Building a Condition Monitoring System based on PI AF

Presented by **Kimmo Nepola, Fingrid Oyj**

Asle Frantzen, Amitec AS

FINGRID

AMITEC
REALTIME INFORMATION

Kimmo Nepola

- Planning Engineer
- M.Sc. in power systems and high voltage engineering
- Working at Fingrid since 2009
- Project management for maintenance and retrofit projects
- Development of condition monitoring systems and techniques

FINGRID

- The electricity transmission system operator in Finland
- Responsible for planning and monitoring the operation of the Finnish electricity transmission system and for maintaining and developing the system
- Appr. 14.000 km of 400, 220 and 110 kV transmission lines, plus more than 100 substations
- International benchmarking studies have indicated that Fingrid is one of the world's best performing transmission system operators.

Asle Frantzen

- Sr. Software Engineer
- Working at Amitec since 2008
- OSIsoft vCampus All-Star 2010 & 2011
- 9 years of experience in industrial IT
- Project management and software development with most PI System technologies

- PI System integrator / Value Added Reseller (VAR) in Norway
- OSIsoft partner since 1996
- Working with clients in the Nordic countries
- Most clients in the oil & gas industry
- Fingrid CMS is our first large project in the interesting T&D industry

Agenda

- Background
- Business challenge and vision
- Solution
- Results and benefits

Background

- Fingrid representatives attended the OSIsoft EMEA Regional Seminar in Barcelona, in May 2011
- Met with Amitec and their key customers, and just months later a 1-week workshop had been conducted in Helsinki
- The first delivery was completed during spring 2012
- The system is continuously developed with more equipment types, analyses, BI views, etc.

The root task of asset management

- Maximize the network realibility and minimize the maintenance and investment costs at the same time
- To discover the weak performing assets, components and hidden defects at an early stage
- Repairs, service program changes and replacement investments can be undertaken at the optimal time.

Business challenge

- How to monitor and analyze large asset populations easily?
- How to combine data from scada, analyzers and EAM/ERP systems together?
- How to have a complex system which is user friendly at the same time ?

Our vision for the CMS

automatic alarms

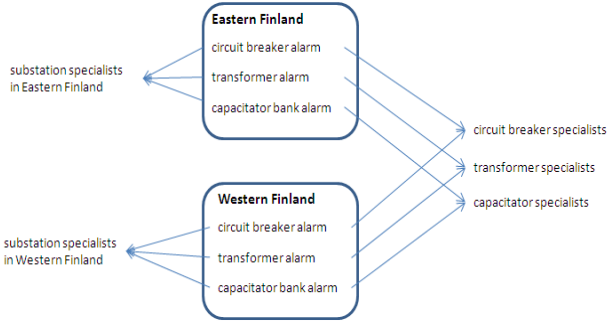
- notifications and alarms based on trigger rules
- generate tasks to our asset management system in the future

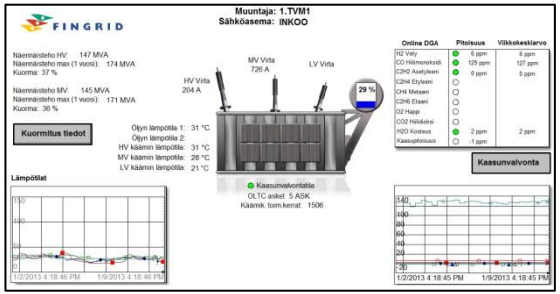
smart data visualization

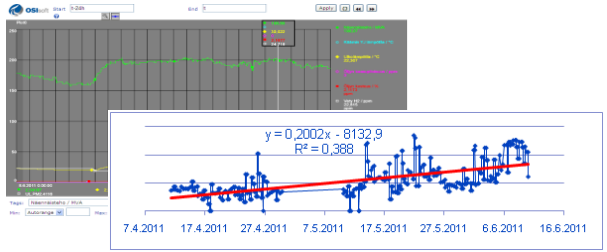
- different kind of displays
- traffic lights based on alarm values
- gauges, embedded trend windows
- drill-down user interference

easy analysis tools

- maximum, minimum, averages
- ratios (e.g. gas ratios)
- trend curves, slopes
- health indices



