

The Internet of Things Ecosystem:
Unlocking the Business Value
of Connected Devices

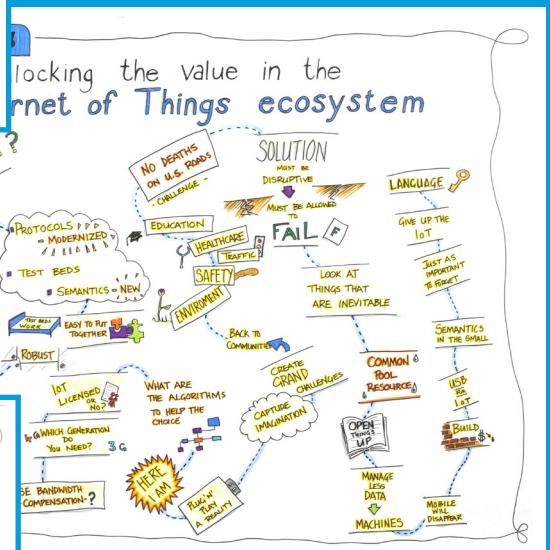
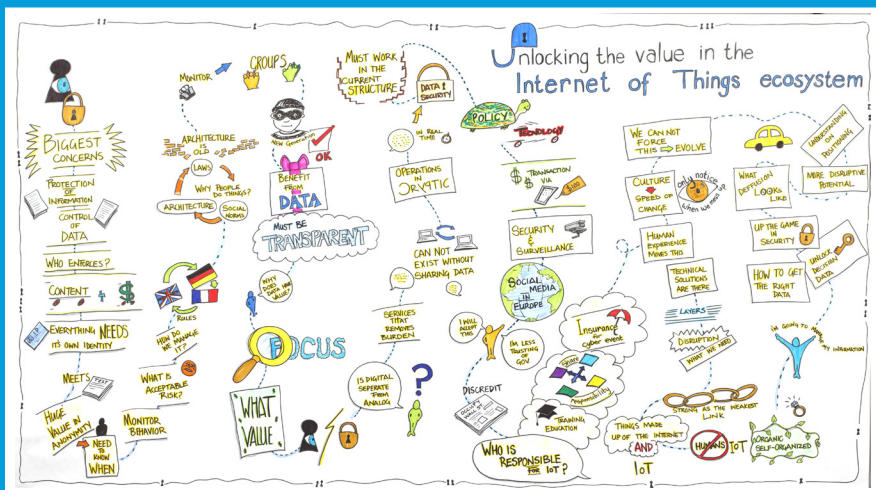


Unlocking the value



About the images used in this report

On May 6 and 7, Deloitte, in collaboration with the MIT Media Lab, hosted an executive workshop to design the future of the Internet of Things (IoT). Over the course of two days, a select group of business executives and thought leaders explored strategies focused on unlocking the value within the IoT ecosystem. A graphic artist captured the two day workshop discussions in real-time which you will see throughout this report.





An all-terrain truck with the symbol of a well-known aid organization on the side bumps off a mountain road and through a rutted crossing in Africa. It is one of two dozen vehicles to use this route, typically deserted, in the past few hours. Eventually, it turns onto a main highway and is soon whizzing along having bypassed a washed-out bridge and hours of snarled traffic. The truck and the vehicles it follows are part of a digital caravan, some connected to an international aid organization, others not linked in any real way except for the fact that sensors in each vehicle are sending data about road and traffic conditions back to the cloud to be accessed by onboard computers and translated into driver displays in other vehicles. Without human intervention, the vehicles are crowd-sourcing information, sharing vast amounts of real-time data and making real-time routing recommendations to drivers to get the vehicles safely to their destination faster, reducing the costs of delays and enabling the organization to deliver on its mission.¹

Imagine a similar vehicle in an urban environment, constantly communicating with other vehicles, traffic controls, and transit systems to preempt, predict, or avoid accidents and traffic jams. As the vehicle nears a retail area, the driver's GPS-enabled mobile device—aware of his recent shopping and purchase information—transmits offers for products in the stores to the in-car interactive dashboard, suggests a restaurant with openings or a show about to begin, and identifies available parking spaces. Or perhaps it cross-checks the driver's calendar and task list against traffic and events to propose a route that would accomplish two errands and still get him to his next appointment on time. Thus, connected devices, context awareness, and knowledge of the individual over time could improve the user experience, as well as the consumer's ability to accomplish the necessities and luxuries of daily life, while making the entire city function more effectively.

