

# Building Management System

Part 7

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## Latest Trends and Next Level of BMS Controls

### Introduction

A conventional BMS system, which controls HVAC system and equipment in a typical commercial environment, has a 4-tier architecture starting from the field devices in the occupied space, AHU rooms, plant room, etc. and ending up at the BMS control room with the User Interface (UI) system. In recent years, with advancements and innovations in IT surging ahead, the conventional way of building a BMS also has started witnessing advancements.

In this concluding part of the Classroom series on BMS, we will discuss the following trends: wireless controls, simple architecture for small office buildings, cloud computing offering analytics, mobility and how the way we work in buildings will be transformed with BMS and energy kiosks.

### Wireless Controls

Just as most office buildings today use wireless networks to connect IT equipment, wireless technology is now viable and cost-effective for BMS. Wireless communication provides a wireless platform for devices across multiple levels of a BMS – from room temperature sensors to supervisory engines to field controllers. The wireless devices can co-exist with hard-wired devices on the same network as shown in *Figure 1*. Many of the today's wireless products use the ZigBee protocol ([www.zigbee.org](http://www.zigbee.org)). Please note that other protocols also exist, and are used by

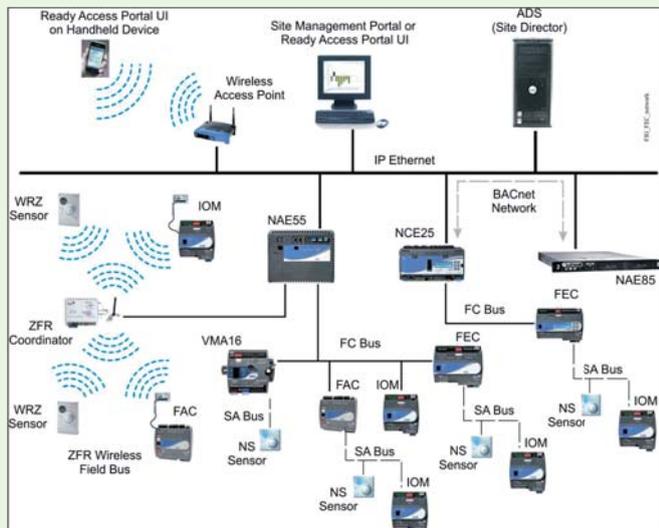


Figure 1: ZigBee wireless co-existing with wired BMS devices

some manufacturers. The ZigBee standard operates on the IEEE 802.15.4 physical radio specification and operates in unlicensed bands including 2.4 GHz, 900 MHz and 868 MHz. It uses extremely low power (10 milliwatt) to transmit data.



Figure 2: Wireless devices

### Devices Used in Wireless Architecture

Figure 2 shows wireless devices like sensors, routers and coordinators that are required for a wireless communication system. Wireless sensors measure parameters like temperature, RH

### About the Author

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and occupancy (PIR), and transmit data. The sensors are battery-operated and have in-built capability to check wireless signal strength and low-battery condition mapping. Because of the low power consuming architecture of the wireless system, the battery life is usually long, minimum 5 years.

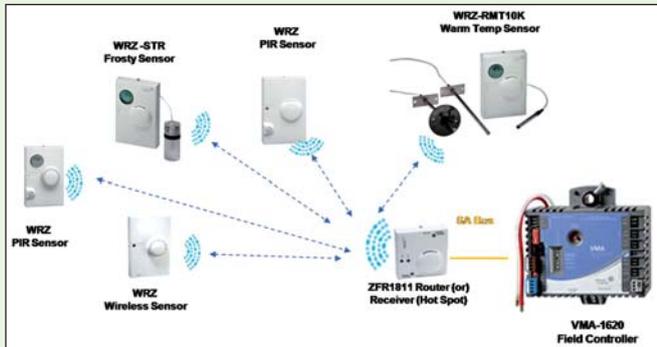


Figure 3: Wireless sensors connected on SA bus to field controller through a receiver

Now refer Figure 3. The sensors are SA bus devices with analog input and are connected on SA bus to a field controller (DDC) through a router or receiver. Up to nine sensors can be connected to a router and field controller (this could vary across manufacturers) and facilitates mapping thermal comfort in a large zone, offering options like averaging, polling and min-max levels for optimum control.

A router can also be used as a repeater (wireless node) to extend the wireless transmission distance of BACnet data communications over 50 feet, to fill any gaps within the mesh network and provide multiple wireless data transmission pathways. The effective transmission range/distance for indoor applications varies because of wireless signal absorption and reflection due to metal obstructions, walls (or floors), and furniture found in typical building interiors. The maximum range is given in Table 1.

