Imagination at work.

GE Grid Solutions
Industrial Communications Solutions
Grid Solutions

Grid Solutions, a GE and Alstom joint venture, is serving customers globally with over 20,000 employees in around 80 countries. Grid Solutions equips 90% of power utilities worldwide to bring power reliably and efficiently from the point of generation to the end power consumers.

- Helping to meet growing energy demands
- Improving grid resiliency and energy efficiency
- Upgrading and digitizing aging infrastructure
- Enabling renewables and a diversified energy mix
Advanced products and services

- **Power Electronics**
  - High Voltage DC
  - Flexible AC Transmission Systems
  - Industrial DC Substations
  - Energy Storage

- **High Voltage Equipment**
  - Transformers
  - Gas Insulated Substations
  - Air Insulated Substations
  - Capacitors & Reactors

- **Automation & Protection**
  - Protection & Control
  - Substation Automation
  - Communications & Metering
  - Monitoring & Diagnostics

- **Software Solutions**
  - Distribution & Outage Management
  - Energy Management Systems
  - Geospatial & Mobile Solutions
  - Gas & Pipeline Management

- **Projects & Services**
  - Turnkey Projects & Consulting
  - Electrical Balance of Plant
  - High Voltage Substations
  - Maintenance & Asset Management
From power plant to power consumer

Power Generation
- Electrical Balance of Plant
- Renewable Integration
- Generator Protection
- Control Room Software
- Asset & Energy Management
- Maintenance & Modernization

Transmission
- High Voltage Equipment & Services
- HVDC and FACTS
- Digital Substations
- Grid Protection & Control
- Monitoring & Diagnostics
- Control Room Software & Analytics

Distribution
- Control Room Software & Visualization
- Protection & Control
- Distribution Automation
- Telecommunications solutions
- Asset Management
- Maintenance & Modernization

Oil & Gas
- High Voltage Equipment
- Protection & Control
- Fast Load Shedding
- Industrial Communications
- Pipeline Management Systems
- Substation Operations & Maintenance

Industry & Infrastructure
- High Voltage Equipment
- Industrial DC Substations
- Protection & Control
- Industrial Communications
- Industrial Energy Management
- Substation Operations & Maintenance

Buildings & Cities
- Analytics Software
- Demand Response Systems
- Microgrids
- Energy Storage
- Metering & Power Quality Monitoring
- Substation Operations & Maintenance
Industrial Communications
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 SOLUTIONS**
- Licensed, Unlicensed, Cellular, Wi-Fi
- Enclosures & Accessories
- Network Management Solutions

**GLOBAL PROFESSIONAL SERVICES**
- Radio System Design & Engineering Services
- RF Site Surveys & Path Studies, Spectrum Planning, Propagation Coverage Models
- FAT Testing, Commissioning, Network Audits

**HARDENED OPTICAL NETWORKS**
- Packaged Switched Solutions – MPLS-TP
- Optical Multiplexers – SONET / SDH
- Network Management Solutions

**BROADBAND POWERLINE SOLUTIONS**
- Broadband on Existing Power Cables
- Easy and Fast Installation
- Integrated Network Manager
The GE Advantage
A Global Leader Providing Tailored Communication Networking Solutions
for a Broad Range of Industrial Applications

INDUSTRIALLY HARDENED COMMUNICATION NETWORKS

• 2+ MM devices deployed across the globe
• Extended operating temps -40°C to + 70°C
• Products certified to IEEE 1613, IEC 61850-3, Class 1/Div2 standards
• Products built to IPC-A-610 REV E CL-2 standards
• Manufacturing sites ISO 9001:2008 accredited
• Rigorous HALT / HASS testing on all products delivering highest quality/reliability performance
• 68 years Mean Time Between Failure (MTBF) for MDS solutions

