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MULTITECH

UNLOCKING THE POTENTIAL OF SMART BUILDINGS

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WHAT DO WE MEAN BY SMART BUILDINGS?

At its core, the concept of smart buildings includes the transformation of all aspects of commercial and residential buildings to optimise the use of resources including water and energy while increasing occupants' comfort and decreasing building maintenance costs.

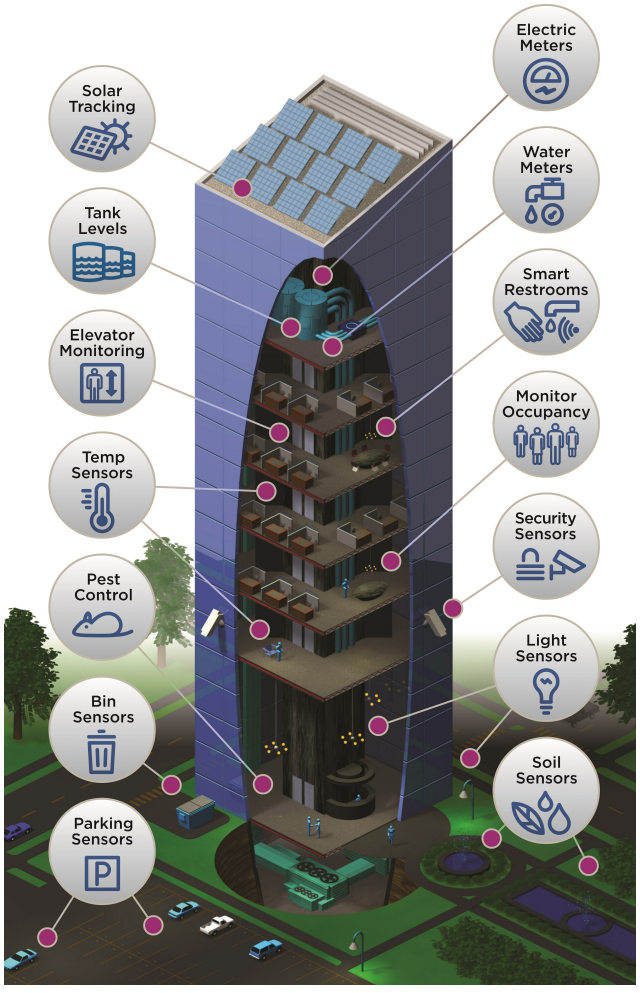
Key IoT application types often found in smart buildings include:

- Smart heating, ventilation, and air-conditioning (HVAC) systems, including controllers and potentially smart peripheral devices affording control at the level or a single device, or room. The components of HVAC systems can also be deployed separately, for instance as standalone smart heating systems or smart ventilation systems.
- Building safety and security, including smart connected security alarms and fire alarms. Also including connected video cameras/CCTV used by enterprises for building security.
- Access control, including monitoring whether doors and windows are open or closed, or monitoring shop windows for breakage events in a retail context, and a range of vibration-monitoring based movement sensors.
- Building lighting including the monitoring and control of interior and exterior building lighting systems and potentially also lights (bulbs, luminaires) individually.
- Air condition monitoring, including monitoring for a range of pollutants (chemical, particulate, and so on), moisture levels, and carbon monoxide and carbon dioxide monitoring.
- Building automation, including controllers and peripheral devices (monitoring devices, controlled devices, or actuators) to support an extended range of automated functionality, such as the control of window shades.

The smart buildings concept can also extend to include the monitoring of specific assets and facilities within a building. Such applications can be very diverse and include applications such as:

- The monitoring of water flow and water storage in plumbing systems, potentially for multiple reasons including leak detection to prevent flooding and also to guard against the development of legionella in hot water pipelines. The latter is most relevant for buildings like hotels where water flow can be stagnant potentially for long periods.
- Monitoring specific building resources such as elevators, parking spaces and renewable generation assets. Also potentially monitoring electricity consumption at the level of an individual asset or machine.
- Monitoring of shared restrooms including, for example, soap dispensers to provide alerts in the case that supplies run low. Similar solutions can potentially

Figure 1: Illustrative Smart Building applications
[Source: MultiTech, 2022]



also monitor stocks of paper goods and other consumables within restrooms.

