

PUBLIC

HITACHI
Inspire the Next

High Voltage Products

Enabling digital substations and digital components

© 2022 Hitachi Energy. All rights reserved.

 **Hitachi Energy**

Digitalization of High Voltage Products is the key to meet most of today's urgent challenges

- Ageing infrastructure
- Retiring know-how
- Increased reliability demand
- Increased power demand

THE DEMAND

- Shorter project time
- Less physical changes
- Easy extensions
- Higher working safety
- Less travelling time
- Lower equipment stress
- Lower stress to the grid
- Less outages
- Less unproductive time
- Remote inspection

THE SOLUTION



Productivity

Safety

Reliability

Availability

Control

Point-on-wave control for circuit-breakers



Power quality control and active filters



Fully digital high-voltage circuit-breaker control

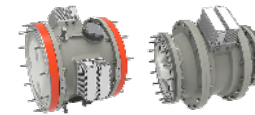


Digital components

Motor drive for circuit-breakers



Low-power instrument transformers



Condition monitoring

Modular switchgear monitoring



Generator circuit-breaker monitoring



Surge arrester monitoring



Remote software

Lumada asset performance management



Volt-VAr Management Software



Remote services

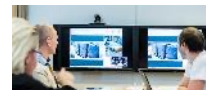
Remote support with digital kit



Collaboration center



Remote Factory Acceptance Test (FAT)