The Internet of Things (IoT) has the potential to offer business value that goes beyond operational cost savings. Providers in the IoT ecosystem have a largely unexplored opportunity to develop compelling IoT solutions that explore how the ability to collect and analyze disparate data, in real-time and across time, might transform the business. These developments will play out within and across enterprises, offering opportunities for sustained value creation and even disruption for those who can imagine possibilities beyond the incremental.

We are still early in the adoption of the IoT. Yet, belief is widespread—among analysts, investors, IoT technology providers, and enterprises large and small—that we are on the cusp of an explosion in the potential and adoption of IoT. Economic and technological barriers are receding, and with the proliferation of connected devices and evolving analytics capabilities, the possibilities for IoT seem boundless. The stories above are examples of the way connected devices might play out in one industry. As IoT develops, each industry will have its own use cases, some focused on businesses, some on consumers. Already, agriculture is experimenting with more efficient irrigation and soil monitoring, while manufacturing and process industries increasingly instrument and connect machinery, and wearable applications developed in the wellness industry are migrating into health care.

But significant obstacles remain. Executives worried about security and interoperability are unsure of the economic rewards relative to the risks of implementing IoT solutions. Consumer-facing use cases, in particular, raise

additional privacy and security concerns. IoT providers (of hardware infrastructure, software, communications, and devices) have yet to articulate compelling propositions for how IoT solutions can drive lasting economic value for the enterprise. Instead, many vendors focus on selling technology to the CIO—without a comprehensive vision of how it will translate into returns for the business. There is a largely unexplored opportunity for IoT providers who can broaden the sales horizon to encompass the CEO, CMO, CFO, and even major line managers and engage them around the question of how the ability to collect and analyze disparate data, in real-time and across time, might transform the business. As machines and objects become more intelligent, armed with enhanced analytics, context awareness, and predictive decision-making, they will be able to act in ways that benefit individuals and the larger system.

From smartphones to smart factories: Why connected devices matter now

This is the year that some experts predict more data will be generated by machines than by people—with that expectation comes renewed attention on the promise of IoT.² In a recent survey, nearly 75 percent of executives indicated that their companies were exploring or adopting some form of IoT solution, and executives believe that integrating IoT into the main business is necessary in order to remain competitive.³ Although estimates vary, analysts expect significant growth for the entire IoT ecosystem. Gartner



predicts IoT to include nearly 26 billion devices, with a global economic value-add of \$1.9 trillion by 2020.⁴ The International Data Corporation (IDC) estimates that devices connected to the Internet will generate nearly \$9 trillion in annual sales by 2020.⁵

The Internet has always connected devices; however, those devices have tended to be computers mediated by humans. It has been people—sharing pictures, creating ideas, uploading video, crowdsourcing assets, and making decisions based on circulated data—who have made the Internet dynamic.

Now, technology has advanced such that machines can make the Internet dynamic, and the stage is set for IoT. In recent years, the improved cost performance of computing, storage, and bandwidth has enabled devices of all kinds—including smartphones, wearables, appliances, medical equipment, and vehicles—to connect with the Internet and each other to create, share, and analyze information, all without human intervention.⁶ Higher

speed networks, cloud storage and computing power, the proliferation of inexpensive sensors and positioning devices, and advanced analytic capabilities to make sense of the data are enabling rapid advances that make a range of scenarios put forth for the future of IoT plausible.⁷

Given the optimistic predictions and large market figures put forth, it is worth asking: where will the value come from in IoT? Enterprises tend to adopt a technology solution if the expected benefits to firm performance outweigh the costs and risks. Existing machine-to-machine (M2M), defined here as a somewhat narrower version of IoT focused more on "machines" and less on "people" and extended network endpoints in IoT, as well as early-stage IoT solutions provided some proof points, although they have not yet unlocked the full business value of IoT.



A framework for finding business value

As with other enterprise technologies, such as social software, adoption can be more successful when the technology is applied against specific operating and financial pain points. The question for a given enterprise or industry sector is what metrics can IoT be most effectively applied against to generate significant returns and a sustainable competitive advantage? The following framework offers a way to think about where business value resides and where opportunities might exist for IoT solutions. We will revisit the framework in examples throughout this paper.

