IoTNOW

ANALYST REPORT

INDUSTRIAL IoT

It's about more than just the IoT....

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Industrial IoT is about more than just the IoT

The first thing to note about Industrial IoT is that it encompasses all of IoT and more. If we define 'IoT' as our connected future (including devices, services, new business models and new ways of interaction) then, behind every one of these propositions, we should expect to find an enterprise of some form. In short anything that is 'IoT' from an end-user perspective, is 'Industrial IoT' from the perspective of companies supporting that IoT proposition.

Jim Morrish is founder and chief research officer of Machina Research. He is also co-chair of the Industrial Internet Consortium's (IIC's) Business Strategy & Solution Lifecycle Working Group, and is responsible for Business Strategy & Planning work within the IIC.

But, explains Jim Morrish, Chief Research officer at Machina Research, Industrial IoT (IIoT for short) is more than that in that it also includes consideration of product development and product lifecycle management, partner ecosystems and project management – all in an IoT context. In short, IIoT includes all aspects of the IoT, plus supporting infrastructures, and there are a number of specific ways in which IIoT is more complex than just IoT. These include:

- **Fragmentation:** The number and diversity of Industrial IoT applications are huge, and it is an incredibly fragmented environment. This means that the environment is typically characterised much more by bespoke services rather than products when compared to end-user environments. Systems integration will often play a dominant role in the development of IIoT solutions, drawing on productised tools (including IoT platforms) where applicable.
- **'Brownfield' deployments:** The 'everything connected' roots of IoT thinking tend to prompt most people to imagine new connected devices and services associated with those devices when considering the IoT. However, there is a significant trend within enterprises to simply pull existing data into an 'IoT like' environment and experiment to see what can be done with the resulting datasets, including support for new processes and products. We term this 'top down' IoT, in contrast to 'bottom-up' IoT that is characterised by the deployment of new devices and associated services higher up the stack.
- **Possible absence of devices:** Whilst this also applies to plain-old IoT solutions, it is worth highlighting that many IIoT solution deployments will not involve the deployment of new 'things'. There are many instances in the IIoT context where simply pulling already existing data feeds from diverse sources and combining them can bring significant value to the enterprise.
- **Machine Guys vs Internet Guys:** Underpinning all of these dynamics is a more fundamental concept of the 'DNA' of any enterprise engaging in the IoT. Companies that have 'Machine DNA' are used to shipping devices and hoping that they never hear about their device again (since this would usually mean that something had gone wrong). Companies that have 'Internet DNA' are used to working in a world of continual-beta, where software and services are never actually 'finished'. These two perspectives can create endless tensions throughout IIoT project cycles.
- **The IT/ OT fight match:** Traditionally, Operational Technology specialists and Information Technology specialists have not seen eye-to-eye. IIoT projects often force these two constituencies to cooperate to deliver business-critical solutions.

This publication includes a further two articles on IIoT topics. In the first (**"How to get Industrial IoT projects off the ground"**) we focus on all aspects of the development of IIoT propositions up to and including the business case, whilst in the second (**"Managing IIoT Value Chain Transformation"**) we focus on the more downstream aspects of developing and deploying IIoT solutions, post-business case approval.

