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MARK THROWER MANAGING EDITOR
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SERIES **16** | MODULE **09** | **SMART BUILDINGS**

Prepare now for smart buildings

by Susan Logan, managing director, Ecoteric Ltd

'Smart' is commonplace terminology for all manner of technologies from phones to cities. Definitions are somewhat arbitrary. This article will seek to find a reasonable description of 'smart' as it applies to buildings and explore the technologies, benefits and barriers when creating a smart building.

As we get used to our lives being surrounded by the Internet of Things, increasingly we need to embrace the BIoT - Building Internet of Things. This is as much about process and working philosophy as technology but any organisation moving towards creating a smart building will need to embrace these three aspects.

It is perhaps useful firstly to describe a conventional building. For many years, buildings have incorporated systems which require or provide a range of monitoring, data transfer and controls systems such as:
• building energy management systems (BEMS) which control heating, ventilation and ventilation (HVAC);
• fire and life safety systems such as fire alarms, sprinklers, fire suppression systems, smoke ventilation, gas and carbon monoxide monitoring etc.;
• internal transportation such as lifts, escalators and moving walkways;
• security systems incorporating alarms, occupancy detection, CCTV, access controls etc.;
• voice, telecoms and entertainment systems, audio visual (AV) facilities for display and conferencing, intercoms, public address (PA);
• data infrastructures including wireless access;
• power networks monitoring, uninterruptible power systems and associated changeover, standby generation and changeover controls, power factor controls and other electrical distribution controls and monitoring;
• metering and associated monitoring;
• lighting controls, such as occupancy based or daylight linked controls; and
• condition-based maintenance systems.

In a conventional building, each element of the building services has its own system and usually functions autonomously. These systems may be locked into a single manufacturer or product or some may be open protocol and accept other manufacturer's products. The key point is that the systems will tend to be autonomous and have defined interfaces.

For example, an office building has a ventilation system, a fire alarm system, lighting controls and access controls. In the event of a fire, the ventilation system is interfaced to the fire alarm so that it shuts down. The lighting controls bring the lights up to full output and access controls release to allow evacuation. In this example, each system has an interface to the fire alarm system. Each system is commissioned separately, and the interface needs to be compatible with both systems served. The interface exists for a single purpose.

These interfaces are reliable, easy to install, low cost and serve many buildings very well for essential life safety.

Variable occupancy patterns

Consider however another example. An education building has a variable occupancy pattern. Close to exams, the building is highly occupied from early morning until late evening. Out of term time, the building occupancy is low, boosted occasionally by conferences and tends to be very low past 6pm. The BEMS is set to control the HVAC to set occupancy periods based on the highest level of occupancy and resetting is not difficult, but the BEMS team have no direct knowledge of the occupancy patterns and therefore do not realise

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that significant energy savings can be made by varying the HVAC set periods.

The access control system measures the number of occupants in the building and the times of entry and leaving. Linking the systems would allow the HVAC to go off or set back when the last occupant leaves. When the number of occupants is low, the system may allow ventilation systems to supply less fresh air. In this instance, more intelligent interfaces would be required.

The latter example multiplied across many systems and for many purposes starts to define a smart building.

Use of multiple terms

There are multiple terms that may be used to describe buildings which are smart, and of course it is not a binary definition, more of a spectrum or direction of travel. Many buildings will have integrated systems for multiple functions while retaining conventional "stand-alone" or single interface systems for other functions.

Terms used may include 'intelligent buildings' or 'smart buildings'. The point is that there is a level of connectivity that allows the buildings to adapt and respond to changing conditions.

Estate services provider, Jones Lang Lasalle suggest: "To be considered an intelligent system, automation should be able to: monitor performance; detect inefficiencies; diagnose possible causes; make automatic adjustments; alert facilities management staff to issues that can be automatically corrected; and suggest possible tools and parts that may help staff members get the job done quickly." (JLL, Smart Building Technology: Driving the Future of High Performance Real Estate).

