

JOURNAL OF BUILDING AUTOMATION

Special Edition: BACnet Celebrates 30 Years as a Standard



Issue
28

BACnet: 30 Years Building
a Smarter Future

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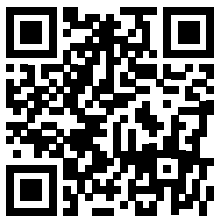
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Letter from the President

Dear Members (and future Members) of the BACnet Community,

As we celebrate the publication of this special BACnet 30th Anniversary edition of the Journal, it is a moment not just for reflection, but also for reaffirming the strategic purpose that gave rise to the BACnet protocol three decades ago.

In the late 1980s, facility managers were burdened with systems that were incompatible and proprietary, creating operational silos that increased costs and restricted innovation. It was this challenge that inspired the creation of the ASHRAE Standard Project Committee 135P in 1987. Driven by the vision and passion of the late H. Michael Newman, the Committee spent eight years developing the first release of BACnet and, in 1995, gave the world an open, interoperable solution for building automation.

After its ratification as an ISO Standard in 2003, adoption accelerated to the point where it is now the global standard, specified in more than 75 % of commercial building automation projects worldwide. BACnet's success was not accidental. It was built on the foundational work of the original ASHRAE committee and the hundreds of volunteers who have followed in their footsteps. With equal focus on forward progress and backward compatibility, the committee has ensured the standard continues to meet the needs of building owners and operators. Another key factor in BACnet's success has been the community-wide commitment to interoperability, safeguarded by the rigorous standards of BTL Certification. As demonstrated in the pages of this journal, particularly in the article "Why BACnet Certification Matters", this assurance process is essential for reducing integration risk and protecting users' capital investments.

The longevity of any technical standard is bounded by its ability to evolve. The BACnet community has maintained a commitment to continuous evolution, resulting in 30 protocol revisions over 30 years. These revisions have

enhanced and extended the BACnet protocol through updates ranging from BACnet/IP and IPv6 support to extending functionality for lighting control, energy metering, elevators, and other building subsystems. This issue's article, "Think BACnet is just for HVAC? Think Again!", highlights how BACnet's broad functionality is being applied. In addition, recent BACnet revisions have addressed the increasing need for digital resilience by introducing BACnet Secure Connect (BACnet/SC). The technical effort required to achieve these specification extensions and enhancements while maintaining backward compatibility is clear in the article, "Guide to the Network Port Object".

BACnet has reshaped the building automation industry, but it's been equally important in driving enhanced sustainability. With buildings accounting for approximately 40 % of global energy use, our ability to connect disparate systems is critical for energy reduction and decarbonization. BACnet enables the optimized, cross-system control necessary for enhanced energy efficiency, sophisticated ESG reporting, and active participation in utility Demand Response programs.

Thirty years is a good time to reflect, but it is no time to stop. As much as BACnet's origin and evolution have been dynamic and impactful, there is still much to do. Technology continues to evolve, and at each technological transition, there is a natural push to return to proprietary solutions. The ongoing role of BACnet is to pull those new technologies into the standard to ensure users and suppliers can leverage them in an open, interoperable environment.

To all the architects, engineers, developers, integrators, technicians, and building owners who rely on and contribute to BACnet, thank you. We are not just maintaining a standard; we are continuously building the essential digital infrastructure for a safer, smarter, and greener future. 



Andy McMillan President, BACnet International

ABOUT THE AUTHOR

Andy McMillan is President and Managing Director of BACnet International, where he works with users and suppliers to expand and enhance the BACnet community. Previously he served as President of a building automation and energy management business unit of Philips Lighting.

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Think BACnet is just for HVAC? Think Again!



The “Building Automation and Control Network” (BACnet) is a communications protocol. It was developed in 1987 under the direction of the International Society of Heating, Refrigeration and Air-Conditioning Professionals (ASHRAE). BACnet is a standard data communication protocol to provide interoperability between building automation devices that has been an ANSI standard since 1995 and ISO standard since 2003.

BACnet is traditionally known for HVAC and lighting control in traditional verticals such as commercial real estate, education, and healthcare. Today BACnet is expanding into a spectrum of more complex installations. From data centers and laboratories to large scale growth farming systems, BACnet is proving to be a versatile and indispensable protocol for smart building automation. BACnet enables these more complex installations with communication, intelligence, resilience and sustainability.

In Data center environments where rack densities can exceed 50kW, BACnet can serve as the communication backbone for integrating HVAC, lighting, Power Monitoring and Data Center Infrastructure Management (DCIM) systems.

BACnet's object-oriented data model (e.g., Analog Input, Binary Value, Schedule objects) enables structured data exchange to enable predictive and adaptive operations in the following areas:

- Predictive Cooling: Anticipates cooling needs based on workload forecasts, reducing energy waste and operational costs.
- Thermal Mapping: Supports real-time monitoring and control of thermal conditions, optimizing airflow and identifying hotspots.
- Energy Optimization: Facilitates sustainability by reducing environmental footprint and improving system reliability.
- Interoperability: Ensures seamless integration across multi-vendor systems, essential for complex data center ecosystems.

Many labs, especially research labs operate under zero-tolerance conditions for environmental deviation. Other types of labs have stringent regulatory requirements. Temperature, humidity, pressure cascades, and air change rates must be maintained with surgical precision. Slight deviations can compromise experiments or violate compliance standards. BACnet can provide

integration of the following lab sub-systems with very fast response times for control and critical alarms:

- Fume hoods (VAV control, sash position monitoring)
- HEPA filtration and UV sterilization systems
- Differential pressure sensors across zones
- Refrigeration units for sample storage (-80°C freezers)

Implementing BACnet in lab environments can provide the following capabilities:

- Real-Time Data Access to enable electronic audit timestamps
- Fault Detection & Diagnostics (FDD) to provide early detection of sensor drift or filter clogging
- Compliance Logging enabling digital signatures to meet requirements of FDA 21 CFR Part 11 or EU GMP Annex 11

Large scale vertical farming systems, sometimes called GigaFarms, produce hundreds of tons of leafy greens annually in controlled, soil-less environments. These facilities require the integration of multiple subsystems into a single cybersecure-physical system. BACnet can be the protocol used to integrate these subsystems to help deliver sustainable and efficient food production. In a GigaFarm, BACnet can be the protocol to connect the following:

- LED grow lights (spectrum, intensity, photoperiod control)
- HVAC (temperature, humidity, CO₂ enrichment)

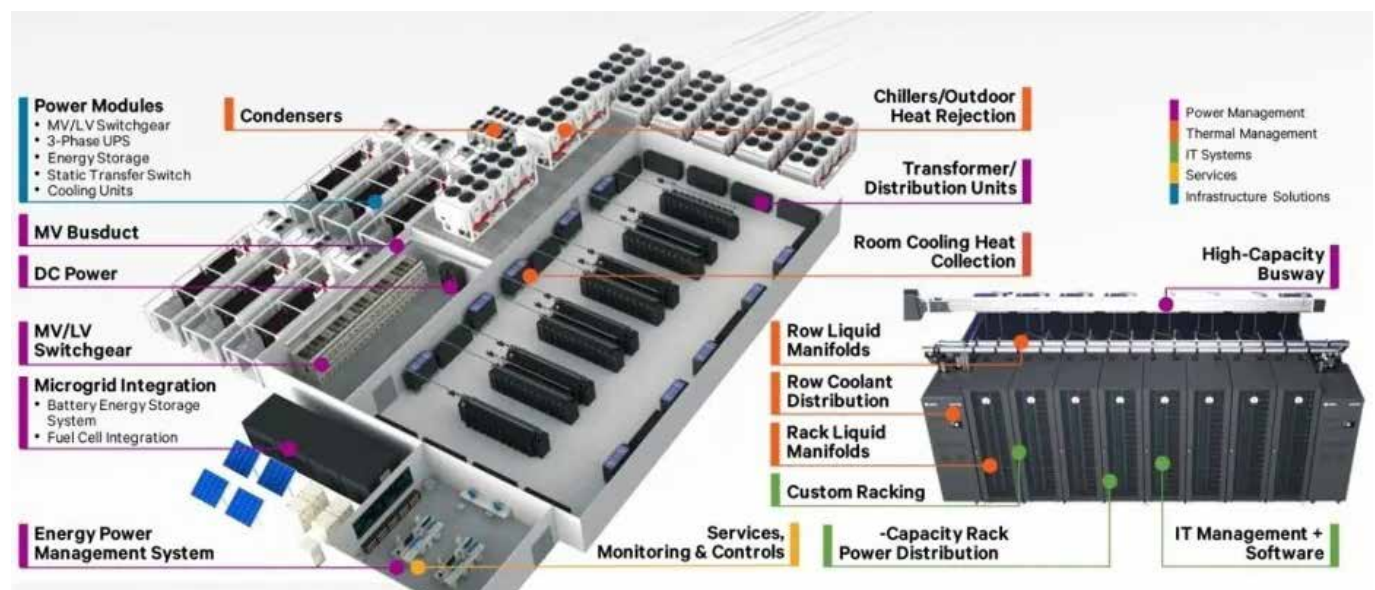




Illustration 2: Once implemented, FDA 21 CFR Part 11 and EU Annex 11 can both lead to enhanced productivity.

- Hydroponic pumps and nutrient dosing systems
- Waste-to-value loops (anaerobic digesters, water reclamation)

BACnet Secure Connect (BACnet/SC) can provide secure, encrypted communication as many times the GigaFarms are remotely monitored. BACnet.

BACnet is scalable and BACnet-enabled optimization provides GigaFarms the following sustainability enhancements:

Climate Control – Reduce HVAC energy with CO₂ and humidity setpoints

Lighting – Cut electricity use over static lighting with dynamic spectrum tuning based on crop growth stage

Nutrient Delivery – Minimize fertilizer waste using closed-loop feedback trend data from pH/EC sensors

Waste-to-Value – Convert waste into biogas and fertilizer by triggering digester feed pumps when organic slurry levels rise

In these complex environments, BACnet provides three very important benefits:

- Interoperability – Future-proof integration of multi-vendor systems
- Scalability – From 100 to 100,000+ data points without protocol bottlenecks
- Resilience – Peer-to-peer communication, Change of Value (COV) subscriptions, and secure failover

In addition, BACnet's open standard enables owners/users to adopt emerging technologies like digital twins, edge AI, and zero-trust-security without ripping and replacing existing infrastructure.

As mission-critical and unconventional environments continue to raise the bar for efficiency, safety, and sustainability, BACnet has become the automation protocol of choice. More than just a communication standard, BACnet functions as the digital backbone of resilient, next-generation operations. Whether it's preventing costly downtime in a data center, preserving life-saving research in a BSL-4 laboratory, or powering food production in massive vertical farms, BACnet operates quietly behind the scenes, ensuring that complex systems perform in harmony. The future of smart infrastructure isn't locked into proprietary silos. It's implementing the open and built for scale BACnet protocol.



ABOUT THE AUTHOR

Ken Gilbert is a Solutions Consultant for Automated Logic. In this role, Ken works with specifying consulting engineers and ALC factory-authorized dealers with industry trends as well as “what is new”, and developing project solutions including specifications, sequences of operations, points lists, and flow diagrams.

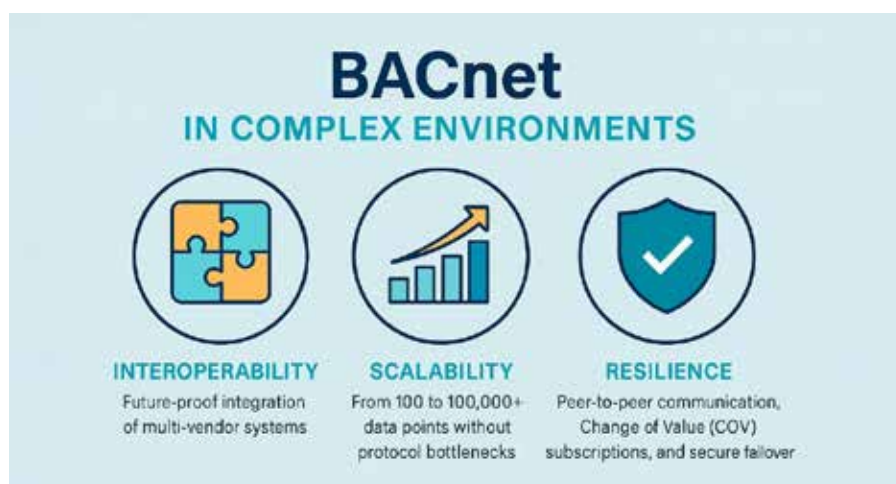
Ken brings significant industry experience to ALC, having served in various sales, engineering, and consultative roles. Ken graduated from the Georgia Institute of Technology with a Bachelor of Science in Industrial Management and completed his MBA from the University of Georgia in 2023. Ken is a LEED AP actively involved with ASHRAE and BACnet International. Ken, his family, and two dogs reside in the Atlanta area.

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A Protocol for the Planet: Celebrating 30 Years of Building a Smarter Future with BACnet



By Andy McMillan, President, BACnet International

December 2025 marks a profound milestone – the 30th anniversary of the BACnet protocol's publication as an ASHRAE/ANSI standard. Three decades ago, an industry defined by proprietary and fractured communications took a dramatic leap into openness. Today, BACnet is more than a standard; it is the global operating language of intelligent buildings, a platform driving unprecedented energy efficiency, occupant wellness, and technological innovation.

This anniversary is a moment to look back at our improbable origins, celebrate our current role as the global standard, and, most importantly, commit to the next era of smart, sustainable infrastructure that the protocol continues to enable.

The Genesis of Openness: An Origin Story Against All Odds

The 1980s landscape of building control systems was chaotic." Every manufacturer's products spoke a different, proprietary language, locking building owners into single-vendor solutions that were expensive to maintain, impossible to integrate, and quickly obsolete. Interoperability was a dream, and system integration was a costly, bespoke challenge.

BACnet – the Building Automation and Control Network – was just a vision in June 1987 when the ASHRAE Standard Project Committee 135P was formed. Initiated and chaired by the late H. Michael Newman, the "Father of BACnet," this committee was tasked with the seemingly impossible: creating an open, non-proprietary

communication protocol that could allow devices from competing manufacturers – HVAC, lighting, fire safety, and security – to communicate seamlessly.

It was a process fraught with technical challenges and fierce commercial resistance. It took eight years of tireless work, complex negotiations, and a deeply committed consensus process to bring the standard, ANSI/ASHRAE Standard 135, to publication in 1995. This moment was revolutionary. BACnet did not simply offer another communication method; it defined a common object model – a universal way to describe an input, an output, a schedule, or an alarm – that systems could understand, regardless of who made them. This object-oriented approach was the foundation upon which true, cost-effective interoperability was built.

The industry impact was broad and deep. Manufacturers, no longer constrained to building a full, proprietary ecosystem, could specialize, leading to a surge of innovation and a dramatic reduction in system lifecycle costs for building owners.

From Protocol to Global Standard: A Collaborative Journey

From its ANSI/ASHRAE roots, BACnet quickly gained international traction. By 2003, it was ratified as an ISO Standard (ISO 16484-5), cementing its status as a technology that transcended borders. Coupled with the support of BACnet Interest groups in Europe and elsewhere, BACnet rapidly became the preferred solution for building automation solutions and integration of diverse building systems.

Today, BACnet is the global market leader in building automation and control. Evidence of its ubiquity is everywhere:

- **Widespread Adoption:** Market research estimates BACnet is specified in over 75% of building automation projects for new commercial building installations. The number of manufacturers receiving official Vendor IDs has surpassed fifteen hundred, demonstrating the vibrant, diverse ecosystem of products that support the standard.
- **Breadth of Integration:** BACnet has expanded far beyond its original HVAC focus. It now serves as the backbone for sophisticated integration across energy metering, physical access control, lighting, elevators, and other building systems.
- **Infrastructure:** From global corporate headquarters and flagship universities to critical infrastructure like hospitals and data centers, millions of devices worldwide communicate via BACnet.

The key to this exponential growth has been the committed, collaborative community and infrastructure supporting it, including the BACnet Testing Laboratories (BTL). BTL certification ensures that products not only claim to support BACnet but are rigorously tested to ensure they are interoperable, providing an essential layer of assurance and investment protection for every building owner.

The BACnet Mandate: Evolving Without Abandoning

A standard that "stands still" is a standard that



fades into obsolescence. Over the 30 years of BACnet's existence, the technology landscape – from networking speeds to security threats – has changed profoundly. The enduring mandate of the BACnet community, driven by the ASHRAE SSPC 135 committee and supported by organizations like BACnet International, has been to evolve without abandoning its installed base. The commitment to continuously incorporate new technologies and capabilities without losing sight of backward compatibility has been one of the most important commercial features of BACnet.