①

Financial Metrics:

At the simplest level, firms have revenue, expenses, and assets that support the revenue and expenses. So far, most of the investment has been around efficiency and expense reduction or improved asset utilization/ reduction of assets needed to run the business rather than on revenue growth through innovation or market disruption.

②

Operating Metrics:

The drivers of the firm's financial metrics can be understood in relation to three core processes of any firm: **customer lifecycle, product lifecycle, and facility lifecycle**. So far, most of the investment in IoT has focused on the facility lifecycle (optimizing the cost of operating facilities, increasing the utilization of facilities, etc.). But, smart, context-aware, connected devices potentially offer new insights and capabilities related to better understanding and managing how companies acquire or develop customers and products, how long they have customers and products, and how much revenue and profit they generate from customers and products during that time.

③

Approach to Performance Improvement:

So far, IoT solutions have targeted specific incidents, such as an inventory "out-of-stock" or a "machine down," with point solutions. Little has been done to consider what can be learned from IoT data over time to improve processes and product design to reduce the occurrence of incidents in the first place. This approach to performance improvement can also be thought of as extending the time horizon for performance improvement. Rather than focus on optimizing a single transaction (a sale to a customer, a purchase from a supplier, a run on a machine), how might the business think about the chain of past and future transactions with that entity that make up a relationship and then use that perspective to deliver and derive sustained, increasing value in the relationship?



Business values: cost reduction, risk management, revenue growth, and innovation

To date, most IoT implementations have been relatively modest in that they have attacked expenses and enabled risk management without addressing other aspects of the business. In fact, analysis of 89 IoT implementations by 20 major providers between 2009 and 2013 revealed 65 percent of use cases were focused on cost reduction and efficiency, while 22 percent focused on risk management, with only 13 percent possibly targeting revenue growth or innovation.⁸ While cost-reduction and efficiency efforts can be valuable to a firm, the returns diminish over time, and the value is often competed away as competitors implement similar efficiency improvements. Nonetheless, IoT providers have an opportunity to build on and extend current efforts, as well as to consider business value more broadly and look for the disruptive, rather than the optimizing, value of IoT.

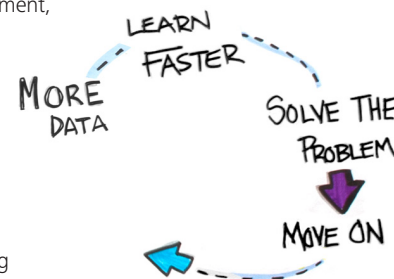
In the following sections, we will look at how IoT can be deployed for cost reduction and risk management and use the business value framework to consider areas where these solutions might be extended to drive revenue and innovation.

Cost reduction and efficiency

Delays in response time; lost, stolen, or misdeployed assets; process inefficiencies; and human error all drive higher operating costs for businesses. The right combinations of connected devices, infrastructure, data analytics, and processing—specific to the industry—can help companies reduce these types of costs. This is where the real value of IoT comes into play – in being able to take advantage of the almost boundless potential provided by the mass quantities of data produced in IoT transactions and making it valuable through advanced analytics. For example, real-time data flowing from multiple sources, transferred automatically and without human intervention, can be integrated and analyzed (“mashed up”) to make business decisions. Specifically, a packaged foods distributor might mash point-of-sale data with

weather forecasts, truck locations, and production data to predict stock-outs, reroute distribution, and reduce stale inventory write-offs. Of course, these types of data analytics can be complicated (and are worthy of their own paper) and may not provide enough value for the expense, so companies need to consider where the status quo is causing pain and might benefit from solutions that add information and remove human involvement. Other types of IoT efficiency solutions are embedded in end-point systems. For instance, sensors placed in supervisory control and data acquisition (SCADA) systems trigger alerts or signals (a “transaction”) that can be used to monitor processes and equipment. The real-time, location-based intelligence these signals provide can also be tracked and analyzed over time (creating a “relationship”) to provide insight into machine performance and advanced notice of issues with equipment and facilities.⁹

Asset tracking is just one example of how companies can use data transmissions to help reduce costs and improve efficiency (see sidebar). For enterprises that have many assets or high-value assets deployed across multiple locations, operational performance depends on balancing resource utilization, rapidly redeploying resources, and keeping assets in service. Automatic tracking can eliminate the need for repetitive human labor, improving ease of use, removing human error, improving asset management, and making decision-making simpler. For instance, shipping and logistics companies can precisely track the location of shipping pallets that carry expensive inventory (whether high margin or large volumes) through continuous monitoring of pallet condition, location, and movement via wireless relay.¹⁰



