Forbesinsights

INTELLIGENT WORLD

THE STATE OF THE IOT

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PART 1

THE INTERNET OF THINGS: FROM THEORY TO REALITY
How Companies Are Leveraging IoT to Move Their Businesses Forward

Of all emerging technologies, the Internet of Things (IoT) is projected to have the greatest impact on the global economy. Heralded as the foundational technology for breakthroughs in artificial intelligence, robotics and other broadly applicable advances, it is too early to tell if IoT will live up to that promise or become the most overhyped of new wave technologies.

For frontline decision makers—the executives who are charged with implementing IoT in their organizations—it can be difficult to separate the hype from reality. It can be even more difficult to discern the practical steps required to make IoT projects a reality.

To better understand the current state of IoT, Forbes Insights partnered with Hitachi Vantara to survey more than 500 senior executives around the world who are leading IoT initiatives within their companies. The following is a compilation of articles that highlight key findings from this research, including: :

- **Is IoT still an aspiration or is it becoming an operational reality?**
- **How is IoT being leveraged within companies?**
- **What do IoT implementations look like at this early stage?**
- **What are some of the early implementation lessons learned?**
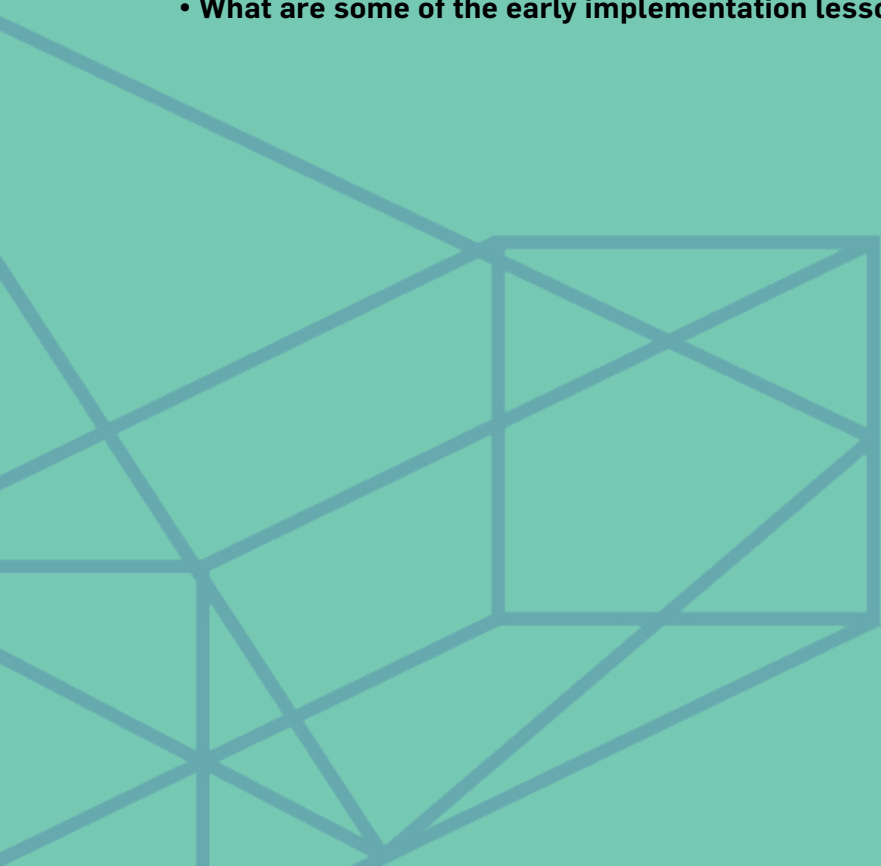
STATE OF THE IOT: WHY SO MANY BUSINESS LEADERS ARE PAYING ATTENTION

Of all the emerging technologies that companies are contending with, the Internet of Things (IoT) is what's keeping business leaders up at night. In fact, according to a new survey by Forbes Insights, IoT is ranked as the most important technology initiative by senior executives; more important than artificial intelligence and robotics, among many others.

Given all the speculation around IoT, these numbers aren't entirely a surprise. Gartner recently suggested that as many as 3.1 billion IoT devices could already be in use by businesses today, and by 2020, that number could more than double to 7.6 billion connected devices.

Others suggest even higher numbers. IHS Technology believes 30 billion devices could be in play by 2020, and by 2025, the number could top 75 billion. Even using the more conservative figures, the business impact of IoT will be profound. AT Kearney estimates IoT could impact 6% of the global economy, and that more than half will be driven by disruption, where revenue will be shifted from one player to another.

With so much at stake, companies everywhere are starting to think seriously about IoT and how they can leverage it for their business. In industrial sectors like manufacturing and transportation, IoT has the potential to help improve efficiency and reduce supply chain costs. In more commercial sectors like healthcare and financial services, it could help companies gather new data and improve the customer experience.

THE FUTURE IS NOW

Despite these benefits and all the recent talk about IoT, it's not as if executives only recently discovered its potential. The technology has been top-of-mind for some time. In fact, IoT peaked at the top of Gartner's famous Hype Cycle curve back in July of 2014.

At the time, a number of people were saying it was going to be a game changer. In fact, Daniel Burrus, a well-known technology forecaster and innovation expert, said that IoT was the one technology trend "that's going to give us the most disruption as well as the most opportunity over the next five years."

Fast forward to today and we're starting to see some results from all this hype. According to the Forbes Insights study, many companies are already leveraging IoT

technology and many others are ramping up their efforts. Eleven percent of respondents said that IoT programs are already a major contributor to their businesses. Another 40% said they had significant IoT programs in operation, and 36% said they were operating pilot programs. Only 13% said they were still in the planning stages, which makes it clear businesses are taking IoT seriously.

THE RACE IS ON

But, even with all this momentum, when looking at where companies stand with IoT development, executive enthusiasm is a bit more muted. More than 50% of executives say that when it comes to IoT deployment, they are in the middle of the pack, or on par with most of their peers in IoT development. Only a small minority—19%—see themselves as either ahead of their peers or pioneers when it comes to these technologies. The rest, 28%, admit they're followers.

Additionally, when respondents in the Forbes Insights study were asked about the success of their company's current IoT initiatives, feelings were lukewarm, with 51% ranking their success as a neutral three on a five-point scale. Thirty-nine percent said they were succeeding to some degree, and only 3% said their programs were exceeding expectations.

IOT IS NOW A REALITY THAT CAN'T BE IGNORED

What does this all mean? Companies see IoT as an important emerging technology with the potential to give them an important competitive advantage now and in the near future. Yet, while they're investing resources and getting results, most don't feel they've separated themselves from their peers.

For those who haven't identified IoT as an important part of their strategies, or are on the fence, the climb is even steeper. The longer companies delay, though, the further behind they'll fall. The exponential nature of technologies like IoT intensifies the problem. The speed of change isn't linear, it's compounded by previous advancements. As the number of connected devices continues to accelerate, the pressure to leverage the IoT's capabilities and benefits will intensify, putting laggards in a position that may eventually be indefensible. More advanced competitors will widen the gap, quickly creating significant differentiation that will jeopardize the relevance of slow movers.

The message for executives is clear. Predictions about the importance of IoT are starting to pan out. IoT is, and will continue to be, massively disruptive. Those who are already experimenting with IoT need to keep up the momentum, and those who aren't, need to get in the game—soon—or they risk complete disruption.

WHY EVERYONE IN YOUR ORGANIZATION IS CRITICAL TO IOT IMPLEMENTATION

T he Internet of Things (IoT) is growing by leaps and bounds. Some estimates suggest that the number of connected devices could reach 30 billion by 2020, with 7 billion of them running in business environments. This creates a huge opportunity for those who embrace it.

Most, if not all, of these devices will be generating data, which, when analyzed properly, can help companies make better decisions, improve their customer experiences, drive costs out of their operations and create new revenue opportunities. IoT even has the potential to blur the lines between industries, helping companies expand into entirely new markets. With so much on the line, careful thought must be given to how an IoT initiative is implemented from both a technology and an organizational standpoint.

HOW COMPANIES APPROACH IOT TODAY

More often than not, implementing IoT requires a team that is cross-functional in nature. In a recent Forbes Insights study, over 500 business executives were asked to indicate which groups or employees are involved in the day-to-day activities of their IoT team. Outside of the C-suite, results were pretty evenly split:

- • VP of IT (38%)
- • Suppliers or vendors (33%)
- • Head of commercial line of business (32%)
- • Chief Information Security Officer (31%)
- • Product designers (31%)
- • Programmers (26%)
- • Security specialists (25%)
- • Mobile communications specialists (23%)

This varied breakdown isn't surprising when you consider the myriad of ways companies are leveraging IoT. With supply chain or logistics, for example, where IoT has the potential to drive significant cost savings, it's reasonable to have IT, programmers and vendors involved. In other cases where IoT could affect the customer experience or create revenue and growth opportunities with new products and services, product specialists need to be more involved. But whether your goal is to better track assets through your facilities or create a product feedback loop, IoT also creates a new element of risk, necessitating the involvement of security personnel.

3 REASONS A BOTTOM-UP APPROACH TO IOT IMPLEMENTATION IS BETTER

Regardless of who is involved, IoT projects are better implemented from the bottom up versus the top down. In a bottom-up approach, managers set the milestones and employees determine the steps needed to reach them. Individuals and team are encouraged to reach goals and objectives in ways that work best for them. Projects start small with a well-defined scope, teams move quickly, learn as they go and repeat in iterations until they find success. This agile style works particularly well with IoT for three reasons:

1. The technology around IoT is changing so rapidly.
By the time corporate identifies a problem, writes a position statement, requests RFPs, interviews vendors and finally makes a recommendation, the solution will likely be obsolete. Smaller teams can move through the technology selection process faster, and as things change, adapt more quickly.

2. It's far more difficult to be agile from the top down.
Companies are looking at IoT opportunities in many different functional areas. The needs of a team working to implement a program on the manufacturing floor are likely different from those of a team tasked with adding IoT connectivity to a new product. Smaller, nimble teams can accomplish their goals more quickly. With a supportive senior leader, they

can get the resources they need, and with the right cross-functional support, they can still ensure corporate standards and protocols are met.

3. The far-reaching benefits of IoT are often hard to imagine. It isn't until you've successfully implemented a project and have started collecting data that you're able to see how a particular solution might benefit other parts of the organization. By using an iterative, bottom-up approach, you can build on each success, finding new ways to apply new knowledge. A top-down approach, on the other hand, takes far longer, delaying the benefits for individual parts of an organization.

THE NEED FOR A CHAMPION

While, in a bottom-up approach, the people working on IoT implementation are responsible for getting projects to the finish line, they still need to be empowered and entrusted to do so. That's where an executive champion comes in.

When asked who in their company has the greatest responsibility for the day-to-day development of IoT programs, respondents in the Forbes Insights survey overwhelmingly said the CTO (52%),

with the CIO in a distant second (15%). This makes sense. If you've ever worked with cross-functional groups, you know it can sometimes feel like herding cats. Everyone is busy with other, nonrelated projects, so you need someone to facilitate and make decisions around platforms, devices, connectivity, security, data collection, analysis and more.

