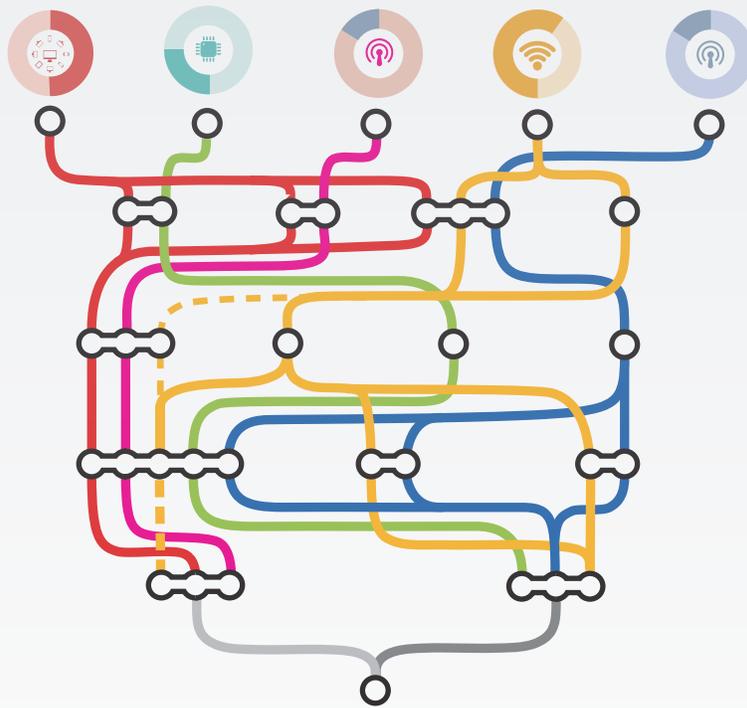


how glassbeam is
driving internet of
things machine
data innovation

machine data
analytics drives
perfect information



technology
innovator
perspective

Harbor
Research

Many diverse businesses are now discovering the concept of connected products and smart services. The opportunities driven by this trend are enormous and everywhere. Data management, modeling and analytic tools are the core enablers of these opportunities. However, numerous hurdles have constrained growth in the Internet of Things and machine data analytics; users are just scratching the surface of the real values the vast stores of collected data from their connected products can unlock. A new generation of machine data intelligence is emerging that takes the value of connected products one significant step further. These tools dramatically increase visibility and understanding of product usage and behavior. Machine data will help manufacturers build “perfect information” about their products enabling unimagined new values for users and customers.

ABOUT HARBOR RESEARCH

Founded in 1984, Harbor Research Inc. has more than twenty five years of experience in providing strategic consulting and research services that enable our clients to understand and capitalize on emergent and disruptive opportunities driven by information and communications technology. The firm has established a unique competence in developing business models and strategy for Smart Systems and the Internet of Things

TABLE OF CONTENTS

CONNECTED PRODUCTS and THE INTERNET OF THINGS DRIVE PERFECT INFORMATION

THE ADVENT and CHALLENGES OF MACHINE INTELLIGENCE

MACHINE DATA ANALYTICS REQUIRES NEW TOOLS and CAPABILITIES

GLASSBEAM DRIVES MACHINE DATA INNOVATION

ADDRESSING THE CHALLENGES OF MACHINE DATA MANAGEMENT

PRODUCT INTELLIGENCE VALUE - THE SHIFT FROM SIMPLE TO COMPOUND DATA VALUE

THE NEXT CHAPTER OF MACHINE DATA INTELLIGENCE

EXTENDING MACHINE DATA VALUE THROUGH PARTNERSHIPS and ECOSYSTEMS

CONNECTED PRODUCTS and THE INTERNET OF THINGS DRIVE PERFECT INFORMATION

We have been steadily designing devices and products with more and more intelligence, but this information has gone largely unleveraged. This is surprising, because this information can offer extraordinary business advantage to the companies that manufacture and deliver and service those products, especially in terms of customer relationships.

