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A roadmap for the future of **digital services** in buildings

Contents

Executive summary

If you consider that buildings account for 40% of global energy usage - a quarter in their construction phase and three-quarters in operation, and our management of these buildings causes 27% of global carbon emissions – we can immediately assume the sector's reliance on fossil fuels is a problem.[i]

Reducing these levels is not only essential from an environmental perspective but also from an economic and societal one. The soaring cost of energy, which the World Bank says could last for years,[ii] is forcing many building owners to seek efficiency in building operations.

The need for efficiency is being increasingly addressed through building design, but that is not enough. The most inefficient buildings that will be in place 30 years from now are ones that are already standing today, so a key challenge is how to improve the operation of existing structures.

One of the easiest and most effective ways to achieve this is through the implementation of digital services, intelligent maintenance programs that leverage the power of technology and new business models to guarantee outcomes such as energy savings and cost reduction. Digital services can be deployed anywhere and at any time, across a single building, a campus or a global real estate portfolio.

Research shows best-in-class facilities managers are 33% more likely than their peers to seek out digital services in meeting their building management needs, most to increase operational efficiency.[iii] This paper, created in partnership with Siemens Smart Infrastructure, describes the steps that building owners and managers can take today to improve operations through the implementation of digital services.

Why improve building operations?

Buildings are not usually built for change. Large amounts of money and effort go into building design and construction on the assumption that the structure will remain largely as is for the duration of its useful life, which in some cases can extend to centuries. This is still the case with modern commercial and industrial buildings, where building design has a significant impact on operations. The blueprint for an office block, for example, will dictate a very different mode of operation to that of a shopping mall.

However, a series of trends are altering this picture and creating a need for more flexibility in building operations. Without doubt the most significant of these is the drive to reach net zero emissions by 2050. According to the International Energy Agency (IEA), total direct emissions from the building sector need to fall from around 3 metric gigatons of carbon dioxide equivalent in 2020 to just 120 megatons in 2050, a 96% cut, while accommodating a 75% increase in floor area.[iv]

This will require a shift in focus to operations, since around 72% of a building's lifetime emissions come from its operations—the way it is heated, cooled, powered etc..[v]

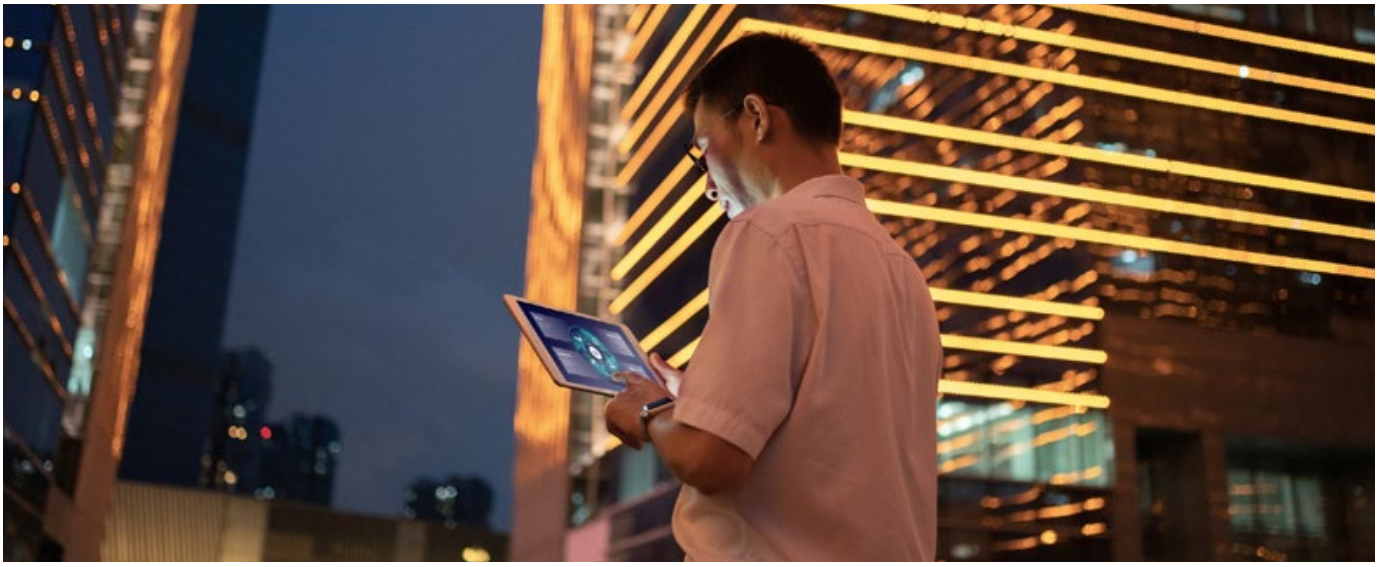
"80% of the total lifecycle costs of a building occur in the operation phase."[vi]

Ultimately, says Victoria Burrows, director of Advancing Net Zero at the World Green Building Council, "It is not enough to make buildings that are less bad anymore. They must make a positive contribution to the environment they are in."