Yet it's important to note that an executive champion is not a micromanager; the primary goal is to provide the tools and platforms required to successfully carry out IoT initiatives. Bottom-up projects work only when teams are empowered and clear boundaries are set. It's ultimately the role of a champion to simultaneously advocate for the team and bring accountability for adhering to program boundaries.

For organizations still considering an IoT strategy or thinking about expanding their current efforts, managing from the top down is risky: Six months or a year from now, you may find yourself in the same position you are in today. Those who allow IoT projects to develop from the bottom up can dramatically improve the speed of implementation. The pace of this technological change is accelerating, and you need to move quickly to keep up.

6 WAYS TO GET ACTIONABLE INSIGHT FROM YOUR IOT DATA

The number of IoT-enabled devices is growing exponentially. Gartner recently suggested that as many as 3.1 billion IoT devices could already be in use by businesses today. Some estimates even predict that by 2025, the total number could be much higher, exceeding 75 billion. Together they'll generate an immense amount of data, and companies everywhere are scrambling to get their heads around it and figure out how to make the best use of it.

IoT-enabled devices are already being used for many different applications. In some cases, the data they collect is used to communicate status, such as whether a device is running properly. In other cases, data is used to provide actionable intelligence that helps people (and machines) change their behaviors, or to provide a feedback loop that companies can leverage to improve the functionality and user experience of their products. Regardless of use though, here are six ways your company can make the most use of data gleaned from IoT initiatives.

1. SET A GOAL
Even when you're in discovery mode, it pays to have a goal in mind. At the trial stage, goals could include things like making sure the technology works, confirming whether your solution actually solves a customer problem or flushing out systemic problems that are likely to be an issue as you scale. The track can be loosely defined, but you still want to be able to confirm progress and achieve a result. In the end, you're looking to make smarter decisions that yield business results.

2. KNOW WHERE YOUR DATA IS COMING FROM
Collecting data from IoT initiatives is part of the challenge. Many different types of IoT devices are used in business settings, including:

- Industrial control systems that enable centralized control and monitoring in manufacturing environments

- Commercial wearables like gas detection monitors and police body cameras

- Sensors and devices that monitor temperature, pressure, humidity and other environmental conditions

- Location beacons and GPS systems

- Tablets and other devices running business applications

Beyond devices, data can also come from other sources, including open application programming interfaces (APIs) that connect with other internal and external networks and systems, as well as web data, social networks and traditional media. Regardless of source, to take full advantage of IoT, you have to collect all the data and know where it's coming from. Only then can you prioritize its usefulness and importance.

3. SOLVE THE INTEGRATION ISSUE
Within a business setting, thousands of different devices could be collecting data simultaneously. While that's impressive (or frightening, depending on your outlook), the raw data doesn't bring much value unless you can refine it and put it in context.

In a recent Forbes Insights study, over 500 business leaders were asked to name the biggest challenges their company faced in building out its IoT capabilities. Thirty percent said it was integrating disparate data. When it comes to IoT data, the whole is often greater than the sum of the parts. To maximize its potential, data has to be gathered and transported somewhere where it can be viewed holistically.

4. MANAGE THE BASICS OF DATA ANALYSIS
Once IoT data is captured and integrated, the real work begins. Data must be analyzed for meaningful insights, which is an expensive and time-consuming endeavor. In fact, more than a third of executives in the Forbes Insights survey said they were

collecting large amounts of data but weren't able to take full advantage of it.

IoT data analysis has many nuances of its own. Determining the frequency of data collection is a common challenge. If data is collected too frequently, it can be difficult to identify bigger trends. Complexity can create another challenge. Abnormalities can be difficult to spot, especially when you're trying to analyze multiple disparate sources. Add the fact that systems aren't always reliable: Sensors can misread and transmissions can be interrupted. All of these must be understood and accounted for before data can be blended and analyzed.

While more data is created with IoT, it doesn't automatically lead to new insights. IoT data must be prepped before it can be properly analyzed. Typically this involves blending data from multiple different sources, including devices, sensors, databases and applications like customer relationship management (CRM) and enterprise resource planning (ERP) software. Once everything is blended, attributes and relationships in data also have to be normalized to reduce redundancy and improve integrity. Other issues can also creep in. Frequency of collection, complexity of the data and device reliability can all be challenges, though most can be accounted for when using a data analysis tool like Pentaho or Talend.

5. HAVE THE RIGHT PERSONNEL

According to recent research from Boston Consulting Group, annual spending on IoT will pass $250 billion by 2020. Nearly 10% of the money spent ($21.4 billion) will be on analytics to support IoT applications and drive insights. A large chunk of that will be spent on people.

In the Forbes Insights study, executives were asked if they had the right people and resources to manage the data generated from their IoT programs—almost a third said they didn't. Without the right team in place, though, the data from IoT initiatives is almost useless. When looking for talent, make sure you look for people who can write algorithms, manage and segment data, interpret what they're seeing and—most important—communicate it to other parts of the business.

6. FOCUS ON OUTCOMES

Data from IoT that is properly analyzed, by the right team, can be useful in many ways. For respondents in the Forbes Insights

survey, among those operating IoT programs to generate incremental revenue, 55% said they were using connected data to create new services they could offer customers, and another 44% said IoT was creating data and analytics they could sell outright.

Whether your company is considering an IoT program or is already actively involved, give considerable thought to how you'll collect, analyze and leverage the data that's generated by these systems. Given the number of sources, it can be difficult to manage, but if you know what your goal is, and have tools in place to measure your success, the results will dramatically improve your business.

The data gleaned from IoT can play a crucial role in helping companies reduce costs and create new business opportunities. But to fully realize these benefits, the right people, processes and technology must be in place to collect and analyze the data, identify the strongest insights and determine how these findings can move the business forward.

CHAPTER FOUR

DON'T GET CAUGHT UNPREPARED WHEN IT COMES TO IOT SECURITY

IoT is top of mind for many business leaders today. While executives continually hear about the proliferation of IoT-enabled devices, what's really driving their interest is how these technologies can be applied and the benefits they can deliver for their businesses. In virtually every industry, IoT can have an impact.

- In manufacturing, IoT can be used to predict machine failures in order to improve maintenance schedules and reduce or eliminate unscheduled downtime.

- In transportation, IoT can be used to track vehicles and optimize routing, which improves on-time performance and safety while simultaneously reducing cost.

- In medicine, IoT has the potential to provide better monitoring, which can be used to promote wellness in addition to enhancing outcomes for those who are ill.

These are just a few examples of IoT's potential. While executives may understand the opportunity, they're also concerned about the pitfalls involved with implementing an IoT strategy, mainly security.

According to a recent Forbes Insights survey of more than 500 executives, 70% are confident in their ability to maintain the security of IoT, but over half also say they're placing a higher security standard on their programs. While it seems companies are confident in their ability to protect their assets, executives also perceive the risk, and in some cases, that's affecting

the speed with which they execute. In fact, 39% of executives surveyed say IoT programs at their companies have been delayed due to security concerns.

SIX RECOMMENDATIONS FOR IOT SECURITY

One of the challenges with IoT is managing a complex group of disparate hardware, software and network platforms. With this structure, and the number of potential devices and entry points into your network, IoT requires an end-to-end approach to security. Here are six steps you can take to better ensure the security of your IoT initiatives:

1. Secure IoT networks: Just like other IT systems, networks used for IoT should employ all the normal security measures, including antivirus, malware protection, firewalls and intrusion prevention.

2. Focus on authentication: IoT devices must be able to communicate with other devices, but it's crucial that they also authenticate. Things can get a bit more complex given the various types of devices, including single-user, multiple-user and machine-to-machine scenarios, so it's recommended that companies use a trusted platform for authentication. These can include digital certificates, two-factor authentication and even biometrics. Newer options like Trusted Platform Module (TPM) are also being used to robustly manage the authentication process.

3. Monitor the health of IoT devices: Individual IoT devices are a point of vulnerability. If they are compromised, the system should not allow them access. A standard like Trusted Network Connect (TNC) can be used along with other tools to confirm the health of software and firmware at boot, during operation and during sensitive upgrade cycles. If an IoT device is infected, it must be returned to a healthy state before it can be allowed to gain access to a network. This can be done using files saved in protected storage on the device, over a network, or with runtime verification.

4. Encrypt wherever possible: Whether it is in transit or at rest, protecting data is critical and encryption is key to protecting data security. Devices that can't prove their health should be denied access to encryption keys and other sensitive data. It's also important to maintain encryption key

management processes over the entire life cycle of each device.

5. Secure your APIs: Application Programming Interfaces (APIs) authorize and enable the movement of data between edge devices, applications and back-end systems. Securing APIs is necessary, and only authorized devices and apps should be accessing them. Tools should also be in place to detect potential threats and attacks on these key points of connection.

6. Analyze IoT security data: Collecting, integrating and analyzing data from different devices, applications, legacy systems and other elements of an IoT system for vulnerabilities and abnormalities is critical to the overall health of an IoT system. This area of IoT security is starting to see significant benefits from machine learning and artificial intelligence, which provide predictive analytics and detect anomalies in ways that aren't possible with traditional network security tools.

Beyond security related to technology, companies should also ensure that their people, processes and procedures are secure and enforced. Social engineering can be just as effective a method for hacking as a more technology-based approach. While technology is the lynchpin of IoT security, it is important to be vigilant on all fronts. Even with the best technology solutions in place, social engineering tactics are surprisingly effective at exploiting other types of vulnerabilities.

Security with IoT is not something that can be ignored or overlooked; the consequences of a breach are just too severe. Consider the Mirai botnet attack in 2016 that took down a long list of websites, including Shopify, Netflix and Twitter, by targeting vulnerabilities with outdated firmware in IoT devices. To avoid a similar attack, companies must keep security top of mind. With proper planning and diligence, businesses can minimize risk while also gaining a significant advantage over their competitors.

CHAPTER FIVE

THE FUTURE OF INDUSTRIAL IOT: Q&A WITH RICH ROGERS, SVP, HITACHI VANTARA

T he Internet of Things (IoT) is increasingly becoming an integral part of companies—their strategies, their day-to-day activities and their futures. In fact, when 500 executives were recently surveyed by Forbes Insights, more than 90% said IoT would be important to the future of their companies.

Nowhere will IoT be more disruptive than in the industrial sector. To learn more about the future of how IoT will affect this broad and influential sector of the global economy, we spoke with Rich Rogers, SVP, product and engineering, industrial IoT portfolio at Hitachi Vantara.

WHY IS IOT SO IMPORTANT FOR BUSINESSES IN THE INDUSTRIAL SECTOR?

At Hitachi Vantara, we look at industrial IoT (IIoT) as powering the next industrial revolution. In the first revolution, we went from man-made goods to machine-made goods. Then electricity came along and brought factories and machines to life. Now we think industrial IoT will turn every asset into a smart, connected asset. In the past, companies would send armies of people out into the field, performing regularly scheduled maintenance on everything from elevators to dump trucks and conveyors. With IoT, those machines will send information about their activity, health and location, creating more of a just-in-time model for service. That opportunity alone is a game changer. But there's plenty more.

