

**BACnet**  
International



**JOURNAL**

**Issue 17**

## This Issue

BACnet Secure Connect and Cyber Security in Buildings



**Global Testing of the Global Standard**



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**Acquire Device Data**  
For HVACaaS initiatives to be successful, equipment manufacturers have access to data generated by their installed devices. If monitored and managed remotely, their data to their current physical location, it need not be aggregated and analyzed from the device.

**Improve Service and Support**  
By monitoring and analyzing device data, manufacturers can proactively identify and take steps to prevent it. Or they can respond faster to service calls with equipped technicians to get the job done more quickly.

**Generate Revenue**  
At this point, it's time to monetize the data.

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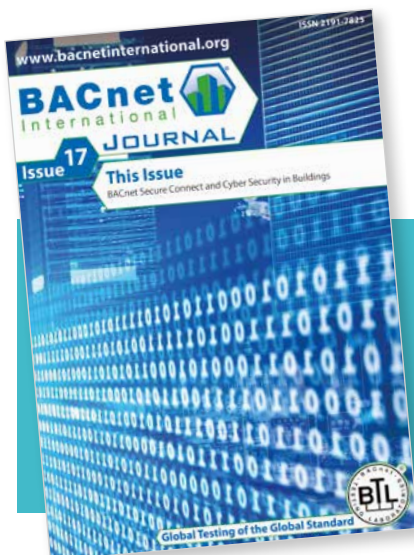


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# Letter from the President

## Dear Reader,

This is an exciting time to be involved in BACnet and the building automation industry so we have focused this issue on some of the things generating that excitement. Read through this issue or just take a look around you to see that things are changing rapidly, no doubt leading to new challenges and new solutions. Some of the dimensions of change are technical but others are commercial, and even political. With all the change underway it seems that both old-timers and newcomers to our industry will have some exciting opportunities to make a difference, and (maybe) make a fortune.

Thirty years ago, a group of people came together to address the problem of incompatible communications protocols in building automation. Motivated by frustration with proprietary systems and determined to create a better way, they launched the BACnet standard initiative that has since become a global standard and changed the world of building automation. Users have come to expect devices and systems to integrate and interoperate. With the advent of IoT we have come full circle. Getting Apple devices and services to integrate and interoperate with Google and Amazon devices and services in our homes is challenging. And now, all three of those companies, along with Intel, want to bring their gated ecosystems into commercial building automation. There are certainly opportunities to make a difference in this area by developing and promoting architectures, solutions and business models that ensure commercial building IoT (BIoT) comes with all the technological power of consumer IoT but without the closed ecosystems.

Another area of dramatic change and immense opportunity is lighting. LEDs have become relatively inexpensive and ubiquitous which is driving the demand for connected lighting. As a result, more and more building automation can manipulate light in ways that improve the value of the built environment. It is well understood that changing the color and intensity of light can impact human behavior. The appropriate application of that capability to buildings with specific applications (think medical, education, retail) can create huge value. Figuring out how to embed the science of lighting and human behavior in commercially viable products and business models is an opportunity to both make a difference and make a fortune.

Still another dimension of change in the industry is the increasing interest of government in driving the industry in specific directions. California has long pushed building energy efficiency through regulatory efforts and other governments have joined the battle. New European regulations will require building automation in most buildings and will go further by requiring reporting (monitoring) of those buildings. The business opportunities are obvious and no doubt will make a fortune for someone(s).

Security is also an area where dramatic changes are underway. The credible cybersecurity threat to safety and equipment in buildings has prompted an industry-wide push for re-thinking building automation security. Some parts of the push are technical in nature (think BACnet Secure Connect) while others are commercial and business model (think BAS-specific

certificate authorities). And, of course, in the security realm there is the huge challenge of changing the old culture of "security is IT's problem" that has been prevalent for so long in the building automation industry. Opportunities abound for creative ways to update technology, evolve the culture and make a real difference in security for building automation.

Of course, no discussion of change in the building automation industry should omit the ongoing generational changes. Experts in our industry seem to be aging out at a rate that will create a dramatic shortage of knowledge and skill in mechanical equipment and building systems. At the same time the breadth of knowledge and skill needed to successfully design, install and operate building automation systems is rapidly increasing. Finding innovative ways to attract and retain the right people for roles throughout the building automation value chain is another area where a person could make a difference, and perhaps, make a fortune.

Whether your interest is in technology, people, systems, strategy, operations or some combination of them, there is a lot happening in building automation. This is indeed an exciting time to be part of the building automation industry. Do good, and have fun!



### 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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# Connecting Wi-Fi to a BACnet/IP Backbone

One of the advantages of being on an IP (Internet protocol) network is that you can take advantage of the many advancements made to enhance IP networks. One of those is wireless communications with Wi-Fi being one of the best known. When we say “Wi-Fi” we are usually referring to a technology that extends our Ethernet network wirelessly and not the Wi-Fi Alliance that promotes the technology, certifies products, and grants the use of its Wi-Fi trademark. The technology is described in a group of standards under IEEE 802.11 just like IEEE 802.3 describes Ethernet with many other related standards. When IEEE 802.11 was first introduced it was dubbed wireless Ethernet because of its similarity to the wired standard. BACnet/IP systems are usually implemented with wired Ethernet, so the opportunity of mixing wired and wireless networks on the same BACnet/IP backbone with little concern is attractive.

Wireless networks offer the advantage of not needing to drill holes, pull wire, and terminate connections thus saving money while not damaging the owner’s premises especially in landmark buildings. Wi-Fi also allows us to temporarily connect a laptop-based service tool to the BACnet/IP network for troubleshooting and commissioning. This non-invasive connection provides convenience and we wonder how we did it before Wi-Fi.

Wi-Fi devices are called stations and a collection of stations in a service area is called a Basic Service Set (BSS). If these devices are within range of each other, they can communicate with one another in an ad hoc manner. But we have little interest in this arrangement beyond initial commissioning because if all the devices are BACnet servers, there will be little communication except for a possible I-Am. What we are more interested in is gaining access to the BACnet/IP backbone which is usually Ethernet.

An Infrastructure BSS incorporates one or more devices called Access Points (AP). The AP

provides the connection between the wireless network and the wired network. For our example we will use a group of Wi-Fi thermostats that are within communication distance of other thermostats and an AP. Each thermostat is a BACnet/IP server while a BACnet/IP client or clients reside on the wired Ethernet side. Not all Wi-Fi devices are the same so we will first examine the technology.

## Evolution of IEEE 802.11

Wi-Fi is defined by the IEEE 802.11 Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) standard. With over 3,500 pages in the standard you know the technology is complex. It also has similarities to its cousin IEEE 802.3 IEEE Standard for Ethernet with its 5,600 pages. Wi-Fi stations utilize the same 48-bit MAC addressing scheme as Ethernet. Like all 802 standards, they mostly address the two lower layers of the Open Systems Interconnection (OSI) model – physical and data link – and therefore not related at all to the BACnet network or application layers.

Early Ethernet was called shared Ethernet with all stations occupying one collision domain. That restriction was eliminated when switched Ethernet was introduced thereby allowing for full-duplex communication. With wireless, we are back to a single collision domain and half-duplex communication as the norm. While Ethernet is based on carrier sense, multiple access with collision detection (CSMA/CD), Wi-Fi is based on carrier sense, multiple access with collision avoidance (CSMA/CA). With the restricted nature of a wired medium, performance is predictable. With unrestricted wireless, noise and multipath interference is expected. Unlike Ethernet, it is not easy for a Wi-Fi sender to detect a collision, so Wi-Fi requires every frame that is sent to be acknowledged by the receiver.

The initial version of 802.11 was released in 1997 operating in the unlicensed 2.4-2.5 GHz industrial, scientific, and medical (ISM) band

along with microwave ovens, cordless phones and now Bluetooth. When modulation is involved in this band, it must be spread spectrum and Wi-Fi offered two approaches – Frequency Hopping Spread Spectrum (FHSS) and Direct Sequence Spread Spectrum (DSSS) – with resulting speeds of either 1 or 2 Mbps. Not quite the speed of wired Ethernet at 10 Mbps. With all Wi-Fi encoding schemes that push the limit on how much information can be packed into a single channel, signal-to-noise ratios determine the resulting data rate. High ratios grant more speed. The original DSSS method was improved with a different encoding scheme that increased the speed to either 5.5 or 11 Mbps. This enhancement was identified as 802.11b and would interoperate with the earlier DSSS stations at the two lower speeds but not with FHSS which was dropped in this revision.

A much different approach occurred with revision 802.11a which was released after 802.11b. Not only was a new encoding method developed called Orthogonal Frequency Division Multiplexing (OFDM), the new PHY operated in the less crowded unlicensed 5 GHz band. Although interference is less in the higher band, distance is much less. An 802.11a device cannot communicate with an 802.11b device because of the differing frequencies. However, OFDM proved to be a superior encoding technology allowing speeds of 6, 9, 12, 18, 24, 36, 48, and 54 Mbps. Of those speeds, only 6, 12 and 24 are mandatory to be 802.11a compliant.

The need for speed as well as distance and compatibility led to the 802.11g development of the extended rate PHY (ERP). It took the best encoding approaches from versions a and b to improve the speed of 802.11b to that of 802.11a (54 Mbps) while maintaining compatibility with 802.11b. However, 802.11g only works in the 2.4 GHz range and therefore is not compatible with 802.11a. While 802.11a operates in the U.S. over eight 20 MHz wide channels where spectrum is not an issue, 802.11 b and g oper-

### Popular 802.11 variants

802.11 Variant	Frequency (GHz)	Channels (U.S)	Data Rates (Mbps)
802.11a	5	8	6, 9, 12, 18, 24, 36, 48, 54
802.11b	2.4	11 (3 non-overlap)	1, 2, 5.5, 11
802.11g	2.4	11 (3 non-overlap)	1, 2, 5.5, 6, 9, 11, 12, 18, 24, 36, 48, 54

ate in the U.S. over eleven 5 MHz channels with only three non-overlapping (1, 6 and 11).

IEEE 802.11 continues to evolve with other revisions such as dual-frequency 802.11n with support for multiple antennas, and 802.11ac with further PHY refinements in the 5 GHz band.

### Stations and Access Points

Our laptops, Wi-Fi thermostats, access points or any other device communicating over a wireless LAN (WLAN) are called stations but only access points have a station identifier called an SSID. Some stations are mobile such as our laptops because they can move between two access point areas and still communicate to the infrastructure. Wi-Fi thermostats and access points are termed portable because they are wireless but once their intended location is determined, they remain fixed. Make sure all devices within the access point domain operate at the same Wi-Fi frequency.

Access points are basically microcontrollers running TCP/IP with one wired Ethernet port and one Wi-Fi port. However, they can be quite sophisticated supporting both 2.4 and 5 GHz bands, providing DHCP server functional-

ity, or passing on DHCP client requests to the Ethernet side. They could also support enhanced security protocols or have the power to handle heavy traffic. The industry has defined the market of access points as thin or fat. A fat access point is self-contained with all features built-in probably incorporating webpage configuration. The thin version can still operate standalone but receives supervision from a Wi-Fi network controller located somewhere on the network, or from Wi-Fi controller software that can run on a PC. The thin approach could be handy on large networks where remote commissioning is attractive, but they can lock you in to one vendor with proprietary software.

The throughput of an access point can be an issue. Remember that all traffic to and from the backbone and the BSS goes through the access point. Access point manufactures do not always advertise the number of wireless devices that can be served from one access point but experience usually says 20 to 30 devices.

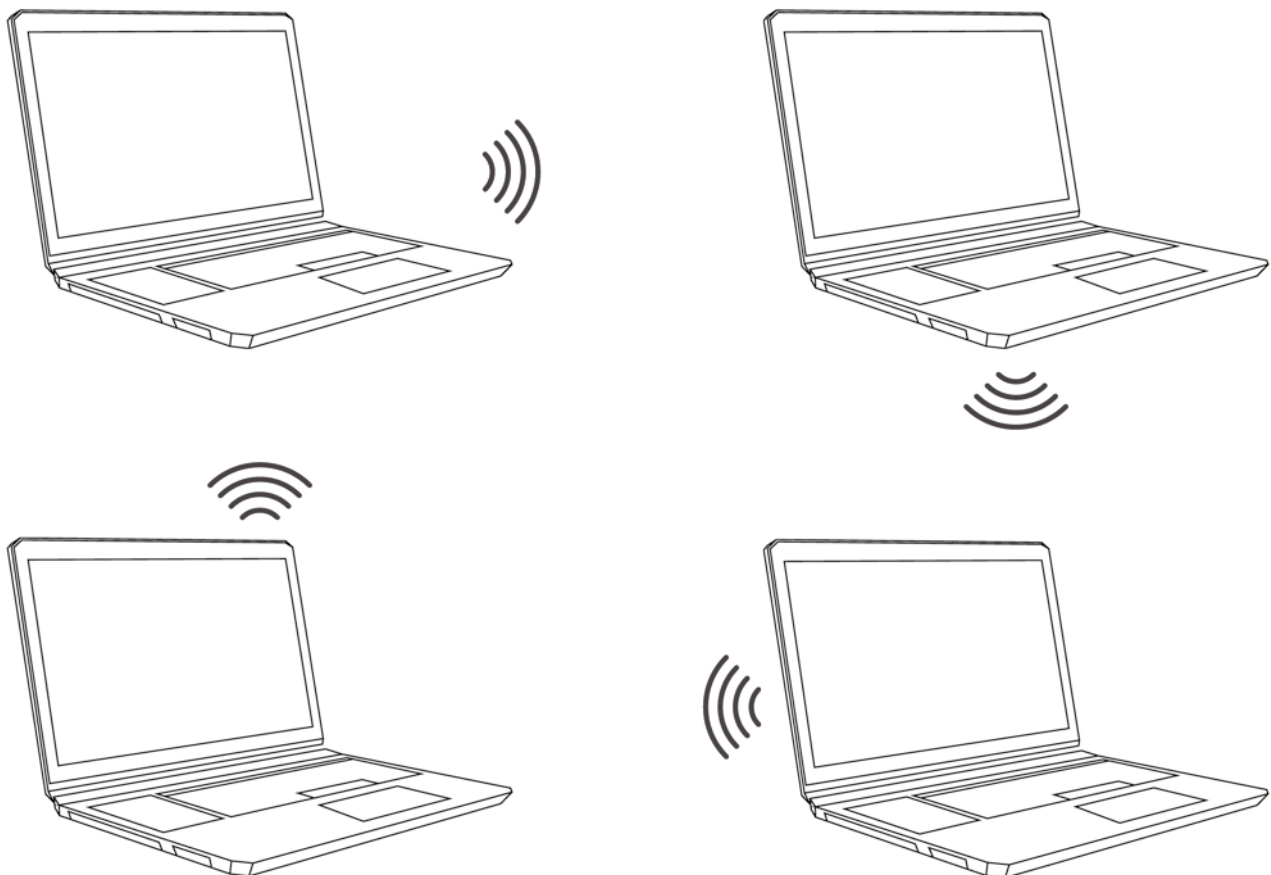
### Powering Access Points

This may not seem like a big issue, but a common practice of powering access points is through Power over Ethernet (PoE) which is also defined in IEEE 802.3 with 802.3af providing

15.4W of power and 802.3at providing 25.5W both at a nominal 48 VDC. Verify the access point powering requirements. Some vendors of access points will indicate a PoE requirement of 24 VDC which is not in the standard. In this case, they provide a proprietary mains-powered power supply. PoE allows the powered device (PD), which in our case is the access point, to be located 100 m from the power sourcing equipment (PSE), which is usually an Ethernet switch that supports PoE or a mid-span PSE used when no PoE compliant Ethernet switch is available. The 100 m of Ethernet cabling could be helpful when positioning the access point in areas close to the needed Wi-Fi coverage but far from sources of power.

