IoT, Device Connectivity and IP Networks—A Synergistic Relationship

Embedded, "smart" devices pervade our environment. In a commercial building, they can be found in all types of equipment, as well as behind walls and beneath ceilings. They are responsible for everything from environmental control (air and water temperature, humidity, lighting levels, air quality), to security (video, cameras, access control, intrusion detection), to energy metering. You will find them in the ovens, grills and mixers in commercial kitchens as well as embedded in the production equipment making and ensuring the safety of the goods we buy. Smart devices are the brains that operate our world allowing us to focus on other things.

Equally important to achieving an end-to-end solution, however, are the other layers of the stack — device connectivity, protocol conversion, data modeling, device management, application logic and user presentation layers.

Sometimes collectively called the Internet of Things (IoT) and operational technologies (OT), these devices have much intelligence and capability of their own. But, are we really using them to their full advantage? Do they tell us what they are doing, what conditions they sense, what decisions they are making, or not making? Are they aware of each other and the

actions that each is taking? Do they coordinate with each other? The reality is that OT devices, unlike IT devices — the PCs and servers that support desktop and mobile applications — do not easily talk with each other. The world of embedded devices is characterized by literally hundreds of different IP and non-IP (serial) communications protocols. Some are considered standards, other are artifacts of substantial investments in legacy systems. Another differentiator from our short-lived personal IT devices, these OT systems have useful economic lives measured in decades, not years. The point? These systems will be with us for a considerable period of time. Any solution that hopes to help companies gain efficiencies by digitalizing operations and making data-driven decisions must be able to embrace these devices, not require them to be replaced.

VALUE OF CONNECTING DEVICES

As with teams of people, the effectiveness of intelligence increases when information is shared and correlated. Metcalf's law highlights this by positing that the value of the network increases in relation to the square of the connections. What are the implications when we can easily connect new intelligent technologies as well as legacy building devices?

Let's think about the devices for a moment. How can the network help them collaborate; be more effective and valuable? How can the real-time, often critical data contained
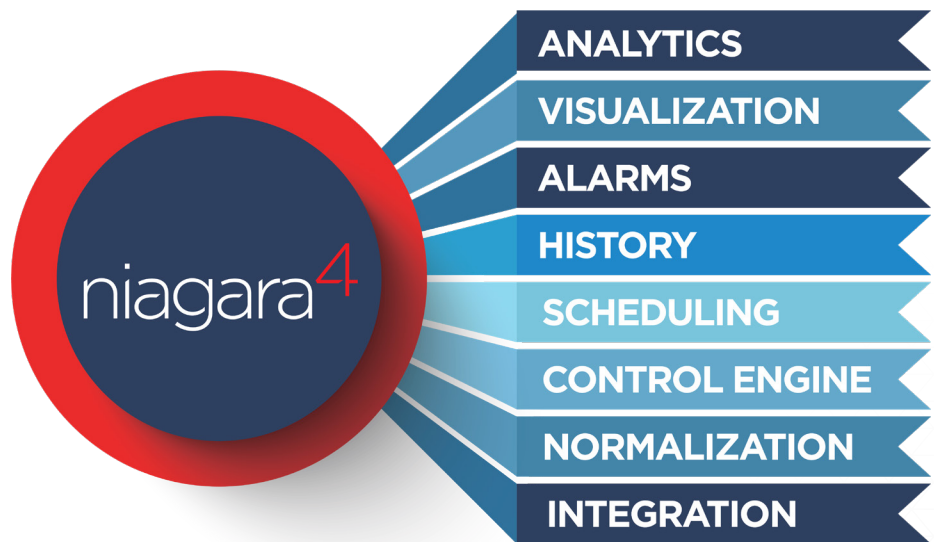
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in these devices be shared, coordinated, and turned into useful, actionable information to help companies maximize the benefit of their technology investments and improve their business operations?

IP networks that provide connectivity to PC-based client applications, browser-based thin client views, and real-time data feeds to enterprise applications are part of the solution — part of what we refer to as the 'device-to-enterprise' or basement-to-boardroom' solution stack. Equally important to achieving an end-to-end solution, however, are the other layers of the stack — the device connectivity, and security protocol conversion, data modeling, device management, application logic and user presentation layers. Without these, there can be no device-to-enterprise solution and no effective connection of the devices to enterprise networks.