In reality, BACnet is one standard that has never “stood still”. The standard has been continuously extended and expanded through a transparent, consensus-driven process that has yielded 30 protocol revisions in 30 years, with changes including:

- **Network Modernization:** Initially supporting low-speed serial connections (MS/TP), BACnet rapidly adapted to the IT revolution, defining BACnet/IP and later added support for IP v6 to leverage the high-speed, ubiquitous IT infrastructure.
- **Functional Extension:** The protocol has added objects and services for new building systems like Lighting Control, Advanced Scheduling, Vertical Transport and Energy Metering, allowing for ever more sophisticated and integrated control strategies.
- **Future-Proofing with Security:** In a world of increasing cyber threats, the committee responded with a significant addition: BACnet Secure Connect (BACnet/SC). It added an IT-friendly, secure transport option using modern

encryption (TLS 1.3) and authentication (X.509 certificates). Critically, BACnet/SC is designed to seamlessly integrate with and route to existing BACnet/IP and MS/TP networks. This innovation allows users to introduce state-of-the-art cybersecurity to their networks without forcing a costly, wholesale replacement of their existing networks or controllers.

By moving forward while maintaining backward compatibility, every major revision has protected billions of dollars in user and supplier investments.

Societal and Environmental Impact: BACnet as a Catalyst for Sustainability

The legacy of BACnet is not just technical; it is the profound environmental and societal impact it has enabled. Buildings are massive consumers of energy, responsible for nearly 40% of total energy consumption and a significant portion of global greenhouse gas emissions. BACnet is a fundamental tool in the effort to reduce energy use and its environmental impacts. BACnet has also reshaped the building automation industry by lowering barriers to entry and facilitating industry-wide collaboration.

1. Enhanced Energy Efficiency and

Decarbonization: BACnet's core strength -- the ability to share data across disparate systems -- enables advanced, multi-system control strategies that are impractical in proprietary silos. Solutions built on BACnet's open communications integrate across the functional boundaries of lighting, access control, HVAC, power management and other subsystems to optimize energy, CO₂ and

financial outcomes. In addition, the broad integration capabilities of BACnet enable:

- **Measurement and Verification:** The standard provides robust mechanisms for trending and metering, giving building owners the transparent data needed to measure energy usage, verify savings from retrofits, and meet increasingly stringent ESG (Environmental, Social, and Governance) reporting requirements.
 - **Grid Integration:** BACnet-enabled buildings can participate actively in Demand Response programs, communicating with the energy grid to temporarily reduce load, enhancing grid stability, and utilizing clean, on-site energy sources more effectively.
- 2. Improved Occupant Wellness and Productivity:** The “S” in ESG – Social – is increasingly tied to the indoor environment. BACnet facilitates the creation of truly intelligent spaces that enhance human comfort and productivity.
- **Harmonious Comfort:** By integrating temperature, humidity, CO₂ levels (IAQ), and lighting intensity into a single framework, BACnet systems maintain precise, responsive, and holistic comfort levels, which are proven to boost occupant focus and health.
 - **Safety Integration:** The protocol's role in linking fire, security, and access control systems means that in an emergency, all building services – HVAC (smoke control), lighting, and access – can operate cooperatively based on a common, real-time command, making buildings safer.

The Next 30 Years: An Open Future for Building Automation

As we celebrate 30 years, the commitment of the entire BACnet community, is unwavering: to continue to provide the open, non-proprietary foundation necessary for the next generation of smart buildings.

The challenges of the future – cybersecurity, AI-driven autonomous control, deep energy retrofits, and decarbonization – will be met by building automation enabled by a BACnet standard that is continuously adapting. Ongoing

efforts in the areas of advanced cybersecurity, semantics and data modeling and cloud connections ensure that the protocol will remain the most cost-effective, secure, and future-proof choice for building automation worldwide.

To every developer, installer, system integrator, building owner, and occupant who has contributed to or utilized the open connectivity BACnet provides: Thank you, you have helped to make the world better. We look forward to the next 30 years of building a smarter, greener, and more interconnected world, together. 



ABOUT THE AUTHOR

Andy McMillan is President and Managing Director of BACnet International, where he works with users and suppliers to expand and enhance the BACnet community. Previously he served as President of a building automation and energy management business unit of Philips Lighting.

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Versatile BACnet Edge Controllers with Cloud Connectivity



BACnet/IP and MS/TP compliant Edge Controllers provide easy-to-use and secure cloud connectivity via MQTT over TLS, making them ideal for standalone or BACnet supervised HVAC applications.

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- Graphical Dashboard
- Free Programming Software and N4 Sedona Driver
- Email alarms and notifications
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Why BACnet Certification Matters: Lessons from a Manufacturer's Approach to Interoperable Airflow Measurement

Abstract

In a multi-vendor building automation world, "BACnet" alone isn't enough. Specifiers, integrators, engineers, and owners increasingly insist on BACnet Testing Laboratories (BTL) certification as proof that devices interoperate cleanly and predictably on a BAS. This article explains what BTL certification covers, why it reduces integration risk, and how airflow measurement devices deliver accurate airstream data that supports reliable control across BACnet MS/TP and BACnet/IP networks. We outline practical object/point examples, clarify IP vs. MS/TP trade-offs, and conclude with a call for broader certification across the industry to strengthen the BACnet ecosystem.

Interoperability Built on Standards

Through BACnet, devices from different manufacturers can exchange data and cooperate in control sequences through standard objects, services, and behaviors. The challenge is consistency: two devices may claim "BACnet compatible," yet implement different feature subsets. That's why BTL certification matters: it verifies conformance to the BACnet standard with repeatable tests, issues a Certificate of Conformance, and posts a public BTL Listing for specifiers and integrators to reference. A key takeaway is that BTL certification helps reduce integration risk, shorten commissioning time, and avoid costly "finger-pointing" when multi-vendor networks perform poorly.

Certified devices are listed in the public BTL Listing across various categories. These listings document device profiles (e.g., B-SS, BACnet Smart Sensor) and supported services (BIBBs), such as Read/Write Property and Change of Value (COV), which directly impact BAS performance and bandwidth. For specifiers and integrators, this transparency simplifies design review and commissioning planning. Certified devices, covered by broad protocols, are "drop-in" replacements for most BAS topologies, whether new or retrofitted.

What's Tested and Why

BTL testing validates that devices implement BACnet correctly at the protocol and object/service layers. That includes:

- Device profiles (e.g., B-SS) and BIBBs (e.g., DS-RP-B, DS-RPM-B, DS-WP-B, DS-COV-B)
- Conformance to specific BACnet protocol revisions
- Proper behavior for discovery, binding, and COV reporting (where supported)

For engineers, this translates into predictable discovery, reliable reads/writes, and event-driven updates that minimize traffic.

Practical: BACnet Objects in Certified Devices

Exact points lists vary by model and options; Protocol Implementation Conformance (PIC) statements and object maps across certified

devices document common patterns that designers and integrators can rely on. Examples include:

- Device (object) – identification, instance, location, firmware, etc.
- Analog Input (AI) – Airflow (FPM/CFM), Temperature (°F/°C), and on Relative Humidity equipped models, Humidity (%RH); some models expose calculated Enthalpy and Dew Point via additional AIs.
- Binary Input (BI) – Alarms/Status (e.g., airflow low/high alarm, sensor/system status).
- Change-of-Value (COV) – event-driven updates for key AIs to reduce polling.

These objects can be bound into graphics, logs, and sequences since they are mapped and named according to standardized PIC/OM documentation. In practice, integrators can consult the public BTL listings and manufacturers' PICs during the design review and submittal process.

TABLE 2 - Standard Object Types Supported (GTM116e)

Object	Create Object Service	Delete Object Service	Optional Properties Supported	Writeable Properties	Proprietary Properties	Property Range Restrictions	Special Requirements
Device – GTM116e	No	No	• Description • Location • Active COV Subscriptions	• Object Identifier • Object Name • Description • Location • APDU Timeout	• BBMD Remote Address • BBMD Remote Port • Time To Live • Service Tag	None	
Analog Input 1 – AMD Airflow	No	No	• Description • Reliability • COV Increment	• Units • Out of Service • COV Increment • Present Value	None	Units: FPM, CFM, MPS, LPS	
Analog Input 2 – AMD Temperature	No	No	• Description • Reliability • COV Increment	• Units • Out of Service • COV Increment • Present Value	None	Units: °C or °F	
Analog Input 3 – AMD Pressure	No	No	• Description • Reliability • COV Increment	• Units • Out of Service • COV Increment • Present Value	None	Units: PWG or Pa	-B
Analog Input 4 – AMD Alarm Status	No	No	• Description • Reliability • COV Increment	• Out of Service • Present Value	None	None	
Analog Input 21 – RH	No	No	• Description • Reliability • COV Increment	• Out of Service • COV Increment • Present Value	None		-P w/H
Analog Input 22 – Dew Point	No	No	• Description • Reliability • COV Increment	• Units • Out of Service • COV Increment • Present Value	None	Units: °C or °F	-P w/H
Analog Input 23 – Enthalpy	No	No	• Description • Reliability • COV Increment	• Units • Out of Service • COV Increment • Present Value	None	Units: Btu/lb or kJ/kg	-P w/H
Analog Value 1 – AMD Area	No	No	• Description • Reliability		None	Units: sq ft or sq m	
Analog Value 10 – Traverse Status	No	No	• Description • Reliability	Present Value	None	Only write 0 - 3	
Analog Value 21 – Node 1 Velocity	No	No	• Description • Reliability		None	Units: FPM, MPS	Enabled in AV 10

Difference Between BACnet/IP and BACnet MS/TP

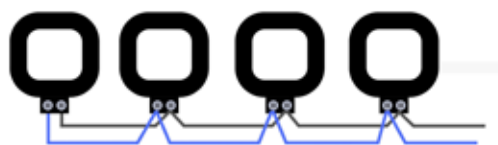
BACnet MS/TP (RS-485)

- Twisted-pair, token-passing field bus; widely used on controllers and sensors.
- Durable cabling delivers dependable long runs and simple system growth.
- Segment planning (node count, baud rate, termination) and good installation practices are critical.

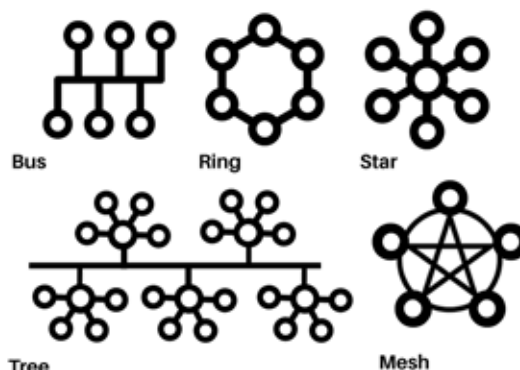
BACnet/IP (Ethernet/IP)

- Runs over standard IT networks (switches, VLANs), supports high throughput, and is easier to integrate with enterprise tools and analytics.
- Scales across buildings/campuses; may require BBMD for broadcast management across subnets.
- Aligns with the market's migration to IP-centric architectures.

BACnet MS/TP (RS-485)



BACnet/IP (Ethernet/IP)



Security note: BACnet/SC (Secure Connect) adds TLS-based encryption and authentication for secure transport; it's increasingly relevant as BAS converges with IT. (Evaluate roadmap/compatibility and security policies in your environment.)

Choose MS/TP when extending existing RS-485 trunks or minimizing network complexity at the edge; choose BACnet/IP when you require faster supervisory updates, easier enterprise integration, or are standardizing on IT infrastructure. EBTRON offers both network connectivity options, so selection can align with the site's overall network strategy.

Certification + Good Objects Improve BAS Sequences

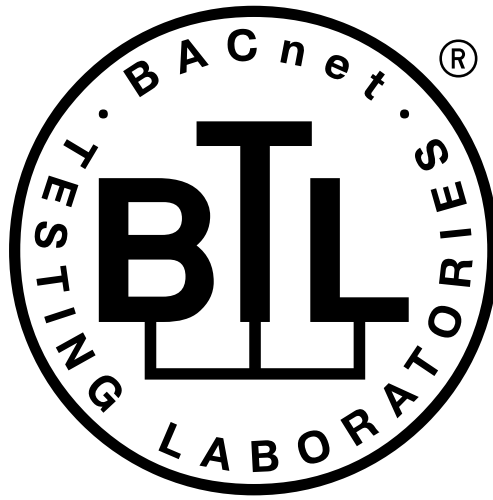
With certified devices and well-chosen objects, integrators can:

- Implement COV-driven outdoor airflow resets without excessive polling, preserving bandwidth on shared trunks.
- Using velocity-weighted temperature, humidity, and airflow measurements to qualify enthalpy for economizer changeover (rather than dry-bulb alone).
- Trend actual airflow at terminals and intakes to validate air change rates, pressurization, and DCV strategies – backed by objects the BAS understands.

Certification Drives Confidence and Future Readiness

When manufacturers pursue BTL certification, the benefits extend across the entire building ecosystem. Designers can specify products with confidence, knowing they meet a recognized interoperability standard. Integrators gain efficiency by commissioning faster and encountering fewer protocol surprises in the field. For owners, certification ensures a resilient, future-ready BAS that scales seamlessly from individual terminals to enterprise systems – and positions their facilities to adopt BACnet/SC security features as roadmaps evolve.

Examples across the BTL listing show that pairing accurate measurement technologies with BTL certification is more than sound engineering – it is a practical path to improved IAQ, enhanced energy outcomes, and more reliable project delivery.



Are you using BACnet products that have achieved **BTL Certification?**

BTL Certification provides users with confidence that a product has passed the industry standard BACnet conformance tests conducted by a recognized, independent testing organization (RBTO). Many building owners and control system designers consider BTL Certification to be a must-have to be eligible for a project. BACnet products that have successfully completed compliance testing are eligible for BTL Certification. **Certified products are listed in the BTL Listing of Tested Products which contains over 1,460 products from over 234 manufacturers.**

Lower Integration Cost

BTL Certified products accelerate and lower the cost of system integration. As such, it is becoming commonplace for specifications to require BTL Certification to be eligible to bid on a project.

Less Integration Risk

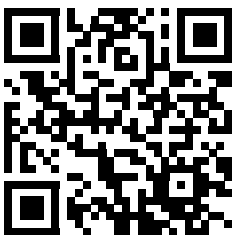
Reliance on BTL Certified products lowers the risk of integration problems and the project delays and cost-overruns. This also provides a solid foundation for future system enhancements and extensions.

Assurance of Independent Compliance Testing

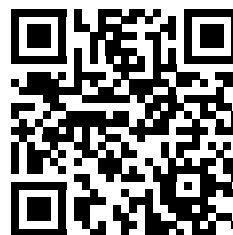
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Converting BAS Devices into Cloud-Connected Assets

In a building automation system (BAS), integrating cloud computing with IoT technologies enables scalable, remote monitoring and control of systems, such as HVAC, lighting, and security. However, systems integrators often face challenges in determining the data transfer method to the cloud and accessing the data once it's resident in the cloud. This article explains how BACnet Edge controllers can leverage proven security protocols, such as SSL/TLS encryption, and open Internet of Things (IoT) messaging protocols, such as MQTT, to enable secure cloud connections to software-as-a-service (SaaS) platforms. With this configuration, users can upload data to the cloud for remote access, dashboard visualization, trend and performance analysis, alarm notifications, and monitoring from any location. Additionally, this connection converts BAS devices which are attached to the controller into cloud-enabled assets, allowing for centralized management and remote supervision across multiple sites.

Today's modern BAS platforms rely on data from the equipment, including devices at the "edge" of the network, to optimize building operations. Cloud connectivity gives facility managers mobile and global access which streamlines system management. "Cloud computing" and "IoT" are common industry terms, but there is still a fair

amount of confusion about their meaning and on-site applications.

Cloud computing is the delivery of computing services over the Internet. Cloud computing services – including storage, networking, databases, virtual machines, and other IT infrastructure – are offered by providers, such as Amazon Web Services (AWS), Microsoft Azure, Google Cloud Platform (GCP), usually for a fee. Cloud services also expand the traditional IT offerings to include Internet of Things (IoT), machine learning (ML), and artificial intelligence (AI).

IoT refers to a network of physical devices that are embedded with sensors, software, and network connectivity. These devices, also known as "smart objects," can collect and share data and automatically make decisions or trigger actions based on the data. IoT protocols enable these smart objects to communicate with each other and with other internet-enabled devices. For a BAS, these IoT devices can consist of thermostats, lighting systems, access control systems, and energy meters.