- Monitoring the condition of safety equipment such as fire extinguishers and AEDs (Automated External Defibrillators) within a building.
- Environmental and ancillary systems such as for pest control, waste management and monitoring green spaces.

In summary, the 'smart buildings' concept can extend to encompass all kinds of sensors associated with a wide variety of assets and a plethora of use cases within a building. The potential is almost limitless. Figure 1 illustrates a range of smart building applications that can all potentially work in concert.

WHAT ARE THE BENEFITS OF SMART BUILDINGS?

The benefits of smart buildings are manifold, and include reduced operating costs, sustainability benefits, risk management benefits and more. In this section we discuss these broad categories of benefit in more detail.

Reduced operating costs

The deployment of smart technologies can reduce the operating costs of buildings in a number of ways. Direct effects include reductions in energy used for lighting and heating, ventilation and air-conditioning (HVAC) by better matching resources provided to building occupancy. For example, lights can be automatically dimmed in areas of a building that are unused and HVAC can be adjusted to take into account both current and expected occupancy levels along with contextual considerations such as current and forecast weather conditions.

Smart buildings solutions can also help to reduce other (non-energy related) operating costs by enabling a range of pro-active and pre-emptive maintenance techniques. For example, restrooms can be serviced based on actual recorded usage levels rather than simply according to a timetable and consumables within those restrooms can be topped-up only when necessary. The concept of pro-active and pre-emptive maintenance can extend to include very diverse asset types. For instance, smart mousetraps can send a signal when a mouse has been caught and the trap needs to be emptied.

Smart HVAC systems can be particularly important and impactful in certain situations, such as when medicines (or other perishable goods) are required to be kept at certain set temperatures and can result in substantial reductions in losses due to storage at incorrect temperatures.

Sustainability benefits

The sustainability benefits of smart buildings are very closely associated with efficiency benefits since any reductions in electricity and hydrocarbon fuel used by a building will naturally correspond to reductions in the building's carbon footprint. Buildings account for nearly one-third of global energy consumption and 55% of global electricity demand[1] and according to the International Energy Agency (IEA), digitalisation of buildings (including smart thermostats, controllers, smart lighting) could cut total energy use in residential and commercial buildings between 2017 and 2040 by as much as 10%.

Building Automation Systems (BAS), smart HVAC and smart building lighting are some of the most impactful electricity saving applications and maximum electricity savings are realised when these systems are used in conjunction. Benefits include:

- 35-40% of electricity consumed by lighting devices can be saved by using smart lighting control systems.
- 20-25% of electricity consumed by HVAC systems can be saved by deploying artificial intelligence (AI) and IoT enabled control systems. Equivalent savings can be made in the context of hydrocarbon fuels used for heating.
- Integrated building systems with HVAC and lighting control can save nearly 10-20% of total building electricity consumption.

Other aspects of the cost savings associated with smart buildings also give rise to sustainability benefits due to reduced levels of manpower required to support the building and also reduced travel enabled by a shift from timetable- and event-based maintenance to needs-based pro-active and pre-emptive maintenance. Sustainability benefits associated with the adoption of pro-active and pre-emptive maintenance techniques can be significant, often achieving a reduction in technician visits (and associated truck rolls) of 10-20%.

IoT-enabled monitoring of assets can also help to ensure that those assets are running at optimum efficiency and can help to identify components (for instance, HVAC fan motors) that are consuming excessive power as an early indication of an imminent failure state. Clearly, targeting such scenarios in a timely way has the benefits of avoiding a potential system breakdown, and also avoiding excessive electricity consumption (and corresponding CO2 emissions) in advance of any breakdown. Addressing emerging problems before they become full breakdowns can also reduce repair costs and extend the overall life of a system. Additionally, the opportunity to undertake pre-emptive repairs as part of routine maintenance can reduce the overall number of engineer visits and associated travel.