NIAGARA DEVICE-TO-ENTERPRISE SOLUTION STACK

niagara⁴

- ANALYTICS
- VISUALIZATION
- ALARMS
- HISTORY
- SCHEDULING
- CONTROL ENGINE
- NORMALIZATION
- INTEGRATION

DIVERSE APPLICATIONS

Tridium's Niagara Framework® is a software infrastructure designed specifically to address the challenges associated with creating Internet-enabled products and comprehensive, device-to-enterprise applications — applications that utilize IP networks to connect real time operational data to the people and systems that manage business enterprises. Niagara provides the critical device connectivity, cyber security, control, data management, device management and user presentation layers of the stack. In short, it is a complete IP-Convergence platform.

Today, there are almost one million instances of Niagara at work in hundreds of thousands of projects worldwide covering a wide range of applications— all of which bring device data to the people and systems that need it via IP networks. Some representative types of commercial property owners and vertical-market applications include:

Industrial Mixed-Use

Corporate Real Estate teams that are overseeing large industrial portfolios have the combined challenge of integrating data from the manufacturing side and from corporate office space and other mixed-use facilities. Tridium counts many Fortune-ranked industrial

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VISUALIZATION

PROVISIONING

companies in its customer base, and the Niagara platform has evolved to unify data from sources as diverse as occupant mobile apps and assembly-line robotics. The public brands of such customers and the productivity of their employees are impacted by how they run their campuses, so facility managers are always on the lookout for smart solutions that improve operations and enhance environmental sustainability. Among the big US carmakers with large Niagara deployments, one has been engaged in a decades-long energy performance contract that has paid for itself in energy savings through a combination of controls retrofits, air system networking and scheduling improvements, and a cloud-based compressed air system monitoring solution powered Niagara Framework. Such big industrials are also highly vigilant when it comes to cyber defense. For them, it is critical that their valuable data travel seamlessly and securely from edge devices up to and back from their private cloud infrastructure overseen by IT. To stay on their approved vendors lists, Tridium builds strong security capabilities into all Niagara products and encourages its systems integration partners to also adhere to cyber best practice, as defined by standards bodies like FIPS, ICS-CERT and NIST.

Multi-Branch Retail

Retailers today rely on a wide variety of intelligent systems and devices to manage personnel, supply chain, accounting, and other enterprise management applications. Among the Tridium Niagara customers in this category is a large convenience grocery store and fueling station retailer. For this customer, Niagara Framework serves to integrate data from a variety of operational technology (OT) systems, enabling the management and control of HVAC, lighting (interior and exterior), refrigeration, food preparation, physical access security, utility meters, fuel-tank monitoring, fuel dispensing and, in some cases, car-wash irrigation. All these systems are critical to store operations and customer satisfaction. Connecting to and communicating with these devices and systems enables the store to maximize operational efficiency and profitability.

Hospitals & Healthcare

Major healthcare networks are requiring that all vendors and controls contractors that work on their hospitals and out-patient facilities support an open BMS strategy. They are publishing their own frameworks and standards specifying Niagara 4 as a common requirement. Many also call for BACnet IP-based controllers across their network of buildings. In this way, they have a technology roadmap set for future growth and a robust pool of Niagara-certified systems integrators to call upon any time service is needed. Commonly, they forge strong trust relationships with those they select for their service work, knowing that they will consistently get:

▶ Niagara 4 command-and-control over all building services from HVAC, to access control, to lighting, to special equipment like sterile-environmental air systems typical in operating rooms
▶ Niagara graphical user interface they can customize for the unique needs of care-giving environments
▶ Niagara's enterprise-IT-grade cyber defenses

By specifying Niagara Framework, they are assured of an integrated automation platform and building management system that meets their patient comfort and healing needs, all while helping them drive energy waste from their operations to meet their environmental/social governance requirements.