Augmented reality

PTC Vuforia





Digital further increases the value of High Voltage Products and components

Control

Condition monitoring

Software & services

Augmented reality

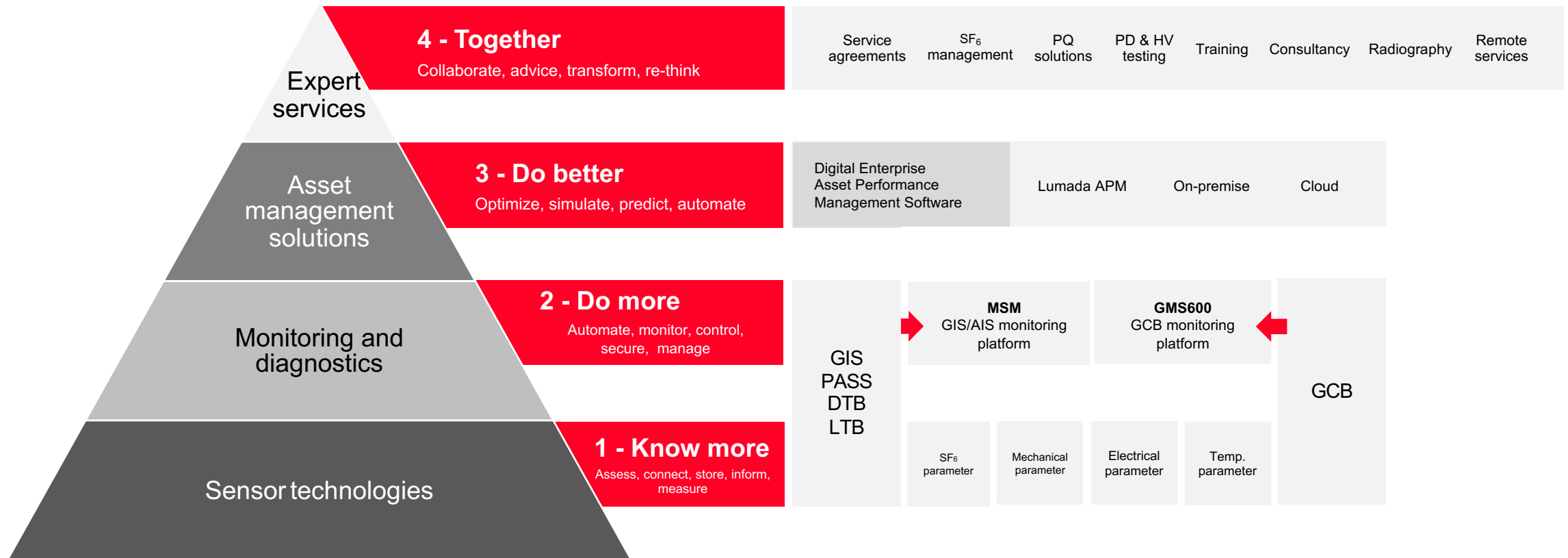
PRODUCTIVITY

RELIABILITY

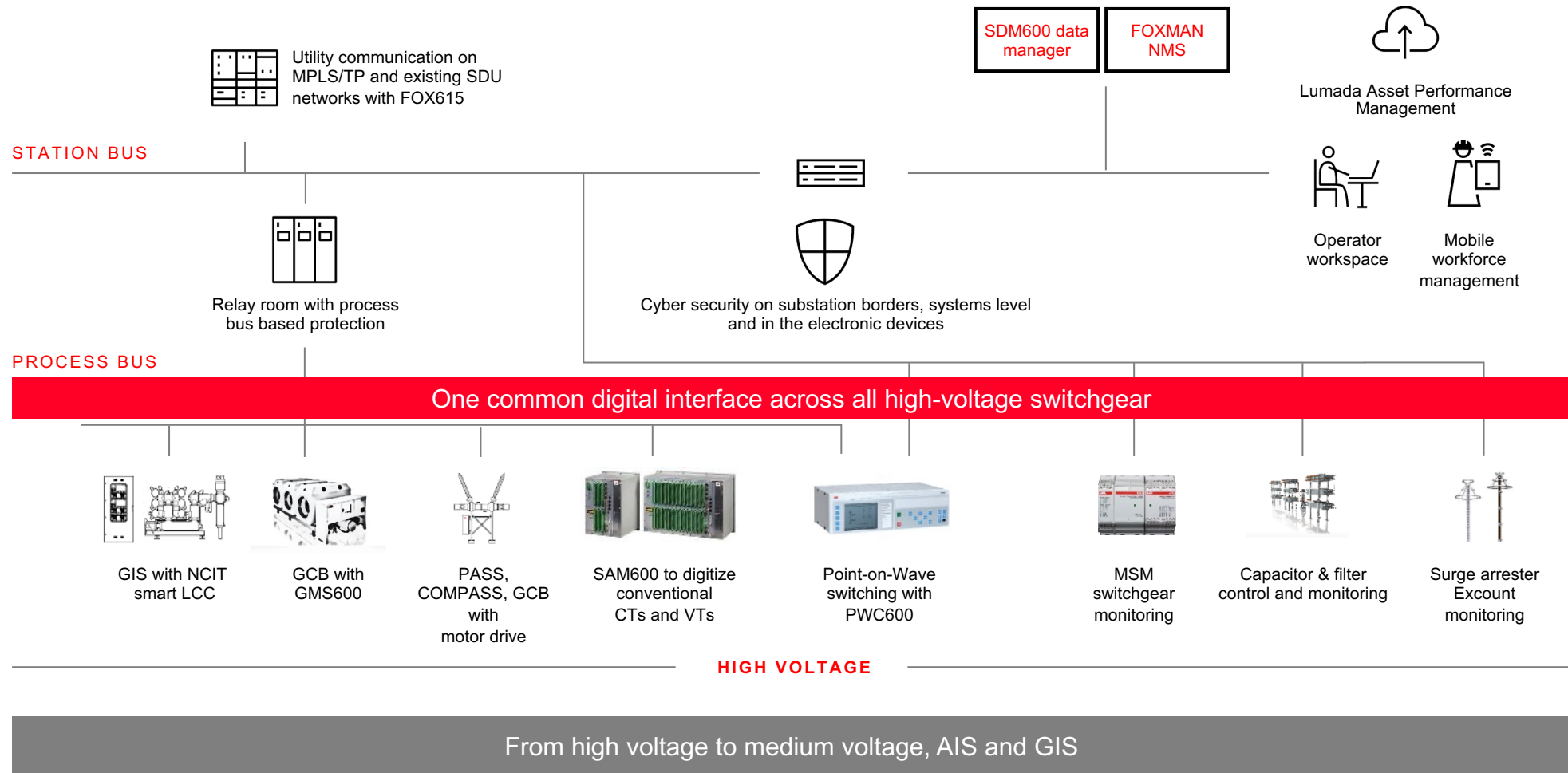
AVAILABILITY

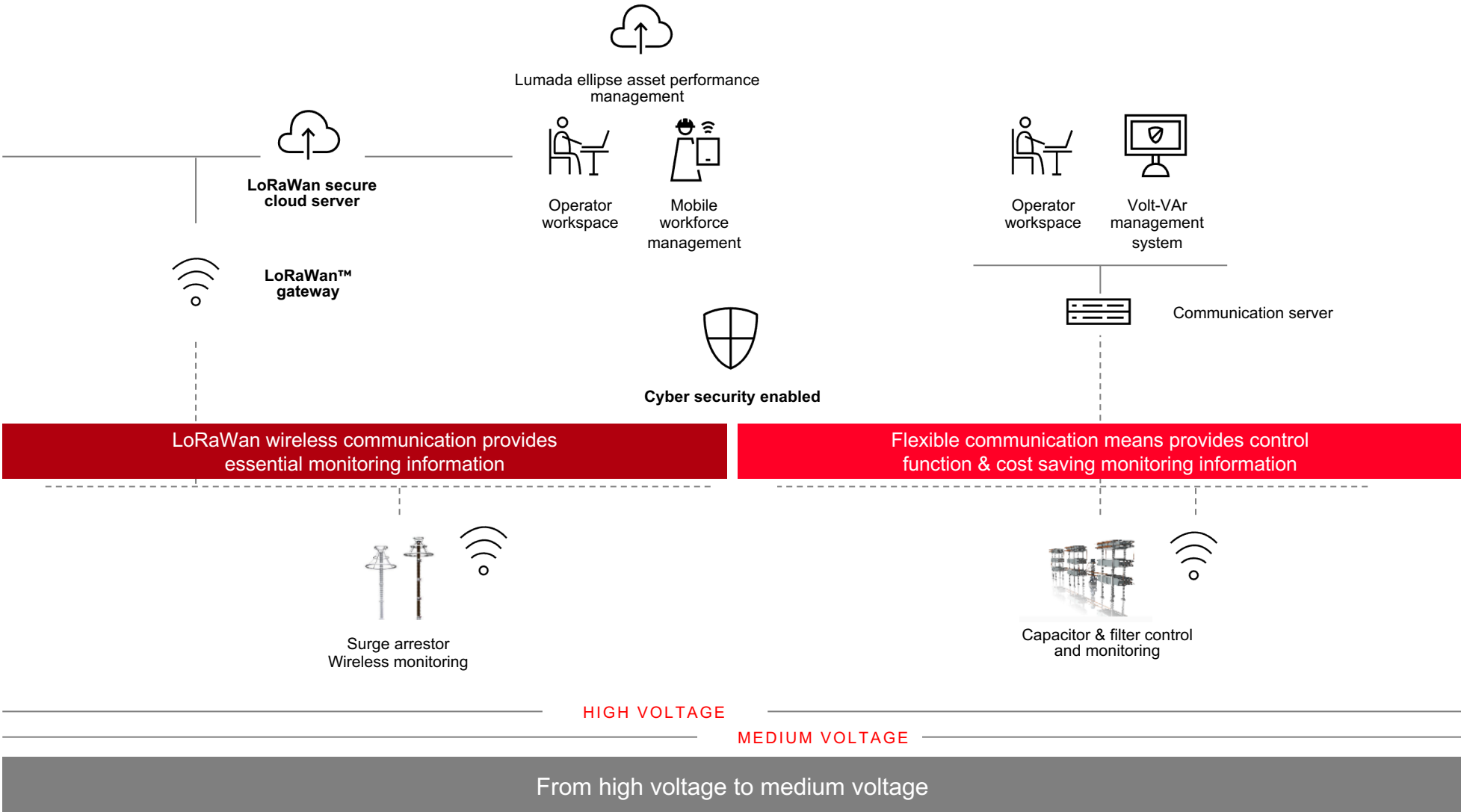
SAFETY

QUALITY



Connecting real-time data from monitoring and supervision to smart asset management – to enable analytics, avoid unplanned outages and offer additional remote services





Reliability

- Operating conditions
- Application specific
- Automatic adjustment features
- Reduced wear
- Reduced equipment stress
- Redundancy features

Impact of failure

- Effect on grid
- Connected customers
- Spare part availability
- Time to repair / to replace

Increased health

- Removed secondary circuits
- Reduced physical work
- Increased configuration work
- Remote access
- Automatic adjustment features
- Reduced asset stress



INCREASED RELIABILITY

- Improved operational performance
- Reduced wear and stress with improved design, control and redundancy



INCREASED SAFETY

- Reduced work and asset risk exposure
- Improved remote accessibility

PRODUCTS



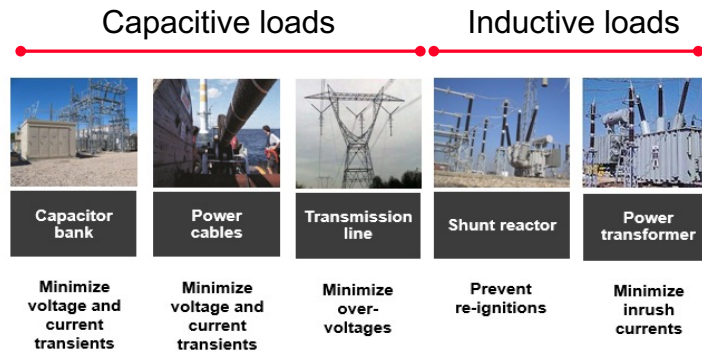
The stress on the interrupter and connected grid through high-voltage circuit-breaker switching is one of the main causes for losses in reliability and increased overhaul cost. Point-on-wave control with Switchsync PWC600 solves the problem by switching each individual phase at the right point of time.