Case study: Asset tracking in the oil fields

Allocating resources efficiently and effectively is critical in the oil and gas (O&G) industry, especially when resources are short and tempers are high, such as in oil spill cleanups. “There is always a feeling that not enough assets are being deployed quickly enough,” says Henry Rosen, senior vice president of sales and marketing for Geoforce, Inc., an O&G equipment asset tracking and utilization solutions provider. “With the move from RFID technologies to GPS tracking and IoT solutions, savings have hit enterprise adopters’ bottom lines in two ways: operating and capital expenditures. For example, operating costs are reduced with fuel savings and reduction in labor man-hours; and capital costs are reduced with increased volumes of turns and velocity of use.”¹¹

Consider the case of an O&G rental equipment provider struggling with the costs of managing its remotely deployed assets. Given the complexity of the equipment, technicians had to investigate user complaints on-site, often traveling hundreds of miles. Sensors were placed on critical parts of the machinery that would automatically send alerts if equipment-related problems developed and provide enough data to central technicians to allow some remote troubleshooting and resolution. Site visits decreased by 50 percent, reducing labor, vehicle, and fuel costs. In addition, the

amount of time required for problem diagnosis dropped from hours to minutes, resulting in less machine downtime. With lower workloads, technicians could be deployed to other parts of the business.¹²

How might O&G companies use IoT to realize benefits beyond cost reduction and savings?

IoT has the potential to enable O&G companies to explore and discover new energy sources in even deeper and complex reservoirs. Sensor devices plugged on-field at exploration sites can gather and transmit seismic data to a central monitoring location, creating data flows that may provide new insight into potential new sources. IoT solutions may provide greater precision to uncover potential O&G fields thousands of feet beneath the earth’s surface, potentially improving the probability of new discoveries and allowing for better asset/equipment and workforce planning.

Another possibility is to consider how an oil field services company might target its customer relationships by using the real-time data flowing from oil production customers, combined with internal equipment-performance data and publicly available commodities data. The oil field services company could use this data mash-up to monitor customers’ production rates relative to fluctuating energy prices to anticipate equipment needs by geography and potentially offer new, valuable services.

Risk management

Enterprises are exposed to risk in the physical and virtual security of assets and data, the physical safety of workers—especially those deployed in the field, such as truck drivers, maintenance technicians, and construction crews—and the quality and safety of products and services for the end customer. These risks increase with more professionals working remotely.¹³ Enterprise customers expect telecommunications infrastructure to provide high-quality, anytime/anywhere connectivity within and beyond enterprise boundaries, while also maintaining security.

Connected devices already help ensure physical safety through technologies, such as video surveillance, that track and capture movements at strategic locations and transmit them back to the monitors where humans make decisions. IoT can also restrict access to locations or equipment, and track or restrict the movement of equipment and assets, through badges and geo-fencing. Enterprises with many remote workers can manage workforce safety and business continuity through autonomous systems that use the sensors in workers' smart devices to provide real-time, context-aware intelligence about where human and other assets are physically located at any time. Similarly, devices attached to the equipment of deployed personnel, such as first-responders or miners, could gather and analyze data about the immediate environment, as well as provide this information back to central command posts to enable faster, more effective decision-making in response to changing conditions.

The application of IoT to vehicles through telematics (telecommunications and informatics) offers an example of risk management through improved end-customer experience and fleet monitoring (see sidebar).¹⁴ Telematics can also be used to influence driver behavior and has helped reduce accidents and crashes involving young drivers by 20 percent.¹⁵ For Progressive Insurance, monitoring driver behavior through usage-based insurance program has directly reduced risks and resulted in the ability to offer discounts (that is, lower insurance premiums) for safe drivers, generally about 10–15 percent.¹⁶ Driving behavior models can also be appended in real-time with fraud and crash statistics to recreate scenarios and detect or prevent false claims.¹⁷

Case study: Telematics and fleet maintenance

For enterprises that maintain fleets of vehicles, telematics can improve vehicle operations to reduce risk and costs and improve customer satisfaction. Predictive maintenance and risk management can help companies ensure that products and services are in good working order. GPS receivers can communicate with electronic GSM devices installed in each vehicle to allow enterprises “to monitor the location, movements, status, and behavior of a vehicle or fleet of vehicles,” according to Stein Soelberg, director of marketing at KORE Telematics. Such solutions can detect issues in vehicles before they are used. For example, one manufacturer of cranes and earth movers (worth from several hundred thousand to millions of dollars per vehicle) placed sensors in tires to reduce the risk of machines going off-line or failing. The sensors allowed constant monitoring of tire pressure so that the manufacturer could predict potential defects and proactively fix them.¹⁸

How might telematics and IoT solutions deliver business value beyond risk management and safety?

