Asset Management for Electrical distribution

Co-innovating a Digitization Journey

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General Agenda

- Introduction and Why
- General Examples
- Connected Field Devices
- Useful Data
- Architecture Examples
- Cloud Data Push
- Data Value
- Analytics

A Unique Blend

Profile

Integrated Solutions Expertise

Power Distribution Multi-Equipment expertise
(Standards, Requirements, Design…) MV and LV

Expertise on Multi-Asset Electronic Devices (Relays, Meters..), Sensors and Instrumentation Application

Electrical SCADA

Able to articulate the **value and difference** between SCADA/On Prem vs. Cloud Service difference

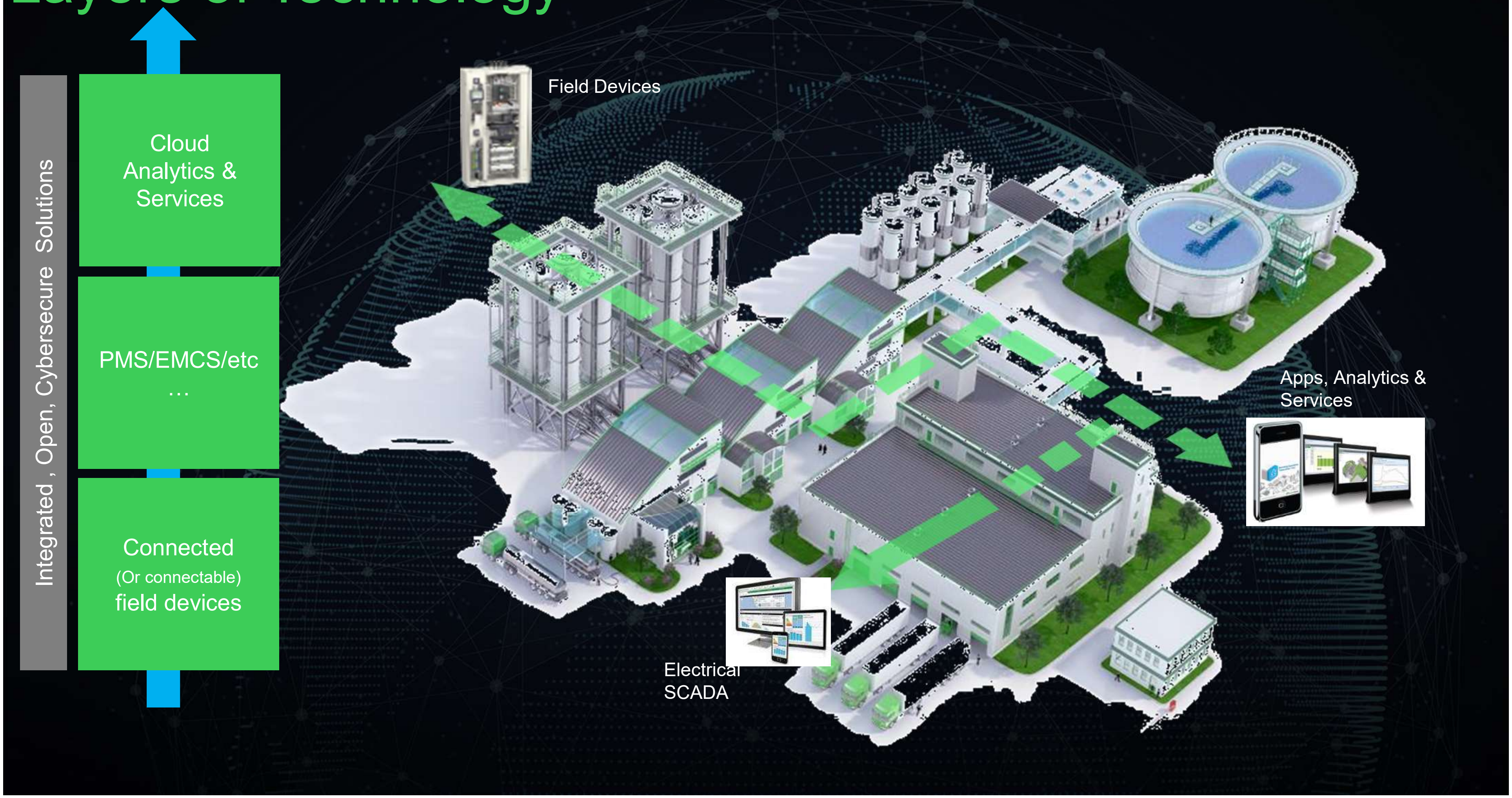
Communication Protocols and Their Application. Including Cloud Protocols (i.e. MQTT)

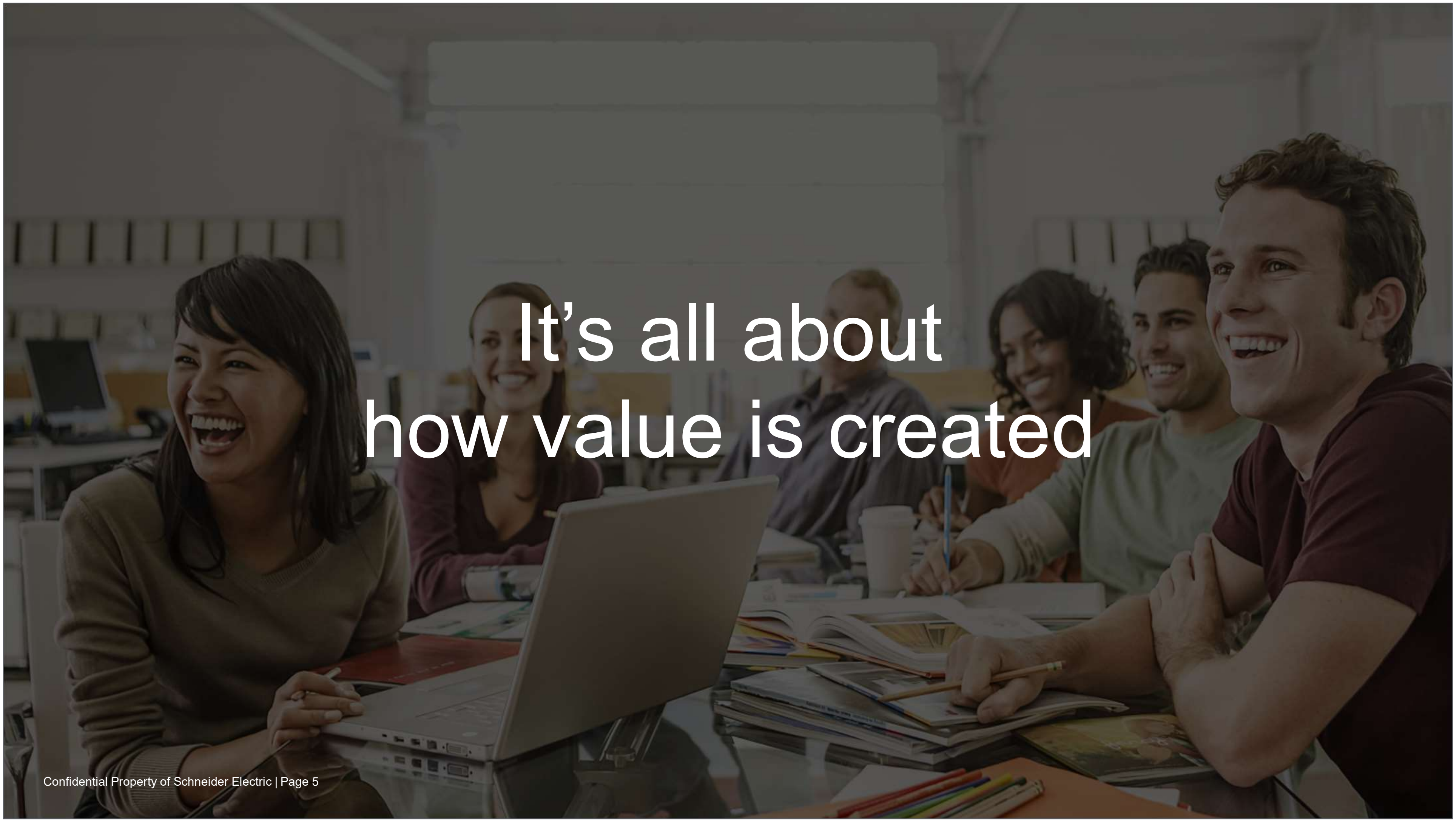
IT/OT Communication Networks

Analytics and ML knowledge (value, application, etc…)

Cybersecurity Knowledge

Layers of Technology



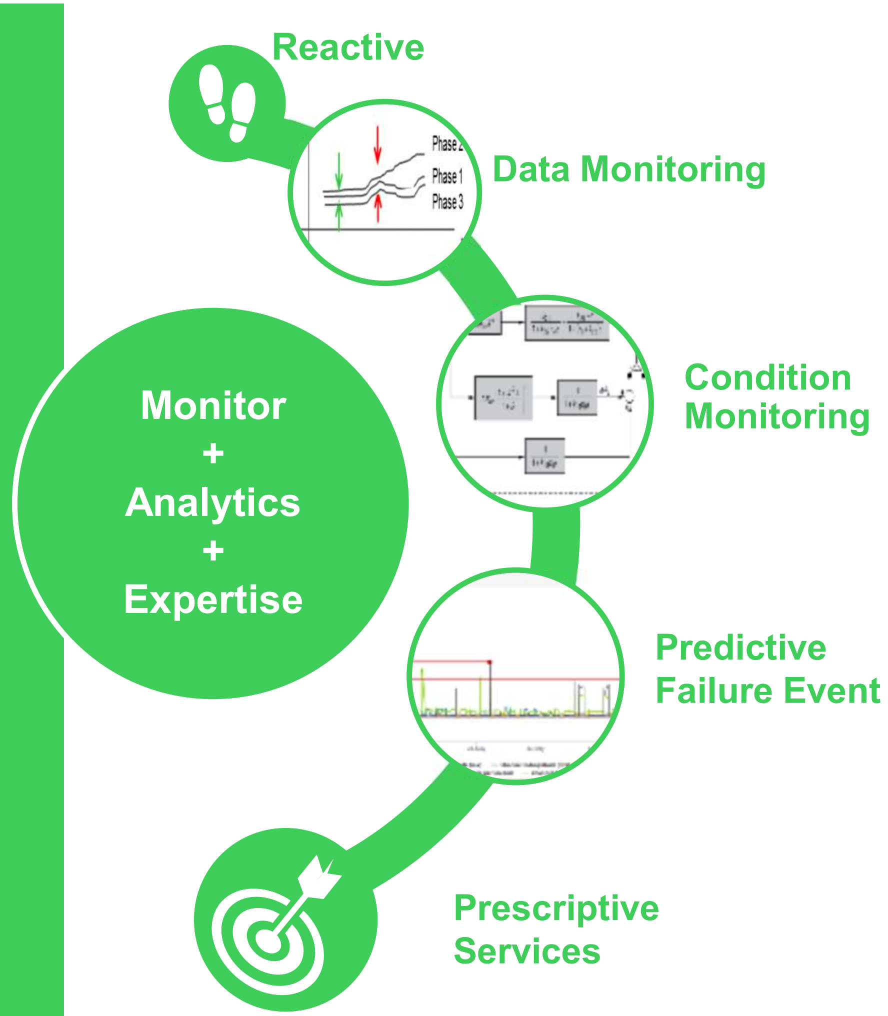

It’s all about
how value is created

Value Drivers
why should we look into this?

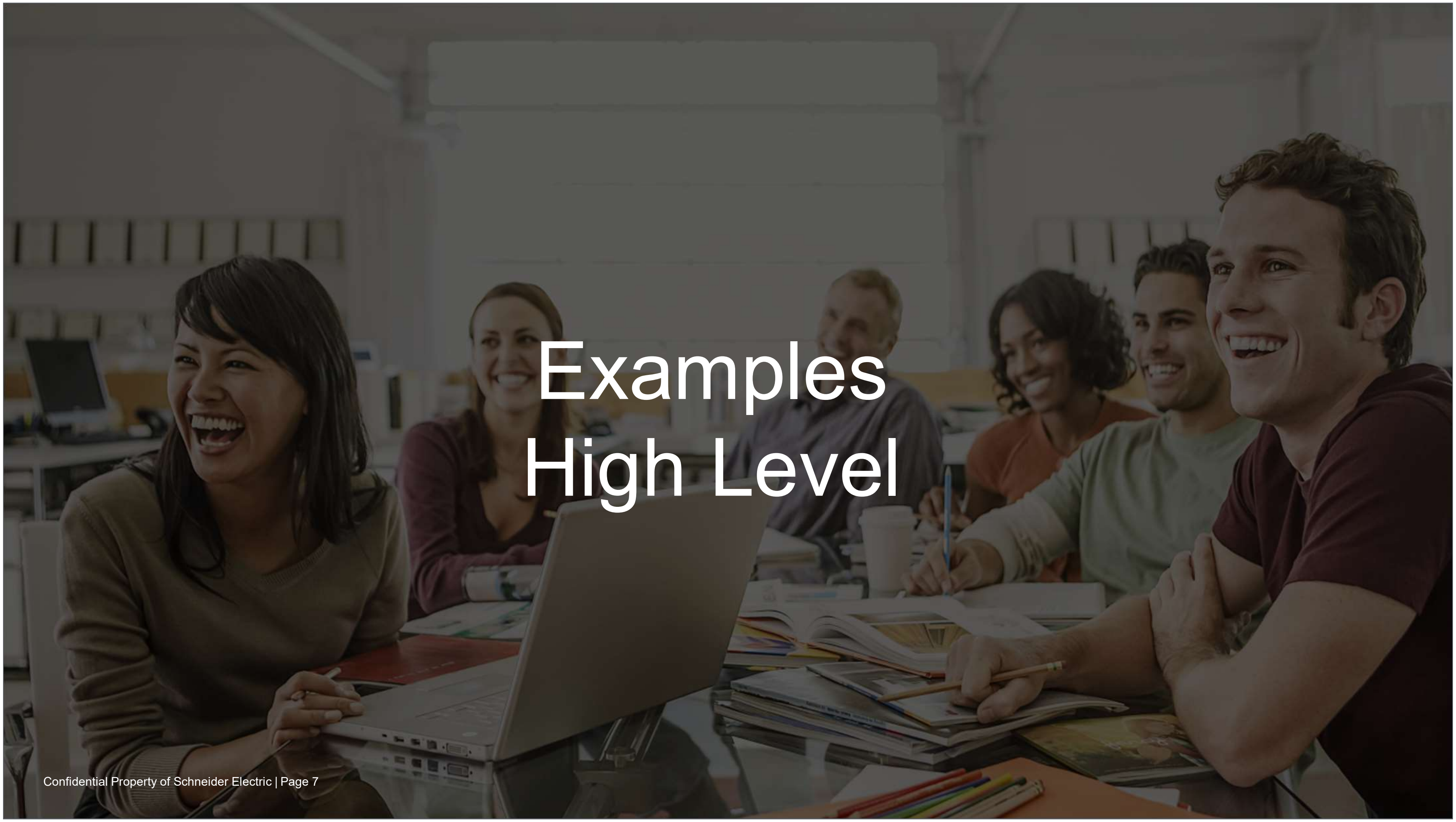
Increase employees and infrastructure protection by detecting early abnormal asset conditions (event avoidance)