VALUE

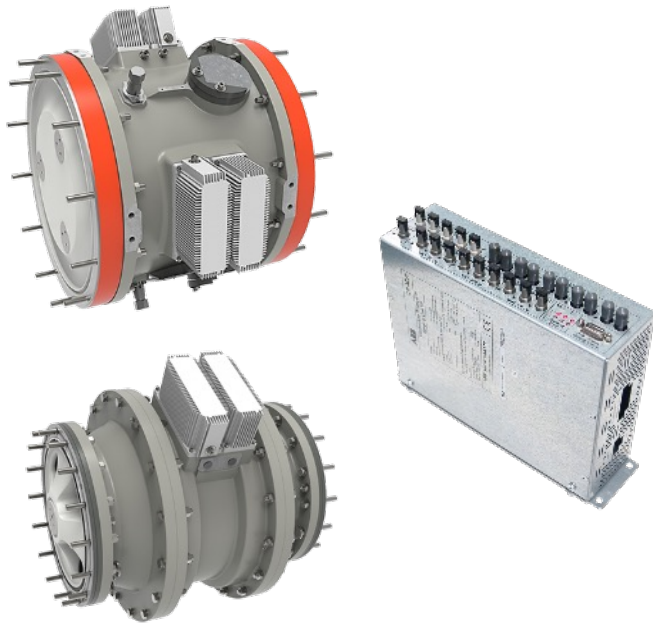
- Cost-efficient way to reduce the stresses and increase the lifetime of high voltage equipment
- Cost-efficient way to increase the stability of the power system
- Controlled closing and opening in one device for all common switching applications
- Compensation of environmental influences and adaptive correction of systematic variations in switching times
- Semi-automatic learning of circuit-breaker operating times

FEATURE

- Point-on-wave control for shunt reactors, capacitor banks, power cables and power transformer
- Accepts signals from conventional or sampled values from non-conventional IT
- Local HMI for direct access to settings and operation data; web interface allows online viewing of operation data
- Circuit-breaker monitoring integrated based on POW control including storage of last 100/ 1000 operations
- IEC 61850 communication for station and process bus, time synchronization acc. IEC 61850-9-3 and IEEE1588, network topologies acc. IEC62439-3 PRP and HSR



PRODUCTS



CP-Sensors for GIS

Secondary circuits are a main source of electrical hazards during site work, secondary cable size and engineering are a reason for frequent changes and high costs. Low-power instrument transformer solves these problems with their digital interface, configurable ratings, wide-band calibration, low weight and possible footprint reduction.

VALUE

- Wide dynamic range, high precision and no saturation effects
- High productivity due to lack of project specific dimensioning, no burden calculation, reduced cable engineering
- Increased personnel safety with removed analog secondary circuits
- Increased flexibility as one multi-purpose device is used and configurable to different applications
- Primary sensor with high reliability and reduced failure rate. Same lifetime as GIS
- Easy of maintenance for secondary sensor electronics, no re-calibration or re-configuration
- Reduced efforts in overall substation engineering, building and operation
- Plug-and-play technology, no experts needed

FEATURE

- Ready for SF₆ and eco-efficient EconiQ™ products
- IEC61850 sampled value streams
- Process bus replaces secondary circuits
- One multi-purpose device for all applications
- Reduced size and weight
- Configurable ratings
- No saturation, linear measurement
- No burden calculation
- High measurement bandwidth
- Primary sensor with HV CB lifetime
- Reduced thermal and dielectric stress compared to conventional

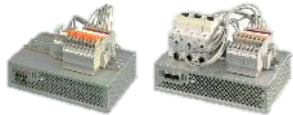
PRODUCTS



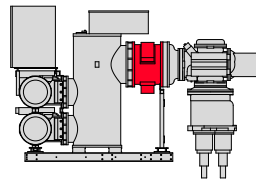
Relion 670
for protection and
control



SAM600 merging
units



Optimize



Full redundant control for mission critical substations is challenging, analog interfaces and cable engineering are cost drivers, analog designs are static and physical changes are always needed. All this can be solved by full digital control because of true redundancy, replaced analog wiring and interfaces, flexible configurations and reduced space.

VALUE

- Reduced size local control cubicle (LCC) due to reduced conventional wiring with bay control units
- Digital LCC with shorter installation, commissioning and testing time
- Integrated LCC for GIS with full factory testing reduces overall project time
- Combined bay control and protection units inside LCC enables to reduce relay room size
- Full digital control enables shorter outage times for future retrofit and high flexibility for changes
- Shorter project lead time of the substation through full digitalization

FEATURE

- IEC 61850 communication for station and process bus, time synchronization acc. IEC 61850-9-3 and IEEE1588, network topologies acc. IEC62439-3 PRP and HSR
- Outdoor and indoor ambient conditions
- High flexibility in solution engineering for IEDs
- Differential protection handles both conventional and non-conventional IT at different ends of the overhead lines or power cables

Success stories: installations with process bus IEC61850-9-2

Status end of 2020:

GIS-NCIT delivered since 1999: ~400 CP-sensors
 AIS-FOCS (AC) delivered since 2013: ~210 FOCS
 AIS-FOCS (DC) delivered since 2005: ~900 FOCS

2011-2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
<ul style="list-style-type: none"> Switzerland GIS NCIT, 670, Australia GIS NCIT, 670, REB500 Germany AIS 3rd NCIT, REB500 	<ul style="list-style-type: none"> Sweden, AIS 3rd NCIT, 670, 630, 615 	<ul style="list-style-type: none"> UK GIS NCIT, 670 Taiwan SAM600, 670, 	<ul style="list-style-type: none"> Australia GIS NCIT, 670 	<ul style="list-style-type: none"> US DTB+FOCS, SAM600 670 China DCB/LTB +FOCS, 	<ul style="list-style-type: none"> Brazil AIS, SAM600, 670 India AIS, SAM600, 670, 615 Taiwan GIS, SAM600, 670 Czech AIS FOCS, SAM600, 670 US DTB+FOCS, 670 	<ul style="list-style-type: none"> UK AIS FOCS, SAM600, 670 Iran GIS NCIT 670 Poland GIS conv. IT SAM600, 670 Canada AIS-FOCS, SAM600, 670 Poland AIS FOCS, 670 Norway AIS FOCS, SAM600, 670 	<ul style="list-style-type: none"> US DTB+FOCS, 670 Germany SAM600, PASS w/ MD FOCS-SO Belarus SAM600, AIS FOCS, DCB/LTB, 670 US AIS FOCS, 670 	<ul style="list-style-type: none"> Iceland GIS NCIT, 670 	<ul style="list-style-type: none"> Iceland GIS NCIT, 670 Norway GIS NCIT, 670

PRODUCTS



Reliability of high-voltage circuit-breaker is influenced by number of moving parts, operating mechanism performance and unstable switching performance due to ageing copper cables, which are one of the cost drivers. MotorDrive for PASS and COMPASS solve these problems with its fully digital operating mechanism for high-voltage circuit-breaker.

