THE OFFICIAL JOURNAL OF AIRAH

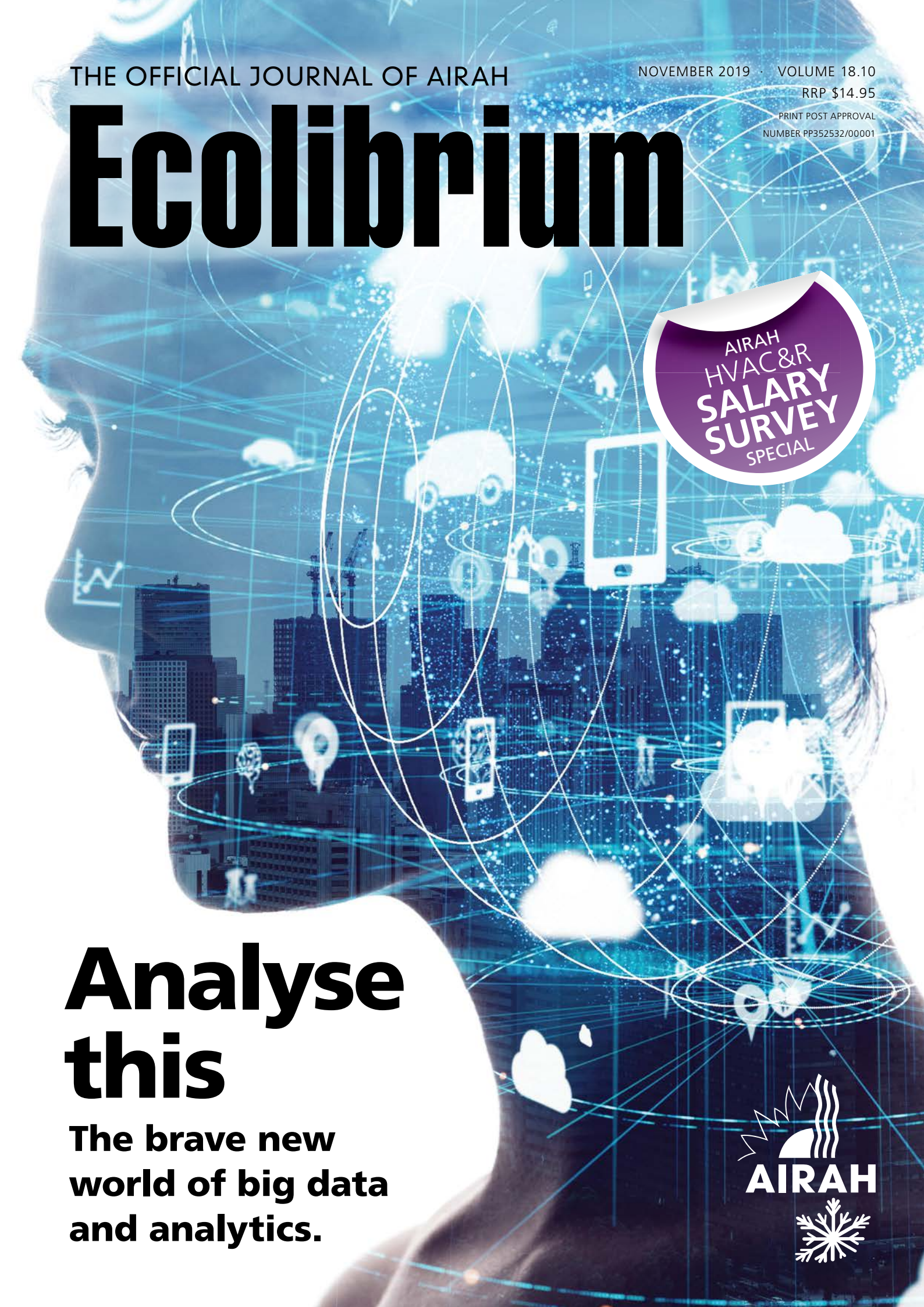
NOVEMBER 2019 · VOLUME 18.10

RRP $14.95

PRINT POST APPROVAL
NUMBER PP352532/00001

Ecolibrium

AIRAH HVAC&R SALARY SURVEY SPECIAL



Analyse this

The brave new world of big data and analytics.