Risk management benefits

There is also potential for smart buildings to unlock benefits related to risk management, based on the availability of more timely and more accurate information about building condition and about specific assets within the building.

Knowing about a problem quickly and before it causes consequential damage, or even predicting that a problem will arise before the event, both reduces the frequency of failure events and the costs associated with such events. Risk management benefits are particularly applicable in the case of water leaks, based on analysis of water flows within a building, but can extend to the monitoring of activities in and around building. For example, in the case of certain buildings CCTV enabled with artificial intelligence and edge computing can be used to monitor activities around critical infrastructure or assets either to ensure that those assets are appropriately protected, or to ensure that building occupants are kept away from potentially dangerous situations.

Associated benefits

Occupancy sensors and indoor air quality monitoring systems have a significant impact particularly in terms of the 'social' aspect of ESG. The monitoring of indoor air quality can have a profound impact on health, wellbeing and productivity of employees, residents, and customers. In addition, water flow monitoring systems can be important for the safety of building occupants, as they are effective in preventing floods and detecting the potential presence of legionella bacteria in water pipes. Flood mitigation systems can also indirectly reduce the material waste that goes into landfill in the case of a flood by ensuring that leaks are more quickly identified and fixed.

Apart from these benefits, space monitoring, room booking, indoor building navigation and a range of other monitoring and pre-emptive maintenance solutions can significantly improve the wellbeing of building occupants. In the case of commercial premises such increased comfort is often associated with corresponding increases in the productivity of workers.

WHO CAN BENEFIT?

Many different kinds of stakeholders can potentially benefit from smart buildings applications. These range from occupants to owners, and multiple potential parties in between. This section provides a summary of the perspectives of a range of key stakeholders in smart buildings.

Owners

Building owners can benefit from better maintained buildings, more contented occupants, and lower churn of occupants. Depending on the kinds of smart building solution deployed, building owners may also suffer lower losses as the result of fire or flood, if the damages caused by such events can be limited by a faster response to any emerging problems.

In a range of cases, smart building sensors that enable pre-emptive maintenance can significantly reduce the maintenance cost of buildings. For instance, moisture sensors can alert to a range of potential slow, creeping,

Working with **Renfrewshire Council** in Scotland, iOpt created an IoT solution for monitoring 2,400 social homes to measure temperature, humidity and the carbon dioxide levels in the properties. The solution was connected with LoRaWAN technology provided by MultiTech.

The impact of poor air quality cannot be over-estimated, and homes too often become breeding grounds for moulds proven to cause grave illnesses in children and adults. For large apartments in city dwellings often housing thousands, these challenges are exacerbated by the fact that monitoring the inside of apartments has typically been an enormous task - both costly and intrusive for its tenants.

"iOpt's pioneering IoT technology, being delivered in partnership with Renfrewshire Council, is a fantastic example of how innovation and collaboration can help people live healthy lives at home, supported by remote monitoring" said Scottish Minister for Trade, Investment and Innovation Ivan McKee.

damage events such as slow leaking pipes, mould development, cracked drains, and so on. In all of these cases, frequent and accurate measurement of moisture levels present in the air of buildings can provide advance warning that repairs are needed.

Additionally, energy efficient smart buildings (that have been certified for instance according to SBC[2] or RESET[3] specifications that measure the sustainability, health and energy performance of buildings) can have higher lease rates and sale value compared to non-smart buildings.

Landlords

Landlords can avail of many of the same benefits as building owners, although the main ways in which such benefits will manifest will be in the form of higher lease charges, lower churn in tenancies, shorter void periods, and less foregone rent as a consequence of events such as flood or fire.

Facilities Managers

Facilities Managers can benefit from a plethora of information relating to the condition of the building that they manage. This could range from the status of access doors (whether they are they open or closed, whether they have they been recently opened, and so on) through to the condition of assets, facilities, and equipment within the building, the condition of fire alarms and fire suppression systems. Even including the condition and levels of consumable supplies within restrooms.

