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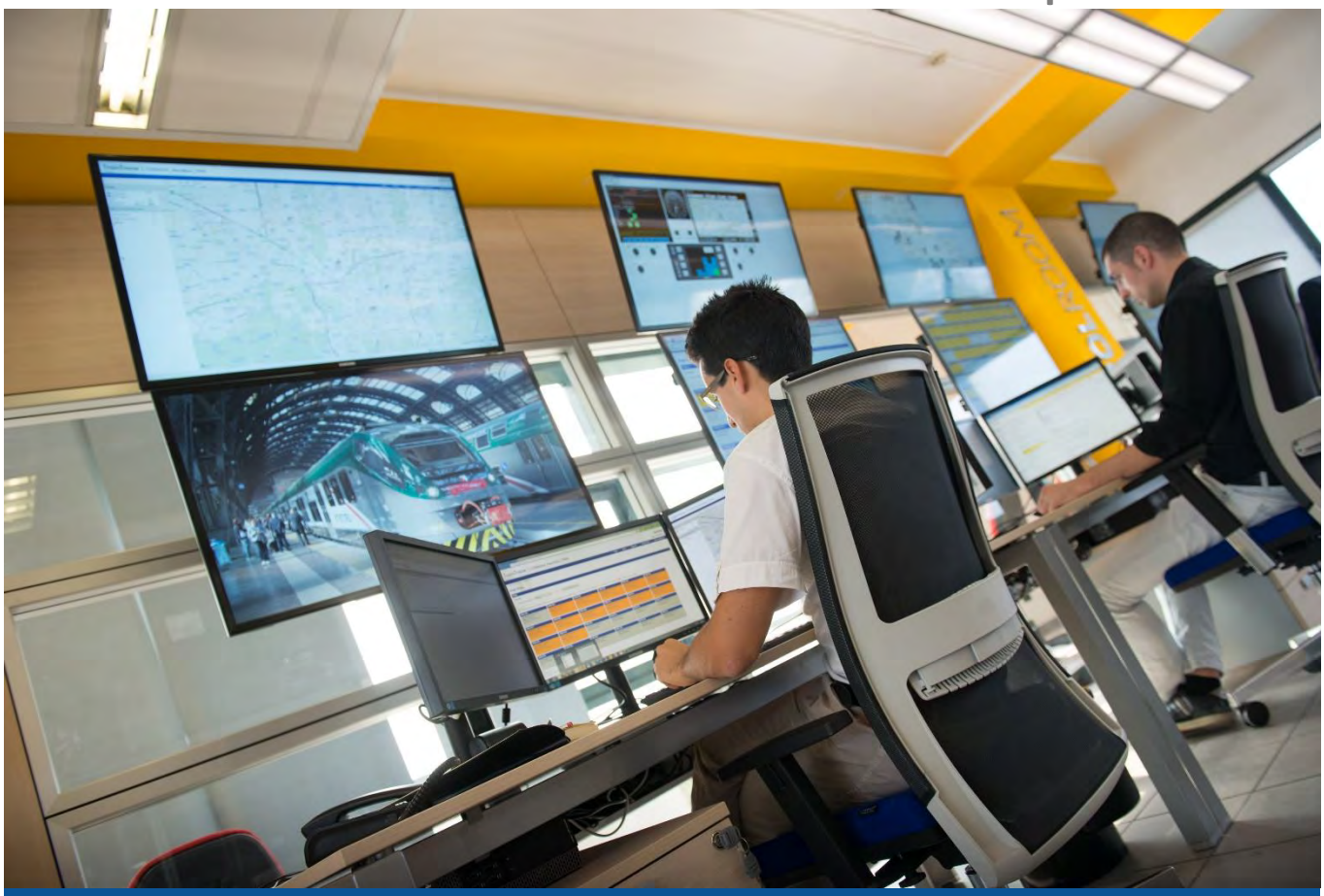

FM Consultants White Paper:

The FM/IT Nexus - Remote Monitoring Solutions

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IFMA FM Consultants Council
International Facility Management Association

Founded in 1980, IFMA is the world's largest and most widely recognized international association for facility management professionals, supporting more than 24,000 members in 94 countries.

The association's members, represented in 130 **chapters** and 17 **councils** worldwide, manage more than 37 billion square feet of property and annually purchase more than US$100 billion in products and services.

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The FM Consultants Council supports new and existing FM consultants as they build a career around their workplace expertise. Through geographical and cross-discipline networking, best practices and small business management skills, the council empowers members to step out into the marketplace. This is a noncommercial forum for members to network and share ideas.

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- John Ringness, Rick Rolston, and Alberto Cayuela

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John Ringness has been a solution architect for the Facility Management industry since the early 1980's having worked with such companies as ARAMARK (Canada), Sodexo (Canada), Marriott (Canada), Lavasa (India), Kohinoor Group (India), and Partners in Health (USA/Haiti). John is the CEO, NEXT FMA, an international FM solutions company based in Vancouver, Canada. John is the Immediate Past-President IFMA's FM Consultants Council, Team Member of IFMA's ESS Strategic Advisory Group, and FM Consultants Council Global Liaison for India. John's passion is to provide sustainable business solutions through consulting, training, and technology especially within the international context.

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Rick Rolston has over 30 years of experience as an entrepreneur in delivering software and (later) web-based information services. For the past 25 years, he has focused on building related information, after launching ConFax Publishing, the first information service to distribute construction project information electronically. In 1999, as Co-Founder and CTO of Ingenium, Rick developed the first successful web-based software as a service (SaaS) application for sales management in the construction industry. After partnering with McGraw Hill in 1999, this service became the industry standard for construction information management. In 2011, Rick co-founded, with his wife Marcie, the BuiltSpace companies, which will fundamentally change how buildings are operated and maintained. Recognizing that facilities management is not a core competency of most building owners, BuiltSpace provides a collaborative asset/service management platform which enables integrated remote facilities management services, for single buildings, or across large facilities portfolios.