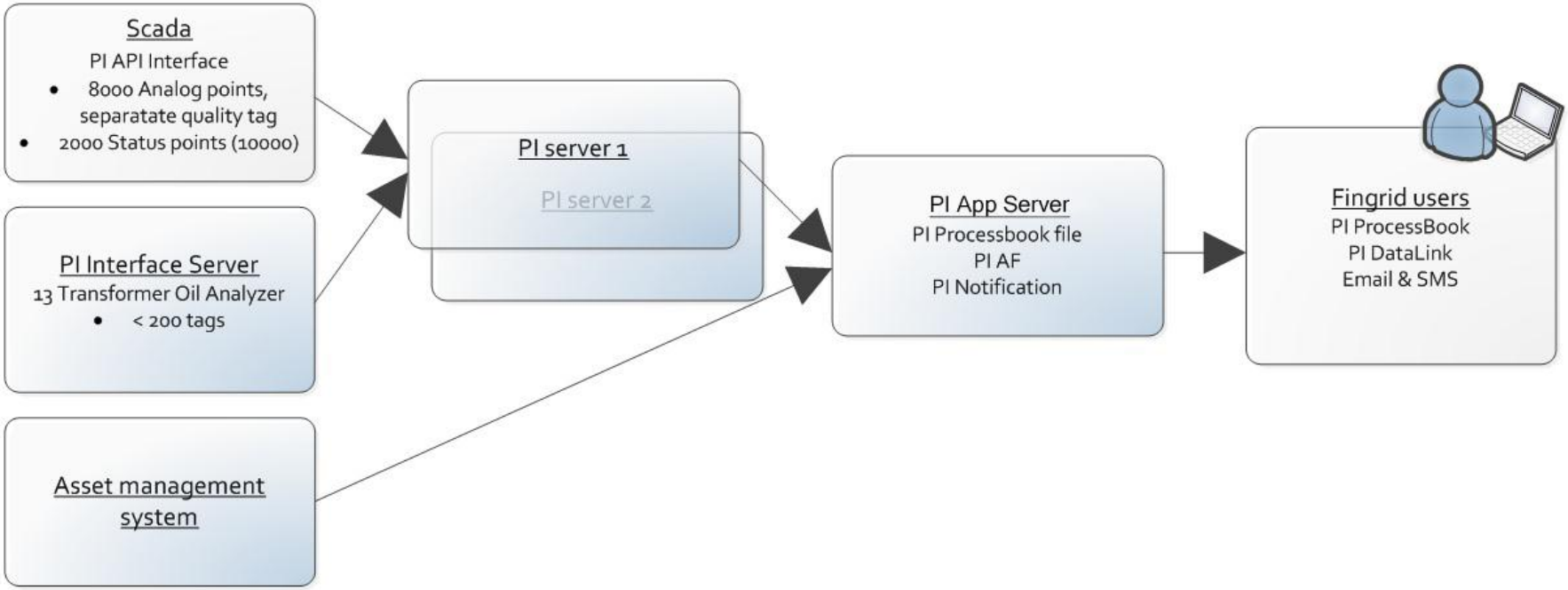




Solutions

- PI AF - data source for the CMS project
- PI Notifications – deliver warnings to users
- PI ProcessBook – visualize and analyze

Architecture

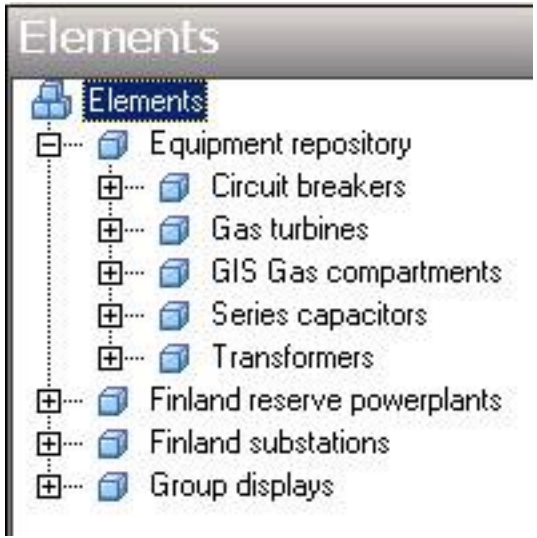


PI AF

- Needed a solid hierarchy in PI AF - single point of contact for data in the CMS system

- Started with the following number of devices:
  - Transformers (70)
  - Circuit breakers and gas insulated switchgear (500)
  - Capacitor banks and SVC (10)
  - Reserve power plants (12)