COMPREHENSIVE CYBER SECURITY FRAMEWORK

• Depth-in defense strategy across energy infrastructure (hardware, firmware, network & user)
• Standards-based encryption, authentication, data integrity verification
• Designed for NERC CIP, NIST SP800-82, NISTIR 7628, FIPS 140-2
• Device security tested and validated
  • Wurldtech Achilles L1 Certified

DIVERSE PORTFOLIO FOR APPLICATION FLEXIBILITY

• Licensed wireless solutions covering a broad range of frequencies including:
  • 100MHz to 38GHz with data rates up to 350Mbps
• Unlicensed wireless solutions providing:
  • Private 900MHz and 2.4GHz with data rates up to 1.25Mbps, and WIMAX and backhaul
• Cellular routers and gateways providing:
  • 2G/3G/4G LTE worldwide carrier coverage
• Hardened Optical Networks including:
  • MPLS packet switched solutions and SONET-SDH, and T1 multiplexers
Markets Served

GE’s Industrial Communications provides a broad array of products to service the needs of critical infrastructure and industrial operations for multiple sectors including:

**Energy**
- Distribution Automation
- AMI Gateway Networks
- Protection and Control
- Maintenance Workforce Mobility
- RTU Serial/IP SCADA and IEC 618506

**Oil & Gas**
- Gas Production
- Oil Production
- Midstream
- Wellhead Completion & Construction

**Mining**
- Extraction Applications
- Transportation Applications
- Processing Applications

**Transportation**
- Positive Train Control
- Remote Control Locomotive (CAI-220 RCL)
- Switching Yard Automation
- Signalling and Switching, Fiber and Wireless
- Backhaul, Distributed Power

**Water & Wastewater**
- Production & Distribution
- Wastewater / Storm Water
- AMI Gateway Networks
Industrial Communications
modernizing the grid from the power plant to the power consumer
Portfolio Overview
Industrial Communications Portfolio

Hardened Optical Networks
Multiplexers, Packaged Switch Solutions (MPLS, SONET–SDH)

Hardened Optical Networks
Multiplexers (T-Carrier System T1)

Broadband Power Line (BPL)
Data rates up to 200 Mbps

Industrial Wireless Solutions | Wireless Licensed
- Licensed 100 to 900 MHz, Data rates up to 120Kbps
- Microwave networks 38GHz, Data rates up to 350 Mbps
- WiFi, 802.11b/g/n - 54Mbps

Industrial Wireless Solutions | Wireless Unlicensed
- 900 MHz and 2.4 GHz, Data rates up to 1.25 Mbps
- 2.4, 5.3, 5.8 MHz data rates up to 200Mbps
- 3.65 GHz, Mesh, Low Power LAN, (WIZY)
- WiFi, 802.11b/g/n - 54Mbps

Industrial Wireless Solutions | Wireless Cellular
(Routers with 2G/3G/4G LTE worldwide carrier coverage.)

Global Professional Services

Network Management Solutions

Industrial Wireless
Industrial Communications
Leading Edge Products

MDS SD Series
Long Range IP/Ethernet & Serial

Industrial wireless solutions that provide long distance communications over licensed 200MHz, 400MHz and 900 MHz frequencies. Providing users with the following key benefits:

- **High speed**, up to 65 Kbps in 50 KHz channel in SD2 and SD9
- Operate IP/Ethernet and serial communications on a **single network**
- Connect multiple host systems to a **single Access Point radio**
- **Simple, intuitive** web based configuration and maintenance

INDUSTRIAL WIRELESS SOLUTIONS

Licensed • 200MHz, 400MHz, 900MHz

Industrially Hardened

- Operational temperature range from –40°C to 70°C
- CSA Class I, Div. 2 groups A,B,C,D for Hazardous Locations
- IEEE 1613, IEC 61850-3 and EN61000 for electric substation environments

Application Flexibility

- Supports two serial ports and an IP/Ethernet port simultaneously
- Broad coverage flexibility over distances up to 50 miles
- Extend communication paths using single radio store and forward
- Supports Ethernet bridging, IP to serial and serial to serial communications
- Low power consumption with sleep mode for solar and battery powered applications
- Fast-serial features with embedded terminal server functions for serial to IP/Ethernet encapsulation