### Commissioning a BACnet Wi-Fi Device to an Access Point

Using our example of a BACnet Wi-Fi thermostat with no Ethernet connectivity, we will discuss the required steps for commissioning a hypothetical Wi-Fi thermostat to an access point connected to a BACnet/IP backbone. Assume the access point is in place and working. The first step is to create an ad hoc network between our laptop and thermostat without connecting to the access point. Your laptop functions as a Wi-Fi client and DHCP client. In the initial setup, the Wi-Fi ther-



Independent or ad hoc basic service set (BSS) can communicate peer-to-peer

mostat defaults to access point mode and DHCP server otherwise we could not reach it. If it is functioning as an access point, it will publish its SSID allowing the laptop to authenticate to the thermostat. From the list of access points in range on your laptop, select the thermostat SSID. After we obtain an IP address from the thermostat, we bring up our browser and enter the default IP address of the thermostat and a configuration webpage will be reachable where we can enter the BACnet device name and BACnet device instance and possibly information on BBMD support. We also need to decide if the thermostat should be given a fixed IP address or it should obtain its IP address via a DHCP server.

Once configuration is complete, we need the thermostat to associate with an access point connected to the BACnet/IP backbone. Set the thermostat to infrastructure mode and it should be able to display a list of SSIDs in range. Select

the desired access point. Saving the settings usually forces a reboot of the thermostat after which it will associate with the access point and therefore be part of the BACnet network. Not all device commissioning will work the way as explained but it does give you an appreciation of what is involved in associating Wi-Fi stations to access points.

### Conclusion

The benefits of wireless communications cannot be ignored. There is no need to pull wires and put holes into walls. There is also the convenience of making a connection to a system without disturbing the wiring. A BACnet/IP backbone will almost invariably be wired Ethernet and the wired standard IEEE 802.3 (Ethernet) and the wireless standard 802.11 (Wi-Fi) play well together. To interface the two standards together requires an access

point, but once installed, stations seamlessly communicate to the BACnet/IP backbone.

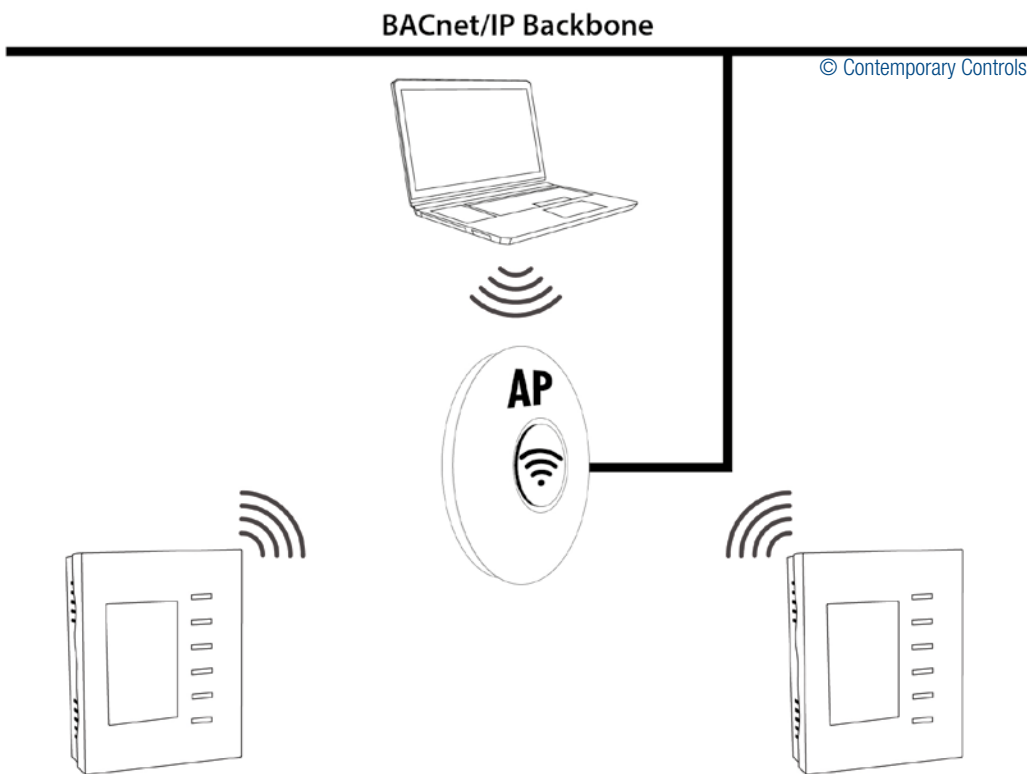
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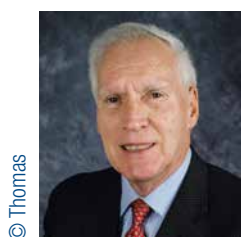
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Infrastructure basic service set requires an access point to attach to a wired network



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# The HVACaaS Revolution

People don't buy a shovel because they want a stick with a metal blade. They buy a shovel because they want a hole. The same can be said for HVAC systems. The buyer of an HVAC system doesn't want a giant metal box with a whirling blade that sits on their roof. They want hot air or cold air. Or — more likely — they just really want a temperate indoor environment.

That's unfortunate when you think about how HVAC manufacturers do business today. The process of buying an HVAC unit — or any type of industrial equipment — ultimately results in the purchase of a giant box that puts the purchaser or site manager in the service business. It puts them in the business of providing the service of cold air.

But what if there's another option? What if there was a way to introduce a new business model or go-to-market strategy that would manage to flip that script and keep the equipment owner from becoming the service provider? HVAC as a Service (HVACaaS) could be the solution.

## The Evolution of Equipment “as a Service”

Traditionally, industrial equipment has been sold as capital equipment that could be bought or leased. Leasing may seem like a service offering, but leasing is simply buying over time with better tax incentives. But HVAC manufacturers with fully connected equipment can turn the model upside down by offering a managed HVAC as a Service.

Thanks in part to today's increasingly deep integration of expansive protocols like BACnet into equipment — and the connecting of those systems to the cloud — OEMs can have more insight about their products in the field. With those systems in place, the OEMs can then take the next step by taking advantage of the real-time operational data and deep insight into performance and functionality of the units on site that these systems provide.

This information is the foundation for delivering a new and potentially disruptive managed service by allowing the OEM to:

- Proactively monitor functionality
- Monitor and proactively maintain equipment
- Schedule service and maintenance calls before there's a problem, or before there's downtime.

That operational data can effectively enable the OEM to remove the headache of managing a “cold air service” from an over-worked, under-paid facilities manager. Instead, the OEM would be in a position to sell that as a service to the customer.

In this scenario, the customer is no longer buying a box that they own and maintain for the sake of becoming a “cold air service” provider. Instead, they're buying “cold air as a service” from the OEM — and that service is powered and enabled by the real-time data that OEMs can only get from the cloud and descriptive protocols like BACnet.

But is this something that customers want, and will it generate revenue for the manufacturer?

## The Economics Behind HVAC as a Service

Consumers have become accustomed to purchasing music as a service through iTunes® or other streaming music companies and have moved away from purchasing it as a physical product — like they did when records, cassettes and CDs were the standard. They've also grown accustomed to purchasing these music services as a follow-on purchase to their product purchases — such as paying for music on iTunes after paying for an iPhone®.

But does this make sense for manufacturers in the HVAC industry? What about other commercial and industrial equipment manufacturers? And would customers be open and willing to embrace it? I think it does make sense in this industry. And I think customers would welcome it.

Much like how the iTunes store opened up new revenue streams for Apple® in the form of music and movie sales, embracing an HVACaaS model, where the OEM sells a solution or product to the customer and then sells add-on services for that product, will open the door for multiple new revenue streams for the manufacturer.

When selling an air conditioner, or a hot water heater, the OEM is effectively selling a product to the equipment owner that they then need to install and operate. But they're really not the best equipped to do so.

Ultimately, there is no organization, company or individual that knows a device better than its manufacturer. They know it inside and out. They

know how to make it operate optimally. And that knowledge is practically wasted when they sell the product or device only to watch it be poorly installed, maintained and managed by the equipment owner.

By selling maintenance and management services to the equipment owner following the sale of the equipment or device, the manufacturer can profit from this knowledge. This enables the manufacturer to provide operational guidance and insight and deliver a better, more efficient experience — at a reasonable monthly rate.

But, would consumers want to buy these services from the manufacturer? I would argue, “Yes,” because outsourcing equipment management equals savings.

Let's flip the equation and look at HVACaaS (or any equipment as a service, really) from the perspective of the customer.

If they buy a hot water heater or an HVAC system, they purchase the physical device and then they have to operate it themselves. They're spending the money to get it, and then spending money over time to operate it. But they're not particularly good at operating it, because they aren't the ones with the real knowledge and understanding of how it works and how to configure it to operate optimally.

HVACaaS rolls product and operation into a service. Should the customer buy an air conditioning unit, the manufacturer would operate it for them and save them money. The manufacturer can then work to manage and maintain that device, utilizing available data to optimize its performance and ensure that it's operating optimally. They could even analyze the equipment data to proactively schedule maintenance and roll service trucks before a device stops functioning.

So, would a consumer want to purchase HVACaaS? I think they would. For a low monthly fee to the manufacturer, they can ensure that their devices and equipment are always working and are repaired before problems lead to actual downtime. What's more, they'll probably make their investment back in energy savings and efficiency.

So, HVACaaS makes sense for the manufacturer and the customer, but how can companies make it happen?





# STEPS FOR EMBRACING HVACaaS



## Acquire Device Data

For HVACaaS initiatives to be successful, it's essential that equipment manufacturers have access to the data being generated by their installed devices. If devices are going to be monitored and managed remotely, their data can't be confined to their current physical location, it needs to be set free so that it can be aggregated and analyzed from anywhere.

# 01



## Improve Service and Support

By monitoring and analyzing device data in the cloud, manufacturers can proactively identify if a device is going to fail and take steps to prevent it. Or, they can use that data to respond faster to service calls with better prepared and equipped technicians to get the user back on their feet more quickly.

# 02



## Generate Revenue

At this point, it's time to monetize the services established in step two. Device owners can benefit significantly by having the organization that knows the most about their equipment – the manufacturer – monitoring, managing and optimizing their devices. And chances are, they're willing to pay for that.

# 03



## Prepare for Organizational Change

To make HVACaaS a reality, new skills will be needed within the organization. Data scientists and people that can analyze device data for actionable insights will need to be brought on board. These skills will be essential to making the most of the device data that is being generated and aggregated in the cloud.

# 04

## Steps for Embracing HVACaaS

While offering HVACaaS may make sense for equipment manufacturers, the process of adding services to their portfolio could seem daunting. After all, this is a whole new offering that requires a new set of skills and personnel to execute on. But embracing HVACaaS doesn't need to be difficult or confusing.

Let's look at four steps that organizations can take to make HVACaaS a reality, then we can address some of the larger organizational changes that they may need to make if their movement towards HVACaaS is going to be successful.

### Step one: acquire device data

For HVACaaS initiatives to be successful, it's essential that equipment manufacturers have access to the data being generated by their installed devices. If devices are going to be monitored and managed remotely, their data can't be confined to their current physical location, it needs to be set free so that it can be aggregated and analyzed from anywhere.

By cloud-enabling devices, the equipment manufacturer opens the door to aggregating and analyzing their data. This allows them to begin monitoring their devices in any location, in real-time. This also allows their customers – the device owners – to begin monitoring their devices remotely. Even more exciting, by pushing their device data into a device cloud, they're opening the door to remotely managing these devices. Which brings us to step two...

### Step two: use that data to improve service and support

Now that the device data has been set free from its current physical location and made accessible from the cloud, equipment manufacturers can start to do things with it. We suggest using it to improve service and support.

Begin implementing programs that more proactively identify device problems. Begin to utilize and analyze data to enable more timely and better equipped service calls. By introducing these services as pilot programs, companies can ensure that they're ready to start charging for them, which brings us to...

### Step three: generate revenue

By this step, equipment manufacturers are aggregating their data in the cloud, monitoring their devices in the cloud and using device data to improve service calls and maintenance. They're also most likely changing settings and managing their devices in the cloud. At this point, it's time to monetize these services.

Step three involves taking the processes and services established in steps one and two, and simply starting to charge customers for access to them. This may seem simple, but it will be a change and – like any organizational change – will need to be managed.

### Step four: prepare for organizational change

Change is hard. Organizational change is really hard. And embracing HVACaaS is certainly going to require a change for equipment manufacturers.

To make HVACaaS a reality, new skills will be needed within the organization. Data scientists and people that can analyze device data for actionable insights will need to be brought on board. These skills will be essential to making the most of the device data that is being generated and aggregated in the cloud.

The sales team will also need to be trained on how to evolve from selling a product – with a definitive, tangible list of features – to selling services. In many cases, this will be the first time that consumers and customers are ever approached with the HVACaaS concept, and many will find the intangible nature of "remote device management" difficult to grasp. Sales people will need to be trained to highlight the potential cost savings and productivity benefits to overcome inevitable sales objections.

That being said, the potential benefits for manufacturers certainly outweigh the changes that they'll have to make. HVACaaS can revolutionize a company's business and introduce new revenue streams at a time when the marketplace is becoming increasingly crowded, equipment is becoming increasingly commoditized and margins are growing thin. With the inclusion of BMS protocols like BACnet becoming more prevalent, these steps as well as being open to some change, allow manufacturers the ability to truly differentiate themselves, opening the door to incredible revenue growth in the future. 🌐



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### ABOUT THE AUTHOR

Steve Shaw is excited to be leading Sierra Monitor's sales and marketing efforts as the Vice President of Sales and Marketing. As an advocate for data security, he also serves as the Data Protection Officer for the company. With over 20 years' experience in B2B marketing in networking and wireless companies, Steve sees the power and opportunity in SMC's products to protect and connect the Industrial Internet of Things (IIoT).

Prior to SMC, Steve was the Vice President of Marketing for Accuris Networks, a Dublin-based SaaS provider to the mobile/wireless industry. He has held various marketing, business development and strategy roles with technology companies during his career in Silicon Valley.

A passionate marketer, Steve is a frequent speaker, blogger and thought-leader who holds a B.S. in Computer Science from USC.



Airports and other facilities require efficient and reliable building automation and HVAC systems.

# How Supplier Participation Can Drive the Growth of BACnet's Global Community

## An Interview with BACnet International Board Member, Paul Bartunek

Paul Bartunek, Vice President Commercial Sales & Marketing, ABB Motion US, recently joined the board of BACnet International. An accomplished business development professional, Paul has extensive experience in HVAC, energy, power systems, sales, and applications engineering. In this Q&A with the BACnet International Journal, he explains why it is important for supplier company executives to become involved on a broader basis than contributing resources to BACnet's technical work.

### *What does your role cover within ABB?*

My responsibilities cover everything related to commercial HVAC from a variable frequency drive (VFD) perspective. That includes channel management, applications engineering, working with OEMs and driving the commercial strategy. Drives are a very significant business within ABB Motion and my overall mandate is to help create energy efficient solutions for our customers.

