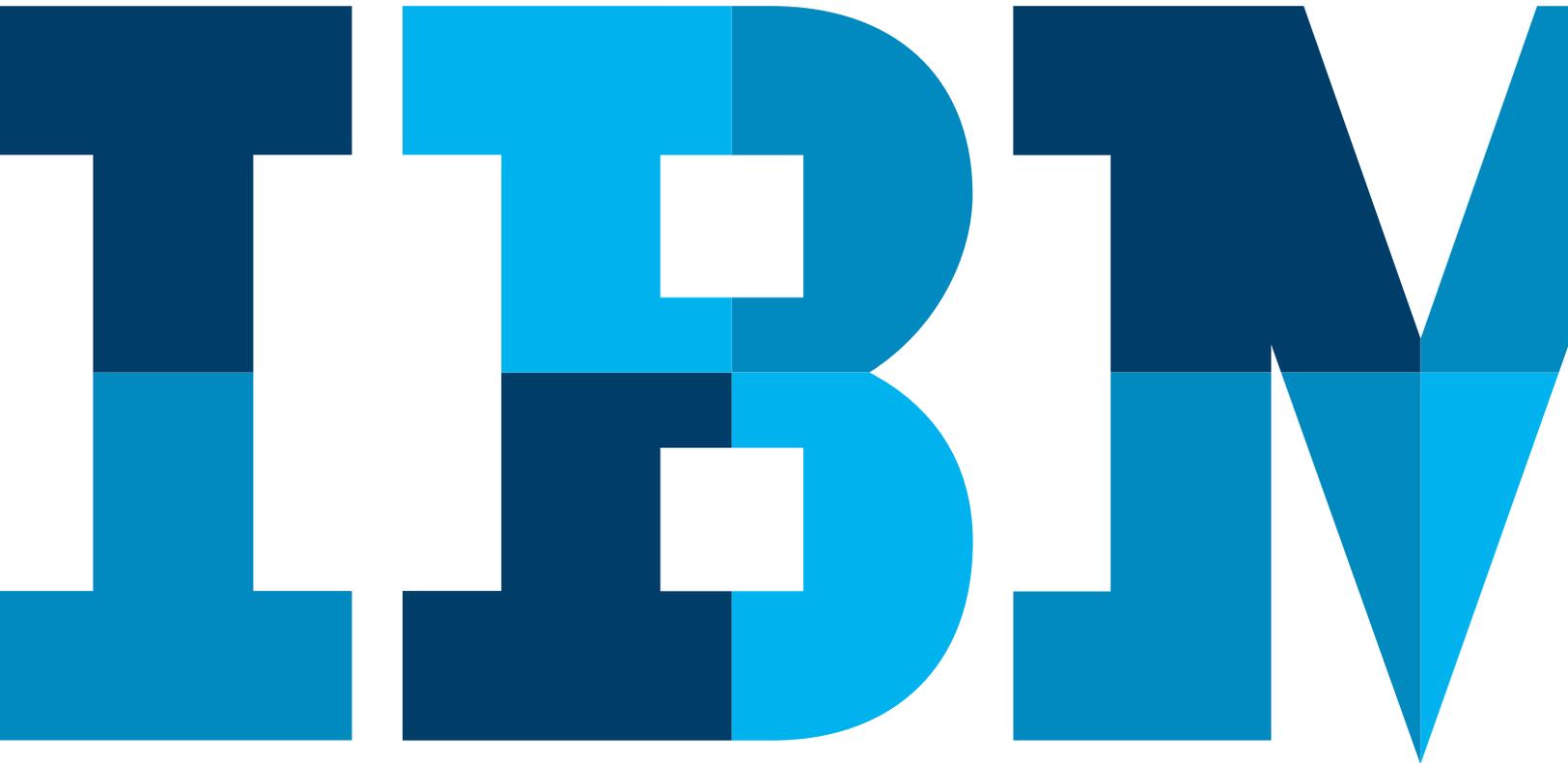


Internet of Things in the industrial sector



Executive summary

The Internet of Things (IoT) and its ability to transform business is not a new concept. In various forms, it has been around for decades. For example, the Rolls Royce's performance-based "Power by the Hour" offering has been in the market for almost 30 years and energy producers and utilities have been operating SCADA systems for even longer. However, the intersection of a number of technological advances in cloud, mobile, networking, analytics and the cost of sensor and actuator devices means that IoT now represents a unique opportunity for companies in every part of the industrial sector to reinvent and transform themselves and their services. The advent of cognitive computing means that the large volumes of data generated by IoT devices can now be understood, acted upon and monetized like never before.

