

# JOURNAL OF BUILDING AUTOMATION



**Issue  
29**

**Advancing Interoperability  
in Smart Buildings**

A PUBLICATION BY:



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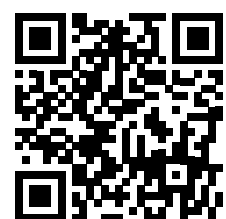
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# Letter from the President

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


Welcome to this issue of BACnet International's Journal of Building Automation. BACnet passed the 30-year mark as an ASHRAE standard last December, and the milestone invites a straightforward question: how much impact has it had? Our AHR Expo 2026 recap sets the scene – nearly 54,000 attendees, a record 1,039 BTL-listed products, and four well-attended educational sessions from The BACnet Institute. But the announcement that deserves the most attention came from a University of New Hampshire study quantifying, for the first time, the cumulative carbon impact of three decades of BACnet-enabled building automation.

"How Smarter Buildings Have Quietly Cut Global Carbon Emissions" presents those findings in full. Since 1995, BACnet-enabled systems have avoided an estimated 1.4 billion metric tons of CO<sub>2</sub> equivalent globally – comparable to the combined annual emissions of Japan and Spain – with projections reaching 2.1 billion metric tons by 2030. The savings come from electricity reductions in cooling-heavy markets like the United States and from natural gas savings in heating-dominated climates across Europe and Canada. Buildings have long been acknowledged as a major emissions source; this research begins to quantify what three decades of smarter operation on the other side of that ledger looks like.

"Why BACnet Endures: An Owner First Standard" traces how a founding orientation toward owner interests has guided every evolution of the standard, from BACnet/IP to BACnet Secure Connect, always providing a path forward without forcing replacement of existing infrastructure. The latest evolution is now landing on job sites, and "BACnet/SC in the Field: A Contractor Migration Playbook" addresses the practical reality head-on. Written for the people doing the work, it is a field-tested guide to avoiding the schedule and integration surprises that catch teams off guard in the mixed legacy environments that are the rule on virtually every real project.

Reliable outcomes depend on reliable data. "When BACnet Data Goes Wrong: Diagnosing and Resolving Data Integrity Issues in Building Automation Systems" offers a structured methodology for tracking down the priority conflicts, mapping errors, and unit mismatches that produce values that are consistent but wrong – a particularly insidious failure mode. Looking further ahead, "When Buildings and Bodies Finally Talk: From Automated to Programmable" argues that the convergence of BACnet/SC, ASHRAE 223P, edge AI, and digital twins is carrying the industry across a genuine threshold: from buildings that react to conditions, to buildings that can be given an intended outcome and reason their way to it. The article pushes further still, making the case that people inside those buildings are part of the overall system and need to be integrated in a standard, interoperable way, too.

We pull it all together with a case study that grounds all of this in a real building. Four Embarcadero Center in San Francisco retrofitted its chilled water system where BACnet/IP connected valves achieved a 28% reduction in energy use and roughly \$131,000 in annual savings from the chiller plant alone. Equally telling: the data surfaced a stuck bypass valve that had been silently wasting energy for years. Visibility enabled diagnosis, and diagnosis enabled correction that would otherwise have gone unnoticed – a clean illustration of how interoperable, standards-based systems pay dividends well beyond their initial scope.

Taken together, these articles describe a standard that has been doing significant work quietly for three decades and is well-positioned for what comes next. None of it happened loudly. That, perhaps, is the nature of infrastructure that works. 

Enjoy the read!



Andy McMillan  
President and Managing Director  
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## 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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# BACnet SC in the Field: A Contractor Migration Playbook



BACnet Secure Connect, often called BACnet/SC, is no longer a “future” feature that only shows up in vendor roadmaps. Cybersecurity has become a major driver in many building automation decisions today, and BACnet/SC is landing in specifications, owner standards, and IT security reviews as a result. For contractors, that shift brings opportunity and pressure at the same time. The opportunity is a clearer cybersecurity story, better alignment with IT expectations, and a modern network foundation that can scale. The pressure is that most buildings are not clean-slate projects, they are a mix of BACnet MS/TP trunks, BACnet/IP segments, legacy supervisory devices, and third-party integrations that still have to work on day one.

This article is a contractor-focused playbook for migrating from MS/TP and BACnet/IP to BACnet/SC. It is written for the people who have to make it run, support it, document it, and hand it off. The goal is not to turn the reader into a cybersecurity expert. The goal is to reduce surprises, protect schedules, and deliver a system that the owner can operate and expand with confidence.

## Why BACnet/SC is showing up on projects now

Owners and engineers are being asked to treat building automation networks like any other network used for business operations. That means encrypted communications, strong authentication, and fewer vulnerabilities in the architecture. In many organizations, Building Automation System (BAS) cyber requirements are being driven by IT policies, insurance carriers, and risk management teams. Even when the facilities group is comfortable with traditional BACnet/IP, organization-wide security policies often are not.

From a contractor standpoint, the key point is simple. BACnet/SC changes the default posture of the network. Instead of depending on an isolated BAS Local Area Network (LAN) and a collection of informal remote access habits, BACnet/SC is designed to operate in a security-conscious environment. That difference matters most when the BAS network must coexist with corporate infrastructure and modern cybersecurity expectations.

## BACnet/SC in contractor terms

Most contractors already understand MS/TP and BACnet/IP in practical terms.

- MS/TP is the fieldbus. It is reliable when it is built correctly, but it requires discipline around wiring, biasing, grounding, termination, and device counts.
- BACnet/IP is the network layer most of us use to connect controllers, routers, and supervisory devices across Ethernet.

BACnet/SC adds a secure communication model that uses WebSockets, TLS encryption, and certificate-based trust. The part that matters in the field is not the vocabulary, it is what changes in your workflow.

With BACnet/SC:

- Device onboarding is no longer based simply on IP reachability.
- Trust is explicit, not assumed.
- Secure connectivity depends on certificates, time, and configuration that must be planned, not improvised.

Think of it this way. MS/TP is about clean wiring and stable trunks. BACnet/IP is about sound IP networking. BACnet/SC is about sound IP networking plus an added layer of security that must be commissioned just like the controllers and their sequence.

### Migration scenarios contractors could face

Most projects fall into one of these patterns:

#### 1. Retrofit in a single building

- Existing MS/TP trunks and a legacy IP front end.
- New controllers are being added, but old ones remain for years.

#### 2. Campus or multi-building owner

- Buildings are connected by an enterprise network.
- IT requires segmentation, firewall rules, and control of remote access.

#### 3. Addition or expansion

- A new building must integrate with an older BAS.
- The new building is held to modern standards, the old building is not.

#### 4. Partial modernization

- The owner is replacing the head end and some field controllers now.
- The rest will come later, often in phases tied to equipment replacement.

Your playbook should always assume mixed environments. The migration plan fails when it assumes the entire world will convert at once.

### Architecture patterns that work in the field

Contractors win when they standardize architectures that are repeatable. BACnet/SC does not mean everything becomes BACnet/SC immediately. A practical approach is:

- Keep MS/TP where it makes sense, especially for existing installed trunks that are stable.
- Keep BACnet/IP where it is needed, especially for existing devices that do not support BACnet/SC and will need to remain in service.
- Introduce BACnet/SC as the new secure backbone for new supervisory infrastructure, modern integrations, and owner standards moving forward.

A contractor-friendly architecture often looks like this:

- MS/TP trunks land into routers.
- Routers and IP devices sit on a BAS Virtual Local Area Network (VLAN).

- BACnet/SC is used for the segments where secure connectivity is required, especially where IT insists on encryption and explicit trust.

The key is to avoid turning the project into an all-or-nothing conversion. Use BACnet/SC where it provides clear value, and bridge to legacy where needed with a plan that protects uptime.

### Preconstruction checklist that prevents field pain

BACnet/SC projects can fail before anyone pulls a single wire if the contractor does not drive alignment between the owner's facilities team, the owner's IT or cybersecurity group, the engineer, and any integration partners. This step is critical. If network architecture, remote access, certificate responsibilities, and acceptance criteria are not agreed to in writing during preconstruction, those decisions will surface later during startup and they almost always cost schedule.

Before ordering hardware and before finalizing submittals, confirm the items below.

#### 1. Device support and firmware

- Which devices support BACnet/SC today.
- Minimum firmware versions required.
- Any licensing or feature enablement needed.

#### 2. Integration inventory

- What third-party systems are tied to the BAS today.
- What protocols and connection types those integrations use.
- What must remain operational throughout the cutover.

#### 3. Network expectations

- Who supplies and configures switches.
- Whether the BAS network is segmented, and how.
- Whether VLANs and firewall rules are required.

#### 4. Remote access

- What method is preferred or permitted, and what is prohibited.
- Whether IT requires a jump box, VPN, or approved secure access platform.
- Who owns credentials and who approves access changes.

#### 5. Certificate decisions

- Who owns certificate generation and lifecycle.
- Where certificates will be stored, and who can renew them.
- What happens if a certificate expires after turnover.

If these questions are not answered early, they will be answered late. Late answers usually cause project delays.

### Cybersecurity coordination with IT

The biggest shift with BACnet/SC is not technical, it is organizational. Contractors are used to owning the BAS network end to end. IT teams are used to owning anything that touches Ethernet. BACnet/SC forces those worlds to coordinate.

A practical contractor approach is to define responsibility boundaries in writing. Here is a simple split that works on many projects:



### Controls contractor typically owns:

- BAS devices and their configuration.
- BACnet objects, naming conventions, point lists, and sequences.
- Commissioning tests and functional validation.
- BAS documentation and handoff deliverables.

### Owner IT typically owns:

- VLAN creation and IP address allocation policy.
- Firewall policy and routing between VLANs.
- Remote access standards and approval processes.
- Enterprise certificate policies, if they require using corporate certificate infrastructure.

The contractor should also bring “translation” to the conversation. IT does not want ports opened broadly “because BAS needs it.” They want an explicit list of what is required and why, with a minimal exposure approach.

### Certificates and trust, explained without the headache

Certificates can sound intimidating, and sometimes they are. Contractors do not need to be experts in certificate systems to succeed with BACnet/SC, but they do need a clear plan for certificate ownership, storage, and renewal. The best approach is to treat certificates like a commissioning deliverable.

The key contractor takeaways:

- Certificates have an owner.
- Certificates expire.
- Certificates must be documented and transferred at turnover.

If the owner wants IT to own the certificate lifecycle, that needs to be decided early. If the

owner expects the controls contractor to provide and manage certificates, that also must be explicit, including what happens after warranty.

Common field pitfalls include:

- Certificates generated without a renewal plan.
- Certificates stored in one person’s laptop without a documented handoff.
- Incorrect time synchronization causing certificate validation issues.
- Expired certificates that cause sudden loss of connectivity months after turnover.

Contractors can prevent most of this with a simple deliverable: a certificate register, a clear renewal responsibility statement, and a turnover checklist item that the owner signs.

### What changes in startup when BACnet/SC is involved

Traditional BACnet/IP startup often looks like this:

- Power devices.
- Confirm IP settings.
- Verify network connectivity.
- Discover devices at the head end.
- Start building graphics and sequences.

BACnet/SC adds steps that must be staged deliberately:

- Establish secure connectivity and trust.
- Validate the secure communication path.
- Confirm discovery and data exchange under the secure model.
- Document the configuration so service teams can reproduce it.

The field lesson is that you do not want to be learning BACnet/SC onboarding at 2 a.m. during an outage window. Build a lab approach into the project, even if it is small. Validate the onboarding workflow and the required IT settings before the cutover.

### Commissioning workflows and acceptance testing

Commissioning on a BACnet/SC job should test more than “device online.” It should validate communication integrity and operational performance. Contractors can create a repeatable test pack:

#### Connectivity and trust tests

- Confirm devices establish secure connections as designed.
- Confirm expected discovery behavior.
- Confirm failure behavior, such as what happens if a device loses trust or time sync.

#### Performance validation

- Confirm key points trend correctly and at reasonable intervals.
- Confirm alarms behave as designed and route correctly.
- Confirm change of value behavior or polling behavior does not overload the network.

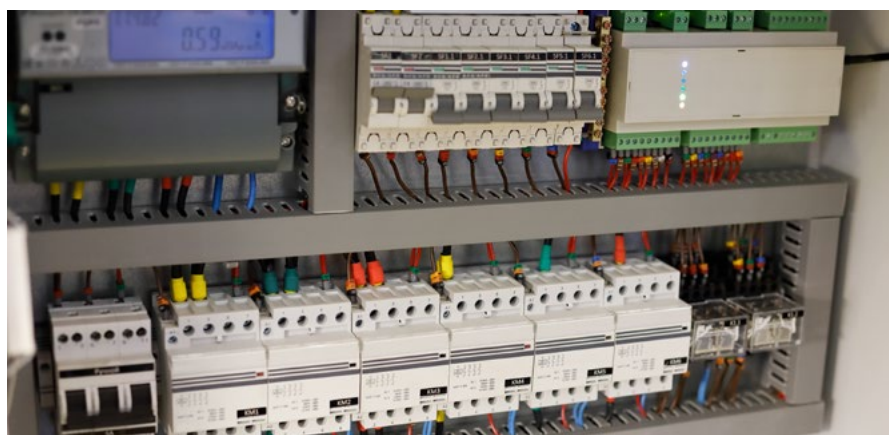
#### Operational tests

- Verify graphics are mapped correctly.
- Verify schedules, overrides, and safety sequences.
- Verify integrations that rely on BACnet data remain stable.

For acceptance, consider providing the owner with a short “proof of supportability”. Show that a service technician can securely connect, identify a device, view key trends, and confirm alarm status without bypassing security. Owners care about cybersecurity, but they care even more about maintaining operations.

### Coexistence strategies for legacy MS/TP and BACnet/IP devices

The most common real-world requirement is





coexistence. Legacy devices cannot always be replaced, and some will remain for years. Contractors should plan coexistence as a stable end state, not as a temporary inconvenience.

Practical coexistence strategies include:

#### Parallel networks with controlled bridging

- Keep legacy BACnet/IP and MS/TP on their existing segments.
- Introduce BACnet/SC for new systems and supervisory layers.
- Bridge where necessary through routers and approved integration methods.

#### Staged cutovers

- Convert one building or one system at a time.
- Validate each phase with a commissioning checklist.
- Avoid touching stable legacy trunks unless there is a clear scope and benefit.

#### ABOUT THE AUTHOR

Chris Ruth is a building automation professional with Integrated Facility Services, where he has spent 20 years helping design and manage systems that improve comfort, energy efficiency, and indoor air quality in buildings. He is a past Chair of the Missouri Gateway Green Building Council and serves as President Elect of the ASHRAE Ozarks Chapter. Chris developed the current ASHRAE eLearning Course on DDC Networks and Protocols. He is an Adjunct Professor of HVAC Controls and regularly facilitates programs for ASHRAE, MSPMA, MGGBS, and other organizations. He volunteers with K-12 Schools on developing and implementing low cost/no cost sustainability projects.

#### Gateway use with caution

- Gateways can solve short-term needs, but they can add long-term support complexity.
- Document what the gateway is translating, what features are not supported, and how it is monitored.

