IoT Analytics: Using Big Data to Architect the Products and Services of Tomorrow

Introduction

We are in the early stages of a new world where everything worth connecting will be connected and can communicate. Connected vehicles, systems, and machines across numerous industries, including healthcare, transportation, retail, agriculture, and manufacturing make up a few billion connections today; by 2020, connections will reach nearly 24 billion. With new short-range wireless technologies, advances in battery life and node power management, and the miniaturization of sensors, it is conceivable that connections will grow to 100s of billions and, ultimately, even *trillions*.

The Internet of Things (IoT) is the term that describes our increasingly connected world. It represents connectivity enablement of nearly any object or *thing*, consisting of cars, buildings, machines, plants, animals, and so forth. It also describes a more interconnected environment where data from connected objects can both share data with and consume data from connected systems and people. Ultimately, the IoT is part of the evolutionary path to products and services that are naturally intelligent, requiring little user input for their operation and use.

The lifeblood of this evolution is the data from all the connected objects. Equally important are the tools—the analytics—to act upon the data and, thus, enable intelligent business decisions. But how do businesses maximize the value of their data? What IS, after all, the right solution that will create the products and services of tomorrow?

This white paper will address these questions and provide a real-world example of an IoT solution. It will also highlight the top trends both driving and inhibiting the IoT analytics market, as well as outline the top use cases for IoT analytics.

Trends Driving the IoT Analytics Market

- **Feasibility of Data Capture:** The real megatrend that is allowing the IoT analytics market to take off in full force is the increasing feasibility of capturing and delivering data from physical assets to an analytic backend. On one hand, this is being driven by the decreasing cost of sensors that can collect relevant data readings on machines and their environment. On the other hand, the cost of connectivity and cloud computing—for data transfer and transformation—is falling to levels that open up the IoT business to an increasingly diverse set of enterprises. The future evolution of IoT architectures, enabling organizations to handle certain tasks on the endpoint level, some other tasks at the network's edge (*e.g.*, routers), and the rest of the tasks in the cloud, will further improve the outlook.

- **Convergence of External and Internal Data:** Another great shift that will take place in analytics is the convergence of external and internal data sources, as the companies investing in big data are starting to realize that the data they possess internally tend to answer the questions they need to ask only partially. More reliable findings, especially in the field of predictive analytics, can usually be gained by combining the internal data sets with external ones. On this front, the analytics industry has a synergetic link to the rise of the so-called API economy, which is proving instrumental as a layer to facilitate data-sharing between different data-driven organizations.

- **Evolution beyond Descriptive Analytics:** The core analytics component of the market's value chain has three distinct areas within it. Often referred to as three phases of analytics, these areas are known as: descriptive analytics, predictive analytics, and prescriptive analytics. They have a hierarchical relationship between each other, in the sense that the descriptive type of analytics needs to be mastered before advancing to the predictive one, which, in turn, can ultimately lead to prescriptive analytics. One major trend that is convincing enterprises initially to experiment with IoT analytics and, later on, develop actual business cases around it, is the ongoing evolution from the descriptive phase to the predictive one. This is largely being enabled on established best practices in statistical modeling, as well as parallel advances in machine learning.

Challenges Limiting the Uptake

- **Database Dilemma:** Arguably the most pressing challenge in IoT analytics is the matter of storing and computing data. While enterprises dealing exclusively with traditional "digital-first" data have been able to move on, or at least muddle through, with new database technologies (built mainly on Hadoop), the problem associated with IoT use cases is substantially more difficult. Data from machines and their sensors are typically time-series data, which can come in extremely high volumes, depending on the number of sensors and the frequency of readings. Hadoop tends to be slow for feeding such data into the analytic process, which can be particularly problematic if the analyses need to be done in real-time. In-memory databases, meanwhile, have the opposite problem—enabling fast computing, but often struggling with massive volume increases. The bottom line is that all technology options are far from the ideal and there remains much opportunity for innovation in this field.