The leaders in this transformation will be able to mix their traditional CAPEX-based products with a continuous OPEX-based service model, giving customers better experiences. They can engage with and understand their customers like never before and offer new innovative services, opening up new revenue streams through new business models. The remainder will be left competing on price and become increasingly dislocated from their customer base as more nimble competitors step in and wrap their product in a service offering, thus owning the relationship with the end customer and claiming a healthier profit margin. Those companies who have begun this transition can, in many cases, already demonstrate the value that the IoT brings.

Many industrial Original Equipment Manufacturers (OEMs) are experiencing this fundamental shift, through changes in:

- The nature of what they sell and the associated value proposition and revenue streams
- Their client base and their relationship to their clients
- Their competitors and the basis on which they compete

As traditional, linear supply chains evolve into more organic value networks, industrial OEMs are striving to carve out their role, and the successful ones will establish a point of control in their ecosystem.

While companies recognize that this change is happening, the practicalities of how they adapt remains uncertain to them. IBM has been helping our industrial clients to successfully move through the "instrumented, interconnected and intelligent" journey for over a decade using our Smarter Planet initiatives and thought leadership.

The purpose of this white paper is to further help our clients move beyond the IoT hype and to provide insight into how they can transform their business. It filters out the buzzwords and identifies the issues that are truly fundamental to their business and then suggests ways of favorably repositioning themselves for the IoT age. The second part of this white paper identifies the key things that organizations must get right to successfully execute and achieve the vision that the IoT represents.

The transition will not be easy, and the biggest challenges will not lie in systems but in the willingness of the organization to change. However, for the companies prepared to undertake the journey, it is time to begin.

"The best time to plant a tree was 20 years ago, the second best time is now."

Chinese proverb

What the IoT means to industrial manufacturers

The evolution of the IoT is driving four major trends:

Instrumenting products with sensors and exploiting the operational data received, is disrupting both the marketplace for industrial manufacturers products, and the ecosystem in which they operate, as it:

1. Drives the shift to data-enabled services offerings
2. Transforms an OEM value chain from product-centric to customer-centric
3. Changes relationships through the supply chain to disrupt existing ecosystems
4. Provides valuable feedback into engineering and product design

This ability to disrupt existing business models and move to higher value services has been necessary to address threats such as:

- Globalization and reduced-cost manufacturing
- Natural erosion of profit margins on existing products as they become commoditized
- Competition from after-market companies wrapping OEM equipment in services-based contracts

More than half of CxO executives see the Internet of Things (IoT) as an important technology.¹

The Internet of Things has a total potential economic impact of \$3.9 trillion to \$11.1 trillion per year in 2025.²

1. The shift to data-enabled services offerings

Many OEMs have been offering services, either in place of or in addition to, equipment sales. This approach goes beyond the traditional maintenance contract post sales, which is often a more attractive proposition to those customers who do not wish to worry about the long-term maintenance of the asset. In effect these customers wish to pay for operating hours and not hardware. The costs can often then move from capital to operating expenditure. This will not suit all customers, but all will appreciate the choice.

For the OEM, it provides a counterpoint to more volatile equipment sales and enables a more stable long-term revenue stream. It can also be a more profitable and sustainable proposition, and can provide the OEM with greater control over the use of their product. However, in order to manage this risk, manufacturers need data on how their equipment is being used and maintained.

A manufacturer of rotating equipment and associated industrial products working with IBM, has instrumented their products with a number of sensors and connectivity that allow them to receive real-time data on parameters such as vibration, temperature, humidity and so on. This operational data allows them to understand how the equipment is performing in the field and enables them to sell condition monitoring and predictive maintenance services to their clients, opening up a whole new revenue stream and type of relationship with their customer base.

