White Paper for ThingWorx
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A new agenda item for enterprise executives: Enterprise IoT
(Part One of Three)

1 Executive Summary

The Internet of Things provides a host of opportunities for enterprises to introduce and integrate innovative connected devices, advanced analytics, and new cross-platform applications with enterprise systems. These innovations offer enterprises new and exciting capabilities to design and launch products with value-added services. Consequently, this creates further opportunities for enterprises to develop new business models, customer engagement structures and revenue streams. The broad-ranging impact of Enterprise IoT is set to change the rules of the game.

To realize these service opportunities, enterprises will need to identify, select and prioritize machine-to-machine (M2M) and the Internet of Things (IoT) related opportunities and technologies. As part of this process, enterprise executives should consider a number of crucial questions and recommendations to inform the design of a technology architecture that ensures the scalability, agility and flexibility necessary for a successful IoT implementation. Whether this is achieved through a 'build or buy' approach will need to be assessed by the executives of the enterprise.

[2] For reference, our definition of the difference between M2M and the IoT is detailed in the Research Note "What's the difference between M2M and IoT?", published September 2014.

2 Contents

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3 Scope

The purpose of this White Paper is to highlight and define the real potential impacts that the Internet of Things is generating for enterprises. Successful Enterprise IoT implementations are not just the result of technology innovation, but rather the intelligently coordinated innovation of products, services, and business models. By integrating new data streams from connected devices with workflows, legacy systems and new technologies, Enterprise IoT implementations ultimately help build and redefine a business' customer and partner relationships.

In this three-part White Paper series, Machina Research will look at Enterprise IoT from the viewpoint of enterprises and develop a blueprint to guide enterprise executives to effectively address and make the most of this disruptive business and technology force.

In this first part Enterprise IoT will be examined in closer detail through uses cases that will explain and illustrate some of the top IoT opportunities available for enterprises. These cases will highlight how IoT differs from past innovations and detail the high-level questions and considerations that enterprises must address to develop successful Enterprise IoT strategies.

In Parts II and Parts III of the White Paper series, we will explore the foundational and tactical elements of how Enterprise IoT strategic initiatives approach effective projects, and highlight key, next-step considerations in building and implementing Enterprise IoT solutions.

The successful implementation of an Enterprise IoT strategy will help companies overcome what has been identified as "The Innovator's Dilemma," shifting away from status quo business practices towards new levels of customer engagement through new products and services. It all begins with that new agenda item: Enterprise IoT.

[1] Referring to Professor Clayton Christensen's book, "The Innovator's Dilemma" (Harvard Business Review Press, 1997)

4 Identifying significant opportunities in Enterprise IoT

Enterprise IoT brings together a number of innovations in connectivity architecture, smarter connected devices, advanced analytics, new cross-platform applications, and integration with enterprise systems. Ultimately, these innovations will turn stand-alone products such as vehicles, white goods, consumer electronics, security systems and office equipment into products with intelligent, highly integrated services. Through this process termed 'servitisation,' enterprises will be able to create differentiated business models, enhance customer engagement and develop new commercial terms facilitated by products with integrated services. In the manner, the Enterprise IoT has started to change the rules of the game.

To illustrate the transformative potential of Enterprise IoT, we will provide examples of significant opportunities, for new value-added services and products to help inspire enterprises to consider enhancements to their own products.

For the manufacturing industry, the ability to extend (if not develop for the first time) direct and longer lasting relationships with end customers disrupts the status quo of many business models. In this wide ranging industry, products such as engines, compressors, brakes, irrigation systems, packaging equipment and so on are now launched with integrated sensors and devices to monitor and measure the performance of the product in near real-time with advanced analytical tools. This new approach delivers an innovative set of service opportunities, including:

- Changing the nature of service maintenance practices from reactive to proactive through the u se of advanced analytics for predictive maintenance and optimal machine performance;
- Establishing over-the-air programme updates and corrections with limited machine disruption
- Capturing performance data in real-time and including this processed information as part of ongoing product design, custom service, warranty and development processes
- Enabling improved asset and tracking management of parts throughout the production process
- Implementing new business models including a shift away from up front, capital intensive (CAPEX) solutions to more subscription and usage-based models

For automobile manufacturers and fleet management companies, the connected car has opened up a significant number of opportunities for new and compelling engagements with car owners and drivers that were previously limited to car dealerships. These new services include:

- Providing car owners and drivers with information about driver performance and behavior particularly with regards to greener driving practices, fuel management and user-based insurance schemes (pay as you drive)
- Moving service maintenance routines and warranty management into significantly more intelligent models based on advanced analytics and actual use of the vehicle
- Offering new car sharing schemes (either rental or ownership) enabled through easy-to-use location information, booking and payment systems

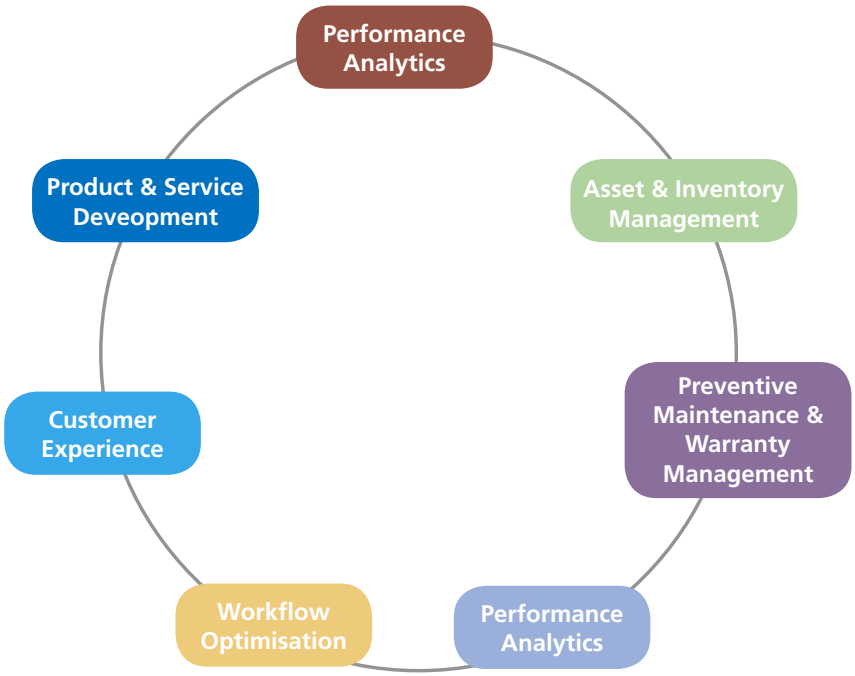
■ Stolen vehicle recovery, roadside assistance as well as emergency call systems – all designed to enhance the safety and security of drivers and car owners with immediate and automated notification systems while simultaneously opening more opportunities for developing important value-added services

For connected lighting, the enhanced capabilities of Enterprise IoT solutions are engendering a wide range of new and innovative services separate from the installation of a new lighting system. These services may include:

■ Opportunities for determining the occupancy in offices, retail outlets, parking areas and buildings to facilitate the creation of value-added services related to more efficient space utilisation, optimal product location and general energy management;
Providing additional energy management services as part of the overall lighting management and enabling preventive maintenance solutions. There are multiple paths available to identify new and innovative opportunities in Enterprise IoT. Exploring new boundaries within product development processes represents a key starting point which can involve bringing in examples and use cases from industry analysts, consultants and customers to enrich the exploratory process.

