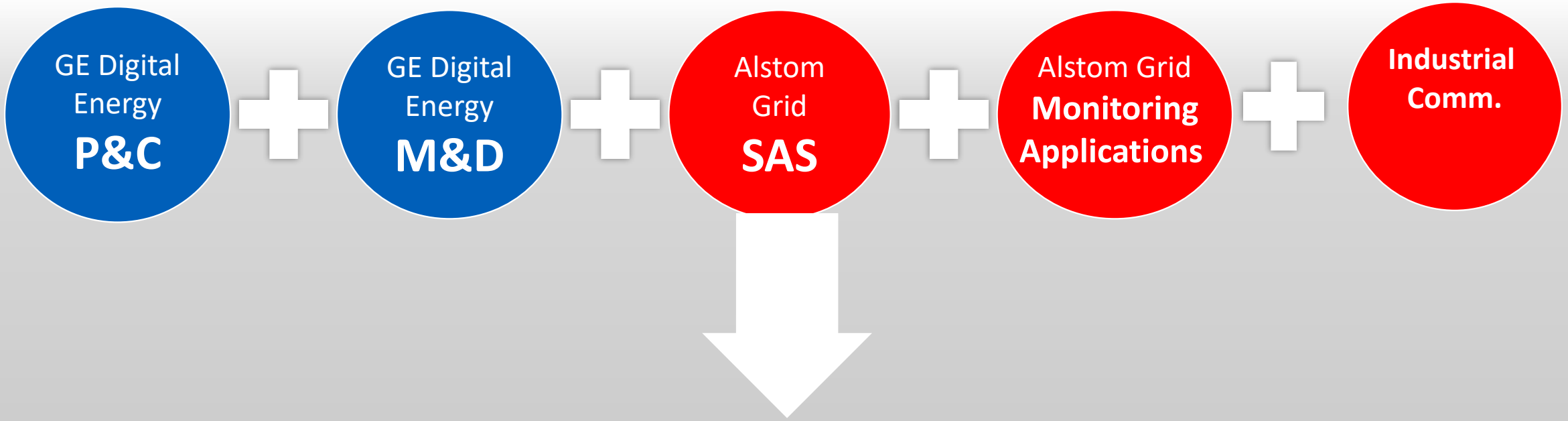
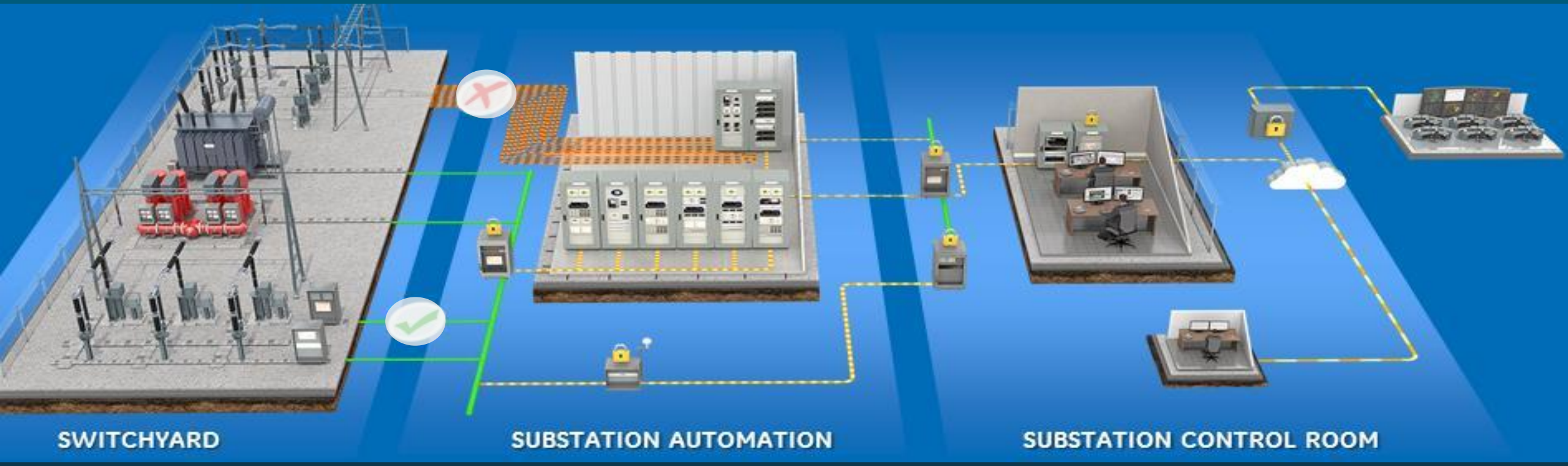
SUBSTATION AUTOMATION

Stronger player on the market



Grid Automation

Digitizing Substation Data for Greater Productivity & Reliability



Industrial Communication

Monitoring & Diagnostics

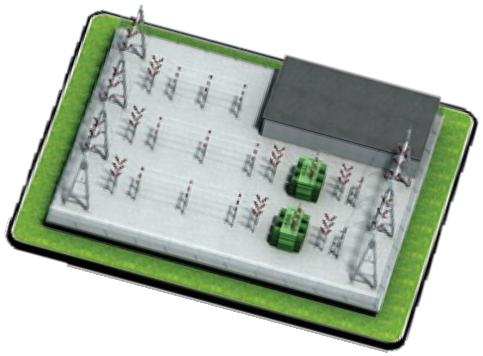
Substation Protection

Substation Automation

Substation Protection Portfolio

DISTRIBUTION

INDUSTRY



TRANSMISSION

GENERATION

Beyond the Fence

Cable Faults
Sensors (DIT)

Distribution
Automation
Line
Sensors

Distribution
Automation
Recloser
Control

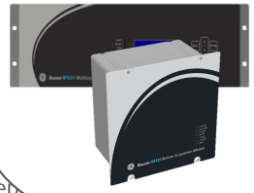
In the Yard

Digital Instrument Transformers (DIT)

Merging
Units

In the Relay Room

Protection Relays
Industry, Distribution, Trans., Generation



Fault
Recording

Fault
Location

Meters

In Relay Room & Control Centre Networks

Ethernet
Switches

Time
Synchronizing

Product Portfolio

P50

Low End Feeder, Self-Powered, Basic LV Motor

3 Series

Industrial Apps
Feeder, Motor, Trafo.

P40 Agile

Scalable Feeder, Motor, Voltage, Check Synch, A/R.