Airports

Airport construction projects have always been about designing the future. For more than a decade, airports like Changi Airport in Singapore, Minneapolis-Saint Paul Airport in Minnesota and many more of the world's busiest transport hubs have deployed the Niagara Framework® to integrate the many different controls and environmental-monitoring sub-systems necessary to support operations. Dubai International Airport, for example, is achieving unprecedented operational efficiency and energy savings through an on-demand control system that synchronizes operation

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of critical systems in the airport with flight arrivals. It's command-control system enables the building management system, lighting control system, access control system and even the airport's sky-train people-mover and luggage conveyors to inter-operate. The many connected devices associated with each subsystem are orchestrated based on flight data updates forwarded from the airport's enterprise management information system to the Niagara-powered integrated controls system.

Government and Municipality Buildings

The facility and engineering teams overseeing government-owned building portfolios are faced with greater complexity and a higher imperative to demonstrate leadership when it comes to delivering comfort and energy efficiency. Portfolio-wide analytics are complex when the scope is across buildings of all ages, many brands and eras of building equipment, and scores of building service providers of all types. Niagara Framework's open-protocol, open distribution approach also allows government customers to run competitive 'request for proposal' processes, allowing market forces to keep the cost of building management equipment and integration services in check. One of Tridium Niagara's largest and longest running Niagara deployments is for a large government portfolio that now monitors over a billion data points a month.
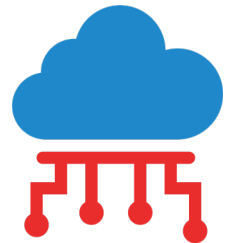
Data Centers

Data center operators are a large and growing segment of the Niagara customer base. With 24X7 high availability a driving concern, they have need to proactively manage every aspect of how their facilities operate. They cannot wait for equipment failure or degradation to signal an operational problem. Investment in predictive analytics powered by Niagara achieves a multifold return when compared to the cost of downtime. Data center customers can select from numerous Niagara Community UI specialist partners to easily define custom interfaces for their facilities that are impactful, easy-to-interpret and interactive. Niagara data

makes for more informed decision-making about server moves, adds and changes. Niagara can be configured for power usage effectiveness monitoring, heat and thermal mapping, power chain management, cooling optimization, reliability and uptime, co-location management and energy usage management.
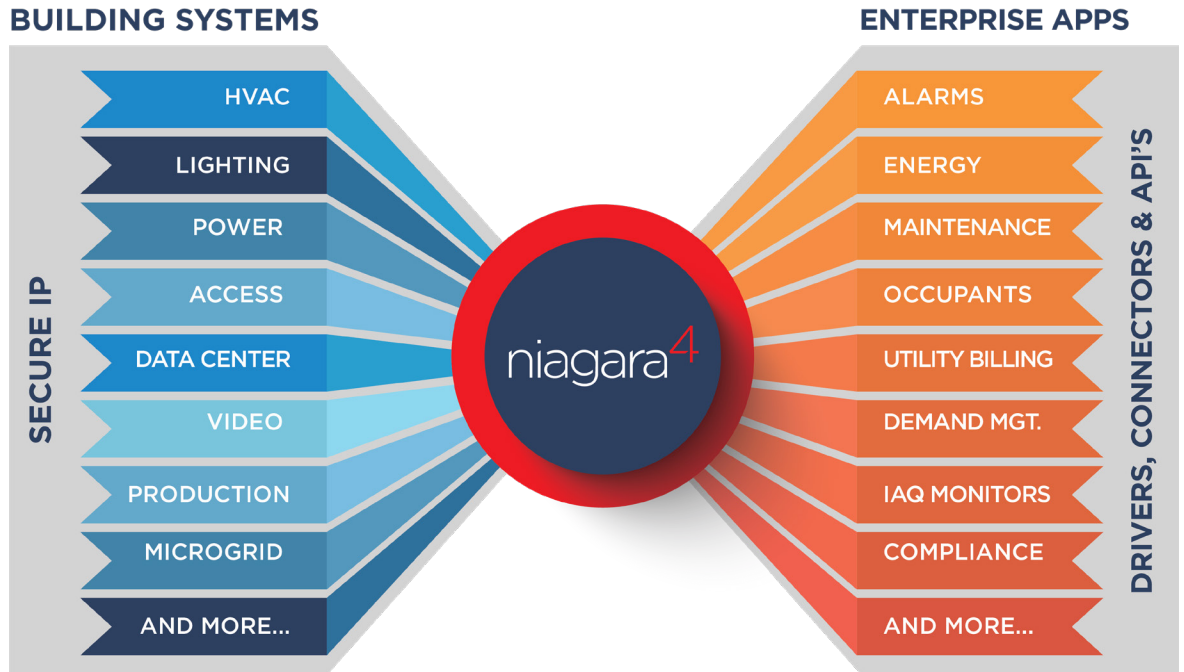
Military Bases, Defense Properties

