Forbes insights

Driving Enterprise Value through Smart Connected Devices

Academic Research Based on Studies of How the World's Biggest Companies Are Leveraging the Internet of Things

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INTRODUCTION

Initially, executives in traditional enterprises were skeptical of the internet as a mechanism for creating value. In 1995, the CEO of a major book chain scoffed at a nascent company just starting to sell books on the "Web," exclaiming, "The world will wait for a better website!" That nascent company was Amazon, and the world didn't wait.

Twenty-two years since, the internet has developed at breakneck pace into a ubiquitous and indispensable tool, which is now connecting "things" with a strikingly similar momentum. So fast, in fact, that the protocol computers and "things" used to communicate (TCP/IPv4) ran out of its 4.3 billion addresses and was replaced by a new protocol (IPv6) that has enough for every atom on the planet. This seemingly arcane technical change should strongly indicate to executives that a true transformational tsunami will soon follow. Yet, again, until very recently, few took note.

One reason for this is that technology evolves slowly but is continuous and relentless. Just like the parable where a frog in a slowly heating pot of water fails to notice any change until it's boiled, so can companies remain oblivious to gradually evolving technology, until its ultimate impact sneaks up on and suddenly overwhelms corporations.

Thus, to avoid becoming the next poached amphibian, executives and boards must ask themselves three questions:

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 authors of this paper, in partnership with Forbes Insights and with the support of Hitachi Vantara, set out to answer these questions by interviewing 20 chief technologists and other senior executives at major corporations who have made (or are making) significant IoT-led transformations. We sought to fully understand their journey from idea to implementation; the roadblocks they faced, the triumphs they've won and the strategic vision that drove their success. Based on this real-world guidance, we have constructed a framework—or series of "thinking tools"—that executives can use to analyze their position and chart a course to deriving breakthrough value from the Internet of Things.

THE COMPETITIVE LANDSCAPE: THE IMPACT OF SMART CONNECTED DEVICES

Every enterprise, be it for-profit, non-profit or a regulatory agency, is about to undergo a radical change as the impact of smart connected IoT devices and associated big data technologies creates and reshapes relationships within industries.

To understand this better, market dynamics can be envisioned through the following 4C's model:

The model captures elements an enterprise needs to understand in order to maintain a market leadership position.

CAPITAL: The first step executives need to take is to gain an understanding of the capital basis and new economics of the IoT. Put another way, to what extent can IoT technologies 1) reduce costs to enable more-competitive pricing and free up capital to chase innovation and/or 2) enable top-line revenue growth through product improvements, new products or new business models.

Initially, most companies view IoT as a way to accomplish the first objective: This easily delivers value through predictive analytics based on data collected from IoT devices. For example, Caterpillar's Marine Division examined the efficiency with which containers on their ships were refrigerated. They took fuel meter readings from generators and relayed that back to their headquarters, where the analytics team determined that the use of more generators at lower power was more efficient than a few at maximum power. This created savings—for a fleet of 100 ships, running 24 hours a day, 52 weeks a year—of $2.6MM.[1,2]

However, the technology should not be viewed as a mechanism solely for reducing costs. Instead, IoT must be a basis for transitioning to a new business model that monetizes the data from a smart connected ecosystem through a product-as-a-service (PXaaS[3]) model. Used this way, the model can have multiple functions. For example, Pratt & Whitney doesn't just sell engines to airlines; it also captures the data from its (Geared Turbo Fan PW1000G) engines to drive revenue in two ways. The first includes airlines paying for the time engines are actually used ("power by the

1 http://info.tcs.com/enterprise-solutions-oracle-manufacturing-and-the-internet-of-things-blog.html
2 https://www.forbes.com/sites/bernardmarr/2017/02/07/iot-and-big-data-at-caterpillar-how-predictive-maintenance-saves-millions-of-dollars/#7950fddc7240
3 PXaaS – Product X as a Service; where X is any product.

hour"), while the second stream includes airlines paying for MRO (maintenance, repair and operation) services based upon data collected from the engines and devised through analytics. For example, airlines like American send engine health data to their ground operations from an inbound airliner. This allows preemptive planning for any maintenance repairs that need to be undertaken, allowing the ground crew to obtain the necessary resources, minimizing aircraft downtime. The manufacturer also embedded technology allowing it to add features to its products after the unit has left the factory floor. This is achieved for Pratt & Whitney through its EngineWise[4] program, which works in a similar fashion to a program deployed by Tesla that provides "over the air" updates to improve its cars, their self-driving ability, and their battery life.

This approach to feature-pricing gives companies several pricing mechanisms. They can charge for features directly, monetized in the form of a higher initial purchase price, or features can be provided for free—as many SaaS software firms do—with the intent of gaining market value through the added market share that a continuously improving product can capture.

Other value proposition variants of IoT economics include open platforms and data sharing. The Climate Corporation, a subsidiary of Monsanto, provides analytical capabilities to farmers based upon sensor readings in their fields. For example, its moisture and soil temperature sensor network feeds data into its agronomic models, which can be viewed through the Climate FieldView™ data visualization system to support the farmer's decision-making capabilities around seed selection and field fertility. The company uses weather data and field imaging systems (a similar technology to facial recognition systems) to feed machine learning algorithms in order to predict and identify crop disease and give solution diagnosis. Its aim is to increase crop production through predictive analytics. This application has a significant upside potential for both Monsanto and the farmers, as up to 40% of global crop production is lost to disease. Central to its value proposition to farmers is that basic data services should be free—namely access, transfer, and storage of data, to and from systems of other companies. This strategy provides the basis of the Open Ag Data Alliance (OADA), an association of farmers, industry organizations, and companies that provide data, advisory services, and other agribusinesses. This independent organization is intended to ensure interoperability, common data formats, as well as security and privacy standards across the agroindustry. By not locking down a farmer to a specific tool set and platform, it leaves farmers free to develop customized best practices with vendors and to share that data. Aggregated data can be shared among stakeholders, providing research data to seed growers and other industry members, closing the loop on the production quality cycle through the incorporation of After Action Reviews (AAR—borrowed from the military) after every planting and harvesting season.

CONTROL (OF ASSETS): The second step requires developing an understanding of how to effectively deploy smart connected devices to control existing assets and to develop new ones, be they human, physical, or cyber. This is vital as it enables organizations to transition from their current operational business model to a new data-driven one, one that will tightly integrate all assets: people, processes, and technology.

A frequent theme we found is that companies such as Pratt & Whitney, Goodyear, the Climate Corporation, and Caterpillar, use the data generated by IoT sensors and systems to effectively monitor physical assets such as aero-engines, trucks, and other equipment while in service. This IoT implementation strategy has also led to these companies driving increased productivity and a higher return on investment for their customers leveraging these IoT-based services.

Other companies use IoT to drive their analytical analysis of processes and deploy assets. To illustrate, Jack Levis, Senior Director of Process Management at UPS, notes, "UPS' ORION (On-Road Integrated Optimization and Navigation) system uses IoT telematics and algorithms to save UPS about 100 million miles driven per year. That's a reduction of 10 million gallons of fuel consumed. It also reduces carbon dioxide emissions by about 100,000 metric tons and saves the company around $350MM to $400MM per year." Levis comments that "UPS has clearly identified the need for IoT data to be captured and run through analytical models. This way ORION optimizes the driver's day. ORION

4 http://www.mro-network.com/maintenance-repair-overhaul/pratt-upgrades-flight-hour-program-parent-makes-300-million-digital

gathers and organizes data, creating an operational model, a forward-looking data model that knows not only where everything is but where it's going, where it should be going, and why it should go there."