The contractor's job is to protect uptime. Legacy coexistence is successful when the owner experiences the migration as "organized improvement," not "rolling instability."

#### Using testing and certification to reduce integration risk

Trade readers know the pain of "BACnet compatible" devices that do not behave as expected. Contractors can reduce risk by using certification and documentation practices during selection and submittals.

Practical steps:

- Prefer devices with BACnet Testing Laboratory (BTL) Certification when possible.
- Request and review device capability documentation before approval.
- Validate that required objects and services are actually supported.

This is not about paperwork for the sake of paperwork. It is about preventing change orders, avoiding schedule impacts, and ensuring the

delivered system is supportable without vendor-specific workarounds.

#### Common field issues, and how to avoid them

Many BACnet/SC project failures trace back to a few predictable patterns:

##### 1. Unclear ownership of certificates and renewal

- Fix with a certificate register and a documented owner.

##### 2. Late involvement of IT

- Fix by bringing IT into preconstruction and requiring network decisions early.

##### 3. Mixed device support discovered too late

- Fix by validating firmware and feature support during submittals, not during startup.

##### 4. Under-scoped commissioning time

- Fix by treating BACnet/SC commissioning as a real scope item with defined tests and deliverables.

##### 5. Remote access confusion

- Fix by documenting the approved path and testing it before turnover.

**Closing:** A contractor mindset for BACnet/SC success

BACnet/SC does not replace good BAS fundamentals. It builds on them. Contractors who already deliver clean MS/TP trunks, stable IP networks, strong naming conventions, and disciplined commissioning are positioned to succeed. The difference is that BACnet/SC adds a security layer that requires planning, coordination, and documentation, not improvisation.

If you approach BACnet/SC as "just another protocol," it will bite you in schedules and support calls. If you approach it as a deliverable, with clear ownership, repeatable architecture patterns, and a commissioning workflow built for secure connectivity, it becomes a competitive advantage. In the field, that is ultimately what owners expect, a secure system that still behaves like a building system should. 🛡️

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# When Buildings and Bodies Finally Talk: From Automated to Programmable

In 2017, I co-authored an article for this journal's Foundations publication about BACnet Web Services. The thesis was simple: what happens when building data becomes accessible through standard web APIs? When any application, anywhere, can query a building's state the same way a browser queries a website? Nine years later, I want to ask a different question. A harder one. What happens when we do the same thing – but for people?

## BACnet's Unfinished Revolution

Let us take stock of where BACnet has brought us. From serial trunk cables to BACnet/IP. From IP to Web Services. From Web Services to BACnet Secure Connect – TLS 1.3 encryption, certificate-based device authentication, zero-trust architecture. And now, through the collaboration between ASHRAE's BACnet Committee, Project Haystack, and Brick Schema, we are building ASHRAE Standard 223P: a unified semantic data model that finally gives BACnet points meaning, not just connectivity.

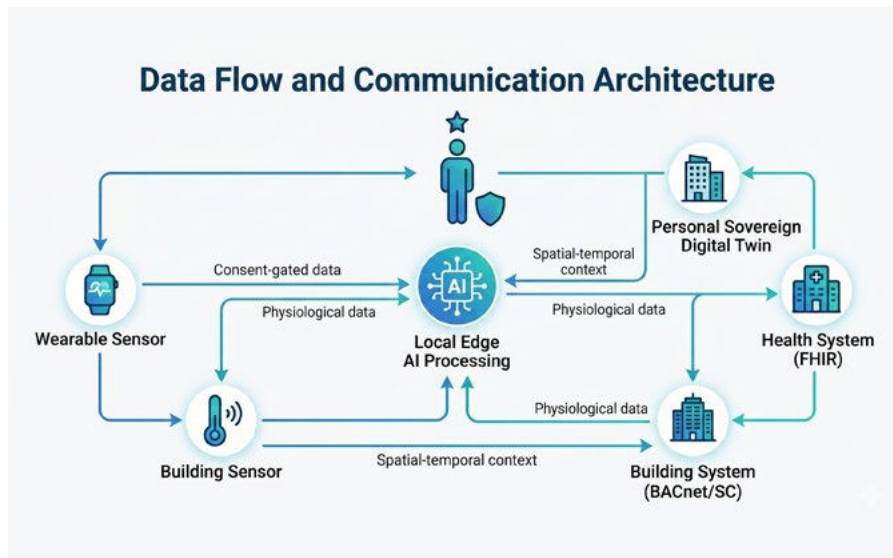
This is remarkable. BACnet carries the signal. Haystack and Brick tag it with context. 223P harmonizes the two so a point discovered through BACnet can be understood semantically by any application that speaks the standard. You can now discover a device AND understand what it does, what it serves, and how it relates to the rest of the building – all through open standards.

Ken Sinclair – founder of AutomatedBuildings.com, where I have published over 47 articles and host the Beyond Buildings podcast – once framed the challenge: we need to "make buildings aware of what they really need to be aware of." BACnet, in its many dialects, brings us closer to that goal than anything before it.

But I have spent the last four years building something else entirely. And it has forced me to confront an uncomfortable truth: BACnet made buildings aware of themselves. We never made them aware of the people inside them.

## The Fragmentation We Know – And the One We Ignore

Anyone who has worked in real estate knows the pattern. Asset owners do not know where



Data Flow and Communication Architecture

their data is, who controls it, how fragmented it is, or what value it could unlock if understood longitudinally. Buildings are managed through dozens of disconnected systems – BMS, lighting, fire, access, energy – each generating data that never meets the data from the system next to it. We have been fighting this fragmentation for decades.

Now consider: people experience the exact same fragmentation with their own bodies.

When a close relative of mine was diagnosed with cancer, I did not first see a medical failure. I saw a design failure – the same design failure I had been fighting in buildings. Everything that mattered about her life before she became a patient was invisible. Her heart medication was not accounted for by her oncologist. Her lifestyle history was irrelevant to the system. Data existed, but it lived in disconnected systems that never spoke to each other.

I recognized the pattern immediately:

Buildings	People
Data scattered across BMS, HVAC, lighting, fire, access	Data scattered across GPs, specialists, labs, wearables, pharmacies
No shared model of the building	No shared model of the person
Owners do not control their data	Individuals do not control their data
Snapshots, not longitudinal understanding	Episodes, not longitudinal care
BACnet solved the protocol layer	No equivalent exists for people

BACnet gave buildings a programmable interface. People still do not have one. And until they do, any building that claims to optimize for "occupant comfort" is optimizing for an abstraction, not a person.

## From Automated to Programmable

This is where I want to push our industry's thinking forward.

In 2019, I introduced what I called the BB-Cycle – the Building Buzz Breakdown – a framework mapping how metadata tagging, digital twins, IoT, edge computing, streaming platforms, and security converge in building automation. The argument was that these technologies are not separate innovations. They are an interconnected cycle, and the real barriers to adoption are organizational, not technical.

Seven years later, the cycle has matured. Haystack and Brick have merged their efforts into 223P. BACnet/SC has solved the security

layer. Edge computing has brought inference to the device level. Digital twins have moved from concept to deployment. What emerges from this convergence is something fundamentally new: the programmable building.

An automated building reacts. A programmable building can be told an outcome and figure out how to get there.

You do not tell a programmable building "set zone 3 to 22°C." You tell it "optimize this zone for the health and productivity of its occupants while reducing energy consumption by 15% relative to last quarter." The building – through BACnet/SC for device communication, 223P for semantic understanding, digital twins for simulation, and edge AI for local inference – works out the how.

This is the shift from building automation to building intelligence. From reactive to intentional. From data-driven to impact-driven.

### Precision Automation Meets Precision Medicine

Medicine went through the same shift. For decades, medicine was reactive – you got sick, you got treated, you got discharged. The same protocol for everyone. Now, precision medicine promises treatment tailored to your genetics, your lifestyle, your specific physiology. Not population averages. You.

Our industry needs the same revolution. Call it precision automation.

Precision automation means the HVAC system does not optimize for "thermal comfort" – a statistical abstraction. It optimizes for this person's comfort, right now, based on their physiology. The lighting does not follow a schedule. It follows a circadian pattern that is personalized and health-informed. Air quality

thresholds are not generic – they are specific to the respiratory profiles of the people in the space.

But here is the critical insight: precision automation is not possible without intelligence inside the building.

If all the intelligence lives in the cloud, you have latency, you have data sovereignty issues, and worst of all – you have a building that goes dumb when connectivity drops. Precision medicine does not work if the hospital loses its records every time the internet goes down. Precision automation does not work if the building cannot think for itself.

This is why edge-native intelligence is not a nice-to-have. It is the resilience layer. BACnet was designed for reliability – it runs on dedicated networks precisely because building systems cannot afford to fail. Edge AI must follow the same design principle. Local inference. Local models. Local decision-making. The cloud is a collaborator, not a dependency.

### Why Visual Reality Is the Foundation

But protocols and AI alone are not enough. Data is not understanding.

In my research on scaling digital twin deployments in Swedish buildings, I documented what I called "shadows" – interpretations of truth filtered through outdated systems and abstractions (Waern, 2025b). Drawing on Plato's cave allegory: participants in a four-month deployment discovered they had never encountered their building as a tangible entity. They had only ever experienced it through fragmented dashboards and spreadsheets. The moment they saw a visual, spatial representation of their building – with live data embedded in the geometry of reality – knowledge transfer

accelerated. Silos dissolved. People who had never spoken to each other suddenly had a shared language.

The shared language was not a protocol. It was reality itself, rendered visually.

The Minimal Interoperability Mechanisms (MIMs) framework recognizes this: context – spatial, temporal, human – is a first-class interoperability dimension. Technical and semantic interoperability can succeed while knowledge transfer fails, if people cannot see what the data means in the context of their physical world. Visual representation of reality is not a visualization layer on top. It is the foundation that makes everything else meaningful.

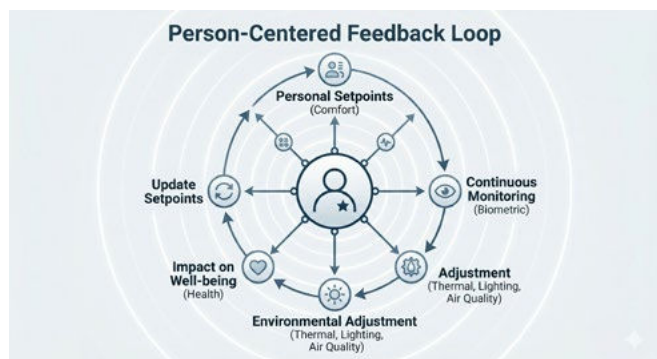
This is what the BACnet ecosystem needs to internalize. We have the protocol (BACnet/SC). We have the semantics (Haystack, Brick, 223P). We have the security (TLS 1.3, zero-trust). What we need now is the visual grounding – the spatial, temporal, reality-anchored representation that turns data into understanding and understanding into action.

And if this works for buildings – and it does – it works for people too.

### One API to the World

People need what buildings now have: a programmable interface. A sovereign, standardized way to represent their data, their preferences, their boundaries – and to control what is shared, with whom, under what conditions.

Just as BACnet/SC introduced certificate-based authentication for every device, a personal interface must be consent-based and user-controlled. The person is the certificate authority of their own body. Healthcare already has FHIR.



Person-Centered Feedback Loop

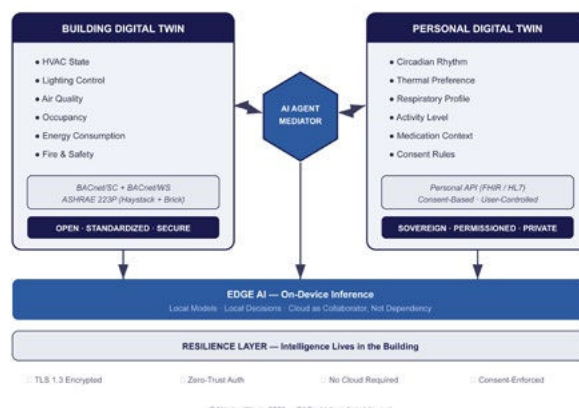


Figure 1: The Two-API Architecture – When Buildings and Bodies Talkture



Figure 1: The Two-API Architecture – When Buildings and Bodies Talk

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Buildings have BACnet. The missing piece is the bridging layer – the interface that lets a building's intelligence query a person's needs with the same standardized, secure pattern that one BACnet device uses to query another.

And just as visual reality makes building data meaningful, visual reality makes personal data meaningful. Not lab reports. Not portal logins. Your reality – your body, your environment, your trajectory through time – rendered as a living model that you, your care providers, and the built environment around you can all reason about.

When the building has a digital twin and the person has a digital twin, something unprecedented emerges: digital twins communicating with digital twins. The twin is not a dashboard – it is what I have called a "boundary-spanning object" (Waern, 2025a). A shared representation that bridges different worlds. The building twin bridges facility managers, engineers, and occupants. The personal twin bridges the individual, their care providers, and their environment. Both grounded in visual reality. Both sovereign. Both programmable.

### Contextual Interoperability: Six Layers Deep

Making this work requires interoperability far beyond what we typically discuss in BACnet circles. In my Zenodo research, I proposed a six-layer model (Waern, 2025a):

1. **Technical** – can systems exchange data? (BACnet/SC: yes)
2. **Semantic** – do they understand each other? (223P/Haystack/Brick: getting there)
3. **Legal** – are they permitted to share? (GDPR, HIPAA, building codes: complex)
4. **Social** – do stakeholders trust the exchange?
5. **Contextual/Spatial** – does the exchange account for where, when, and for whom?
6. **Resilience** – can shared meaning persist when systems fail?

Our industry excels at layers one and two. But when a building's intelligence communicates with a person's health data – when precision automation meets precision medicine – all six layers are in play. Legal frameworks must span building codes AND health data law. Trust

must exist between occupant and building operator. Context must be spatial, temporal, AND physiological. And the system must remain resilient – coherent when sensors fail, when people move, when regulations change.

The BACnet community is uniquely positioned to lead this conversation. We solved interoperability for buildings when no one else could. The same discipline – the same commitment to open standards, vendor independence, and practical deployment – is exactly what is needed to bridge the gap between buildings and the people who inhabit them.

