Metro Control Solutions

Optimizing Your Operations for the Future

geautomation.com

One-third of the world's major metros use GE control systems to help get people where they need to go, safely and on time.

GE is responsible for the automation and control of processes that generate one-third of the world's power. For more than 130 years, we have delivered energy where it is needed most.

We are also a leading provider of automation and control products and services for metro systems. One-third of the world's major metros use GE control systems to help get people where they need to go, safely and on time. We can help optimize your equipment performance and increase the reliability and efficiency of your metro operations by connecting your machines, data, insights, and people.

Industrial Internet Control System for Metro

Unprecedented growth in urban population is increasing ridership of existing metro systems and demand for new and improved transportation solutions. In 2014, 54% of the global population lived in urban areas; by 2050, this number will climb to 66%. But metro systems throughout the world are showing their age, resulting in disruptions, delays, and even safety risks. Meanwhile, transit authorities face a shortage of experienced personnel, rising costs, and tightening environmental regulations.

Solutions to Meet Today's Challenges

In today's increasingly urban world, to improve your operations you need a metro control system that is integrated, data-driven, and accessible from anywhere.

To meet the challenges facing metro operations, GE has developed integrated control solutions that provide a comprehensive view and intuitive control of the disparate systems that make up a subway network. GE's Industrial Internet Control System (IICS) makes it possible to actively monitor and dynamically regulate processes throughout your metro system, reducing strain on operators and improving overall system reliability.

Why GE?

We have extensive expertise with metro system automation and control. GE offers:

- BAS Environmental Control (station ventilation, lighting, conveyance, and other environmental systems, monitor and control system of tunnel ventilation)
- Power Monitoring System
- Shielded Gate System
- Traction Distribution Systems
- Subway Station Monitoring Systems

GE metro control systems

- Connect to cloud resources and perform advanced analytics in the cloud or at edge nodes
- Scale from simplex unit control to high availability redundant systems all the way to process control solutions with a single portfolio of products with a single run-time and toolset
- Include a broad portfolio of complementary products for integrated solutions
  - Fully Integrated VFDs
  - Fully integrated industrial Ethernet switches
  - IPCs and display panels
  - Wireless communications
  - Power equipment monitoring
  - HMI/SCADA, Historian, and Web visualization software
  - Secure Predix Cloud, local storage, or third-party cloud connectivity
- Are designed with security in mind, with features like TPM, secure boot, signed firmware
- Meet industry security standards
- Include built-in software firewalls

Take your industrial control system to the next level.

The Industrial Internet Control System (IICS) helps to improve your operational efficiency by providing the ability to access and use data from your facilities to better understand patterns, trends, and disparities in your control systems. This helps to lower overall risk, total cost of ownership, maintenance expense, and unplanned downtime while increasing overall performance and productivity. Outcome Optimizing Controllers combine reliable and secure controls with data acquisition management in a single unit.

Choose to send and manage data on-premise or in the cloud with the flexibility to use convenient Predix*-enabled Embedded Field Agent technology or PACEdge, which enables specific Linux-based applications and access to your preferred cloud environment.

48% Of customers said they have a talent gap for gathering and consolidating disparate data

70% The % of industrial companies who believe it's important to adopt an Industrial Internet of Things Strategy the next over the next 5 years

80% The average % of industrial companies who indicate big data analytics is the TOP priority for their company, or in the top 3

(Sources: Morgan Stanley Research; Global Capital Goods, "Insight: Cloud Control – The Future of Industrial Automation", March 15, 2016")

Unlock Hidden Value Through Controls

Optimize Asset & Process Performance

- Securely collect and integrate data across the plant
- Analyze data on-premise or in the cloud

Maximize Productivity

- Drop in complete, cyber-secure IIoT solutions or use our Linux-based platform to develop your own scripts and applications in a standard Linux environment
- Reduce maintenance cost through monitoring and diagnostics