VALUE

- Reduction in moving parts by 99% providing high operating reliability and extended mechanical endurance
- Reduction of contact wear and delivering stable performance with adjustable travel curve
- Lowest noise level of circuit-breaker operation
- Reduction in Cu cables in substation by about 80%
- Continuous self-diagnostic and automatic error notification
- Availability of event log for operation and failure tracking

FEATURE

- Power-electronic controlled motor drive for circuit-breaker operation, only one moving part
- IEC 61850 process bus communication, cyber security certified: ready for digital substations
- Configurable via software, no need for complex wiring and external devices
- Smart human-machine-interface (HMI) for effective visualization and control
- Modular system, able to fit any I/O configuration

LTB Live Tank Breaker



PASS hybrid switchgear



Generator Circuit-Breaker



Status end of 2020:

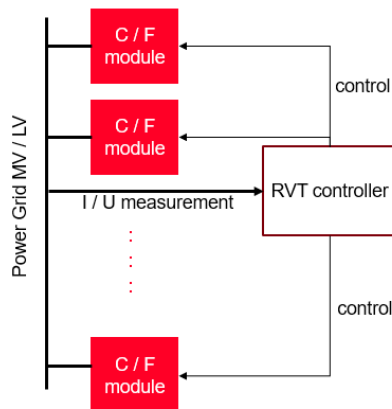
LTB / PASS with MD 1.3 delivered since 2000: ~900

LTB / PASS with MD 1.4 delivered since 2015: ~250

2015	2016	2017	2018	2019	2020	2021
<ul style="list-style-type: none"> Germany PASS MD1.4 Italy PASS MD1.4 	<ul style="list-style-type: none"> Germany PASS MD1.4 Switzerland PASS MD1.4 Vietnam PASS MD1.4 Denmark PASS MD1.4 Colombia PASS MD1.4 Chile PASS MD1.4 Italy PASS MD1.4 	<ul style="list-style-type: none"> Germany PASS MD1.4 China PASS MD1.4 Vietnam PASS MD1.4 	<ul style="list-style-type: none"> Germany PASS MD1.4 China PASS MD1.4 US PASS MD1.4 Italy COMPASS MD1.4 Italy PASS MD1.4 Australia COMPASS MD1.4 	<ul style="list-style-type: none"> Germany PASS MD1.4 Thailand PASS MD1.4 Oman PASS MD1.4 US PASS MD1.4 India PASS MD1.4 Japan PASS MD1.4 COMPASS MD1.4 Italy PASS MD1.4 COMPASS MD1.4 	<ul style="list-style-type: none"> Germany PASS MD1.4 Japan PASS MD1.4 Italy COMPASS MD1.4 	<ul style="list-style-type: none"> China PASS MD1.4 Windtower Germany PASS MD1.4 Italy COMPASS MD1.4

PRODUCTS

Power factor controller RVT



Capacitor and filter switching reliability is essential for power factor control, harmonics reduction and low line-losses and mal-function can reduce the grid performance. The power factor controller RVT solves these problems with automatic parameterization, safe operation, protection functions, remote access and communication facilities.

VALUE

- Easy commissioning with fully automatic setup of RVT parameterization
- Easy of use with multi-voltage and multi-frequency use, flexible secondary CT inputs, remote access to all parameters and all measurements, alarm relay outputs and fan warning output
- Safe operation ensured with high programmable protection thresholds allowing protection regarding over- and under-voltage, over-temperature and excessive harmonic distortion
- Highest reliability with high ambient temperature ratings
- Effective maintenance and operation control with network information and bank monitoring
- HMI with advanced menu navigation and RVT programming

FEATURE

- Power factor correction for both balanced and unbalanced loads for low-voltage, medium-voltage and high-voltage banks
- Complete three phase measurements including active, apparent, reactive power, cosphi and current and voltage harmonics (up to 49th) and total harmonic distortion on current and voltage
- Touch screen for operation, supervision and parameterization
- Ethernet TCP/IP, Modbus RS-485 and CANbus connection
- USB connection
- Temperature monitoring of the C&F bank with 8 sensors
- Real time clock
- Hardware and software lock

PRODUCTS

Capacitor bank controller CQ900



Capacitor switching reliability is essential for power factor control and low line-losses and malfunction can reduce the grid performance. The capacitor bank controller CQ900 solves these problems with automatic control schemes, flexible mounting solutions, wide operating conditions and operational ease of use.

VALUE

- High reliability through real-time sampling, measurements and decision making enabling a variety of automatic control schemes
- Flexible mounting options, power supply and high flexibility on connectable switch types
- Wide operating conditions, high enclosure protection class including integrated electrical protection against overvoltages and EMC providing high durability
- Ease of use with reliable faceplate, user-friendly navigation, local or remote programmable interface
- High data integrity with real-time monitoring of network parameters and data logging capabilities

FEATURE

- Complete solution for controlling and monitoring capacitors on distribution systems
- Real-time sampling, extensive set of measurements and decision making enabling a variety of automatic control schemes, external temperature sensor available
- Reliable faceplate for user programmable operation, supervision and parameterization
- Data logging of 10,000 events at set time periods into non-volatile memory
- Ethernet TCP/IP, DNP3 communication available, IEC61850 under preparation
- Real time monitoring of network parameters
- Remote control and monitoring through MicroSCADA and/ or centralized Volt-var Management Software

Reliability

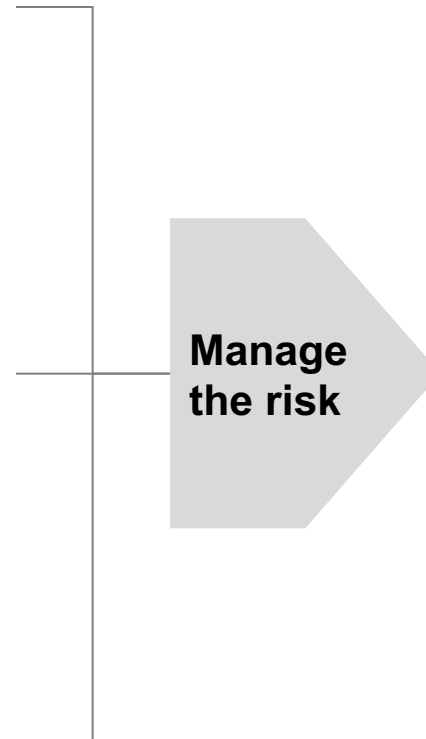
- Operating conditions
- Application specific
- Aging and wear
- Environmental conditions