Service Providers

Clearly, service providers (such as cleaning firms) have the potential to incorporate into their offerings the same kind of information as may be used by facilities managers. For instance, information about stock levels in washrooms and the condition of those washrooms can help a cleaning firm to better schedule workloads and ensure that workers take appropriate consumables with them to job sites.

Building Occupants

Building occupants include office workers, retail staff, factory operatives, and residents (in the case of housing offered by a landlord). In all cases, occupants can benefit from occupying spaces that are better tailored to their needs and better managed. In the case of office workers in particular, increased satisfaction with a workspace can result in increased productivity.

Insurers

Typically, it is end-user adopters that are leading in their endeavours to monitor buildings, however, the more innovative players (or 'carriers') in the insurance market are now experimenting with a diverse range of associated services that have the effect of positioning insurers as partners that enable risk avoidance, rather than the more traditional role of mitigation after an event. Such an approach has the dual advantages of reducing costs for an insurer and assisting customer acquisition (particularly if some of the cost savings are passed on to customers). Effectively, smart services and support for loss avoidance can help an insurer to reposition as a partner to assist the ongoing management of risk for building stakeholders.

HOW TO MAKE A BUILDING SMART?

Ultimately, the main challenge with IoT solutions for smart buildings is the deployment and connection of IoT devices, although the challenge varies a lot depending on the context. Deployment is simplest in new build scenarios, and also relatively simple when smart solutions are deployed as part of a building refit. Deploying smart building IoT solutions into buildings that are currently in use, and not due for refurbishment, has traditionally been more challenging but nowadays simple solutions do exist.

New-build and refurbished smart buildings

Clearly, the design stage for a new-build building is the ideal time at which to design-in an array of smart buildings solutions. A comprehensive and sophisticated vision of smart buildings capabilities can simply be built-in as part of the overall construction process, ensuring that power sources are available wherever needed and communications infrastructure (either wired, or wireless) is present throughout the building and in the locations that it is needed to connect the envisaged solutions.

The approach with deploying smart building capabilities at the time of a building refit is similar: a comprehensive vision should be developed and deployed as part of the refit. The deployment of smart buildings solutions at the time of a refit is generally not challenging in most modern office spaces with floating floors, suspended ceilings, and partition walls. In the case of older building stock, however, the necessary ducting of cables can be challenging.

A limitation with this approach in both new-build and refurbishment contexts is flexibility. Unless the building tenant is known at the time of construction (or refit) and is not expected to change until the next refurbishment, then the 'smart building vision' of any tenant may differ to that designed and installed in the building. This scenario (alongside the potential emergence of new applications in the marketplace over time) mean that it is very challenging to fully futureproof smart building infrastructure deployed when a building is constructed or refitted. When tenants demand new solutions that were either not envisaged at the time of construction (or refit) they must effectively be deployed as 'retrofit' solutions as described below.

Retrofit solutions

For retrofit IoT smart building solutions, the priority is to deploy devices into the building with minimum disruption. This generally means a combination of wireless connectivity and battery powered devices, potentially connected to a local hub device that has access to a power source. To a great extent this approach does away with the need to run new cabling within a building to connect newly deployed IoT devices, together with the associated disruption and cost. It also adds significant flexibility in terms of the locations of connected devices which will not be limited to places where line power can feasibly be deployed. For example, a battery powered accelerometer can be attached to the door of a stall in a restroom to count the number of times that it has been used since it was last cleaned. Clearly, deploying a sensor powered by mains

Maidstone Hospital, a leading hospital in the South-East of England, wanted to significantly reduce its carbon footprint and also recognised the cost-saving potential of energy conservation. The first step in controlling its consumption involved measurement - a daunting task as the hospital is a large site, spread over more than 2 million square feet. Maidstone ultimately opted to work with Synetica Limited, providers of EnLink long range wireless monitoring solutions for energy, assets and the environment, supported by LoRaWAN connectivity.