Besides providing environmental and societal benefits, buildings that use efficient, flexible and controllable digital services can deliver economic benefits to building owners and occupants across five value pillars:

- **Helping to meet regulatory requirements**, through improved compliance with building, sustainability and cybersecurity standards.
- **Enhancing the occupant experience**, for example with safety and comfort features that drive productivity.
- **Cutting costs**, through a reduction in operating expenditure, capital requirements and energy use.
- **Driving revenue and growth** by optimizing space and safeguarding business continuity.
- **Optimizing performance**, which helps improve asset uptime and staff productivity.

The exact value of each of these pillars will naturally depend on the building owner or operator. However, it is important to note that investments in operational optimization will usually deliver returns across all or several pillars, not just one. The results can be outstanding. At Tampere University in Finland, for example, a data-driven approach to building maintenance has helped identify issues—57% of which were hindering energy efficiency—while cutting user complaints by 50%.[vii]



Digital tools for smarter maintenance

Furthermore, tapping into the value pillars is increasingly straightforward thanks to the advent of digital technologies that can be incorporated into buildings alongside Internet of Things (IoT) and anything-as-a-service (XaaS) service provision models. Technology advancements are enabling the deployment of solutions via the cloud, reducing the need for businesses to invest in costly IT infrastructure. Delivery models such as XaaS are enabling firms to shift significant capital costs to operating budgets.

"IoT is really enabling technology, that allows us to do things we always wanted to do, just couldn't do cost effectively," says Brad Haeberle, senior vice president of the Global Services Business for Siemens Smart Infrastructure, Regional Solutions & Services. "Buildings were operated on a set of schedules based on assumptions, without really knowing what was happening in that building. [With] IoT, the sensor network has a very good idea of who's there and when they're there."

Using this sensor data, digital technology can create specific outcomes, including optimizing energy use or cutting emissions, which may be quicker, cheaper and easier than other ways of achieving building optimization, such as retrofitting energy efficiency measures. According to Andy Mazzucchelli, energy and sustainability manager at Land Securities Group (Landsec), the largest commercial property development and investment company in the United Kingdom, using artificial intelligence (AI) can cut energy bills by up to 25%.

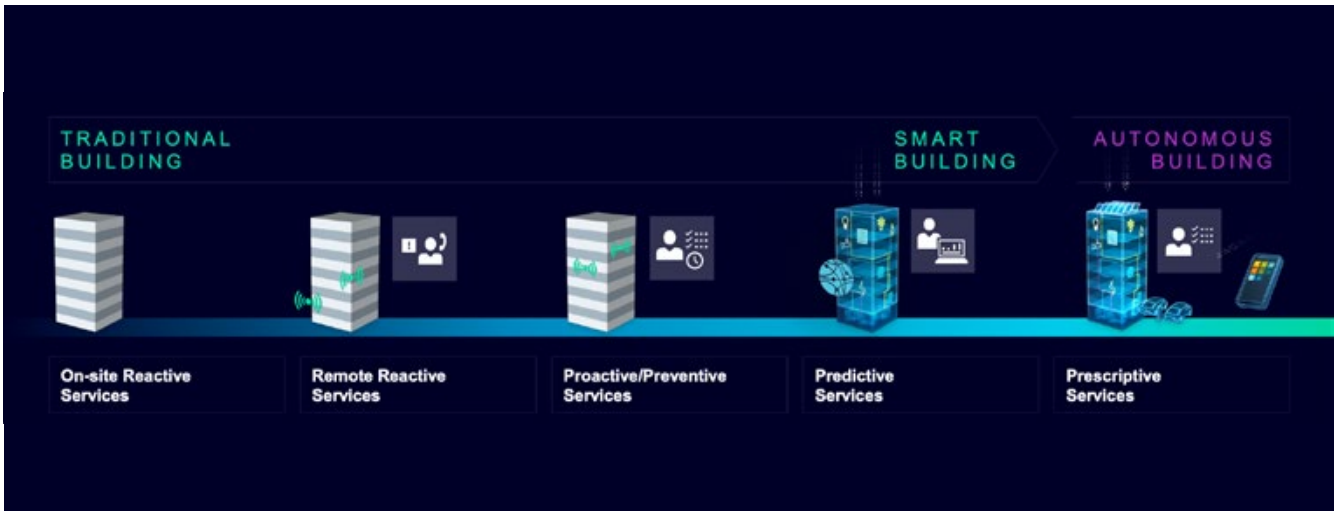
Up to another 20% could come from optimizing equipment use through data monitoring, he says. Digital tools will also play a key role in allowing the construction industry to reuse and repurpose buildings rather than knocking them down, says Will Cavendish, global digital services leader at Arup, the British multinational professional services firm.

