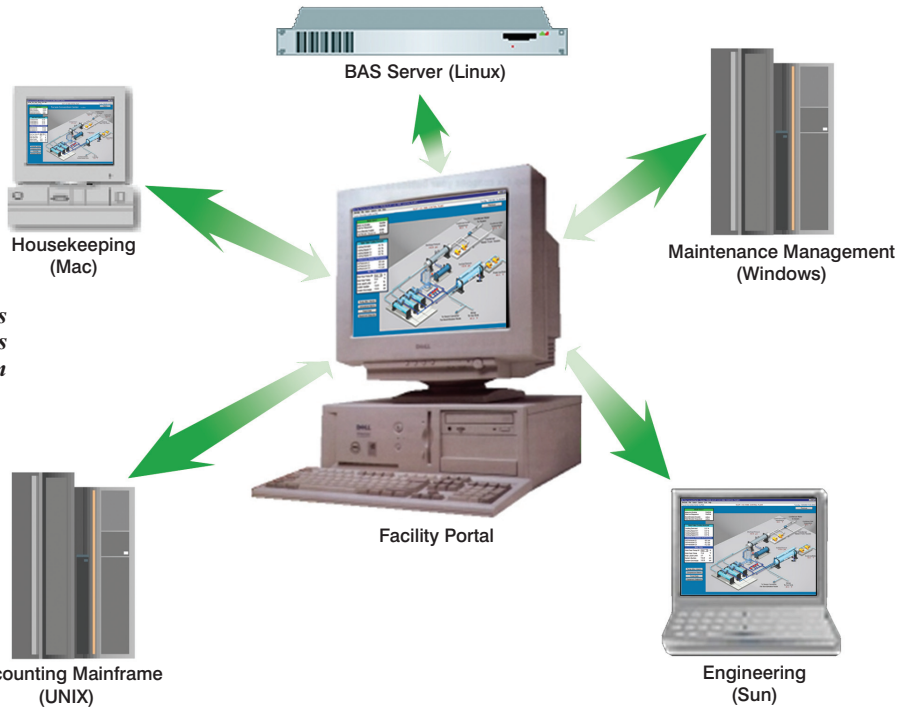

Figure 1: A facilities portal uses Web services to integrate data from multiple systems.

Web Services & BACnet®

By Steve Tom, Ph.D., P.E., Member ASHRAE

Admiral E.J. King was the U.S. Chief of Naval Operations during WWII, overseeing global operations that included the Battle of the Atlantic and the island-hopping campaign in the Pacific. Keeping these far-flung operations supplied with food, fuel, ammunition, building supplies, and other materials was one of the greatest logistical achievements in history, so it is not surprising that Admiral King is famous for a statement he made about logistics. What is surprising is the statement itself. Leaving a meeting with the U.S. Army chief of staff, Admiral King turned to an aide and said, "I don't know what the hell this 'logistics' is … but I want some of it."

Today many HVAC engineers could make a similar statement about Web services. They're not quite certain what Web services are, but they know they want some. ASHRAE took a significant step toward giving them Web services by proposing an addendum to the BACnet® specification that would add Web services to the BACnet toolkit. Now the question is, "What are Web services?"

Webopedia™ (www.webopedia.com) defines Web services as "a standardized way of integrating Web-based applications using the XML, SOAP, WSDL and UDDI open standards over an Internet protocol backbone." It's easy to get lost in the alphabet soup of acronyms in this definition (see sidebar), so let's pare it down to what's important to HVAC engineers. Web services are a standard way of integrating applications over an IP network. XML, SOAP, WSDL, and UDDI are the essential "machinery" that makes Web services work, but you don't need to understand them to use Web services. The people who create Web services need to understand them, and many HVAC engineers will want to learn them, so they can modify or create their own Web services. However, trying to learn what

‘ How could this widespread compatibility benefit BAS systems? Imagine being able to incorporate weather forecasts into control algorithms. Ice storage systems, boiler start-ups, morning pre-cooling—all could be more efficient if a way existed for the BAS to retrieve a weather forecast from a computer .... ’

Web services are by dissecting the acronyms is like trying to learn how to drive by studying an automatic transmission.

When HVAC systems first switched to digital controls, they used small stand-alone controllers and proprietary communications networks. This was not surprising, as people used them to replace small stand-alone pneumatic control systems. Digital systems were capable of much more; however, it wasn't long until manufacturers were linking these digital controllers into Building Automation Systems (BAS). These systems offered monitoring and control capabilities far beyond those of pneumatic systems.

Unlike pneumatics, however, you couldn't easily connect digital controllers from different manufacturers. Connecting dissimilar systems required an extensive knowledge of both protocols, a "gateway" or translator module, and expensive custom programming. The same was true when engineers tried to integrate their BAS with a lighting system, or a security system, or a fire alarm system. Frustrated users turned to ASHRAE for help, and ASHRAE created BACnet.

