ISCM, INTEGRATED SUBSTATION CONDITION MONITORING

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ABSTRACT

This abstract describes an innovative solution combining a multiplicity of different online condition monitoring systems to provide one integral solution for all relevant network assets. Up to 11 state of the art monitoring systems survey every major element in the energy networks supply chain in the ISCM (Integrated Substation Condition Monitoring) solution. The portfolio includes the following Condition Monitoring systems: Transformers (including different component supervision), Gas Insulated Switchgear (Partial Discharge Monitoring and Gas Density Monitoring, Circuit breakers, Over Head Line Capacity Monitoring, Cables, and optionally also Isolators, Surge arresters, Instrument transformers, Auxiliaries (Diesel, Batteries etc.) and Control & Protection relays. The modules will be described briefly.

INTRODUCTION

Utilities today face a number of unique challenges: expenditure is being cut, knowledge and expertise is being lost when people retire or through downsizing. Furthermore, operating aging equipment at higher levels impacts on lifespan and reliability. Yet, utilities are expected to continually levels of performance.

Application of Condition Monitoring can provide answers. It is an important element of both asset management and operation support providing recommendations based diagnostics of measured values.
The Condition monitoring modules are implemented in such a way that complete asset-related condition information is available to the operator and the asset manager in a common format.

The real innovation of Integrated Substation Condition Monitoring, is the evaluation of the logged data with centrally administrated knowledge modules on substation or preferably control centre level. Centrally, with one look and feel for the user.

ISCM comes with sophisticated modelling techniques for all considered primary asset types, and each module focuses on improving the reliability of the equipment as well as on the reduction of unscheduled downtime by monitoring and predicting equipment health. Thus, ISCM provides a major contribution to the optimal use of resources.

ISCM is based on expert knowledge modules for every asset family. Using unique proficiency and manufacturer experience along the entire energy conversion chain, this solution is ideally positioned to supply a sophisticated

comprehensive monitoring concept that covers all transmission and distribution network assets

WHAT IS ISCM?

Where condition monitoring is not new in the market, ISCM is!

Monitoring (e.g. temperature at transformers) is known for more than decades; however, monitoring has become increasingly more advanced over the years. The development of CM took place for each type of asset on its own. This resulted in no or limited synergy at condition monitoring.

With ISCM Siemens took the leading role to establish a platform which is suitable for connecting different types of T&D monitoring systems. With this platform standard modules can be offered very efficiently and are proven in the market. On the other hand, the platform is open to customer specific solutions for optimal integration.

The ISCM Solution is therefore a modularized system, surveying all relevant Substation components. It can be implemented in the existing substation communication and visualization infrastructure. Starting from simple asset embedded value monitors up to fully integrated condition monitoring – with generation of actionable recommendations at its highest level.

ISCM offers:

- One central system (single platform)
- One look and feel
- Implementation in existing SCADA if possible
- Asset specific “Knowledge Modules”
- available for various standards (e.g. IEC, ANSI)
- Sensors for all types of monitored assets

WHY ISCM?

Today our customers face a lot of dynamic competition which force them to take measures. These measures result in:

Over-aged network assets due to:
Higher loading caused by raising energy demand
Alternating loading caused by intensified energy trading and regenerative generation

High replacement- and extension-costs for energy-infrastructure
Optimization of maintenance and rehabilitation costs
Loss of Expertise due to:

- Cutback of expenditure
- Retirements
- Downsizing

Ageing equipment due to:

- Postponed invest in T&D infrastructure
- Extended component life-time

Higher loading due to:

- Renewable energy transmission
- Increasing energy demand

Increasing performance targets due to:

- Penalties

Condition monitoring enables an effective prediction and by that avoidance of failures.
In most cases ISCM can contribute to the prediction of failures. With ISCM it is possible to define which accuracy is required and to select the right type and price of monitoring accordingly.

Condition monitoring offers a possibility for safe use of assets at higher loading
With ISCM the critical (bottleneck) components can be equipped with the required monitoring. The ISCM platform offers a high flexibility and by that supports both Asset Management and Operation.

WHEN ISCM?

Customers will consider their savings using ISCM and decide on their investment. Most savings using ISCM can be found in reducing the risk of failing equipment and subsequent penalties. The potential for offering ISCM differs therefore if an asset is considered as "strategic". For strategic assets generally failure of assets can lead to high penalties or influence reputation of the asset owner. To a certain extent, a redundant configuration of assets can be seen as competition for ISCM. Furthermore, geographical constraints increase the value add of ISCM. Furthermore cost of failing equipment at e.g. off-shore platforms have very high costs compared to on-shore solutions. A summary for ISCM potential is given in figure 1.3-1 where redundancy, accessibility and the relevance of the assets define segments with ISCM potential.