Figure 2: The BB-Cycle Revisited — From Automated to Programmable (2019 → 2026)

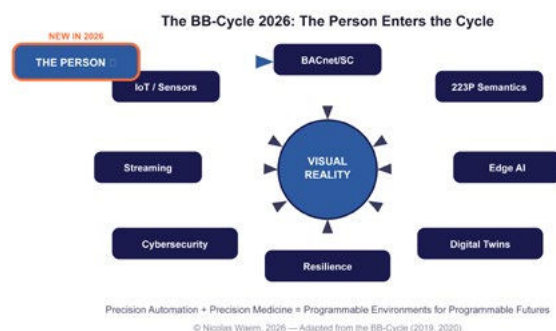
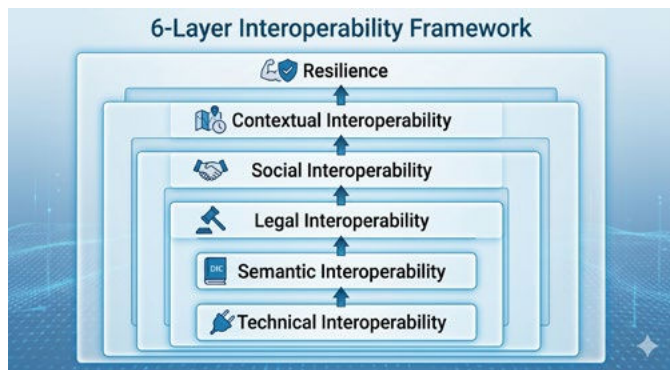


Figure 2: The BB-Cycle Revisited – From Automated to Programmable (2019 → 2026)



6-Layer Interoperability Framework



Programmable Realities Venn

### The BB-Cycle, Revisited

When I first drew the BB-Cycle in 2019, it mapped the convergence of metadata tagging, digital twins, IoT, edge computing, and cybersecurity. Today, the cycle has expanded:

- Metadata evolved into semantic ontologies (223P)
- IoT evolved into edge-native intelligence
- Digital twins evolved into boundary-spanning objects – visual reality models that transfer knowledge
- Cybersecurity evolved into BACnet/SC and zero-trust architecture
- Cloud evolved into federated, edge-first computing

And now a new element enters the cycle: the person. Not as an occupancy sensor reads them – as a count. But as a sovereign digital twin, with their own API, their own consent model, their own visual representation of reality.

The cycle is no longer about making buildings smarter. It is about making environments intelligent – environments where buildings and bodies are part of the same system, the same data fabric, the same visual reality. Where you can tell the system an outcome you want – for

the building, for your health, for the planet – and the system shows you how to get there. Past, present, and simulated future. Zoom out to see the whole. Zoom in to act on the specific.

### The Road Ahead

I will be honest about the obstacles. Standards bodies for buildings and standards bodies for healthcare do not attend each other's conferences. Regulatory interoperability barely exists. Liability questions – if a building adjusts conditions based on health data and something goes wrong – are unresolved.

But these are governance barriers, not technical ones. BACnet/SC proved that an entire industry can adopt a new security model when the architecture is sound and the need is clear. The BACnet community has done harder things than this.

Intelligence must live in the building – not just in the cloud, not just in phones, not just in data centers. Because when the connection drops, the building must still think. When the person is at risk, the environment must still respond. Resilience is not a feature. It is the foundation. And BACnet has always understood that.

Not building automation. Not automated buildings. Not even smart buildings.

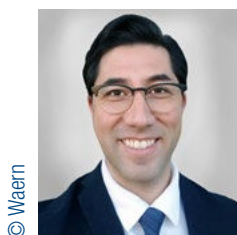
Programmable environments, for programmable futures. One API to the building. One API to the person. Both open. Both sovereign. Both grounded in reality.

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# How Smarter Buildings Have Quietly Cut Global Carbon Emissions

## The climate impact of building automation and the BACnet standard (1995–2030)

Commercial buildings are a hidden giant when it comes to climate change. Offices, schools, hospitals, stores, and other non residential buildings use enormous amounts of energy for heating, cooling, lighting, and ventilation. Globally, buildings account for a large portion of all energy related carbon emissions, making them an important sector for climate action.



While new technologies like renewable energy and electric vehicles get most of the attention, a powerful climate tool has been quietly working in the background for decades: building automation systems, or BAS.

A new global study from researchers at the University of New Hampshire shows just how large that impact has been and how much more potential remains.

### What are building automation systems?

Building automation systems are the “brains” of modern buildings. They automatically manage systems like:

- Heating and air conditioning
- Ventilation
- Lighting
- Scheduling and occupancy control

Instead of running equipment at full power all the time, BAS adjust building operations in real time based on conditions like temperature, occupancy, and time of day. This improves comfort while reducing wasted energy.

Most modern BAS rely on BACnet, an open communication standard first developed in the 1990s. BACnet allows equipment from different manufacturers to work together, making building automation cheaper, more flexible, and easier to scale worldwide. Today, BACnet is used in more than 190 countries.

### What did the study examine?

The researchers looked at 30 years of global building automation, from 1995 to 2025, with projections through 2030. They analyzed commercial buildings in four regions:

- United States
- Canada
- Europe
- Rest of the World

Rather than examining single buildings, the study tracked automation adoption across entire building stocks. It asked a simple but powerful question:

How much carbon pollution has been avoided because buildings have become smarter?

To answer this, the researchers combined data on:

- Commercial building floor area
- Energy use before and after automation
- Adoption rates of BAS and BACnet
- Regional electricity and natural gas emissions
- How building automation performance changes over time

### The headline result: a massive climate benefit

The findings are striking. Between 1995 and 2025, building automation systems enabled by BACnet avoided an estimated: 1.4 billion metric tons of carbon dioxide (CO<sub>2</sub>e).

That’s roughly equivalent to:

- The entire annual emissions of Japan and Spain
- Removing 300 million cars from the road for a full year
- The annual carbon sequestration of 56 billion mature trees, a forest that would cover two-thirds of the landmass of the US

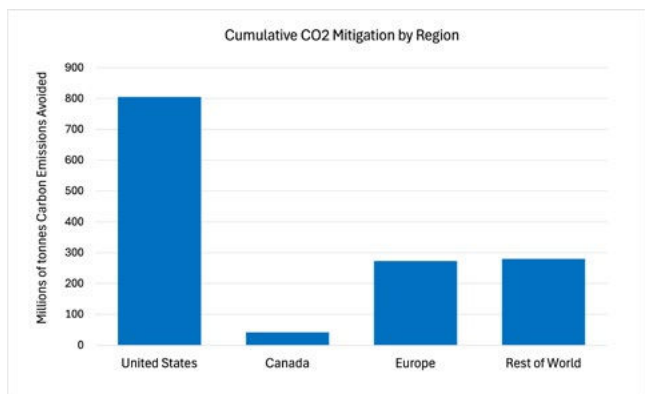


Figure 1. Cumulative carbon emissions avoided by region from 1995–2025.

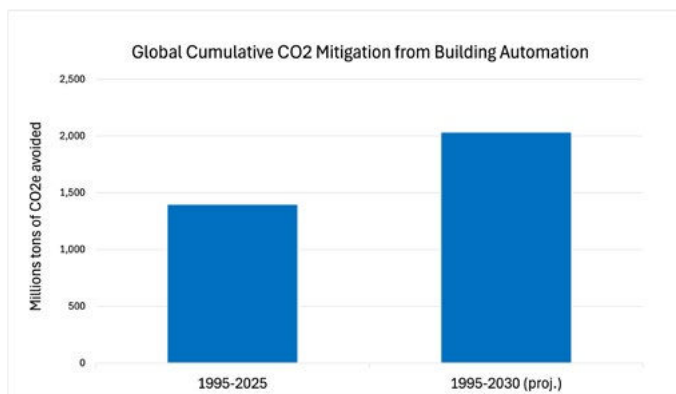


Figure 2. Global cumulative carbon mitigation from building automation.

The United States accounts for the largest share of avoided emissions (about 805 million tons), largely due to its massive commercial building stock, early adoption of automation, and due to electric generation producing more carbon. Europe contributes around 273 million tons, while the Rest of the World adds 280 million tons. Canada's total is smaller (42 million tons), but still significant relative to its building stock size.

An important insight from the study is that where the carbon savings come from depends on climate and energy systems.

- United States: About 70% of reductions come from electricity savings, due to high cooling and lighting demand.
- Europe and Canada: A much larger share comes from reductions in natural gas use, especially for heating in colder climates.

This means automation delivers climate benefits in different ways depending on local conditions.

If current trends continue, cumulative avoided emissions are expected to reach approximately 2.1 billion metric tons of CO<sub>2</sub> by 2030. This shows that building automation is not a one time efficiency gain, it delivers benefits year after year as systems accumulate across the building stock.

### Electricity vs. natural gas: an important difference

One of the useful insights from the study is that not all carbon savings come from the same energy source.

Globally, about 70% of avoided emissions come from electricity savings, while 30% come from reduced natural gas use. However, this balance varies by region:

**United States:** Electricity dominates due to cooling, lighting, data, and historically carbon intensive power generation.

**Europe:** Natural gas plays a much larger role because of widespread gas based heating.

**Canada:** Gas savings are especially important given long heating seasons and already low carbon electricity grids.

This matters because electricity grids are decarbonizing, while the carbon content of natural gas combustion remains basically unchanged.

### Why annual savings grew – then slowed

Each year, new buildings adopt automation while older automated buildings continue operating. This creates a “stacking effect,” where carbon savings grow year after year as more building cohorts come online.

However, after about 2015, the growth in annual carbon savings began to slow. This happens for two main reasons:

1. Automation adoption is maturing, especially in large commercial buildings.
2. Electricity grids are getting cleaner, meaning each kilowatt-hour saved avoids less carbon than it used to.

This is good news overall, it reflects progress in clean energy, but it means energy efficiency must work alongside grid decarbonization.

### Automation still saves energy – but carbon benefits depend on the grid

A key insight from the research is that building automation continues to save energy for decades, even as technology ages.

However, the climate impact of those savings changes over time.

- As electricity becomes cleaner, carbon savings from electricity efficiency decline.
- Natural gas savings remain highly valuable because burning gas produces roughly the same carbon emissions over time.

This makes automation especially important for heating efficiency and for managing buildings as they electrify in the future.

### Why maintenance and recommissioning matter

The study also finds that automation performance gradually declines if systems are not maintained. Sensors drift, equipment settings are overridden, and software becomes outdated.

When systems are replaced or recommissioned, performance rebounds, but the carbon benefit may be smaller if the electricity grid has already cleaned up.

This highlights an important policy lesson:

Maintaining and optimizing existing automation systems is just as important as installing new ones. Modern BACnet systems make this easier by allowing centralized monitoring, analytics, and fault detection across entire building portfolios.

### Conclusion

The results of this study point to a clear conclusion: the climate impact of building automation on a global scale would not have been possible without BACnet.

For three decades, BACnet has served as the common language that allows heating, cooling, lighting, sensors, and controls from different manufacturers to work together as unified systems. By removing vendor lock in and reducing integration complexity, BACnet made building automation practical not just for flagship projects, but for millions of everyday commercial buildings worldwide. The 1.4 billion tons of carbon emissions avoided since 1995 are not the result of a single technology or product line, but of an interoperable ecosystem that can grow, adapt, and persist.

This interoperability has proven especially important over time. As buildings age, ownership changes, equipment is replaced, and energy systems evolve, BACnet allows automation systems to be upgraded rather than abandoned. The study shows that automation systems continue delivering energy

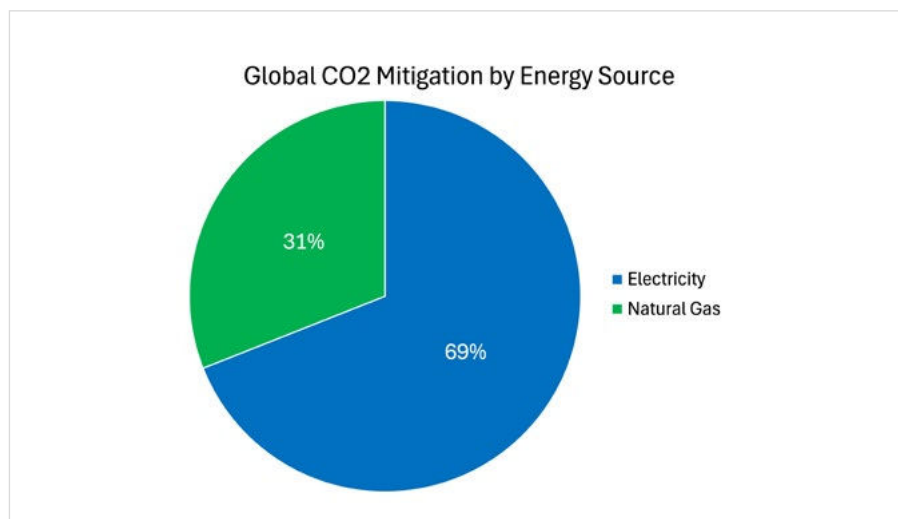


Figure 3. Global carbon mitigation split by energy source (1995–2025).



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savings over decades – and BACnet is a key reason those systems can be recommissioned, expanded, and modernized instead of becoming obsolete.

Looking ahead, BACnet’s role becomes even more critical. As electricity grids decarbonize, the carbon value of efficiency is increasingly tied to how intelligently buildings interact with the grid, not just how much energy they save. BACnet already enables advanced strategies such as demand flexibility, fault detection, analytics, and integration with distributed energy resources. These capabilities allow buildings to respond to real time grid conditions, reduce emissions during high carbon periods, and support renewable energy integration.

In regions where natural gas remains a major heating fuel, BACnet enabled controls will continue delivering strong carbon reductions by optimizing heating performance and supporting

hybrid and electrified system transitions. In this context, BACnet is not just a standard, it is a bridge technology connecting today’s buildings to tomorrow’s low carbon energy systems.

Perhaps most importantly, this study demonstrates that open standards matter for climate outcomes. The long term carbon mitigation documented here did not depend on a single policy, region, or manufacturer. It emerged from decades of global collaboration around an open, non proprietary communication framework that allowed innovation to scale.

Smarter buildings have already avoided 1.4 billion metric tons of carbon emissions and BACnet has been the quiet enabler behind that success. As the world accelerates toward net zero goals, the continued evolution and deployment of BACnet based automation will be essential to unlocking the next generation of building driven climate solutions.



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# BACnet Challenges and Opportunities in Enabling Interoperability in Smart Buildings

## Introduction

The introduction of smart buildings has brought a paradigm shift to classical infrastructure, transforming it to adaptive, intelligent spaces that are able to optimise energy consumption, enhance occupant comfort, as well as simplify operations. Such structures are made up of highly intricate and interdependent subsystems (HVAC, lighting, fire, access, and PV energy). The sharing of information and coordination of activities among devices and networks which are heterogeneous is required to operate these systems efficiently. The process of interoperability to communicate and to carry out a coordinated action, has become a key requirement towards realizing the potential of smart buildings.

The standardized BACnet, which is under the ISO 16484-5, offers a rate structure to support the unit contact and system combination in building automation. It is a vendor-neutral, object-based protocol that specifies standard data structures, communication services and network behaviours to allow devices of dissimilar manufacturers to communicate with each other. Nevertheless, though BACnet offers an interoperability foundation, little interoperability is met in operational deployments making seamless integration more of a challenge. Differences in vendor applications, compatibility with legacy systems, compatibility with other communication protocols, and security weaknesses pose hurdles to the realization of totally interoperable smart buildings. This paper evaluates such obstacles and points out emerging solutions to tap into BACnet to have powerful, open-ended and clever building automation.

This paper discusses the contribution of BACnet toward facilitating interoperability in smart buildings, identifies several challenges, and emerging opportunities associated with IoT integration, semantic data models, cloud connectivity, and secure communications. Future directions of how interoperable smart building ecosystems should be improved to achieve scalability, intelligence, and reliability. The paper concludes that the most important gaps identified are semantic interoperability and cybersecurity and middleware and BACnet/SC are viable solutions.