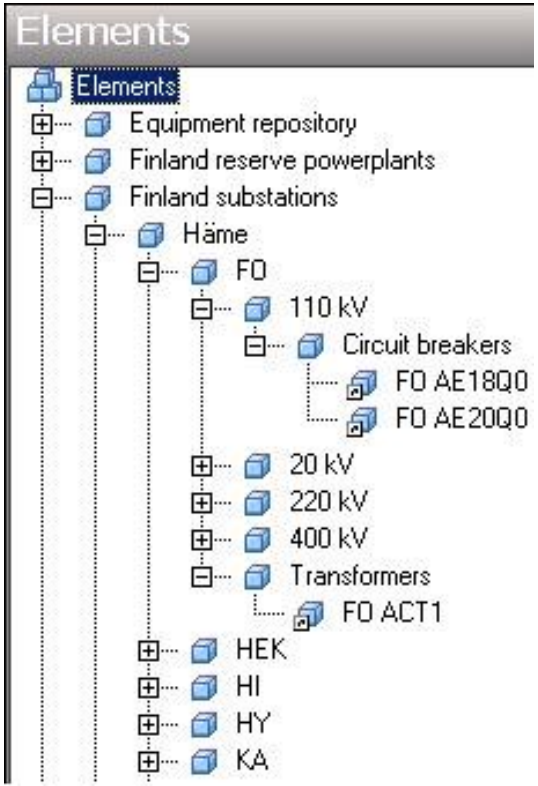
PI AF



- Equipment organized / grouped by type in «Equipment repository»
- Reserve power plants are grouped together, each with references to the Gas turbines available in the Equipment repository

- The main hierarchy is «Finland substations» which is organized by regions, substations, voltage levels, etc.

PI AF



- All equipment in this hierarchy is referenced from the Equipment repository
- Creating the references is a manual job
- Going to be automated

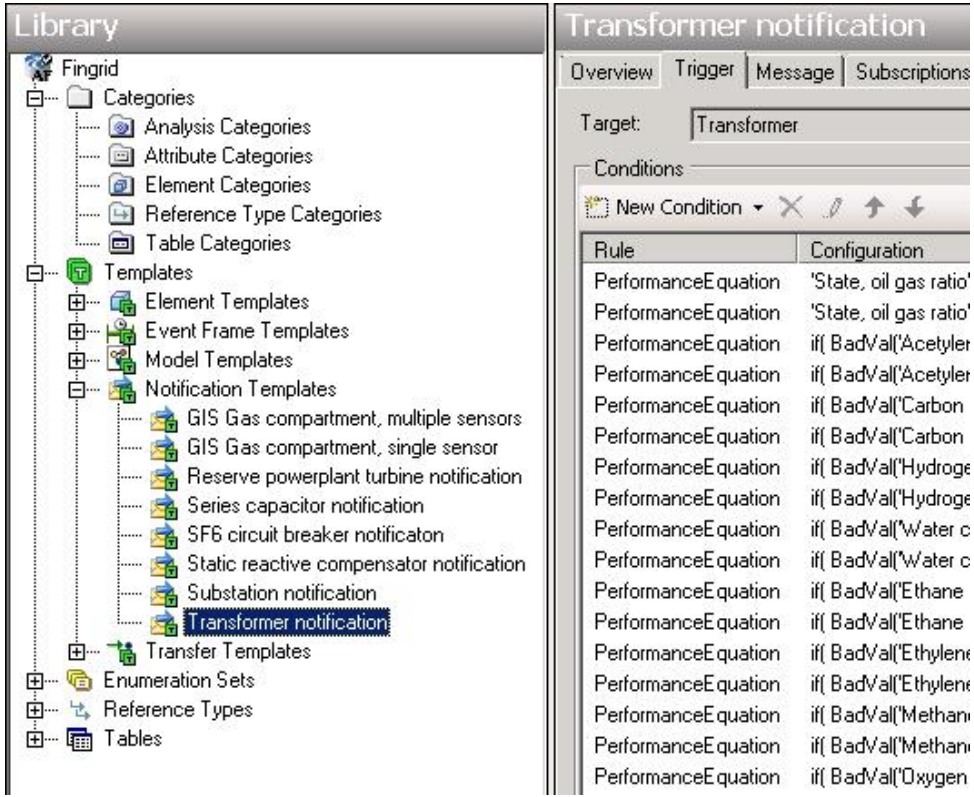
PI AF

- 10 element templates for structuring elements in the main hierarchy (incl. roll-ups / aggregations)
- 30 element templates for equipment types and variations.
- Up to 110 attribute templates in each
- Attributes check for data quality / availability by using formulas and child attributes
- ~13k elements today