Making the most of your investments by optimizing your assets lifetime

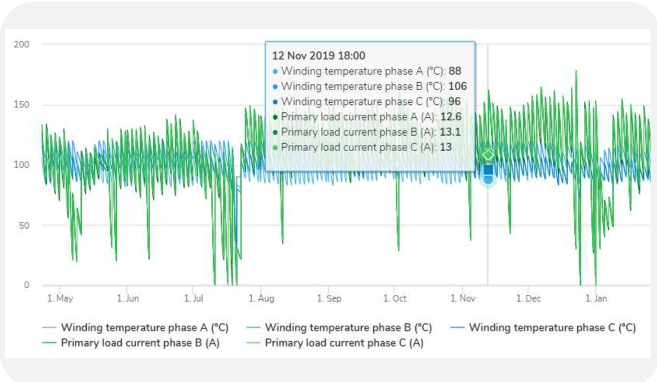
Achieve a better efficiency by optimizing your maintenance routines and budgets



Examples
High Level



Asset lifetime optimization
Nestle North America



High temperatures on TR3-04 Transformer

Sensors and HMI level (Data monitoring/trending)

Temp oscillating between 106 °C and 120°C temperature on Phase B winding, independently on the load.
Customer **Team did not prioritize immediately**

Lifetime shortening & heat trace

Analytics add further value to increase equipment TCO and precise diagnostics

Transformer lifetime was already at aprox 50%.
Aging algo determined lifetime was being shortened for operating equipment under the mentioned conditions.

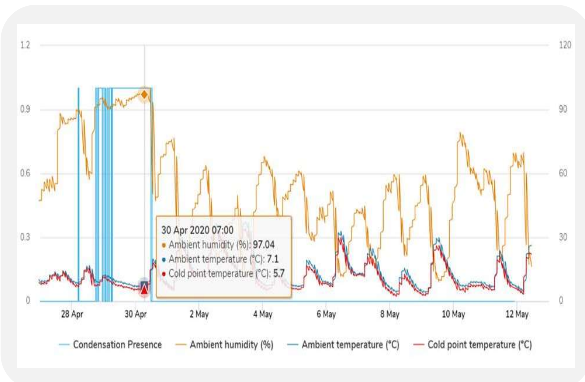
If the problem continued (or worsened), Transfo was going to lose between 2 months and 2 years of life during the following year.

Prescriptive Level

- **To repair 1 fan which is damaged.**
- **To correctly cable the low voltage section and correctly position the tap changer.**
- **Analyze THD and individual harmonics.**

Asset critical event prevention

Refinery, Texas



Condensation Presence on MV Equipment

Sensors and HMI level

Alarm appeared on Local HMI display but didn't raise any immediate Concerns.
Temperatures tracked through CL110 Sensors (inside Switch + Room Temp)

ONLY Analytics add precise diagnostics

Blue lines indicate "condensation presence" building up.
Condition is generated when relative humidity (orange line) is above 90% and "cold point temperature" (HVL metal enclosure plates temp) is below the "ambient temperature"

"Dew Point" predictive algorithm available through Asset Advisor
Determined projected risk of significant condensation presence

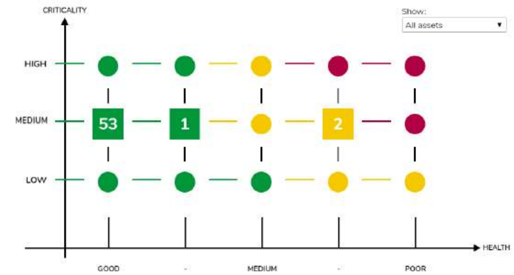
Prescriptive Recommends

To check the HVL heater control system because:

1. **A fuse may have been removed**
2. **The thermostat may be turned off or requires adjustment**
3. **120 VAC electric power may be supplied to the heater causing the heater power to be reduced to 300 watts (25%) instead of 1200 watts**

BASF North America

Recommended optimization of maintenance as a result of data driven consultation with Service Bureau



SITUATION

- Health Data Historization and analysis of many electrical devices over many months
- Accurate condition assessment of assets
- Large amount of data and discussion

CONSULT

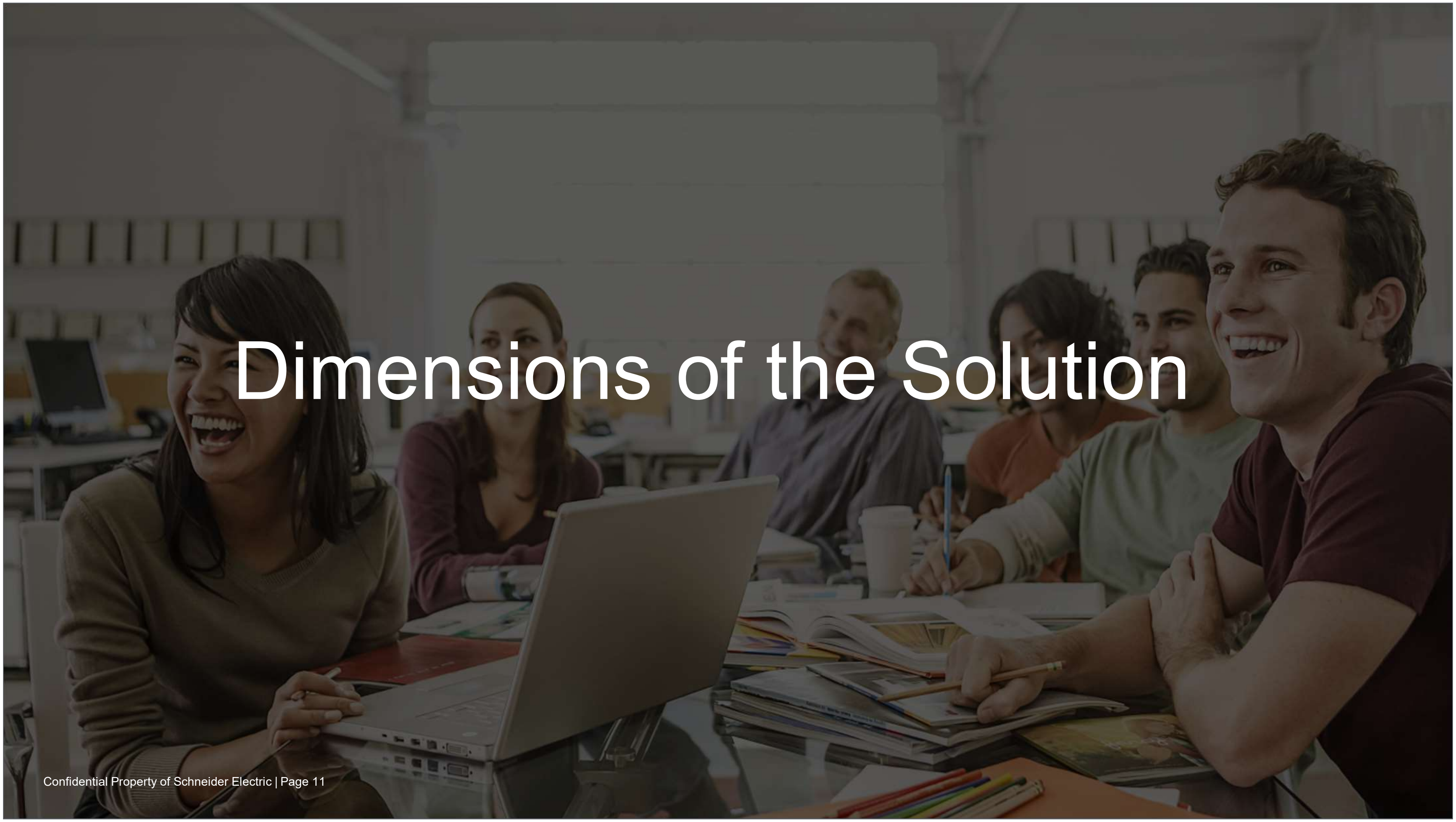
- Consultation between Online Consultants and product / maintenance experts
- Physical validation of site and asset conditions

RECOMMENDATION

- Optimize maintenance of monitored assets
- Good condition in optimal environment and operation conditions – extend intervals
- Poor condition – decrease intervals due to risk

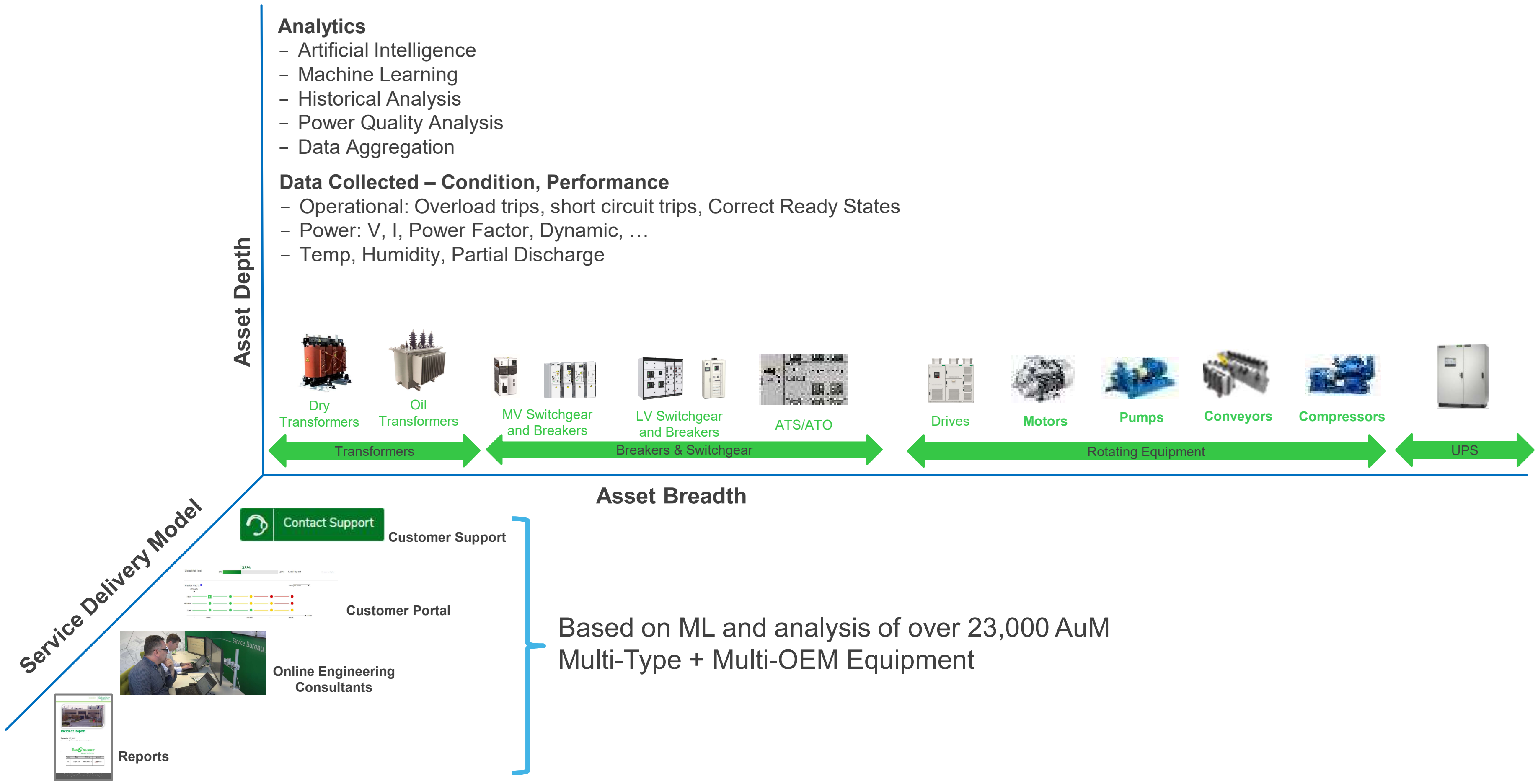
Assets	Standard Maintenance	Criticality	Condition	Optimized Maintenance
Med Voltage Circuit Breakers	3 Years	Medium	**Good**	6 Years
Low Voltage Circuit Breakers	2 Years	Medium	**Good**	4 Years
Variable Speed Drive	3 Years	Medium	**Good**	6 Years
Variable Speed Drive	3 Years	Medium	**Medium / Poor**	1.5 Years

-50% reduction in physical maintenance on **>96%** of assets
Accelerated maintenance on assets which have a **high risk of critical failure**