## BACnet and the Smart Building Ecosystem

Robust smart buildings have stratified architectures with gadgets and under groupings that interrelate with others to fulfill useful purposes. Sensors and actuators are found at the field layer and implement control commands and collect data. The control layer operates controllers that communicate the operations of the many devices, whereas the management layer offers monitoring, analytics and optimization services through supervisory systems. In this ecosystem, BACnet is a common protocol which allows homogeneous communication between devices at various layers and domains.

The open-standard, object-oriented nature of BACnet means that devices are able to broadcast information using defined services like reading and writing property values, reporting alarms and running of control commands. Its support of various types of networks, such as BACnet/IP, MS/TP, BACnet/SC and Ethernet eases integration of numerous building systems. But the protocol only guarantees technical and syntactic interoperability and does nothing much about semantic interoperability - making sure everyone understands the data meaning. Devices can share data in a correct way when there is no semantic consistency, but interpretation might differ, restricting automated analytics and system insight.

## Interoperability Obstacles in BACnet Implementations

Although BACnet is standardized and adopted in a building management system, there are a variety of challenges constraining its performance in the practical real-world applications. The major challenge is vendor-specific implementation. Respondents to the standard usually adopt subsets of the BACnet convention, or simply interpret the standard distinctly, and so the behavior of different devices may vary. Two devices can be designated as BACnet-compliant but are not completely compatible because different services are supported, or types of objects, or data processing. These differences make integration difficult and must be configured on to assure functional interoperability.

A second major problem is due to the heterogeneity of the protocol. Smart buildings are often a combination of BACnet with other protocols, such as Modbus, KNX, LonWorks, or proprietary. This heterogeneous range of protocols normally requires the use of gateways that introduces complexity, latency, and cost of operation. Likewise native BACnet supported integration is problematic with legacy building systems that do not support BACnet. In most of the cases the legacy systems are not a BACnet compatible and require protocol

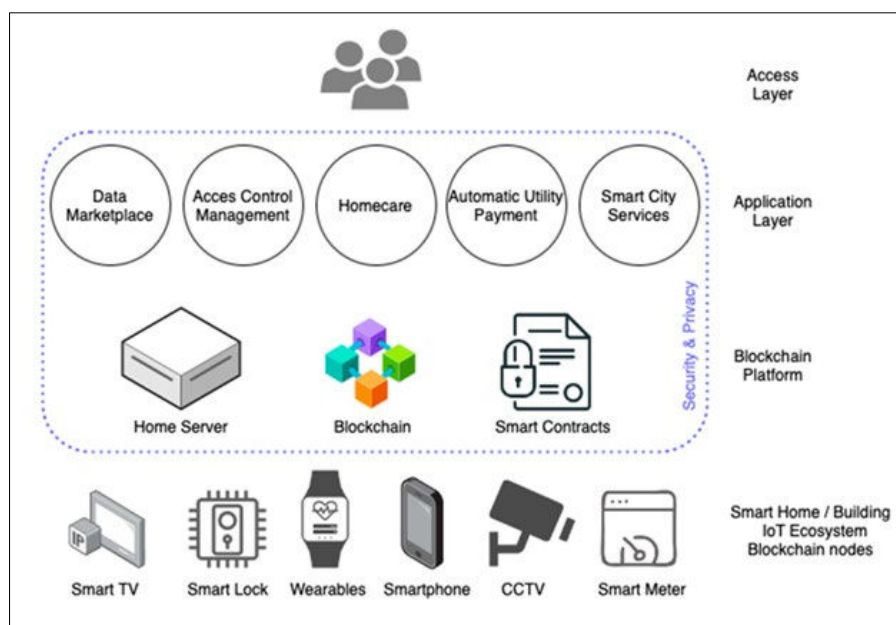


Figure 1: Generic IoT for Smart Buildings and Field-Level Automation (Source: <https://www.mdpi.com>)

converters to communicate those systems with the Building Management System during retrofitting older systems. It increases the cost and creates reliability-related issues to the project.

The consideration of scalability is another aspect, especially in big campuses or business complexes. With increased connected devices, network congestion and latency, as well as complexity in managing devices, get progressively higher. Even though BACnet/IP is enhanced with scalability, using standard IP networks, network design and segmentation is critical to guarantee the desired performance and reliability. Of constant limitation is semantic interoperability. BACnet standardizes the format of communication and data but does not dictate consistent naming or contextually sensible interpretation of the data. We can take an example of temperature sensor. The dissimilar systems temperature monitoring exhibits discrepancies in the names, units, or circumstances. It will create analytics, predictive maintenance and AI-driven automation more challenging. Furthermore, to this Cybersecurity vulnerability is another problem. With the integration of cloud computing, IT and OT (Operational Technology) networks, the increased susceptibility of systems to cyber-attacks, such as malware spreading, intruders, and data breaches are increasing. The encryption and authentication methods used in the legacy systems are inadequate or null. This needs to develop new security features.

Lastly, compliance usually fails to resolve the issues at system-level integration, making it necessary to have end-to-end interoperability testing frameworks. BACnet-based interoperability implementation testing requires considerable investment in both gateways and qualified personnel. Most facility managers do not have the technical skills to set up multi-vendor BACnet systems in a proper manner. Further demotivation to adoption comes in the costs of training and maintenance over time, especially in the small to medium size buildings. This economic impediment has frequently resulted into under-realization of the full potential of BACnet with organizations opting to have basic connectivity instead of genuine interoperability.

## Rising Possibilities for Interoperability

This section asserts that despite these challenges there are numerous new trends and technologies that can be used to support BACnet-based interoperability in smart buildings. The implementation of BACnet/IP and cloud integration also enables building systems to utilize the IP networks to provide remote monitoring services, centralized analytics, and manage more buildings remotely. This change helps connect with cloud-based IoT solutions and more advanced analytics and provides real-time decision-making and predictive processes.

Interoperability is also increased by the integration of IoT devices. IoT sensors and actuators extend and enhance monitoring abilities, offer finer data gathering, and allow automated response. The integration of IoT devices with BACnet systems will allow building managers to have predictive maintenance, energy optimization, and determine comfort among occupants as well as compatibility with old infrastructure.

Middleware platforms provide other platforms for integrating heterogeneous systems. Middleware, as protocol translators, can allow communication between systems and aggregation of their data without making large-scale changes to the current infrastructure. Like project Haystack and Brick Schema the middleware can accelerate context-aware analytics and high-level automation. It can be associated with semantic modeling frameworks. Semantic interoperability enables the systems to analyze and respond to data in a similar way, thereby making AI-based functions and digital twin simulations possible to optimize performance.

Machine learning algorithms are able to automatically chart semantic relationships among various BACnet devices and save human effort in configuring devices manually. Anomalous device behavior, failure prediction and optimization of control sequences can be determined by AI-powered analytics without the need of a human being. The building automation systems maintain the building comfort conditions with changing occupancy and weather conditions. The regenerating structures

can be developed if the BAS and AI data model use together and that structures can accommodate the varying occupancy patterns and atmospheric weather conditions. This autonomous decision-making layer converts BACnet into an intelligence communication protocol platform.

The evolution of the BACnet Secure Connect (BACnet/SC) is a major improvement in cybersecurity especially it brings encryption, authentication, and network isolation that have managed the vulnerabilities of earlier deployments. By simulating the systems of buildings in the digital environment, digital twin technology should be regarded as the supplement of such an approach because it will facilitate predictive maintenance, fault detection, and energy optimization. Combined, these strategies enable BACnet to make smart, secure, and interoperable smart building ecosystems foundations.

## Future Directions

Future research and development need normative semantic models, scalable networks, testing of interoperability in an automated way and edge computing to make low-latency decisions. Moreover, blockchain or the distributed ledger technologies might also facilitate a secure and verifiable exchange of data between building systems. As AI is increasingly involved in the construction process, interoperability models will need to facilitate autonomous decision-making, adaptive control, and predictive maintenance across a variety of devices and protocols. These capabilities will be achieved through a set of standardization and middleware solutions, semantic modelling, and cybersecurity aspects. The other important area that needs to be taken over in future research is to harmonize BACnet with new international standards regarding digital twins and building information modelling (BIM). At present, there is a lack of an agreed standard to assign the BACnet objects directly to the BIMs to establish a bridge between the preparing stage (design), construction, and use of the building in the lifecycle of a building. Further research should be done with attempts to create automated translation layers that will create

BACnet data streams into Industry Foundation Classes (IFC) formats. Also, policymakers should set minimum interoperability standards for publicly funded building projects, as energy efficiency standards. These rules would spur trends in the market towards genuinely interoperable BACnet implementations and prevent vendor lock-in behaviour. Standardized testing guidelines that would recreate real-life multi-vendor environments also need to have dynamic interoperability testing under diverse network conditions.

## Conclusion

BACnet has also continued to play a significant role in building automation as it is an easy-to-use framework of integrating heterogeneous systems in smart buildings. Nevertheless, some challenges such as vendor-specific implementations, legacy integration, semantic inconsistencies, scalability, and cybersecurity, are still inhibiting its potential. Advanced technologies, such as tupling of Internet of Things, middleware platforms, semantic data models, cloud analytics, and secure communication protocols, provide

avenues to achieve these limitations. Through these strategies, building managers and system designers can develop intelligent, secure and scalable smart building environments that can harness the entire opportunities of interoperable automation systems. Follow-up research and application of these strategies will prove paramount in achieving the next generation of interoperable smart buildings. Through these developments, the building automation sector will be able to go beyond mere connectivity to the truly intelligent, self-optimizing and self-evolutionary smart building systems of tomorrow.

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# When BACnet Data Goes Wrong: Diagnosing and Resolving Data Integrity Issues in Building Automation Systems

## Abstract

In modern Building Automation Systems (BAS), BACnet enables interoperability between multi-vendor devices through a standardized object-oriented communication model. However, real-world implementations can encounter data integrity issues, where values observed at supervisory systems differ from actual field conditions. This paper presents a detailed analysis of such inconsistencies, identifying root causes across protocol layers, configuration practices, and integration workflows. A structured diagnostic methodology is proposed, supported by practical examples, object-level analysis, and communication-level verification strategies. The goal is to provide engineers/Site Managers with a systematic approach to ensure reliable, accurate, and deterministic data exchange in BACnet-based systems.

## 1. Introduction

BACnet (Building Automation and Control Network) has established itself as the global standard for communication in building automation systems. Its object-oriented architecture allows heterogeneous devices such as controllers, sensors, actuators, and supervisory systems to exchange information using standardized services and data representations.

## Problem Statement Under Site Conditions:

Despite this standardization, field engineers routinely encounter discrepancies between actual system behavior and values displayed in supervisory platforms such as SCADA or BMS interfaces. These discrepancies manifest as incorrect status indications, delayed updates, or inconsistent values across system layers.

Such issues are rarely attributable to a single fault. Instead, they emerge from the interaction of multiple factors, including object configuration, network behavior, priority handling, and data interpretation.

## 2. BACnet Data Model and Communication Fundamentals

BACnet represents all information using objects, each defined by a set of properties. include Analog Input (AI), Binary Input (BI), Analog Value (AV), and Binary Value (BV). Each object contains a Present\_Value property, which is the primary data point exchanged between devices.

Object Type	Example Use	Key Properties
Analog Input (AI)	Temperature Sensor	Present_Value, Units
Binary Input (BI)	Fan Status	Present_Value
Analog Value (AV)	Setpoint	Present_Value, Units
Binary Output (BO)	Command Output	Present_Value, Priority_Array, Active_Text
Multistate Value (MV)	Mode Selection	Present_Value, Priority_Array, State_Text

Communication between devices occurs through services such as ReadProperty, WriteProperty, and Change of Value (COV).

## 3. Common Field Challenges in BACnet Data Integrity

### 3.1 Data Type and Representation Mismatch

One of the most common issues arises when different systems interpret the same data differently. For example, a binary value may be transmitted as 0/1 but interpreted as OFF/ON or FALSE/TRUE depending on the receiving system configuration. If text mappings (Active\_Text/Inactive\_Text) are not aligned, the displayed status may not reflect actual device behavior.

### 3.2 Priority Array Conflicts

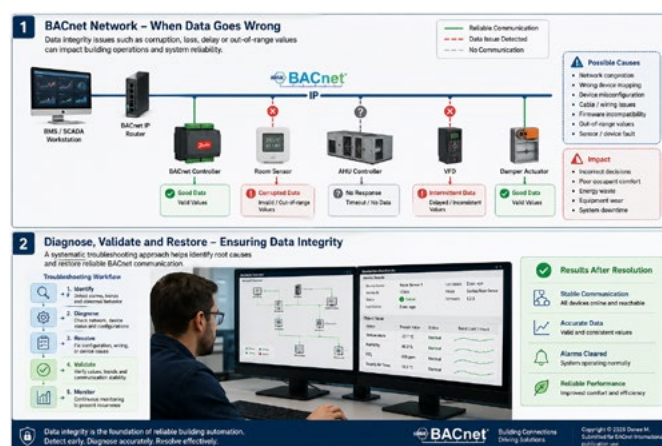
BACnet defines a 16-level priority array for commandable objects. Commands written at higher priority levels override lower-level commands. If a value is written at a higher priority (e.g., manual override), subsequent writes at lower priorities will not take effect, leading to apparent non-responsiveness.

### 3.3 Communication Latency and Stale Data

Polling-based communication can introduce delays, especially in large networks. If COV subscriptions are not properly configured, supervisory systems may display outdated values.

### 3.4 Object Mapping and Instance Errors

Incorrect mapping of object types or instance numbers can result in valid but incorrect data being displayed. For example, reading from an unintended object instance may produce consistent yet misleading values.



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### 3.5 Unit and Scaling Inconsistencies

Differences in unit configuration (e.g., Celsius vs Fahrenheit) or scaling factors can significantly distort data interpretation. These issues are particularly critical in energy monitoring and control applications.

### 4. Proposed Diagnostic Methodology –

#### 1. Verify physical condition and local controller values.

Check the actual field device condition and compare it with the value shown in the local controller or HMI. For example, verify sensor readings, fan status, or valve position. If the field condition and controller value do not match, the issue may be related to wiring, calibration, or controller input configuration.

#### 2. Validate BACnet object configuration including type, instance, and Present\_Value.

Confirm that the correct BACnet object type and instance number are configured. Verify that the Present\_Value transmitted through BACnet matches the controller’s internal value. Also

check related parameters such as units and point mapping to avoid incorrect data display.

#### 3. Analyze network communication using protocol tools.

Use BACnet diagnostic tools such as BACnet browsers, packet analyzers, or Wireshark to monitor communication between devices. Verify whether ReadProperty, WriteProperty, or COV messages are exchanged correctly and identify delays, timeouts, or communication failures.

#### 4. Inspect the Priority\_Array and verify commands are assigned according to the agreed BACnet priority levels defined in Clause 19.2.2.

Check the Priority\_Array of commandable BACnet objects to identify any active higher-priority commands overriding normal operation. Ensure commands are assigned according to the agreed BACnet priority levels defined in Clause 19.2.2.

#### 5. Validate SCADA/BMS mapping and data interpretation.

Verify that SCADA/BMS points are mapped to the correct BACnet object type and instance. Confirm displayed values, units, and status text are interpreted correctly to avoid misleading information at the supervisory level.

