

TRiDIUM™

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Tridium & Niagara Framework™ Overview

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Given the choice customers prefer open, interoperable control devices.

Tridium is motivated to provide customers the best architecture and infrastructure to service to these devices. These embedded components, also called smart devices, include sensors, machines, lights, appliances, actuators, robots, cable boxes, etc. that contain microprocessor intelligence and communications.

Executive Summary

The Environment

The shrinking cost and increasing capabilities of microprocessors has led to the rapid proliferation of smart devices in buildings, machines, homes, cars, and virtually every other aspect of our society. The growth of Internet usage and capabilities makes large-scale interconnectivity of heterogeneous devices economically possible. If these devices can be connected and remotely controlled in a cost-effective manner, they can provide dramatic new services and capabilities.

The Concept

Tridium recognizes that a Java™-based platform, or framework, developed to solve problems with interoperability between different device protocols and the Internet, and between those devices and enterprise business management systems, provides a tremendous market opportunity. This type of framework enables businesses to take advantage of the enormous potential of smart devices in ways not previously imagined.

The Company

Tridium, Inc. was formed in 1995 to develop such a framework. In the past four years, Tridium developed the Niagara Framework™, a core technology that can be used to develop specific applications to access, automate, and control smart devices in a wide range of industries. It has also developed a number of applications for vertical markets.

The Technology

The core of Tridium's technology is the Niagara Framework™. This patent pending technology is a fully Internet-enabled, distributed architecture for real-time access, automation, and control of embedded devices. The Framework provides a platform for device integration, application program execution, and enterprise interconnectivity. Niagara is the first commercially available Java-based distributed access, automation, and control system in existence today.

Industry Background and The Tridium Concept

Several years ago, the founders of Tridium recognized that a number of trends in the industries of microprocessors, software, communications, and digital controls were converging in a manner that presented an extraordinary business opportunity. The shrinking cost, increasing capabilities, and rapidly expanding penetration of smart devices, combined with the unprecedented growth in usage and capabilities of the Internet, were creating a market demand for new software tools and methods.

The combination of smart devices and the Internet will allow companies in the future to remotely manage buildings and factory operations, actively govern their energy usage patterns and energy sources, and administer global resources from virtually any location. For example, energy service providers will monitor real-time consumption of energy across thousands of facilities, shed loads by turning off non-critical pieces of equipment during peak demand, and turn on micro-turbines when economically prudent. Businesses will be able to offer a variety of new services such as managing individual home energy costs and performing off-site vehicle maintenance remotely. Home owners will be able to monitor their home security system, control their lights, modify room temperatures, lock and unlock doors, and even adjust oven temperature from anywhere in the world via their web-enabled palmtop computer. As the information age unites with the world of smart devices, people and companies will be empowered to benefit from previously unimaginable applications and services.

Growth of Smart Devices

Increasingly each day, the world around us is being monitored and controlled remotely through smart devices. The low cost of microprocessors is allowing electronic intelligence (smart devices) to be built into everyday consumer electronics. These embedded, headless computers are increasingly becoming a part of everyone's everyday life. A fully integrated, programmable world will shortly become a reality and that world will offer many new conveniences, services, and opportunities. Smart devices already outnumber people 25 to 1 and their reach into our lives far exceeds that of conventional desktop PCs.

Impact of the Internet

The level of interconnection that smart devices achieve will be dictated by the growth of the Internet. If predictions about Internet usage hold true, millions of smart devices, along with their conventional desktop brethren, will be integrated into an unprecedented single network. The result will be an instrumented world that communicates across a seamless global network. As smart devices become more prevalent on the Internet, a wealth of new information about machine status, equipment performance, energy usage, human habits, environmental parameters, and factor efficiency, to name a few, will be available to the world. This incredibly large volume of readily available data will give people and businesses access to information at levels never before known. To take advantage of this new power, companies need to adopt revolutionary new approaches in software and network solutions.

