Power Systems Engineering Research Center

PSERC Background Paper

Monitoring and Control of Power Grids: Looking Beyond Reliability Standards

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After the 1965 Northeast blackout investigative teams took months to figure out what exactly happened. Most of the recorded data were in ink charts rather than digitally stored, the recordings over a lage geographic area were not time synchronized, and the analytical tools available were quite primitive to simulate and reconstruct the event.

Today, with the availability of banks of super fast digital computers recording everything in the control centers, substations and power plants, with satellite ability to time stamp all measurements anywhere in the country to micro-second accuracy, and with the most sophisticated digital simulation tools that can simulate the complete behavior of the largest power grids, the investigation of the 2003 blackout will take – er, well, months. Why? Well, the mountains of digitally recorded data are in variously formatted databases and not easily readable by one computer. The time stamping is not calibrated and synchronized. Thus, putting together all the models and real time data from the time of the blackout to simulate what happened remains an arduous task.

The Eastern US power grid is monitored and controlled by a very large number of control centers, each one being responsible for a portion of the grid. Another smaller set of second level control centers, designated security coordinators, oversee and coordinate the reliability of an area covered by several first level control centers. However, there is little standardization of the monitoring process and data gathering at the first level, making it almost impossible for the second level control centers to coordinate. (Consider that MISO, the security coordinator for the Midwest was having trouble trying to figure out what was happening within First Energy's portion of the grid. Further, consider that the operator conversations during the blackout sound like the blind men and the elephant whereas their control centers should have been automatically alerting them to outages and abnormal measurements.)

In addition to the control centers, many substations and generating stations have their own computers gathering data often at much faster speeds than the control centers, but this valuable information is not often available to the control center operators and security coordinators, or to the computers that can detect anomalous patterns across the grid.

Much has been said about making reliability standards mandatory, and, by and large, reliability standards already exist for planning and operating the power grid. Unfortunately, these standards do not cover monitoring and control in any detail (with the notable exception of frequency control), perhaps because of the mistaken assumption that only redundancies in transmission and generation provides reliability. However, closer monitoring and better control of the grid also provides reliability because it enables the operation of the grid even closer to its limits.

The following are some considerations for the monitoring and control of the power grid.

- One interconnected grid cannot be controlled by many control centers that cannot talk to each other. There must be easy ways to store and exchange data automatically and continually rather than depending on telephone calls between operators.

- There must be standardization of the monitoring systems including the frequency of data gathering, time stamping, alarming, visualization, etc. so that operators on different control centers on different parts of the grid can communicate intelligently.

- The reliability standards for control need to be more specific. This has been done for frequency control but the same ones for, say, voltage control, are much less so.

- The reliability standards for operation should be made consistent over the whole area of the same grid. For example, the operational procedure for maintaining a particular level of generation in New York City was substantially increased after the 1977 blackout but was not mandated for any place else.

- The analytical tools available to the operator should be standardized. Control centers choose and pick at whim whether they need to have tools, such as state estimators, contingency analysis or optimal power flows to help the operators control the system.

- The real time data made available to control centers and operators all over the grid should be determined on the basis of reliability needs. The

present debate on whether some data is proprietary to generating companies must stop at the point where reliability of the grid is affected.

The above recommendations do not require any new technologies. The technologies to achieve these have been in place for over 25 years. However, the major strides that were made in computerized monitoring and control as a result of the recommendations from the 1965 blackout studies petered out in the 80s. The communication architecture between substations and control centers, and between control centers are essentially of the same design as in the 60s.

Why hasn't the new technologies in communication, computation and control been brought to bear on the monitoring and control of the grid? Probably for the same reason that transmission lines have not been built.

The new communication technology will allow much closer monitoring of the grid with more frequent and synchronized gathering of real time data. The new computers are capable of not only processing this data but also analyzing it to determine anomalous patterns across the grid. It becomes possible to then initiate fast controls across wide areas of the grid whereas today's architecture only allows fast controls locally. Finally, the new generation of power electronic (FACTS) controllers can provide fast control for more parts of the grid than ever before. The application of these technologies will require research and development to determine how enhanced monitoring and control can enhance grid reliability. Historically, the highly regulated power industry has been a leader in utilizing new technologies and it is ironic that the slowing down of such innovation has coincided with the deregulation of this industry.

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