LIKE WHAT?

Getting everything connected to get real-time visibility into what's actually happening is the first opportunity. Bringing machines to life through software is the second side of it. The example everyone gets is Tesla. In 2014, thousands of people already owned a Tesla, but then in October of that same year, those cars received a new capability. Through a software update, they added self-driving capabilities. Software is rippling through everything right now.

WHERE IN THE INDUSTRIAL SECTOR WILL IOT LIKELY HAVE THE GREATEST INFLUENCE?

There's a tremendous amount of upside with IoT in manufacturing. At Hitachi Vantara, we've found that manufacturing companies often have some of the lowest revenues per employee. With artificial intelligence (AI), software and robotics, you can almost flip it to the point where those types of businesses can be among the highest. Consider data centers for a moment. Through automation and orchestration software, they run with very little human intervention. With IIoT, we're taking what we've learned in the data center and applying it on the factory floor. This enables all aspects of the business, from materials management to operations and maintenance to production and finishing, to become very efficient, really driving down the costs of manufacturing.

HOW WILL INDUSTRIAL IOT IMPACT PRODUCT DEVELOPMENT?

There are so many parallels, and one of the best ways to learn is through analogies. When promoting a product, Amazon conducts A/B and multivariate testing, where they have one product and run multiple different ads to see which performs the best. We think a similar approach will be taken with product development. As a product is being deployed and consumed, data will feed right back into the product development process so improvements can be made to subsequent versions of that product or inform new product design. Just as Amazon can optimize their ads, manufacturers will be able to develop smarter, more reliable and more effective products based on how the products are actually being used.

HOW WILL IOT WORK WITH OTHER EMERGING TECHNOLOGIES?

For us, AI is one of the hottest things right now. It's sort of like the new electricity. It will be as important to the next industrial revolution as electricity was to the second. We also think augmented reality (AR) will be very important, and there are many opportunities for collaboration. For example, envision how AR might be used to help a general-purpose maintenance person service a company's entire equipment portfolio. They show up on site, they scan an IoT-enabled asset, AI helps them make the right diagnosis, and then AR helps them make the repair or swap out a part. IIoT brings all of these technologies together. How we manufacture products will change, the products themselves will change, and how we service them will change.

WHAT'S THE "KILLER APPLICATION" FOR INDUSTRIAL IOT?

In manufacturing, to be specific, I feel like it's the combination of AI, software and robotics, leveraging IoT and working toward a fully automated manufacturing facility. When you play things forward 10 to 20 years, you can almost envision manufacturing-as-a-service. Just like it wouldn't make sense for most companies to open their own data center today because there are cloud-based options, in the future it may not make sense for them to open their own factory. In that environment, OEMs would have access to plants that are highly reconfigurable, capable of supporting many different customers. It also better enables distributed manufacturing. In that sense, we're moving away from globalization and back to localization. Companies want to manufacture in their local economies. AI, software and robotics could help manufacturers bring new, modular facilities online without the gigantic challenges they face today.

HOW SHOULD INDUSTRIAL COMPANIES PREPARE FOR IOT?

Everyone needs to be in learning mode. People need to dip a toe in the water and create some projects. Businesses can start by inventorying their end-to-end capabilities and then figuring out where they can get the best learnings. Then there are some other obvious first steps, like selecting an industrial IoT platform and getting their gear connected to it so they can start to have visibility into the data. Companies should also put a team in place that can analyze and leverage the data. Beyond that, they need to focus on

software. In the past, industrial companies would compete based on their equipment, but now in many cases, the key differentiator is software. There's a lot of application and programming work that needs to take place to fully take advantage of the opportunity. Marc Andreessen nailed it when he famously said that software is eating the world, and right now, every single company needs to become a software company.

While the future of IoT is bright, it seems there is still much work to be done. Given the size of the industry now, and projections going forward, IoT has the potential to create a lot of value for organizations that embrace it.

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<div>CHAPTER SIX</div>

5 AREAS WHERE THE IOT IS HAVING THE MOST BUSINESS IMPACT

It's no secret that the Internet of Things (IoT) is poised to have a big impact on how organizations design, produce and sell products and services. More and more, companies are looking at how the IoT can be leveraged across their entire operation, from how they identify new business models and source materials, to how they streamline production and manage the customer experience. Here are five areas where the IoT is having the most impact within industrial companies.

1. PRODUCTION OPTIMIZATION

Recent Forbes Insights research found that 45% of executives surveyed identified IoT-enabled manufacturing as a high or very high priority for their enterprises—despite only 21% of respondents being directly involved in the manufacturing sector. This seems logical given the impact the IoT can have on almost any product-oriented business. For example, when IoT-based solutions are introduced on the factory floor, they can have a dramatic impact on overall quality by helping manufacturers detect substandard materials and ensuring adherence to product specifications. For brands, the resulting higher level of quality generates cost savings throughout a product's life cycle.

Production optimization drives additional benefits. For companies like Harley-Davidson, with complex manufacturing operations, investing in IoT-enabled production facilities is a relatively simple decision with tangible results. At the Harley-Davidson manufacturing plant in York, Pennsylvania, for example, every step in production is now tracked and recorded into a real-time performance management system. As part of the implementation, Harley-Davidson installed software and sensors that measure, record and manage the performance of different equipment and processes. The paint booth, for example, is monitored for heat and humidity, and software automatically adjusts the speed of fans when measurements deviate from acceptable ranges.

The system also returns real-time data to employees and managers via large screens, computers and smart devices. This information gives them better visibility into what is happening on the plant floor and improves decision making in the fast-paced environment. The results of Harley-Davidson's efforts to optimize production have been profound. They have reduced costs by 7%, improved employee productivity by 2.4% and increased net margin by an impressive 19%.

2. SUPPLY CHAIN MANAGEMENT

In the same Forbes Insights survey, 64% of executives said that the overall management of the supply chain was a priority for their company. For companies with sprawling logistics operations, this seems obvious. Amazon, for example, has experienced rapid growth in the past few years. It currently manages over 500 million stock keeping units (SKUs) (up from 400 million earlier this year) and operates more than 490 fulfillment centers, hubs and other locations around the globe, some of which are over 1 million square feet in area.

Amazon employees used to walk through these massive fulfillment centers, scanning and picking products. But in 2012, Amazon acquired Kiva Systems, which manufactures IoT-enabled robots that are now used to automate that process. By improving warehouse efficiency, these robots have cut operating expenses by 20%, saving an estimated $22 million every year in each distribution center where they've been deployed. If the Kiva robots were installed globally, at all of Amazon's estimated 255 distribution centers, it could save the company more than $5 billion annually.

Amazon is not alone, and warehousing is not the only application. Solutions enabled by the IoT can also help streamline the costs of distribution and logistics in many types of commercial and industrial enterprises. In the healthcare industry, for example, the supply chain for medical devices and implantables wastes $5 billion annually due to complexity, redundancy, inaccessible data

and inadequate analytics. A recent report from Strategy Analytics suggests that IoT capabilities could help slash medical supply chain costs by 25% or more, saving the industry more than $1.25 billion per year.

3. ASSET TRACKING AND MANAGEMENT

The IoT can also improve asset tracking and management, another area that's important to executives. Seventy-four percent of respondents in the Forbes Insights survey said asset tracking and management was a large priority for their companies.

For organizations with a large inventory of assets, the IoT can provide important information about the location, health and efficiency of equipment. Consider Sullair, for instance. For more than 50 years, the company has manufactured air compressors that are used in a wide variety of industrial applications. The company's redesigned remote monitoring IoT solution—AirLinx—is a standard

feature across Sullair's product line, enabling customers to monitor their compressors and receive maintenance alerts that help minimize downtime.

Downtime is costly in any production environment, and the prevalence of air compressors in industrial settings makes reliability critical. According to Jon Hilberg, Sullair's vice president of commercial and industrial air systems, "compressor downtime in a factory is one of the most critical problems a user can face." Having the ability to monitor the health of that equipment and eliminate unscheduled maintenance is an important way to ensure overall productivity.

Of course, asset management is a need in virtually every industry and business type. Assets can include everything from handheld devices, furniture and vehicles to raw materials, parts and large industrial equipment. When armed with near real-time data,

including asset location, environment and health, companies can optimize how assets are used and deployed to help maximize return on investment.

4. FINANCIAL DECISION MAKING

One challenge for financial leaders in any business is gaining access to metrics that can help avoid risk while simultaneously taking advantage of the opportunities these new insights present. Perhaps it's not surprising then that 82% of executives in the Forbes Insights survey said that finance was one of the functions they were prioritizing most.

The IoT can play an important role in financial decision making by providing real-time visibility that complements data from enterprise resource planning (ERP) and accounting systems and allows for a more holistic view of the enterprise. Take Atria Power, for instance. Atria Power is one of India's largest independent power producers. Through a partnership, it recently created a forecasting model for its power generation and distribution network. Atria has multiple locations that use both wind and solar technology sourced from several different manufacturers. To populate the forecasting model, Atria needed an IoT solution that would enable it to capture and analyze information from its equipment, including environmental factors, such as wind direction and cloud cover, despite variances between the OEMs in how data was stored and transmitted.

Atria began by collecting data from its wind turbines, which use sensors to measure things like the speed and angle of the turbine's blades and temperature of components. Every 90 minutes, the IoT-enabled solution sends details on the equipment and environmental conditions and helps Atria determine how much energy will be produced over the next 24 hours. With this information, Atria Power can more accurately forecast how much energy it can provide to utilities and plan for the storage of excess energy that can be sold later.

5. CUSTOMER EXPERIENCE

One of the most broadly applicable manifestations of the IoT is in its potential to help organizations improve the customer experience (CX). In the Forbes Insights study, 90% of executives said that potential improvements to CX was one of the most important opportunities for the IoT. While this seems obvious in the consumer space, the IoT can also dramatically impact how customers procure and consume industrial equipment.

Heavy equipment manufacturer Caterpillar, for example, is transforming its business by incorporating the IoT and other digital technologies. More than 10 years ago, the company began outfitting its equipment with sensors and embedded connectivity. Today, almost everything Caterpillar produces, from locomotives and industrial generators to construction and mining equipment, can measure and communicate critical data. As a result, over 560,000 Caterpillar vehicles now collect and transmit data to their owners. To help customers engage with these new data streams, the company has also developed a suite of software, analytics tools and application programming interfaces (APIs) that enable customers to retrieve, process and analyze their data.

Caterpillar's IoT-enabled products increase the value it provides to its customers by reducing operating costs, increasing efficiency and improving productivity. In some cases, these tools have even led to full autonomy. Caterpillar's autonomous mining vehicles, which can function for longer periods and along more precise routes than manually driven vehicles, have helped increase mine productivity by over 20%.

As these examples show, the IoT has the potential to help almost any company move its business forward. Whether it's through production optimization, a streamlined supply chain, better asset tracking and management, improved financial decision making or a better customer experience, the IoT can, and will continue to, improve the bottom line for companies in nearly every vertical.