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Alberto Cayuela heads CIRS business development efforts and oversees the operations of the Centre. He leads the preparation of strategic research plans and manages research collaborations and industry partnerships. Mr. Cayuela brings a wealth of experience in sustainable building and renewable energy projects garnered in the private sector: his last position was senior project manager with Stantec Consulting where he managed the planning, implementation, and delivery of complex capital projects and high-performance buildings, including the CIRS building. With 20+ years' experience in capital and technology projects, Mr. Cayuela has developed a strong background in front-end project planning and controls, and significant expertise in project management best practices, project organization and governance, stakeholder management, and performance tracking and reporting. He has presented many times at national and international conferences and has served on the Board of the Cascadia Green Building Council and is a Past President of the Society of Project Management Professionals of Greater Vancouver.

Foreword

The Strategic and Tactical Action Group (STAG) of FM Consultants Council, has made great efforts to align its activities and service delivery to our members within the FMCC vision, which is 'to be the resource and voice for Facility Management Consultants Worldwide, to leverage our collective expertise to benefit IFMA members and the Facility Management Profession'.

The publication of 'White Papers' by FMCC members are one of the many activities promoted by STAG and the senior leadership team, and as part of this effort and campaign, we are delighted to publish this white paper.

By creating the platform for such white paper publications, we hope to encourage our members and offer them opportunities to express their view points and share knowledge with our membership and fellow consultants, and the wider FM fraternity around the world.

We appreciate that lot of time and effort goes into writing a white paper, the way of researching material on the topics chosen and would like to thank the authors for their efforts put towards writing this white paper and sharing this knowledge with us.

We also would like to thank you, the reader for taking the opportunity and your time to read this publication and I hope you will learn something new in the process.

Regards,

Val Moraes CFM MBA
President (2015-2017)

IFMA FM Consultants Council
International Facility Management Association

Building Futures for FM Consultants Worldwide

Executive Summary

In various places around the globe the built environment is being increasingly challenged by dwindling natural resources, climate change, increasingly complex building systems, terrorism threats, a shrinking skilled workforce due to the Baby Boomer global phenomena exiting from the workplace, pressing financial realities attributed to escalating real estate costs, and reduced allocated funds to properly maintain the physical assets. Addressing these environmental, social, and financial challenges of the built environment requires innovative solutions. This paper will review the rapidly emerging field of sustainable remote monitoring solutions, its associated practices and technologies, and the potential benefits for new and existing building stock in North America and beyond.

Environmental:
Dwindling natural resources
Climate change
Complex Building Systems

Social:
Shrinking workforce
Terrorism Threats

Financial:
Escalating real estate costs

The term sustainable development was coined in the 1987 paper "Our Common Future", released by the Brundtland Commission. "**Sustainable development is the kind of development that meets the needs of the present without compromising the ability of future generations to meet their own needs"**. Sustainable development is at the heart of Remote Monitoring Solutions.

These Remote monitoring solutions are ultimately the "**FM/IT Nexus**". This is where decades of best practices in Facility Management collide with the rapidly changing landscape of the IT world. The amount of building data to manage will be staggering but if the FM industry can begin serious dialogue with the IT industry and actively craft sustainable solutions, the future will look very different.

The global built environment is rapidly moving towards a technologically based central nervous system where building systems respond in real time to immediate environmental conditions both inside and outside the building. Furthermore, we will see the day when Business Intelligence (BI) runs algorithms, trending historical to current reality, and then project future scenarios to assist Facility Managers better manage their available resources.

Who will monitor these technologies remains to be seen. As expected, some of early adopters have already been in the energy solutions business with their proprietary cloud enabled platforms but we are also starting to see Remote Monitoring as independent 3rd party business solutions. This may be located within large companies or outsourced to those who have the technology infrastructure and facility management background to interpret the data.

The FM industry must get organized in preparation for this nexus. A key issue is the FM industry's unstructured data. IBM estimates (1) **80 percent of new data is unstructured**, growing at twice the rate of structured data and more than 90% of global data has been created in the past 2 years! This coupled with the fact that **FM knowledge does not always equal FM understanding**, there is some urgency for FM professionals to become more active requesting standards as well to engage with the IT business community to help bring practical innovative sustainable solutions.

In closing, it is a very exciting time as the FM/IT Nexus merges through remote monitoring solutions into the main expressway of global FM best practices.

Background

Global challenges – including climate change, rapid urbanization, degradation of the biosphere and natural systems that sustain life, together with the enormous task of providing food and drinking water for an expanding population – require the rapid adoption of more global sustainable practices in all branches of economic activity. Worldwide, cities house more than 50% of the global population of 7.3 billion people and are responsible for approximately 80% of global carbon dioxide (CO_2) emissions. Conversely, because of the concentrated nature of their ecological impacts, urban areas represent one of the greatest opportunities to effect change toward a more sustainable future.

North America (Canada and the US) has about 6.5 million commercial buildings, approximately 155 million residential housing units and some 145,000 colleges, universities, primary and secondary schools, many of which occupy multi-building campuses. Collectively, **these buildings account for 40% of the total energy and approximately 70% of the electricity consumed in North America, as well as 40% of the total CO_2 emissions of the two countries.** North America uses about 40 billion cubic meters of water a year. This is roughly equivalent to a **per-capita water consumption of 300 liters a day**. Of the total amount of **water consumed every year, about 15% is used in buildings (6 billion cubic meters)** and about 30% is used to irrigate gardens and landscapes (12 billion cubic meters). Furthermore, about **10% of the energy used in the US and Canada goes to treating, pumping and heating water**. This is equal to the electricity consumption of about 5.5 million homes.

On average, North Americans spend about 90% of their time indoors, where the levels of pollutants may be 2 to 5 times higher than outdoor levels. Sources of air pollution in buildings include materials, furnishings, cleaning and personal care products, heating, cooling and humidification devices, as well as radon gas, pesticides and infiltrated outdoor air pollution. Among other health impacts, these pollutants exacerbate underlying conditions such as asthma, an affliction suffered by about 22 million North Americans, including about 7 million children. In the US alone, in the **year 2000 asthma accounted for 10 million outpatient clinic visits, 2 million emergency department visits and approximately 4,500 deaths**.

Meanwhile, we are seeing the growing stringency of design standards and building codes in countries around the globe, together with a wider acceptance and adoption of sustainable design and green building rating systems such as LEED, IGBC, Green Globes, Green Star, BREEAM, etc. This has contributed to the design of better, more efficient and healthier buildings, the deployment of renewable energy, water treatment and reuse technologies, as well as materials and systems that improve the comfort and wellbeing of building occupants, remains a relatively small portion of the larger building sector. Additionally, the vast majority of existing buildings in many nations were built prior to the emergence of green building practices in the late-1990s, and as such lack high efficiency energy and water systems, were built with poorer performing building envelopes, and were not designed to maximize occupant comfort and wellbeing.

