GE Fanuc
Intelligent Platforms

GE Data Center Solutions

In the last seven years the need to leverage digital information has grown significantly, causing data centers to become a common and essential element in the functioning of business, communications, academia, and government systems. The U.S. data center industry is currently in an unprecedented growth phase driven by demands for data processing, storage and networking, largely driven by:

- Faster, smaller, more power consuming IT devices
- Increased use of electronic transactions in financial services and electronic trading
- Growth of Internet communications, entertainment and trading
- Increased disaster recovery centers
- Growth in global commerce and services
- More government regulations requiring significant records retention
- Growth of high performance computing

And, the last five years has also seen a doubling in data center energy consumption to support the power and cooling infrastructure required to maintain these services.

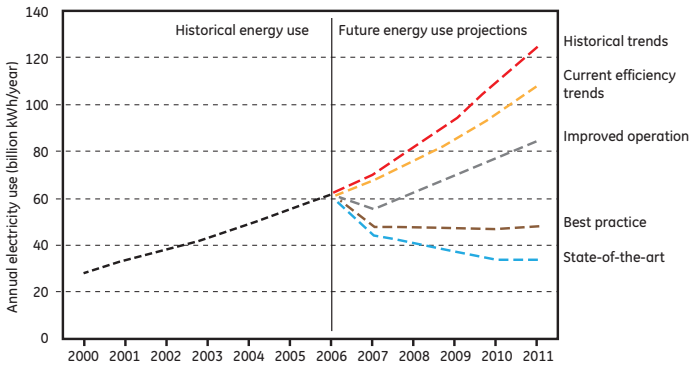
GE, which has a number of large data centers around the world, is being affected by these same factors driving up operational costs and forcing consideration of further high cost investment in the data center infrastructure space. The company has developed aggressive strategies to improve overall data center efficiencies for energy, water use, and greenhouse gas reductions – while providing simple and holistic insight to enable continuous local and global decision-making. These strategies will enable optimization of resources extending the usable lifespan of our data centers.

In fact, GE is uniquely able to address these issues. The ability to draw on a comprehensive set of offerings, resources, and expertise from across the company puts GE in an extremely advantageous position. This case study examines how these capabilities and resources were brought to bear to reduce costs at one of GE's mission critical data centers, while also establishing a best-practice controls, monitoring and reporting standard for the future.

The Need to Reduce Operating Costs and Carbon Footprint For A Sustainable Advantage

The "Projected Energy Use" chart, provided by the Environmental Protection Agency (EPA), below clearly illustrates that a combined set of actions and strategies is necessary to meet future needs.

Comparison of projected electricity use, all scenerios, 2007 to 2011



In companies large and small, the data center serves as the heart of the operation. Its purpose is to house electronic components needed for data communication and information storage. Businesses around the world depend on their data centers on a daily basis, so it is imperative that data centers be efficient, always "on" – and have the ability to grow as demand increases. Of course, there are challenges that every business faces related to its data center including continually simplifying the overall architecture, reducing maintenance, automating manual processes, time-to-value for refreshes and new facilities, compliance, evolving "Green" requirements, and in this day of skyrocketing fuel costs - energy consumption reduction.

The environment of a data center is designed to be electronic-friendly by regulating temperature and providing uninterruptible power. Air conditioning typically accounts for 40% of the overall data center power consumption and, therefore justifies focus in terms of optimal usage and configuration. A number of strategies are assessed to ensure that the major components of the cooling infrastructure, which are significant, are optimized to deliver conditions at the correct temperature, humidity and pressure. Too cold equals unneeded extra cost.

In any large company with many data centers around the world, there is a growing need to simply understand the overall state of operations, provide real-time information to drive improvement, and deliver analytics to understand longer-term needs. Finally, architectures need to be simplified and standardized to reduce a broad spectrum of associated costs as well as execution speed and time-to-value for changes and new builds.

From this "big picture" view, the data center also needs to be able to drill down into disciplines and problem root-causes, automate manual processes, and historize all data to enable continuous improvement. In addition, companies seek to tie traditional building management, as well as power management and control, into a broader overall management system to allow a simpler, more agile, and leaner backbone architecture. Leveraging this capability globally enables facility comparisons and understanding of best practices.