WHY COLLABORATION IS ESSENTIAL FOR SUCCESSFUL IOT IMPLEMENTATION

L ike other aspects of digital transformation, successfully implementing an IoT strategy at the enterprise level requires tight coordination and collaboration from many different internal and external parties. Most organizations understand that collaboration with capable and proven partners is necessary for IoT program planning and deployment, but a successful program can also provide insight and knowledge that can be integrated back into the enterprise to help improve many facets of the operation. In this regard, IoT project implementation can be a scenario where everyone wins.

As companies begin to plan for how they'll manage digital transformation, it can be helpful to start by taking stock of what they already have and how their current systems and processes perform. This often involves reviewing current operational practices, information technology systems, business processes and organizational structure, and determining how those align with current business objectives. From there, companies can consider what 451 Research calls the "Realm of Possible," which involves asking what could be accomplished if they were starting with a blank slate. While starting from scratch typically isn't realistic, envisioning it this way can help business leaders better understand what is possible in a dynamic environment enabled by the IoT.

A key challenge of IoT program implementation is to demonstrate value in a way that enables people to visualize the return on their time and energy. A recent Forbes Insights study asked over 500 executives about their challenges with implementing an IoT strategy, and 31% said cross-department collaboration is one of the biggest obstacles to success. Yet collaboration, both internal and external, is critical to successful IoT implementation.

WHO NEEDS TO BE INVOLVED WITH IOT INITIATIVES INTERNALLY?

Given the strategic nature of the IoT, initiatives need the support of senior management as well as operations, IT and security leaders, but a number of other key, internal influencers should be involved, including:

- **Product development:** If an IoT initiative involves the company's current or future products, the product development team most certainly needs to be involved. This team can benefit from these initiatives since data coming from IoT-enabled products enables them to make better decisions about future features and resources and, as a result, maximize customer benefit and ROI.

- **Marketing and sales:** Data derived from an IoT initiative can help marketing and sales optimize customer interactions and track experiences throughout the path to purchase and beyond. IoT data can also help these departments make important decisions about how to monetize future offerings, determining whether a capability should be offered as a product or as a service.

- **Manufacturing:** The IoT can certainly provide benefits on the factory floor, providing key data that can help eliminate downtime, improve efficiency, ensure quality and reduce costs. But IoT data from the field can also provide real-time visibility into customer demand and create a tighter connection with the customers, helping manufacturing teams improve forecasting and logistics while also streamlining inventory.

- **Post-sale service and support:** IoT data regarding customer use can provide insights that would help this group improve ongoing customer satisfaction, be more proactive and unlock new revenue opportunities.

- **Finance:** Early involvement with IoT initiatives can help a company's financial team better plan for initial capital requirements and make better decisions regarding ongoing operational costs.

- **Legal and compliance:** Depending on the scale and reach,

data collected and shared by an IoT solution could be impacted by licensing and regulation. With this group's oversight, companies can ensure data stays within regulated boundaries and that information is protected from the point of origin to the cloud (or wherever computing resources are located).

THE 4 BENEFITS OF CO-CREATION

While internal collaboration is key for IoT implementation, collaboration with external parties is just as important. One way to view external collaboration is through the lens of co-creation, where multiple parties join together to produce a mutually beneficial outcome. This is an area where external partners, including third-party IT providers, operational equipment vendors and systems integrators, can also make significant contributions to IoT initiatives. By understanding the needs of the organization, they can help develop more collaborative approaches, including new business models that focus on shared risk outcomes.

When it comes to developing an IoT strategy or program, here are four benefits of a co-creative approach:

1. Buy-In: Co-creation is attractive to stakeholders because they are involved in every key decision and get to leverage the results of one another's work. The process is highly motivating because everyone understands how the project will be organized and share a common vision.

2. Gets IT and OT in the same room: While IT has deep knowledge of computing, software, networking and other key areas of their domain, they're not intimately familiar with challenges faced by operations staff. Members of the operations team generally have the best grasp on what happens on the factory floor but may not be fluent in current IT technology. Together, these groups can bridge the gap,

ensuring that solutions are sound from both perspectives.

3. Amplifies knowledge of existing staff: By involving partners from outside the immediate organization (which can include other affiliates, parent companies and/or external partners) and sharing data gleaned from their respective silos, all parties have an opportunity to gain new insight.

4. Exposes needs for additional expertise: Co-creation helps clarify all the key areas of technology, including hardware and sensors, data analytics, security, cloud and edge computing, standards and protocols, and storage, among others. Getting all parties together helps highlight areas where expertise is missing.

We live in an era when the IoT is already having an impact on business outcomes, helping companies save money, make money and reduce risk. As platforms mature and program implementation accelerates, the IoT is likely to become an even more important factor in business operations and decision making. This will place a greater value on the co-creation approach, where internal and external influencers collaborate to improve buy-in and integrate the perspectives of multiple functions and teams. As a collaborative effort, co-creation amplifies knowledge, identifies gaps in expertise and helps organizations maximize the benefits of IoT-based solutions.

4 REASONS WHY ARCHITECTING FOR CHANGE IS CRITICAL FOR IOT

Over the past 40 years, technological change has proven highly disruptive to virtually all global enterprises. From computers and networks to e-commerce and mobile devices, companies have been forced to quickly adapt or experience the pain that comes with being a follower. The Internet of Things (IoT) is likely to be the next monumental shift. The IoT is quickly becoming mainstream, and together with artificial intelligence, robotics and other emerging technologies, could end up having a bigger impact than any of the technologies that preceded it.

The problem, though, is that there are a lot of unknowns. Hardware will continue to improve, standards and protocols will continue to proliferate, and advancements will be made in where, when and how data is collected, analyzed and acted upon. For companies who are planning an IoT strategy, this can be daunting. The traditional method of architecting for change, where people analyze the current state and then try to envision a future state, just doesn't work. There are too many unknowns. A better solution is to focus on improving the current state of business and developing an architecture that can evolve instead of having to start over each time a change occurs.

ARCHITECTING FOR CHANGE

As software has developed over the last few decades, it has become much more diverse. The move from client-server to networks and the cloud has created many opportunities for integration, but it's also made architecting solutions more difficult. By creating hooks that allow software to more easily communicate, application programming interfaces (APIs) have been an enabler for growth, but they've also become a source of heartburn for enterprise architects. At times, corporate systems are evolving faster and more broadly than they can anticipate. Change is no longer the exception, it's the new normal, and companies must be ready and able to adapt.

To account for this sort of rapid transformation, companies are considering more agile forms of architecture. Typically, these are based on several key principles:

- **Ontology:** The architects, implementers and other constituents need to utilize a common structured vocabulary that represents the meaning of terms within a specialized context. It acts as a specific form of glossary.

- **Abstraction:** Components that make up a system are decoupled to the point where they don't need to know much, if anything, about one another. That way, when a change is made to one, there's minimal impact elsewhere.

- **Standards-based:** Modern architectures rely on industry, de facto, and corporate standards as a way to ensure everyone is building things the same way. Among other things, it allows new people and processes to plug in without having to learn a customized work system.

- **Agnosticity:** The goal here is to avoid being locked in by a specific technology, product or vendor. An architecture might be reliant on a specific technology (for now) but can change as other options become available.

TOPICS TO CONSIDER WHEN PLANNING FOR IOT

In a recent Forbes Insights study of more than 500 executives, 40% of respondents said they already have significant IoT programs in place. To ensure ongoing success in this highly dynamic environment, companies need to build flexibility and modularity into their architecture. Within an IoT system, there are four main areas that must be considered:

1. Hardware and software: With so much variation in devices and so many different protocols for connecting and moving data, the architecture must be highly modular so that, if needed, specific hardware components and software programs can be replaced without having to reengineer the entire solution.

2. Network connectivity: While the devices in an IoT system might be diverse, they still must send and receive data while also protecting security. Some of the principles of abstraction can help here, where the location, language and naming convention of each component are irrelevant. The system must be designed for transparency.

3. Edge computing: The whole idea behind edge computing is to have some decisions made as close to the point of data creation and/or collection as possible. This helps improve speed and reduce network bandwidth. But edge computing also diverges from a traditional cloud-based system. An agile IoT architecture must be able to account for new advancements, not only in hardware and software, but also with networking and other innovations.

4. Data management: Data that requires more complex processing and doesn't require immediate decision making is often delivered to a data center or the cloud for analysis, insight and storage. The architecture for these systems must be flexible enough to support multiple environments. For example, an IoT device might need to connect and communicate with legacy equipment and share that information with a cloud-based enterprise resource planning (ERP) system. IoT architecture must be adaptable and agile enough to process and manage data from many disparate sources.

IoT architectures must also consider elements beyond the technology itself, including data analysis and insight, both of which are driven by people. In the past, companies would create a specific role with responsibility for ensuring that people and workflows were reviewed and prepared to support new capabilities. As part of their work, these individuals would analyze a current process, make recommendations, test their theories and, if successful, reduce the new process to practice. In the highly fluid world of IoT, this approach is too rigid and too slow. Companies have to make benefiting from change a core competency, and that begins by planning for change in their architecture, enabling rapid and thorough adaptation.

4 WAYS TO OVERCOME THE COMPLEXITY OF IOT IMPLEMENTATION

In the consumer space, it is well publicized how nearly every device is becoming smarter and more connected. What receives less attention in mainstream media is the considerable impact the Internet of Things (IoT) is having in the industrial sector. The Industrial Internet of Things (IIoT) is already helping enterprises operate more safely and productively while improving efficiency and reducing costs.

While IoT-based solutions can offer significant benefits, they can be challenging to implement. Forbes Insights recently surveyed more than 500 executives and, when asked about their greatest challenge in building out their IoT capabilities, 29% said it was the quality of IoT technology. This isn't surprising. In some cases, IoT platforms must support thousands of vendors, dozens of standards, and be able to scale to millions of devices, together sending and receiving billions of messages.

CHALLENGES WITH MANAGING IOT TECHNOLOGIES TODAY

IoT-based solutions are typically made up of a group of technologies, some already existing and some entirely new. Each has its own path of development, and when they're combined, they can create an environment that is complex and rapidly changing. Here are four challenges with managing IoT technologies today.

1. Integrating New Technologies Into Existing Environments. In the era of the smartphone, it may seem as though every machine is connected and sharing information, but that's not the case. In the consumer world, a mix of technologies are competing for dominance, and standardization remains elusive. As a result, relatively few homes, appliances and other consumer goods are actually IoT-enabled and connected.

In the industrial world, it gets even more complicated because of the nature of the investments. Capital equipment that has been in the field for 20 years or more is not always a viable target for replacement, as a stove or refrigerator

may be in the consumer world. Retrofitting is often the only realistic solution to bring IoT capabilities to existing equipment. However, retrofitting is neither simple nor assured. While connecting legacy equipment and systems offers big benefits and is an important step in the IoT initiatives at many industrial companies, the hurdles to implementation can be formidable.

That said, companies are making important strides in this area. They're adding stand-alone sensors and cameras to existing environments and devices to monitor and collect data about machine performance and health. These sensors attach directly to existing devices and connect to gateways to securely collect and transmit data, which can then be analyzed and used to help prevent failures and downtime.