Finally, just as social media and crowd sourcing have become catalysts for social mobilization, democracy, social equity, and environmental protection, the Internet of Things (IoT), enabled by cloud computing and powered by big data promises to revolutionize the way we plan, design, build, operate, and maintain buildings. Currently this technology is fragmented and not generally optimized to achieve the lowest environmental impact, highest indoor environmental quality, and lowest cost of ownership possible over the service life of building assets. Focus and reliance on first cost constraints, limited adoption of effective and integrated BIM processes, and over reliance on disjointed and proprietary building automation and asset management software packages provide the perfect storm conditions for a new approach to planning, delivering, retrofitting, and operating building assets connected through Remote Monitoring.

The Internet of Things within Facilities

There are some misconceptions about what the Internet of Things (IoT) is, and what it means for facilities managers. In fact, the IoT has little to do with actually connecting things in buildings, unless, by connecting those things we can improve business processes and reduce costs. Following are some of the definitions of the IoT found with a Google search:

> *The Internet of Things (IoT) is a scenario in which objects, animals or people are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. (WhatIs)*
>
> *The Internet of Things (IoT) is a computing concept that describes a future where every day physical objects will be connected to the Internet and be able to identify themselves to other devices. The term is closely identified with RFID as the method of communication, although it also may include other sensor technologies, wireless technologies or QR codes. (Techopedia)*
>
> *The Internet of Things Is Here. The Internet of Things (IoT) is increasing the connectedness of people and things on a scale that once was unimaginable.* ***Connected devices outnumber the world's population by 1.5 to 1.*** *The pace of IoT market adoption is accelerating because of: Growth in analytics and cloud computing, increasing interconnectivity of machines and personal smart devices, the proliferation of applications connecting supply chains, partners, and customers (Cisco)*
>
> *The Internet of Things (IoT) is the network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or the external environment. (Gartner Group)*

Another way the Internet of Things can be defined:

> *The IoT is the application of inter-corporate business processes supported by Internet connected devices.*

This definition recognizes that the value proposition of the IoT is driven by inter-corporate business process change. Facilities managers simply don't need the Internet to connect devices to a network, unless they need to share information with external stakeholders, such as outsourced service providers.

IoT Implementations resulted in 41% reduction in service dispatches.

Remote monitoring can be considered "killer app" of the Internet of Things. The Service Council recently surveyed their members (service organizations) with IoT implementations, where they reported an average of 41 percent reduction in "service truck rolls", an 11 percent increase in first-time fixes, and a **9 percent increase in asset up time**. The amount of machine down time also decreased by 9% with the implementation of remote monitoring (2).

According to IBM estimates, **90 percent of the world's data has been generated in the past two years**. It's expected that 40 ZB of data will be created by 2020—300 times the amount in 2005.

Servicing Things in an IoT Enabled World

The idea of a unique identifier for each Thing was specifically mentioned in the above definitions of the IoT. This becomes a critical factor when business processes extend beyond corporate boundaries.

Unfortunately for FM, many common business processes, and the software that supports them, are document centric. This means facilities manager's work with Work Order numbers, or Purchase Order numbers to identify units of work, and track costs, without reference to the specific equipment being serviced. When that equipment becomes IoT connected, traditional work order processes using paper medium in a digital age no longer work. (See Asset Management Page 21)

Software as a Service (SaaS)

Software-as-a-Service, the delivery of software over the internet, or "in the cloud," is becoming more accepted as security protocols and market acceptance continues to grow, since web-based applications were first introduced in the late 1990s. This is largely because SaaS implementations cost less to manage, for both the SaaS service provider and end-users. Gartner reports (3) that **44% of a 2014 survey respondents indicated "cost reduction" as the number one reason for migrating to SaaS model**.

As far as the adoption rate of this technology, The Service Council (2) surveyed 100 service and manufacturing organizations**, nearly 70% indicated they have leveraged some form of remote monitoring**, and of those 70%, more than 50% have been connected for more than 5 years.

Pricing is moving from a capital expense model to an operating expense often deployed as a monthly fee. Useful life cycles of technology have been reduced over the years as well as getting smaller and cheaper, thereby aligning better with SaaS strategies in recent years.

Commercial terms for remote monitoring solutions could be a flat rate per connected device (machine/asset) per month, a rate per connected parameter i.e. kwh, liters, etc. or any combination.

Typically with SaaS there are reductions in the monthly fees in the area of **25% if the user purchases 12 months in advance**.

Special consideration must be afforded when drafting the contract terms of a SaaS agreement: specifically, upon exit of the relationship, identifying who owns the data. It is essential the FM manager should never be left in a situation where they do not have access to their own historical FM data in a usable format.

A foundational SaaS premise should look like this: **the people who need to use the data, have access to the data, anytime, and anywhere.** This includes would include costs and consumption per square foot, building, department, device/asset, and parameters (KWH, volts, time, flow, efficiency, etc.).

Mobility

A Gartner study in **2013 indicated that 1/3 of Business Intelligence users will access their dashboards from a mobile device** so ensuring that these platforms have this configuration is essential as this trend will only continue to increase in the future.

There are currently approximately 1.6 billion smart phones and EMarketer (4) projects that will top 2 billion by 2016.

Another astounding fact occurred in 2014 when the global number of smart phones exceeded the global number of PC desktops. So this means that remote monitoring coupled with mobility strategies are essential.

Dashboards

While the look (visualization) of a dashboard is important, it is equally critical for the dashboard to gather and reflect business intelligence to better assist companies improve their decision-making decisions.

The assumption here is that the person who is viewing the dashboard has the necessary skills to interpret the data, and use the analytics to trend future what if scenarios.

LogiAnalytics reported (5) there were 4 elements of an effective dashboard:

Value – Must be useful

Usability – easy to use

Adoptability – easy to get started

Desirability – exciting to use

FM managers will want the ability to immediately customize their dashboard to their user preference and not have to wait for the IT team to make these required changes.

"Design isn't just what it looks like and feels like. Design is how it works."