The advent of connected products makes the state of (i.e., the information about) a business's assets vastly more visible. These new offerings enable equipment manufacturers to accelerate a migration from reactive product support to "predictive" services and, ultimately, to a customer relationship informed by real-time product intelligence. This is what we like to call "perfect information" about usage, behavior and history of the product in use.

The convergence of large-scale data management and networked computing with real time machine intelligence is driving the integration of the physical and virtual worlds. The intersection of these trends - the Internet of Things and People - will create unimagined new values. Data and analytic tools and skills will be the core enabler of these new values.

Analyzing and storing the massive amounts of data that will be received from sensors and machines is only possible with extensible and adaptable systems. Analytics are the enablers for deciding which alternative courses to pursue, either automatically through the application of a

rule that says "if this happens, do this," or through human review of machine data anomalies to determine alternative courses of actions and decisions. The basic functions underlying machine data management and analytics will drive seismic leaps in productivity and efficiency in a world of vastly expanded real-time data and awareness.

Machine intelligence will inform a new level of understanding of how machines and systems behave and adapt this new level of understanding to business scenarios, with specific intelligent software components pushed down to intelligent devices where they can execute a specified action. The Internet's most profound potential lies in the integration of people, information systems AND smart machines. In a connected world of smart systems, not only people but all electronic and electro-mechanical products and machines will produce mountains of valuable information, all the time.

THE ADVENT and CHALLENGES OF MACHINE INTELLIGENCE

In the last few years, early adopters of connected services across diverse domains have recognized the strategic implications for their businesses that comes with automating data collection, data management and analytics. Because it is impractical to deploy human beings to gather and analyze the real-time field intelligence, connected services depend on "machine intelligence." In an automated machine environment, reliable and fast microprocessors

do what they are particularly good at doing: digesting large numbers of data points, talking to each other about the data, controlling each other based upon the state of the data—all in a matter of nanoseconds. Human beings cannot do this, nor should they. This incessant stream of ongoing business information should be invisible to people; connectivity and automation provide the foundation for machine data analytics.

Equipment vendors increasingly view data management and analytics as a minimum requirement for managing equipment, systems and infrastructure. While there are a wide range of potential benefits created from connected product services, it is in the area of service efficiency and support effectiveness where the most immediate and tangible efficiencies have been seen.

A networked machine generates information value over its entire lifespan. Product manufacturers can know where the device is located, when it was installed, critical specifications, diagnostics, availability of spare parts, usage patterns, support status and so on.

Traditional customer relationship and product support programs yield only intermittent, uneven and incomplete windows into how customers interact with a product. Once a product is shipped to a customer, the manufacturer loses sight of who buys it, how it is configured, what its use is and what the customer experiences with it. When products become networked and support is automated, the environment in which they are utilized becomes more “aware” and responsive.

If you apply the concept of network effects to connected products - where the value of a

network grows exponentially with the number of nodes connected to it - along with the increase in network value, so too grows the complexity of managing smart systems and the reliance on these networks of connected products to function properly. All of this points to the many pressures cast upon customers and equipment suppliers. The complexities of managing connected machines today has become enormous. The number and the diversity of devices that organizations must accommodate is rapidly growing.

Ultimately, the “real-time awareness” that networks enable is driving vigorous interest in and deployment of analytic tools. Machine data management will soon become a minimum requirement to manage the complexity challenges, but only if machine data and analytics solutions are well organized and easy to use for customers.

Eventually, this environment helps customers optimize their processes, save money, and become significantly more efficient. However, given the immature state of today’s real-world systems, most people have trouble grasping the power and importance these capabilities enable. The ability to detect patterns in data is the holy grail of Smart Systems and IoT because it allows not only patterns but a whole higher order of intelligence to emerge from large collections of ordinary machine data. The implications are obviously immense.