Performance benefits

The objective of any smart building is to improve performance. Performance benefits can be considered in several different ways which may include:

- better energy efficiency through matching system output as closely as possible to demand;
- lower or more responsive maintenance, predicting when failures may occur, and matching system performance to maintenance needs;
- better environment for occupants, such as responsive lighting, comfortable temperatures, adequate fresh air, good air quality, good acoustic environment boosting occupant satisfaction and staff retention;
- better productivity through creating a good environment and adequate space available to perform tasks efficiently;
- lower facilities management costs and life cycle cost improvement;
- optimisation of space to reduce facilities costs; and
- reduction of energy spend by matching demand to optimal charging periods.

Some practical examples illustrate the benefits:

- monitoring power use at peak and low charging periods and load shedding or shifting non-essential use to low charging times is possible now. In the future, it is likely that smart grid technology will shift loads, for example according to availability of renewable electricity generation. Smart buildings could be ready for schemes which minimise usage at peak times in return for lower fuel bills or financial incentives; and
- daylighting is beneficial to occupants, but glare is detrimental to visual comfort. Automated blinds which respond to glare but open when the glare has passed allow maximum use of daylight creating a good environment for occupants and minimising lighting energy costs.

These aims all require information and control across multiple systems. Some require "real time" response. For example, responding to daily space requirements cannot be managed through historic data.

Data management is at the heart of a smart building. At some level, there will be one or more data infrastructures which network systems, gather information, and have a central or distributed intelligence. The infrastructure may be wired, wireless or most commonly a combination of both.

Most BEMS systems communicate through systems such as BACnet, KNX, LonWorks or Modbus, and will primarily be hardwired. Mbus, DALI and others are also used for specific applications in this case, metering and lighting.

All these provide open access depending on configuration. In some systems, for example KNX, there is not just one single automation installation for all intelligence, but this intelligence is spread over individual system components.

Wireless systems integrated into building automation include ZigBee, EnOcean, Z-Wave, Wi-Fi, Bluetooth, Thread, and Infrared.

Connected systems

The different systems can be connected together, and many buildings will have a combination of technologies for example DALI lighting, Modbus enabled building services components, BACnet protocol BEMS.

A depth of understanding of the limitations and complexity of interconnection is needed, along with a robust conversation on which is best for the application.

The integration of systems is however complex and requires cooperation between the facilities team or services designers and the IT team.

Consider business priorities

If retrofitting, it is best practice to consider the business priorities such as space utilisation or productivity and focus on the key aspects that should migrate onto the smart building platform. Trying to integrate all services in a single project may lead to failure due to the sheer cost and complexity of the project.

The data infrastructure is a critical factor. There is a massive increase in demand on most data systems due to trends in video streaming and conferencing, increased density of occupancy, BYOD (Bring Your Own Device), security and surveillance. BIoT will add to the traffic creating bottlenecks and loss of speed unless the infrastructure is in place to support it. A scalable data infrastructure is essential. This will mean allocating space for hubs and vertical and horizontal cabling, all with space for expansion.

At the end of the infrastructure resides the analytics which is the heart of the enterprise. This is perhaps the most important aspect as this is what determines what happens to the data collected and what decisions are taken as a consequence. The analytics are evolving and expanding rapidly and moving into the business market, alongside the more traditional BEMS providers. The focus of the business-based providers tends to be space utilisation and productivity as a priority with comfort, resilience and energy efficiency as secondary benefits. There is a good reason for this focus as the major cost to an organisation is primarily its staff, followed by premises.

A smart building can meet all these parameters, but in terms of making a business case, there is no doubt that a project which promises increased productivity and reduced facility costs will appeal to the financial decision takers.

