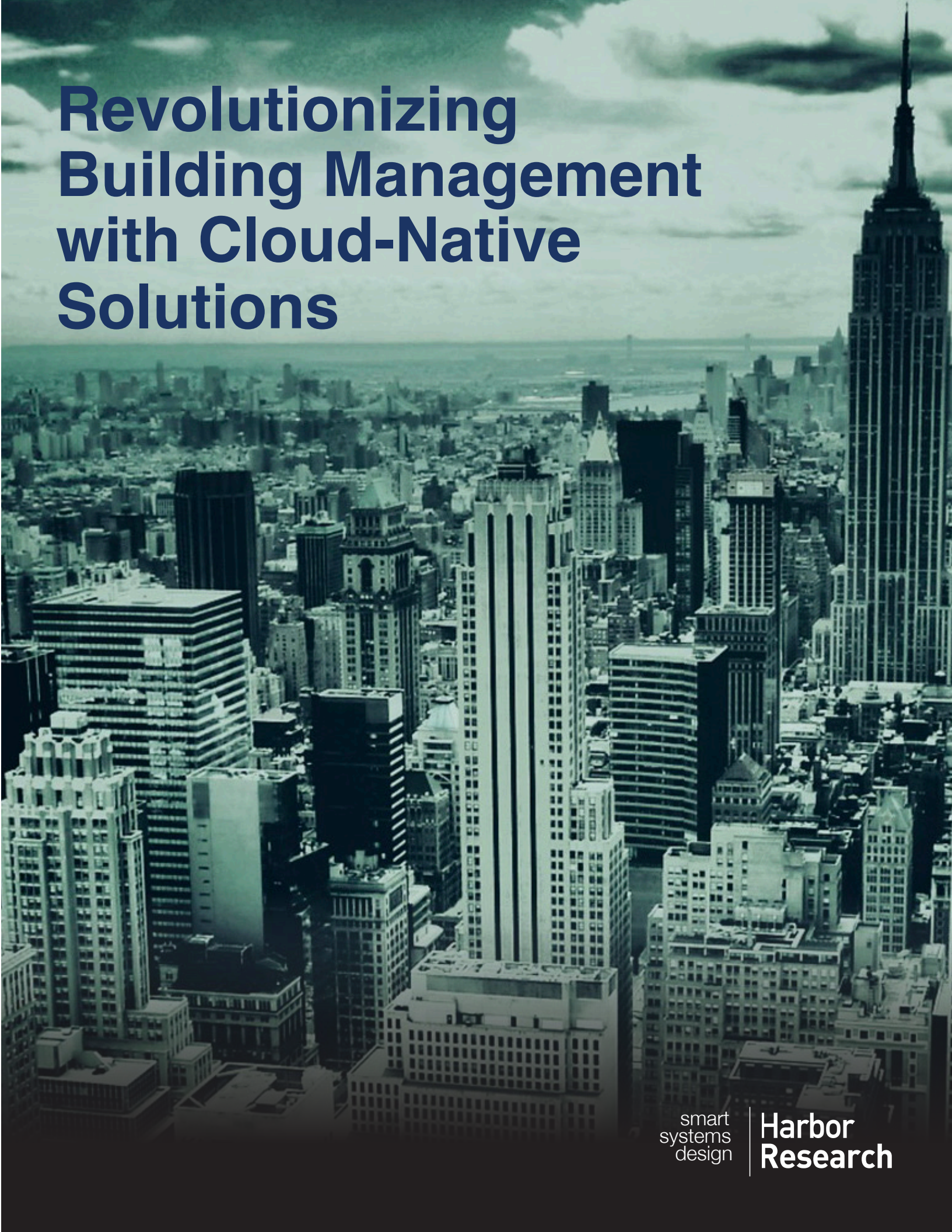
Revolutionizing Building Management with Cloud-Native Solutions



smart systems design | Harbor Research

The emergence of connected devices has exponentially increased the volume of data available from the myriad of equipment in buildings. The increase of data and networked communication between equipment has created the potential to unlock value through energy efficiencies, predictive maintenance, HVAC control and entirely new business models to either add to operational efficiencies or enhance end-user comfort and convenience. Today much of this value remains unrealized by OEMs, service providers and building operators alike due to a lack of understanding of the value data management tools offer players across the value chain. Without implementing data management tools, such as cloud-native solutions, OEMs and service providers are ultimately diminishing their role in the future Smart Buildings competitive landscape. A new generation of applications and analytics tools born-in-the-cloud are creating genuinely differentiating experiences and ongoing value-creation for end-users and occupants in buildings. As native cloud applications, these solutions are designed to enable continuous connections with customers, creating a new enterprise class of Smart Building solutions. These digital applications provide equipment manufacturers, service providers and building operators with tools for a modern equipment service workforce, generating more value through efficiency, while also providing end-users or customers of commercial buildings with more comfort and convenience. As the commercial buildings space becomes more focused on the end-user experience and an agile workforce, decision-makers in the buildings space will increasingly adopt digital tools that bridge the data from their building systems and devices, elevating the OEMs and service providers with a desire to employ continuous value delivery models through cloud native solutions.