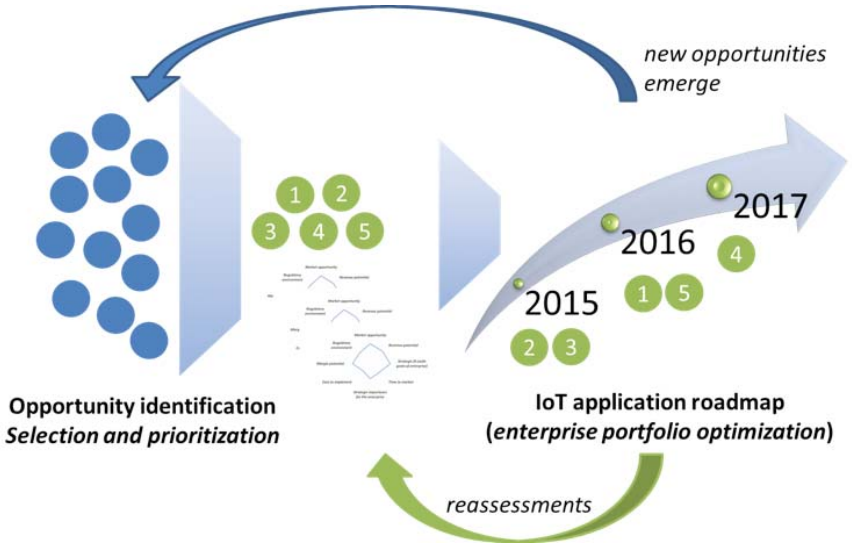

Figure 1: The Enterprise IoT Identification, selection and management process [Source: Machina Research, 2015]

How to get Industrial IoT projects off the ground

While Industrial IoT (IIoT) projects are in many ways quite similar to more traditional systems integration projects, there are significant differences. In this article, we focus on those differences, including sections on:

- IIoT strategy
- IIoT opportunity identification
- IIoT opportunity management
- IIoT project initiation
- IIoT Centre of Excellence
- IIoT Platform

IIoT Strategy

Before engaging in IIoT projects, an enterprise must set out their overall strategy with regards to the IoT, starting with defining a vision. Are their motivations for engaging in IIoT purely economic or (for example in the case of smart cities applications) could there be a broader motive of societal benefit also be a driver. What is the overall market and competitive environment in which the enterprise in question plans to engage? How is it likely to change in coming years?

When seeking to engage in IIoT, any enterprise will also need to define some kind of guiding framework for working with partners and the overall ecosystem. In parallel, the enterprise will also need to identify, at a high level, the capabilities that they are likely to need to engage in IIoT projects.

It is also beneficial to put in place frameworks and processes for tracking IIoT projects from conception through to live operations, including validation of results to check that individual IIoT projects have achieved what they set out to achieve. Significant time should also be invested in identifying and profiling a long list of risks - including operational, technology, execution, implementation and security risks - and identifying any pitfalls or lessons learned from previous projects, or from potential suppliers and ecosystem partners.

IIoT Opportunity Identification

Industrial IoT applications can unlock many different kinds of benefits, including:

- Creating new revenue streams
- Reducing costs
- Extending customer relationships
- Improving product design and management
- Creating opportunities for new business models
- Improving decision making processes
- Supporting better product and service quality
- Improving asset management
- Enhancing environmental considerations
- Improving health and safety
- Developing new markets
- Supporting new strategic partnerships
- Enhancing operational performance
- Improving customer services
- Improving overall enterprise efficiency

Clearly, executives need to identify and prioritise the IoT applications they believe will best benefit their business. Compared to other IT or machine-to-machine projects, the task of the executives is made that one degree more complex by having to decide in terms of roadmaps rather than single implementations. One of the more compelling and challenging attributes of IoT architectures is that once properly implemented, enterprise IoT environments can become a platform for growth. 'Properly implemented' means that architectural principles of scalability, agility, flexibility and modularity have been followed, and not compromised for the sake of singular goals. Identification of IoT opportunities can be achieved through such diverse management tools as brainstorming sessions, workshops, accessing industry analyst reports, engaging with consultants and receiving customer feedback.

The list of possible IIoT projects is almost endless. Which highlights a new problem: where to start? The real challenge for executives in IIoT is the prioritisation process, rather than the identification of opportunities.

Additionally, throughout the operational Plan-Build-Run stages, enterprises may discover new IoT opportunities or may need to discard or amend selected ones. Compared to the well-defined and detailed planned IT projects of the past, IoT methodologies work better with agile software development approaches – try, try and try, and if it fails, be ready to move on. And only invest as you go, and avoiding committing to multi-million dollar projects from the very beginning.

Figure 1, above, summarises the central process of IIoT opportunity identification, selection and prioritisation, and developing an IoT application roadmap with an optimised portfolio. Reassessments of existing opportunities and identification of new opportunities are critical elements in the process of continuous innovation.

