Inventing the Future

Judith Hurwitz
President and CEO

Sponsored by Hitachi
Introduction

Only a few years ago, the greatest concern for businesses was being able to link traditional IT with the requirements of business units. This has changed as more and more physical devices have become IT systems. Increasingly we are moving to the next industrial revolution that requires us to understand and take action on data from machines and sensors in near real-time.

The average car may have dozens of embedded computers and hundreds of sensors. Industrial equipment ranging from assembly line systems to mining equipment and power plants use technology to both operate, manage and optimize capabilities. The challenge of the next phase in the new industrial revolution is to break down the silos between IT systems, departmental systems, and physical systems. Bringing together the physical infrastructure with data and process is an imperative for the future. This convergence of the IT world with the world of physical systems will impact a huge number of industries. For example, this convergence will have a profound impact on the next generation of manufacturing. This new era, called Industry 4.0, is an initiative intended to rethink and plan for the future of automating the future of manufacturing.

In this paper, we will present the key requirements that enable companies to transform business operations based on the requirements for a services-based approach to managing business processes. We will focus on the key technology imperatives: innovation, flexible infrastructure, and the ability to gain actionable insights. These issues will be explained in context with the innovations being designed and developed by Hitachi Laboratories across the globe.

The impact of the requirement for a blended environment comes into clear view when business change is required. Companies are increasingly required to change their existing products and services to cope with customer demands and competition. At-risk profit margins mean businesses need to find ways to optimize processes to reduce costly waste and mishaps. Organizations must be able to innovate in ways that could never have been anticipated only a few years earlier. Management has to find ways to leverage expertise and value across business units to maintain leadership. Likewise, organizations must find ways to use data from their physical systems to transform their business models. The solution to these management imperatives demands a foundation of services to support a complex big data infrastructure.

Building the Internet of Things Technology Foundation

This market transition to intelligent systems is directly tied to emergence of the Internet of Things (IoT). The Internet of Things is the movement toward equipping devices with sensors that understand the reactions and actions of systems. Executing on the IoT requires a deep understanding of how sensors are connected to an analytics framework. You need to a deep knowledge of the industrial equipment, how it operates, and the type of data it produces. It is critical to have a level of expertise about sensors and how they are implemented. For IoT to be effective it must bring together the physical world with the world...
of data analytics. To become operational requires that this semi-structured data be gathered at the right speed with the right security. This data must also be connected with relevant enterprise data. The blending of data from physical systems and IT systems is beginning to have a profound impact on many industries. It has become a growing imperative to have an infrastructure in place based on speed and efficiency in order to innovative quickly based on changing conditions and customer demand.

The following three elements need to be in place to accomplish this goal:

- The ability to translate the physical world into understandable data that can be managed and analyzed.
- The requirement to leverage data from sensors and combine that data with enterprise data in a blended data model with process
- The need to provide a flexible set of services designed for reuse based on a framework.

Understanding and Optimizing Physical Systems

Physical systems have been equipped with sensors for decades. However, in the past it was only possible to understand the current state of a machine to diagnosis immediate problems. The economics of data storage and data analytics were not available to enable translating that data into techniques for optimization. The ability of economic storage, cloud based analytics and big data analytics tools have changed the landscape of what is possible.

What is changing across industries? There is an increasingly important requirement to manage and understand data in context with physical systems and business process. Accomplishing these goals requires deep understanding of physical systems like industrial machines, sensors and the data produced by these systems.

Below are a few of the important changes happening within a variety of industries:

- A manufacturing company is required to reduce waste byproducts in order to meet mandates. Also, by reducing waste the company also saves significant money that can be returned to the bottomline.
- A city can improve services to citizens by monitoring and managing everything from crime reporting to rerouting traffic based on changing conditions such as accidents and road maintenance.
- A healthcare company can use data captured from sensors to analyze and improve customer care by taking proactive steps when a vital statistic changes. A hospital can use the sensors to monitor the health of premature babies in a neonatal intensive care unit or to monitor heart data and take action based on real-time analysis of data.
- Energy companies can use the data from sensors to better optimize power management based on understanding customer requirements and being prepared for spikes in power utilization.
All these organizations have one thing in common: They are all dependent on the physical systems to manage and operate their businesses. All these organizations will be successful only if they can understand the current state of these systems and anticipate the future state. They have to be able to use the data produced by the sensors to understand their world and react to where the data is leading them. As more and more devices are equipped with sensors, it will be critical to have the ability to not just monitor but understand the data in context.

