Experiences with Root Cause Analysis Software

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Agenda

Why do we need it?

What have we done?

Did it work?

Where are we going?

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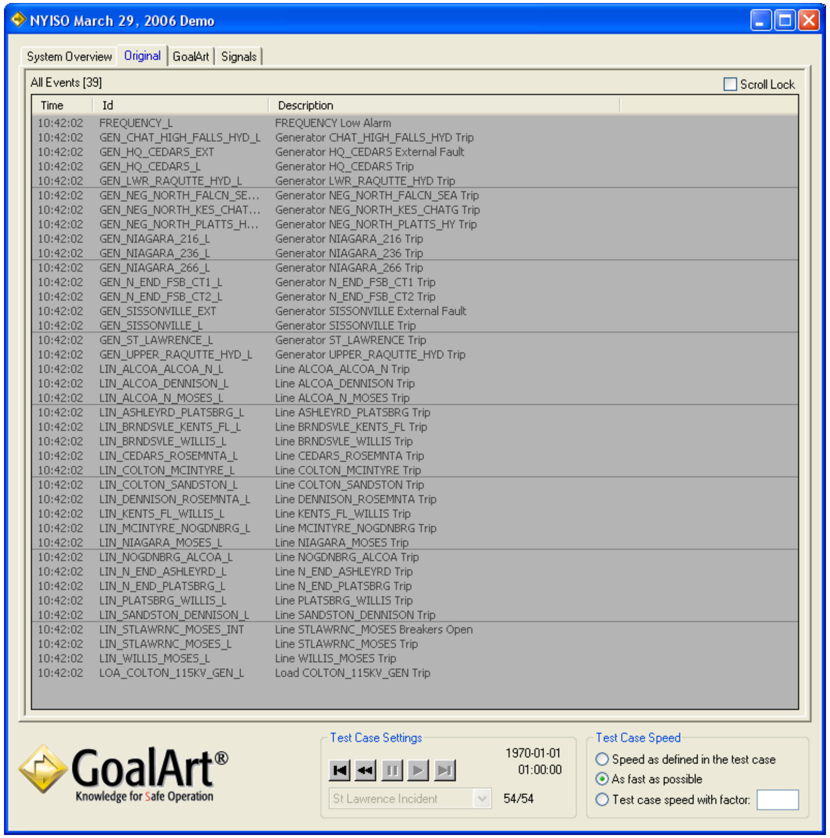
Standard Alarm List



- Too much information
  - Different types of alarms
  - Different importance
  - Several alarms from same place
- Beyond human capabilities to understand this quickly
- Alarm lists become useless during incidents
- Look in other places to really understand what happened…