UPS has three primary asset classes: the driver, the vehicle, and the packages. These assets are monitored and generate data for analysis by the firm. The first two, the driver and vehicle, for example, have independent UPS tracking devices feeding data back to the ORION system; the truck itself sends data back on the packages within it, and data on the driver; for example, is the driver using a seat belt while driving. This enables descriptive analytics to be undertaken about what's happening to the assets at any time, data that is otherwise unknown or "dark," without direct human observation.

Levis comments, "Analyzing this data allows us to understand a driver's complete day in 45 minutes of processing time, which would have taken us a full day of riding along with them to understand.…Then we use that data to make more data more accurate, like our maps, [which] are now the most accurate maps in the world as we needed that data for routing optimizations. This allows us to understand and optimize at the package level with consistency all year long."

By using IoT to control assets, significant benefits can be gained. Initial results at UPS show that a reduction of just one mile per driver per day over one year can save UPS up to $50 million.

CONNECTIVITY: The third aspect of the IoT strategic landscape is where executives must understand the power of connectivity. This requires a significant mind shift from the traditional enterprise computing perspective and even from the recent exploration of big data many companies have been through.

One company that illustrates this is KONE, a 100-year-old global leader in elevators and escalators, whose stated purpose is "to improve the flow of urban life." It has developed an IoT strategy to manage its assets and its connectivity, and to improve the lives of its customers. With over 1.2 million assets in place globally, its equipment transports an enormous number of people each day. As Tomio Pihkala, CTO of KONE, notes, "KONE moves one billion people a day, so in seven days that's the entire population of the planet." To manage this global presence, KONE has developed an interesting IoT strategy. Pihkala states, "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. And when you think about that kind of world, IoT is playing an important role helping connections, especially equipment, its condition and usage. But also by collecting the data, we can improve the service, improve the quality of our operations, and ensure our customers succeed in their business." Beyond the initial value proposition to customers through connectivity and remote sensing of elevators, KONE approaches its design process through a new lens in the IoT era. Pihkala comments, "At KONE we also connect R&D within this connected world. R&D can see exactly how the solution services are working and getting feedback from customers. We partner with IBM Watson to collect data from equipment, reanalyze it, and create new ideas regarding products and services from this data." KONE also then uses this data to keep the customer informed: "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 see the status of their equipment through KONE Online Customer Portal. Importantly, they can also see what our response is—this delivers peace of mind to the facilities managers and significant value to all parties."

The network effect of connecting with asset data individually and, more significantly, as a whole network through a real-time "sense and response" interrelationship is a very powerful driver of the IoT value proposition. Intelligent connectivity is a differentiator in this era of systems—from previous Machine-to-Machine devices and sensors—where the network effects multiply economic results tenfold.

CURATION: The fourth consideration executives need to make regards data curation. Increasingly, the most critical question moves from "what data can we capture?" to "which data is important?" Companies must become experts at curating their data as well as being selective around what data they use and share with channel partners and

consumers. Executives must have a laser focus on this question—because their existing business is transforming to a new data-driven one, the foci of that data must be carefully selected and drive value within the new corporate strategy.

Earlier, we illustrated how companies such as The Climate Company and KONE used IoT sensors and analytics to provide value to consumers through specialized portals. This curation process is also undertaken at UPS, which harvests, analyzes, and focuses the data from all its input streams for internal and external customer usage. UPS' Levis comments, "We created a data model that not only is used for internal agility, but through UPS My Choice®, customers have access to the same data on their package as the internal view of the package, providing greater value to them."

The exponential growth of data[5] means that the data curation process is more important than ever. Increasingly, the question data scientists need to ask is moving from "can we capture big data?" to "which data is valuable?"

Ultimately, this reverses the question from big data to small data—finding the data needles in the big data haystack. As such, for IoT, executives need to not only think about opportunities available in context of the ever-increasing bandwidth in which enterprises and ecosystems interconnect with each other, but to data in the small. The power of "small data" from individual devices with fine granularity and from small data sets has historically been overlooked, but it can be high-value and offer new market potential. Value may not always be derived from ever expanding big data. Newcomers to the IoT game must map out problems/questions they wish to solve and determine how collecting data from selective devices will provide meaningful solutions/answers.

> "We started thinking about the IoT space, and we said this could be a big opportunity for us, an enabler—and what you find is you can dismiss the technology as not being relevant or you can chase it as the shiny new object. We decided that we thought there was some value there and asked the question 'How do we activate it?' And so my message to the organization was 'think big, start small, but move fast,' and that was really the genesis for having these Lighthouse factories."
>
> **STEVEN STAFSTROM,**
> VICE PRESIDENT OF OPERATIONS
> FOR GLOBAL TOOLS & STORAGE AND
> EMERGING MARKETS, DE WALT

Small data is a critical asset in an IoT transition because it provides a precise framework for problem solving without overwhelming stakeholders, while allowing firms to manage and understand cloud economics and the costs typical of data accumulation. A frequent theme across interviews was the importance of breaking down problems into smaller pieces. This allowed for units to assess their individual needs for IoT, canceling unnecessary noise, and then join the dots between these pieces.

This interconnection of data among things, processes, and ecosystems will increasingly become some of the most important information being passed between B2B partners, as well as through distribution channels, even to and from the retail consumer. The area of supply chain is particularly ripe for development, as a McKinsey study identified that

5 According to a McKinsey study: 90% of all the data ever produced was created over the past two years https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/why-digital-strategies-fail

only 6% of supply chains are fully digitized. As this changes, enterprises will have even more data pushed to them and extracted from them, and thus understanding the value of each data item within this ecosystem will become increasingly valuable. This value should not be underestimated: Pratt & Whitney, for example, has created a dedicated system, eFAST, which is used to manage its substantial data ecosystem. The eFAST solution, like that of UPS, is a system that captures, analyzes, and wirelessly sends full-flight data intelligence to clients within minutes of engine shutdown. This allows operations crews to maximize aircraft availability, optimize maintenance planning, and reduce operating costs.[6]

An integral part of the curation aspect of IoT utilization and analytics is to ensure decisions are being made upon clean data. Accurate sensor data as well as clean data from channel partners and other systems is vital to the analytics. The old technology adage "Garbage In, Garbage Out" still applies, and part of the curation process is IoT Master Data Management, where data integrity has to be ensured.

As Jack Levis of UPS comments, "We were using predictive analytics to understand where to expand our buildings, and the system came up with two suitable locations. I understood why New York, but why St. Louis? But when we dug into the data, we found that we had one bad piece of data showing you can go from New York to St. Louis in zero time, and the algorithm exploited it. So it is vital that you have clean data when undertaking analysis."

As such, market leadership does not come from a single factor, but from an amalgam of four factors: understanding the cost economics of IoT; using IoT data and analytics to control assets; understanding and leveraging connectivity within the enterprises ecosystem and to curate the data; and understanding it at a level where the maximal value can be extracted from the right data set. These factors have already been embraced and combined by IoT leaders, as we have discussed and illustrated earlier. Companies like KONE, UPS, and The Climate Company have built their strategies around these factors and are market-leading companies. In the next section we will illustrate that while these factors are vital, they are less powerful when not aligned together within a real-world operating environment.