Impact of failure

- Effect on Grid
- Connected customers
- Spare part availability
- Time to repair / to replace

Increased health

- Integrated intelligence
- Internal supervision
- External supervision
- Communication features



INCREASED AVAILABILITY

- Avoid unplanned shutdowns
- Change risk of major failure to managed minor failure



INCREASED SAFETY

- Reduced site and inspection visits
- Better understanding of complete health of site assets

High-voltage circuit-breakers and components

Monitoring devices and connected sensors

Connecting real-time data from monitoring and supervision to smart asset management enable analytics, avoid unplanned outages and enable additional remote services

Remote services and applications

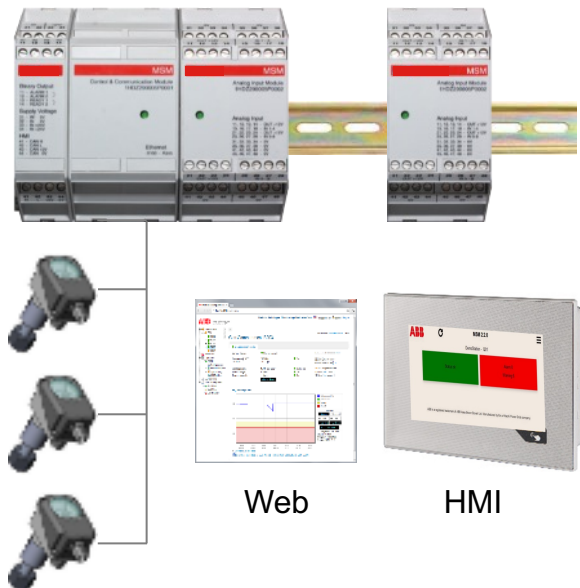
- Fleet Asset Management, Remote Monitoring Software, Collaboration Center
- IoT cloud
- IoT gateway

Devices on-premise are connected to

- MicroScada
- Asset Management
- Monitoring Software

PRODUCTS

Modular switchgear monitoring (MSM) for high-voltage circuit-breaker



Long-time operation, ageing effects, circuit-breaker switching, grid load, grid disturbances and other effects can lead to breakdown of high-voltage circuit-breaker. **MSM monitors high-voltage circuit-breaker function and performance, detects problems early and enables a switch to predictive maintenance.**

VALUE

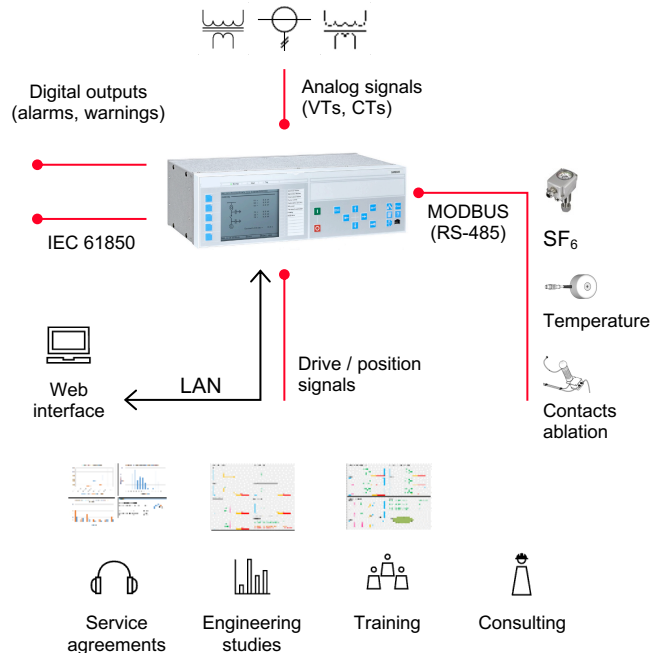
- Early detection of maintenance needs with maintenance alarms and trending
- Predictive maintenance enabled, enough time for preparation of countermeasures avoiding unintended shutdowns
- Detailed reporting, e.g. of banked gas in the equipment
- Reduction of inspection work and maintenance cost
- Integrated Monitoring and diagnostics

FEATURE

- Gas monitoring (SF₆ and non-SF₆)
- Moisture monitoring for SF₆
- Circuit-breaker monitoring
- Disconnecter and earthing switch monitoring
- Arc localization
- Heater operation
- Scalable and flexible monitoring system
- Local HMI
- Embedded webserver
- IEC 61850, DNP3 or Ethernet TCP-IP communication
- Connection to Lumada APM enabled

PRODUCTS

Generator circuit-breaker monitoring (GCB) system GMS 600



Long-time operation, ageing effects, circuit-breaker switching, grid load and other effects can lead to breakdown of GCB. GMS600 monitors GCB function and performance, and detects problems early and enables a switch to predictive maintenance.

VALUE

- Proactive and cost-effective maintenance with simplified inspections/ overhauls
- Maximize availability by avoiding GCB output reduction with temp. monitoring
- Minimized environmental impact by SF₆ gas monitoring
- Increased safety by secure fleet remote monitoring, no on-site presence required
- Improve GCB availability, reduced power plant operations and maintenance (O&M) costs and optimized operational performance by comparing project-specific performance indicators with aggregated fleet data
- Reduced maintenance costs with Hitachi Energy expert data-driven recommendations

FEATURE

- SF₆ gas monitoring
- Primary conductor temp. monitoring
- Primary contacts ablation monitoring
- GCB operating mechanism supervision
- Real-time remote condition monitoring of GCB health status allowing predictive maintenance strategies
- Optimized asset performance and utilization through actionable data-intelligence
- Digitally integrated enabling on-premise, as well as, cloud connection, including asset health for GCB

PRODUCTS

Wireless monitor for surge arresters



EXCOUNT monitor for surge arresters



Long-time operation, ageing effects, over-voltages, lightning strikes, operation resonances and other effects can lead to a frequent use of surge arresters which quickly leads to end-of-life status. Malfunction of surge arresters increases risk for grid downtime. The surge arrester monitors detects problems early and enables a switch to predictive maintenance.