IIoT Opportunity Management

The development of analytical underpinnings to support the analyses described above is key. There are two main aspects that must be considered, and we discuss each in turn:

- Business model development
- Impact and risk assessment

Clearly, as is almost always the case for significant projects, some kind of underpinning business case and business model will be required. The difference with IIoT projects is that historically most business case have been 'isolated' or standalone, rather than cast in the context of an overall enterprise strategy. In the case of an IIoT business case, it is necessary to consider how the business might perform in absence of the adoption of IoT concepts, and also to effectively 'share' the costs of the development of a generic IoT capability between any number of current and future IIoT projects. In many cases, the business cases that underpin IIoT projects are more analyses of existential questions, rather than simple analyses of costs and revenues. In concept, this might be similar to analyses undertaken by banks in the 1960s and 1970s deciding whether to adopt computer systems, or not. As we know now, in retrospect, the question was never really 'whether' computerisation would be embraced, but 'when'.

An accurate understanding of the impact of an IIoT project and a detailed analysis of risks is also required. With regard to analyses of impact, the key aspect is to understand the degrees of elasticity in a specification to match budgetary constraints. The IoT is such a new environment, with so many unknowns, that IIoT project propositions must often be re-worked during the course of the Plan-Build-Run lifecycle. For instance, it may transpire that data sovereignty regulations limit the scope of potential solutions in ways that were not envisaged at the time that the initial business cases were developed, or certain planned QoS levels may not be achievable, due, for instance, to the limited availability of connectivity. It's hard to imagine the full diversity of potential problems that might crop up to blow an IIoT project off course, and that's the point: IIoT business cases need to be flexible enough to support analyses of how best to 'compromise' an optimal solution to match unforeseen technical constraints within available budgets. IIoT business cases must be sufficiently detailed and flexible to provide context when a business planner has to discuss project de-scoping with downstream project managers. Effectively, this implies an 'agile' interface between IIoT business planners and IIoT project managers.

Clearly, it is also necessary to undertake a complete risk analysis for any new IIoT project, including with regards to security, and to support decisions regarding how much to invest in product security. 'Gold standard' security will not be an option for all IIoT projects.

IIoT Centre of Excellence

Whilst it's not strictly part of getting an individual IIoT project off the ground, it will be beneficial for many enterprises to develop an in-house IIoT Centre of Excellence to get all IIoT activities off the ground. Such a center of excellence could encompass a range of activities, such as:

- **IIoT Platforms:** including the overall supporting technical infrastructure that exists within an enterprise to support IIoT projects. Main components should include an application platform, and a connectivity platform (or just a connectivity management capability). This does not necessarily imply a sizeable investment, and 'low grade' version of such a capability could almost be thought of as a centralised procurement function.
- **Change management:** IIoT projects often imply significant change to working practices that have been established over decades. In many cases, in many industries, the option to deploy change management specialists to drive the human changes that need to happen to match the technological (IIoT) changes will be a significant benefit.
- **IIoT Consulting:** On a slightly wider note, IIoT concepts are sufficiently new, and sufficiently different from 'business as usual' that it can often be beneficial to establish a wider consulting capability. This should be configured as an internal (shared) center of excellence staffed with people who live-and-breath IIoT concepts, and who can guide their peers who are embedded in the wider enterprise.
- **IIoT Benchmarking:** Clearly many of the members of the IIoT consulting group could beneficially spend part of their time analysing the wider industry in which their company participates. They should seek to identify best practices within the industry, and assess the overall maturity of IIoT concepts within the industry, with a view to painting a long term IIoT future scenario to act as a backdrop to further strategic planning.

Conclusions

The IIoT - and, more widely, IoT concepts - will change the way in which business is done in coming years. The potential is almost limitless, and companies that fail to effectively capitalise on the opportunities that the IIoT presents run the risk of being outcompeted.

Industrial IoT projects themselves are quite similar in nature to current day systems integration projects, but there are significant differences which must be appreciated in order to gain the full benefits from IoT concepts, and to de-risk the process of IoT adoption.

