WHITE PAPER

IoT-Enabled Analytic Applications Revolutionize Supply Chain Planning and Execution

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IN THIS WHITE PAPER

The unprecedented availability of sensor-based data on physical assets, as well as the capability to transform machine language into usable data, delivers on the promise of true end-to-end supply chain visibility for the first time to drive optimal real-time execution. The data arising from the connectivity of physical assets is the foundation of the *Internet of Things* (IoT). But converting this raw IoT data into an opportunity for process improvement brings challenges in dealing with nonstandard data in unprecedented volumes. To address these challenges, a new generation of *IoT-enabled analytic applications* for *supply chain planning and execution* is now becoming available. Supply chain professionals have grappled with the challenges associated with a lack of complete visibility across the supply chain for decades. Fortunately, forward-thinking innovative companies have developed purpose-built supply chain visibility solutions, leveraging IoT technology, to finally achieve the requisite layer of visibility into the supply chain. For the first time in history, complex global supply chains have the capability to connect with their products and processes to achieve new levels of supply chain visibility.

IDC OPINION

As ubiquitous connectivity becomes the norm across the global business landscape and the Internet of Things continues to gain acceptance, the explosion of data created out of such a connected world is driving firms to develop and implement IoT strategies with purpose-built analytic applications to capitalize on this wealth of information. The lag between data collection and action has been dramatically reduced because of the increased sophistication of sensor technology, advanced mobile communications, and purpose-built analytic applications. The reduction in the time between data capture and decision making enables firms to react to changes in operations in real time, presenting the opportunity for dramatically improved operations to those who leverage this advanced technology.

The Internet of Things is driving supply chains to rethink and retool in order to inject a layer of agility and responsiveness never before seen into an ever-changing environment. Massive real-time data captured by sensors represents the raw material for this transformation of operations. But it is the delivery of purpose-built analytic applications that turns this raw material into actionable insight.

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SITUATION OVERVIEW

The external business environment (whether manufacturing, retail, oil and gas, or anything else) is a highly dynamic, ever-changing landscape where industries operate sophisticated, complex supply chains; those organizations must adapt to changes that are happening or have happened as well as anticipate changes that will happen. That the market is dynamic comes as no surprise to supply chain professionals, though the way forward generates much debate. Rather than repeat the litany of current challenges, we highlight a handful of challenges that we believe are the most compelling:

- **Data driven.** Repurposing the old saying that "you cannot improve what you don't measure" into "you cannot respond to what you don't see" speaks volumes for the many manufacturers that are wrestling with massive, and constantly growing, amounts of data. Let's put the terminology of "big data" aside for the moment: The reality is that the requirement for supply chain organizations to broaden their "supply chain intelligence" is paramount, and it is increasingly unacceptable to "not know" — particularly when consumers are increasingly empowered with "ubiquitous visibility." And it is not just about what a business knows versus what a business doesn't know; it is also about making information available to critical decision makers when and how they need it. Manufacturers have a wealth of information across the enterprise, and if that information is managed and analyzed in a unified fashion, it can drive product and service innovation. Of course, manufacturers need to be able to trust the information such that it can be used to accurately verify customer demand, determine the right mix of suppliers, and validate product and process quality.
- **Consumer/customer centric.** There seems little question that supply chains are much more aware of the consumer/customer than ever before, and the questions of how to personalize products; manage "mass customization" from facilities that are not well suited for that very purpose; ensure the highest level of product quality from increasingly distributed, global supply networks; and provide consistently high levels of customer service are central to discussions of strategy and competency.
- **Demand awareness.** While there has been a decades-long discourse on the relative merits of being "demand driven," there is little question that supply chain organizations can benefit from greater visibility into the cadence of demand. While some businesses will never use demand signals to inform factory run strategies, the ability to better manage service performance and late-stage assembly/postponement through enhanced insight into demand patterns and more accurate supply chain forecasts is quite apparent. That is not to say that manufacturers ought to be fully and inflexibly "calibrating" their supply chains to a particular forecast, because forecasts will always be wrong and some supply flexibility is critical, but clearly, being demand aware gives the supply chain a better chance of responding seamlessly to changes in the business.
- **"Always on."** This is more an overall business requirement, perhaps, but a requirement that clearly impacts the supply chain and fulfillment/customer service, in particular. The world is moving to a "24 x 7 x 52" mentality, with expectations for round-the-clock shipment and customer and consumer service support. Just as the 3PL community has moved essentially to an "always on" approach, so will the logistics and fulfillment functions within the consumer products manufacturer, essentially adopting a 24 x 7 x 52 "continuous" logistics operations and supply chain model. Clearly, there will be regulatory implications and the need to navigate country- or region-specific operating rules, but the move to an approach of 24 hours a day, 7 days a week, and 52 weeks a year seems inevitable. If manufacturers are going to respond to shrinking order and delivery timelines, greater numbers of delivery points (as a result of omni-channel commerce), or even direct-to-consumer shipments, it is hard to see how to effectively do this without moving to the reality of 24 x 7 x 52 continuous logistics. Manufacturers that fail to adapt will fall behind the industry.