Reliable & Scalable

- Exclusive, non-shared licensed band operation
- High performance Media Access Control for asynchronous polling and exception reporting
- Collision detection and avoidance ensures data arrives at destination without lost messages
- High receive sensitivity for long distance communications
- Compatible with multiple industry protocols including Modbus, Modbus TCP, and DNP3

Secure

- AES 128-bit data encryption
- Password protected access
- VLAN data segregation

Solution is ideal for customers using dedicated frequencies for long range communication.
Industrial Communications
Leading Edge Products

MDS Orbit Platform
Highly reliable, industrial wireless communications solutions for critical applications

MDS Orbit platform is designed with a common operating system, device management tools, and a comprehensive networking and cyber-security framework.

These commonalities significantly:

- Reduce the overall learning time for users
- Simplifies the set-up and commissioning of communications networks
- Enables the deployment of a variety of configurations and topologies

Industry Leading Reliability

- 30 years of extensive experience with more than 1.5 millions radios deployed
- Combined cellular and private radio options for redundant wireless uplinks resulting in higher network availability
- Built for harsh environments with compliance to IEEE 1613, IEC 61850-3 and Class 1 Div 2
- Industry leading Mean Time Between Failures (MTBF) of 68 years
- 5-year manufacturer warranty lowers total cost of ownership
- MDS Orbit Platform certified to ATEX QA / IECEx QA

Advanced Networking & Security

- Diverse choice of cellular modems provide coverage for majority of bands and regions with GPS support
- Flexible Quality of Service enables simultaneous applications on the same uplink while preserving performance
- Concurrent routing and bridging enables flexibility for a variety of network designs and topologies
- Enterprise-class device with network cybersecurity functionality and VPNs ensures advanced protection for network assets

Ease of Use & Compact Design

- Intuitive user interface and configuration wizards simplify complex network configuration tasks resulting in accelerated deployment of advanced networking
- One of the industry's most compact radios with full router functionality

The platform has a wide range of models with different radio, port density and technology combinations providing customers the flexibility to design a solution that best fits their unique application requirements.

INDUSTRIAL WIRELESS SOLUTIONS

- Licensed
- Unlicensed
- Cellular
- Wi-Fi

- 400MHz, 900MHz
- 900MHz
- 2G/3G/4G
- 802.11b/g/n - 54Mbps
# Wireless Licensed Solutions

<table>
<thead>
<tr>
<th>MDS Orbit Platform</th>
<th>MDS SD Series</th>
<th>MDS Mercury</th>
<th>MDS Intrepid</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Converged Communications for Hybrid Networks</strong></td>
<td><strong>Secure, Long Range IP/Ethernet &amp; Serial</strong></td>
<td><strong>High Throughput, Standards-Based Networking</strong></td>
<td><strong>High-Capacity, Licensed Point to Point</strong></td>
</tr>
<tr>
<td>400, 900MHz</td>
<td>100, 200, 400, 900MHz</td>
<td>3650MHz</td>
<td>6-38GHz</td>
</tr>
</tbody>
</table>

- **Ethernet & serial connectivity**
- **Local range wireless WiFi up to 54 Mbps**
- **Security enables FIPS 140-2 & NERC-CIP compliance**
- **Point to multipoint solutions**
- **Long range -- up to 50 miles**
- **Low power and sleep mode functionality**
- **Speeds up to 65 Kbps**
- **Ethernet, serial, USB and WiFi connectivity**
- **Extended range and aggregate throughput of up to 30 Mbps**
- **Capacity from 50 Mbps to 1 Gbps**
- **Native IP and TDM interfaces**
- **Supports OC3/STM1 interfaces**
- **Shares bandwidth between TDM and IP traffic allowing for an easy migration path from TDM to IP**
# Wireless Unlicensed Solutions