650

Small BCPU Feeder. Control,

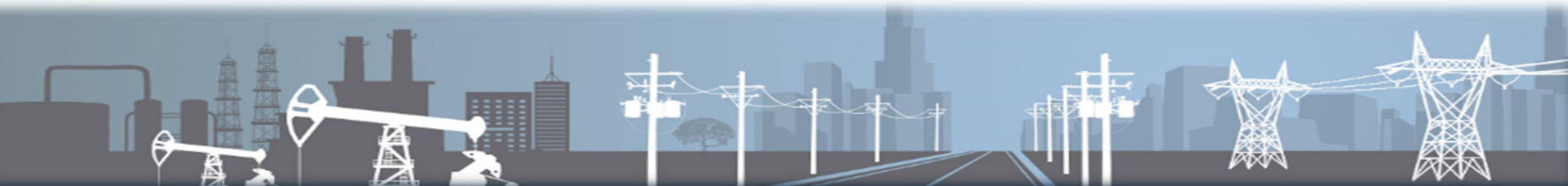
8 Series

Feeder, Motor, Gen, Transformer.
APM & One-Box

MiCOM/UR

Transmission: Complete Range of Modular, Digital P&C Applications

MM200/MM300



MICOM P40 Agile

Platform Advances and Rebranding

SOLID | DYNAMIC | INTUITIVE

MiCOM **P40 Agile – Versatile Applications…**

P14x
Feeder Management

P84x
Auto reclose & PMU

P24x
Universal Motor Protection

P74x
Busbar Protection

P34x
Generator protection and DLR

P64x
Transformer Protection

P54x
Line diff. & phase comparison

P44x
Distance Protection

- Comprehensive protection range
- Programmability & customization
- Fault analysis tools
  - Instrumentation
  - Self diagnostics & commissioning tools
- Communications
- Bay monitoring & control
- IEC61850, cyber security
- Redundant ports

MiCOM **P40 Agile – Versatile Hardware**

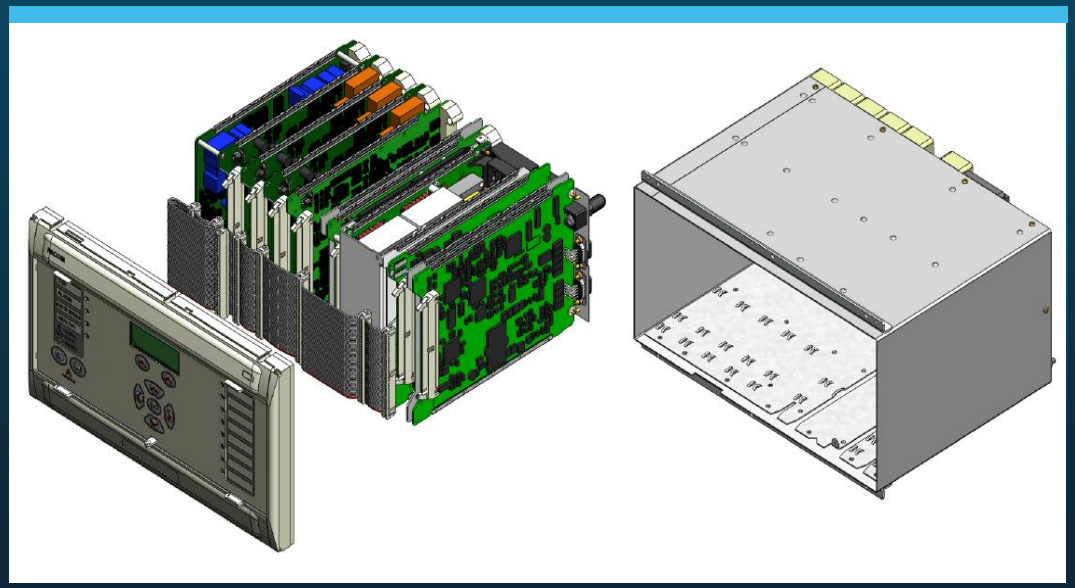
80TE full rack | 60TE 12” | 40TE 8”

Eg. P546 (80TE)

Eg. P543 (60TE)

Space for 1 or 2 Test Blocks MMLG/P991

- Hardware K and M
- Hardware K uses XCPU2
- Hardware M uses XCPU3
- Case sizes 60TE and 80TE



- Hardware J and P
- Hardware J uses CPU2
- Hardware P uses CPU3
- Case size 40TE

Eg. P54A (40TE)

MiCOM P40 Agile Transmission Range

Rebranding | New Features | Added Value

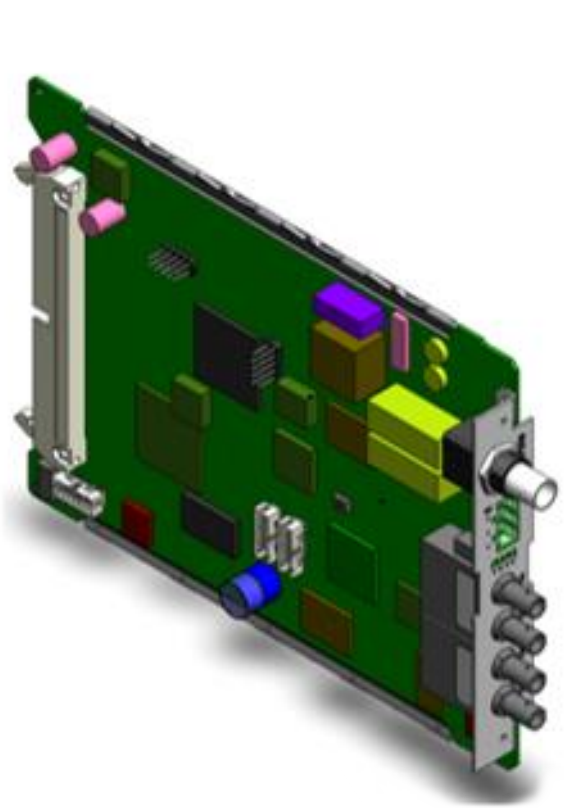
USB Front Port Replaces Serial and Parallel user interfaces	**Compatible with laptop PCs** of substation personnel, no need for special leads	Break from legacy Faster interaction
No Internal Battery Replaced by Supercapacitor design proven in P40 Agile compact	**Air freight regulations compliance:** speedier logistics, Removal of a maintenance item	
Enhanced Cybersecurity Local, Remote user authentication with SYSLOG, Duplicated GOOSE	**Addresses NERC CIP 6, EU NIS** and other critical grid infrastructure directives, New detection of GOOSE spoofing	Responsible and secure Grid operation
MiCOM P40 Modular IEC 61850 Ed. 1/Ed. 2 switchable, Cyber security enhancements	**Parallel supply to allow homologation:** Orders thru' Q1/Q2 2019 – delivery in White From September – Black/Silver (White opt.)	New **mounting code S, T, U** for new GE HMI. Former white remains as-is today.

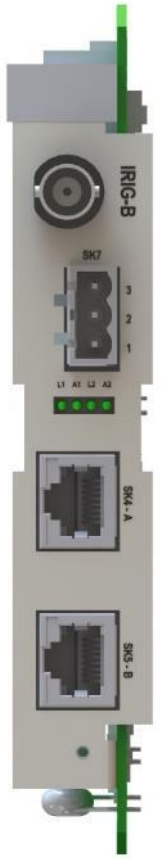
Continued Investment | **GE's MiCOM P40 Agile** Retains Leading Position

New **Ethernet Modules**

Traffic Density Handling Doubled

- **PRP, HSR and RSTP** supported in same order option – standardization
- Modulated/demodulated IRIG-B also standardized
- HSR extended to **50 node** support in a ring
- Redundant Ethernet configurator tool in S1 Agile harmonized in-one
- New **dual RJ45 copper** option – economical connection to switches
- Price advantage!