Table 1: Indoor line-of-sight transmission range

Range Type	Transmission Distance	
	ZFR 1810 Coordinator, ZFR1811 Router	WRZ Series Sensor
Recommended	15.2 m (50 ft)	15.2 m (50 ft)
Maximum	76.2 m (250ft)	30 m (100 ft)

Figure 4 explains the wireless communication model on the SA bus and FC bus for a typical set-up. The circles on the right side in the figure indicate the wireless communication distance in radius between sensors and routers and also in-between the field controllers. Router-D in the figure is used to bring the device 'address-10' within the communication radius range. A wireless coordinator provides wireless interface between the field controllers and supervisory controllers (marked 'NAE' in the figure), and is hard-wired on the FC bus. Each coordinator can handle and connect up to 30 field controllers (could vary for different manufacturers) to the supervisory controllers.

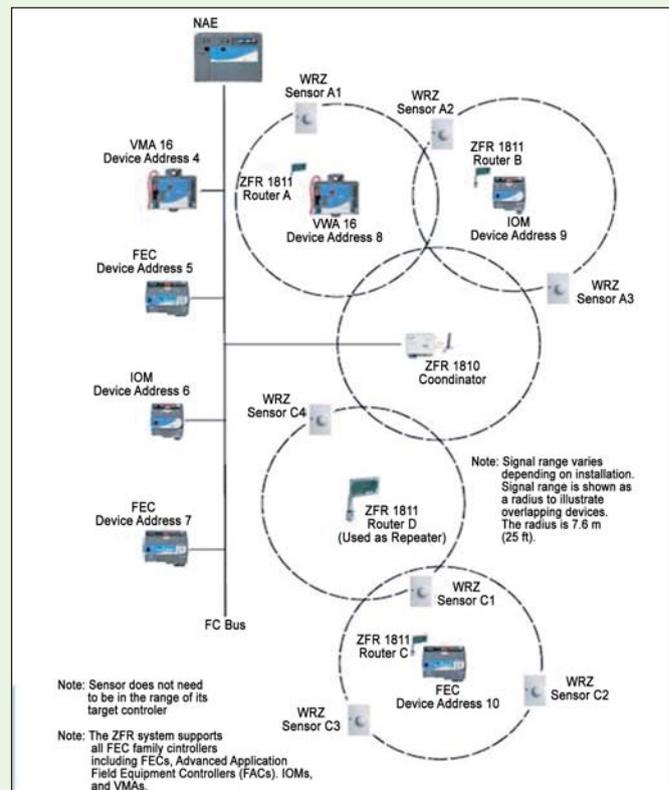


Figure 4: Wireless network communication on SA bus and FC bus

### Mesh Network

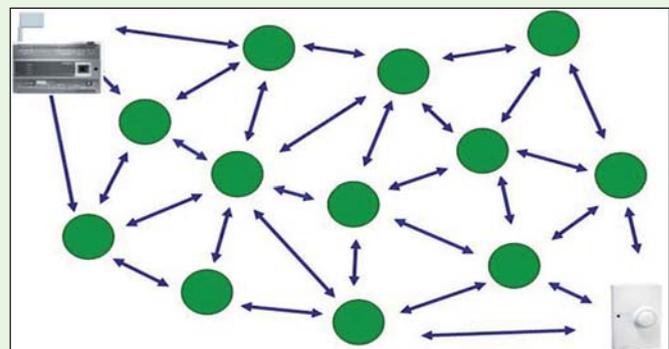


Figure 5: Wireless mesh network example

The wireless devices create a wireless mesh network as shown in Figure 5. The mesh network enhances reliability by providing redundant wireless data transmission paths, enabling the BACnet data to traverse the network through alternate, automatically forming paths and arrive at the target destination device even if a router or repeater within the wireless mesh network experiences interference or drops out of the network. The result is a resilient, self-healing network, as shown in Figure 6.