As Rich Rogers, SVP, product and engineering, industrial IoT portfolio at Hitachi Vantara, explains: "There's a whole bunch of legacy stuff out there that needs to be integrated, and we're looking at the best ways to do that. We're thinking of a Fitbit-like approach for industrial machines. If legacy machines don't have sensors built into them today, how can we attach them in a cost-effective manner? Doing so would enable us to begin measuring things like vibration, temperature, the climate where the machine is deployed, dust in the air and other factors. Cameras also play a big role, enabling companies, through a common platform, to pop open a video and get a real-time sense for where a machine is and how it's being used."

2. Managing Complexity: Protocol Proliferation. Another big challenge in the deployment of the IIoT is the vast number of protocols. Some of the more common standards include:

- BLE (Bluetooth low energy)
- ZigBee

• Z-Wave

• Thread

• We-Mo

In some ways, BLE, ZigBee, Z-Wave and Thread are similar. They're all wireless technologies that use mesh networks to wirelessly connect and network IoT devices without involving a cellular or Wi-Fi signal. But they differ in the radio frequency they use, their operating range and the number of devices they can support at a given time. We-Mo, however, does require Wi-Fi, which eliminates the need for a hub or controller, and allows devices to connect directly via the internet. Two of the big disadvantages of this system are that it requires significantly more power and processing capability than other, lower-energy options.

Again, this is just a short list; the number of protocols is extensive. Each has its advantages and drawbacks, but since there is no single common standard, companies must determine the right protocol for each use case and ensure the technologies they choose are compatible with their overall platform. As standards continue to evolve, it may be advantageous to replace or upgrade along the way.

3. Bringing Data In From The Edge: Networking Challenges. Beyond the many different protocols and disparate hardware, there are basic networking challenges that must be addressed to make IoT-enabled devices a reality. It starts with connectivity. The first step is to ensure that data is flowing quickly and reliably. Security is also critical, as IoT devices are more frequently becoming targets for hackers and cyberterrorists. When devices connect, they must authenticate, data must be encrypted, and they need to communicate their presence and activity.

Power consumption and bandwidth present other unique challenges. In a scenario where thousands of devices are communicating with one another, frequent signaling and transmission can be a drain on battery-operated devices. In those cases, minimal, efficient power usage is key. In a scenario where thousands of devices are communicating over wireless networks, bandwidth can become a concern, and costs can add up quickly. The goal must be to keep IoT data streams as compact and efficient as possible.

4. Too Few Best Practices In Evolving Areas Of IoT. In the IT world, best practices are typically defined as procedures that are well-known and accepted to be the most effective. Today there's a lack of best practices to help companies write code, manage the life cycle of certain IoT-related hardware and software, and deal with the unique types of breaches that can occur, including intrusions that are initiated at the device level.

Without best practices as a road map, programmers and IT professionals are traveling in uncharted waters. Consider the Mirai botnet attack in October 2016. During this incident, IT professionals saw firsthand how prolific a breach could be. While the incident was damaging, much was learned, including the importance of having an IoT security strategy and a plan for quick response and resolution of incidents.

As the IoT continues to proliferate, there are bound to be growing pains. Hardware will continue to advance and improve. Software will become more sophisticated. New standards, protocols and connectivity options will become more prevalent. But companies must remember to ensure that their new capabilities remain compatible with legacy systems and that existing processes account for innovation. With this type of approach, companies can more easily handle the speed of change that comes with the IoT and fully realize its benefits.

IOT SUCCESS DEPENDS ON AN ADAPTABLE, NIMBLE CULTURE

"If you do not change, you can become extinct."

— Spencer Johnson,
Author, *Who Moved My Cheese?*

Companies in almost every industry are faced with the opportunities and challenges of digitalization. Transformative technologies like machine learning, big data and the Internet of Things (IoT) are impacting everything from the way organizations innovate to how they design, produce, market, sell and distribute their products and services. Those who successfully adopt these technologies have the potential to reap newfound benefits, and those who ignore them risk losing their competitive advantage as they struggle to remain relevant. However, making the digital shift requires people and organizations to alter their behavior and ways of thinking to fully embrace change.

With the IoT, transformation goes beyond the digital realm and into the physical world, and the pace of change is only accelerating. Effectively managing this change requires an agile, adaptable culture. In a recent Forbes Insights study of over 500 executives from different industries, more than a third said culture was the biggest obstacle to implementing IoT initiatives. This number was even higher in industries like retail (39%) and transportation (42%).

THE IMPORTANCE OF CULTURE

Culture can play an important role in the success or failure of a business. In part, it helps establish identity. In companies with cultures that are centered on business results, individual employees tend to focus on attaining their goals and objectives. In other cases, cultures are driven by specific values. Examples might include those who wish to be known for their commitment to diversity or environmental friendliness.

A strong culture can also help with recruitment, retention and even innovation. People want to work for companies where they are respected and feel like they are part of a team. And when employees are empowered and incentivized to think differently, they can create new solutions and solve problems in ways that can positively impact sales and customer loyalty.

In the Forbes Insights study, nearly one-third of respondents in sectors from manufacturing to financial services said that fostering innovation was one of their greatest challenges when creating IoT-enabled solutions. In part, this may have to do with the way companies approach the topic. Many are finding that the traditional top-down approach to innovation isn't very effective. They're learning that R&D driven by customer insights, empirical research and data analytics yields better results. Leaders still must provide a road map, where they clearly communicate the types of ideas they're willing to invest in, but from a cultural perspective, they need to empower employees to use the tools they think will work best to achieve their goals.

HOW CULTURE DRIVES INNOVATION

Emphasizing creativity and innovation can create a significant competitive advantage. Consider Apple as an example. At a 2013 Goldman Sachs conference, CEO Tim Cook was asked about the company's culture of innovation. He said, "Innovation is so deeply embedded in Apple's culture. The boldness, ambition, belief there aren't limits, a desire to make the very best products in the world. It's the strongest ever. It's in the DNA of the company."

Apple is not alone. A PwC study found that from 2010 to 2013, the most innovative companies grew by 38%, while the least innovative grew only 10%. Their research has also found that it's not just a matter of throwing more money at the problem. In the last 12 years, PwC has found no statistical relationship between financial performance and the raw amount spent on research and development (R&D). Better-performing companies simply innovate more effectively, and a lot of their ability to innovate comes down to culture.

HOW TO BUILD THE RIGHT CULTURE FOR IOT

In almost every case, IoT has the potential to impact the people that make up an organization. For IoT initiatives to be successful, companies must have a culture that embraces and celebrates change. Here are four steps you can take to improve your company culture and ensure the success of IoT initiatives.

1. Be honest with one another: As companies go through any digital transformation, roles and goals are likely to change. It's an unavoidable reality, but it's much better for companies to be transparent with their employees (and customers) so that everyone understands and can prepare for change rather than being blindsided by it.

2. Open the lines of communication: An environment where every employee feels that his or her voice is being heard is key to navigating change. Team members must feel that their ideas and concerns are taken seriously, from the top down. A free exchange of ideas, from the bottom up, often yields solutions that wouldn't have been evident otherwise.

3. Empower and reward those who adapt: Creating a culture where pursuing change is encouraged means giving employees the tools they need to learn and develop new skills while incentivizing them to become more agile and efficient. Condone reasonable risk-taking, and reward employees when they succeed.

4. Foster collaboration: Given the broad impact of IoT, a culture that encourages collaboration—especially across organizational boundaries—creates a framework for success in an environment where domains, expertise and technology are being combined more often and at a much faster pace. In the case of IoT projects, the concept extends beyond internal stakeholders, where companies encourage a co-creative approach with vendors and other third parties.

Consider Hitachi, for example. The company was formed in Japan in 1910 and over the decades has reinvented itself several times. Three of its core values include harmony, sincerity and a pioneering spirit. They encourage employees to respect one another, be frank and honest in their communication, work together to achieve common goals and be creative in their approach to problem solving. A reliance on these goals has helped the company manage many technology and business transformations, including how it approaches the IoT.

Implementing an IoT strategy requires companies to consider more than technology. They must also have a plan that considers their current business processes and the initiative's impact on their people. Building a strong culture that's focused on innovation helps everyone in the organization understand the need for change and plan for its eventuality. By creating this kind of culture, organizations will be able to fully leverage their greatest resource: their people.

PART 2

## DRIVING ENTERPRISE VALUE THROUGH SMART CONNECTED DEVICES

Original Research Identifies New Models for IoT Program Planning and Implementation

The keys to becoming a digital organization are many and varied, which makes successful transformation complex and elusive. New research from the University of Miami and Forbes insights reveals new ways that companies are leveraging data from the Internet of Things (IoT) to transform their business in ways that help them improve operations, develop new offerings and reach new markets.

To participate in the data-driven future, organizations must uncover and embrace new ways of doing business that are sometimes uncomfortable, always challenging and never linear. The truth is, there is not any one thing that enables companies to make the shift, but there are three fundamental questions that must be answered that will put you in the best position to succeed.

1. **What is going to be the impact of smart connected devices within our industry?**

2. **How will our organization have to reposition itself to maintain market leadership within the new industry dynamic?**

3. **What is the pathway we need to follow for a successful Internet of Things (IoT) deployment that yields the maximum value from the smart connected devices and the ecosystems within which they connect?**

The articles that follow loosely summarize the full research report and provide ideas on how your organization can apply decision-making models to develop a solid strategy in this time of sweeping change.
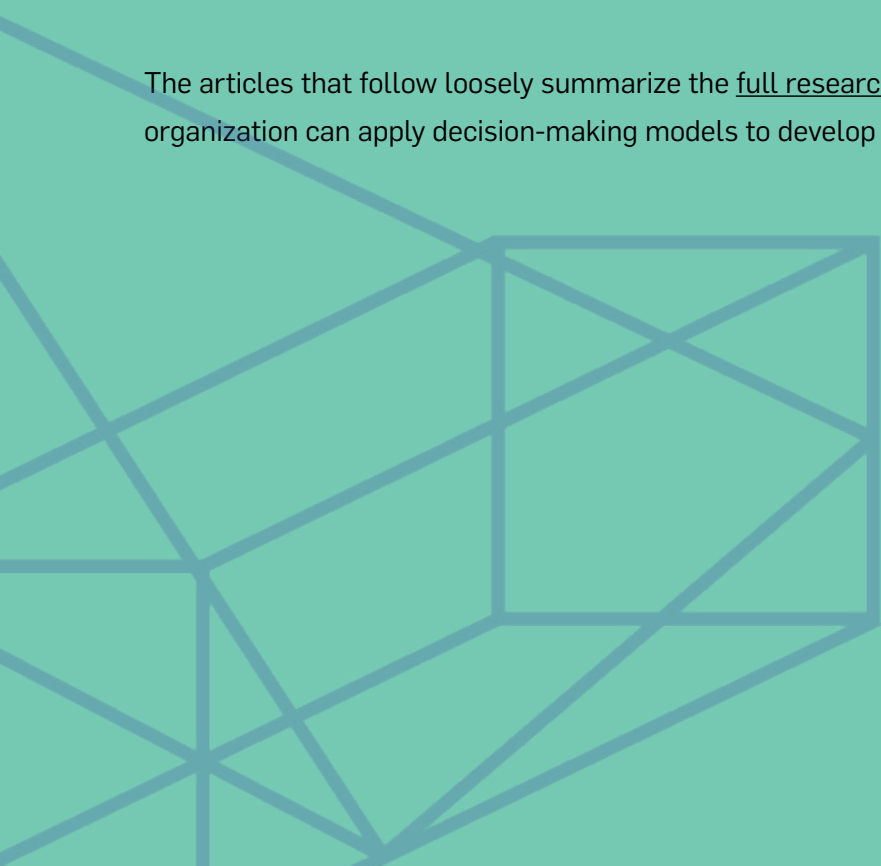
THE FOUR C'S OF WINNING WITH IOT

In the era of IoT, business leaders across industries will be judged by their ability to strategically manage the "Four C's" of data—curation, control, connectivity and capital. Here's why the Four C's matter and how companies are currently using them to win with IoT.