New Revenue Opportunities for SIs and OEMs

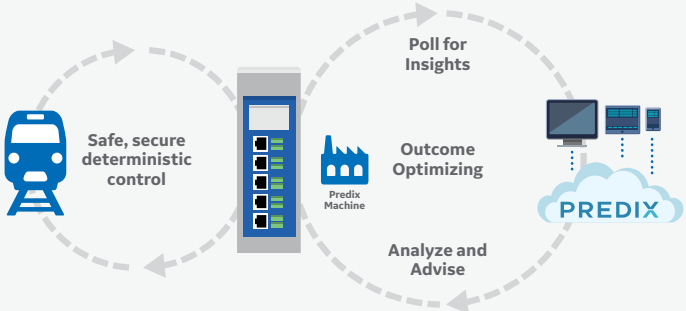
- Develop new data-driven service offerings for end customers
- Maintain competitive advantage through continuous software-based innovation

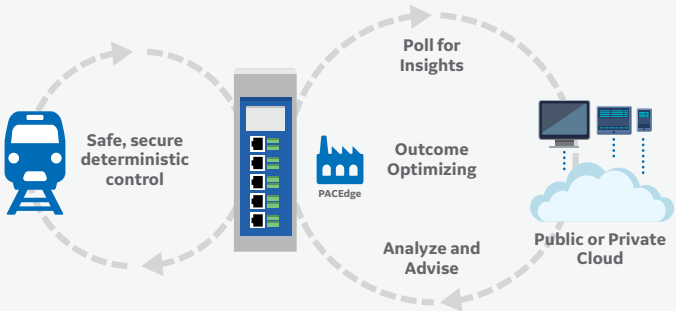
Transform the Equipment Lifecyle

- Select the right on-ramp to the Industrial Internet for either greenfield or brownfield applications (no retrofit required)
- Eliminate the impact of component obsolescence through modular hardware, firmware, and software

Choose from Two Outcome Optimizing Control Options:

CPE400 + Embedded Field Agent *Predix Machine provides:*	**CPL410 + PACEdge for Linux** *PACEdge with Linux provides:*
Automated OPC UA Client for data collection from CPE400 PLC runtime	OPC UA Client for data collection from CPL410 PLC runtime
Hoover data collection and aggregation	SQL_Lite database for datacolleciton and aggregation
REST for secure cloud connectivity to PREDIX cloud	Webserver with HTTPS Support to connect to your preferred cloud
Predix enabled Edge Applications	Develop your own scripts and applications in a standard Linux environment
JAVA/C/C++ support for Predix Apps	C/C++/Python development environment for Edge Apps
Predix Edge Manager to deploy and manage your devices	Connect directly to your local storage solution or download standard tools to connect to your choice of cloud services.





Open Communication Protocols

Open standards allow equipment from multiple vendors to work together seamlessly for the end application. This ease of interoperability allows systems to be combined, and reduces the skill level required to do so.

Development, deployment, and commissioning become easier

- Code can be reused with the ability to define standard objects and a fixed, yet flexible, API allows for rapid development and modifications.
- Metrics and historical data from disparate vendors and systems are integrated

Provisions are built-in for communications security

- Data and associated attributes are transferred collectively to reduce the likelihood of a data mix-up
- Common APIs reduce the likelihood of coding errors, reducing vulnerabilities in the application

Cyber Security

We understand the risk involved in securing our customers' assets and believe in a defense-in-depth architecture to help secure from the hardware layer up, guarding against potential cyber threats. Our PACSystems platform has earned Achilles and TRIMPS certifications. GE implements a secure design lifecycle, scrutinizing each components' hardware and software through testing and reviews.

At GE, we realize that the control system must be secure by design and should have a hardware root of trust as the foundation of all the security constructs in the control system. For our IICS portfolio, all our controllers now come with Trusted Platform module (TPM) technology that enables hardware root of trust. All boot firmware is signed by GE with the private key stored in the TPM module to ensure only GE signed firmware will run on the hardware. GE supplied patches are also signed for verification purposes prior to loading.