### Tools to Support Wireless Systems

A wireless sensing system tool is available to determine the wireless signal strength between potential locations of wireless devices. This tool is used as a site survey tool to survey the application and to adjust the device locations before installing them. Wireless system-specific installation and commissioning

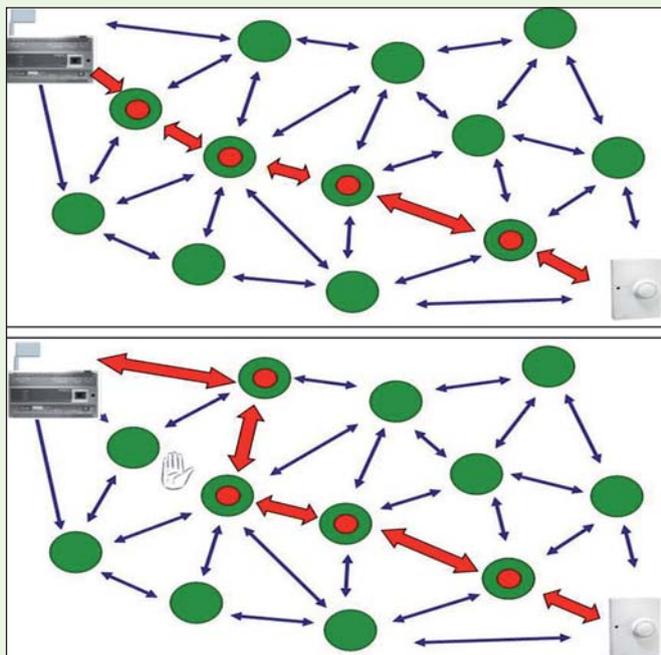


Figure 6: Wireless mesh network: self-healing example

tools are available, which are also useful for analyzing a wireless mesh.

### Wireless Interference and Security

The wireless system is designed to minimize the potential for wireless interference with other wireless applications. In most commercial environments, the wireless system does not encounter or generate wireless interference, even in environments with cell phones and competing Wi-Fi applications. They use different modulation schemes than Wi-Fi applications and use frequencies between popular Wi-Fi bands, enabling Wi-Fi and ZigBee Wireless networks to exist in the same areas.

We need to keep in mind that wireless BMS may not be suitable in applications like operating rooms or radiation therapy rooms, data centers, life-safety applications, etc. and need to be evaluated appropriately for any risks involved.

### Benefits

Wireless BMS communication offers many benefits, a few of which are listed below, because of which industry experts anticipate widespread use of wireless BMS technology in the coming days.

- BMS applications generally require less bandwidth and can withstand some delays, i.e. taking a few extra seconds to respond, unlike voice or video.
- Wireless is more environment-friendly and 'green' than wired networks, as they eliminate wasting resources like copper (for wiring), steel (for clamps), rubber and plastic (for cable sheath, casing), etc.
- It is also highly scalable and facilitates phased deployment. Adding new nodes, sensors, actuators and controllers to an existing wireless system is very simple and does not take much time.

- Very easy and faster installations – both at new sites and when applied to existing buildings for retrofits. It saves installation time, costly labour and avoids all manual errors related to wired systems.
- Wireless devices are non-intrusive, i.e. they do not require working through false ceilings or repainting, etc. and do not require holidays or non-working hours to install them.
- Wireless system is economical for spaces and layouts that are frequently re-configured, or where hardwiring is a challenge – like difficult to reach spaces and heritage structures.

### Simple BMS with Reduced Tier of Architecture

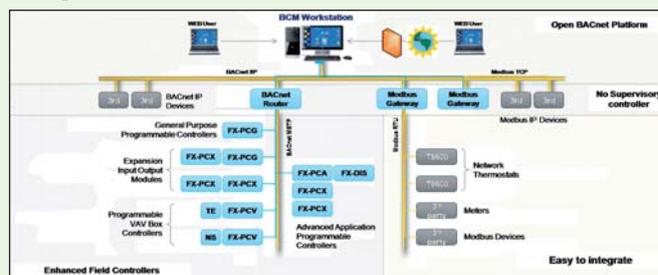


Figure 7: Simple BMS architecture for small offices

Small offices having simple layouts could be cost-effectively automated using a simple BMS architecture, as shown in Figure 7. This simplified version eliminates supervisory controllers. Modbus devices like thermostats and energy meters could be connected to the workstation on the Modbus trunk, using a gateway. Field controllers are connected on the BACnet MS-TP trunk to the workstation using a router.

This simple BMS architecture is more suitable for a 'standardized approach' in building automation, typically for small offices requiring around 1,500 to 2,000 I/O points on the BMS. This uses graphic wizards with pre-built modules for VAV, FCU, AHU and chiller plants. Required layouts, as shown in Figure 8, could be created using a simple drag and drop function.