TABLE OF CONTENTS

EXHIBITS

The Advent of Machine Intelligence & Smart Building Systems

For decades, machines and various "non-intelligent" devices have been able to automatically perform basic tasks. Later, these basic tasks were configured to be in lock-step with other machines or people. Eventually, basic machine-to-machine (M2M) communication allowed devices to communicate basic information to each other, as well as to central locations where people could interact with, understand, and analyze the data to make better-informed decisions. Today, all electronic devices are becoming connected in an ever more distributed and pervasive way, enabling the convergence of physical and virtual worlds.

These networks of intelligent, connected machines are the world of Smart Systems, a new generation of information architecture that — when combined with cloud computing, artificial intelligence, machine learning, and Internet of Things (IoT) technologies — represents a radical break from yesterday's information, computing and telecom (ICT) paradigms.

Smart Systems in the buildings sector are entering a dynamic period with emerging solutions across all segments that will result in OEMs, technology suppliers, third-party value-adders, and users needing to leverage, react to, and monetize emerging technologies in different ways.

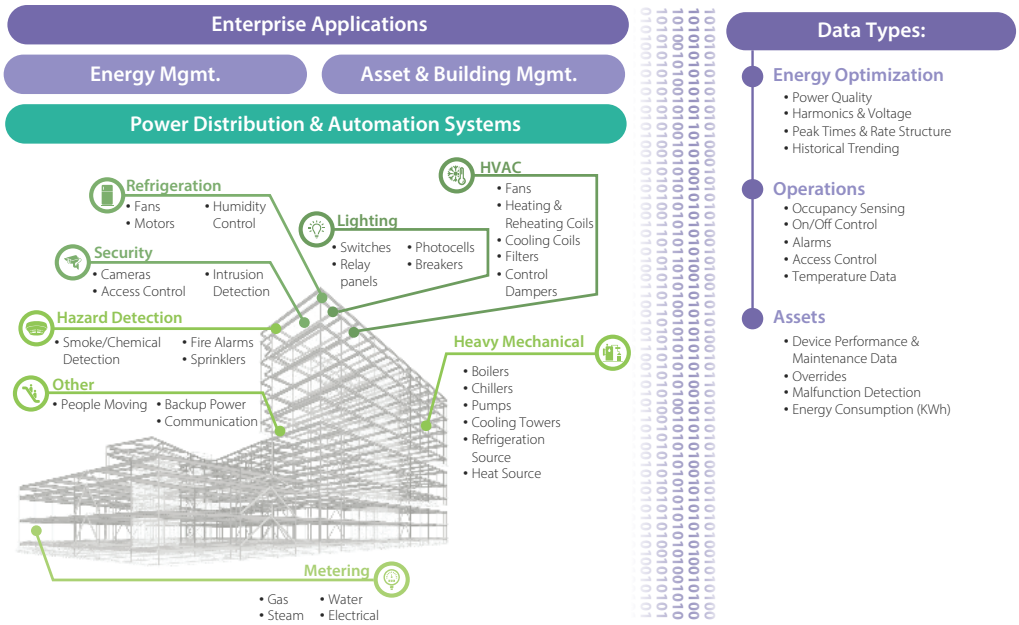
Building automation systems (BAS) have, to one degree or another, controlled equipment for decades. BAS have moved from closed proprietary systems, to open standards-based architecture, to fully integrated systems. And yet most building automation leaders haven't broken away from yesterday's computing paradigm (on-premise systems) to embrace today's native cloud computing, which is the architectural enabler for Smart Systems. In fact, many OEMs and service providers are leaving money on the table by believing in the short-term notion that siloed data from devices under their control will increase revenue. You would think that losing money and missing the chance to be an innovator would be scary enough. But many players in the buildings space believe that the complexity of use cases enabled by Smart Systems is an overcomplication of their devices and services. This lack of foresight into the future of open data architectures and ecosystems will position these companies poorly for the future.

Some emerging solution providers, however, are embracing native cloud architecture and creating Smart Systems across a variety of building segments, and this will simplify operations for players across the entire value chain. The use cases derived from Smart Buildings include energy efficiency, predictive maintenance of equipment, automated HVAC control, and any other application that increases service provider efficiency and profitability while enhancing the end-user experience. Indeed, enhancing end-user experience is the best single metric for core value added by an open ecosystem of Smart Systems in the buildings space.

Challenges With The Current Managed Buildings Environment

Several factors inhibit the evolution of the modern buildings market segment. Traditionally, BAS/BMS offerings have focused on reducing energy consumption via efficiency gains achieved through HVAC and commercial lighting control, with vendors of such equipment and controls systems being the primary suppliers of these solutions. The expansion of "smart" sensors, actuators, meters and systems across buildings is challenging the ability of these vendors to deliver the awareness, visibility and control that end-users are increasingly demanding.

Figure 1: Building Management Systems & Data Types



Today, despite these devices being integrated and enabled with network connectivity, OEMs and suppliers have been inhibited in unlocking the value of Smart Systems, and ultimately the value of their own devices, by considering their opportunity narrowly through the lens of aging business models and practices. On the end-users' side, lack of willingness to change, along with concern over the cost of migrating legacy systems, creates resistance to adoption as well.