Optional IRIG-B

Link Fail Contacts

Channel Health

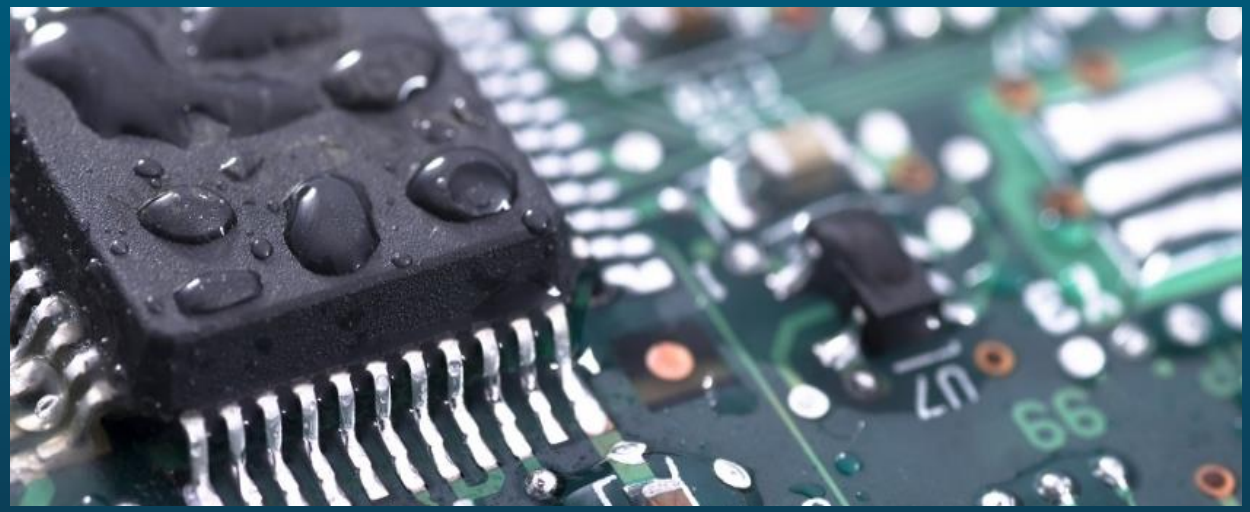
Channel 1
LC or RJ45

Channel 2
LC or RJ45

CORTEC order code change:
R = dual fiber | S = dual copper | T = single port fiber and copper

MiCOM P40 Agile – Harsh Environmental Coating

Enhanced Reliability at No Extra Cost



Results

- Defence against humidity/moisture
- Defence against salt mist in coastal areas
- Defence against H_2S, NO_2 and SO_2 industrial pollution

Maximised Performance and Longevity

- Intelligent electronic devices run software applications on digital hardware
- Printed circuit board assemblies are central to correct functioning
- GE's Harsh Environmental Coating (HEC) protects the PCBs

Investment in Quality

- PCBs cleaned in purified water to remove any residue
- PCBs dried
- HEC applied as a microscopic protection layer for all components and tracks
- Envelops the board without trapping heat

Exclude Contaminants, Moisture & Air | The Triangle for Best Reliability

MiCOM P40 Agile – Cyber Security (SW 9x)

RBAC Role-Based Access Control	**Local or Server-Based User Authentication / Certification** Admin, Operator, Observer…	Real-time alignment with active users and permissions of personnel
RADIUS AAA – Triple A	**Authentication, Authorization and Account Management**	Preventing incorrect access
SYSLOG Secure recording and reporting of cybersecurity events	**Non-erasable** records of access attempts, settings changes, remote commands	Full traceability and accountability
Duplicated GOOSE Detecting spoof publishers or wrong config. on the network	**Out-of-sequence or duplicated GOOSE message rejection** Reject, and/or optional alarm	Defense against incorrect publishing
… plus more: Password, disabling unused ports, inactivity disconnection	**NERC CIP compliance** In support of NERC, EU NIS and other cybersecurity standards	GE's cybersecurity measures continue to advance

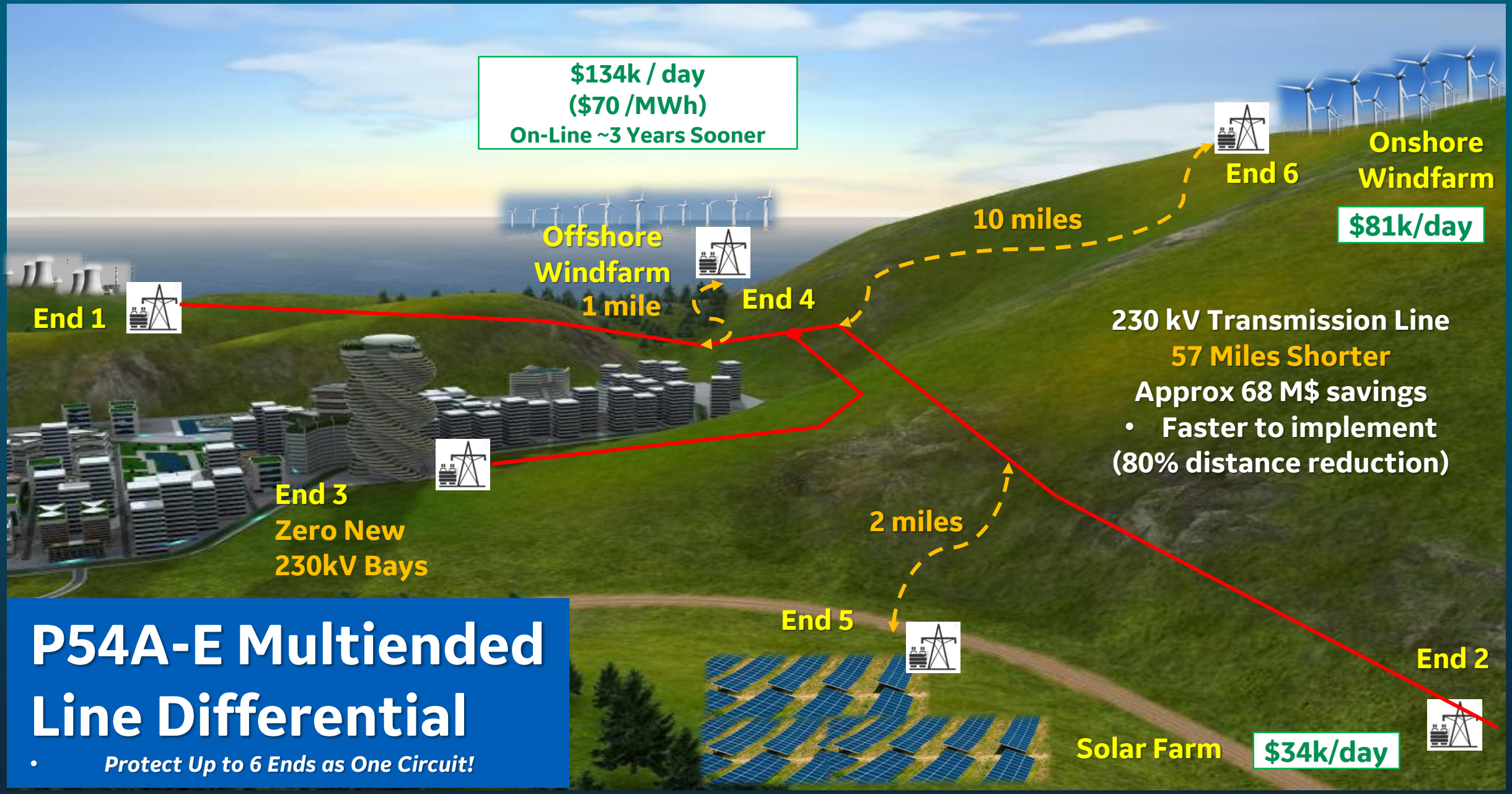
Strength to counter threats | Defends reliable operation of Grid networks