Steve Jobs

Business Intelligence

Acquisition of data serves no point if the data is not converted into business intelligence to serve the business objectives of the organization gathering the data. IBM reported that there will be 300 times the amount of data available by 2020 so it is critical to determine the indicators and processes to achieve business objectives. These include:

Clear – remove any possible ambiguity

Meaningful – not all data serves the business objectives of all levels of an organization, i.e. in financial terms for CFO, Building Operator KWH, etc.

Timely – "real" time (time) vs. a set time (transactional), i.e. monthly, weekly, etc.

Relative – ability to interplay with other data sources

Scenarios – ability to future gaze

Gartner predicts (6) **by 2016, 30% of businesses will be monetizing asset data**. Therefore the potential before the built environment is very real and meaningful.

Benchmarking has long been central to world class Facility Management services paired with appropriate Key Performance Indicators (KPI). We now have the ability to monitor asset performance both at the granular level (by connected machine) and as well as the traditional building level. The performance of those assets can then be connected to quality of machine manufacturing, servicing (whether in house or outsourced), and consumption.

This transparency in machine performance will cause all stakeholders to improve their game.

Cloud Considerations

The IoT wouldn't exist without cloud-based applications. For facilities managers and building service providers, mobile applications used for managing operations and maintenance workflow depends on 3G/LTE (cellular) or WIFI connectivity. Often, neither services are available in parking structures, mechanical rooms, and electrical vaults. Off-line applications can partially fill the gap, but ultimately Smart Buildings will deploy sensors throughout the facility, and that needs seamless connectivity.

Public WIFI hotspots are notoriously prone to hackers using them to eavesdrop on other connected devices, yet occupants and visitors often expect Wi-Fi connectivity, as part of their building "experience". Securing WIFI connected devices, and maintaining a safe computing environment will become more and more a facilities management issue. (See Cyber Threats page 13).

Data Integration

Building operational technology data (sometimes called OT) and information technologies data (IT) are converging towards the center of the Internet of Things for buildings. Facilities managers leveraging IoT technologies are combining data from IWMS/CMMS/EAM, service or financial management systems, energy or utility data, building automation systems, and even occupant engagement systems. Outsourced service

providers, each with their own management systems, create additional data silos for facilities managers, while the service providers may be required to provide service data to multiple customers.

Standard business processes, even simple transactions like sending an invoice to a customer, have suffered from fragmented digital processes. Many service providers now deliver electronic PDF invoices to the customer's personal email, or require their customers to visit their website, enter credentials, and navigate through the site in order to find invoice or service data. Some larger facilities or real estate managers require their service providers to close out work orders within their enterprise work order system. Neither solution works well for the various parties involved in the business transaction.

Databases require a handshake, a means which connects the two databases. More times than not, databases are not structured in a way which requires additional labor for data scientists to integrate the databases to ensure data integrity.

IBM report indicates 80 percent of new data is unstructured,

growing at twice the rate of structured data!

We must start ensuring data is being gathered in a structured manner. Project Haystack (7) is one such attempt to do so. It is an open source initiative to organize and streamline working with data from the Internet of Things. Project Haystack standardizes semantic data models and web services with the goal of making it easier to unlock value from the vast quantity of data being generated by the smart devices that permeate our homes, buildings, factories, and cities. Applications include automation, control, energy, HVAC, lighting, and other environmental systems. For example, air handling units are referred to AHU; HVAC refers to any assets records associated with HVAC (Heating, Ventilating, and Air Conditioning).

Cyber Threats

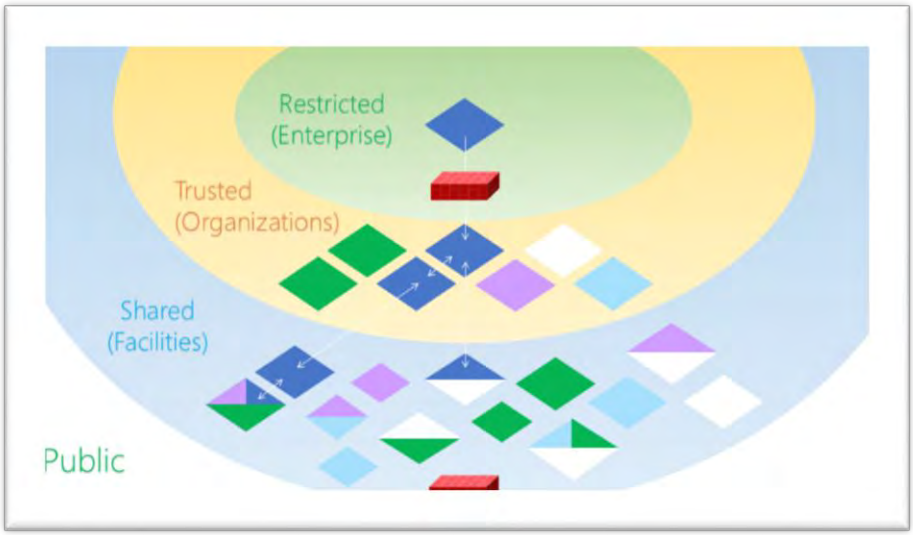
Exposing computers or intelligent devices to the Internet invites cyber-attack. Each addressable device is a security concern, and **Cisco estimates that there may be 50 Billion devices connected to the Internet by 2020 (8).** Even more frightening is trying to remember all those credentials!

The Open Web Application Security Project (OWASP) analyzed the top 10 security issues related to the IoT. They found:

1. *Insecure Web Interface*
2. *Insufficient Authentication/Authorization*
3. *Insecure Network Services*
4. *Lack of Transport Encryption*
5. *Privacy Concerns*
6. *Insecure Cloud Interface*
7. *Insecure Mobile Interface*
8. *Insufficient Security Configurability*
9. *Insecure Software/Firmware*
10. *Poor Physical Security*

As a facilities manager, should you be concerned about these issues? Yes. Do you need to become an information security expert? No. You should understand that the IoT will demand new skill sets in this area, and those skills will likely come from internal IT resources and/or your service partners. It is interesting that poor physical security hits number ten on the list.