Infrastructure

The distinction between a smart device and a PC is its use. A PC is a general-purpose tool, where smart devices are dedicated to a particular function. To harvest the power of dedicated devices, an infrastructure must exist that standardizes the way devices work together to solve a larger problem. For example, consider an office building outfitted with a smart electrical meter, which provides the current real-time price of electricity being used, and a chiller, which controls office temperature. By themselves, the electrical meter and the chiller cannot communicate. However, when joined together using a standard communications and applications infrastructure, such as the Niagara Framework, it becomes possible to vary the building temperature and thus chiller energy consumption in accordance with energy prices. In other words, maintain higher building temperatures when energy prices are high to minimize chiller energy consumption – each degree of temperature can save significant energy costs and not significantly affect worker comfort.

Tridium's Concept

Tridium's flagship technology, the Niagara Framework™, has been developed to meet those architecture and infrastructure needs. Our technology provides the integration capability to connect devices and applications across the Internet. The Niagara Framework™ connects devices together in ways never before possible, creating unprecedented opportunities. By building the Niagara Framework™ to use the existing network infrastructure of the Internet, the wealth of information available from these devices can be tapped from anywhere on the globe at no additional cost.

The Technology

In early 1999, Tridium launched the patent-pending Niagara Framework™; a fully Internet-enabled distributed architecture for real-time access, automation, and control of embedded devices. The Niagara Framework™ is the first commercially available Java-based distributed control system in the world.

At the heart of the Framework lies an enhanced JavaBean object model that forms the operating environment in which applications are executed. In addition, information from devices and enterprise data are integrated within this object model. The Niagara software suite can be installed and executed on a variety of hardware platforms and operating systems that support a Java virtual machine. Multiple layers of applications comprised of a combination of general applications, vertical market solutions, and custom applications can operate together in parallel. The flexible Niagara Framework™ allows customers and partners to tailor applications and integrations into custom solutions that meet specific customer needs.

Technical Accomplishments

The Niagara Framework™ solves many technical challenges faced by distributed control systems in today's information world. Some of the important accomplishments include providing Internet-enabled real-time control, allowing for easy integration of heterogeneous devices, integration of legacy systems, and integrating control and enterprise systems to form a robust cross-industry solution. While each individual accomplishment brings significant advantages to the world of embedded devices, the collective accomplishments achieve unprecedented functionality and capability as an integration platform, which connects legacy systems, open systems, the Internet, and enterprise information systems. It was this combination that landed Tridium a *Breakthrough Technology Award* nomination from the Greater Richmond Technology Council.

Providing Internet-Enabled Real-Time Control

Tridium's unique approach and implementation provides a multi-vendor interoperable control system that satisfies the need for Internet/intranet openness while maintaining the determinism and integrity required for real-time control. To be deterministic means that every time the same function occurs, it must happen in exactly the same way and at exactly the same speed. For example, the user must have guaranteed delivery of an alarm within a specific time. The Niagara Framework™ control system partition is based on the Java computing model to insure the deterministic control interoperability of JavaBean components and portability to all control and server platforms. In addition, a real-time control environment must be physically robust, with the ability to support redundant components. They must also be error-tolerant to protect against operator error. While providing determinism alone is not a breakthrough, doing so over a vast distributed network through the Internet is.

Product Offerings

The Niagara Framework

The core technology is licensed to entities that strive to develop their own applications built on the Framework. This is an appealing technology for those needing to integrate smart devices and develop cost-effective application server solutions.

The key elements of the Framework include database management, security, web server, browser user interface, real-time control engine, enterprise support, and a complete application development environment.

Niagara Web Supervisor™

The Tridium Niagara Web Supervisor™ is the core of the Niagara Framework™, an Internet-accessible system aimed at making Building Automation Technology easy to use and reducing the costs of implementation. This software package incorporates open standards to achieve a new level of interoperability previously unavailable to the building owner. This Server technology supports the complete range of control products from Tridium as well as LonWorks™ based control products and BACnet™ compatible devices to make monitoring and controlling your building easy and affordable.

Combined into one suite is a comprehensive user interface (Workplace Pro™) a Java™ based control engine to run global supervisory applications, a complete network management tool to configure attached LonWorks network devices, as well as a configuration tool for the LonWorks devices. The Niagara Web Supervisor also acts as a server for access of data from all connected or supported JACE™ stations by users over a local Intranet or the Internet with extensive password protection.