- **Digitally executed.** Whether adopting modern document management processes and technologies, mobile tools, demand signal repositories, the Internet of Things, or emerging technologies such as 3D printing, the world is going digital and the supply chain is not to be spared. Nor would we want it to be! Although not the exclusive purview of the supply chain, managing B2B (and potentially B2C) networks is part of what we at IDC see as the central driver of the next generation of supply chains.

Increasingly, businesses across industries are participating in complex, extended, and overlapping value chains. Dynamic change due to increasing product complexity, customer demand, and service efficiency has become the norm rather than the exception. Therefore, these companies need to build a level of agility, risk mitigation, and resilience into their value chains that enables rapid response, aligning resources with market demands before and after product launch in as close to real time as possible. Supply chains have also tended to not be early adopters of new technologies, preferring, in many cases, to wait until the technologies have proven themselves in delivering tangible business value. One consequence of this approach is a persistent overreliance on cumbersome manual processes, which constrain the ability to optimize in an increasingly complex environment. For supply chains willing to be early adopters, IoT-based analytic applications are driving transformational improvements across the supply chain and business operations.

At the same time, companies are also engaged in an ongoing search for business improvement, seeking new market opportunities in the face of these constantly shifting markets. For some (perhaps most), the question is not whether the data exists to support business improvement initiatives but how to optimize the analysis of the existing data that is available yet underutilized.

The Implications for the Internet of Things

IDC defines the Internet of Things as a network of networks of uniquely identifiable endpoints (or "things") that communicate without human interaction using IP connectivity. At the edges of these networks are billions of sensors attached to a wide range of physical assets such as trucks, freight, wind turbines, drilling equipment, and smart meters. In the context of supply chain processes, the massive quantities of data emitted from these devices, when effectively harvested and analyzed, can offer unprecedented visibility into real-time conditions, providing early warnings of situations that require remediation. Responding to these signals in time can drive new levels of supply chain efficiency.

But this opportunity for process improvement is not easily achieved. As a general rule, 80% of the effort in an analytics project is expended in gathering and preparing data for analysis. This principle applies with special force in IoT projects for the following reasons:

- Sensors are manufactured to be small, inexpensive, and low power.
- As a result, there is limited processing power within sensors available to structure the data.
- There are millions of types of sensors, with few or no industry standards for the data that is generated. And given the many types and varieties of sensors, it is unlikely that any standard or set of standards could be adopted that would serve the entire industry.

The result is that sensor data is complex to deal with and challenging to integrate and/or combine across multiple devices. The skills required to do this data work are limited within an organization and even within the marketplace at large. These data challenges and the shortage of expertise to deal with them increase the complexity and thus increase the cost of IoT analytics projects compared with other types of analytics projects. However, there do exist in the market innovative solution providers with SaaS model IoT-enabled analytic applications that can drive value while providing a solution capable of delivering on rapid ROI.

IoT-Enabled Analytic Applications

A promising sign for meeting the needs mentioned in the previous section is the emergence of analytic applications, purpose built for IoT scenarios, that package expertise for dealing with the unique challenges of IoT-related data. So what are analytic applications? IDC was the first to define analytic applications, back in 1997. Analytic applications must meet each of the following conditions:

- **Process support:** Structure and automate a group of tasks pertaining to the review and optimization of business operations.
- **Separation of function:** Operate separately from the transactional applications that run the business but interoperate with them.
- **Time-oriented, integrated data:** Offer data organized to provide a time-based dimension for analysis of past and future trends.

IoT-enabled analytic applications apply these principles for IoT analytics in a supply chain context in the following manner:

- **Supply chain process support:** Review and analyze data captured in supply chain operations.
- **Linked to operations:** Decide on a remediation plan and act to implement the recommendation.
- **Time-oriented, integrated sensor data:** Facilitate the structuring and integration of sensor-based data over time to analyze trends and discover relationships that drive corrective actions.

