

PURPOSE AND AUDIENCE

This document provides an overview of the scope, mission, and status of the engineering work of the Industrial Internet Consortium (IIC). There are four audiences for this document:

- Members:** What is happening in the engineering-related IIC Working Groups to date.
- Prospective Members:** What the IIC engineering activities are, and where members can engage.
- Standards Groups:** What is being specified, and what the potential collaboration points are.
- Analysts & Media:** An overview of IIC activities and progress towards goals.

EXECUTIVE SUMMARY

What is the Industrial Internet?

The Industrial Internet applies “internet thinking” to industrial settings, covering the non-consumer side of the internet of things. It connects smart machines and devices and people at work, leading to better decision making through advanced analytics that result in transformational business outcomes.

What is the Industrial Internet Consortium?

The Industrial Internet Consortium brings together the organizations that will accelerate growth of the Industrial Internet by identifying, assembling and promoting best practices in ecosystems comprising industry, academia and governments. To achieve this objective, work is coordinated by *IIC Working Groups*, which can be added or refined based on the direction of the membership and approval by the IIC Steering Committee.

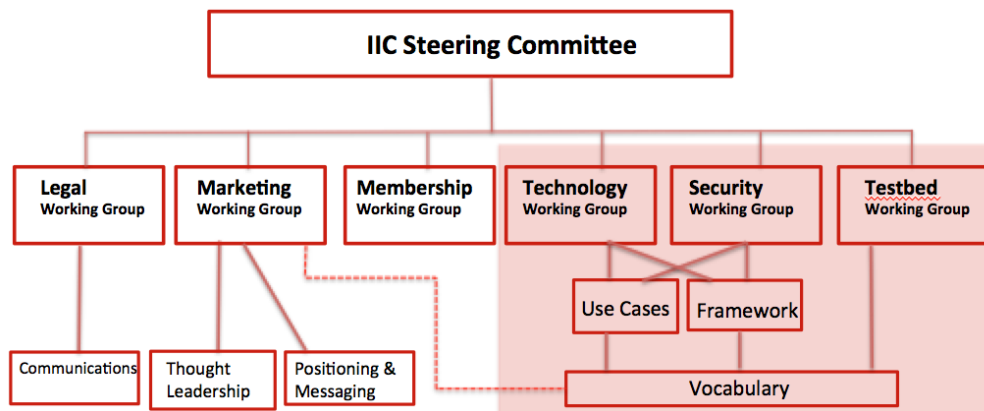


Figure 1 Engineering Working Groups and Teams discussed below

Each of the Working Groups can charter one or more *Teams* that build specific IIC deliverables. The current Working Groups and Teams are represented in Figure 1. As of July 2014, there are 18 Working Groups & Teams. This document focuses on the work of the Technology, Security and Testbed Working Groups and Teams that have made progress we can report.

Technology

The Technology Working Group focuses on *coordination* of the technical work. It has an approved Charter and ten deliverables that it will create over time. It has created teams to work on three of these deliverables:

- Use cases
- Framework for the construction of reference architectures
- Vocabulary

Other deliverables include: Identification of elements that make up the Industrial Internet architecture; Definitions of multi-view reference architecture(s); Identification of extant Industrial Internet technologies that can be integrated into such an architecture; Evaluation of the identified technologies; Proposals to standards organizations to fill in the technology gaps; Review of testbed requirements to validate the architecture(s); and Recommendation of adoptions to the IIC Steering Committee.

Use Cases

The Use Cases team is identifying architectural requirements and gaps to be filled in Industrial Internet applications and scenarios. Members identify and propose specific use cases based on their specific knowledge and needs. Sample IIC use cases are shown below:

| Use Case | Title | Overview |
|----------|--|---|
| UC002 | Identity and Credential Lifecycle | Address the lifecycle identity (issuance, renewal, and deactivation) of machines, users, groups, events, and data that comprise the industrial internet |
| UC003 | Distributed Autonomy in the Power Grid | Address the distributed control and rebalancing of the power grid resulting in optimum generation and distribution of poer |
| UC004 | Security | A set of use cases describing specific aspects of Industrial Internet Security ranging from policy management to detection |
| UC005 | Web Application Developer | Improve the support for application developers to develop web applications that are built upon and use internet of thing devices and protocols. |
| UC006 | Component Pedigree and Chain of Title | Address the Vulnerabilities of our semiconductor supply chain to counterfeiting represent a threat to the health, safety, and security of people around the world |
| UC007 | Device Management | Use Cases specifying how devices connect, collaborate, and organize themselves to achieve specific specified outcomes |
| UC008 | Data Management | Collecting, aggregating, and sharing operational data for industrial machinery |

Figure 2 Sample IIC Use Cases

This stage of use case development will be considered “complete” when the IIC has a sufficient range of use cases to specify the architectural requirements for the Industrial Internet, confidently and reliably.