Key Findings

1. Every company's business model will change due to IoT.
2. Every company needs to reconsider its core competency and product value proposition to include an "as-a-Service" dimension based on the data from connected devices.
3. IoT is not about "big data" alone but high-value "small data" and "dark data"—data that was otherwise inaccessible yet when captured creates new process, ideas, markets, or relationships.
4. By understanding how the four pillars of Capital, Control, Connectivity, and Curation contribute to an IoT-led market-leadership position, companies can better assess their unique path to capitalizing on these technologies.

ALIGNMENT IN THE ERA OF SMART CONNECTED DEVICES

As the industry landscape changes in the era of smart connected devices, more than ever it will be imperative that executives manage their organization through a transformative lens. This will dictate that they focus heavily on aligning their IoT strategy with their evolving corporate strategy. Alignment over the past few decades has been the holy grail for CIOs. Yet, like the concept of a sustainable competitive advantage, it is merely an aspirational state.

6 http://www.pwc.ca/en/service-support/pwcs-complete-solution-fast

Historically, strategic planning was a process involving having a vision for the future of the organization within a context of competitive positioning. For decades, executives tried to establish their market leadership position through excelling in operational effectiveness, customer intimacy, or brand positioning. They would use Porter's strategic matrix model to evolve a position based on their differentiation in the market, or—if a low-cost strategy would be more

EXECUTIVE INSIGHT: GANESH JAYARAM, VICE PRESIDENT, INFORMATION TECHNOLOGY, DEERE & COMPANY

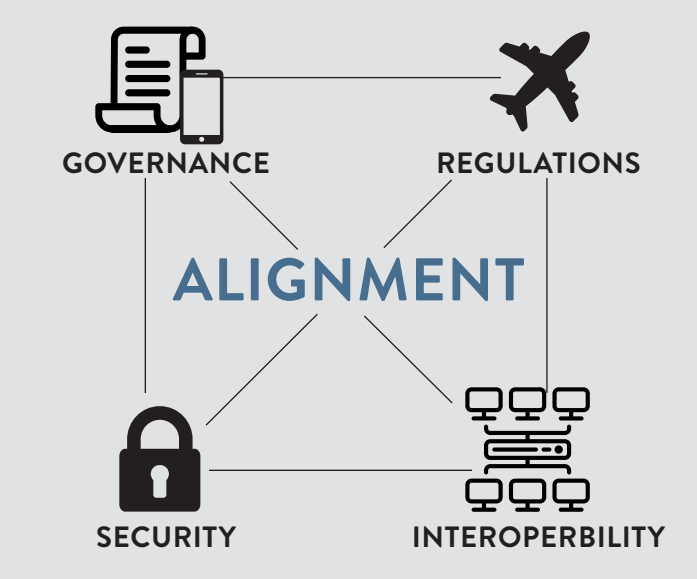
"We have pulled the increased role of data, technology, and analytics to the front and center of our strategy here at John Deere. We also recognize that as a company which has a rich history as an equipment manufacturer, the longer-term game is about solutions. Solutions that combine the quality and robustness customers traditionally associated with the Deere brand with the intelligence that originates from the data and software that is already in our machines.

So as you look at the John Deere strategy today, we have identified our technology and analytics leadership as a critical success factor. This is built upon our foundational success factors, our core strengths—manufacturing and product quality—to create an integrated solution.

Our primary goal with IoT is that we are bringing a differentiated product to our customers that enables them to do things differently. Farming is a very intensive industry, lots of variables: Unlike a factory, where statistical control methods are well known and understood, the field has lots of variables that can't be controlled. The interplay of those different variables that the farmer, as our customer, has to manage, be it the depth at which they have to place the seed, the moisture level in the soil, the type of seeds they are going to use, the spacing between the seeds, all of that in the past has been done based on experiential knowledge and the work they do with their agronomic advisors after the season is over. What we at Deere are trying to do with IoT and sensor technology is to ask, "How can we help our farmer customers in real time?"

As a company in 1999 we acquired NavCom, a leader in GPS guidance (GNSS) systems, and this started the efforts to enable the large equipment to run autonomously, combined with high levels of accuracy in planting, smart localized decisions being the value driver—the amount and type of seed they are going to plant in a particular area, the localized environmentally conscious spraying of fertilizer. All this helps our farmers increase yield and reduce cost.

effective given their scope of product offerings—they would ultimately connect the dots through a model such as Porter's five-force model to craft a strategic plan. Unfortunately, this prescription is not applicable for the IoT era; in the future, strategies need to incorporate operational excellence with customer intimacy and brand leadership. Without this they will have no differentiation, and low costs are table stakes as technology and Moore's Law continue to drive the basis for cost.



Thus, executives need to understand that within this climate of digital transformation, the strategic position they create (having used our earlier leadership model) needs to be made operational within a new executional framework that achieves alignment among the people, processes, and technology of the strategy. Alignment can be achieved only from a top-down proliferation of policy, as this will dictate strong governance, technical interoperability policies, security requirements, and regulatory compliance. Firms that attempt a bottom-up strategy in which individuals or functions choose their own IoT devices and deployment paths are destined to failure in the long run, or at least to wrestling with extremely expensive albatrosses around the corporate neck; this is known as the alignment trap, which we will describe later.

To understand this better, the following Alignment Model helps executives visualize the interacting dynamics that need to be actively managed to ensure consistency of alignment over time. Four dynamics are at play: If these are not clearly understood and built into the operationalization of the strategy, then the full value proposition for the IoT strategy cannot be achieved, and this may, in fact, cause the company to completely fail to digitally transform.

> "The pivotal IoT challenge is aligning people. Because we a re so big, and in so many areas, the risk is that you have so many systems all doing the same thing, so how do we get everyone aligned?"
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> **MANAGER** AT LARGE AUTOMOBILE MANUFACTURER

REGULATORY: The first alignment constraint is a regulatory one, which ties directly to both governance and our third constraint, interoperability. The regulatory dynamic is very real and powerful, especially since it is normally beyond the direct control of the enterprise. Regulations are typically set by government actors such as the Securities and Exchange Commission, the Federal Aviation Authority or the Occupational Safety and Health Administration in the United States. These rules shape the governance framework because enterprises must follow them to stay within legal compliance. For example, drone users and manufactures are subject to the unmanned aircraft systems (UAS) regulations and policies of the FAA, including a presidential memorandum "Promoting Economic Competitiveness While Safeguarding Privacy, Civil Rights, and Civil Liberties in Domestic Use of Unmanned Aircraft Systems," which requires that agencies: "establish policies and procedures, or confirm that policies and

procedures are in place, that provide meaningful oversight of individuals who have access to sensitive information (including any Personal Identifying Information) collected using UAS."