"The main barrier is developer uncertainty as to whether a structure is physically possible, and if it is, whether it will be too expensive," he says.

For example, at Portland House in Westminster, London, Arup used vibration modelling and machine learning to understand the structural stresses the building faced and what would happen if certain aspects of it were changed. "That allowed us to refurbish and reuse a building that would almost certainly have been knocked down otherwise," Cavendish says.

A smart building roadmap

The journey to change how buildings are operated and maintained.



Source: Siemens Smart Infrastructure, Solutions and Services

Another advantage of digital technologies in building operations is that they can be installed in phases, minimizing the need for large capital outlays and allowing the journey towards smart buildings to be largely self-funded. The ability to self-fund can be further enhanced through the use of XaaS business models.

With energy as a service, for example, building managers are able to forgo capital investment in power infrastructure and pay instead based on usage and performance. Energy cost savings can help fund the change. These digital transformations will typically be journeys in which it is important for companies to first identify what outcomes are needed.

Among the different pathways to creating smarter buildings, Siemens Smart Infrastructure, Solutions and Services proposes one that is defined by layers of services as follows:

- **On-site reactive**: delivered by building professionals, as is the case with most building services today.
- **Remote reactive**: allowing off-site diagnostics and control to improve fault resolution rates and times.
- **Proactive and preventive**: identifying issues before they occur, to optimize asset uptime and reduce costs.
- **Predictive**: modelling asset utilization and implementing optimal operation strategies to extend the lifetime of assets.
- **Prescriptive**: incorporating diverse data flows to manage building ecosystems holistically, maximizing the value of assets throughout their life cycle.

The rest of this paper sets out these steps in more detail.

Towards remote reactive services

Building operations is a major industry today, with the global facility management market—which includes functions such as equipment maintenance, space planning and portfolio forecasting—worth more than $1.2 trillion in 2021.[viii] It is also an industry that is ripe for modernization, since most services are carried out manually and only in response to problems. For the most part, today's buildings are dumb.

Individual assets, such as HVAC systems, may have limited monitoring and control capabilities, but these are rarely integrated into wider building management platforms and offer little or no scope for remote operations. Thus, building services must be carried out by on-site teams in response to fault notifications. Not having the right maintenance engineers available at the right time can lead to delays in issue resolution.

"Maintenance in most buildings is very reactive," points out Haeberle of Siemens Smart Infrastructure. "Something goes wrong, the maintenance team gets a call and sends someone out to deal with that problem. But they don't have the time to look at how they can do things more efficiently."

Growing Digitalization

While data tools can help to improve maintenance services and reduce costs in buildings lacking digital infrastructure, the deployment of sensors and similar technologies is critical in delivering against building operations' five value pillars. Even limited levels of digitalization, such as enabling assets to connect to a building management system through application programming interfaces, can enable the development of remote reactive services offering sustainability related benefits.

"Digital technology is absolutely imperative as part of a decarbonization strategy and for any building to achieve energy intensity reductions with net zero in mind," says Mazzucchelli at Landsec.

As a first step towards smarter building management, digitalization can help asset owners move from on-site to remote reactive services. This reduces the need for on-site maintenance teams. Tools such as workflow engines, system performance management platforms and smart building recorders can carry out remote maintenance diagnostics and identify automation system performance-related issues, improving staff efficiency and cutting operating costs.

Whereas with on-site reactive services it can take around 2.5 days to analyze a problem, by addressing issues with remote diagnostics, "we can fix the problem remotely 60% to 70% of the time and we don't have to send a truck out," says Haeberle at Siemens.

Proactive and preventive services

Technology such as the IoT means that it is possible to diagnose issues remotely and solve up to 70% of them without needing to visit the site. With further technological advances, it is also possible to offer remote planned maintenance based on system health reporting.