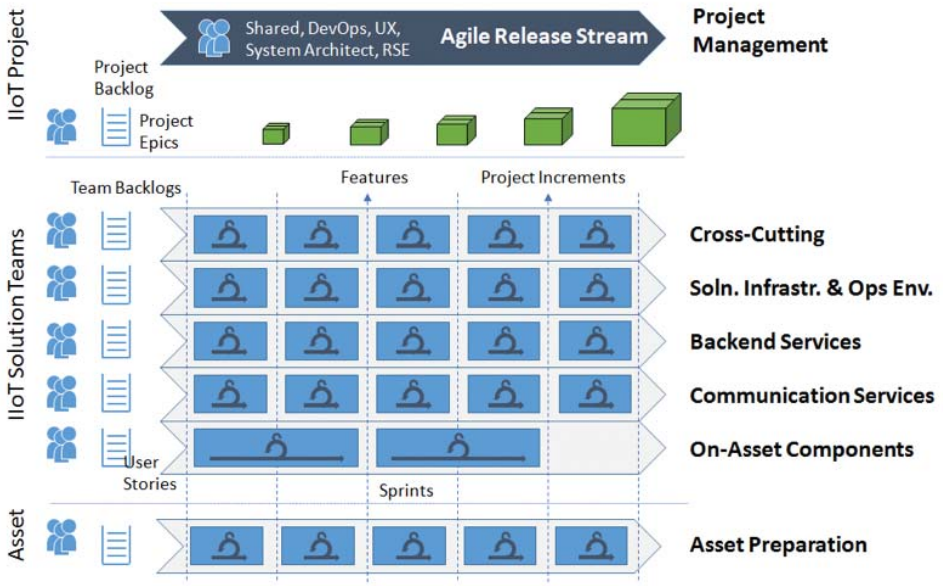

Figure 2:
Agile IIoT Project Organisation
Source: www.enterprise-iot.org

Managing IIoT Value Chain Transformation

INTRODUCTION

To address the Industrial IoT (IIoT) challenge, the Industrial Internet Consortium (IIC) has established the Business Strategy and Solution Lifecycle Working Group (BSSL WG), the goal of which is to support business managers, solution architects and operations managers to better manage the complexity IIoT introduces and to more effectively achieve their business goals.

Whilst the previous article "*How to get Industrial IoT projects off the ground"* focusses on the Business Strategy & Planning elements of Industrial and Enterprise IoT, this article focusses on the more downstream consideration of IIoT Solution Lifecycles, and Libraries of project artefacts.

IIOT SOLUTION LIFECYCLE

On the solutions level, the entire lifecycle of the IIoT solution needs be supported – from planning and designing to building and testing, then preparing the operations environment, gathering data on the deployed solution or the product in use and ensuring the solution is performing as expected while able to evolve. Adding new services after the initial launch is important, and so is the support of existing and new customers. In this section we focus on three key aspects:

- The role of IIoT system characteristics
- Creating agile organizations for IIoT projects
- Validation and improvements

The Role of IIoT System Characteristics

IIoT system characteristics are about risk mitigation and managing trade-offs. How secure? How safe? How reliable? How resilient? All these qualities have a price, in terms of budget, complexity and operational resource. Their benefits are not easy to quantify, yet getting them right is crucial to the long-term viability of the overall System.
Another way to look at system characteristics is their role in the value chain. What do all of these system characteristics (security, safety, reliability, etc.) have in common? They preserve the business value chain under adverse conditions, either by preventing bad events from happening (e.g., thwarting security threats) or by enabling the system to cope with a bad event when it occurs (e.g., designing an architecture with built-in redundancy for reliability.) Defining system characteristics is critical to the control and predictability of widely distributed systems spanning multiple providers and under fragmented governance, hence to the business value chain that relies on them.

System characteristics also add a non-functional layer of requirements, which are almost certain to conflict with functional system requirements. Required system characteristics may impact all aspects of an IIoT solution - e.g., security involves processes and roles as much as a set of functions and an architecture choice - while also being determined by business requirements and acceptable level of risk. This is why system characteristics must be taken into account at design time.

The BSSL Framework under development within the IIC helps to manage the interdependencies between non-functional and functional requirements. It also helps evaluate various ways to achieve a particular non-functional objective, balanced with an acceptable level of risk. For example, the choice between securing a data flow with full encryption or with a faster and simpler integrity checksum will be influenced by very different factors such as how sensitive the data is, key management complexity, company policies and regulations, whether increased latency is an obstacle to future scalability, etc. The ability to handle these factors, the constraints that dictate them and their consequences are all crucial for IIoT solution architects.