MiCOM P40 Agile Software 9x

Networking and Communication Improvements

Switchable IEC 61850 Ed 1/Ed 2 Software configurable	**Single model order option** – supports utility migration strategy and reduces spares/inventory holding	Future-proofing, easier matching of on-project specification changes
Fixed Length GOOSE Option for standardization	**Faster GOOSE** performance in engineered schemes, eg. process bus digital substations with MU320 merging units	Process bus tripping **faster** than conventional hardwired
Higher Ethernet bandwidth and number of nodes	**HSR ring support extended to 50 nodes** Advanced message handing and filtering on Layer 1 **reduces latency** by 50%	Fast communication even in the most complex schemes
S1 Agile toolsuite Advanced usabilty and new features	Universal Ethernet configurator, **off-line fault locator** for 2-6 ended circuits, **PSL off-line simulation**, automatic **check for updates**	Test PSL **without need for physical relay** (Q4 2018)

Highest usability | Proven performance in digital substations



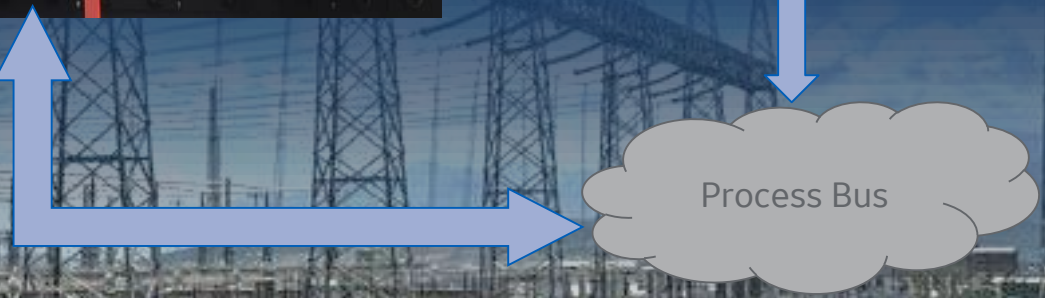
P54A-E Multiended Line Differential

- *Protect Up to 6 Ends as One Circuit!*

Migration Planning - Process Bus Fiber

UR Unique Capabilities

- Reduced wiring – Up to 90%
- Less equipped and lighter relays – less modules
- Reduced documentation – Wiring books
- Reduced labor (wiring and testing)



UR FW 7.8 Process Bus Module

New Options

Module	Description	Preferred Use Case	Future Available Upgrade
H85	2 x 1000BaseF, LC Connectors	PRP or HSR Network Dual HSR when upgraded Point-to-point also available	Add 2 x 1000BaseF, LC transceivers for a total of : 4 x 1000BaseF, LC ports
H86	4 x 1000BaseF + 4 x 100BaseFx, LC connectors	All architectures PRP, HSR, dual HSR, Point-to-Point	
H87	4 x 100BaseFx, LC connectors	Point-to-point Point-to-point Busbar protection when upgraded to 8 ports PRP and HSR also available	Add 4 x 100BaseFx, LC connector for a total of: 8 x 100BaseFx LC ports

Process Bus Module

Three Module type to cover all Network Topologies and Bandwidth Needs

Universal Relay

Proven **State-of-the-Art** Protection and Control

Robust, Scalable Hardware

- True Modular Design
- 7” Full-color Graphical Display
- Field swappable modules and display
- Meets IP54 with collar
- 10 year warranty

Protection and Control

- Multi-Feeder P&C & breaker monitoring
- Process bus BBP up to 24 feeders (Q3 ‘19)
- Process bus across all product applications

Cyber Security

- Password robustness exceeding IEEE 1686 & NERC
- AAA: RBAC, Radius
- SEM: Syslog
- Secured: SSH
- Achilles Certified

Asset Management

- Breaker Arcing, Re-strike & Flashover
- Coil circuit supervision
- Transformer Life
- Downed/broken conductor
- Incipient fault
- 2 and 3-ended fault location

Networking and Interoperability

- 3 Eth. ports for Station Bus + up to 8 for Process Bus
- IEC 61850 KEMA/DNV certified, Ed. 1 / Ed. 2
- Full-range process bus -9-2LE and IEC61869 ready
- PRP, HSR and point-to-point process bus
- Extensive range of supported protocols

Wide-Area Protection and Control

- Embedded PMU: Protection and Metering class
- Multi-feeder PMU device
- IEC61850-90-5 (PMU Multicasting)
- Routable GOOSE for secure Teleprotection