GOVERNANCE: The second parameter is governance, specifically technology governance. Weill and Ross have defined this as "the decision rights and accountability framework to encourage desirable behavior in using technology."[7] This can be further broken down into two constituent parts, one that assesses value and another that assesses risk. In value governance, a business evaluates the return on investment in a technology and monitors the investment over its life cycle. Risk-based governance, on the other hand, is assessed on the impact a technology may have on the business should it become unavailable, e.g., breakage or being hacked. For example, an ATM is a IoT device for a bank; its presence drives value to the consumer and the bank; the risk is that it may get hacked or go offline. For Chamberlain, a manufacturer of garage door openers, the risk of fully embracing an IoT strategy is that it is increasingly subject to heightened security requirements as it connects its door openers to devices such as the voice-activated Google Assistant. For Chamberlain and others, the added connectivity around these technologies adjacent to their core product drives the new value proposition for their companies, enticing new users and upgrading existing customers but requiring greater risk governance in the process.

INTEROPERABILITY: The interoperability constraint is a key factor in the alignment of technology and strategy as enterprises become ever more connected on many levels.

Historically, this has meant the arrangement of people, processes, and technology based on an enterprise resource planning (ERP) systems model. Within leading firms, since the 1990s this model has been under control, well understood, operating within a well-capitalized budgetary environment; it Includes vendors in the supply chain and partners in the distribution and retail channels who also have enterprise systems. The different ERPs interconnect through application programming interfaces (APIs), passing data and messages across the entire value system.

With the advent of the new era of smart connected devices, new data streams and platform interaction is underway. It is vital that strong governance is in place to ensure that risk is minimized and value is maximized. While this may involve greater oversight, the benefits will be enduring. Decisions on device role, type of technology utilized, and the infrastructure deployed will need to be made centrally and with future enhancements in mind. This will avoid the heterogeneous deployment of technologies, systems, and resource requirements that follow.

> "Security will take 10-plus years to stabilize, as the cost of security over the entire infrastructure is driven by two things. One, the large number of vendors and systems; two, the legacy systems. Companies will not replace all of their turbines, their assembly lines and manufacturing, as the cost is too high until they are end of life. And so we are going to have to solve this problem until that point is reached, in perhaps 20 years."
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> **BARAK PERELMAN,**
> CEO, INDEGY

7 https://hbr.org/product/it-governance-how-top-performers-manage-it-decisio/an/2535-HBK-ENG

SECURITY: The fourth alignment constraint is security. Interoperability, regulations, and governance all depend upon purposeful security. Traditionally, when systems could be sealed off from one another as if by a moat around a castle, high security levels were easier to enforce. However, the IoT's vast amounts of connected, interoperable distributed devices have massively expanded the number of ways bad actors can get into systems, also known as attack vectors. Aligning security with architectural changes is critical, as there is no room for a lag in corporate infrastructure. Recently, blockchain technology has been implemented to solve security concerns with interoperable devices.

Regulatory issues are also continually being updated, and require that the enterprise security-technology envelope be continuously aligned. Again, these requirements vary by jurisdiction. In the United States, the U.S. Department of Homeland Security released an extensive set of "Strategic Principles for Securing the Internet of Things (IoT)."[8] This document clearly identifies all stakeholders in the collective security of IoT systems in respect to both corporate and homeland security. Included is a comprehensive set of governance guidelines, for example, concerning "the Internet of Things Upgradeability and Patching," which recommend following the National Telecommunications and Information Administration (NTIA) multi-stakeholder processes designed around that task "to ensure best security practices in relation to the identification of vulnerabilities and their redress."[9]

As the objective of utilizing the alignment concept is to drive digital transformation, this itself is also in a constant state of change. To manage this, an executive steering committee should be established with authorization from the CEO. Within this group should be the chief technology officer, providing insights and guidance from a infrastructure perspective; the chief information officer, advising of processes and enterprise computing; the COO on integration and oversight; and the general counsel for regulation oversight and securing IP rights. This group can not only provide executive support and guidance but, importantly, steer and manage resources for the projects, dedicate human capital resources, and bridge the gaps between stakeholders in the organization being transferred.

AVOIDING THE ALIGNMENT TRAP: IOT PLATFORMS

The most common reason companies fail to achieve technology-strategy alignment is the tendency of business units within the organization to opportunistically deploy smart connected devices—or any technology, really—in an uncoordinated manner. Often referred to as a shadow IT deployment, this moves the organization away from a balanced, aligned, and secure environment.

When the systems are eventually connected, complexities arise that lead to lower efficiencies and higher costs. This in turn causes heightened security and interoperability issues that have been described above. This is what David Shpilberg[10] terms the "Alignment Trap." As more and more resources are poured into poorly architected projects to keep an organization competitive, it rarely moves out of misalignment and into "IT-enabled growth" without a major overhaul of its systems and underlying architecture.

For traditional business technology issues, this has meant moving an organization away from point solutions to an ERP solution, where business processes are joined together within a secure architecture. For IoT this movement is towards what has been termed an "IoT Platform." These platform environments offer stability and security for the deployment of connected devices, thus making regulatory and governance issues easier to manage. Just as changes to the tax code are handled by an ERP vendor, so interoperability, regulatory, and security changes are facilitated by the platform vendors, alleviating the burden on the technology team in an enterprise.

Platforms combine the technical and application functionality required to build, host, and deploy IoT strategies within a framework of strong governance and regulatory compliance. They also provide an integrated technical environment for managing the interconnectivity of heterogeneous devices and associated systems. Their overall purpose is to offer support for a wide array of functionality that typically includes, for example: edge computing, automation management, network connectivity, securing data in motion, IoT device management, IoT device clouds and secure storage

8 https://www.dhs.gov/sites/default/files/publications/Strategic_Principles_for_Securing_the_Internet_of_Things-2016-1115-FINAL....pdf
9 https://www.dhs.gov/sites/default/files/publications/Strategic_Principles_for_Securing_the_Internet_of_Things-2016-1115-FINAL....pdf (p7)
10 https://sloanreview.mit.edu/article/avoiding-the-alignment-trap-in-it/

(securing data at rest), business intelligence (BI) and stream analytics, big data analytics functionality such as Hadoop, AI and machine learning, and application development tool sets.

Key Findings

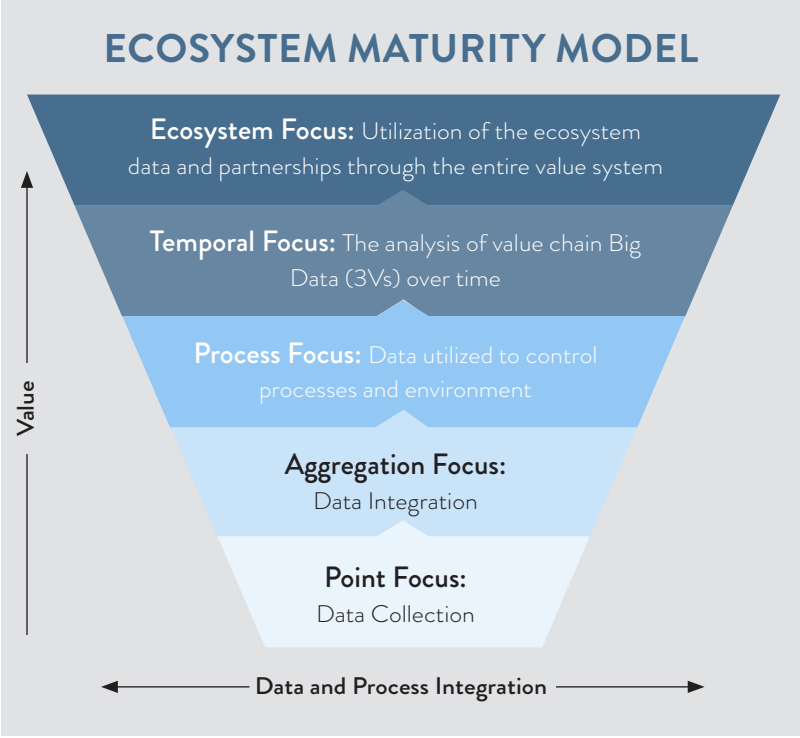
1. Alignment between the corporate tech strategy and the business strategy must be at the forefront for executives in the IoT era.