Telematics solutions have the potential to help vehicle manufacturers receive a continuous stream of rich intelligence about their vehicles. As IoT meshes tens of billions of data points generated from fleets, it can enable businesses to unravel and introduce new concepts or features in their products and services. For example, the sensors in heavy equipment can provide rich information back to the manufacturer about how and where the product is used and how that affects performance over its lifecycle. This insight might lead to product design changes. It also yields insight into customers' businesses, including highlighting critical differences, which the manufacturer might offer back to the customer or use to develop additional products or financing and leasing models.

WHERE IS THE \$

Opportunity in revenue growth and innovation

Nearly three-fourths of enterprises who express interest in adopting IoT solutions are looking for new business opportunities and ways to fortify existing products.¹⁹ Yet, as stated previously, only 13 percent of IoT use cases between 2009 and 2013 targeted revenue growth or innovation. IoT providers revert to incremental solutions that offer diminishing returns and may not offer enough value to outweigh the perceived risks for some enterprises. They have yet to articulate a proposition for using IoT to grow revenue, shape new products and services, or innovate processes and products, all of which can offer increasing returns over time.

In the context of the business value framework, there is opportunity to develop IoT solutions focused on driving new revenue growth, opening up new markets, providing better products and services through greater insight and management of product and customer lifecycles, and enabling relationships rather than transactions. For example, the same IoT technology being used to collect and transmit data to drive cost reduction for a logistics company might provide additional opportunities for using flows of signal data to better understand customer use patterns to improve service levels or to work with other supply chain participants to offer additional valuable services. In many cases, there may be an opportunity for customers. This technology allows for greater visibility and control of the enterprise itself, but also allows companies to understand and begin to shape their relationships with customers, business partners, and their own workforce. What a company can do with this intelligence depends on the industry and the company.

The breakthrough potential in IoT lies in uncovering the additional, and potentially disruptive, value that is enabled by having real-time, context-aware data feeds from multiple sources over time. For example, wearable devices allow companies to digitize employees, which may include tracking and providing feedback on behaviors that affect wellness or job effectiveness, and could improve productivity across the workforce with the right supporting systems.²⁰ But wearables enable a far more innovative product/service in mobile health (mHealth) platforms—one that may actually disrupt the health care industry (see sidebar). These mHealth platforms can deliver remote monitoring for patients, especially veterans and the elderly, who are in a home environment or reside in remote areas. This allows hospitals to not only offer much-needed, lower-cost home care rather than a hospital visit, but also delivers patient care in a more comfortable setting.²¹ The medical industry is exploring other opportunities in equipment products and health care services to address health issues ranging from diabetes²² to heart disease²³ and even neonatal infections.²⁴ Further potential disruption comes from the use of this collecting and connecting technology by people focused on maintaining wellness. The disruption is a shift from a transactional view of health (see me when you are sick) to a relationship view where individuals stay connected at all times and the value of a health or wellness provider is to become a trusted advisor to help an individual use her data for better health. These innovations are transforming a traditional industry with disruptive new growth.

VALUE
THRU
DISRUPTION

Case study: mHealth and remote health monitoring

How mHealth and remote health solutions will disrupt health care through advanced warnings and preventive care