### 4.1 Diagnostic Tools and Techniques

Effective troubleshooting requires the use of specialized tools such as BACnet browsers, network analyzers, and controller diagnostic interfaces. Packet-level analysis using tools like Wireshark enables verification of ReadProperty and COV messages, ensuring correct protocol behavior.

### 4.2 Impact on System Performance

Data integrity issues can lead to incorrect control decisions, reduced energy efficiency, and operational instability. In mission-critical environments, such discrepancies may compromise safety and compliance requirements.

### 7. Conclusion

Ensuring BACnet data integrity requires a holistic understanding of object models, communication services, and system integration practices. By adopting a structured diagnostic approach and adhering to best practices, engineers can significantly improve system reliability and performance.

### 8. References

[1] ANSI/ASHRAE Standard 135, BACnet—A Data Communication Protocol for Building Automation and Control Networks.

#### ABOUT THE AUTHOR

Donee M is a Senior Software Test Engineer at Danfoss with experience in building automation systems, BACnet communication protocols, interoperability testing, and data validation. He specializes in ensuring reliable system integration, communication stability, and accurate data exchange across connected HVAC and smart building platforms. His professional interests include automation diagnostics, protocol compliance, and advancing intelligent building technologies.

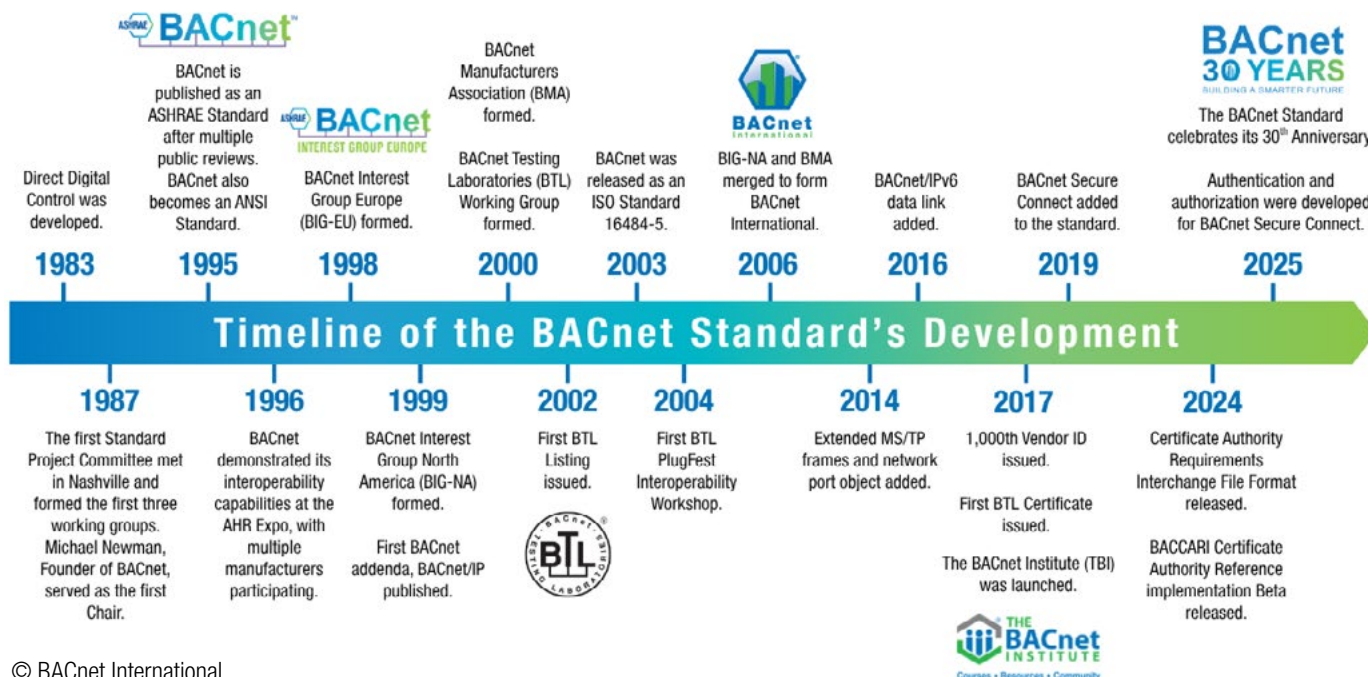
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# Why BACnet Endures: An Owner First Standard



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The Building Automation and Control Network (BACnet) protocol is celebrating 30 years since becoming an ASHRAE and ANSI standard. As we reflect on this 30-year history, one idea continues to permeate the fabric of the BACnet community and standard. That idea is to consider the owners' priorities and needs first. BACnet was founded on the principle of open interoperability for HVAC systems, designed to adapt as technology evolves while prioritizing the long term needs of building owners, and has grown to include other building system applications.

The BACnet protocol was born out of the need to solve issues owners experienced with the

first direct digital control (DDC) systems of the eighties. The father of BACnet, Mike Newman, oversaw the installation and development of Cornell University's computerized energy management and control system. Mike became frustrated with the fact that the DDC manufacturers at the time were developing their own proprietary communication protocol to network their own devices together. A solution to network these DDC devices from different manufacturers together. Mike began leading the effort within ASHRAE to develop an open protocol to enable owners to enjoy the benefits of interoperability within their building systems. This effort began in 1987 and led to the creation of ASHRAE Standard 135, BACnet, in June of

1995 and later became an ANSI standard in December of 1995. As technology has changed, BACnet has adopted these changes that allow owners to continue to implement BACnet in their buildings and maintain interoperability.

BACnet has continued to evolve as owner's technological needs have changed with the evolution of computers/microprocessors and the network solutions used for communication between those devices. BACnet has been proactive in taking steps to keep up with the changing computer/microprocessor world. The following timeline highlights the evolution of BACnet and ethernet/computer/microprocessor changes:

BACnet	Ethernet
	1976 ARCnet Introduced
	1979 3COM Formed to Commercialize the Internet
	1985 Microsoft announces Windows; First dot-com domain registered (Symbolics.com)
BACnet begins in Nashville, TN (ASHRAE BACnet committee)	1987
	1990 Tim Berners-Lee develops HTML (HyperText Markup Language)
	1993 Kalpana invented first network switch
	1994 PCs become gaming machines
BACnet became ASHRAE/ANSI Standard 135	1995
BACnet Standing Standard Project Committee (SSPC) 135 formed	1997
BACnet IP added to standard	1999
BACnet becomes ISO 16484-5	2003
	2007 iPhone introduced
BACnet/SC introduced	2019

Each of the BACnet milestones represents an “adoption” of technologies and a benefit to Owners. Let’s examine how the BACnet milestones have benefited owners:

Date	Milestone	Goal
1987	First BACnet Committee Meeting	Solving Interoperability Issues
1995	BACnet becomes ASHRAE/ANSI Standard	Become a Trusted, Vendor Neutral Protocol
1997	The BACnet Committee becomes a Standing Standard Project Committee (SSPC), SSPC 135 within ASHRAE	ASHRAE Governance Provides Continuity and the Ability to Change/Evolve
1999	BACnet IP Added to the Standard	Provided a Path for Building Systems to Connect to Owner’s IP Networks
2003	BACnet Becomes ISO-16484-5	Owners Can Implement BACnet Around the World
2019	BACnet/SC Introduced	Owners Can Implement TLC Based Security in BACnet

It is important to note as BACnet has adopted changes like BACnet IP (BACnet Internet Protocol) or BACnet/SC (BACnet Secure Connect), the standard has provided a path for owners to adopt these new technologies without replacing their existing BACnet infrastructure. Owners can implement BACnet IP or BACnet/SC for new additions and maintain interoperability/communication with their existing BACnet devices. Not only has BACnet evolved with technology but has grown to include more than just HVAC control.

BACnet has become the interoperability solution allowing owners to provide control of multiple types of building systems. BACnet began with HVAC systems and allowing for the control of chillers, roof top units, and other HVAC equipment. BACnet quickly moved from HVAC applications to energy management and energy services. Today BACnet is used for

lighting control, power monitoring/management, vertical transportation (elevators and escalators), access control, security and fire alarm systems monitoring, and many other building systems. These various applications enable owners to achieve both equipment and system interoperability, while also gathering useful data that supports daily operational activities.

BACnet began with the concept of solving owner’s frustrations with proprietary vendor central building control solutions. As BACnet has become a standard, it has continued to address the interests of building owners as technology has evolved by adopting BACnet IP and BACnet/SC all while providing a path to implement these changes without the costs of replacing existing BACnet systems. Lastly, BACnet has evolved from just HVAC applications to other building systems allowing owners to have interoperability that improves overall building operational costs.



**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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# BACnet International Celebrates BACnet's 30th Anniversary at the AHR Expo in Las Vegas



The BACnet International booth at the 2026 AHR Expo. All images © BACnet International

During this year's AHR Expo, BACnet International was excited to celebrate BACnet's 30th anniversary as an ASHRAE standard. The show drew nearly 54,000 attendees from the HVACR and building automation industries to the Las Vegas Convention Center in Las Vegas, NV. It also featured a record-breaking 1,039 BTL-listed products from more than 120 companies.

The BACnet International booth was located in the AHR Expo's Building Automation Pavilion. The event was well attended by volunteers,

members of the BACnet community, and visitors interested in the BACnet standard, membership opportunities, free BACnet education from The BACnet Institute (TBI), and the benefits of BACnet Testing Laboratories (BTL) testing and certification programs.

Before the show opened, BACnet International held its annual leadership dinner and awards reception. Multiple individuals and organizations were honored for their commitment to advancing the BACnet standard worldwide.

BACnet International presented the following awards:

- BACnet Testing Laboratories Working Group Volunteer of the Year Award:** Courtney Adams, PassiveLogic
- BACnet International Marketing Committee Volunteer of the Year:** Ken Gilbert, Automated Logic
- BACnet International Hall of Fame Award:** Jim Lee, Cimetrics
- Lifetime Achievement Award:** Karl Heinz Belser
- Lifetime Achievement Award:** Jim Butler
- The Atlas Award:** Joel Bender
- Recognition of Service as BTL Technical Advisor:** Michael Osborne
- The Clipper Award:** Emily Hayes, BTL Manager
- BACnet Impact Award:** Fei Han and Weiwei Mo, University of New Hampshire

BACnet International was honored to be the inaugural recipient of the Catalyst Award from the INBAC Association. This award recognizes BACnet International's continued commitment to and support of the INBAC Association, as well as their shared role as dual pillars supporting open standards and protocols worldwide. INBAC Founder and President Sakhee Chandrayan presented the award to Michael R. Wilson, Chair of the BACnet International Board of Directors.



BACnet International President Andy McMillan presents Fei Han (left) and Weiwei Mo with the BACnet Impact Award.



Michael Wilson, Chair of the BACnet International Marketing Committee, presents Ken Gilbert, Automated Logic, with the Marketing Committee Volunteer of the Year Award.



INBAC Founder and President Sakhee Chandrayan presented the award to BACnet International. Michael R. Wilson, Chair of the BACnet International Board of Directors, accepted the award on BACnet International's behalf.



President McMillan presents Jim Lee, Cimetrics, with the BACnet International Hall of Fame Award.



President McMillan presents Karl Heinz Belser, with the BACnet International Hall of Fame Award.



President McMillan presents ASHRAE with the Foundation Award. Stephanie Reiniche, ASHRAE Director of Technology, accepted the award on ASHRAE's behalf.

Andy McMillan, President and Managing Director of BACnet International, presented the Foundation Award to representatives from ASHRAE in recognition of their longstanding support of BACnet, from its first publication in 1995 to its growth into the most widely specified protocol worldwide, now included in 77% of projects. The award was accepted by Stephanie Reiniche, Director of Technology at ASHRAE.

To celebrate BACnet's 30th anniversary as an ASHRAE standard, McMillan also presented attendees with commemorative challenge coins and thanked them for their ongoing support in advancing BACnet adoption.

BACnet International hosted four educational sessions during the AHR Expo:

**BACnet 101:** An Introduction to BACnet: Presented by Edward Tom, Product Manager, Drives, Yaskawa America, Inc.

**BACnet:** Past, Present & Future on Its 30th Anniversary: Moderated by Andy McMillan, BACnet International President and Managing Director, featuring panelists Steven Bushby, Coleman Brumley, James Lee, Sakhee Chandrayan, Nate Benes, Karl Heinz Belser, Fei Han, Dave Robin, Scott Ziegenfus, Hans Symanczik, Alexandra Henczka, Emily Hayes, and David Nardone

**See the Light:** Integrating DALI and BACnet: Moderated by Andy McMillan, with panelists Stuart Berjansky, DesignLights Consortium, Luke Baar, LOYTEC, and Michael Davidson, Synapse Wireless

**BACnet in Mission-Critical Applications:** Presented by Ken Gilbert, Americas Solutions Consultant and Managing Director, Automated Logic Corporation



Edward Tom, Yaskawa Americas, presents "BACnet 101" at the AHR Expo.



President McMillan moderates "BACnet: Past, Present & Future on Its 30th Anniversary" at the AHR Expo.

BACnet International also announced groundbreaking research quantifying the 30-year climate impact of the BACnet standard. A study published by the University of New Hampshire revealed that, since BACnet's release in 1995, the adoption of smart building technologies using BACnet systems has helped avoid approximately 1,401 million tons, or 1.4 gigatons, of CO<sub>2</sub> equivalent (CO<sub>2</sub>e) globally.

In addition, BACnet International announced that the BACCARI Beta 3 executable is now available for public download. BACCARI, the BACnet Certificate Authority Reference Implementation Tool, can create a Certificate Signing Request (CSR) for products that cannot generate their own, validate CSR files, package CSRs into a CARI file for submission to a certificate authority, and even act as the certificate authority for a BACnet/SC network. A BACnet/SC site may use some or all of these capabilities. The tool was originally released in 2025, and its "operating



President McMillan moderates "See the Light: Integrating DALI and BACnet" at the AHR Expo.

code was made publicly available at no cost in Q1 2026 to promote interoperable certificate signing and exchange.

BACnet International looks forward to next year's AHR Expo, taking place January 25<sup>th</sup>-27<sup>th</sup> in Chicago. 🌱



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# Guide to the Device 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 toward developers and testers of BACnet Devices.

This guide was designed to point out small facts in the standard that are often missed by first time developers of a BACnet product. This focuses on the Device object only. Please refer to other guides for other objects or service information.

## 2. The Device object

The following guidelines apply to all BACnet devices.

### 2.1. All BACnet devices shall contain a Device object

All BACnet devices with an application layer shall contain a Device object, even BACnet clients. This is required by the BACnet standard See Standard 135, Clause 22.1.5 Minimum Device Requirements and Clause 12.11 Device Object Type.

### 2.2. All Device objects shall contain a non-empty Object\_List property

All Device objects shall contain an Object\_List property, and this property shall include at least the Device object and the Network Port object (PR >= 17). This is required by the BACnet standard.

### 2.3. Be prepared to read the Object\_List array element by element

Some small devices that do not support segmentation have Object\_List properties that are too large to transmit unsegmented. If a device needs to read another's Object\_List property, be prepared to read it array element by array element.

### 2.4. The Device instance shall be configurable

Device instances are required to be configurable to allow for an internetwork-wide identity across the entire valid range of 0 to 4194302.