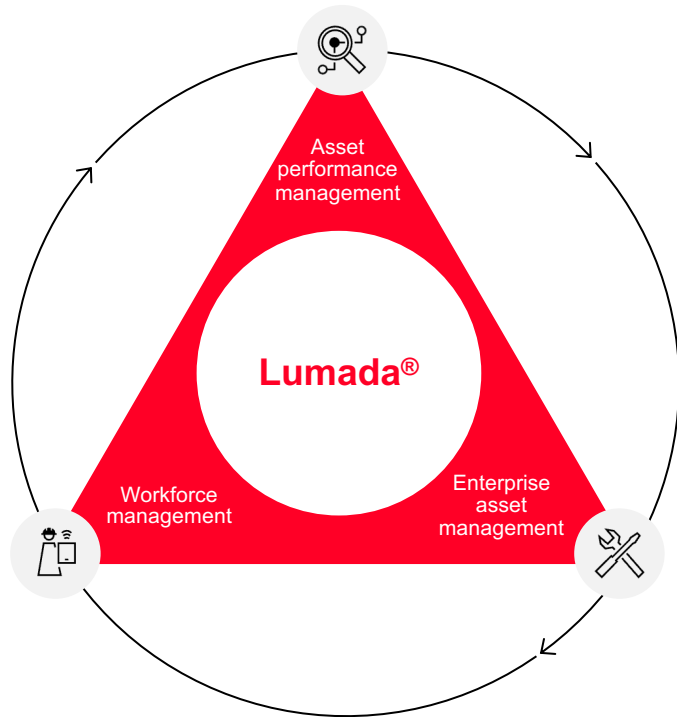
VALUE

- Predictive maintenance enabled for high-voltage and medium-voltage surge arresters
- Reduction of maintenance cost by reducing substation or grid downtime providing increased grid reliability¹
- Remotely available supervision information reduces inspection costs
- Wireless monitor reduces secondary cables and comes with LoRaWAN™ (Long Range Wide Area Network) to transmit data wireless to the cloud platform and comes with independent power supply based on solar panels
- Easy retrofit for older product solutions

FEATURE

- Remote monitoring, available either through IEC 61850 communication or wireless transmitted to cloud or on-premise server
- Measuring and communicating several surge arrester monitoring data, e.g. overvoltage discharge currents and leakage current
- Data can be accessed by a SCADA system, asset management or maintenance planning system of the user, or through an Lumada APM (Asset Performance Management) platform

PRODUCTS



Lack of asset condition monitoring and asset performance data increase the risk of grid downtime and high repair costs. The Lumada offering around APM, EAM and FSM helps to keep the grid up and running.

VALUE

- Monitoring of high-voltage products supports early detection of component failures and avoid unintended breakdowns
- Reduction of maintenance costs and extension of asset life with predictive maintenance
- Realtime and historic data enable trend analysis and effective maintenance and asset performance management
- Optimize worker productivity with a mobile workforce

FEATURE

- Integrated asset management for the entire life cycle
- Scalable and modular system
- Main components are
 1. Asset performance management (Lumada APM)
 2. Workforce management (Lumada FSM)
 3. Enterprise asset management (Lumada EAM)
- Performance models deliver
 - Health score (proxy of the probability of an error), separated in subsystems
 - Health score quality (proxy for data quality)
 - Recommendations for maintenance or operations

PRODUCTS

CQ900



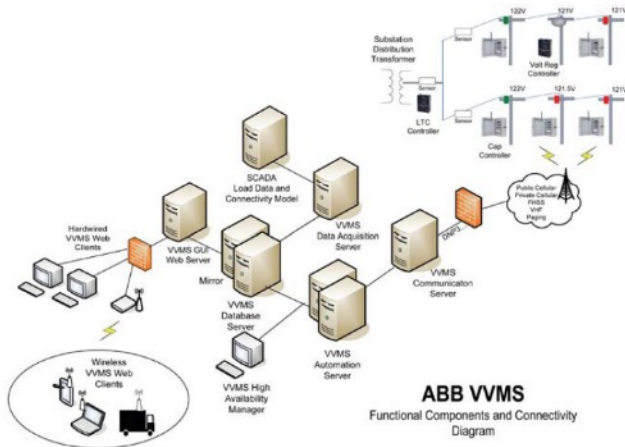
VALUE

Power factor supervision, control and optimization of voltage to reduce the losses are essential grid performance indicators (GPI). Missed GPIs increase operational costs. Volt-VAr Management software improves power factor and voltage, reduces line-losses and saves money.

- Optimization of circuit VAr flow improves power factor and may result in substantial savings in cost of energy and infrastructure utilization
- Optimization of voltage improves power quality by preventing over and/ or under voltage conditions and by achieving a flatter voltage profile along circuits
- Loss minimization applications along distribution lines
- VAr management along distribution lines having pole-mounted capacitor banks

FEATURE

- Closed-loop voltage and VAr control. It continually samples loads and voltages along feeder circuits and when appropriate switches compensating devices
- Real time Volt-VAr application displays and reports, e.g. circuit “VAr loss performance” statistics
- Control and supervision of substation, feeders, capacitors and voltage devices
- Web browser based, no need for vast IT infrastructure, user management



Optimizing maintenance and operations with fewer resources and expertise

Improve first time fix rate

- All issues are not resolved on first visit.
- Prior knowledge of conditions improves first time repair percentages

Repair in remote locations

- Getting experts to remote locations may require extensive travel time
- Ability for experts to provide instant visual guidance dramatically improves repair efficiency

Shorter resolution times

- Systems have become more complex and connected
- Proficiency in multiple disciplines is required to identify problem sources
- Faster access to expertise shortens resolution time

Increase collaboration

- Customers are increasingly dependent on OEMs to maintain their operations
- Tools that facilitate on the spot knowledge sharing greatly improve outcomes