ISCM potential strategic assets		Accessibility	
		Good	Bad
Redundancy	None	+	++
	n-1	-	+

Figure 1.3-1: usability for ISCM on strategic assets

CONCEPTUAL MODEL OF ISCM

Siemens ISCM solution is a modular system in two aspects. First of all the system is modular in order to select the right type of monitoring (e.g. Transformer, GDM, PDM, etc). Secondly the system is modular to the extent of implementation which is shown in figure 1.4-1. and explained below.

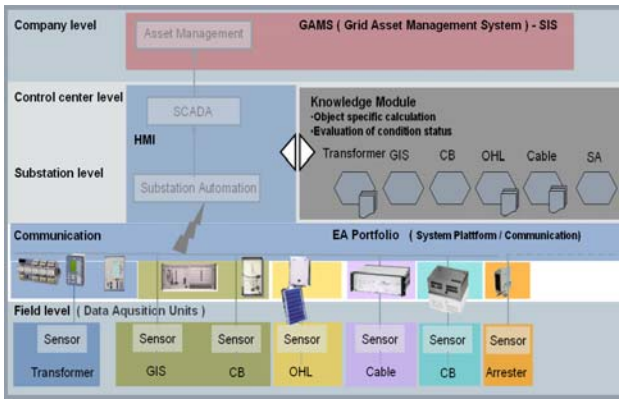

Figure 1.4-1: Modular design of ISCM

Each type of monitoring minimally exist out of: Sensors at field level, Data acquisition units at communication level and HMI at Substation level, control center level or company level. Furthermore Knowledge modules complement the delivery for evaluation of condition status. The place of implementation of knowledge modules depends. A more detailed description of these hardware and software components is described below.

Sensors
For each type of asset, sensors are available. For some assets there is the possibility to choose the best price/accuracy ration. Due to the specific properties of the different sensors, they are described into more detail in chapter 3 to 6.

Data acquisition units

Data acquisition units for the standard available modules are predefined. With predefined data acquisition units Siemens saves engineering costs, delivers well proved

units and minimizes customer specific solution with their relative high maintenance costs.

HMI

The Human Machine Interface to the customer is currently available at SICAM PAS, SICAM 230 and POWER CC. This interface is as much as possible aligned for each module. This means that the visualization and operation of transformer monitoring is aligned with high voltage monitoring modules. The HMI can be installed at substation level, control center level or at company level.

Knowledge Modules

Knowledge Modules diagnose and evaluate condition information for visualization and furthermore to actionable recommendations. The availability of asset condition status is the prerequisite for generation of actionable recommendations. The Knowledge Modules are hosted in a 'software frame' which is designed to communicate system internally via data-interfaces with the ISCM's HMI or customer's SCADA system.

The knowledge modules are independent from an existing HW platform and can be implemented in the different CM-levels from substation control system up to the Central Data Acquisition Units or to the Control Center. For some monitoring modules a selection can be made between different kinds of knowledge modules. The knowledge modules, and thereby their evaluation, varies due to different norms (e.g. IEC / ANSI), standards or used best practices (e.g. Siemens' experience). The customer decides which knowledge module to implement.

Diagnosis or prognosis is essential for the need of Operators and Asset Managers of complex systems to optimize equipment performance and to reduce unscheduled downtime. Prognosis is a difficult task requiring precise, adaptive and intuitive models to predict future equipment health states. This prediction capability is the key competence of the knowledge modules. Modeling techniques for all considered primary asset types are implemented in the ISCM approach. All focus on improving reliability and reducing unscheduled downtime by monitoring and predicting equipment health.

Outcome of the Knowledge Modules

As said the Knowledge Modules diagnose and evaluate condition information for visualization. The different modules offer different information of all the various important network assets:

Transformer:

- Hot Spots
- Aging
- Loss of Lifetime
- Moisture
- Cooler efficiency
- Gas Analisis
- Tap Changer Condition
- Partial Discharge
- Bushings

Gas Insulated Switchgear:

- Gas trending and balancing
- Partial discharge
- Arc detection
- Circuit Breaker performance

Circuit Breaker:

- Coil Currents
- Trip Speed
- Mating surface
- Gas Density
- Ageing

Overhead Line:

- Dynamic Line Rating
- Sagging
- Ice Loads
- Transport capacities
- Over temperature

Overhead Line:

- Dynamic Line Rating
- Sagging
- Ice Loads
- Transport capacities
- Over temperature

Cable

- Line Rating
- Temperature
- Fault Location
- Reserve capacities

Surge Arrester

- Peak current
- Energy
- Leakage current
- Temperature
- 3rd Harmonic (~ resistive element)

UNIQUE SELLING POINTS

ISCM enables Siemens to act as system integrator for various Condition monitoring systems for an integrated substation approach for substation's primary asset types including connections with overhead lines, cables and Balance of Plant assets.
ISCM enables professional execution of service and O&M contracts
ISCM offers a significant price/cost reduction potential if more assets / asset clusters (e.g. TX and GIS) are implemented
ISCM offers well proven standard condition monitoring modules as well as the possibility to integrate your existing modules.
ISCM offers a preferred Condition Monitoring analysis and visualization application based on Siemens energy automation product portfolio being SICAM and PowerCC
ISCM enables a coordinated approach for Condition Monitoring, Analysis and Visualization of T&D assets
ISCM enables the use of Power Transmission and Power Distributions sales forces for CM sales
ISCM emphasizes the technical competence on transformers and circuit breakers by offering sophisticated analysis tools for interpretation of Condition monitoring data
ISCM enables the use of existing Condition Monitoring Systems of 3rd party where technically viable.
ISCM is NOT a new Condition Monitoring System

CUSTOMER BENEFITS (IN GENERAL).