A few key challenges facing the evolution of the buildings space include:

» **Building Data is Still Locked in the Building:** Building automation systems remain in a client/server configuration which, by design, has limited ability to hold data. Even with connectivity, few OEMs, service providers and operators are streaming and storing their data as an asset.

- **Lack of Understanding The Value Potential of Smart Systems:** Many end-users are unfamiliar with the value derived from Smart Systems, leaving their equipment unconnected or unable to communicate with equipment from different vendors. They tend to believe that the upfront cost is too high to justify new equipment. OEMs and service providers have also experienced headwinds in implementing new technologies, often due to the lack of network and computing infrastructure as well as underlying opinions that adding capabilities for more complex applications will make managing and servicing equipment more costly and time consuming.

- **Archaic BAS/BMS Architectures:** Traditional BAS/BMS are architected with a computer server that resides on-premise, with limited storage and processing power, and that is only accessible outside of the firewall via VPN. These factors make software updates difficult, and therefore the improvement cycles are generally clocked by years not months. Building systems with on-premise servers tend not to amass data, and have been unable to move beyond rules-based analytics.

- **Complex Services/Solutions Delivery:** With a fragmented equipment and service landscape, building owners and operators are unable to manage their various operational systems seamlessly with one provider. The more that OEMs and service providers offer solutions that are unable to interoperate with the entire ecosystem of devices that buildings require to function, the more difficult it becomes to manage the building as a whole interconnected system.

- **Fragmented Vendor Landscape is Misaligned with Current IT, Data & Network Security Practices:** Many OEMs and service providers are not savvy about network security, and still (unsafely) recommend putting building systems on the Internet. Moreover, if several vendors are all implementing equipment in the same building, these devices do not operate on the same networks or cooperate with existing data architectures, rendering them unable to be a part of an Integrated and optimized Smart System.

- **Scalability:** Many OEMs and service providers encounter problems when scaling their operations. Notably, these players have difficulty integrating legacy existing systems onto the cloud. Without the ability to bring new and old equipment onto a network and into a scalable platform that puts the data to work, OEMs and service providers are likely to wait until old equipment fails before they sell new cloud-enabled systems to replace them.

Core Technologies Enabling Opportunities In Smart Building Systems

The buildings space has seen a number of key technological advances that have shifted the narrative from basic building automation to intelligent building systems interacting within buildings or across a whole portfolio of locations. Data management innovations have enabled highly capable applications that do not unduly burden end-users by exposing them to the underlying complexity. Across the buildings arena, innovators are attempting to address the challenges posed by the fragmented

equipment supplier landscape, and native cloud applications are leading the charge. Key technologies that are driving change in buildings include:

» **Sensors, Actuators & Machine Data Fusion:** The cost of devices, and the marginal cost of storing the data generated from them, will continue to plummet with advances in silicon, packaging and integration technology. Component miniaturization and the integration of a broad range of sensing capabilities into intelligent devices will continue to provide a variety of features that support the integration of digital information and sensory inputs.

» **High-Performance Networks & Infrastructure:** The current fragmented landscape of proprietary device networks is beginning to give way to a new generation of wireless communications developed for challenging environments such as buildings.

» **Distributed Data Management:** Systems designed for distributed capture, computing and control are enabling new application and system functions such as exception reporting and edge analytics.

» **Cloud-Native Applications:** Cloud-native is an approach to building and running applications that exploits the advantages of the cloud computing delivery model. Cloud-native is about how applications are created and deployed, not where. Cloud-native solutions leverage modern application frameworks for rapid innovation, continuous delivery and superior experiences. Benefits to customers include constantly improving software with new features, less IT headaches and rich mobile applications.

