SMART | IoT | Artificial Intelligence

The SMART Tech' Ecosystem – An Introduction (Part 1 of 2)

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Baffled, confused, and don't know where to start with 'SMART Buildings'? This 2-part article aims to remove the mystery of workspace technology by providing a pragmatic view of workspace technologies today and in the future.

'SMART technology is the key to solving our real estate challenges' is a claim that technology consultants are likely to hear when engaging with real estate leadership and business stakeholders. When the consultant asks what this claim means to their client, the answers vary widely within teams and departments of an organisation, never mind across the entire industry. There is plentiful editorial space telling the real estate sector that 'Smart Buildings' and 'Smart Cities' are the future growth areas for the sector, and that every occupier should be digitally enabling their workspace. Yet very few can define what 'Smart' means to them.

Added to this absence of a definition for Smart Buildings, is the sales hype pushed into the market by solutions providers seeking to promote the use of their SMART solution or product with little to no consideration of whether it is the right answer to a business's needs in creating and sustaining productive workspaces.

So, where do we start in finding a comprehensive definition of SMART that is meaningful to real estate?

In this article, we are taking the agnostic view of the technology required to make a space 'Smart'. I.e. we are not considering specific solutions or systems that make up a workspace but the higher-level conceptual principle of how this should be technically architected.

Nor will we be focusing on the specific viewpoint of either landlords or their tenants (which we will touch on this in Part 2).

So, what is going wrong?

A 2017 Cisco survey[i] of a wide range of businesses concluded that only 26% of companies surveyed believed their Internet of Things (IoT) initiatives were successful, in any way. The reason they reached this conclusion was that these initiatives looked good on paper but failed to deliver real value to the business or organisation.

So, to gain maximum value from any SMART initiatives an organisation must understand, as best it can, what insights and optimisation needs to be obtained before starting to procure any solutions.

People; Space and Technology

The workplace comprises of three core components: People; Space and Technology.

To deliver successful workplaces, the professional team must balance the understanding of the PEOPLE who will use the space with providing the business with a practical SPACE that supports the organisational workflows and to meet the stakeholder's aspirations for the organisation. All too often, clients challenge technologists with creating the 'wow' in a project; In most cases, this is not feasible.

In my experience, successful TECHNOLOGY deployments underpin the space design and work styles of a business to enable that frictionless experience for the people who use the space. Very rarely should the technology be the showpiece. Experience has taught us that where technology drives a design concept rather than workflow understanding, it leads to a reduced lifespan of the technology as the usage of the solution diminishes as the 'wow' factor fades.

I am an advocate of the concept that technology should be layered into a workspace solution and not define it. We will come back to layering concept shortly.

First Myth Shattered

Technology will not solve your real estate or business challenges, but cohesively designed space will go a long way to deliver operational and working optimisation enabling better workplaces.

This principle supports the findings of Cisco that by creating IoT enabled spaces businesses are struggling to find the promised returns on investment claims made by the system manufacturers.

Workspace as an Ecosystem

We can consider the workspace as an 'ecosystem'. Like any ecosystem, the workspace has multiple components, processes, and influencing factors positive and negative that go together to make the

ecosystem function 'as a whole'. To achieve ecosystem/workspace functional optimisation, we start with the principle that the ecosystem should aim to deliver an as frictionless experience for the people who use and visit the space. I.e. the best possible occupier experience considering the limitations.

We might observe that organisations tend to be dysfunctional because the components of their ecosystem are not linked and are operating in functional silos. As a result, they function as independent "nodes" and do not unlock the full capability of the systems that may already make up their organisation.

These nodes are the systems and processes that facilitate the operation of a workspace. Such nodes will combine sub-systems (or sub-nodes) that provide data and user input to the node. A good example of this is a room booking system, illustrated below. The node comprises of the software and hardware running the room booking platform.

The system sub-nodes are:

- Booking Systems User App.
- Room Booking Panel
- Online calendar room accounts
- Concierge Tablet with all bookings

These sub-nodes make up a stand-alone room booking node that can operate in isolation within a workspace.