### *Why did you decide to get involved with BACnet International?*

In late 2018 I was asked by BACnet International President and Managing Director Andy McMillan to attend a meeting of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). Then in January 2019 I was elected to join the BACnet International board, which was also a first for ABB. All ABB employees have a certain responsibility to take on additional roles that support and benefit our respective communities. So, when this opportunity was offered to me, I didn't hesitate to embrace it.

My own involvement with BACnet had been fairly limited. However, our application engineering team, led by Tim Skell, is extremely active in the technical committees driving the ongoing development of the BACnet protocol as well as the BACnet International Marketing Committee. From this perspective, ABB has a long history of substantial contribution to BACnet, including integrating the protocol into our HVAC drive products.

### *What would you say are the advantages of the BACnet protocol?*

Our customers, in particular, benefit greatly from utilizing equipment that's embedded with the BACnet protocol because it gives them choices. Traditionally, in the HVAC industry, companies have used proprietary solutions which were quite restrictive from a hardware perspective. But owing to BACnet's 'open' nature it works with all major control systems, allowing owners to specify a protocol that allows for any complying user's hardware to be selected. This generates healthy competition too.

### *What is the process of becoming a board member?*

I was nominated by one of my peers in the industry. After a telephone interview I was sent an in-depth application form which required a resumé and information about my history, experience and philosophy. Following a review by the other nine board members I was invited to join the board.



Data center © ABB

Data centers are very energy-intensive as they need to run 24 hours a day. Efficient drive and motor packages can help reduce energy costs.

***What do you hope to bring to the BACnet International organization as a board member?***

I have broad experience in channel management and demand creation, which is somewhat different to that of the other board members. We already have the ABB application engineering team that brings enormous technical domain expertise, so my contribution is more of a business management and entrepreneurial nature, which I think has an important part to play.

***How important do you think it is for suppliers like ABB to become actively involved in promoting BACnet?***

I think it's critically important. BACnet's success, which is vital for the industry, depends on technical experts donating their time and knowledge. And because of its open nature, anyone that meets the standards and specifications associated with the protocol, can participate. It is critical for manufacturers such as ABB who are utilizing these open protocols to give their customers the power of choice that isn't locked

into proprietary firmware or protocols. This offers a tremendous advantage to both manufacturers and customers.

***How do you plan to get other suppliers involved?***

Part of what we're doing with BACnet is to promote the protocol across the globe. For instance, I'm working closely with regional ABB executives responsible for India to investigate the prospect of developing the BACnet community in India. So more than me trying to influence other manufacturers, I'm starting by trying to influence other ABB people across the globe to embrace and promote the protocol.

***What can suppliers do to promote BACnet?***

From an R&D perspective they need to make sure that they understand the technical aspects of the protocol. In other words, they need to test their equipment to the requirements of the BACnet certification program to make sure it complies with the operational specifications of the standard.

***What role can community organizations, such as BIG-EU and BACnet International, play?***

I think we all have a responsibility to work on a global basis with the ASHRAE student chapters within the large learning institutions, to make sure graduates have a thorough understanding of the importance of the protocol and its operational benefits. Probably the biggest thing community organizations can do is to participate in education via seminars and training sessions.

Manufacturers that are BACnet community members can, with their specific domain experts, also contribute in educating the community on the benefits and operational importance of the protocol. Everything in a building – from lighting and security systems to HVAC equipment – touches BACnet in some way. So, it's equally important for contractors involved in construction and building infrastructure to have a thorough operational understanding of BACnet and its technical application.

**What are your hopes for the emerging community organizations in China/Asia and India?**

My hopes and aspirations are to expand opportunities for customers in emerging markets by introducing and sharing these technologies. With reliable and efficient HVAC systems, buildings across the world can become more pleasant places to work and live in. One of the biggest selling points for drives is their energy efficiency, and we want to promote that message globally.

**What are your views on the importance of global product specifications?**

In terms of BACnet's significance in the global economy, many OEM customers will ultimately

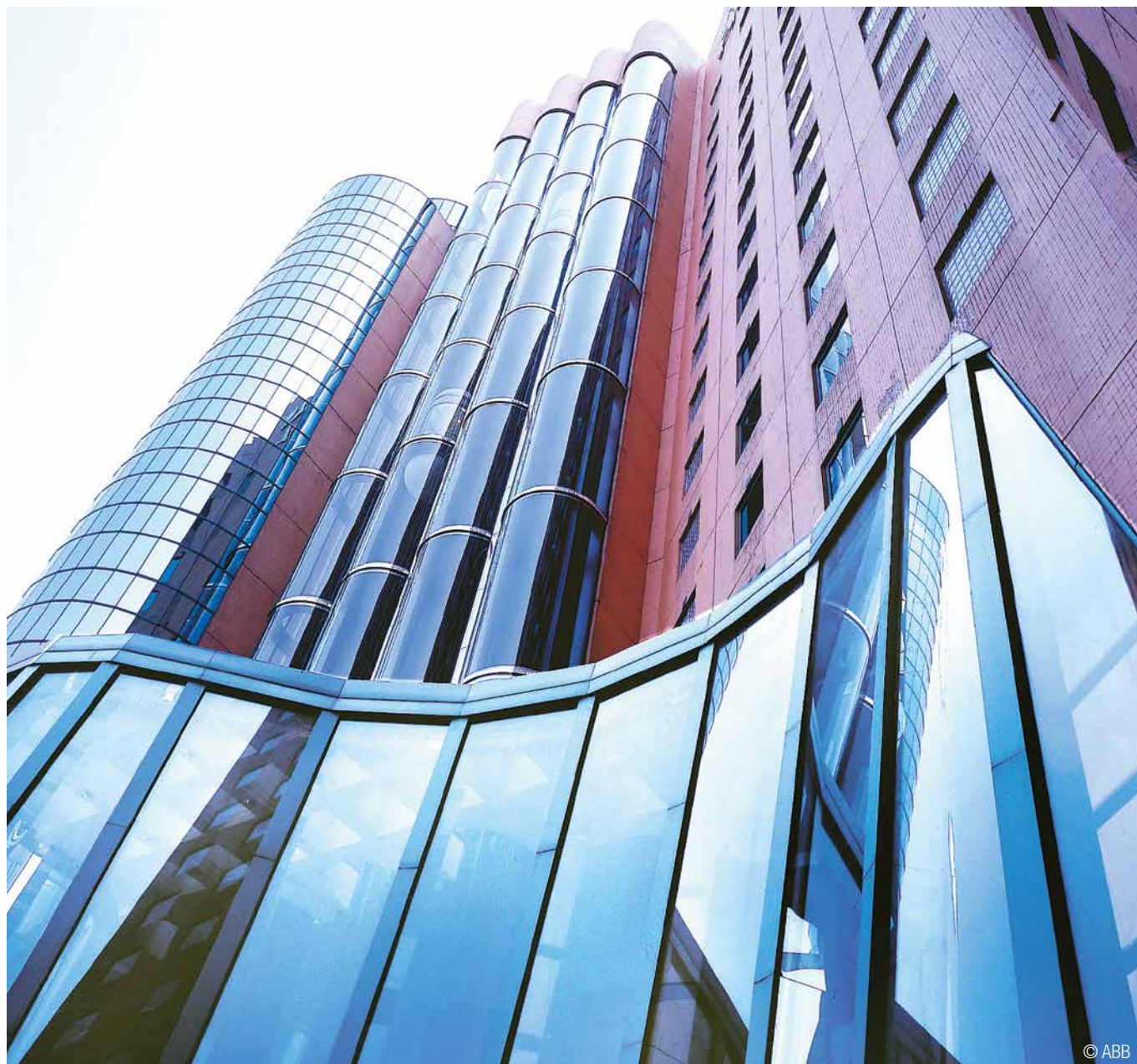
end up being connected to BACnet in some way. With this open protocol, regardless of where a system is designed or built, we can create a global consistency. BACnet certification assures our customers that we care about our products and have gone through the time and effort to prove that our BACnet implementation is not only correct, but robust and interoperable.

**How do you see the future evolution of BACnet?**

In general, we will most likely see a normal evolution. The technology is mature and expanding and I see the usage of BACnet being integrated with more and more components. In fact, at some point it may well extend to residential developments too.



**Paul Bartunek**  
 Vice President Commercial Sales & Marketing | ABB Motion US  
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BACnet-certified drives help to control the ventilation of buildings to match actual needs.

# ASHRAE SSPC 135 Meetings – BACnet Proceedings

In April, the interim BACnet committee meeting took place once again at Lutron's Experience Center in Plantation, Florida. With the ASHRAE Annual Conference in Kansas City, Missouri in late June, more days of meetings of the working groups and the committee were added. Following, the state of core work items and the addenda are detailed.

## Configuration of Device Identity of Out-of-the-Box Devices

In Kansas City, a new important piece of interoperable configurability of BACnet devices was approved for first public review as addendum 135-2016bz. The new services "Who-Am-I" and "You-Are" allow for initial or subsequent configuration of the MAC address and device ID of a device via BACnet, without the need to know the device's MAC address.

## BACnet Secure Connect

The BACnet Secure Connect (BACnet/SC) addendum 135-2016bj continued to be a focus of the IT convergence working group (IT-WG). This addendum was prepared for the third public review with a simple to implement, yet interoperable, solution. For example, BACnet Secure Connect can be implemented in any protocol revision, including older revisions. The addendum was approved for its third public review shortly after the Florida meeting. The review took place from the end of June to early August. The objective is to finalize and publish the addendum by the end of 2019. In case a fourth review will be necessary it should follow swiftly. The IT-WG is also working on the interoperable configuration of keys and certificates as a next phase for BACnet/SC.

BACnet Secure Connect is a virtual data link layer for the existing BACnet stack, which is fully compatible with all existing BACnet devices via a standard BACnet router. BACnet/SC supports a virtual hub-and-spoke connections topology and allows direct connections between devices. All connections are based on WebSockets secured by TLS v1.3 and PKI certificates.

In connection with Secure Connect, the new addendum 135-2016by is now also in the public

review process. It proposes to remove the network security Clause 24 from the standard.

## ASHRAE 223P, Semantic Tags for Building Data

In the meetings of the Application Profiles working group (AP-WG), the work on the projected ASHRAE Standard 223P "Designation of Semantic Tags for Building Data", was continued. The interest in 223P is still high.

The proposed ASHRAE 223P standard will standardize the semantic information of building data as ontologies to make it interoperable. Therefore, the purpose of the standard will be adjusted, as it is more about "Semantic Interoperability

Furthermore, the AP-WG is working on a proposal for the support of Linked Data in the existing "Tags" properties of BACnet. Both the tag's name and its value shall be enabled to be IRIs (Internationalized Resource Identifiers) according W3C's RDF and Semantic Web.

## Status of Addenda to BACnet Standard 135-2016

Nine addenda to the BACnet standard are published and are part of the BACnet standard 135-2016 in protocol revision 1.20.

In the meetings, further addenda were approved for a first or a next public review, of which some reviews are already closed, and others will take

## Published Addenda to 135-2016 for BACnet Protocol Revision 1.20

135-2016bd	Adds the new Staging object type to the standard. This object controls a set of binary objects, based on a commanded analog value.
135-2016be	New BIBBs and device profiles for the lighting domain.
135-2016bi	Introduces a standardized audit reporting and logging mechanism for auditable actions of BACnet devices and users.
135-2016bk	Extends the range of reserved property identifiers above 4194303.
135-2016bl	Clarifications in response to official interpretation requests.
135-2016bm	Enhances and clarifies MS/TP on some of its aspects.
135-2016bn	Extends and corrects some BIBBs and device profiles.
135-2016bp	Corrects and tweaks the BACnet RESTful Web Services in some details.
135-2016bq	Complements and clarifies some smaller aspects of the Access Control objects.

of Building Data". Both Brick and Haystack will play an important role, since this is where industry participation in defining the vocabularies is large. The concrete use in protocols and data, as well as in BACnet, will need to be defined by themselves. In BACnet, addendum 135-2016bo is foreseen for this.

place this fall. The addenda ready for publication are foreseen to be included in the packet making protocol revision 21. The status of the addenda in work is: (see next page)

Addenda in Work

135-2016ap	In AP-WG for second review, on hold	Application Interfaces, is on-hold at this point for 223P.
135-2016bb	New approach in PS-WG for second review	Zero configuration capabilities of MAC addresses for MS/TP devices.
135-2016bj	Processing 3rd Public Review comments	BACnet Secure Connect (BACnet/SC)
135-2016bo	In AP-WG for first review, on hold	Application of ASHRAE 223P in BACnet
135-2016br	Ready for Publication	Miscellaneous Clarifications
135-2016bs	Ready for Publication	New BIBBs and Device Profiles for Elevators (Lifts) and Escalators
135-2016bt	Ready for Publication	Life Safety Enhancements and OEO Support
135-2016bu	Ready for Publication	Miscellaneous Clarifications
135-2016bv	In first review	Miscellaneous Clarifications
135-2016bw	Ready for Publication	Time Series Data Exchange Format
135-2016bx	Processing 1st Public Review comments	Device Address Proxy Function
135-2016by	Processing 1st Public Review comments	Removal of NL-based Network Security in Clause 24
135-2016bz	Processing 1st Public Review comments	New Who-Am-I and You-Are Services

Status of Addenda to the BACnet Test Standard 135.1-2013

Four addenda to the BACnet Test Standard 135.1-2013 are published (see right).

It is planned to incorporate these four addenda and errata into the test standard and republish it as 135.1-2019.

Numerous change proposals for the test standard are in work by the TI-WG, brought forward together with the BTL-WG and other BACnet Committee working groups to a first public review. This includes new tests for IPv6, the Network Port object, Life Safety objects, and a lot of other additional tests and amendments.

The next interim meeting of the BACnet Committee will be taking place at The Georgia Institute of Technology in Atlanta, October 28 - November 1, 2019.

Status of Addenda to the BACnet Test Standard 135.1-2013

135.1-2013o	Align SubscribeCOVProperty error codes.
135.1-2013p	New EPICS consistency tests.
135.1-2013q	Additions and amendments of tests for covering the revision of the alarming which had been introduced with protocol revision 13.
135.1-2013r	Tests for new properties and error codes.

Public review and final versions of addenda are available at no cost from ASHRAE (<https://www.ashrae.org>) as well as on the BACnet website (<http://www.bacnet.org>). To stay up-to-date on public reviews, publications, and interim meetings, you can subscribe to the weekly ASHRAE

Standards Actions electronic newsletter, or read it, at the ASHRAE website <https://www.ashrae.org/technical-resources/standards-and-guidelines/standards-actions>.



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# Addressing the Cybersecurity Threat

An attack on a building automation system in two apartment buildings in Finland left residents in the cold during the winter of 2016. A distributed-denial-of-service (DDoS) attack hit the Domain Name System service and disabled remote connection access forcing building management to inspect the homes on-site. The automation system that controlled the homes' heating, hot water and ventilation systems continuously rebooted, until the system stopped working entirely.

By disconnecting the system from the Internet, the problem was resolved in about an hour. While the building automation system attack did not cause lasting or life-altering damage, the lack of awareness of building automation system security can result in damage to a facility and its occupants, said Levi Tully, Member ASHRAE.

"The most severe data breach in a traditional organization is unlikely to have direct physical impact on the occupants of the building. But a malicious attack on a building automation system can very easily pose a significant threat to the health and welfare of people," he said. "The biggest threat is that no one appreciates the risk of building automation cybersecurity."