Creating Agile Organizations for IIoT projects

Another key challenge for IIoT project managers is to find the best project organization that will be able to deliver the desired solution functionality in an agile way, while simultaneously ensuring adherence to the architecture and design. BSSL WG has developed a best practice for the organizational set-up of an IIoT project, which includes the following teams:

- **Project Management**, to ensure cohesion and adherence to project goals
- **Asset Preparation team**, to ensure the integration of the IIoT solution with all aspects of the asset`s lifecycle.

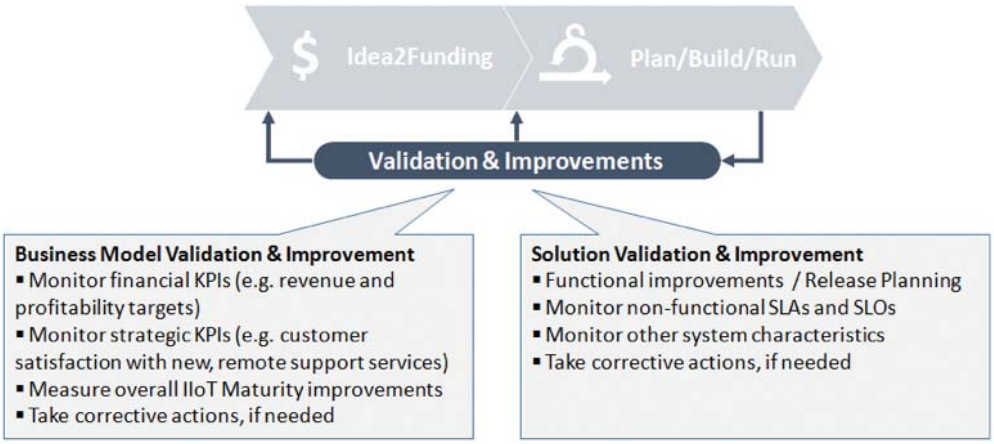

Figure 3: Validation and Improvements
BSSL LIBRARIES

- Teams for key solution elements, including Backend Services, Communication Services and On-Asset components.
- Cross-Cutting Concerns team, addressing aspects such as Security, Asset Lifecycle Management (e.g., Asset Activation) and Solution Integration and Test.
- Solutions Infrastructure and Operations team, responsible for infrastructure set-up, operations preparation and application lifecycle management

Efficiently managing the interactions of these different teams is a challenging task. **Figure 2** on the previous page outlines a structure that can support this task. At the top-level is project management. On this level, the central project backlog is managed. The key entities here are project epics (a high-level specification artifact from the agile toolbox), which are used to capture larger bodies of work. Furthermore, the overall system architecture is managed on this level. The individual IIoT solution teams are structured as described above. Here, the epics are broken down into more fine-grained user stories, which are managed in the individual team backlogs. For the on-asset components (e.g., gateways deployed on the asset), it may make sense to choose longer sprint cycles or project iterations, because hardware development is often not moving as fast as software development. However, sprint cycles should be aligned across the individual workstreams.

Validation & Improvements

The last part of the Business Solution Lifecycle Management is Validation & Improvements. Especially in a highly complex and dynamic environment like the IIoT, this part ensures ongoing solution optimization. The Validation & Improvements part consists of two pieces - see **Figure 3** above:

- **Business Model Validation & Improvement:** This part focuses on all aspects of monitoring the financial and strategic KPIs of the solution, measuring overall IIoT maturity, and implementing corrective actions, if need be.
- **Solution Validation & Improvement:** This part focuses on monitoring and improving the performance of the solution from the perspective of functionality, non-functional Service Level Agreements (SLAs) and Service Level Objectives (SLOs), as well as other system characteristics like security, reliability and resilience.

BSSL LIBRARIES

A key goal of the Industrial Internet Consortium's BSSL WG is to create a library of reusable artifacts for IIoT project managers and architects. Two of these key artifacts are design templates and solution metrics.