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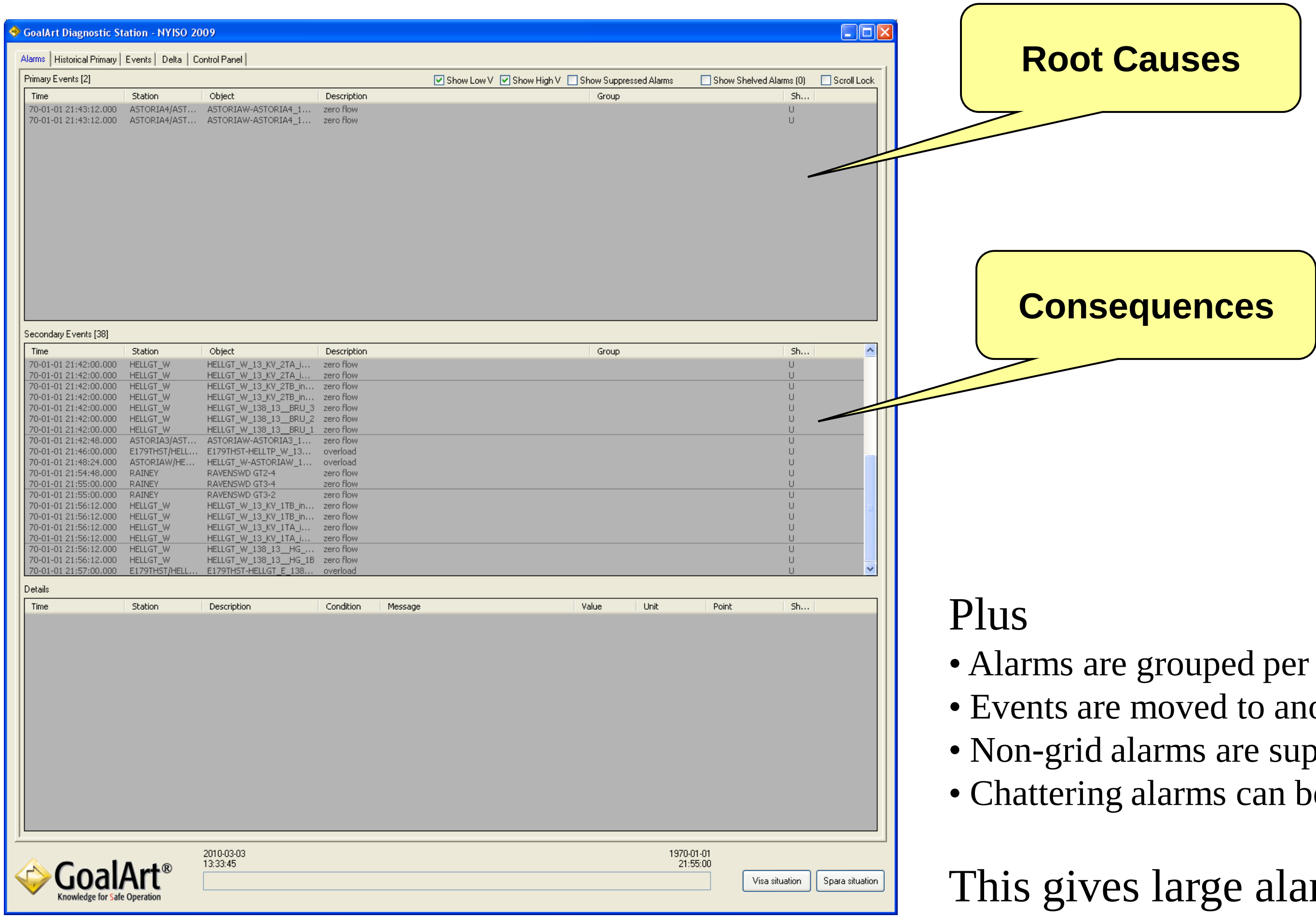
GoalArt Alarm List



Plus

- Alarms are grouped per equipment
- Events are moved to another list
- Non-grid alarms are suppressed
- Chattering alarms can be suppressed

This gives large alarm reduction

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It is about Situational Awareness

- Too many alarms are detrimental to situational awareness
- Happens exactly when (larger) incidents develop
- Very efficient reduction possible by:
  - Grouping of alarms to ”natural” process objects
  - Root cause analysis on the grouped alarms
- Make the root cause stand out among the alarms, and
- Make sure not to loose independent alarms in the clutter of a cascade

It is almost lunchtime, let me show you how this works in practice...

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Real Life Alarm Problems

- On September 24th 1998, the recovery boiler of the Vallvik pulp plant blew up
- Hundreds of alarms reported, boiler went into automatic shutdown
- Exactly (almost) the same scenario had happened many times due to “oversensitive” fault detection
- Boiler shutdown is costly, so the operator's practical response was to ignore the alarm shower and attempt manual re-start
- This time, there were extra alarms indicating lost steam pressure
- Water in the smelt => BOOM

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Root Cause Analysis

"This system really tells you what happened! You should call it 'what happened?' analysis."

Richard Candy, ESKOM, South Africa

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Root Cause Analysis

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What can we do for Power Grids?

- Operates on the entire grid and finds global root causes
- All configuration based on CIM XML --- 100 % automatic
- Handles all grid constructs and all combinations of events
- Has been installed on-line at the Swedish National Grid and at NYISO
- Ongoing delivery project for a European TSO