IoT-enabled analytic applications are now available in the market and are being packaged to support a variety of product and supply chain decisions across a range of industries from transportation to government to energy and more. Cloud-based applications are of particular interest because of their flexibility, scalability, and low touch and because they typically cost less than traditional deployments.

Beyond Query and Reporting and Beyond the Planning Function

The first generation of analytic applications focused on query, reporting, and analysis with an emphasis on the planning function. This started with financial planning but soon embraced other use cases such as sales and operations planning. The new generation of analytic applications must address much more than query and reporting and more than the needs of planners:

- **Real-time operations:** IoT-enabled analytic applications must cover the real-time environment — monitoring and processing sensor data to provide frontline operators and line managers visibility into the current state of a freight shipment or detailed weather conditions at a wind farm.
- **Data exploration and predictive and prescriptive analysis:** In addition to planners and operators, IoT-enabled analytic applications must support data scientists and analysts who use predictive analytics to explore massive data sets looking for patterns and leverage prescriptive analytics to make decisions ahead of a potential disruption. Discovering a pattern or leading indicator of change can guide operators on what signals to pay attention to — at a time when they are still weak signals or early warnings of critical changes.

By addressing three constituencies — planners, operators, and data explorers/consumers — IoT-enabled analytic applications increase their value to the business. Demonstrating incremental value (over and above the incremental costs) is critical for businesses considering IoT-enabled supply chain analytics initiatives.

Market Development Drivers and Key Use Cases for IoT in Supply Chain Management

While the complexity relative to implementing IoT solutions and realizing value from such implementations remains high, the potential value relative to a successful initiative far outweighs the challenges, and as a result, we are seeing dramatically increased interest in IoT/sensor-related efforts in the market. We have seen successful early applications in the consumer sector (connected homes, connected vehicles, wearable health devices, etc.), yet the value of IoT sensors, systems, and products will likely be higher in the commercial world than in consumer markets as B2B solutions are implemented, following software value trends of prior generations. A number of factors have contributed to the lack of value capture in the commercial space so far, although things are clearly changing:

- Perception of the technology as business ready or business robust
- IT budgets that are overstretched with significant project backlogs
- Business process redesign to leverage new approaches (rather than just "plugging" new technology into an old business process or the same business process)
- The need to identify and scope high-value use cases

Despite the relative immaturity of IoT solutions, and considering the impediments just noted, opportunities and use cases for IoT (sensors, systems, and products) are quite numerous across vertical markets. Clearly, differences across vertical markets and business models create a situation where the value of IoT varies significantly across the markets (see Figure 1), but the appeal is broad. It is also fair to point out that many of the use cases are not new. They are efforts that have been aspired to by organizations for decades, in some cases, yet the potential for IoT technologies to enable capabilities in new and accretive ways is both intriguing and potentially compelling.

FIGURE 1

Internet of Things Use Cases by Industry

Q. Which of the following best describes your organization's deployed or planned use of connected sensors, systems, or products? (Please select all that apply.)