PI Notifications

- ~500 notifications
- 8 templates
- Auto-create

- Tuning is important to avoid too many emails



PI ProcessBook

- ~20 device displays / group displays
- ERD functionality in most displays
- Extended the ERD functionality to let you navigate to other displays using the Elements of interest menu
- Created two plugins for visualizing alarms/warnings and load duration curves

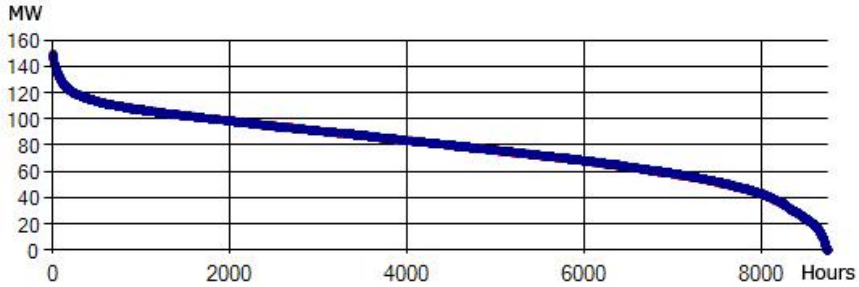
Custom notification viewer component

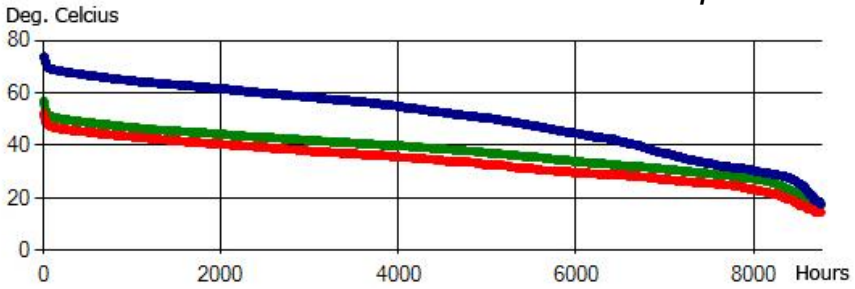
Hälytykset

Warnings | Alarms | All notifications

Time	Region	Substation	Equipment	Device	State	Acknowledged	Acknowledged by	Comment
20.08.2013	Uusimaa	TAMMISTO	GIS	TM 1.09/1.10 LÄPIVIENTI	GIS Gas compartment warning	No		
20.08.2013	Uusimaa	TAMMISTO	GIS	TM 1.03.1	GIS Gas compartment warning	Yes	Nepola Kimmo	
15.08.2013	Länsi-Suomi	SEINÄJOKI	GIS	SJ B27	GIS Gas compartment warning	No		
15.08.2013	Länsi-Suomi	SEINÄJOKI	GIS	SJ B27	GIS Gas compartment alarm	No		
14.08.2013	Uusimaa	TAMMISTO	Circuit breakers	TM 1.03.1	SF6 Circuit breaker alarm	No		
14.08.2013	Uusimaa	TAMMISTO	GIS	TM 1.09/1.10 LÄPIVIENTI	GIS Gas compartment alarm	No		
13.08.2013	Uusimaa	TAMMISTO	Circuit breakers	TM 1.03.1	SF6 Circuit breaker warning	No		
09.08.2013	Uusimaa	TAMMISTO	Transformers	TM 1.PM1	Oil gas ratio warning	No		
24.07.2013	Uusimaa	TAMMISTO	GIS	TM 1.03.1	GIS Gas compartment alarm	No		
24.07.2013	Uusimaa	TAMMISTO	Transformers	TM 1.PM2	Oil gas ratio alarm	No		
15.03.2013	Länsi-Suomi	SEINÄJOKI	GIS	SJ B01	GIS Gas compartment warning	Yes	Amitec1	OK, test