A comprehensive approach to data center and general building management would address the following:

- Energy consumption including Power, Cooling, Air Flow and Water
- Ability to simply and seamlessly connect disparate hardware and software systems (Agnostic)
- Process Control and Power Supply, Distribution and Quality
- Identification and alert on component problems or "out of spec" conditions
- Simplification of architecture, processes, maintenance, and in-house expertise requirements
- Reusability - Modular and easily re-deployable
- Expandability to assure simple inclusion of systems such as HVAC, Fire Protection, Lighting Control, Sensing, and Security, as well as compatibility with multi-site deployment needs
- Short and long term needs, from both local and global perspectives
- Providing a comprehensive and intuitive user interface

As a plan is developed to address the various needs of the data center, management must consider the various upgrade paths they might employ, and what is the best approach for their particular situation. As shown in the first graphic of this white paper, a synchronized and combined set of efforts will be needed to meet future demand and operational requirements: Options in executing an improvement plan:

1. Utilize existing disparate equipment, adding a summarized or unified view to operations to better understand overall operations while providing some local control and improvement possibilities.
2. Replace some system elements, adding a unified view and/or control (provides simplification values) with improved stand-alone efficiencies.
3. Replace some system elements, plus adding new desired functionality. Example: adding new UPS, Lighting Control, and local operations improvement capabilities.
4. Removing unneeded or problematic hardware and software and utilizing one new simpler less expensive system. A broad single approach versus a "stepped" strategy delivers quicker and broader improvements – but requires a larger single expense and coordination requirement.

The Need To Be Green

The Environmental Protection Agency reported that power use in data centers doubled from 2000 to 2006 and now accounts for about 1.5% of U.S. electricity consumption. Not unexpectedly, there is a significant push worldwide for businesses to get a handle on energy usage and become more "green" in their operations, especially considering the demand increases projected.

As businesses seek to become more energy efficient with their data centers, they look to improve their "carbon footprint." A carbon footprint is a measure of the impact our activities have on the environment, and in particular climate change. It relates to the amount of greenhouse gases produced in our day-to-day lives through burning fossil fuels for electricity, heating and transportation etc. Some important environmental facts about data centers:

- A data center can consume 15 times the amount of power of a typical office building
- Server energy usage doubled from 2000 to 2005; more than 50% of data centers will lack sufficient power and cooling by 2008
- In 2006, the total data center electricity consumption in the United States was estimated to be 60 billion kWh.
- By 2011, under current efficiency trends, this could double again to more than 120 billion kWh.
- By reducing power consumption and heat generated by data centers, energy efficiency can extend the existing infrastructure and defer costly investments in new data centers.

You can't significantly improve what you don't measure. Data Center Efficiency Metrics

The ability to know current operating efficiency and other important metrics helps guide improvement actions, and supports current and evolving compliance requirements. PUE, or Power Usage Effectiveness, is a common measurement of how efficiently a data center is utilizing energy and electricity. This is calculated by total facility power / IT equipment power. DCiE, or Data Center Infrastructure Efficiency, is the reciprocal of PUE. EPA estimates for PUE in 2011 are shown in the table below, indicating the significant gap of current trends to desired state-of-the-art.

Scenario	PUE
Current Trends	1.9
Improved Operations	1.7
Best Practices	1.3
State-of-the-Art	1.2

The GE data center solution provides PUE information and other operational metrics, including compliance requirements, to enable improvement opportunities to be identified and acted upon. Some of the other important measurements and metrics include:

- Asset utilization and optimization
- Maintenance information for preventative and scheduled tasks
- Root-Cause problem analysis, prioritization, and "dollarization"
- A wide variety of regulatory requirements, both to prevent negative actions and fines and take advantage of credits and incentives

GE Corporate Data Centers and the Cincinnati Site

As you would imagine, in a company as large as GE, one data center doesn't cover all of the business. In fact, the company employs 14 data centers globally, as well as all GE facilities that may have a local data center within their walls. Collectively, this is hundreds of data centers worldwide.

The data center in Cincinnati and other corporate data centers are managed by GE Global Infrastructure Services (GIS), a corporate entity in charge of the overall operation of the data centers on a worldwide basis. The Cincinnati facility has 29,000 square feet of raised floor, 3800 IT devices, and consumes 24 million kwh of power each year. It runs 24 hours per day, seven days per week, 365days per year, with complete multi-level redundancy of all major components to insure 100% uptime.

In 2007, GIS was looking to make improvements in the Cincinnati facility, as the site had a number of challenges. In addition, it was time to consider technology refreshes on various pieces of equipment. Like many data centers, the site has a widely disparate set of hardware and software, a good amount of functionality overlap, and no "simple summary" of the operation. They also desired to simplify their overall architecture, systems, and processes to support on-going lean initiatives.