How will you protect yourself? Traditional enterprise systems create perimeter protection, with firewalls and security policies to exclude non-trusted people from entering a network zone. Like a physical building, once inside an intruder may be free to roam. Strategically, IoT security will isolate network segments (like creating secure "rooms" within the building), protecting the most sensitive data in the most secure zones with a gateway which blocks inbound connections. Data required for monitoring within these zones will be pushed out from within the zone, using credentials only known inside the zone. All communication with external systems may be initiated from within the secure zone, with the connection occurring with an "endpoint" that is also isolated from the public. Like a facility with card access utilizing area restrictions by function or position in the organization, so the IoT will create these virtual rooms, with controlled access as determined by FM and the It departments.



Knowledge Transfer

Knowledge transfer is one of the largest issues in facilities management today. Buildings are complex systems, often maintained by a multi-disciplinary team of service providers and in house operators, with service records delivered via fragmented business processes. Often critical knowledge is maintained in the heads of senior building operators, or the engineering team that designed the system. Over time, knowledge is lost.

End-to-end service processes, a single data repository, and collaborative services delivery are an answer to the knowledge transfer problem. Integral to the IoT for buildings will be building "Avatars", which are virtual representations of the physical building, allowing an authorized user to navigate through the building to access and update building information. The Avatar needs to be available to all stakeholders in the building, with access to data based on the stakeholder's role. The Avatar creates a collaboration point for stakeholders, to allow the sharing of knowledge, and visibility to business processes, as needed.

Collaboration

Collaborative services delivery enables Business to Business (B-2-B) processes. Today, when a service provider rolls a truck in response to a maintenance issue, the field technician is often blind to the issue or the service history of equipment involved. They may not even know where the equipment is located. Creating this visibility, and providing a business process which **allows the field technician to access this information before reaching the site**, (even knowing with remote monitoring what the actual problem is), creates efficiencies in the service process. Recording the work activity performed in real-time, and making that information instantly available to the customer and the service provider's own back office, eliminates further administrative workload, and creates accurate service records for each piece of equipment.

Having better data available, including equipment specific service records, allows facilities managers supported by building experts, to make better repair/replace decisions.

Applications

The aforementioned information has provided a high level summarization of new and emerging technological developments linked to the Internet of Things, that have the very real potential of transforming current FM technological practices as we know them. Current FM technologies have very real limitations from the perspectives of interpreting data that is relevant, real time monitoring, openly collaborative, and data transferrable compared to that of emerging FM technologies that do exactly what current FM technologies cannot do. The following topics will now address the significant and exciting implications and varied applications that this new FM technology will have within our FM industry both today and tomorrow, which we call the **FM / IT Nexus** i.e. when the elements of Facility Management intersect with the digital world.

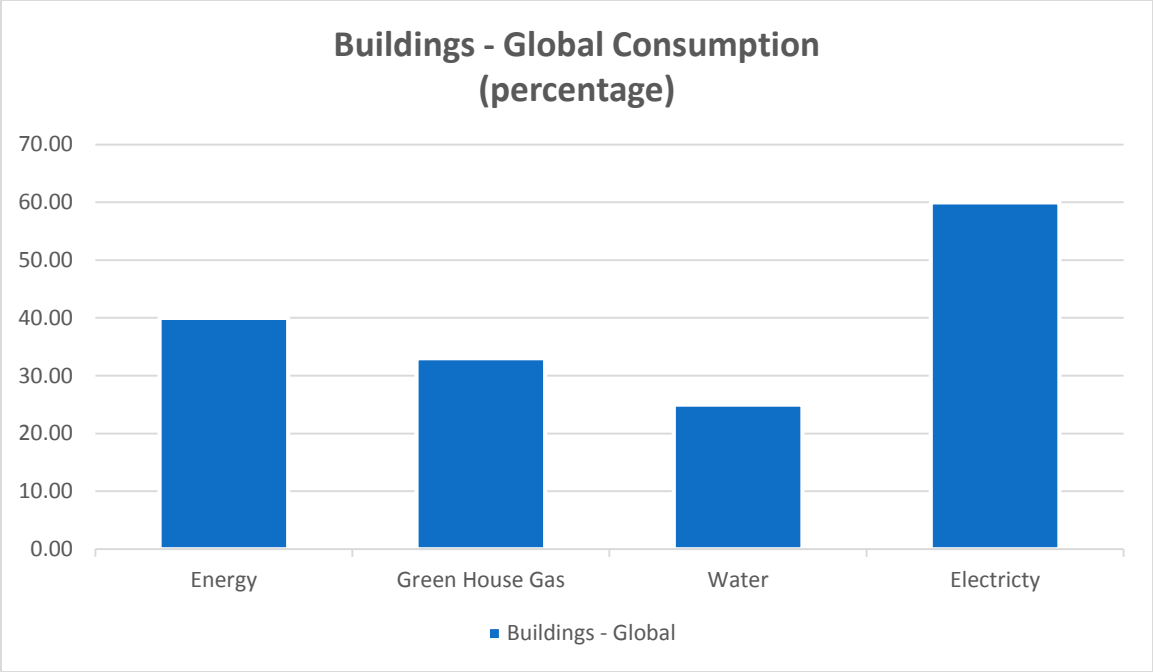
Command & Control Centers

Command & Control Centers (CCC) have traditionally been the space within a facility which collects and monitors the data coming from Building Automation Systems (BAS); receiving data from sensors, meters, devices, alarms; feeding it back to the command center where the building operator explores data alarms operating outside operating parameters i.e. temperature, run time, intrusion, etc. within that respective structure or groups of structures. Typically an on-site CCC may hold 1 or 2 employees who while reviewing the incoming data signals, may also be dispatched to assess and often undertake the asset repairs; this is very inefficient, and can be very expensive to maintain this way.