	Local/State/ Federal Government	Education	Healthcare/ Medical	Consumer Packaged Goods	Retail	Financial Services	Manufacturing	Construction/ Architecture/ Engineering	Transportation and Logistics	Utilities	IT and Telecom
Supply Chain/Warehouse Management	22.2	20.1	9.4	44.7	45.6	20.7	52.0	32.3	52.8	10.4	24.0
Fleet Tracking	28.7	25.2	4.4	23.1	25.7	17.9	33.9	29.5	49.3	51.4	21.6
Asset Tracking	26.4	35.9	16.8	30.8	35.6	24.7	39.9	38.0	29.8	21.5	26.8
People Tracking	40.0	30.0	19.3	46.8	27.7	38.5	34.6	42.9	38.1	39.7	42.8
Vehicle Performance	21.6	10.1	8.5	12.9	27.2	13.7	23.0	30.0	36.5	19.2	20.7
Vehicle Entertainment	11.4	11.9	6.9	6.6	12.7	15.2	9.1	14.7	18.5	24.1	14.0
Remote Monitoring	41.0	31.7	18.5	30.7	32.6	23.1	33.5	42.7	42.8	23.1	35.6
Digital Signage	13.3	25.0	3.8	16.2	22.2	26.1	21.1	8.3	20.5	16.2	18.6
Augmented Reality	17.2	27.7	11.7	15.7	13.8	19.3	19.8	21.8	19.4	16.6	20.0
Energy Management	16.2	42.1	5.0	34.1	27.6	11.8	37.7	22.6	11.0	68.8	26.9
Security Systems	64.9	37.5	27.1	26.5	53.0	50.5	54.7	55.7	53.2	72.4	59.0
Manufacturing Process	21.9	15.6	10.9	26.5	25.5	20.4	55.6	22.1	23.4	14.4	23.3
Product Testing and Quality Control	29.1	16.9	9.1	33.6	27.9	29.5	51.1	26.1	17.4	23.1	43.0
Smart City Initiatives	24.1	12.5	5.4	11.7	9.5	8.5	14.1	17.0	15.9	26.6	18.5
Agriculture Processes	11.1	10.3	0.7	5.2	8.5	9.7	2.3	1.4	3.3	7.1	9.5
Industrial Machine Maintenance	9.7	15.8	2.3	18.0	15.3	15.4	34.8	23.0	17.9	28.2	16.7
Payment Systems	45.3	17.4	23.1	40.9	57.0	41.4	33.3	29.5	39.7	28.2	31.4
Remote Asset Control	20.6	30.8	11.0	26.4	34.4	16.7	35.9	18.3	34.5	16.6	29.0
Building Management	42.8	50.7	13.2	18.7	20.5	29.9	33.3	49.9	32.7	41.8	30.7
Level of deployed or planned use of IoT			Very High	High	Medium	Low					

Source: IDC's *Global IoT Survey,* 2014

Figure 1 clearly displays a lack of commonality regarding IoT use case opportunities across industry verticals. However, the heat map also points out that firms in the manufacturing industry have the highest adoption rate (or planned adoption) of IoT use cases, while IoT applicability in security systems appears to span the greatest number of industry verticals. Ultimately, what we see is a broad range of industry vertical- and application-specific use cases relative to the current state of planned or deployed IoT initiatives. Over time, as IoT continues to gain steam in the market, we will see an increased level of adoption across both industry and application of IoT solutions.

Leveraging Sensor-Enabled Analytics Within the Manufacturing Supply Chain

Sensor-enabled analytics is an area of particular interest within the manufacturing supply chain, where adoption of new technology has typically been slower than other areas, creating a tremendous amount of opportunity. The dynamic nature of the manufacturing supply chain and the extremely competitive environment push all actors in the manufacturing supply chain (manufacturers, suppliers, distributors, third-party logistics providers, and retailers) to aggressively seek out opportunities to improve performance and create a competitive advantage. In addition, the required collaboration and alignment between all parties in the manufacturing supply chain help support the need for sensor-enabled analytics that are capable of improving insight into performance and reduce the time it takes to capture, analyze, communicate, and act upon supply chain performance information.

- **Real-time visibility:** Visibility across the supply chain has long been a hot topic relative to required supply chain improvements, whether the discussion is around visibility into supplier capacity, supply availability, inventory, or manufacturing capacity. Fortunately, sensor technology can help support supply chain visibility improvements as sensors are the only technology truly capable of capturing data in real time. Sensor technology, in addition to acting as a medium for improving visibility, can capture vital data and leverage it in analytics to drive end-to-end supply chain improvements. With visibility into materials, inventory, how much supplier capacity is available, and how much manufacturing capacity is available, supply chains will be better equipped to plan and execute within the supply chain and be better positioned to respond and adapt to changes in the operating environment.
- **Transportation and logistics:** Sensor-based technology has long been a part of the transportation and logistics industry. However, what seems to have been lacking is the ability to effectively capture the data relative to the movement of goods and convert that data into actionable insights capable of driving improvements across the supply chain. For example, trucks have been outfitted with GPS devices and other sensors that capture information such as location, speed, and idle time. With this information, logistics companies have been able to assess delivery times, fuel consumption, tire wear, and emissions. However, with IoT sensors and analytics, this information can be leveraged to identify optimum departure times based on historical data and real-time traffic scenarios and far more accurately predict arrival times. A better understanding of such information can improve supply chain performance through reduced late deliveries, improved warehouse labor productivity, improved planning, and optimized routing. In addition, IoT creates the potential to leverage such information in nonlogistics elements of supply chain planning such as inventory positioning, inventory levels, and safety stock calculations, which have a direct relationship to profitability.
- **Improved manufacturing productivity:** Manufacturing process improvements begin with understanding performance and identifying areas in the process where opportunities exist. Manufacturing process improvements can come in many areas, including speed, motion, flow, and quality. Implementing sensors into the manufacturing process to capture these elements on the production line enables a manufacturing firm to analyze the production process and

more rapidly implement change into the process to drive production process improvements. In addition to the actual process improvement opportunities, sensor technology plays a significant role in improving machine performance. The Internet of Things creates a platform for data capture, communication, and analysis of production machinery that drives the capability to actualize predictive and prescriptive maintenance of machinery.