What is common to all the examples above, and in Enterprise IoT applications in general, is the opportunity to design and develop new services. These services are able to monitor the status and performance of core products and extend the base of value-added services and benefits. Far from an exhaustive list, the benefits and opportunities which may be identified in Enterprise IoT include:

Figure 1: Service Benefits from Enterprise IoT [Source: Machina Research, 2015]



5 Which technology innovations are changing the game in Enterprise IoT?

As companies embrace the broader framework of IoT, Enterprise IoT implementations are prone to disrupt business practices. Well-designed Enterprise IoT solutions are not solely a continuation of advanced information technologies, but in fact embrace smarter connected devices, advanced analytics, new cross platform applications, and integrate these elements seamlessly with enterprise systems.

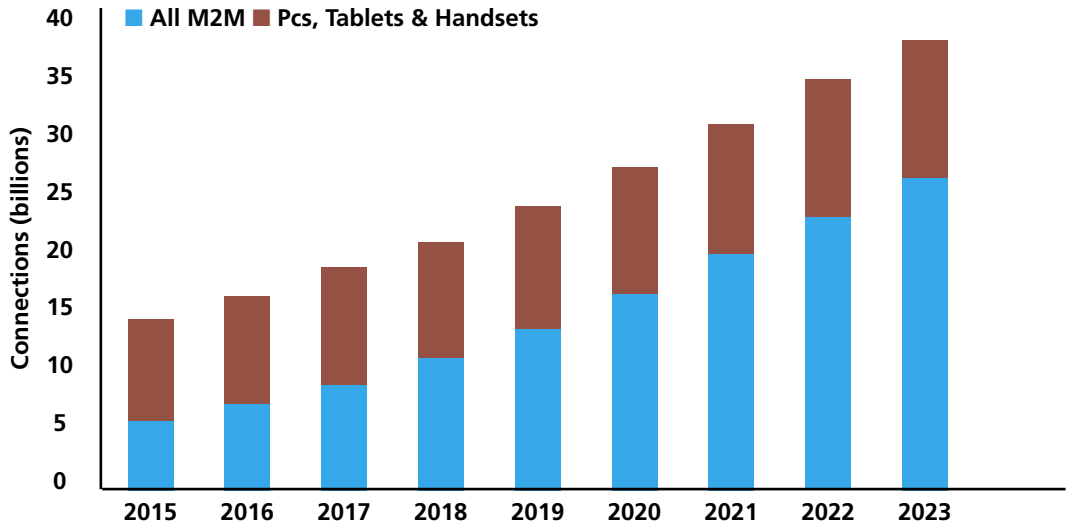
Smarter connected products have opened new opportunities

We are moving into a new era. Products are no longer stand-alone devices with operational purposes alone. Increasingly, devices are being embedded with additional sensors, greater processing power and expanded memory capabilities. These devices are also 'connected' – either permanently or intermittently – and together, these smarter and connected devices have changed the game for a wide array of business segments and industry sectors. Information is now being generated, extracted and processed in the device, across the network and on and in the important aggregation and processing platforms and applications. Devices, products, goods have become 'connected' or 'networked,' and together with the latest generation of agile application enablement platforms have significantly enhanced the opportunities for new applications and services.

Take the example of a connected "reefer", or refrigerated shipping container. Sensors embedded in the container are constantly monitoring the status of the container, its surrounding environment and its contents, generating information for future analysis. This information allows for transport companies to confirm the quality arrival of refrigerated products, or to take immediate action should temperatures rise or fall above desired levels, travel times be extended, or products are incorrectly handled. Near real-time information enables many business processes to be more responsive, with swift reaction times that can help companies recover from an adverse incident and still deliver a positive outcome.

Smarter connected products are becoming increasingly widespread among many key industry verticals. Machina Research forecasts a growth from 14.2 billion Machine-to-Machine (M2M), PC, tablets and handset connections in 2015 to over 37.9 billion connections by the end of 2023.[2]

Figure 2: Global M2M and PC, tablet and handset connections, 2015-2023 [Source: Machina Research, 2015]



[2] Machina REsearch Global M2M Forecast Database

Advanced analytics is a primary enabler of new services

Advanced analytics can help establish greater understanding of business processes and product usage patterns that can be used to improve operational efficiency. The focus of advanced analytics is using historical as well as real-time data to predict future scenarios, identify potential correlations and with the use of new visualisation tools, assist in the development of predictive modelling.