Design Template Library

The BSSL design template library provides templates for IIoT project managers and solution architects to help them create project specification documents as well as higher-level entries for the project backlog (e.g., epics) - see **Figure 4** on the next page.

The different templates are grouped into five groups:

- **Cross-Cutting:** Includes templates to document site surveys, project dimensions/taxonomies, project projections, milestone plans
- **Business Viewpoint:** Includes templates for IIoT stakeholder analysis and problem statement
- **Usage Viewpoint:** Includes templates like the "IIoT Solution Sketch" (a structured one-page overview of all key elements of an IIoT solution), as well as use cases or process landscapes for the solution
- **Functional Viewpoint:** Includes templates like the data-centric "IIoT domain model", as well as a template for "Asset Integration Architecture" and the IIRA Functional Domains
- **Implementation Viewpoints:** Includes templates for software architecture, hardware architecture and integration architecture

Metrics Library

Especially relevant for Validation and Improvement efforts, a set of standardized IIoT metrics will be very helpful. There are several dimensions that can be used to evaluate an IIoT system to include:

- **Functional dimensions:** evaluating the functions of the system and their capacity under various perspectives: performance, throughput, data volumes, transfer time, connectivity and quantity of assets.
- **Characteristic (or system characteristics) dimensions:** assessing higher-level properties such as reliability, safety, resilience, scalability, security, privacy

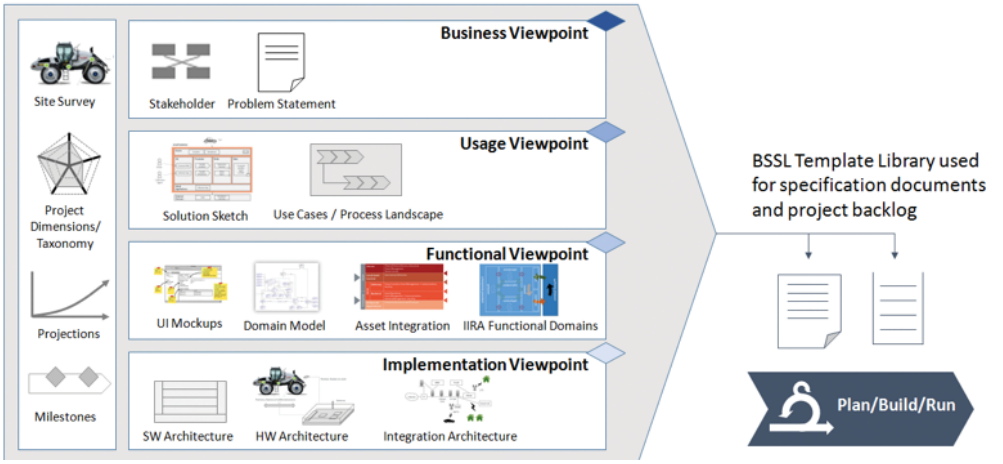

Figure 4:
BSSL Template Library

The functional dimensions can be divided into specific areas such as assets, data and communication. In turn, each one of these areas may involve a cluster of indicators designed to produce a well-rounded profile of the system for this particular area.

Such metrics and indicators will be key to establishing contracts and responsibilities in largely distributed systems under fragmented ownership and governance. The evolution toward an IIoT value network - as opposed to linear value chains - means that a particular station or agent in the IIoT value network will have responsibilities to several others thus getting closer to operating in a service mode for various consuming parties. For example, asset tracking in a manufacturing plant will not just deliver tracking data to the production manager, but will become a service used by other business units or departments, such as shipping/receiving, equipment maintenance or even the quality assurance department.

It is clearly of importance that a common set of metrics be used across IIoT systems – or at least a common way to define metrics (including common templates, terminology and models). Customers and users will expect to find similar well-established definitions across SLAs. Experts and regulators will want stable and well-understood definitions of system characteristics such as security, privacy or safety. Tools vendors and system administrators will want to implement similar monitoring indicators and technologies across IIoT solutions.

It is the role of the IIC BSSL WG to help define (or select) methodologies about such metrics to include what are typical metrics that make sense for a wide array of IIoT systems, what is a common representation for them, how to use them as system requirements, in SLAs, and how to implement their monitoring.