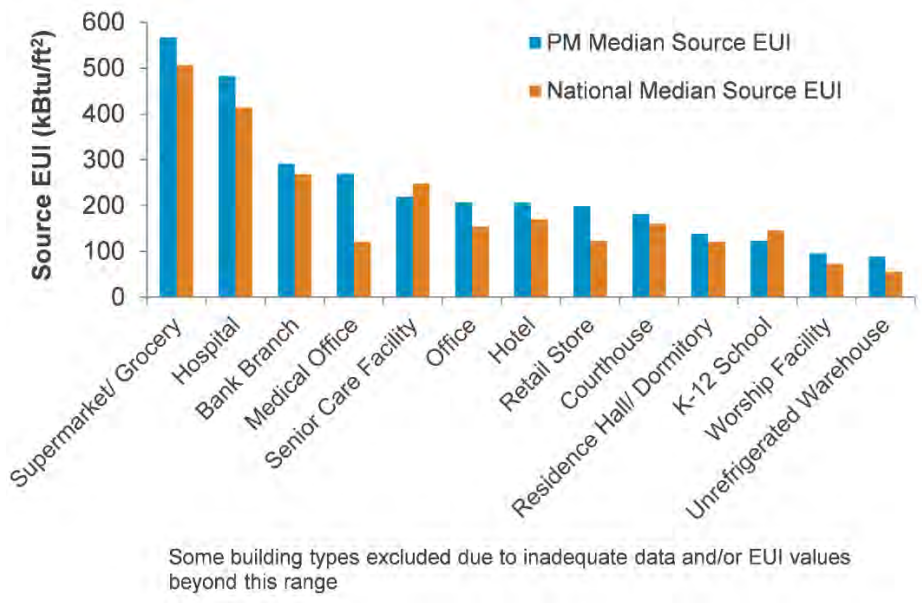
Just as outsourcing of Facility Management human resources occurred in the developed nations 30 years ago, today the FM industry is on the cusp of a new form of outsourcing. This outsourcing will focus on monitoring and analysis from the data of the connected buildings and machines within the built environment to CCC in another part of the globe where skillset maybe higher (or readily available) and labor costs are lower. There are advantages and disadvantages with outsourcing of monitoring building programs, but other than critical operations like hydro projects, nuclear plants, transit hubs, and high pressure boiler plants, how many facility management departments can afford to constantly watch their building operating parameters? Remote monitoring centers are being established to address the incoming digital messages, and initiate service request orders as required; these individuals are trained to address and swiftly interpret these messages.

Building Energy & Water Nexus

The United Nations Environment Programme reports, "Buildings use about **40% of global energy**, **25% of global water**, **60% of global electricity**, and they emit approximately **1/3 of GHG emissions.** Yet, buildings also offer the greatest potential for achieving significant GHG emission reductions, at least cost, in developed and developing countries. Furthermore, **energy consumption in buildings can be reduced by 30 to 80% using proven and commercially available technologies**. (9)



One trend is the building reporting of energy consumption per year per square foot through the Energy Use Index (EUI), the Portfolio For most property types in Portfolio Manager, the EUI is expressed as energy per square foot per year. It's calculated by dividing the total energy consumed by the building in one year (measured in kBtu or GJ) by the total gross floor area of the building. The following is a recent depiction of results (10): **Source Portfolio Manager**



The emerging trend is to report the Energy Use Index but perhaps a more reflective term may be considered as the **Facility Utilities Index (FUI)** where energy and water costs & consumption are gathered, monitored, reported, and communicated for each building.

In some countries, food packaging now contains the health content of the food we ingest. For example, in the photo of the milk jug below, the consumer can decide if this milk company offers the type of vitamins they want, as well as fat content. With this information, we can alter our purchasing decisions. That data empowers us to modify one's eating behavior, if they choose. In a number of countries, if one purchases an automobile, buyers can alter their purchasing outcomes via the manufacturer's data reporting the performance of gas consumption per liters or distance per liter of gasoline.

When one considers the total impact of buildings on our resources, environment, and a sustainable way of heathy life, we must move forward in transparency and transformation. Each building should contain a similar communication (performance) label or publically displayed screen which in real time depicts the energy / electrical and water consumption per occupant, machine performance, etc. Then employees looking for employers to work for, tenants looking for commercial buildings to occupy, or students looking for university's to attend, could all do through an informed sustainable decision.

Asset Tagging

Remote Monitoring Solutions (RMS) are only as effective as the most granular data point and the protocols which develop the datasets into analytical formats. A facility's assets require an asset tag or unique identifying code which provides the RMS foundation to build upon. Many facilities have "AHU2" scribbled the pump with felt marker and while this may have served a purpose in the past, technologies and business processes have vastly improved. Asset tags have morphed into labelling systems, then bar codes, RFID, and more recently QR codes.

QR type of labelling system has become more widespread since approximately 2010, and continues to offer a growing continued to offer an increasing number of advantages; some of which include:

1) requires no special equipment to read the code (other than bar code reader app on a smart phone)
2) is an open source
3) links to websites which could contain Standard Operating Procedures, Maintenance Programs, Safety Procedures, etc.

4) facilitates a 2-way communication between the asset and the employee (or customer!). An employee from any department can be set up so they can file service requests directly to the FM department when the customer discovers a failed asset. They can scan the QR code, and a Work Order Service Request form will open.

Within the asset tag, there is a viable solution is the utilization of **international standards** (11) such as ASTM Uniformat 11 E1557. This classification defines building elements as major components common to most buildings. The classification is a common thread linking activities and participants in a building project from initial project planning through operations, maintenance, and disposal. This assists in eliminating guesswork and assigns, standardize nomenclature. It groups assets in logical manner.

For example:

D Services	D20 Plumbing	D2010 Plumbing Fixtures	D2011 Water Closets D2012 Urinals D2013 Lavatories D2014 Sinks D2015 Bathtubs D2016 Wash Fountains D2017 Showers D2018 Drinking Fountains and Coolers D2019 Bidets and Other Plumbing Fixtures
		D2020 Domestic Water Distribution	D2021 Cold Water Service D2022 Hot Water Service D2023 Domestic Water Supply Equipment

The users of UNIFORMAT II include owners, developers, facilities programmers, cost planners, estimators, schedulers, architects and engineers, specification writers, operating and maintenance staff, manufacturers, and educators.

With the introduction of QR codes the ability to acquire much more meaningful data associated with an asset tag. For example, a roof top air handling unit asset coding string could be represented as follows:

Business Unit	City	Building Name	Floor Number	Area/Room	Category	Class	Definition	Number
Hydro	VNCR	Education Building	Roof Top	NE Corner	D30 HVAC	D3040 Distribution Systems	D3041 Air Distribution Systems	1

An example of an asset string embedded into a QR code: hydro/vncr/edu/rooftop/NE/D3041/001

Asset Management

Enterprise Computerized Maintenance Management Systems (CMMS), are data silos and can be expensive to maintain, especially when maintenance services are outsourced. The application of inter-corporate business process improvement, using Software-as-a-Service, and IoT enabling technologies like RFID or QR code asset tags, mobile field service applications, and collaborative services delivery will streamline these business processes to reduce administrative and operational costs. Real-time access and update of asset service records and documentation improves operational efficiency, and cost avoidance.