CURATION: KNOWING WHAT'S IMPORTANT

Executives today need to be experts in both business execution and in data curation. According to McKinsey, 90% of all data in the world today has been created in just the past two years. Given the volume and pace of new data creation, simply collecting and storing data is not enough. To derive true value from IoT data, organizations must take an active, deliberate approach to how they manage and curate their information.

To do this, companies first need to be clear on what questions they need data to address and then mine the right data sets, so they're led to the right insights. Instead of asking about "data," executives need to be asking, "What data provides value?" This shifts the focus from big data to "small data"—the data needles in the big data haystack. The power of small data is often overlooked, but it's invaluable. Once trends are identified or assumptions are validated through big data analysis, it is often the more accessible and tangible small data sets that form the basis for strategic decision making.

American aerospace manufacturer Pratt & Whitney understands the value of identifying the right data and asking the right questions. In fact, the company has created a dedicated system to help manage the data ecosystem surrounding its aircraft engines. The system, dubbed eFAST, captures, analyzes and wirelessly transmits selective, mission-critical information to ground crews during flight. By providing the right mix of information, customized for each engine model, eFAST allows airlines to optimize maintenance planning, maximize aircraft availability and reduce operating costs. When the need arises, airlines can also access full-flight data within minutes of engine shutdown to diagnose and address more complex or problematic scenarios.

CONTROL: MAKING DATA DANCE

Smart companies use smart connected devices to control existing assets while deploying new, interoperable ones. This enables a company to manage all assets, both new and old, under one platform. Shifting from an old business model to a new data-driven one requires a tight integration of people, processes and technology.

Jack Levis, senior director of process management at shipping and logistics firm UPS, says the company's On-Road Integrated Optimization and Navigation (ORION) system uses IoT technology to allow more control over its operations. This ORION system is constantly collecting information from several sources, including drivers, vehicles and packages, and data from all sources is integrated and analyzed to create a full picture of the operation.

By using IoT and predictive analytics, UPS has ultimately been able to better control and manage its assets, which has led to significant benefits. Combining knowledge of a given day's delivery locations, which packages are in which warehouses, truck locations and real-time traffic information allows UPS to optimize its routes. With IoT technology, UPS has cut the miles driven per year by 100 million, ultimately cutting CO_2 emissions by 100,000 metric tons, using 10 million fewer gallons of fuel and saving the company $350 million to $400 million per year.

CONNECTIVITY: BRINGING DATA TOGETHER

The power of IoT connectivity is huge. There is a paradigm shift from the traditional transaction-based enterprise computing philosophy to a new-school movement of total information ubiquity. KONE, a leader in elevators and escalators, has over 1.2 million assets worldwide, its equipment transporting an enormous number of people. "KONE moves 1 billion people a day," explains CTO Tomio Pihkala. "In seven days, that's the entire population of the planet."

Successfully managing this global presence requires an IoT strategy that takes these billions of people into account. "We believe we are going to live in a connected world where not only equipment but also our customers, our users and our own employees will be connected," says Pihkala. "When you think about that kind of world, IoT is playing an important role in building

connections. By connecting data, we can improve the quality of our operations, and ensure our customers succeed in their businesses."

With the help of IoT sensors, KONE can collect data from equipment, analyze it and create new ideas regarding products and services. To analyze all this information, KONE is partnering with IBM and using its Watson platform, which will allow it to open up application programming interfaces (APIs) and encourage a developer ecosystem. So a business partner could develop an app, for instance, allowing people to pre-order an elevator during the busiest times of the day. "We connect to our equipment through real-time IoT, and that enables us to create transparency for customers, which is very important to them as they can then see the status of their equipment through KONE Online Portal," says Pihkala. "Importantly, they can also see what our response is—this delivers peace of mind to the facilities managers and significant value to all parties."

CAPITAL: USING DATA TO DISCOVER SAVINGS—AND NEW REVENUE STREAMS

With IoT, the discussion around capital centers both on cost savings and on new revenue generation. For many organizations, much of the cost saving from IoT is first realized in the form of predictive maintenance—this is the low-hanging fruit of IoT. Predictive maintenance uses real-time data to anticipate downtime and streamline maintenance intervals for physical equipment and automated systems, which directly reduces O&M costs.

IoT-derived data can also be used to drive new revenue streams, as demonstrated by Pratt & Whitney. Instead of simply selling engines to airlines, the company is capturing the data from these devices to drive revenue in two ways. The first is through having airlines pay for the time engines are actually used ("power by the hour"), and the second is through having airlines pay for MRO (maintenance, repair and operation) services, which are determined based on the data collected.

To successfully transform any company into an IoT-led business, executives need the right strategy to take advantage of the incredible new capabilities the technology offers—and the volumes of new data being generated. But developing the right strategy depends on a thorough understanding of how these capabilities create competitive advantage. Consulting the Four C's—so you know what data is important, how to control your assets to maximize efficiency, how to connect your data and how to improve your capital position—can give you a strong framework to grasp these concepts and understand how to apply them to your own business.

CHAPTER TWELVE

HOW MATURE IS YOUR IOT STRATEGY? A NEW MODEL FOR UNDERSTANDING AND PLOTTING YOUR PROGRESS

"Failing to plan is planning to fail." This popular adage, often attributed to Benjamin Franklin, is especially true as organizations seek to shift to new digital business models and develop IoT solutions in a rapidly evolving technology landscape.

Without a clear vision and a model of the concrete steps needed to achieve success, organizations will continue to struggle with implementing IoT. In fact, according to a recent Forbes Insights/ Hitachi survey of more than 500 global executives, 57% say their current IoT initiatives are either not meeting expectations or aren't yet showing any clear signs of success.

While the survey reveals current challenges with IoT implementation, knowing where you stand on the IoT maturity curve can help you gain insight into what is realistic for you to take on now and what preparations are necessary for future progress. After interviewing more than 20 companies leading the way with IoT, we've identified five stages to IoT maturity:

While the final stage is one where the enterprise uses data from partners and the entire ecosystem, the first stage—point focus— includes organizations deploying simple, proof-of-concept systems that deliver minimal value and are vulnerable to attack. This new research-based model can illuminate where your company stands and help you plot your IoT strategy.

It's important to follow a comprehensive maturity model so that any test deployment can serve as a foundation for future innovation. Otherwise, there will be a lot of wasted work on the journey to full IoT value. Bear in mind, the maturity model is defined by value and data volumes, but it should be noted that these are relative scales. It's useful when comparing companies in the same industry or sector, but be careful when comparisons are not apples-to-apples.

Keep reading to learn more about each stage and what steps you can take to maximize value from your IoT initiatives in the future.
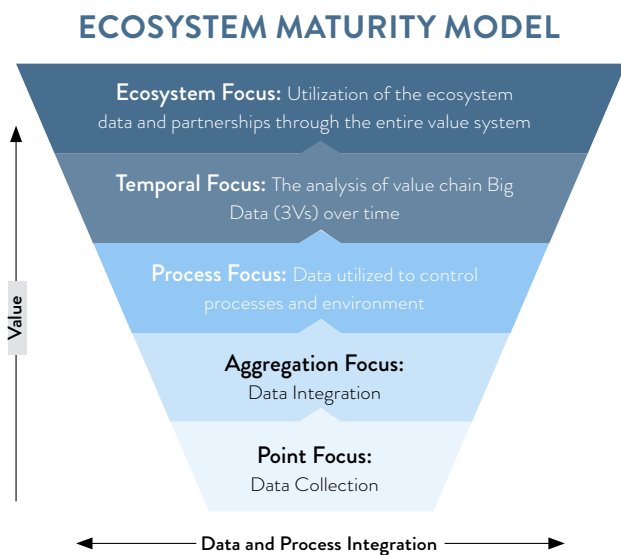
STAGE 1: POINT FOCUS—DATA COLLECTION

At Stage 1 on the IoT maturity spectrum, companies have determined that collecting data will help answer a series of specific, narrow problems or help them create tests to prove the value of IoT. So they deploy new devices and scour existing sources to collect all sorts of data: big, small, sensor, image, video, financial, social media, etc. Because these data collection systems are created for limited, distinct use cases, we call this a point focus system. Point focus systems typically stand alone and are easy to develop and deploy. They also provide simple types of homogenous data that doesn't have to be highly integrated with other systems to create value.

To illustrate with simple examples, RFIDs in cars for tolls and warehouse ON/OFF sensor lighting are two instances of simple systems. With car tolls, charges accumulate and the driver is billed without the system needing to connect to every department or transportation database. Likewise, ON/OFF

ECOSYSTEM MATURITY MODEL

Ecosystem Focus: Utilization of the ecosystem data and partnerships through the entire value system

Temporal Focus: The analysis of value chain Big Data (3Vs) over time

Process Focus: Data utilized to control processes and environment

Aggregation Focus: Data Integration

Point Focus: Data Collection

Value

Data and Process Integration

sensors just detect when people aren't there and shut off the lights to save money—no big data analysis needed.

However, a company must decide at this stage where its devices or sources fall on the IoT interoperability spectrum to determine how compatible and reliable a device or system will be when communicating with others. Choices made in Stage 1 can greatly impact an organization's options as it advances along the IoT maturity curve. As described in subsequent stages of the model, integrating data from many different sources is critical to achieving optimal value from IoT. Devices and systems that don't play well with others may need to be replaced over time, limiting the value of the initial investment and potentially throwing later-stage efforts into chaos.

STAGE 2: AGGREGATION FOCUS— DATA AGGREGATION

The shift in focus from collecting data to aggregating data occurs in Stage 2. At this stage, the emphasis is on preparing data so relationships can be understood and complex dependencies can be revealed. It is not unusual for large IoT networks to generate hundreds of terabytes of data per day. This can make aggregation difficult because data volumes can grow so quickly that companies often become paralyzed by their limited storage and processing capacity or are discouraged by high holding costs. Leaders must think through what data is most valuable, the cost to collect it, where to keep it, how much to keep and the acceptable cost to keep it.