Large BAS systems often rely on a cloud specialist to configure scripts and settings that enable users to access cloud-pushed data.

For smaller systems, users can incorporate a cloud-connected BACnet controller, such as Contemporary Controls' BASpi-Edge, with a Software-as-a-Service (SaaS) solution, such as Microsoft's Azure IoT central as shown in Figure 1.

The BACnet Edge Controller acts as a smart bridge between a BAS (that uses BACnet protocol) and the cloud. It connects to BACnet devices, such as HVAC systems, lighting controls, sensors (temperature, humidity, occupancy), and access control systems. For devices that do not support BACnet, such as Modbus chillers, boilers, or HVAC units, a gateway can bring them into the BAS, making each device appear as an individual BACnet device. The controller collects data from these devices and pushes it to the SaaS platform.

The controller can also send commands back to the connected devices. The SaaS platform enables users to access and format the data via dashboards, alerts and notifications, historical data analysis, and remote-control capabilities.

The following steps provide a simple overview how a BACnet Edge controller can leverage SSL/TLS encryption and MQTT protocol to transmit and receive data using a SaaS platform.



Figure 1: A Cloud-Connected BACnet Controller Uses SaaS to Exchange Data Over the Internet.

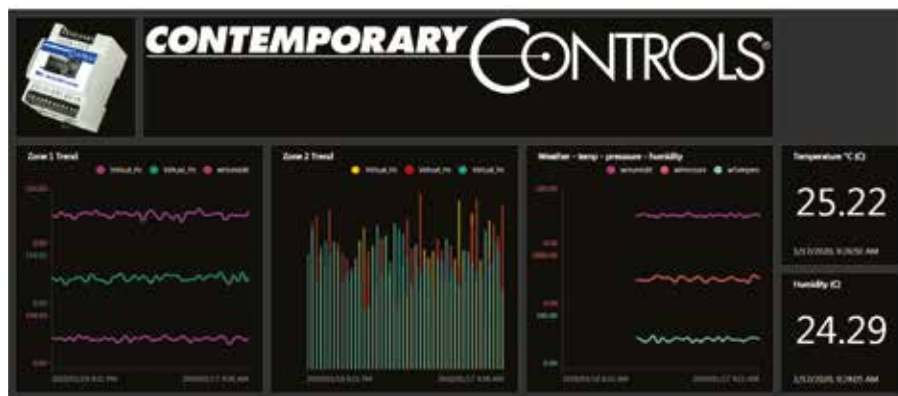


Figure 2: The IoT Central Dashboard displays real-time data from the BACnet controller.

1. Data Acquisition: The controller polls BACnet devices for data, such as temperature, status, energy usage. The controller may filter, normalize, or aggregate data locally to reduce bandwidth and improve efficiency.
2. Secure Communication: The controller uses MQTT messaging that is encrypted using TLS/SSL to ensure secure transmission and connection to the cloud.
3. Outbound Connection: The controller initiates outbound connections to the SaaS platform, which avoids firewall issues and simplifies setup.
4. Cloud Upload: The controller sends data to the SaaS platform, where it's stored, visualized, and analyzed.
5. User Access: Systems integrators or building managers log into the SaaS dashboard via web browser or mobile app to view data, set alerts, or send control commands.
6. Command Execution: If the SaaS sends a command, such as "decrease temperature," the controller receives the command and relays it to the appropriate BACnet device.

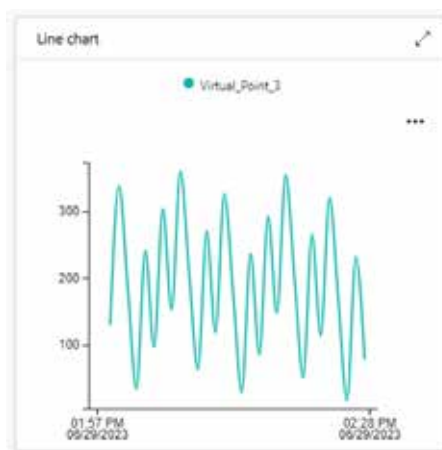


Figure 3: Users can graph controller data, shown here as a one-hour graph.

At Contemporary Controls, we use Azure IoT Central to access cloud data sent from the BASpi-Edge controller. To connect this controller, a "device" must be created in IoT Central (one per controller). This device will have three parameters – ID scope, Device ID, and key – that must be added to the controller's cloud configuration webpage from the IoT Central account.

Once configured with these three parameters and the points to push to the cloud have been selected, the data from the BASpi-Edge will be in the IoT Central "device." The points being pushed to the cloud can be internal BASpi-Edge data, data read from other BACnet devices, or data written to the BASpi-Edge from the BAS.

Next, an IoT Central dashboard must be created for this "device" to view the data Figure 2. The IoT Central dashboard displays the data sent to the IoT Central account by the controller. Users can also view the current value of a point on the BASpi-Edge.

Users can graph data from the BASpi-Edge, showing one hour's worth of data (as shown in Figure 3) or 30 days' worth of data.

Users can also control virtual points in the BASpi-Edge from IoT Central. These virtual points would then be applied to the controller's Sedona wiresheet logic.

With Azure IoT Central, many users can access an account with different permission levels, so that some can only view the data, while others can make setting changes to the IoT Central dashboard. Azure IoT Central provides a collection of services and features, with a lower threshold for setup and configuration, to get started with cloud connectivity. IoT Central does have its limitations, but if those limitations impact a project, the IoT Central features can be expanded for an additional cost.

Integrating a BACnet Edge controller with a SaaS platform offers a secure and efficient framework for modernizing building automation systems. Additional devices with different protocols that include MQTT support can be integrated into the cloud for a more holistic view of the facility. By utilizing trusted security protocols and open IoT messaging standards, this solution enables secure and seamless cloud connectivity, real-time data access, and centralized control. It converts traditional BAS devices into cloud-enabled assets, giving systems integrators and building managers enhanced visibility, remote supervision, and data-driven insights across multiple sites.

ABOUT THE AUTHOR

Harpatap Parmar is a Director of Product Management at Contemporary Controls, which designs and manufactures BACnet building controls and IP networking equipment. Parmar focuses on network security, IP routers and their application to Building Automation. He has over 25 years of experience at Contemporary Controls with a range of networking, control, and communication products.

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Protocols That Power Data Center Integration

The modern data center is an ecosystem of immense complexity. Once viewed as simple repositories for servers and storage, they have evolved into the dynamic core of enterprise operations, powering everything from cloud services and artificial intelligence workloads to global commerce. As this complexity grows, so does the imperative for a holistic management approach. Effective operation is no longer a matter of monitoring isolated systems but of achieving deep, seamless integration across all functional domains. This convergence of Information Technology (IT) and Operational Technology (OT) is the hallmark of the modern Integrated Data Center.

At the heart of this integration lies the communication fabric, a sophisticated network of protocols that enables disparate systems to communicate and cooperate. The equipment that manages the data center environment, from chillers and power distribution units to servers and network switches, originates from different industries and was designed with different objectives. Consequently, these systems speak different languages. A building automation system communicates differently than an IT network switch, and an industrial generator reports its status differently than an Internet of Things (IoT) sensor.

Achieving true data center integration is therefore a multilingual endeavor. It requires a platform capable of interpreting, translating, and correlating information from a diverse

set of protocols. This article explores four foundational communication protocols that form the backbone of data center integration: BACnet, Simple Network Management Protocol (SNMP), Modbus, and Message Queuing Telemetry Transport (MQTT). Understanding the unique role, architecture, and application of each protocol is essential for data center managers, IT leaders, and facilities engineers seeking to build a resilient, efficient, and future-ready infrastructure.

BACnet: The Language of Building Automation

BACnet, which stands for Building Automation and Control Network, is the global standard for building automation systems. Developed under the auspices of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), it is codified as ANSI/ASHRAE Standard 135. Its primary purpose is to provide a standardized method for communication between building automation and control devices from different manufacturers.

Core Architecture and Function

BACnet operates on an object-oriented model. Every piece of information in a BACnet system, from a temperature sensor reading to a fan schedule, is represented as an object. Each object has a set of properties that define its characteristics and status. For example, an Analog Input object representing a temperature sensor would have properties like Present_Value

(the current temperature), Units (e.g., degrees Celsius), and High_Limit. This standardized structure allows any BACnet-compliant device to understand and interact with data from any other device on the network without requiring proprietary drivers or gateways.

Communication can occur through both client-server and peer-to-peer interactions. A central Building Management System (BMS) might act as a client, polling devices for their status, or devices can communicate directly with each other, for instance, a thermostat instructing an air handler to adjust its output.

Application in the Data Center

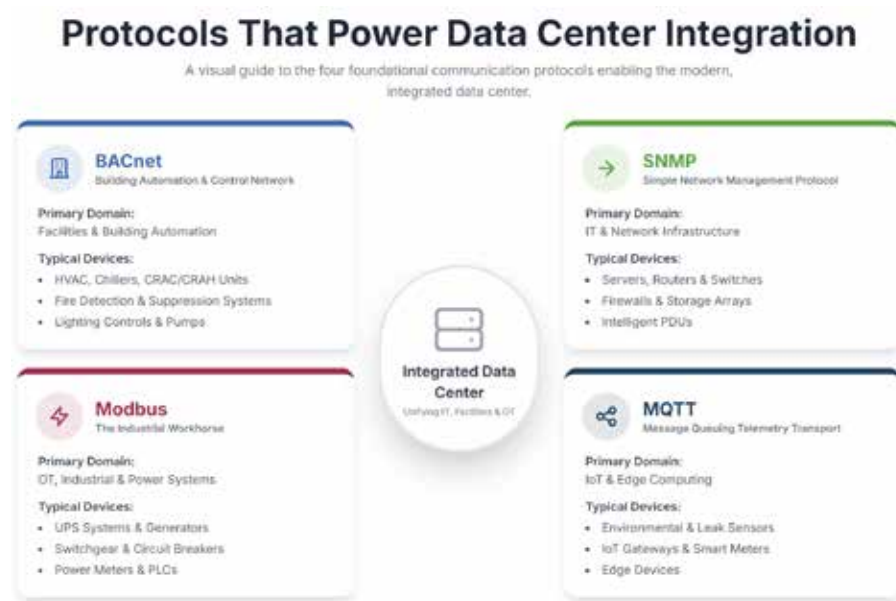
In a data center, maintaining precise environmental conditions is critical for equipment reliability and performance. BACnet is the protocol that enables the integration of the facility's mechanical and electrical infrastructure. This includes:

- Chillers and cooling towers
- Computer Room Air Conditioning (CRAC) and Computer Room Air Handler (CRAH) units
- Lighting control systems
- Fire detection and suppression systems
- Pumps, fans, and variable frequency drives (VFDs)

Through BACnet, a data center integration platform can gain real-time visibility into the health of the cooling plant, monitor temperature and humidity levels in the white space, and automate environmental controls to optimize for both uptime and energy efficiency.

Security Considerations with BACnet/SC

As OT systems become increasingly connected to corporate IT networks, cybersecurity has become a paramount concern. The original BACnet/IP protocol sent data in cleartext, creating a significant vulnerability. To address this, the industry developed BACnet Secure Connect (BACnet/SC). This updated standard redesigns the communication architecture to align with modern IT security best practices. BACnet/SC uses Transport Layer Security (TLS) to encrypt all communications and requires device authentication through digital certificates. This ensures that data is protected from eavesdropping and that only authorized devices can participate in the building control network, a crucial requirement for mission-critical facilities.



SNMP: The Standard for IT Infrastructure Monitoring

Simple Network Management Protocol (SNMP) is an Internet Standard protocol for collecting and organizing information about managed devices on IP networks. Developed in the 1980s, it has become the ubiquitous language for monitoring nearly all IT infrastructure, from core network components to the servers that run critical applications.

Core Architecture and Function

SNMP functions on a manager-agent model. An agent is a software module that resides on each managed network device, such as a router, switch, firewall, or server. The agent collects management data from the device and makes it available to a central manager, which is typically part of a Network Management System (NMS) or a data center integration platform.

The structure of this management data is defined by a Management Information Base (MIB). A MIB is a hierarchical database that defines every piece of information that can be collected from a device. Each specific data point, known as an Object Identifier (OID), represents a variable, such as CPU utilization, network port status, or fan speed. The manager can perform several key actions:

- **GET:** To retrieve the value of a specific OID from an agent.
- **SET:** To change the value of a writable OID on an agent.
- **TRAP:** An unsolicited message sent from an agent to the manager to report a significant event, such as a link failure, a power supply fault, or a security alert. Traps are essential for real-time fault detection.

Application in the Data Center

Within the data center, SNMP is the primary protocol for monitoring the health and performance of the entire IT stack. It provides critical data from:

- Routers, switches, and firewalls
- Servers and hypervisors
- Intelligent Power Distribution Units (PDUs) and rack transfer switches
- Storage arrays

An integration platform uses SNMP to constantly poll these devices, collecting thousands of

metrics on bandwidth, power consumption, device temperature, and operational status. When a server's temperature exceeds a predefined threshold or a network switch port goes down, the device sends an SNMP trap, enabling immediate alerting and rapid incident response.

Security Considerations with SNMPv3

Like early versions of BACnet, the first two versions of SNMP (v1 and v2c) had significant security flaws, transmitting data and community string "passwords" in cleartext. SNMPv3 was introduced to remedy these issues by adding robust security features. It provides a security model that includes authentication to ensure that traps are read by authorized managers only, and encryption to protect the privacy of the data in transit. The use of SNMPv3 is a mandatory security practice in any modern data center.

Modbus: The Industrial Automation Workhorse

Modbus is a serial communication protocol developed by Modicon (now Schneider Electric) in 1979. Despite its age, its simplicity, reliability, and open standard have made it one of the most widely used protocols in industrial automation and a staple for connecting power infrastructure within the data center.

Core Architecture and Function

Modbus uses a client/server (formerly master/slave) architecture. A client initiates a request, and a server device responds with the requested data or acknowledges that an action has been performed. Its data model is straightforward, organized into four basic types:

- **Coils:** Read/write single bit values (e.g., turning a relay on or off).
- **Discrete Inputs:** Read-only single bit values (e.g., the status of a switch).
- **Input Registers:** Read-only 16-bit word values (e.g., a temperature reading from a sensor).
- **Holding Registers:** Read/write 16-bit word values (e.g., a configuration setpoint).

The protocol comes in two primary variants relevant to data centers:

- **Modbus RTU:** A binary version used for serial communication over physical layers like RS-485. It is common for local device networks.

- **Modbus TCP/IP:** This variant encapsulates Modbus requests within a TCP/IP packet, allowing it to be transmitted over standard Ethernet networks. This is the most common implementation for modern data center integration.

Application in the Data Center

Modbus is the de facto standard for communication with the heavy industrial equipment that constitutes the data center's power train. Its deterministic and robust nature makes it ideal for these mission-critical systems. Typical devices communicating via Modbus include:

- Uninterruptible Power Supply (UPS) systems
- Backup generators
- Automatic Transfer Switches (ATS)
- Switchgear and circuit breakers
- Branch Circuit Monitoring Systems (BCMS)
- Power meters

An integration platform acts as a Modbus TCP client to query these devices for crucial information such as voltage, current, power factor, battery charge level, and equipment status. This data is fundamental for capacity planning, energy management, and ensuring the resilience of the facility's power infrastructure.

ABOUT THE AUTHOR

Michael is responsible for marketing strategy and execution to ensure that Nlyte retains its market leadership position for data centers globally. He orchestrates Nlyte's global market messaging, plans and executes SEO/SEM, administers lead generation, conducts product launches, and manages Nlyte's social media presence.

Michael has worked in the building automation and controls industry for nearly two decades and serves as a member of the board of directors of BACnet International, and its Marketing Committee chair. Connect with Michael on LinkedIn: <https://www.linkedin.com/in/mrwilson>

Protocol Comparison Table

Feature	BACnet	SNMP	Modbus	MQTT
Standardization	ASHRAE, ANSI, ISO	IETF	De facto (Modbus-IDA)	OASIS, ISO/IEC
Primary Domain	Building Automation	IT & Networking	Industrial & Power	IoT & Edge
Comm. Model	Client-Server / Peer-to-Peer	Manager-Agent	Client-Server	Publish-Subscribe
Transport Layer	Ethernet, IP, MS/TP	IP (UDP)	Serial (RTU) / IP (TCP)	IP (TCP)
Security	BACnet/SC (TLS)	SNMPv3 (Auth/Encrypt)	Limited (Secure Modbus TCP)	TLS, Auth/ACLs
Typical Use Cases	HVAC, chillers, fire systems	Servers, switches, PDUs	UPS, generators, switchgear	Sensors, gateways, edge devices

MQTT: The Protocol for IoT and the Edge

Message Queuing Telemetry Transport (MQTT) is a lightweight messaging protocol designed for environments with low-bandwidth, high-latency, or unreliable networks. Developed initially for monitoring oil pipelines, its efficiency and scalability have made it the leading protocol for the Internet of Things (IoT) and edge computing.

