OVERWHELMED BY ALARMS: BLACKOUT PUTS FILTERING AND SUPPRESSION TECHNOLOGIES IN THE SPOTLIGHT

By John McDonald, P.Eng.

The Blackout of 2003 has focused attention on a serious flaw in the design and operation of SCADA/ Energy Management Systems (EMS). Developed to warn dispatchers of impending problems in generation and transmission networks, SCADA/EMS have little or no ability to suppress the barrage of alarms that bombard control room personnel during a rapidly escalating event.

This can pose an almost debilitating challenge for dispatchers facing a major outage situation. In just a few minutes, thousands of warnings can pour into the control room in the form of text messages clogging computer printers, filling the alarm zones on console displays and scrolling down screens faster than anyone can read them. With limited ability to prioritize the power system failures and decipher the sequence of events, overwhelmed dispatchers often ignore the very system that is designed to help them.

While the exact role of SCADA/ EMS alarms in the Blackout of 2003 has yet to be determined, this incident has forced the utility industry to examine all of the factors that potentially contribute to major outages. Power alarm overload has been well documented as a control room distraction at the very least, but utilities are now scrutinizing this phenomenon as a dangerous contributor to situations that cascade out of control.

Upon closer scrutiny of the SCADA/EMS alarm issue, utilities will be surprised and possibly frustrated to learn that power alarm overload should not have been tolerated for this long. Viable alarm processing technology already exists. In fact, utilities need look no further than their own distribution SCADA systems to find alarm suppression and filtering techniques that have been implemented for the past 15 years.

Alarm processing technology ensures that dispatchers receive only those alerts relating to events that must be addressed immediately, while the details of less critical secondary warnings are sent to databases and possibly printed for later review. With only the most important distribution system alarms presented in a prioritized fashion, dispatchers can assess problems more easily and make better decisions to prevent a bad situation from getting worse.

The reason that alarm-processing technology has been implemented in distribution SCADA and not in SCADA/EMS is a combination of application necessity and customer demand. And the fact that companies providing distribution SCADA products are typically different from those offering SCADA/EMS has not helped the situation. Fortunately, these two types of SCADA systems operate similarly, which means distribution alarm suppression technology can readily be implemented in SCADA/EMS.

On the distribution side, SCADA alarms are typically triggered by faults and the events surrounding them, which occur continuously during routine operations. When a breaker on a substation feeder trips due to a transient fault, for instance, up to seven alarms may be triggered - one for the breaker trip and three each when voltages and currents on all three phases hit zero. The dispatcher only needs the breaker trip alarm, and he may not even need that if the breaker is automatically reclosed after a transient fault where the situation resolves itself.

With audible and visual alarms inundating the control room throughout the day, dispatchers asked distribution SCADA vendors to suppress some alarms while letting critical ones through. In response to this demand, the vendors developed several filtering techniques, some of which can be configured during SCADA implementation or activated on the fly during a storm.

Such demand never occurred on the generation and transmission side since SCADA/EMS alarms are triggered less frequently and only during actual outage events. Because these alarms have not posed the same daily nuisances, utilities simply never pressured vendors to implement alarm filters in SCADA/EMS — until now.

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FOUR SUPPRESSION TECHNIQUES

The 2003 Blackout has compelled the power industry to revisit the alarm issue. With prompting from utility customers, SCADA/EMS vendors are now considering their options. In general, there are four proven alarm processing methods currently used in distribution SCADA systems, which vendors can choose from for implementation in their future products.

AREA-OF-RESPONSIBILITY (AOR) ALARM FILTERING

Inherent in the SCADA architecture is the ability to partition the system by function or geography. This allows a utility to separate the monitoring and operation of various SCADA displays, alarms and control points and assign responsibility for them to different control rooms, dispatchers, or even other utilities. Distribution SCADA systems can usually be partitioned into 64 functions or geographic areas.

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SCADA systems are designed this way due to the broad variety of their applications. A water, gas and electric utility, for instance, may want to invest in only one SCADA system but establish separate control rooms for each of its three services. Creating AORs for gas, water and electric service accomplishes this. A more common example is a generation-transmission co-op that turns distribution network monitoring functions over to its electric member cooperatives from 9 am to 5 pm every day and resumes those duties at all other times. Some large utilities divide their service territory by geographic region and assign one dispatcher to each.

AOR Partitioning also gives utilities tremendous flexibility in routing alarms. For example, all operational alarms can be sent to the control room while equipment monitoring alarms go to maintenance. Or one dispatcher may receive alarms pertaining to one geographic region while another dispatcher gets the alarms for another geographic region. The variations of alarm partitioning are almost endless, but the bottom line is that this enables the utility to filter the alarms so that only the most important reach the people who can handle them.

The good news for utilities that have purchased SCADA/EMS in the past three to five years is that partitioning is probably already built into the system, although the number of partitions may not be as numerous as those in distribution SCADA. Regardless, power system alarms can be divided and filtered in the exact same way as those on the other side and with the same result - less distraction for the dispatcher.

ALARM POINT PRIORITY FILTERING

During the configuration of a distribution SCADA database, each monitoring and control point in the network is assigned an alarm priority level by the utility. These points usually rank in importance from one to eight, with eight being the most critical. On the distribution side, for example, breakers on critical feeders could be assigned high numbers.