As unprotected building automation systems can quickly become high-risk with potential life damage to a building and its occupants, securing these systems is becoming a necessity. Some places and applications are even requiring security protection, said Bernhard Isler, Member ASHRAE, a former chair of the standard committee for ASHRAE Standard 135-2016, BACnet—A Data Communication Protocol for Building Automation and Control Networks.

"Building automation systems are part of the infra-structure of buildings, and malicious users that get access to the building automation system's communication may interfere with the system and produce unwanted behavior or damage to HVAC and other equipment, or life-safety threats even," said Isler, a senior systems architect for Siemens Switzerland, Ltd.

## Common Mistakes

People who, intentionally or by accident, change a device's configuration or control parameters

are the principal security threats to BACnet systems.

Unauthorized access to a building control system and its data could be used to:

- Exploit operating information such as occupancy schedule
- Cause tenant discomfort;
- Interrupt facility operations; and
- Contribute to equipment or facility damage.

These could interrupt mission readiness, cause financial loss, environmental destruction and potentially risk human health and safety, said Tully, a manager of application engineering for Reliable Controls Corporation.

Steven Bushby, Fellow ASHRAE, a previous chair of the Standard 135 committee, said the legacy of the building industry ignoring building automation system's cyber-security is because closed, proprietary systems were not connected to anything; thus, not seen as much of a risk. That changed with the development of BACnet, the most widely used building automation system protocol in the world.

The most common BACnet system is a multi-level system with workstations and supervisory controllers connected to an Internet Protocol (IP) network. The supervisory controllers often serve as routers to a different, lower-cost network technology that connects equipment specific controllers, according to Bushby, who works for the National Institute of Standards and Technology (NIST). He is the leader of NIST's Mechanical Systems and Controls Group of the Energy and Environment Division of the Engineering Laboratory.

He said it is common practice for building owners to connect building controllers to the same networks used for general business and IT purposes. Sometimes facilities will have a standalone, separate network for building control that is isolated from the Internet, but the more common approach is sharing the network because it is cheaper, according to Bushby. This creates vulnerabilities to phishing attacks and compromised login credentials. In this model, login credentials intended to provide an operator or vendor with remote access to the building automation system becomes a vehicle to access or attack anything connected to the IP network.

Putting BACnet devices and other operational technology (OT) devices on IT networks can lead to dangerous installation practices such as placing unprotected devices on the IP backbone or across the Internet, said David Robin, Member ASHRAE, a member and past chair of the ASHRAE Standard 135-2016 committee. Virtual LAN (VLAN) or Virtual Private Network (VPN) configurations should be used to protect OT devices that do not have their own security, but this requires coordination with IT, which may cause delays when setting up or changing a facility's operational side.

The most common mistake people make regarding building automation system security, Tully said, is the lack of awareness about inherent vulnerabilities and the threats they pose to organizations and mission capabilities.

"This poor judgment or awareness often results in negligent user account management, weak or vulnerable passwords, poor system/server/application administration, use of standard openly published ports, preservation of default credentials, inbound firewall penetration, little to no auditing and no recovery/resilience plan for when a breach occurs," he said.

Tully said it also is common for vendors and service providers to leave default passwords in place for convenience.

## Recommended Solutions

There is no single security solution that is appropriate for every building automation system because of technology and the ever-changing threat environment, Tully said.

One of the recommended strategies for protection schemes commensurate with security controls already established in the IT domain is using NIST Special Publication 800-27, Fundamental Engineering Principles for Information Technology Security (EP-ITS). Standards have implemented the use of EP-ITS, and organizations have used EP-ITS for some time, he said.

"Rather than ignoring or avoiding these standard practices and security controls, BAS manufacturers and vendors should embrace these techniques and engage in proactive collaboration with cross-functional teams with the organizations and IT teams whom they serve," Tully said.



Another strategy is hardening—improving an information or computing system’s security by reducing its surface of vulnerability. Hardening trusts a minimum number of system elements, which reduces exposure to vulnerabilities that could be exploited for unauthorized information access and manipulation.

Building automation system environments should be appropriately secured to each organization’s requirement and functional expectations, Tully said. The goal of hardening is mitigating risk to an acceptable level.

“The most common solution today is to put the building automation part in a virtual private network (VPN), which blocks access except for specifically designated devices that can connect, and it encrypts the message and it provides a pretty reasonable level of security,” Bushby said. He said this secures the IP part of the BAS network, which reduces a system’s vulnerabilities, but this does not protect against physical access security breaches.

To better protect building automation systems, Tully said a multilayered, defense-in-depth strategy involving overlapping security mechanisms should be applied by following these steps:

- **Vendor Hardening:** Work with the vendor and service provider to implement the manufacturer’s hardening guidelines for the BAS, servers, etc.
- **Network Architecture:** Deploy BAS on trusted networks without breaching firewalls with inbound rules and exceptions. Use non-standard ports and segregate the BAS from the organizational network.
- **Data encryption:** All IP-based building automation system data should be encrypted, and credentials should be encrypted in storage and transmission.
- **Contingency and Recovery Plans:** The BAS should have a resilient design including a plan to recover service following a breach. The system should be audited regularly for security control management and proper use.
- **Proper authentication:** Public/default users should be disabled. Least privilege should be enforced by defining role-based permissions, standard user account management and disabling unused accounts.
- **Servers and applications should be properly hardened and regularly maintained.**

“Each organization should perform an objective, risk-based assessment of the potential impact to its ability to perform normal business/mission operations and assets in the event of a security breach,” Tully said.

This assessment is a component of a Risk Management Process (RMP) or Risk Management Framework (RMF) and building automation system manufacturers and vendors should be an integral component and consideration of the assessment and RMP/RMF, he said.

### BACnet Secure Connect

There is an urgent need for a more IT-friendly solution that is consistent with standard IT infrastructures, Tully said. BACnet could have a solution to remedy that challenge.

A new addendum to Standard 135 seeks to increase protection of building automation systems integrated into traditional IT systems, which is common practice.

To make BACnet more IT-friendly, the BACnet standards committee is looking for ways BACnet can be used in public or shared IP infrastructures and complex and highly managed IP network setups, said Isler. The building industry did not adopt its current security architecture well, which left BACnet without an inherent cybersecurity solution for IT departments and network managers, he said. This made VPNs necessary for protecting BACnet.

To remedy these challenges, BACnet Secure Connect is IT-friendly and shifts BACnet into the application space of using well-known, accepted IP application protocols and techniques, according to Isler.

“BACnet Secure Connect will provide cybersecurity inherently, equal to what is currently achieved using VPNs and such. No extra VPN equipment or software and according setups will be needed anymore,” he said.

BACnet previously only allowed for physical or virtual separation of the network for protection. “BACnet Secure Connect will provide inherent means of protection for a BACnet-based BAS, even if it is used across the public Internet or in shared private IP networks,” Isler said.

The new protocol allows devices to protect themselves with built-in security mechanisms. This should eliminate risky behavior such as placing unprotected devices directly on the Internet. The new protocol eliminates broadcasts, supports DNS for name resolution, and uses industry standard security with Transport Layer Security (TLS) (née “SSL”) and Private Key Infrastructure (PKI) certificates, said Robin.

“This is the same technology that you use to make a secure Web connection to your bank with ‘https’ as opposed to the old unprotected ‘http’ protocol,” said Robin.

Robin said all connections in BACnet Secure Connect are mutually authenticated, meaning that both ends must complete a TLS validation of the other end before they can talk to each other. BACnet communication through BACnet Secure Connect will be secured using TLS V1.3, the most modern version of TLS, said Isler.

“Even if you have ‘boring’ systems that do not have the potential to create a public hazard, the risk of financial loss from casual or deliberate hacking is very real and should not be ignored,” he said.

*The BACnet standards committee released a white paper on BACnet Secure Connect in May. The white paper matches the draft of the addendum that will be in public review soon. To read the white paper, visit [https://www.ashrae.org/File%20Library/Technical%20Resources/Bookstore/BACnet-SC-Whitepaper-v15\\_Final\\_20190521.pdf](https://www.ashrae.org/File%20Library/Technical%20Resources/Bookstore/BACnet-SC-Whitepaper-v15_Final_20190521.pdf).*

### Recommended Sources

Tully said Addendum bj to Standard 135 gives good background information that goes beyond the technical definition of how protocol will be revised. He offered more resources.


NIST’s Special Publication series 800 on computer security is the most in-depth, actionable resource for network, computer and industrial control system security, he said. The series defines risk, vulnerabilities and mitigation techniques and establishes standard principles for performing risk assessments, selection and deployment of security controls.

Tully recommended two specific publications in the series:

- NIST SP 800-27 Engineering Principles for Information Technology Security (A Baseline for Achieving Security), Revision A. This includes a list of system-level security principles for an information systems’ design, development and operation.
- NIST SP 800-82 Guide to Industrial Control Systems (ICS) Security, Revision 2. This publication provides guidance for establishing secure industrial control systems.

Building automation system manufacturers should also be used as a reference for hardening guidelines for their products as they have designed and developed the hardware and software components, he said.

“Consultants, system designers and end-use organizations should expect manufacturers, vendors, and service providers to be accountable for BAS cybersecurity as a building automation systemic qualification,” Tully said.

Tully also recommended that consultants, system designers and organizations ensure the guidelines are commensurate with the organizational RMP/RMF and followed during BAS deployment. They should also audit the deployed configuration. 

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# BACnet Edge Controller with Azure IoT Central



The BASpi Edge Controller is BACnet/IP (B-ASC) compliant with a built-in Azure IoT Central connector providing an easy interface to a cloud-based dashboard and supervision

- 6 Universal Inputs, 6 Binary Outputs or 4 Binary and 2 Analog Outputs
- Web page configurable, Sedona programmable, BACnet networked
- Convenient installation – 10/100 Mbps Ethernet, Wi-Fi, 24 VAC/VDC power, DIN-rail mounted enclosure, real-time clock
- 12 physical points and 24 virtual points
- Free programming tools

# An Effective Controls Procurement Process Does Make a Difference

Traditionally, facility equipment was purchased using a low-cost approach. Suppliers would submit their bids based on requirements provided in an RFP (Request for Proposal), then the supplier with the lowest bid would win the contract. However, this does not guarantee that the best product and service is chosen. And based on the expense and longevity of a Building Automation System (BAS), it is definitely not the most effective approach.

## So what is the best approach?

While most facility managers would prefer a sole source approach, and most purchasing departments want a competitive bidding approach, an optimal approach is achieved by combining the two through an Approved Supplier List bidding

process. Not only does this allow you to better ensure the best product (and service) is selected at the right price (Best Value), but also establishes a manageable process for future bids.

There are 5 simple steps required to execute an Approved Supplier List bidding process, resulting in optimal results.

### Step 1: Develop an accurate and comprehensive Request for Proposal (RFP)

An effective RFP is dependent on how well your specifications and plans have been documented. Therefore, before developing the RFP, check the specifications for accuracy and thoroughness. This includes equipment requirements, BACnet object lists, system infrastructure, front-end

graphics, points naming conventions, training, commissioning as well as the responsibilities of team members. The RFP must be accurate and comprehensive; and most importantly, reflect the details provided in the Specification.

Once the accuracy and thoroughness of the specification and plans is verified, identify the mandatory and non-mandatory supplier and product features and requirements that should be included in the RFP process. To ensure thorough and consistent responses from the suppliers, develop worksheets, e.g., a Mandatory Functionality Checklist (requirements that must be met), and a Scored Functionality Checklist (not mandatory but important). The latter worksheet will aid in the technical score portion of the evaluation (Step 5).

## SCORED BACnet FUNCTIONALITY CHECKLIST

Submitted By: \_\_\_\_\_

Date: \_\_\_\_\_

B-OWS			B-BC			B-AAC			Functionality Description and Extended Device Profiles
Index 95	Comply	Score	Index 96	Comply	Score	Index 97	Comply	Score	
									Basic BACnet Functionality (applies to all BACnet devices)
1		5	1		5				Uses MAC broadcasts for router discovery for transmitting unicast service requests other than COV notifications.
2		5	2		5				Initiates Confirmed Requests for transmitting unicast service requests other than COV notifications.
									Segmentation - Receives Segmented Messages
			3		10				Processes received segmented responses
			4		10	1		10	Processes received segmented requests
									Segmentation - Transmits Segmented Messages
			5		10	2		10	Transmits segmented responses
			6		10				Transmits segmented requests
									Device Object
3		5	7		5	3		5	Supports ALL of the following optional properties: active_cov_subscriptions, apdu_segment_timeout, backup_failure_timeout, configuration_files (applies to B-BC or B-AAC only), database_revision, daylight_savings_status, description, last_restore_time, local_date, local_time, location, max_info_frames (MS/TP devices only), max_master (applies to routers to an MS/TP device only), time_synchronization_recipients, utc_offset, vt_classes_supported.
4		5	8		5	4		5	Supports the following properties as writable: apdu_segment_timeout, apdu_timeout, backup_failure_timeout, description, local_date, local_time, location, max_info_frames, max_master, number_of_apdu_retries, object_identifier, object_name, time_synchronization_recipients, utc_offset.
			9		10	5		10	Supports Database Revision property
									Accumulator Object
			10		15				Base Requirements: Defined as required properties per the ASHRAE 2008 standard as well as BTL requirements needed to achieve a BTL Listing.
			11		5				Supports writable Out Of Service properties
			12		5				Supports command prioritization for all 16 priorities.
			13		10				Supports writable Out Of Service properties

VENDOR SCORECARD											
PROJECT:						REVIEW DATE:					
Rating Factor	Weight	Bidder Name									
		Vendor A		Vendor B		Vendor C					
		Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score	Score	Weighted Score
Price Proposal	0.15		0.00		0.00		0.00		0.00		0.00
Branch/dealership/personnel capabilities (based on responses provided on the forms)	0.20		0.00		0.00		0.00		0.00		0.00
Quality of Service and References (based responses to the project forms)	0.30		0.00		0.00		0.00		0.00		0.00
Vendor compliance with BACnet Objects and Services required for the project	0.35		0.00		0.00		0.00		0.00		0.00
	1.00		0.00		0.00		0.00		0.00		0.00

Rating Factor	Weight	Sample	
		Score	Weighted Score
Price Proposals	0.15	4	0.60
Branch/dealership/personnel capabilities (based on responses provided on the forms)	0.20	3	0.60
Quality of Service and References (based responses to the project forms)	0.30	3	0.90
Vendor compliance with BACnet Objects and Services required for the project	0.35	2	0.70
			0.00
	1.00		2.80

**Instructions:** Enter a score (0 to 5) in the each of the five evaluation criteria boxes:

- 0 Totally unresponsive, does not meet minimum requirements.
- 1 Well below average, barely meets minimum requirements.
- 2 Slightly below average, meets minimum requirements.
- 3 Average, meets minimum requirements, exceeds minimum requirements in some areas.
- 4 Above average, exceeds minimum requirements in many or all areas.
- 5 Outstanding, far exceeds minimum requirements in most areas.

REVIEW COMMITTEE		
_____	_____	_____
_____	_____	_____
_____	_____	_____

Supplier Scorecard, © BACnet International

**Step 2: Submit RFP using an Open Bid process**

To ensure a highly competitive process, submit the RFP, with accompanying worksheets, using an open bid process. An open bid process should eliminate any bias while ensuring transparency in the selection process.