Core Architecture and Function

Unlike the client-server models of the other protocols, MQTT uses a publish/subscribe architecture. This model decouples data producers from data consumers via a central message broker.

- **Publisher:** A device (e.g., a sensor) that sends data. It publishes messages to a specific topic on the broker (e.g., datacenter/aisle3/rack15/temperature).
- **Subscriber:** An application (e.g., a data center integration platform) that receives data. It subscribes to one or more topics on the broker.
- **Broker:** A central server that receives all messages from publishers and forwards them to the appropriate subscribers.

This architecture is highly scalable, as a single sensor can publish data to thousands of subscribers without needing to know anything about them. MQTT also features a Quality of Service (QoS) mechanism to ensure message delivery reliability and a Last Will and Testament (LWT) feature that can notify subscribers if a device unexpectedly disconnects.

Application in the Data Center

The rise of IoT and edge computing has introduced a new layer of instrumentation within data centers. MQTT is the ideal protocol for collecting telemetry from a massive number of low-power sensors and devices. Use cases include:

- Wireless environmental sensors for granular temperature, humidity, and air pressure monitoring at the rack level.
- Water leak detection sensors placed under raised floors or near cooling pipes.
- Vibration sensors on mechanical equipment for predictive maintenance.
- Smart meters and gateways in remote edge data centers or network closets.

MQTT allows for the collection of high-frequency, real-time data from across the distributed infrastructure, providing insights that are not possible with traditional polling-based protocols alone.

Protocol Comparison and Synergy

Each of these four protocols has a distinct role, shaped by its design and primary domain. A truly integrated data center requires fluency in all of them, using each for its intended strength.

The Power of Integrated Communication

The real value emerges when data from these protocols is correlated within a single platform. Consider a potential thermal event:

1. **BACnet:** A CRAH unit reports a fan failure alarm.
2. **SNMP:** An integration platform receives traps from multiple servers in the affected aisle indicating their internal temperatures are rising.
3. **MQTT:** Wireless temperature sensors in the hot aisle publish rapidly increasing values, confirming a localized heat buildup.

4. **Modbus:** A query to the Branch Circuit Monitoring System shows a stable power draw, ruling out a widespread power failure as the cause.

An integrated system can quickly correlate these disparate data points. Instead of four separate alarms requiring manual investigation, the platform can identify the root cause (the failed CRAH unit) and its direct impact (overheating servers), enabling an automated response. This could involve triggering a high-priority work order for facilities, initiating a live migration of virtual machines from the affected servers, and alerting operators to the precise nature and location of the problem. This level of intelligent orchestration is only possible when the platform can seamlessly communicate across the entire technology stack.

Final Thoughts

The silos between facilities, OT, and IT are rapidly dissolving in the face of demands for greater efficiency, resilience, and automation in data centers. The foundation of this convergence is not a single technology but rather a cohesive communication strategy built upon a diverse set of open-standard protocols. BACnet, SNMP, Modbus, and MQTT are not competing technologies; they are complementary languages, each essential for its specific domain. Fluency in these protocols is no longer a niche specialty but a core requirement for building and operating an intelligent, integrated data center that is prepared for the challenges of today and the innovations of tomorrow. 🌱

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Director of Marketing | Nlyte Software
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Office and manufacturing facility, energy efficiency through automation



As demand for increased energy efficiency and modernization has ramped up in the HVACR industry, manufacturers of HVACR equipment or components must also expand their capacity to keep up with that demand. While having outgrown their existing manufacturing facilities, the new 270,000 square foot ABB variable frequency drives (VFDs) factory in New Berlin, WI looked to increase production output through improving manufacturing efficiency. This brand new facility includes advancements on the production floor in automation with smart-tools and robotics, as well as office space, training rooms, and research labs. With this variety of building environments, the design of the HVACR system focuses on many aspects used to reduce energy consumption and maintain occupant comfort.

Building construction and HVACR system

The previous office space and factory were used to showcase various HVACR equipment and drives controlled with a building automation system over BACnet. The decision was made to invest in a new facility and location that could accommodate current demands and be capable of supporting future growth. The new facility

is also meant to be a showcase for HVACR equipment, operations and integration, so presentation and open access to visitors was at the forefront of the system layout.

With new construction comes innovative opportunities as well as overcoming challenges. The building started as a common, tilt-up construction style warehouse. After the shell was complete, phase 1 started with the 2-story office area, training rooms and lab spaces built inside. Phase 2 was primarily the production and manufacturing space in the same shell building as well as connecting to an adjacent warehouse. Finally, phase 3 included research and development testing labs, services and medium voltage manufacturing all within the same structure.

The office space includes a separate HVACR system from the production and R&D areas. The office space central plant includes the following equipment:

- WaterFurnace 6-pipe, ground-sourced chiller with 150 tons of capacity
- Chilled water, hot water and condenser water loops with N+1 redundant Taco pumps

- Nortek (Ventrol) air handling unit with 12 fan array designed for 60,000 CFM
- Building pressure relief fans with Baldor EC Titanium and Super-E motors
- All fans and pumps are controlled with variable frequency drives, including ACH580, ACH180 and integrated motor drive EC Titanium.

The manufacturing production area has a separate HVACR system from the office area as well as R&D. For the factory space, 12 AAON rooftop units are spread over the area of the building to serve a variety of production lines. Each unit is individually controlled and operating to its own space temperature. All the RTUs are DX cooling coils, 2-stage compressors, electric heat and outdoor air economizing following the same electrification focus as the office HVACR system.

Finally, the R&D area includes office space as well as labs and testing chambers. The HVACR system in this area is separate but similar to the main office area and uses the same equipment (chiller, AHUs, pumps, RTUs) as the rest of the building but scaled down for the smaller area. This system allows R&D teams to not only have



an isolated environment but also to apply and test future releases of both hardware or software in real-world conditions on active equipment.

The 6-pipe chillers are capable of simultaneously cooling and heating by supplying chilled water and hot water to either the air handlers, the VAV boxes for reheat, or to the geothermal field. This 6600-gallon geo-exchange system allows the heat removed from the chilled water to be used for heat recovery or stored in the geo-loop rather than rejected to the outdoor atmosphere. During the Wisconsin winter months, the chilled water is sent to the geo-loop and draws heat back out of the ground. By storing heat energy rather than rejecting to the atmosphere, ABB reduces energy consumption in the heating months by not burning fossil fuels or using electric heat.

One air handling unit provides air to the office areas and lab spaces. This AHU utilizes 12 fans with IE5+ ultra premium efficiency EC Titanium motors each with their own VFD. Redundancy and efficiency were paired in this design and the drives' user control panel features were utilized during the system commissioning. After taking occupancy for phase 1, many employees mentioned audible noise from the air vents. Not having full access to the building automation system yet, ABB set out to use the VFDs' control panel interface to understand what was happening. By using data in the drives, presented as a graphical trend on the control panel, ABB identified that the fans were shutting off and turning back on then ramping up to recover the duct static pressure. It was discovered the Start Command from the BAS was intermittently

dropping out due to a loose wire. During troubleshooting, the team discovered that the Start Command digital input as well as the Status feedback relay output on all 12 VFDs were each run as a series loop back to the AHU controller. When one or more loose wires were discovered on the status outputs, this was the cause of the BAS stopping and starting the fans. Providing this information to the controls contractor, they were able to revise the programming and use the BACnet point BVO running status for each drive status, providing a better design of the fan array.

Finally, to help offset the electrical demands of the facility, 332 kW of solar panels are also installed on the building roof. After the first year of operation, the solar system generated 413 MWh of power for the facility, saving approximately 640,000 pounds of CO₂. Through the integration of the BAS, a future phase of the project will combine data from the integrated power meters with the power factor correction capabilities of active front end drives to further improve building energy efficiency.

Redundant equipment benefits

The office area central plant design includes N+1 pumps programmed from the BAS to rotate operation and provide redundancy in case of any failure or planned down time for maintenance. To further take advantage of this design, ABB's R&D group can test new firmware versions in a live system before release. For example, when a new addition to the BACnet/IP fieldbus adapter was ready, the adapter was applied to drives in the mechanical room for real world verification

and testing, before making it available to the public. In a case like this, ABB confirmed the new firmware did not negatively impact the network and existing devices as well as working with the BAS to discover the new BACnet/IP points and confirm they were reading as expected.

BACnet/IP connectivity

Tying together all the HVACR equipment, lighting controls, monitoring and alarms is the ABB Smart Buildings INTEGRA building automation system connected to each piece of equipment over BACnet/IP. Ring topology was implemented looping around the building from the supervisor panel through the chiller plant and AHU, to the VAV boxes and terminal controllers, out to the production area RTUs as well as the R&D space. While the final design may work with many devices all interconnected, this topology leads to difficulties during the phased construction.

ABOUT THE AUTHOR

Starting with ABB in 2022, I have been working in the HVAC industry since 2015. My background has been HVAC equipment and Building Automation System design, programming, implementation, startup, commissioning, training and support. With ABB, I am an HVACR Application Engineer and I support our Channel Partners with complex drive applications and answer questions assisting with variable frequency drives in the HVACR market.

For example, with two links of the BACnet/IP cabling leaving the supervisor's rapid spanning tree protocol ethernet switch, the phase 3 R&D area was incomplete with devices not installed closing the link in the ring. Several production area RTUs have needed additional commissioning and when these units have been shut down, many other devices go offline as well. While this may be common during the construction process, phase 2 included ramping up manufacturing production. It was becoming more critical for the HVACR equipment to be online, not only for occupancy but also production quality control.

As a lesson learned on the project, an ideal opportunity for BACnet/IP and a phased construction would have been to implement several network rings. Each phased construction HVACR system is isolated by the area it serves. Phase 1 could have had its own BACnet/IP ring, phase 2 its own as well as phase 3. As each area had been completed, all devices could have been discovered and commissioned with the redundancy of the BACnet/IP ring. As the following phases were added, each would have its own ring to connect to the supervisor. As issues arise from the construction or commissioning process, only areas involved would have been exposed, leaving the existing networks unaffected.

While it is inconvenient for the facilities team working to understand where issues are to trace down with the single ring network, the advantages of the multiple BACnet/IP ring topology could have been leveraged to make the system more robust during construction, commissioning and possibly future expansions.

Building analytics

With the focus on energy and operational efficiency, the building's design roadmap is to showcase and leverage analytics to continuously optimize the building's performance. Using the BAS and equipment communicating over BACnet/IP, the monitoring data, trends, active setpoints, energy consumption and more is continuously collected to understand how the building is operating. From the chiller's geo-loop energy meter, to the building's electrical power meters, energy data available from the VFDs, the lighting system occupancy sensors, the VAV zone temperature sensors and the rooftop solar energy being produced, the information will be used to adjust temperature or pressure setpoints and occupancy schedules to reduce energy needs without negatively impacting office space comfort or production area requirements.

This new building was designed to accommodate ABB's current needs and future growth, as the products manufactured in this facility support the HVACR industry's demand for efficiency and sustainability. From the flexible workspaces in the offices, the adaptable production area utilizing advancements in automation, and the efficient HVACR systems with BACnet integration, the building meets today's demand while being flexible to tackle tomorrow's challenges.

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Guide to the Network Port Object

Although significant effort has been made to ensure the accuracy of this guide, any discrepancies between this guide and the ASHRAE Standard 135-2020 or 135-2024, the standard shall take precedence.



1. Introduction

This guide is targeted at developers and testers of BACnet devices.

This guide discusses the differences between hierarchical and non-hierarchical Network Port objects and the benefits of each. It dives into the changes to the Network Port object when Standard 135-2020, Addendum cc (Protocol_Revision 24) was published and the consequences of choosing between pre and post Addendum cc Network Port objects. Finally, this guide provides a detailed list of the required properties and required to be writable properties for each data link and what level each required property exists within a hierarchical chain of Network Port objects.

Many of the clauses in the guide include one or more notes which contain important requirements or facts relevant to the topics in the clause.

2. Background

The Network Port object was added to the standard in December 2014, has gone through two major functional changes and has had two new data links added. This object has also had eight different formal Interpretations and 17 different errata.

Addenda history:

- 135-2012 Addendum ai (Protocol_Revision 17) introduced the Network Port object.
- 135-2012 Addendum aj (Protocol_Revision 18) added the BACnet/IPv6 data link and updated the Network Port object to include BACnet/IPv6.
- 135-2012 Addendum bf (Protocol_Revision 18) significantly changed the requirements for the Network Port object.
- 135-2020 Addendum cc (Protocol_Revision 24) added the BACnet Secure Connect data link and updated the Network Port object to include BACnet Secure Connect. Made significant changes to the Network Port object.

3. Definitions and Acronyms

NPO: Network Port object as defined in Standard 135.

PR: The Protocol_Revision property defined in Standard 135-2024, Clause 12.11.13.

Topmost NPO: The Network Port object with Protocol_Level equal to BACNET_APPLICATION or NON_BACNET_APPLICATION in a hierarchical chain of Network Port objects.

Lower level NPO: The Network Port object with Protocol_Level equal to PROTOCOL or PHYSICAL in a hierarchical chain of Network Port objects.

4. Referenced Standards

For devices claiming PR 18 through 23, this document references 135-2020 along with any interpretations and errata for that standard that may apply.

For devices claiming PR 24 or greater, this document references 135-2024 along with any interpretations and errata for that standard that may apply.

If the referenced clause or table is the same in both 135-2020 and 135-2024 only the 135-2024 Clause will be referenced.

5. Choosing a Protocol_Revision

Choosing the Protocol_Revision for your device depends on several factors and dependencies.

- A derivative device where the parent device claims PR 18 through 23 may want to remain at a lower PR to reduce the time to market.
- If the BACnet Secure Connect data link is being added to a device that has already been BACnet tested, claiming a PR less than 24 is allowed and may reduce the time to market.
- If a device supports the BACnet Secure Connect data link and the Secure Connect NPO, PR 24 or greater must be claimed.
- New devices should consider claiming PR 24 or greater to avoid additional development in the future.

5.1. Protocol_Revision 17

135-2012 Addendum ai (PR 17) added support for the NPO. Slightly over a year later, 135-2012, Addendum bf (PR 18) significantly changed the functionality of an NPO and resolved several fundamental issues found in the original PR 17 version of the NPO.

NOTE: PR 17 is not recommended in any existing or new products.

5.2. Protocol_Revision 18 and 24 Differences

Addendum cc to 135-2020 (PR 24) added the Secure Connect NPO and changed several requirements that affect all NPOs. The below clauses describe the differences between a device claiming PR 18 through 23 and PR 24 or greater.

5.2.1. Property Inheritance (Hierarchical NPOs)

5.2.1.1. Protocol_Revision 18 through 23

For devices claiming PR 18 through 23 that contain hierarchical NPOs, property inheritance is required. Property inheritance requires the topmost NPO to contain all properties from its lower level NPOs and any changes to a property at one level must be reflected in the topmost level.

Property inheritance has the benefit of allowing clients to read and write all network port settings by accessing just the topmost NPO in a hierarchy of NPOs.

Writable properties, including inherited properties, must be writable in the topmost NPO. These inherited writable properties can be, but are not required to be, writable in the lower level source NPO.

If a property is writable in a lower level NPO it must be writable in the topmost NPO.

When inherited properties are written, in either the lower level or the inheriting NPO, the values must be written through to the other NPO.

NOTE: If a property is specified in multiple NPOs in the hierarchy chain, the property's value in the NPO nearest to the top of the chain is the value reflected in the topmost NPO. See 135-2020, Clause 12.56.10.1.1.

NOTE: NPOs at Protocol_Level equal to PROTOCOL cannot inherit any properties from referenced NPOs. See 135-2020, Clause 12.56.10.1.1.

5.2.1.2. Protocol_Revision 24

As of PR 24 a device is not allowed to support property inheritance so the topmost NPO cannot contain any properties from its lower level NPOs. See 135-2024, Clause 12.56.1.1.

5.2.2. Link_Speed Property

5.2.2.1. Protocol_Revision 18 through 23

For devices claiming PR 18 through 23 the Link_Speed property is required in all NPOs with Protocol_Level equal to PHYSICAL. See 135-2020, Table 12-73.

NOTE: The Link_Speed property is required in a non-hierarchical NPO where the Network_Type supports a Protocol_Level is equal to PHYSICAL as specified in 135-2020, Table 12-73. Because of property inheritance, the equivalent topmost NPO is also required to support the Link_Speed property.