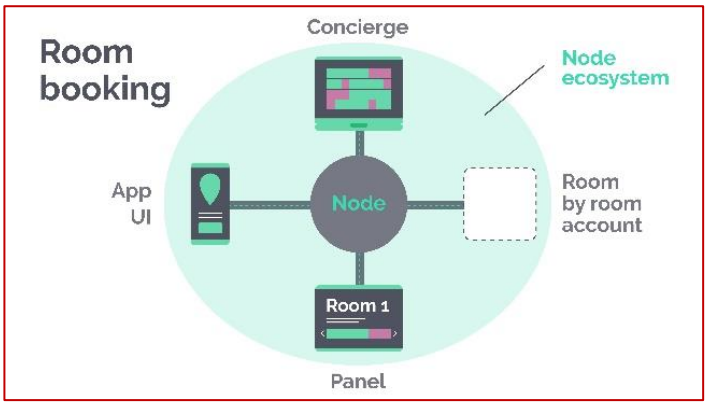

Figure 1: Room booking system node

Such an isolated node provides a two-dimensional experience and viewpoint. They are functional and will provide a solution but provide limited automation and intelligence, and, as a result, do not offer the user a frictionless experience. They will also provide a limited viewpoint into how your workspace is being used and hence not be of great value to space operators.

To achieve automation and intelligence, we must link these nodes to allow the nodes to interconnect and communicate with each other, to form a 'cluster'.

These clusters start to build a more three-dimensional view of the workplace. Added to the increased functionality and automation, the resulting insights gained from combining the information provided become more reliable and actionable. Combining more relevant nodes into a cluster will increase the available level of insight and automation possible.

