

phasor value

proving the worth of phasor measurement units

THE AUTHORS OF THE ARTICLES in this issue are necessarily modest but I think it is acceptable for an interested observer to assert that the development of phasor measurement units (PMUs) is, together with the general development of microprocessor-based protection, the most significant technological advancement in T&D technology in the past decade or two. When, after the 1967 blackout, the industry began developing methods for assessing the security of the grid, the need to model the transmission network as part of system operations became clear. The supervisory control and data acquisition systems of the time offered nothing like the data accuracy and coverage of the systems of today, much less the precision promised by PMUs in a wide-area measurement system (WAMS). In developing state estimator applications and implementations, we wrestled with assumed accuracies of 3–5% from the megawatt and Mvar telemetry, and it was not unusual to find erroneous scaling factors, reversed Mvar data, and the like. The nonlinearity of the estimation problem and the power (or lack of) of the energy management systems of the time led to compromises in the modeling, algorithms, and uses of the estimators. Many of the more powerful tools available in estimation theory were impractical. Parameter estimation, for instance, could never really take advantage of the mathematics of system identification. A lot of us wrote doctoral theses that never had a chance of seeing

the light of day due to lack of real-time data, computer power, and a general will to address the problem in light of the difficulties.

We have had adequate computer resources for at least a decade, and systems theory has come a long way, but lack of synchronized high-speed data was still the problem. PMUs promise to eliminate that last obstacle. The articles in the issue point to a future of linear state estimators and advanced control algorithms that can make use of the high-speed phasor data. The articles also make clear that North America is not in the forefront of deploying PMUs; hopefully, the North American SynchroPhasor Initiative will “catch us up.” What we do need now is an industry focus on identifying and developing high-value applications of phasors, which are compelling cases for more rapid and widespread deployment.

Reducing the threat and scope of wide-area outages (blackouts) should in and of itself be enough of an incentive. However, reliability as an economic driver works best in the aftermath of a disaster and fades over time. And the economic burden is borne by the consumers who are not at the table when budgets and priorities are established. Where then, can we find the pocketbook issues that will motivate all the market participants? Where can we find a cost benefit analysis to warm the coldest finance officer’s heart?

I would like to suggest a couple of examples. One would be to reduce congestion costs. In our various real-time mar-

kets, we have monetized the constraints due to transmission limits as congestion costs, which are ultimately borne by the consumer. These existed as redispatch costs in the old regulated world, but only the incremental redispatch cost was considered and it was socialized. Under a marginal clearing price regime, congestion costs are both higher and more locationally and temporally focused. Many times, congestion is a result not of lines already at limit but as a result of contingency limits that would otherwise be violated. It is a truism that when there is congestion then a line somewhere is at a contingency limit. Planners and operators alike tend toward conservatism and it is perfectly plausible to believe that some margins of safety are built in. This is especially true when stability and not thermal limits are at issue. Better and more complete information is the answer to intelligently reducing the safety margin and squeezing more capacity out of a congested system. When a WAMS can be coupled to other smart grid technologies such as sensing line temperature and sag, or using dynamically insertable reactances to control line flows in real time, then the margin of safety can be further reduced and congestion decreased. Using those technologies will not be possible without WAMS.

Another possibility to consider is whether phasors can assist in the integration of renewable resources. Photovoltaics and wind generation, whether connected

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to transmission or distribution, are all inverter-based. Over the years, the dynamic characteristics of system load have slowly changed away from being predominantly resistive with some inductive component to being more and more inverter based. The substitution of LED lighting, the advent of vehicle-to-grid integration exploiting electric vehicles and pluggable hybrid vehicles, renewable portfolio standards for renewables, and new storage technologies will dramatically accelerate the amount of inverter-based generation and load, altering system dynamics beyond recognition. Phasors offer the chance to rely not only on planning simulations but observations to better understand the characteristics of what is happening.

The early deployments of PMUs are already showing their worth. In the WECC last year, there was one occur-

rence where a faulty component at a dc terminal began to cause low-frequency oscillations in the interconnection. The PMU data that were transmitted to the California Independent System Operator (ISO) control room and displayed there allowed operators to confirm what plant operators had reported and to diagnose the situation, which they might otherwise not have been aware of. The ISO and the utility were able to take the affected components out of service before further equipment damage or system reliability problems occurred. This is a real-world instance of PMUs, even at this early stage of deployment, proving their worth.

There are several "places" where opportunities exist today to install phasors at the very beginning. One is new/upgraded transmission to remote renewable resources; the other is substation

upgrades and protection upgrades associated with substation automation. In both cases, we will find ourselves wishing down the road that PMU technology had been installed as part of these projects. No one would commission a new station or a major upgrade with other than digital protection today; we should go the next step and ensure that all such stations are "PMU enabled" or "WAMS ready." We'll be glad we did. Perhaps the North American Electric Reliability Corporation could consider this as a recommended best practice.

In the meantime, we can be grateful that the authors of the articles in this issue and other key individuals and organizations have supported the development and deployment of PMUs. It makes you want to go back to grad school and do the thesis that wasn't possible way back when. 

calendar (continued)

June 2009

PowerTech, 28 June–2 July, Bucharest, Romania, contact Prof. Mircea Eremia, Department of Power Systems, University "Politehnica" of Bucharest, 313 Spl. Independentei, 060042 Bucharest, +40 21 4029344, fax +40 21 4029446, powertech2009@system.power.pub.ro, <http://ewh.ieee.org/conf/powertech/2009> (sponsored by PES).

July 2009

PES General Meeting, 26–30 July, Calgary, Alberta, Canada, contact General Chair W.O. (Bill) Kennedy, b7kennedy@shaw.ca or Technical Program Chair Om Malik, maliko@ieee.org (sponsored by PES).

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