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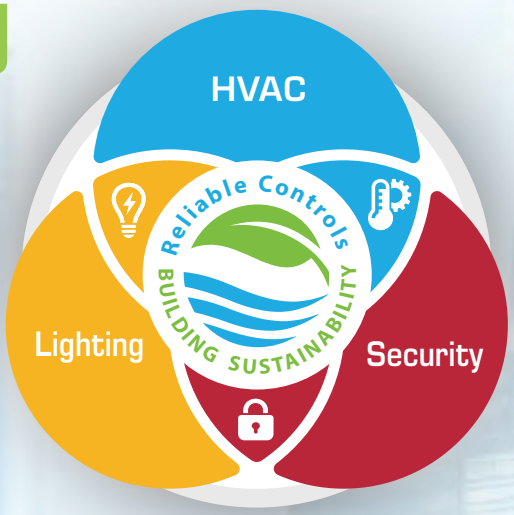
Issue 19

This Issue

The BACnet Ecosystem

Global Testing of the Global Standard

the ART of Building Sustainability



1 CERTIFIED OPEN STANDARDS

Ensure a strong level of interoperability by using open protocols which have third-party listing laboratories to verify adherence to your protocol's form and function.

2 SECURE DATA

Employ a single sign on (SSO) architecture with compliance to scalable credentialing architectures and secure tunneling methodologies such as BACnet Secure Networks (B/SN).

3 INTEGRATED FAULT DETECTION & DIAGNOSTICS

Specify integrated FDD (IFDD) that delivers real-time fault detection, step-by-step root-cause diagnostics while using all your existing cabling structures, including twisted-pair networks.

4 OWNERSHIP OF ANALYTICS

Insist on timely analytics for all stakeholders with complete control of formatting and scheduling while retaining full ownership of your data and the reports generated.

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Create better-connected spaces with real-time access to occupancy, lighting, ventilation, and thermal comfort levels, using a holistic single app on the occupant's mobile device.

6 MINIMAL WASTE

Select lifecycle-centric manufacturers who minimize the negative impacts of waste with long-term warranty and repair services while adhering to WEEE, RoHS, R2, and LEED directives.

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Stay on top of regular advances in technology with supplier-certified, multi-lingual online educational videos, technical documentation, software updates, and advanced face-to-face classroom courses.

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Sustainability requires a high level of integration between HVAC, lighting, and security systems. The art of building sustainability skillfully combines this integration with other technological and supporting elements that must endure over the long term. When these additional elements are maintained over the life of your building, true building sustainability emerges. To learn more about the ART of Building Sustainability please visit **reliablecontrols.com/TABS**

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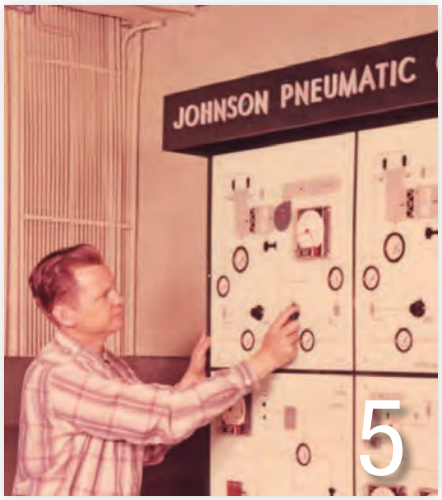

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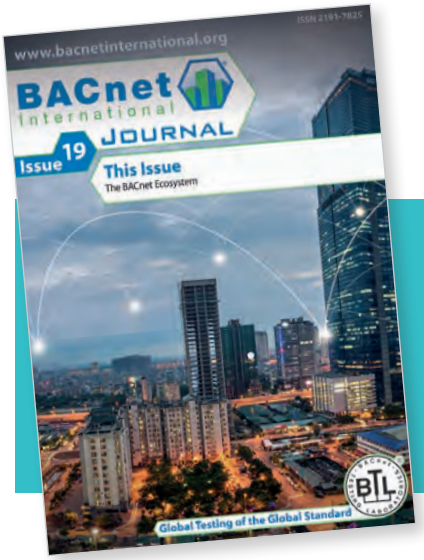

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Letter from the President

Dear Reader,

The increasing awareness of cybersecurity threats is driving evolution of the Building Automation Industry. The BACnet Committee has responded by publishing an addendum to the standard called BACnet Secure Connect, or BACnet/SC for short. Products incorporating BACnet/SC are appearing in the market so we have included some information in this issue of the Journal to help you make sense of BACnet/SC and understand how it might impact your organization. The topic of cybersecurity is complex and multilayered, so it is not surprising that there is some confusion and misunderstanding around BACnet/SC as well. To clear up a few things, let's consider what BACnet/SC "***is***" and what it "***is not***".

BACnet/SC "is"

BACnet/SC is a new option for getting system information and control commands from one device to another, just like BACnet/IP and BACnet MS/TP. It does basically the same thing as BACnet/IP and MS/TP … that is transporting information and commands among devices. The key difference is that BACnet/SC encrypts the information being sent so that no device on the network can determine the content of secure messages unless they have the appropriate encryption keys. The encryption process and the certificates that make it work are like those used in smartphone banking apps when they communicate with a bank.

BACnet/SC is particularly appropriate for applications that are sensitive to cybersecurity issues. The obvious examples are military and government, but it might be equally applicable to high-value manufacturing, process control and similar facilities.

BACnet/SC is backward compatible and is interoperable with BACnet/IP and MS/TP so it is possible to use BACnet/SC for certain parts of a building or campus and use BACnet/IP and/or MS/TP in other parts. The design of BACnet/SC allows it to keep track of message routing to ensure that messages are considered secure only as long as they remain in the BACnet/SC portion of the overall network.

BACnet/SC "is not"

BACnet/SC is not a new version of BACnet or a different BACnet. It does not involve any change in data or control commands. You can consider BACnet/SC to be equivalent to mailing a letter in a fully opaque, foil lined envelope where BACnet/IP and MS/TP are more equivalent to mailing the letter in a translucent envelope. The letter is the same and the process is the same, just the carrier is different.

BACnet/SC is not for every application. The cost and complexity of managing certificates that provide encryption capability may not be appropriate for facilities with low risk of cybersecurity issues.

BACnet/SC is not going to "solve" the cybersecurity issues surrounding building automation systems. The vast majority of cybersecurity breaches involve weak administrative processes, inadequate training or limited organizational discipline. BACnet/SC will not help with any of those.

The Bottom Line

BACnet/SC is an important addition to the toolbox of designers developing more secure building automation products and systems. It does not replace existing BACnet options but complements them. In the end, it is one piece of the larger industry effort to address the growing need for cybersecurity in building systems.

At BACnet International we strive to equip building professionals with information needed to stay up-to-date on BACnet. BACnet/SC has been getting a lot of coverage on various platforms lately, but what's presented is not always clear or correct. We hope you enjoy this issue of the Journal and that it provides valuable material that keeps you current and informed.

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Comfort Control: A Brief History of Building Automation and BACnet

Today, BACnet is a dominant universal standard in building automation. The data communication protocol developed by ASHRAE in the 1980s has worked for decades to help Building Automation System (BAS) devices and objects from different manufacturers interact, share data, and work together in a standardized fashion. This was a lofty goal from the outset, so it's impressive to see how much progress BACnet has made. And yet, the sophisticated operations of modern building automation systems arose from humble origins.

Johnson Pneumatic Control Center. Per a Johnson Controls tweet, "Throwback to 1956, when our pneumatic control center made the centralized monitoring of building conditions possible for the very first time."

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https://twitter.com/johnsoncontrols/status/966745164411621376?s=20

Centuries of Technological Incubation

While commercial building automation systems arguably emerged with pneumatically controlled thermostats in the early 20th century, many trace the origins of the BAS to the introduction of the thermostat itself. Cornelius Drebbel, a Dutch inventor, developed a chicken incubator in the 1660s that kept eggs at a stable temperature with feedback from a mercury thermostat–the first recorded feedback-controlled device.

An old "Super-Sensitive Thermometer" by Johnson Service Company — the original name of Johnson Controls — on an air-conditioning unit. The glass capillary tube has come loose from its attachment and is leaning at an angle within the bezel.

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It was centuries before this first leap in technology transferred over to rudimentary building automation. In 1883, Milwaukee schoolteacher Warren Johnson deployed his "electric telethermoscope" (a bi-metal coiled thermostat with a mercury switch) at the State Normal School. It would ring a bell at set temperatures to alert the firemen that the heating damper needed to be opened or closed. This was the first patented building automation device to move into production, as it did with the Johnson Electric Service Company in 1885.

Air-based pneumatic systems came next at the turn of the 20th century, eventually to be succeeded by the far more versatile and precise analog electric systems of the mid-century period. These early electronic systems marked the first time that building controls began to resemble the BAS systems we know today, with networks of computers, sensors, valves, and actuators, but they still presented significant challenges. Proprietary BAS systems in the 1980s, including both analog and later digital or "DDC" systems, were incompatible across manufacturers and tended to restrict building owners to the maker of each building's individual BAS.

The Rise of BACnet

Pressure began to mount by the late 1980s to standardize devices and move towards a more open communication system. The American Society of Heating, Refrigerating, and Air-conditioning Engineers (ASHRAE) responded in 1987 with an ambitious campaign to revolutionize device interconnectivity with a standard set of rules: their Building Automation and Control network or "BACnet" communication protocol. The establishment of BACnet as an approved ASHRAE standard in 1995 made it possible to govern and align communication between various devices in the building control system, regardless of manufacturer. It's now the accepted standard across ASHRAE, ANSI, and ISO.

A Different Way of Going to Market

The flexibility offered by a standardized universal communications protocol has led to powerful new innovations in the market. For example, ODIN (Operator Display Integrated Network) is a BTL-certified B-OD product that was developed with the sole purpose of streamlining and simplifying building management for users. With the help of BACnet-enabled devices, any building owner using ODIN can be independent of the BAS that is installed in each building, accessing and operating the system (or even multiple systems) from anywhere via a unified user interface in ODIN's cloud-based BACnet dashboard. Solutions like these make BACnet-enabled products unique in the market, as they are marketed directly to building owners, not the BAS and integration community.

With that said, ODIN was never intended to replace the BAS in buildings, but to provide the critical enterprise-wide control across the entire property portfolio that has long been prom-

ised by the Internet of Things (IoT). Any BAS with an open BACnet protocol empowers ODIN to offer unlimited local control as well as the flexibility to easily expand the BAS as the facility's needs evolve or new technologies emerge. It is the underlying BACnet technology that enables ODIN to innovate and simplify building management in this way.

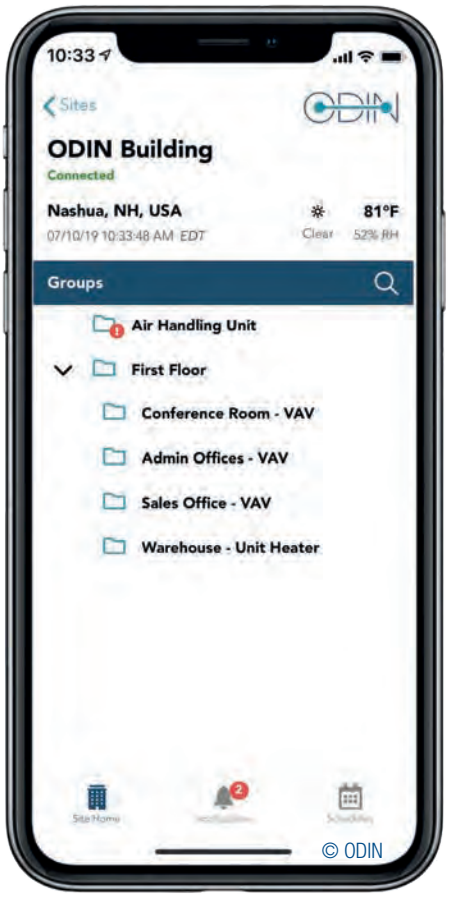
Building managers simply run the ODIN BACapp software in each building and it automatically discovers all local BACnet devices and objects. The application acts as a secure gateway to publish this information into a cloud-based system, connect everything with the local BAS, and communicate all updates back and forth between the BAS and the unified cloud-based dashboard. This is a safe, fully encrypted solution, as a primary function of the BACapp software is to create protected WebSocket connections for the open protocol devices (by using port 443 and SSL commercial x509 certificates, as well as asynchronous 256 CBC encrypted data, with a matching configuration on the cloud server). This gives facilities personnel the best of both worlds–a cohesive and secure local BAS on the one hand, and the freedom to leverage diverse devices or operate them from diverse locations on the other.