Three pillars of remote service solutions

01 Remote support

02 Remote monitoring

03 Collaboration center (CoCe)



We utilize **Remote Factory Acceptance Test (FAT)**



Digital solutions accelerate delivery and value



Faster and shorter resolution



Increased availability



Improve first time fix rate



Increase collaboration and safety



Reduce costs



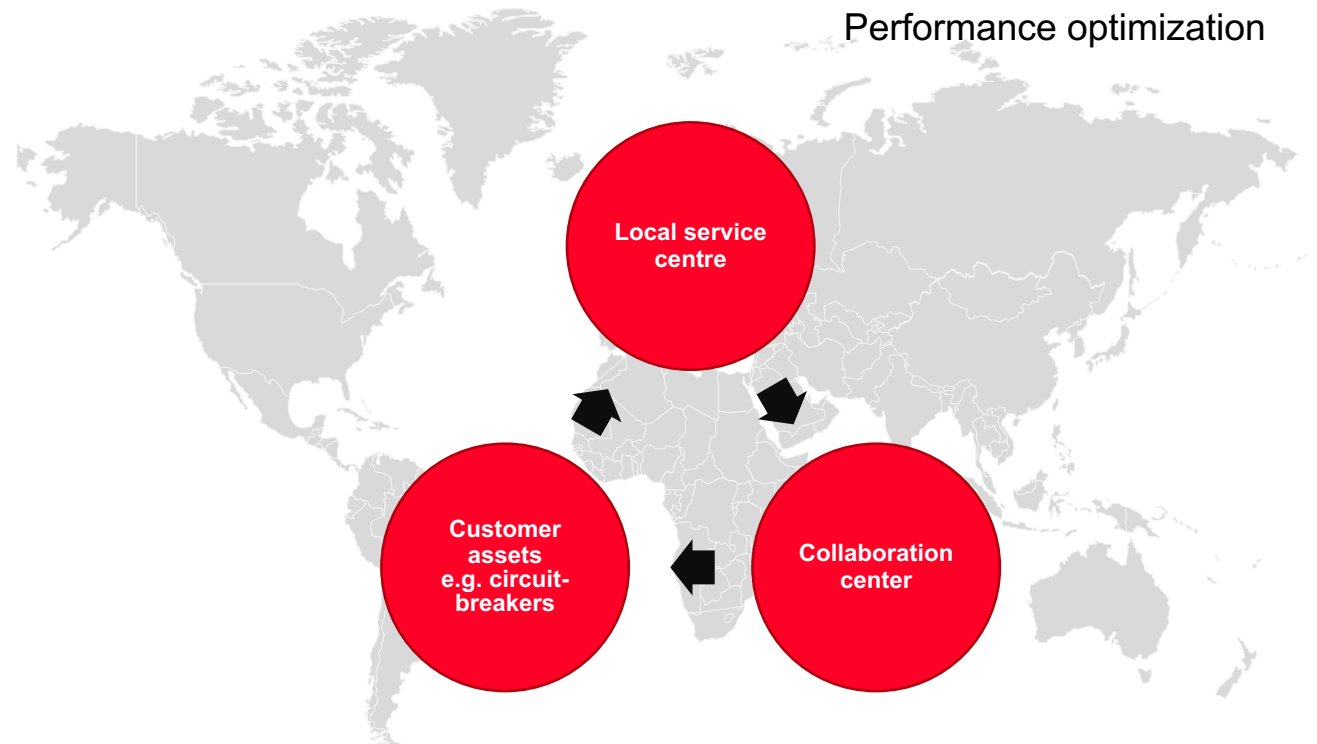
Collaboration center

REMOTE SUPPORT OFFERINGS

- Troubleshooting
- Installation and commissioning
- Training and development

REMOTE MONITORING

- Asset health
- Condition monitoring
- Analytics and visualization
- Performance optimization



LOCATIONS WORLDWIDE

01 Mount Pleasant, USA

02 Lodi, Italy

03 Zurich, Switzerland

04 Xiamen, China

BENEFITS



Get 24/7 continuous access to experts for remote assistance and collaboration



Reduce time to fix critical issues through immediate remote analysis and troubleshooting



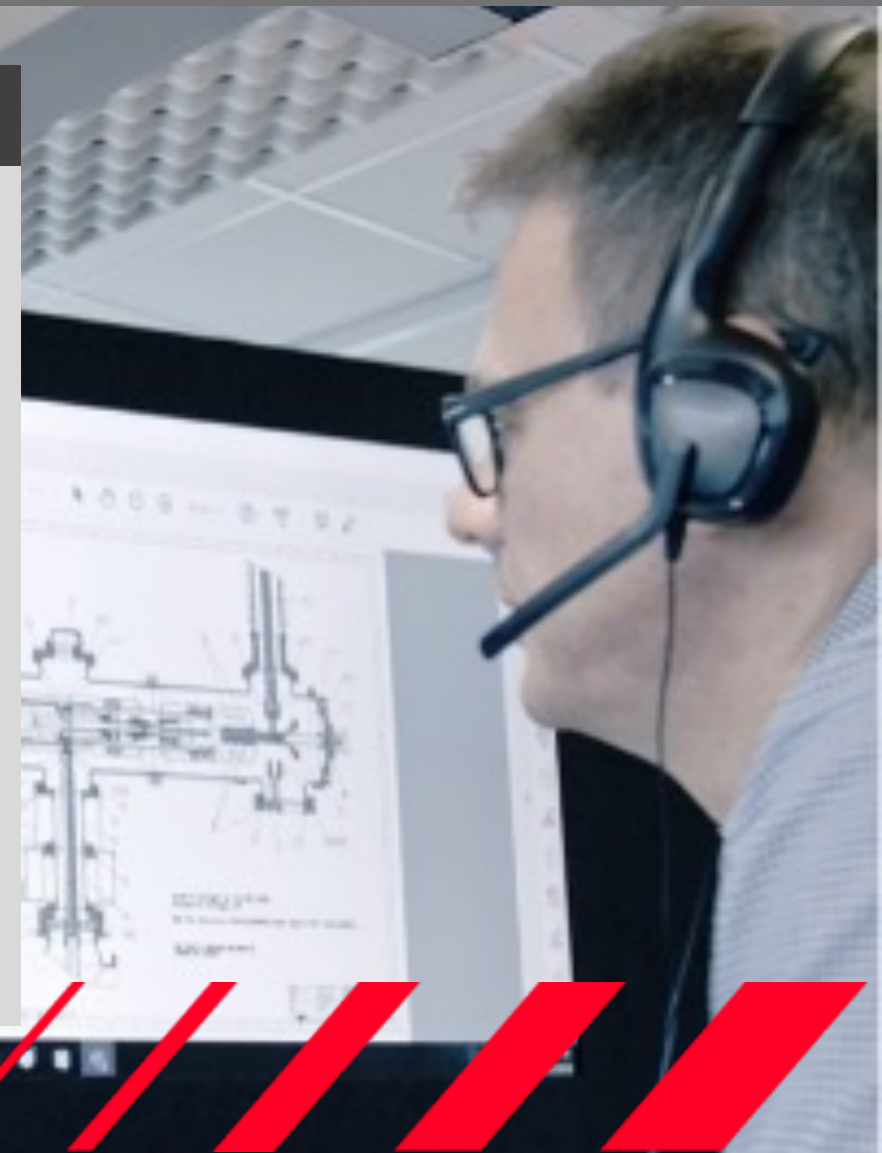
Reduce costs for on-site visits as issues can be resolved remotely



Condition monitoring and proactive maintenance strategy



Improve availability and operations performance



The most effective solution to provide instant service during COVID-19 limitations

Advantages of Remote Factory Acceptance Test (RFAT)

- Full execution of FAT remotely
- MS Teams for meeting execution
- Web-access video transfer of routine tests
- Full information including testing available to all parties



Highest safety due to complete travel avoidance



Reduce costs from removed travel



Increased efficiency from saved travel time



Challenges



- Physical presence needed
- Health & Safety issue in pandemic situation
- Travel & accommodation expenses
- Need co-ordination with travel management system
- Commute hours
- Carbon emissions

Advantages

Marketing

- Improved customer engagement
- Easy communication of value propositions
- Brand memory is reinforced
- Differentiation with competition by innovation
- Safety training and planning

Service

- Better understanding of the product
- AR service manuals and instructions
- Reduce human error
- Increased productivity and reduced cost
- Remote assistance

Project execution

- Project management becomes simpler
- Drawing approvals
- Clearance analysis (AR measurements)
- Product modifications are discovered early
- On site visualization before installation
- Team collaboration
- Installation visualization

Terminology

What?