Pete Celano, director of consumer health initiatives in the Innovation Group at MedStar Health, has seen firsthand the benefits of IoT solutions in health care. "In a machine-to-machine communications era, the possibilities of wireless medical devices are changing remote patient monitoring, especially as there are tectonic shifts taking place in the health care industry." Hospital systems, for example, benefit from more intelligent medical equipment that enhance preventive care through new types of medical sensors that enable remote, real-time monitoring of vital health-related metrics, irrespective of where the patient is located.²⁵ Celano describes how a patient at home "can transmit health-related data to the cloud via an always-on wireless network, providing early-warning signals to hospital nurses that the patient is in duress, or going into duress." Medical professionals can respond with appropriate interventions. He adds, "In an age where hospitals are becoming payers too, there is a need to manage hospital admissions proactively. Increasingly, if providers do not deliver results (outcomes), there is no income—this replaces the old test-heavy, encounter-based model and means the smart health care systems are racing to create programs that

keep patients from ending up in the emergency room."²⁶ This intelligent monitoring capability leads to other health care services and treatments, such as next-generation smart health dashboards and wellness hubs.²⁷ Market revenue for IoT innovations in health care was estimated at \$10.6 billion in 2012 and is expected to double by 2016.²⁸

Remote health monitoring begins to disrupt the traditional treatment environment and the incident-based model. The combination of wearables and other intelligent equipment that allows an individual to capture, track, analyze and share data about themselves, will open up even more disruptive potential: the individual, rather than the health care provider, will own the data about her body. Health and wellness providers will use the data to offer more personalized treatment or course of action based on the individual's context and responses to previous measures. Individuals will connect with a diverse ecosystem of wellness providers who can help individuals get more value and insight out of their data to improve wellness and better use traditional health care providers when they are not well.

How can providers overcome challenges to realize the promise of IoT?

Across industries as diverse as O&G, manufacturing, health care, public sector, and defense,²⁹ targeted IoT solutions can help businesses improve performance. Improved resource efficiencies and reduced costs deliver savings to the operation. Risks can be better managed by securing physical and virtual assets, ensuring consistent product and service quality, preempting and lowering fraud, and accelerating responsiveness. New revenue may come from product and service innovations that enable growth beyond current products and market segments. Finally, value may be created and destroyed by deploying IoT to do something entirely differently to disrupt a market or an industry.

To realize the expected impact and potential market for IoT, providers will have to work together within the IoT provider ecosystem of infrastructure, hardware, software, and other vendors (Figure 1) to develop solutions that have greater potential to drive significant business value for enterprises.

Much of the potential value from this technology will come from moving beyond the proprietary technology silos that largely exist today. In many respects, IoT technology is at a comparable stage of development to the early days of the personal computer when proprietary technology stacks were the dominant mode of operation. It wasn't until some shared layers of technology (like the operating system and microprocessor) facilitated distributed innovation and expanding choice for the customer that the PC business really took off. In particular, the ability to share data across existing IoT technology stacks will be key to unleashing much of the economic value for large enterprises who themselves are interacting with broad

ecosystems of partners. This data sharing capability will also foster much more robust ecosystems of specialized participants on the provider side, helping customers to get much more value from the data that is being generated and captured.

With so much potential, why is delivering IoT solutions that drive customer business value to enterprises challenging? Providers of IoT solutions face several business and market barriers collectively unique to IoT. These issues can be addressed through specific strategies and tactics that apply to providers across the IoT ecosystem.

IoT PROVIDER ECOSYSTEM

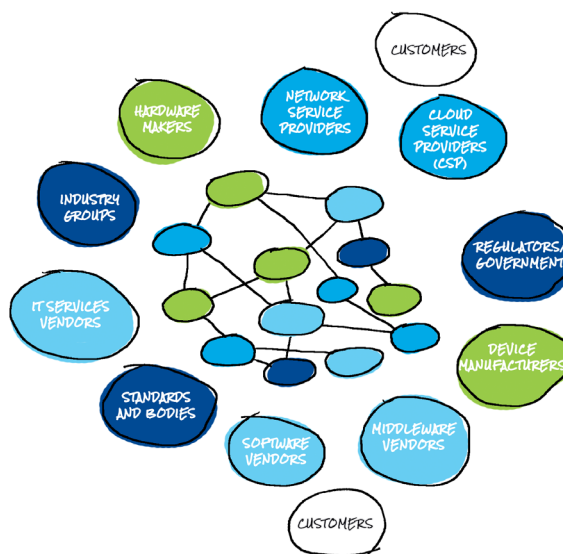


Figure 1. Participants in the IoT Provider Ecosystem

HOW DO WE
WORK
TOGETHER

Six strategies to unlock the business value of connected devices

① **Extend cost-reduction and risk management deployments to explore revenue and innovation potential.** CIOs are not typically focused on revenue growth and innovation, and providers who only sell to the CIO will usually revert to talking about lowering transaction and maintenance costs. Cost reduction is not bad, but it also is not enough. Broaden the potential for adoption and business value by reaching out to the CMOs, CFOs, major line managers, and even CEOs. Working at the executive level can help ensure that the designers of IoT solutions have considered what other business functions might leverage IoT components or the data being generated.