In this way, BACnet behaves much like an API, providing the needed integration between the local control of the BAS in the building and the value-added services that ODIN is providing from the cloud. The combination of an open communication protocol and a cloud-based B-OD product is more powerful than either one could possibly be on its own. Nothing has been more true to the Building IoT (BIoT) concept than this fusion of user freedom and device interconnectivity.

The Future of Comfort Control

Automation enthusiasts often ponder the bright future of Building IoT and automation controls. While the march of technology will always advance, the truth is we're living in the future right now. It's never been easier or more convenient to control the comfort of the building environment. Consider what BACnet has already made possible:

- Vendor Interoperability: As BACnet International explains, building owners are free to "choose the right piece of equipment for the right job, from any manufacturer you want, instead of being limited to the brand of the system that's already in place."
- True Remote Control: BACnet has made it possible to create cloud-based solutions that empower building managers to access and manage a building from anywhere in the world, at any time, on any internet-enabled device. We were able to use this strength in our BACnet-certified software, ODIN, to allow our users to set schedules, adjust BACnet objects, view trends, and navigate all sites remotely through simple Apple® and Android™ mobile apps. Without BACnet, it would be much more difficult to offer the familiar and convenient format of a remote phone app.
- Intuitive Multi-Site Management: Now that mainstream devices and objects are using an open format for communication, it's possible to create multi-site, enterprise-wide software solutions that unite control for all locations in a single digital dashboard (even if each building uses a different BAS). We were able to build simple multi-site management into the ODIN product because of BACnet.
- Freedom From Obsolescence: Lifecycle systems used to be a struggle. In the past, an average BAS controller lifecycle of 10-15 years meant that you'd need to replace the whole system to escape obsolescence and discontinued support. With an open protocol, it's now possible to integrate new and emerging technologies as they arrive, in a rolling lifecycle, with no risk of the communication protocol becoming obsolete.
- Unlimited Scalability: Because it imposes no limit on the number of devices or "points" that a device can contain, BACnet makes it possible to scale from simple to enormously complex systems with no loss of responsiveness or usability. Even a global network that spans thousands of BACnet-enabled devices and objects is easy to organize and manage via a central BACnet-certified software that can see and communicate with every BAS, device, and object.
- Smart Energy Efficiency: Research has shown that the development of BACnet has made it possible for BAS to save $0.20 to $0.40 in energy costs per square foot (or up to $80,000 each year for a 200,000 square foot building)[1].



iPhone-XS-home
Simple mobile applications like this one from ODIN have been a major leap forward in user-friendly control for buildings with a BACnet-enabled BAS.
© ODIN

These conveniences will only continue to advance in the coming years. The surging BAS market is already projected to reach $82,517.4 million by 2023 at an astounding 11% compound annual growth rate (CAGR)[2] , and further expansion of the universal BACnet standard is sure to follow. Advocates for the open BACnet protocol are proud to see the great leaps that have already been made towards the concept of a dynamic global Building IoT. Facilities today are smarter than they've ever been. With BACnet as a true global standard, they'll only continue to get smarter.

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1. www.researchgate.net/publication/276273243_HEURISTIC_VIEW_ON_INTELLIGENT_BUILDING_DESIGNS_AS_A_MEANS_TO_SAVE_ENERGY
2. www.businesswire.com/news/home/20180524005797/en/Global-Building-Automation-System-Market-Analysis-Growth

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The Open BACnet Ecosystem

The BACnet standard was developed and is maintained under the auspices of ASHRAE SSPC 135, the BACnet Committee. BACnet International is an industry association that facilitates the successful use of the BACnet protocol through interoperability testing, educational programs, and promotional activities. It also oversees operation of the BACnet Testing Laboratories (BTL) and maintains a global listing of tested products. This article is going to explore BACnet from the viewpoint that the standard is applied by developers to create devices, networks, and applications, i.e., "Things" that participate in the open BACnet ecosystem.

Before jumping into the details, let's set the stage for a discussion of the concept of open systems.

The Open Systems Interconnection model (OSI model) is a conceptual model that characterizes and standardizes the communication functions of a telecommunication or computing system without regard to its underlying internal structure and technology. Its goal is the interoperability of diverse communication systems with standard communication protocols[1]. This is why BACnet products from different manufacturers can successfully work with each other to produce best-of-breed solutions.

Seven Layers of the OSI Model[2]

In 1984, the ISO (International Organization for Standardization) published this Model. The OSI Model has seven different layers, divided into two groups (see figure 1).

It is important to emphasize that this is a conceptual model. In practice it is OK that some implementations take liberties with the model by combining some of the layers or eliminating functionality that is not applicable to a specific implementation. The critical issue is that all the functionality is defined and, when necessary, is implemented. That is exactly what happens in the BACnet ecosystem.

The BACnet standard defines data objects, network objects, their properties, and services that operate on these objects. From this standpoint there is one BACnet. BACnet follows the spirit of the OSI model by allowing the implementor to choose from one of seven BACnet-defined transport methods. These transport methods are adopted from well-defined and standardized IT networking and cybersecurity technologies. Where necessary, BACnet specific network services are combined with these standard transport methods.

Using this approach, any "Thing" implemented by following the BACnet standard will successfully connect with and interoperate with other "Things" in the BACnet ecosystem. The BACnet Testing Laboratories function within BACnet International defines testing requirements and provides certification services to make sure that the above statement is true. BTL Certified products have passed the rigorous test procedures defined by the BTL Working Group. There are multiple testing laboratories around the world capable of providing testing services.

Here is a summary of the value proposition for "Things" that are built following the BACnet standard.

- They have a great object discovery mechanism.
- They are vendor agnostic.
- They are open.
- They are extensible.
- They promote competition.
- They promote manufacturer innovation.
- They are backwards compatible because the standard is continually maintained by the BACnet committee ASHRAE SSPC 135.
- They are supported by both an ASHRAE and an International standard.
- They prevent vendor lock-in.

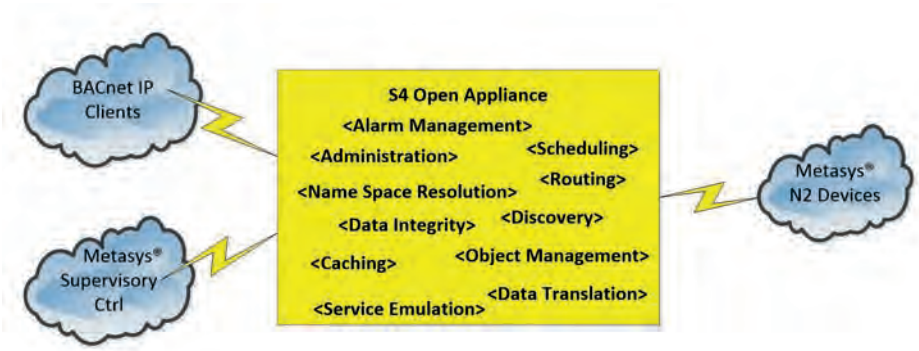
It is up to the product developer to provide the code in their "Thing" to implement the logic behind the BACnet protocol that delivers the unique services offered by their products. This leaves lots of room for innovation and competition between manufacturers. It is also up to the product developer to provide their own user interface and configuration and commissioning utilities consistent with the standards they have set for their brand.

The BACnet standard provides opportunities for both large building automation system (BAS) manufacturers and smaller, or niche, players. Nothing in the standard says that you need to offer every type of product defined by the BACnet profiles. If your product offering(s) follows the BACnet standard, it can participate in the BACnet ecosystem and either compete with, or augment, the products of larger players.

BACnet is at the heart of the Building IoT (BIoT) concept. Devices implemented following the BACnet standard provide local control critical to keeping buildings operational, maintaining Indoor Air Quality (IAQ) and occupant comfort, and energy efficiency to keep occupants safe and productive. Data from the local control environment can be sent to cloud-based systems

Group	Layer Number	Layer Name	Description
Top Layers	7	Application	Provide user interface to send and receive the data
	6	Presentation	Encrypt, format and compress the data for transmission
	5	Session	Initiate and terminate session with remote system
Bottom Layers	4	Transport	Break data stream in smaller segments and provide reliable and unreliable data delivery
	3	Network	Provide logical addressing
	2	Data Link	Prepare data for transmission
	1	Physical	Move data between devices

Figure 1: OSI Seven Layer Model (from an article in Computer Networking Notes[2])



S4 Open: BACnet-N2 Router Architecture, © The S4 Group, Inc.

where their value can complement, augment, and tune the local control provided by BACnet systems.

There are many application scenarios for BACnet and one of them is providing an integration platform for a building with a legacy BAS. To accomplish this, a specialized BACnet device can provide gateway/router services to/from the BACnet ecosystem. For example, the S4 Open: BACnet-N2 Router acts as the enabling technology to introduce BACnet-based "Things" to legacy buildings. It is a perfect example of using BACnet as the API which normalizes the data from legacy BAS implementations and allows them to fully participate in the BACnet ecosystem. All the code that provides the mapping between BACnet and the legacy systems, the user interface, the value-added features provided, and the legacy system protocol itself, is implementation specific and independent of the BACnet standard.

Similarly, each major BAS manufacturer typically offers a field level controller for Rooftop Unit (RTU) Controller applications. Every RTU talks to the BACnet ecosystem following the standard. But implementation details for all the algorithms beyond what is defined in the BACnet protocol are completely up to the manufacturer. They differentiate their products by the level of operational efficiency and the ease of use provided by their configuration and commissioning utilities.

BAS manufacturers also offer building level controllers and fully programmable devices. Like the above examples these devices communicate and interoperate with the BACnet ecosystem following the rules defined by the BACnet standard. It is beyond the scope of the BACnet standard to specify the functionality offered by these devices or the methodology offered by the manufacturer for the integrator to program these devices. There is lots of room here for manufacturers to differentiate themselves!

Operator Workstations and other display devices play another important role in the BACnet ecosystem. Again, they must follow the BACnet standard to be able to successfully connect and interoperate with the BACnet ecosystem. Here again, it is completely up to the developer to determine how they define their user interface and what value-added capabilities they offer beyond the functionality mandated by the standard. There is lots of room for innovation and differentiation of products while maintaining compliance with the standard.

These BACnet "Things" are Open Systems, Open Networks, Open Applications, or Open Devices depending on the application or service that they provide to the BACnet ecosystem.

We have not yet discussed Open Source. In fact, BACnet is represented in this area also. Many BAS manufacturers have implemented their own BACnet stacks following the BACnet standard. There are several commercial BACnet stack offerings that developers can include in their own products. There is also at least one Open-Source implementation of the BACnet stack where developers can utilize source code developed by others and contribute to its maintenance and enhancement for the benefit of the community. A variation of Open-Source is the reference implementation of BACnet Secure Connect (BACnet/SC) provided as part of BACnet International's BACnet/SC Interoperability Acceleration Program.

BACnet adoption continues to grow because of the ongoing work of the BACnet Committee to enhance and extend its functionality as buildings evolve into Smart Buildings. The ongoing work of BACnet International, and BTL, to certify BACnet implementations, promote the use of BACnet, and provide educational and testing services makes sure that building owners, and their trusted advisors, understand that BACnet should be their first choice for automating their building systems.