This shift often manifests itself as an evolution from the simpler propositions, to the more sophisticated. The speed of this transition is dependent on a number of factors, such as market appetite, availability of data and position of the OEM in the supply chain.

Some examples of service offerings that are enabled by IoT include:

- Condition monitoring
- Performance-based maintenance
- Predictive maintenance
- Uptime guarantees
- Outcome-based equipment as-a-service
- Asset performance management
- Sale of spare parts and consumables
- Cross-sell of related products
- Monetize the data itself

2. Value creation shifts from the product to the end customer

Industrial OEMs have historically been focused on their traditional value chain of manufacturing and selling physical products, ordering raw materials and components; assembling them; and then manufacturing a product, which is then distributed through their sales channels. Much work has been done in recent decades (i.e., ERM and SCM projects) to make this value chain as efficient and optimized as possible.

As these products become connected, industrial OEMs can now reach their end customers and observe how their products perform in the real world. At this point their value chain is suddenly extended from their product to their customers. They can now understand the end customer and their buying behavior, communicate with them directly and offer additional products and services to them through the lifecycle of the product's usage. This realization can be something of an "aha moment" as the implications sink in: "My value chain just shifted from being product centric to customer centric."

When this happens, new sources of value are suddenly available to OEMs (see "The shift to data-enabled services offerings" earlier) and the value chain primarily becomes centered on the customer rather than the product. Or it may be more accurate to say that the value chain becomes extended to also include the end customer (as well as the product), but it is around the end customer that most new sources of value can be found.

A prime example is manufacturers of consumer electronics such as home appliances and TVs who traditionally have never had significant contact with their end customer. Once their products become connected and the user has to register to use the mobile app in order to interact with the device, they suddenly have a direct touch point to the consumer and are able to sell additional products (like washing powder and filters for a washing machine) and services (such as maintenance) throughout the lifecycle of the product. They can also influence their buying behavior when it is time to replace the product.

Industrial OEMs then become part of a more complex value network (rather than chain). They must now interact with a whole ecosystem of new partners, providers and competitors that are involved with servicing their end customer (for example, after market services, maintenance, accessories, consumables, operations, outsourcing). They are unfamiliar with communicating with this group and must now consider how they will partner or compete with these new players.

3. As the market moves, the traditional ecosystem is disrupted

As mentioned previously, with the introduction of connected products and data-enabled services, industrial OEMs can now have a direct touch point with the end customer, often for the first time (for example, cars are traditionally sold through dealers, home appliances through retail outlets, industrial machinery through resellers and distributors)

This is a point of control, as whoever owns the relationship with the end customer and controls the service platforms (whether that is the OEM or service provider) will be best positioned to monetize that customer.

However, it is not always efficient for an OEM to manage all the stages of the chain to the end-user or provide all necessary services themselves. This drives OEMs to participate in a services ecosystem within the supply chain. These ecosystems are characterized by the erosion of boundaries between companies and a readiness to work with different partners to provide a set of turn-key services to the end customer. The goal is to offer a services-based solution that directly solves a business problem for the end customer, rather than simply selling a product as a one-off transaction.

A German automotive manufacturer has partnered with IBM to enable them to make the shift from selling physical cars to selling access to vehicles in an on-demand fashion. User register and an app allow them to locate a vehicle that meets their needs in their proximity. The vehicle can be opened from the app, and the user is simply charged for the miles they drive. What's more the service has been integrated with public transportation networks, allowing the car manufacturer to sell a complete smarter transportation service.

As these services may require the participation and collaboration of several players from across the ecosystem, they are increasingly supported and enabled by the use of digital platforms. These platforms provide a low friction way of using data from the instrumented product combined with a 360-degree view of the customer and the cross ecosystem collaboration and commercial capabilities (often in the form of a services marketplace) required to profitably deliver and monetize the required service.