CONCLUSIONS AND OUTLOOK

Outputs of the he Industrial Internet Consortium's BSSL WG provide executives, IIoT managers, project managers and solution architects with many benefits, including:

- CxOs and senior managers are provided with a set of useful tools which help them managing the IIoT value chain transformation.
- Project managers are provided with a set of structured best practices which help them reduce IIoT project risks and Time to Market.
- IIoT Solution Architects are provided with a set of technical references which help reduce technical risks and increase re-use and standardization which helps in reducing heterogeneity and complexity.

*This article is based on an original article co-authored by Dirk Slama (**Bosch Software Innovations**), Jacques Durand (**Fujitsu**) and Jim Morrish (**Machina Research**). Dirk, Jacques and Jim are the co-chairs of the Industrial Internet Consortium's Business Strategy & Solution Lifecycle Working Group.*

Company Summary

AT&T helps people mobilise their worlds - with advanced mobile services, next-generation TV and high-speed Internet services, and smart solutions for businesses. For more than a century, it has consistently provided innovative, reliable, high-quality products and services. AT&T has the best worldwide coverage of any U.S. carrier, with data roaming in more than 200 countries and territories. AT&T serves nearly all of the Fortune 1000, as well as neighborhood businesses all around the US. We offer solutions like highly secure mobile cloud and corporate network management that helps businesses in every industry serve their customers better.

Company Credentials

AT&T connects cars, machines, wearable devices and more. It is working with top automakers and technology companies to make customers' lives easier - so they can use their car to order a pizza on the way home, and then use a connected watch later that night to track how many extra steps they'll need to take at the gym the next day. AT&T is constantly innovating to find new connections in the Internet of Things. AT&T provides carrier-grade IoT Managed Services for storage and next generation Rapid Application Development for new IoT Solutions.

AT&T has spent the past several years pushing into the connected-car market, with deals with General Motors, Nissan, Audi, Tesla, BMW, Subaru, Ford Motor Co. and Volvo.

Elsewhere in the transport and telematics space, AT&T has connected over 1.9 million commercial vehicles, 900,000 usage-based insurance users, and 280,000 refrigerated containers. It is in the process of re-launching a unique global AirCargo Tracking solution.

Key Differentiators

AT&T monitors virtually everything, everywhere. It enables asset monitoring solutions across all major verticals including Energy, Transportation and Logistics, Healthcare, Aviation, Automotive, Construction, and Retail. It has more than 25 million devices deployed across the key IoT markets, including meter reading, fleet, transportation, air cargo, healthcare, automotive, construction, digital signage and retail. Its Global SIM enables connectivity in 200+ countries and territories.

AT&T's customisable and scalable solution stack is designed to meet the unique needs of an enterprise, so customers can quickly implement IoT solutions and get to the bottom line faster, with increased efficiency, productivity, and visibility. Capabilities include pre-certified devices, global connectivity with a single SIM, a single online management platform, application development tools, pre-packaged vertical solutions, and a professional services team to help every step of the way. Also, the the company's various IoT Foundries, support IoT rapid prototyping and innovation.

To make sure AT&T's customer's needs are met, it has developed strong partnerships across industrial companies, technology enablers, and IoT service providers. Customers benefit from the expertise and successes of the partner ecosystem working together to innovate the Internet of Things. AT&T is a founding member of the Industrial Internet Consortium and has partnered with top industrial manufacturers, service providers, and technology enablers to accelerate IoT development, including GE, IBM and Rockwell Automation.

Competitive Pressures

In addition to its success in telematics, transport and automotive, AT&T's Digital Life home-automation and -security business, which is only two years old, was the No. 1 security company in terms of net subscriber additions in the US last year. Its emphasis and differentiation is completely different from other carriers who have stayed more in the traditional sense of focusing on adding smartphones instead of venturing into what is the next era. Specific to the transportation space, AT&T tries to differentiate itself by making it easier for Transportation companies to create their own solutions. It works together with customers on new IoT Managed Services. This means it is easier for customers to develop solutions on their own via the AT&T Flow Designer and store and access the data using the M2X Data Service.