2. Alignment is a top-down exercise, not a bottom-up one: It is driven by executives who build an overarching strategy and enterprise architecture to support that strategy.

3. Alignment means constantly being in a state of flux and requires executive-level attention, including the general counsel for regulation oversight and securing IP rights, the CTO for architectural construction, and the COO for process change through DevOps, just to name a few essential roles.

IOT MATURITY: FROM POINT FOCUS TO ECOSYSTEM

As just described, many organizations are deploying uncoordinated, simple, proof-of-concept IoT systems that deliver minimal value. This makes these deployments and any of their subsequent IoT experiments weak in terms of governance and vulnerable to attack. For that reason, it's important to follow comprehensive maturity models from the beginning so that any given test deployment can be a foundation for future innovations. Otherwise, there will be a lot of wasted work on the pathway to getting the full value from IoT. The maturity model we created identifies five stages to maximize value along the journey.



STAGE 1: POINT FOCUS—DATA COLLECTION

At stage one, organizations have a point data and value focus—meaning they have one or a series of unique problems they'd like to solve or tests they'd like to run. With a point focus, firms can explore where it will reside on the IoT interoperability spectrum. General IoT systems are termed "open" and designed to interface with anything, enabling new devices to be added effortlessly. If integrating a new device requires a specific technology, interface, platform, or operating environment, the IoT system is considered specific (most typically, vendor specific).

Point focus IoT systems are designed for limited and discrete purposes. As they are stand-alone, they are often

more straightforward to develop and execute, collecting data from individual devices and typically resulting in discrete value propositions.

Organizations at this level typically invest in basic data collection systems such as LED lighting systems in warehouses that automatically turn on and off based on occupancy (ROI for replacement of 25 lights in a warehouse with LED is approximately six years[11]), or the RFID devices drivers utilize in their cars to pay tolls on the highway. This level of data collection typically involves homogenous data types and low levels of integration with other systems. In the automobile RFID example, the tolls are simply added up and drivers are billed.

> "Security is the enabler for moving up the value maturity curve."
>
> **BARAK PERELMAN,**
> CEO, INDEGY

STAGE 2: AGGREGATION FOCUS—DATA AGGREGATION

Once a company has successfully deployed point solutions that collect data across a variety of discrete locations and devices, the next step is to connect them. At that point the focus changes from collecting data to aggregating it and the increased value proposition that allows. To realize the full benefits from this stage in the maturity life cycle, the firm must significantly grow its capacity to handle and process data. Data from IoT systems can grow very quickly, to hundreds of terabytes or more a day, and, as such, catch organizations by surprise.

Rapid growth can stall and collapse if a firm does not plan for the large volume of data it will have to handle. Questions of where to store, what to store, and the cost of data storage become important, as do questions around how to scale the firm's capacity to analyze the data. While processing billions of transactions through their ERP is old hat for large companies, IoT data pathways represent new and challenging territory for many organizations at stage two.

Moreover, firms must give great thought to which technologies—and specifically which platforms—they will select and how they will address their security, governance, and regulatory compliance needs. Once those decisions are made, they are difficult to undo. Equally vital but frequently neglected is the need to frankly assess what skill sets are needed and how to plug those gaps. The most expensive technology in the world is useless if no one in the company knows how to work it. Likewise, if the solution is not secure, there is no viable path to advancing along the maturity curve.

> "Within the manufacturing enjoinment, for example, we have 80 machines hooked up to a manufacturing execution system, we have the operators trained in how to enter the OE data; you will see people walking the floor with their tablets looking at the process in the production numbers."
>
> **STEVEN STAFSTROM,**
> STANLEY BLACK & DECKER

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

In stage three, as organizations mature with their IoT

11 https://blog.schneider-electric.com/power-management-metering-monitoring-power-quality/2016/12/14/whats-roi-leds/

skills, the aggregated point solution from the prior stage becomes the staging point for the redefinition and design of enterprise processes and the environment in which the firm operates. During this business process redesign, enterprises can focus on obtaining a more refined understanding of their data. A better understanding of (big and small) data sets while managing active devices leads to higher value obtainment. This stage increasingly utilizes analytics to gain deeper insights as to how processes perform as opposed to what was their prior perceived performance. This is the point where IoT truly meets big data analytics and, for many, intelligent manufacturing. These are skill sets that, as Kamran Shah from Silicon Labs points out, may not be within the traditional human capital skills development path:

"IoT is a multi-discipline design problem, so the question is, how do you develop that expertise if, say, you're a traditional white-box manufacturer?"
—Kamran Shah, Silicon Labs

> "One automobile executive described the necessity for alignment in moving from stage one to stage two, using an analogy of a team of dogs and a bobsled, having each unit pull in a different direction, a problem that must be overcome. Business units with differing viewpoints lead to potential short-term savings in cost but potential long-term issues in data aggregation."
>
> **MANAGER** AT LARGE AUTOMOBILE MANUFACTURER

While thinking about skill sets is important in stage two, it is an absolute necessity in stage three, where the enterprise needs to define the long-term strategic goals for scaling and realigning human capital. As the enterprise develops through the maturity stages, the impact on the organization in terms of its systems and workforce will be significant. The new and evolving data collection, analysis, and utilization taking place in this digital transformation will cause changes in human capital requirements. These include the possibility of positions being removed as automation and AI systems driven by the IoT data and analytics change many roles and processes. Stanley Black & Decker has created three "Lighthouse" flagship manufacturing facilities, with two locations in the United States and the other in Germany. These sites are tasked to innovate in new product design and to incorporate IoT and other next-gen technologies within innovative components and products. These facilities are staffed by innovators and high potentials who, upon completion of a staffing rotation, are sent out to larger, more established facilities as technology/IoT/analytics evangelists, thus propagating the new cultural awareness throughout the firm.

Transformative product creation and data collection from IoT devices creates a strong business model and use cases that have clear and demonstrable value. Firms at this level are focused on utilizing the data and analytics to control processes and environments, even if they are at the Proof of Concept (POC) level. In Stanley Black & Decker's case, this involved bringing together many technology providers and challenging them, as Steven Stafstrom puts it, "to show us what they can do, to create a POC, and where the technology makes sense, we are going to adopt it to our manufacturing environment."

The development of process-centric IoT deployment combines both operational technology (OT) and information technology (IT) as control systems making manufacturing environments more effective.

"Within the manufacturing enjoinment, for example, we have 80 machines hooked up to a manufacturing execution system, we have the operators trained in how to enter the OE data; you will see people walking the floor with their tablets looking at the process in the production numbers." —Steven Stafstrom, Stanley Black & Decker

While in stages one and two, OT was a cost-saving mechanism for the organization, in stage three, aggregating micro-level data facilitates significant possibilities for macro-level process changes. Consequently, enterprises can refocus on new strategic objectives and utilize business process reengineering to achieve these goals. Ultimately, companies can take the data from the smart connected devices (OT) and drive iterative process improvements through performing analytics (IT) on them.