MACHINE DATA ANALYTICS REQUIRES NEW TOOLS and CAPABILITIES

In today's world, data and information from machines is not free (and that's free as in "freedom," not free as in "free of charge"). In fact, thanks to present information architectures, it's not free to easily merge with other data and enable any kind of intelligence.

What would truly liberated machine data and information be like? It might help to think of the atoms and molecules of the physical world. They have distinct identities, of course, but they are also capable of bonding with other atoms and molecules to create entirely different kinds of matter. Often this bonding requires special circumstances, such as extreme heat or pressure, but not always.

In the world of information, such bonding is not all that easy. Today's software platforms focus on execution processes that generate one of three types of data - unstructured, transactional or time series. For each of these data types, a specific set of intelligence tools have evolved to provide "insight" but, in most cases, these tools limit the questions that can be answered to those known in advance. So for a user attempting to do something as simple as asking a certain multi-dimensional question, creating new information from multiple data types that is an easily perceivable, manipulable, or mappable "model" of the answer to that question is a significant challenge.

The traditional approaches to data discovery and systems intelligence have three failings: 1) they

can't provide a holistic view of diverse data types; 2) the types of intelligence tools available to users are, at best, arcane and typically limited in use to "specialists;" and, 3) most analytics today are still developed in a "batched" warehouse not in real time.

Machine builders and users need new tools to liberate the intelligence in the world of connected things. Tools need to be able to conduct a search or query that acts on unstructured, transactional and time series data simultaneously. This would allow users to determine where deeper analytics or the creation of an ad hoc business process can add value.

The world needs an entirely new approach that avoids the confinements and limitations of the today's differing data types and tools. Tools that allows data to maintain their fundamental identity while bonding freely with other data and facilitate "Real-time awareness" is driving vigorous interest in and deployment of analytic tools. discovery, based on data and information accessibility and cumulative systems intelligence.

However, in the machine world, unlike say the consumer retail or financial services arena, the analysis has to be real [or near] time and state-based. In short, for machine data to mean anything in business, the prevailing IT-biased model of batched "big data" analytics model has to change. New tools need to be developed.

It has become evident that the large existing big data and BI players are not the defacto leaders in Smart Systems and IoT analytics. While the "traditional," players may have a head start they are just not accustomed to the physical sensor

and machine-based applications within the IoT arena. A growing number of relatively young companies are introducing products that have been purposely designed for machine data analytics. This paper is about an important new machine data analytics platform and application offering from Glassbeam.

GLASSBEAM DRIVES MACHINE DATA INNOVATION

The Glassbeam team of innovators understand that the tools we are working with today to discover and analyze machine data were not designed to really address operational and business challenges. The Glassbeam platform provides business insight for sales, support and engineering organizations by mining log data generated from machines and products.

Glassbeam's machine data analytics application platform is not an incremental improvement or new flavor of the existing IT-centric big data tools. Their development represents a true shift in thinking about how device and machine data will be utilized for business intelligence. The Glassbeam approach is about looking forward to a single, unified platform for search, discovery, analysis and prediction utilizing diverse machine data types.

Glassbeam is providing a true end-to-end solution for machine data analytics and intelligence that provides a complete picture of the myriad of interactions and states that machines evolve through including status, configuration changes and usage.

Before delving into the new thinking that makes this story possible, let's talk about why it's necessary at all.

Current technology suppliers, customers and users are operating with outdated and ill suited models of data management and analytics for the Smart Systems and the Internet of Things era. These models were conceived in the past or developed in an classical IT environment and cannot serve the needs of a truly physical and real time connected world. Systems today, for the most part, exhibit several severe limitations in the context of machine data.

Reactive Systems; Not Predictive: Most users are still pursuing relatively simple applications of analytics tools. Users developing IoT analytics, or experimenting with new modeling, data management or visualization tools have, for the most part, not been able to deploy newer predictive capabilities. We believe this will require better end-to-end solutions from suppliers, increased understanding of how to analyze machine data and new organizational skills.