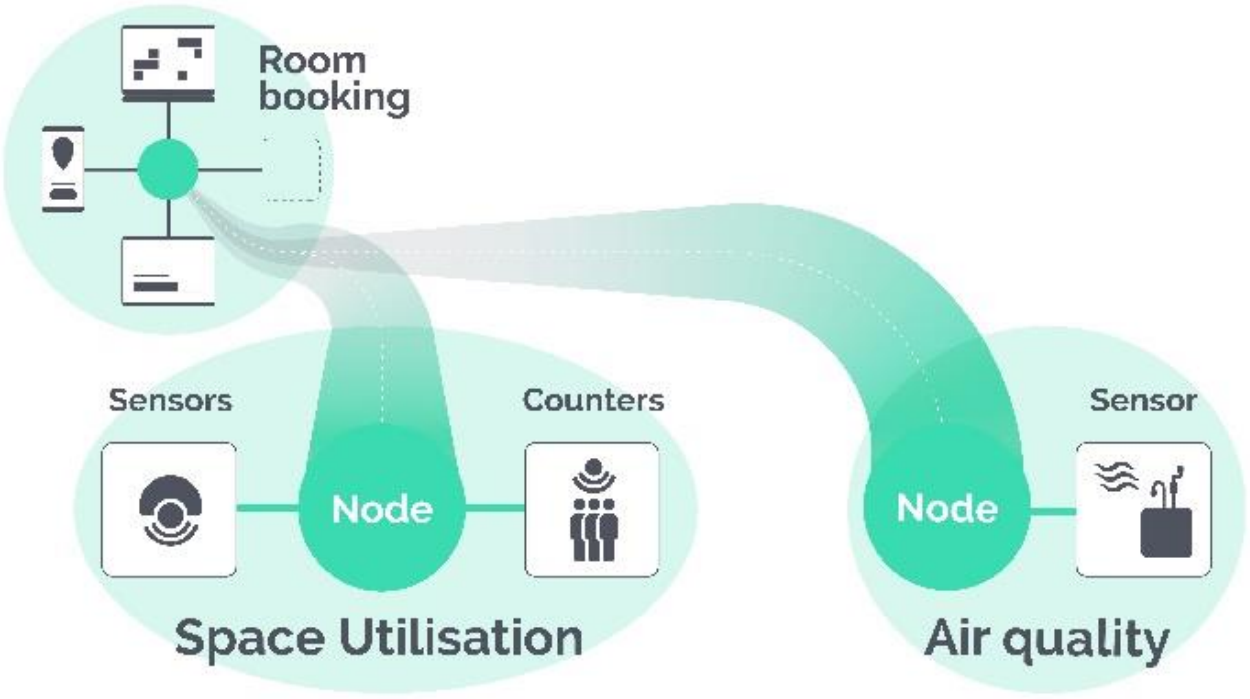

Figure 2: Combining the Room Booking "cluster" with space and air quality data input added.

Our room booking node will tell us only so much about how well utilised the 'bookable' space is.

If the Space Utilisation Node includes people counting sensors, then this data can be mapped to show the actual usage of the space. For example, an eight-person meeting room being used by two people for a meeting – delivering more in-depth INSIGHT.

It will also show when no one enters the meeting room at the beginning of a meeting, the automation of 'no-show' meetings where the system releases a space if a booking does not turn up- increasing AUTOMATION by removing human intervention in this process.

Include the Environmental Management Node, allows the cooling/heating node optimisation. Basing these actions on usage data AND the number of people in the room, reduces complaints from users – EFFICIENCY. Management can then apply better rules to the usage of space based on data, not instinct – AKA "Data-Driven Decision Making."

Developing the functionality of clusters within the workplace ecosystem needs to be planned and executed with oversight of all the nodes and their sub-systems. Different clusters will interlink across the ecosystem to provide a matrix of data control connections that go together to create a **SMART Space**.

For our purposes, you need to understand that the complexity of these clusters and nodes varies widely. Creating this ecosystem requires a service provider to understand your building and space management systems, your business, your space, your workflows and what you are trying to achieve by creating a smarter space.

The good news is that many organisations already have the capacity in their existing building portfolio 'ecosystems' to create such broader *clusters*. Their challenge is to gain the know-how to plan and execute cluster integration, bringing the data together.

Second Myth Shattered

When creating a "Smart space," no single system node can solve a client's challenges or deliver on their aspirations. It takes the individual ***nodes***, connected together to form functional ***clusters***, that make up the workplace **Ecosystem.**

BIM

Digitising your building or space, does not make it smart.

Many of you may be wondering where BIM (Building Information Modelling) fits into this ecosystem. BIM creates a more accountable and accurate data of building and building system information, including the geospatial location of the nodes and their sub-systems. The benefits of BIM are well documented, but these only form part of the workspace ecosystem as it will not help you achieve your frictionless experience or operational efficiencies on its own.

The Layers of a Smart Building

Figuring out the complexity of a Smart ecosystem should not be necessary for most real estate specialists but having an understanding of the common terminology and where it fits into a workspace ecosystem is an essential part of today's real estate professional's capability.

For simplicity, we divide the different processing elements that define the components of the technology and data ecosystem into five clearly defined **Functional Layers**:

- Progress (Evidence-based, KPI Measurable)
- Insights (Dynamic)
- Machine Learning (Intelligence)
- Big Data (Aggregation)
- Internet of Things (IoT) (Harvesting)