At consoles in the control room, dispatchers can select which alarms they want coming through to their display window based on priority level. In daily operations, the dispatcher may want to see alarms from all priority levels on the screen, but when a storm starts moving into the territory, for example, the dispatcher can dynamically change the preference to show only priority alarms six and higher. This gives dispatchers control over the filtering and suppression of warnings based on the gravity of the situation at hand.

As with AOR filtering, utilities operating new SCADA/EMS may find they already have some ability to establish point alarm priorities and set control room display parameters accordingly.

TIMED-ALARM SUPPRESSION

When a SCADA system is configured during installation, the utility can determine the length of time that an out-of-threshold situation must last before it actually triggers an alarm. If the situation is transient or resolved before this time period elapses, the trigger never occurs, and the dispatcher is not bothered with a non-critical event, although details are still written to the alarm and event disk file and possibly printed.

An example is a distribution feeder with an automatic recloser. When a tree branch blows against the feeder in the midst of a wind storm, the recloser opens and then recloses as programmed. If the branch is no longer striking the line, the recloser remains closed. But the dispatcher would needlessly receive two alarms, one for the opening and one for the reclosing, despite the fact that normal operations had been restored.

Under the Timed-Alarm Suppression process, a timer begins when the recloser first opens, and no alarm is activated. Once the pre-determined time period ends, perhaps two to four seconds, the SCADA system again looks at that point to see if the recloser is still open. If it is, the alarm is triggered and the dispatcher knows a situation more serious than a transient condition has occurred. Otherwise, if the SCADA system finds the feeder operation has returned to normal, there is no alarm.

For use in generation and transmission SCADA operations, the Timed-Suppression technique would be applied to the status of transmission lines and power generation units. Since SCADA/EMS typically monitors whether these components are inside or outside certain limits, acceptable durations of threshold exceptions can easily be assigned to each control point for alarm suppression.

KNOWLEDGE-BASED ALARM SUPPRESSION

Within the SCADA database, direct linkages can be created between network elements that trigger primary and secondary alarms. By linking them, the secondary alarms can be eliminated if the primary one has already been activated. This can be illustrated using the above example of the feeder opening that causes voltages and currents to drop, sending six needless warnings to the dispatcher.

Database records can be created for the voltage and current measurement points on the feeder and linked to the status of the feeder breaker. If the value drops to zero at any of those points, an address pointer in the SCADA database will automatically check the measurement point of the feeder breaker status before activating the low voltage alarm. If the breaker status is open, the SCADA system knows a primary alarm has already been triggered, and it suppresses the redundant low voltage alarm. Occurring in a split second, this process then records the secondary alarm in the alarm and event disk file and sends the alarm to the alarm/event printer.

Feeders and breakers are elements of the electric distribution system, but knowledge-based alarm suppression can be applied just as easily on the generation and transmission side. The key in implementing this technique in SCADA/EMS is identifying and linking critical system functions that secondarily impact other operations which can trigger alarms. For example, when a generator breaker trips, the terminal voltage will go to zero. The breaker trip would be the primary alarm and the terminal voltage would be a secondary alarm.

VENDORS, UTILITIES CONSIDERING OPTIONS

With pressure from the utility industry, SCADA/EMS vendors will undoubtedly consider implementing one or more of these filtering and suppression techniques. Since the basic technology that makes AOR and Alarm Point filtering possible already exists in some SCADA/EMS, it is likely these two will emerge as the dominant alarm processing methods.

Vendors, however, will need to enhance both techniques significantly to make these solutions more practical. Currently, for example, the typical

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SCADA/EMS offers a limited number of priority levels. These will have to be expanded to at least eight, and the dynamic activation capability will have to be added. Vendors will also need to give SCADA/EMS the ability to partition into a greater number of Areas of Responsibility. Most now offer less than 64 partitions.

In addition to enhancing or introducing these processing techniques, SCADA/EMS vendors must improve the memory capacities of their systems for filtering and suppression to work properly. The key is to add a function alternately called 'status with memory' (SWM) or 'momentary change detection' (MCD), which is common in distribution SCADA systems.

SWM or MCD points essentially provide multiple levels of memory with every SCADA status point. These memory units record very fast or brief events such as recloser operations, that occur between the scan rate of the SCADA system. By including up to seven levels of memory with these points, the SCADA system does not miss any vital operating functions that might trigger an alarm.

With these new alarm processing capabilities almost certain to be introduced by SCADA/EMS vendors in the next few years, utilities will face a tough decision regarding upgrading or replacing existing systems.

For utilities operating newer systems implemented in the last five years or so, it is likely their SCADA systems can be upgraded to accommodate the new technology. But SCADA/EMS older than five to eight years may have to be replaced. Attempting to refit these systems with alarm suppression technologies will degrade SCADA performance.

Utilities will soon have to decide if alarm filtering and suppression and other new technologies now offered in SCADA systems are worth the cost of implementing an entirely new system. When the final North American Electric Reliability Council report on the Blackout of 2003 is released and the contributing role, if any, of SCADA/EMS alarms is revealed, this decision could become much easier to make.

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