Achilles Level 2 Certification

RX3i has been industry-certified to meet rigorous standards for reliability and communications robustness. Its cyber-hardened platform is designed to help prevent cyber attacks, reducing operational risks.

Role-Based Access Control

Privileges assigned to users are based on pre-defined levels of authorization, enhancing system security. This provides layered user access, allowing only specific user access to critical competitive and customer data.

Secure User Authentication

Access to the controller is implemented using an authentication process that does not require passwords to be passed over the network. This helps prevent an attacker from eavesdropping and collecting credentials from the network that would provide unauthorized access to the controller.

Signed Firmware Updates

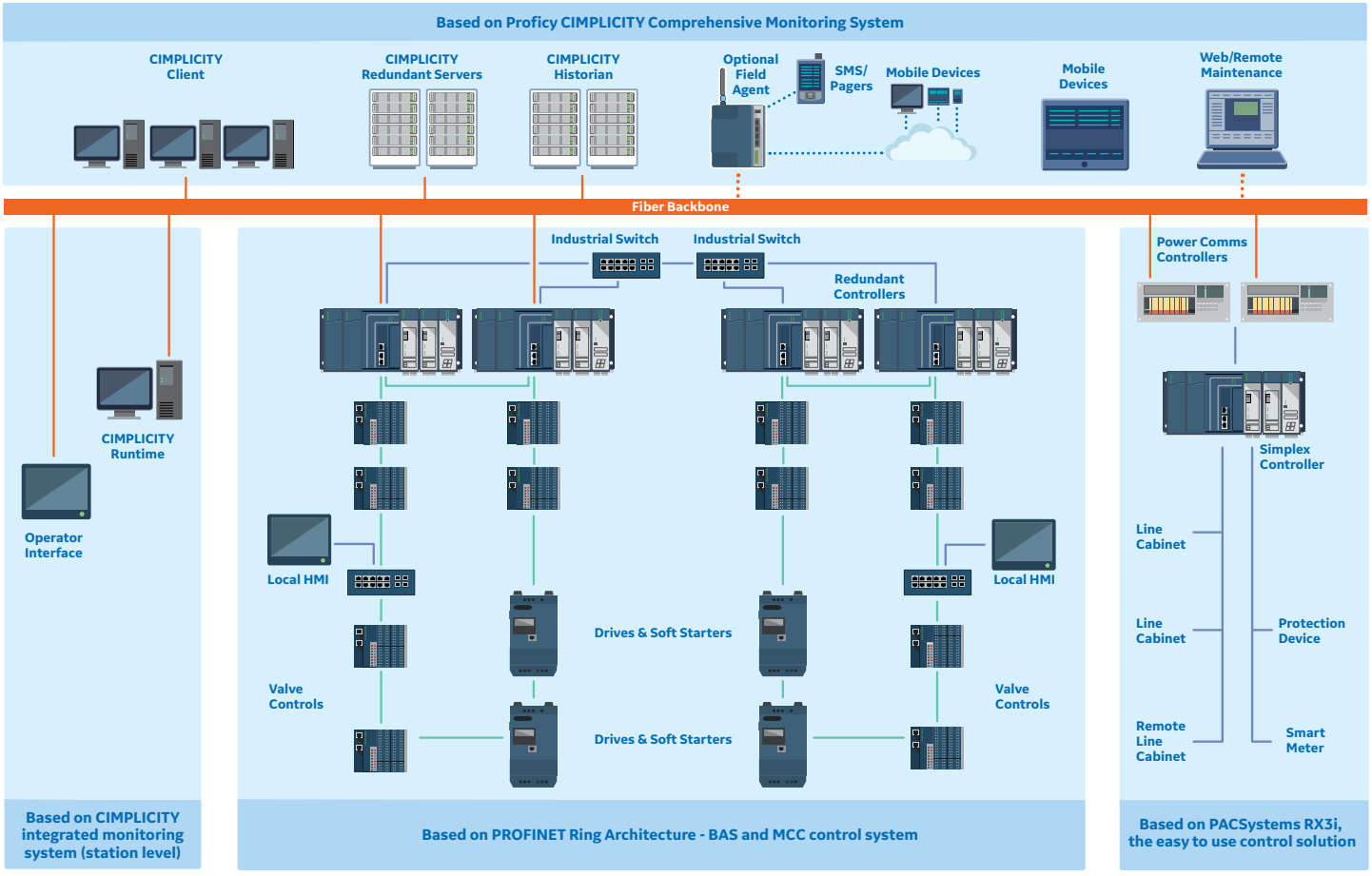
Signed firmware updates help ensure only core operating system software supplied by GE will run on the PLC and that it has not been tampered with since it left the factory. This prevents code that has been compromised from entering the controller, protecting system availability and valuable operation information.