To do that, the IIC is mapping some use cases to an architectural framework. (See the next section.)

Because architectural requirements will be driven by these use cases, the IIC is actively soliciting use cases from its entire membership in order to capture architectural requirements that work in vertical markets or with specific features of a platform. The use cases also have an important role in testbeds, which is covered later in this document.

Framework

The Framework Team is building a framework for expressing the reference architecture(s). The framework must be easy-to-use and lightweight. It is a precursor to the construction of the reference architecture(s), not an end in itself.

The framework must specifically support the Industrial Internet and enable the construction of an open architecture on which to build ecosystems for innovative products.

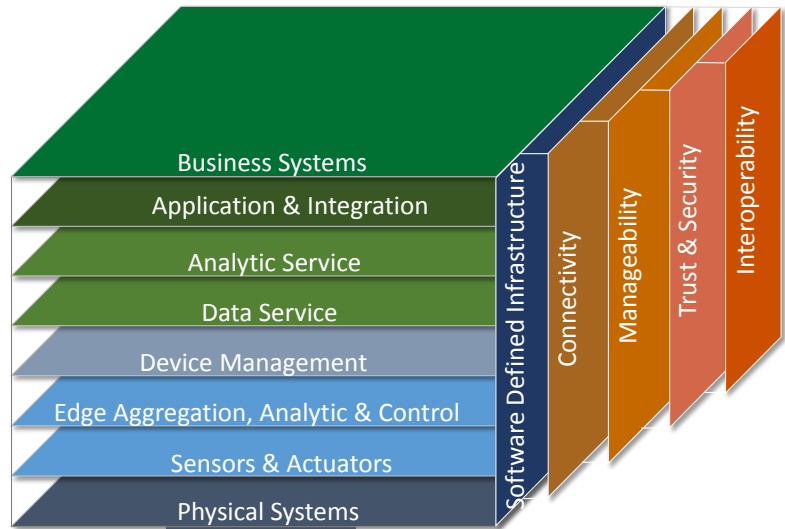


Figure 3 IIC Architectural Framework

Collectively, the IIC Founding companies (AT&T, Cisco, GE, IBM & Intel) operate in all these areas and formed the IIC to ensure complete coverage of the stack comprising the Industrial Internet.

The Framework Team is also working to ensure that this framework is not arbitrarily inconsistent with other frameworks. As such, the diagram above represents a preliminary framework that may evolve over time.

| Layer | Definition |
|--------------------------------------|---|
| Physical Systems | The actual physical hardware, including EPROMs and other chips that are necessary to represent, or sense, the environment. Physical systems are often “below” a <i>Hardware Abstraction Layer</i> which contains software interfaces to the hardware. |
| Sensors and Actuators | Environment sensors often abstracted by software components that manage the interface from the physical sensor to the overall controlled software system. |
| Device Management | A set of services ranging from in-factory provisioning and assignment of X.509 certificates to Device de-provisioning, deactivation, and un-deployment. |
| Data Management | This layer is responsible for ingesting data from sensors, devices and Gateways. Specific functions range from cleansing, filtering and checksum to semantic transformation |
| Analytic Service | Provides a set of data aggregation and analytic across a domain of edge devices; logs information for Big Data analysis. |
| Application & Integration | Provides control and orchestration of a domain of devices and their software proxies. |
| Business Systems | Sets of services that permit connections-to / incorporations-of framework services into business systems |

Figure 4 IIC Framework definitions

Vocabulary

As with any complex and multi-faceted endeavor involving multiple organizations, multiple backgrounds, and multiple points of view, the potential for ambiguity and misunderstanding is high. Every IIC Working Group and Team requires a common and reusable vocabulary of terms. This vocabulary includes standardized definition of terms—preferably from accepted sources such as IEEE, the OMG, or NSF, as well as usage of the term as it applies to specific IIC outputs.