With the help of a team of consultants from GE Fanuc Intelligent Platforms supported by other GE businesses, and working together with GIS in a lean partnership approach, a multi-step strategy was developed that addressed local and global needs, as well as balancing short and long-term challenges and ambitions. A holistic view of needs anchored all efforts, and specific improvement goals and metrics were jointly defined to clearly understand expected improvement.

Key Goals

- Provide simple visualization and analysis of summary operations, with drill-downs into specific functional elements and equipment
- Provide compliance reporting, and ability to address future requirements. Provide easy (inexpensive) modifications for these reporting needs
- Automate manual processes
- Reduce water and electrical consumption
- Reduce waste water
- Improve survivability and reduce single points of failure
- Increase cooling capacity to keep pace with the growth of server base
- Improve maintainability
- Leverage ambient air for cooling during winter months
- Simplify and reduce direct and recurring infrastructure costs – everywhere possible

An upgraded chiller system was to completely replace the existing equipment and would be comprised of a new cooling tower system, chiller units, heat exchangers, pumps, a new control system and other ancillary systems. Additionally, GIS wanted the chiller system to have economizer features that could be used to reduce power consumption.

The project that started as a simple conversion of some outdated building management equipment in need of an update, evolved into a comprehensive cooling plant refresh and a broad long-term improvement strategy. Along with the potential savings of 10% in energy alone, the strategy applied will yield continuous improvement from multiple business dimensions in the years to come along with adding flexibility and speed-to-change values for the GIS data centers worldwide.

A Simple, Holistic View of The Data Center

When the cross-GE team led by GE Fanuc sat down with the Cincinnati team to really look into the issues they had at the data center, they discovered a number of Critical To Quality (CTQ) points that needed to be addressed. The CTQs broke down into two main categories: Local and Global – and two outlooks; short and long-term

The Local Control critical factors included minimizing the number of tools used, interfacing with all equipment categories, having the ability to send data to a Global View system, having the ability to integrate to My Notification and rest of the centers ITSM tools, web accessibility with full functionality and security according to the highest GE standards, the ability to page by alarm category, user group and escalation tier, and the ability to store and trend data at the local level. Additionally, and this became a very key component, the GIS team demanded a trained and responsive local supplier that could support them and the deployed solution with appropriate maintenance contracts in place.

The Global View factors focused mainly on providing simple centralized management in the form of a console view, a database for utilization, alarms, historical data, and a common asset database of data center components. Web accessibility and the ability to build customized web views for service support and delivery were also important. Finally, the team required the ability to bring other GE business sites into the overall system as needed, as simply and quickly as possible.

The functions of the data center were broken down into critical needs of facility-wide monitoring, local command and control, notification, cost reduction, data collection, global enterprise view and expandability. The next-step was to develop a solution that would meet all of the site's needs, plus all other GE data centers easily and effectively.

Working Together To Provide The Optimal Solution

Being part of the larger General Electric Corporation gave the GE Fanuc team a lot of leverage in employing the wide reaching technology resources within the company. GE Fanuc is one of the high-tech, high-growth businesses within GE Enterprise Solutions, along with its sister companies Sensing & Inspection Technologies, Security, and Digital Energy. Together these companies provide integrated solutions using sensors and non-destructive testing; security and life safety technologies; power system protection and control, plant automation and information, and a broad set of embedded computing capabilities.

In the case of the Cincinnati data center, the GE Fanuc team would rely not only on its Enterprise Solutions brethren, but also GE Lighting Systems, GE Energy and GE Water & Process Technologies, as well as a number of other GE businesses and third-party OEMs to provide a comprehensive solution that can easily be replicated.

The diagram on the following page summarizes GE Data Center capabilities, along with checkmarks denoting Cincinnati use.

A Broad Cross-GE solution, With a Lean-Focused Relationship

Although multiple GE companies contributed to the overall solution, a single relationship keeps everything simple, lean, and speeds progress. An additional focus on removing all non value-add documents and processes takes out additional cost, while still adhering to required GE standards and project management rigor.

The team partnered with third-party providers for generators, chillers, Computer Room Air Conditioners (CRACs), HVAC systems, fire suppression and prevention equipment, security and energy storage.

GE Fanuc created a Functional Design Specification (FDS) for the Chilled Water Control system that detailed hardware and software requirements as well as overall operation of the system. In addition, the team assisted in the review of Chilled Water Control components, and other connected primary and sub-systems to identify optimal interfacing approaches. There are often various options for communicating with the many sophisticated components and these should be reviewed on a system basis so that the best and simplest interfaces can be selected to meet short and longer-term goals.