NOTE: The Link_Speed property is required in a non-hierarchical NPO with Network_Type equal to MSTP. See 135-2020, Table 12-73.

NOTE: Interpretation IC-135-2020-5 clarified that the Link_Speed property is not required in every NPO.

5.2.2.2. Protocol_Revision 24

As of PR 24, the Link_Speed property is only required in NPOs with Protocol_Level equal to PHYSICAL and Network_Type equal to SERIAL. See 135-2024, Table 12-71.9.

NOTE: The Link_Speed property is required in a non-hierarchical NPO with Network_Type equal to MSTP.

5.2.3. Allowed Properties

5.2.3.1. Protocol_Revision 18 through 23

For devices claiming PR 18 through 23, an NPO is allowed to contain properties that are not part of its Network_Type. For example, an NPO with Network_Type equal to MSTP could contain the IP_Subnet_Mask property. See 135-2020, Clause 12.56.

5.2.3.2. Protocol_Revision 24

As of PR 24, NPOs cannot contain any properties from any other Network_Type. A hierarchical NPO can only contain properties specified in its protocol level. See 135-2024, Clause 12.56.1.1.

5.2.4. Reference_Port Property

5.2.4.1. Protocol_Revision 18 through 23

For devices claiming PR 18 through 23, the Reference_Port property is allowed to be absent or equal to 4194303 to indicate an NPO at Protocol_Level equal to BACNET_APPLICATION or NON_BACNET_APPLICATION is a non-hierarchical NPO.

5.2.4.2. Protocol_Revision 24

As of PR 24, the Reference_Port must be absent to indicate an NPO at Protocol_Level equal to BACNET_APPLICATION or NON_BACNET_APPLICATION is non-hierarchical.

NOTE: If the Reference_Port is equal to 4194303, it is considered an unconfigured hierarchical NPO.

5.2.5. Additional_Reference_Ports Property (Hierarchical NPOs)

The Additional_Reference_Ports property was added in Addendum cc to allow an NPO to reference more than one lower level NPO. A device must claim PR 24 or greater to support this property.

6. Choosing Hierarchical or Non-hierarchical NPOs

Hierarchical NPOs are beneficial in devices that contain multiple logical or physical ports such as routers or gateways or devices that support multiple data links. They may also be useful when a higher level NPO references the same lower level NPO.

A non-hierarchical NPO represents the entire data link in a single object. This is beneficial in devices that support a single data link. They are also beneficial when a device supports a single physical layer interface per data link.

Choosing hierarchical or non-hierarchical NPOs is up to the developers of the product.

NOTE: A device is allowed to contain non-hierarchical NPOs, hierarchical NPOs, or both.

6.1. Non-Hierarchical NPO

The definition of a non-hierarchical NPO is one where its Protocol_Level is equal to BACNET_APPLICATION or NON_BACNET_APPLICATION and the NPO does not reference a lower level NPO.

6.1.1. Protocol_Revision 18 through 23

The Reference_Port of a non-hierarchical NPO must be absent or equal to 4194303.

A non-hierarchical NPO must contain all required properties specified in Table 12-71 and all required properties specified in Table 12-72 and 12-73 for its Network_Type.

NOTE: If a property is specified in multiple protocol levels, the property's value used will be from the NPO at the highest protocol level. For example, an IPv4 NPO's MAC_Address is the six octet B/IP address at the BACNET_APPLICATION level and not the Ethernet MAC Address from the PHYSICAL level.

6.1.2. Protocol_Revision 24

The Reference_Port of a non-hierarchical NPO must be absent.

In most cases, a non-hierarchical NPO contains only the required and optional properties in Table 12-71 and the properties specified at all protocol levels in the sub-table for the NPO's data link. Some standard data links such as MS/TP require additional properties. See the specific requirements in the descriptions of the data links.

6.2. Hierarchical NPOs

The definition of a hierarchical NPO is one where its Protocol_Level is equal to BACNET_APPLICATION or NON_BACNET_APPLICATION and its Reference_Port exists and is not equal to 4194303. All NPOs with a Protocol_Level equal to PROTOCOL or PHYSICAL are hierarchical NPOs.

Each hierarchical chain of NPOs, starts with an NPO with Protocol_Level equal to BACNET_APPLICATION or NON_BACNET_APPLICATION followed by zero or more NPOs with Protocol_Level equal to PROTOCOL and zero or one NPOs with Protocol_Level equal to PHYSICAL.

Generally speaking, an NPO:

- with Protocol_Level equal to BACNET_APPLICATION or NON_BACNET_APPLICATION, its Reference_Port must reference at least one NPO with Protocol_Level equal to PROTOCOL or PHYSICAL.
- with Protocol_Level equal to PROTOCOL, its Reference_Port will equal 4194303 or reference another NPO with Protocol_Level equal to PROTOCOL or PHYSICAL.
- with Protocol_Level equal to PHYSICAL, the Reference_Port must equal 4194303.

Each data link has specific protocol level requirements See the requirements in the descriptions of the data link.

NOTE: NPOs with Protocol_Level equal to BACNET_APPLICATION, NON_BACNET_APPLICATION, or PHYSICAL cannot be in the middle of a hierarchical chain.

NOTE: A device may contain an unconfigured or unreferenced hierarchical NPO. These NPOs are not referenced by other NPOs and are at Protocol_Level equal to PROTOCOL or PHYSICAL.

6.2.1. Protocol_Revision 18 through 23

Because property inheritance is required, the topmost NPO will contain all the properties that are present in the lower level NPOs. This NPO will contain the same properties and values as the non-hierarchical version of the NPO except for the Reference_Port.

6.2.2. Protocol_Revision 24

For each data link, the sub-tables specified in 135-2024, Clause 12.56 provide the required and optional properties for each NPO in a hierarchical chain of NPOs. Some standard data links such as MS/TP require additional NPOs. See the specific requirements in the descriptions of the data link.

Addendum cc added the Additional_Reference_Ports property to the NPO. This property allows hierarchical NPOs to reference more than one lower level NPO. A possible application of this is a hierarchical BACnet Secure Connect NPO that references IPv4 and IPv6 NPOs at Protocol_Level equal to PROTOCOL.

NOTE: The Reference_Port property must be present and reference a lower level NPO before the Additional_Reference_Ports property can contain a reference.

7. Data Link Specific Requirements

7.1. General

As of PR 18, an NPO is required for each BACnet data link supported in a device.

Each NPO in a device must contain the required properties specified in 135-2024, Table 12-71.

For a device claiming PR 18 through 23, the required and optional properties for each of the data links is specified in 135-2020, tables 12-72, 12-73 and 12-74.

For a device claiming PR 24, 135-2024, Clause 12.56 contains Table 12-71, that contains the required and optional properties for all NPOs and a series of sub-tables that contain the required and optional properties for each data link. The sub-tables are further divided into protocol levels to document the required and optional properties for each level.

NOTE: If a property is required in a hierarchical chain of NPOs, it is also required in a non-hierarchical NPO.

NOTE: A device that supports gateway functionality using a virtual BACnet network requires a Virtual NPO. See 135-2024, Clauses H.1.1.1 and H.1.1.2

NOTE: For non-BACnet data links, a proprietary NPO can be used to represent the port, but it is not required.

The below tables contain the required (R), conditional required (O), required writable (W), and required configurable (C) properties for each type of NPO. The Protocol_Level is provided to indicate where, in the hierarchical chain of NPOs, each property is required to be present. When a hierarchical NPO can or must reference a lower level NPO with a different Network_Type, the table includes the Network_Type property.

7.2. ARCNET

This table is valid for devices that claim PR 18 or greater.

Property Identifier	Protocol_Level	Conformance
Network_Number	BACNET_APPLICATION	R, W ¹
Network_Number_Quality	BACNET_APPLICATION	R
APDU_Length	BACNET_APPLICATION	R
MAC_Address	PHYSICAL	R, C ²
Link_Speed	PHYSICAL	O ³

1. Required to be writable if a device is a BACnet Router.
2. Required to be configurable. See 135-2024, Table 12-71.1.
3. Required to be present if PR >= 18 and <= 23.

7.3. Ethernet

This table is valid for devices that claim PR 18 or greater.

Property Identifier	Protocol_Level	Conformance
Network_Number	BACNET_APPLICATION	R, W ¹
Network_Number_Quality	BACNET_APPLICATION	R
APDU_Length	BACNET_APPLICATION	R
MAC_Address	PHYSICAL	R
Link_Speed	PHYSICAL	O ²

1. Required to be writable if a device is a BACnet Router.
2. Required to be present if PR >= 18 and <= 23.

7.4. IPv4

This table is valid for devices that claim PR 18 or greater.

Property Identifier	Protocol_Level	Network_Type	Conformance
Network_Number	BACNET_APPLICATION	IPV4	R, W ¹
Network_Number_Quality	BACNET_APPLICATION	IPV4	R
APDU_Length	BACNET_APPLICATION	IPV4	R
MAC_Address	BACNET_APPLICATION	IPV4	R
BACnet_IP_Mode	BACNET_APPLICATION	IPV4	R, C ²
BACnet_IP_UDP_Port	BACNET_APPLICATION	IPV4	R
BBMD_Broadcast_Distribution_Table	BACNET_APPLICATION	IPV4	O ³ , W ⁵
BBMD_Accept_FD_Registrations	BACNET_APPLICATION	IPV4	O ³ , W ⁵
BBMD_Foreign_Device_Table	BACNET_APPLICATION	IPV4	O ³
FD_BBMD_Address	BACNET_APPLICATION	IPV4	O ⁴ , W ⁵
FD_Subscription_Lifetime	BACNET_APPLICATION	IPV4	O ⁴ , W ⁵
IP_Address	PROTOCOL	IPV4	R
IP_Subnet_Mask	PROTOCOL	IPV4	R
IP_Default_Gateway	PROTOCOL	IPV4	R
IP_DNS_Server	PROTOCOL	IPV4	R
MAC_Address	PHYSICAL	ETHERNET	O ⁶

1 Required to be writable if a device is a BACnet Router.

2 Required to be configurable if a device is capable of functioning as a foreign device. See 135-2024, Clause J.4.3.

3 Required to be present if a device is capable of functioning as a BBMD. See 135-2024, Clause 12.56.38 and 12.56.39.

4 Required to be present if a device is capable of functioning as a foreign device. See 135-2024, Clause 12.56.41 and 12.56.42.

5 Required to be writable if present.

6 Required to be present and contain the Ethernet MAC address if the Protocol_Level is equal to PHYSICAL and Network_Type is equal to ETHERNET.

For NPOs at Protocol_Level equal to BACNET_APPLICATION and PROTOCOL, the Network_Type is equal to IPV4. An IPv4 NPO at Protocol_Level equal to PROTOCOL can:

- reference an Ethernet NPO at Protocol_Level equal to PHYSICAL and Network_Type is equal to ETHERNET,
- reference other BACnet or non-BACnet NPOs at Protocol_Level equal to PROTOCOL,
- not reference any lower level NPOs and contain a Reference_Port equal to 4194303.

NOTE: An IPv4 NPO must support NORMAL and FOREIGN modes or BBMD mode or all three modes. See 135-2024, Clause J.4.3.



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7.5. IPv6

This table is valid for devices that claim PR 18 or greater.

Property Identifier	Protocol_Level	Network_Type	Conformance
Network_Number	BACNET_APPLICATION	IPV6	R, W ¹
Network_Number_Quality	BACNET_APPLICATION	IPV6	R
APDU_Length	BACNET_APPLICATION	IPV6	R
MAC_Address	BACNET_APPLICATION	IPV6	R
Virtual_MAC_Address_Table	BACNET_APPLICATION	IPV6	R
BACnet_IPv6_Mode	BACNET_APPLICATION	IPV6	R, C ²
BACnet_IPv6_UDP_Port	BACNET_APPLICATION	IPV6	R
BACnet_IPv6_Multicast_Address	BACNET_APPLICATION	IPV6	R
BBMD_Broadcast_Distribution_Table	BACNET_APPLICATION	IPV6	O ³ , W ⁵
BBMD_Accept_FD_Registrations	BACNET_APPLICATION	IPV6	O ³ , W ⁵
BBMD_Foreign_Device_Table	BACNET_APPLICATION	IPV6	O ³
FD_BBMD_Address	BACNET_APPLICATION	IPV6	O ⁴ , W ⁵
FD_Subscription_Lifetime	BACNET_APPLICATION	IPV6	O ⁴ , W ⁵
IPv6_Address	PROTOCOL	IPV6	R
IPv6_Prefix_Length	PROTOCOL	IPV6	R
IPv6_Default_Gateway	PROTOCOL	IPV6	R
IPv6_DNS_Server	PROTOCOL	IPV6	R
MAC_Address	PHYSICAL	ETHERNET	O ⁶

- 1 Required to be writable if a device is a BACnet Router.
- 2 Required to be configurable if a device is capable of functioning as a foreign device. See 135-2024, Clause U.4.2.
- 3 Required to be present if a device is capable of functioning as a BBMD. See 135-2024, Clause 12.56.38 and 12.56.39.
- 4 Required to be present if a device is capable of functioning as a foreign device. See 135-2024, Clause 12.56.41 and 12.56.42.
- 5 Required to be writable if present.
- 6 Required to be present and contain the Ethernet MAC address if the Protocol_Level is equal to PHYSICAL and Network_Type is equal to ETHERNET.

For NPOs at Protocol_Level equal to BACNET_APPLICATION and PROTOCOL, the Network_Type is equal to IPV6. An IPv6 NPO at Protocol_Level equal to PROTOCOL can:

- reference an Ethernet NPO at Protocol_Level equal to PHYSICAL and Network_Type is equal to ETHERNET,
- reference other BACnet or non-BACnet NPOs at Protocol_Level equal to PROTOCOL,

- not reference any lower level NPOs and contain a Reference_Port equal to 4194303.

NOTE: An IPv6 NPO must support NORMAL and FOREIGN modes or BBMD mode or all three modes. See 135-2024, Clause U.4.2.

7.6. LonTalk

This table is valid for devices that claim PR 18 or greater.

Property Identifier	Protocol_Level	Conformance
Network_Number	BACNET_APPLICATION	R, W ¹
Network_Number_Quality	BACNET_APPLICATION	R
APDU_Length	BACNET_APPLICATION	R
MAC_Address	PHYSICAL	R, C ²
Link_Speed	PHYSICAL	O ³

- 1 Required to be writable if a device is a BACnet Router.
- 2 Required to be configurable. See 135-2024, Table 12-71.1.
- 3 Required to be present if PR >= 18 and <= 23.

7.7. MS/TP

This table is valid for devices that claim PR 18 or greater.

Property Identifier	Protocol_Level	Network_Type	Conformance
Network_Number	BACNET_APPLICATION	MSTP	R ¹
Network_Number_Quality	BACNET_APPLICATION	MSTP	R
APDU_Length	BACNET_APPLICATION	MSTP	R
MAC_Address	PROTOCOL	MSTP	R, C ²
Max_Manager	PROTOCOL	MSTP	O ³ , W ⁴
Max_Info_Frames	PROTOCOL	MSTP	O ³ , W ⁴
Link_Speed	PHYSICAL	SERIAL	R

- 1 Required to be writable if a device is a BACnet Router.
- 2 Required to be configurable. See 135-2024, Table 12-71.6. All devices shall be able to be set to any valid unicast address (MS/TP Managers is 0 to 127, MS/TP Subordinates is 0 to 254). See 135-2024, Clause 9.3.
- 3 Required if a device is a MS/TP manager.
- 4 Required to be writable if a device is a MS/TP manager and supports the WriteProperty service. See 135-2020, Clauses 12.56.51 and 12.56.52 or 135-2024, Clauses 12.56.55 and 12.56.56.

NOTE: A device that claims PR 17 or greater and supports DS-WP-B must support writable Max_Manager and Max_Info_Frames properties. Since the device must support DS-WP-B it must also support receiving a ReinitializeDevice service with WARMSTART or ACTIVATE_CHANGES and must claim DM-RD-B.

For MS/TP NPOs at Protocol_Level equal to BACNET_APPLICATION and PROTOCOL, the Network_Type is equal to MSTP. For MS/TP NPOs at Protocol_Level equal to PHYSICAL, the Network_Type is equal to SERIAL. This means a non-hierarchical MS/TP NPO must contain the required properties from 135-2020:

- Table 12-72, Network_Type equal to MSTP,
- Table 12-73 for Network_Type equal to MSTP and Protocol_Level equal to PROTOCOL,

- Table 12-73 for Network_Type equal to SERIAL, and Protocol_Level equal to PHYSICAL.

For 135-2024, Table 12-71.6 and Table 12-71.9.