- **Increased alignment between planning and execution:** Often discussed but rarely seen is true alignment between supply chain planning and supply chain execution. Achieving the scenario where the planning drives supply chain execution and supply chain execution feeds the next planning cycle is often a cumbersome and inaccurate exercise resulting in inefficient capacity, excess inventory and/or stock-outs, expedited freight costs, and more. Through sensor-enabled analytics, firms can begin to better align the planning and execution functions of their supply chains by improving communications and creating visibility between the planning and execution functions.
- **Supply chain collaboration:** The global and interconnected nature of today's supply chains has driven the need for greater collaboration among supply chain partners. Such collaboration must go beyond the simple sharing of data and collaborating on process and design; true collaboration exists when supply chain partners break down organizational barriers and integrate with one another to form a seamless flow of data that enables agility and responsiveness throughout the end-to-end supply chain. The Internet of Things can provide a platform for real-time multidirectional information sharing to help in creating true supply chain collaboration.

None of these concepts are new, or should come as a surprise, but they are highlighted today in the context of ubiquitous information, global complexity, and the "need for speed." Indeed, yesterday's "visibility" is woefully inadequate for today's business environment. The challenge/opportunity for the manufacturing supply chain, indeed for any supply chain, is to continue to be faster and more transparent while maintaining productivity and profitability levels. At IDC, we simply do not believe this is possible without leveraging new/emerging technologies. Yet, at the same time, both new and older technologies must interact to move the supply chain forward in a sensible and constructive way. It is only then that the business benefits will come:

- Leveraging sensor technology to improve supply chain visibility
- Improving manufacturing productivity by enhanced analytics aligned with the manufacturing process
- Connecting elements of the supply chain where there has been a traditional gap in fundamental coverage (e.g., in-transit item location, speed, delivery expectations)
- Improving supply chain planning through enhanced visibility and improved reliability of supply chain execution and performance metrics
- Benefits throughout the entire organization
- The "community" aspect of IoT — benefits beyond the organization
- Achieving predictive and prescriptive insights relative to supply chain performance

Of course, it is not enough to just "sense"; one must also "respond." In one of the examples noted previously, it is not enough to improve supply chain visibility — one must also *act upon* that information. In this context, we can consider the glaring difference between "milestone based" solutions and real-time sensor-based solutions. The inherent value in sensor-based solutions is the capability to capture real-time data, thus enabling analytics, insight, and action based on the best information available at the present time. Such an approach truly enables an agile and responsive supply chain with a narrow lag between data capture and value realization. When we compare sensor-based solutions with milestone-based solutions that periodically communicate data based on a series of scheduled data collection points, we can clearly see the transformational value of sensor-enabled, purpose-built analytics applications.