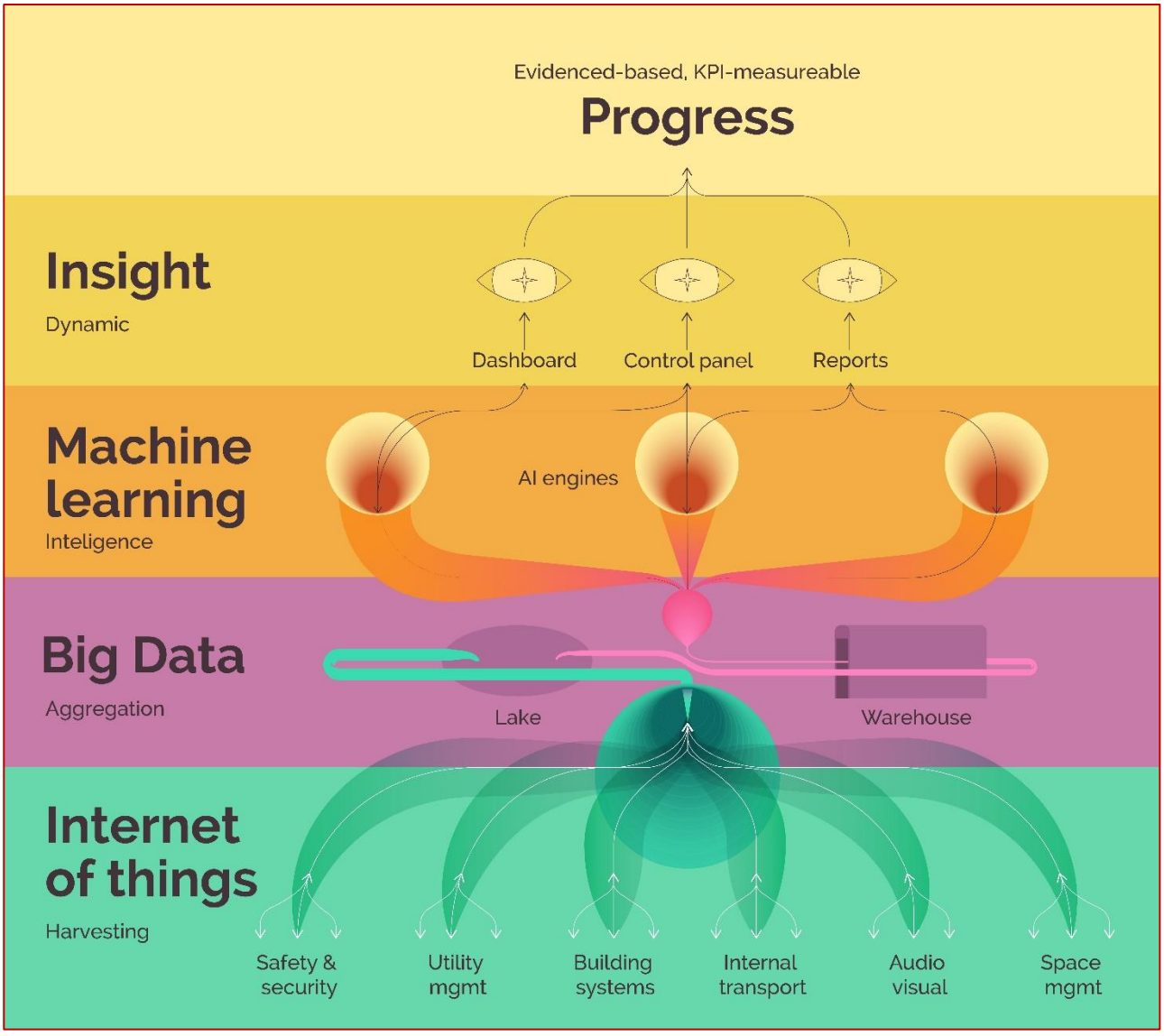

Figure 3: Smart 'Functional Layers' (Authors own)

The best way to understand this is to follow the data pathway through the layers that make up Smart Spaces. So, starting at the beginning of the data workflow:

Internet of Things (IoT)

IoT is now a mainstream concept widely discussed in all walks of life but frequently misused and misunderstood. The term was first heard in 1999, ironically not by a techy but a marketing manager at Proctor and Gamble. IoT devices provide the foundation of any data-enabled space. As with any system, the quality of data input into the system will dictate the ease of analysis and value of potential insights.

Consider IoT as the harvesters of data from spaces. IoT devices are *node* sub-systems (including sensors and devices from nodes that generate raw data) and defined as any connected device in an ecosystem that gathers information as part of its day to day function. As raw output, all these devises will present their data in different ways and different formats and whilst there is currently no global IoT standard, it is surely coming[ii].