Traditional manufacturing combined in real-time with third-party services on new digital platforms can create highly customizable services, which can have a disruptive impact on traditional business models and the competition.

This requires suppliers of connected products and services to cooperate and collaborate across traditional industry sector and market segment boundaries. For example, a pump motor manufacturer sells to a pump manufacturer through an agent. The pump is installed in a chemical plant, whose owner has subcontracted maintenance to a specialist services company. To predict when the motor needs to be maintained will require information from all the parts of this supply chain. By sharing information between the various parties, the customer gets a better service and both the OEM and the other parties share in the benefits. Hence there is a need to define and adhere to business and technical rules that enforce transparency and fairness in value definition and allocation within a given services ecosystem.

Done correctly, such a close relationship allows companies to provide customers with a far better overall value proposition that in turn can lead to higher rates of customer acquisition and retention.

4. Data driven R&D of next generation products

Industrial OEMs can now see how their connected products are really used in the field and how they perform in real life. This insight can be fed back into and optimize the research and development (R&D) cycle for the next generation of product. The benefits of this are:

- Products that more directly meet actual customer requirements and expectations
- Accelerated development cycles
- Elimination of redundant features
- Building new connected and data-rich products

Engineering of connected products leads to a fundamental change in the way that products are designed and produced. OEMs can start to move to a more agile, continuous engineering approach—where the design and update of new products happens continuously based on real-time feedback rather than the traditional, often waterfall-based approach of product development cycles that may take several years to design and manufacture the next generation product.

A major manufacturer of jet engines is working with IBM to receive detailed operational data from their jet engines in use on commercial airliners. Thousands of continuous data points are gathered every second, allowing the product engineers to understand how their engines perform when subject to real world conditions such as extreme weather and varying load cycles.

Connected products themselves are also possible to update and manage after they have been sold—potentially providing new features and capabilities to existing products and fixing any bugs or problems that may occur without the need for costly product recalls. This also provides an additional form of value to the end customer, a product that is continuously improved and updated through the active support of the OEM, which in turn places additional demands on the OEM's organization and capabilities, as they start to support both the product and the end customer throughout the product's lifecycle.

These trends are reshaping the industry

These trends are themselves reshaping the landscape of the industrial manufacturing industry in a number of ways:

- Allowing many industrial OEMs to transform the nature of their business by shifting from a product-centric to a customer-centric model
- Enabling the move from commoditization of products to high value product or service combinations as products sense and understand their environment and can be personalized
- Driving new relationships and ecosystems as the industry realigns in the search of new sources of value and control

The second section of this paper identifies the key things that organizations must get right to successfully execute and achieve the vision that the IoT represents in the face of these disruptive forces.

How to execute

Given the rewards available to those choosing to exploit IoT opportunities, how should industrial OEMs begin? How do you cut through the noise, confusion and excitement in the IoT market?

From hype to insight

We propose a first step, which we call moving from “Hype to Insight.” This approach, which is illustrated in Figure 1, is designed to provide clarity and understanding into what is actually important and relevant to your organization and your business across a number of key dimensions: Industry, Customer, Competition and Technology.



Figure 1: Hype to insight.

While the exact approach is tailored for each client and industry, the basic premise is the same: to gain a clear-eyed view of the current reality and future trends affecting an industrial OEM in the connected world by providing answers to some key questions. This is usually achieved through a combination of structured workshops and SME interviews complemented with external intelligence (that is, from industry bodies or analysts) and analysis.

These are not questions that can or should be answered by an individual. It is crucial to engage key stakeholders from across the organization, some of whom would not normally have been involved with such discussions. This is because the disruptive effects that IoT is having on the marketplace, is allowing

players into markets where they have not previously been associated. As an example, Connected Cars was previously associated exclusively with automotive manufacturers. However the range of players jostling for positions in this space now includes wireless networking providers (telcos), mobile ecosystem providers (Google & Apple), IoT platform providers (both niche and enterprise), the major IT system integrators, data providers (maps, traffic, content), insurance companies, next generation mobility providers (Zipcars, Car2go), and a whole range of startups and point technology providers. This is a complex and dynamic situation, and knowledge of these different segments resides within different parts of an automotive manufacturer's organization.