AIRAH

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Although our industry has gradually got its collective head around data analytics, many opportunities remain unfulfilled. Sean McGowan takes a deep dive into the relationship between HVAC and data analytics with **Dr Troy Wilson**, Affil.AIRAH, chief data scientist at CIM; **Paul Jackson**, F.AIRAH, national contracts manager at ECS; **Silvia Quaglia**, Affil.AIRAH, senior engineer – smart buildings at NDY; **Brad Schultz**, M.AIRAH, building performance manager at VAE Group; and **Jason Harrison**, M.AIRAH, NSW state manager at Airmaster.

Eco: Is the HVAC industry keeping up with advances in data analytics?

Harrison: The HVAC industry was a first mover in the big data and data analytics space around six years ago. Fast forward to today and we are now slightly behind the global trend of the use of big data.

The shift initially commenced when the HVAC industry was looking at ways to help gain visibility over the building/portfolio to help provide insight into what was occurring near real-time, and provide actions that would help drive energy efficiency, improve tenant comfort and provide support to shape the way preventative maintenance was being performed.

Wilson: It's an exciting time for the HVAC industry. In the past few years building analytics companies have liberated HVAC data from proprietary silos, increasing the visibility, transparency, accountability and control over system performance. Historically this information was used for running equipment, and while some was stored, access was cumbersome, and data was not standardised.

Building owners can now access this data from the cloud in real time, standardised across their portfolios. Building analytics is now available in real time on this data, providing actionable insights, which can be managed and tracked through to rectification and beyond.

Jackson: The HVAC industry is still firmly entrenched in the BMS space, which has been fairly slow at evolving into the brave new world of data and analytics. Most data and analytics packages sit over the top of BMS systems and networks, which are not designed to manage and distribute the data sets.

Quaglia: It is important to understand that HVAC is just a small part of systems that needs to be integrated into a building.

There are multiple challenges in the data collection, one being that different systems speak different languages; however, with tenderised protocols like BACnet or Modbus, the HVAC industry has a major advantage here. We also face another challenge in the big data world – data tagging – as data needs to have a semantic model in order to be collected in a database. The HVAC industry

again provides multiple solutions for this, like Brick Schema or Project Haystack. Therefore, I would say that HVAC is better placed to deal with these challenges than other industries related to the building.

Schultz: It's a mixed bag, and depends at which part of the industry you are looking. There are some exciting things happening, but there are also numerous sites stuck in the dark ages. However, even at the top end of the industry – large, premium facilities – there is significant work to do to ensure we are delivering an asset that utilises the best that technology can offer.

That's not to say that everyone should be always implementing the latest and greatest – it's about utilising the best value solutions currently available to achieve your organisation's aims while also investing in the future.

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Eco: Where are we keeping up, and where are we falling behind? Is it a technology or implementation issue?

Schultz: There are certainly technology offerings available that utilise new technological advances. For example, the capabilities and computing power in edge devices keeps increasing, BMS platforms keep getting better. Cloud computing is increasingly being used for data warehousing and more. Communications standards and data meta-models are increasingly useful.

Where the industry is falling behind is in the speed of uptake of these capabilities and the industry's ability to deliver them within a consistent, open, standards-based framework that everyone can work with. Also, technology implementation is a process of cultural change and meeting expectations. Matching expectation with delivery is a process the industry is still going through, and it requires ongoing focus from customers and tech providers. The industry needs to do better at fostering domain experts who can drive real change. Currently, much of the talk is about a rosy future, without really mapping out how to get there. In short, at the moment, devices are smart, but systems are not.

Harrison: The reason I believe that we are slightly behind the global trend is that data is everywhere and if we were only using it to analyse what was occurring within the building/portfolio then we would be ahead of the curve. However, within the HVAC industry we need to combine the data with humans and many other stakeholders to provide outcomes to realise the value the data is providing.

Quaglia: A major failing of the HVAC industry is the tendency to focus on the FM world and not on the final users of a building, the tenants. It seems the industry is not keeping up with the new IoT world related to the end user, such as incorporating in the offer wireless intelligent sensors that can detect multiple items or integrating different services like wayfinding, or implementing new features like predictive maintenance.

Wilson: Historically, the data just hasn't been available to make the most of HVAC systems, but the opportunities are rapidly opening.

The more data we collect, analyse and standardise across portfolios of assets, the more we can achieve for asset owners and managers. Having standardised data not just from individual sites, but across portfolios, allows aggregated insights to be applied. This is where the real opportunity of building analytics lies.

