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Novel State Estimation for Networks with Limited Measurement Data

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Since Fred Schweppe introduced the Weighted-Least Squares (WLS) method for state estimation in 1968, it has become the conventional practice for state estimation on the transmission grid. However, increasing renewable energy penetration and load demand present a need for state estimation on both the sub-transmission and distribution network levels. Whereas conventional state estimation works on the transmission grid because of the high measurement redundancy and availability, it is very expensive to outfit the lower voltage networks with this amount of redundant measurement data. Therefore, without enough measurement information, conventional state estimation does not work well on network segments with limited measurement data.

Bigwood Systems, Inc. has developed and implemented a novel method for non-linear state estimation called quasi-gradient systems (QGS) state estimation. The QGS method can take limited measurement information or just PMU data and provide observability in the network. This novel method takes a dynamical approach to determining the actual network state by translating the state estimation problem into a non-linear dynamical system problem. Then QGS will prove there is a unique mapping between the algebraic and dynamical equations. By doing this, a solution can always be found through the non-linear dynamical equations that have been developed, even with limited measurement data.

The QGS method shows advantages in greater convergence properties and tailored requirements on accuracy in power systems with fewer measurements. The tool uses PMU measurements, both with and without SCADA measurement data, to provide accurate state estimation results as well as high-quality solutions. The beauty of QGS State Estimation is that it does not need to replace conventional state estimation but instead, will improve and ensure the convergence of conventional SE engines. QGS will output a high-quality solution while also finding accurate SE solutions when the conventional WLS SE diverges. The QGS-based engine has been implemented and benchmarked at various utilities and continues to gain traction.