Custom load duration chart component



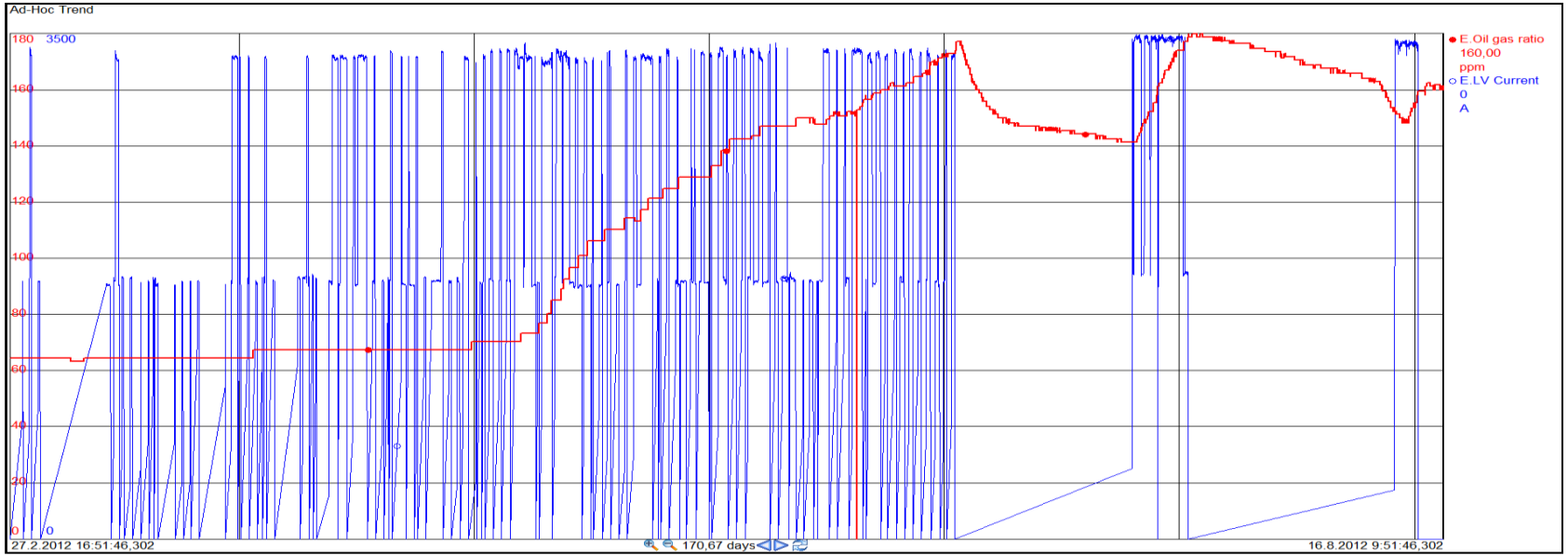


Results and benefits

- Transformer fault detected
- SF6 gas leaks (circuit breakers and GIS)
- Health index analysis tool for switchgear