During this step, it is important for vendors to have the opportunity to ask questions and comment on the RFP as well as the items listed in the worksheets.

**Step 3: Conduct an initial review of bids**

Once the RFP is closed, conduct a preliminary review of all the bids. Begin with an initial check of all bids, identifying those that do not meet all the mandatory items. Next check information in the worksheets against the supporting documentation provided, and where necessary, request additional information to

confirm the supplier’s claim of compliance. At this point, all bids that do not comply with the mandatory requirements are eliminated from the selection process.

Note, to ensure full team collaboration include IT and other applicable team members in the initial review.

**Step 4: Execute in-person interoperability demonstrations**

The remaining suppliers should then be invited to an in-person interoperability demonstration. This will allow them to showcase specific pre-determined features of their equipment, demonstrate their collaboration skills, and participate in confidential interviews with the evaluation team.

A ‘worse-case’ scenario can be tested during the interoperability demonstration by crashing all the systems. In addition, bandwidth usage

and security issues can be checked. If possible, projecting the monitor information onto large screens will allow evaluators to better assess the results.

**Step 5: Create the final Approved Supplier List**

Using the information gathered, the evaluation team completes a Scorecard for each supplier. The Scorecard gives the evaluation team the ability to establish scores for all elements, supplier capabilities and technical features of the equipment, that were identified as important in final selection. Now a final score can be compiled for each supplier.

Using the final score, a ‘Best Value’ approach is then used to select 2 to 3 suppliers for the Approved Supplier List. These suppliers will remain on the list for approximately 3 to 5 years. This is done to ensure that there is a “sunset clause” to the contract as most public



**Why a Cooperative Competition Environment?**

You will find that a cooperative competition or a “coopetition” supplier culture provides great results when implementing multi-supplier networked controls.

In a coopetition culture, suppliers, even when they are competitors, will cooperate on a job site to ensure that all of the equipment will interoperate properly. This accelerates system integration and reduces the time and cost of troubleshooting.

To enable a coopetition culture make sure the spec is clear about working arrangements among the trades and equipment suppliers, providing details like who is responsible for attending the commissioning meetings. You can also use a supplier’s receptiveness to coopetition as a criterion in the bidding process.



agencies do now allow for open-ended contracts. This process should be repeated periodically; frequency should be determined based on number of facilities managed and risk involved. Selected suppliers should have the opportunity to participate in future reviews, even before their selection expires, in case equipment improvements and advances may increase their earlier score. These claims of improvements and advances should be checked with the same rigor as used for the initial scoring process.

**Moving forward**

With the completion of Step 5, Construction Managers can now use the Approved

Supplier List to bid out specific projects to the suppliers listed on the Approved Supplier List. On a project by project basis, proposals can be selected based on either best value or lowest cost since the suppliers on the list have been thoroughly vetted.

By employing an Approved Supplier List bidding process, you can better ensure you achieve the balance between cost and performance (Best Value), while still maintaining a manageable process over time. A BAS is a critical component in the efficiency of a facility. Having an effective controls procurement process can make quite the difference.

**There’s More...**

*Want more information on how to achieve a more successful BACnet-based BAS integration? Access the FM Guide to BAS course on The BACnet Institute (TBI) e-learning website, [www.thebacnetinstitute.org](http://www.thebacnetinstitute.org).*

**ABOUT THE AUTHOR**

Grant Wichenko, P. Eng., is President of Appin Associates, a 40-year-old Consulting Engineering firm based in Winnipeg, Canada. Grant is actively involved with BACnet, serving as chair for the Applications Working Group of the SSPC-135, and as a member of both the SGPC-13 (DDC Guideline Specification) and ASHRAE 201P (Smart Grid) committees.



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# Optimal Virtual Metering in Building Automation

Today's typical Building Automation System (BAS) is capable of delivering higher energy efficiency and greater savings to building owners than ever before. This trend is expected to continue and will require ever increasing amounts of accurate real-time metering data to implement energy-saving strategies. Basically, the more energy data you have, the better your result. As the old saying goes:

*"You can't manage what you can't measure"*

Of course, engineers can always use knowledge and experience to design systems as efficiently as possible. However, without direct real-time measurement of meter data, how would an engineer:

- Report on and verify energy savings with clients?
- Know when to modify a strategy if it is flawed?
- Learn, adapt and make incremental improvements over time?

Additionally, unlike slow energy data from sources like utility bills, continuous real-time measurement can be incorporated directly into control strategies. Imagine trying to control the temperature of a tenant space without continuous measurement from a space temperature sensor. Similarly, the ability of a BAS to effectively impact energy efficiency requires a continuous stream of power and energy data in as many places as possible.

## Optimal Virtual Metering

This article doesn't cover energy management techniques. There's already considerable information available on this topic. Instead, we start with the simple assumption that most energy saving strategies are hungry for increasing amounts of energy data. We describe several methods of acquiring this data through cost-effective means—both well-established and new.

We define a Virtual Meter simply as a collection of data points normally associated with physical meters, but instead these values originate from cheaper alternatives described below. These cheaper alternatives to physical meters allow the modern BAS to acquire ever-increasing

amounts of meter data to help save energy in a cost-effective way.

This doesn't mean there are no physical meters. In many cases physical meters offer the fastest and most accurate data available, providing good value to building owners. The key is to use the best mixture of physical and virtual energy data sources.

The term "Optimal Virtual Metering" describes the process of acquiring the most energy data using the least expensive means. When proposing a new energy strategy to building owners, the best value proposition comes from surveying all building systems and finding the optimum mix of physical meters and alternative sources. Using well-established methods, as well as emerging technologies, we hope to show how today's engineers can implement better energy strategies with the smallest up-front cost.

## What Meter Data?

Over time, the evolving BAS will want to consume larger amounts of meter data to produce higher energy efficiency in buildings. Specifically, the most important data is:

- Electric Power (kW)
- Electric Energy (kWh)
- Thermal Power (Tons)
- Thermal Energy (BTU's)

The question is how much of this data and from where? Building systems vary greatly in electrical and mechanical design. Furthermore, utilities and rate schedules also vary across countries, states and individual buildings. There's no set rule, but we'll briefly describe the value of metering different areas of a typical large building.

First, we can eliminate data from areas of a building that we have no control over. For example, measuring plug loads may have some value in analysis and reporting, but large amounts of this type of data is of little use in a BAS.

Meters on the whole building or larger systems provide the best value. The quantities measured here are very significant, while their numbers are few. These areas include:

- Whole-Building Electric Consumption
- Chiller/Boiler Plant Electric Consumption
- Chiller/Boiler Plant Thermal Production

These are the areas where we can typically justify purchasing and installing physical meters. Even though these areas require relatively expensive meters, they are few in number and provide fast, accurate data. As you will see, this data can be used with other data to produce more fine-grained meter data.

Below this we'll want meter data for smaller equipment and systems like:

- Individual Air Handler Electric Consumption (Fan Energy)
- Individual Air Handler Thermal Consumption
- Individual Lighting Circuit Electric Consumption

The quantities measured here are smaller but still significant. Even though these meters are cheaper than their larger cousins, they are numerous (100's). Although this meter data allows us to save energy, the value of purchasing new physical meters in these applications become questionable. Here is where we will want to start to shift toward virtual meters.

As we move down to even smaller equipment under our control (VAV's, exhaust fans, etc.) it is unlikely that we can justify individual meters. It's not that this information wouldn't be useful, it's simply that these are too numerous (1000's) and the savings realized simply could not justify the cost of physical meters. In these applications we will rely on virtual meters almost exclusively.

## Alternatives to Physical Meters

Below we list several cheaper alternatives to physical meters. Each can provide a BAS with real-time meter data. These are:

- Protocol Interfaces to existing Meters, Systems and Devices
- Constant Estimates of Meter Data
- Simple Calculations programmed into the BAS
- Machine Learning and Big Data

The sections below expand on each of these alternative meter data sources.

### Protocol Interfaces

Interfaces between building systems and devices is commonplace today thanks to the proliferation of open protocols like BACnet. For example, engineers can use BACnet to get electric consumption information from Variable Frequency Drives (VFD's) on fans and pumps. Typically installed to provide variable speed motor control, open protocol VFD's also serve as a great source for meter data.

Another interface example is acquiring electric consumption data for the whole building directly from the local utility. With new Smart Grid initiatives, fast and accurate real-time energy data from utilities is becoming more commonplace.

### Constant Estimates

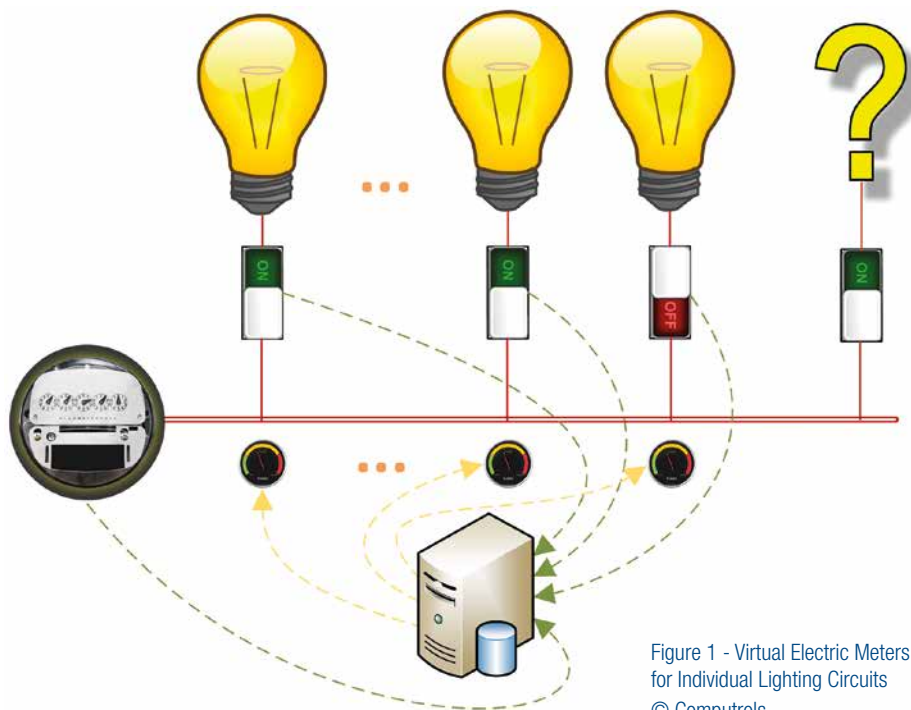
For data points that don't vary much, we can use simple constant-value estimates. For example, you could estimate A/C voltage as a constant line voltage instead of measuring it. Constant estimates can be taken from equipment name plates, test and balance reports or one-time measurements with a portable meter.

### Simple Calculations

In many cases we have all the information we need to calculate missing meter data. For example, to get electric power consumption (kW), we need Current (Amps) and Voltage (VAC). Installers will often find that current transducers exist on equipment for status. Just combine this existing current value with a constant estimate for voltage into a calculation, and you can get a reasonably good estimate for power.

### Machine Learning

Along with BAS data collection and classical HVAC engineering principles, emerging technologies like machine learning and big data can be used to produce a new source of accurate meter data. Similar in concept to the simple calculations described above, machine learning algorithms can construct missing data from existing data using math. What differentiates this technique from simple calculations is the size and scope of the data and math used. Luckily, modern machine learning algorithms are readily available from the open source community.



### System Modelling

When we combine all of the physical and virtual meter sources together—especially machine learning—we produce a complete mathematical description of systems in our building. From the perspective of a BAS we refer to this as a Model.

Modelling combines the following:

- Data from existing HVAC and Lighting systems
- Carefully selected measurements of Meter Data
- Large historical data archives of classic BAS data points (Big Data)
- Machine Learning and Estimation algorithms

There are many examples of modelling that can be employed in buildings. Complicated examples and detailed descriptions are outside the scope of this article. Instead we offer two simple examples in the sections below that highlight how these techniques can be used.

#### Example 1: Virtual Electric Meters from One Physical Electric Meter

Consider the diagram above (Figure 1): In this example, we use one physical meter to get accurate Power consumption measurements for all downstream lighting circuits. We combine this meter data with the On/Off status for each lighting circuit (represented by a single bulb) to eventually calculate the portion of the total power consumed by each circuit.

To see how this is possible, first consider the trivial case where only one lighting circuit is On and all others are Off. For this case the total power measured is equal to the power of the individual circuit. We could use this measurement directly to represent typical power consumed by that circuit. We would add this to our model for future use.

In the real world, this type of one-at-a-time measurement isn't typical. To start, the question mark on the right represents things that are part of our total measurement, but NOT under our control. These contributions complicate our calculations. Additionally, in many cases it is not possible to isolate each equipment or circuit under normal building operations. Binary outputs—and lights in particular—are the simplest case.

The real method behind building a model that produces virtual meter estimates for each circuit requires that the total power and circuit values be collected and archived for a long time. Only then, can the model be built and used for individual energy estimation moving forward. Luckily, many systems today can archive all points over long time periods.

One of the simplest machine learning methods for this is called **Linear Regression**. In this method, a single linear equation, representing a single snapshot in time, is used to relate all known point values to estimated point values. In this case we know the total power and On/Off status, and we're estimating the typical power

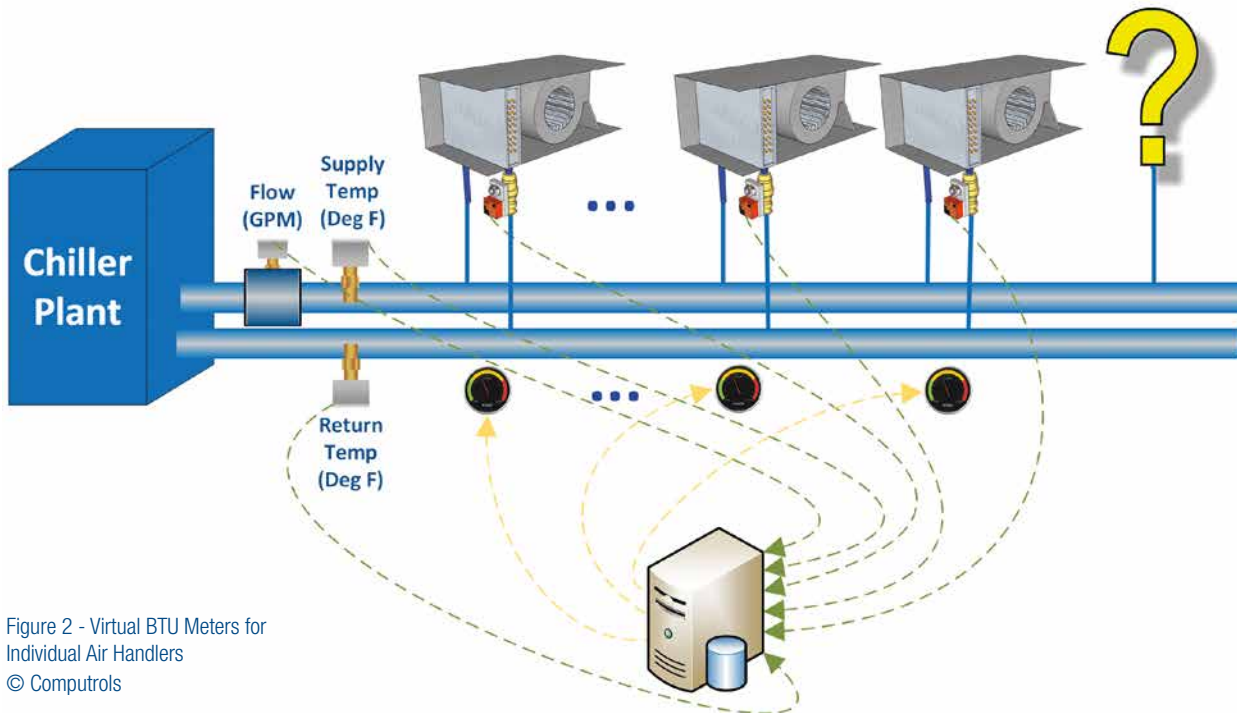


Figure 2 - Virtual BTU Meters for Individual Air Handlers  
© Computrols

consumption of each circuit (virtual meter). **Linear Regression** uses large sets of these equations from historical data—each built from a single snapshot in time. It reduces the entire equation set to best estimates using techniques like Least Squares. At the end of this machine learning process, we have a model that can estimate the virtual meter data for each circuit from a single meter measurement and each On/Off value.