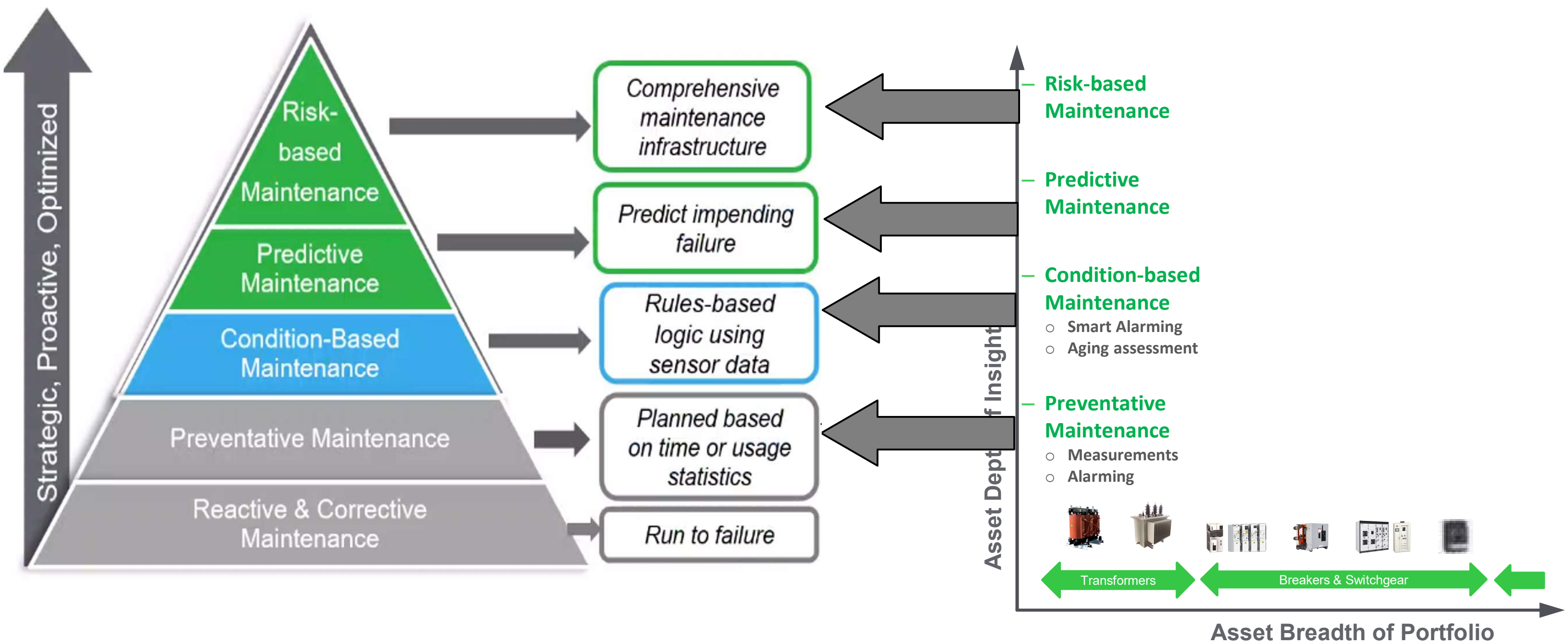


Dimensions of the Solution

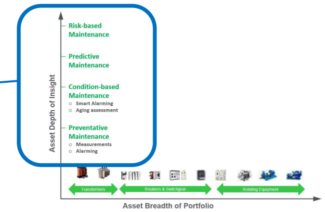
Holistic Power Systems Asset Management



Asset Management Strategies



Asset Management: Analytics Segmentation

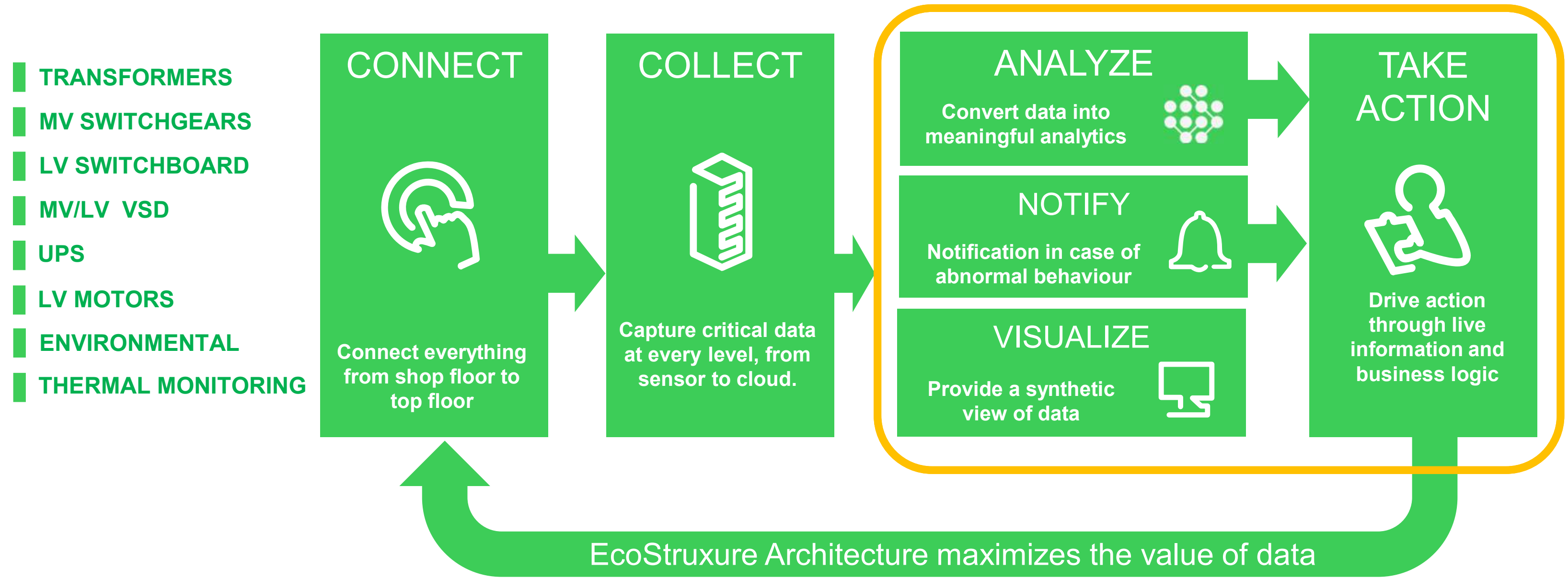


Increasing Value for Operations ↑

SERVICE CATEGORY	ENABLER FOR...
RISK ASSESSMENT: Asset operation, process recommendations. Risk assessment on time-to-critical failure, confidence level.	→ **Risk-based Maintenance**
PREDICTIVE: Early warning about a deviation from the standard behaviours learned before it become critical and while the asset is still operating normally	→ **Predictive Maintenance**
CONDITION MONITORING is a set of services providing information on the state of the asset based on the data that is captured onsite. It includes a continuous check that the behavior and operating conditions of the device are correct and detection of malfunctions or abnormal behaviors ▪ **Smart Alarming (anomaly detection) :** basic failure, fault or event detection using rules or algorithms applied to site data, ▪ **Aging assessment**: provides information regarding the wear and aging of the asset to help plan or anticipate maintenance or plan investments. Aging assessment can be based on aging models (statistical approach) or deterioration measurements.	→ **Condition-based Maintenance**
PREVENTATIVE MONITORING provides remote and user-friendly visualization of information available onsite. No treatment but basic ones like scaling or filtering. ▪ **Measurements :** remote visualization of measurements captures by sensors or by the assets themselves, ▪ **Alarming**: provides remote notification of events generated by the assets,	→ **Preventative Maintenance**

EcoStruxure Asset Advisor solution overview- From data to actionable insights

Get the best end-to-end service supported by experts that provide actionable recommendations and on-site support for your electrical distribution system



*Transforms **data** from your electrical distribution assets…* → *…through a **cloud-enabled anaytics** & expertise…* → *… into actionable **insights** and **recommendations** from experienced professionals to manage and maintain equipment health*

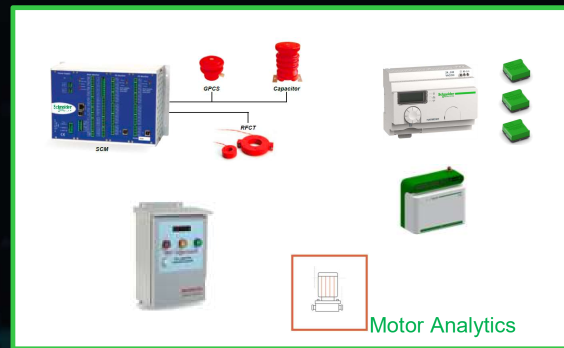
Connected Technology Overview

Integrating technologies to deliver value

Direct Connect

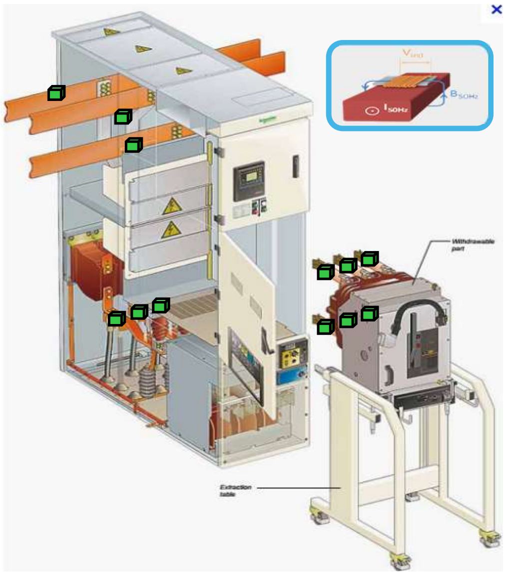
- LV Trip Unit
- Protective Relays
- XFR Temperature Controllers
- Power Meters
- Variable Frequency Drives

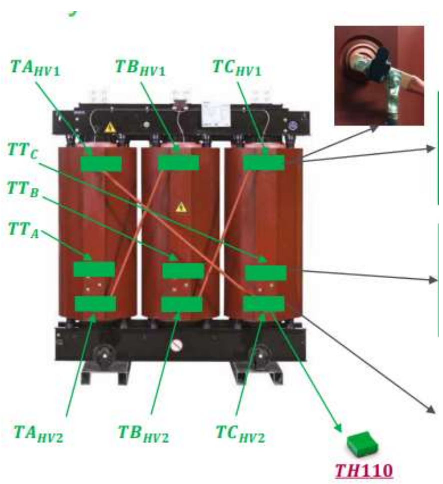
Instrumentation Technologies



- Wireless Temperature
- DGA Oil Sensors
- Partial Discharge (CB, XFR….)
- Motor Monitoring Sensors

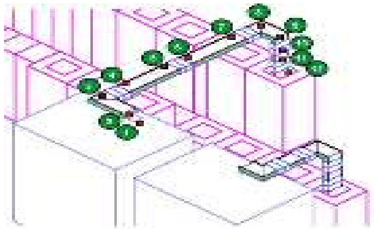
Thermal Monitoring

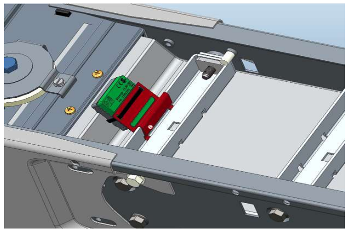




Thermal monitoring

Wireless Thermal Sensor
Or Wired Thermal Monitoring





Environmental monitoring

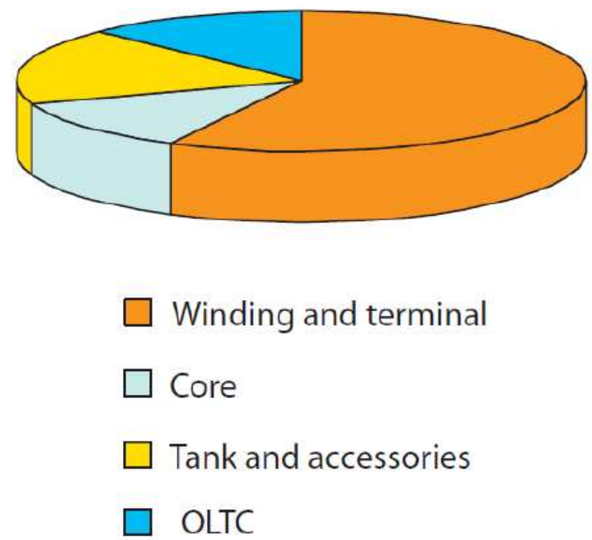
Humidity/Temperature Sensors

Life Is On | Schneider Electric

Transformer faults

- Transformer faults are generally classified into six categories:
  1. Winding and terminal faults
  2. Core faults
  3. Tank and transformer accessory faults
  4. On-load tap changer faults
  5. Abnormal operating conditions
  6. Sustained or uncleared external faults

- For faults originating in the transformer itself, the approximate proportion of faults due to each of the causes listed above is shown on the attached graph.



EAA Components

For Oil Transformer: DGA (Dissolved Gas Analyzer)

The justification for on-line monitoring is driven by the need to:

– Increase the availability

– Facilitate the transition from time-based / operational maintenance to condition-based maintenance

– To improve/maintain asset life

– To enhance failure-cause analysis.

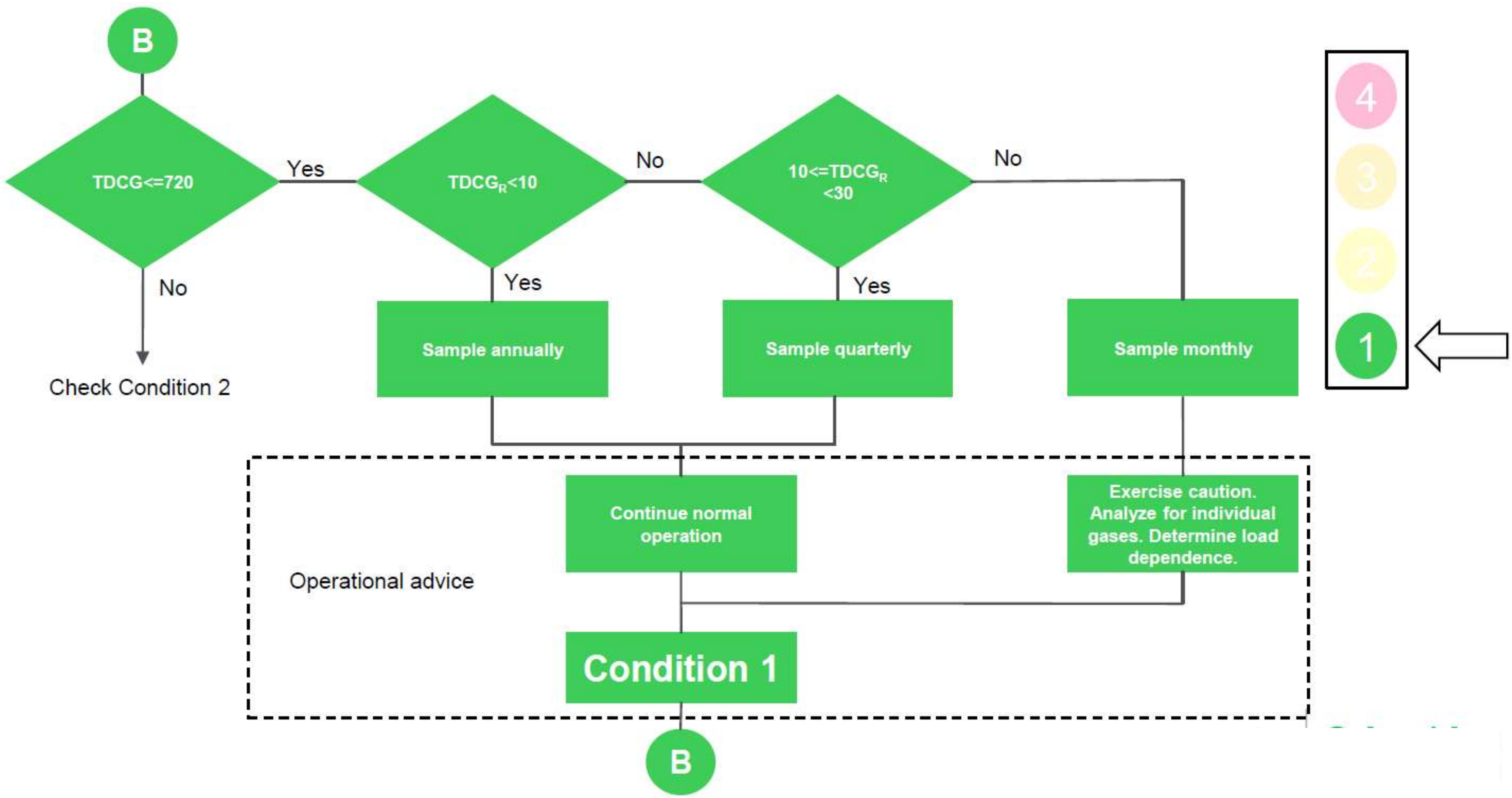
<u>DGA multi parameter/multi gas technology</u>