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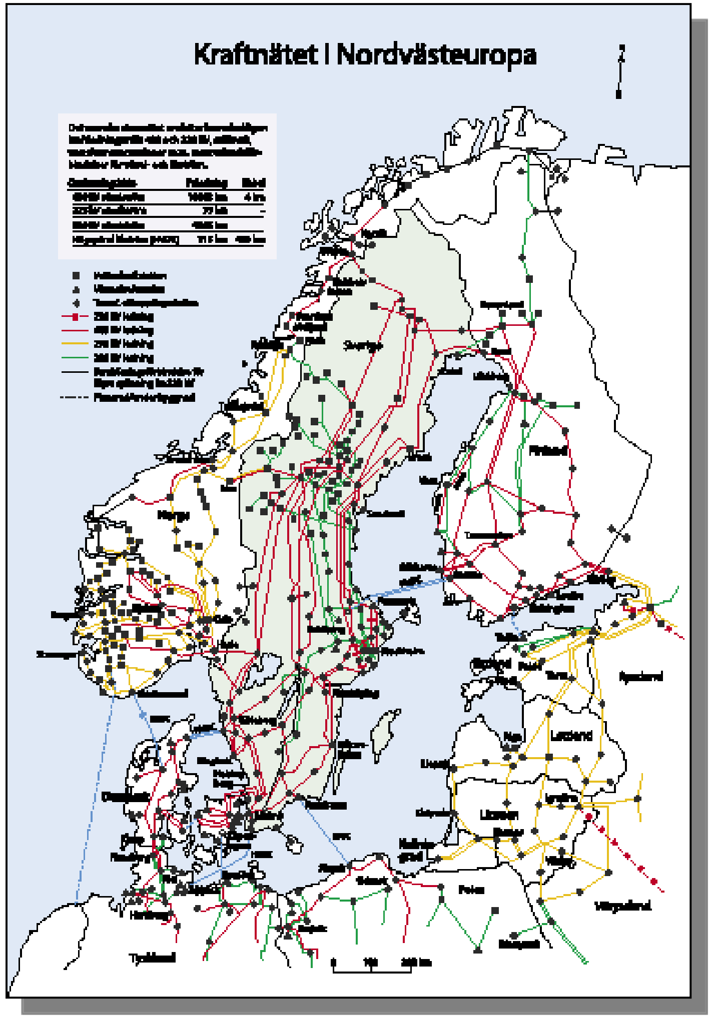
State of Current Power Grid Projects

- Svenska Kraftnät – system running on-line since January 2009
  - Monitors Sweden’s power grid on SvK and E.ON / Vattenfall / Fortum levels
  - Located at SvK national control center in Sundbyberg

- NYISO – system running on-line since June 2009
  - Monitors NYISO part of US power grid (1 of 7 monitoring organizations)
  - Located at NYISO control center, Albany, New York

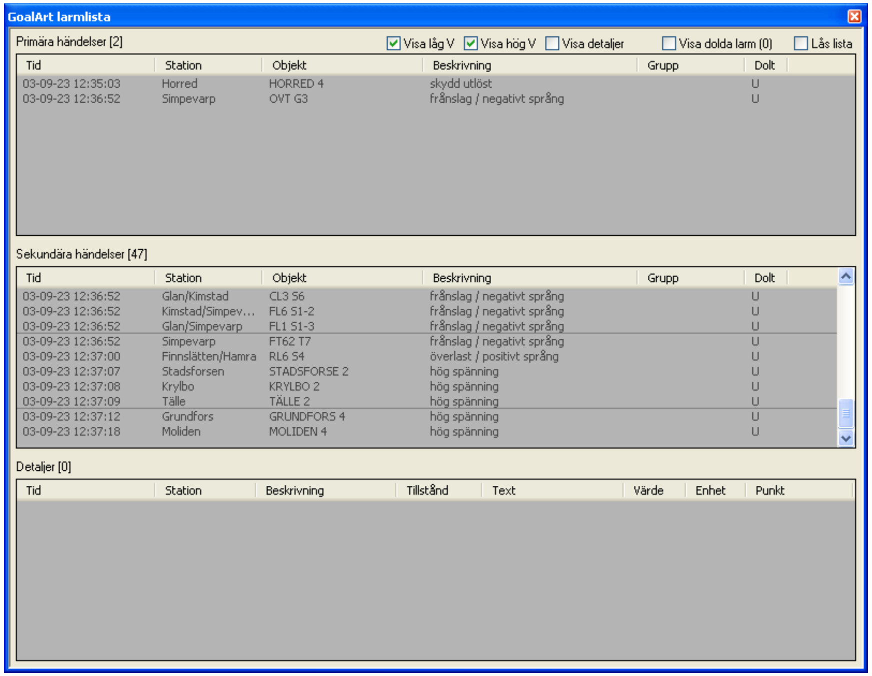
Blackout September 23rd 2003

- Large blackout in Scandinavia
- September 23rd 2003, 12.35 PM
- Root causes
  - 12:30 OKG 3 nuclear reactor trip (east)
  - 12:35 Internal station short-circuit (west)
- Consequences
  - Two lines for all of southern Sweden
  - Southern Sweden collapsed (5-15 min)
  - Eastern Denmark collapsed
  - Lasted 1-5 hours
- Actions
  - Second root cause unknown for 4 hours
  - Helicopters looking for line faults
- Cost
  - Lost ~ 10 000 000 kWh
  - Cost ~ 500 000 000 USD
  - Largest disturbance in 22 years