Military installations all over the world use Tridium as a secure, compliant and flexible control system. To cite just one of many examples, when it was time for a HVAC retrofit of a depot spanning 1,295 acres and employing over 5,600 personnel, one army facilities team outfitted 21 new boilers across 10 boiler rooms with Niagara Framework controls. Military customers, with some of the planet's most strict cyber security requirements, find that Niagara's Defense in Depth approach helps them meet IT standards of cyber defense. Tridium builds strong cyber protections into Niagara products and works with organizations like ICS-Cert to ensure cyber best practices up and down the Niagara value chain. Niagara Community partners seeking U.S. Government site authorizations have a head start in that Niagara Framework, Niagara Edge 10 and the JACE 8000 are eligible for accreditation under the federal Risk Management Framework (RMF). Tridium has RMF artifacts they can share with these partners upon request.

Telecommunications

Telecommunications network operators all over the world use Niagara-based systems to provide real time monitoring and control of remote sites and central stations. Such a Niagara deployment is at the foundation of South Africa Telekom's network infrastructure. The SA Telekom project connected non-IP based systems including security, fire monitoring and suppression, battery backup, emergency generators, and temperature control systems into an integrated solution that is managed from a central network operations center in a fully web-based application. The system currently supports over 300 sites.

INTELLIGENT EDGE

CONNECTIVITY & CLOUD

SMART BUILDING INTEGRATION PLATFORM

BUILDING SYSTEMS

ENTERPRISE APPS

SECURE IP

- HVAC
- LIGHTING
- POWER
- ACCESS
- DATA CENTER
- VIDEO
- PRODUCTION
- MICROGRID
- AND MORE...

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DRIVERS, CONNECTORS & API'S

- ALARMS
- ENERGY
- MAINTENANCE
- OCCUPANTS
- UTILITY BILLING
- DEMAND MGT.
- IAQ MONITORS
- COMPLIANCE
- AND MORE...

Niagara is the underlying unification platform that enables communication between a diverse host of smart, embedded devices, regardless of manufacturer or communication protocol. It models the data and behavior of the devices into normalized software components, providing a seamless, uniform view of device data to the enterprise via a wide variety of IP-based protocols, including BACnet, OPC UA, XML/SOAP, Modbus TCP, SNMP and NTP. Sharing data with enterprise applications is facilitated by the large collection of connectivity options and open APIs available through Tridium as well as from the many Independent software vendors (ISVs) and Niagara Community developers that offer connectors via the Niagara Marketplace.

IP CONNECTIVITY

COMPLIANCE & CERTIFICATION

It is helpful at this point to look at how devices are integrated by the Niagara Framework, and connected to the IP network infrastructure.

Niagara software runs in embedded and non-embedded devices. For over twenty years, Tridium has manufactured and white-labeled Niagara-based hardware and software for this purpose. Today, Tridium's JACE (Java Application Control Engine) and ACE (Application Control Engine for embedded devices) are sold under a wide variety of

manufacturer brands and are placed at the edge of IP networks where they connect to legacy non-IP devices and to equipment systems, as well as to the IP network infrastructure.

Niagara communicates with the diverse devices and transforms their data into normalized software components that form the foundation of the higher-level functions and services, shown earlier in the Niagara device-to-enterprise stack diagram.

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Niagara includes a rich application server specifically designed to perform functions such as: control, alarming/notification, business rules processing, data logging, user presentation to a browser-based device, and data serving to other applications and systems. Niagara provides a complete automation infrastructure and can be run on a wide variety of hardware platforms, from small single-board computers to fault-tolerant server clusters.

