

## Experiences with Root Cause Analysis Software

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### Abstract

GoalArt has developed an automatic tool for root cause analysis of complex fault situations. This tool analyses alarm cascades and identifies a small number of initiating events. It provides a powerful alarm reduction and allows operators to maintain situational awareness during cascading grid problems.

### Completed Projects

In the beginning of 2009, a GoalArt system was installed at the national control center of Svenska Kraftnät (SvK) in Stockholm. The system has a model comprising the Swedish parts of the Nordel power grid, primarily on the 220 and 400 kV voltage levels. It is connected to real-time SCADA data from the SCADA/EMS system and provides on-line root cause analysis of the grid situation in real time. SvK has, based on experience gained during almost two years of pilot installations, recently taken the decision to commercially deploy the software in their control room.

During the spring of 2009, GoalArt developed a system for the NYISO grid. The model comprises all alarms from all voltage levels in the NYISO control area. This system was delivered in May 2009, connected to both real-time and historical data, and was subsequently evaluated by NYISO control room personnel during a 12 month period.

### -Technical Background

In power grids, a larger fault usually leads to several *consequential faults*. Most of these consequential faults generate alarms. Often, alarms arrive out of time order, depending on system physics, alarm limit settings, and clock skew, and it is usually hard for operators to analyze the developing fault situation, to understand what is really going on, and to take actions to alleviate the situation or perform a graceful reconfiguration of the grid in time.

The effect is known as an *alarm cascade*. It is the most difficult alarm problem and also the most dangerous, since it appears in exactly those situations where the alarm system is needed the most.

The tool described here performs *efficient root cause analysis*, even as an alarm cascade starts and progresses, and presents the analysis in a *comprehensive HMI* providing a high degree of *situational awareness*. An attractive feature of the tool is that the tool model data is generated automatically from existing topological and alarm data.

### Experience Gained from Deployed Tools

Large test scenarios, based on raw, unmodified historical data from the SCADA/EMS systems, have previously been run, demonstrating the capability to perform root cause analysis with real time performance even as a major blackout is developing. Even though the on-line projects described above has been running for an extended period of time, no major incidents have occurred during the period.

Even in the absence of major incidents we have experienced an average alarm reduction exceeding 60%, typically varying from 40-80% day to day. During incidents with smaller cascades, involving 2-3 substations occurring perhaps 5-10 times per year, we have observed 80-95% alarm reduction.

Apart from the alarm reduction, the operators have given positive feedback on the situational awareness provided by the tool, giving a comprehensive view of the overall state of the grid, e.g., emphasizing areas with high or low voltage levels.