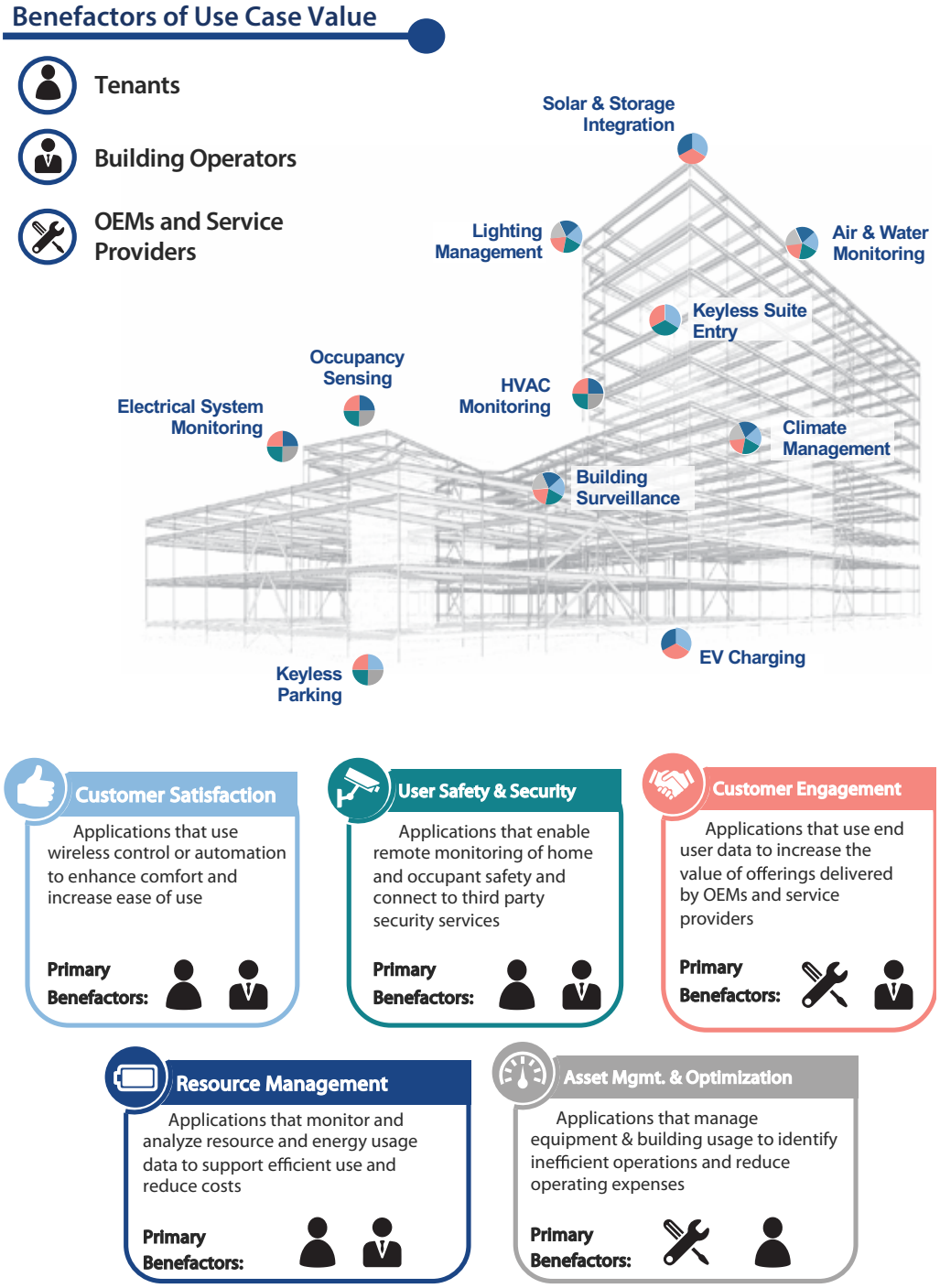
» **Artificial Intelligence & Machine Learning:** Machine learning development tools to build complex predictive models and algorithms are being leveraged within building systems to predict HVAC optimality by learning from droves of past data. Algorithms can even take into account factors outside of buildings such as weather, pedestrians, traffic, and more. These new capabilities turn data into contextualized awareness and knowledge.

» **User Experience (UX/UI, AR, VR) and Services Interaction:** As more devices in buildings become connected and start emitting sensor data, new user experience (UX) tools are being created to drive services delivery. An example is modern logic programming that allows building operators to create simple interactions between devices with more complex underlying algorithms executing the logic.

» **Semantic Data Tagging:** Standardized methods for describing data are being brought to market, making it easier to analyze, visualize and unlock additional value from the vast quantity of data being generated by devices from a range of vendors within buildings. The open-source Project Haystack is a leading framework for semantic data tagging. Haystack allows for a level of data fluidity critical to enabling advanced analytics and machine learning which identifies new avenues of value creation in the buildings venue.

» **Self-Tuning Controls:** Integration of wide-ranging sensor data is enabling collective awareness of building state, which dynamic control systems are leveraging to adjust building parameters including set temperature, heating/

Figure 2: Use Cases Unlocked By New Technologies



cooling schedules and light lumens. Control systems react to inputs, including:exterior temperature, weather forecasts, ambient light, occupancy and learned user preferences to optimize the environment based on real time, user-specific cues.

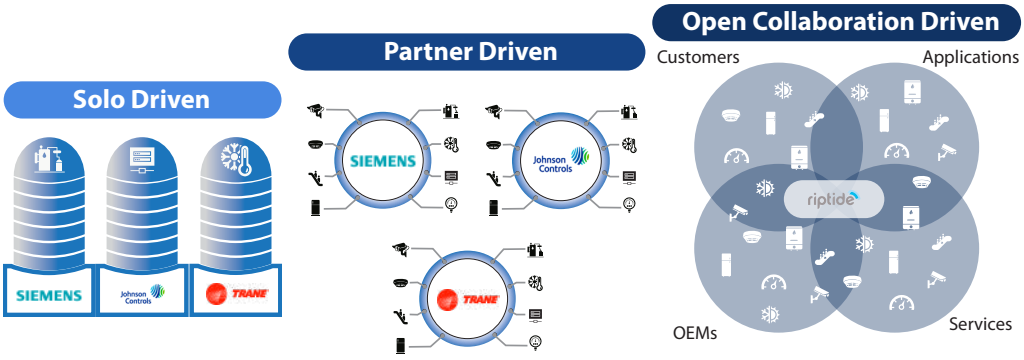
For OEMs, the ability to enhance existing services and offer additional remote services tends to be the primary driver for adoption. Understanding the status of their devices, the reasons for any previous downtime, as well as an ability to service a machine before shutdown are all critical elements to use cases such as customer satisfaction. Service providers are able to seamlessly monitor the status of all of the devices under their management, while generating customer satisfaction by leveraging data to create reliable servicing and cost-minimizing efficiencies. An additional use case includes tech support and troubleshooting tools for repair personnel.