GE Fanuc also designed controller cabinets for the Chilled Water Control system. These include controller rack layouts, panel power schematics, I/O connection drawings, and panel layouts with terminal strip details. The remote I/O cabinets will have enough spare capacity to allow for future doubling of I/O racks. I/O is distributed between the main and out buildings. Redundant controllers are connected to the Data Center remote I/O panels via network switches and cables provided by GIS.

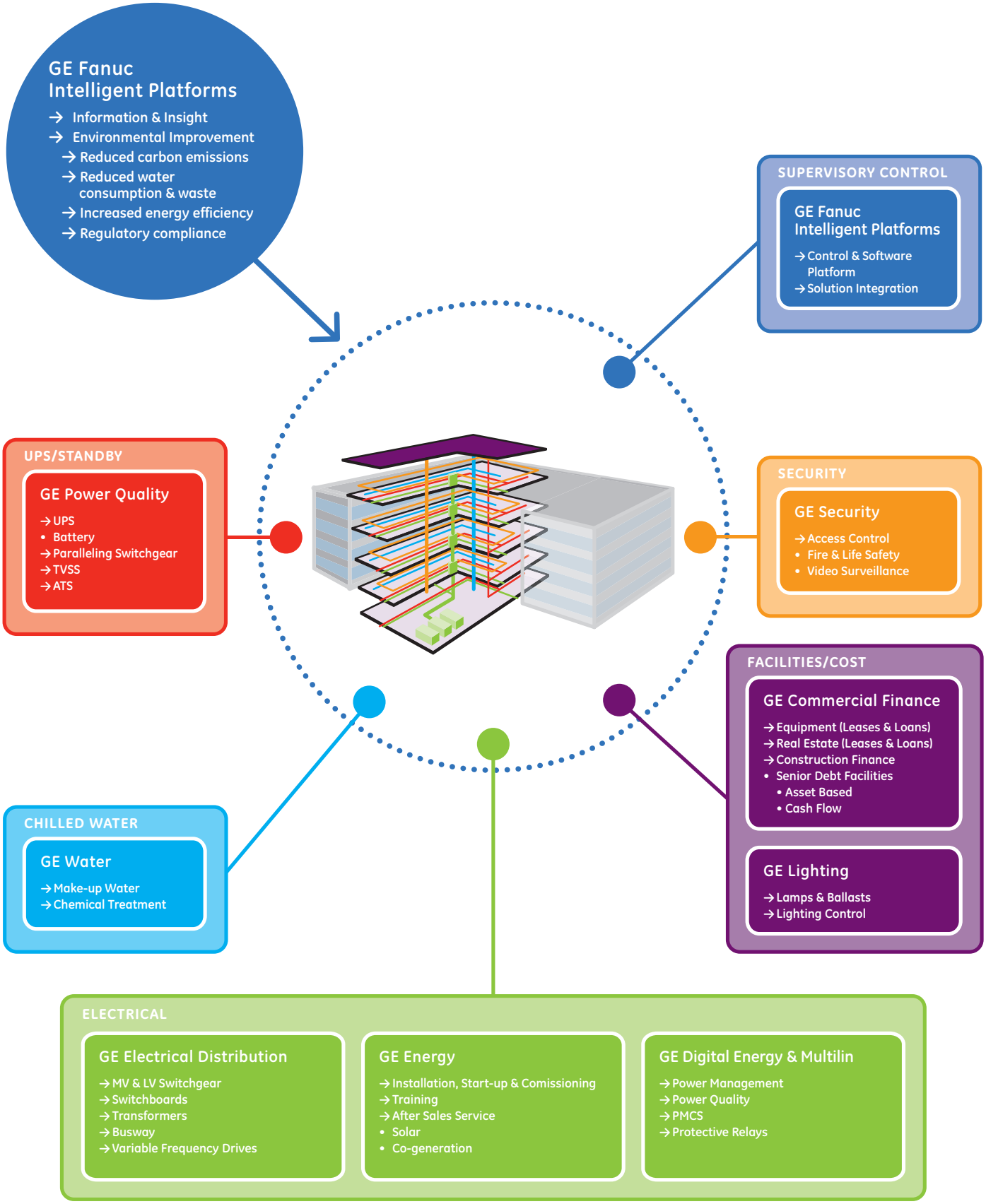
Three remote I/O panels were provided for the data center, each placed at the location of an existing controller, receiving the I/O for all equipment in their immediate area. One panel has a Modbus interface for communications to the Liebert CRAC units.