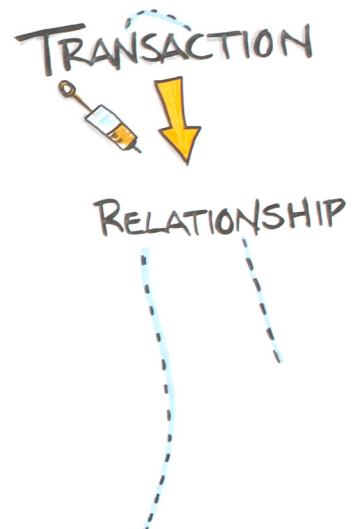
Economically, what does this technology do for the enterprise? How can connection and real-time context support more effective marketing? How can real-time monitoring and predictive analytics across multiple sites lead to process innovations on the line? How can assets be better or more proactively deployed to expand business into new customer segments or new regions? How might autonomous connectivity and analytics between a mobile workforce shorten the sales cycle or improve the conversion rate for sales prospects?



② **Focus on product and/or customer-lifecycle.** As the mHealth example illustrates, there is value in moving beyond facility-lifecycle management to product-lifecycle management and customer-lifecycle management. The key question to ask is, how do we instrument the world to get insights into ourselves and our systems to improve our performance? In other words, how do we acquire it, how long do we have it, and how much revenue and profit do we generate from it while we have it?

The retail sector offers examples of how companies can benefit from using real-time data to move beyond transactions and understand their customers and products better. For example, the UK-based retailer Tesco used the ubiquitous store loyalty club card to track customer visits, buying behavior, payment modes, and inventory. By paying close attention to customers (customer lifecycle) and product sales (product lifecycle), the retailer was able to

dynamically adjust merchandise to suit local tastes, customize offers for customers, manage inventory volume based on demand/purchases, and plan inventory refresh as needed. The result? Sales, customer loyalty, and coupon redemption rates all increased.³⁰ In Apple® retail stores, iBeacon™ location and proximity detection technology interacts with customers' mobile devices to provide information about products and services. The iBeacon location and proximity detection technology further engages customers through games or contests related to the products they are looking for. And, when the customer is ready to purchase, the technology helps facilitate an automated transaction through mobile wallet. The stored transaction data captured at the point-of-sale helps Apple to better understand customer behavior and offer targeted promotions, paving the way to stronger relationships.³¹

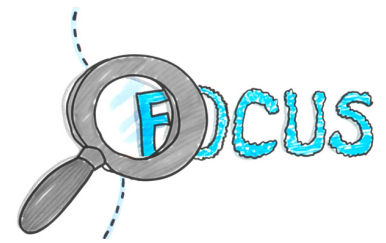


3

Target early deployments to maximize impact.

The challenge with this technology is that its value increases dramatically as more and more devices are deployed in more and more contexts. But covering all those contexts will require substantial investment and long lead-times. Far better to begin with carefully targeted deployments at the outset to reduce initial investment, shorten lead-times to value creation and maximize the value generated. The Metrics that Matter framework can help executives to do this. It begins by focusing on the most important financial pain point/opportunity area for the company or business unit. Let's say it is revenue growth. Then drill down to the operating metric level to identify the operating metric that is the most important lever in addressing the financial issue. Again, as an illustration, let's say it is a high customer churn rate that is holding back revenue growth. The final step is to drill down one more level

to front line metrics to identify where IoT technology might be deployed to have the highest impact. In this illustrative example, it might be that customers are frustrated by the time it takes to get a service person to repair the product when it breaks down. In this case, the deployment of sensor-based IoT technology in the product to monitor its performance and anticipate potential breakdowns could play a significant role in increasing customer satisfaction, reducing customer churn rates and helping to drive revenue growth. Now, we have something that will really move the needle in terms of overall company performance while at the same time reducing initial investment. As the results of this initiative become apparent, it will build interest and willingness to deploy the technology in other parts of the enterprise.



4

Use data mash-ups to create context and build/deepen relationships.

M2M communications already happen continuously around us, but the resultant data tends to stay relatively local or in silos that are not connected in ways that create new and interesting insight. IoT offers the potential to facilitate connections that are surprising and useful (and potentially disruptive) when an object generates or collects information that is more useful when it is combined with information that exists elsewhere.