Jackson: The issue is a technology problem, which is slowly being resolved as the BMS vendors have started to embrace the move to fully open IoT systems.

Eco: How is traditional HVAC integrating with the data analytics field? Do demarcation lines exist between the two?

Wilson: Actually, it is data analytics that is integrating with the HVAC industry, not the other way around, and it is enhancing the traditional industry.

A good example of this is the BMS. Most buildings use a BMS to manage the day-to-day operations of a facility. While a BMS provides features like alerts, notifications and metering dashboards, you are still missing the big picture of the entire data created by the various equipment and systems that consume energy in your building. Building analytics platforms provide insightful data that can be used to optimise a facility's equipment performance and remove any inefficiencies, including in energy consumption and cost. This has indirect benefits like improving the comfort of tenants and extending the life of equipment too.

Quaglia: The main task of data analytics in the HVAC industry is to rectify the anomalies of the system.

Typically, the data analytics supplier will allow the owner to understand if their HVAC equipment is working correctly. There is a wonderful Latin sentence – quis custodiet ipsos custodes? – which translates to who watches the watchmen? Therefore, the demarcation is still relevant, as they are providing different services; however, it is important to say that what they want to achieve is the same – they both want to provide to the client a system that is working properly.

Jackson: The analytics packages are not only extracting data from the HVAC/BMS but also from a large number of disparate systems within buildings. The lines between HVAC control and control of other building systems are definitely blurring, as traditionally the BMS has been an HVAC control system as opposed to a true building management system.

Harrison: Data analytics is continuing to disrupt the way we are operating within the HVAC industry space. With skill shortages becoming ever more prominent and labour costs increasing, data is being used to assist with these two challenges.

There are two parts to data analytics – "just in time" maintenance and service and building performance and optimisation. These are separate functions when managing a building with the ultimate goal of operating in synergy. A building must be compliant, whereas the performance of a building can be relaxed at times, though we should be striving for best-in-class performance at all times.

Schultz: The behavioural/cultural change I mentioned earlier is a challenge when integrating data analytics with the daily life of a technician or

facility manager. This change needs to occur both on site as well as with the technology providers. Everyone needs to come to the table with open minds to possibilities. In my experience, some of the best suggestions for new analytics rules have come from the site technician – but to offer their ideas, they need to be part of the conversation.

Since analytics became widely known a few years ago, it's gone through a "hype cycle", as is common with new technologies. We've come through a peak, and many sites have also experienced a trough as they struggle to integrate the technology with the daily demands of customers. It's encouraging to see people working together to evolve the technologies and their daily workflows to increase their productivity. A great example of this was the Big Data and Analytics Forum held by AIRAH in August where some productive conversations were held. However, there is a long way to go.

Eco: Is the Master Systems Integrator (MSI) a new role in the industry? What is their role and function?

Schultz: The concept of a fully integrated building platform (IBP) has been around for many years, and traditional BMS providers have attempted to deliver it with varying degrees of success. In recent years, as the industry increases its appetite to connect and converge all buildings systems through one centralised system, traditional BMSs have struggled to cope.

The perceived role of the MSI varies significantly and depends on who you talk to. I see the core role of an MSI as not only connecting/extracting data from a vast array of building systems and providing converged network services for the building, but to also be the conductor of the orchestra so to speak. The MSI should be the key technical resource. Someone the project or client can draw practical technical insights from to achieve their desired outcomes.

Jackson: This role is relatively new for Australia. We are seeing more and more complex projects, particularly in the "smart" building space, that require the input from an MSI.

Typically the MSI identifies all the systems to be connected and communicated with, and ensures that

data and in some cases control, can be exchanged between the systems. Effectively the MSI becomes the translator specifying and facilitating conversion of systems and devices to a common language.

Harrison: We have always had a form of MSI within a building/portfolio in the HVAC industry – the enterprise building management system (BMS).

However, with that said the role description has changed dramatically as open platforms and technologies are becoming the norm within buildings. Clients want freedom of choice when it comes to choosing what equipment, product or tenant engagement system is included into a building design. The primary role of the MSI is to develop a single pane of glass with workflow management capability that feeds all the data points within the building into a normalised data lake.