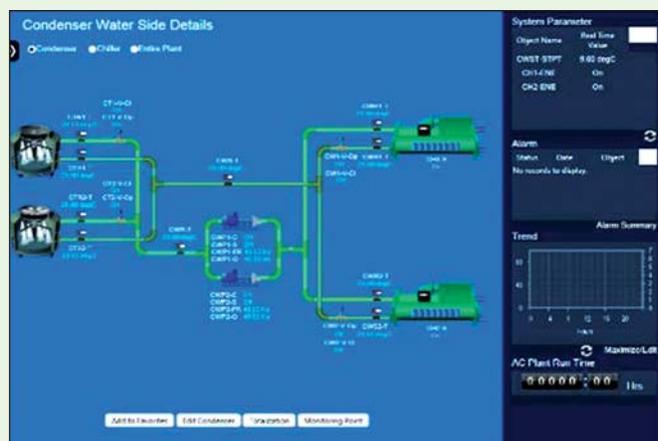


Figure 8: Standard graphic wizard

### Analytics

Internet of Things (IoT) is one of the hottest topics of recent times, and is set to play a crucial role in building automation and improving building operational efficiency. IoT does not mean

simply connecting devices on cloud servers. It encompasses much more than that. It allows one common IP platform to link all the smart sensors and smart devices together to interchange information and through analytical software, commonly called Big Data, optimize the controls automatically.

In many existing buildings, there is approximately 30% unnecessary energy use due to the system and equipment not being maintained and operated properly. (Reference: ASHRAE 2015 HVAC Application Handbook, Chapter 61). Much of this could be prevented by adopting Automated Fault Detection and Diagnostics (AFDD).

A chiller is one of the most critical pieces of equipment in a facility, responsible for comfort and productivity. The chiller plant is also the key contributor to energy use – as much as half the energy used in the building. Some of these analytics done through IoT (refer Figure 9) help to predict when a chiller will go down, or when it is running at less than peak performance that results in unexpected expenses. The process is usually pre-defined to inform the concerned people to take corrective actions.

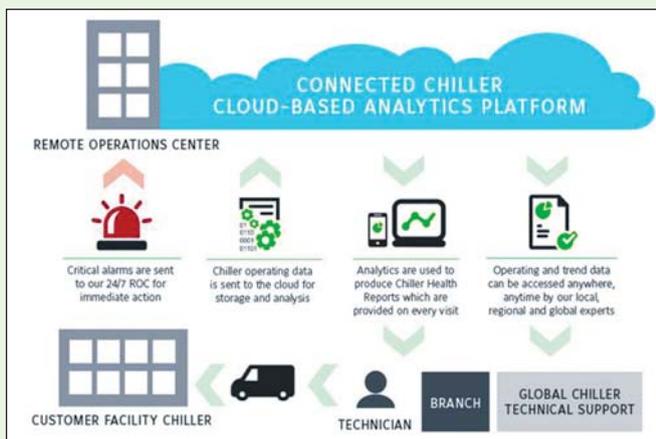


Figure 9: IoT analysis and process flow for connected chillers

Let us now see how it facilitates real mobility for the key people responsible for the uptime of building equipment.

### Mobility and Control Capabilities

Facility teams in buildings spend most of their time in the field, not at a desk. The work of the facility staff needs to be streamlined for maximum productivity, and their tools must improve operational and energy efficiency to reduce costs. This is better served by a BMS with 'simplified' connectivity, actionable data and control capabilities that will enable them to be productive while they are in the field. The connectivity aspect is addressed by the BMS delivering an experience that is device-agnostic, meaning it is optimized for both mobile use (on phones and tablets) as well as computer use and automatically adjusts the content to fit the screen size in use. Refer Figure 10.

The intuitive graphical interface makes navigation easy on any device, with real-time views of a single floor or even a single office, for fast status checks and immediate response. No software installation is required – and building operators can work anywhere in the facility, on the campus or around the world, with



Figure 10: IoT driving mobility

a good Internet connectivity. The intuitive graphical UI eliminates extensive training needs through an easy-to-learn design.

A recent research conducted in the USA makes it clear that the magnitude of information that facility operators are confronted with – from set points to equipment schedules, alarms to energy-use data – can be staggering. In some facilities, the data points