"Batched" Data Repositories Alone Won't Cut It: Historically, to gain meaning from operational data meant building dedicated data warehouses and analytics applications is a major undertaking. A typical project might involve several months of effort and expensive infrastructure and software licenses. Data warehouses and big repositories alone do not address the complete requirements scope for machine data analytics. While in many cases repositories may be needed as part of a wider architecture, they alone will not equal an end-to-end solution for machine data management and analytics.

Real Time, Event-Driven and State-Based

Systems: Since most of today's business intelligence systems have provided only a retrospective view of operations, systems to analyze real-time complex events are still fairly emergent in nature and use. To perform equipment and systems monitoring and to support more state-based and real-time decision-agility, machine data analytics systems will need to become much more responsive. This generally means these tools will need to be embedded into machines and business processes to reduce the latency of analysis by filtering and processing data at the network edge before ingesting it into the analytic back-end. This is critical, given the volume and velocity of sensor and machine data.

ADDRESSING THE CHALLENGES OF MACHINE DATA MANAGEMENT

The Glassbeam platform fundamentally changes the way we think about machine data and analytics. The next great step in machine data technology—completely fluid multi-dimensional machine data analytics—requires a simple, flexible, and universal tool that will make diverse machine data types easily accessed, integrated and interpreted for business and operations staff.

Glassbeam's unique approach to machine data analytics is based on a new class of tools enabled by its breakthrough Semiotic Parsing Language (SPL) language that is specifically designed to let users extract value from multidimensional machine data types. Glassbeam's unique SPL-driven tools and iterative development environment allows users to explore how a

product or system is configured, how it is used and how well it is performing. Data can be aggregated to perform a variety of functions, including:

- » The organization of details on devices, configurations, locations, status and related usage;
- » Gathering and analyzing performance data across various products and segments;
- » Aggregating and analyzing multiple, parallel levels of data to allow interpretation by product development engineers, support technicians, and other functions. like sales and marketing.

Businesses can benefit from a deeper examination of machine data in many ways including deeper diagnostics, proactive problem identification and intelligence on product usage and behaviors. Unlocking these values can only be achieved by using effective tools that not only search and index but extract critical insights about machine performance and behaviors.

Glassbeam's back-end system technology enables high velocity and high volume streaming data to be processed in real time. Extracting new insights into equipment health, support and usage require they be acted on real time.

Glassbeam uses an entirely new approach that avoids the confinements and limitations of the today's differing data types and tools. It allows data to maintain their fundamental identity while bonding freely with other data. Facilitating discovery, based on data and

information accessibility and cumulative systems intelligence, is one of the fundamental purposes of Glassbeam' platform. They are designing a system for a genuinely connected world in which there are no artificial barriers between pieces of information.

PRODUCT INTELLIGENCE VALUE - THE SHIFT FROM SIMPLE TO COMPOUND DATA VALUE

To date, remote services and M2M systems have largely been focused on remote monitoring as well as tracking and location services – in large part because of technical complexities, and business model challenges. Existing technology has proven cumbersome and costly to apply with many conflicting protocols and incomplete component-based solutions. The challenges of developing analytics applications and integrating diverse device data sources have been big adoption hurdles.

Simple applications largely focus on the product manufacturer's own service delivery chain. They are simple "hub and spoke" remote support. While there is value in these models, there are significant untapped opportunities for providing new value for the users and customers.

Return from simple applications, while extremely valuable, is limited to the manufacturer's service delivery efficiency. Contrary to what current market offerings depict, however, the value of connectivity does not have to end with just simple applications focused on a single class of device or machine.

As technologies mature and open standards become the norm, applications based on deeper, peer-to-peer interactions between devices, systems and people will drive more compound and dynamic value streams. This opens up new collaborative business model opportunities that have the potential to drive much greater value for the customer.