From vision to implementation

Within the context established from the initial stage (from hype to insight), it is then possible to start to formulate the overall vision and strategy. This includes how your organization will use IoT opportunities and how to assert a point of control in an evolving ecosystem. The next stage is then to implement the technology solutions and components required in order to drive this transition.

Given the speed of transformation within many industries, this step needs to be both iterative and ongoing throughout the business transformation process. It also forms the basis and requirements for the delivery model shown in Figure 2.

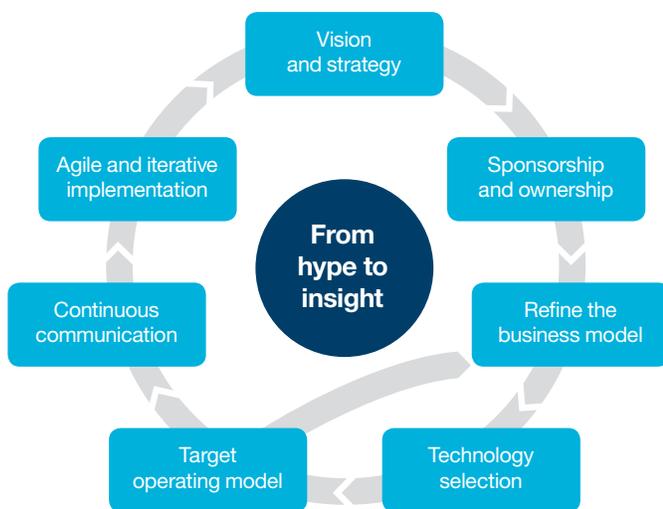


Figure 2: Hype to insight delivery model.

As previously mentioned, this process is iterative between individual steps. For example, the Target Operating Model assessment is a key indicator of preparedness for change. The outcome of this may well affect either the scope of the business model or the delivery plan for it.

While the delivery model outlined above is not necessarily unique to IoT initiatives, there are some aspects that are specific to IoT-enabled transformations that will be described later in this paper:

- Securing the right sponsorship
- Continuously refining your business model
- An agile and iterative implementation

Secure the right sponsorship

The ownership and sponsorship of an IoT-related initiative is of critical importance. If an industrial OEM intends to start selling “connected” products, this is a strategic decision that fundamentally affects what a company sells, who they sell it to and the associated value proposition. This means that the senior product management needs to own any such connected product decision with the support of corporate strategy and often the CEO as well.

In other cases where industrial OEMs use IoT to instrument and optimize their internal production and quality management systems, the full support of the COO is typically needed.

We are increasingly seeing the deployment of IoT solutions as a means of improving the end user experience and thereby boosting the perception and value of the overall brand. In all these cases, the introduction of IoT is not something that can be left to the IT department or even the R&D department alone. These departments will have a critical role in the overall process and implementation, but they need the support and sponsorship of the senior management across the organization to achieve success. Without this level of executive support and ownership by the product management or operational executives, most IoT initiatives will struggle to deliver their full potential.

When industrial OEMs decide to start selling connected products, they quickly find that it also cuts across many other business functions, some examples include:

Business function	Possible changes
Marketing	Significant increase in product registrations and a detailed view of who the end users are and how they use the product Possibility to target end users with direct and personalized marketing messages
Sales	Possibility to sell additional, data-enabled services such as condition monitoring and predictive maintenance More detailed and fine-grained information on who their customers are and their buying behavior
Channel management	The OEM is no longer dependent on the Channel Partners to reach the end users or even to sell the product
After Market and support	Possibility to sell additional, data-enabled services such as condition monitoring and predictive maintenance
R&D	Direct feedback on how the product is used in the field