Run to Failure (RTF) is essentially a "no maintenance program" scenario. While this should never occur with most assets, in a few instances it may be practical for smaller assets such as bathroom exhaust fans (other than a PM frequency to clean the grill).

Corrective Maintenance (CR) is a reactive form of maintenance i.e. an asset fails, and the repair or replacement is initiated.

Preventative Maintenance (PM) is a proactive form of maintenance usually aligned with a time frame cycle such as monthly, quarterly, etc. or in some cases may be tied to run time in operating hours.

The third proactive level also proactive is referred to **Predictive Maintenance (PdM)** and is tied to actual performance of the asset at that moment of inspection i.e. through vibration analysis, IR scans, etc. While this is helpful, the data is only as accurate as the last moment of testing; the asset could fail post PdM.

Perhaps the most effective and efficient form of proactive maintenance is called **Condition Based Maintenance (CBM)**. This form of maintenance measures the **condition of the asset in real time**; it operates in a continuous commissioning mode i.e. the asset receives maintenance based on its current operating performance versus initiating preventative maintenance requests based upon pre-set time frame (i.e. monthly, quarterly, etc.). This is extremely helpful for those building assets which are business continuity essential. (See Machine Monitoring)

The following are some examples of current applications for devices connected to Remote Monitoring Solutions:

Video Analytics

According to Wikipedia, the first CCTV system was installed by Siemens AG at Test Stand VII in Peenemünde (12), Germany in 1942, for observing the launch of V-2 rockets and since then, intelligence through algorithms & object recognition have been applied to objects within the field of view of cameras, enabling the Remote Monitoring Programs (RMP) to detect and anticipate potential movements. For example, consider a video camera focused on customers within a bank lobby. If someone starts to move quickly towards a bank teller, the analytics determines the increased body speed is greater than those present and/or historical data, and then sends an alert to the Command and Control Center where a decision will be a taken to an emergency response or not.

Drones/ Unmanned Aerial Vehicles (UAVs)

What was once observed in sci-fi movies or utilized in military applications has now moved into the built space environment. How many times have FM Managers hesitated to correct or inspect something due to the time, expense, and service inconvenience to set up scaffolding? Or wondered about the risk to FM employees due to operating at unsafe heights or working in confined spaces? Drones remove this type of risk especially as they shrink in size (23).

While nations grapple how to integrate this emerging technology within their respective aviation regulatory requirements which factor taking into account height of operations, line of sight, weight, safety requirements etc., exciting progress continues to develop with this innovative technology.

In some countries drones (with cameras) flying less than 30 meters are considered a "toy" which are potentially interesting options for FM inspections. Above 30 meters and below a certain height, the drone is controlled by a pilot or operator while real time data can be sent to a digital device. The data is then reviewed and analyzed for the required action.

It will be a different skyscape according to Amazon (13). They indicated that in the United States there are approximately 85,000 commercial, cargo, military, and general aviation flights every day. This number is expected to be dwarfed by low altitude Small Unmanned Aerial Vehicles (sUAV) in the next 10 years.

Some current drone applications are:

Security – While the issue of privacy is real, the benefit and cost effectiveness of "eyes in the sky" are undeniable.

Thermography Scans – Buildings with failing joints in the infrastructure can result in increased heating and cooling costs. UAV's can scan a facility and send mages to the operator indicating the areas of the building requiring corrective maintenance due to heat loss etc.

Maintenance – Service drones are now able to inspect and clean HVAC ducts, weld, fasten, drill, clean exterior windows (22), and conduct FM assessments for roof top and as well safety inspections.

Surveying – HD quality video and high resolution images enable Facility Managers to obtain optimal information for Building Information Modelling (BIM) strategies. Also, conducting roof take offs for measurements for roofing estimates.

Safety – In 2014, Abu Dhabi (14) a high-rise window cleaner scaffold failed 10 stories above the ground. The UAV was deployed using audio and visual devices and was able to calm the worker down, observe why the scaffold failed, and relay instructions to repair it.

Photo source: Window Cleaning Drones

While the costs and sizes of drones were at one time prohibitive, they continue to drop in both accounts.

Depending on brand model, and aviation restrictions, UAV's can travel up to 1000 meters in altitude at 50 KMH, have a flight time of 1 hour, and pay load up to 12 pounds (10,11).

UAV are typically less than 1 meter in diameter but experiments are being conducted with compressed technologies enabling the drone to fit into the palm of one's hand. This would facilitate a host of opportunities within the built environment.

Recently at Colorado's largest utility provider, tests were conducted using drones to inspect the interiors of power-plant boilers in Denver, as well as a plant in Minnesota. Inspecting components inside the boilers, traditionally involves the use of scaffolding, ladders and people. The drone inspection resulted in quicker work and was conducted at a lower cost at about $25,000, compared with $125,000 with conventional techniques of ladders, scaffolding and personnel.

The following chart depicts partial elements of various countries regulatory requires for drones. Please consult local aviation requirements to understand the full impact of local UAV regulatory requirements.

Drone/UAV Regulatory Overview (partial requirements – check countries current aviation regulations)	
In Canada, Unmanned air vehicles (UAVs): • The exemption will permit non-recreational UAVs with a maximum take-off weight exceeding 2kgs but not exceeding 25kgs • Maximum calibrated airspeed of 87 knots or less to be operated away from built-up areas, airspace, controlled aerodromes, forest fire areas, and other restricted locations. • Shall have no less than $100,000 in liability insurance coverage • The pilot shall operate no more than one UAV at any one time. • The pilot operating under this exemption shall only operate a UAV during daylight hours. • The pilot operating under this exemption shall operate a UAV at or below 300 feet above ground level (AGL).	**CANADA (17)**