From data generated by thousands and millions of different networked smarter connected devices, advanced analytics has the potential to deliver an array of new actionable insights, meeting the initial design requirements of the IoT solution but also, through further data sharing, providing information to other applications.

For many retailers, the analysis of customer movement within shops has provided crucial information to facilitate optimal product placement, shelf replenishment, stock management, layout planning, and even mapping out customer journeys through the store. A wide range of applications utilising a number of IoT technologies have appeared including iBeacons[3], and Retail Footfall analytics in connected lighting solutions. The important point here is that data captured by end devices and sensors is processed, using fairly advanced analytics' tools to then deliver new and immediate services to in-store customers. These services may include: product promotion and guiding customers to the products, in-store discount information and marketing, and with integration to back-end systems and other applications, better insights to customer behavior.

Greater value from platforms, cross platform applications and APIs

To create robust, secure and extensible IoT solutions, smarter connected devices and applications need to be managed across the unifying architecture of an IoT platform. IoT platforms address a wide range of functions including device and connectivity management, service enablement and application development. Other functions include security analytics and additional integration capabilities with other enterprise systems and applications through managed Application Programming Interfaces (APIs). Not all IoT platforms are the same. Some have greater depth and capabilities in such areas as device management or application development whereas others have strengths in connectivity management.

Top IoT platforms share the following three basic attributes:

1. Capability to engage complex and heterogeneous ranks of devices, protocols, connectivity forms and applications. This creates substantial challenges for quick, seamless and robust IoT solutions without unifying IoT platforms resolving these interoperability issues. While few IoT platforms will be able to address this increasing diversity of 'things,' where implemented, IoT platforms become substantial removers of technology friction
2. More recent Internet of Things platforms such as ThingWorx have addressed the greater value of application development, recognising the immense opportunities from unifying and aggregating different applications and services, and leveraging the sharing of data across all applications. With easy to use and intelligent tools to combine applications, ThingWorx has substantially reduced the time to market for application development, and allowed enterprises to focus their scarce development resources on the elements within an IoT architecture which add business value, namely applications and data.
3. System integration has always been a formidable challenge. Developing pre-configured IoT platforms with integrations to other applications and enterprise systems such as Enterprise Resource Planning or more discrete systems such as Supply Chain Management, Product Lifecycle Management or Customer Relationship Management systems delivers significant benefits to enterprise customers. These pre-configurations or established integrations reduce the overall implementation times of solutions, any information flow bottlenecks, optimize reporting and planning and enable the seamless access to data between all systems to improve operational efficiency and decision-making.

[3] For a further discussion on iBeacon technologies, read Machina Research Research Note on "iBeacon Opens New and Attractive Markets with Close Proximity Technologies," March 2014

6 Prioritising between opportunities and technologies

Executives are no strangers to the process of having to prioritize and decide between different opportunities and technologies. At these very early stages, feasibility assessments and studies may be undertaken, or business cases and proofs of concept (PoCs) fleshed out and initiated before launching full scope projects.

Executives will need to perform such high level assessments of each Enterprise IoT application in terms of the market opportunity, the revenue potential, the strategic fit and importance to the company, time to market, the margin potential, and costs to implement, including channels to market and regulatory constraints. And having done so, understanding some of the potential business models and specific opportunity markets will be important. Not all IoT markets will develop at the same pace, and this may vary from country to country, and segment to segment.

It is crucial for executives to also recognize that there are the fundamentally new characteristics and features of Enterprise IoT (as opposed to more traditional IT approaches). These new characteristics and features are particularly important when exploring technology options and paths, and looking to minimize risks. They include the main attributes as scalability, agility, flexibility, security and partnerships, and are increasingly important when considering the appropriate IoT platform.