[1] Wikipedia
[2] Computer Networking Notes: www.computernetworking-notes.com/ccna-study-guide/osi-seven-layers-model-explained-with-examples.html

ABOUT THE AUTHOR

Steve Jones founded The S4 Group, Inc. in 2002. His professional experience includes delivering networking and integration services for carriers, networking vendors, and system integration companies in both the government and commercial sectors, and he is currently Chair of the BACnet International Marketing Committee.

Mr. Jones previously held multiple positions with Johnson Controls focusing on developing enterprise solutions and integrating the Metasys® Building Automation System into customers' IT environments, network infrastructure, and management platforms. He belonged to both ASHRAE and BACnet International and reviewed BACnet standard Annex J (BACnet/IP) as it was being adopted. He holds a Master's degree in Computer Science from Stevens Institute of Technology, a Bachelor's degree in Computer Science from Rutgers University, and an Associate degree in Computer Science from Penn State.

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Co-Existence of BACnet in the IoT Ecosystem

Introduction

ASHRAE took a great step in 2020 by introducing the latest standard security layer (TCP, TLS 1.3) as an option in the BACnet protocol stack. In support of that, in February 2021, BACnet International launched an online interoperability test environment where suppliers wanting to adopt BACnet Secure Connect (BACnet/SC) can test their data integration and interoperability capabilities with other OEM controllers and make sure their BACnet/SC implementation is smooth and hassle-free.

This is a major milestone in bringing the BACnet protocol and its full potential to the IoT and Cloud infrastructure.

Background

Traditionally, building management system controllers, namely DDC controllers (general purpose, equipment specific), were following an MSTP connectivity interface with twisted pair STP/UTP cabling. Multiple DDCs were looped/daisy chained (MSTP loops) and connected to a network controller or supervisory controller, and from there to the Server/BMS software application. So, the presence or requirement of IP ports/Ethernet interface was very limited, only to the supervisory controller and BMS server. Moreover, the BMS server and supervisory controller were not connected to the LAN/WAN/VLAN of the building's IT network. So, the network security requirement or related threats were a rare occurrence with this kind of architecture.

In the past, to deal with cybersecurity requirements, we would disable the USB ports on the BMS server/PC and keep the login password confidential. Additionally, we would put an access control door to the BMS room. Those three steps were sufficient enough to keep the building BMS safe and secure. This may be a little difficult to digest in this IoT and Cloud era, but that was the reality in those times.

It was very difficult educating the facility managers and real estate stakeholders on the need for remote monitoring, remote access of the BMS, alerts and notifications in mobile via SMS, etc. There were not enough use cases to explain the need for building BMS access from a remote location.

As building systems technology evolved and became more connected and digitized, the above 3 steps remained necessary to secure the BAS. But they were not sufficient. As soon as BASs became connected to the IT infrastructure of a building the door was opened to cyberattacks.

Present Scenario

It's not like that now - everything is at your fingertips. For example, the facility manager of a data center who is under Covid-19 quarantine can access his BMS from home and give directions to the team.

Or, sitting at your corporate headquarters during your sustainability budget discussion you can access the energy consumption of all the buildings under the portfolio, which may be in the 100s or 1000s, as well as volumes of energy meter data covering the last 10 years. These can be displayed with visualization tools and you can get the single number KPIs within minutes with the help of cloud hosted cold storage service, time series analytics and business intelligence tools.

Using a Natural Language Processing (NLP) service, you can give the command to change the temperature setpoint, adjust the light lux level, find a meeting room, create an ad hoc dashboard, and more.

This is heterogeneous transformation contributed by diverse elements like:

- Product feature enhancement
- IT and Network infrastructure
- Telecom network influence, like 4G/5G
- Smart phone and related applications presence
- Integration software, APIs, frameworks, gateways
- Cloud hosted services and enterprise solutions
- Data integration, availability and visibility
- Data security and user identity management services
- User/Stakeholder mindset

At the same time, it brings new challenges and risks as well. Instead of only being concerned with the security of a single building, the real estate owner needs to be concerned about cybersecurity for the entire portfolio of buildings. Once a malicious intruder gains access to the enterprise network they have access to everything in that network, not just the building where they entered. The devices on serial buses or IoT-connected devices are now also vulnerable to attacks due to the IP-connected devices that host them. The attack surface is greatly expanded and physical security no longer protects these assets.

An integrated data and application security plan at different levels need to be considered and continuously improved in order to mitigate these cybersecurity threats.

Role of BACnet and ASHRAE in the Cloud Ecosystem*

The cloud service and application providers are providing commendable data security services, data scalability, computation power, AI, ML services, powerful visualizations like digital twin, and also continually improving all their services. And cloud service providers recently introduced a testing and certifying platform for the IoT devices and Edge devices which is managed by their internal certification panel.

This certification includes the number of compliances for hardware, firmware and software components of the IoT devices and security testing, etc. This method helps the cloud solution providers ensure data security at different levels, starting from the on-premises endpoint to cloud services with the help of security certificates, active directory, dynamic keys, blockchain, etc.

The Cloud service providers are also providing a number of services which are part of their SaaS (software as a service) and PaaS (platform as a service) which include, but are not limited to:

- Data sampling, data modeling for getting better insight from sensor data feeds
- Developing and continuously improving rule library with complex computational logics
- Data visualization by utilizing the BIM drawings and providing digital twin services

The cloud solution framework requires the addition of an IoT gateway that is configured

specifically for the immediate application. This requires some duplication of services already provided by the BACnet BAS, and possibly underutilization or completely ignoring services already provided by the BAS. Since this is typically performed by a separate organization these situations are rarely noticed. This approach also tends to lock the building owner into a supplier because to move to another supplier requires the same effort to configure an IoT gateway for the new application provider.

A few examples are:

- Converting the on-premises BACnet data into a messaging format and push/pull via cloud accepted protocols
- Remapping the assets and space relations at the cloud instance/end point which is already done at the on-premises level
- Standardizing the data point nomenclature, units, etc.
- Recreating the control logics at the cloud level

Also, there is another aspect which is going to be more prominent in the cloud solution implementation and that is the management and configuration of APIs. As most of the on-premises building systems now provide the API interface for cloud integration, it gives a lot of flexibility to the cloud installer to customize the data according to the cloud application requirement. At the same time, though, it can lead to non-standardization in the integration layer and vendor dependency.

ASHRAE and BACnet organizations are pioneers in the building automation industry and have a large footprint across the globe with a wider pool of subject matter experts in the panel and working committees. It will be easily possible to define the message layer data format library in the sense of incorporating the semantic data models with the help of BRICK Schema, Project Haystack etc., thereby reducing the need for custom API development (which will lead to non-standardization of data, more clarity available in the above table) and directly exposing the BACnet Secure Connect (BACnet/SC) data to the cloud application.

Feature	BACnet/SC with a standard messaging layer	API/Cloud Protocol Interfacing
Data standardization across the OEMs	**Yes** **applicable to all the BACnet controllers following BACnet/SC standards	**No** There is no standard method followed, depends on the individual project use case requirement
Controller interoperability	**Yes**	**No** The field controller can't play an active role even though it's an IP-based controller
Cloud interoperability	**Yes** as it follows standard libraries	**Yes** with additional development efforts
On-premises IoT gateway/application requirement	**No** ***The BACnet/SC IP based controllers can manage this	**Yes** with additional development and configuration efforts
Field configuration & setup easiness	**Yes** BMS & ELV domain engineers are familiar with BACnet configuration compared to a new protocol/API	**No** Less familiar

Key benefits of having BACnet protocol data at the enterprise/cloud application layer

There are also some key benefits of having BACnet protocol data at the enterprise/cloud application layer rather than going with an API interface/cloud protocols, which are outlined above.

The superior value proposition provided by BACnet is evident in the above table. IoT applications and services are evolving and offer unique value propositions of their own. However, interoperability between cloud-based applications is not one of its characteristics. As the IoT industry matures it will need to adopt many of the founding principles of BACnet to encourage competition, prevent vendor lock-in, encourage innovation, provide adequate security, and enable best of breed solutions. As IoT matures and becomes more standardized, utilizing BACnet and IoT services together provides the building owner the best of both technologies helping them become more efficient and lowering operational costs.

***Disclaimer from author**

Whatever vision and ideas expressed in this section regarding the messaging layer are purely my personal views and it does not represent either my employer or the BACnet organization.

**Once the BACnet/SC with messaging layer incorporates semantic data modeling like BRICK Schema.

***Subject to approval of BACnet protocol cloud acceptance by public cloud providers.

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Anish Krishnamurthy is an IoT, Smart Building Services & Energy Management professional with 13 years of experience in project management, techno commercial consulting, IoT, iBMS system design & commissioning, Energy audits, ELV system integration, PLC-SCADA & automated energy distribution. He worked with various multinational companies and clients from the Building Automation, Physical Security, Energy and ICT domains in multiple countries, including India, UAE, KSA, USA & Chile.

Commissioning and Troubleshooting BACnet Networks Securely Using VPNs

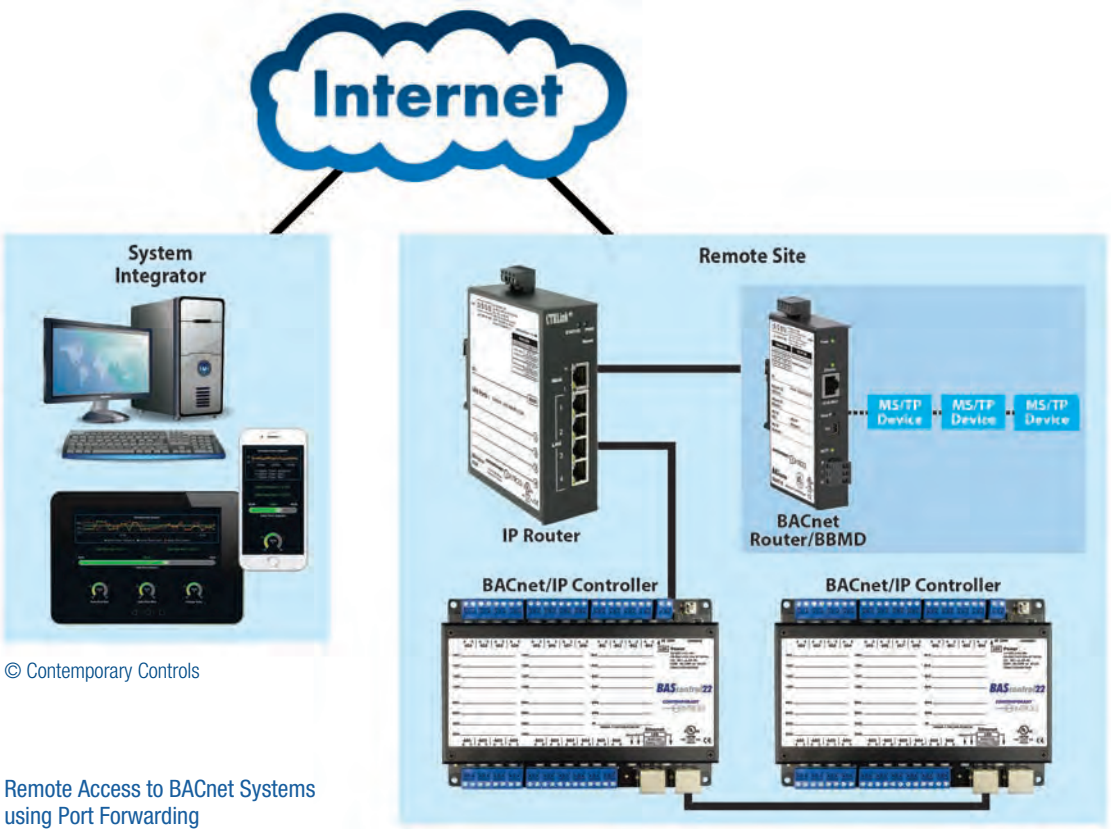
There has always been a need to access systems remotely and securely, either for initial commissioning or for troubleshooting later over its lifetime. The advent of internet has made it possible to access Building Automation Systems from anywhere in the world. The days of an HVAC system being in a silo are long gone. There may be a requirement to just gather the building performance data for energy optimization, or to further change the parameters remotely for optimal operation. While this connection to the internet provides ease of access, it also raises some security concerns regarding unauthorized access and misuse. Fortunately, the world of Building Automation is dominated by the BACnet protocol and its IP version, BACnet/IP, lends itself well to all the enhancements and techniques deployed in the Information Technology (IT) world. This includes the use of IP routing, Firewalls and Virtual Private Networks (VPNs). BACnet Secure Connect (BACnet/SC) communication layer is another example of including the security aspects from the IP protocol, that powers millions of safe credit card transactions every day, into BACnet. The adoption of BACnet/SC will take time and not everyone will replace their working "non BACnet/SC legacy devices", so there is a need to maintain safe and secure access for these legacy devices. Common techniques for remote access involve the use of Port Forwarding through a firewall and the use of VPNs. But the security provided and their ease of setup for BACnet systems varies.