Measurement & Networking

Reason Intelligent Devices and **Optical Instrument Transformers**

PRECISE | SAFE | COMMUNICATING

Digital Substation Products

CMO

AC Digital Substation

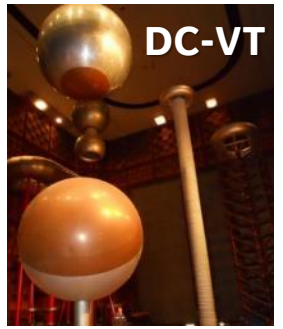
CTO – CT

CMO
Combined CT/VT

VTO – VT

COSI

DC Application



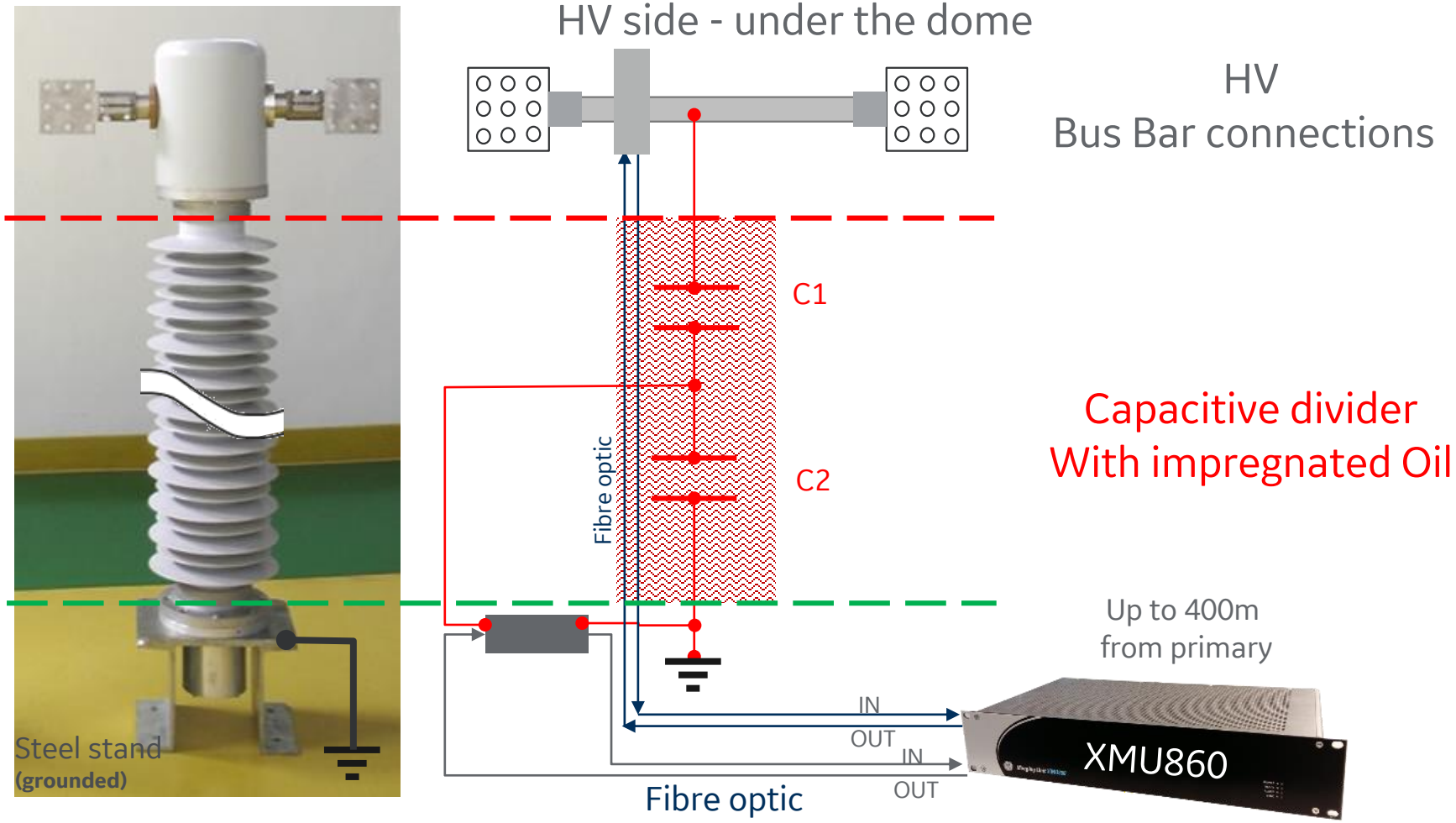
Specific AC-CT Applications

Digital Instrument Transformers

Measurement & Networking

NEW !

CMO Combined Optical CT and VT



Ethernet Switches

Reason S20 Ethernet Switch Family

S2024G Full gigabit Ethernet Switch up to 24 port w/ PTP

- Hardened for substation applications
- High performance time synchronising with IEEE 1588 (S2024)
- Hardware based time-stamping on all ports
- Operation as Transparent Clock / Boundary Clock
- Ultra-RSTP for recovery time less than 5 ms (IEC 61850-90-4)

Redundant power supply option

Full suite of features – VLAN, Port Mirroring, Link Aggregation, SNMP v3 etc.

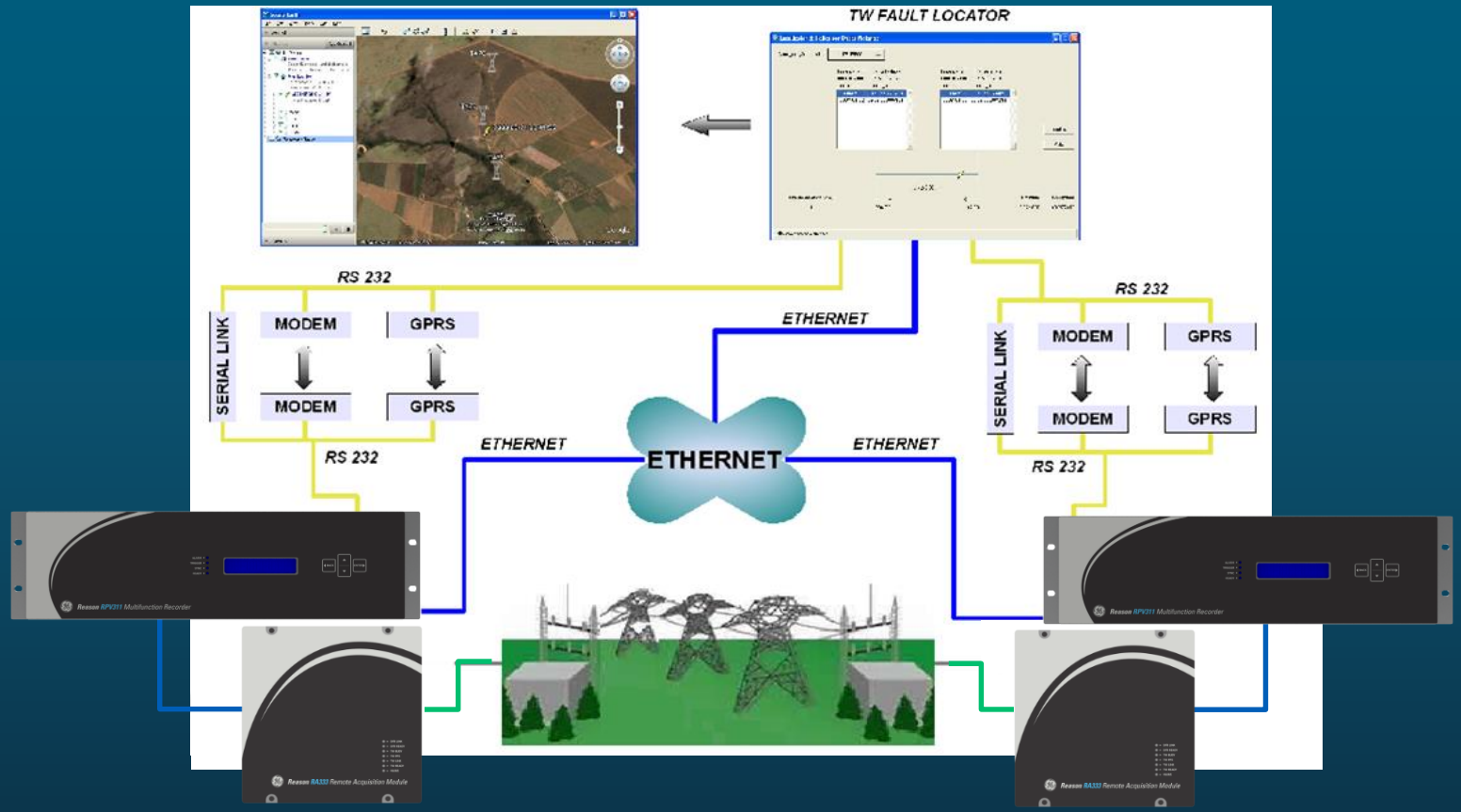
Substation Time Synchronisation

Reason RT43x Range

RT430 – GNSS Clock, 2 Ethernet ports, PRP function
RT434 – GNSS Clock, 4 Ethernet ports
RT431 – Compact GPS Clock , DIN Rail Mounting

- Supports **NTP, 1588v2, PPS, PPM and IRIG-B** outputs, web interface
- IEEE 1588-2008 Grandmaster or Ordinary (Slave) clock
  - PTP Power Profile (C37.238-2011) / PTP Power Utility Automation profile (IEC 61850-9-3:2016) – available in FW08
- TCXO internal oscillator, holdover +/- 800 µs per day (~ approx. 9ppb)
- Status monitoring using SNMP v1, v2c & v3
- Redundant power supply option

Travelling Wave Fault Locator



GE to supply & commission TWFL for 83 Transmission Lines at 400 & 765kV at 52 substations.