The Real Root Cause

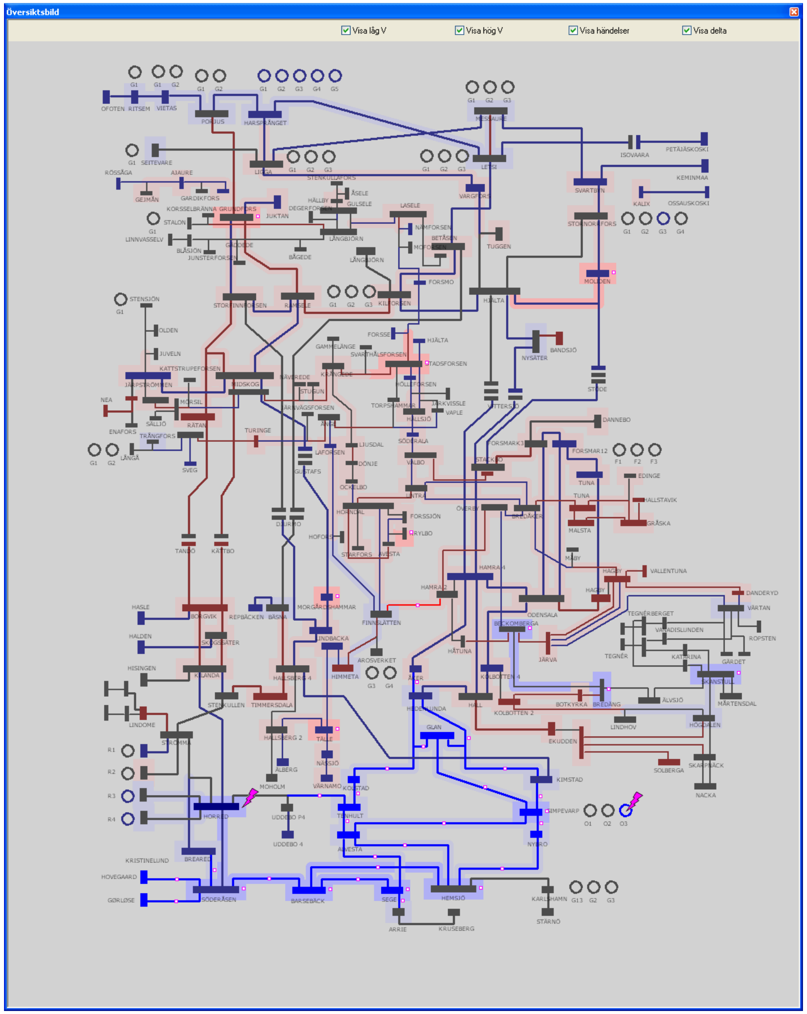
SvK System



- Delivered SvK system contains
  - Auto-generated MFM model from Oracle database
  - SCADA communication protocol based on Web Services (XML)
  - GoalArt custom HMI
- Historical data from Sep 23, 2003
  - Analog and discrete signal data
  - Alarms and events
- Conclusions
  - Correct analysis of fault situations
  - Correct results in historical tests

GoalArt HMI

- Dynamic alarm presentation
  - Root causes are shown as "lightning" strikes
  - Line color shows power flows
  - Background color shows voltage
  - Highs are red, lows are blue
- Situational awareness at a glance



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Examples of Alarm Reduction Performance

- Measured December 18th 2009 – January 7th 2010
  - Lowest daily average, December 23rd 2009: **37.6 %**
  - Highest daily average, January 5th 2010: **80.8 %**
  - Total average over the period: **61.1 %**

- East 179th Street Incident, February 7th 2009
  - Directly after incident (7 alarms): **80.0 %**

- Newbridge Incident, June 18th 2009
  - Directly after incident (7 alarms): **82.2 %**

- Astoria West Incident, June 27th 2009
  - Directly after incident (22 alarms): **94.4 %**

- Swedish Blackout, September 23rd 2003
  - Directly after incident (500 alarms): **99.6 %**

Current Grid — Future Grid

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Smart Grid

Current grids

Few generators

Few measurement points

Little control, global load balancing

Typically ~ 10 000 signals

Manual fault handling is difficult

Future smart grids

Large number of active generators and loads

Lots of metering and advanced control

Typically 100 000 – 1 000 000 signals

Communication network is critical part of the infrastructure

Manual fault handling will not be efficient

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Ongoing Development Project

- Intelligent software support for fault handling is necessary for Smart Grid
- Based on GoalArt alarm processing for current grids

- Develop solution based on same technology for communication networks
- Integrate fault handling for power grid and communication network

- Automated fault handling enables smart grid
- Smart grid enables "green" energy system

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Thank you!

Questions?

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