To grapple with the onslaught of data, many companies at this stage choose to invest in IoT or other data aggregation platforms. When doing so, it's important to choose a platform that matches your operational and strategic goals while also meeting security, governance and regulatory compliance needs. Although Stage 2 is primarily a necessary preparation for Stage 3, which is focused on data analytics, the simple aggregation of data may uncover previously obscure relationships and reveal useful insights. Equally important—but often overlooked—is the task of assessing whether your company has the right talent and skill sets to manage the new technology. If there are gaps, they must be filled now.

One last point: Even though the focus of Stage 2 is on aggregation, that doesn't mean companies should stop collecting data. In fact, to reap the full benefits of this stage and prepare for the next, a company needs to prioritize collecting and aggregating data.

STAGE 3: PROCESS FOCUS—DATA USED TO CONTROL PROCESSES AND ENVIRONMENT

In Stage 3, proper data aggregation redefines the enterprise and its internal environment. Here, organizations use data analytics to gain granular insight into, and control of, process performance and manufacturing environments. This stage, where IoT meets analytics, is, for many, where intelligent innovation—in manufacturing, logistics, business processes and more—begins.

The development and deployment of this kind of process-centric IoT combines both operational technology (OT)—which is the hardware and software that detects or causes a change through the direct monitoring and/or control of physical devices, processes and events—and information technology (IT), which includes "digital things" like networks, software, databases and so on. When IT and OT work in harmony, manufacturing, transportation and many other processes and systems become more efficient. For example, as IoT improves the ability to actively monitor complex machines in the field, much industrial equipment will likely shift from a model where end-users "procure and maintain" to one where equipment makers service the machinery, using predictive analytics and "digital twins"— virtual mock-ups of the machinery.

In Stages 1 and 2, opportunities to gain efficiencies and reduce costs in OT prevail, but in Stage 3, macro-level opportunities arise from aggregating micro-level data. In this stage, organizations can focus on developing new strategic objectives and utilizing business process reengineering to achieve their goals by analyzing data from resources and smart connected devices to drive iterative process improvements.

STAGE 4: TEMPORAL FOCUS— THE ANALYSIS OF VALUE CHAIN DATA OVER TIME

In Stage 4, companies shift their focus from measuring and controlling processes and environments to delivering value across the entire enterprise—including external, customer-facing use cases and wholesale transformations of their business models. (A value chain is a high-level model that describes the process by which businesses receive raw materials, add value through various processes to create a finished product, and then sell that end product to customers. Companies analyze value chain data by looking at every production step required to create a product and identifying ways to increase the efficiency of the

chain.) The priority also changes from understanding what the data says about the present state of their systems to the value that can be created (both for the firm and its customers) by analyzing and using data over a longer period.

Companies that succeed at this level make the most out of the rapidly increasing volume of data being created, the accelerating velocity at which it's being sent to their systems, and the proliferating variety of data types available (the 3Vs) by actually evolving their core competencies. For most organizations, this involves an evolution from developing a physical product to creating adjacent information products or services that supplement the original product or even replace it as the main value driver. You can call this a "product-as-a-service" (PaaS) strategy.

For example, in 2016, Goodyear began transforming its fleet-focused business by moving from simply selling tires to helping customers reduce their fuel and tire maintenance costs. It did this by providing its customers with valuable analytics. The company's goal is to avoid 75% of tire-related blowouts, reduce fuel costs up to $300 per vehicle, per month, and decrease tire maintenance costs by up to 70%, which in turn reduces the carbon footprint by using approximately 10% less fuel. This shift in business model generates higher recurring revenue from the services provided and encourages closer customer connections due to the frequency of contact and depth of their conversations.

In terms of corporate performance, the firms who now operate in the PaaS space are rapidly pulling away from those still selling only physical products. The PaaS model prioritizes recurring revenue from longer-lived products that use connectivity and embedded services to continue to evolve after they leave the factory floor. By contrast, physical product makers' cash registers ring only when a net-new unit is purchased. Likewise, customers can get new features only by trashing their old model and buying the next one.

This mindset encourages enterprises to focus on product excellence and customer intimacy instead of price. Shifting the

focus to providing new levels of value can help manufacturers escape the trap of competing on price with a product that has become commoditized. To come out on top, though, it is important for executives to understand they are building a whole new business model, not just building out a new system.

STAGE 5: ECOSYSTEM FOCUS—USE OF THE DATA AND PARTNERSHIPS THROUGHOUT THE ENTIRE VALUE SYSTEM

The final step of IoT maturity, Stage 5, involves positioning devices and collecting data throughout the value chain. Connecting suppliers, channel partners and customers ultimately creates an ecosystem. The value of participating in, or organizing, an ecosystem versus going it alone is that:

- **You can readily integrate features developed by others to extend the capabilities of your products and services**

- **You can improve the customer experience by helping to improve products and services they already use**

- **It gives your firm access to a broader customer base**

An example of this is Nest, the smart thermostat entity and a subsidiary of Alphabet (Google). While the product is sold directly to the consumer as an energy-saving device, the company collects information from lots of other systems, like customers' HVACs, that is then leveraged in a partnership with utility companies to help save energy across the grid by changing consumers' thermostat settings. The savings are then split with the customers who let their thermostats be adjusted. This is an example of how success at Stage 5 can include consumers in the ecosystem and how their data streams can be used to guide product development or create customizable services.

Yet even in relatively advanced IoT implementations, companies face different and significant data challenges. For example, the Boeing Dreamliner produces over 500GB of data per flight; with a service fleet of 20,000 aircraft in service globally, projections of the amount of data being generated by 2026 are on the order of 98 exabytes. This ecosystem faces multiple challenges, including the volume of data being created and spun out during flight. As the data volumes spiral upwards, capture and retrospective analysis within these environments will become less feasible. In the future, this will require context-dependent streaming technologies, which demand robust platforms, aligned OT and IT, and clarity surrounding automated data handling—especially when using AI, machine learning and robotic process automation.

MAKING IOT WORK FOR YOUR ORGANIZATION

It's easy to get so close to your products and services that it becomes difficult to perceive all the value your offerings deliver or all the ways your customers benefit. As a result, identifying service gaps and making product or process refinements are based on feedback from a variety of sources that are often inconsistent and incomplete. IoT-derived data can provide a whole new view of your offerings that allows you to perceive things differently and in ways that may have otherwise gone unnoticed. By standardizing the feedback loops via IoT and bringing strong data analytics into the mix, you will have a more complete and reliable source of information for making decisions.

Once your firm is using IoT data to fine-tune its grasp on everything from production process to service delivery and consumption patterns, it will be easier to understand how to use IoT-derived data to drastically improve your offerings—and drive profitability.

To help you get there, use the IoT maturity model to see where you are today and what you need to do to progress to the next stage. In most large companies, divisions can be at very different stages of IoT adoption maturity, so it can be important to assess maturity at the business unit level as well. Remember that because IoT is in its infancy in many ways, no one company has all the expertise needed to make IoT work, so find experienced partners who can give you the knowledge you need to develop a sound strategy and help champion implementation.

MAY THE FIRM WITH THE BEST (NOT MOST) DATA WIN

A t a conceptual level, companies understand the potential impact the Internet of Things (IoT) can have on their business. Not only can IoT help companies cut costs and operate more efficiently, but the insights gleaned from IoT data can also help develop innovative products and services that feed entirely new revenue streams. IoT execution, however, is another matter.

Forbes Insights and Hitachi Vantara recently conducted research on the state of IoT, and while more than 90% of the 502 executives surveyed said IoT would be important to the future of their business, only half had significant IoT programs in place, and a large portion of those were still in the early planning stages. Even among those who had IoT programs in place, only 42% said those initiatives were meeting or exceeding expectations.

When the benefits of IoT are so clear—identifying new revenue streams, better customer experiences and lower business costs—why hasn't more progress been made? It may be because companies don't yet know how to best leverage IoT, but it may also have to do with how data is being collected, curated, analyzed and visualized within companies.

SMALL DATA AND BIG DATA WORK COOPERATIVELY

While 66% of respondents from the Forbes Insights/Hitachi survey said a key part of their IoT strategy was to learn from small projects and then move on to bigger initiatives, the size of a project isn't the only way to start small. In the early stages of implementing IoT, companies can also learn a lot from "small data," or data that is easily comprehensible and presented in a format that is accessible, informative and actionable. This contrasts with "big data," which refers to large volumes of structured and unstructured data that is mined, blended and analyzed with the help of technology.

IoT sits at the intersection of small data and big data. Sensor data can describe the health or performance of an individual or piece of equipment, and that same info can be aggregated into big data sets that describe entire communities of people or complex systems. While big data offers transformative potential by enabling organizations to identify patterns in past performance and behavior, small data provides the granular detail that can be used to develop strategies for prioritizing which problems to solve first and how to allocate resources accordingly.

In a recent interview, *New York Times* bestselling author Martin Lindstrom said, "Big data is all about finding correlations, but small data is all about finding the causation, the reason why." At later stages in an IoT strategy, during wider-scale deployment, big and small data should work cooperatively. Big data should identify correlations, and executives should then take a small-

data approach toward understanding causation.

DATA DOESN'T AGGREGATE AND ANALYZE ITSELF

Regardless of whether your company relies heavily on big or small data, it's not valuable unless you're able to successfully collect, analyze and leverage it. Especially in an industrial setting, the information provided by sensors, including things like temperature, speed, vibration and machine status, can be highly beneficial. On a manufacturing line, for example, data can help companies spot bottlenecks and improve efficiency. Or, on a wind farm, it can play a key role in helping energy firms optimize production and minimize downtime.

Yet data doesn't collect itself. In the planning stages of IoT implementation, businesses must identify all potential and relevant data sources and determine how they'll get access to the information. People and systems must also quickly adapt as new data sources become available. To ensure the flow of data is comprehensive and current over time, companies must architect for change. Software, along with the right IT infrastructure, can help bridge this gap, allowing users to create data pipelines and apply actions as part of a workflow as well as help improve data quality by filtering out anomalies automatically.

Just as data doesn't collect itself though, it doesn't analyze itself either. To be valuable, data needs to be refined and put into context—this transforms data into information. In a small data environment, this can be accomplished by humans. In a big data scenario, machine learning algorithms can be used to reduce large chunks of data into small, more comprehensible visuals like charts, histograms and other graphics.

DATA TACTICS TO CONSIDER

For organizations to be able to execute in real time, they need information that is immediately actionable. But as technology and data get smarter, humans must get smarter too. To get the most of your IoT data, consider the following data tactics:

1. **Make data easier to locate:** Whether it's big or small, the easier data is to locate, the more likely it can be consumed. Again, this requires upfront planning and an adaptable architecture that allows companies to consume new data sources as they become available.

2. **Increase the speed at which data gets collected, analyzed and made available:** The faster data becomes available, the quicker it can be analyzed and made actionable. Often this comes down to identifying roadblocks and bottlenecks. If IoT data is stuck in departmental silos, for example, companies need to find ways to foster collaboration so data can be easily shared across teams.

3. **Address and improve the quality of data:** Resolving data quality problems can help eliminate anomalies. To solve data quality issues, organizations must first be able to detect outliers and determine how extreme they are. It's also important to determine the cause of anomalies since that can indicate something amiss with a company's overall data collection processes.