The information from a building is rich, and many stakeholders need the data to complete other responsibilities such as tenant afterhours billing, IEQ rating and lease requirement confirmation.

Quaglia: Historically, different service disciplines like BMS or lighting controls were siloed in different networks, protocols, etc. As we create a space (data lake) where all the data from different systems is available, through a common network, to different applications, the MSI becomes a crucial role in ensuring all the systems are compliant and allows the communication between different services.

Wilson: Integrating and standardising building data is part of what advanced buildings analytics platforms do well, so potentially there won't be a need for this kind of role.

Eco: Who performs this role – is it an individual or contracting firm? And where do they sit in the FM or project hierarchy?

Jackson: Generally the MSI is someone in the BMS/DDC world. The role should be a standalone non-vendor centric role, ideally with experience in the IT sector.

Harrison: In my experience the MSI typically sits at the top of the project hierarchy, due to the role it is playing within the building ecosystem. It is centralising all the downstream data to provide that single pane of glass and is the golden key to provide an experience for the building. The experience comes in many forms – tenant engagement, maintenance/service contractor insight, facility manager response time.

Schultz: Currently, the industry is in a state of change, as many traditional BMS providers attempt to transition into MSIs. Navigating this complex transition will often lead to failure or frustration if not well thought out. Being a successful MSI is usually less about the technology and more about the people and the expertise. To be most successful as an MSI, you need to be truly product agnostic. An MSI whose main business is selling products will not always be best placed to deliver the solution, as they find it difficult to step back and take a truly impartial view of the technology landscape. The ideal MSI has a broad technology and industry background and most importantly has the right people to deliver the project.

Quaglia: As this role is quite new, individual engineers may not have enough experience or specific training in this unique field. But typically, to cover the MSI role you should have experience through projects-based work across IT, data science and building systems, and demonstrate through case studies software engineering capabilities including, but not limited to, the use of such things as IoT, cloud computing, data analytics, data architecture and Linux.

Eco: With ever-increasing sources (and amounts) of data, what considerations need to be given to the cloud environment's role in storing data, and issues of data ownership and access?

Quaglia: The cloud environment is definitely one of the hot topics right now. As the market pushes for integration while maintaining open protocol systems, a common manufacturer solution for retaining an element of control appears to be to charge for API (application programming interface) usage – that is, a tool that allows exchange of data between different parties – and require this is to be hosted on manufacturer servers or cloud space in order to retain control.

To explain it simply, the manufacturer (under the guise of providing a secure storage) is hosting all your data in a cloud space that would normally be provided by other big companies like Microsoft (Azure), Amazon (AWS) or Google (IoT). Hence, it is important to ask yourself who is the owner of your data – the final user, the company that owns the cloud service or the manufacturer?

Jackson: Cyber-security is a major issue with data breaches occurring on an almost daily basis. A quick scan of the internet reveals a large number of "open" ports potentially allowing easy access to facilities. Not enough attention is being paid to the set-up and security of these systems.

Data storage location is also very important, with a large number of cloud storage facilities located overseas and in unstable jurisdictions.

Wilson: Customer data that exists in building systems is owned by the customer and is considered raw data. Data analytics platforms collect, copy and store this data in the cloud, leveraging it to generate new insights and improve the ability of our system to deliver value to customers. The customer receives the benefit of this enhanced data set. A platform like CIM's PEAK uses raw customer data from IoT sensors, the BMS and electricity meter provider feeds, and merges it with things like weather data and the outputs of machine learning to enhance the insight received by customers.

Schultz: Data ownership is an emerging issue. It's not just about who owns the raw data – it should unarguably be the property of the building owner. But who owns the meta-model? Who owns the analytics rules? These are issues still being addressed and there needs to be clear agreement on this up front before any project commences.

Harrison: Without smart consideration of how we should be storing and indexing the data we are capturing from each building, I fear we are going to end up back in the good old days of having a filing cabinet.

I remember using a filing cabinet and storing all files and documents within each drawer inside a folder with a nice label on it. The issue was when I wanted to find a particular document it often took some time. I had to remember how it was named and what folder it was placed under. Then it became difficult for someone else to locate that file if they didn't understand my filing structure. So, with that said, it is important to have a consistent tagging, naming and folder structure for all data that is captured so that when someone needs that historical data it is easily found.

Eco: To this end, what are the security issues surrounding the capture, storage and analysis of this data?