"The Synetica EnLink system was installed in a short space of time and with almost no disruption," said Barry Leaf, Estates Manager, at Maidstone Hospital. "The operatives needed a minimum amount of permits to work and certainly no disruptive electrical isolations were required." Pivotal to the success of the Synetica's solution is MultiTech's Conduit®, a configurable, manageable, and scalable communications gateway for industrial IoT applications. The hospital now has real-time data from over a hundred meters across the site that allows for an instantaneous measurement of energy impact and carbon reduction.

electricity in this same scenario would likely be impractical.

In the context of wireless connected, battery powered, solutions for smart buildings two connectivity technologies stand out: LoRaWAN and Bluetooth.

LoRaWAN and Bluetooth

LoRaWAN is a two-way low power wide area (LPWA) wireless connectivity technology that can be deployed to provide coverage within a building, or across an entire campus, supported by a limited number of access points. The technology uses licence-exempt radio spectrum so no licences are required before a network can be deployed. LoRaWAN devices also consume very low levels of power so enabling those devices to be battery-powered in many cases and with a battery life potentially extending to many years. Within the coverage area of a LoRaWAN network, LoRaWAN devices connect directly to an access point (in a similar way to how Wi-Fi devices might connect to an access point).

Bluetooth is another significant technology that can also support IoT connected smart buildings devices. It also has the advantage of very low power consumption, enabling the connection of battery-powered devices. It has the additional benefit that many manufacturers of IoT devices that can potentially be incorporated into a smart building solution are already beginning to incorporate Bluetooth connectivity as standard. However, Bluetooth signals do not travel well over significant distances within buildings and generally cannot penetrate walls. With these limitations, Bluetooth-only solutions are typically limited to close-proximity communications between an IoT device and a user with a smart phone or tablet.

Accordingly, a key technique to use when implementing a retrofit smart buildings solution is to deploy a number of LoRaWAN bridge devices that are connected to a LoRaWAN network and can gather information from multiple local Bluetooth connected devices. Such an approach combines the best aspects of both technologies: the burgeoning presence of Bluetooth connectivity as an option for connecting smart buildings devices and the use of LoRaWAN as an easy and robust way to provide more extended coverage within a building.

Scale in the marketplace

Another consideration is the overall scale of the new-build, refit, and retrofit markets. With the retrofit market being far larger and more agile (in terms of the potential to develop and deploy new applications over time), it is likely that the retrofit market will become the dominant consideration when new smart buildings products and applications are developed. There are few significant downsides to this approach since, clearly, 'retrofit' applications can also readily be deployed into new-build or refit environments. The result is that effectively many aspects of the market for smart buildings solutions are likely to be dominated by retrofit solutions and approaches, even in new build and refit contexts.

[1] https://www.iea.org/reports/digitalisation-and-energy

[2] 'Smart Building Certification' is a certification process for intelligent buildings.

[3] 'Regenerative Ecological, Social, and Economic Targets' is an international building standard, accompanied by a set of assessment tools, to develop actionable, long-term strategies towards health and sustainability.