Moving from "Simple" to "Compound" applications involves multiple collaborating systems with significant interactions between and among devices, systems and people. No longer is the focus solely on the product supplier's ability to deliver support for their product efficiently. Rather, value is brought to the customer through business process automation and optimization.

The nature of compound and complex systems applications is just beginning to be understood where the information value generated by these capabilities positions players to take on significant additional tasks for the customer in the future, such as:

- » Providing the customer's first line support staff, the machine builders' service technicians and other third party support personnel with complete access to a unified machine maintenance record that captures all of the machine's performance data, history and knowledge about the status of the equipment, enabling faster, more effective and far more collaborative maintenance processes;
- » Create a collaborative closed, real-time loop, between the vendor's support resources,

product development organization and related business units allowing products to be specifically designed for, and implementations tuned to customer requirements and usage patterns

- » Analyzing the history of the equipment in use against diverse data sources such as weather patterns and peak usage requirements to optimize its performance;

What the Glassbeam team have come to understand from their years working on machine data management and analytics is that while field intelligence provides significant improvements to after-market support there is significant but often “hidden” value in product intelligence.

Connectivity enables many additional values including transparency into the usage and behavior of products as well as feedback to customers to help optimize systems and equipment performance.

This will allow equipment manufacturers to look beyond simply providing the minimum service required to attain customer satisfaction and utilize machine data analytics and automation as a foundation tool that enables product intelligence which will, in turn, allow manufacturers to create lasting and binding relations with customers.

The emergence of connected product analytics has the potential to provide manufacturers with comprehensive, real-time information on devices and systems throughout their entire life cycle. It will allow manufacturers to see patterns and signatures that reveal robust information about the product’s behavior and usage by allowing the

manufacturer to aggregate not only information about the product and its configuration but also about how it performs.

Once a manufacturer knows how customers are utilizing products, information can be shared across various functions, helping to enhance the entire life cycle experience for customers. Ultimately, this information can be used by manufacturers for sales and marketing efforts, product development, and an expanding range of customer services.

Information such as log files can be sent back to a product intelligence platform in a standardized format where data can be aggregated into a database to perform a variety of functions, including:

- » The organization of details on devices, configurations, locations, status and related usage;
- » Gathering and analyzing performance data across various products and segments; and,
- » Aggregating and analyzing multiple, parallel levels of data to allow interpretation by product development engineers, support technicians, and other functions.
- » Allow the vendor to deliver detailed and proactive information and services that are tailored to the unique needs of individual customers;
- » Improve the value and profitability of partners service offerings and allow the vendor to establish closer, more proactive relations with their customers.

Machine data management and analytics will generate the intelligence necessary to deliver smart product and smart services. It will also allow for insights into how products should be designed, marketed, sold and delivered. With the introduction of product analytics, the distance between the promise of automation technologies and their real-world “applied” value is closing quickly.

THE NEXT CHAPTER OF MACHINE DATA INTELLIGENCE

The trend to expand the field of machine data and IoT analytics beyond historical BI and data warehousing is now in force. Traditional BI applications predominantly have used historic data from large repositories. These applications are constrained by the limited service-level capabilities of static data. The latency inherent to static data implies that there is no real-time connection between the data and its operational sources. The goal of the transition to real-time, state-based analytics is to reduce latency. IoT and machine data analytics extends the definition of BI beyond the traditional data warehouse and query tools to include complex event streams and processing. The challenge is to turn real-time data into actionable information to enhance operational decision-making.

As new data management and analytics tools become a part of operational decision-making, IoT intelligence must also embrace closed-loop performance management. New applications will emerge by embedding analytics in business processes. What is needed is real-time visibility

of performance (“what is happening now ?”) and metrics to enable operational business intelligence.

Customers, who are accustomed to being “blind” gain visibility. With performance data available at any time for service providers and customers alike, equipment vendors will be able to flag potential problems as well as predict possible future failures or to advise on a course of action to save cost or improve performance. Performance metrics discovered via machine data enables corrective actions and faster reaction to business events, and thus the optimization of a variety of business activities.