- Supports multiple simultaneous client workstations over Ethernet, the Internet, and dial-up access
- User Authentication for secure Internet access using standard web browsers such as Internet Explorer™ and Netscape Navigator™
- Supports multiple JACE™ controllers connected via Ethernet, or remotely via Wide Area Network (WAN) access, or the Internet
- Complete JACE™ controller database storage / backup
- Comprehensive user password protection to protect valuable information
- Audit trail of all database parameter changes with User, time/date, and new value for each change
- Data collection, trend graphing and enterprise level information exchange using a SQL database
- Automatic archiving of historical data from all JACE™ controllers on a user selected basis

- Sophisticated Alarm Management including the ability to send alarms via email and pagers
- Incorporates automatic time synchronization via Web accessible government time standards
- Web Server for remote Internet Access by password protected clients
- Full Java™ Enabled Browser support for all building data access.
- Intranet and the Internet for remote access. The user does not have to hit a “refresh” or “reload” button to get real-time data, as the Web Server automatically uploads new values as they change.

Niagara WorkPlace Pro™

The Niagara WorkPlace Pro™ is a comprehensive set of engineering tools combined into one, common, and easy-to-use engineering environment. WorkPlace Pro™ simplifies the complexity of working with multiple protocols by consolidating them into one common object model. Everything a user needs to manage and integrate multiple protocols is available in one, powerful engineering toolkit.

- WorkPlace Pro comes with out of-the-box- BACnet and LonWorks support.
- Powerful Java-based object modeled programming environment
- Quick application development with a common object library
- Easy-to-use, powerful programming language for custom applications
- Automatic learn, binding and network management tools for LonWorks™ sub-systems and devices
- Simple, common linking mechanism allows for transparent data sharing between devices of similar or different protocols
- Graphical engineering environment to create, configure and test control system application logic and user interface screens
- Extensive animation features for data displays
- Tree diagram representation of database structure

JACE™ Controllers

JACE™ (Java Application Control Engine) controllers are a series of embedded computer hardware devices that act in an area controller capacity to distribute real-time control functions across an Ethernet bus in a large system. They run control and user interface applications standalone, connected to a browser or remote server over the Internet. Tridium, with their JACE™ controller, is one of the first companies to market a Java controller.

This platform has strategic significance. Most of the Tridium software runs on this hardware platform. This “black box” allows for more cost-effective remote operation the software without the need to run the software on a traditional PC. This platform provides for an excellent infrastructure for a distributed environment. The Niagara Framework™ combined with this Java platform provides a complete solution.

JACE-NP™

The Niagara JACE-NP-1™ is a compact PC platform with an integral hard disk, but no keyboard or monitor. It provides integrated control, supervision, and network management solutions for a network of Echelon LonWorks™ based application controllers for building control. It is a key component of the Niagara Framework™. When connected over an Ethernet network, the JACE-NP can communicate to BACnet™ devices or systems and interoperable share data between the LonWorks devices and BACnet systems. A complete, set of Java™ based control, application, and user interface “objects” are included in a library for the Systems Integrator to create a robust control system for any size building. When provided with a connection to the Internet, the JACE-NP-2™ with Web User Interface Service, the system’s graphical views can be accessed using any standard Java enabled browser (Netscape Navigator™ or Internet Explorer™).

Specifically designed for mechanical room, factory floor, and other harsh environments, the JACE-NP™ is ideally suited for System Integrators or users who require a rugged and compact PC that can be wall-mounted, table-mounted, or installed in other space-limited applications.

Technical Services

Tridium provides component redistribution, training, technical support, and professional services to distribution channel members.

Tridium’s first vertical market solution was designed for the large commercial BAS market. Many large System Integrators are adopting Tridium’s commercial BAS solution as their premiere control system infrastructure. Each Tridium System Integrator (TSI) maintains certification by an intensive training program, which insures a high level of product knowledge.