### 2.5. Client devices should expect to see Device instances across the entire range of 0 to 4194302

Client devices should expect to see Device instances across the entire range of 0 to 4194302.

### 2.6. Device instance number 4194303

Device instance number 4194303 can be used as a "wildcard" value for reading a Device object's Object\_Identifier property (to determine its Device instance). If a ReadProperty or ReadPropertyMultiple request is received for the Object\_Identifier property of Device 4194303, the response shall convey the responding device's correct Device object instance. See Standard 135, Clause 15.5.2 and Clause 15.7.2.

### 2.7. The length of Bit Strings might be different than expected

The length of the Device object's Bit String properties, in particular the Protocol\_Services\_Supported and Protocol\_Object\_Types\_Supported properties will vary depending upon the protocol revision to which the



device was implemented. Client devices should be prepared to accept Bit String values from servers with lengths longer or shorter than those defined for the Protocol\_Revision value to which the client device was implemented.

The length of Protocol\_Services\_Supported property value (See Standard 135, Clause 21, BACnetServicesSupported).

Revision	Size	Notes
0	35	
1	37	Added ReadRange(35), UTCTimeSynchronization(36),
2 – 13	40	LifeSafetyOperation(37), SubscribeCOVProperty(38), GetEventInformation(39)
14 – 17	41	WriteGroup(40)
18 – 19	44	SubscribeCOVPropertyMultiple(41), ConfirmedCOVNotificationMultiple(42), UnconfirmedCOVNotificationMultiple(43)
20 - 21	47	ConfirmedAuditNotification(44), AuditLogQuery(45), UnconfirmedAuditNotification(46)
22-28	49	WhoAmI(47), YouAre(48)
29-30	50	AuthRequest(49)
31	51	DirectoryQuery (50)

The length of Protocol\_Object\_Types\_Supported property value (See Standard 135, Clause 21, BACnetObjectTypeSupported):

Revision	Size	Notes
0	18	
1	21	Added Averaging(18), Multi-state Value(19), Trend Log(20)
2 - 3	23	Added Life Safety Point(21) and Life Safety Zone(22)
4	25	Added Accumulator(23) and Pulse Converter(24)
5	30	Added Structured View(29), and reserved bits for several other objects in review.
6	31	Added Load Control(28), Access Door(30)
7 - 8	31	Added Event Log(25) and Trend Log Multiple(27), and reserved bit for Global Group(26) object in review
9	38	Added Access Credential(32), Access Point(33), Access Rights(34), Access User(35), Access Zone(36), Credential Data Input(37), and reserved bit for a future object type

10	51	Added BitString Value(39), CharacterString Value(40), Date Pattern Value(41), Date Value(42), DateTime Pattern Value(43), DateTime Value(44), Integer Value(45), Large Analog Value(46), OctetString Value(47), Positive Integer Value(48), Time Pattern Value(49), Time Value(50), and reserved bit for object Network Security(38) in review
11 - 12	51	Added Global Group(26) and Network Security(38)
13	53	Added Notification Forwarder(51) and Alert Enrollment(52)
14 - 15	55	Added Channel(53) and Lighting Output(54)
16	56	Added Binary Lighting Output(55)
17	57	Added Timer(31) and Network Port(56)
18 - 19	60	Added Elevator Group(57), Escalator(58), and Lift(59)

20	63	Added Staging (60), Audit Log (61), Audit Reporter (62)
24-30	65	Added Color (63), Color Temperature (64)
31	66	Added Directory (65)

**2.8. The Protocol\_Services\_Supported property identifies only executable services**

Only bits representing services that are executable by the device shall be set to '1' in the Protocol\_Services\_Supported property. Bits representing services that are initiated by the device but not executed shall be set to '0'.

This property is a means for a device to advertise to other devices which services may be sent to the device with an expectation that they will be accepted and executed.

**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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# BACCARI Certificate Authority Software Tool Beta 3: Now Available for Public Download

BACnet International's Cybersecurity Acceleration Program was developed to help suppliers jumpstart BACnet/SC by providing the means to efficiently generate, exchange, and manage these files, significantly simplifying system integration. The program developed BACCARI (BACnet Certificate Authority Reference Implementation Tool) to build and process files using the CARL file format, as proposed in 135-2020 Addendum cs. The tool's zip file format conveys BACnet/SC CSRs to a certificate authority and returns the signed operating certificates. This tool is the industry's standard for certificate authority implementation.



The BACCARI Certificate Authority software tool beta 3 was released in 2025 and the operating code has been made public (at no charge) in Q1 2026 to promote interoperable certificate signing and exchange. For more information, email [info@bacnetinternational.org](mailto:info@bacnetinternational.org).



BACCARI Beta 3 Registration



**BACnet International**  
[info@bacnetinternational.org](mailto:info@bacnetinternational.org)  
[www.bacnetinternational.org](http://www.bacnetinternational.org)

# New Minimum Protocol Revision Coming January 2027



BACnet Testing Laboratories requires that products being tested for BTL Certification claim a Protocol Revision equal to or greater than a moving minimum. The minimum Protocol Revision is determined each January 1 and is the highest Protocol Revision that has been available in a BTL Test Plan for at least four years. The schedule below indicates the specifics of how this will work for the next few years.

Beginning in January 2027, the minimum Protocol Revision required for all products entering testing will be Protocol Revision 23. The previous minimum Protocol Revision was 18. Protocol Revision 23 brings the opportunity to add many new capabilities. These capabilities include:

- Extending BACnet Webservices with RESTful services
- Adding 'All-Domain Advanced Workstation' Profile
- Adding Lighting, Life Safety, and Access Control BIBBs and Profiles
- Adding Audit Reporting functionality
- Adding a file format for Time Series Data exchange
- Adding BACnet services to allow a device to receive its device identifier and MAC Address

BTL Listings expire after 25 years for BACnet Smart Sensor (B-SS) and BACnet Smart Actuator (B-SA) device profiles and after 15 years for all other device profiles.

The specific requirements for retesting can be found in the BTL Testing Policies on the Test Documentation page of the BTL website. It is the manufacturer's responsibility to determine whether any active BTL-listed product has changed in a way that requires retesting. If so, please notify the BTL Manager at [btl-manager@bacnetinternational.org](mailto:btl-manager@bacnetinternational.org) immediately.

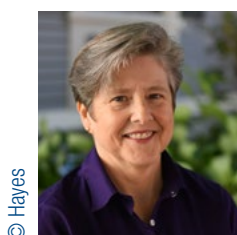
Protocol Revision	Protocol Revision Publication Date	Date that BTL-WG Test Plan for this Protocol Revision was published	Year Protocol Revision becomes the minimum on January 1 <sup>st</sup>
13	June 2011	November 13, 2014	---
14	January 2012	November 13, 2014	2019
15	January 2013	October 19, 2017	2022
16	July 2014	October 4, 2019	2024
17	December 2014	October 30, 2020	---
18	February 2016	October 30, 2020	2025
19	April 2016	January 18, 2022	---
20	June 2018	January 18, 2022	---
21	August 2019	December 22, 2022	---
22	November 2019	December 22, 2022	---
23	August 2021	December 22, 2022	2027
24	January 2022		
25	November 2022		



[View BTL Test Documentation](#)



[Upcoming Expiring BTL Listings and Certificates](#)



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# Belimo Energy Valve™ Helps San Francisco Office Tower Fix Low Delta T and Reduce Energy Costs



Type of Building: Office Tower; Project: Retrofit+; Sector: Commercial; Products: Energy Valve

## Belimo Energy Valve Retrofit at Four Embarcadero Center Improves Chiller Plant Efficiency

Four Embarcadero Center, a 48-story commercial tower on San Francisco’s waterfront, was completed in 1981 and remains one of the city’s most recognizable landmarks. BXP, one of the nation’s largest developers, owners, and managers of premier workplaces, acquired the Embarcadero Center complex in 1998 and has continued to invest in modernization across the property.

## Turning Visibility into Measurable Performance

### Project Overview and Motivation

By 2019, the building’s 40-year-old chilled water system, equipped with two-way, pressure-dependent globe valves with pneumatic actuators, was struggling with low Delta T, rising energy costs, and no visibility into hydronic performance. “We were seeing unstable flow, poor Delta T, and no way to truly understand what was happening in the system,” said Daniel G. Murtagh, Vice President of Engineering at BXP.

To address these challenges, BXP turned to its long-time controls partner Syserco to evaluate options for upgrading the system. Derek Eggers, Chief Executive Officer of Syserco, explained, “Belimo’s Energy Valve technology is proven. It allows us to show our customers quantifiable energy reduction with minimal capital expense. For older buildings like Embarcadero Center it’s a smart way to deliver measurable results.”

After reviewing the building’s needs, Syserco recommended retrofitting each of the six air-handling units with Belimo Energy Valves. The upgrade converted the system to pressure-independent operation, stabilized Delta T across the coils, and gave BXP real-time insight into flow, temperature, and energy data.

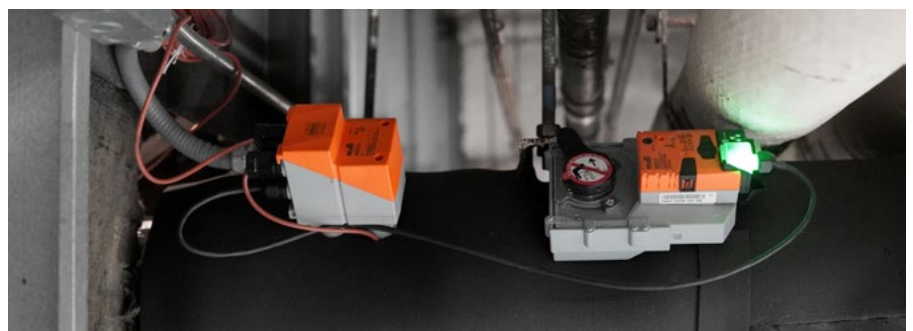
### Discovery Through Data

The retrofit was completed just before the pandemic, and with the building at low occupancy for several years, meaningful performance data was not available until 2024 when operations returned to normal. When the team reviewed Energy Valve data from January through July 2024, the average Delta T across the six air-handling units was

10.9 °F. This was an improvement over the legacy system, which was trending around 1 to 3°F prior to the retrofit, but lower than expected. At that point, Hush Tahir, Belimo District Sales Manager, called in David Kandel, Regional Application Manager, to help analyze the Energy Valve data, which was gathered using Belimo’s WebView interface via Ethernet. Working closely with Syserco and Steven Travis, Chief Engineer for Four Embarcadero Center, the group studied the Energy Valve trend reports to isolate the source of the performance loss. The data made clear that a large amount of chilled water was being wasted, and their investigation ultimately traced the problem to a faulty bypass valve that was allowing continuous overflow through the system.

Travis recalled, “Once we started digging into the Energy Valve data, it became clear something wasn’t right. You could see the numbers weren’t lining up. When we found that bypass valve stuck open, it all made sense. We were bypassing too much water and wasting energy. Fixing that changed everything.”

Once the bypass valve was repaired, system performance improved significantly. Kandel





“The Energy Valve modernized our system without a major capital investment. It has given us measurable improvements, reliable data, and a clear path to meeting BXP’s long-term energy efficiency goals.”

Daniel G. Murtagh, Vice President of Engineering at BXP (left)  
 Also featured in photo: Don Colquhoun, Regional Engineer, BXP (center)  
 Controls Contractor: Derek Eggers, Chief Executive Officer, Syserco (right)

explained, “By the summer of 2025, the Delta Ts at the air handlers exceeded 14 °F. Using the Energy Valve and its built-in reporting, we were able to identify the issue, make the correction, and improve the efficiency of the chilled water plant.”

Tahir added, “This project shows how the Energy Valve turns the coil into a diagnostic point. It gave the team visibility they never had before and helped pinpoint problems well outside the valve itself.”

**Performance Results**

Comparing January through October 2019 (pre-retrofit) with the same period in 2025 (post-retrofit), the Energy Valve retrofit delivered measurable improvements in Delta T performance and overall system efficiency,

reducing energy use by 28%, which translates to approximately \$131,000 in energy cost savings coming directly from the chiller plant.

The retrofit significantly increased system efficiency by stabilizing flow and maintaining proper Delta T across the coils. Continuous monitoring through the Energy Valve allowed the team to fine-tune operation, correct inefficiencies, and maintain a consistent 14 °F Delta T at the AHUs during the summer months of 2025, while using just 53% of the chilled water compared to 2019 levels. The project demonstrates how accurate flow control and visibility into coil performance can optimize chilled water systems in existing high-rise properties.

Don Colquhoun, Regional Engineer for BXP, noted, “This is a classic example of continuous improvement. We solved the major problems first and now have the tools to fine-tune the system even further.”

Murtagh added, “The value of the Energy Valve comes from taking a 40-year-old pneumatic system that had conventional modulating valves and replacing them with a valve that gives us real intelligence. We finally had flow control, BTU control, and visibility into our Delta T across the equipment, which allowed us to slow down pumping and save energy.”

- Patented Power Control and Delta T Manager logic continuously optimize available coil energy.
- Integrated ultrasonic flow measurement and temperature sensors provide real-time BTU data.
- Local WebView access via Ethernet allows direct trend analysis, configuration, and reporting through the BMS.
- Broad communication platform support includes BACnet/IP, Modbus, MP-Bus, and analog signal.

**Looking Ahead**

BXP continues to track Energy Valve performance data as part of its ongoing efficiency program. With coil-level Delta T materially improved, the team plans to use the insights provided by Belimo’s WebView and their BMS trend logs to maintain optimal operation and evaluate further opportunities to implement the Energy Valve across the Embarcadero Center portfolio and beyond.

Murtagh concluded, “The Energy Valve modernized our system without a major capital investment. It has given us measurable improvements, reliable data, and a clear path to meeting BXP’s long-term energy efficiency goals.”



Steven Travis, Chief Engineer for Four Embarcadero Center

**BELIMO ENERGY VALVE™**

The Belimo Energy Valve™ is an IoT cloud connected pressure independent valve that monitors coil performance and energy consumption while maintaining Delta T.

# Phased VAV modernization without replacing the LON trunk



## How Wireless BACnet enabled a gradual LON-to-BACnet migration at a 119,000 sq ft office building.

When Conserv Smart Buildings, a building automation specialist in Indianapolis, helped their customer modernize failing VAV controllers at a three-story office building, the goal was clear: restore reliability without forcing a costly, building-wide infrastructure replacement.

By implementing LumenRadio's Wireless BACnet (W-BACnet) solution, Conserv Smart Buildings enabled a phased upgrade strategy that allowed the property manager Cushman & Wakefield to replace failed devices one at a time — without replacing the entire communication trunk. The result was a flexible, future-proof modernization that minimized capital expense while maximizing long-term control options.

## LON protocol failures: the VAV upgrade challenge

The property Woodland Corporate Park VII, a 119,000-square-foot, three-story office building, was equipped with VAV controllers operating on the LON protocol. As controllers began to fail, the building faced a significant challenge: LON is now a discontinued protocol and replacement devices are no longer readily available. Additionally, T1L controllers cannot coexist on the same communication bus as LON devices.