In today’s rapidly changing business environment, organizational agility not only depends on monitoring how the business is performing but also on the prediction of future outcomes which is critical for a sustainable competitive position. An “aware” product strategy introduces the capability to apply changes almost instantly. With fewer direct human interactions, updates can be automatic and support changes to intelligent products deployed much more efficiently.

Connected products and machine data tools create compelling new options for equipment manufacturers. Equipment partners will be able to remotely connect to customers’ infrastructure, including after-hours support when customers often have no staff on-site, and remotely diagnose and schedule downtime required for repairs and updates. Service centers can be automatically linked to interrogate products remotely to ensure that technicians

and operators are equipped with the correct diagnosis and tools thus reducing the time the technician requires to resolve customer issues or problems. These actions obviate the need for manual support while at the same time ensuring maximum systems availability.

EXTENDING MACHINE DATA VALUE THROUGH PARTNERSHIPS and ECOSYSTEMS

Data management, modeling and analytic tools are the core enablers of new Internet of Things values. However, numerous hurdles have constrained growth in machine data and IoT analytics.

It has become evident that the large existing big data and BI players are not the defacto leaders in Smart Systems and IoT analytics. While the “traditional,” players may have a head start they are just not accustomed to the physical sensor and machine-based applications within the IoT arena. A growing number of relatively young companies are introducing products that have been purposely designed for IoT analytics.

A renewed focus on developing ecosystems and the critical relationships that will drive value are key to success.

Smart Systems and IoT analytics will be enabled by a new generation of players. There have been signs of this beginning to emerge over the last two years. Today it has become evident that the large BI incumbents are not in the driving seat in this market, despite their recent dominance. A

growing number of relatively young companies are introducing products that have been purposely designed for IoT data integrations and analytics. For providers of core device integration and management platforms for the Internet of Things, developing partnerships to extend the platform’s reach beyond simple monitoring to machine data analytics capabilities is a prime example of an opportunity to gain share and really differentiate.

The convergence of device data collection, aggregation and analytics will drive big opportunities. However, partner and alliance innovation in the IoT platform business will need to extend beyond just simple ideas about new function and service extensions. To successfully develop this market, core platform providers will need to think and act differently. A renewed focus on developing alliances and ecosystems around machine data analytics and the critical relationships that will drive value for OEMs and end customers are keys to success.

Given all of the aspects that must be addressed to provide a full end-to-end data management and analytics solution, alliances between platform suppliers and a new breed of IoT analytics solution partners represent the best available means to address these market development challenges.

Since most of the real value of smart connected systems is generated from data and analytics, players like Glassbeam can significantly and fundamenatally extend the value of integration and app development platform players. A for these platform players, adding data and

analytics capabilities will create true applied value for customers and enhance competitive differentiation.

Glassbeam enables partners to add unobtrusive machine data analytics to a broad range of equipment monitoring and integration systems. It treats user concerns—from product usage and performance and to health and support—as a unified challenge that can be addressed by a new generation of analytics as a service. In taking this perspective, we believe Glassbeam is pioneering a new meta-market opportunity with vast potential.

Within applications utilizing complex machines and smart equipment systems, users are highly motivated to apply analytics to many diverse functions. As equipment and systems become ever more integrated and “closed loop” in their operation, using data and analytics within the environment that the machine is being used to automatically adjust its behavior or performance moves us closer to a world of autonomous machines, systems and artificial intelligence.

Systems awareness, within the context in use of the machine, is what will drive autonomous systems in factories, in the air transport system, down the roads we drive and beyond.

The ability to detect patterns from large scale sensor and machine data aggregation based on “perfect information” has finally arrived. Machine data analytics allows not only data patterns but a much higher order of intelligence to emerge from large collections of machine and device data.