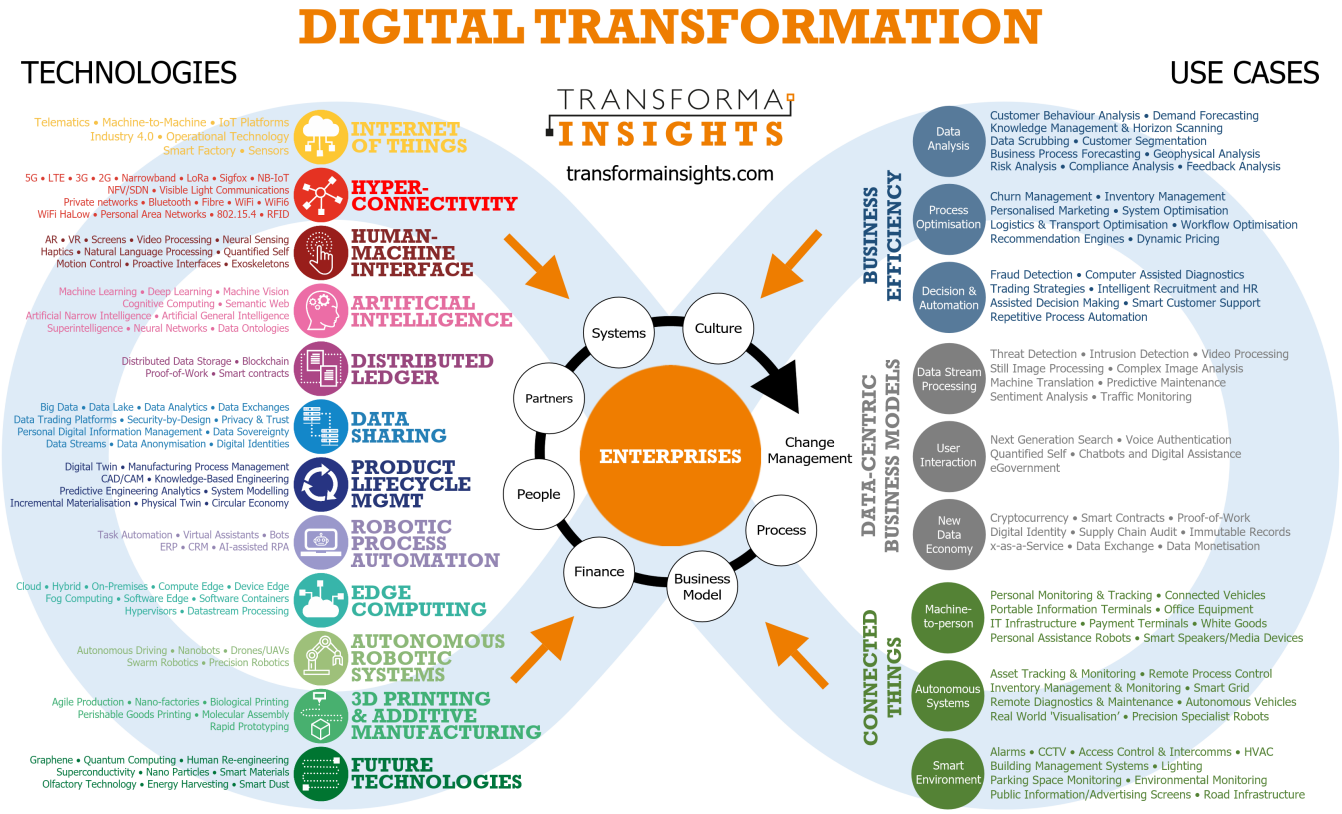
CONCLUSIONS

The concept of Smart Buildings can potentially include a plethora of different IoT solutions. These range from relatively well-established applications such as smart security and propositions that can optimise HVAC and lighting based on occupancy, through a wide range of ancillary monitoring and pre-emptive maintenance applications. The concept can extend to include numerous kinds of ancillary monitoring and maintenance applications. As the cost of smart building solutions falls and wireless connectivity solutions become more well-established, the diversity of potential smart buildings solutions will only increase.

The benefits of smart buildings, meanwhile, are manifold. Smart building solutions can reduce operating costs, secure sustainability benefits, help to manage risks, and also unlock associated benefits including improved well-being of building occupants.

Given the wide range of smart building applications and corresponding benefits, it is no surprise that smart buildings solutions can deliver benefits for many different kinds of stakeholders. These include owners, landlords, facilities managers, service providers, and, of course, building occupants. The benefits can also extend to insurers, who can use IoT-enabled smart building solutions to help their clients to both minimise risks and reduce the severity of adverse events: clearly such propositions are potentially beneficial to both the insurer and the insured party.

Connectivity for smart buildings has traditionally been challenging. However, increasingly LoRaWAN networks and Bluetooth devices are being deployed together with appropriate bridging equipment to address such challenges. As a result, the implementation of smart building IoT solutions is now easier than ever.



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