Tridium introduced the Niagara Edge 10 to bring the power of the Niagara Framework to the edge and make it easier to connect and control systems and optimize performance within the Internet of Things. The same tools that have evolved to assist Niagara customers in the configuration and management of Niagara Edge 10 devices are also available to partners that have ported Niagara Framework to their own edge hardware. By running Niagara at the edge, you can reduce training costs, learning curves and dependence on proprietary systems. In addition, end-customers can take advantage of new and improved workflows that will save on installation time and maintenance costs over the long run. Niagara edge devices can run built-in Niagara analytics as well as other high-value apps from the Niagara Community and they can connect directly to apps hosted in the cloud.

KEY ELEMENTS OF AN OPEN SYSTEM

1 Device Connectivity

How many products of importance to my application can the system communicate with?

2 Support for accepted standard protocols

Does the system support a majority of relevant standard communication protocols?

3 Access to products for initial purchase and system expansion

Where can I buy these products? Where can I get them installed or serviced? How many suppliers? Do I have my choice of service providers? Can I get competitive bids for projects?

4 Third-party development community

Can independent developers create complementary new products and applications that work coherently with the system?
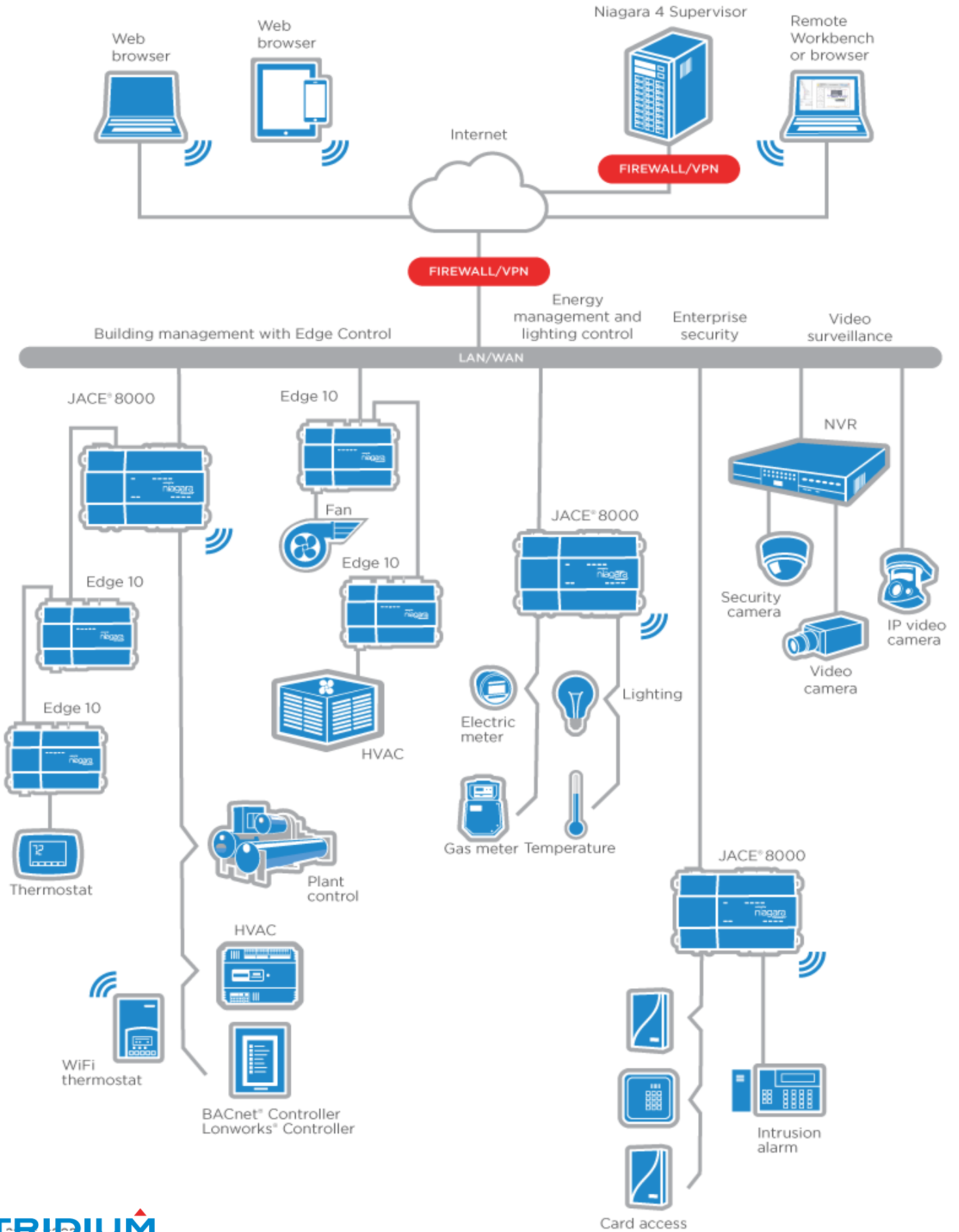
5 APIs for third-party access to data