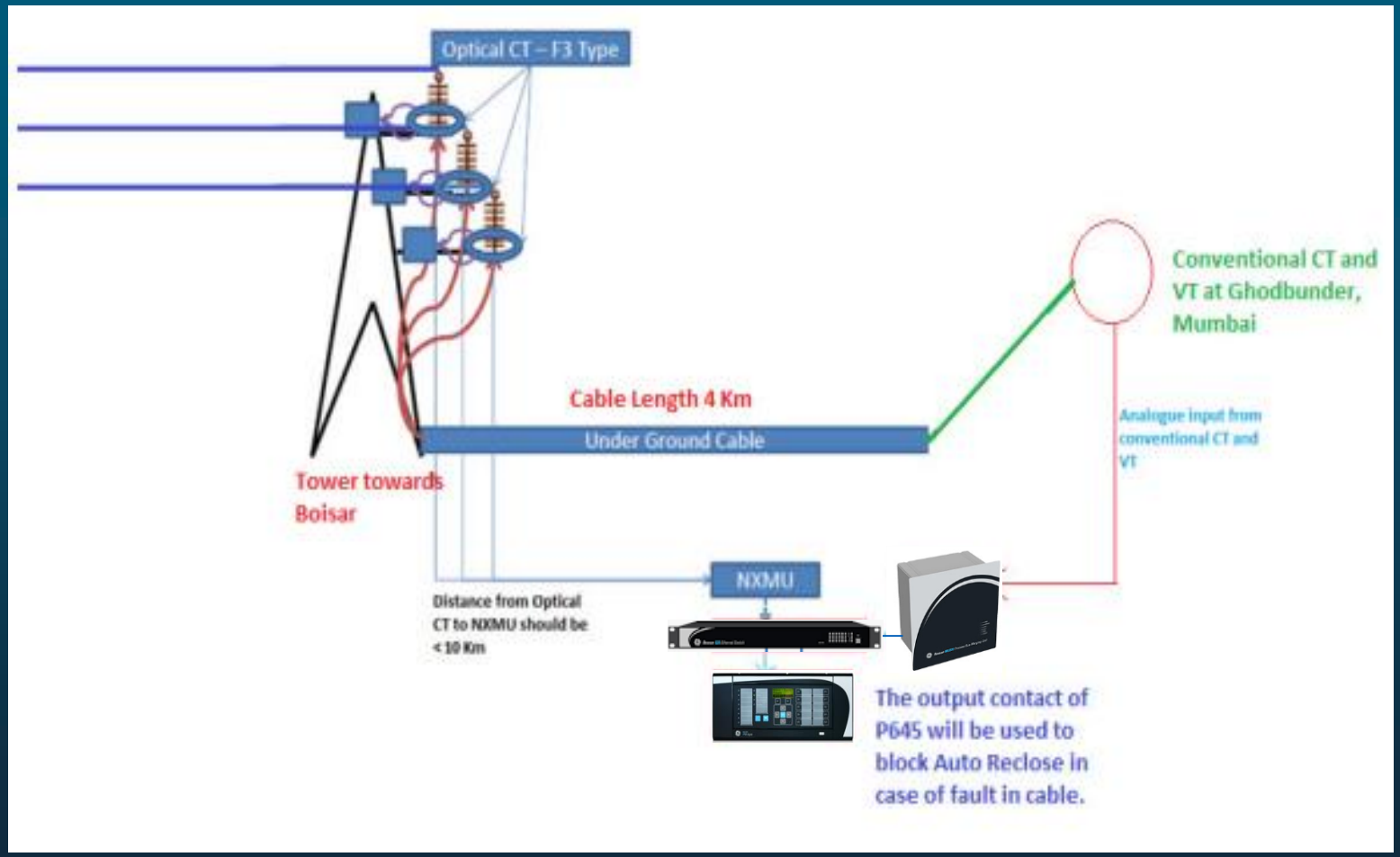
First Reason Travelling Wave Fault Locator has been commissioned 274km 765kV Bhiwani – Moga line of PGCIL.

Benefits

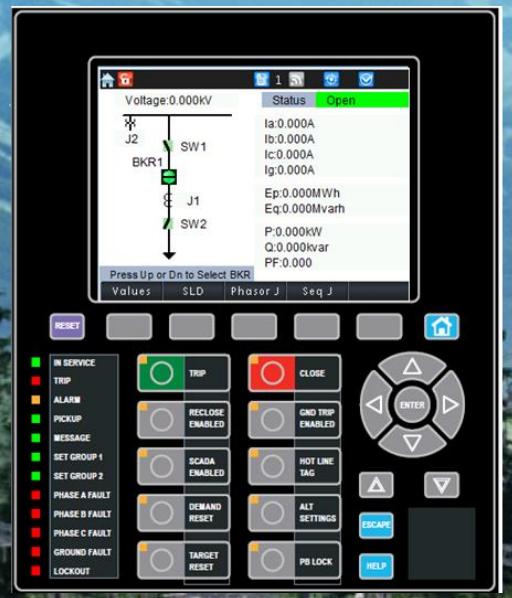
- Fault Location Accuracy ± 150m
- Maintenance crews are directed to the exact location of the fault without the need to resort to vehicular, helicopter or foot patrols to find the exact location
  - ✓ Reduces time to re-establish the line
  - ✓ Reduces costs of finding the fault
  - ✓ Reduces ‘fines’ for non-availability of the line
- Able to detect non-permanent faults (incipient), and therefore useful for predictive maintenance
- Immune to line transposition, line coupling and line load

Type B Optical CT for Cable Fault Detection

- Differential protection for underground power cables section of hybrid Lines
- Identify the cable faults and blocks the auto-relosure
- Up to 30 km between CTs and control room
- No need for power at the remote cable termination
- Can mix conventional CTs and COSI-CTs



Commissioned the DIT Successfully @ 220kV Godbunder SS Adani



Multilin **8 Series**

for Industrial and Distribution ‘One-Box’ Applications

PERFORMANCE | COMMS | ASSET PERFORMANCE

8 Series Platform Highlights – Complete offering

Quality / Reliability

- Extruded Aluminum Chassis
- Field Swappable PSU
- IPC Class 3 Manufacturing
- Component Traceability
- ALT & HALT Testing
- Automated Final Testing
- 100% Complete ESS

Performance

- Subcycle protection operating time
- 1/8 cycle protection pass
- 1/16 cycle digital input pass
- 128 samples / cycle oscillography
- 64 samples / cycle protection
- 46 x CT rating
- 1024 lines of Flexlogic
- 1024 SOE / T.S. 1ms
- SR to 8 Series Retrofit solutions enabling upgrade in about 20 mins
- Easy to use Enervista Suite with Logic Editor and Logic Monitor integrated

Communications

- IEC61850
- MODBUS RTU, TCP/IP
- IEC60870-5-103 & 104
- DNP 3.0
- IEC62439 / PRP
- 2 – Independent IP Addresses
- 2 - Fiber or Copper Ethernet ports
- 1 - Copper Ethernet port
- 1 – 485 port
- USB Front Port
- Optional WiFi for configuration
- IEEE1588/ IRIG-B / SNTP

Diagnostics

Environment Diagnostics

- Temperature Monitoring
- Humidity Monitoring
- Surge Monitoring

Asset Diagnostics

- Motor M&D
- Breaker M&D
- Transformer M&D
- Enervista visualization tools and Health reports