Flexible Architectures to Fit Your Needs

Flexible and scalable solutions allow a for multitude of existing infrastructure and applications to reap the benefits of our metro solutions.

- Same tool chain across our solutions: Manage controls, Industrial Ethernet Switches, and VFDs from one integrated tool
- Link to Predix, local storage, or cloud storage directly for Outcome Optimizing Control
- Simple retrofit on top of any existing vendor or mix of vendors
- Seamless integration of environmental and electrical systems with built-in protocol and power monitoring
- Single HMI solution for local, remote, and even Web interface with one tool
- Best-in-class high availability solution for control applications improves performance, reliability, and availability
- PROFINET System Redundancy enabled VFDs reduce system installation cost up to 15% and simplify monitoring and maintenance of VFD applications

Built-in power protocol and power monitoring mean seamless integration of environmental and electrical systems



Customer Successes

GE customers have successfully deployed our flexible and scalable metro solutions around the globe.

Major Chinese Metro Line

As usage increases, this metro line will produce more heat and noxious gas in underground spaces, resulting in environmental deterioration in the stations.

To address this issue, GE upgraded the BAS system, using two-level control and real-time monitoring for various stations, drainage and fire ventilation and air conditioning, lighting system, elevator and escalator, shielding door, air defense closed, flood gate and other mechanical and electrical equipment operation using PACSystems controllers and VersaMax I/O.

The system is connected to the project control center and the center stage equipment monitoring system.

European Metro System

The underground public transportation network in this European capital is the continent's most-used on a per capita basis. Comprised of 3 lines, 57 stations and nearly 60 kms of mostly underground railways, this metro system has relied on GE to help ensure the uptime of its critical applications for:

- Escalators and elevator controls
- Ventilation systems in the stations and tunnels
- Water drainage
- Electricity supply to stations in the transformer center

A recent modernization and expansion project upgraded the existing control system with GE's PACSystems solutions to help increase performance. This project met customer requirements for cost effectiveness and ease of migration.

United States Mass Transit System

A major city's transit authority uses a mix of control vendors for station automation throughout their metro network. They turned to GE to help determine the cause of system failures quickly and reliably, without interrupting their current controls solution.

GE deployed a monitoring solution on top of the existing control solution. It consists of CIMPLICITY Historian software on an IPC for local collection and storage, but direct connection to the existing SCADA system via Modbus/TCP from RSTi-EP Remote I/O drops. The solution provides real-time remote monitoring and diagnostics from a central control station and emergency local data storage in the event of network outages.

Large Metropolitan Auto Tunnel

A traffic tunnel in a large American city, consisting of two tubes with two lanes of traffic each, is over one mile in length and handles over 27 million vehicles per year. The tunnel's two ventilation buildings bring three million cubic feet of fresh air into the tunnels each minute, and provide a complete air change every 90 seconds.

Fixing damage caused by a devastating storm, GE refurbished and updated the tunnel systems, providing state-of-the art control systems for the ventilation and parallel switchgear controls using RX3i PLCs, VersaMax remote I/O, QuickPanel+ for local visualization and CIMPLICITY Historian software.

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