Key questions of Strategic Electrical Asset Management

- What is the condition of my assets right now?
- How to extend the lifetime of my assets?
- Which long term resources do I need to manage replacement waves?
- Am I doing the right maintenance at the right time?
- How will the condition of my assets develop in the future?
- When should I replace my assets?
Challenges in Medium Voltage Switchgear

Prioritization in relation to health status and relevance of the feeder becoming key factor to reduce unplanned outage.

Due to life time extension policies and changes in maintenance criteria defined by users, care should be taken to keep higher reliability level.

This is a challenge when the equipments and components, like the drives, are exposed to stressing operation conditions.

Especially non-operation long time may have effect on a reliable switchgear behavior.
Siemens SI DS (Example of SaaS)
IoT Services Models

Option I: Cloud Computing
Lower CAPEX, higher OPEX

Application & HMI
Enable access to data and analytics to experts anywhere

Option II: Edge Computing
Higher CAPEX, lower OPEX

User
SIEMENS

Siemens Experts
Customer support on evaluating data and defining actions
### Benefits of a Digital Asset Management ecosystem for infrastructure networks

#### 3 x 3

**Key Benefits**

<table>
<thead>
<tr>
<th>Lower Costs</th>
<th>Higher Performance</th>
<th>Efficient Processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Improved decision making based on reliable data, e.g. better prioritization</td>
<td>• Improved asset utilization and reliability</td>
<td>• Optimization and justification of work programs and investment schedules</td>
</tr>
<tr>
<td>• Reduced outage cost, revenue loss, penalties</td>
<td>• Find pending failures and reduce unplanned outages</td>
<td>• Workforce efficiency by having the right data at hand; compensate retiring experts</td>
</tr>
<tr>
<td>• Reduced maintenance and repair expenses by adoption to Condition Based strategy</td>
<td>• Prevented catastrophic failures and fewer accidents of planned vs. unplanned outages</td>
<td>• Improved regulatory compliance</td>
</tr>
</tbody>
</table>

---

**Remote Diagnostic and Analytics Services**

Siemens Asset Management eco-system

**Siemens Asset Management Consulting**

**Siemens Asset Management Solution**

**Remote Diagnostic and Analytics Services**

**Integrated Substation Condition Monitoring**

**Condition Monitoring Products**

**Cyber Security**

**On-site Condition Assessment**

**Autonomous on site inspection - SIEAERO**

**Think big – start small**

---

**What keeps you awake at night?**

**Start Menu**
Why digitalization can increase resiliency

- Early detection of incipient faults situations
- Triggering offline diagnostics measures
- Triggering life extension measures
- Full transparency on Install Base status
- Supporting of maintenance strategies
- Checking of maintenance results
- Prioritization on Health Index and relevance
Siemens eco-system to support Digitalization
Condition Monitoring and Asset Management

Asset Management Consulting

“Siemens Digital Asset Management Solution” based on IPS-Systems™ incl. Siemens RCAM Dynamic Models

Siemens Condition Monitoring Systems and Solutions

Traditional scenario

AMC

Enterprise Asset Management and Asset Performance Management

Enterprise Level

Substation Automation System (SAS)

Substation Monitoring

Substation Level

SCADA

ISCM Enterprise Integrated Substation Condition Monitoring

New scenario

Optional integration with existing APM/IT System

3

Basic Asset Management

Assetguard APP

MindSphere for Energy

EnergyIP

ON PREMISE Diagnostics

Start Menu

1

Field Technician APP

2

3rd party online monitoring

BCU and Protection

MV ASSETS

Distribution TRAFO

HV ASSET

ON PREMISE Diagnostics

3rd party online monitoring

BCU and Protection

MV ASSETS

Distribution TRAFO

HV ASSET

ON PREMISE Diagnostics

Start Menu
Condition Monitoring Products Catalog
Assetguard product family for monitoring and diagnosing

High Voltage
- **Power Transformers**
  - **Bushing Monitoring**
    - SITRAM H2Guard – early fault detection in oil
    - Multisense 5 and 9 – Comprehensive fault detection in oil
  - **Transformer Monitoring**
    - SITRAM TDCM – Comprehensive fault diagnostic Transformer Monitoring System

Low & Medium Voltage
- **Assetguard MVC** – Circuit Breaker Monitoring System
- **Assetguard IoT**
  - IoT device to acquire and connect HV / MV / LV
- **Assetguard PDM** – HV GIS Partial Discharge Monitoring System
- **Assetguard HVC** – HV AIS/GIS Circuit Breaker Monitoring System