and their need for mobile tools to improve serviceability. All of these status checks and analyses that OEMs and service providers can offer to their customers are made possible by these cloud-native technologies.

Suppliers are Evolving, but Few Serve Customer Needs Well

In the present buildings landscape, significantly different business processes are required to take advantage of Smart Systems. Even many of the players that are primed to capitalize on the new opportunities of Smart Systems in buildings are unsure how to change their business model in accordance with these new technologies. Equipment suppliers, contractors and engineering firms are purely transactional, and walk away following the completion of a project. Evolving customer expectations are forcing suppliers to prioritize user-centric design with end-to-end systems and services, challenging not only technical solution design but also legacy business models and channel structures. Smart Systems has offered OEMs and service providers

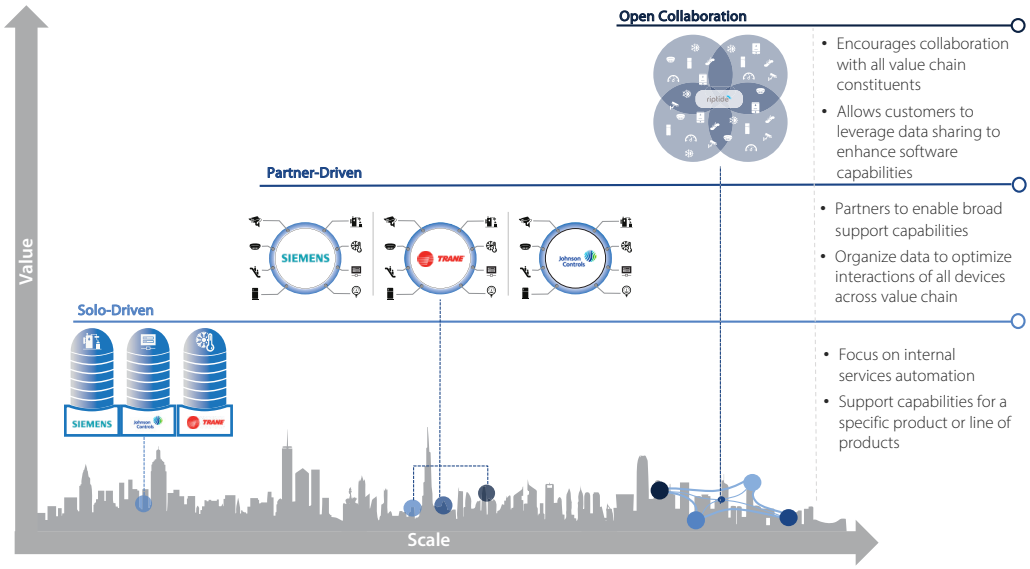
Figure 3: Ecosystems in Buildings



the ability to digitally connect to their customers and engage in ongoing, value-add services; however, few have embraced this modern mode of driving value.

Building industry suppliers have bundled equipment, software and services contracts to major customers via a largely unchanged model since the early days of BAS/BMS. Central to this model is the control of information generated by building equipment, ensuring that vendors alone are able to deliver services atop their hardware. Steadfastly clinging to the status quo is not exactly a recipe for success in a rapidly evolving space

Figure 4: The Value Riptide Brings By Bridging Data Streams



where digitization is redrawing the competitive landscape. Again, a primary inhibitor of Smart Systems and the related value of creating Smart Systems in buildings is the digital divide between equipment and service providers tasked with servicing it.