Sample Network Configurations

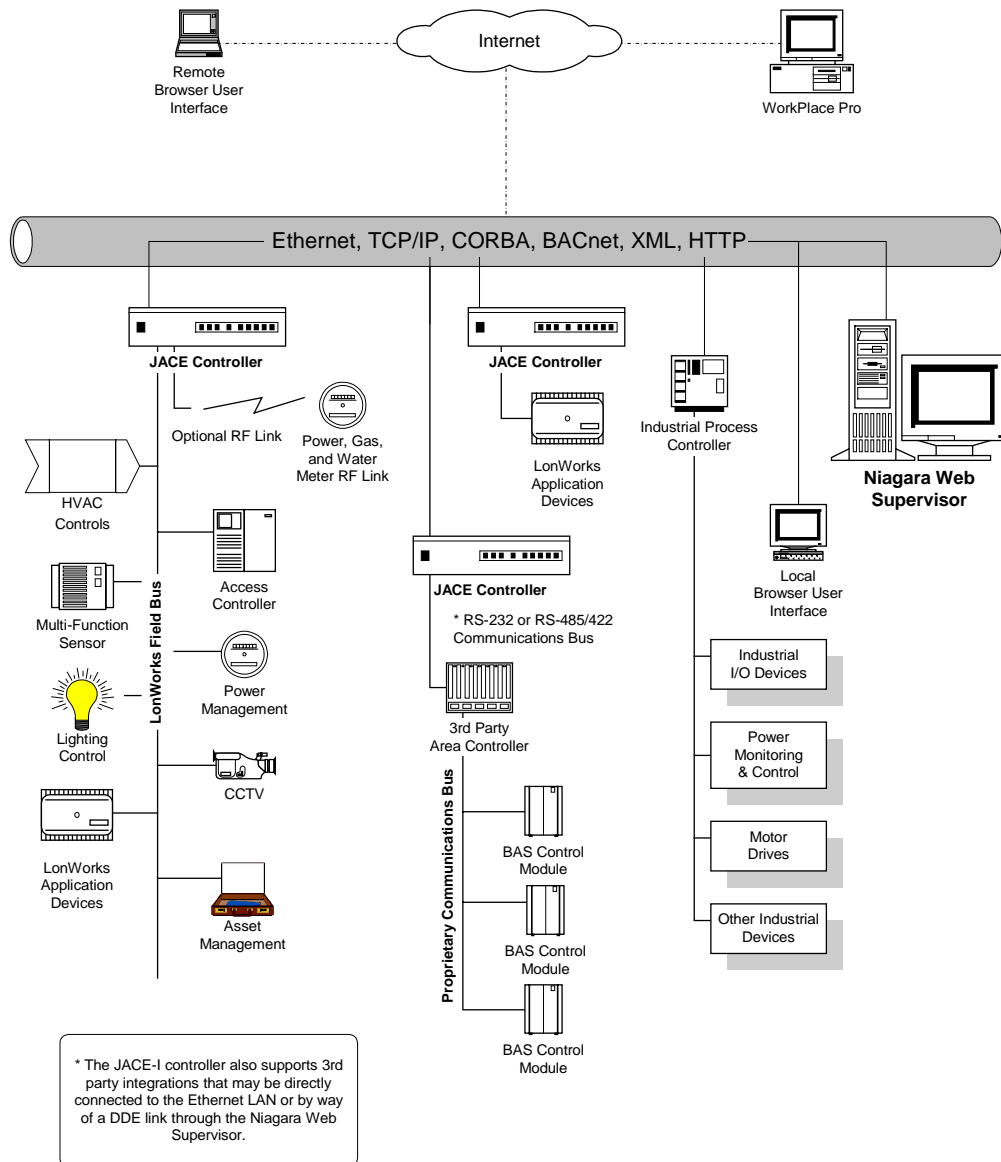


Figure 5. Large-Scale, Single Site Network Configuration

Local and remote browser access to large-scale integrated BAS and process control networks via Internet/intranet, Ethernet, TCP/IP, BACnet, LonWorks, and proprietary communications protocols. Niagara Web Supervisor provides multi-station and multi-client support and hosts the WorkPlace Pro application development environment.