**Example 2: Virtual BTU Meters from Chiller Plant Meter Data**

In our second example we'll examine the more complex case of estimating virtual meter information for a group of air handlers (AHU's) fed from a central chiller plant. Consider the following diagram: (Figure 2)

This example is more complex than the previous one for two reasons. First, besides the simple binary On/Off status for each air handler, we have the additional analog Chilled Water Valve position that varies continuously from 0-100% open. The analog position quantities must be considered when estimating

the BTU's consumed by each AHU. And secondly, the BAS will never be able to run a single AHU from the plant. Let's assume that the plant requires a minimum load of several AHU's in order to stay on line. The question mark again can represent losses or smaller equipment not under our control.

Similar to the previous example, our system will learn from historical data containing Plant Tons, as well as AHU On/Off and Chilled Water Valve data over a long period of time. It will produce a model that can estimate the BTU's consumed by each AHU in real-time. That is very valuable information that would normally require the installation of many individual BTU meters.

**Conclusion**

To operate efficiently, today's building automation systems should be capable of interfacing to disparate systems throughout a building, consuming as much useful information as possible. The BACnet standard has made such protocol interfaces commonplace. Furthermore, every BAS should be able to archive very large amounts of data for analysis. And finally,

systems should employ the latest computer algorithms and techniques, like machine learning, to leverage this data into models capable of estimating and predicting building status. Using these techniques, a BAS can achieve higher energy efficiency for lower cost.



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**ABOUT THE AUTHOR**

Mike Donlon received both his Bachelor's and Master's degrees in Electrical Engineering from the University of New Orleans. He began his career in 1989 as the Principle Developer of Computrols Building Automation Software. After the initial introduction of CBAS, he led his engineering team to develop new controllers, firmware, software and protocol interfaces. Today Mr. Donlon is the Director of Research and Development and one of the owners of Computrols. He spends most of his time applying new technologies to Building Automation, with specific interest in machine learning, building system modelling and open source technologies.



# Integrating Asset Management and BAS Delivers Smarter Buildings

A smart building is a high functioning building where technology and human interface combine data and actions to keep occupants and building owners comfortable and productive at the lowest possible cost. Smart buildings use sensors, actuators, and microchips to collect data and manage it according to a business's functions and services. This infrastructure helps owners, operators and facility managers improve asset reliability and performance, which reduces energy use, optimizes how space is used and minimizes the environmental impact of buildings. But smart buildings are constantly changing and becoming "smarter" as technology such as CMMS (computerized maintenance management software) and BAS (building automation systems) become more integrated into their daily operation.

CMMS is computer software designed to coordinate and simplify building and asset maintenance management. It helps plan preventive maintenance and records maintenance data such as employee time, parts usage and emergency breakdowns.

Building automation systems monitor and automate the control of various building systems such as HVAC, fire alarms, security, and lighting. The BAS provides a user interface that allows the end-user to adjust the control settings, view the system status, and detect any potential issues related to building system performance.

Both of these features help in developing smart buildings, but when they're combined, the sum is greater than the whole, and smart building technology can be further realized.

Since a CMMS is concerned with the upkeep and efficiency of a building and its assets, any

information that can help with this task is greatly beneficial. That's where programs such as BAS come in. These building automation systems monitor points and sensors that are critical to operation. When these indications go past specified levels or generate alarms, they can generate actionable data responses in a CMMS.

CMMS is designed to generate work orders for planned and unplanned maintenance, incorporating data such as employee skill and time, parts specifications and usage, maintenance procedures, budget information, work categories, etc. These work orders can now be automatically generated by an integrated BAS whenever an alarm is triggered or certain specifications are met.

This integration is facilitated by BACnet. BACnet is a communications protocol that allows the transfer of information between building automation and other systems such as CMMS. It is the technology that brings open interfaces to BAS systems and therefore a CMMS that is designed to work with BACnet will work with any manufacturer's BAS.

BAS can publish alarms over BACnet, and a smart CMMS can subscribe to these alarms. You can create alarm points or conditions in BACnet that are relayed between BAS and CMMS. When an alarm is triggered, such as a room being too hot, that information is sent to the CMMS, which will then automatically generate a work order that can contain instructions, tools, parts and employee information to fix the problem.

Building system alarms are an everyday fact of building operations. However, few building operators have a solid alarm management plan. The



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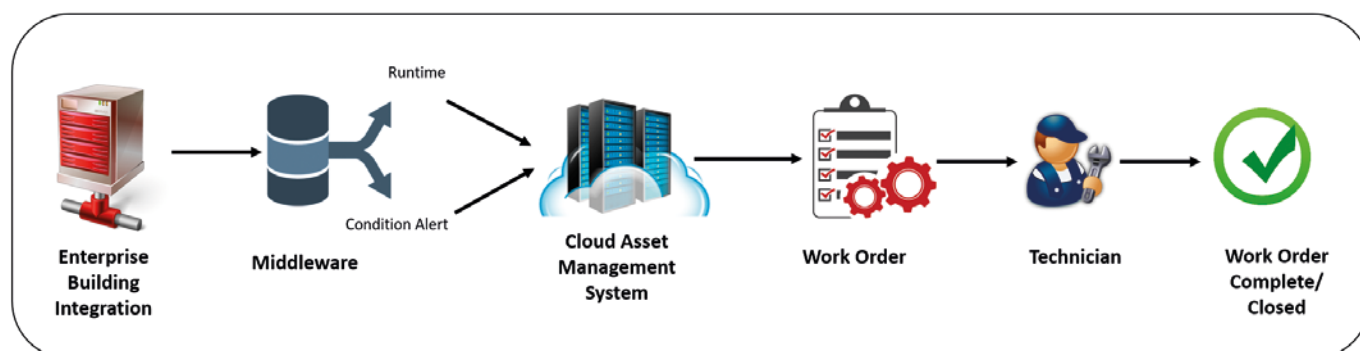
Continuous alarm vigilance via a direct interface to Building Automation Systems (BAS) supporting popular standards as BACnet®, asset management systems can issue work orders based on alarms, events or equipment runtimes.

"plan" for many is to simply react to alarms when they occur and figure out what to do when it happens. This "ad-hoc" approach views alarms as nuisances that need attention rather than valuable data that can improve operations and tell a building owner a lot about how the building is performing.

Building system alarms are not just nuisances; they affect system performance, equipment life-cycles, life safety, regulatory compliance issues, energy consumption, lost occupant production, and building technicians' efficiencies.

Building operators must develop a response plan for every alarm.

- Listing every possible alarm for each building system.
- Prioritize these alarms. Is it related to life safety, critical operations, energy consumption, government regulations, etc.?
- For each alarm determine the response of the building technician or operator. Identify the roles and responsibilities of each person



CMMS and BAS Integration

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involved as well as the work process from alarm notification to resolution and documentation. Include hierarchy rules for escalation.

- Map each alarm to a work order for the asset in CMMS to trigger automatically when an alarm occurs.

An integrated CMMS can be used for:

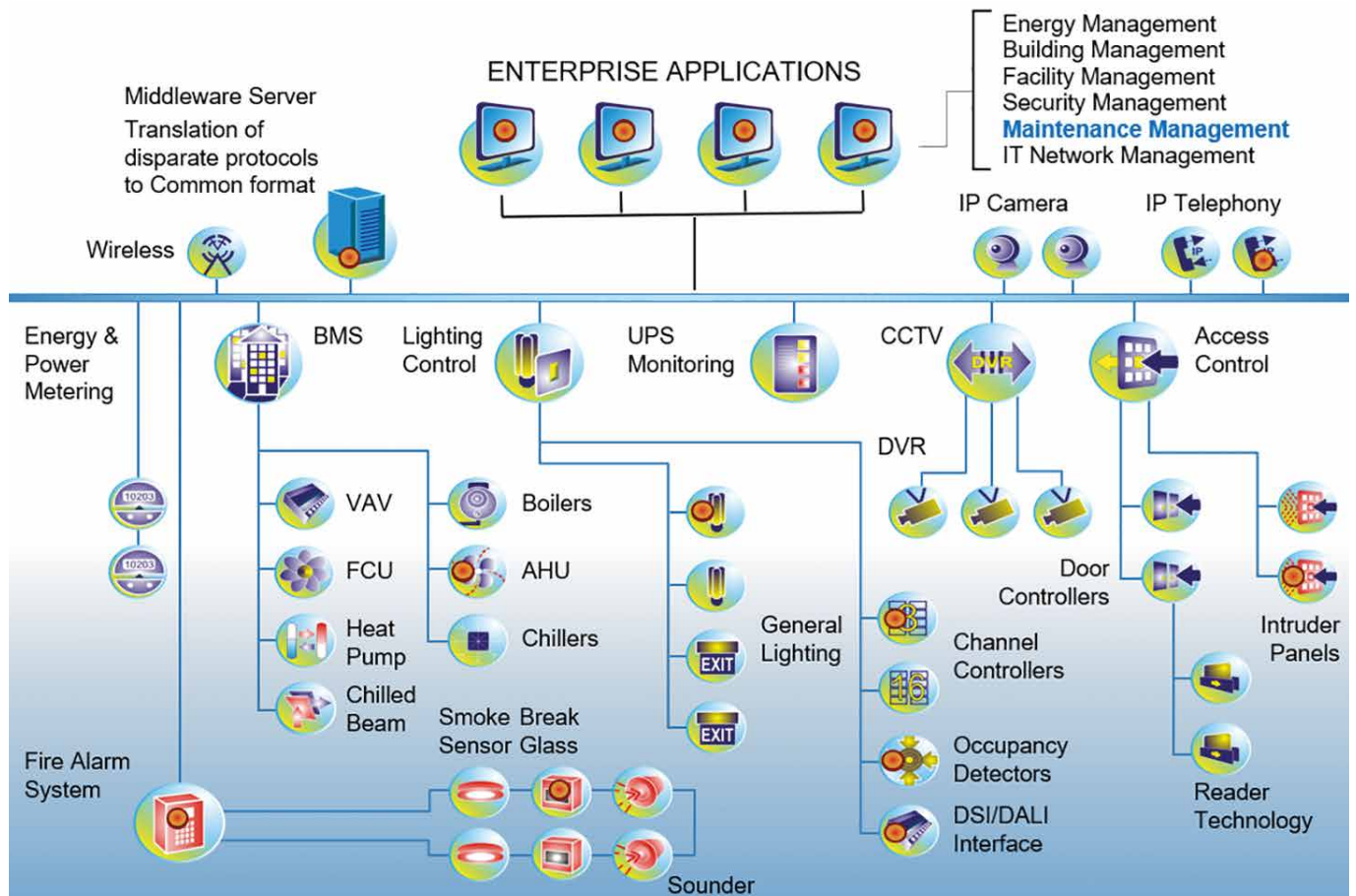
- Alarm acknowledgment - where it is recognized that someone is aware of the alarm and addressing it

- Status of out-of-service alarms - including their history and changes in status
- Reporting on any sub-system communications or component failure

It is also possible to capture runtime information and generate work orders based on meter readings. The BAS can measure the actual runtime on equipment and send this information to a CMMS. Then the CMMS can automatically generate a work order based on the runtime values. These work orders can also be instantly sent to a technician out in the field via their mobile device.

This continuous monitoring of assets allows technicians to respond to alarms as soon as possible and allows for the most efficient use of their time. It also minimizes the downtime of assets.

All of this goes into the model of smart buildings. The benefits of this integration include energy savings, increased productivity and increased sustainability. Smart building strategies can reduce energy costs, increase employee productivity, improve building operations and enhance decision making in the organization.



Integration approach to systems and services Building Automation System (BAS) and the BACnet™ environment maximize building performance.

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**ABOUT THE AUTHOR**

Harshad Shah founded Eagle Technology, Inc. in 1986. His background includes extensive experience in manufacturing automation having held positions with Honeywell and consulting assignments with Ford Motor Company. Shah holds a Masters Degree in Computer Science from Utah State University. He has led Eagle Technology, Inc. through its growth to become a leading CMMS/EAM developer.

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 harshads@eaglecmms.com | www.eaglecmms.com



# New to the BACnet International Family



BACnet International is the global organization that encourages the successful application of BACnet through interoperability testing, educational programs and promo-

tional activities. BACnet International complements the work of other BACnet-related groups whose charters limit their commercial activities.

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

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

## Silver Member



### BACnet Interoperability Testing Services, Inc.

BITS provides a variety of sophisticated software tools, consulting services, and a Perpetual PlugFest® to developers of BACnet products to aid in development and performance optimization. BITS products and services allow for early detection and remediation, enabling more seamless BTL testing as well as increased confidence during use in the field.

809 B Cuesta Drive, Suite 2180  
Mountain View, CA 94040-3667  
United States



### Cimetrics

Cimetrics has supplied M2M networking products to the automation industries since 1991. It began as a supplier of networking technology for control and monitoring systems, and it has leveraged its networking expertise to become a leading provider of analytic services for ongoing building commissioning.

180 Lincoln Street  
Boston, MA 02111  
United States

## Silver Member



### Critical Environment Technologies

Critical Environment Technologies is a leader in the design, manufacture & service of gas detection and indoor air quality systems. They've developed more than 100 different products that are sold in all states & provinces and can be found in more than 20 countries globally.

145 - 7391 Vantage Way  
Delta, BC  
V4G 1M3  
Canada



### MBS

MBS has been an innovator in industrial and building automation for more than 30 years, offering full service, customized software and hardware development, OEM products, consulting, training and support, and on-site commissioning.

Römerstraße 15  
47809 Krefeld  
Germany

# New to the BACnet International Family

## Silver Member



### Phoenix Contact GmbH & Co. KG

Phoenix Contact's IoT-based framework enables the integration of standard communication paths as well as new IP-based protocols. Thanks to open interfaces, existing systems can simply be integrated in the building management system.

Flachsmarktstraße 8  
32825 Blomberg  
Germany



### Regulator Australia PTY LTP

Regulator Automation designs, manufactures and services the HVAC market in Australia. Regulator is continually looking to the future, developing new product and systems, including innovative features and interoperability with other control systems.

8 Hope Street,  
Melrose Park NSW 2114  
Australia



### Richmond

### Richmond Heights Sdn Bhd.

Richmond Heights has developed a series of sensors, switches, wiring accessories, and hospitality devices. They are adding more solutions to their portfolio, including all kinds of control systems from one front end, Keypad, Touch Panel or through a mobile application.