Wilson: While often regarded as not as sensitive as PII, credit card or health record data, great care must be taken while gathering and analysing data and sharing the derived insights.

Any data gathering approaches – whether they use a data gathering device or not – need to ensure they do not expose building networks to greater cyber or physical security risks. This is at the forefront of CIM's approach. It is important that data and all the derived insights are only shared with authorised individuals to ensure that the privacy and competitiveness of the rightful owners of the data is protected.

Jackson: All systems connected directly or indirectly to the internet should be fully reviewed by a cybersecurity specialist to determine vulnerability, and to develop and assist in the implementation of a security package.

Schultz: Cybersecurity is a massive risk for the operational technology domain. One of the challenges is that appropriate allowance for cybersecurity is often not scoped into specifications, so it is difficult for many technology providers to deliver it at an appropriate level. Similarly, with the increasing connectivity of existing sites, the business case must be made for increased budgets for cybersecurity.

The industry is still learning to accept that more must be spent in this area. In the meantime, providers must do the best they can in an environment increasingly full of threats.

Harrison: What type of device is being added on site? Is it secure? Is the data going to be mixed with other sources of data? It is easily extracted if need be?

Is it going to be analysed to show holes in my portfolio's operation, or embarrass the current state of the building?

These are the questions that need to be asked when considering the security of captured, stored and analysed data.

As we open up more channels into any given building, it does create challenges with securing and having control of where your data is going to. How often do you walk around a site and see multiple 4G routers, computers and the like, and no one seems to know what they are being used for?

Quaglia: The more important topic would be about device security, rather than data analytics issues, as the low-level layer (IoT, controllers) are easily hackable. Therefore, the security should pass through all different levels that comprise the architecture of a building, starting from the device/IoT level, passing through the network and ending with the data lake and the API.

Data security will be the main topic of conversation in the coming years – as soon as people understand more fully that all the devices we all use every day are easily hackable.

Eco: How is machine learning impacting HVAC, and what progress is being made in this area?

Quaglia: Machine learning is a very powerful tool that will be used more and more in all the processes related to data. In terms of progress, it seems more related to the application above the HVAC equipment, like data analytics. But there is huge land left to be explored, as through machine learning we could forecast the consumption of our building or detect an anomaly or even better prevent anomalies.

When we are able to integrate more useful data, machine learning will become a fundamental tool to help us better manage all the different equipment we have.

Wilson: The machine learning impact on HVAC is increasing rapidly and its potential is enormous.

I've just come back from a workshop in London to finalise a research annex under the International Energy Agency's "Energy in Buildings and Communities Program", which was all about data-driven smart buildings. Almost 30 research and industry experts from 13 countries came together to collaborate and progress research and applications in the efficiency of the built environment, predominantly focused on HVAC.

Traditionally, optimisation of HVAC systems has been tailored to each individual building, making the scalability and cost of these solutions challenging. The promise of machine learning in HVAC is the ability for data-driven solutions that reduce the need for individual hand-tuning of algorithms for specific buildings. The point of these data-driven solutions is to have a framework and let the algorithms automatically learn how to tune each building.

Harrison: With equipment and control systems becoming smarter, machine learning is becoming more prominent within the HVAC world. It requires a stronger processor to be able to perform the required functions to automatically learn from the operation and business-as-usual to work through ways to improve the performance.

This term relates to the HVAC world in regard to control loops, automatic tuning to reduce short cycling and overshooting. As the quantity of equipment being installed within a building increases, machine learning is able to assist with the tuning and ongoing optimising of the systems to trigger optimal control without the need of engineers or technicians tuning individual control loops.

Jackson: The term "machine learning" is often confused with artificial intelligence (AI), which it is not. There are many systems available in the marketplace that can learn using historic data. These systems are capable of optimising system performance and enhancing energy consumption. However, most do rely on a level of human intervention in the way of review prior to implementation.

Schultz: There are some great machine learning ideas around, but the bespoke systems being developed are often not mature enough to have a cost/benefit that most in the market will accept.

While buildings have many similarities, each one is still unique, and out-of-the-box systems currently need a lot of customisation to make them work. There is so much data being generated by buildings that it's a data scientist's paradise; however, just because something is possible doesn't always mean it's a good business decision. Machine learning will only be successful with consistent data meta-models – something the industry has not yet achieved.