If a device is a MS/TP Manager and supports an NPO with Network_Type equal to MSTP and Protocol_Level equal to BACNET_APPLICATION or PROTOCOL, the Device object must contain the Max_Manager and Max_Info_Frames properties. The values of these properties reflect the values of the properties in the lowest object instance of the NPO that contains a Network_Type equal to MSTP. If either of these properties are writable, writing to the Device object properties will cause the new value to take effect immediately, bypassing the activation functionality of the NPO. See 135-2024, Clauses 12.11.32 and 12.11.33.

7.8. Secure Connect

This table is valid for devices that claim PR 24 or greater.

Property Identifier	Protocol_Level	Conformance
Network_Number	BACNET_APPLICATION	R, W ¹
Network_Number_Quality	BACNET_APPLICATION	R
APDU_Length	BACNET_APPLICATION	R
MAC_Address	BACNET_APPLICATION	R
Max_BVLC_Length_Accepted	BACNET_APPLICATION	R
Max_NPDU_Length_Accepted	BACNET_APPLICATION	R
SC_Primary_Hub_URI	BACNET_APPLICATION	R, C ²
SC_Failover_Hub_URI	BACNET_APPLICATION	R, C ²
SC_Minimum_Reconnect_Time	BACNET_APPLICATION	R, C ²
SC_Maximum_Reconnect_Time	BACNET_APPLICATION	R, C ²
SC_Connect_Wait_Timeout	BACNET_APPLICATION	R, C ²
SC_Disconnect_Wait_Timeout	BACNET_APPLICATION	R, C ²
SC_Heartbeat_Timeout	BACNET_APPLICATION	R, C ²
SC_Hub_Connector_State	BACNET_APPLICATION	R
Operational_Certificate_File	BACNET_APPLICATION	R
Issuer_Certificate_Files	BACNET_APPLICATION	R, W ³
Certificate_Signing_Request_File	BACNET_APPLICATION	R, W ³

- 1 Required to be writable if a device is a BACnet Router.
- 2 Required to be configurable.
- 3 The file data in the referenced File objects is required to be writable.

Since the BACnet Secure Connect data link contains only properties at Protocol_Level equal to BACNET_APPLICATION, a hierarchical chain of NPOs for this data link will reference other BACnet or proprietary NPOs at Protocol_Level equal to PROTOCOL or PHYSICAL.

NOTE: A device claiming PR 18 through 23 that supports the BACnet Secure Connect data link requires an NPO with Protocol_Level equal to BACNET_APPLICATION and Network_Type of any proprietary value. A device claiming PR 24 or greater requires an NPO with Protocol_Level of BACNET_APPLICATION and Network_Type of SECURE_CONNECT.

7.9. Virtual

This table is valid for devices that claim PR 18 or greater.

Property Identifier	Protocol_Level	Conformance
Network_Number	BACNET_APPLICATION	R, W ¹
Network_Number_Quality	BACNET_APPLICATION	R
APDU_Length	BACNET_APPLICATION	R
MAC_Address		R ²
Link_Speed	PHYSICAL	O ³

- 1 Required to be writable.
- 2 Required to be present in any one protocol level.
- 3 Required to be present if PR ≥ 18 and ≤ 23 .

A Virtual NPO represents a non-BACnet network of non-BACnet devices as a virtual BACnet network.

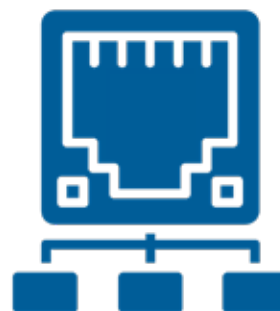
NOTE: The device is a BACnet router between one or more BACnet networks and one or more virtual BACnet network. See 135-2024, Clauses H.1.1.1 and H.1.1.2.

7.10. ZigBee

This table is valid for devices that claim PR 18 or greater.

Property Identifier	Protocol_Level	Conformance
Network_Number	BACNET_APPLICATION	R, W ¹
Network_Number_Quality	BACNET_APPLICATION	R
APDU_Length	BACNET_APPLICATION	R
MAC_Address	PHYSICAL	R
Link_Speed	PHYSICAL	O ²

- 1 Required to be writable if a device is a BACnet Router.
- 2 Required to be present if PR ≥ 18 and ≤ 23 .



7.11. Proprietary

This table is valid for devices that claim PR 18 or greater.

Property Identifier	Protocol_Level	Conformance
Network_Number	BACNET_APPLICATION	R
Network_Number_Quality	BACNET_APPLICATION	R
APDU_Length	BACNET_APPLICATION	R
MAC_Address		R ¹
Link_Speed	PHYSICAL	O ²

- 1 Required to be present in any one protocol level.
2 Required to be present if PR >= 18 and <= 23.

A proprietary NPO represents a non-BACnet network supported by a device. The topmost Protocol_Level must be NON_BACNET_APPLICATION.

A proprietary NPO presents a non-BACnet network as an object that contains properties that can be read or written using BACnet services. This NPO cannot represent a BACnet network and cannot be part of a BACnet internetwork.

NOTE: Any standard NPO property may be present in the object. If the presence or capability of one of these properties requires other properties to be present, then the other properties must also be present.

ABOUT THE AUTHOR

Michael Osborne has over 35 years' experience in various aspects of the high-tech industry. For the last 19 years, Michael has designed building automation products, managed technical projects, and supervised a team of talented developers. For most of his time in the building automation industry, Michael has also been involved in the BACnet community where he developed tests for the ASHRAE 135.1 Testing Standard and wrote proposals for the ASHRAE SSPC 135 Standard. From 2012 to 2021, Michael was the Secretary, Vice-Chair and finally Chair of the ASHRAE SSPC 135 Committee.



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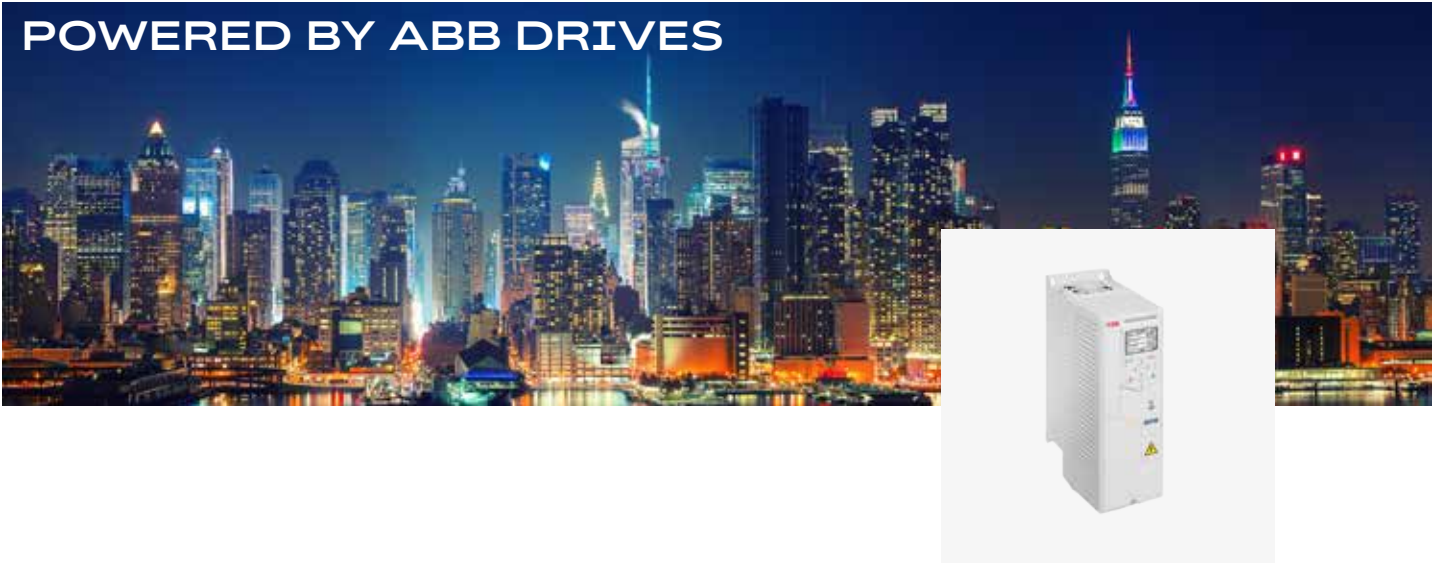


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BACnet International Hosts PlugFest Interoperability Workshop



BACnet International recently hosted its 25th PlugFest Interoperability Workshop, October 14th – 16th, at the University of New Hampshire's Interoperability Laboratory. PlugFest allows participants to test the interoperability of their company's BACnet products with other vendors in a friendly and neutral environment. Attendees can discover and fix implementation errors during PlugFest before they are found in the field. Twenty-eight companies sent 68 total attendees, consisting of 33 teams and 24 first-time attendees.

"Some of the reasons companies come to Plugfest include, validating that new feature, testing with one or specific companies, testing a new product, or doing some load testing at the Roundtable. Each vendor finds value at a Plugfest and that is why they return year after year," stated BTL Technical Advisor Michael Osborne.

Attendees also attended the educational panel discussion, "Testing, Certification, and the Future of BACnet". The panel brought together industry experts to address key topics in BACnet testing, certification, implementation, and deployment. Through a series of targeted questions, the panelists shared their experiences, best practices, and insights into the evolving BACnet landscape. Attendees gained

a deeper understanding of the importance of conformance and interoperability testing, strategies for efficient BTL testing, and the steps required for successful product submissions. The discussion also explored BACnet's ongoing relevance, anticipated advancements, and practical solutions to implementation and deployment challenges –including datalink pain points, proprietary property integration, and BACnet SC certificate management.

The discussion was moderated by Emily Hayes, BTL Manager, and the speaker panel included Osborne; Dave Robin, BSC Softworks; Coleman

Brumley, LumenRadio; Patrice Hell, Sauter; and Chris Howard, Schneider Electric. The panel discussion is available to view in The BACnet Institute (TBI) Resource Library.

This year's PlugFest was a successful and collaborative workshop enjoyed by attendees. As the BACnet standard continues to advance and influence the building automation industry, PlugFest workshops play a crucial role in enhancing product interoperability and the implementation of BACnet solutions. BACnet International looks forward to welcoming BACnet enthusiasts to its 26th PlugFest in 2026. 🌐

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Attleboro High School Sets New Standards in Efficiency with Belimo EPIV



When Attleboro High School underwent a significant transformation with the construction of a new \$260 million campus, it represented the largest municipal undertaking in the history of Attleboro, Massachusetts. Breaking ground in October 2019, and opening its doors for the first time in September 2022, the AHS is a four-story edifice encompassing 475,000 square feet with the capacity to accommodate 1,725 students.

Project Motivation

Massachusetts is considered a leader in the United States when it comes to energy efficiency standards, and the state provides financial incentives to districts that build highly efficient schools. The new construction was expected to conform to the Massachusetts Ninth Edition of the MA State Building Code 780 guidelines, which closely follows the energy efficiency requirements of ASHRAE 90.1-2013.

"The Green Schools Program is a system of reimbursement that provides monetary benefits to schools that opt for sustainable, high-performance designs," says Derek Bride, Principal at Consulting Engineering Services (CES). "The Green Schools Program was certainly on our minds from the start of the project, and we wanted to ensure they'd be eligible for benefits," Derek said.

Under the Green Schools Program, the Massachusetts School Building Authority (MSBA) rewards school districts an additional 2% reimbursement for projects that meet its sustainable building design requirements. In the case of AHS, this would mean a reimbursement upwards of \$4.0 million.

All new schools in Massachusetts are required to exceed ASHRAE 90.1 by at least 10%. Green Schools, however, must achieve LEED certification, which requires that buildings exceed the energy efficiency requirements of the ASHRAE Standard 90.1 by at least 20%.

System Design

With overall budget considerations in mind, CES originally designed a traditional pressure dependent HVAC system. "Engineers often assume that going pressure independent is going to be too costly in terms of parts, but it's not always the case," said Paul Carter from Arden Engineering Constructors/Earthwise Energy Technologies, the mechanical and controls contractor on the job.

Pressure independent HVAC systems offer substantial benefits over traditional pressure dependent designs, providing improved energy efficiency and lower maintenance costs over

time. But also, PI systems can save money during the construction phase.

"In a pressure independent system, the need for circuit setters and manual balancing is eliminated because each control valve regulates its own flow rate regardless of pressure changes. This reduces both materials and installation costs," Paul explained.

Familiar with Belimo's pressure independent control valve offering, Paul quickly concluded that the Belimo EPIV offered the perfect balance of performance and affordability for the larger valves in the system. "The EPIV is great for managing higher flow rates. The integrated electronic flow sensor uses a robust control algorithm which talks to the actuator and adjusts the valve to compensate for pressure variations, performing dynamic balancing. This ensures system efficiency."

The EPIV assembly integrates a characterized ball valve, a high-performance actuator, a flow sensor equipped with glycol compensation, a temperature sensor, and flow control logic all-in-one unit. Despite fluctuations in system pressure, the EPIV maintains the flow set point by adjusting the characterized control valve based on the measured true flow.



"We used the EPIV in parts of the system where the flows were above 9 GPM, about 62 assemblies in total. But, for flow rates under 9 GPM, we went with an affordable, compact mechanical PI solution from Belimo, the 2-way ZoneTight PIQCV," Paul explained.

The Belimo ZoneTight PIQCV is a mechanical pressure independent control valve with an ultra-small form factor, making it ideal for tight spaces. It combines a spring-action differential pressure regulator with a 2-way valve to ensure a consistent flow regardless of any variations in system pressure. The PIQCV's actuator operates at just 0.3W, which conserves energy and transformer power. 223 PIQCVs were used throughout the system at AHS.

Customer Satisfaction

"Thanks to Belimo, we were able to deliver the customer a far superior system for the same amount of money," Paul added. "Using PI valves cut costs on parts, and avoiding the need for manual balancing saved on labor," he said.

"The current projected energy usage in the building is 32 kBtu/SF, which is 36% better than the baseline," according to Dave Hillburn, a Senior Mechanical Engineer at CES. "That well exceeds the performance required to

become LEED certified and receive the 2% reimbursement. The system will run more efficiently, will be easier to maintain, and will save the school money down the line."

EPIV Features

- Ultrasonic flow measurement technology and glycol compensation enable true flow measurement and total volume readings
- A temperature sensor integrated into the flow body allows accurate fluid temperature measurement and glycol monitoring
- Maintains pressure independent operation eliminating the need for manual balancing valves, reducing installation and commissioning
- Digital workflows support device commissioning and operation with the Belimo Assistant App
- The App enables remote calibration and commissioning report that can be generated automatically



BELIMO

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www.belimo.com

BACnet France Launches New Website Integrated into Unified BACnet Web Presence



bacnetfrance.org

BACnet France has recently unveiled its revamped website, now fully integrated into the unified BACnet web presence. This consolidation of multiple online platforms has a significant backstory:

A few years ago, BACnet International and BACnet Interest Group Europe (BIG EU) identified a growing challenge in the digital landscape: scattered information about the BACnet protocol appeared across various websites, often inconsistent or overlapping. This fragmentation complicated the search for clear and reliable information.

In response, BACnet International led an initiative to merge key informational hubs into one cohesive web framework. As a result, the new unified platform now encompasses:

- ASHRAE SSPC 135 Committee (BACnet Committee)
- BACnet International
- BACnet Interest Group Europe
- BACnet Testing Laboratories (BTL)
- The BACnet Institute (TBI)

The latest addition, BACnet France, now elevates this consolidation further. The redesigned site brings:

- a streamlined, modern structure and navigation,
- bilingual content (French and English)
- improved accessibility, ensuring that insights and resources from the French BACnet community are easily available to an international audience.

Altogether, the updated platform strengthens BACnet France's digital presence and contributes to the global visibility and accessibility of the BACnet protocol.

Deep Dive: New BACnet France Website Features

- **Clear and Comprehensive Navigation:** Website visitors can easily access a wide range of information including membership benefits, association overview, BTL Certification, journals, events, and more! Visitors can also access other BACnet organizations in the global BACnet community.
- **BACnet Secure Connect (BACnet/SC):** BACnet France offers a plethora of BACnet/SC information including trainings, their secure data project, and exclusive content for BACnet France members.