Hydrogen is the most typical fault gas to appear in most fault scenarios

Moisture in oil provides long-term monitoring trends as well as daily fluctuactions due to load and temperature variations and is a good indicator for transformer maintenance timing

<u>Monitoring Goal</u> : ELECTRICAL PARAMETERS + DGA + ENVIRONMENTAL CONDITIONS

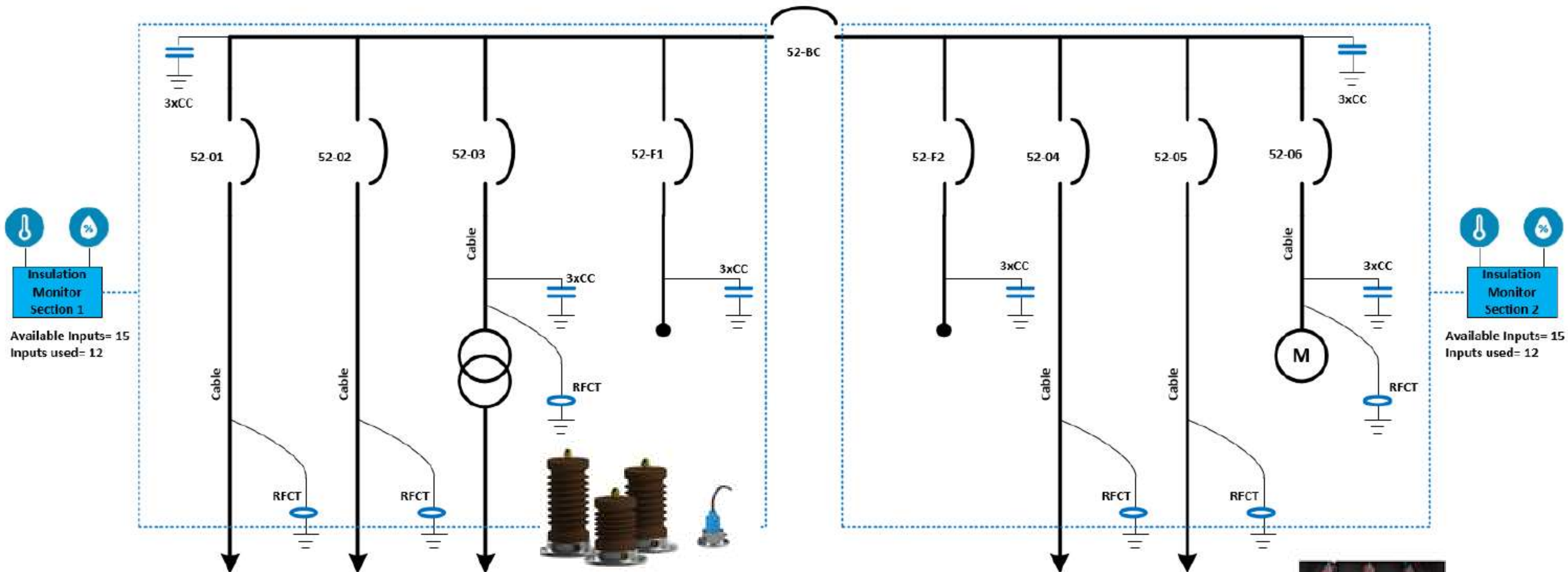
Key Gas Method



Partial Discharge

- PD is a localized electrical discharge that does not completely bridge the electrodes, essentially a small spark inside insulating material or along insulating materials surface.
- PD is a ***leading indicator*** of an insulation problem.
- It is not a unique cause of failure, however quickly accelerating PD activity can result in complete insulation failure.
- Discharges in air gaps are a typical type of PD.
- Since air has a lower permittivity than insulating materials, an enhanced electrical field forces the voids to flashover, resulting in PD.
- Energy dissipated during repetitive PD will carbonize and weaken the insulation.
- PD happens **in voids and cavities filled with air in poorly cast transformers**.

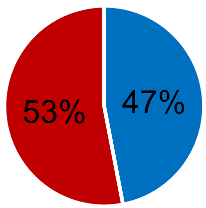
Partial Discharge monitoring in a substation



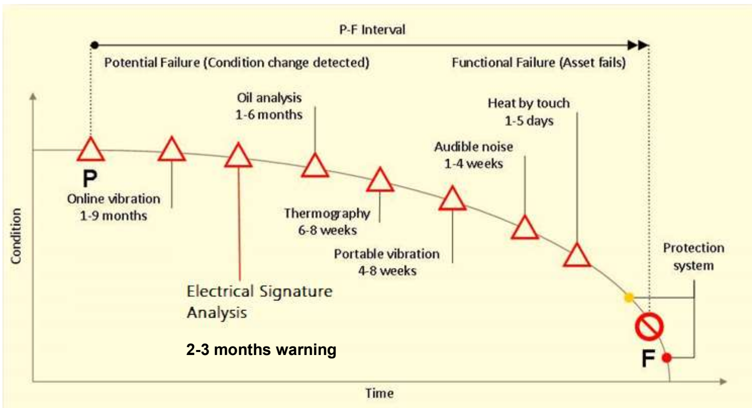
Protected assets: 2 semi-bars, transformer, motor, 6 cables, 9 CB

Motor Monitoring

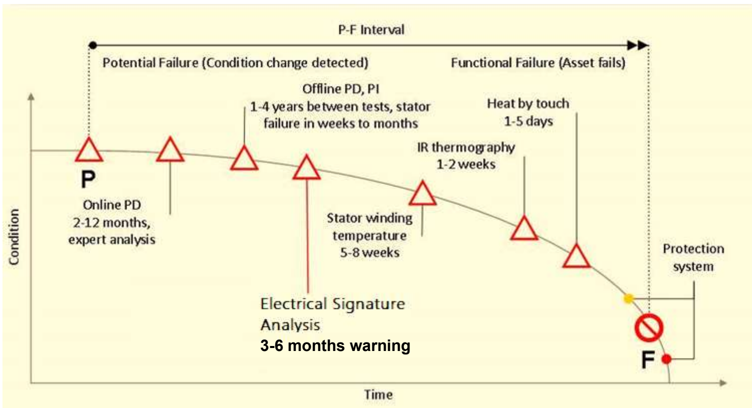
Motor Fault category



Mechanical Failures



Electrical Failures



1. Bram Corne, Jos Knockaert, Jan Desmet, "Emulating bearing faults — A novel approach", *Electrical Machines (ICEM) 2016 XXII International Conference on*, pp. 2223-2229, 2016.

2. Bram Corne, Jos Knockaert, Jan Desmet, "Misalignment and unbalance fault severity estimation using stator current measurements", *Diagnostics for Electrical Machines Power Electronics and Drives (SDEMPED) 2017 IEEE 11th International Symposium on*, pp. 247-253, 2017.

3. Noureddine Bessous, S. E. Zouzou, Salim Sbaa, Wafa Bentrah, Z. Becer, R. Ajgou, "Static eccentricity fault detection of induction motors using MVSA MCSA and discrete wavelet transform (DWT)", *Electrical Engineering - Boumerdes (ICEE-B) 2017 5th International Conference on*, pp. 1-10, 2017.

4. Noureddine Bessous, Salah Eddine Zouzou, Salim Sbaa, Abdellatif Khelil, "New vision about the overlap frequencies in the MCSA-FFT technique to diagnose the eccentricity fault in the induction motors", *Electrical Engineering - Boumerdes (ICEE-B) 2017 5th International Conference on*, pp. 1-6, 2017.

5. Tomasz Ciszewski, "Induction motor bearings diagnostic indicators based on MCSA and normalized triple covariance", *Diagnostics for Electrical Machines Power Electronics and Drives (SDEMPED) 2017 IEEE 11th International Symposium on*, pp. 498-502, 2017.

6. Bram Corne, Bram Vervisch, Stijn Derammelaere, Jos Knockaert, Jan Desmet, "Emulating single point bearing faults with the use of an active magnetic bearing", *Science Measurement & Technology IET*, vol. 12, no. 1, pp. 39-48, 2018.

How new technology works on rotating equipment

MCSA (ESA) with AI can detect electrical and mechanical failures in each stage of the transmission path

Installation

Hardware to install inside of Motor Control Center (not in motor), fitted in small space with safety

1- 2 hrs. per motor

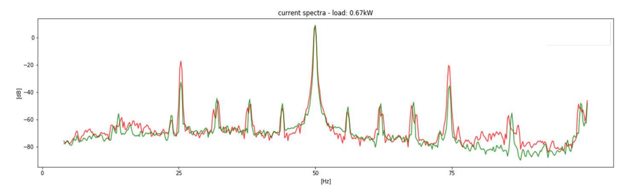
Learning phase

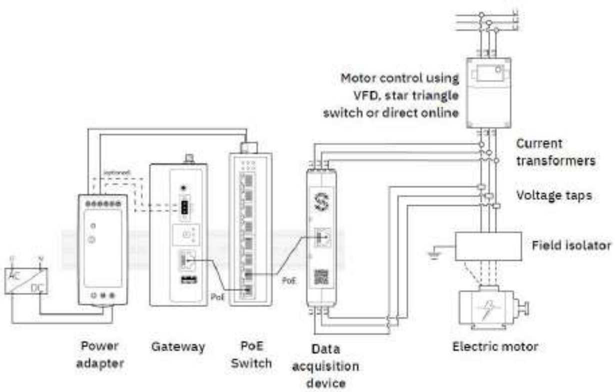
Once installed, system starts to learn assets' specific patterns

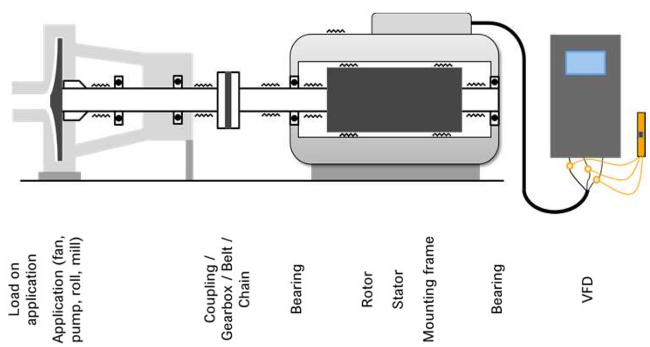
2–6 weeks

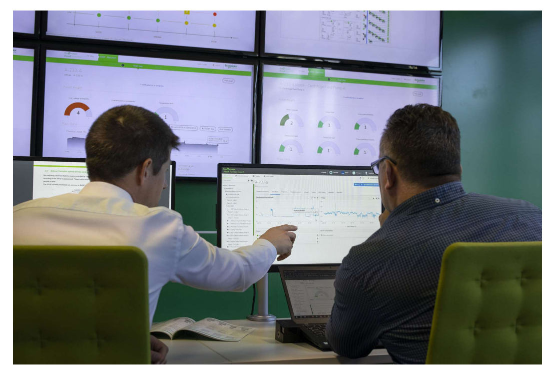
Go live

System monitors assets 24/7 and sends notifications when upcoming failure is detected