• The pilot operating under this exemption shall only operate a UAV at least five (5) nautical miles away from the centre of any aerodrome from a built-up area.	
In the USA, • Unauthorized drone operators may be subject to fines of up to $25,000 and up to 20 years in jail. • Unmanned aircraft must weigh less than 55 lbs. (25 kg). • Visual line-of-sight (VLOS) only; the unmanned aircraft must remain within VLOS of the operator or visual observer, with vision unaided by any device other than corrective lenses. • Daylight-only operations (official sunrise to official sunset, local time). • Must yield right-of-way to other aircraft, manned or unmanned. • Maximum airspeed of 100 mph (87 knots). • Maximum altitude of 500 feet above ground level. • Minimum weather visibility of 3 miles from control station.	**USA (18)**
In the UK, regulation applies to small unmanned aircraft (UA): • Weight 20kg or less used by model aircraft enthusiasts or hobbyists and to devices of all sizes used for aerial work purposes. • For smaller hobby devices, the Civil Aviation Authority (CAA) sets out some requirements within Article 166 & 167; including restrictions on flight within congested areas, at heights of over 400ft and within visual range of the pilot. • Additionally, UA cannot be flown within 50m of any structure which is not under the control of the person in charge of the aircraft. • Figures from March 2015 indicate that there are currently 549 approved small UA operators in the UK. Review of these suggests they are predominantly film production related, with a handful performing aerial surveys and inspections for a variety of reasons.	**UK (19)**
In Austria, unmanned aerial vehicles ("UAVs") or "drones" are regulated by Austrian aviation law, the regulating agency is named "AustroControl". • Toy UAVs are excluded from these regulations, even if they contain a camera, and fly no higher than 30 m. • UAVs are differentiated by weight, and their area of operation is differentiated as uninhabited, lightly inhabited, densely inhabited. • The person who remotely pilots such UAVs must have a valid certification which depends on weight and area of operation, certification exams are administered online by AustroControl.	**Austria (20)**
In China, Civil UAV Air Traffic Management Measures, • A civil unmanned aerial vehicle (UAV) shall be in accordance with the law is engaged in industry, agriculture, forestry, fisheries, mining, construction of flight and medical and health, disaster relief, meteorological observation, ocean detection, scientific experiment, remote sensing mapping, education and training, culture, sports, tourism and other aspects of flight activities. • Civil UAV activities used in radio frequency, radio equipment shall comply with the national radio management regulations and rules, and may not cause harmful interference to radio frequency. Aeronautical radio frequency shall be used for civil UAV remote control system. On civil unmanned aerial vehicle (UAV) set the radio equipment, the use of aeronautical radio frequency, shall apply to the civil aviation radio management committee office.	**China**
Drones in Brazil (generic term) are classified and regulated as its purpose of use, • Leisure, sports, hobbies or any competition for instance, classifies the equipment as a model airplane, which does not require any specific authorization under any agency to operate it. However if the final purpose of the use is for research, experiments, deliveries, photos, films or any other professional destination for instance the same equipment (Drones) will be categorized as UAV Unmanned Aerial Vehicle and must have federal authorization issued by the ANAC (National Civil Aviation Agency) to fly. • Nevertheless, there are some of Air Force's regulations which apply to model airplanes (drones) that must be followed during the flying operation. It cannot be operated over cities, districts or	**Brazil**

any densely populated neighborhood, strictly prohibited close of any airport or aerodrome and it cannot fly higher than 400 feet.	

Space Utilization

A conference room may have been booked, but was it used the entire time? A desk may be assigned to a staff, but are they out of the office 70% of the time? It is highly common to have an occupancy rate of 85%, but have a utilization rate of 25%-40%. How can we optimize our workplace strategy and increase our utilization rate, while hopefully also increasing productivity of the occupants?

Workplace strategies requiring essential space utilization assessments once regulated to a time consuming walk through with clip board in hand, walking through floor by floor, room by room, can now efficiently be measured via sensors. The walk through process was a static initiative while the occupancy sensors are dynamic i.e. sending continuous information to the CCC for analysis into staffing to floor plate ratios.

Lighting Systems

Lighting systems often consume the single greatest amount of electricity (20-45%) in commercial buildings so it is important to integrate this data into the CCC. It is also essential the consumption of the electricity is tied to occupancy and natural sunlight availability (security purposes excluded).

Parking Systems

Remember the days of driving around and around trying to locate a vacant parking spot in a parking structure wasting time and creating additional greenhouse gas by wasting fuel? Today sensors mounted in parking structures send vacancy data to a command center. Through directional arrows, and numeric display signs, drivers can be redirected to the vacant stall on the respective floors. Furthermore signage adjacent to the parking lots located at street level, can also display in real time the number of vacant stalls (if any) so drivers are not wasting valuable resources driving to an already full parking structure.

Machine Efficiency Monitoring

The ability to be able to monitor buildings energy consumption and costs has been available for quite some time but recently technology has evolved to measure the efficiency on individual assets ex. pumps and motors in real time.

Imagine each machine gathering and sharing data as an individual cost and performance center.

Factoring in business intelligence, we are now also able to **predict when the motors will fail** and the **cost of NOT maintaining the asset**. In essence it is a continuous commissioning process and could form the basis of a new maintenance philosophy - Performance Centered Condition Based Maintenance. Machine-to-Machine (M2M) communication is right around the corner when less efficient motors and pumps will be reassigned to other machines which are running more efficiently.

Grundfos reports that pumps account for 10% of the world's electrical consumption. (21)

The Future

Imagine machines, buildings, cities, countries so connected and integrated through remote monitoring whereby the consumption, costs, performance of everything is monitored in real time, enabling inhabitants to modify behavior which results in an outcome for the betterment of future generations. Now that's sustainability.

To say that FM technology is literally changing before our very eyes would be at best an understatement, and at worst, an overused cliché. Faced with the almost overwhelmingly reality of new and emerging FM technologies in today's workplace that have been discussed in this paper, it is understandable that technology fatigue and a keenly felt visceral reaction can occur when FM leaders simply do not know where to begin, in embracing and utilizing this new technology that has the potential to turn the world upside down, or rather, it is hoped, right side up.

This white paper ends with an invitation to talk to your colleagues in the FM industry about these new technologies. It is also an invitation to talk to the authors, about implementation strategies, about knowing where to begin, and about knowing that this integrative and collaborative technology will only provide sustainable solutions for our globe, if the FM leaders themselves using this technology are equally committed to collaboration and mutual success. So come and join us on this FM / IT Nexus journey!

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