There are four roles in vocabulary development:

- 1) The *Document Teams* (i.e. all teams that produce output) author documents and identify new terms, then rationalize specific terms to those in the dictionary;
- 2) The *Vocabulary Team* manages the review and incorporation of terms into the glossary. This Team also scrapes existing sources for defined terms in order to reduce unnecessary duplication and difference.
- 3) *Tools* that automate the review of documents for the purpose of identification of new terms and synonyms/antonyms of existing terms.
- 4) *Other IIC Teams* that must review and use terms added to the glossary as a result of the work performed by a specific Document Team.

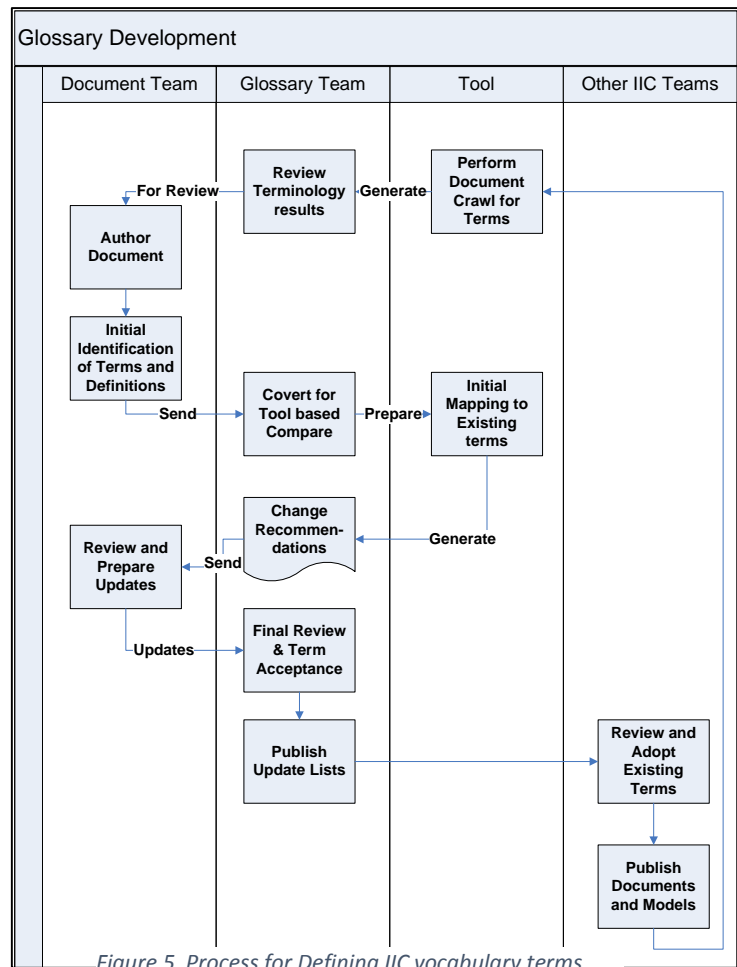


Figure 5 Process for Defining IIC vocabulary terms

The goal is to create a set of documents that use consistent terminology throughout.

The Use Case, Framework and Vocabulary teams described above constitute the first steps of the IIC Technology Working Group. Further teams have recently been established, and we shall report on their progress as those steps are taken.

Security

The Security Working Group is focusing on systematically designing and incorporating security into the reference architecture(s) of the Industrial Internet from the start, as opposed to adding it as an afterthought. The team's first steps were to identify their deliverables, which included a set of use cases and a framework that could be applied to security. They also realized that their vocabulary had to be consistent with the work of the other teams. Consequently, the members of the Security Working Group are working with the Technology Teams on activities that were described in the sections above. They also meet separately to provide a "second pair of eyes" to IIC activities through a specific security lens.

The Security Working Group has divided into small, rapid teams to examine a general use case from three security-related points of view. They include (so far):

Endpoint Security: A set of use cases designed to describe endpoint security, policy management, orchestration, and overall access control.

| (a) Endpoint Security | |
|------------------------------|-----------------------------------|
| UC004a1 | Endpoint identity |
| UC004a2 | Policy Management |
| UC004a3 | Provisioning and Event Management |
| ... | |

Secure Communications: A set of use cases designed to describe secure communications between endpoints.

| (b) Secure Communication | |
|---------------------------------|---|
| UC004b1 | Endpoint Communication |
| UC004b2 | Mutual Authentication between Endpoints |
| UC004b3 | Communication Authorization |
| ... | |

Security Management and Monitoring: A set of use cases designed to describe secure provisioning and technical health and status of endpoints.

| (c) Security Management and Monitoring | |
|---|--------------------------------|
| UC004c1 | Identity Management |
| UC004c2 | Provisioning and Commissioning |
| UC004c3 | Policy Management |
| ... | |

This list is being expanded to include topics such as data management to cover as much as possible in the evolving architecture. As that architecture takes shape, the IIC will apply these security-focused use cases to the architecture so that these issues are considered.

