates faults by independent methods, from measured fault current and from which meters went dark, and says whether they agree. Every meter is modeled as a service point with its interval reads and events, and the AMI communications network is modeled as its own network, so a cluster of silent meters on one collector reads as a communications fault rather than an outage. SAIDI, SAIFI, CAIDI, MAIFI, and CEMI are computed to IEEE 1366, per feeder, per substation, and system-wide.

GDEA is monitoring-only. It tells operators where the fault most likely is. The utility decides where to send the crew.

ILLUSTRATIVE EXAMPLE (HYPOTHETICAL)

The following scenario is hypothetical. On a stormy evening, a recloser on a rural feeder locks out. The fault-current view narrows the fault to one section of the feeder, with two laterals as candidates. The meter view shows that meters on one of those laterals sent last gasp events and went dark, while meters on the other are

still reporting. The two methods agree on the first lateral, and the crew goes there first instead of patrolling both.

Across town, a group of meters goes silent at the same time. They sit on different laterals of feeders with normal SCADA telemetry, but all of them report through the same collector. GDEA shows it as a communications fault. The communications team gets the ticket, and no line crew is sent.

When power is restored, the power restored events close the loop, and the interruption flows into the feeder's reliability indices from the same source records.

Questions to ask any vendor

- Does the product locate faults from more than one independent source of evidence?
- Does it tell operators whether those methods agree, and what a disagreement means?
- Is the AMI communications network modeled separately from the electric network?
- Can it tell a communications fault from a power outage when a group of meters goes silent?
- Does it use meter events such as last gasp and power restored?
- Are IEEE 1366 indices, including MAIFI and CEMI, computed from source records you can trace, per feeder, per substation, and system-wide?
- Does the decision to dispatch stay with your operators?

Closing

A fault leaves evidence in more than one place. Asking both witnesses, and checking whether their stories match, shortens patrols, speeds restoration, and produces reliability numbers the utility can stand behind.

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