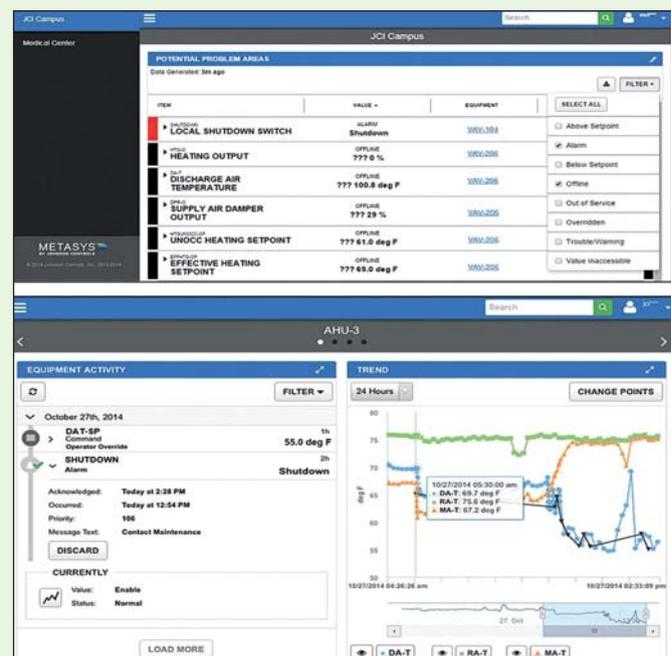


Figure 11: Status, history and trend analysis

can number tens of thousands. Facility operators want to know where the problems exist in their buildings. But the challenge of finding that information, quickly, can be overwhelming. This is resolved by the BMS sifting through this data and simplifying the Potential Problem Areas list, to help operators easily dig deeper to get additional information about equipment status, history and trends they need to resolve the issue. Refer *Figure 11*.

For example, if a facility operator is looking at a damper, he can use voice commands to access the damper data on his mobile device, then make a change to the damper's operation and watch to see whether the change has solved the problem – all without having to call a colleague sitting at a desktop computer and asking him to make changes in the BAS. They do not have to return to the facility once they have gone home just to make a correction to the system; they can log in and make changes from anywhere with an Internet connection! The result is faster problem resolution, lower operating costs, and better building performance.

### **Troubleshooting and Training Will get Re-defined**

To diagnose a complaint, currently we send a well-trained, experienced technician or engineer to the site. The IoT and analytics has already demonstrated that the person at site need not be a subject matter expert to diagnose and resolve a complaint. Fault diagnosis tools, available on his phone or I-pad, can guide the person at site and take him through a list of checks, to figure out the issue and resolve the complaint. The IT industry has long ago adopted this method of diagnosis and we are going to see widespread use of this technology and tool in our HVAC/BMS industry in the coming days.

### **Energy Kiosk**

Many corporates have their energy and environment policy and have a vision to work towards sustainability. Kaizen activities, employee involvement, competition between buildings in the same campus to drive down CO<sub>2</sub> emissions, and showcasing achievements to visitors and customers visiting their campus are the order of the day and are driven vigorously by the ENCON and HR/facility teams. Publishing real-time data on energy and water use and displaying them in 'easy-to-grasp' graphs or forms at the

reception area of the building, elevators, etc. could go a long-way towards sensitizing all the stakeholders responsible for the building.

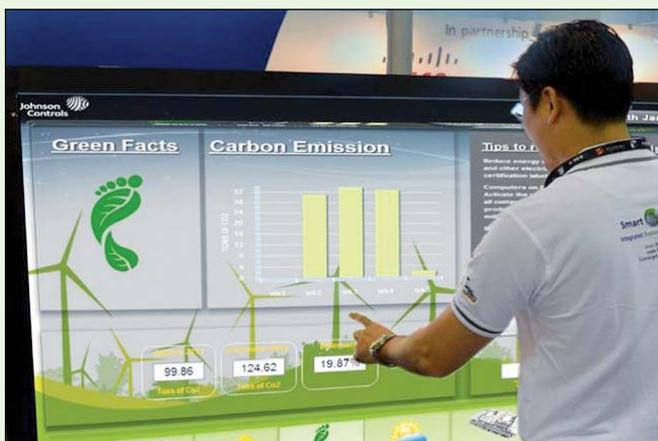
The UI of the BMS is suitably designed to pull the required data from the system and present it on the screen in the required graphical formats. Refer *Figure 12*. Nice looking kiosks have been demonstrated in a few buildings in India. When this trend gathers momentum, it will drive sustainability initiatives of organizations further.

### **Conclusion**

With this we come to the end of this Classroom series on BMS. Let this not be the end of learning the subject. Let us keep learning, adopting innovations and good practices, and keep driving the Green movement in India.

### **References**

1. <http://www.zigbee.org>
2. ASHRAE 2015 HVAC Applications, Chapter 61
3. *Intelligent Building Systems*, Albert Ting-pat So and Wai Lok Chan, published by Johnson Controls
4. Different articles and presentations on BMS by Johnson Controls



*Figure 12: Energy kiosk at buildings to sensitize and involve all stakeholders*