Sample Network Configurations

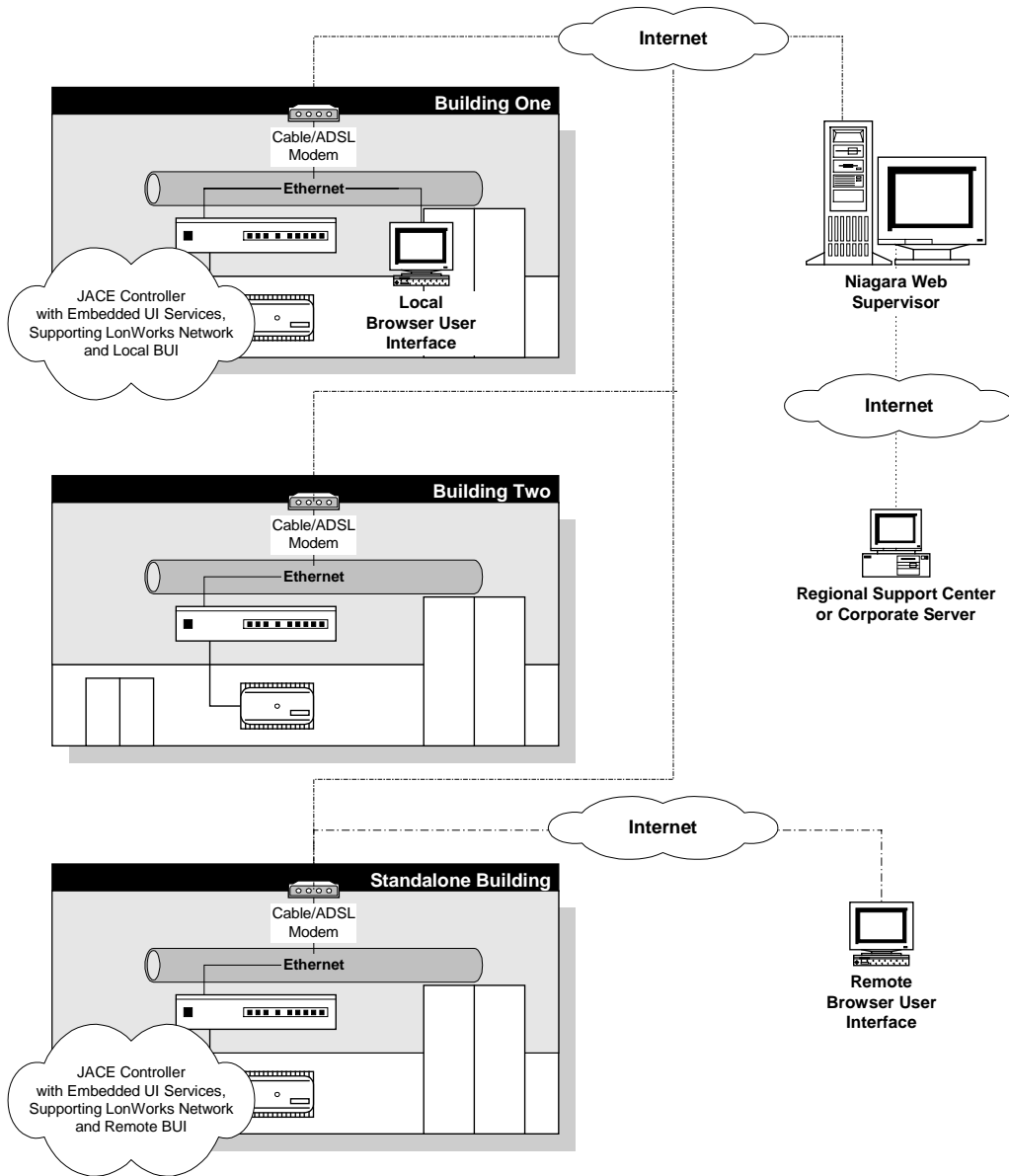


Figure 6. Multi-Building, Remote Monitoring and Control

Local and remote small building monitoring and control over Internet cable/ADSL modem network. Niagara Web Supervisor provides multi-station and multi-client support for local/regional support center or corporate server