Scalability leads the way

Ever increasing numbers of smarter connected devices, applications and all associated data will require highly scalable platforms. As more devices send more data and that data is accumulated over time, the need for system scalability increases exponentially. These increases must be considered and planned for from the beginning.

Agility will complement the speed of change

In traditional IT and M2M solutions, solutions and architectures were designed with well-defined tasks including specific routines and data sets. With the expanded importance and scale of data, platforms will need to not only scale but also to adapt to the rapidly changing requirements from changing data sets as a consequence of more and more devices becoming connected and contributing with new data streams.

Flexibility is where adaptation is necessary

IoT platforms will need to be flexible to effectively handle the influx of diverse data sets. At one moment, data flowing into the platform may be highly structured, time series-based data. This sort of data will benefit from significantly different types of analytical tools as well as data management processes as compared to completely unstructured data, potentially extracted from cameras or audio sensors. In the case of the latter, databases will need to flexible enough to handle such data structures, and issues of interoperability will become key. Platforms will need to show these capabilities in terms of scalability, agility and flexibility.

Security must be a constant concern for enterprises

In an architecture where data is transmitted and managed across several devices, networks and platforms, enterprises will need to be highly aware of possible security threats to the IoT solution and underlying systems. As part of the design and development of the solution, enterprises should take adequate steps to build in suitable security measures and procedures where possible. These will include designs around tamper proof modules, encryption of data across local and wide area networks, and ultimately, procedures around the storage and access to data.

Prioritising IoT opportunities and the technologies that enable them will require executives to consider such questions as those above, assess the strengths and weaknesses in each case, and ultimately ensure that the new agenda item for enterprise executives establishes the right balance between long-term strategic objectives and short-term solutions. One way of achieving this is to design the platform not just for the immediate and identified requirements but also for the potential developments in the enterprise.

In IoT, ensuring the greatest agility and flexibility for the enterprise and its business processes becomes a strategic imperative. For many enterprises, this begins perhaps with one starting question having identified, selected and prioritized some of the opportunities – should we build or buy? Should we buy a turn-key solution or assemble the solution with best-of-breed components/partners?

7 Partners will be needed irrespective of questions of 'build or buy'

Having identified, selected and prioritized the service opportunities that smarter connected devices bring, executives will need to begin to consider how best to develop and build the components that comprise IoT architecture. For many enterprises, the process will start with looking at the manufacturing or potential service processes around the product, and see how connected devices may enable such identified services.

In connecting smarter connected devices to applications, enterprise systems and application development, and ensuring that the appropriate management tools are in place to manage and monitor the device and connectivity, enterprises will logically begin to explore the field of platforms. Here, the first discussions of 'build or buy' will emerge, and without a hard and firm rule in place, enterprises will need to consider every service opportunity individually in relation to the platform. Some recommended guiding principles include:

- With substantial in-house programming skills, enterprises can realistically design and build parts of a complete platform to manage device, connectivity and application requirements. This effort will provide the enterprise with purpose-built architecture at a standard build of materials cost
- Buying-in or licensing a platform does come at a recurring cost to the enterprise with a level of dependency and lock-in to the platform provider
- Buying-in or licensing a platform does however ensure a degree of future proofing and development particularly important in the changing environment of IoT
- As time to market and future scalability, agility and flexibility are important factors, the use of programming resources may be better utilized for additional application development than ensuring end-to-end architectural design

The decision to 'build or buy' will be driven by time, cost, skills and requirements. It is however imperative that enterprise executives continue to balance between long term strategic objectives and short term solutions.

8 Conclusions & recommendations

Introducing the new agenda item of Enterprise IoT must be accompanied by a change of culture and mind-set across the entire business. Enterprise IoT is not just an innovation in technologies; it is a fundamental and disruptive innovation of the way business has been conducted for many decades, and will require executives, managers and employees at all levels to recognize the need for this change.