As the project progressed, additional elements to the overall systems were continually reviewed and evaluated for ways they might add to:

- Granularity of the overall system, which would add greater insight into possible problems or improvement possibilities.
- Better or deeper control of systems and subsystems, to further mitigate possible risks or provide additional operational improvements.

These would be evaluated, and decisions made to include now, include later, or not include – based on current and future technical/commercial needs. This approach provides the team with the ability to continuously improve the overall solution.

GE Data Center Solutions

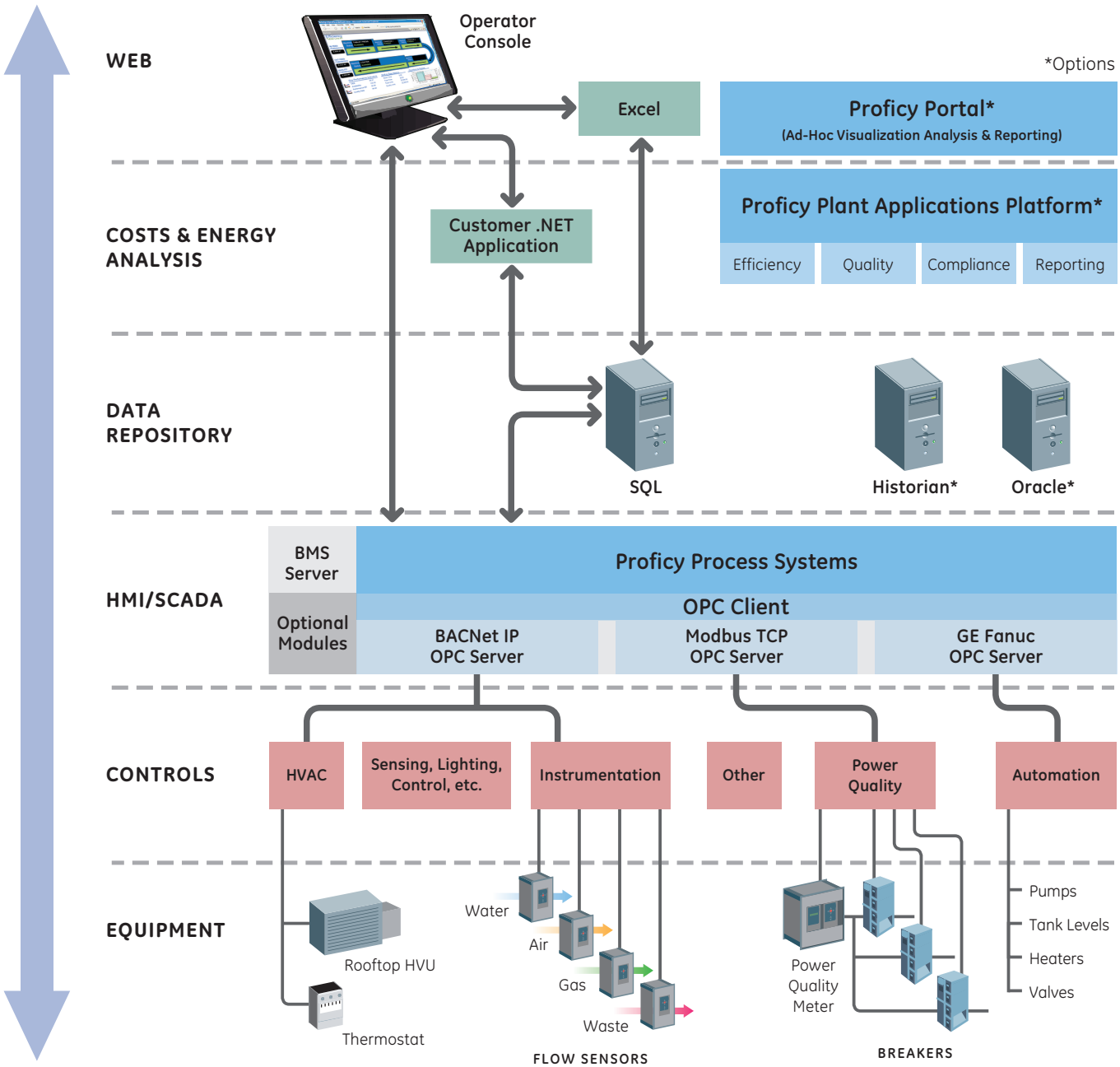


GE Data Center Capabilities

Powered By Proficy

The GE Fanuc Intelligent Platforms project is built around the company's automation hardware and software platforms, including Proficy Process Systems. This state-of-the-art fully integrated system is based on a contemporary hardware and software infrastructure that offers the benefits of both traditional DCS and PLC/HMI systems. GE Fanuc's proven, multi-disciplined control technology, the PACSystems controller platform, in this case the solution employed the PACSystems RX7i, as well as Proficy HMI/SCADA software, CIMPLICITY – are the backbone of the system in Cincinnati.