Remote Access to BACnet Systems via Port Forwarding

One current method of accessing devices at remote locations involves setting up Port Forwarding entries in the internet facing firewall/IP router. For BACnet/IP, this involves setting up a port forward entry to a BACnet/IP device, usually a BACnet router, behind the firewall. BACnet communication occurs over UDP ports 0xBAC0 to 0xBACF that are configured by the user. There are many port and IP scanning programs available on the internet for free that can be misused. With the popularity of BACnet, malicious scanning software now also scan for the UDP ports used by BACnet and can provide information regarding Building Automation Systems to bad actors. The use of an Allowlist in an IP router with the list of originating IP addresses allowed to access the system should be used at a minimum. This is not a foolproof method with IP spoofing, and the traffic over the internet is still unencrypted.

Remote Access via Virtual Private Networks

VPNs provide a secure method for accessing BACnet systems for commissioning and troubleshooting. VPNs use the same Transport Layer Security (TLS) standard that is the basis for the new BACnet/SC communication layer. It incorporates the use of security certificates and keys that provide authentication to prevent unauthorized access, data integration to prevent against data tampering, and encryption to safeguard data as it traverses over the open internet. A VPN server and a VPN client form a secure communication channel, or VPN tunnel, that can provide remote access to all kinds of data over the single IP port used for VPN connection. The IP protocol port numbers go up to 65535, can be TCP or UDP, and provide more security for remote communication than the well-known BACnet UDP ports. A client can only succeed in creating a remote connection if it has the client certificate and security key that must be explicitly provided to it.



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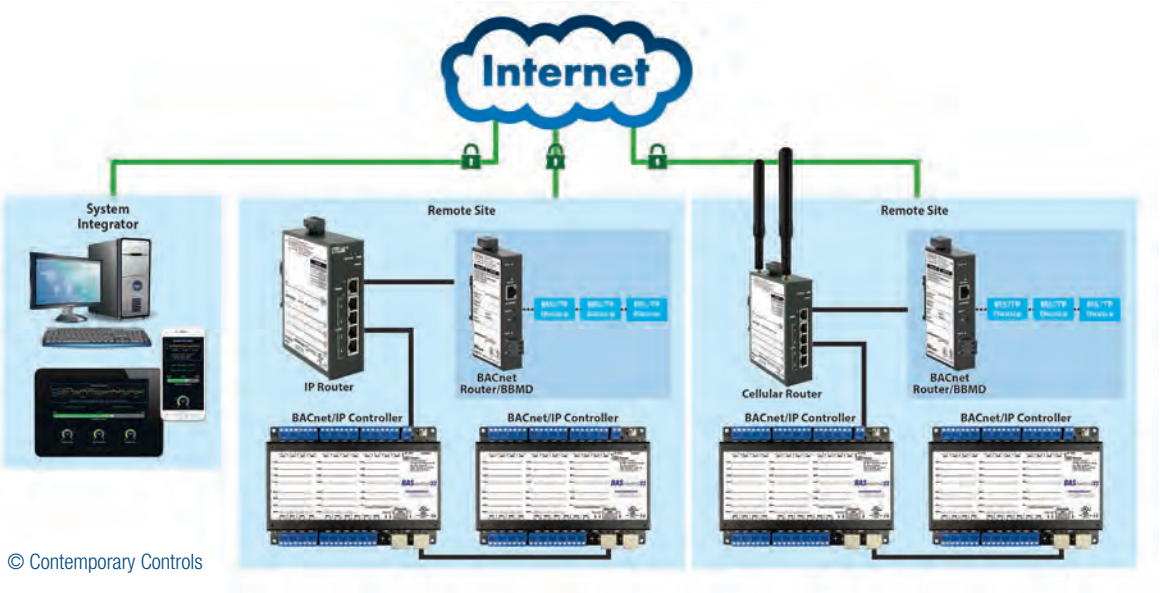
Remote Access to BACnet Systems using Port Forwarding



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Secure Remote Access to BACnet Systems using VPNs

Routing Mode vs Bridge Mode VPNs for BACnet Access

There are two popular methods for VPN – Routing Mode and Bridge Mode that can be used to securely access BACnet systems. With routing mode, the remote site IP address and the VPN address for the client are on separate subnets. This is the same as accessing a BACnet system across an IP router with different subnets where Broadcast messages are blocked. A BACnet Broadcast Management Device (BBMD) is required to relay the messages between the different subnets. With a Bridge Mode VPN, a VPN client device is assigned an IP address from the same pool as the remote site subnet and the VPN connection occurs over Layer 2 of the OSI Model. The bridge allows passing the broadcast messages over the VPN tunnel and there is no need to setup BBMD to discover and communicate with BACnet devices. The user has the same application experience as if they were present at the remote site.

VPNs can be setup between two sites or multiple sites. It can be set up by the IT department for large sites or can be set up by system integrators using IP routers. Furthermore, remote sites benefit from the options of wired or wireless IP routers. Cellular IP routers can be used for locations where wired internet connectivity is not possible or for buildings where the commissioning can be done before the wired internet connection is installed. To introduce secure remote access or to securely connect current BACnet/IP systems across sites, VPNs are needed. BACnet/SC communication layer will introduce inherent secure communication to BACnet/IP systems. BACnet/SC hubs will also allow the connection between multiple sites without the need of VPNs or BBMDs.

Remote Access Method	Data Encrypted	BBMD needed
Port Forwarding	No	Yes
Routed VPN with BACnet/IP	Yes	Yes
Bridge VPN with BACnet/IP	Yes	No
BACnet/SC	Yes	No

Security and ease of setup for BACnet access

Cybersecurity is no longer an option. Every building automation system needs to be designed with security for both the BAS, and the enterprise, considered as a part of the design. Remote access and digitalization technologies provide significant operational benefits and cost savings to both the building owner and their support contractor. But, along with that comes the associated risks. This article has presented multiple ways to mitigate those risks. In the short term, a Bridge VPN provides the best protection with minimum complexity. Longer term, BACnet/SC will become a part of every BACnet product offering.

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Harpartap Parmar is a Senior Product Manager at Contemporary Controls, which designs and manufactures BACnet building controls and networking equipment. Parmar focuses on network security, IP routers and their application to Building Automation. He has more than 20 years of experience at Contemporary Controls developing and testing a range of networking, control, and communication products.

BACnet Streamlines Commissioning HVAC Systems

Setting the Example

A handful of commissioning providers around the country are pioneering a new way of commissioning – automating control system overrides and trend data collection, then letting a computer automatically answer their functional performance questions. Commissioning teams at Epsten Group, CMTA, Mazzetti and SiteLogIQ, are all leveraging the BACnet standard to make this happen.

Traditionally, these tests are conducted alongside the controls contractor, sitting in front of a computer on-site for days, sometimes weeks, at a time, while manually taking notes on how the equipment is operating. A typical testing procedure on 100 terminal units might require more than a thousand control system overrides and answering anywhere from 2,000 to 4,000 functional questions. Now, they let technology handle that time-intensive work, and instead spend more time helping solve problems.

Old Versus New

In the old days, troubleshooting car problems largely involved lifting up the hood. What you heard, felt, saw, and smelled was really all you had to work with. Many HVAC problems can be detected the same way. In fact, most commissioning firms pride themselves on being hands-on with HVAC testing because of this aspect.

Today, however, we largely rely on computers to diagnose car problems. Buildings have evolved the same way. In most large buildings, and many smaller ones, HVAC components work together through a Building Automation System (BAS), a "computer" for the building systems. The Commissioning Provider (CxP), although still on site, will spend days, even weeks, sitting alongside the controls contractor looking at the BAS interface on a computer while they do functional performance testing. Physical activities are still conducted, but a large chunk of activities have shifted to the computer.

BACnet Enables Automatic Commissioning

Almost every modern HVAC control system is designed with BACnet as its primary communications protocol. The maturity of this ecosystem has resulted in more consistent applications and interoperability between machines, which is great for all stakeholders. Given this evolution, commissioning providers can now perform functional performance testing in a new way, automating much of the workload traditionally done alongside the controls contractor through the manual approach. The prevalence of BACnet makes this process repeatable and reliable.

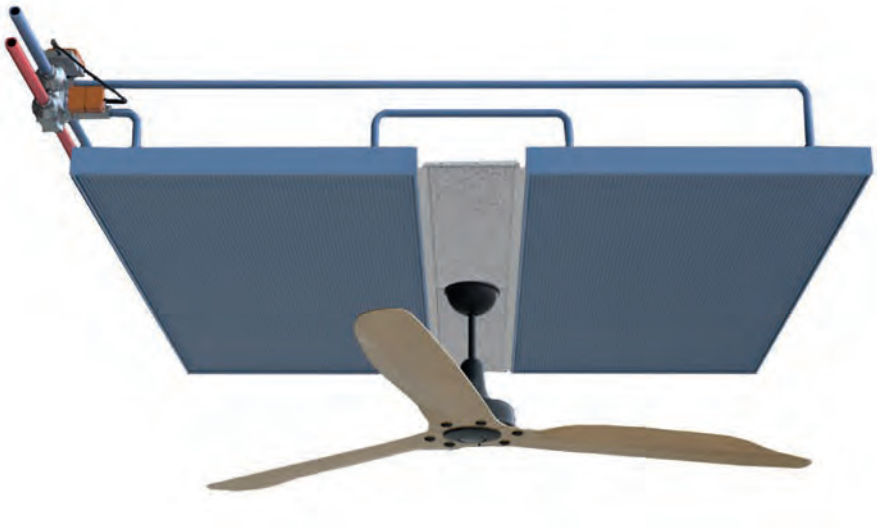
This new automated approach looks very similar to the traditional approach, but takes a fraction of the time and effort, which translates to cost savings. Normally you would ask the controls engineer to override setpoints to force various modes of operation. Now instead, these setpoints can be overridden automatically through a coded script. Normally you would then observe the BAS graphics to see if the systems responded appropriately. Now instead, a computer watches on your behalf and records what it sees.

Examples of Success

At the new ASHRAE Headquarters in Atlanta, for example, the Epsten Group successfully automated testing on 75 radiant heating and cooling systems through a connection to an Automated Logic control system. At a major university in North Carolina, CMTA is connecting to a control system installed by Schneider Electric to automate testing on nearly 150 VAV terminal units. Outside of Minneapolis, MN, SiteLogIQ is automating testing on VAV air handlers, and their associated terminal units, throughout an entire K-12 school district. At a new hospital wing at University of Pittsburgh Medical Center's Hamot location, Mazzetti automated the testing on multiple floors of VAV terminal units, through a Honeywell control system.

Regardless of the system brand, BACnet was the critical element that enabled automated commissioning for each of these projects.

What BACnet Enables © OTTO



Radiant panel system in WebCTRL® BAS at ASHRAE HQ. Image courtesy of Automated Logic Corporation

What Might I be Missing?