As more equipment has sensors fitted, tools such as AI engines can track performance data and allow asset owners and operators to prioritize services according to when they are needed, rather than relying on a schedule. This lets maintenance crews identify potential issues before they occur, extending the life of equipment and systems, and reducing the level of system failures, downtime and related costs, as well as saving energy.

The latter will be increasingly important as buildings become active players in energy markets, by hosting generation assets such as solar panels and/or adjusting demand intelligently to meet grid requirements. An example of how this works in practice is the application of White Space Cooling Optimization (WSCO) in data centers.

Using a network of sensors, WSCO collects temperature and power data then uses an AI engine to calculate the adjustments needed for each cooling unit to maintain the correct environment for IT equipment. The WSCO platform goes beyond alerting human operators to temperature fluctuations and automatically adjusts settings itself.

By automating the control of cooling units, the platform significantly reduces the risk of a thermal outage and maintains a consistent air temperature among servers. It also reduces wasted energy by dynamically matching cooling to the IT load in real time, automatically responding to temperature changes and eliminating overcooling.[ix]

"For building owners, it's good business," says Haeberle. "A lower environmental impact also means lower costs and a better-run building."

Any data-driven service program needs to be tailored to the needs of a building and its occupants. It should be developed to address one or more of four key building service categories:

- **Planning** to ensure the service plan addresses the unique goals of the organization.
- **Optimizing** to make the most of the technology already in place.
- **Maintaining** and improving operations through data.
- **Supporting** workforces affected by digitalization.

Case study: white space cooling optimization

Temperature optimization is key to data center operations but can also represent a major energy drain and cost. The Baltics' most energy-efficient data center gets around the problem with a dense mesh of sensors across the center's white spaces, which provides Siemens software with detailed temperature data.

The system then uses an advanced machine-learning model to analyze the effect of cooling on specific areas, creating an influence map to optimize cooling distribution at rack-level, and limiting energy use to only what is necessary. The WSCO platform allows the data center to operate at 25% higher energy efficiency than the market average.[x]

Smart buildings, predictive services

Proactive and predictive services can be achieved with digital technologies in many buildings today. The next stage of building services evolution is to move to a fully data-driven model where systems are pervasive, interconnected and intelligent. In such truly smart buildings, "We're getting live energy usage and data from thousands of sensors, from smart meters and from the building management system," says Mazzucchelli.

"It's about being able to capture data that provides meaningful insights that allow us to make informed decisions around how systems should operate," he adds.

A smart building will identify issues before they occur and prioritize maintenance work to minimize downtime, as well as scheduling upkeep and repairs for times when they will cause the least disruption.

It will monitor and control the operation of assets to maximize system performance and lifetime, while reducing maintenance and energy costs.

"We are pulling information out of buildings and combining it with what's happening in maintenance management routines," says Haeberle. "By correlating that and running analytics, we can tell you where problems will happen before they happen."

These buildings will not only boast improved levels of efficiency and sustainability but will also be ones that people are more willing to work and live in, says Victoria Burrows at the World Green Building Council. "Buildings that use energy more efficiently should mean better comfort levels," she says. "And that makes happier and more productive employees."

The promise of prescriptive services

There is one further step in building digitalization, which goes beyond data-driven services and opens the door to new business models. In autonomous buildings, where intelligent systems are not only connected to each other but also to wider networked assets, such as forecasting systems and the electric grid, the building is able to deliver prescriptive services based on future-state models.

Imagine, for instance, that an autonomous building picks up a cold front warning from a weather forecast feed. Without human intervention, it could use the energy from rooftop solar arrays and nighttime grid supplies to charge uninterruptible power supplies, electric vehicle batteries and other building-connected sources of energy storage.

Once the weather front hits, the building would use this stored energy to power heat pumps while cutting back on non-essential loads such as pool heating and lighting in spaces not in use. Responding to grid signals, it could even participate in demand response programs or feed any excess available energy back to the grid, helping to avoid blackouts and earning revenues for the building owner in the process.