Proficy Historian also plays a large role in the software implementation by providing an effective plant data repository to collect, archive and distribute large volumes of real-time information. Historian, along with SQL, addresses the need to historize the huge amounts of data they maintain and provides insight and business analysis to allow continuous improvements to be made across all elements of operations.



Governors Hill Functional Site

The heart of the Proficy software solution is Proficy HMI/SCADA - CIMPLICITY. CIMPLICITY HMI is a client/server based visualization and control solution that provides process visualization, data acquisition and supervisory control over manufacturing environments. The result is a solid and reliable data foundation for digitized production management. With CIMPLICITY HMI, operators and engineers have the power and security to precisely monitor and control every aspect of the manufacturing environment, equipment and resources.

CIMPLICITY packaged within the Power Monitoring and Control System (PMCS) interfaces with the GE Digital Energy Power Quality Metering solution, ensuring mission critical facility equipment and processes are protected and not interrupted by power system anomalies. Other GE companies also use GE Fanuc hardware and software inside of their own solutions, making the overall data center solution simplified and seamless.

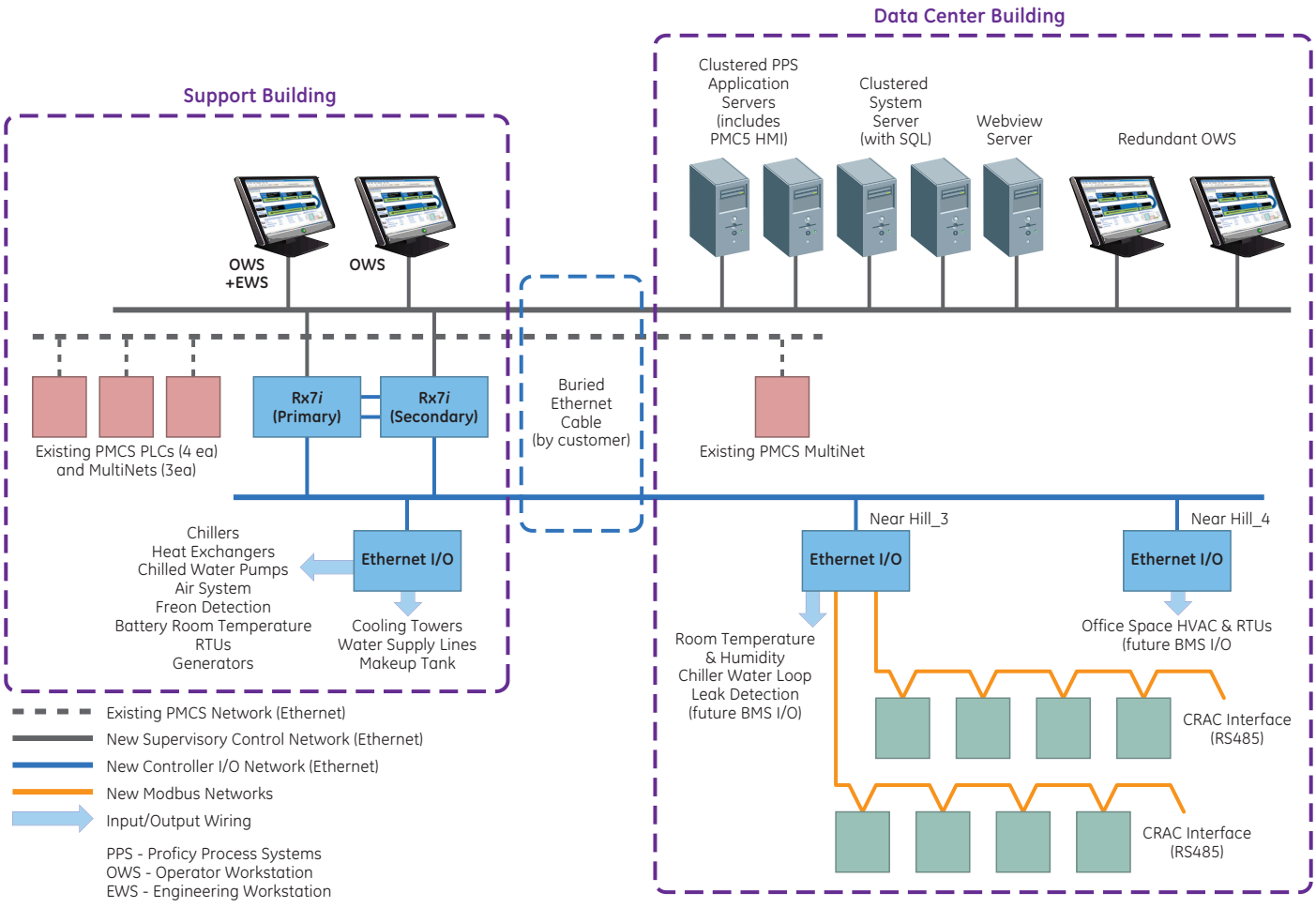
On the hardware side, the PACSystems RX7i plays a critical role. Part of the PACSystems family of solutions designed with more power, memory and bandwidth to handle mid-to high-end applications, this hardware platform grew from GE Fanuc's proven Series 90 systems and supports complete Genius functionality. It is a standards based product that supports many third-party and customer-developed boards and can be easily and quickly upgraded for improved performance. For GIS, the GE Fanuc controllers are the interface to the pumps, tank levels, heaters and valves of the data center cooling system.