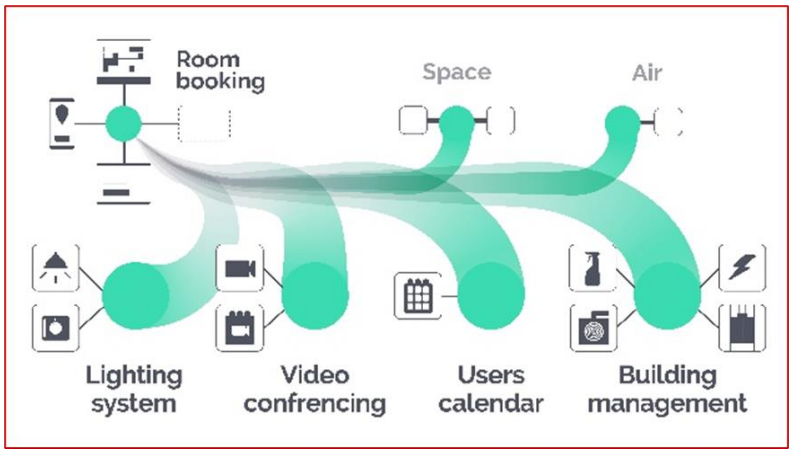

Figure 4: Bringing Multiple Nodes Together (Authors Own)

Back to our room booking example, the IoT devices in this cluster would give you:

- Occupancy data
- Air quality data
- Internal / external light level data
- Temperature data
- Meeting attendees' data
- Building system data

Big Data Layer

Big Data covers the collecting, processing, and packaging of the IoT data into structured and easily accessed locations and formats for the next layer (Machine Learning) to utilise. The Big Data layer is also where low-level integration takes place, bringing multiple IoT sources into a more manageable container of data sometimes referred to as a 'Data Lake'[iii]. Building Management Systems are an excellent example of this where multiple IoT devises send their data to the centralised iBMS node first.

A straightforward way to look at data aggregation is that there are two components to this:

- **Data Lake** is where all IoT data will be stored and brought together in a relatively unstructured way. Many organisations continue to store IoT data that currently has no value to them but might be of some use in the future.

- **Data Warehousing** is where the aggregated and packaged data is stored ready to be accessed by the Machine Learning Layer. Data here are more ordered and simpler to read than trying to pull the data from the less structured Data Lake. Consider it as a library, where data is indexed in the same way library books are, using a common filing structure and naming convention, enabling users to find publications quickly regardless of the genre or content.

It is important to understand where the data is stored; there are two ways that this data can be stored securely:

- **On-Premises (a.k.a. 'On-prem')** - The data is contained within the client's data network environment and secured and managed within an environment that is entirely within the controlled by the client (i.e., using their technology and IT team's expertise).
- **Cloud Storage** – The data is transferred to a remote internet-connected storage facility and held there for further processing within the Intelligence Layer. There are many competing providers for Cloud Storage that can be tailored to the precise needs of the customer.

One advantage of Cloud Storage versus On-Prem Storage is that Cloud Storage services are simpler and more cost-effective to scale should you require more data-storage versus the capital cost of increasing your data storage capability in your own data centres. This is particularly relevant since the quantity of data harvested from space is growing significantly over time, as the number of IoT devices increase.

Another more important benefit of Cloud Storage is that accessing the data for the Intelligence Layer is more straightforward and less complicated for the client's internal IT teams to manage and for the Machine Learning layer's systems to access and manipulate. The reason behind this is because many of the data analytics tools commonly used are internet (cloud) based tools, so access to the data in On-Prem solutions has to pass through your corporate security net which may complicate or exclude specific data analytics tools.

More about BIM

The Big Data layer is the layer that BIM is primarily located, as a system that aggregates and packages the building data, in a centralised depository. This model is most beneficial for the operational teams, where BIM allows remote and straightforward access to the Operating and Maintenance Manuals and the current Asset Register of the nodes and their sub-systems. Adding the geospatial information in BIM saves countless hours in the day to day maintenance and upkeep of a space.