145 - 7391 Vantage Way  
Delta, BC  
V4G 1M3  
Canada

## Gold Member



### Computrols

Computrols designs, manufactures, installs, and services intelligent systems that make buildings smart, secure, healthy, and energy efficient. Since its beginnings, Computrols has worked with building owners, property managers, and facilities managers to develop a simple to use building automation system.

2520 Belle Chasse Hwy  
Gretna, LA 70053  
United States



### Global Control 5

### Global Control 5 Ltd.

Global Control 5 Ltd. (GC5) consists of specialists who have been professionally involved in advanced systems in the field of building automation for years. It develops and produces very innovative, intelligent solution managing automation (iSMA). iSMA portfolio consists of managing and supervisory software, automation controllers, DDC controllers, fan-coil units, IO modules and peripherals like sensors, relays etc.

Wyczolki Street 71  
02-820 Warsaw  
Poland



### Nenutec

For the past 25 years, Nenutec has been bringing quality products with European technology into the global market. They specialize in customized OEM solutions and have developed quality products including damper actuators, VAV actuators and characterized ball valve, etc. for the HVAC markets.

7030 Ang Mo kio  
Ave 5 Northstar @AMK #03-56,  
Singapore, 569880

# New to the BACnet International Family

## Gold Member



**Shenzhen Mek Intellisys Pte Ltd**

6C, KeChuang Mansion,  
Quanzhi Technology Park, Shajing,  
Shenzhen, Guangdong 518104  
China

## Platinum Member



**Comfy**

Comfy is on a mission to create amazing workplace experiences for everyone—from the people who operate the building to the people who fill it. With expertise in machine learning, UX design, and enterprise service, they create great relationships between people and their workplaces.

300 Frank H. Ogawa Plaza  
Oakland, CA 94612  
United States



**Ruskin**

Ruskin is always out front with their air control solutions. From dampers and louvers, to air measuring systems and ERVs, Ruskin is recognized for consistent innovation, engineering excellence and precision manufacturing.

3900 Dr. Greaves Rd.  
Grandview, MO 64030  
United States

## Platinum Member

# SOFTWARE HOUSE

**Software House**

Software House has built a solid reputation in the security industry as an innovator of security and event management technologies. Reliability, flexibility, and power are why many companies choose Software House solutions for their security needs. Its security and event management technologies are currently installed in thousands of facilities worldwide.

6 Technology Park Drive  
Westford, MA 01886  
United States

## Corporate Affiliate



**ETM Professional Control**

ETM develops the SCADA system SIMATIC WinCC Open Architecture. SIMATIC WinCC Open Architecture, formerly known as PVSS, forms part of the SIMATIC HMI range and is designed for use in applications requiring a high degree of client-specific adaptability, large and/or complex applications and projects that impose specific system requirements and functions. ETM's solutions are particularly placed in the areas of traffic, water, energy, oil & gas, building automation industry as well as research.

Markstraße 3  
7000 Eisenstadt  
Austria

# Member News



BACnet International would like to congratulate the following companies on their strengthened commitment to the BACnet protocol and increased involvement in the BACnet community. As part of these actions they have moved their membership to a higher tier. We thank them for their continued support and look forward to many more years of collaboration.

## Corp Affiliate to Gold



### Belimo

Operating in 80 countries, Belimo is a leader in the development, production and marketing of actuator solutions for controlling heating, ventilation, and air-conditioning systems. Actuators, control valves, and sensors make up the company's core business. For over 40 years, Belimo has been focusing solely on innovative technology in the HVAC market to provide comfort, safety, and efficiency in buildings.

P.O. Box 2928  
Danbury, CT 06813  
United States



### Sauter

For more than 100 years, the globally active SAUTER Group, based in Basel, Switzerland with a new development and production site in Freiburg, Germany, has provided products, expertise and solutions for building management and room automation over the entire building life cycle. Their product range is distinguished by its Swiss quality and covers services, projects and facility management.

Im Surinam 55  
CH-4016 Basel  
Switzerland

## Silver to Gold



### Contemporary Controls

With over 40 years in business, Contemporary Controls has four locations around the world serving the Americas, EMEA and APAC. They design and manufacture the system building blocks for networking, integrating and controlling automation processes where performance and reliability are important, and their customers include systems integrators, contractors, mechanical and controls OEMs.

2431 Curtiss Street  
Downers Grove, IL 60515  
United States



### Intesis

Founded in 2000, Intesis is today a leader in design, fabrication and commercialization of innovative solutions for building automation. With HQ in Spain, and customers in more than 90 countries worldwide, Intesis offers a wide portfolio of products, as the result of a continued commitment to and investment in R&D, based on a highly qualified team.

C/Mila i Fontanals, 1  
Igualada  
Barcelona Province, 08700  
Spain

# Member News

## Silver to Gold



### Midea

Midea Group is a leading technologies group in consumer appliances, HVAC systems, robotics and industrial automation systems, and smart supply chain (logistics). It offers diversified products, comprised of consumer and various small home appliances, HVAC (residential air-conditioning, commercial air-conditioning, heating & ventilation), and robotics and industrial automation.

Midea industrial City, Beijiao, Shunde  
Foshan, Guangdong, 528311  
China

## Silver to Gold



### Setra

Setra Systems, Inc. was founded in 1967 by brothers Dr. Y.T. Li and Dr. S.Y. Lee, both professors of engineering at the Massachusetts Institute of Technology and co-developers of the variable capacitance transduction principle. Building on this heritage of innovation, Setra continues to design and deliver sensing devices for many diverse applications and industries — innovating solutions for HVAC & building automation, industrial OEM, test & measurement, and critical environments.

159 Swanson Road  
Boxborough, MA 01719  
United States

# The BACnet Institute Update

## TBI Continues to Expand

New resources are constantly being added to The BACnet Institute. Take a look at what's new...

### BACnet International AHR Expo sessions to be captured

The five sessions comprising BACnet International's Education Track at the 2020 AHR Expo will be captured and added to TBI's extensive Library. The sessions include BACnet 101: An Introduction to BACnet; BACnet Physical Connectivity; Design Considerations When Applying the BACnet Standard to a 'Smart Building' BAS; BACnet Edge Solutions - Ideal for IoT; and HVAC as a Service – How soon is now?

### The Library has new articles, some in German!

There are now over 20 new articles spanning topics from cybersecurity to IoT. For our German speaking learners, eight of these new articles are available in German and English. With these new additions, articles and presentations, the TBI Library now holds over 140 articles and presen-

tations, covering a variety of topics that accommodate various experience levels and languages!

### BACnet Device Profiles course currently in production

A new interactive course, titled BACnet Device Profiles, is currently in development. This course will introduce learners to the various BACnet Device Profiles and explain the role of each in the building automation context. It will also show the learner how various profiles can be combined in a single device, explaining the rules behind the combinations. This course is projected to launch in early 2020.

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



Education • Library • Community

### The BACnet Institute

*A One-Stop, 360-Degree BACnet Online Learning Environment*

The BACnet Institute is an enriching online environment containing a wide breadth of BACnet educational resources, information and learning for everyone involved with BACnet systems.

Registration is required to access the TBI site; however, it is free! Simply visit [www.thebacnetinstitute.org](http://www.thebacnetinstitute.org), sign up, and be prepared to learn!

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### Michelle Eriquez

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[education@thebacnetinstitute.org](mailto:education@thebacnetinstitute.org) | [www.thebacnetinstitute.org](http://www.thebacnetinstitute.org)





# BTL Certification Process: Updates and Tips

The BTL Certification Program was launched in 2017 to merge the BTL Listing Program and the WSP-Cert Certificate Program. A BTL Certification indicates that a product has successfully passed rigorous verification by testing and demonstrates that it correctly implements rules and interoperability of the BACnet protocol. The BTL Certification includes all the privileges previously granted by the BTL Listing and WSPCert, including a Certificate of Conformance, a BTL Listing and the right to use the BTL Mark.

Product specifiers continue to require BACnet as the protocol and BTL Certification to ensure the correct implementation of the BACnet protocol. BACnet continues to gain market share in the Building Automation industry, and the BTL Certification Program allows specifiers to have confidence that products from multiple manufacturers will be compatible.

The BTL Mark may be displayed only on products that have successfully passed BTL Testing. Testing ensures that the device correctly implements all of the BACnet functionality it contains as governed by ASHRAE standard 135.1. The BTL Working Group defines the BTL Test Plan and governs the testing.

## New BTL Certification Renewal

A BTL Certification includes both a BTL Listing and a BTL Certificate. BTL Listings are valid for 15 years from BTL Testing Completion (B-SS and B-SA device protocol BTL Listings are valid for 25 years). However, the BTL Certificate is only valid for five years following BTL Testing Completion.

In January 2019, the BTL Working Group provided the ability for Regression Testing for Renewal of a BTL Certificate. (See BTL Testing Policies document on the Test Documentation page of the BTL website.) This addition to the BTL Testing Policies

allows manufacturers to renew their BTL Certificate without having to do complete re-testing of their products. The BTL Certificate Renewal Testing may be done at the same Protocol\_Revision of the original BTL Testing; it will include appropriate tests from the current BTL Test Package.

Manufacturers and BACnet users should be careful not to confuse expirations and renewals of BTL Listings with those of BTL Certificates. BTL Listings may not be renewed. Once the BTL Listing on a product expires, it must be updated and undergo BTL Testing at the current minimum Protocol\_Revision level to have a new BTL

When BTL Testing has been completed, a manufacturer may apply for a BTL Certification based on their Final Test Report. Links to BTL Certification Applications may be found on the BTL website at:

[www.bacnetlabs.org/page/BTL\\_Cert\\_forms](http://www.bacnetlabs.org/page/BTL_Cert_forms)

The following table shows what testing is required for BTL Certification in different situations.

It is important to provide complete and accurate information requested in applications and forms.

	New	Retest	Certificate Renewal	Field Defect
<b>Test</b>	all for all functionality	new or changed tests	new or changed tests	specific to defect
<b>Functionality</b>	all	new functionality tested	no new functionality allowed	no new functionality allowed
<b>Protocol Revision</b>	minimum PR	minimum PR	original	original
<b>Device profile</b>	as is	may be different	same as original	same as original
<b>Description</b>	full test for product not previously tested	testing for derivative or previously tested products that have changed. This also includes testing a product with an expired BTL Certificate when the product has changed	to renew an expired or expiring BTL Certificate for a product which has not changed	testing to ensure a reported defect has been corrected

Certification.

The ability to renew a BTL Certificate gives manufacturers added flexibility for the longevity of their product lines.

## Tips For Manufacturers Seeking BTL Certification

Manufacturers seeking BTL Certification begin the process by testing at any of the Recognized BACnet Testing Organizations (RBTOs). Manufacturers are required to supply the RBTO with a complete and accurate BTL Checklist, an EPICS, and additional documentation specified by the RBTO. The RBTO will provide the manufacturer with an estimate for the BTL Testing that will be required.

TIPS:

1. (attestation from) Tested Product Information must match the Final Test Report exactly.
2. (attestation form) BTL Certification Product Information must match the BTL Certification Application exactly.
3. (derivative products) Functionality of the product for certification must match the functionality of the Final Test Report exactly.
4. If you are unsure about completing your attestation form, send drafts to [certifications@bacnetinternational.org](mailto:certifications@bacnetinternational.org) for review before obtaining signatures. 🌐

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# BTL Testing Services

More and more product specifiers are requiring BACnet as a "must-have" for system requirements. Specification of BACnet as the protocol, and requiring BTL Certification, is becoming THE benchmark for project specifications to ensure interoperable installations.

The BTL Certification process, and using the BTL Mark, starts with having your devices tested by a Recognized BACnet Testing Organization (RBTO). There are currently three RBTOs, including the BTL Lab which is administered by BACnet International. For a list of RBTOs and more about the Certification process, visit [https://www.bacnetlabs.org/page/device\\_testing](https://www.bacnetlabs.org/page/device_testing).

In January of 2019, the BTL Testing Services Team was formed in order to have a dedicated team administering the BTL Lab. This team consists of Rich Ruel as Testing Services Manager and Jenn Conrad as Testing Services Project Manager.

## Testing Process

For suppliers who want to apply for BTL Testing at the BTL Lab, please submit these three forms to [testing@BACnetinternational.org](mailto:testing@BACnetinternational.org): BTL Checklist, BTL Testing Application, and BTL Testing Agreement.

The current test package and instructions can be found at [http://www.bacnetlabs.org/test\\_documentation](http://www.bacnetlabs.org/test_documentation) under the heading Current Test Package.

If using the BTL Lab as your preferred RBTO, the application and agreement forms can be found at: <http://www.btlab.org/testing.php> under the BTL Lab Forms link.

Another great document to review is the BTL Testing Policies document. This will explain the entire process and policies for successful testing. This document can also be found at [http://www.bacnetlabs.org/test\\_documentation](http://www.bacnetlabs.org/test_documentation) under the heading BTL Testing Policies.

The signed BTL Testing Agreement and the \$750 Application Fee are required to secure a place in the testing queue. The testing queue is currently around one month but may vary depending on the number of applicants at any given time. The BTL Checklist and BTL Testing Application determine the testing which will be performed. An Application Acceptance letter will be supplied that includes a formal estimate for the amount and time of testing and a test entry date. Final BTL Testing fees are billed at the conclusion of testing.

BACnet International member companies with Silver level or higher memberships receive a discount on testing fees. (The Testing Application fee is the same for all applicants.) Participants may apply for Testing and BTL Certification of a family of devices that share underlying BACnet software in order to minimize testing costs.

If you have any questions, please contact [testing@bacnetinternational.org](mailto:testing@bacnetinternational.org).