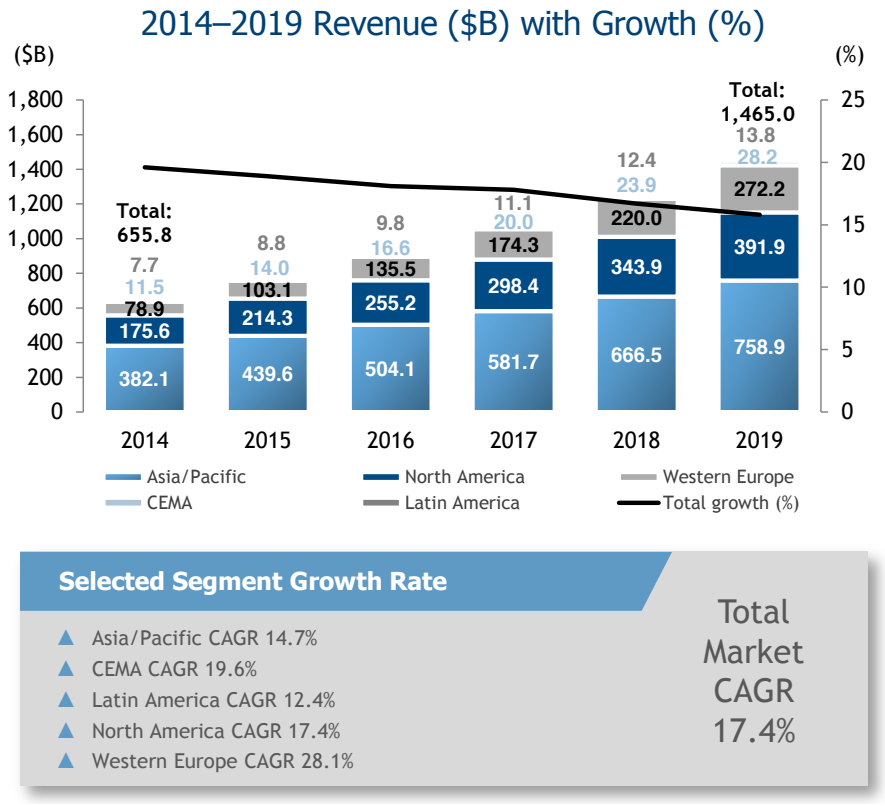
Financial Impact

There are two dimensions to the potential financial impact of the Internet of Things. The first dimension is the new marketplace that will develop and grow based on the demand for IoT technology. The second dimension, which is perhaps more important because it will define the first, is the extent to which these technologies drive the kinds of real business benefits we have touched upon in this white paper.

IDC estimates, from a macro perspective, that the global market for the Internet of Things will maintain a compound annual growth rate of 16.9% to reach over $1.7 trillion from 2014 through 2020 (see Figure 2). This estimate was put forth in 2015, at a time when the best-known global IoT market stood at roughly $655.8 billion (2014).

FIGURE 2

Worldwide Internet of Things Revenue Snapshot



Selected Segment Growth Rate

- Asia/Pacific CAGR 14.7%
- CEMA CAGR 19.6%
- Latin America CAGR 12.4%
- North America CAGR 17.4%
- Western Europe CAGR 28.1%

Total Market CAGR 17.4%

Source: IDC, 2015

At its most basic level, the implication is that firms providing products (software, hardware, and connectivity) and services in the IoT space have a significant new revenue opportunity of over $1.04 trillion. Typically, up to 80% of the costs of an analytics project are related to preparing and integrating the data before any analysis can be done. While we expect the costs of sensors to continuously come down, the packaging of expertise (via purpose-built, IoT-enabled analytic applications) to integrate and analyze the distributed sensor data should contribute even more to reducing the time to benefit. The resulting financial impact will be significantly improved return on investment.

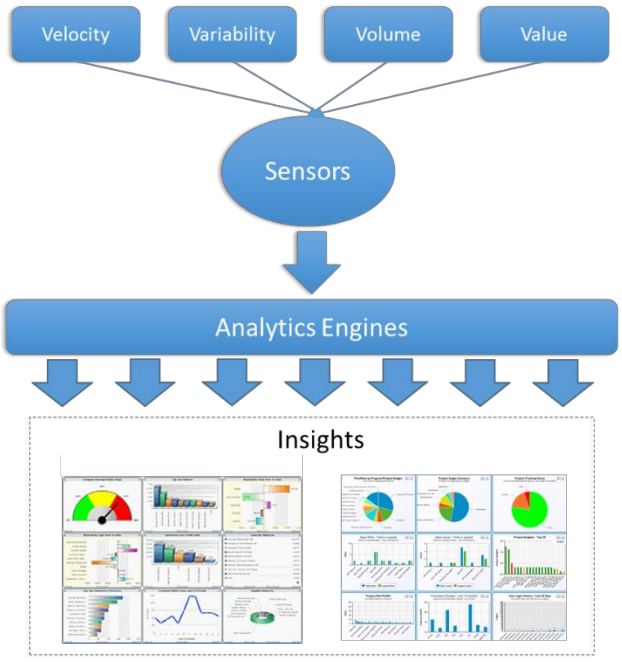
As firms across vertical markets including manufacturing, distribution, and retail adopt and implement IoT within their business processes, they will inject a tremendous amount of opportunity to capture financial benefits. The Internet of Things creates a web of interconnected devices that have the capacity to interact autonomously with each other, thus reducing the time it takes to conduct analysis, make decisions, and act on insight. In addition to reducing data to action, IoT provides a platform to optimize business performance and drive KPI and metric improvements.