Digital building maintenance tools

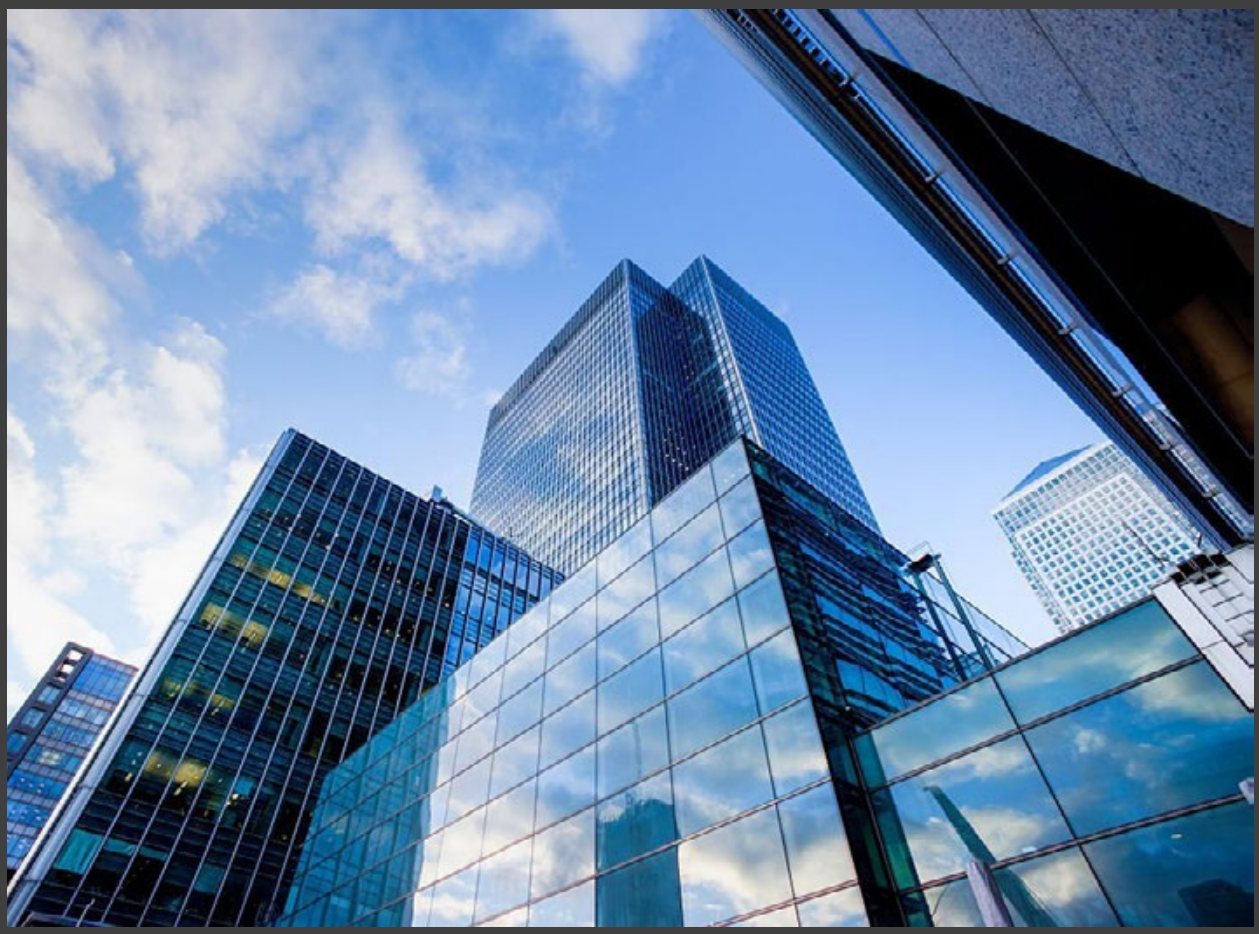
As described previously, to deliver against services value pillars data-driven programs should address one or more of four key building service categories: planning, optimization, maintenance and support. Throughout the lifetime of a building, it is the maintenance part of the cycle that is often most amenable to optimization, and here asset owners should be aware of a range of tools supporting four key service sub-categories:

- **Energy optimization** services specifically intended to help building owners and operators whose goals are to reduce energy costs and drive sustainability.
- **Asset management** services that enhance the performance of assets and are specifically related to servicing equipment, whether onsite or above site.
- **Monitoring reporting and event resolution** services that create data transparency into a building's performance, for quick response to issues.
- **Managed services** where a third party takes responsibility for meeting building performance goals and/or brings advanced technology, remote digital service experts, analytics and on-site skilled technicians and operators to service a space.

"A number of equipment suppliers are now developing more open and shareable systems that allow increased connectivity," says Cavendish at Arup. "That allows the management of a building as a whole entity and is welcome. A lot of this requires a move away from the closed, siloed approach we have pursued in the past to a much more open and interconnected way of working."

Outlook and conclusions

Whether working across single buildings, campuses or global real estate portfolios, building owners and operators must embrace digital services if they are to remain compliant, reduce their energy costs or hit self-imposed or regionally mandated sustainability targets. The technology is available, in the context of IoT, the business models are there in the form of XaaS and there is clear transparency over the outcome.



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