This meant the customer traditionally would have had to either:

- Replace all devices on the trunk with T1L controllers, or
- Replace the entire communication bus with BACnet MS/TP or IP

Both options required substantial capital investment — funding that was not available at the time.

The objective was not a full system upgrade. It was to replace failed devices while preserving as much of the existing infrastructure as possible.

## How Wireless BACnet enabled a phased VAV replacement

To avoid replacing the entire trunk infrastructure, Conserv Smart Buildings implemented LumenRadio's W-BACnet wireless solution.

The failed LON VAV controllers were replaced with BACnet MS/TP VAV controllers, connected wirelessly using W-BACnet nodes. The original LON network remained in place, while new BACnet devices were integrated via wireless communication.

The three-story office building required:

- One centrally located W-BACnet gateway per floor
- 5–10 W-BACnet nodes per floor at each VAV box above the dropped ceiling

By eliminating the need to pull new communication wiring across all floors, Conserv enabled a phased migration strategy. Devices

can now be replaced gradually as they fail, rather than forcing a complete system overhaul.

As Jim Deckard, Service Manager at Conserv Smart Buildings, explains:

“The main benefit for choosing wireless in this case was that the customer gets the flexibility to choose service providers and brands of controls to replace devices as they fail.”

The Wireless BACnet backbone now allows the building owner to select from any BACnet MS/TP-compatible controller brand moving forward — eliminating protocol lock-in and expanding service provider options.

Installation also proved straightforward and reliable:

“Installation and configuration of the LumenRadio W-BACnet devices was very simple. The range and performance were much greater than expected.”

By using wireless, Conserv Smart buildings delivered a cost-effective modernization that restored reliability, avoided major capital expense and future-proofed the building's automation system.



© Wäppling

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# EIMK-T1L SPE Media Converter – Supercharge your Serial Cables

10BASE-T1L (T1L) is a physical layer specification for Ethernet introduced in IEEE 802.3cg that supports 10 Mbps, full duplex communication over single twisted pair cabling for distances up to 1 km. Single-Pair Ethernet (SPE) enables data and power transmission over a single twisted pair, reducing cabling complexity.

Contemporary Controls' new EIMK-T1L SPE Media Converter complies with IEEE 802.3cg to provide a cost-effective and reliable solution for connecting 10BASE-T Ethernet and 10BASE-T1L networks in full-duplex Ethernet operation. The EIMK-T1L supports 10 Mbps full-duplex transmission up to 1 km using a single twisted-pair cable to provide IP connectivity over long distances. It supports plug-n-play functionality through its default configuration and provides four external DIP switches for configuring advanced features. Its built-in microcontroller protects against brownouts and voltage fluctuations in the field.

## Reuse of Existing Cables Streamlines BMS Upgrades and Lowers Installation Costs

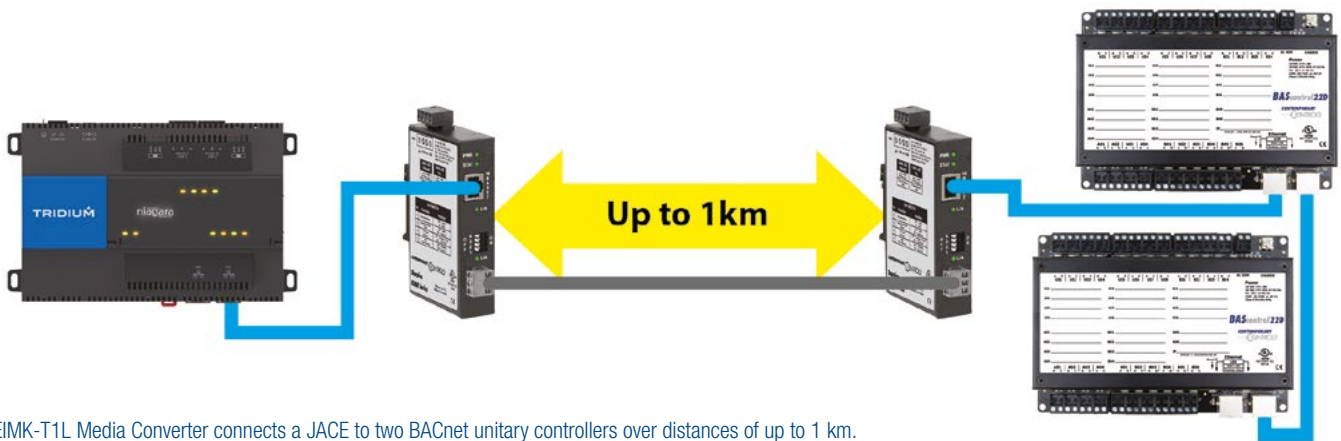
Many existing buildings contain long runs of two-wire cabling originally used for MS/TP, Modbus, LON, or other legacy fieldbuses. T1L allows those same wires to be repurposed for full IP communications, reducing disruption and avoiding the expense of installing new Cat5/6 in occupied spaces.

The EIMK-T1L is optimal for both new and retrofit applications because it combines the benefits of Ethernet with the flexibility and reach of fieldbus and serial networks. It can reuse existing cabling, allowing systems integrators to upgrade a BMS from legacy serial networks to IP based networks without replacing existing wiring.

In summary, the EIMK-T1L bridges 10BASE-T Ethernet and 10BASE-T1L to deliver IP connectivity over long distances and supports reuse of legacy cabling which minimizes installation costs while improving network scalability.



EIMK-T1L SPE Media Converter supports 10 Mbps full-duplex transmission up to 1 km using a single twisted-pair cable. © Contemporary Controls



EIMK-T1L Media Converter connects a JACE to two BACnet unitary controllers over distances of up to 1 km. © Contemporary Controls

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# 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.**

## New Silver Members

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### Aeterlink

Aeterlink, a Stanford University startup, provides long range wireless power transmission technology that can transmit power over distances of up to 17 meters. The company's initial focus was on medical implant devices. Today, Aeterlink applies this technology to factory automation (FA), building management (BM), and medical devices (MD).

**13<sup>th</sup> Floor, Mitsubishi Building,  
2-5-2 Marunouchi, Chiyoda-ku,  
Tokyo, Japan**  
<https://aeterlink.com>

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### AirCare Automation

AirCare Automation is at the forefront of cleanroom management and monitoring systems, delivering industry specific solutions for critical environments. The company designs customizable FFU (fan filter unit) controls and consoles, cleanroom monitoring software, and environmental control systems to ensure that critical processes and technologies achieve the highest levels of performance while meeting regulatory requirements.

**8546 Broadway St., Suite 203,  
San Antonio, TX 78217  
USA**  
<https://aircareautomation.com>

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### Aparian

Aparian was founded on the principle of delivering innovative solutions to the industrial automation sector. With more than 70 years of combined experience in industrial product development and offices in South Africa and the United States, the company understands the diverse design criteria required to create globally integrated, reliable, and easy to use products. Aparian specializes in providing commercial off the shelf (COTS) solutions as well as end to end custom automation and control systems for a wide range of industrial and commercial applications.

**3621 W. MacArthur Blvd  
Suite 104  
Santa Ana, CA 92704, USA**  
<https://mcscontrols.com>

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### Caleffi Hydronic Solutions

Caleffi Hydronic Solutions is one of the major global Italian producers of HVAC and plumbing components and systems. One hundred percent of the company's production is located within a 10 kilometer radius in Italy. Since 1961, Caleffi Hydronic Solutions has focused on constructing the "perfect flow" through a production process designed to achieve maximum results in products, people, warranties, and customer satisfaction, while offering a high level of customization at every stage.

The company designs high quality HVAC and plumbing solutions that redefine comfort and help improve energy efficiency. Its components and devices for heating, cooling, hydraulic and domestic water systems, heat recovery ventilation (HRV), and related accessories are produced exclusively in Italy to deliver sustainable comfort in homes.

**S.R. 229, n. 25**

**28010 Fontaneto d'Agogna (NO), Italy**

<https://www.caleffi.com>



### ClimateMaster

ClimateMaster's role as a domestic energy and geothermal heating and cooling leader dates back to the late 1950s, when the company was founded in Florida. The company later relocated to New York, where it began manufacturing water loop heat pump systems, and eventually moved its headquarters to Oklahoma City, where it continues to thrive today. For more than 70 years, ClimateMaster has developed and produced some of the industry's most innovative and energy efficient heating and cooling systems. Throughout its history, the company has continued to invest in the value of its U.S. patented technologies, the expansion of its American manufacturing facilities, the growth of its national distributor network, and the training of its domestic workforce.

**7300 SW 44th St.**

**Oklahoma City, OK 73179, USA**

<https://www.climatemaster.com>



### GPS Air

GPS Air, formerly Global Plasma Solutions, is an American indoor air quality company that provides air quality technologies for residential, commercial and industrial buildings with a focus on using "needlepoint bipolar ionization", also known as soft ionization. The company produces in-duct and in-room air quality products designed for nearly all indoor spaces.

**3101 Yorkmont Rd, Ste 1500**

**Charlotte, NC 28208, USA**

<https://gpsair.com>

## New Platinum Member



### QEL

Founded in 1986 with a strong commitment to research and development, Quatrosense Environmental Ltd. (QEL) is a privately held, North American Corporation. The 18,000 square foot head office and factory is located in Richmond, Ontario, just outside Ottawa, Canada's capital. QEL manufactures and markets a wide selection of instrumentation for hazardous gas detection. With this equipment, QEL assists its customers in the protection of life, property, and the environment.

**5935 Ottawa Street, Box 749**

**Richmond, Ontario, Canada, K0A 2Z0**

<http://www.qelsafety.com>

**Learn more about membership opportunities with BACnet International.**



# Expand your BACnet Knowledge



Courses • Resources • Community

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.
- 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](http://thebacnetinstitute.org) to sign up or log in. 

# BACnet Testing Laboratories (BTL) Test Package Update

## BTL Testing and BTL Test Package Information

A BTL Certification indicates that the product's BACnet Stack has successfully passed rigorous industry-standard testing and demonstrates that the device correctly implements all of the BACnet functionality it contains as governed by ASHRAE standard 135. The BTL Listing, the BTL Certificate of Conformance, and the right to use the BTL Mark are the three elements that indicate a product has passed the testing and achieved BTL Certification.

The BTL Working Group defines the BTL Test Plan and governs the testing. The BTL Test Package and BTL Testing Policies are published on the BTL website: [btl.org/testing-documentation](http://btl.org/testing-documentation).

## BTL Test Package 26.0

The current BTL Test Package is 26.0. This test package includes testing up through Protocol Revision 26 of the BACnet standard (ANSI/ASHRAE 135-2020 plus addenda: cd)


BTL Test Package 26.0 includes testing up through

BACnet Protocol Revision 26. The BTL Working Group has established a transition period for BTL Test Package 26.0, so that testers can update tools used in BTL Testing. During the transition period, vendors with products claiming Protocol\_Revision 23 or less may test with either Test Package 26.0 or with BTL Test Package 23.3-v2. Products claiming Protocol\_Revision 24 or greater must test with BTL Test Package 26.0. The Transition Period will end April 30, 2025. All product entering BTL Testing as of May 1, 2025, must test with BTL Test Package 26.0.

The changes in the BACnet Standard (ASHRAE 135), the BACnet Testing Standard (ASHRAE 135.1) and the new BTL Test Package 26.0 are the normal progression and enhancement of these two organizations collaborating to improve the documentation and testing process for BACnet develop organizations and Recognized BACnet Testing Organizations.

## Minimum Protocol Revision for Testing

BTL Testing Policies requires that the minimum Protocol\_Revision for BTL Testing increase over time. The minimum Protocol\_Revision is determined each January 1st and is the highest Protocol\_Revision which has been available in the BTL Test Plan for at least 4 years. Protocol\_Revision 18 becomes the minimum Protocol\_Revision for BTL Testing as of January 1, 2025.

Products at an RBTO either waiting for testing or in the process of testing as of January 1, 2025, must have a minimum Protocol\_Revision of 16 (the current minimum PR). All products entering testing January 1, 2025, or later must have a minimum Protocol\_Revision of 18 or higher. 



Scan for BTL Test Documentation

## ABOUT THE AUTHOR

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

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

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

© Hayes



## Emily Hayes

BTL Manager, Certifications and Listings Manager and BTL Working Group Chair | BACnet International  
[btl-manager@bacnetinternational.org](mailto:btl-manager@bacnetinternational.org) | [www.bacnetinternational.org](http://www.bacnetinternational.org)



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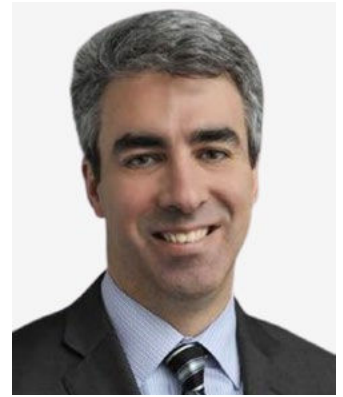
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Learn more about Corporate Membership:



## New BTL Listings (October 1, 2025 - March 30, 2026)

Manufacturer	Product Name	Model
ABB, Inc.	X series	XC8064, XC1200
Adveco Technology Co. Ltd.	X Network Controller	BAC-3551, BAC-3451
Alerton	BACnet IP (CAT5/6, T1L) Unitary Controller	VLC8u8-IP, VLC8u8-IP-BLE, VLC8u8-T1L, VLC8u8-T1L-BLE, VLC16u8-IP, VLC16u8-IP-BLE, VLC16u8-T1L, VLC16u8-T1L-BLE
	BACnet IP (CAT5/6, T1L) VAVi Controller	VAVi-7u5-IP, VAVi-0-IP, VAVi-7u5-IP-BLE, VAVi-0-T1L, VAVi-7u5-T1L, VAVi-7u5-T1L-BLE
Antec Controls	Cava™ Touchscreen Fume Hood Controller	CAVA
	Lume™ Room Pressure Monitor	LUME20
	Pace™ Critical Space Controller	PACE
Caleffi S.p.A.	LEGIOMIXevo 6003 Series	600301A, 600302A, 600303A, 600306A, 600308A, 600311A, 600312A, 600313A, 600336, 600338, 600353, 600354, 600356, 600356A, 600358, 600358A, 600363, 600364, 600373, 600374, 600383, 600384, 600393, 600394, F0007676, F0007683, 600316, 600318, 600351, 600361, 600371, 600381, 600391, F0007677, 600354A, 600354AF, NA600356A, 600356AF, 600359A, 600359AF, 600364A, 600364A 001, 600364AF, 600364AF 001 600366A, 600366A 001, 600366AF, 600366AF 001, 600369A, 600369A 001, 600369AF, 600369AF 001, 600374A, 600374AF, 600376A, 600376AF, 600379A, 600379AF, 600384A, 600384AF, 600386A, 600386AF, 600389A, 600389AF, 600394A, 600394AF, 600396A, 600396AF, 600399A, 600399AF, 600366AFS, 600376AFS, 600386AFS, 600396AFS, 600360AFS, 600380AFS, 600366AFS 001, 600376AFS 001, 600386AFS 001, 600396AFS 001, 600360AFS 001, 600380AFS 001
Carlo Gavazzi Controls S.p.A.	EMS10XXXXXX	EMS10MV501X, EMS10MV5S1X, EMS10AV501X, EMS10AV5S1X, EMS10AV201X, EMS10AV2S1X
	EMS10XXXXXX	EMS10MV501X, EMS10MV5S1X, EMS10AV501X, EMS10AV5S1X, EMS10AV201X, EMS10AV2S1X
DAIKIN Industries Ltd. DAIKIN Industries Ltd. DAIKIN Industries Ltd.	DK-CONNECT edge, Daikin HERO Pro Edge	DGE601A1, DGE601B1, DGE601A71, DGE601B71
	DK-CONNECT edge, Daikin HERO Pro Edge	DGE601A1, DGE601B1, DGE601A71, DGE601B71
	DVH Series Light Commercial Packaged Unit	DVH0903D, DVH0903W, DVH0904D, DVH0904W, DVH1023D, DVH1023W, DVH1024D, DVH1024W, DVH1203D, DVH1203W, DVH1204D, DVH1204W
Danfoss Drives A/S	iC7 Drive	iC7-HVACR
EmFirst	EmFirst DDC Controller	eDC-3000, eDC-1200EX, eGW-3000, eGW-1200EX
Hager Electro SAS	AGARDIO Manager	HTG410H, HTG411H, HTG411L
IDEC Corporation	FC6A Plus CPU module	FC6A-D16RxCEE, FC6A-D16PxCEE, FC6A-D16KxCEE, FC6A-D32PxCEE, FC6A-D32KxCEE
J2 Innovations	FIN Framework	FIN-Framework-BACnet-OWS-SUP, FIN-Framework-BACnet-OWS-F200, FIN-Framework-BACnet-OWS-NEXIO, FIN-Framework-BACnet-OWS-EMB  FIN-Framework-BACnet-OWS-SUP, FIN-Framework-BACnet-OWS-F200, FIN-Framework-BACnet-OWS-NEXIO, FIN-Framework-BACnet-OWS-EMB  FIN-Framework-BACnet-OWS-SUP, FIN-Framework-BACnet-OWS-F200, FIN-Framework-BACnet-OWS-NEXIO, FIN-Framework-BACnet-OWS-EMB