Sensor-Enabled Technologies

Any discussion of IoT in a commercial context is not complete without considering the value, impact, and applicability of the sensors that ultimately drive data capture and enable analytics within IoT. The sensor acts as the medium between action and analysis by capturing various elements of action (velocity, variability, volume, and value) and communicating these elements to analytics engines, which in turn convert this data into actionable insight (see Figure 3). In this context, we can clearly recognize the fact that sensor technology provides the foundation by which the data elements required to effectively execute an IoT strategy are collected.

FIGURE 3

The Four V's Captured by IoT Sensors



Source: IDC, 2015

Yet, as we noted previously, both new and older technologies must interact to move the supply chain forward in a sensible and constructive way. While IoT technologies may prove to be the big driver of data volumes, they will not be the only sources, with both social and traditional ERP remaining critically important. Purpose-built applications for sensor data, therefore, must both scale to handle sensor data and be adaptable to address the varied sources of that data. Likewise, the ability to both "consume" the output of analytics (and thus *act upon*) and provide feedback loops becomes the function of cloud, mobility, or

traditional on-premise access. At this point, it would be prudent to also point out that the real value in this equation is not the capture of data; rather, it is the emergence of IoT-enabled, purpose-built analytic applications that make sense of vast amounts of data to produce insight and drive action in the supply chain.

FUTURE OUTLOOK

The future for IoT appears bright; indeed, where the supply chain is concerned, we have barely scratched the surface. In terms of the overall trend, we expect that IoT technologies will be materially affecting the way that all companies manage their supply chains by 2020 and that 25% of their supply chain IT spend will be for IoT or IoT-related technologies (this prediction will feature prominently in our IDC Supply Chain FutureScape for 2016).

Sensors have been part of the supply chain for decades, but they are rarely connected and even more rarely integrated beyond a narrow "purpose built" role. The implementation of wide-ranging, integrated, and connected sensor webs allows businesses to do things previously not possible, and we expect to see a significant number of these types of implementations. Table 1 provides a sampling of the kinds of things we expect to see companies do (and in some cases are already doing) across multiple industry verticals, along with the impact on key metrics.

TABLE 1

Future Use Cases for IoT by Industry

Industry	Use Cases	KPI/Metric Impact
Supply chain (function rather than industry)	Real-time track and trace	Working capital, safety stock, and productivity
	Inventory visibility	Inventory turns and ROA
	Alignment of planning with execution	Forecast error, perfect order fulfillment, and production plan adherence
	Predictive ETA	Customer service level, on-time delivery, and productivity
Transportation and logistics	Optimized routing	Customer service level, productivity, and on-time delivery
	Predictive maintenance	ROA and asset utilization
	Improved scheduling	Labor costs and productivity
Manufacturing	Predictive maintenance	ROA, asset utilization, and uptime
	Modern VMI	COGS, inventory turns, and reduced downtime
	Alignment of inventory with production	ROA, inventory turns, and working capital
	Reduced energy consumption	Carbon footprint
Retail	Real-time inventory optimization	ROA, inventory turns, and working capital
	Demand sensing and shaping	Sales, OTIF, and perfect order fulfillment
Oil and gas	Predictive maintenance	ROA, asset utilization, and downtime
	Connected components	Operating costs and ROA
	Well monitoring	Throughput and ROA

Source: IDC, 2015

OPPORTUNITIES AND CHALLENGES FOR IOT IMPLEMENTATIONS

The adoption of IoT across the supply chain is inevitable, in terms of both depth and breadth. No part of the supply chain will be spared, as implied by the range of use cases in Table 1. All that really is at question is how quickly and how broadly IoT will be adopted and what the "killer" use cases will be (either those in Table 1 or others that we have not thought of yet). Even technologies that seem "blindingly obvious" can take years to become commonplace (the barcode being one good example), depending upon the state of the technology, the underlying infrastructure, the ease of implementation, and clarity into the business case.

Elements for Success

What we have seen in successful technology implementations, and would expect in future IoT projects, is pretty standard. It is important to have a senior "champion" for the initiative and to engage both the IT side and the line-of-business side of any organization. We frequently see IT taking the lead on data- and technology-driven business initiatives because of obvious perceived alignment. However, in the case of IoT implementations, LOB and IT must work in tandem to ensure success. Business process requirements definition should remain a function of LOB while IT works to ensure the capabilities exist to enable these requirements.