System Architecture – Simple, Agnostic, and Flexible

The system architecture is broken into two physical parts: the Support Building and the Data Center Building. The buildings are connected via buried Ethernet cable. The Support Building houses Engineering and Operator Workstations, existing PLCs, chillers, heat exchangers, chilled water pumps, an air system, Freon detection, RTUs and generators. In addition, two PACSystems RX7i controllers, one primary and one secondary connect to the workstations and the controller I/O network that connects to the other building.

System Architecture

The Data Center Building features clustered servers running Proficy Process Systems, SQL and Webview. Ethernet I/O units monitor room temperature and humidity, chilled water loop and leak detection. In the future critical environmental factors will be monitored and



controlled by the PPS Building Management System. CRACs, Lighting Control, office space HVAC and RTUs are also tightly connected to the overall management system to allow adjustments - and historical insight into improvement possibilities.

The Process Functions in the system include:

Condenser Water System Three Cooling Towers, including condenser water temperature, fan speeds, and sump pump operation. The Condenser Water System includes a makeup water system that consists of monitoring and control of one city water feed to a makeup storage tank and delivery of the makeup water from this tank to the cooling tower sump with inline chemical treatment.

Chiller Plant Control of three Chillers, which deliver chilled water to the Data Center building CRAC units. The controls includes an interface to the chiller controls for enabling, set-point speed, temperature controls, and a strategy for meeting data center cooling demands in an energy efficient manner. The control system also operates the chilled water loop booster pumps and monitor the chemical treatment system for the chilled water loop. In "free-cooling" mode, the chiller plant controls will operate one or two heat exchangers to directly cool the chilled water using condenser water from the cooling towers. The control system collects real-time data, including power usage, which can be used to analyze equipment performance to identify better energy-saving strategies.

Other Chiller System Controls Control for two air compressors to operate control valves, an HVAC blower and chilled water air conditioning units for chiller room ambient control, and operation of dampers to evacuate the chiller room air in the event of a Freon leak.

Data Center Temperature and Humidity Controls Communication via Modbus to 31 new, plus six existing, CRAC units to provide enabling and set-point control of temperature and humidity based on measurements by the CRACs.

System-wide Functions The GE Fanuc control system includes CIMPLICITY Pager functionality to inform support personnel of alarm conditions requiring immediate attention. The system connects to the GIS MyNotification system to deliver additional notifications as well as Terminal Services to allow remote access for system updates and revision. CIMPLICITY WebView supports remote viewing and interaction with the system by several simultaneous users using a web browser. The control system collects historical data to support trending, analysis, and report generation. GE Fanuc configured the CIMPLICITY Pager for up to 20 users and provides training to GE GIS so that they may manage the paging configuration.

Control Strategies GE Fanuc implemented control strategies for cooling towers, chillers, free-cooling heat exchangers, chiller loop temperature and flow controls, and CRACs as defined by GIS.

