Strategic Asset Management

actionable loop

Planning

- Plan Assets and Review Policies
- Optimize to Enterprise/Industry Requirements
- Execute and Record Action/Condition

Health and Performance Management

- Assess Condition/Health and Predict Potential Failures
- Diagnose Root Cause and Identify Alternative Actions
- Recommend Action based on Asset Management Policy

Source: ISO 55000, IDC
The Key Drivers

need to balance benefit and cost, assess risk and prioritize implementation

1. Improve asset utilization
   ex: reducing downtime, enabling controlled overloading, securely extending asset life, enabling dynamic ratings

2. Reduce maintenance costs
   ex: automating routine activities, minimizing (planned) operations and related materials, improving information access and flow.

3. Lower CAPEX expenditure and working capital
   ex: minimize catastrophic failures and related collateral costs and emergency repair costs, better investment planning.

4. Increase power system reliability
   ex: reducing downtime, enabling predictive protection and control.

5. Corporate drivers
   ex: reduced exposure to safety and environmental issues, reputation, liability, standards compliance and regulation, competition

The business value of each driver is different between organizations as is each asset base and company strategy.
Digital Asset Management Components

key digital solution elements

- **Master Data Management**
  Positions, identification and nameplate, features and capabilities, components, lifecycle status, documentation, etc.

- **Asset Sensing and RT Monitoring**
  Sensors, communications and data capture (live field data), online analytics

- **Asset Health and Performance Management**
  Condition assessment (health), diagnostics (cause), predictive (health evolution/ time-to-fail), prescriptive (action recommendation, asset optimization)

- **Maintenance and Workforce Management**
  Work order tracking, crew management, record-keeping (inspections, operations, asset data)
  Connected workforce, powerful visualization and VR/AR

- **Asset Planning**
  Enterprise asset view including financial and accounting views, warranty management, investment planning

- **Autonomous Operations**
  Robotics, drones, automation
Managing Secondary Assets
key drivers and digital solutions

1. Availability
   Keep Automation System Operational

2. Cybersecurity
   Protection and Compliance

3. Remote Management
   Optimize O&M

Solutions

System and Device Monitoring
Online status and fault monitoring, logging and reporting (IDS), cybersecurity testing

Fault and Performance Management
Real-time diagnostics, predictive analytics, prescriptive

Power System Data Management
Manage COMTRADE, COMFEDE, PQDIF data
Events and P&C system response

Version Management
Version and patch management

Configuration Management
Backup and recovery, active settings
Centralized historical storage of system settings

Protection Settings
Online supervision, control and management of active settings

User Management
Centralized RBAC
Data and Information are Key

- **Equipment Monitoring Data**
  - Events
  - Sensor data
  - Data records and logs
  - Local calculations

- **Data Aggregation**
  - History Tracking
  - Health Evaluation

- **Maintenance Process Data**
  - Work orders
  - Rounds
  - Inspections
  - Tests
  - Repairs
  - Failures

- **Inform**
  - Dashboards
  - Reports and alerts
  - Data interfaces
  - Mobile/web access

- **Nameplate Components**
  - Positions and Fleet
  - Asset tree

- **Master Data**

- **ERP**
- **EAM**
- **Asset Manager**

- **Mobile/web access**
- **Data interfaces**
- **Reports and alerts**
- **Dashboards**
- **Local calculations**
- **Events**
- **Sensor data**
- **Data records and logs**

- **Crew**
- **Maintenance Manager**
- **Asset Manager**
- **Asset Planner**
- **ERP**
- **EAM**
- **WfMS**

- **SCADA**
- **Historian**
- **Substation System**
- **Monitoring IED / Sensor**

- **WfMS**
- **Crew**

- **EAM**

- **ERP**
- **EAM**
- **WfMS**

- **APM System**
- **Data/ Info. flow**
- **People**
- **Other Systems**
And Also Standards

IEC 61850, CIM and ISO/PAS 55000

IEC 61850 Power Transformer Model Objects
- YPTR: Power Transformer
- SPTR: Power Transformer Supervision
- SIML: Insulation Medium Supervision
- CCGR: Cooling Group Control
- MMXU: Electrical Measurement
- ZBSH: Bushing
- SPDC: Partial Discharge Monitoring
- YLTC: Tap Changer
- SLTC: Tap Changer Supervision

CIM (IEC 61968)
- Enterprise integration
- AMI, DMS, OMS, GIS, CIS, Asset management, Work management

IEC 61850
- Online/ connectivity
- Information modeling
- Systems engineering interoperability

ISO 55000
- Strategic asset management
- (Corporate) asset management systems

Other
- SNMP, syslog, LDAP, COMTRADE, etc.
- IEEE C57–104, IEC 60599, CIGRE, etc.
Efacec Technical Architecture

SGAM mapping

- **Operation and Enterprise Levels**
  - SCADA, WIMS, EAM, ERP Systems
  - Asset Manager/Planner
  - Maintenance Manager

- **Substation Level**
  - Substation Data and Management Gateway
  - Systems O&M Crew
  - Transformer Data
  - Power System and PQ Data
  - Circuit Breaker/ Switch Operation
  - System Events and Parameters
  - Cybersecurity Data

- **Bay and Process Levels**
  - Transformer Monitor and Control
  - IEDs and Communication Networks
  - Power Equipment O&M Crew