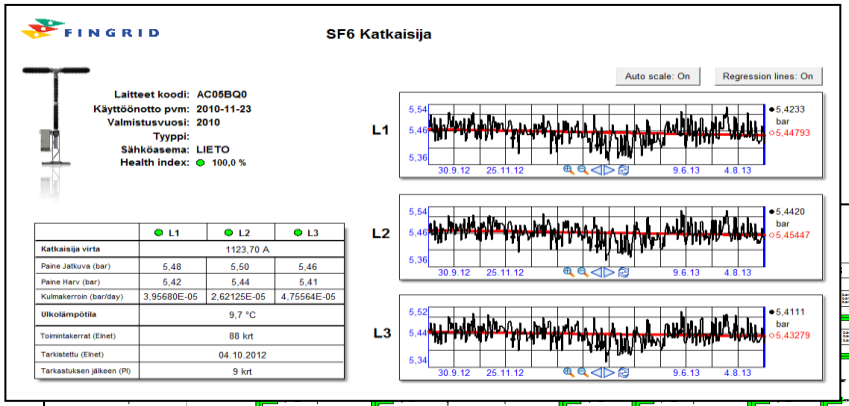
Transformer fault

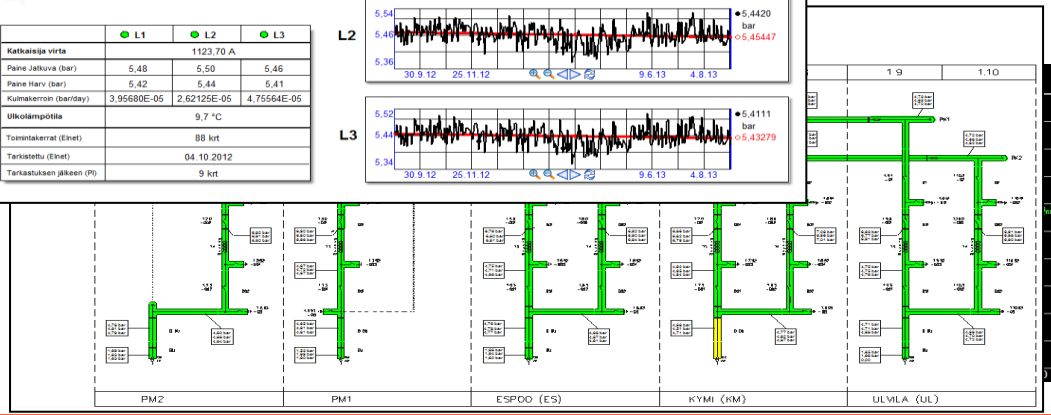
Juha Mertanen, Adviser, Grid Management:
"I use the CMS system daily to monitor the state of our assets. Two detected transformer faults have already paid back the time and money used."

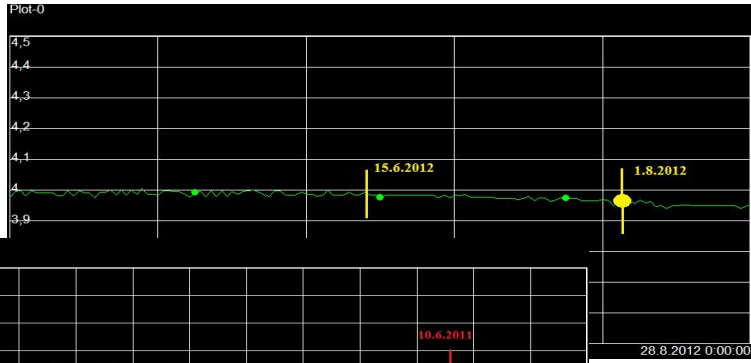


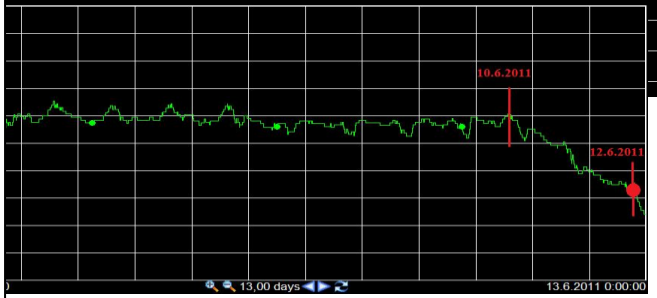
SF6 gas leaks in breakers and GIS

Tuomas Laitinen, Special Adviser, Grid Management:
"SF6 online monitoring has significantly improved possibilities to detect gas leaks in circuit breakers and GIS-stations. "



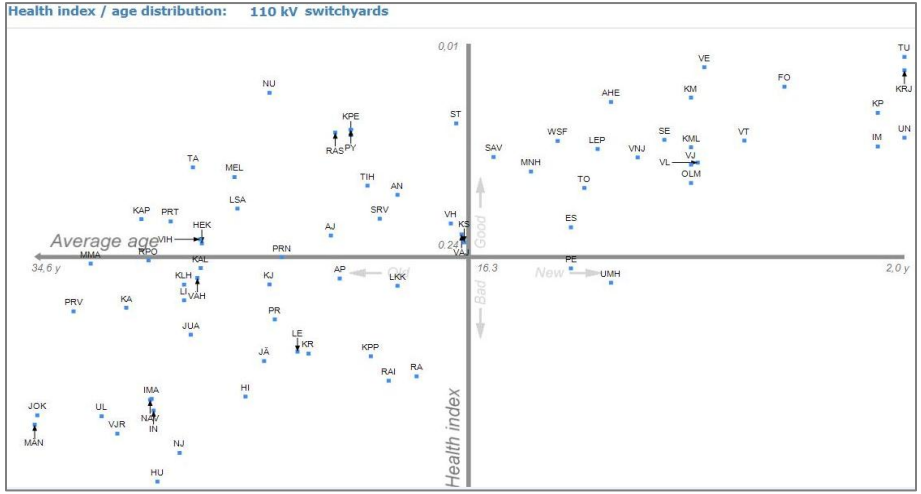






Health index analysis tool for switchgear

Tuomas Laitinen, Special Adviser, Grid Management:
"Health index is a long needed tool for analyzing large asset populations like switchgear."