- **Skills Shortage:** Often said to be one of this decade's hottest professions, the so-called data scientist is instrumental in extracting value from any data assets that an organization may have for analysis. It is a role that requires an in-depth understanding of mathematics, solid programming skills, and, ideally, some commercial acumen. It is a rare skillset, so for the growing number of groups that need to employ data scientists, they are expensive to hire and retain. In ABI Research's view, the most fundamental force that will determine the growth of the big data industry in the long term is, indeed, the skills gap and the responses it will prompt from the technology suppliers.

- **Complexity of Deployments:** ABI Research identifies four different technology components in the value chain of analytics: data integration, data storage, core analytics, and data presentation. As is typical of such early days of a market, the most innovative technology suppliers tend to be companies—often start-ups—that focus on just one of these components. The main downside of this dynamic is the fact that it turns many deployments into a piecemeal exercise, which can be highly complex for the customer to procure, integrate, and manage. The lack of end-to-end solutions that would reduce some of that complexity makes the customers reliant on system integrators and other professional services outfits, which, in turn, can undermine their ROI.

Top Use Cases for IoT Analytics

The application of analytics on data from connected products is, on the whole, in the very early stages when considering that the vast majority of all things that could be connected are not connected—yet. However, from some of the more advanced industry verticals already using analytics, it is becoming clear what the top use cases during these early stages of IoT analytics will be. ABI Research has identified the following five as the most prominent use cases for the next 5 years or so:

- **Predictive Maintenance:** Predictive maintenance refers to a method in which the equipment, infrastructure, or vehicle is maintained and serviced when an analysis of its operational (*e.g.*, sound, vibration) metrics indicate that a breakdown is probable to occur. The condition-based method can be complemented by circumstantial data (*e.g.*, weather temperature, employee absences) to make the analysis more accurate.

- **Product/Service Design and Development:** As an analytic use case, product development aims to assess the connected product's quality and behavior, flagging areas of improvement based on the assessment. The assessment can be used to improve both hardware and software elements of the product or the service. For instance, a tractor manufacturer could study the real-life usage of its latest model and base modifications to following iterations on the analysis of how the customers tend to operate the machines.

- **Usage Behavior Tracking:** Usage behavior tracking refers to cases in which usage or consumption of a product or service is tracked and analyzed by taking advantage of connectivity and subsequent analysis of the collected data. Importantly, ABI Research counts a large share of the smart metering and smart grid analytics under this category. Also, car-insurance providers and other companies applying usage-based pricing are counted under this use case.

- **Operational Analysis:** In operational analysis, the organization in possession of IoT analytics uses the data assets to monitor and optimize its operations. For instance, a logistics group can analyze the behavior of the units within its delivery fleet to optimize the routes and provide more accurate estimates on the delivery times. Similarly, a retailer running connected vending machines can spot the bottlenecks and quiet zones within its network, thereby optimizing the machine sites.

- **Contextual Awareness:** In this use case, connected objects are used to collect data from the surrounding environment in order to operate in a manner that takes into account the dynamic circumstances. Additionally, the gained contextual awareness can be used to similarly "smarten up" other objects within the same network. Modern collision-aware construction vehicles and learning home appliances are examples of this.

Makings of a Right Solution

Collecting and analyzing the data are the obvious goals for connecting products and processes. However, choosing the right solution is another matter. One of the big trends is the creation of one-stop-shop IoT suppliers. They have emerged because the supplier and technology choices enabling the connected enterprise are vast and complex. Decisions are needed on areas including: connectivity hardware; software and protocols; data collection and management; application development services; system integration; as well as numerous analytic paths ranging from rudimentary, alert-based to predictive machine-learning algorithms. Furthermore, all of these are underpinned by the support services that ensure the connectivity investment remains maintained and highly reliable.