<table>
<thead>
<tr>
<th>MDS Orbit Platform</th>
<th>MDS WiYZ</th>
<th>MDS iNET Series</th>
<th>MDS TransNET</th>
<th>MDS Intrepid</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Converged</strong></td>
<td><strong>Intelligent Data</strong></td>
<td><strong>Long Range, High-Speed</strong></td>
<td><strong>Long Range, High-Speed</strong></td>
<td><strong>High-Capacity</strong></td>
</tr>
<tr>
<td>Communications</td>
<td><strong>Acquisition, Cellular &amp; Wi-Fi</strong></td>
<td><strong>Ethernet, Ethernet &amp; Serial</strong></td>
<td><strong>Serial Communications</strong></td>
<td><strong>Point to Point Point to Multipoint</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Frequency</th>
<th>900MHz</th>
<th>900MHz, 2.4GHz</th>
<th>900MHz</th>
<th>900MHz, 2.4GHz</th>
<th>2.4, 5.4, 5.8GHz</th>
</tr>
</thead>
</table>

- Ethernet & serial connectivity
- Local range wireless WiFi up to 54 Mbps
- Security enables FIPS 140-2 & NERC-CIP compliance
- Support sensors, transducers and I/O
- Range up to 30 miles and speeds of 106 kbps
- Multi-purpose gateway supporting private, cellular, WiFi
- Interoperable, standards-based battery powered remotes
- Standards-based mesh communications with battery power remotes
- Point to multipoint solutions
- Range up to 30+ miles
- Speeds up to 115 kbps
- Frequency hopping technology, sleep mode, store and forward
- Unlicensed, point to multipoint solutions Range up to 30 miles
- Speeds up to 115 kbps
- Frequency Hopping Spread Spectrum
- Transparent data communications
- High receive sensitivity for noisy environments
- Store and Forward to extend network range
- Hardened and reliable radio systems
- High capacity up to 200 Mbps throughput
- Shares bandwidth between TDM and IP traffic allowing for an easy migration path from TDM to IP
- Scalable solutions through sectored base station capabilities in 60, 90 and 120 degree sector
Cellular Solutions

MDS
Orbit Platform

Converged Communications
for Hybrid Networks

2G/3G/4G/LTE

• Ethernet & serial connectivity
• Local range wireless WiFi up to 54 Mbps
• Security enables FIPS 140-2 & NERC-CIP compliance
Hardened Optical Networks
Industrial Communications
Leading Edge Products

Lentronics JunglePAX
Packet Switched Networking Solution for Teleprotection

Rugged telecommunications platform for industrial applications that maintains deterministic performance through packet based communications providing utilities with the following key benefits:

• Improved service quality
• Maximized service uptime
• Flexible and scalable solution
• Improve system-wide manageability
• Simplified network management

Purpose Built for Teleprotection & Superior Performance

• Industry leading protection switching within 10ms
• Low end-to-end service latency within 4ms excluding propagation delay
• Designed with layers of redundancy for improved security and dependability
• ‘AAA’ secured for NERC/NIST compliance

Single Solution Converging & Simplifying Operations

• Flexible design with user defined scalability for deployment across backhaul, aggregation and access networks
• One box solution for mission critical and essential Operational and Informational Technologies (OT/IT) capable of connecting multiple and diverse applications
• Integrated and application-driven software that simplifies the network management model
• Network-wide Summary and Status Information (SASI) dashboard for simplified health and integrity validation

Ruggedized & Modular Design Lowering Total Cost of Ownership

• Industrially hardened for IEEE 1613 & IEC 61850-3 compliance, no cooling fans resulting longer life in harsh environments
• Processes 24 Gigabit/s of traffic across the extended -20° C to + 60° C operating temperature
• Flexible redistribution of service ports to ‘future-proof’ investment
• 10x the capacity of SONET/SDH icons at the same price without compromising reliability