Johnson Controls Inc.	<p>Advanced Application Field Equipment Controller (FAC)</p> <p>Advanced Application Programmable Controller (PCA)</p> <p>Advanced Application Programmable Controller (PCA)</p> <p>BACnet Router</p> <p>Facility Explorer General Purpose Application Controller (F4-CGE)</p> <p>Facility Explorer General Purpose Application Controller (F4-CGM)</p> <p>Facility Explorer Server</p> <p>Facility Explorer VAV Box Controller (CVM)</p> <p>Facility Explorer VAV Box Controller (F4-CVE)</p> <p>Metasys General Purpose Application Controller (CGE)</p> <p>Metasys General Purpose Application Controller (CGM)</p> <p>Metasys I/O Expansion Module</p> <p>Metasys VAV Box Controller (CVE)</p> <p>Metasys VAV Box Controller (CVM)</p> <p>Modbus Gateway</p> <p>SNC Series of Network Control Engines, SNE Series of Network Engines</p>	<p>MS-FAC2513-0, MS-FAC3613-0</p> <p>FX-PCA2513-0, FX-PCA3613-0</p> <p>CH-PCA2513-0, CH-PCA3613-0</p> <p>JC-RTR11002-0</p> <p>F4-CGE09090-0, F4-CGE04060-0</p> <p>F4-CGM09090-0, F4-CGM04060-0</p> <p>FX-SL000-0, FX-SL001-0, FX-SL002-0, FX-SL003-0, FX-SL010-0, FX-SL100-0, FX-SLUNL-0, FX-SL000-0E, FX-SL001-0E, FX-SL002-0E, FX-SL003-0E, FX-SL010-0E, FX-SL100-0E, FX-SLUNL-0E</p> <p>F4-CVM03050-0, F4-CVM03050-0P</p> <p>F4-CVE03050-0P</p> <p>M4-CGE09090-0, M4-CGE04060-0</p> <p>M4-CGM09090-0, M4-CGM04060-0</p> <p>M4-XPM09090-0, M4-XPM04060-0, M4-XPM18000-0</p> <p>M4-CVE03050-0P</p> <p>M4-CVM03050-0, M4-CVM03050-0P</p> <p>JC-GTW11002-0</p> <p>M4-SNE22000-0, M4-SNE11000-0, M4-SNE110L0-0, M4-SNE10500-0, M4-SNE22001-0, M4-SNE11001-0, M4-SNE110L1-0, M4-SNE10501-0, M4-SNE22002-0, M4-SNE11002-0, M4-SNE110L2-0, M4-SNE10502-0, M4-SNC25150-0, M4-SNC25150-0H, M4-SNC25150-04, M4-SNC25150-04H, M4-SNC16120-0, M4-SNC16120-0H, M4-SNC16120-04, M4-SNC16120-04H, M4-SNC25151-0, M4-SNC25151-0H, M4-SNC25151-04, M4-SNC25151-04H, M4-SNC16121-0, M4-SNC16121-0H, M4-SNC16121-04, M4-SNC16121-04H, M4-SNC25152-0, M4-SNC25152-0H, M4-SNC25152-04, M4-SNC25152-04H, M4-SNC16122-0, M4-SNC16122-0H, M4-SNC16122-04, M4-SNC16122-04H F4-SNC25150-0, F4-SNC25150-0H, F4-SNC25150-04, F4-SNC25150-04H, F4-SNC16120-0, F4-SNC16120-0H, F4-SNC16120-04, F4-SNC16120-04H, F4-SNC25151-0, F4-SNC25151-0H, F4-SNC25151-04, F4-SNC25151-04H, F4-SNC16121-0, F4-SNC16121-0H, F4-SNC16121-04, F4-SNC16121-04H, F4-SNC25152-0, F4-SNC25152-0H, F4-SNC25152-04, F4-SNC25152-04H, F4-SNC16122-0, F4-SNC16122-0H, F4-SNC16122-04, F4-SNC16122-04H C16122-04H</p>
Lynxspring, Inc.	JENEsys	JENEsys PC-9000, JENEsys PC-9000-001, JENEsys PC-9000-002, JENEsys PC-9000-005, JENEsys Edge 414, JENEsys Edge 514, JENEsys Edge VAV, JENEsys Edge VAV-E, JENEsys Edge 434, JENEsys Edge 534, JENEsys Edge 534 - 4G LTE, JENEsys Edge 534 - Monnit, JENEsys Edge 634
Optergy Pty. Ltd.	WBG-1000	WBG-1000 Application Software Version: 1.0.0
Phoenix Contact GmbH und Co. KG	EMpro - Multifunctional energy measuring devices	EEM-MA390-R – 1576552, EEM-MA391-R – 1576585, EEM-MA390-R-24DC – 1576594, EEM-MA790-R – 1576595
Produal Oy	Room Transmitter	RTX-D
Saia-Burgess Controls AG	ControlEdge PCD	HPCD3.M6893
	Honeywell PCD	HPCD3.M6892
	Saia PCD	PCD3.M6893

Shanghai Yuankong Automation Technology Co., Ltd.	DDC Controller	YK-BA6201, YKEMC-D01, YK-BA6204, YKEMC-D04, YKEMC-F
Siemens	Desigo PXC3 and DXR2 Automation Stations	PXC3.E72-100A, PXC3.E72A-200A, PXC3.E75-100A, PXC3.E75A-200A, PXC3.E72A-100A, PXC3.E16A-200A, DXR2.E09-101A, DXR2.E09-101A/BP, DXR2.E09-101A/TB, DXR2.E09T-101A, DXR2.E09T-101A/BP, DXR2.E10-101A, DXR2.E10-101A/BP, DXR2.E10PL-102B, DXR2.E10PLX-102B, DXR2.E12P-102A, DXR2.E12P-102A/BP, DXR2.E12P-102B, DXR2.E12P-102K, DXR2.E12PX-102B, DXR2.E12PX-102K, DXR2.T12P-102B, DXR2.E18-101A, DXR2.E18-101A/BP, DXR2.E18-101B, DXR2.E18-101K, DXP2.E18-110BR, DXP2.M18-110BR, DXR2.M09-101A, DXR2.M09T-101A, DXR2.M10-101A, DXR2.M10PL-102B, DXR2.M10PLX-102B, DXR2.M11-101A, DXR2.M11-101B, DXR2.M11-101K, DXR2.M12P-102A, DXR2.M12P-102B, DXR2.M12P-102K, DXR2.M12PX-102B, DXR2.M12PX-102K, DXR2.M18-101A, DXR2.M18-101B, DXR2.M18-101K, DXR2.T18-101B, DXR2.E17C-103A, DXR2.E17C-103B, DXR2.E17CX-103A, DXR2.E17CX-103B, DXR2.M17C-103B, DXR2.M17CX-103B
	Desigo PXC7, PXC5 and PXC4 Automation Station	PXC5.E003, PXC5.E24, PXC5.E24-N, PXC4.E16, PXC4.E16S, PXC4.E16-2, PXC4.E16S-2, PXC4.M16, PXC4.M16S, PXC4.M16-2, PXC4.M16S-2, PXC7.E400L, PXC7.E400L-N, PXC7.E400S, PXC7.E400M
	Desigo PXC7, PXC5 and PXC4 Automation Station	PXC5.E003, PXC5.E24, PXC5.E24-N, PXC4.E16, PXC4.E16S, PXC4.E16-2, PXC4.E16S-2, PXC4.M16, PXC4.M16S, PXC4.M16-2, PXC4.M16S-2, PXC7.E400L, PXC7.E400L-N, PXC7.E400S, PXC7.E400M
	Desigo PXC7, PXC5 and PXC4 Automation Station	PXC5.E003, PXC5.E24, PXC5.E24-N, PXC4.E16, PXC4.E16S, PXC4.E16-2, PXC4.E16S-2, PXC4.M16, PXC4.M16S, PXC4.M16-2, PXC4.M16S-2, PXC7.E400L, PXC7.E400L-N, PXC7.E400S, PXC7.E400M
	Desigo PXC7, PXC5 and PXC4 Automation Station	PXC5.E003, PXC5.E24, PXC5.E24-N, PXC4.E16, PXC4.E16S, PXC4.E16-2, PXC4.E16S-2, PXC4.M16, PXC4.M16S, PXC4.M16-2, PXC4.M16S-2, PXC7.E400L, PXC7.E400L-N, PXC7.E400S, PXC7.E400M
Strato Automation Inc.	OPENSTAT	OS214, OS214W, OS537H, OS537HW, OS537MHW, OS537MHCW, OST537HW, OST537MHW, OST537MHCW, ORS200H, ORS200HW, ORS200MHW, ORS200MHCW, OS215, OS215W, OSV214, OSV214W, OSV424H, OSV424HW, OSV424MHW, OSV424MHCW, OSTV424HW, OSTV424MHW, OSTV424MHCW, OST300HW, OST300MHW, OST300MHW
Tridium, Inc	EDGE-10	EDGE-10
	JACE-8000	JACE-8000
	JACE-9000	JACE-9000, JACE-9000-001, JACE-9000-002, JACE-9000-005
	JACE-9000	JACE-9000, JACE-9000-001, JACE-9000-002, JACE-9000-005
	Niagara 4 Supervisor BACnet Advanced Workstation	SUP-0, SUP-1, SUP-2, SUP-3, SUP-10, SUP-100, SUP-UNL
UV Partners, Inc	UV Angel Clean Air Active™	102-2200-01-00-30, 102-2200-01-01-30, 102-2200-01-04-30, 102-2200-02-00-30, 102-2200-02-01-30, 102-2200-02-04-30

<p>WAGO GmbH &amp; Co. KG</p>	<p>Compact Controller 100</p> <p>Controller PFC100</p> <p>Controller PFC200</p> <p>Controller PFC300</p> <p>Touch Panel 600   Edge Controller</p>	<p>751-9301, 751-9401, 751-9402, 751-9403</p> <p>750-8110, 750-8111, 750-8112, 750-8112/0025-0000</p> <p>750-8210, 750-8210/0040-0000, 750-8211, 750-8211/0040-0000, 750-8211/0040-0001, 750-8212, 750-8212/0000-0100, 750-8212/0025-0000, 750-8212/0025-0001, 750-8212/0025-0002, 750-8213, 750-8214, 750-8215, 750-8216, 750-8216/0025-0000, 750-8216/0025-0001, 750-8217, 750-8217/0025-0000</p> <p>750-8302</p> <p>Edge Controller 752-8303/8000-0002</p> <p>Touch Panel 600762-4301/8000-0002, 762-4302/8000-0002, 762-4303/8000-0002, 762-4304/8000-0002, 762-4305/8000-0002, 762-4306/8000-0002, 762-5303/8000-0002, 762-5304/8000-0002, 762-5305/8000-0002, 762-5306/8000-0002, 762-6301/8000-0002, 762-6302/8000-0002, 762-6303/8000-0002, 762-6304/8000-0002</p> <p>Edge Controller 752-8303/8000-0002</p> <p>Touch Panel 600762-4301/8000-0002, 762-4302/8000-0002, 762-4303/8000-0002, 762-4304/8000-0002, 762-4305/8000-0002, 762-4306/8000-0002, 762-5303/8000-0002, 762-5304/8000-0002, 762-5305/8000-0002, 762-5306/8000-0002, 762-6301/8000-0002, 762-6302/8000-0002, 762-6303/8000-0002, 762-6304/8000-0002</p> <p>Edge Controller 752-8303/8000-0002</p> <p>Touch Panel 600762-4301/8000-0002, 762-4302/8000-0002, 762-4303/8000-0002, 762-4304/8000-0002, 762-4305/8000-0002, 762-4306/8000-0002, 762-5303/8000-0002, 762-5304/8000-0002, 762-5305/8000-0002, 762-5306/8000-0002, 762-6301/8000-0002, 762-6302/8000-0002, 762-6303/8000-0002, 762-6304/8000-0002</p> <p>Edge Controller 752-8303/8000-0002</p> <p>Touch Panel 600762-4301/8000-0002, 762-4302/8000-0002, 762-4303/8000-0002, 762-4304/8000-0002, 762-4305/8000-0002, 762-4306/8000-0002, 762-5303/8000-0002, 762-5304/8000-0002, 762-5305/8000-0002, 762-5306/8000-0002, 762-6301/8000-0002, 762-6302/8000-0002, 762-6303/8000-0002, 762-6304/8000-0002</p>
<p>WindowMaster International A/S</p>	<p>CompactSmoke™ Smoke Panel, Comfort MotorController</p> <p>WSA 5MC BACnet-IP</p>	<p>CompactSmoke™ Smoke Panel WSC 310 P, WSC 320 P Comfort MotorController WCC 310 P, WCC 320 P</p> <p>WSC520, WSC540, WSC560</p>



## Calendar of BACnet International Events

2026	Event	Location
February 2 <sup>nd</sup> – 4 <sup>th</sup> , 2026	AHR Expo – Booth C540	Las Vegas, Nevada
September 29 <sup>th</sup> – October 1 <sup>st</sup> , 2026	PlugFest Interoperability Workshop	Durham, New Hampshire

## Journal of Building Automation 29

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