8 Series Installations

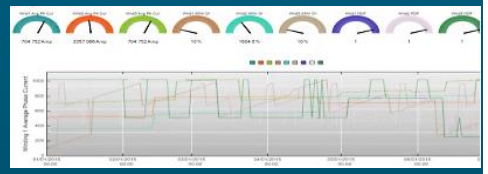
869 with APM

- 869 with ESA based Motor Asset Performance Monitoring
- Pilot installation of 869 replacing the SR269.
- Pilot installation on 869 for pulverizing mill for mechanical fault monitoring

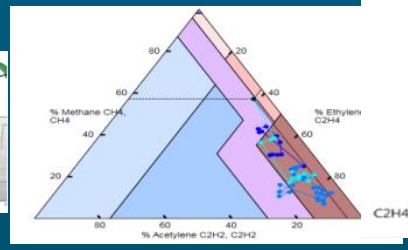
Retrofitting of 750 with 850

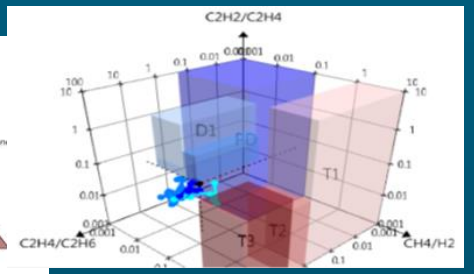
- SR750 to 850 with retrofit option
- One to one replacement with no wiring modification
- Hassle free setting conversion
- Retrofitting in 45 minutes

845 with Transformer M&D

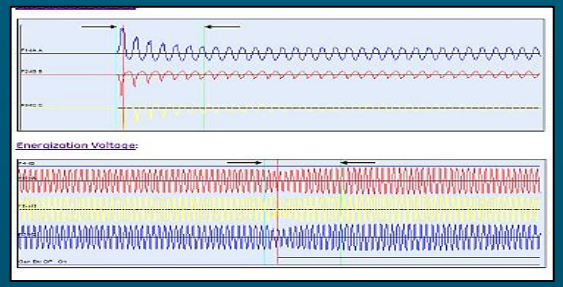


Electrical Models

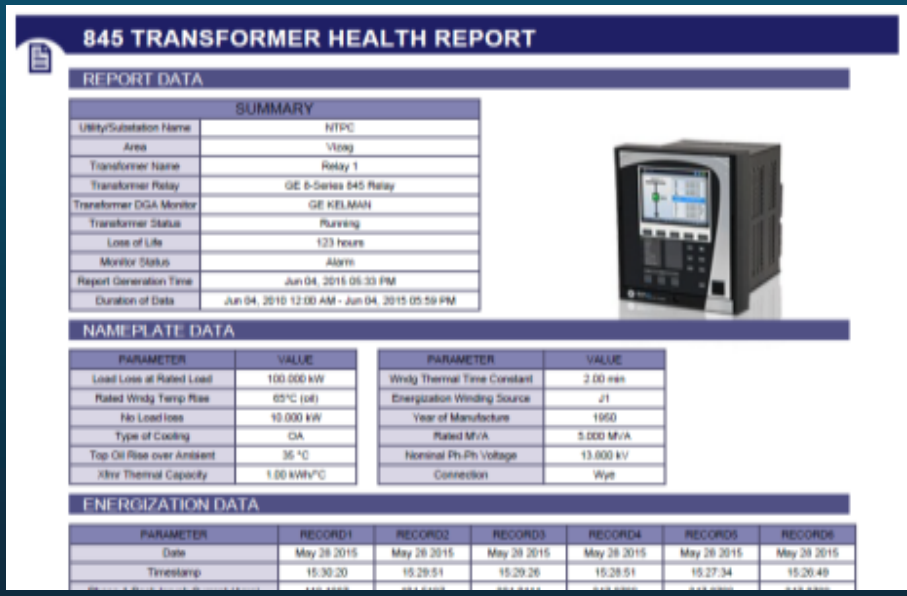




DGA Models



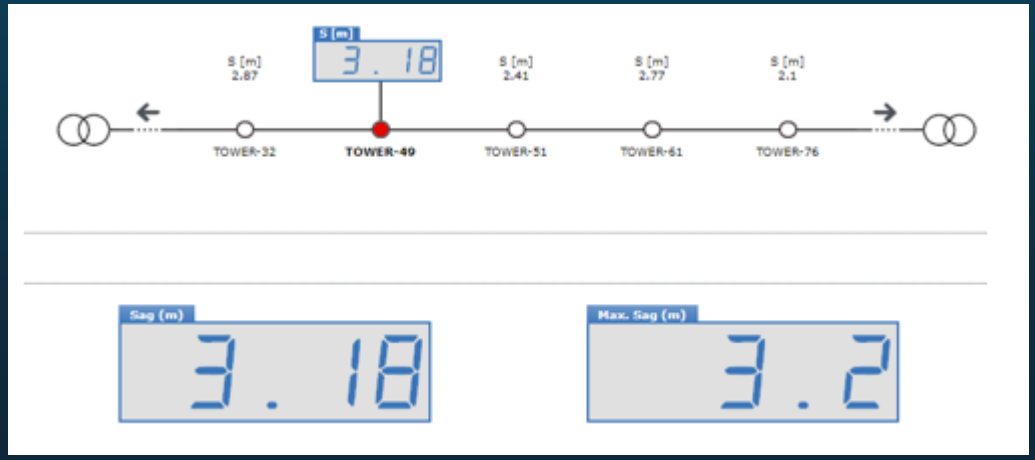
Energization Record



Health Report

Intelligent Line Monitoring System

- Monitoring of multiple Nodes for DLR function
- It consists of SNG Gateway, Line current monitoring with temperatrure (FMCT 6), Davis whether statio, Windsonic Animometer.
- ILMS server is located at Jasdan Substation
- SAG calculation SNG (Tower Span, Conductor Temp, Current load, Initial tension, Wind direction, wind speed)
- Max rating considering wind direction, wind speed, current load, temperature, solar radiation



What's New?

Summary of Recent Releases and Upcoming Roadmap

Recent Releases and Imminent Future

P44T
Railway Catenary Distance

MiCOM
P54A to E Multi-end Line Diff.

MiCOM
New HW Ed. 1/2 & Cyber (2Q)

P40 Agile
PRP/HSR/ RSTP Hi-Z

P145 / P14NB
High-Imp. Busbar (2Q)

P40 Agile
CDG refurbish. (2Q)

P40 Agile
Enhanced Feeder (3Q)