**Field Sensors**
- Sensor KIT for CB Measures

**+3rd Party Products e.g. PD sensors for Cables etc.**
Focus Assetguard MVC
On Premise Solution
Assetguard MVC

Content

Challenges in Medium Voltage Switchgear Monitoring

Siemens Assetguard MVC: Basic vs Extended version

Hardware setup

Knowledge Module analysis & event

Optional Functionalities

More information

DEMO LINK
http://assetguardmvc.azurewebsites.net/

Use Contact: Region: Agostino Trotta, HQ @ Nicolo Bianchi
Overview: Basic vs Extended version
Simple solution and easy installation

**Basic configuration**
One box for monitoring large installed based
Indicated for AIS Switchgears

- 12 Panels Monitoring in one Rack chassis
- Master functionality for 12 Panels Monitoring
- Aux voltage value before operation
- Arcing Ft (for currents higher than 10% Isc)
- Arcing Ft and interrupted currents Summation
- CB operating times
- IEC 60870-5-104 protocol
- Easy to be Installed reduced engineering

**Extended configuration**
One box for monitoring critical/strategic equipment
Indicated for AIS & GIS Switchgears

- 6 and 12 Panels in one Rack chassis
- Master & Slave functionality up to 60 panels for one Master
- Coil Current Waveforms history and viewer
- Plotter with zoom functionalities
- Auxiliary Voltage waveform during operation and history
- Bus Bar SF₆ Gas density monitor 3 or 6 points
- Relative Humidity & Ambient temperature
- Coil continuity check
- Digital inputs for alarms
- Motor drive analysis
- 100 operations history
- Non invasive solution available for all CB brands
Optional Environmental/Bus Bar Monitoring

Focus on extended version

This option are available only for Extended configuration version in order to extend the monitoring to Bus Bar and Asset Environment status.

- **2 Ambient temperatures for 2 Bus Bar points**
- **2 Ambient Humidity for 2 Bus Bar points**
- **3 or 6 SF₆ density inputs for bus bar compartments**
- **Coils continuity check**
- **8 Digital inputs for alarms**
- **Multilanguage Features (on request)**
- **Additional Reports (pdf format)**
Hardware setup (basic and extended version)

All in one Box – Reduced adaptation engineering

Integration
Level C

Central Unit
Assetguard MVC

Switchgear

SCADA

OTHER eg. PC, tablet

Electrical safety according to EN 60529, EN 61010-1 and EN 60255-5

Electromagnetic compatibility (EMC) according to EN61000 and EN 55011
Level 3 electrostatic and electromagnetic immunity
4 kV surge immunity

Environmental strength according to EN 60068
Operating temperature -25°C to 70°C
Humidity 10 - 95%

Protection class IP 20

Power supply port and each channel has a dielectric withstand capability of 3 kV_{RMS} and 5 kV 1.2/50 µs impulse

Measurement resolution
12 bit at 10 kS/s sampling rate
Accuracy 0.5 % of range

Available communication protocols
IEC 60870-5-104, others on request

Data storage
2 Gigabit for each CB = 100 Operations for CB
Cyclical structure (oldest data is dropped first)

Visualization
Web HMI as stand alone

Dimensions w x h x d
Rack Version (477 x 125 x 210 mm)
up to 12 CBs
Knowledge Module analysis & event

Normal behavior: No Alarm

- All operations are useful to collect data
  - Environments info (temp, humidity)
  - CB Timing & Status
  - Counter for I²t
  - Aux voltage measurements
  - Coil current data
  - Others

Fault identification

- Synthetic data are essential in order to focus on the asset
  - Alarms for defined limit violation
  - Warnings on counter overcoming
  - Warnings on data analysis (KM)
  - Information on Monitoring status on the asset

Plan & Define restoring measures

- Detailed data are useful to define the maintenance activity
  - Actual trace comparison with oldest one
  - Evaluation of limit violated & other measures
  - Remote operation to verify last data
  - Log evaluation
  - Definition if a local intervention is needed and skills of maintenance people

* Current waveforms and plotter functionalities just available for the extended version
Synthetic Analytic Dashboard
Focus Assetguard APP
A scalable IoT solution for all your Install Base
Siemens’ Asset Management Software Ecosystem
Scalable solution in relation to our customers needs

Customer & **SIEMENS**

Asset Data Acquisition
- Inspection results
- Condition Monitoring
- Protection devices
- Manual measurements

Strategic Asset Evaluation
- Energy IP Assetguard APP
  - BASIC Asset Management
- Transformer & Switchgear
- Asset Health Index
- Asset Risk and Importance
- Maintenance strategy & plan
- Investment strategy & plan

Full Asset Performance Management
- All customer assets: Poles, Cables, Meters, …
- Asset Data Repository
- Asset Type Library
- Document management
- Geo-Information