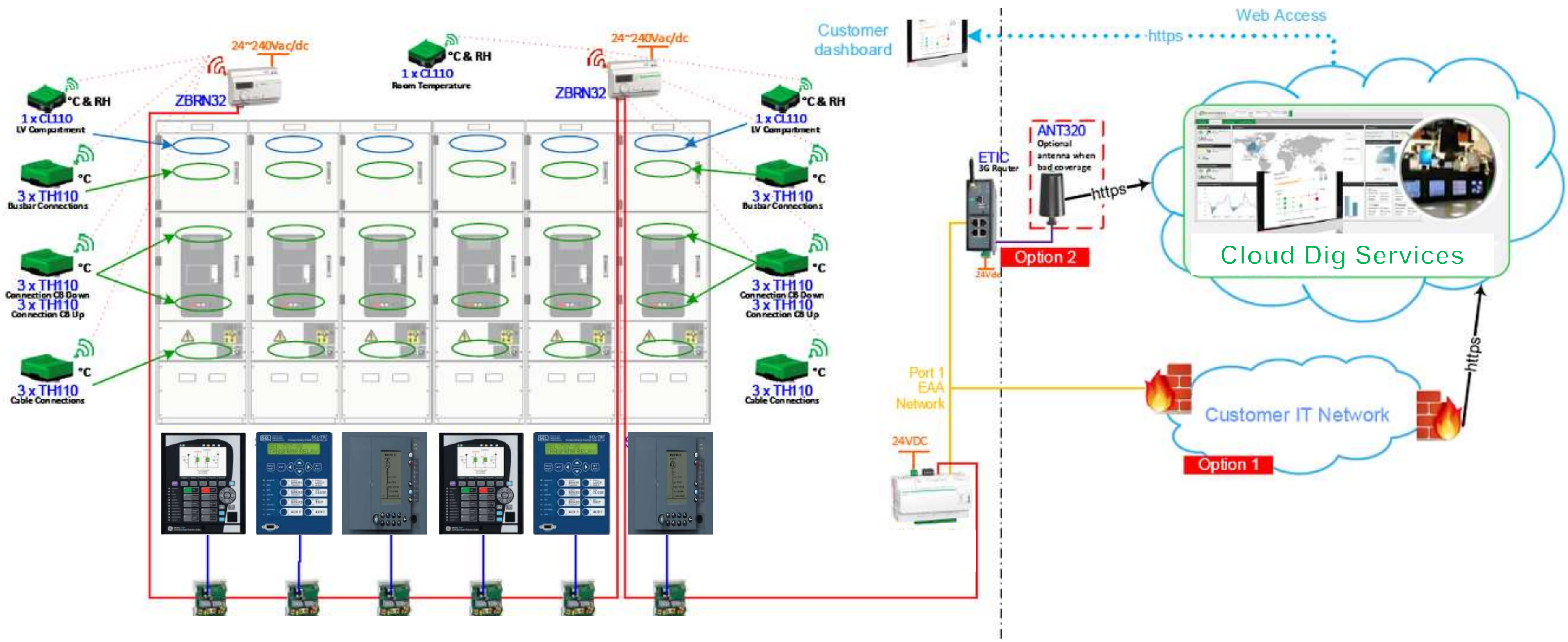


Examples – Data Collected

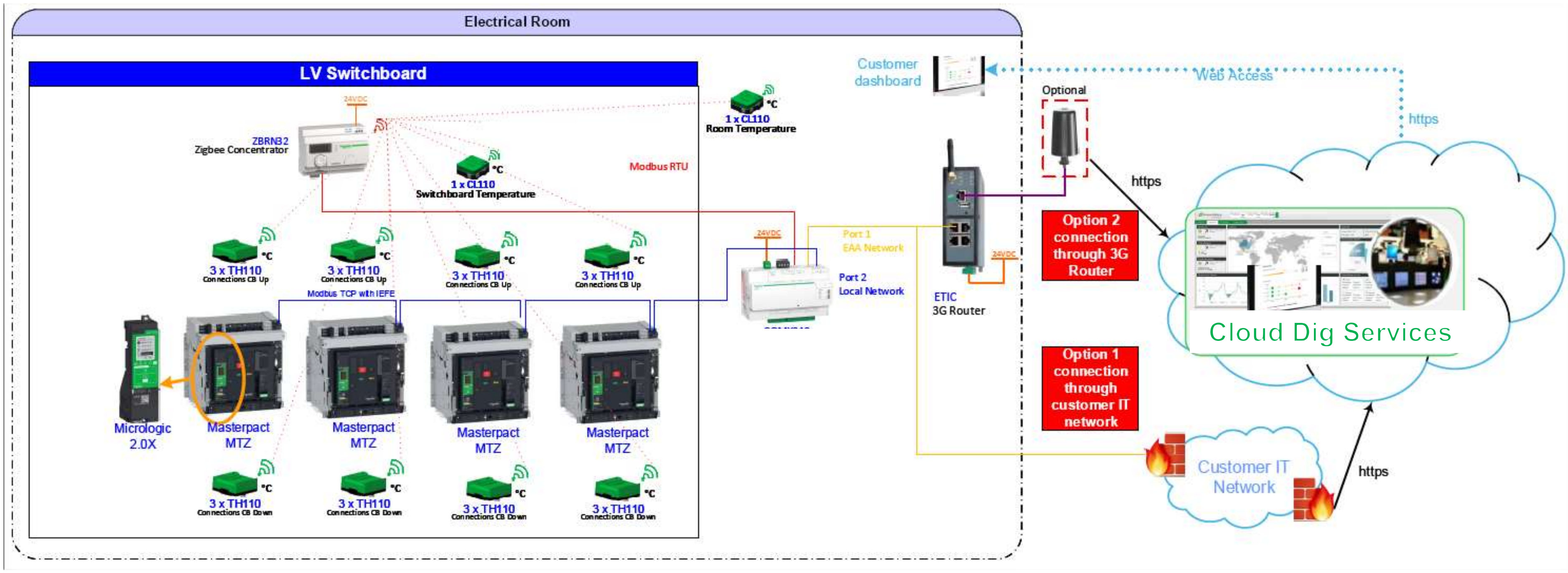
Equipment Type	Device	Signal	Purpose	Method
Medium Voltage CB	Protection Relay	Active power	Total active power	Measured
Medium Voltage CB	Protection Relay	Apparent power	Total apparent power	Measured
Medium Voltage CB	Protection Relay	Aux Voltage 1	Auxiliary voltage	Measured
Medium Voltage CB		Auxiliary voltage status	AuxVoltageStatus	Computed
Medium Voltage CB	Protection Relay	Broken Amp	Total number of broken amps	Measured
Medium Voltage CB	Protection Relay	Current phase A	Current phase 1	Measured
Medium Voltage CB	Protection Relay	Current phase B	Current phase 2	Measured
Medium Voltage CB	Protection Relay	Current phase C	Current phase 3	Measured
Medium Voltage CB	Protection Relay	Frequency	Frequency	Measured
Medium Voltage CB	Protection Relay	Last Charging Time	Charging / reloading time of the circuit breaker	Measured
Medium Voltage CB	Protection Relay	Last Opening Time	Opening time of the circuit breaker	Measured
Medium Voltage CB		Load Factor	LoadFactor	Computed
Medium Voltage CB	Protection Relay	Number of trips measured	Total number of trips	Measured
Medium Voltage CB	Protection Relay	OpNb Measured Non Resettable	Total number of operation (open / close) non resetable	Measured
Medium Voltage CB	Protection Relay	Power Factor	Total power factor	Measured
Medium Voltage CB	Protection Relay	Rack In Out Nb Measured Non Resettable	Total number of drawer operation (rack in / rack out)	Measured
Medium Voltage CB	Protection Relay	Reactive Power	Total reactive power	Measured
Medium Voltage CB		Total Broken Amp Cumulated	BrokenAmpCumulated	Computed
Medium Voltage CB	Protection Relay	Trip Current N	Last value of current N causing trip	Measured
Medium Voltage CB	Protection Relay	Trip current phase A	Last value of current on phase A causing trip	Measured
Medium Voltage CB	Protection Relay	Trip current phase B	Last value of current on phase B causing trip	Measured
Medium Voltage CB	Protection Relay	Trip current phase C	Last value of current on phase C causing trip	Measured
Medium Voltage CB	Protection Relay	Voltage A - B	RMS phase-to-phase voltage A-B	Measured
Medium Voltage CB	Protection Relay	Voltage B - C	RMS phase-to-phase voltage B-C	Measured
Medium Voltage CB	Protection Relay	Voltage C - A	RMS phase-to-phase voltage C-A	Measured
Medium Voltage CB	Smart RH sensor (CL110)	Ambient Humidity	Provide room ambient level of humidity	Linked
Medium Voltage CB	Smart Thermal sensor (TH110)	Ambient Temperature	Provide room ambient Temperature level	Linked
Medium Voltage CB		Corrosive Gas Level	CorrosiveGasLevel	Linked
Medium Voltage CB		Dust Level	DustLevel	Linked
Medium Voltage CB	Time to open	Opening Time Status	Opening Time Status	Computed
Medium Voltage CB	Fault Status	Over Fault Status	Over Fault Status	Computed
Medium Voltage CB	Total cumulative breaking current (kA²)	Electrical Wear	ElectricalWear	Computed
Medium Voltage CB	Threshold 1	Electrical Wear Aging T1	ElectricalWearAgingT1	Computed
Medium Voltage CB	Threshold 2	Electrical Wear Aging T2	ElectricalWearAgingT2	Computed
Medium Voltage CB	Number of operation	Mechanical Wear	MechanicalWear	Computed
Medium Voltage CB	Threshold 1	Mechanical Wear Aging T1	MechanicalWearAgingT1	Computed
Medium Voltage CB	Threshold 2	Mechanical Wear Aging T2	MechanicalWearAgingT2	Computed
Medium Voltage CB		Number of trips cumulated	TripsCumulated	Computed
Medium Voltage CB	Time to open	Total Open Bit	TotalOpenBit	Computed
Medium Voltage CB	Number of operation	Total Operation Number	TotalOpNb	Computed
Medium Voltage CB	Number of draw out operation	Total Rack InOut Number	TotalRackInOutNb	Computed