- Augmented Reality (AR) is an overlay of digital content on the real world
- Simply AR rests on top of any surface, with the physical world acting as a static background for it
- The computer-generated content and the real-world content are not able to respond to one another.

How?

- Augmented reality starts with a camera-equipped device—such as a smartphone, a tablet, or smart glasses—loaded with AR software
- When a user points the device and looks at an object, the software recognizes it through computer vision technology, which analyzes the video stream
- The device then downloads information about the object from the cloud, in much the same way that a web browser loads a page via a URL. A fundamental difference is that the AR information is presented in a 3-D “experience” superimposed on the object rather than in a 2-D page on a screen. What the user sees, then, is part real and part digital

User platform

Hardware platform for AR

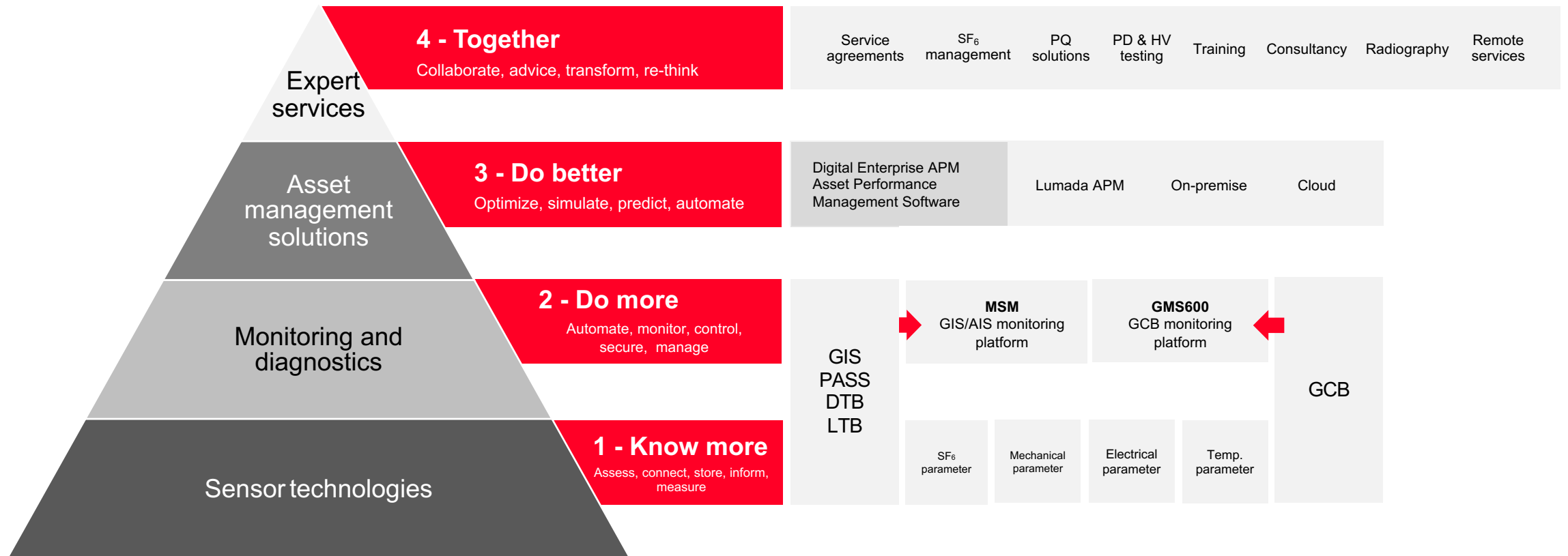
- Smart phones
- Tablets
- MS HoloLens



Software platform for AR

- Synergies with CAD-models from PTC Creo and Windchill
- PTC Vuforia engine as backbone
- PTC Vuforia studio for development
- PTC Vuforia viewer app for AR experience



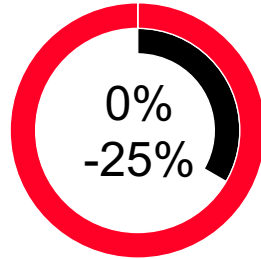


Connecting real-time data from monitoring and supervision to smart asset management – to enable analytics, avoid unplanned outages and offer additional remote services

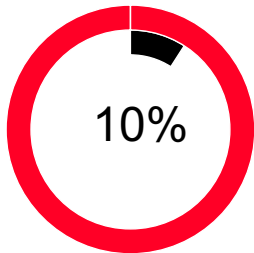
Capital savings



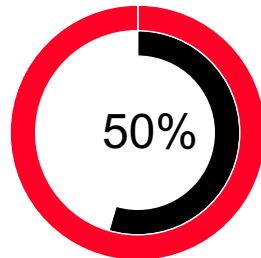
Reduced relay room footprint



Reduced switchgear footprint

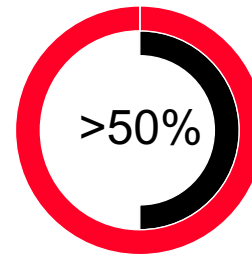


Faster time to energize

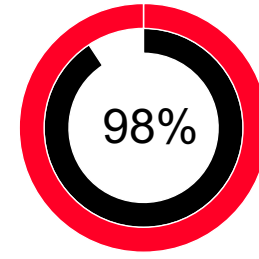


Reduced cable costs

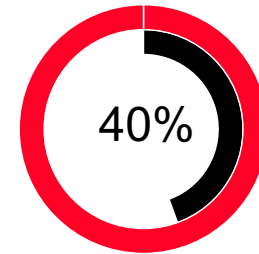
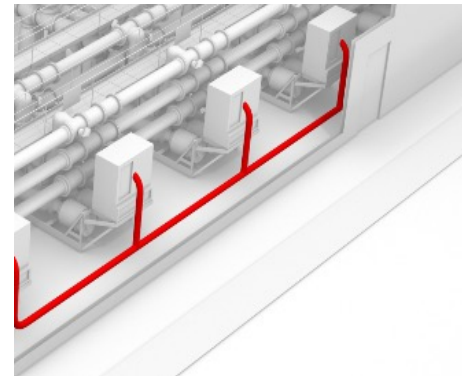
Operational savings



Reduced OPEX and O&M



Reduced risk exposure



Shorter outage for retrofit



HITACHI
Inspire the Next 