**Leveraging and Interpreting Blended Data**

The world of data is becoming more complex every day. While there has always been unstructured data, we have never before had the tools and technology to make sense of that data. While we have done a good job harnessing structured data in databases, we had to use visual cues to understand the rest of the information contained in our environments. In the past, we might have gotten an indicator from the sensor on an industrial machine that the temperature was too high. If we were lucky enough to notice, we would have someone take that machine off line or repair the error. The same observations could be made about sound, vibrations, or moisture. The problem has been how to understand this data in context.

If you look at the myriad of data produced by systems and physical devices of all types, it is now possible to turn this data into analytics. Therefore, it is possible to begin to evaluate results of structured data analytics with results from analysis of semi-structured data from sensors. In addition this data needs to be compared with batch data from ongoing operations. This approach is not a one-step process. Rather, there are multiple stages. There is one stage that is well understood for collecting, ingesting, cleaning and managing structured data. There are different process needed to ingest the data, determine meta data, select which data engine is necessary for different types of data. Therefore, the requirement in the era of Industry 4.0 is to be able to have the right data analyzed continuously in context with real world changes. When processes change, those changes need to be reflected in the environment, without requiring massive recoding. It isn't enough to simply collect information, you have to be able to understand that data so that the appropriate action can be taken.

Data is not homogeneous; rather data is complex because it reflects the real world. Therefore, we have to manage data in the forms that it needs to be managed. This includes the following data forms:

- **Structured data from databases.** The structured data is typically used in our foundational business systems that manage customer transactions and interactions with suppliers and partners. This data typically does not change very often and must be highly managed for precision. This data must be able to interact with other data sources.

- **Unstructured data.** There are many forms of unstructured data that are critical in both an IoT environment and an industrial application. Data that
comes from sensors in manufacturing systems, for example is considered semi-structured. In other words, the output from sensors has some structure but it must be interpreted in order for this data to be analyzed. Likewise, data from text is considered unstructured. However, words that are linked together into phrases and sentences have well understood meaning and thus provide an implied structure. More complicated is to understand unstructured data that comes from images, video, and voice. It requires much more data to make sense of the underlying patterns and structured data.

Blending Structured and Unstructured Data

Blending data from so many different data sources requires a number of important steps. First, you have to gain a full understanding of all of these data types including the types of data engines, ingestion processing, and meta data management. Whether you are looking at streaming data from sensors or batch data, it will be important to look at these forms of data in context. For example, streaming data from a series of sensors on a manufacturing system needs to be compared and contrasted with the recommended state for that system. Likewise, there is a need to interpret the meaning of that data through meta data tagging and management. The ability to orchestrate and integrate these data types is critical to be able to understand business in context. Machine learning and cognitive computing techniques are adding analytics intelligence to this process. The data is becoming fundamental in helping to transform processing as business conditions change.

Implementing a Reusable Services Framework

The underlying infrastructure is critical if data is to be used effectively to transform business processes and manage the integration of critical data. While you might think of a reusable framework as a solution, it is much more. A framework provides a set of underlying services that apply to many different use cases. A framework is a model that captures foundational services that can be reused in many different solutions. Foundational services will include various types of middleware that can compare transactional data with streaming data, security and compliance services, and data orchestration services. There can also be analytics frameworks that allow for consistent analysis of sensor data. For example, there are best practices such as how to process traffic streaming, and how to integrate data from different engines. These types of services are widely used in a variety of solutions. By creating independent services that can be used in a variety of situations, it is easier for organizations to create solutions in record time. This flexible model also provides a consistent testing methodology that avoids errors. By taking the complexity out of building foundational services, it allows organizations to focus on innovating on process. This process innovation is key to the new world of Industry 4.0 and the future of the Internet of Things.
Hitachi Research Lab Innovations

Research and development is a cornerstone of Hitachi and nearly $3B is invested in research projects conducted by 4,900 personnel (http://www.hitachi.com/rd/hrl/). Hitachi research labs are unique in their blend of industrial, IT, analytics and telecommunications networks R&D projects. This blend of expertise is resulting in cutting edge innovation around the Internet of Things. The following are some examples of products that are coming out of this research.