Get  
the right  
information  
as you move

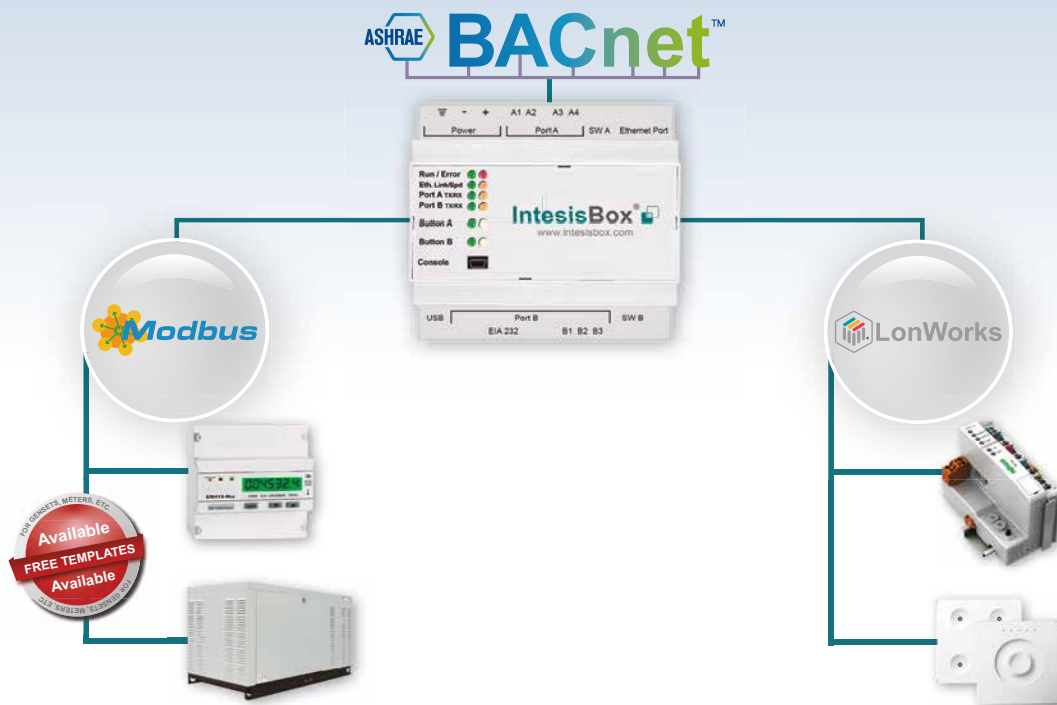
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**Devices:**

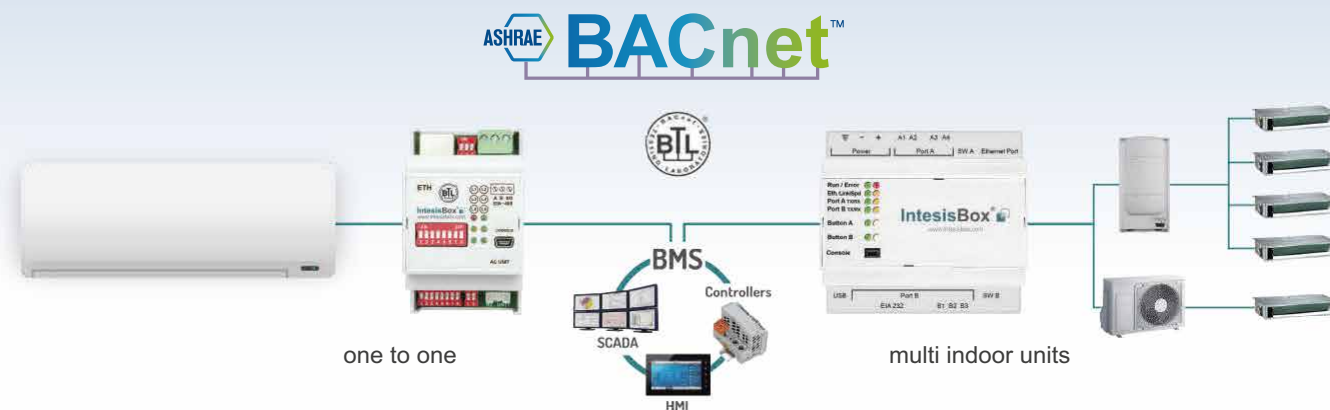
· Heat meters · Gas meters · Electricity meters · T<sup>a</sup> and HR probes · Gensets · Energy meters · Water meters · And many others ·

**Product Highlights**

- Project Templates
- Secure
- We take quality seriously
- Product Templates
- Diagnostic
- Conversions



**BACNET SERVER GATEWAYS**  
For Air Conditioners



**Product Highlights**

- HVAC Gateways developed jointly with the major HVAC manufacturers
- Cost-effective solution
- Easy to install & set up
- Scan function
- Direct connection to AC units
- BTL certified:



## NEW BTL-LISTED PRODUCTS, December 2018 – August 2019

Manufacturer	Product Name	Model
E+E Elektronik Ges.m.b.H.	EE160 RH&T Transmitter	EE160D
E+E Elektronik Ges.m.b.H.	EE210 RH&T Transmitter	EE210D
Price Industries	Pace	Pace
WAGO	Controller PFC200	750-8212/000-100
Honeywell International	IRM N4	CLMERL4N, CLMERL6N, CLMERL8N, CLMERS4N, CLMERS5N, CPO-RL4N, CPO-RL5N, CPO-RL6N, CPO-RL8N, CPO-RS3N, CPO-RS4N, CPO-RS5N, AL-RL4N, AL-RL6N, AL-RL8N, AL-RS4N, AL-RS5N, WEB-RL6N, WEB-RS5N
Intesis Software, SLU	IBOX-BAC-ROUTER	IBOX-BAC-ROUTER
Reliable Controls	MACH-ProAir	MPA-111-A-F, MPA-12-A-F, MPA-12-F, MPA-33-A, MPA-33-A-F, MPA-34-A, MPA-34-A-F, MPA-35-F, MPA-36-F
Reliable Controls	MACH-ProZone	MPZ-44, MPZ-48,
Siemens	Intelligent Valve	EVG4U10Ex <sup>1</sup> where x <sup>1</sup> is 015, 020, 025, 032, 040, or 050 EVF4U20Ex <sup>2</sup> where x <sup>2</sup> is 065, 080, 100, or 125
Siemens	RDY BACnet Thermostat	RDY2000BN, RDY2000BN/NL
Siemens	SINAMICS G120X USS	SINAMICS G120X USS
Siemens	SINAMICS G120XA	SINAMICS G120XA
Vaisala Oyj	HMD60	HMD60, HMD65
WAGO	Controller BACnet/IP	750-832
WAGO	Controller BACnet/IP ECO	750-832/000-002
WAGO	Fieldbus Coupler BACnet/IP	750-332
GD Midea Heating & Ventilating Equipment CO LTD	POL648.10/MID	1.0
GD Midea Heating & Ventilating Equipment CO LTD	POL698.10/MID	1.0
Honeywell International	CentraLine HAWK 8000 Integration Controller	CLNXHAWK8-x <sup>1</sup> , CLNXHAWK8W02-x <sup>1</sup> where x <sup>1</sup> is 100, 10K, 1250, 250, 500, 5K
Honeywell International	PUC Series for BACnet IP	PUC8445
Schneider Electric	SmartX IP Controllers	MP-C-15A, MP-C-18A, MP-C-18B, MP-C-24A, MP-C-36A, MP-V-7A, MP-V-9A, RP-C-12A, RP-C-12B, RP-C-12C, RP-C-16A

Schneider Electric	SmartX IP Controllers	IP-IO-DI10, IP-IO-UIO10, IP-IO-UIO5DOFA4
Siemens	Climatix C600	POL648.10, POL648.80, POL688.10, POL688.80, POL698.10, POL698.80, POL69U.10, POL69U.80
Siemens	Smart Thermostat	RDS 120-B, RDS 120
Tridium	JACE-8000	12977
ABB	ABB E-Clipse 80 Bypass Family	ABB ECLIPSE 80 ACH580, ABB ECLIPSE 80 BYPASS
ABB	Softstarter	PSTX
Azbil Corporation	Compact Remote I/O Module	RJ-1202W0800
Azbil Corporation	Compact Remote I/O Module	RJ-1203W0200
Azbil Corporation	Compact Remote I/O Module	RJ-1204W0400
Azbil Corporation	Compact Remote I/O Module	RJ-1205W0500
Azbil Corporation	Compact Remote I/O Module	RJ-1201W0800
M2S Electronique Ltee	TX COMMERCIAL	TNG15-S, T070AA, TOUCH18, TX120
Critical Environment Technologies	CGAS Family of Gas Detectors	CGAS-D-S1-S2-opt1-...-opt6, CGAS-DP- S1-S2-opt1-...-opt6, CGAS-SC- S1-S2-opt1-...-opt6 where S1/S2 are: null, CO <sub>2</sub> -6, CO <sub>2</sub> -18, NH <sub>3</sub> , LCO, CL <sub>2</sub> , CLO <sub>2</sub> , C <sub>2</sub> H <sub>4</sub> , EETO, F <sub>2</sub> , CH <sub>2</sub> O, EH <sub>2</sub> , H <sub>2</sub> S, HCL, HCN, HF, NO, NO <sub>2</sub> , O <sub>2</sub> , O <sub>3</sub> , PH <sub>3</sub> , SIH <sub>4</sub> , SO <sub>2</sub> , CH <sub>2</sub> , CCH <sub>4</sub> -100, CC <sub>3</sub> H <sub>8</sub> -100, SPL, SPH, SR <sub>2</sub> <sup>2</sup> , SR134A, SR402A, SR404A, SAR407C, SR410A, SR422D, SR438A, SR507A, STVOC, R, RT, RD and opt1 through opt6 are: null, 2AO, A, LT, L2, RHT, S, SN, WA, RLY
Georg Fischer JRG AG	Hycleen Automation System	JRG 9900.000, JRG 9900.001
Johnson Controls	A525 Series Wall Mount Refrigeration and Defrost Controllers	A525AEDV
Johnson Controls	DR5 Refrigerated Case Controllers	DR556
Johnson Controls	MR5 Refrigerated Case Controllers	MR534
PowerTech Engineering AS	Zaphire B-BC	750-8212
Beckhoff Automation GmbH	TwinCAT BACnet	CX8191, CX9020, CX51x <sup>1</sup> , where x <sup>1</sup> is 20, 30 or 40 CX52x <sup>2</sup> , where x <sup>2</sup> is 30 or 40 C60x <sup>3</sup> -00x <sup>4</sup> , where x <sup>3</sup> is 15 or 17 x <sup>4</sup> is 10 or 20 C60x <sup>5</sup> -0060, where x <sup>5</sup> is 30 or 32 CP66x <sup>6</sup> , where x <sup>6</sup> is 00 or 06 CP67x <sup>7</sup> -0001-00x <sup>8</sup> , where x <sup>7</sup> is 00 or 06 x <sup>8</sup> is 50 or 60 CP22x <sup>9</sup> -00x <sup>10</sup> , where x <sup>9</sup> is 12, 13, 15, 16, 18, 19, 21 or 24 x <sup>10</sup> is 10 or 20 CP27x <sup>11</sup> -00x <sup>12</sup> where x <sup>11</sup> is 12, 13, 15, 16, 18, 19, 21 or 24 x <sup>12</sup> is 10 or 20
BELIMO	CQ Zone Rotary Actuator	CQ24A-BAC

Delta Controls	enteliZONE Unitary	eZFCP-424R4-24, eZVP-440, eZP-440R4-230, eZFC-424R4-24, eZV-440, eZ-440R4-230
Johnson Controls	Facility Explorer Server	FX-SLx <sup>1</sup> -0, FX-SLx <sup>1</sup> -0E, FX-SLx <sup>1</sup> -0A where x <sup>1</sup> is 000, 001, 002, 003, 010, 100 or UNL
LG Electronics	LG Smart Lighting Manager	9LH00N5VVX1
Pegasus Automation International LLC	Pegasus Smart Building Gateway	FSCCx <sup>1</sup> x <sup>2</sup> where x <sup>1</sup> is 6, 7, 8, or 9 x <sup>2</sup> is 000, 250, or 600 FMCx <sup>3</sup> x <sup>4</sup> where x <sup>3</sup> is A, B, C, D, or E x <sup>4</sup> is 000, 250, or 600
Schneider Electric	EcoStruxure Building Operation	ES, AS, AS-P, AS-B
Tridium	Niagara 4 BACnet Advanced Workstation	DR-S-BAC-AWS, DR-S-BAC-OWS with DR-S-BAC-AWS-UP, SUP-0, SUP-1, SUP-2, SUP-3, SUP-10, SUP-100, SUP-UNL
Vertiv	iCOM – High Definition	iCOM – High Definition
Danfoss	NovoCon M	Medium
Danfoss	NovoCon S	Energy
Johnson Controls	Advanced Application Field Equipment Controller (FAC), VAV Modular Assembly (VMA) Controller	MS-FAC4911-0, MS-VMA1930-0
Johnson Controls	Advanced Application Programmable Controller (PCA)	FX-PCA4911-0
Johnson Controls	Advanced Application Programmable Controller (PCA)	CH-PCA4911-0
Johnson Controls	Network Automation Engine	MS-NAE5510-3G, MS-NAE5520-3, MS-NAE5520-3G, MS-NAE5510-2, MS-NAE5510-2G, MS-NAE5520-2, MS-NAE5520-2G, MS-NAE551S-2, MS-NAE551S-3
Johnson Controls	Network Automation Engine	MS-NAE5510-3G, MS-NAE5520-3, MS-NAE5520-3G, MS-NAE5510-2, MS-NAE5510-2G, MS-NAE5520-2, MS-NAE5520-2G, MS-NAE551S-2, MS-NAE551S-3
Johnson Controls	Programmable Controller VAV (PCV)	FX-PCV1930-0
Johnson Controls	Programmable Controller VAV (PCV)	CH-PCV1930-0
Ruskin	Thermal Dispersion Probe Airflow Measuring System	TDP05K
Viessmann Elektronik GmbH	Vitogate 300	1.0



# Calendar of BACnet International Events

2019		
November 19 – 22, 2019	Greenbuild Conference & Expo	Atlanta, GA
2020		
January 30, 2020	BTL Working Group Meeting	Orlando, FL
February 3 – 5, 2020	ASHRAE AHR Expo	Orlando, FL
March 17 – 19, 2020	National Facilities Management & Technology (NFMT) Conference & Expo	Baltimore, MD
April 19, 2020	BTL Working Group Meeting	Plantation, FL
May 5 – 7, 2020	LIGHTFAIR International	Las Vegas, NV
June 25, 2020	BTL Working Group Meeting	Austin, TX

Subject to change. For more information, contact David Nardone, BACnet International, [david@bacnetinternational.org](mailto:david@bacnetinternational.org) or visit [www.bacnetinternational.org](http://www.bacnetinternational.org)

## BACnet International Journal 17

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

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## **MACH-ProLight™** ADVANCED LIGHTING CONTROLLER

Better by design™



Empower your facility managers to integrate lighting controls into the MACH-System™ using the MACH-ProLight™ advanced lighting controller, and save energy while achieving OpenADR and Title 24 compliance.

The MACH-ProLight is the world's first BTL-Listed Lighting Device [B-LD], additionally meeting the B-BC profile. This freely programmable and scalable controller provides 0-10 V continuous dimming and implements the BACnet® Binary Lighting Output object [BLO]. The MACH-ProLight allows you to implement advanced control strategies such as daylight harvesting, dim-to-off control, vacancy control, plug-load control, and scene/theme control. Compatible with standard lighting-control relays, low-voltage peripherals, EnOcean® wireless products, and the Reliable Controls SPACE-Sensor™ and SMART-Net™ products, the MACH-ProLight conveniently ships in pre-assembled, UL 508A listed control panels, or as individual components, and will illuminate your building's operational efficiency, today and tomorrow.



MPL-LCP-64



EnOcean®  
Transceiver

EnOcean® wireless lighting products



[www.reliablecontrols.com/MPL](http://www.reliablecontrols.com/MPL)



# BTL CERTIFICATION

## On-ramp to Intelligent Building System Integration



Any roadmap to intelligent buildings must include provisions for integrating information and control from multiple systems provided by a variety of suppliers. BACnet is the industry standard for building automation integration but it only works when correctly implemented.

The BTL Mark is awarded to products that have **passed rigorous industry-standard tests** conducted by independent testing organizations. The mark is your best assurance that a product is compliant to the BACnet standard.

BTL industry-standard testing provides extensive validation of a product's compliance with the

BACnet specification and promotes a high level of interoperability of products in the field. It has been developed over the last 20 years by the BACnet Testing Laboratories (BTL), which is overseen by BACnet International. Using products that have earned the BTL Mark **reduces system integration cost and time.**

**Requiring BTL tested BACnet controls can pave the way for your journey to intelligent buildings.**

You can find products that have earned the right to use the BTL Mark through the BTL Listing Service at [www.bacnetlabs.org](http://www.bacnetlabs.org)



**BACnet Testing Laboratories**  
[bacnetlabs.org](http://bacnetlabs.org)  
[btl-manager@bacnetinternational.org](mailto:btl-manager@bacnetinternational.org)  
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