Lighting Control As Part of the Management System

GE's Total Lighting Control (TLC) system reduces energy costs by providing programmable control of lighting circuits, allowing the management team to specify what to light, plus when and where to turn all unnecessary lights off. This was just one part of the environmentally friendly approach that the overall solution required. GIS wanted this functionality to be a part of the overall control system, not a standalone or loosely coupled element. Being part of a tightly integrated system allows analysis and optimization of lighting needs, while also providing data for security control and analysis. TLC solutions drastically cut energy consumption and can often reduce lighting costs by a third year-to-year. In addition to the lighting control panels, the solution also consists of:

- Occupancy Sensors – TLC has the ability to sense user occupancy by integrating various sensing technologies.
- Daylight Harvesting System – This solution measures light and uses a dimming mechanism to maintain preset light levels.

With lamp and ballast changes plus lighting control the changes made will payback investment in 1.1 years, then the savings go right to the bottom line each year after.

Water Conservation

The GE Water & Process Technologies reverse osmosis system transforms drinking water into high purity water for industrial use. Reverse osmosis separation technology is used to remove dissolved impurities from water through the use of a semi- permeable membrane involving the reversal of flow through a membrane from a high salinity, or concentrated, solution to the high purity, or "permeate," stream on the opposite side of the membrane. Pressure is used as the driving force for the separation. The applied pressure must be in excess of the osmotic pressure of the dissolved contaminants to allow flow across the membrane.

GE Water & Process Technologies uses spiral-wound membranes - tightly packed filter material sandwiched between mesh spacers and wrapped in a small-diameter tube - to desalt and demineralize process water. The membrane's operating conditions are fine-tuned to balance the flux, or the amount of water that passes through the membrane, with the specific rejection rates of contaminants to achieve up to 99.8% salt rejection at low pressures and high flux rates.

Use of the Reverse Osmosis technology resulted in a savings of approximately 20%, or two to three million gallons of water per year, average tower cycle increased by a factor of five; chemical treatment reduction of 50% and an annual savings of $6,000.

The more eco-friendly cooling plant solution also accounts for a reduction of approximately 10% in electricity via technology efficiency, heat exchangers and water cycle reduction.

GE Water also provided the ChillerCheck Efficiency Tool, a PDA and web-based software application that analyzes chiller performance efficiency and utilizes daily operational data to detect potential problems. The system works like this:

- Operator visits all operating chillers and collects data on a daily basis
- Operator hot syncs with the website for chiller report
- Problems are identified and quantified by source
- Corrective actions are given and scheduled
- Efficiency is restored or maintained

As the GE Water solution also utilizes GE Fanuc as a framework for its own offerings, this part of the solution is also easily integrated into the larger data center architecture.

Keeping It Green

Reducing the carbon footprint aspect of this installation as well as others in the future has been extremely important from the beginning. High efficiency UPS systems, energy efficient lighting, lighting controls systems, variable frequency drives and controls for existing CRACs to reduce flow rate and energy costs, and energy storage were all included in the overall design. Other possibilities continue to be examined for fit and impact.

As a company, GE is committed to the environment and GE products are certified eco-friendly as part of a program called ecomagination. Sustainability is a business imperative, also driven by rising costs and regulatory pressure.

GE solutions can address more than 50% of data center energy usage including power supply, distribution, cooling and lighting, with 40% annual energy savings improvement possible with a broad facility wide approach.

Translating To Your Business

This significant implementation is translatable to any business, whether the company has a formal data center or not. The architecture is not facility type dependant - and the proven infrastructure can drive different improvement metrics as defined by the individual business. In addition, it can easily coexist and leverage your current ERP investment.

All of the developed applications are also reusable within other businesses. GIS is a perfect example of that point, given the number of disparate businesses within the greater GE and the global nature of the company's operations. To provide flexibility and reduce future costs, software changes, new visualizations, reports, etc., are configured versus custom coded so there is less initial and recurring cost incurred.

As this case study shows, it is possible to simplify a broad disparate installation, while providing a holistic view of all facility operations – and address compliance and efficiency improvement. GE is particularly well suited to this type of partnership as we have the breadth of products required, proven technologies that can be applied, an agnostic approach that easily brings together all of the disparate products everyone has installed, and resources that understand data centers and similar types of facilities.

Most importantly is the ability to bring all of this capability together in one relationship. Whether the need is a complex global solution, or a "packaged application" with similar functionality installed in a panel along with Lighting Control in a small electrical closet, GE has a solution to fit your needs.

GE Fanuc Intelligent Platforms Information Centers

Americas:
1 800 GEFANUC
1 800 322 3616

Global Regional phone numbers are available on our website at www.gefanucembedded.com

Additional Resources

For more information, please visit the GE Fanuc Intelligent Platforms web site at:

www.gefanuc.com

10.08 GFT-724