For example, Waze, the navigation app, facilitates connection between the mobile GPS systems of vehicles present in a geographic location. These systems communicate on their own without any action from the driver. Real-time traffic data from across different locations/areas are mashed together and presented back to the driver in the form of optimized route options based on real-time traffic flow.³²

With the rising volume of data generated by connected devices, predictive analytics may deliver customer insights and even anticipate customer behavior. Businesses may use advanced analytics on top of connected machines to actively sense and shape customers behaviors, as well as tailor products and services at timely customer decision points.³³ Analytics coupled with interactive visualization tools will allow not only large amounts of clean data but also sparse and fuzzy data (i.e., cognitive computing) to yield insights.³⁴ Providers and enterprise adopters might consider how and where insights from new mash-ups could radically change a market or industry. Of course, connected smart devices do nothing to resolve the current challenges of data analytics, and considerations of integration, off-the-shelf software versus custom software, and data integrity still apply.



- ⑤ **Develop security that is both preventative and responsive.** Enterprise adopters can get enormous value from reducing transaction costs by connecting assets. The trade-off is that connecting assets also provides a potential virtual (or physical) break point (i.e., more risk when assets are connected). IoT solution providers and enterprises need to work together to develop security that strengthens and protects break points, as well as enables rapid detection and mitigation of security breaches. Thus, most experts agree that 100 percent defense of the perimeter is impossible, but it matters as much or more whether a security breach will result in bringing down one machine for an hour or the entire electrical infrastructure of the Western United States for days.

Fortunately, technology is advancing to provide greater levels of security. One of the interesting developments

is the ability for homomorphic processing to perform real-time algorithms on encrypted data, alleviating the need to de-encrypt and re-encrypt data, making cybersecurity purely an encryption problem. As a case in point, IBM inventors recently received a patent for an encryption technique that may become an alternative to traditional M2M security. The homomorphic encryption (HE) technology allows entities in the IoT ecosystem to perform operations on customer data without decrypting the original data, thus maintaining its confidentiality.³⁵ According to Global Industry Analysts, the HE market is forecast to grow quickly, given the escalating need for tightened security measures at each tier of data transmission across public networks (e.g., Internet and cloud-based services of smart computing and connected devices).³⁶



- ⑥ **Maximize transparency to enhance user trust.** IoT providers can increase the trust of users, either individual consumers or enterprises, by offering full transparency to users about what data is being collected and how it is being shared, while also giving users the ability to see, analyze, and act on data in real-time. Transparency can be a double-edged sword. For instance, Waze gives us a better drive, but insurance companies may use our driving data to charge higher rates. Companies need to outline exactly what information is needed to deliver value to the customer, and then allow users to select that data and only share that data. IoT can raise the game in privacy by allowing users to control their own data—

how and when different apps get access to what information—based on the expressed needs of the app provider and the resulting benefits to users. For instance, the lockbox technology from Machine to Machine Intelligence Corporation allows a user to selectively control information flow in an IoT ecosystem. The technology allows elements in the IoT ecosystem to access user data based on the rules and guidelines preset by the user. It can set or drop specific connections in the IoT ecosystem, ensuring customer policy compliance.³⁷





Unlocking the value in the Internet of Things ecosystem

Realizing the promise of IoT

As connected devices have proliferated and networks have penetrated into remote regions, the potential for IoT solutions and growth in the IoT ecosystem has increased. If IoT solutions can improve enterprise adopters' fundamental business values, not just savings and risk management, but revenue growth and innovation, demand and new uses for connected devices will grow. At a higher level, IoT has a role to play in helping companies create more sustained value through moving from a one-time transaction focus to a continuous, relationship focus with customers, suppliers, workers, and assets.

While technical issues that affect reliable connectivity and performance still exist, enterprises will be more willing to adopt IoT solutions if they can see significant, lasting benefits to the business that outweigh the real and perceived risks of connection. Participants in the IoT ecosystem will need to work together to create solutions that improve enterprise adopters' business performance, not just in the short term but sustained over time. In so doing, they will unlock the business value for enterprise adopters and grow the IoT market for everyone. The potential for the next stage of IoT is unbounded and it will be shaped by the decisions that participants in the IoT ecosystem make today.

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Endnotes

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