4. **Improve the way information is visualized:** Enhancing the way information is presented can reduce or eliminate "noise" and make key insights easier to spot. Often this can be automated using business intelligence and analytics software. Key players in that market are even beginning to develop "augmented analytics" tools that use machine learning and artificial intelligence to help humans better visualize insights from large and fast-moving data sets.

5. **Lower the cost of data collection, preparation and analysis:** Driving down the cost of data preparation can increase processing capacity while simultaneously improving return on investment. Mostly this involves getting the "technology versus labor" equation just right. Software helps with that by creating data pipelines, improving data quality and filtering out anomalies as part of a workflow. When freed from crunching numbers, people can focus on developing solutions based on the data and addressing other business concerns.

In a nutshell, IoT offers organizations access to a wealth of information that wasn't previously available. At the tactical level, these new data streams can help companies discover and understand relationships and dependencies in their data that can be used to avoid problems and optimize their operations. The strategic value comes when the lessons from IoT-derived data are translated into processes and methodologies that enhance productivity and profitability. By following the tips above, and knowing when and how to leverage big and small data, companies can execute their IoT strategies with confidence.

Forbes insights

WHAT IT TAKES TO MAKE IOT IMPLEMENTATION A SUCCESS: Q&A WITH JOHN MAGEE, VP, HITACHI VANTARA

Organizations around the globe understand the importance of IoT. In fact, in a recent Forbes Insights/Hitachi survey of more than 500 executives worldwide, over 90% said IoT will be important to the future of their business. What's more, of all emerging technologies, executives said IoT would be the most critical, ranking it above others like artificial intelligence and robotics.

While executives acknowledge the importance of IoT, 49% remain in the early stages of planning or are only operating pilot programs. We spoke with John Magee, Hitachi Vantara's vice president of product and solutions marketing, to get his perspective on this state of development and how organizations can make IoT a larger part of their strategy and operations going forward.

IF AN EXECUTIVE IS LOOKING TO INVEST IN IOT AND UNDERSTAND THE ECONOMICS BEHIND IT, WHAT DOES HE OR SHE NEED TO KNOW?

Most organizations are looking to IoT projects to either improve operational efficiency or drive new revenue streams. A lot of organizations are seeking to use the data they can get from IoT sensors and connectivity to provide better visibility and help them understand what's going on in their operations. For product companies, they're often looking to optimize how their products are being manufactured or used, and to offer new data-driven services with those products.

The goal for most of these companies is to transform the way they operate and the way they compete. For business leaders looking to take advantage of IoT, the most important thing is to begin with the business outcome goals first and then determine what data IoT can provide that can help deliver those outcomes. It's the new data that delivers the business value. So that should be the starting point for any project. Then you can work back from there to the technology required to meet the objective.

For example, manufacturers might want to understand why quality issues are creeping into one of their manufacturing lines but not the other. Logistics companies may want to understand the location

of parts and deliveries to optimize scheduling. Product companies may want to sell new value-added software services that help customers get more value from their products. Whatever the goal, by understanding what data you need to collect and who needs access to it, the technology requirements will fall into place more easily and you won't over- or underspend for success.

WHEN EXECUTIVES ARE THINKING ABOUT WHAT DATA IS MOST IMPORTANT TO ACHIEVING THEIR DESIRED OUTCOMES, WHAT DO THEY NEED TO KNOW? HOW SHOULD THEY APPROACH THIS?

IoT is essentially a rich source of new business data. Data that comes from machines and devices, and from the spaces and environments those machines operate in. In many situations, just having access to real-time data about what's going on—in a manufacturing plant, on a remote oil rig or in a city train station— can be transformative. In most situations, though, some analysis of the data is going to be needed to gain the insights that lead to business value.

This is where technologies like big data analytics, machine learning and artificial intelligence come into play. Analytics is the key to not just understanding what is happening but also learning and getting smarter so that your IoT solutions can predict when a problem will occur or find the root cause of product quality issues that would have been unsolvable without analyzing the mountains of data that IoT can deliver.

The right way to think about IoT is as an extension of the business analytics that your organization is probably already doing in other areas. At the end of the day, IoT is a means to accessing and interpreting more data. And data management, data integration and data science are all key enabling technologies for IoT, just as they are for most other areas of business today.

One new twist on IoT data that differs from traditional business data is the idea of a "digital twin." The digital twin is the software representation of a physical device, such as a pacemaker, an

elevator or a dump truck. As data streams in from the physical device, it is collected and stored in the corresponding digital twin. The digital twin knows everything about that asset: where it was manufactured, how it has been operated, when it was last serviced.

By using software to analyze hundreds or even thousands of these digital twins, data scientists can build powerful analytic models that can optimize the corresponding physical assets. Organizations are using this approach to enhance asset uptime and performance, extend the useful life of critical assets and optimize maintenance and operations.

ONCE YOU'VE AGGREGATED DATA INTO A SINGLE VERSION OF THE TRUTH AND ARE DRAWING CONCLUSIONS, HOW CAN COMPANIES BEST INTEGRATE THAT INFORMATION INTO BROADER NETWORKS?

There's a sort of stairway to value in many IoT scenarios. The first step of the stairway is the physical devices themselves. The second step is the operations around those devices. And the third step is the business processes and ecosystem around those operations.

Think of a manufacturing plant. If you use sensors on critical plant equipment, you can get data that can help you operate that equipment more effectively. If you collect enough data, you can even

start to predict when it will fail so you can service it before that happens. So that's the next step—using the data insights about the equipment to optimize your maintenance and repair operations.

But that data can also be useful at the next step in the stairway, which is how your supply chain responds to requirements for parts or materials being delivered based on the performance of the equipment and operations in the factory. The more data you have, the more visibility you have, and the more opportunity to optimize every part of the operation. Sort of like air traffic control for the factory.

This stairway, or hierarchy, of value—from asset to operations to business process—is one we see play out in industry after industry.

WHEN IT COMES TO IOT, WHICH IS A COMPLICATED ENDEAVOR, RESEARCH SHOWS THAT IT'S BEST NOT TO GO AT IT ALONE. WHAT SHOULD EXECUTIVES BE LOOKING FOR IN A PARTNER WHEN THEY'RE CONSIDERING MAKING THIS TRANSFORMATION?

Working with a partner who understands your industry and has a methodology to help you think through your data strategy are the real enablers for success. IoT is a hot technology right now, and it is easy to get caught up in the hype and invest in the wrong areas. Working with an experienced partner who has a pragmatic approach that starts with understanding how IoT data and analytics will drive the desired business outcome is the key to success.

<div style="border:1px solid">CHAPTER FIFTEEN</div>

HOW TESLA, NEST AND MEDTRONIC ARE USING IOT-DERIVED DATA TO MOVE THEIR BUSINESSES FORWARD

Technology-enabled growth can come from many sources, but it's rarely technology alone that spurs progress forward. In the case of the Internet of Things (IoT), the "things" are important, but it is the combination of their interconnectivity and the data they generate that delivers value. Early adopters of IoT are not leading just because they're implementing these technologies first; they're leading because of how they're embracing IoT. We spoke with Tesla, Nest and Medtronic to learn how they are leveraging IoT-derived data to move their businesses forward in ways that were not possible just a few years ago.

TESLA: IMPROVING AND MODIFYING PRODUCTS ON THE FLY

With a goal to build autonomous vehicles, it's no surprise that Tesla has heavily invested in IoT and artificial intelligence. In fact, as previously reported in a *Forbes* article, all vehicles Tesla has ever sold were built with the potential to one day become self-driving. This means that as Tesla has grown so has the number of sensors on the road, which means millions of data streams have been, and continue to be, generated, collected and analyzed. With the sensor data it collects, Tesla can do something most car manufacturers can't—remotely modify its products and provide customers with improved functionality via software updates, immediately, at no additional cost.

For example, during Hurricane Irma in September 2017, Tesla temporarily extended the range of the cars that were in the storm's path by changing how the batteries were consumed. This helped its customers get to safety without needing to recharge as often. In another instance, Tesla was able to complete a mandated fix of charger plugs on more than 29,000 vehicles via a software update. This "over the air" fix was immediate and seamless, and saved its customers and the company countless hours that would have otherwise been spent with on-premise service at its dealerships. The lesson from Tesla: Planning for this level of upgrading via software is a good way to future-proof products.

NEST: SAVING ENERGY AND SERVING CUSTOMERS

Consumer product companies are also leveraging IoT-derived data to better serve their customers. For instance, Nest, maker of connected devices for the home such as thermostats, alarm systems and doorbells, enables its customers to check and control their devices from anywhere through a smartphone app. Nest extends the value of its products by learning from customer behaviors and adapting device functionality to user preferences. In the case of its thermostats, preferred temperatures and use patterns are recorded and analyzed over time and adjusted automatically to save energy. This has saved customers up to 12% on their heating bills and 15% on their cooling bills, or an estimated average savings of $131 to $145 a year, according to independent studies.

So, what can other companies learn from Nest? Companies with IoT-connected devices have access to more data about their customers than ever before, in terms of both data volume and detail. These new streams create an unprecedented opportunity for organizations to leverage that data to deliver better products, services and superior customer experiences. To be clear, this opportunity is not confined to consumer goods or even products. Companies from virtually all industries can use data to identify new revenue streams, improve product design and lower costs based on patterns of customer use.

MEDTRONIC: IMPROVING PATIENT CARE

As recently reported in a Forbes Insights/Hitachi survey, roughly half of the more than 500 executives surveyed said they have IoT programs in place, but only 42% of this segment said those initiatives were meeting or exceeding expectations. Clearly, having the right technology isn't enough for IoT programs to succeed. To be able to make the most of IoT and the data these devices provide, companies also need to ensure they have a clear analytics strategy.

Medtronic, a global leader in medical technology and services, understands how data drives its future. It is an example of a company that has successfully transitioned from being a manufacturer to a company competing through data analytics. The company's Medtronic Care Management Services (MCMS) division offers remote monitoring platforms that collect patient biometrics and symptom data. With the help of rules-driven algorithms, MCMS software can assemble patient health status and trigger corresponding alerts for potential clinical review.

By rigorously collecting, aggregating and analyzing patient data, the company can provide personalized care coordination and has been able to deliver the service to over 95,000 individuals. Additionally, by allowing clinicians to monitor their patients remotely and deliver the right care at the right time, MCMS is greatly reducing the burden on both patients and healthcare resources.

DATA IS THE WAY

What's clear from these examples is that companies in all industries need to have a strategy for how they'll leverage IoT data. The new IoT-based data streams are only useful if your company has the analytical capabilities to mine them for insights and use them to your advantage. The question of whether your company needs to start leveraging IoT is a foregone conclusion; the real question to ask yourself is how best to do so.

ABOUT HITACHI VANTARA

Data is your greatest asset, if you know how to use it. The key to new revenue streams, better customer experiences, and lower costs of doing business is there in your data, waiting to be discovered. It reveals your path to innovation and new ways for you and the world to work. Hitachi Vantara elevates your innovation advantage by merging operational and informational experience to offer you a data partner with unprecedented range and depth in data management. We are analytics, industrial expertise, technology and outcomes rolled into one great solution provider. We listen. We understand. We work with you.

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