What if the BAS tells you something happened but it didn't really happen in real life, physically? Sure, bad data can obscure results. Commissioning involves many steps to mitigate against this already, including requirements around start-up checklists, pre-functional checklists, point-to-point verification, and Test-and-Balance work, all of which remain as physical activities.

When it comes to BAS data itself, though, heat-balance and flow-balance equations can help paint a pretty good picture of what is going on. Although a signal sent to open a heating valve doesn't prove that the valve actually opened up, a corresponding change in discharge air temperature does. Although a 0% damper signal may not really mean the damper is closed, a corresponding airflow reading close to zero backs it up.

With traditional functional performance testing (FPT) conducted alongside the controls contractor while sitting at a computer, these same equations are going through the CxP's head while observing equipment performance. Now, using a machine to perform these calculations on their behalf makes things much easier (and arguably more repeatable and reliable).

How it Works

With BACnet as a foundational building block, machine to machine communication becomes easy, repeatable and reliable. Through proper networking, the communication can even be conducted remotely.

Once a machine is connected to the BACnet controls network, various setpoints can be overridden to force systems into various modes of operation that need to be tested. While this is going on, the machine collects trends from all the relevant data points on the network.

Based on the collected data, software is then able to automatically answer "functional questions" such as, "After the terminal unit went into heating mode, did the discharge temperature raise above 85°F within 15 minutes?"; or "What was the space temperature rise over 60 minutes of full cooling?"; or for testing a morning warm-up sequence, "How many zones were within setpoint once scheduled occupancy began?"

Closing Thoughts

For any commissioning effort, multiple professionals end up spending a significant amount of time executing and observing functional performance tests through manual manipulation of the BAS on-site. BACnet based control systems now enable much of this activity to be conducted automatically and remotely. Now more time can be spent solving problems. As Darren Draper, PE, CxA (Principal and Director of Commissioning, Epsten Group) puts it, "We can now spend more time troubleshooting and less time box-checking. We can even test 100% of terminal units for the same cost we normally apply to sampling just 30% of the units."

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ABOUT THE AUTHOR

Derek McGarry, PE, LEED AP has been working in the built environment for over 20 years, spanning roles as energy analyst, mechanical engineer, energy manager, commissioning provider and technology enthusiast. He has spent the past 7 years focused on the development of Commissioning technology that shortens the amount of time required to extract the greatest value from BAS systems and data. McGarry has served on the local Boards of ASHRAE and USGBC. He graduated from Cornell University with a degree in Mechanical Engineering and is a registered Professional Engineer.

Building Automation in India: Building Connectivity

INBAC Association was founded on December 16, 2019 as a non-profit organization driving a community of various stakeholders involved in the building automation domain in India. Its mission is to drive standardization within the building automation industry by creating awareness of various building automation technologies and open communication protocols which meet the critical needs of the buildings market in India.

INBAC facilitates the successful use of open standards and protocols in building automation and control systems through standardization, interoperability testing, events, seminars, training programs and promotional activities on a global platform.

One of the main focuses of INBAC is to structure collaborations between various stakeholders in the major growth segments to enhance the following drivers:

- Energy optimization
- Occupant safety
- Occupant comfort
- Pollution control
- Attracting foreign Investments

INBAC held its first webinar in October 2020 which included an esteemed panel of stakeholders representing important sectors of the building automation arena, over 200 participants, and a lively question and answer session. There was a great deal of discussion covering the evolution of building automation in India right up to global standards and the global collaborations happening now. To view the panel discussion, visit www.inbac.org/news-events.

Membership in INBAC is now available and open to manufacturers, system integrators, consulting engineers, end users, independent software vendors, and anyone with a passion for open systems protocols.

By joining INBAC, you can participate in a nation building techno social movement, become part of the strategy council and influence the building automation market in India, be a partner in the association, join the technical Core Working Groups to drive the market, and explore global collaborations.

For more information on INBAC and membership in the association, visit www.inbac.org or contact info@inbac.org.

ABOUT THE AUTHOR

Mrs. Chandrayan is a social entrepreneur, helping businesses tap into the potential of collaborative development through technology driven community. She has product, business and customer experience focused on enterprise-scale software for sustainable building solutions. She is engaged in the techno-social movement in India by bringing together visionary industry leaders to create an ecosystem for sustainable growth and interdependence by driving open standards and protocols.

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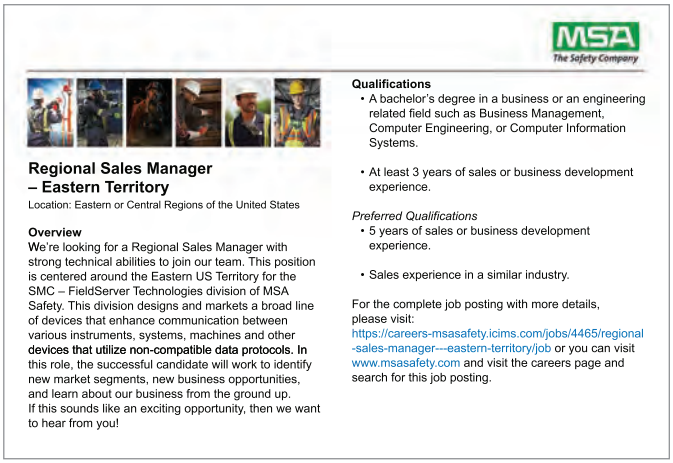

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MBS GmbH: BACeye now available for BACnet/SC

The tried-and-tested network diagnostics software has been upgraded with BACnet Secure Connect

BACeye, the cross-manufacturer de-facto standard is now available for BACnet Secure Connect (BACnet/SC). The customer-favorite "Swiss army knife" for commissioning, maintenance, diagnostics and repairs for building automation networks has been upgraded to the current Revision 22 of the BACnet standard. "This makes our innovative tool perfect for use in networks based on the BACnet/SC security infrastructure," explains Nils-Gunnar Fritz, Managing Director of MBS GmbH in Krefeld.

Document and compare system states with snapshots

BACeye/SC combines the features of the tried-and-tested BACeye 2.0 tool with the full range of functions of BACnet/SC – including access restriction, authentication, authorisation and encryption. It can be used in protected communication environments and allows for encrypted browsing. However, browsers can still be used in traditional systems that communicate with any topology that is supported by the hardware. It is also possible to display BACnet Port Object for a full visualisation with all properties in the interface.

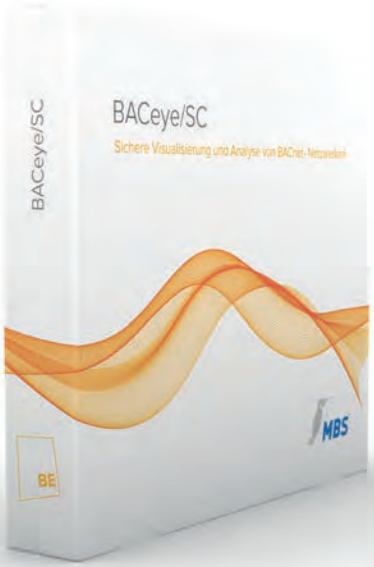
What's more, it makes the work of system integrators, commissioning technicians, operators and end users much easier. Users can snapshot, export and read the system status. This allows users to compare the snapshot of the status taken during commissioning with the current system status during a fault. This significantly accelerates the troubleshooting process to make it easier for all involved.

The right tool at the right time

"Considering standard requirements such as the federal KRITIS guideline introduced by the German government, building automation systems will increasingly make use of encrypted communication," predicts Fritz. Manufacturers are now introducing more related devices based on BACnet/SC to the market. To display these networks clearly and be able to monitor them, BACeye/SC is a must-have tool.

For users, BACeye has long been a brand-related term for all things problem-solving in BACnet networks. Thanks to the upgrade to Revision 22, BACeye/SC will also play a leading role on the market, Fritz expects. Some customers are already using the tool in their systems. Their needs and suggestions have, as always with MBS products, been worked into the development of the software.

BACeye/SC is now available. As with previous software, a free version is available without read or write operations (such as the snapshot function). For paid versions, MBS offers its customers a fair deal. Users that have purchased BACeye 2.0 in the last six months will only pay the price difference between the old and new version for the upgrade. Customers that have owned BACeye 2.0 for more than six months will only pay half of the licence costs for BACeye/SC.



BACeye/SC – secure visualization and analysis of BACnet networks.

About MBS

MBS has been an innovator in industrial and building automation for over 30 years, delivering state-of-the-art hard and software and assisting our customers in solving their technical needs.

Our gateway product platform offers our customers and partners extraordinary versatility and flexibility to adapt to changing requirements – an advantage that leads to especially low total costs. MBS also offers full service, tailor-made software and hardware development, OEM products, consulting, training and support as well as on-site commissioning.

MBS has been an active partner in the associations relevant to our business for many years – both nationally and internationally. These include BACnet Interest Group Europe (since 1999), BACnet International, OCF (Open Connectivity Foundation) and Thread Group. We work hard on many different industry standards and help to actively shape the future of traditional industrial and building automation and the Internet of Things.

As a manufacturer, we offer you comprehensive expertise and a wide selection of products that meet all your requirements – made in Germany. For more information, please visit
www.mbs-software.de

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BACeye fit for BACnet/SC

The tried-and-tested network diagnostics software has been upgraded with BACnet Secure Connect

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With the upgrade to the BACnet standard Revision 22, BACeye/SC combines these features with the full range of functions of the BACnet/SC security infrastructure - such as access restriction, authentication, authorisation and encryption. It can be used in protected communication environments and allows for encrypted browsing. However, browsers can still be used in traditional systems that communicate with any topology that is supported by the hardware.

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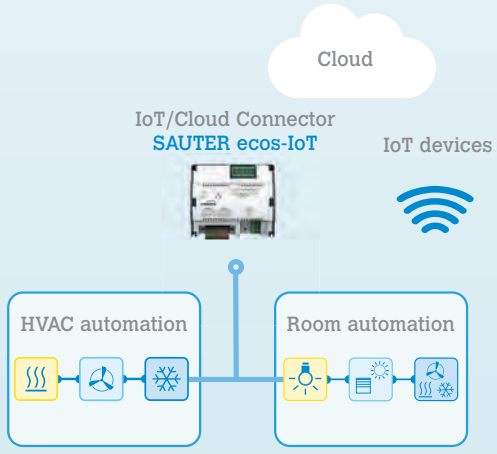
- Part of the SAUTER modulo system family
- BACnet/IP Building Controller, B-BC profile
- MQTT client (Pub/Sub) and broker

Enabling building IoT

- Integration of cloud data and services into building and room automation
- Efficient data exchange between BACnet and IoT devices
- Two integrated interfaces RS485/SLC bus for remote I/O
- On-board commissioning web server

Examples of application

- Remote control and monitoring of building/room automation
- Integration of intelligent sensors into the network
- Voice control of lighting, temperature, ventilation etc. via Google Home or Amazon Alexa
- Subscription to cloud data and services, i.e. weather data
- Publication of building automation data for performance analysis to the cloud



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Playground for a Holistic Building Automation

Intelligent building management means going beyond classic building automation to meet user demands for networking and comfort

Within the field of building automation, many isolated solutions for very specific tasks exist. Commonly, each new function calls into play a new system with new interfaces and controls. Thus, each function on its own might be practical, but keeping track of the entirety is very complex. Within the development and presentation area "Smart Spaces", SAUTER shows the practical benefit of a system that unites all building functions under a single standard. On the fifth floor of SAUTER Germany's head office in Freiburg, customers can test the interconnected building and room automation in practice.

Module-based system for customized solutions

The "Smart Spaces" are designed as a typical office floor – including corridors, toilets, cafeteria, technical rooms and a staircase. The use cases shown range from demand-led room maintenance and asset tracking to indoor navigation. Individual scenarios can be simulated under realistic conditions.