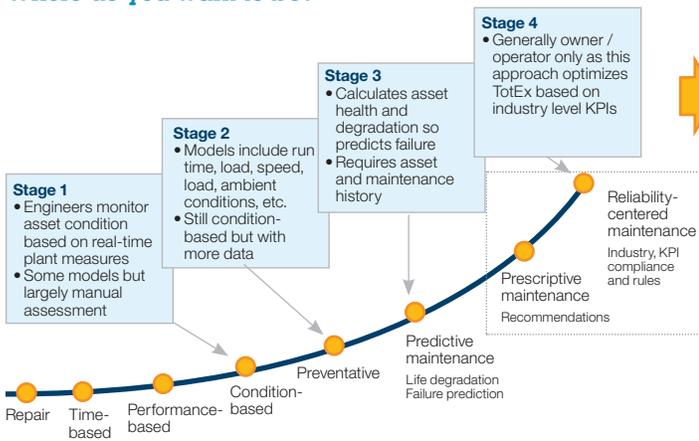
This requires further anchorage and support from the affected business units (which in itself usually requires the direction and support of the CEO to be accomplished smoothly) and heightens the need for a clearly articulated Target Operating Model to enable the transition to the desired future state.

In short, although much of the discussion and hype around the IoT has centered on the technology (for example, the devices, networks, protocols, and analytics.), the fact is that a successful IoT initiative must be 100 percent business focused. It needs to be owned and driven by senior executive management, and the subsequent changes to how an industrial OEM is wired must be managed as a business transformation project.

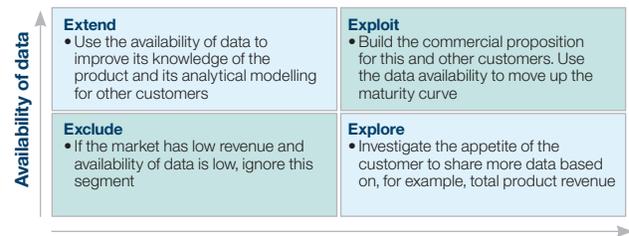
Refine your business model

To understand this requirement better, consider the illustration of a company wishing to move from supplying equipment to supplying services.

Where do you want to be?



Which customers do you want to serve?



How ready are you to deliver?

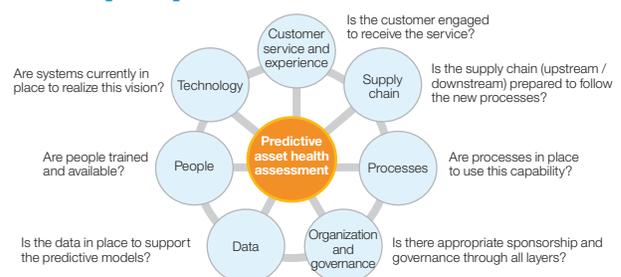


Figure 3: Illustrative business model.

Such a company can offer maintenance services at various levels through a maintenance maturity curve shown. However, the assessment of where to position itself on the curve and the value to be obtained will vary from customer to customer. Two dimensions of this decision making could be availability of data from the customer and the revenue from that customer. Other dimensions could include such things as operating cost. For many automotive and consumer product manufacturers, the reduction in product recalls during warranty is an immense benefit and drives down the cost associated with warranty returns without directly raising sales volumes.

Positioning the customer or customer segment can provide the OEM with a view on the potential benefits to be gained from each level of service offering. It also provides a framework for assessing where the market is moving in each of these segments.

This potential shift from product-centric to customer-centric business models will have a painful impact on suppliers of successful products as they often lack the in-house expertise to deliver smart services. Indeed, many product manufacturers lack both in-depth expertise in the field of digital business and the ability to develop new, data-driven services and business models. Therefore, the challenge for the industrial OEM becomes the potential for cooperation with other suppliers within the ecosystem.

This gives the OEM a starting point for defining the benefit of evolving its business model to include a significant services-based component. This leads on then to the technology discussion and the readiness of the business to change according to a set of criteria also shown in the diagram.

An agile and iterative implementation

The advantages of implementing a solution in an agile and iterative manner are by no means exclusive to an IoT initiative, but there are a number of factors that make such an approach even more appropriate in this context.