Reusable Frameworks
Hitachi approaches IoT from both a solution and technology perspective leveraging both IT and industry domain specific expertise. To accelerate solution development and better capitalize on IP across the teams they are developing solution frameworks. These frameworks deliver reusable services and analytics that can be leveraged across a broader range of problems as well as promote a more collaborative working environment for developers.

Searchable Encryption
As more and more data moves from the traditional data center to the cloud it is critical to have the right level of protection of important intellectual property. For example, areas such as clinical data management require that an individual’s information be safe and secure. Often companies have to sacrifice speed and restrictive access in order to protect their data. Hitachi has developed searchable encryption technology in their Yokahama Research Labs that enables high-speed data search and processing of encrypted data in its native state.

Preventive Maintenance
One area that industrial companies can achieve massive savings is by effective asset maintenance. Maintenance in industries ranging from mining to transportation and medicine can save huge amounts of money by preventing unscheduled downtime. In addition, preventive maintenance can prevent catastrophic failure. Hitachi research laboratories have created analytics algorithms that help anticipate failures before they can disrupt operations.

Unstructured Data
Hitachi is investing in research to support unstructured data. Hitachi has focused much of its research on analyzing and searching images and video. Research projects in this area can be used to search media archives or analyze video to help automate public safety solutions. By being able to monitor industrial infrastructure can protect businesses from potential disasters and aid in determining innovative solutions to problems. Hitachi has developed both object and face search technologies along with image enhancement to enable visual data to be a powerful source of insight.

Hidden Correlations
In large data sets with many variables relationships and trends are often not readily apparent. It is often difficult to distinguish data that is simply noise from data that is important. Identifying areas of statistically significant correlation to

... preventive maintenance can prevent catastrophic failure. Hitachi research laboratories have created analytics algorithms that help anticipate failures before they can disrupt operations.
guide further investigation is paramount. Hitachi is conducting research with models and algorithms in areas like human behavior and healthcare analysis to gain insights into correlations hidden inside huge volumes of complex data.

**Conclusion**

As the amount and variety of data expands, it is critical that we have the type of technology frameworks and engines that support industrial transformation. There is a new generation of manufacturing processes that rely on sensors of all varieties to provide flexible automation of processes. This supports the emergence of the Internet of Things and the next generation of the industrial revolution. To be successful, businesses need to be able to capture all types of data and analyze that data in context with the business problem being addressed. At the same time, there needs to be a rearchitecting of how businesses handle process that is easy to change. We have passed an important milestone that has given organizations the ability to create new solutions to support innovation through reuse of services in a consistent and predictable way.
About Hurwitz & Associates
Hurwitz & Associates is a strategy consulting, market research and analyst firm that focuses on how technology solutions solve real world customer problems. Hurwitz research concentrates on disruptive technologies, such as Cognitive Computing and Big Data Analytics, Cloud Computing, Service Management, Information Management, Application Development and Deployment, and Collaborative Computing. Their experienced team merges deep technical and business expertise to deliver the actionable, strategic advice clients demand. Additional information on Hurwitz & Associates can be found at www.hurwitz.com.

© Copyright 2015, Hurwitz & Associates

All rights reserved. No part of this publication may be reproduced or stored in a retrieval system or transmitted in any form or by any means, without the prior written permission of the copyright holder. Hurwitz & Associates is the sole copyright owner of this publication. All trademarks herein are the property of their respective owners.

35 Highland Circle • Needham, MA 02494 • Tel: 617-597-1724
www.hurwitz.com