SAUTER consistently relies on BTL certified solutions in building automation, room automation and the management level. The following systems, among others, are used in the "Smart Spaces":

- modulo 6 automation stations are designed for the challenges of IoT. They provide unequalled performance in terms of data points, memory space and processing speed and speak the languages of smart spaces. The modular automation station and web server, modu680-AS, has been BTL-certified in accordance with the BACnet Standard Revision 1.16.
- SAUTER ecos room automation stations with the B-BC BACnet profile guarantee both seamless integration in the building management system via BACnet/IP and in the automation system of the HVAC plants. This scalable solution provides maximum flexibility with minimum use of energy.
- SAUTER Vision Center, the HTML5-standard, web-based management and operating level allows plants to be operated and visualised using standard web browsers, regardless of location or system. It's the first BACnet client to meet the requirements of a revision 18-compliant Cross-Domain Advanced Operator Workstation (B-XAWS profile).

Customers only pick and choose the features they really need. SAUTER fashions them into a concept that can be implemented shortly after and supplies all necessary components such as controllers, sensors, mobile user apps and management and operating software. Facilities from external providers can be integrated on request.

Flexibility for future developments

As all components are connected, they are able to intercommunicate – even across different systems. This creates flexibility for completely new functions as well as the adaption of the system to new developments that might shape our increasingly smart future world.

Headquarters of SAUTER Deutschland in Freiburg i. Br.

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Diagnostic Switch Aids BACnet Troubleshooting

Many building automation systems utilize BACnet/IP as the backbone for their intranet. Although one benefit of an Ethernet based network is that messages are only directed to ports that are party to the communication, that feature can make network debugging difficult. The Skorpion Diagnostic Switch simplifies BACnet troubleshooting by allowing all messages to be observed.

The Skorpion Diagnostic Switch retains all the features of an unmanaged switch such as auto-negotiation and auto-MDIX except for one significant feature – it does not learn. Because it does not update its database of source MAC addresses and switch port pairings, the Skorpion Diagnostic Switch continues to flood all ports with messages as if they were broadcast messages. This allows protocol tools such as Wireshark® to capture any network traffic that goes through the switch regardless of the port location of the traffic with simple plug-n-play operation. Being able to view all the communication packets helps the user determine why BACnet devices are not responding properly.

Using the Diagnostic Switch for Compliance Testing

The Skorpion Diagnostic Switch is a popular way to test compliance and interoperability, especially when testing between vendors at BACnet PlugFests. The ability to capture traffic and look at the bits and bytes of BACnet traffic is an important aspect to achieve compliance. The Skorpion Diagnostic Switch allows manufacturers to verify that their products can communicate among compliant equipment.

BACnet uses both broadcast messages and directed messages as part of the communication between devices. The broadcast messages are flooded while the directed messages are only directed to the ports on the Ethernet switch where the device is located. An Ethernet Hub that passes traffic received from one port to all the other ports can be used but they are not readily available anymore. A managed switch offers port mirroring functionality that can be configured to mirror or duplicate the traffic, but it adds additional cost.

Instead of installing a managed switch with port-mirroring, the Skorpion Diagnostic Switch is often used at PlugFests, along with a sniffer tool like Wireshark to analyze BACnet messages sent over Ethernet. The Diagnostic Switch allows all participants at the PlugFests to connect at the data rate of their equipment with no concern for other participants' data rate. With the Skorpion Diagnostic Switch and a protocol tool, issues can be found in the development phase rather than in the field.

Using the Diagnostic Switch for an Easily Accessible Test Point

If you need an easily accessible test port, instead of installing a managed switch with port-mirroring in each equipment room, install a diagnostic switch in each control panel that has an Ethernet connected BACnet Building Controller. Just about all the traffic you would be interested in is going to be related to the building controller.

The diagnostic switch is ideally inserted between the building controller and the IP network. If the building controller is located at the end of a single Ethernet drop, the diagnostic switch will act as a three-port active tap with one connection to the building controller, one connection to the IP network and one connection reserved for a protocol tool such as Wireshark running on a laptop. In fact, with this setup you gain two additional spare ports. It is not necessary to leave the laptop connected, just connect it when you need to perform protocol analysis or device configuration. The diagnostic switch is always active in the network but will not reduce any communications throughput other than the normal latency of a store-and-forward Ethernet switch.

If the building controller is located mid-span of the IP network with a backbone connection coming into the control panel and exiting the control panel, use the diagnostic switch for all connections leaving two spare connections – one for the laptop and one additional spare. You can also use the spare port for connection to another control panel.

The Skorpion Diagnostic Switch can be permanently installed on an installation or replaced with a regular Skorpion switch once a system is commissioned. This device can also be useful when developing BACnet/IP devices because you can connect the Skorpion Diagnostic Switch between two BACnet/IP devices and view their messages using Wireshark.

The Skorpion Diagnostic Switch can be used for control panel installations where one needs the ability to diagnose problems in the field. It can also be used in a development environment when debugging code. A metal DIN-rail clip attached to the aluminum enclosure can survive the toughest installation. A writable side label allows the installer an opportunity to document field cabling locations right on the unit.

Contemporary Controls
info@ccontrols.com | www.ccontrols.com

Utilize Industrial Devices in Building Automation

There is a wide variety of equipment that has been developed for the industrial market, but which finds good use in the building automation market. The challenge then is how to integrate the industrial equipment into the building automation network. One of the oldest and still widely used industrial communication protocols is Modbus. There are literally thousands of different models of equipment with Modbus communication capability. Control Solutions' Babel Buster gateways offer an efficient and cost effective way of interfacing these Modbus devices to a BACnet network.

The Babel Buster BB3-7101 BACnet IP to Modbus Gateway provides a BACnet IP client and server, Modbus TCP client and server, and Modbus RTU port configurable to be client or server. Most often used to connect Modbus devices to a BACnet IP network, the BB3-7101 is configured via simple web page templates to automatically read and write Modbus registers in one or more Modbus devices, making that data accessible as BACnet objects on the BACnet IP network.

The roles can be reversed. The BB3-7101 includes a BACnet IP client which allows BACnet IP devices to be accessible from Modbus TCP or RTU. You configure the device instance, object type and instance, and poll interval for reading or writing BACnet objects. The object data is stored in the BB3-7101 server for subsequent retrieval by the remote Modbus client. The same polling schemesthat apply to Modbus also apply to remote BACnet IP servers polled by the BB3-7101's BACnet IP client.

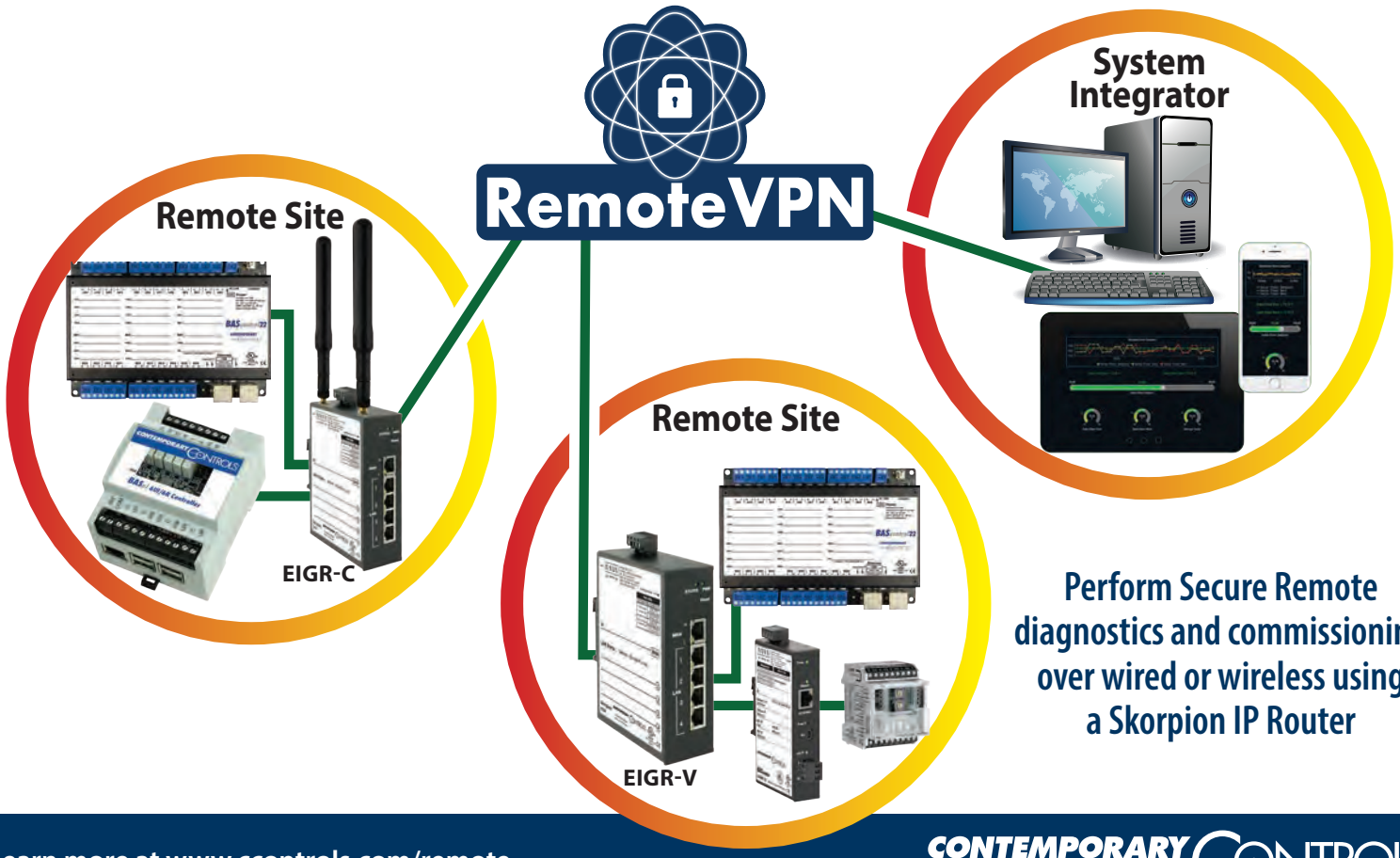
It is common to see a number of status bits packed into a single Modbus holding register. The BB3-7101 supports "unpacking" these registers into multiple Binary objects in BACnet. This process may be reversed. The BB3-7101 can gather up multiple BACnet Binary objects and pack them into a single Modbus holding register to be written to a Modbus device.

The BACnet Value object is most synonymous with the Modbus holding register. It can be used for reading or writing data, or both. BACnet Value objects are useful for maintaining setpoints in a Modbus device. The Value object will read the present setting in the Modbus device. When BACnet wants to change the value, it will write to the Value object. When the same Value object is mapped for both reading and writing in the BB3-7101, these actions will be interlocked such that new data is never overwritten by old data that was in the process of being read. Writes to Modbus can be set up as periodic, but for the setpoint type of application, they should be configured to write only when a change in value occurs.

Control Solutions' Babel Buster BB3-7101 incorporates all of the flexibility needed to interface virtually any Modbus device found into a BACnet IP network. Many BACnet systems do have the ability to also communicate directly with Modbus devices; however, the cost of running a parallel network may often exceed the relatively low cost of a gateway. The BB3-7101 provides a cost effective solution for bringing Modbus devices into the BACnet network. Visit www.csimn.com for more information about this gateway.

Control Solutions Minnesota, Inc.
sales@csimn.com | www.csimn.com

Remote Diagnostics and Commissioning



Perform Secure Remote diagnostics and commissioning over wired or wireless using a Skorpion IP Router

Learn more at www.ccontrols.com/remote

CONTEMPORARY CONTROLS

Modbus to BACnet Gateway

Babel Buster BB3-7101

Easily integrate industrial Modbus devices into your BACnet IP building automation network!