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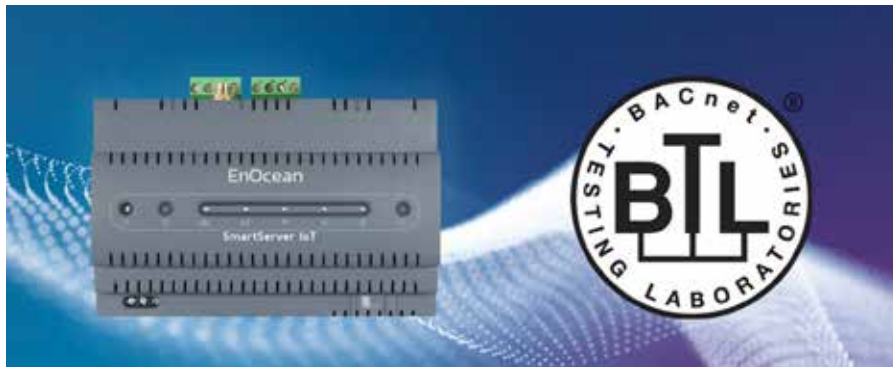
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Smarter Airports with Battery-Free Wireless Sensors



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SmartServer IoT © EnOcean

Bridging BACnet and Wireless EnOcean Technology

Airports are complex infrastructures where facility managers face significant challenges in maintaining high levels of passenger comfort while keeping energy use in check. Varying occupancy patterns across terminal zones – gates, lounges, baggage claim – require flexible, real-time environmental data to support optimal HVAC and lighting. Battery-free wireless sensors, integrated with BACnet-based building automation systems, provide an efficient, scalable solution for these challenges.

Scalable Sensing for Smart Terminals

Continuous monitoring of indoor environmental quality demands extensive sensor deployment – particularly across high-traffic public buildings like airport terminals. A conventional approach using wired or battery-powered sensors becomes cost-prohibitive due to installation labor and maintenance needs.

For example, Heathrow's four main terminals span over 540,000 m². Ensuring comfort and air quality in such a space requires dense sensor coverage – typically one CO₂ sensor per 2500 m², plus temperature, humidity, illumination, and motion detection. Roughly 400 multi-sensor devices would be necessary, each traditionally involving either extensive wiring or periodic battery replacement.

To address this challenge, multi-functional, battery-free wireless sensors powered by ambient energy sources offer a compelling alternative. With a pair of devices providing integrated temperature, humidity, CO₂, light, and

occupancy detection, each pair minimizes the number of units needed while maximizing data coverage.

Energy Harvesting: No Wires, No Batteries

These sensors use indoor solar cells to harvest energy from ambient light enabling permanent operation without external power or batteries. Data transmission is wireless and can be easily integrated with BACnet-based systems, ensuring seamless integration into existing building management frameworks.

Installation becomes dramatically simplified: sensors can be adhered directly to walls or ceilings, eliminating the need for wires or battery maintenance. The result is a future-proof sensor infrastructure that is highly adaptable to spatial reconfigurations or operational shifts – ideal for dynamic environments like airports.

Integrating with the BACnet Network

The EnOcean SmartServer IoT integrates battery-free sensor data into the existing BACnet building management system. Each sensor appears as a digital twin with location and key values like CO₂, temperature, and humidity. These BACnet objects behave just like those from wired devices, making integration seamless. The SmartServer also supports semantic tagging with standards like Project Haystack or Brick Schema to simplify use in analytics and optimization tools.

Conclusion

Battery-free wireless sensors represent a transformative technology for large-scale facilities. By harnessing energy harvesting and BACnet integration, airports can significantly improve passenger comfort while achieving demonstrable energy savings. These next-generation sensing technologies will play a critical role in making airports smarter and greener spaces.

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Rich Blomseth
Director of Product Management at EnOcean
www.enocean.com

EnOcean
Sustainable IoT

New to the BACnet International Community



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

Learn more about membership opportunities with BACnet International.



New Silver Members



Rolbit

With 34 years of experience in the industry, Rolbit offers a broad line of products including HVAC thermostats and controllers, zone control systems, motion detectors, hotel room control. Their products can interface with multiple BMS systems and incorporate communication protocols such as Modbus, KNX, and BACnet.

**26 Hashoham St.
Barkan Industrial Zone
Israel, 4482000**
<https://rolbit-thermostat.com/>



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To thus contribute to the functioning and well-being of society, based on the premise that at times humans make mistakes and machines break down, we are inspired to pursue and attain consistently high levels of safety, ANSHIN, and well-being, and protect humans even in unforeseen circumstances. We are determined to continue providing innovation and value as we enter a new era, sustaining the commitment we have had since our foundation, expanding it on a global scale, and staying on course toward the next milestone, our 100th anniversary.

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Micro Control Systems

Micro Control Systems (MCS) designs and manufactures microprocessor-based controllers for the hostile environment of the HVAC/R industry. Founded in 1994, MCS controls are used by OEMs all over the world. We believe our success is built on having a close relationship with our OEM's and independent contractors. MCS is proud to be the North American stock distributor of Hanbell compressor products. Hanbell offers hermetic and open drive screw compressors, as well as standard & magnetic, (oil-free) centrifugal compressors. MCS also produces industrial control panels and provides a wide variety of peripheral devices to complement our controllers including temperature, pressure, humidity, and current sensors. MCS provides support software for Windows-based pc's that allows the user to monitor and interact with the controller from anywhere in the world.

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Shenzhen Sunricher Technology Co., Ltd. (Sunricher), founded in 2007, is a high-tech enterprise certified by TÜV SÜD ISO 9001:2015, specializing in intelligent lighting control system and smart home technologies, with a focus on LED controllers and dimmable drivers. Over the years, Sunricher has grown rapidly and become a leading supplier in the intelligent lighting control industry, driven by a highly skilled R&D team and a 12,000+ square meter manufacturing facility spanning two floors. Sunricher offers a comprehensive range of lighting control solutions, including DALI-2, DMX512/RDM, KNX, 0/1-10V, ZigBee, Z-Wave, Bluetooth Mesh, RF/WiFi, Matter, and more. For further information, please visit our website at www.sunricher.com. Sunricher is a proud member of several prestigious industry organizations, including the DALI Alliance, DALI-CFG (DALI Alliance China Focus Group), KNX Association, CSA (formerly ZigBee Alliance), Bluetooth SIG, ZHAGA Consortium, Thread Group and LoRa Alliance.

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www.sunricher.com

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Coster Group was founded in 2017 from the merger of Coster Tecnologie Elettroniche, well established Italian company leader in HVAC controls with Regula, system integrator focused in innovative solutions for energy optimization and monitoring. Today, Coster Group is a leading Italian company in the field of automation, controls and energy monitoring systems for industrial, commercial and residential buildings. 90 persons: 25 in R&D department, 35 in our own manufacturing plant. Our distribution and after-sales network is widespread all over Italy, with 30 commercial agencies; we are also present in England with our UK branch and in some other European countries.

**Via San G. B. De La Salle
4/A – 20132, Milano, Italy**
www.costergroup.eu

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**233 Washington Ave, Suite L1
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<https://uvangel.com/>



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BeaconMedaes is a global leading specialist in Medical Gas Solutions, providing safe, reliable, and innovative products and services for healthcare facilities around the world. Our extensive network of local customer centers and international distributors allow us to deliver our advanced medical gas solutions to any location. This global sales presence, along with our consistent commitment to after-sales support, shows our dedication to fulfilling the ongoing needs of our customers.

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Rock Hill, SC 29730, USA
www.beaconmedaes.com/

Silver to Platinum Member



Armstrong Monitoring

As a pioneer in the gas detection industry, Armstrong Monitoring is dedicated to pushing the boundaries of innovation in environmental monitoring technology. Our journey began with a shared vision of creating cutting-edge solutions that empower industries to make informed decisions to ensure the safety of building occupants and protect valuable assets. Our mission is to revolutionize the way industries approach environmental monitoring. We believe that precise data is the cornerstone of effective decision-making, and we are committed to providing accurate, reliable, and real-time monitoring solutions that empower our clients to take action with confidence.

215 Colonnade Road South
Ottawa, Ontario, Canada
<https://armstrongmonitoring.com/>



Dent Instruments

For more than 35 years, DENT Instruments, located in Bend, OR, has manufactured power meters, data loggers and energy audit equipment that measure and monitor energy use for residential buildings, large companies, retail outlets, data centers and telecommunications. The monitors provide real-time energy data, identify energy inefficiencies, and facilitate tenant billing. With 22 employees and growing, DENT's products and services help thousands of customers worldwide.

925 SW Emkay Drive
Bend, OR 97702, USA
www.dentinstruments.com



Greystone Energy Systems, Inc.

Greystone has manufactured HVAC sensors and transmitters for over 40 years for building and energy management systems. Our expertise with sensory type devices and custom design engineering capability has complimented many original equipment manufacturers for building automation and direct digital control. Distributors, contractors, and facility engineers have trust in the Greystone brand delivering quality assured and competitive priced product to their commercial and light industrial projects.

321 Desbrisay Avenue
Moncton, N.B.
Canada E1E 0J2
<https://greystoneenergy.com/>

Expand your BACnet Knowledge



The BACnet Institute (TBI) continues to grow. There are now over 15,000 registered users, and articles and presentations are continually being added to the Resources section, providing many materials to help you and your colleagues stay connected and engaged. A better-informed community brings positive change, so take a moment to expand your knowledge of BACnet as well as encourage others!

Multi-Level and Multi-Lingual Materials in Resources

With over 220 articles and presentations focused primarily on BACnet, the TBI library offers a variety of topics, in different languages and expert levels. Among the top articles accessed are "An Introduction to BACnet," "Deploying and Maintaining BACnet Systems in Today's Networks," "LED Lighting – An Automation Armageddon," "Cybersecurity for BACnet BAS Webinar," and many more. Also, check out the bi-lingual "Device Profile Families Facilitate Planning" article by Bernhard Isler. Check back often, since articles will continue to be added.

Interactive Courses Fit into Your Schedule, and Offer FREE CEUs & PDHs!

There are three interactive courses available on TBI, and, as an IACET Accredited Provider, BACnet International offers FREE Continuing Education Units (CEUs) upon completion of each course. Professional Development Hours (PDHs) are also available upon completion. The three courses are:

- BACnet Basics - a comprehensive course that covers all the basics of BACnet. Don't know anything about BACnet or need a refresher? This is an excellent course to take.
- The Facility Manager's Guide to Building Automation Systems. You don't need to be a facility manager to take this course, in fact, this course is incredibly beneficial to anyone who works in the building



automation industry.

- BACnet Device Profiles - introduces learners to the various BACnet device profiles and explains the role of each in the building automation. It also shows the learner how various profiles can be combined in a single device and explains the rules behind the combinations.
- NEW! BACnet Cybersecurity - provides an overview of BACnet Secure Connect (BACnet/SC), focusing on its significance in enhancing the security of interoperable building automation systems.

A Community Forum to Get Your BACnet Questions Answered

The BACnet Community Forum is an interactive environment that offers knowledge-sharing and provides an opportunity for users to submit BACnet-related questions to be answered by a panel of experts in the BACnet industry.

Participants in the forum can submit new discussions, reply to discussions, and receive updates of peer posts through email subscriptions. Answers to submitted questions are posted in the forum, which can then be searched by all registered users.

Past discussions submitted through the Cornell University BACnet-L email list server are also included.

Visit TBI!

TBI is a central and global source for BACnet knowledge and education. To access the wide array of resources and information, visit thebacnetinstitute.org to sign up or log in. 

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Tim Skell
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New BTL Listings (April 1, 2025 – September 30, 2025)

Manufacturer	Product Name	Model
ABB, Inc.	CB Series	CBX, CBX-8R8, CBX-8R8-H, CBV, CBV-2U4-3T, CBV-2U4-3T-N, CBT14, CBT-3T6-5R, CBT-4T4-2U-1R
Abies Technology Inc.	BACnet IP Thermostats/ Transmitters/ Controllers	Tx1B, Hx1B, Sx1B, Wx1B, Vx2B, Tx1B-E, Hx1B-E, Sx1B-E, Wx1B-E, Vx2B-E, Tx1B-W, Hx1B-W, Sx1B-W, Wx1B-W, Vx2B-W Where x1 is A, B, C, D, E, F, G,
AB Regin	EXOrealC family of pre-programmed controllers	EXOcompact C152T-3, C152DT-3, C283TM-3, C282T-3, C283T-3, C282DT-3, C283DTM-3, C283DT-3 EXOcompact Ardo XCA152W-4, XCA152DW-4, XCA282W-4, XCA282DW-4, XCA283W-4, XCA283DW-4, XCA283DWM-4, XCA203W-4 EXOcompact Eedo XCE163W-1 EXOcompact Vido XCV193WM-2, XCV193DWM-2 EXOdos XF192T-1, XF193TM-1, XF193DTM-1, XF192DT-1 EXOclever EC-PU4
	EXOrealC family of pre-programmed controllers, Regio Room Controllers	Corrigo E151W-3, E151DW-3, E152W-3, E152DW-3, E152DWM-3, E281W-3, E281DW-3, E282W-3, E282DW-3, E282DWM-3, E283W-3, E283DW-3, E283DWM-3 Corrigo Ardo VCA152W-4, VCA152DW-4, VCA283W-4, VCA283DW-4 Corrigo Vido VCV203DWM-2 Exigo HC191D-1, HC192DW-1, HC193DWM-1 Exigo Ardo HCA151DW-3, HCA152DW-3, HCA281DW-3, HCA282DW-3, HCA283DW-3, HCA283DWM-3 Exigo Vido HCV191DW-1, HCV192DW-1, HCV193DWM-1, HCV203DWM-1 Regio RC-A203W-4, RC-A203W-4-TP, RC-E163W-1, RC-E163W-1-TP, RCX-T, RCX-T-D, RCX-TH-D, RCX-TC, RCX-TC-D, RCX-THCVP, RCX-THCVP-D IO modules IO-A15MIXW-3-BEM, IO-A28MIXW-3-BEM, IO-V19MIXW-1-BEM
Adveco Technology Co. Ltd.	X Network Controller	BAC-3541-100, BAC-3542-100, BAC-3531-082, BAC-3532-082, BAC-3531-081, BAC-3532-081, BAC-3541-460, BAC-3542-460
Automated Logic Corporation	WebCTRL®Server	WC-A, WC-S, WC-P, WC-LS
	OptiFlex™ Network Isolator	OFISO-E2
	OptiFlex™ Compact Segment Router	OFCSR-E2
	OptiFlex™ BACnet Hardware Integrator	OFHI-A
	OptiFlex™ BACnet Building Controller	OF028-NR-A
	OptiFlex™ BACnet Building Controller	OF1628-NR-A
	OptiFlex™ BACnet Building Controller	OF1628-A
	OptiFlex™ Integration Router	OFINT-E2
Azbil Corporation	Advanced Controller for pump unit Advanced Controller for chiller unit Advanced Controller	WJ-1102P1x1x2x3x4Wx5 where x1 is 2,4, or 8 x2 is 3, or 4 x3 is 0,1,3, or 5 x4 is 0,1,2,3 or 4 x5 is null or -U 1.0.2; WJ-1102Qy1y2y3y4y5Wy6 where y1 is 1, or 2 y2 is 2,4, or 8 y3 is 2,3,4, or 6 y4 is 0,1, or 3 y5 is 0,1,2,3, or 4 y6 is null or -U 1.0.2; WJ-1103W0000, WJ-1103W0000-U
BeaconMedaes	TotalAlert 360 Controls	TA360-S
Beijing Hailin Control Technology Inc.	Harlin H Series Digital Controller	HD1407, HD1407S, HD1407E, HD0904, HM1405, HM0704, HM0008, HM0800, HM0004, HD-16, HM0004A

bticino	UXOne	BT-465001, BT-465002, BT-465003, BT-465004, BT-465005, BT-465006, BT-465007, BT-465008, BT-465080, BT-465081, BT-465082, BT-465083, LG-048900, LG-048901, LG-048902, LG-048903, LG-048904, LG-048905, LG-048906, LG-048907, LG-048980, LG-048981, LG-048982, LG-048983, LG-048923, LG-048924, LG-048925, LG-048927, LG-048928, LG-048929, LG-048930, BT-465015, BT-465023, BT-465024, BT-465025, BT-465027, BT-465028, BT-465029, BT-465030
Carrier Corporation	TruVu™ MPC Controller, non-routing	TV-MPCXP1628-NR
	i-Vu Pro User interface	CIV-OPNPR, CIV-OPNPRUL, CIV-OPNPR32, CIV-OPNPR5, CIV-OPNPR-LS
	TruVu™ Compact BACnet Router	TV-CRB-E2
	TruVu™ Isolated Network Router	TV-ISO-E2
	SystemVu	CEPL131117-02-R, CEPL131117-03-R
	SmartView	CEPL131172-01-R, CEPL131228-01-R, CEPL131167-01-R, CEPL131226-01-R, CEPL131171-01-R, CEPL131227-01-R, CEPL131228-04-R, CEPL131226-02-R, CEPL131227-02-R, CEPL131256-01-R, CEPL131258-01-R, CEPL131260-01-R, CEPL131358-01-R, CEPL131360-01-R
	TruVu™ Compact Link BACnet Integrator	TV-CLB-E2
Carrier Japan Corporation	BN Interface	BMS-IFBN1281U-E, BMS-IFBN1281U-TR, BMS-IFBN1281U-UL, 40VCBB1-8FJEE
CoolAutomation Ltd.	CoolMaster EDGE	CoolMaster EDGE
	CoolMaster CoolLinkBridge	CoolMaster, CoolMasterPRO, CoolMasterLT, CoolMasterNet, HBN200-PRO; CoolLinkBridge, DCABAS-10, DCABAS-48
DAIKIN Industries Ltd.	MEGA-Q BACnet MS/TP Communication Adaptor	DTA118C71
Danfoss Drives A/S	NovoCon	S, M, L, L-SU, L-SD, XL
Distech Controls, Inc.	Eclipse Series	ECY-APEX, ECY-103, ECY-203, ECY-253, ECY-300, ECY-350, ECY-400, ECY-450, ECY-600, ECY-650, ECY-303, ECY-PTU-107, ECY-PTU-207, ECY-PTU-208, ECY-TU-203, ECY-S1000, ECY-VAV, ECY-VAV-POE, ECY-STAT-R, ECY-STAT-Z, ECY-STAT-F, Resense Move
EBTRON, Inc.	Gold Series Dual Ethernet Output Airflow and Temperature Measuring Device	GTS108e, GTS116e
	Gold Series GTB108e	GTB108e, GTB116e
EnOcean Edge Inc.	SmartServer and SmartConnect Series	72201R-240, 72201R-248, 72220-A, 72220-P
Fr. Sauter AG	BACnet/SC Software Hub	YZP483F310
Gebäude Automatisierung GmbH	AS-M B50	B50