No one supplier can ultimately do it all. And at the same time, many businesses want to leverage their existing relationships and competencies in application development and systems integration. However, some of the most successful, timely, and cost-effective IoT projects appear to leverage suppliers that specialize in two specific components of the IoT value chain: application enablement on one hand, and data analytics and visualization on the other hand.

In these two areas, application enablement platforms (AEPs), commonly referred to as IoT platforms, focus on the connectivity, data extraction, data collection, and data transformation activities, also known as the decisive "plumbing" part of the IoT value chain. The most capable are generally not limited by machine type, connecting any type of machine and delivering data both securely and efficiently, regardless of its source. Scalable cloud services are an essential component in AEP deployments and provide tools to rapidly and cost-effectively develop apps using data management tools, web services, and SDKs. The most advanced AEPs offer web-based management tools to remotely monitor, track, and service the connected assets, as well as intelligent agents at the edge (local to the connected product or machine) to process some of the data before sending it to the cloud.

Meanwhile, the analytics suppliers specialize in the quick and efficient delivery of data insights. Key capabilities include integration and storage of both structured and unstructured data, as well as expertise in advanced statistical methods, computational modeling, and machine learning. Significantly, appropriate visualization and other presentation techniques are becoming almost standard in any cost-effective analytic solution, as a way to cut down the critical time to insight. An equally important aspect is the solution's ability to mash up data from various internal business databases and applications together with each other, as well as with external third-party sources. Finally, the more advanced platforms are doing analytics blending, using recent historical sensor or machine data overlaid on real-time data. Anomalies, artifacts, and trends discovered in the historical data can jumpstart the insight discovery when examining real-time data.

Case In Point: Enabling the Industrial Internet

Illustrating the transformative nature of IoT is one of the largest and most successful U.S. multinational conglomerates that, early on, began transforming its business using machine connectivity and big data analytics technologies. Currently, four of its divisions, power generation, oil and gas, healthcare, and datacenter technologies, use Axeda's IoT platform (an AEP) to connect and expose machine data for analysis.

One of those divisions has created a "virtual service engine" concept, an IoT solution that captures and analyzes data from the installed base of its gasoline-powered generators, and then delivers the data to all relevant parts of the organization. The benefits of the solution are four-fold. First, it allows the company to reduce the costs by 50% by avoiding unnecessary service-technician dispatches. Second, it ensures operator safety by monitoring critical components and detecting potential failures. Third, the achieved transparency over asset health extends the lifespan of expensive engine components. And fourth, the service model makes the gas engines easier to run from the customer's point of view, since it eliminates the complexity of diagnostic gathering and troubleshooting.

The virtual service engine concept relies on Software AG's Presto product for the real-time visual analytics that it requires. The first stage of using Presto is to choose which data sources are needed for analysis, which is done with a simple point-and-click interface. The second step in the process is to mash up the multi-source data and analyze it with Software AG's IBO platform. Presto also allows mashing up recent historical data with real-time data. The third and final step, meanwhile, is to visualize the gathered insights in a way that allows the customer to act upon any issues straight away.

Significantly, the visual nature of analytics makes it possible to practice what could be best referred to as "data exploration." In essence, this means that the insight professional does not necessarily need to know in advance the questions that need to be answered. This is fundamentally different from query-based approaches, for example, which require developing a hypothesis and then, subsequently, testing it. On one hand, the more explorative approach to data analysis makes the process more accessible to a wider range of business users and, on the other hand, it can also increase the productivity among the organization's dedicated data scientists.

Conclusion

As the IoT evolves and matures, an ecosystem of partnerships will emerge to deliver end-to-end solutions to customers. As cited in the above example, the combination of Axeda's IoT platform and Software AG's Presto can reduce the cost and complexity of implementing connected product and predictive maintenance solutions. ABI Research expects to continue to see best-of-breed vendors join forces to deliver results for customers, which will lead to the accelerated adoption of IoT analytics.

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