Firstly, the technologies and services used to build an IoT solution are currently in a state of continuous flux. In recent years the advances in cloud, mobile, wireless networking, analytics as well as the base hardware of sensor and actuator devices has been accelerating rapidly. IoT solutions draw on all of these areas, and the IoT domain itself is also extremely volatile (at time of writing, there were estimated to be over 300 different “IoT Platforms” on the market).³ The feature set of all of these platforms is changing monthly, and we can expect significant consolidation in this area as some players exit the market, and the big animals of the IT and OT jungle attempt to assert their dominance through acquisition and investment. Such dynamism makes it hard to plan too far ahead or trust the marketing pitch of IoT vendors. An approach based on short sprints of continuously proving the technology and its fit to your requirements is essential.

Secondly, and even more importantly, such things as smarter services ecosystems and their associated business models and innovative revenue streams are also in a highly experimental phase. Traditional models are being disrupted or extended and while some of the high level characteristics of this disruption (which we outlined in the opening section of this paper) are becoming clear, there is still a lot that needs to be worked out in the market place and much will be specific to an industry or geography. This means that the wise IoT pioneer will check their value propositions and business models in the market as early as possible and continuously update and refine based on the findings. What are your customers really prepared to pay for? How will your new partners actually perform, and what do they expect of you?

This is a highly creative and destructive time from both a business and technology point of view, much is in flux and it may seem overwhelming to many, but it is also a time of great opportunity that will favor the bold.

If a clear perspective of your business environment and own capabilities can be considered the starting point, and your long-term vision and IoT strategy the end point, then the most pragmatic way to move from one to the other is to start small, continuously iterate and validate your business models and technology choices. Detailed planning cycles covering many months or even years are simply not viable when boot strapping an IoT enabled transformation. Also be aware that the distributed nature of an IoT solution makes it difficult to ensure that all components will work as intended all the time. Wireless networks are not perfect, firmware updates may not execute as intended and hardware in the field can and will fail. Your solution and your planning should be built to identify and recover from such failures.

Don't be afraid to fail, in fact, you should plan to fail but aim to fail quickly and gracefully. It is imperative to learn from the experience of failure and continuously update and refine your vision and strategy as you continue on the journey.

Are we nearly there yet?

And make no mistake, this is a journey. It will be an ongoing process with unforeseen developments and implications. As an analogy, let's consider the development of the web or the "Internet of People" as it could also be described. Twenty years ago, who could have guessed what impact the web would have, the types of services and business models it would support? That the original text-based, static web from 1995 would become multimedia and interactive, that was then social and transactional, that websites would give way to web applications and mobile apps, that the ingenuity of an army of empowered developers would build millions of different apps that defy classification? That many services on the web would be completely free to use, but they would enable the companies providing them to claim a healthy profit, often from something we now call "data monetization"? These dramatic advances

were driven initially by the unifying standards of HTTP and HTML, allowing any browser to view any website. Then as the web became mobile, by the advent of app stores, horizontal platforms enabled developers to connect directly with consumers to solve problems that could not even have been imagined by a single organization.

We are at a similar juncture with the IoT, except that the impact of instrumenting everything, of connecting the physical world to the digital one, promises to be far greater than simply connecting people to websites. The point being that we are not in a position to know what the full impact will be yet.

The supply chains of industrial OEMs (whose purpose was to manufacture and sell products to customers) are becoming disrupted and evolving and expanding into ecosystems of smarter service providers. As these ecosystem grow, so too does the ability to devise ingenious new solutions to a myriad of problems and finding new ways to create value across industries and society. This energy and creativity is far greater than a single industrial OEM could bring to bear or even conceive of alone as the ecosystem connects a range of different services, capabilities and data. It is this ferment, this continuous testing of new inventions in the marketplace, reusing and building upon the inventions of others that will unearth the most valuable and beneficial solutions. This is what will disrupt entire industries and create new revenue streams and business models for the pioneers and the winners.

For more information

To learn more, please contact:

Adam O'Gorman

Internet of Things Solutions, Digital Operations

IBM Global Business Services

OGORMAN@se.ibm.com

Or visit:

ibm.com/services/us/business-consulting/digital-operations-internetofthings/



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Global Business Services
Route 100
Somers, NY 10589

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