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There are challenges that need to be carefully considered when moving forward in implementation. These include:

• skill set. When considering a new building, the traditional design and construction team does not normally include a specialist in smart buildings. BEMS specialists are usually from a specific manufacturer and often not appointed until at best, the detailed design stage of the process. There can be a disconnect between those designing the data infrastructure and the building services data and control systems. It is likely that when setting out to implement smart building technology, an expert, ideally not tied to any particular solution, needs to come on board early in the process with enough knowledge and influence to evaluate technologies and advise on optimum solutions.

Communicate benefits

Key to success is the ability of specialists to communicate the technical advantages and disadvantages of system options to a team and client who may not be familiar with the concepts and more critically the detail. It is essential to set out in layman's terms, what the system capabilities are, the limitations, the ability to expand, the extent of open access, the future costs, security, availability of components and maintenance liabilities. Only then can an informed decision be made to go with a platform, system or system provider; and

• privacy and security. Consider a conventional building where data trickles through small pipes which only connect at very limited interfaces. Now think of a smart building where data flows through a common large pipeline. If that pipeline is tapped, there is a much greater potential for a security breach which could cause major business disruption. At the same time, it is easier to protect a single pathway than manage multiple pathways.

There is increasing awareness of surveillance through the devices present in our buildings, and, as these are connected, the potential vulnerability increases. The objective of surveillance is primarily to gather data to predict behaviour. It could be considered benign, but any organisation considering or occupying a smart building would be well advised to consider how data could flow beyond the boundaries of the building or organisation and what the impact of that flow may be now, and in the future. Expert advice should be part of routine design and management activity. Maintenance of security of building services systems should be as important as physical and general data security.

All security and privacy should be considered as part of business critical risk management and be proactive, anticipating and preparing for threats.

In the future, as awareness of surveillance grows, organisations must be prepared to manage the fears and reaction of public and employees. For example, what would be the reaction of staff and visitors to being tracked as they move around the building? Openness and engagement are essential.

Evolution of technology

Technologies are evolving rapidly, and our buildings can very quickly become outdated. The components that make up the architecture of a smart building will inevitably evolve and need to be changed within the design life of a building. It is therefore essential to build in the ability to replace outdated technology as newer systems become available. It is likely that wireless technology will continue to expand, although for the foreseeable future wired backbones meshed with wireless will form the basis for most smart buildings. The limitations of speed, security and connectivity limiting wireless will inevitably be reduced in the future meaning that the mix of wireless and wired may well change. Wireless mesh networks will expand to accommodate the proliferation of devices that BIoT will bring.

It would be prudent to design a new or refurbished building with easily accessed cabling routes. Provision should be made to install a new cabling system while maintaining the existing provision for data hubs that can be changed and adapted. And consideration should be made of how devices can be changed and added without disruption.

Ask the right questions

To start the journey, ask the right questions:

• What are my business or organisational priorities? For example, increased productivity;
• What will address these priorities? For example, better air quality, better lighting, improved collaboration;
• Who are the key people who need to be involved? For example, the facilities, IT, business manager, HR;
• What is needed to improve? For example, better air plant, lighting controls, reorganising work space, new AV facilities;
• How can these be integrated to bring about the desired outcome? For example, CO_2 controls, air monitoring and feedback on air quality to the workforce, ability of the individual to control their lighting levels, wayfinding to collaborative workspace;
• What specialist advice is needed, and what defines best practice?;
• What infrastructure is currently available? For example, BEMS, local lighting controls, access controls, data infrastructure?;
• Can these be used or integrated, what are the limits on functionality? If not, what is needed to upgrade? If an upgrade or new installation, which system or systems best meet the needs?;
• Should intelligence be distributed? What will be the effect of my project on data speeds and reliability?;
• What is the timescale and budget?;
• What are the threats to security and privacy and how are they going to be managed?;
• What might we want to do in the future and what provision should we make now?;
• What analytics are required to make best use of the data gathered?; and
• Who will use the analytics and how?