Architecture Examples

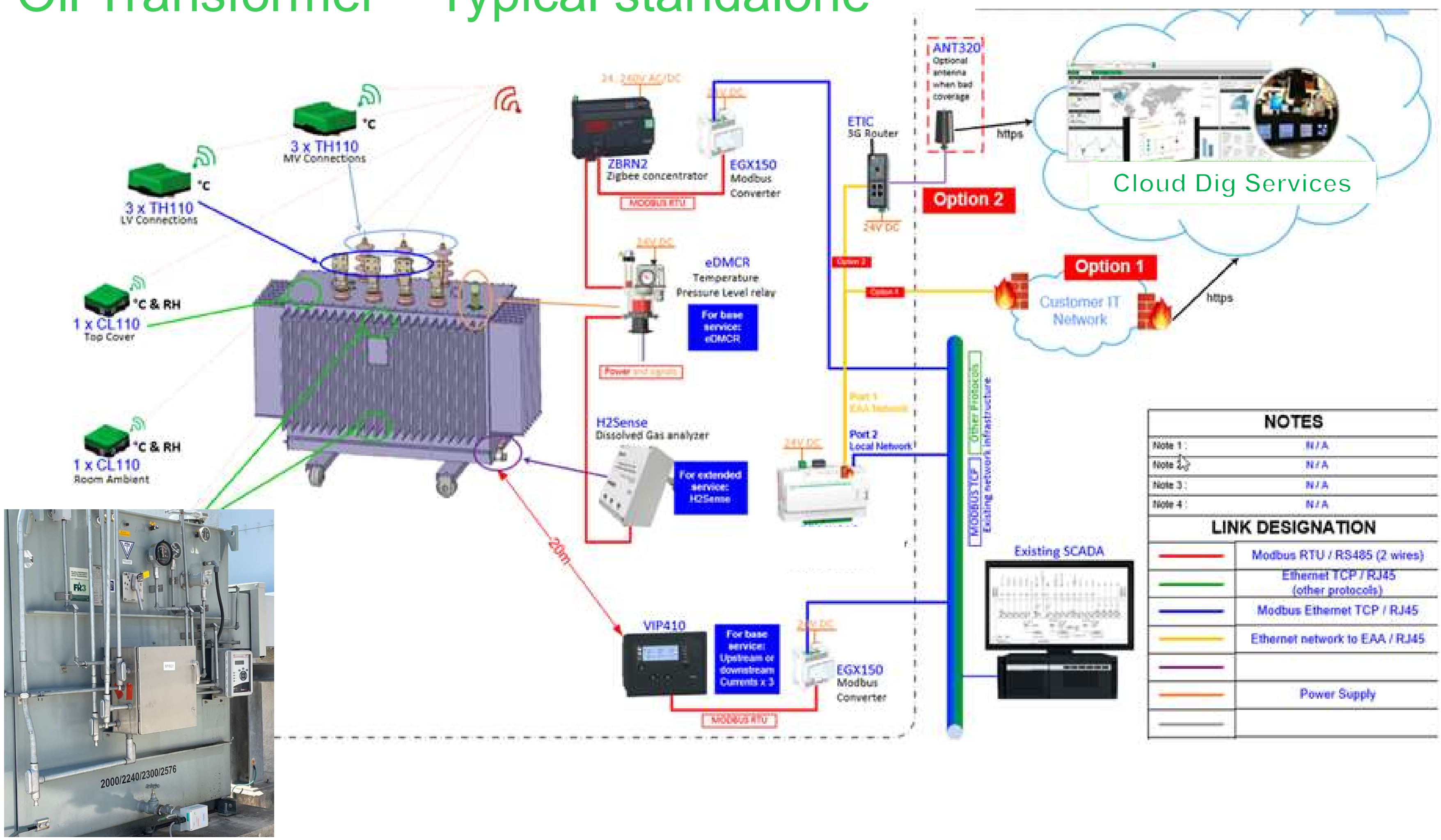
MV Switchgear and Circuit Breakers



LV Circuit Breakers – EAA Platform



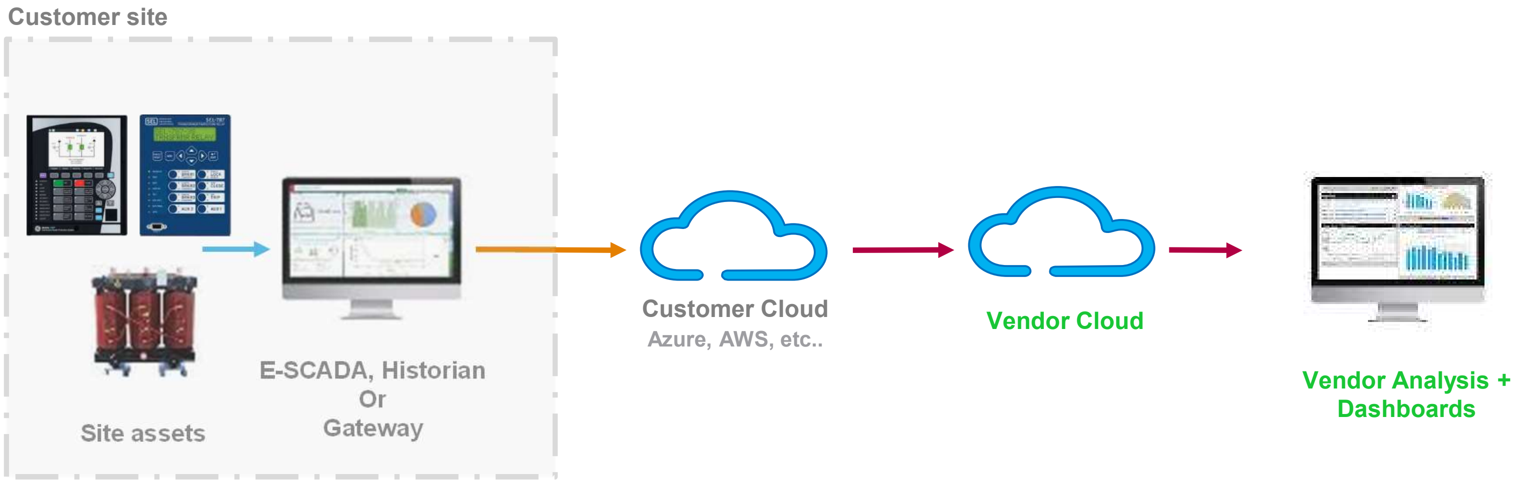
Oil Transformer – Typical standalone



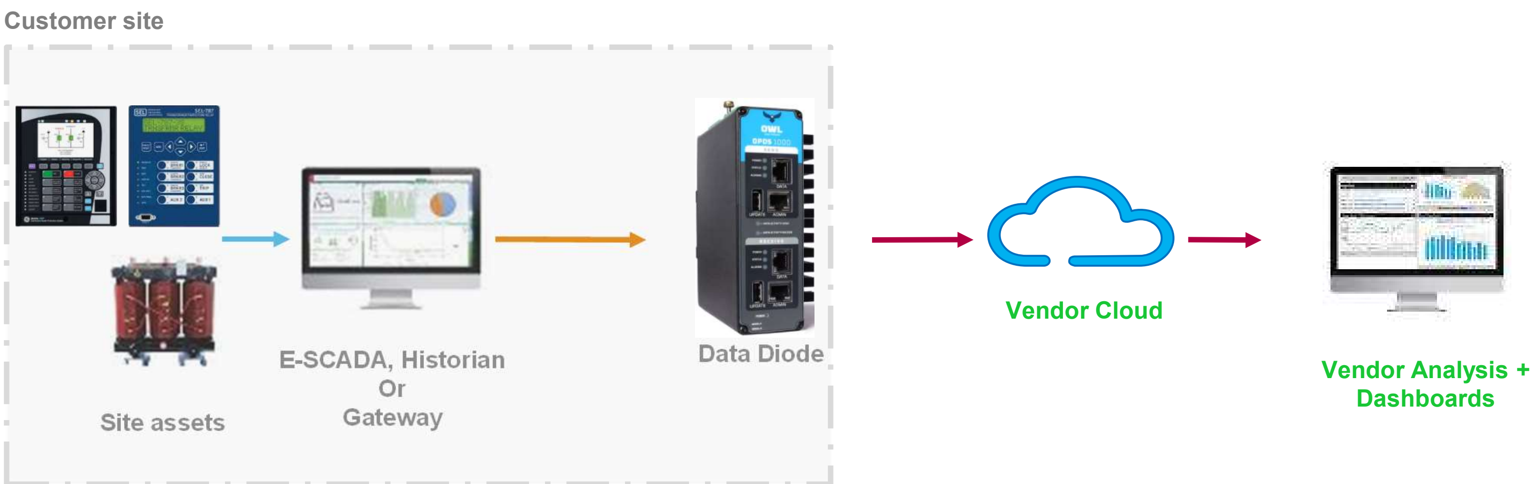
Cloud Data Push

Data Push Options

Data Push Options



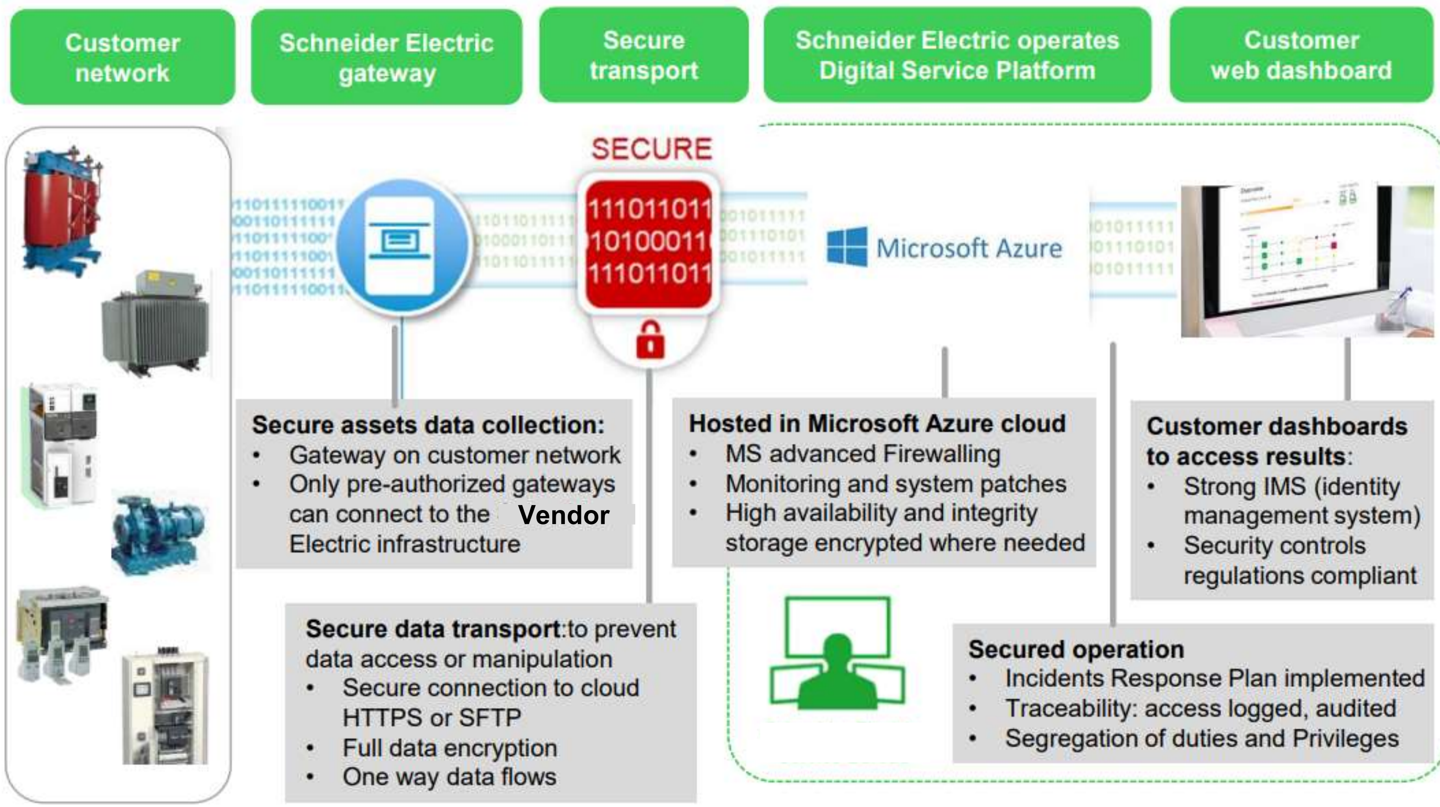
Data Push Options

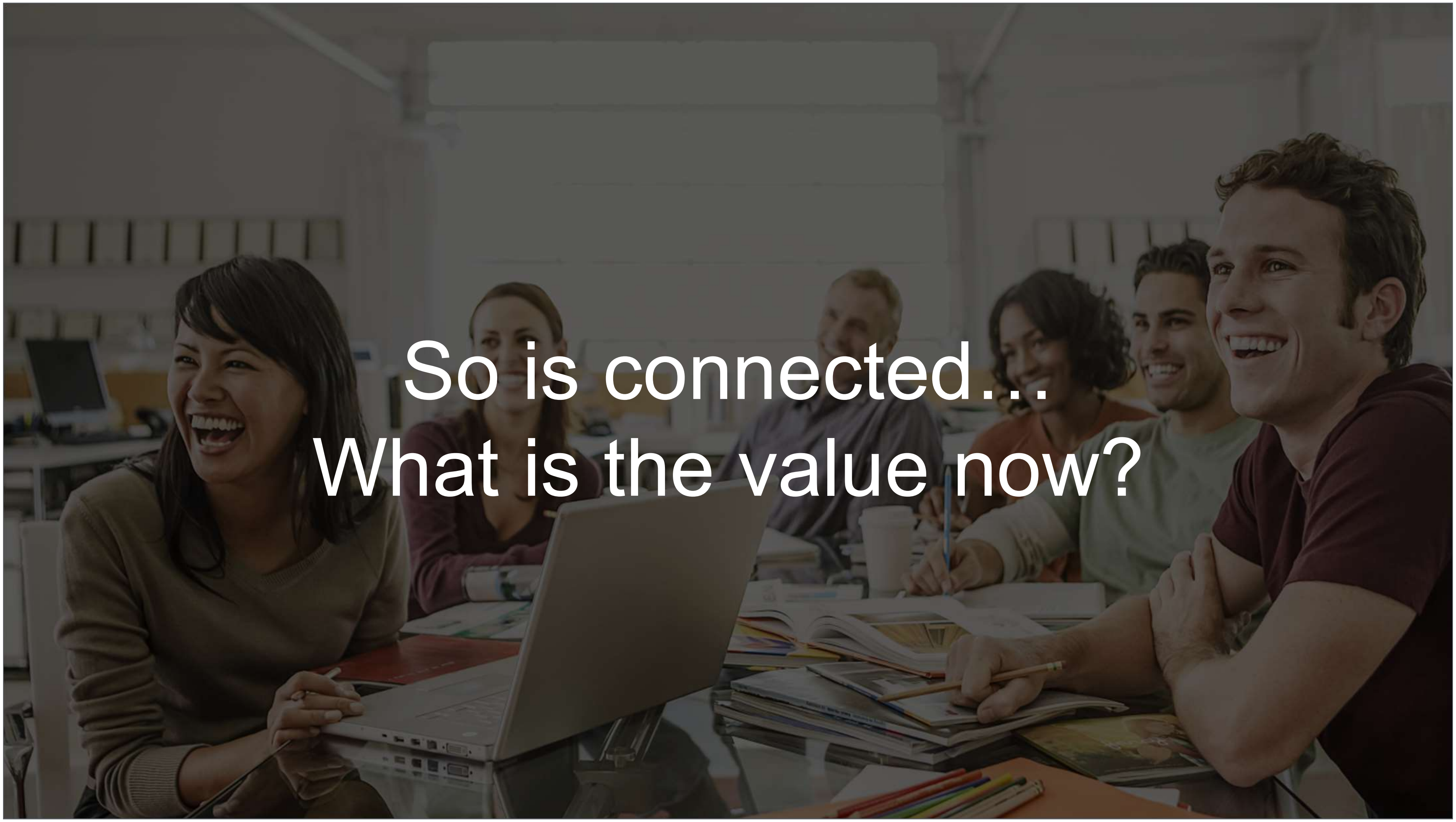



A Touch on Cyber Security

Cybersecurity Overview

- Secured Infrastructure relies on state-of-the-art technologies and security practices
- Secure by design following strictly Secure Development Lifecycle
- Secured operation following global policies and strong validation procedures
- Customer remain as data owner, and vendor follows latest international AND national Data Protection regulations




So is connected…
What is the value now?

LV Panels : Smart alarming and monitoring

Potential Failure Mode	Potential Causes	Data Inputs	Potential Consequences	Value to customers
Flashover	Humidity and Temperature	Sensor Values (Thermal monitoring)	Fire, corrosion	**Safety and Availability**
Over temperature / Wiring issue	Loose Connection, Bad tightening, overuse	Sensor Values (Thermal monitoring)	Fire	**Safety and Availability**
Accelerated ageing	Network fluctuation	Voltage	Unnecessary stress / Life cycle reduced	**Efficiency**
Power Quality	Network perturbations	P,Q,S	Tarification/utilities, Unnecessary stress	**Efficiency**
Over heating	Tightening issue, overuse	Heat Tag sensor	Fire	**Safety**

LV Breakers : Smart alarming and monitoring

Potential Failure Mode	Potential Causes	Data Inputs	Potential Consequences	Value to customers
Over temperature / Wiring issue	Loose Connection	Sensor Values (Thermal monitoring)	Fire	**Safety and Availability**
Accelerated ageing	Environnemental, Usage / loads	Voltage, Trip Unit ageing, sensor value	Unnecessary stress / Life cycle reduction	**Efficiency**
Phase Unbalanced	Loads issue or electrical settings	Voltage, Currents, Load profile & factor	Life cycle reduction	**Efficiency**
Communication issue	On-site communication loss	All KPIs	Life Cycle reduction	**Efficiency**
Bad settings	Commissioning	Trip unit	Failure mitigation	**Safety**
Voltage drop	Network fluctuation	Voltage	Life Cycle reduction	**Efficiency, Availability**
Abnormal wearing	Environnemental, Overuse, Usage / loads	Contact wear, Number of operation and draw out	Fire, Life Cycle reduction	**Safety, Efficiency**
Heath Index warning	Multiples (Eletrical wear, trip currents, opening times)	All KPIs	Fire, Life Cycle reduction	**Safety, efficiency, availability**

MV Cubicles : Smart alarming and monitoring

Potential Failure Mode	Potential Causes	Data Inputs	Potential Consequences	Value to customers
Flashover	Humidity and Temperature	Sensor Values (Thermal monitoring) Condensation presence	Fire, corrosion	**Safety and Availability**
Over temperature / Wiring issue	Loose Connection	Sensor Values (Thermal monitoring) Phase discrepencies Busbar temperature	Fire	**Safety and Availability**
Accelerated ageing	Network fluctuation	Voltage and frequency checks Contact quality	Unnecessary stress / Life cycle reduced	**Efficiency**
Power Quality & Profile	Network perturbations	P,Q,S	Tarification/utilities, Unnecessary stress	**Efficiency**

MV Breakers : Smart alarming, monitoring and Analytics

Potential Failure Mode	Potential Causes	Data Inputs	Potential Consequences	Value to customers
Over temperature / Wiring issue	Loose Connection	Sensor Values (Thermal monitoring)	Fire	**Safety and Availability**
Accelerated ageing	Environnemental, Usage / loads	Electrical and mechanical wears Temperatrue ageing trip unit Corrosion ageing, Stress level	Unnecessary stress / Life cycle reduction	**Efficiency**
Phase Unbalanced	Process loads repartition or electrical settings	Voltage, Currents, Load profile & factor	Life cycle reduction	**Efficiency**
Bad settings	Commissioning	Protection relays and trip circuit supervision	Failure mitigation	**Safety**
Voltage drop	Network fluctuation	Voltage	Life Cycle reduction	**Efficiency, Availability**
Heath Index warning	Multiples (Electrical and mechanical data, environnemental)	All KPIs (+ SF6 leak, Last time operaiton, Logic input interpretation, opening & charging time)	Fire, Life Cycle reduction	**Safety, efficiency, availability**

Dry Transformers: Monitoring, Smart alarming and Analytics

Potential Failure Mode	Potential Causes	Data Inputs	Potential Consequences	Value to customers
Over heat	Fan not working, Loose connection	MV & LV connection sand winding temperatures. Virtual sensor. Electrical data (U, I, P).	Fire risk	**Safety and availability**
Transformer trips	Termination failures Winding Short circuit Insulation failure Relay bad settings	Primary and secondary load / protection relays. Fan setpoint and status High Alarm and emergency setpoint	Flashover Downtime	**Efficiency and availability**
Accelerated ageing	Faulty operating conditions (voltage, magnetizations, load/temperature)	Ambient humidity and temperature Winding temperature Electrical data (U, I, P).	Accelerated Ageing Unnecessary Stress Corrosion risk	**Efficiency**
Innapropriate settings	Network fluctuation Settings not optimized	Current and voltage Control Load factor and profile	Power Quality Power Drops (Voltage and/or current) Load unbalance	**Efficiency and availability**