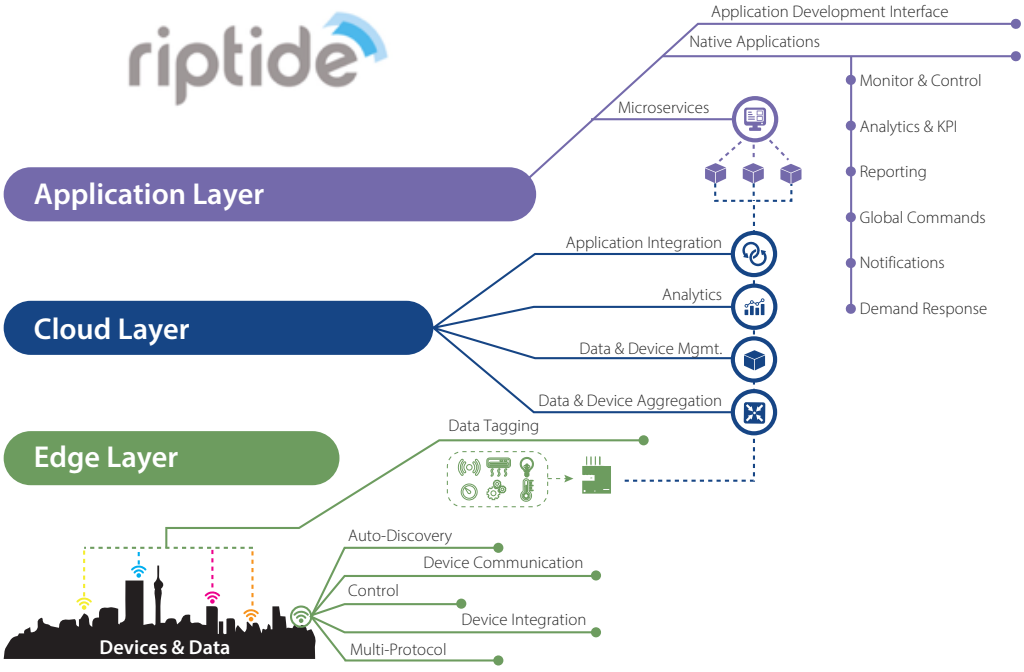
As building providers move toward Smart Systems, many are trying to do so by simply adding capabilities without considering the need for an intricate and interoperable ecosystem, resulting in significant end-users challenges. Without open and flexible data and application tools, building operators are left with several different systems to navigate before getting a holistic picture of their building systems. Evolving end-user priorities make the value proposition of this model decreasingly valuable. Increasing awareness of toolsets that leverage advanced analytics and machine learning to deliver new and continuously improving services is opening the eyes of end-users to the value that agile software vendors can offer.

Enter Riptide: The Cloud-Native BMS Solution

Riptide has the rare ability to effectively harness the core technologies necessary

for Smart Systems and deliver them in an open ecosystem approach. The company offers a cloud-native building management solution for OEMs, service companies, and owner/operators that seamlessly integrates all the data from building systems and equipment, from any number of sites, into a single management application infrastructure. Smart Services are by definition preemptive and just-in-time solutions as opposed to traditional preventative or reactive solutions. They can limit downtime while orchestrating the delivery of data and analysis to the entities that need it, when they need it, in real-time. Unlike other BAS providers, Riptide can provide and is differentiated through enabling modern mobile apps, cloud stored data, and digitally assisted services. Riptide is a vendor-independent solution, thereby bridging data from

Figure 5: Riptide's Solution Architecture



any networked device in a building no matter the supplier. Through the application of these technologies, Riptide allows OEMs and service providers to better serve their end customers, with an ongoing relationship model.

At a high level, Riptide offers OEMs and building service providers the ability to monitor and control equipment, and leverage data to create advanced applications with machine learning, ultimately enabling Smart Services. Beneath the Riptide solution is a technology stack of building systems and sensors, edge applications, IoT native cloud, applications and services. Riptide's technological capabilities not only differentiate their solutions but also demonstrate an ability to implement solutions reliably and at scale for diverse use cases and customer types.

» **Building Systems & Sensors:** Within a contemporary building are numerous devices deployed by a range of different vendors. Even a single HVAC system, can include pieces from multiple suppliers, in different buildings, operated by the same organization. End-user preferences for building systems will always be different, which is why Riptide's ability to deploy vendor-agnostic solutions is critical. The confluence of sensor and actuator data from different devices within building systems can be digested and visualized in a single Riptide dashboard. This is invaluable for building operators or OEMs who have devices deployed around the globe and need to monitor the performance and status of their equipment and proactively address potential issues.

» **Edge:** Distributed computing is a critical component of modern IoT architectures. Devices connected to a cloud rely on the cloud in order to perform. Although this process has so far worked most of the time in commercial buildings, what happens in a more complex future when the connection or cloud itself temporarily shuts down? We've seen harbingers of this in non-commercial buildings when devices connected to the cloud, such as smart locks in residential homes, have left residents locked out of their homes until the cloud was functioning again. Riptide leverages Intel® IoT Gateways with powerful Intel processors at the edge. With Riptide's edge computing capabilities, the devices are able to perform their tasks and compute on the device even when networking and computing infrastructure isn't cooperating.

» **Microservices Architecture:** Underlying Riptide's applications is a "microservices" architecture, an approach to application development in which a large application is built as a suite of modular services that can be deployed in the cloud or at the edge, depending on their importance and storage requirements. Each module supports a specific business goal and uses a simple, well-defined interface to communicate with other modules. These applications enable a suite of services that can be offered to end-users. In a classical architecture, the larger the stack, the more difficult it is to make changes. Developer coordination and unintended consequences of changes introducing regressions are all very real challenges. By contrast, microservices are small, independent services that collaborate via API and are focused on a specific mission. They can be evolved and scaled independently, and can be fashioned in the most appropriate language (polyglot architectures) and technologies given their mission. If a new feature is warranted, then a new microservice is created as opposed to extending the software monolith and introducing additional, unnecessary risk.

