Power Systems Engineering Research Center

PSERC Background Paper

Automated Monitoring and Analysis

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Power systems are very complex yet very robust engineering designs that operate reliably most of the time. However, occasionally operating and environmental conditions combine to create system disturbances that reach system collapse (or blackout). While major collapses are rare, they cause significant economic losses and possibly the loss of human life. Thus, these events are undesirable. With the industry's current monitoring and analysis systems, blackouts are unpredictable and unavoidable, and are difficult to remedy once they occur. Future improvements in these systems can significantly reduce the duration, impact and likelihood of blackouts.

Existing power system monitoring and analysis systems are adequate when the power system is operating under predictable conditions and all power system equipment is well maintained and in good "health". If neither holds, then these systems may no longer be adequate.

The benefits of good monitoring and analysis systems in predicting, avoiding and remedying catastrophic consequences can be seen by examining the simpler case of car steering and related car accidents. Many car accidents could be avoided if cars were equipped with sensors for detecting obstructions and environmental conditions, for automated decision-making to control speed, and for signaling when maintenance is needed on any critical part. When accidents occur, if we had alternative means of transportation, or an automated communication to repair services and a readily available supply of spare parts, we could well be on our way to our destination much more quickly than we can today.

The course of events associated with the 2003 Northeast blackout illustrates the lack of good monitoring and analysis strategies. The event was a surprise. The critical initial series of events took only seconds to unfold. It took two days to fully restore the system (although it took longer in Ontario due in part to the amount of nuclear generation there). Finally, a detailed cause and effect analysis of the events has not yet fully completed almost a month after the blackout. Obviously, the existing monitoring and analysis system was not able to cope with the situation efficiently by anticipating system vulnerability, predicting equipment behavior, and reducing restoration and event analysis time. The overall financial impact and public anxiety would have been far less had an improved monitoring and analysis system resulted in quicker restoration and more timely cause and effect analysis. Generally speaking, improvements in monitoring and analysis systems are clearly needed. We need more sensors, better means for collecting and integrating existing data, and more efficient ways of performing required analyses.

A common concern among power engineers and utility operators is that more and better measurements will lead to an extremely large data volume that will tremendously slow down data transfer and analysis. The solution to that concern is straightforward. As we increase the quality and quantity of measurements, we should introduce automated analysis capability that occurs close to data sources. This approach will provide more useful data for analyzing approaching as well as unfolding events. At the same time, it will enable conversion of a large amount of measurement data to information required to allow immediate assessment of events.

The technology for making these improvements is readily available and affordable. However, it is not clear how to deploy the technology to obtain the benefits. Two major improvements should be studied. One major improvement is to use an integrated data approach where all the relevant measurements and off-line data can be combined for monitoring and analyzing power system behavior. The integrated approach would be used instead of dedicating different measurement infrastructures to specific monitoring tasks, which are subsequently used by specific utility groups today. The second major improvement is to introduce automated methods for extracting and disseminating the required information quickly to the personnel who need it. Our inability to recognize that many analysis tasks can be fully automated needs to be overcome.

How much might it cost to substantially enhance monitoring and analysis systems? It will certainly not be excessively costly to install improved measurement systems by retrofitting existing power system substations, and by adding the necessary PCs and Internet connections. Introducing standards for data integration and information exchange is a matter of vision and will reduce the implementation cost. R&D at a moderate cost is needed for developing new automated monitoring and analysis systems capable of predicting equipment “health” and performance as well as for anticipating environmental conditions. The ability to closely monitor unfolding events, and to quickly restore a system if a blackout occurs, will result in system operation and restoration performance that far exceeds what we have today. The total implementation cost will be a small fraction of a blackout’s cost, which in the case of the blackout of 2003 ran into millions if not billions of dollars.

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