STAGE 4: TEMPORAL FOCUS—THE ANALYSIS OF VALUE CHAIN BIG DATA (3VS) OVER TIME

As smart connected devices increasingly draw data from across the enterprise and beyond, the potential value returned also increases as the analysis can be utilized across the whole enterprise, and process improvement can occur across the whole value chain. Michael Porter of the Harvard Business School has written extensively in this regard

EXECUTIVE INSIGHT FROM ANDREW TILL, VICE PRESIDENT, TECHNOLOGY & MARKETING – HARMAN CONNECTED SERVICES, HARMAN INTERNATIONAL

"It's not about changing a system or collecting data—if I have instantaneous access to data across my business and across my customers, what new things can I then do? What new business models can I embrace? And what new services can I deliver with them? I shouldn't just balkanize processes; trying to turn an analog process into a digital one and that's the entirety of my project, that's kind of designing failure from day one. And some of the really successful projects we have seen bring in that element of something new that the business is able to deliver. Even if it's internally, for keeping their employees happy. We have had smart building projects where people have realized the value to the business is not the cost saving from turning the lights off and the energy down in rooms not being used. It's the fact that you have reduced the friction in people's working life, and they become much more productive, and they don't leave as much. The attrition rates fall, and the cost savings rise from less recruiting, loss of IP and unhappy employees.

"Companies that are getting the most out of IoT today are the ones that have transcended the initial ROI debate and realize that being a data-driven organization is all about accepting change, embracing it and actively looking to see what can be done differently.

"For example, it would be very interesting for the automobile companies to collaborate with the auto industries on driver performance and how that relates to insurance: Can I turn my Tesla's capability down when my teenage son is driving, then back up when I'm driving, and then pay for insurance per minute of drive time per person? It's clear that new business models are going to emerge along these lines from visionary companies."

and on incorporating his five-force model to help managers interpret the impact of the technology on planning and strategy formulation both within a corporation and across industries.[12,13] Further to his body of work, new business models are rapidly evolving in the marketplace. They are not just taking advantage of the basic aspects of big data—the increased volume of data being amassed, the increased velocity of the data being sent within the system, and the increased variety of data types available (the 3Vs)—but are also concentrating on evolving corporate core competences from product focused to service focused. This has required companies to reexamine their core competency, which for many is the development of a new physical product or good, to consider adjacencies leading to the development of an information product or service dimension to supplement the original physical product. In many cases the new service product becomes the true value driver rather than the original core competency.

For example, in 2016, Goodyear began transforming its business fleet solutions by moving from selling tires to fleet operators, to provisioning greater automation and connectivity for its customers. This is in the form of Vehicle-To-Infrastructure, Vehicle-To-Vehicle, and Vehicle-To-Fleet products, termed "Goodyear Proactive Solutions." The company's goal[14] 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.

Rather than focusing solely on selling tires, the company aims to help customers contain and reduce their fuel costs through the installation of telemetric display units and to provide trucking companies with valuable analytics.

This illustrates how market separation is occurring between the firms who now operate in the Software as a Service (SaaS) space and those still solely in the product space. This move creates a trifecta of product excellence, customer intimacy, and product leadership through which to compete with competitors who focus only on price as their value driver.

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

The final step in the evolution of IoT maturity extends to device deployment and data collection across the value system, through connectivity with suppliers, channel partners, and customers, creating an ecosystem. An exemplar 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 such as "Basic home and device data (such as postal code and home type), Smoke and carbon monoxide status, HVAC system specs (if your HVAC system is currently running or not), and Home and Away states."[15] This information is then leveraged in aggregate and anonymized form through its energy services program. In that program, Nest's utility partners reimburse consenting customers $30 to $50 a year per thermostat for the right to change the operating temperature range within the home,[16] and Nest splits the savings with the utility companies.[17]

SOME IMPORTANT CAVEATS

The maturity model is defined by value and data volumes; however, it should be noted that these are relative scales. As such, it's useful when comparing companies in the same industry or sector. However, take caution when comparisons are not strictly apples-to-apples, especially when they span different industries and value criteria.

For example, the value and data sets gathered by tire manufacturers can be directly compared. Their data sets present a relatively manageable data load for the companies and comparable value drivers. However, we advise against comparing tire firms with aircraft manufacturers, which, even though they are technically transportation companies too, utilize larger data sets and live in a bigger ecosystem.

Even within an advanced IoT industry, 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

12 https://hbr.org/2014/11/how-smart-connected-products-are-transforming-competition
13 https://hbr.org/2015/10/how-smart-connected-products-are-transforming-companies1
14 https://www.iot-now.com/2017/05/24/62251-goodyear-launches-connected-fleet-management-solutions-ask-iot-changing-companys-business-model/
15 https://nest.com/support/article/What-kinds-of-data-is-shared-with-Works-with-Nest-developers
16 https://www.forbes.com/sites/parmyolson/2014/04/17/the-quantified-other-nest-and-fitbit-chase-a-lucrative-side-business/#15551bd12c8a
17 https://techcrunch.com/2014/04/18/nest-uses-its-data-to-turn-electric-utilities-into-cash-cows/

amount of data being generated by 2026 are on the order of 98 exabytes.[18] The ecosystem of aircraft and air-industry-related members is extensive: aircraft manufacturers; their suppliers (which include subassembly manufacturers spanning the globe); the engine manufacturers and their supply chains; the airport; the airport services (including aircraft maintenance, supply chains and passenger reservation systems); culminating finally with the customer, and the passenger or freight consigner.

This ecosystem faces multiple challenges, not least of which is the volume of data being created and spun out of the systems during flight. Capture and retrospective analysis within such an environment will thus become increasingly less feasible as the data volumes spiral upwards. This will necessitate employing streaming technologies based upon context-dependent analytics. These advanced systems require robust platforms, aligned OT and IT, and a very high degree of clarity around automated data handling—especially as AI/machine learning systems and Robotic Process Automation systems manage the data load and its analysis.

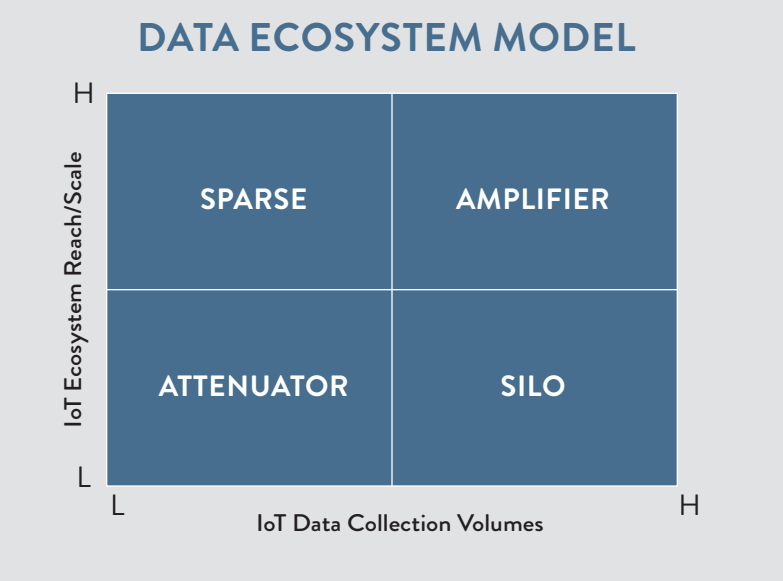
Key Findings

1. Technical choices early on matter, as they will be determinants of and constraints upon the enterprise's future IoT business models.
2. Security is a foundational requirement, not an afterthought bolt-on.
3. To avoid a "data deluge," enterprises need to know how and when to scale, what skills are needed, what platform is required, and need to put in place the necessary governance to manage the environment.
4. Executives need to understand they are building a new business model, not just building out a new system.
5. Alignment is key, not only the alignment of the IoT technology with the strategy of the enterprise but also among the human capital, the new work practices, and value drivers.
6. Big data volumes do not automatically equate to big value insights or financial returns; knowing what data to collect, even if it's small in terms of the three V's, is more important.