Are there published interfaces that makes it easy to access system data?

6 Compatibility with standard databases

Can data from the system be easily shared with common database formats used throughout my enterprise?

ENTERPRISE APPLICATION ARCHITECTURE POWERED BY NIAGARA FRAMEWORK

Web browser

Web browser

Niagara 4 Supervisor

Remote Workbench or browser

Internet

FIREWALL/VPN

FIREWALL/VPN

Building management with Edge Control

Energy management and lighting control

Enterprise security

Video surveillance

LAN/WAN

JACE® 8000

Edge 10

NVR

Fan

JACE® 8000

Edge 10

Security camera

IP video camera

Edge 10

Video camera

Edge 10

HVAC

Lighting

Electric meter

Thermostat

Gas meter Temperature

Plant control

JACE® 8000

HVAC

WiFi thermostat

BACnet® Controller
Lonworks® Controller

Intrusion alarm

Card access

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BUILDINGS MUST LEAP THE TECHNOLOGY GENERATION GAP

Accustom to doing everything on their smartphones, today's end-users expect instant connectivity and easy information access. The people that run the businesses that lease commercial property and the occupants they attract to their spaces are now more likely to be Millennials and Gen Z'ers. Their expectations have been set by the pervasive use of the Internet and mobile applications. When a younger new hire takes the place of a retiring facilities manager, they typically have low tolerance for the technical and standard-practice hurdles that make it difficult to connect to building operational data.

A facilities leader steeped in the current era of mobile technology might ask "How long does it take me to check the latest scores for my favorite professional sports team? Now how long does it take me to determine which of the facilities in my care has the highest energy cost per square foot this month?"

It's more than likely they'll conclude "'Too long!" –if they can do it at all. It is a bit illogical that we can check something as inconsequential as a sports score in near real time, yet we have no similar ability to check the operation and status of our enterprise and the assets and equipment systems that support it. The always-connected lifestyle helps drive the expectations of customers and managers for immediate access to essential data. What could be more essential than information from these assets and the processes that drive your business?

Lean manufacturing, the dramatic costs associated with equipment downtime, competitive pressures, security, regulation compliance – these business realities drive the value of having real-time access to operational data, alarms, alerts and system status.

Device connectivity, the Internet of Things, IP Convergence – whichever term you prefer, the next major wave of data flow for IP networks is well underway. Tridium's Niagara Framework is a proven enabler in driving these needs.

DEVICE CONNECTIVITY & SUPPORT FOR STANDARD PROTOCOLS

The Niagara Framework provides support for a wide variety of protocols. It includes comprehensive support for major standards in the building market including BACnet (Ethernet and IP) and LonTalk™ (LON) and other "open" protocols—e.g. MODBUS, SNMP (Simple Network Management Protocol), and OPC (Object Linking and Embedding for Process Control).

In addition to these open protocols, Niagara directly supports many proprietary protocols used by manufacturers of control systems and other smart devices. While Niagara does not have an interface to every device ever made (no one does), we and software developers within the Niagara Community are constantly developing new communication interfaces to meet the needs of our customers. Today we have working interfaces to well over 1000 different devices ranging across the building automation, industrial automation, IoT, telecommunications, energy and IT infrastructure markets. Further, any new device that supports any of the standard protocols supported by Niagara can be integrated with ease. No additional gateways or custom software is required.