Under Developments
- Maintenance Resource Intelligence
- Work Prioritization
- FMEA & RAM
- Root Cause Analysis

Customer & **IP•S**

EAM & ERP
- Asset Registry
- Spare Parts & Warehouses
- Work Execution and Documentation
- Commercial Processes

Customer & **SAP**
Flexibility in Visualization

Views can be customized, enabling:

- Geolocalization of entire site
- Geolocalization in a plant map of each asset
- Integration of Real Photo layer view for all assets
- Integration of electrical scheme layer view
- Other as requested by customer

- Dashboard can be personalized by each user according to their needs and scope
- Report can be pre-defined to create new widget to be integrated in Dashboard view
- Drag & Drop: modifications can be done by every user allowed without any expertise in SW / Programming
Performance monitoring and Asset Management – Assetguard APP - Sub Station Asset Monitoring

Detail List of Things and Assets

Mapping and identify assets and Things with S/N Type Vendor Model …

EIP Assetguard APP Mindsphere Access Click [here](#); Direct Access Click [here](#)

Please use chrome Browser.

Please note that any changes you make in the app cannot be saved, since this is the public Market Place account. In case you need an account contact bianchi@siemens.com
Think big – start small ...

**Define Customer Needs**
- Define Customer Use-Cases & needs
- Define Data sources and potential gaps
- Define options for data capture and integration
- Define Software key functions

**Analyze Customer Data**
- Build descriptive models e.g. health index & ageing
- Apply analytical methodologies, e.g. Data Discovery Services
- Assess Cost of Failure per assets
- Define implementation scope

**Implement Customer Solution**
- Customize Software and data capture
- Install Software
- Establish data connection
- Parameterization of tool-ecosystem
- Hand over: User Acceptance Test and Training

**Support Customer Operation**
- Add new asset classes
- Add Software functions
- Support learning and model hardening
- Improve data quality and depth e.g. by measurements, lab analysis, condition assessments or online monitoring

**Workshop**
Customer / Siemens

**“Lab Phase”**
Siemens / Customer

**Delivery**
Siemens

**Service**
Siemens / Customer

---

*What keeps you awake at night?*

- Siemens Asset Management eco-system
- Asset Management Consulting
- Siemens Asset Management Solution
- Remote Diagnostic and Analytics Services
- Integrated Substation Condition Monitoring
- Condition Monitoring Products
- Cyber Security
- On-site Condition Assessment
- Autonomous on site inspection - SIEAERO

---

*Integration of Software and eco-systems*
Deployment models yield trade-off between operating or renting infrastructure – Privacy requirements are boundary conditions

Privacy vs. Elasticity
- Private clouds provide a higher degree of resource isolation and privacy
- Public clouds provide nearly unlimited resources with rapid elasticity

CAPEX vs. OPEX
- Private clouds require upfront investment in infrastructure and operation effort
- Services in Public clouds are paid when used

General
- Privacy requirements may restrict freedom of choice
- Economic trade-off determined by
  - Resource requirements
  - Data center locations
  - Application elasticity
  - Public cloud pricing

Digital end-to-end approach from sensor to integrated platform for supporting customer’s asset management

Summary

**Tasks**

1. **Smart devices**
   - Installation of sensors and access to monitoring solutions

2. **Connectivity & Cloud**
   - Secure communication and data storage in data integration platform

3. **Modeling & data analytics**
   - Accessibility of data from experts and service

4. **Service offerings**
   - Realization of use cases as applications

**Applications:**

- **Visualization**
  - Dashboard view, transparent health check of assets

- **Messages and alerts**
  - Evaluation of performance and automatic reporting

- **Enhanced performance**
  - Identifying additional performance capabilities

- **Optimized maintenance**
  - Depending on health check and historic utilization of components

**Customer Benefits:**

- **Improved reliability**
  - By reducing unscheduled outages and prediction of component failures

- **Low opex**
  - Optimized maintenance by reliable prediction of components health status

- **Enhanced performance**
  - Provide performance exceeding standard design ratings, e.g. by dynamic overload management

- **Increased Profit**
  - Enhanced operation and service lead to lower costs and fast return of investment
Use Cases - Examples
Use Case: Panel Monitoring

- Panel Monitoring
  - Terminal cables
  - Temperatures*

- Assetguard IoT
  - Conf. Master
  - Conf. slave

- Modbus
  - Assetguard IoT

- Load Current
  - Rogowski sensor
  - +20 mA

- Terminal cables
  - Temperatures*

- Secondary CT
  - Load Current

- Modbus

- SIEMENS Cloud

* Pictures are only indicative
Use Case: Substation Monitoring

Assetguard solution will take care of:

- Circuit breaker monitoring system with Assetguard MVC
- Communication with the Cloud Mindsphere Assetguard App through Assetguard IoT
- Easy configuration through web server
- External or integrated modem via MiniPCI express 3G / 4G / NB-IoT… (depending on region & modems)

Features:
On Premise Analytics + Remote Global Mapping Management
- Up to 12 Feeders
- Up to 2 Trafos

Added Value:
- All-in-one solution (Power Supply, electrical input/output, etc)
- Compact size allows installation in smaller spaces or external application
- Simple electrical input & Modbus configuration
- Cost Effective
Use Case: Mobile substation application

- Battery damaged by extended discharge status (BMS/Inverter data available?)
- Transformer oil humidity & pollution
- Mechanical stress on substation components + accident
- Environment (metal surface oxidation, vandalism/theft, fire)

Monitoring architecture available to fulfill some requirements

- Battery damaged by extended discharge status (BMS/Inverter data available?)
- Transformer oil humidity & pollution
- Mechanical stress on substation components + accident
- Environment (metal surface oxidation, vandalism/theft, fire)

Supported Monitoring & Diagnostic functionalities

Monitoring architecture to be extended for cloud (Highlighted)
Use Case: Environmental and distribute SS monitoring

- **Substation**
  - Measurement of room temperature
  - Measurement of room humidity
  - Measurement of room air pollution
  - Measurement of water flooding

- **Distribution Transformer**
  - Sensor for top / bottom oil temperature
  - Sensor for vibration
  - 3 phases LV current sensor
  - Sensor for Dissolved Gas Analysis (for measuring $H_2$ & humidity content)

- **AssetGuard IoT**
  - DUST SENSOR X2
  - TEMP/HUMIDITY SENSOR X2
  - FLOOD SENSOR X2

- **SIEMENS Cloud**
  - Start Menu

- **SIEMENS Cloud**
  - ASSETGUARD IoT
  - MODBUS CAT6
  - Ai

- **SIEMENS Cloud**
  - ASSETGUARD IoT
  - MODBUS CAT6
Develop strategic partnerships with customers: Co-creation Benchmarking services, e.g. applications, OEM‘s, substations, …

<table>
<thead>
<tr>
<th>Where?</th>
<th>Why?</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ TCOs, globally</td>
<td>▪ Less CAPEX investment for the customer</td>
</tr>
<tr>
<td>▪ Industry customers, globally</td>
<td>▪ Lower barrier to the Online Monitoring technology for the customer</td>
</tr>
<tr>
<td>▪ Powerplant owners, operators</td>
<td>▪ Better access for SIEMENS to customer operational data</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What?</th>
<th>MindsApp: Online Monitoring, Cooling control</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Transformer Online Monitoring as a cloud-based service</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How?</th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Connect transformer sensors directly to the cloud via Digi-Box or SIMATIC IoT</td>
</tr>
<tr>
<td>▪ Process monitoring algorithms in the cloud</td>
</tr>
<tr>
<td>▪ Provide alarms and diagnostics to the customer as defined in a remote service contract</td>
</tr>
</tbody>
</table>
References & Customer feedback
Assetguard MVC Product References

• 113 total Assetguard MVC units installed between December 2012 and August 2019

• 551 Assets currently being monitored, the majority are in Italy and UK
Reference / DSO in Italy

Scope of Supply 3rd party OEM:
- 4 HV GIS BAY: 170 kV
- 43 MV Circuit Breakers;
- 4 Power Transformers: 2 x 40 MVA; 2 x 6 MVA

Assetguard MVC
- Successfully avoided blackout of 50 MV feeder in the city center
- Condition-base maintenance triggered via warning notification
- Estimated customer cost of potential damage ~300k€
- “More than the full SS cost for the monitoring system itself”

Red and Purple: anomalous opening before maintenance
Green: successful opening after maintenance
CASE STUDY (feedback from the Distribution utility):

ON CONDITIO MAINTENANCE after anomaly detection

This situation has led the customer to the decision for an intervention of maintenance on condition in order to avoid the repetition of the anomalous event and avoid the risk of a failure (missing of opening operation on command).

After the maintenance on the circuit breaker the operation new recording has given positive results indicating a good operation of the circuit breaker and closing the alarm on the monitoring system.
Contact

**Nicolo Bianchi**
SI DS Global Digital Service
Portfolio Manager
SI DS CS
Humboldtstr. 59
90459 Nürnberg
bianchi@siemens.com
Mobile: +49 (173) 3644692

**Jesús Tello**
SI DS Sales Digital Service Portfolio
RG. Suramérica sin Brazil.
SI DS CS
Cerro El Plomo 6000, Piso 10
Santiago, Chile
Jesus.tello@siemens.com
Mobile: +56 (9) 50121910
Thank you