NASPI Distribution Task Team

Technical Report

NASPI DisTT Use Case:

Equipment Health Diagnostics

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Use Case

High-precision synchrophasor measurements can detect early signs of equipment aging, malfunction, or incorrect ~~mis-~~operation from the electrical signature, so as to help prevent costly damage or outages.

Background

Aging and deterioration in distribution transformers or switchgear can be difficult to diagnose inexpensively online. Smaller service transformers are typically just replaced upon failure. Larger equipment such as substation transformers can be tested using dissolved gas analysis (DGA) of the transformer oil that reveals chemical evidence of degradation.

Ongoing condition monitoring of utility equipment would help both to prevent specific device failures and to establish a general improved knowledge base for planning purposes.

Examples

In a pilot deployment of microsynchrophasor measurement units (micro-PMUs) at Riverside Public Utilities funded by ARPA-E, researchers from Lawrence Berkeley National Lab discovered a voltage sag characteristically following within several cycles of tap change operations, accompanied by a small current transient. This observation prompted utility personnel to perform a field inspection, which revealed an oil leak that could have resulted in costly damage to the transformer.

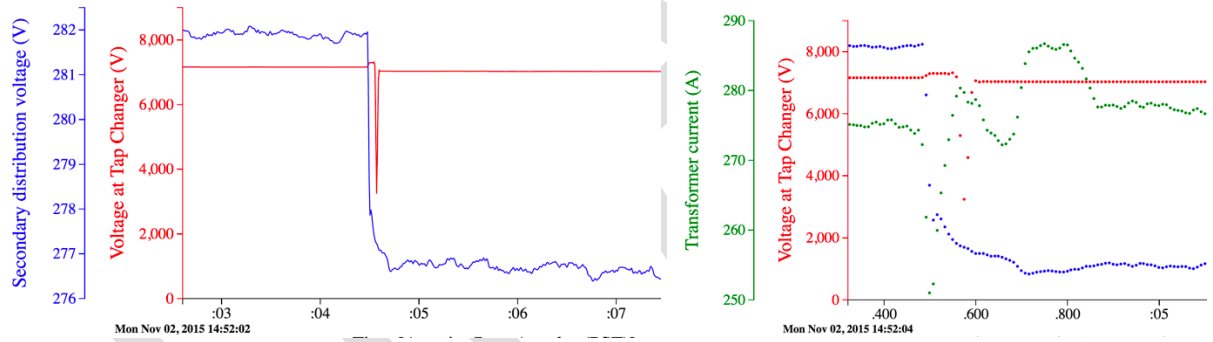

Figure 1: Anomaly in the tap change signature gave early warning of deterioration at a substation transformer. PSL micro-PMU data visualized in Berkeley Tree Database plotter; horizontal axis is in seconds, right graph shows individual 120-Hz samples. (UC Berkeley and LBNL)

Data Requirements

Equipment health diagnostics benefit from precision time-series measurements, time granularity of data on the order of a cycle or better, and synchronization of measurements made across different ~~measurement~~ locations for validation through cross-referencing. There is no specific threshold for absolute accuracy. Explicit voltage phase angle data may be useful but are not intrinsically necessary.

Development and Limitations

Tools for this use case are at Technology Readiness Level (TRL) 6, ready for deployment in pilot-scale demonstrations. Algorithms await formalization on the basis of larger empirical sample sizes.

References

[1] E.M. Stewart, C. Roberts, A. Liao, A. von Meier, O. Ardakanian and K. Brady, and A. McEaachern, "Predictive distribution component health monitoring with distribution phasor measurement Units." Submitted for publication to: Transactions Smart Grid (2016).