OPEN TO ENTERPRISES & AVAILABLE TO INDEPENDENT DEVELOPERS

The end user owns the data in their systems, but effective use of that data is where the real value is created. End users need the means to make the information from their systems valuable –

to give them the intelligence and knowledge they need to improve the operation of their facilities. Many systems offer reporting tools to help address these needs. Tridium's VYKON Suite offers tools for advanced data analysis and reporting. But, every facility is unique and different and in many cases the standard tools offered by any one manufacturer just don't fit the needs of the end user. This is where open access to data comes in. Third party tools are often needed to meet unique data reporting and analysis requirements.

The Niagara Framework provides a wide variety of software features to enable robust interfaces with third party software applications. Here are a few key examples:

▶ Standard Database Support. Niagara supports industry standard databases including Microsoft SQL Server, Microsoft MSDE, IBM Cloudscape, DB2, and Oracle.

▶ Public APIs' and support for JDBC (Java DataBase Connectivity). Even with the freedom to choose among a number of commercially available databases it may often be necessary to pull data from the database to bring it into other applications. JDBC is a standard method of accessing data in databases and is supported by almost all major commercial databases. For specialized access to other data in the Niagara framework, Niagara provides public (this means open) API's which provide third party programmers a defined, officially supported method of accessing, reading and writing data.

▶ Sometimes specialized applications require manipulation of data beyond what the public API's offer. Servlets are a tool that allow a third-party programmer to do virtually anything they need with Niagara data. In addition to the public API's, Niagara includes sample servlets to help developers quickly implement servlets that meet their unique application needs.

▶ Access to data and integration with the enterprise – Niagara provides the richest choice available on the market.

OPEN TO SERVE CUSTOMERS & END USERS

The end-use customer is where the buck stops with open systems – they choose the systems, they pay for them, they live with them. We believe that an open system gives the end user the ultimate flexibility and choice. The more open, the more freedom.

With Niagara, end users have exceptional choice – the manufacturer of their choice, the protocol of their choice, the local contractor of their choice, the choice to select add-on applications and devices from third-party suppliers, and the choice to extend the capabilities of the system through standard software interfaces. There is also a robust community of Niagara System Integrators and Master System Integrators for your projects, whatever the size.

And once those choices are made, the user gets all of the features and benefits of Niagara: the dynamic display of real time information in a standard web browser, built-in network management tools that provide auto-discovery and automated database generation, and the ability to integrate with many proprietary legacy systems. And because Niagara is vendor and protocol neutral, you don't have to commit your future to a single protocol decision. You can specify a project around one protocol today and decide to expand to another in the future. Perhaps most important, the range of choice comes from the names you know and trust. The companies that offer Niagara-based systems are a virtual who's who of the established players in the automation market.

OPEN FOR PARTNERS

The best solutions come from a collaboration of the best minds. The Niagara Framework is a platform built and designed for our partners. It enables companies to quickly and easily develop Niagara Framework-based products, comprehensive device-to-enterprise applications, cyber secure automation systems and IP-convergence solutions.

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NIAGARA MANUFACTURING PARTNERS

Today Niagara is being successfully applied in the building automation, IoT, telecommunications and energy services industries by a wide range of partners that include equipment manufacturers, and their associated distribution channels, Value Added Resellers, and their associated distribution channels, and independent systems integrators large and small. Other companies have built applications that reside on top of, or work with, the Niagara Framework. These partners have several things in common: they see the need for a framework solution, and they recognize the value of an open technology for automation.

OPEN TECHNOLOGY ENABLING AN OPEN MARKET

When evaluated on the measures that matter, Niagara provides industry-leading openness, affording the leading array of connectivity, customer choice, and manufacturer and distribution channel flexibility. Derived from future-oriented IT or information technology standards, Niagara provides the solution to cost effectively integrate multi-vendor, multi-protocol systems with IP networks and enterprise applications to provide true IP convergence. ▲

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