- BACnet IP client & server, BBMD
- Modbus RTU & TCP client & server
- Faster, higher capacity
- Up to 5,000 BACnet objects
- Secure built-in web UI
- Built-in configuration import
- No extra software required
- FCC/CE UL 916 Listed
- BTL Certified
- Low cost, high value

Visit us at www.csimn.com

CONTROL SOLUTIONS MINNESOTA

Comprehensive Controls Solution: Office Park 4

A full building management system for the state-of-the-art Office Park 4 at Vienna Airport via a single source – Johnson Controls keeps track of everything, from basic control functions like temperature and shading to the selection of the optimal energy source.

The newly built Office Park 4 at Vienna Airport comprises 20,000 m² of office space, an additional 2,700 m² of flexible co-working areas and event areas with capacity for up to 400 guests. General contractor Swietelsky AG relied on the expertise of Johnson Controls Austria GmbH & Co OG for the regulation and building management technology of the impressive area.

The operator has paid special attention to the building's energy efficiency. A geothermal system, in conjunction with a heat pump system, provides approximately 530 MWh of heat output for ceiling heating and cooling on the office and conference floors. "Using the latest controllers from the CGM family, Johnson Controls ensures smooth operations while selecting the optimal energy source," said Walter Neuberg, Head of Project Management at Johnson Controls Vienna. "Be it the combination of geothermal energy and heat pumps, or if necessary, supporting via exchangers for the district cooling or heating supply of the airport."

To meet the demand for autonomous control of the individual rooms, Johnson Controls cooperated with LOYTEC electronics GmbH. The latest L-ROC room controllers and their associated room control units from the L-STAT generation were installed to enable a host of features: optimal temperature control, monitoring of all windows and checking of all cooling ceilings for condensation, shading using SMI technology, and DALI constant light control in conjunction with the latest generation of LDALI-MS2 multi-sensors.

Also integrated into the Johnson Controls world is the monitoring and control of all fire dampers as well as the complete control of the complex pressurized ventilation and smoke exhaust systems. In combination with the fire controlsystem "Ringbus", compliance with the regulations according to ÖN F3001 is guaranteed.

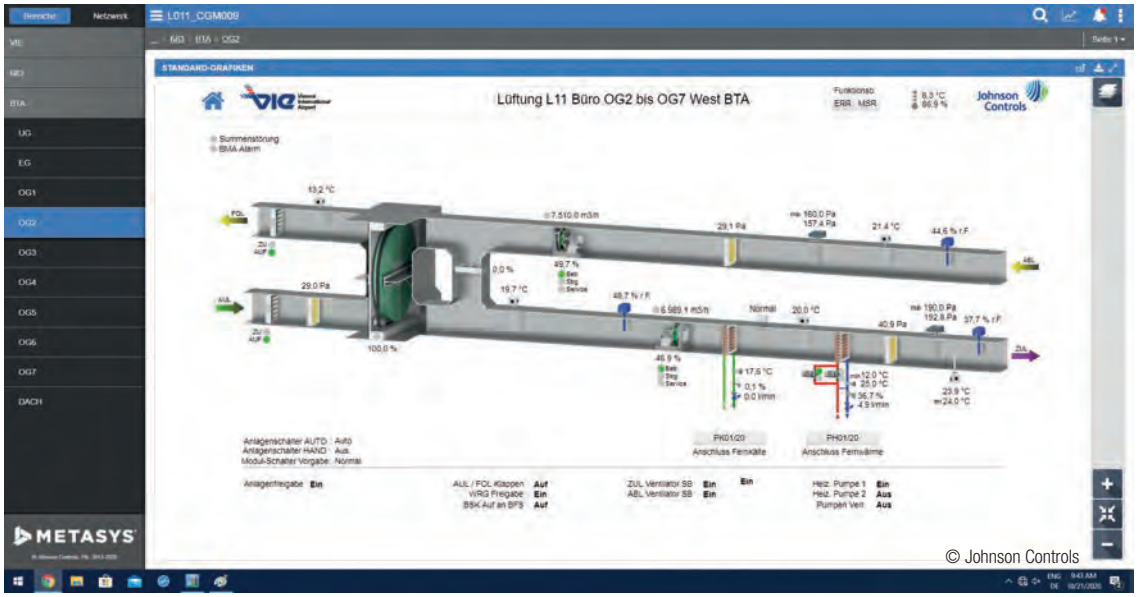
"Together with the complex TGA control centers, a total of 16,000 data points are networked and processed by software," said Walter Neuberg.

This is achieved with Johnson Controls products from the NAE/CGM world of automation. The relevant data points are brought together using the BACnet/IP standard. On one hand, this enables smooth communication between the Johnson Controls components and, on the other, visualization of the room conditions at the airport's user interface.

As a special highlight, Johnson Controls is using its latest product Metasys UI 10.1 for this project. Its state-of-the-art web-based visualization, effective alarm management and informative Trend Viewer support the operator in daily building management.

Modern offices near the terminal at Vienna Airport.

© Vienna Airport AG



Visualisation of ventilation system: An example of one of the numerous ventilation systems, displayed in the building management system.

The integration of the 16,000 data points of Office Park 4 with common communication protocols such as MBUS, ModBus, SMI, DALI, etc. into the airport building control system, realized with the help of the higher-level server JCI ADX and its 120,000 data points, rounds off this successful and impressive project.

Johnson Controls
walter.neuberg@jci.com | www.johnsoncontrols.at

Intesis®
BY HMS NETWORKS

— INTESIS LAUNCHES A NEW UNIVERSAL IR INTERFACE TO INTEGRATE ANY AIR CONDITIONING BRAND IN BACNET INSTALLATIONS —

- Compatible with any AC unit provided with an infrared remote controller.
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ASHRAE BACnet

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NEW POL Panasonic SAMSUNG SAMUI SANYO TCL TOSHIBA Vaillant YORK Zamil

Intesis expands its catalog of BACnet solutions to continue being the system integrators preferred one-stop-shop

Find out more at: https://www.intesis.com

Availability: May 1st 2021

Towards a Smart Commercial Building – Cube Berlin

The cube berlin is currently probably the most intelligent office building in Europe. © Kieback&Peter

After almost three years of construction, the cube berlin was opened in February 2020. Kieback&Peter made a significant contribution to the fully digitalized office building.

The central building services system is directly networked with the individual room and device controls and has interfaces to the Internet of Things (IoT). To achieve this, numerous protocols – M-Bus, Modbus, BACnet® MS/TP, SMI, EnOcean and LON® – had to be integrated and the data transferred via BACnet/IP.

Optimum adaptation to the needs of the users

Hardware and software from Kieback&Peter create an intelligent building management system (BMS) which, in conjunction with the central software (the so-called brain) adapts optimally to the needs of cube berlin users. Thus, the building automation system always knows which parts of the building are occupied by people and controls the room temperature accordingly.

In addition, a Neutrino BMS was installed, which accesses the 16 subnets via BACnet Broadcast Management Devices (BBMD) using BACnet/IP. The "brain" works independently from the BMS and can access all BACnet data points. In the open area of the cube the optimum room temperature is calculated from an average value, which is based on the desired temperature set by the users via an app. The room temperature and the blind position can always be set manually on the approx. 260 EnOcean room operating units installed.

Weather station sends data to controller

A total of 950 blinds are connected to provide optimal lighting conditions or the necessary shading. This is enabled by a weather station integrated in the building control system. The weather station is linked via BACnet/IP with a total of 57 DDC4040e and 184 Warema BAline controllers in the building. Sunlight entering through the windows provides heat in the room, which is desired or undesired depending on the room temperature. In unoccupied rooms, the thermo-automatic system takes control of the sun protection to support heating or cooling processes. In this way, overheating can be avoided in summer and in winter the heating can be relieved by solar gains. The current position of the sun is determined via the azimuth and elevation angle, determining the optimum lamella angle of the blinds. From a certain level of ambient brightness, the blinds are automatically lowered to the calculated angle on the façade side as glare protection. The approximately fifty 6-way valves per floor allow individual control of the heating and cooling ceilings via BACnet MS/TP. The room air conditioning systems are integrated via the DDC4040e controllers.

Vision becomes reality

"Our contribution to the cube berlin shows that digitalization in building automation and the idea of a smart building is no longer a vision, but reality," says René Tiffe, Project Manager Berlin-Brandenburg branch at Kieback&Peter. "This modern office complex combines comfort, security and the efficient use of resources. Kieback&Peter stands for exactly these values – for over 90 years."

Kieback&Peter

Kieback&Peter GmbH & Co. KG
info@kieback-peter.de | www.kieback-peter.de

BTL CERTIFICATION

Your Best Path to BACnet Interoperability

If you are involved with building controls and automation, rely on the BTL Certification program to make sure the products you buy have been rigorously tested for compliance to the BACnet standard. BACnet is the world's standard for building interoperable solutions but it only works when products are correctly implemented. When you buy products that are not correctly implemented it can cost you a lot in terms of system integration time and money.

The BTL Certification program is operated by the BACnet Testing Laboratories (BTL), which is overseen by BACnet International. BTL was established more than 15 years ago to lead compliance testing and host interoperability events. To achieve certification, BACnet products must successfully undergo rigorous industry-standard testing conducted by recognized, independent testing organizations.

Users can identify tested products through the BTL Listing Service which is available to users globally at no cost. The service supports searching for specific products as well as browsing through products with different capabilities. In addition, the listing service provides detailed information on the specific tested capabilities of each product.

Accelerate your system integration and avoid unnecessary integration costs. Require all BACnet products in your system be fully tested. Ensure every product displays the BTL Mark or is verified through the BTL Listing Service.

There are over 1100 products in the BTL Listing Service with more being added every month. **Find tested products to fit your needs at www.bacnetlabs.org.**

BACnet Testing Laboratories
bacnetlabs.org
btl-manager@bacnetinternational.org
+1-770-971-6003

New to the BACnet International Family

Member of BACnet International

BACnet International is the global organization that encourages the successful application of BACnet through interoperability testing, educational programs and promotional activities. BACnet International complements the work of other BACnet-related groups whose charters limit their commercial activities.

BACnet International community membership includes a who's who list of top tier companies and industry professionals involved in the design, manufacture, installation, commission and maintenance of control and other equipment that use BACnet for communication.

We are proud to welcome the following new members to BACnet International.

New Gold

NETIX CONTROLS

Netix Global B.V.
Netix is a IoT and AI based advanced building automation systems provider. Their products and solutions include BAS/BMS, metering and energy savings, enterprise security and smart city integration.

Beechavenue 113
M9RB Schipol-Rijk
The Netherlands

New Gold

성한 Sung Han

SungHan
SungHan was founded in 2002 and is the first company start-up by KISTI. It provides automatic control of facilities through the prediction of heating and cooling loads and leads the control of sound pressure in many major bacterial facilities.

2nd Floor Hosan Building 495-4,
Gung-dong, Yuseong-gu,
Daejeon, 305-335
Republic of Korea

New Silver

DELTA DORE
Smart homes, better living

Delta Dore
Delta Dore has been controlling comfort and energy for almost 40 years. They specialize in products and services that enable private individuals and professionals to improve their living conditions in homes and buildings, and optimize their energy consumption.

Immeuble Atrium
19 boulevard
Paul Vaillant Couturier
F-94200 Ivry-Sur-Seine
France

New Silver

CEWE INSTRUMENT
a Secure brand

Secure Meters (Sweden) AB
Secure Meters (Sweden) AB is a part of the Secure group and has been in the business of energy measurement for over 60 years, with markets in over 50 countries. Their mission has always been to maximize customer benefit through price, product performance, timely delivery and customer support.

Repslagaregatan 43, Box 1006
Nykoping, Sweden SE-611 32
Sweden

New Silver

tekmar Control Systems Ltd.

tekmar Control Systems, a Watts Water Technologies Company, is a world class integrated engineering and manufacturing company, located in Vernon BC, that provides solutions for the heating, ventilating, and air conditioning industry. Over the past 25 years, tekmar has earned a reputation as a leader in complete control solutions for hydronic radiant floor and baseboard heating systems, multi-stage boilers plants, and automatic snow melting systems.