» **IoT Cloud:** With Riptide's distributed computing architecture, the IoT cloud adds unlimited affordable storage and enables fast, on-demand scaling. This allows end-users and third-party providers to develop and deploy value-added applications as well as scale the number of devices within their portfolio seamlessly. Leveraging a wide array of leading open source technologies delivered via a microservices architecture, Riptide allows new functionality to be rapidly deployed. Robust time-

series data storage becomes the foundation by which service providers and end-users can deploy applications that leverage historical data for machine learning and artificial intelligence applications.

» **Web and Mobile Applications & Services:** The applications and services offered on top of Riptide's technology stack include customizable notification-based alerts and alarms, global scheduling, predictive maintenance and other common capabilities to buildings systems. A key differentiator in Riptide's application and services solutions suite includes intuitive drag and drop logic programming which allows end-users and service providers to develop and deploy their own custom control or alarm logic, and a full-feature mobile application.

» **Security:** Riptide offers end-to-end network security to keep devices off the Internet, and avoid messy VPNs.

In addition to these solutions, Riptide has a long-standing partnership with several technology suppliers and OEMs. As an Intel IoT Solutions Affiliate, Riptide has access to a large ecosystem of companies that can readily provide OEMs, service providers and building operators/managers with an end-to-end solution — from connectivity enablement, to developing artificial intelligence applications at the edge. Yet Riptide offers an easily accessible "off-the-shelf" solution that is not a challenge to implement in any building system or with disparate equipment around the globe, no matter the needs or the scale of the operation. Further, these solutions are differentiated not only by technological performance, but also by Riptide's ability to understand their customer's business needs.

Future Value Potential in the Smart Buildings Arena

Riptide's tools help save on overhead in building systems efficiencies while also reducing downtime and reactive or preventative servicing of equipment. Riptide's ability to offer simple solutions to a diverse array of end-users, combined with their ability to securely store the data to create differentiating and forward-looking applications, creates future value potential for OEMs, service providers, and owner/operators alike.

Riptide allows OEMs to monitor all their deployed equipment, while enabling the machines to function in an open environment, making the devices more valuable to end customers. By monitoring their deployed equipment, OEMs can offer services, such as predictive maintenance, usage-based pricing, and service level agreements using equipment data. Riptide's IoT cloud seamlessly adds devices and equipment to the user interface, taking in and leveraging the additional data from newly deployed machines. Riptide allows an OEM's equipment to integrate into larger building management systems, offering manufacturers the flexibility to access more end-users

in the future. And because Riptide makes devices compatible with other vendors, end-users do not have to consider that when designing a building system. On top of helping OEMs make the transition to become a part of more open business models, the data collected, managed and analyzed by Riptide can improve performance of existing equipment and design of future equipment.

Owners and operators can derive immense value from Riptide's building management tools. Each device in the building system can be added to the managers' dashboard, creating greater visibility, more efficiencies, and more informed decision-making. In previous monitoring scenarios, when a piece of equipment failed the operators often wouldn't know the exact problem and be forced to call a specialist service provider to avoid prolonged downtime. With Riptide, operators know the exact diagnosis. Potential solutions are provided to those on-site who may be capable of a quick repair without consulting specialists. More advanced applications directed toward the comfort and convenience of building users help create additional, intangible value for building owners and operators.

Service providers with several buildings under contract can monitor all devices and systems, sending out field workers or adjusting settings remotely before machines fail and create issues. This allows for more efficient scheduling and use of personnel, as well as more satisfied customers. Riptide also allows service providers to scale seamlessly, adding new devices and systems to existing dashboards for managers to oversee. All together, these capabilities create customer loyalty through improved service, and the opportunity for new revenue streams.

Ultimately, Riptide's building management tools position OEMs and service providers to meet the demands of end-users and building systems of the future. As end-user demands become the focal point of building system design, vendors will need to move towards more open business models, collaborating with players across the value chain in order to create the best solutions. In this way, Riptide's innovations can become the mechanism by which OEMs, building owners, and service providers join the Smart Buildings ecosystem of the future.

Figure 6: Nordstrom Customer Success Case Study

Scenario

Nordstrom is an international department store with 370 locations in the US, Canada and Puerto Rico whose facilities management staff have been working to achieve improved efficiencies in their stores and buildings. By leveraging Riptide, Nordstrom has been able to optimize the management of their facilities and share data on operations and energy consumption, including monitoring doors that are left open allowing cool air to escape and analyzing their lighting systems usage. In addition to identifying efficiencies with existing systems, Riptide has also enhanced additional systems such as security via monitoring lighting during after store hours to detect intruders. Challenged with constant pressure for cost savings while still needing to create a safe, comfortable environment for customers, regional facilities managers and corporate stakeholders now have continuous access to relevant data from ~8,000 HVAC and building systems. Implementing a cloud-native system provides new insights into building operations and maintenance.