Honeywell International	Honeywell TC300 Thermostats	TC300B-G, TC300C-G, TC320B-G, TC320C-G, TC320C-N, TC303B-G, TC321B-G, TC322B-G, TC300C-G1, TC320C-G1, TC303C-G, TC322C-G, TC321C-G
	Honeywell ComfortPoint™ Open Plant Controller	CPO-PC400, CPO-PC200, CPO-PC410
	Honeywell ComfortPoint™ Open Plant Controller	CPO-PC500, CPO-PC600, CPO-PC100, CPO-PC250
	Honeywell Enterprise Buildings Integrator™	2025
	Programmable Enhanced BACnet IP Controller	PEC8445-PB1-S0, PEC8445-PB1-SM, PEC8445-FB1-S0, PEC8445-FB1-SM
	Programmable Enhanced BACnet IP Controller	PEC8044-PB1-S0
	Programmable Enhanced BACnet IP Controller	PUC8445
Intesis (HMS Industrial Networks, SLU)	Intesis BACnet Server 700 Series	Modbus to BACnet IP & MSTP, KNX to BACnet IP & MSTP, DALI to BACnet IP, DALI to BACnet IP & MSTP, M-Bus to BACnet IP & MSTP, M-Bus to BACnet IP, Panasonic VRF Systems to BACnet IP & MSTP, Hisense VRF Systems to BACnet IP & MSTP, Hitachi VRF Systems to BACnet IP & MSTP, Mitsubishi Electric to BACnet IP & MSTP, Mitsubishi Heavy Industries VRF to BACnet IP & MSTP, Midea VRF to BACnet IP & MSTP, Samsung NASA VRF to BACnet IP & MSTP Daikin VRV to BACnet IP & MSTP Bosch VRF to BACnet IP & MSTP Fujitsu VRF to BACnet IP & MSTP York VRF to BACnet IP & MSTP
	Intesis HVAC Interface Series 2E	"Universal Infrared AC to BACnet MSTP Daikin Domestic to BACnet MSTP Daikin VRV and Sky to BACnet MSTP Fujitsu RAC & VRF to BACnet MSTP Hitachi VRF systems to BACnet MSTP Mitsubishi Heavy Ind. FD & VRF to BACnet MSTP Mitsubishi Electric Domestic, Mr.SI.&CityM to BACnet MSTP Panasonic Etherea AC to BACnet MSTP Daikin A2W to BACnet MSTP Mitsubishi A2W to BACnet MSTP"
iSMA CONTROLLI S.p.A.	BACnet Modbus I/O Modules - COMPACT Series	BMIO-0800, BMIO-8000, BMIO-0404, BMIO-4004, BMIO-4040, BMIO-0004, BMIO-00004, BMIO-0400ETH, BMIO-4000ETH, BMIO-0404ETH, BMIO-4004ETH, BMIO-4040ETH, BMIO-0004ETH, BMIO-00004ETH
	MINI-Series	iSMA-B-8U, iSMA-B-8U-IP, iSMA-B-8I, iSMA-B-8I-IP, iSMA-B-4I40-H, iSMA-B-4I40-H-IP, iSMA-B-4U40-H, iSMA-B-4U40-H-IP, iSMA-B-4U4A-H, iSMA-B-4U4A-H-IP, iSMA-B-40-H, iSMA-B-40-H-IP, iSMA-B-4TO-H, iSMA-B-4TO-H-IP
	Multiprotocol I/O modules: MIX-series, Max-series	iSMA-B-MIX18, iSMA-B-MIX38, iSMA-B-MIX18-IP, iSMA-B-MIX38-IP, iSMA-B-24I, iSMA-B-120-H, iSMA-B-24I-IP, iSMA-B-120-H-IP
Johnson Controls Inc.	Application and Data Server (ADS), Extended Application and Data Server (ADX)	MS-ADS05U, MS-ADX10U, MS-ADX10SQL, MS-ADX25U, MS-ADX25SQL, MS-ADX50U, MS-ADX50SQL2, MS-ADX50SQL, MS-ADX100U, MS-ADX100SQL2
	NAE85 Network Automation Engine, LCS85 LonWorks® Control Server	MS-NXE85SW-0, MS-NXE85SW-6, MS-LCS85SW-0, MS-LCS85SW-6
	Metasys Critical infrastructure Manager	Metasys CIM
	EasyIO Neo Series Serial Port Communication Module	CM-485
Kieback&Peter GmbH & Co. KG	Qanteon	Version 1

KMC Controls	Conquest II Controller Family	BAC-5901AC, BAC-5901AC-AFMS, BAC-5901ACE, BAC-5901ACE-AFMS, BAC-5971AC, BAC-5971AC-AFMS, BAC-5971ACE, BAC-5971ACE-AFMS, BAC-9001A, BAC-9001ACE, BAC-9021A, BAC-9301A, BAC-9301AC, BAC-9301ACE, BAC-9311A, BAC-9311AC, BAC-9311AC-AFMS, BAC-9311AC-AMD, BAC-9311ACE, BAC-9311ACE-AFMS, BAC-9311ACE-AMD
KMC Controls	Conquest II BACnet Router	BAC-5051AE
Legrand	BACnet Interface	EN-SW-BACNET
Lennox International Inc.	Lennox CORE Lite Unit Controller	107996
LS Electric, Automation Solution	BACnet/IP Driver	XGL-EDGT
Meitav-tec Ltd.	Configurable Terminal Unit Controller with BACnet communication	CTU ARM 2500-x1-x2-x3-x4-x5, CTU ARM 2501-x1-x2-x3-x4-x5, CTU ARM 2524-x1-x2-x3-x4-x5, CTU ARM 2601-x1-x2-x3-x4-x5, CTU ARM 2646-x1-x2-x3-x4-x5, CTU ARM 2701-x1-x2-x3-x4-x5 where x1 is 3, 3S, AC, C1, C2, C3, FC, CP, H1, H3, IRD, P, P2, PM2, WS, PD, SUPER, 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, UV, SH, null x4 is VFS, BT, HU, PE, 110V, WET, 24VAC, OUT12, FAN, 190988, DIM, F, 115V, 24V, IN, GES, UV, EC, SUPER, SH, null x5 is 01, 02, 24, AHU, DIM, EC, FA, FC, HCP, HU, MGD, STI, SUPER, T4, TRAFO, TVA, VAV, UV, SH, null
METZ CONNECT GmbH	BMT-Modules	BMT-Multi-I/O 11089313, BMT-TP 11088813, BMT-F-TP 1108881370, BMT-AI8 11088213, BMT-F-AI8 1108821370, BMT-AO4 1108851302, BMT-F-AO4 110885130270, BMT-AOP4 1108871302, BMT-F-AOP4 110887130270, BMT-AOP2 1108871303, BMT-F-AOP2 110887130370, BMT-CI4 1108901332, BMT-F-CI4 110890133270, BMT-DI10 1108811319, BMT-F-DI10 110881131970, BMT-DI4 1108841319, BMT-F-DI4 110884131970, BMT-DI4-IP65 1108841319IP, BMT-DIO4/2 1108831326, BMT-F-DIO4/2 110883132670, BMT-DIO4/2-IP65 1108831326IP, BMT-DIO4/2-IP65 230 V 1108830526IP, BMT-DO4 1108861321, BMT-F-DO4 110886132170, BMT-SI4 11088913, BMT-F-SI4 1108891370, BMT-TO4 11088013, BMT-F-TO4 1108801370 2.2 MB-Modules MB-DIO ₂ /1-IP65 1108110526IP, MB-DIO ₂ /1-IP65 230V 1108111326IP, MB-DIO4/2-IP65 1108120526IP, MB-DIO4/2-IP65 230V 1108121326IP
	BMT-Routers	BMT-RTR 11088001, BMT-F-RTR 1108800170
	BACnet Server for EWIO ₂	110904, EWIO ₂ -BM, 110909, EWIO ₂ -W-BM (with WLAN), 110935, EWIO ₂ -M-BM (with M-Bus), 110934, EWIO ₂ -MW-BM (with both)

MSA Safety, Inc.	ProtoNode / ProtoAir / ProtoCessor / ProtoCarrier / QuickServer / EZ Gateway / BACnet IoT Gateway	FPC-Ny-x where y = Hardware platform (1, 2, 3, 4, 35, 36, 38, 39, 40, 41,42,43, 54, 64) x = Customer configuration parameters (0000-9999) FPA-Wy-x, FPA-Cy-x where y = Hardware platform (1, 2, 3, 4, 35, 36, 38, 39, 40, 41,42,43, 54, 64) x = Customer configuration parameters (0000-9999) FPC-EDy-x where y = Hardware platform (1, 2, 3, 4, 35, 36, 38, 39, 40, 41,42,43, 54, 64) x = Customer configuration parameters (0000-9999) FPC-Cy-x where y = Hardware platform (1, 2, 3, 4, 35, 36, 38, 39, 40, 41,42,43, 54, 64) x = Customer configuration parameters (0000-9999) FS-QS-yabd-F, PS-QS-yabd-F where a = Point count available (0 = 250, 1 = 500, 2 = 1,000, 3 = 3,000, 4 = 5,000, 5 = 10,000) b = RS232 or RS-485 (0 = RS-485, 1 = RS-232) d = LonWorks or RS-485 (1 = LonWorks, 0 = RS-485) y = Hardware platform (1, 2, 3, 4, 35, 36, 38, 39, 40, 41,42,43, 54, 64) FS-EZa-g-g where a = Point count available (0 = 250, 1 = 500, 2 = 1,000, 3 = 3,000, 4 = 5,000, 5 = 10,000) g = Protocol combination (Modbus, KNX, M-Bus, BACnet) FS-IoT-BAC
Netix Global B.V.	IoT / Smart Building / Network Controller	NXM-IP0800, NXBC-16P-8044, NXBC-16P-8044-D
Neuberger Gebäudeautomation GmbH	Open.Room	RP8100, RP8101, RP8102, RC8100
OEMCtrl	WebCTRL for OEM	WC-OEM, WC-OEM1, WC-OEM10
	OptiCore™ Isolated Network Router	OC-ISO-E2
	OptiCore™ Compact Gateway	OC-GW-E2
Optergy Pty. Ltd.	P442	P442
Panasonic Life Solution India Pvt Ltd.	FIN-BACnet-OWS	FIN-BACnet-OWS 5.1.6,
Panotec Co., Ltd.	BrainEye SKIA	SK8CD-PAN, SK18CD-PAN, SK32CD-PAN
Price Industries	Stream	TA24D
Reliable Controls Corporation	RC-FLEXone-M®	RCFO-M-242, RCFO-M-242-C, RCFO-M-242-C-H, RCFO-M-242-H, RCFO-M-444, RCFO-M-444-C, RCFO-M-444-C-H, RCFO-M-444-H, RCFO-M-646, RCFO-M-646-C, RCFO-M-646-C-H, RCFO-M-646-H, RCFO-M-848, RCFO-M-848-C, RCFO-M-848-C-H, RCFO-M-848-H
	RC-RemoteAccess®	RC-RA3
Schneider Electric - Eliwell Controls S.r.l.	Modicon M172 Family	TM172PBG42RI, TM172PBG28RI, TM172PBG28SI, TM172PBG42R, TM172PBG28R, TM172PBG42RICQS, TM172PBG07R, TM172PBG18R, TM172PDG42RI, TM172PDG42SI, TM172PDG28RI, TM172PDG28SI, TM172PDG42R, TM172PDG28R, TM172PDG42S, TM172PDG28S, TM172PDG07R, TM172PDG18R, TM172PDG18S, TM172OBM42R, TM172OBM28R, TM172OBM18R, TM172ODM42R, TM172ODM28R, TM172ODM18R, TM172PBG07RC01, TM172PBG42RIC01, TM172PBG28RIC01, TM172PBG42RIC02, TM172PBG18RC01, TM172PBG18RC02, TM172PBG28RIC02, TM172PBG42RIC03

Schneider Electric	ION Product Family	PM8000 Power Meter Series, ION9000 Power Meter Series, ION7400 Power Meter Series
	SpaceLogic Thermostat - TC900 Series	TC903-EF4LDPSA, TC903-3A4LXPA, TC903-3A4PDPSA-24, TC903-3A4PDPSA, TC903-3A4LDPSA, TC903-EF4PDPSA, TC907-EF4LDPSAB, TC907-EF4LDPSA, TC907-3A4LXPA, TC907-3A4LXPA, TC907-3A4PDPSA-24B, TC907-3A4PDPSA-24, TC907-3A4PDPSAB, TC907-3A4PDPSA, TC907-3A4LDPSAB, TC907-3A4LDPSA, TC907-EF4PDPSAB, TC903-EF4PDPSA
Shenzhen MEK Intellisys Pte Ltd.	IoT/Smart Building/Network Gateway	SG-100-BM, SG-100-BS1
Shina System Co. Ltd	Lighting Control Unit series	LCU-2000, LCU-2200B, LCU-2200, LCU-3000B, LCU-3000
Siemens	Intelligent Valve	ASE4U10A (EVG4U10A015, EVG4U10A020, EVG4U10A025, EVG4U10A032, EVG4U10A040, EVG4U10A050, EVF4U20A065, EVF4U20A080, EVF4U20A100, EVF4U20A125, EXG4U10A015, EXG4U10A020, EXG4U10A025, EXG4U10A032, EXG4U10A040, EXG4U10A050, EXF4U20A065, EXF4U20A080, EXF4U20A100), ASE4U10D (EVF4U20D0250, EVF4U20D0300, EVF4U20D0400, EVF4U20D0500, EVF4U21D0250, EVF4U21D0300, EVF4U21D0400, EVF4U21D0500)
	Climatix C600, Climatix C600S	POL648.10, POL648.15, POL648.80, POL648.85, POL688.10, POL688.15, POL688.80, POL688.85, POL698.10, POL698.15, POL698.80, POL698.85, POL69U.10, POL69U.15, POL69U.80, POL69U.85
	Desigo PXC7, PXC5 and PXC4 Automation Station	PXC7.E400L, PXC7.E400S, PXC7.E400M, PXC5.E003, PXC5.E24, PXC4.E16, PXC4.M16, PXC4.M16S, PXC4.E16S, PXC4.E16-2, PXC4.E16S-2, PXC4.M16-2, PXC4.M16S-2
	DESIGO OPTIC	FIN-BACnet-OWS
Silvair	Silvair BACnet GW	Minew G1-E
TongFang Technovator Int. (Beijing) Co., Ltd.	Techcon Neosys Series	MCB, ECU1206
Tridium, Inc	VYKON IO	DDC-8043
Viessmann Holding International GmbH	Vitogate	300



Calendar of BACnet International Events

20256	Event	Location
February 2 nd – 4 th , 2026	AHR Expo – Booth C540	Las Vegas, Nevada

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