UR 7.4/7.7
Routable GOOSE Ed.1/2

UR 7.6
Graphical HMI, High Density I/O

UR 7.8
Process Bus

UR 7.9 Process Bus Busbar

850
One Box Solution

869
Motor ESA

869
Motor SPM (2Q)

Digital
MU320

RPV311
TWFL

DR60
DFR and PMU

S20
Switch Layer 3

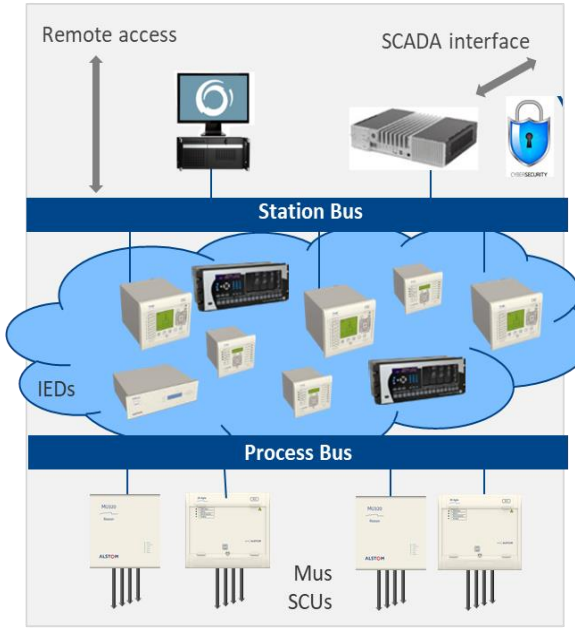
CMO
AC CT/VT Optical Sensors

P153
Low End Feeder

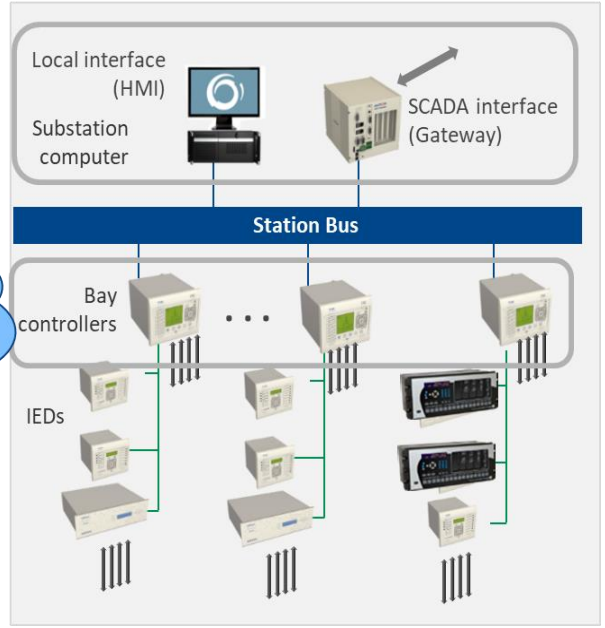
S1 Agile
Off-Line Simulation

Grid Automation Solutions

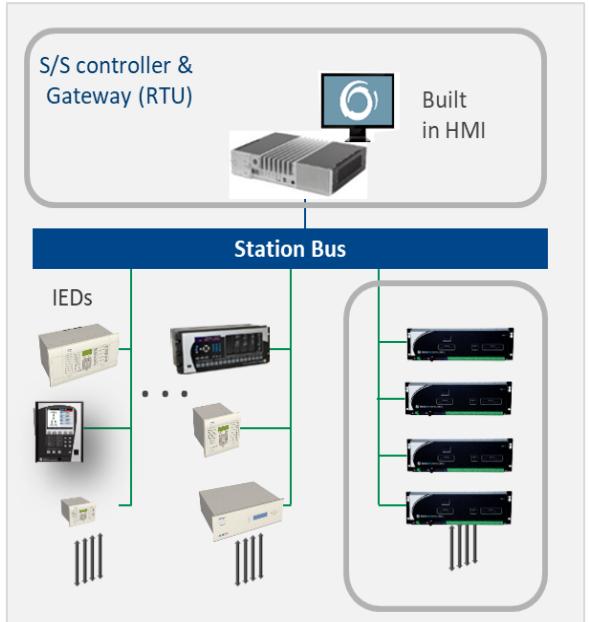
Digital Substation



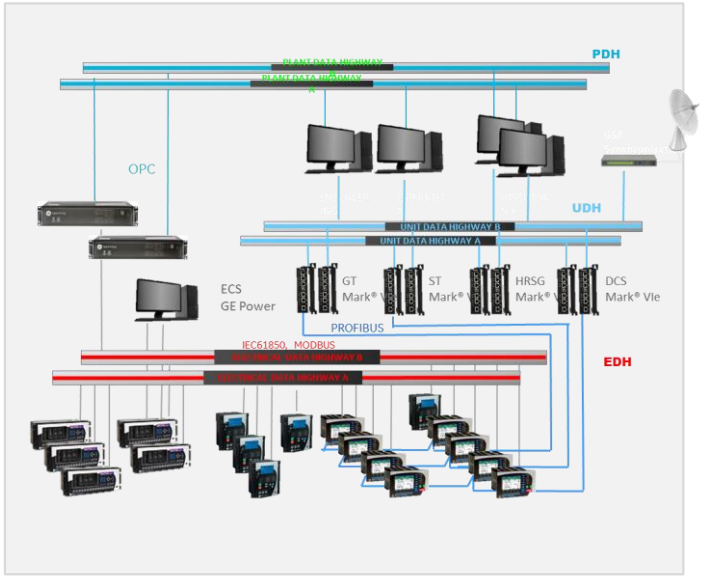
Distributed
DS Agile



Centralized
G500



Advanced Automation Applications
M500/P500/GPG



Transmission

Distribution

Customized solutions

- ✓ **MICROGRID**
- ✓ **INDUSTRY** (PMCS, Power Gen)
- ✓ **WIDE AREA** (advanced DA, SIPS, WAMS)

Industrial Communications Solutions

With over 2MM DEVICES INSTALLED in applications around the world, our products allow customers to collect, manage and analyze data enabling insights that minimize failures and downtime and maximize productivity.

Industrial Wireless

MDS is a world leading, single-source, end-to-end industrial wireless communications provider. Our industrial cellular routers and modems enable wireless networks from 900 MHz to 4G cellular.

Hardened Optical Networks

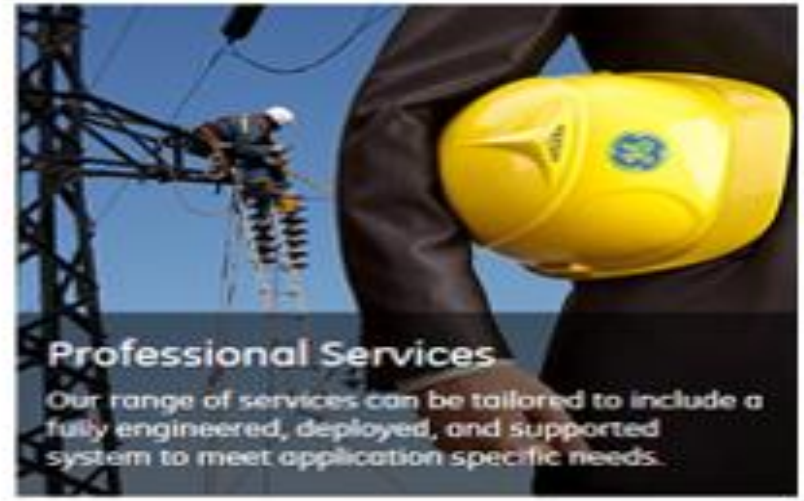
Lentronics multiplexers and switches are rugged telecommunications solutions providing T1, E1, SONET, SDH and MPLS – TP standards based solutions for short and long range applications.

Broadband Power Line Solutions

Advanced broadband PLC technology for building reliable and cost-effective networks using existing MV power lines.

Ethernet Switches & Converters

GE's family of switches and serial port servers provide secure, reliable communications for critical infrastructure and devices.



Professional Services

Our range of services can be tailored to include a fully engineered, deployed, and supported system to meet application specific needs.