Highlighted Solution Capabilities:	Analytics & Edge Control: Riptide's solution enables cross device efficiencies by analyzing and controlling building equipment	Scalability: Riptide's solution is able to handle a high volume of data and securely allow relevant users to access it	Cloud-Native Applications: Riptide's solution enables users to develop applications for compliance and control at various levels of corporate governance

BEFORE:

Facilities Managers follow a maintenance program → Repair personnel are scheduled to operate on equipment → Limited insights into equipment data across all sites

NOW:

Portfolio managers can schedule maintenance when needed based on machine data → Data aggregation and edge control allow portfolio management more accurate control of facilities → Cloud-native analytics allow corporate constituents to optimize training, compliance and facilities management

Outcomes	Impacts	Implementation Challenges
• Solutions beyond traditional preventative maintenance programs • Management of ~8,000 HVAC systems • Ability to analyze building management data with other data sources i.e. weather)	• Increased maintenance efficiency • Efficient corporate compliance • New training protocols based on how customers and employees interact with the building	• Familiarizing regional and corporate constituents with solution • Retrofitting legacy equipment • Combining with additional data sources (i.e. weather, customer behavior)

Figure 7: AirReps Customer Success Case Study

Scenario

AirReps is a Manufacturers Rep in the Pacific Northwest that represents Daikin and other HVAC equipment sold to engineers, contractors and building owners. Many of their clients leverage equipment from different manufacturers. AirReps recognizes that service providers are looking to increase service efficiency by understanding equipment failures ahead of shutdown and deploying repair personnel preemptively.

Many of AirReps customers have equipment that was installed over many years, making it difficult to upgrade device intelligence and integrate them onto networks to provide tools capable of aggregating and visualizing data from systems across multiple buildings. AirReps has partnered with Riptide to bring cloud building management solutions to its customers, which ultimately helps building operators more effectively deliver comfort at a lower cost.

Highlighted Solution Capabilities:	Automation & Analytics: Riptide leverages machine data to display analytics and develop efficiency applications	Data Management: Data tagging and management is made easy with Haystack tagging and aggregation	Microservices: Riptide's microservice architecture allows for scalable applications to deployed throughout an organization

BEFORE:

Equipment breaks, leading to downtime → End-customer calls service company → Repair personnel sent to fix device → Downtime loses money and costly repairs once complete breakdown occurs

NOW:

Dashboard alerts building operator of machine operating status → Repair personnel schedules non-busy time for maintenance → Lack of downtime and heightened machine health leads to ROI

Outcomes	Impacts	Implementation Challenges
• Solutions advanced beyond BAS • Mobile application provides greater visibility for customers • Increased data security • Ease of data management	• New dialogue and relationship with customers • Proactively addressed customer needs • Data aggregation and analysis without traditional BAS	• Often want to deploy a pilot first • Retrofitting legacy equipment • End customers familiarizing themselves with the Riptide product

Conclusions

The buildings space presents a perfect environment for Smart Systems to radically re-order traditional industry limitations and move to a continuous improvement model for Smart Building solutions. Emerging cloud-native providers are leading the charge to capture innumerable data points and turn them, within milliseconds, into predictive, actionable opportunities. Thanks to the combined processing power of edge and cloud computing, this potential has arrived today. Advances in big data analytics and AI are positioned to make self-adaptive buildings a reality via continuous feedback loops between building equipment and software.

Although new technologies surrounding the intelligent buildings space have unlocked the ability to generate more value for OEMs, service providers, and end-users alike, there are several intractable non-technological challenges. A lack of understanding of the immense value provided by native cloud, as well as resistance from OEMs and service providers to move from on-premise solutions, has inhibited the growth of Smart Systems in buildings.

Multiple vendors in singular building systems lack business models that allow for natural interoperability and data sharing. Traditional technology suppliers such as building automation OEMs are trying to leverage old solutions to address new demands, keeping archaic data architectures that prevent them, and their service providers, from creating ongoing digital services around their products. The longer they delay in defining data as an asset, and seeing the cloud as the delivery vehicle for ongoing customer relationships, the farther they will drift from a Smart Systems strategy.

The less money spent on energy, and the less downtime waiting for maintenance, the better for everyone involved. Riptide's cloud managed building solutions offer the antidote to the business-model and technological challenges facing the buildings space today. By allowing OEMs and service providers to easily deploy a connected equipment strategy, and seamlessly integrate any new devices onto their Riptide application, OEMs and service providers are able to improve operations and develop new, ongoing solutions via continuous interactions with their customers. These applications, such as energy management and predictive maintenance, not only improve efficiencies but also add to the end customers' satisfaction.

Riptide's technological capabilities equip it to deploy advanced and reliable solutions, while remaining simple to use for OEMs and service providers. Instead of trying to silo end-users into certain vendors or partnering with a limited selection of suppliers, Riptide operates under an open collaboration model, managing and analyzing data from different vendors' equipment located on diverse sites. Those willing to modernize and adopt a cloud-native strategy can transition from a large, monolithic software package that rarely gets updated to an environment that constantly evolves and improves to meet user

requirements. Cloud-native applications are the glue that ties together a successful, re-occurring value story. Riptide offers a quintessential, one-stop-shop solution for enabling the true potential of Smart Buildings.

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