Lower operating costs due to travel cost savings, better planned maintenance and avoidance of damage.
Common approach to substation monitoring enabling internal synergies.
Opportunity to apply one system to all OEM equipment
Full range of service solutions able to be interlinked
Benefits of latest communication technologies protocols
Improved asset management information
Increased reliability and availability of the network through the effective prediction (and then avoidance) of equipment failures
Minimized downtime through the integrated planning and scheduling of repairs indicated by Condition Monitoring techniques with those indicated by other techniques.
Maximized component life by avoiding the conditions that reduce equipment life (for example, by ensuring ongoing precision alignment, minimal lubricant contamination)
Maximized equipment performance by controlled threshold throughput / overload.
Reduced Life Cycle Costs through reduced maintenance, reduced spares and extended component life.
Maximize customers use with Remote Diagnostic Center

LEVEL OF IMPLEMENTATION & DATA PRIVACY CONCEPT

ISCM can be implemented at different levels, which was already presented in figure 1.4-1. Components of ISCM can be installed at the asset without further communication (Embedded or stand-alone level). Since there will be no Integration, this is called Condition Monitoring, but not ISCM. Single asset condition monitoring can be offered from E D SE AS to a certain extent. Please contact us (chapter 7.2) for more information.

The second level of implementation at is at substation level. Single asset monitoring (systems) can be connected to a HMI which can be delivered with a Siemens EA solution like SICAM or POWER CC in an optional cubicle. Knowledge modules can be implemented at the asset or at the EA ISCM solution. The HMI can be made accessible over internet if customer requires. Furthermore the system can be connected to a Remote Diagnostic Center for extensive expert analysis. Note that ISCM is not connected to any protection or control equipment at the substation, which guarantees customer's data privacy.

The third level of implementation is at control center level. Sensor data is still cached by the Data Acquisition Unit(s) at the substation, but are directly redirected to the control center level. All varieties as described at the second level of implementation are still possible. Main advantage is that control centers are mostly existing at customers. Therefore cost savings can be made on hardware investments.

The fourth level op implementation is at company level with integration in the business architecture with e.g. GAMS – Grid Asset Management Suite.
As introduced, it is possible to integrate ISCM within the business architecture at company level of implementation. Siemens supplies the GAMS, Grid Asset Management Suite which can fulfill this task. With the combination of ISCM and GAMS, Siemens delivers data solutions from sensor up to ERP, enterprise resource planning, systems.

RELATION TO SMART GRID

ISCM in combination with GAMS is one pathway to a "Smart Grid" [1]. The integration of Asset Management and Condition Monitoring into one functional unit – a comprehensive Asset Monitoring cockpit. Performance is seen through the eyes of the asset manager.

Advanced condition monitoring solutions from Siemens provide reliable information about the health and ageing state of the devices in operation. This helps minimize downtimes, maximize asset performance through integrated maintenance planning and paves the way for

reduced lifecycle costs and an extended service life of the assets.

With ISCM Siemens provides asset condition information through a comprehensive range of innovative tools for diagnostic analysis integrated into a unique platform bringing together the most the most comprehensive condition monitoring experts creating unrivalled competence in this field.

Based on the comprehensive asset data available within a Smart Grid structure, the Siemens Grid Asset Management Suite, a modular and SOA-based solution, boosts the efficiency, transparency, and flexibility of grid asset management, and helps control risks and balance technical necessities and economic feasibility.

The grid asset management suite supplies a consistent asset data model, where all commercial, technical and geographical figures are persistently stored. The information analyses functions support the decision making process for the asset manager (replace, repair and invest).

So both, ISCM and GAMS, are fundamental prerequisites for securing required performance levels and with it long-term entrepreneurial success".

REFERENCES

For a Conference citation:

[1] Siemens Smart Grid Internet Page: http://www.siemens.com/energy/smartgrid

[2] Siemens ISCM Internet Page (on Efficient Network and Energy Automation Systems Page): http://www.energy.siemens.com/hq/en/automation/power-transmission-distribution/eneas/monitoring/condition-monitoring.htm

For a book citation:

[3] n.a.

For a paper citation:

[4] Schwan 2009, 2009, GAMS Paper