Enterprise IoT does so much more than 'servitize' the manufacturing industry. It drives executives to explore new business models including changes from CAPEX to OPEX models, launching new and recurring service revenue streams, and building lasting relationships with customers well beyond the brand name. It will require executives to think even more strategically about product and service development, and avoid short term disruptions and panic actions. It will evolve supplier relationship models with additional strategic and commercial partnerships.

At the end of this Part One White Paper, Machina Research would recommend to all enterprise executives to start with the new agenda item of Enterprise IoT by:

- **Identifying the opportunities in Enterprise IoT.** Draw up the long list of ideas and possibilities from smarter connected devices, building on the products and markets of your company. Keep the improvement of customer experience and value to the customer at the front of mind.
- **Breaking down the compartmentalisation and limits to the use of data.** A change in mind-set and culture within the enterprise will be crucial for Enterprise IoT to succeed, and a good starting point is to understand how all the data assets of the company are used, could be used and shared, and how data from smarter connected devices could be used
- **Focusing on the future.** Narrowing the list of opportunities is one task but in the same breathe, keeping the attributes of technology implementations as scalable, agile and flexible will be key as identifying and prioritising opportunities in IoT is set to become a constantly revisited agenda item.
- **Building the right partnerships.** Irrespective of a build or buy approach, IoT markets will strategically and tactically require enterprises to build partnerships and collaborations either for product and service development purposes, for creating channels to market, or for adding value to applications and services.

In Part Two of this White Paper series, we will continue to explore how Enterprise IoT strategic initiatives become projects, and what next step considerations enterprise executives will have to make in building and implementing Enterprise IoT as part of their current business.

About ThingWorx

ThingWorx™, a PTC business, provides the first platform designed to efficiently build and run the applications of today's connected world. ThingWorx's model-based design and search-based intelligence simplifies application development efforts by minimising cost, and risk while accelerating time to value. The ThingWorx® platform combines the key functionality of Web 2.0, search, and social collaboration, and applies it to the world of "things", including connected products, machines, sensors, systems, and industrial equipment.

Businesses use the ThingWorx platform to rapidly deliver innovative applications and connected solutions across markets ranging from manufacturing, energy, and food, to Machine-to-Machine (M2M) remote monitoring and service, as well as in emerging Internet of Things applications, including smart cities, smart grid, agriculture, and transportation.

For more information, please visit our website at www.thingworx.com and our blog at www.thingworx.com/blog or follow us on Twitter at @ThingWorx.

About Machina Research

Machina Research is the world's leading provider of market intelligence and strategic insight on the rapidly emerging Machine-to-Machine (M2M), Internet of Things and Big Data opportunities. We provide market intelligence and strategic insight to help our clients maximize opportunities from these rapidly emerging markets. If your company is a mobile network operator, device vendor, infrastructure vendor, service provider or potential end user in the M2M, IoT, or Big Data space, we can help. We work in two ways:

- Our **Advisory Service** consists of a set of Research Streams covering all aspects of M2M and IoT. Subscriptions to these multi-client services comprise Reports, Research Notes, Forecasts, Strategy Briefings and Analyst Enquiry.
- Our **Custom Research and Consulting** team is available to meet your specific research requirements. This might include business case analysis, go-to-market strategies, sales support or marketing/white papers.

Machina Research's Advisory Service provides comprehensive support for any organisation interested in the Internet of Things (IoT) or Machine-to-Machine (M2M) market opportunity. The Advisory Service consists of thirteen Research Streams (as illustrated in the graphic below), each focused on a different aspect of IoT or M2M. They each provide a mixture of quantitative and qualitative research targeted at that specific sector and supported by leading industry analysts.

Machina Research's analysts also have a wealth of experience in client-specific consultancy and custom research. Typical work for clients may involve custom market sizing, competitor benchmarking, advice on market entry strategy, sales support, marketing/promotional activity, and white papers.

For more information, refer to our website at https://machinaresearch.com, or email us at enquiries@machinaresearch.com.

Advisory Service Research Streams [Source: Machina Research, 2014]