	AHVENKOSKI 110 kV	Average age	Standard deviation	ALAJÄRVI 110 kV	Average age	Standard deviation
Circuit breaker average						
Disconnector average		13,0 y	0,00000		26,0 y	7,07107
Current transformer average		13,0 y	0,00000		25,5 y	6,71585
Voltage transformer average		13,0 y	0,00000		29,0 y	0,00000
Total		13,0 y	0,00000		23,6 y	8,61197
		13,0 y	0,00000		24,9 y	7,46083
	ALAJÄRVI 400 kV	**Average age**	**Standard deviation**	**ALAPITKÄ 110 kV**	**Average age**	**Standard deviation**
Circuit breaker average						
Disconnector average		22,9 y	19,69419		17,3 y	11,61973
Current transformer average		20,0 y	13,44898		23,3 y	14,78178
Voltage transformer average		26,5 y	16,04481		21,0 y	17,52712
Total		18,4 y	5,84002		29,3 y	11,59854
		20,8 y	12,85326		24,7 y	13,91061
	ANTTILA 110 kV	**Average age**	**Standard deviation**	**ANTTILA 400 kV**	**Average age**	**Standard deviation**
Circuit breaker average						
Disconnector average		21,9 y	2,26779		2,6 y	5,48483
Current transformer average		19,7 y	4,47331		20,0 y	
Voltage transformer average		17,3 y	7,28109		1,0 y	0,00000
Total		15,7 y	9,20862		1,7 y	3,59066
		17,9 y	7,16538		2,0 y	4,20987
	ESPOO 110 kV	**Average age**	**Standard deviation**	**ESPOO 400 kV**	**Average age**	**Standard deviation**
Circuit breaker average						
Disconnector average		24,5 y	7,90569		22,3 y	9,26013
Current transformer average		25,1 y	6,67201		22,3 y	8,98365
Voltage transformer average		27,0 y	0,00000		24,4 y	8,03099
Total		24,0 y	7,89362		22,5 y	8,77496
		24,8 y	7,04900		22,9 y	8,57119

Fingrid: We need a common tool for maintenance specialists and control room operators

… for monitoring the condition and state of assets. Maintenance specialists shall be warned about possible problems before they become a problem for the grid operators.

The information load will be minimized by showing only relevant data for each type of equipment, both real time data gathered in the PI Server and meta data from the ERP/EAM system.

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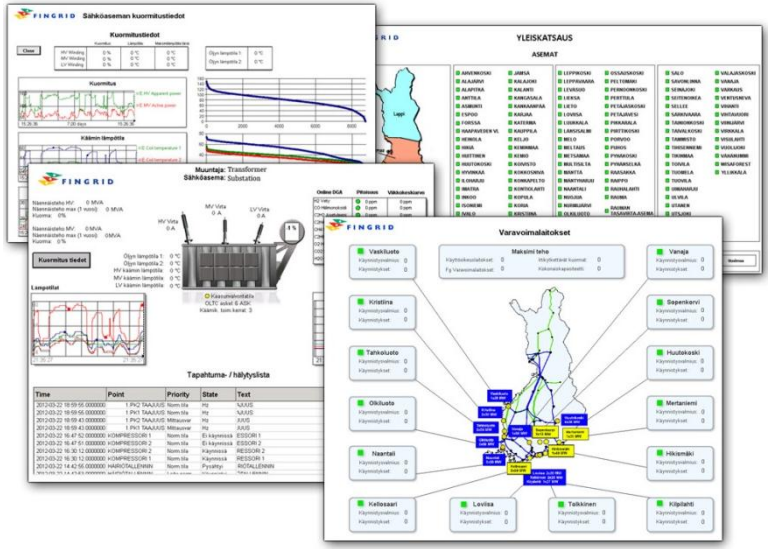

Business Challenge

- Use real time data outside the restricted and protected SCADA environment
- Get early warnings before they become a problem for operators
- Combine real time data and meta data (ERP/EAM) to get the full picture

Solution

- Create template based asset hierarchy in PI AF to be the source / single point of contact for getting data from the PI System
- Set up template based PI Notifications for all equipment
- Visualize in PI ProcessBook displays

Results and Benefits

- Value and support for the asset management personnel with fast data visualization, comparison possibilities and status information.
- Two detected transformer faults, several SF6 leaks and improved understanding of our asset
- Optimize timing of maintenance and replacement investments

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