If all the above can be answered, the organisation will be well on the way to defining a smart building project.

A smart building can be defined as one where there is an infrastructure which allows connectivity for multiple benefits in performance, and where data can be used in real time to react to changing conditions.

There are great gains in environment, energy and productivity, and savings in facilities costs to be made. Along with the benefits, vigilance is needed to maintain acceptable levels of privacy and security. In a rapidly changing world, our buildings need to embrace the future.

Further reading

• *Anixter Global Technology Briefing "Smart Building Infrastructure Best Practices" provides good detail on risk management, network performance, space utilisation, workplace productivity and BIoT enablement.*
• *For a useful overview of the open protocols, Schneider provides a useful overview, "Guide to Open Protocols in Building Automation" available at https://blog.schneider-electric.com/wp-content/uploads/2015/11/SE-Protocols-Guide_A4_v21.pdf.*

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ENTRY FORM

SMART BUILDINGS

Please mark your answers on the sheet below by placing a cross in the box next to the correct answer. Only mark one box for each question. You may find it helpful to mark the answers in pencil first before filling in the final answers in ink. Once you have completed the answer sheet in ink, return it to the address below. Photocopies are acceptable.

QUESTIONS

1. What could be considered as one of the characteristics of a smart building?

- ☐ All devices connected to the internet
- ☐ Devices and systems connected to provide data, analytics and control
- ☐ All devices hard wired
- ☐ A combination of devices which are hard wired and wireless

2. Which of the options below lists three of the performance benefits of a smart building?

- ☐ Energy efficiency, access control and AV facilities
- ☐ Good space utilisation, lower facilities management costs and BEMS
- ☐ Data security, integrated systems, good internal environment
- ☐ Responsive maintenance, reducing energy spend, better productivity

3. Which of the terms below can be used to describe a smart building?

- ☐ BYOD
- ☐ BEMS
- ☐ BIoT
- ☐ IoT

4. According to Jones Lang Lasalle, which of the following are the three things that automation should be able to do?

- ☐ monitor performance; detect inefficiencies; diagnose possible causes
- ☐ make automatic adjustments; alert facilities management staff to issues that can be automatically corrected; keep records of events
- ☐ suggest possible tools and parts that may help staff members get the job done quickly, monitor staff breaks, reorganise work space
- ☐ Provide good daylighting, make automatic adjustments; diagnose possible causes

5. What may prevent successful implementation of a smart building project?

- ☐ Security concerns
- ☐ Privacy concerns
- ☐ Lack of adequate skills in the team
- ☐ All of the above

6. What are the possible consequences of increasing data traffic?

- ☐ Bottlenecks and loss of speed
- ☐ Scalable infrastructure
- ☐ Increased density of occupancy
- ☐ Security and surveillance

7. Which of the following would not be a benefit of a smart building over a conventional building when there are variable occupancy patterns?

- ☐ The heating and ventilation could respond to the occupancy pattern
- ☐ The heating, ventilation and lighting could respond to the occupancy pattern
- ☐ The ventilation and heating could be controlled by setting the time periods
- ☐ Space utilisation could be monitored and optimised

8. What is the closest definition of open architecture?

- ☐ The ability of a system to expand
- ☐ A system or infrastructure intended to make adding, upgrading, and swapping components easy
- ☐ A system and/or and infrastructure intended to control and manage data
- ☐ A collaborative use of design and design tools

9. Who would not be involved typically when implementing a smart building project in a new building?

- ☐ Future facilities managers
- ☐ IT specialists
- ☐ Building users
- ☐ Structural engineers

10. Which of the following features of a smart building is likely to improve the energy efficiency most?

- ☐ The ability of the building to shift energy use to lower charging periods
- ☐ The facilities managers being able to predict and prevent failures
- ☐ The building being able to respond automatically to changing patterns of use
- ☐ The space utilisation improving

Please complete your details below in block capitals

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Completed answers should be mailed to:

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