Intelligence Layer

The Intelligence Layer utilises the aggregated data from the Big Data layer using, amongst other things, Data Analytics (DA) tools. These tools use the data to provide insight and outputs into how the ecosystem is performing and operating. The analytics tools deploy both AI (Artificial Intelligence) and

ML (Machine Learning) engines to analyse the data using specific parameters set by the ecosystem administrators.

The ability for these engines (there may be multiple AI and DA engines) to process large quantities of data looking for patterns, insights, and node issues. Processed at a speed and efficiency that can only be usefully achieved by a machine, is a critical driver for "smart" spaces. A Smart space will utilise these engines to process the data and provide insights. These engines are also able to use these insights to create actionable commands that can be sent to the lower layer nodes and systems to automate processes and actions.

This automation is not without boundaries, and part of the complexity of commissioning a smart workspace is setting the thresholds and creating the events that trigger system automation. It takes careful planning and time to implement automation into the ecosystem. Underestimating the importance of this process when considering planning projects and integrating clusters, may result in you becoming one of the 74% of projects that do not achieve success with your IoT implementation.

Again, illustrating this with the room booking system, the intelligence layer allows the room booking cluster to use all the data collated to action automated responses:

- Releasing booked spaces when meetings end early.
- Cancelling a booking after a set period if no one arrives in the booked space.
- Proactively monitoring the audio-visual systems in space.
- Predicting when a system in space will fail, based on learning from previous failure state data.
- Removing space booking rights of staff who persistently do not use spaces they book.
- Change the space booking criteria according to the actual usage of space
- Help inform future workplace design

These are just some of the real examples where space managers have used the room booking cluster to optimise the efficiency of their meeting spaces using data.

It also removes the CRE guesswork in answering "what do we need to build in our new office space?" by having data on what you require from your meeting spaces.

Full space, building or campus automation is still in its infancy, and many cases merely automate simple tasks within a set of parameters to improve the operational and working efficiency of a client's ecosystem, can achieve high impact results.

Insights Layer

The real value in the data gathered is in the insights that it provides, enabling you to make data-driven decisions, rather than decisions that previously used limited ground studies or instinct,

strengthens Business Cases and reduces Stakeholder scrutiny. The result of this is potential gains from using insights that they could generate vital operational efficiencies, better workplace experiences, and more improve human-focused space design which will show in real financial returns. Such value is realised at the 'Insights Layer'.

Insight Layers can be considered the point at which the User interacts with the building's system. While characterised User Interfaces (UI) or User Dashboards, these are only a part of what makes up the Insights Layer. The challenge is that such dashboard interfaces and insights require the ecosystem/cluster integrators to have a comprehensive understanding of what an organisation is trying to understand or manipulate/automate in their space.

One common problem with 'Insights Layers' is that they are developed by engineers who want to show the full capability or information available to the users/operators. In our experience, this tendency potentially reduces the lifespan of dashboards to 3-6 months.

To avoid this clash of design approaches, the rules of thumb when developing interfaces should be:

- **Relevant** – *the information or functionality displayed should connect to the needs of the specific end User at that time, to execute the task in hand*.
- **Real-Time** – *a digitally connected interface should provide you with data that is current as is available*. The beauty of the digitally connected space is that you should be able to interrogate systems as to their current state and potentially create insights from historical data stored in the data lake at the touch of a virtual button.
- **Effortless** – *the interface must be simple to comprehend and simple to operate*. In recent times, a more customer and end-user focus, primarily inspired by the simplicity of smartphone interfaces, has made UIs significantly better at allowing users to interact with the technology. Generation of automated real-time reports also becomes a reality for space operators.

A great deal of building data is represented in spreadsheets and hard to read and comprehend formats. The creation of graphical representations of information works with humans who naturally assimilate graphical information better than lines of data. Dashboards provide this format and allow easily customisable interfaces to ensure that the user/operator is seeing only information that is relevant to them.

The interfaces should provide simplicity and consistency of experience.