REACHING DATA SCALE AND SCOPE: THE IOT ECOSYSTEM

Within our model of IoT maturity, two facets of evolution were present: the scope of the IoT operations and the data volumes being generated. To help clarify the relationship between these aspects of IoT and how they drive value, the following model can be used:

The model shows the reach of an IoT ecosystem in relationship to the data volumes being collected and is broken down into four aspects.[19] In phase one of the maturity model, organizations collect low levels of data and have a modest reach for their data collection. This is called an Attenu-



18 http://www.oliverwyman.com/our-expertise/insights/2016/apr/mro-survey-2016.html
19 While the diagram incorporates the normal Low High scale, quantitative scales for an industry or across industries providing the data was available.

ator position, because enterprises in this state do not reap the maximal reward from that data, as it is isolated from the larger data sets, and more substantive reach (process-interconnectivity) requirements are needed for value-adding solutions.

The aim for organizations is to gather high-quality data volumes that connect ecosystem partners together—all of whom benefit from the interaction and interconnectivity of data and resultant analytics. Following this logic, companies such as Goodyear and KONE have moved and evolved from the Attenuator position to an Amplifier position by operationalizing their IoT strategies in an effective manner.

Goodyear is historically known as a strong product-oriented firm, making tires, and selling them through the original equipment market (new vehicles) as well as replacement tires through independent tire distributors. This low data intensity industry position placed it squarely in the Attenuator low-value quadrant of the matrix. The move to Amplifier was achieved through its IoT SaaS strategy.

The movement to embedding IoT devices on fleet vehicles and providing data to the ecosystem of fleet operators enabled real-time telemetry of the vehicles and the drivers. This increased the value added by the service to all constituents and enabled Goodyear to build its new service-driven product model.

There will not be a single protocol connecting all active devices and members of an ecosystem. IoT architects will be required to engineer solutions when building their products and ecosystem.

> “There is not going to be a single ecosystem that is going to win. So how do you as a manufacturer support all of these and remain agile and nimble, so you can go to the field, for example, and undertake all the hardware and software updates in the protocols? For example, how do you get your door lock to talk to your switch or a light? More fundamentally, the question is, how do I go from a closed ecosystem to an open one, so any door lock can talk to any switch?”
>
> **KAMRAN SHAH,**
> SILICON LABS

The answer is to focus on security—not building for the present, but building for the future with open, simple, secure, and connected adaptable architectures.

Key Findings

1. The move from using IoT as a control mechanism to one where it is a true value driver comes when data becomes an amplifier, providing a new knowledge base to customers (internal or external) in the form of a service. As a consequence, this frequently moves the product’s value proposition from “product” to “product + service,” extending the enterprise’s core into a new space.

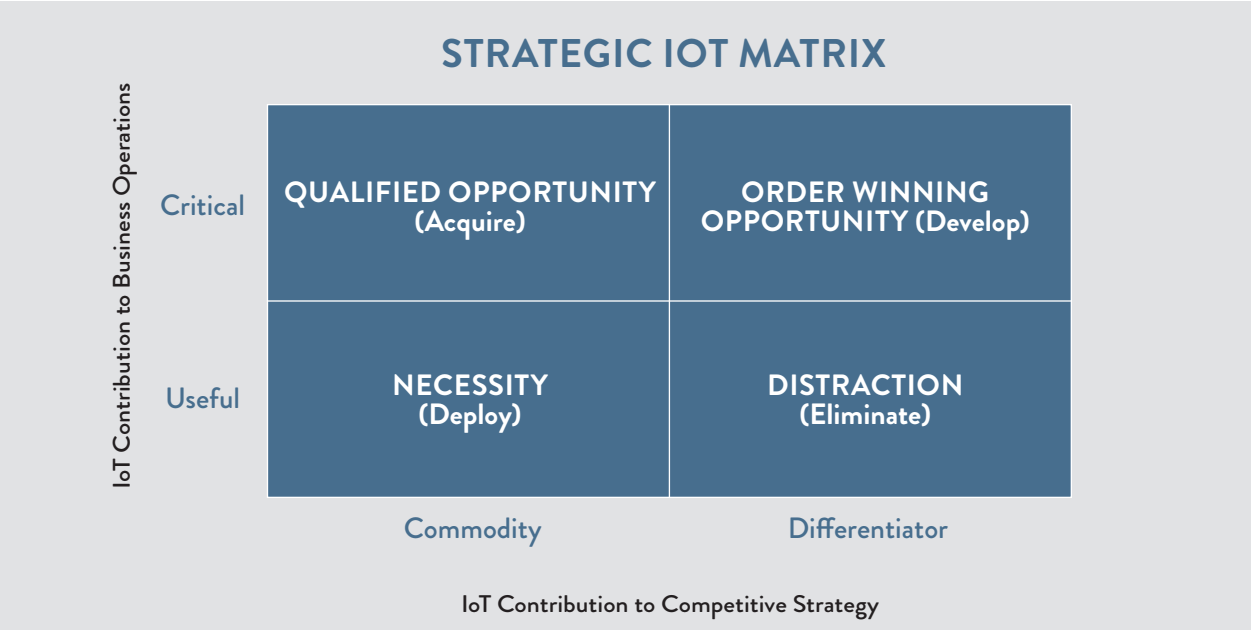
2. As we are only at the beginning of the IoT buildout, companies need to carefully assess their foundational architecture, which is vital for future scaling and ecosystem growth.

DRIVING COMPETITIVE MARKET VALUE FROM IOT

For an organization, no matter where it is on the maturity model, there is a temptation to automate and add sensors to everything. But before doing this, executives need to step back and pause. They must reflect upon their corporate strategy and ask how creating and deploying IoT devices, platforms, applications, and systems aligns with that strategy. They need to ask the fundamental question: Does this drive value for our firm and customers while supporting our strategic objectives?

Total IoT is not a panacea for every firm, just as huge IT spend is not the cure-all for every traditional firm. Zara, the global leader in fashion retail, for example, historically spent 0.5% of revenue on technology compared with an industry average of 2%. However, Zara's spending was aligned perfectly with its operating model of leveraging human capital over technology.

To assess opportunities for IoT deployment, we can leverage the following model.[20]



The model shows the degree to which an IoT device or deployment contributes to business operations and competitive strategy. For maximum ROI, the goal is to be high in each aspect and develop an order-winning business model. While order-winning IoT solutions are the aim, the technology will be used in other ways to different effect, such as cost reduction from smart lighting systems. In other situations, the technology deployment could be mandatory due to regulatory requirements where the ROI may be zero or negative. Alternatively, firms may deploy capital for option-enhancing capabilities in the future but with limited initial payback. One example of such a solution would be a smart employee ID system for location monitoring that will, in the future, enable smart building designs to be created and enhance productivity based upon analysis of actual employee work patterns.