But it's also critical to understand the parameters of any project and not attempt to do too much, too quickly. Many visibility initiatives have died on the altar of unmanageable scope, and we believe that IoT runs a similar risk. Companies should define the project clearly, with a realistic project scope in mind so that the goals can be achieved and a specific benefit realized. IoT implementations are also likely to be a function of specific business use cases. Rather than IoT becoming an enterprisewide capability, companies will achieve IoT capabilities through the aggregation of multiple independent projects.

It is also critical to look at IoT implementations, and the degree to which they are deemed successful, through both a short-term lens and a long-term lens. When companies implement potentially disruptive technology, the tendency initially is to plug that new technology into an existing business process. There may be some appreciation for "doing things differently," but in the main, things usually just run as they have been run. The bigger, more transformational things then happen over a longer period of time as experience with said technology allows businesses to discover new ways of working that were previously not so obvious.

Driving Adoption

As with any new technology, the adoption of IoT will be driven via successes. In the manufacturing supply chain, good ideas are readily copied, particularly if the economic benefits are clear and substantial. To the degree that the adoption of IoT technology facilitates any of the use cases we have discussed in this white paper leading to cost savings, productivity improvements, or revenue generation, there will be a rush to copy. *Me too* may not be the most inspirational of rallying cries, but it's more true than not in the supply chain.

The continued adoption and proliferation of IoT as a viable technology within industry require a strong commitment to drive acceptance and prove the value of the technology through proof-of-concept initiatives that demonstrate the tremendous value potential. IT and line-of-business innovators are well aware of IoT, and many are identifying and evaluating the value potential for IoT in their business. However, identifying this value is not enough to gain executive approval and the subsequent budget to implement IoT solutions into business operations. Innovators must be working with solution vendors,

sensor manufacturers, and services firms to help in the identification and definition of IoT potential and the creation of an IoT road map within their firms. Projects with IoT implications should be undertaken with a well-defined and fairly narrow scope. Within project definition, there should be clear alignment between expected outcomes and the financial value to be realized following a successful outcome. Approach IoT with shorter-duration projects with a clear pilot effort and be capable of providing leadership both the financial value realized out of a pilot and the potential value of the project should it be rolled out with a wider scope.

The wide-ranging possibilities for IoT are both a blessing and a curse for the stakeholders responsible for driving acceptance. Ultimately, the market will decide when, how, where, and why to implement IoT technology into business operations, but we are now at a point where connectivity between sensors/modules, analytics applications, and business processes is a reality, and leading firms are gaining tremendous value through the use of IoT applications to transform business processes. At IDC, we believe that it is not if and when IoT gains wide acceptance but how quickly the adoption occurs. Between the projected financial incentive for technology firms to develop effective solutions and the business value potential for manufacturing firms implementing IoT strategies, it appears clear that the biggest drivers to IoT adoption at this point are case studies and effective messaging.

ESSENTIAL GUIDANCE

The Internet of Things is transforming the business landscape and offering end-user organizations tremendous opportunities to leverage data to provide new business value. With such a profound market, the opportunity exists for technology vendors to capture a piece of a rapidly growing market by developing products, services, and expertise to help end users implement and benefit from IoT. Most IoT technology will focus on solving industry-specific challenges, and therefore, vendors should bring to market purpose-built solutions designed to solve industry-specific challenges.

Actions to Consider for End Users

- Clearly define the objectives and scope of an IoT program and create a road map to help define the long-term goals of the firm relative to IoT.
- Identify use cases capable of providing rapid results to help prove the value of an IoT effort.
- Align line of business and IT to ensure all stakeholders are working toward a common objective.
- Define current capabilities and gaps relative to IoT data capture, communication, analysis, and reporting.
- Work with service providers with proven competencies in the areas of IoT and data analytics to help define an IoT strategy.

About IDC

International Data Corporation (IDC) is the premier global provider of market intelligence, advisory services, and events for the information technology, telecommunications and consumer technology markets. IDC helps IT professionals, business executives, and the investment community make fact-based decisions on technology purchases and business strategy. More than 1,100 IDC analysts provide global, regional, and local expertise on technology and industry opportunities and trends in over 110 countries worldwide. For 50 years, IDC has provided strategic insights to help our clients achieve their key business objectives. IDC is a subsidiary of IDG, the world's leading technology media, research, and events company.

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