Returning to our Room Booking Cluster

The room booking system has multiple interfaces and provides a high level of insight. Providing the right information is vital to the success of the insights provided by this cluster.

	Room Booking Node	Space Utilisation Node	Environmental Control Node	Desktop Technology Node	Audio Visual Node	Space Booking Cluster
NODE FUNCTIONAL ELEMENTS						
Space Booking Information	✓					✓
Online Space Booking	✓			✓		✓
Room Booking Panels	✓					✓
User App Bookings	✓					✓
Space Occupancy		✓				✓
People Counting		✓				✓
Lighting Control			✓			✓
HVAC Control			✓			✓
HVAC Monitoring			✓			✓
Air Quality Monitoring			✓			✓
User Functional Analysis				✓		✓
Room Equipment Usage					✓	✓
Equipment Fault Detection			✓	✓	✓	✓
DESIRED CLUSTER OUTCOMES / INSIGHTS						
Understanding Space Usage	Partial	--	Partial	--	Partial	✓
Changing Workspace Practices	Partial	--	--	Partial	--	✓
Energy Efficient Space	--	--	Partial	--	Partial	✓
User Accountability	Partial	Partial		Partial	Partial	✓
Proactive Support Model	--	--	Partial	--	Partial	✓

Figure 5: Functional Matrix for the nodes making up Room Booking Cluster.

The above-simplified table illustrates the siloed nature of the nodes and the functionality they provide; the end column shows how the cluster brings all this functionality into one virtual place.

Mapping this functionality at an early stage in a deployment helps organisations define what the smart tech' investment value proposition is and will help understand how this information can help the organisation.

Final Myth Shattered

What is all this jargon about, and how does it impact my business? The basic idea that the five layers provide structure and understanding as to where the components of a digitally enabled ecosystem fit allow you to comprehend where the business concerns and justifications fall within your organisation.

So, What Next?

Figure 6: Graveyard of failed technologies (authors own)

[iv] A common challenge faced by Smart Building specialists is to have an answer to: *What will a Smart Building look like in five years*?

The main concern (justified by a graveyard of under-used technologies) is that building owners and workplace practitioners are investing in technologies that may well become obsolete before they reach the end of their depreciation period.

As a result, the corporate real estate market is understandably cautious when it comes to investing in "smart solutions".

One of the main things that you must understand when developing a Smart Building Strategy or creating an interconnected ecosystem is that you MUST have a vision of what the outcomes should be. What does good look like for you and your organisation? We rarely see the delivery of a real return on the investment (as supported by Cisco's findings mentioned earlier in this article), when the client just sets out to make their space "SMART".

Smart building technologies have the potential to deliver so much to the workspace experience, possibly using the nodes and data that you have already invested in. Whilst in many cases we have the capability now, it will probably take another 5 or more years of cautious development in SMART know-how for the technology to become mainstream.

The full range of benefits are only really starting to be understood. Historically, technology may need a catalyst to create the *pull* from organisations rather than the product developers *pushing* solutions onto a client. The COVID-19 situation may have provided that pull. Technology has a significant part to play in the enablement of safer and more dynamic workspace. Maybe this has created the "need" for technology-enabled 'smarter' spaces helping organisation ensure the safety and wellbeing of their people.

The challenge for you, as real estate specialists, is **what** and **how** well-integrated technology will help you deliver safer, optimised, and dynamic spaces to your organisations.

The Author

***Patrick Stewart-Blacker**: Patrick has over 25 years of experience designing and managing the delivery of technology into commercial and public spaces. The integration of technology into workspaces has allowed him to build a deep understanding of all elements of the built environment and the challenges that projects face when working with construction design and multiple contractors.*

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[i] Cisco Report on Future of IoT: 2017

[ii] https://standards.ieee.org/initiatives/iot/index.html

[iii] https://en.wikipedia.org/wiki/Data_lake

[iv] Images copyright ©Patrick Stewart-Blacker produced with Adam McNaughton-Davies @ Lindon East