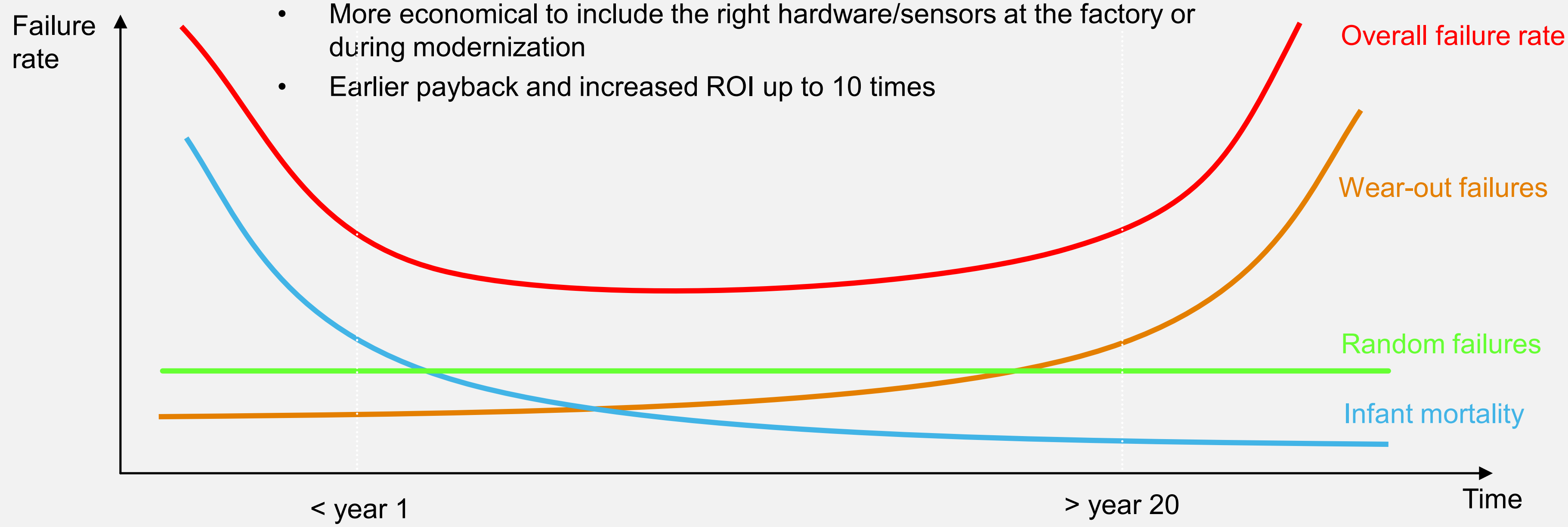
Detection Features

Application	Failure mode or cause of failure	How far in advance can we detect it?
Supply	Voltage/current unbalance	months
	Harmonics distortion, P.Quality issue	months
	Voltage drops/overvoltage	months
Motors	Stator shorts (interturn/turn-to-turn)	weeks
	Stator winding looseness	weeks
	Electrical unbalance	months
	Broken/loose rotor bars	months
	Rotor eccentricities	months
	Misalignment	weeks
	Soft foot	weeks
	Bearing degradation	weeks
	Mechanical unbalance	weeks
Coupling/ Gears	Coupling eccentricity and/or unbalance	weeks
	Broken/cracked gear teeth	months
	Gear misalignment/eccentricities	weeks
	Pulley unbalance	months
	Belt/chain wear	months
Pumps/ compressors	Cavitation	months
	Unbalance	months
	Impeller damage	months
	Bearing degradation	weeks
Conveyors	Misalignment	weeks
	Bearing degradation	weeks
Blowers/fans	Impeller damage	months
	Misalignment	weeks
	Mechanical unbalance	months
	Bearing degradation	weeks
Rolls/mills	Mechanical unbalance	months


Analytics

Digital Services – New and Existing.

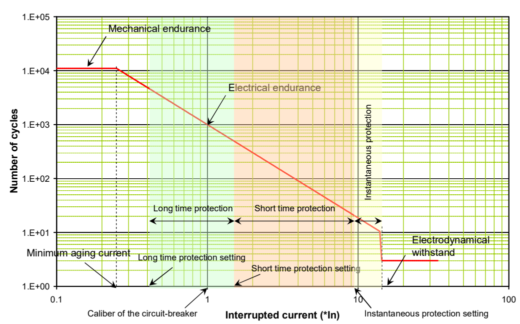
- Consider accelerated ageing, # of operations, harsh environment, maint, Historization of Data (baseline)
- The risk of failure is also present at the beginning (infant mortality, installation errors, manufacturing defects)
- More economical to include the right hardware/sensors at the factory or during modernization
- Earlier payback and increased ROI up to 10 times



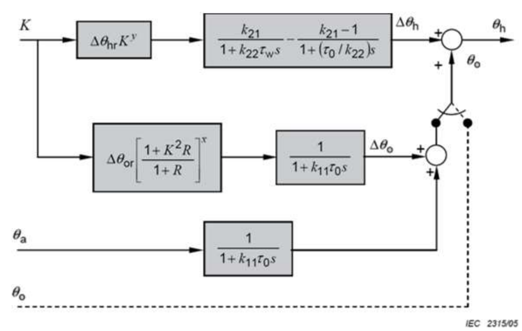
Where do the analytics come from?

Analytics need knowledge on the assets to leverage measurements

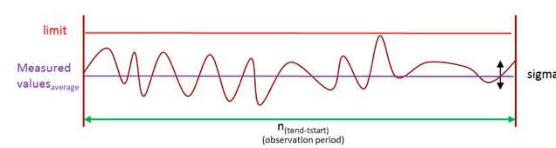
- Equipment manufacturer: Mechanical endurance, nominal lifetime, test results, …
- International Standards: IEC, IEEE, …
- Equipment model: Thermal models, aging models, …
- Equipment Service Expert: Experience from field
- Data scientists: Machine learning detects deviation from normal conditions, advanced statistics
- Historical Analysis: Machine learning constant improvement by comparison of asset historical data vs. new data



Masterpact electrical endurance

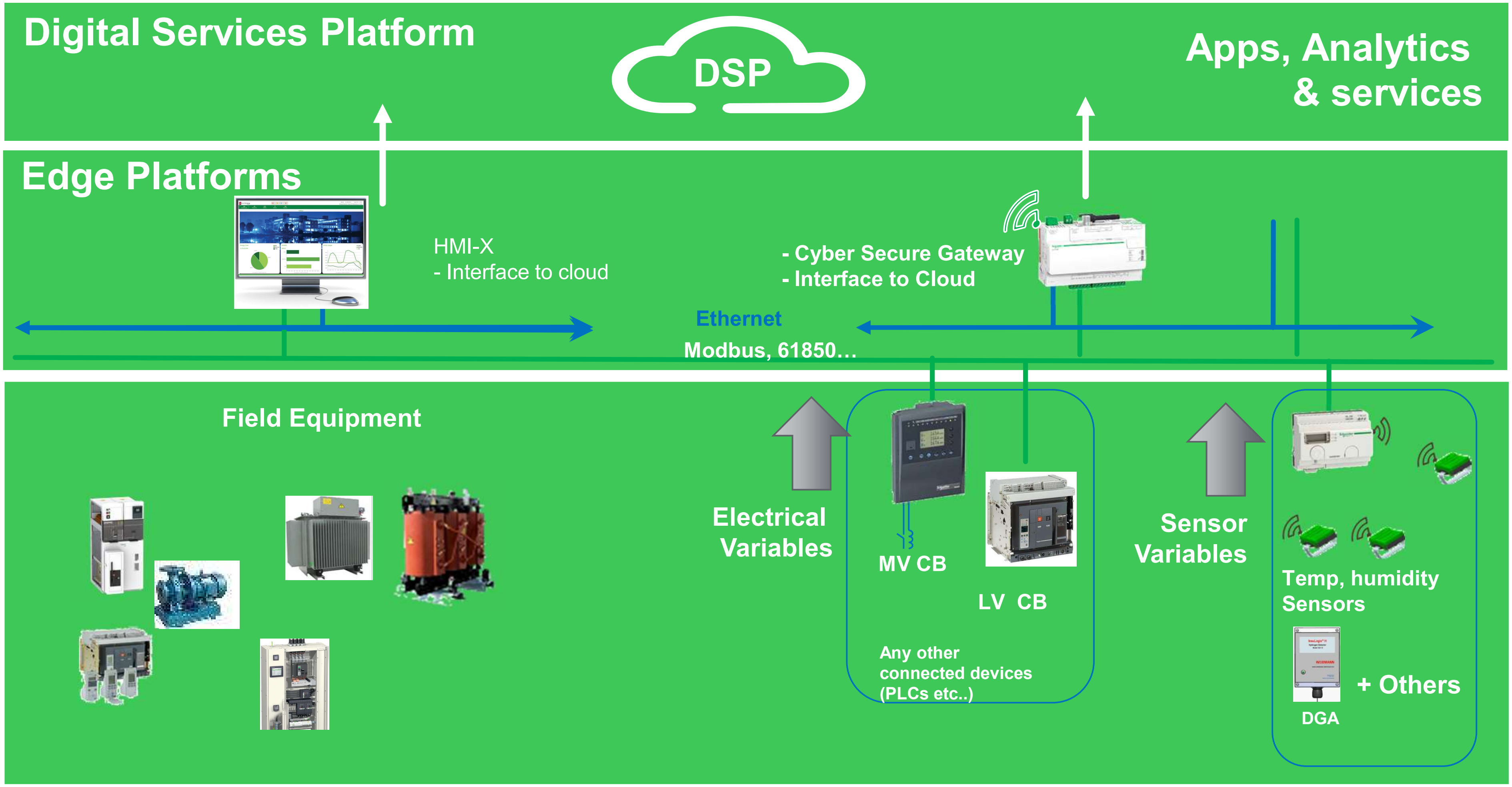


Oil transformers thermal model

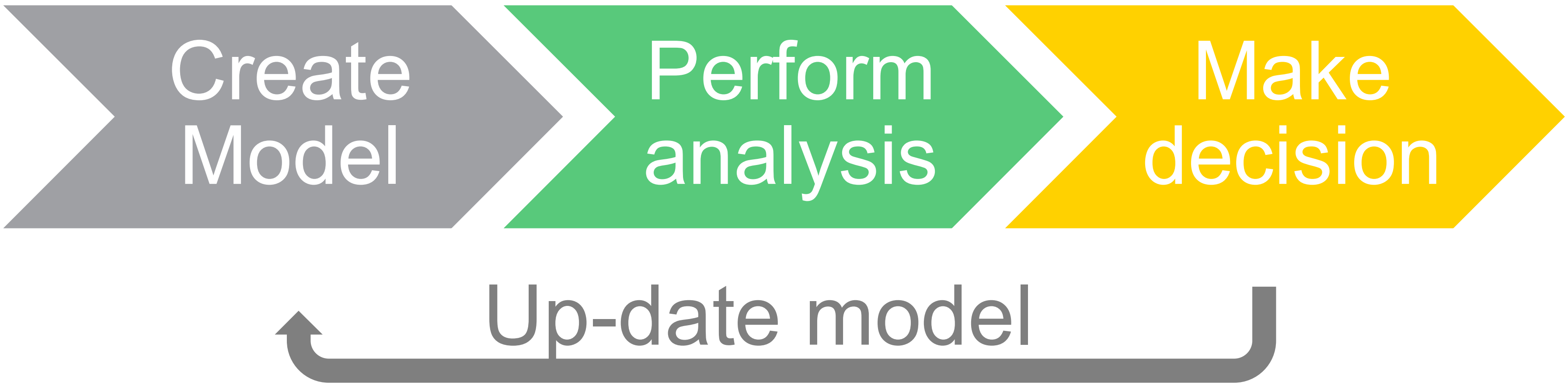


Probability of out-of-range value

Example



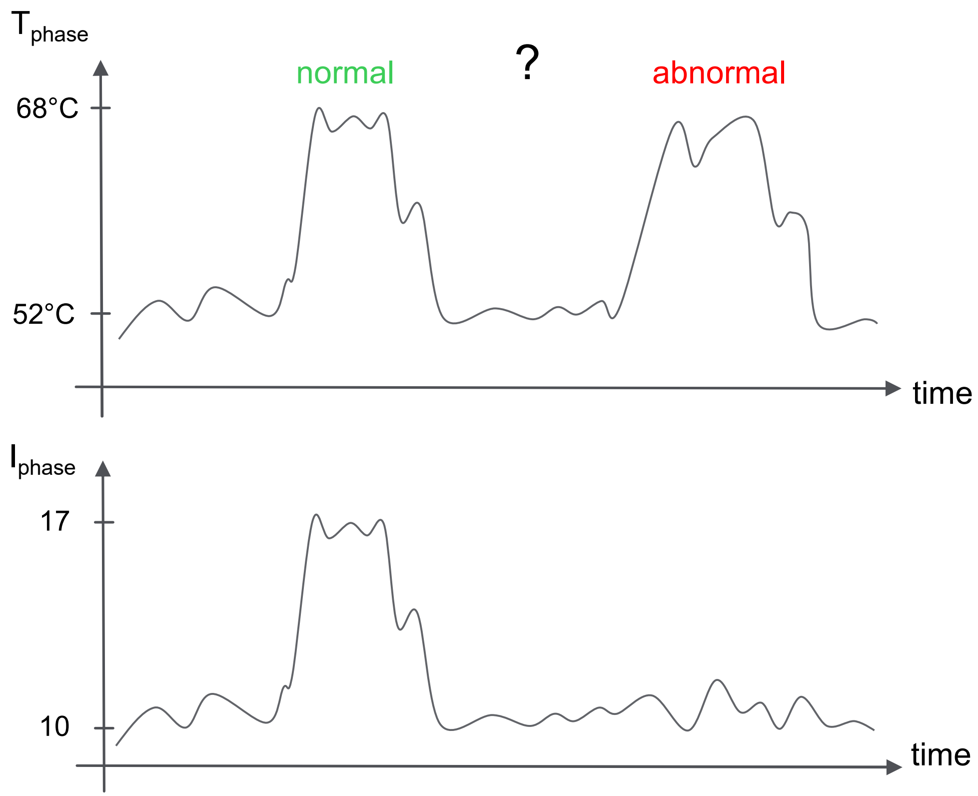
Digital Services Platform
DSP
Apps, Analytics & services
Edge Platforms
HMI-X
- Interface to cloud
- Cyber Secure Gateway
- Interface to Cloud
Ethernet
Modbus, 61850…
Field Equipment
Electrical Variables
MV CB
LV CB
Any other connected devices (PLCs etc..)
Sensor Variables
Temp, humidity Sensors
DGA
+ Others