5100 Silver Star Road
Vernon BC V1B 3K4
Canada

New Silver

Triacta Power Solutions

Triacta Power Solutions designs and manufactures revenue-grade electrical submeters for tenant billing and energy management applications. Long known for its high-reliability, precise, multi-protocol submetering products, Triacta's meters have been easily and successfully deployed by submetering companies, property owners, building system integrators, and local distribution companies since 2003.

130 Industrial Avenue, Unit 100
Carleton Place ON
K7C 3T2
Canada

NEW Corporate Affiliate

OJ Electronics A/S

For more than half a century OJ Electronics has been designing and developing electronic controls for underfloor heating and HVAC controls and drives. Their focus is on developing and manufacturing products with high quality, functionality, reliability, design and intuitive operation. Based in Sønderborg, Denmark, their products are available through distributors worldwide.

Stenager 13B
6400 Sønderborg
Denmark

THE BACnet INSTITUTE
Education • Library • Community

Since its launch in January 2017, TBI has realized almost 5,000 registered users across more than 80 countries worldwide.

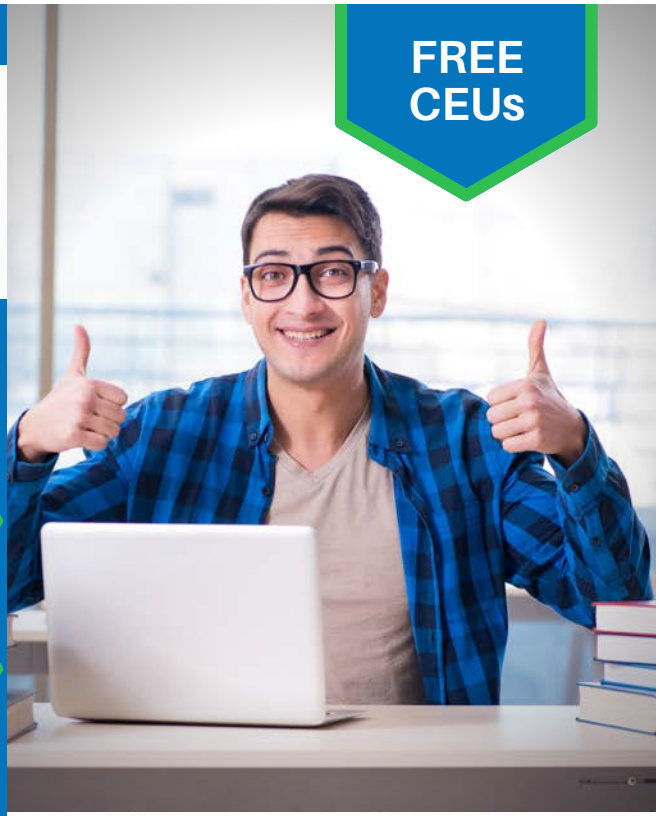
The Library now holds over 140 articles and presentations that accommodate various experience levels and languages.

The on-demand, self-paced courses provide interactive learning experiences for individuals at all levels. FREE CEUs and PDHs are granted with each course.

BACnet Basics
The Facility Manager's Guide to Building Automation Systems
BACnet Device Profiles

A knowledge-sharing community allows peers with various levels of BACnet involvement to learn best practices and procedures from BACnet experts.

If you haven't visited The BACnet Institute recently, you definitely should!



Simply visit
www.thebacnetinstitute.org,
sign up, and be prepared to learn!

BTL Testing Updates and BACnet/SC Remote Interoperability Testing

BTL Testing and New Test Package

A BTL Certification indicates that the BACnet Stack of the product has successfully passed rigorous industry standard testing and demonstrates that the device correctly implements all of the BACnet functionality it contains as governed by ASHRAE standard 135.1. The BTL Listing, the BTL Certificate of Conformance, and the right to use the BTL Mark are the three elements that indicate a product has passed the testing and achieved BTL Certification.

The BTL Working Group defines the BTL Test Plan and governs the testing. The BTL Test Package and BTL Testing Policies are published on the BTL website: www.bacnetlabs.org/test_documentation.

Transition Period for BTL Test Package Ends

Test Package 18.0 was published on the BTL website in October 2020. With this release of the BTL Test Package, test coverage was extended to include most functionality contained in Protocol Revision 18, along with some functionality from later Protocol Revisions (BACnet Secure Connect).

This Transition Period ended February 1, 2021.

BTL Test Package 18.1 Published

As part of the normal process, vendors and testing organizations provided BTL Working Group with needed updates during the Transition Period. These updates were implemented in the form of Errata and Addenda to Test Package 18.0 to create Test Package 18.1.

BTL Test Package 18.1 is the current test package. All products entering testing at any of the four Recognized BACnet Testing Organizations (RBTO) will use Test Package 18.1 for BTL Testing.

© Hayes

Emily Hayes
BTL Manager, Certifications and
Listings Manager and BTL Working Group Chair
btl-manager@bacnetinternational.org | www.bacnetinternational.org

BACnet/SC Remote Interoperability Testing & Interoperability Acceleration Program

BRITE Announced

BACnet International announced the launch of BRITE (BACnet Remote Interoperability Test Environment) in February 2021. BRITE provides a confidential, supplier-independent environment for remote interoperability testing of BACnet devices. The focus of BRITE is BACnet Secure Connect (BACnet/SC) product interoperability testing, and it utilizes BACnet/SC to achieve secure connections over the Internet.

BRITE is built around a collection of cloud based BACnet/SC hubs along with interoperability support and diagnostic tools. Test sessions typically involve two suppliers and are arranged through BTL. Each session is private, only allowing access to the specific suppliers participating in that test session.

Suppliers can now enroll in the program, register their devices, and schedule and attend live test sessions. BRITE is free for BACnet International corporate members throughout 2021.

For more information, and to enroll in BRITE, visit www.bacnetinternational.org/brite.

BRITE should not be confused with BTL Testing for BTL Certification.

New Reference Stack

Participants in the BACnet/SC Interoperability Acceleration Program were provided with a new release of the Reference Stack (BSCref Beta 3.1) in March 2021.

For more information on the BACnet Secure Connect Interoperability Acceleration Program visit www.bacnetinternational.org/secureconnect.

ABOUT THE AUTHOR

Emily Hayes began work with BACnet International in 2014 as BTL-Coordinator, coordinating BTL Testing at the BTL Lab. In 2017, Emily took over leadership of the BTL Working Group as chair. Additionally, she led the transition from the BTL Listing Program to the BTL Certification Program. She became BTL Manager in January 2019.

Emily maintains professional membership in the Project Management Institute (PMI), North Carolina Chapter of PMI (NCPMI), and Institute of Electrical and Electronics Engineers IEEE.

Emily has a BEE from Auburn University and an MSEE from Duke University. She has maintained a Project Management Professional (PMP) Certification since 2010.

NEW BTL-LISTED PRODUCTS, August 2020 – August 2021

Manufacturer	Product Name	Model
ABB	Programmable Logic Controller AC500 V3	PM5630-2ETH, PM5650-2ETH, PM5675-2ETH, PM5670-2ETH
Bosch Rexroth AG	XM	21, 22, 42
Control Solutions, Inc.	Babel Buster	BB3-7101
Crestron Electronics, Inc.	Crestron 4-Series Control System	AV4, CP4, CP4-R, CP4N, DIN-AP4, MC4, MC4-I, MC4-R, MC4-R-I, PRO4, RMC4, ZUM-HUB4
Cylon Auto-Matrix	CB Series	CBXi-8R8(-H)
Cylon Auto-Matrix	FLXeon	FBXi-X256, FBVi-2U4-4T
Dent Instruments	Powerscout 3HD	PS3HD
Distech Controls, Inc.	ECB-103	ECB-103
Distech Controls, Inc.	ECB-203 Series	ECB-203, ECB-253
Douglas Lighting Controls	WLC-4150. Dialog Lighting Control Unit	WLC-4150
Honeywell International	Programmable Enhanced BACnet IP Controller	PEC8445-PB1-SM, PEC8445-PB1-SO, PEC8445-FB1-SM, PEC8445-FB1-SO
Honeywell International	BACnet MSTP Compact VAV Controller	WEB-VA423B24N, CLMEVA423B24N, CPO-VA423B24N
Honeywell International	BACnet MSTP IRM NX FCU Controller	CLMERL4N, CLMERL6N, CLMERL8N, CLMERS4N, CLMERS5N, CPO-RL4N, CPO-RL5N, CPO-RL6N, CPO-RL8N, CPO-RS3N, CPO-RS4N, CPO-RS5N, AL-RL4N, AL-RL6N, AL-RL8N, AL-RS4N, AL-RS5N, WEB-RL6N, WEB-RS5N
Honeywell International	CIPer30	WEB-C3036EPUBNH, WEB-C3036EPVBNH
Kieback&Peter GmbH & Co. KG	Neutrino GLT	Version 9
Meitav-Tec Ltd.	Configurable Terminal Unit Controller with BACnet Communication	CTU2500-x1-x2-x3-x4, CTU2501-x1-x2-x3-x4, CTU2524-x1-x2-x3-x4, CTU2601-x1-x2-x3-x4, CTU2646-x1-x2-x3-x4, CTU2701-x1-x2-x3-x4 where x1 is 3, 3S, AC, C1, C2, C3, FC, CP, H1, H3, IRD, P, P2, PM2, WS, null x2 is 01, 1S, 3S, ABILITY, ECM, FC, H1, H2, H3, H4, HP, IRD, SUPER, null x3 is 01, 02, 24, AHU, DIM, EC, FA, FC, HCP, HU, MGD, ST1, SUPER, T4, TRAFO, TVA, VAV, null x4 is VFS, BT, HU, PE, 110V, WET, 24VAC, OUT12, FAN, 190988, DIM, F, 115V, 24V, IN, GES, null
SDATAWAY SA	EASY3	EASY3-9-N-B-I
Shina System Co. Ltd	Remote Extension I/O Module	RXM-300W
Siemens	DESIGO PXC4 and PXC5 Automation Station	PXC5.E003, PXC4.M16, PXC4.E16
Vacon	VACON 100	All models VACON 100 INDUSTRIAL, VACON 100 FLOW, VACON 100 X

Calendar of BACnet International Events

2021	Event	Location
April 29, 2021	BTL Working Group Meeting	Teleconference
May 13, 2021	BTL Working Group Meeting	Teleconference
May 27, 2021	BTL Working Group Meeting	Teleconference
June 10, 2021	BTL Working Group Meeting	Teleconference
June 24, 2021	BTL Working Group Meeting	Teleconference
July 8, 2021	BTL Working Group Meeting	Teleconference
July 22, 2021	BTL Working Group Meeting	Teleconference
August 5, 2021	BTL Working Group Meeting	Teleconference
August 19, 2021	BTL Working Group Meeting	Teleconference
September 2, 2021	BTL Working Group Meeting	Teleconference
September 16, 2021	BTL Working Group Meeting	Teleconference
October 4, 2021	BTL Working Group Meeting	Teleconference
October 5 – 7, 2021	PlugFest Interoperability Workshop	Durham, NH
October 14, 2021	BTL Working Group Meeting	Teleconference
October 27 – 29, 2021	LIGHTFAIR	New York, NY
October 28, 2021	BTL Working Group Meeting	Teleconference

Subject to change. For more information, contact David Nardone, BACnet International, david@bacnetinternational.org or visit www.bacnetinternational.org

BACnet International Journal 19

The BACnet International Journal is a global magazine for building automation based on BACnet technology. Experts, practitioners and professionals show the way in applying and developing the BACnet standard – from building automation trends to devices and application projects; from qualification and training to testing and certification; from who's who in the BACnet community to useful information on events and publications. Special attention is given to members and activities of BACnet International.

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BACnet International

Continually Raising Building Standards

BACnet International is an industry association that facilitates the successful use of the BACnet protocol in building automation and control systems through interoperability testing, educational programs and promotional activities.

ASHRAE BACnet™

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