One box solution for mission critical and essential Operational and Informational Technologies (OT/IT) capable of connecting multiple and diverse applications
SONET/SDH Multiplexers

Powerful & Flexible Multiplexing Solution
- Provides transport and access capabilities for voice, data, IP/Ethernet, WAN, video and utility teleprotection traffic in a single package
- Fast path protection switching (<3 ms)
- Modular design with seamless capacity upgrades
- 99.999% system availability with redundant common equipment
- Hardened for reliable operation in harsh industrial environments and extreme temperatures from -4°F to +140°F (-20°C to +60°C)
- Comprehensive network management

Lentronics
JungleMUX SONET
Delivers robust, secure wide area telecommunications over an optical cable infrastructure adhering to Telcordia SONET standards, offering reliable support for a wide array of applications.

Lentronics
TN1U SDH
Delivers robust, secure wide area telecommunications over an optical cable infrastructure adhering to ITU-T SDH standards, offering reliable support for a wide array of applications.

Lentronics
TN1Ue SDH
The TN1Ue SDH Multiplexer delivers robust, secure wide area telecommunications over an optical cable infrastructure adhering to ITU-T SDH standards, offering reliable support for a wide array of applications. The enclosed shelf design provides additional security in sensitive electromagnetic interference (EMI) environments.

<table>
<thead>
<tr>
<th>SONET</th>
<th>ITU-T SDH</th>
<th>ITU-T SDH</th>
</tr>
</thead>
<tbody>
<tr>
<td>• High speed fibre optic communications (OC-1, OC-3, OC-12, OC-48)</td>
<td>• High speed fiber optic communications (STM-1, STM-4, STM-16)</td>
<td>• High speed fiber optic communications (STM-1, STM-4, STM-16)</td>
</tr>
<tr>
<td>• Interoperable with T1MX channel banks</td>
<td>• Secured for information assurance</td>
<td>• Secured for information assurance</td>
</tr>
<tr>
<td>• Secured for NERC/CIP compliance</td>
<td>• Interoperable with E1MX channel banks</td>
<td>• Interoperable with E1MXe channel banks</td>
</tr>
</tbody>
</table>
## T1 and E1 Multiplexers

### Powerful & Flexible Multiplexing Solution

- Extends critical channel access into harsh utility environments over microwave radio, leased line and dedicated fiber optic or copper cable networks
- Supports standalone T1/E1 networks, spurs and access applications for connection into higher order systems
- An integrated digital cross connect offers powerful traffic grooming options
- Reliable operation in extreme temperatures from -4°F to +140°F (-20°C to +60°C)
- Interoperable with SONET/SDH multiplexers and JunglePAX MPLS packet switched platform
- Comprehensive network management

### Lentronics Multiplexers

<table>
<thead>
<tr>
<th>Multiplexer</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1MX Multiplexer</td>
<td>T-Carrier System (T1)</td>
</tr>
<tr>
<td>E1MX Multiplexer</td>
<td>E1</td>
</tr>
<tr>
<td>E1MXe Multiplexer</td>
<td>E1</td>
</tr>
</tbody>
</table>

**T1MX Multiplexer**
- Integrated Compact Digital Access X-Connect (CDAX)
- Supports a wide range of JungleMUX SONET compatible DS0 interface units including voice, data, teleprotection and Ethernet applications
- Interoperable with JungleMUX multiplexers

**E1MX Multiplexer**
- Additionally offers ring-mode of operation where route-diversity is required
- Interoperable with TN1U SDH multiplexers

**E1MXe Multiplexer**
- Additionally offers ring-mode of operation where route-diversity is required
- Interoperable with TN1U SDH multiplexers
- The enclosed shelf design provides additional security in sensitive electromagnetic interference (EMI) environments
- This product meets CE mark requirements including all EMC and safety certifications

Network Management
Network Management Solutions

MDS PulseNET

Comprehensive Network Management

MDS PulseNET is purpose-built for industrial communications and includes sophisticated and meaningful pre-built workflows along with intuitive graphical representations of the network at your fingertips.