- **Assets**
  - Substation and Grid Assets

**SGAM mapping**
Efacec Technical Architecture

power transformer

Transformer
- Buckholz, PD

Substation
- Current, Voltage

Oil
- Temp., Gases, Moisture, Pressure, Levels

Bushings
- Capacitance and tan delta

Tap Changer and Coolers
- Pumps, Fans, Position

Sensor Integration
- Wired Communications

TMU 220 Local Transformer Intelligence

Parameters

Inform

Easy-config from local web server
Optional use of Automation Studio

Connectivity

IEC 61850
FTP/SFTP
IEC 60870-5-104
Modbus

Web server
Optional HMI

Field Crew

SCADA
SAS
### Efacec Technical Architecture

**power transformer**

#### TMU 220

**Local Transformer Intelligence**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>YPTR</td>
<td>Power Transformer</td>
</tr>
<tr>
<td>SPTR</td>
<td>Aging and Temperature Supervision</td>
</tr>
<tr>
<td>HPTmplClc</td>
<td>Calculated winding hotspot temperature</td>
</tr>
<tr>
<td>ToTmp</td>
<td>Top oil temperature</td>
</tr>
<tr>
<td>SIML</td>
<td>Oil Supervision</td>
</tr>
<tr>
<td>H2O</td>
<td>Relative saturation of moisture in insulating liquid.</td>
</tr>
<tr>
<td>ZBSH</td>
<td>Bushing Supervision</td>
</tr>
<tr>
<td>CCGR</td>
<td>Colling System Supervision</td>
</tr>
<tr>
<td>EnvTmp</td>
<td>Environment temperature</td>
</tr>
<tr>
<td>CEMod</td>
<td>Cooling equipment operation mode</td>
</tr>
<tr>
<td>YLTC</td>
<td>On-Load Tap Changer Supervision</td>
</tr>
</tbody>
</table>

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#### Remaining Life Time

**IEC 60076-7**

**Paper Polymerization**

\[
DP_i = \frac{1}{3600 e^{\left[\frac{h_{A_i}}{k_{4.314(HPTmplClc+273.15)}}\right]}}
\]

**Percentual Remaining Life**

\[
\text{perLife} = 1 - \frac{DP_i - DP_{\text{start}}}{DP_{\text{end}} - DP_{\text{start}}}
\]

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#### Overload Capacity

**IEC 60076-7**

**Allowed time based on required power factor**

\[
time = -\log \left\{ 1 - \frac{\text{LimitToTemp} - \text{ToTemp}}{d\text{To} \times \frac{1 + R \times \text{Knec}^2}{1 + R} - \text{ToTemp} + \text{EnvTemp}} \right\} \times k_{11} \times \text{Tau0}
\]

**Allowed power factor based on required time**

\[
pf = \sqrt{\left\{ \frac{\text{LimitToTemp} - \text{ToTemp} + \text{ToTemp} - \text{EnvTemp}}{k_{11} \times \text{Tau0}} \right\} \times \frac{1 + R}{d\text{To}} - 1}
\]

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*Equations are simplified and do not represent the complete algorithms.*
Efacec Technical Architecture

**Power Transformer**

**Health Index**

\[
HI = 60\% \times \frac{\sum_{j=1}^{21} K_j HIF_j}{\sum_{j=1}^{21} 4K_j} + 40\% \times \frac{\sum_{j=22}^{24} K_j HIF_j}{\sum_{j=22}^{21} 4K_j}
\]

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| DGA | Load History | Power Factor | Infra-red | Oil Quality | Overall Condition | Furan or Age | Turn Ratio | Leakage Reactance | Winding Resistance | Core to Ground | Bushing Condition | Main Tank Corrosion | Cooling Equipment | Oil Tank Corrosion | Foundation | Grounding | Gaskets, Seals | Connectors | Oil Leaks | Oil Quality | Oil Level | DGA of OLTC | OLTC Oil Quality |

*Equations are simplified and do not represent the complete algorithms*
### Efacec Technical Architecture

**power transformer**

**Health Index**

\[ HI = 60\% \times \frac{\sum_{j=1}^{21} K_j HIF_j}{\sum_{j=1}^{21} 4K_j} + 40\% \times \frac{\sum_{j=22}^{24} K_j HIF_j}{\sum_{j=22}^{24} 4K_j} \]

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**TMU 220**
Local Transformer Intelligence

- **YPTR** Power Transformer
- **SPTR** Aging and Temperature Supervision
- **SIML** Oil Supervision
- **ZBSH** Bushing Supervision
- **CCGR** Colling System Supervision
- **YLTC** On-Load Tap Changer Supervision

**WfMS**
Workforce Management System

- Work Orders
- Rounds
- Inspections
- Tests

**EAM**
Enterprise Asset Management

- Nameplate
- Components
- Repairs
- Failures

*Equations are simplified and do not represent the complete algorithms.*
Efacec Technical Architecture

data integration and normalization

**Operation and Enterprise Levels**
- SCADA
- WfMS
- EAM
- ERP Systems
- Other Systems

**Substation Level**
- Data Historian
- Aggregated and Calculated information
- Other Systems

**Bay and Process Levels**

**Assets**

**Integrate**
- CIM-Compliant Asset/Grid Model
- Historical / Real time Operational Data
- Asset Inventory and WfMS
- Asset Health/Risk Information

**Inform**
- Asset Manager/Planner
- Maintenance Manager
- Systems O&M Crew
- Power Equipment O&M Crew

**Substation Data and Management Gateway**
- Transformer
- Condition
- Data
- Power System and PQ Data
- Circuit Breaker/ Switch Operation
- System Events and Parameters
- Cybersecurity Data

**Transformer Monitor and Control**

**IEDs and Communication Networks**

**Substation and Grid Assets**

**Collection**
- Integrated Substation Data
- Aggregated and Calculated information
- Other Systems

**Data Historian**

**Data Integration and Normalization**

**System Point**
Asset Management

Coordinated activity of an organization to realize value from assets.

Asset management enables an organization to examine the need for, and performance of, assets and asset systems at different levels.

Additionally, it enables the application of analytical approaches towards managing an asset over the different stages of its life cycle.

Thank you

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