BACnet provides a solution to these problems by establishing a standard communication protocol for all building systems. This greatly simplifies integration between vendors using the BACnet protocol, but BACnet isn't the only game in town. LonWorks® provides a different standard for integrating building systems. MODBUS® offers yet another standard, and many vendors have opened up their own protocols to provide additional "standards" for the building industry.

Having multiple standards certainly is better than having none, but multiple protocols means a need still exists for gateways and custom programming. The problem gets worse if you want to connect to a computer outside the BAS, such as a computer at the power company that sets real-time utility pricing. There is very little chance this computer can connect to any of the standard building protocols. This problem is not unique to the building automation industry. It has long plagued business-to-business (B2B) transactions. To help solve this problem the Information Technology (IT) world established a standard called "Web services" for communications between dissimilar computers, and this standard enjoys wide support.

How widespread are Web services? To begin with, Web services have been adopted as a standard by Microsoft, Apple, Sun, Linux, IBM, and many others. They all offer their own tools to work with Web services and they all put their own "spin" on it. Microsoft calls their implementation .NET, while IBM calls it WebSphere. At heart, they're all based on Web services.

Web services have been used in B2B communications for several years and are fast becoming the norm. As a few examples, Amazon.com uses Web services to allow partnering firms to integrate Amazon's products into the partner Web sites. The partnering firm sells the product, but the product information, availability, etc., is automatically updated by Amazon.

Microsoft's Passport service uses Web services to provide a secure way for online vendors to obtain, with permission, the billing and shipping information they need to process a person's order. New Mexico is using Web services to create a "portal," a single Web site where users can access data and services from multiple government agencies.

How could this widespread compatibility benefit BAS systems? Imagine being able to incorporate weather forecasts into control algorithms. Ice storage systems, boiler start-ups, morning pre-cooling—all could be more efficient if a way existed for the BAS to retrieve a weather forecast from a computer on the Internet. Colleges and universities often have sophisticated computer systems to schedule classroom use. Too often, these schedules are then printed and given to a BAS operator who retypes the schedules into the BAS. Wouldn't it make more sense for the two computers to use Web services to exchange schedules? The accounting system computer would also be interested in accessing these schedules to see what department should be billed for each hour, especially if the system were tied to utility meters that recorded the utilities used by each class.

In addition to these automatic data exchanges, Web services also can be used to read or write information on demand, mak-

ing them useful for constructing interactive Web pages. As an example, many systems on a college campus have information a facilities engineer needs: utility consumption, maintenance management, cost accounting, record drawings. A facilities engineer needs to interact with all of these systems, but he shouldn't have to learn a new user interface for each system. For that matter, he shouldn't even have to log on to each system to gather data.

Web services make it possible to create a "facilities portal," an interactive Web page that collects data from all these systems, provides the engineer with a summary of key data, and allows him to "drill down" to more detailed information as required (see *Figure 1*). These examples are not hypothetical flights of fancy. Several vendors have already incorporated Web services into their BAS products. There are examples of integration programs that have already been demonstrated in projects around the world (see *Figure 2*).

Figure 2: King Street Wharf in Sydney, Australia, uses Web services to analyze and manage multiple utility systems.

If BAS vendors already are providing Web services, where does ASHRAE fit in? ASHRAE is establishing a standard means of using Web services to integrate facility data from disparate sources. The IT world has established standards for the mechanism of Web services, but these say nothing about the data being exchanged. Without additional standards, vendors could claim support for Web services while providing as little or as much data as they wished through this interface, using whatever data structure and read/write interface they pleased.

Even if every vendor tried to create useful Web services interfaces, chances are no two interfaces would be alike, and connecting two dissimilar systems would require hours of custom programming. Some more farsighted members of our industry anticipated this problem years ago and began calling for a standard information model.

ASHRAE answered this call by gathering input about potential uses for Web services in facility automation from facility engineers, equipment manufacturers, government agencies,

What Does the Definition Mean?

Webopedia™ defines Web services as "a standardized way of integrating Web-based applications using the XML, SOAP, WSDL and UDDI open standards over an Internet protocol backbone." Here is an HVAC engineer's explanation of these IT terms:

XML: eXtensible Markup Language. XML files are primarily used to transfer data between applications. It is an especially useful way to package data that may be transferred to multiple applications, including custom applications and applications unknown when the file is created. There is no specific format for an XML file; instead, the file includes a description of its own data structure. This makes it easy to modify or extend the data file. XML is stored as a text file, making it easy for a programmer to read the file, find the tags for the data he is interested in, and program another application to read or write data to this file.

SOAP: Simple Object Access Protocol. SOAP is a standard way of packaging a Web service request or response message, including XML data, so it can be transported over an Internet protocol.

WSDL: Web Services Description Language. WSDL is a standard way of describing a Web service's capabilities, including any data that can be read or written through the service. WSDL is designed to make it easy to find out what information is available from a particular application or Web site. It is probably not a surprise to learn that WSDL is written in the XML format.

UDDI: Universal Description, Discovery, and Integration. UDDI is a Web-based directory that allows businesses to list their available Web services. Think of it as the "yellow pages" for Web services. Not every business chooses to list its services in the UDDI, but those that do will post a WSDL on the UDDI.