Lentronics VistaNET

Network Management System

Lentronics VistaNET is a complete suite of software tools to manage the Lentronics family of products. VistaNET can be provisioned as a stand-alone tool or a client-server solution, permitting centralized or distributed network management.
Broadband Powerline Solutions
Industrial Communications
Leading Edge Products

E-terrapowercom
Broadband Powerline Solutions

e-terrapowercom is designed for communication on medium and low voltage power lines, using broadband PLC technology with advanced networking features, to build reliable and cost-effective networks on the existing cables providing the following key benefits:

• Broadband on Existing Power Cables
• Easy and Fast Installation
• Integrated Network Manager

Compact design for harsh and enclosed environments with an IP-40 certified box

Broadband Powerline Solutions

PLC
• Up to 200Mbps of bandwidth

- High bandwidth and low latency
  200Mbps of bandwidth with low latency

- Fast installation
  Using the existing electrical cable, and requiring no extra cabling

- Integrated 4-port switch
  Functional Layer-2 fast Ethernet switch for local applications

- 2 BPL outputs
  An embedded 2-way splitter for double BPL couplers

- Embedded filters
  Configurable built-in hardware filters for noise protection

- AC and DC power supply
  Flexible 90 to 240 VAC or 24 to 48 VDC powering options

- Compact design
  Extremely compact design on DIN rail mountable box

- Intuitive Web management
  Configuration and monitoring by intuitive graphical interface
Professional Services
Professional Services

The Professional Services offering includes a **RANGE OF SERVICES** that can be tailored to provide a **FULLY ENGINEERED, DEPLOYED, and SUPPORTED SYSTEM** TO MEET APPLICATION SPECIFIC NEEDS.

**SERVICES INCLUDE:**

- Radio System Design and Engineering Services Including: RF Site Surveys & Path Studies, Spectrum Planning, Propagation Coverage Model, Factory Acceptance (FAT) and Commissioning
- Application Networking Services Design and Implementation Including: Network Audits, Device Configuration and Network Layouts
- Optical System Design and Engineering services including: Application-defined Performance & Interoperability Testing, Network Analysis, Design & Migration Engineering
- Customized Environmental Solutions & Long Term Maintenance Contracts of Installations

**KEY BENEFITS of working with GE’s Professional Services INCLUDE:**

- Access to technical expertise that utilizes state-of-the-art tools and highly qualified system designs
- Minimizes overall costs and reduces risks through the provision of a guaranteed working design
- Proven processes identify and reduce risks and failure modes prior to implementation
- Single point of contact helps ensure timely implementation within scope and on budget
- GE engineering engagement allows tailoring of products to meet customer’s specific need
Industrial Communications Solutions

With over 2 MILLION 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.

INDUSTRIALLY HARDENED COMMUNICATIONS NETWORKS
Delivering uncompromised performance and reliability

COMPREHENSIVE CYBER SECURITY FRAMEWORK
Delivering protection for critical assets

DIVERSE PORTFOLIO FOR APPLICATION FLEXIBILITY
Delivering tailored solutions for a wide range of applications
Digital Tools that simplify the entire product lifecycle.

Get your Grid Passport and explore 24/7 Online or on your iPad

Explore Grid Challenges
“Fly-Through” an interactive power system that features an in-depth look at the challenges of modernizing the grid from the power plant to the power consumer.

Discover Solutions
Get hands-on with GE solutions through a broad range of advanced digital tools including real-time 3D product explorers, and interactive episodes.

Configure & Buy
Easily specify, configure, and buy GE solutions 24/7 online with interactive selector guides, simple to use product configurators, and our online store.

Learn & Implement
Access videos anytime, anywhere, and learn advanced power system applications from industry experts, get quick answers from technical experts, and more.

www.GEGridSolutions.com