Create Model
Perform analysis
Make decision
Up-date model

From Business Need to Analytics Solution (1)

Business / Problem Statement

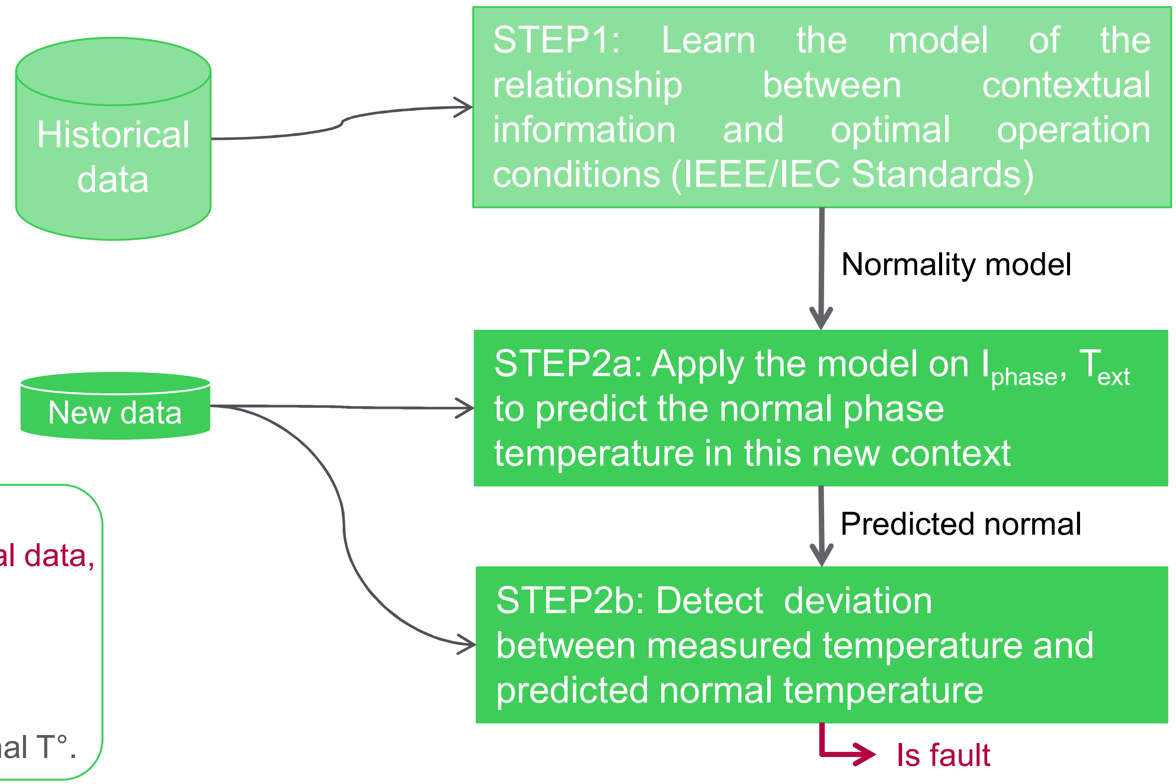
Main problem in brief:
Using a 'high temperature threshold' is not sufficient because the "normal temperature" depends on context: external air temperature and load



From Business need to Analytics Solution (2)

Analytics Solution Statements

- *Describe* ***Analytics Ways*** *to solve the Technical Problem : a way to* ***orchestrate Analytics Components*** *to solve the pb.*
- *Leverage internal / external competencies and cooperation*



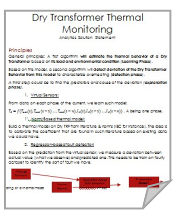
Solution statement in brief:
Learn a reference model from normal historical data, able to provide the “normal operation” in any context;

Then, for example, detect overheating as a deviation of measured T° from predicted normal T°.

From Business need to Analytics Solution (2)

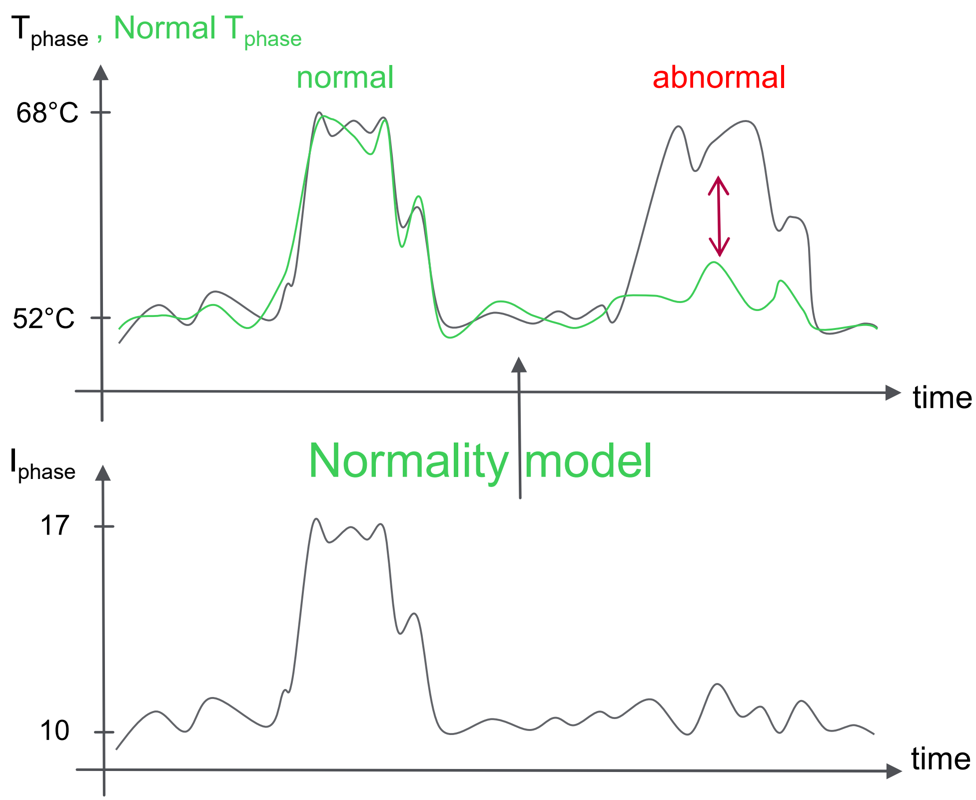
Analytics Solution Statements

- *Describe **Analytics Ways** to solve the Technical Problem : a way to **orchestrate Analytics Components** to solve the problem*


Dry Transformer Thermal Monitoring

Solution statement in brief:
Learn a reference model from normal historical data, able to provide the "normal temperature" in any context;

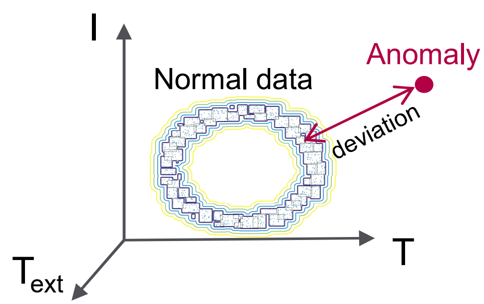
then detect overheating as a deviation of measured T° from predicted normal T°.



Fault detection simple example

Distance-based: directly predict the deviation of all variables from normal

- Machine Learning Model: the model is a mathematical function « wrapping » normal data space.



Can detect faults on any variable in the group

Example of Health Analysis Calculation

To be displayed during presentation – Proprietary Information cannot be shared on hard copy

Other Examples

Customer Success Stories

- BASF – Link
  - Cost Savings – Link

- University of Rochester Medical Center – Link

- Explore our customer stories – Link

Life Is On | Schneider Electric

FPSO anchored in the gulf of Guinea

18 **Months since assets first connected From May 15th 2019**

98 **Assets with health index**

MV Circuit Breaker
Analytics

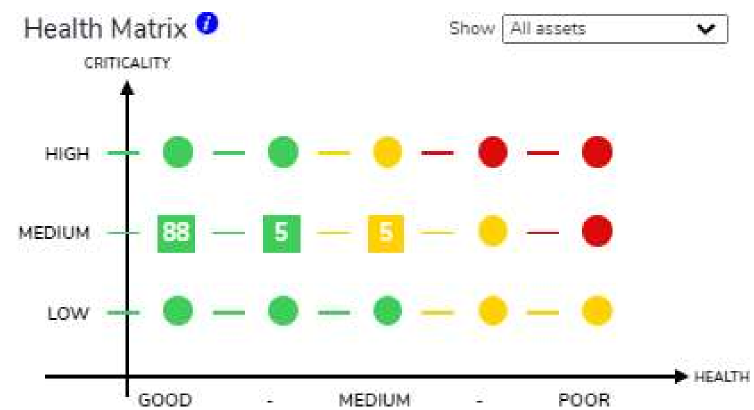
		BASE - Asset Health Monitoring					BASE+ Wireless Thermal Monitoring	
		Electrical Wear	Mechanical Wear	Load Profile	Health Index	Temperature Profile	Temperature Discrepancy	Contact Quality
Electrical	Current Breaked current	☑		☑	☑			☑
Functionnal Status	SF6, CTVT Trip Circuit Auxiliary voltage				☑			
Mechanical	Breaker Position Opening / Draw Out Counters Opening / Charging time	☑	☑		☑			
Environmental	Ambient Temperature					☑		
Thermal	Cables / Busbar / Temperature (3 Phases)						☑	☑

LV Circuit Breaker
Analytics

		BASE - Asset Health Monitoring				
		Electrical Wear	Mechanical Wear	Load Profile	Health Index	Corrosion / thermal Aging of CB and TU
Electrical	Current Wearing	☑		☑	☑	☑
Environmental	Ambient Temperature / Humidity Corrosive gas / Salty atmosphere				☑	☑
Mechanical	Opening / SD Trip / SDE Trip / Draw Out Counters		☑		☑	

More than

100 **different variables (current, voltage, temperature, opening time, broken current ...) are measured and computed through our platform to provide accurate and reliable condition monitoring.**



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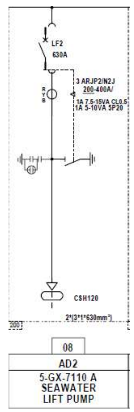
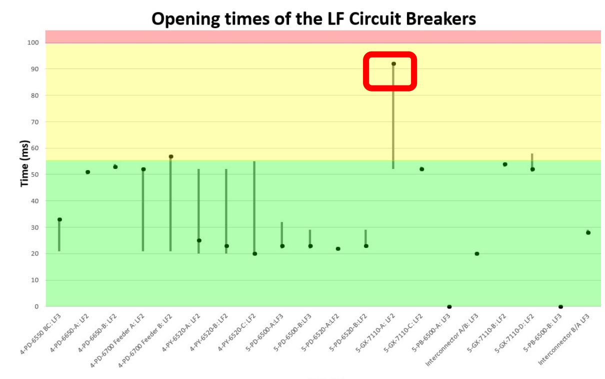
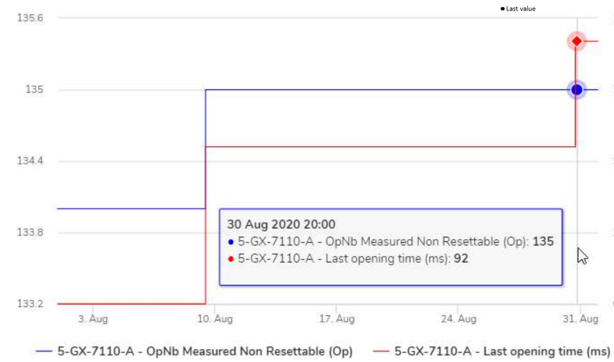
Findings 1: MV Breaker - Opening times drift

- Opening times analysis show no specific issue apart on 5-GX-7110-A on August 30th;
- Opening time reached 92ms instead of 54ms maximum recommended;
- Previously the breaker had already values close or slightly above the limit (55ms)
- However :
  - No increase of operation counter
  - The trip current remained at 0







Our recommendation

⇒ Perform a L4 maintenance operation of this breaker

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Oil & Gas Refinery – Video Link

OIL & GAS

Detection condenser Fan belt failure through ESA

EVENT

Current and active power suddenly dropped indicating the load of the motor disappeared. The motor was operating at very low load suspecting the failure of connection with the Fan.

CAUSE

EAA ED through Electrical Signature Analysis technology detected an exponential increase on multiple spectrum frequencies (especially the rotational and belt ones) prior to the event indicating a belt issue in the condenser Fan-Motor set.

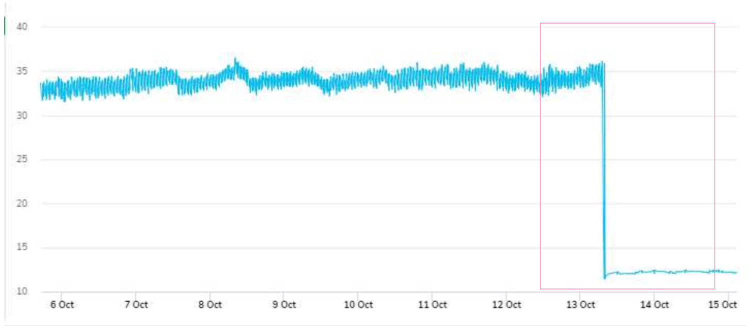
RECOMMENDATION

CSH recommended to check the Fan belt condition.
*Issue was detected and communicated (phone/eMail) in less than 24 hours

ACTION

Customer confirms the failure of the belt and creates a maintenance notification in their SAP system to replace the faulty belt.

Sudden drop in motor current indicating the motor is with NO-LOAD



A gradual increase in belt frequency was observed for 5 to 6 days and showed a transition in an exponential trend before the failure.

$ POTENTIAL IMPACT
Loss of production due to a partial shutdown of the process

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Major OGP Refinery – O3 Detection

Exxon and Schneider developing partial discharge detection with O3 sensors and analytics

- MV equipment are over 40 years, with harsh condition in some substation (water leakage)
- More than 100 substations, very few with digital system
- Plant have already experimented partial discharge and refurbished some feeders
- Engineering team is looking for innovative solution to maintain the existing equipment
- Plant have already tested partial discharge analysis solution with complex and heavy system
- O3 sensor benefits for them
  - Early detection of insulation trouble => condition-based maintenance
  - Simple easy to install solution => systematic approach
- Leveraged Digital Sensor technology Innovation

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