Internet Protocol: An Internet protocol is a standard way of formatting and transporting messages over the Internet. Probably the most well-known Internet protocol is HTTP, or Hyper Text Transfer Protocol. HTTP is used to transfer web pages over a network and give browsers instructions on how to display them. MIME or Multipurpose Internet Mail Extensions is another common protocol, used to transfer email messages with graphics, audio, and video files. Internet protocols are not confined to the Internet, and are often used within an Intranet, such as a small computer network within a building.

So, if you wanted to bring a certain piece of information into your BAS, you would search the UDDI until you found a WSDL that had what you wanted, then wrap your Web service request in SOAP so it would slide through the HTTP to retrieve an XML file.

and universities and developed a standard information model. This model covers the types of data to be exchanged, the path used to locate the data, and attributes of commonly used data objects such as analog inputs or binary outputs. The services required to read or write values are defined, as well as services needed to obtain information about the available data or to return error messages if a service fails. The standard covers arrays as well as scalar data, making it particularly useful for handling trend logs.

Because this standard is designed for use with building automation systems, it was developed by the technical committee in charge of standards for building automation control networks, i.e., the BACnet committee. Once approved, it will become an addendum to the BACnet standard, which means it also will become an American National Standards Institute (ANSI), European Committee for Standardization (CEN), and International Organization for Standardization (ISO) standard.

Naturally, the standard is compatible with the BACnet protocol, but it is not limited to BACnet. One of its most useful applications may be to serve as a standard for exchanging data between building automation systems using different protocols. Web services could be an ideal way to make a "top end" connection between systems running BACnet, LonWorks, MODBUS, or any proprietary protocol. Engineers would not have to learn the details of each individual protocol to program the connections, but would only have to understand the Web services standard. A Web services connection also would avoid the problems with incompatible baud rates, wire types, proprietary communication chips, and other issues that can come into play when a gateway connects dissimilar protocols (see *Figure 3*).

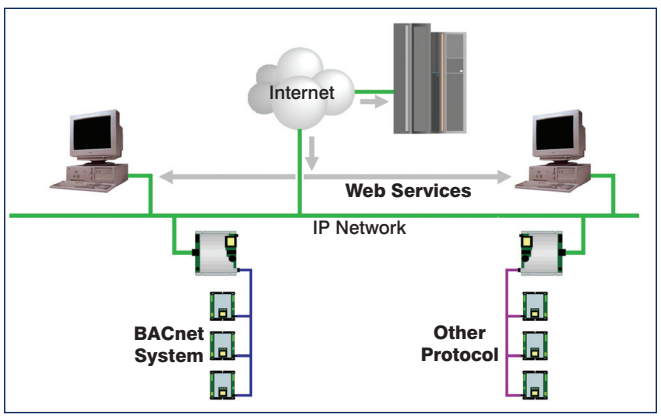

Figure 3: Web services used to integrate BAS running dissimilar protocols, and to connect to a mainframe computer over the Internet.

Since Web services have quickly become the standard for B2B communications, will they replace BACnet, LonWorks, and other protocols within the BAS? That's not likely, for several reasons. To begin with, no one has developed a set of Web services that covers all the functions needed by a BAS. Broadcasts, alarms, time synchronization, backup and restore — there are a host of BAS functions that simply are not covered in the proposed Web service standard. Certainly, such a standard could be developed, but it would in essence become one more BAS protocol fighting for acceptance in the marketplace. It would not be a protocol well-suited for a BAS because the "overhead" required to implement Web services is beyond the capability of most BAS controllers.

By definition, Web services are using XML to communicate over an IP network. IP networks are great for connecting PCs, Web servers, and other high-end computers, but it would be expensive to run an IP network to every unit heater, VAV box, and exhaust fan in a building.

Similarly, XML is a verbose way to package data. It's designed to be easily understood, flexible, and self-documented. These characteristics also mean it needs to be processed by a powerful computer and transmitted over a high-speed network, which is beyond the capabilities of the price-sensitive controllers typically used for small HVAC equipment like VAV boxes. This may be a temporary limitation, as inexpensive microprocessors gain power and speed each year. But since existing protocols such as BACnet are already developed, are a more efficient way of integrating controllers, and are open for use by any equipment manufacturer, little incentive exists to switch these controllers to Web services.

When you go beyond the BAS, the situation changes dramatically. Here the challenge is to integrate with high-end computers over a high-speed IP network, and with systems that are not using a BAS protocol. This is exactly the situation Web services were created for. The computers and the networks have the "horsepower" to handle Web services. There is a certain amount of custom linking, if not custom programming, involved in many connections, but the self-documenting characteristics of XML simplify the programmer's task. Chances are, the programmer already is familiar with Web services from previous B2B integrations, which further simplifies the job. (A customer in Texas who was contracting for a custom interface between their BAS and a billing system found the contractor cut their price in half when they learned the BAS supported Web services.)

The addition of a new ASHRAE standard to the Web services world promises even greater simplification, using IT technology and the foundation of BACnet to take building automation to the next level.

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