The Strategic IoT Matrix helps us understand these options in a variety of ways. For instance, at a primitive IoT level,

20 This is a derivative of the e-sourcing model created by Willcocks and Plant. How Corporations E-Source: From Business Technology Projects to Value Networks. Information Systems Frontiers 5:2, 175–193, 2003

deploying basic devices in a factory setting would result in a matrix that contained:

- **NECESSITY:** LED light arrays provide a positive ROI of up to 90% savings in power and a payback period of six years.
- **QUALIFIED OPPORTUNITY:** Security systems such as cameras and line sensors for gasses and particulates, ensuring a safe working environment as monitored by OSHA, is an eventuality, and will be most cost effectively managed through IoT data stream.
- Another **QUALIFIED OPPORTUNITY** is the use of technologies such as eye-tracking software to develop better work practices. For instance, research by Consultants Tobil Pro[21] studied how visual concentration impacts worker safety and performance in a high-risk, dangerous workplace: a foundry, H&H Castings. The research outcomes were used to train new employees, increasing safe work practices, which led to higher standards. Traditional methods took a week of training, but the new system reduced that training time by two days.
- **ORDER-WINNING OPPORTUNITIES,** where firms use IoT to achieve differentiation, are the ultimate objective. In the logistics industry, UPS entered a partnership with Fast Radius,[22] a Georgia-based 3D printing manufacturer to provide an "on-demand" 3D printing service co-located at UPS facilities in Louisville, Kentucky, and with SAP integrating the manufacturing process into the supply chain management ERP software. This ecosystem allows manufacturers to create products on demand and exploit virtual warehousing.

In another industry, car dealerships like AutoNation use IoT technologies that have created a qualified necessity system, ensuring they can accurately locate the specific vehicle a customer is interested in. Because dealerships have hundreds of identical-looking vehicles across many lots, they used automated systems' access to data being facilitated through the On Board Diagnosis (OBD)[23] port to reduce search time. Moreover, vehicle health can be monitored for a dead battery and other conditions that would prohibit a sale to a customer or other leads.

Driving value through Qualified Opportunities is something Ford is undertaking when considering its next generation of buildings. For example, in building out its new physical infrastructure, the company is looking into the future and envisioning what the systems of tomorrow would look like. It is building towards that data aggregation and process base, running experiments on systems such as LED lights that can be used as beacons for rapid visual identification of work-related problems, moving lighting deployment from Necessity to Qualified Opportunity.

The fourth quadrant, the "Distraction" quadrant, is one in which enterprises are eager to deploy IoT systems they see as Differentiators, but they must carefully examine the basis of the solutions' true ROI. Are the systems critical or merely useful? Companies should undertake careful financial analysis to understand the value drivers of these IoT systems and their true value over their life cycle.

IoT deployments are highly time sensitive, and the project killer is the time needed to gain a positive ROI. For example, placing a rain gauge on every light pole is useful for mapping rainfall in a flood-prone city; however, the cost of undertaking repairs or replacing the batteries is prohibitive, as repair costs can be many orders of magnitude above the cost of the devices or the insights they would glean.

Silicon Labs[24] also identifies two other considerations for the design and creation of battery-powered wireless IoT sensor products: the "small form factor products" and "use of the cheapest bill of materials." They note that subscription-based service providers (e.g., cable or satellite internet service) place greater importance on long-term, reliable operations than on achieving the lowest bill of materials or obtaining the smallest form factor—in essence, balancing out product cost versus sending a technician out to fix the product. Overcoming these constraints can move a product from a distraction to an order winner.

In another example, the partnership between Ingenu and WellAware created what they term "the Machine Network,"

21 https://www.tobiipro.com/insight/cases/hhcastings/?utm_source=Social+Media&utm_campaign=H%26H+Castings
22 https://www.fastradius.com/press/
23 On Board Diagnosis
24 https://www.Silicon Labs.com/whitepapers/battery-life-in-connected-wireless-iot-devices

a Low Power Wide Area (LPWA), Random Phase Multiple Access (RPMA), wireless, machine-to-machine communication technology geared towards transmitting small amounts of data over long distances, at low cost for over 20 years.[25] An application for this IoT technology is the collection of infrequent, low-volume data from a wide area, such as oil wells spread out over about 55,000 square miles of Texas, where satellite data collection is ridiculously expensive and cellular data towers nonexistent. Collection of this previous "dark data" (inaccessible or unknown data to an enterprise) is highly valued; this data collection area accounts for more than 50% of U.S. oil and gas production. [26]

Key Findings

1. The technology alone is never the answer. Technology should be used to craft a business model that solves a problem.

2. The strongest, most valuable projects are those that solve a critical problem and become a differentiator in the market.

3. IoT projects can enhance and even change a company's business model completely.

4. Executives should not allow IoT projects to become a technology in search of a problem scenario; rather, they should have created a definitive business plan and then execute it through the deployment of the appropriate technologies.

THE WAY FORWARD: THE THREE NEXT STEPS

The future of every company is digital, a fusion of technologies and data streams, processed by analytical engines whose results will drive the organization's future processes. To ensure that a company is a leader in the future, its executives and managers need to understand and plan around three points.

First, **innovation comes from doing.** Doing, not watching, is a trait of all successful firms. They actively experiment, put resources into new ideas and let employees explore IoT technologies without the need for an immediate ROI. As such, firms need to embrace new technologies and explore the possibilities within their context.

Second, innovative companies understand the difference between option creation and silo creation. Option creation may have a longer time frame than the immediate gratification of a technology win from a silo; but a silo that is not capable of greater wins on a broader front later can be a significant distraction. Thus, firms need to embrace explorers, technologies, and systems which **create enterprise-wide options.**

Third, innovative companies understand their historical core value proposition to their customers but also understand that even that needs to be questioned and changed when necessary. They understand that technologies such as IoT are catalysts for change, change that affects all members of the value chain—especially customers—as new technologies generate new options for them from competitors. As such, firms need to **reinvent core value propositions**, through adjacencies such as As-a-Service value drivers.

This three-step process—explore, create options, and reinvent core value propositions—will form the basis for executives' consideration of IoT and other technologies going forward. Those that undertake this introspective journey will evolve and prosper; those that stay still and wait to see what happens will, as many companies before them, become footnotes in the history of companies overtaken by technology and change.

25 https://medium.com/achieving-the-grand-vision-of-the-internet-of/without-device-longevity-the-internet-of-things-will-never-be-58c904703abb
26 https://www.automationworld.com/article/technologies/networking-connectivity/partnership-brings-internet-things-texas-oilfields

METHODOLOGY

Companies interviewed:

- **Ford Motor Corporation**
- **Pratt & Whitney**
- **Medtronic**
- **Silicon Labs**
- **UPS**
- **Stanley Black and Decker**
- **CMA Consulting**
- **The Climate Corporation**
- **John Deere**
- **Indegy**
- **Amnick**
- **CAT**
- **RCCL**
- **Harman**
- **Smart Cities**
- **KONE**
- **GE**

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