Testbeds

Testbeds are a primary focus area for the Industrial Internet Consortium. It is here that the innovation and opportunities of the Industrial Internet—new technologies, new applications, new products, new services, new processes—are initiated, thought through and rigorously tested to ascertain their usefulness and viability before coming to market.

A testbed is a controlled experimentation platform that:

1. Implements specific use cases and scenarios.
2. Produces testable outcomes to confirm that an implementation conforms to expected results.
3. Explores interoperability of untested or existing technologies working together in new ways.
4. Generates new (and potentially disruptive) products and services.
5. Generates requirements and priorities for standards organizations supporting the Industrial Internet.

Testbeds may be simulations or models, and they can be controlled from remote locations or onsite.

The IIC divides testbed proposals into plugfest, short-, medium-, and long-term projects. Long- and medium-term testbeds are 24 to 60 months in duration. These longer-term initiatives are characterized by innovation that creates new markets and has an impact on the broader economy and society. They are often funded by institutions (governments, agencies, academia) in collaboration with industry.

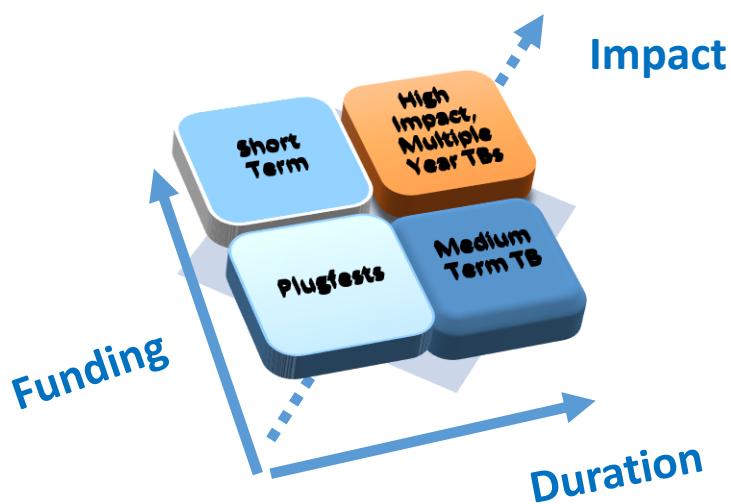


Figure 6 Categories of IIC Testbeds

Short-term and plugfest testbeds are of shorter duration (12 ~ 24 months) and focus on “go to market” product delivery. More than routine product testing, these IIC testbeds must demonstrate interoperability within an ecosystem (more than one company or proprietary technologies) and within the IIC roadmap. These testbeds are opportunities to open up new markets and to identify new applications during the development of multi-year testbeds

Because of the focus on new products and markets, these testbeds will often be funded by industry, and the funding organizations and testbed participants may choose to retain some or all of the intellectual property.

Testbeds are also driven by use cases in the sense that use cases specify desired business outcomes. IIC testbeds evaluate and test the functionality in the use cases. Consequently, as IIC testbeds are approved, new use cases are immediately solicited and identified to exercise the specific functionality that must be validated in the testbeds.

The IIC’s priorities and activities for testbeds will continue to evolve. What will not change is its commitment to create and develop testbeds that support the goals of innovation and interoperability.

Conclusion

Four months into its mission, the IIC has established the structure for growth and begun work on several fronts.

Activities have included:

- Added 60+ member companies in addition to the Founders (AT&T, Cisco, GE, IBM, Intel)
- Established six Working Groups (18 teams total) with charters, work-session schedules, and deliverables
- Conducted two full-membership technical meetings
- Initiated the elections for available IIC Steering Committee seats

The market response to the Industrial Internet Consortium is clear: With 65+ members four months into its existence, the Industrial Internet Consortium has become a significant force in the quest to systematically build the infrastructure for the Industrial Internet.

For more information on the Industrial Internet Consortium, please visit www.iiconsortium.org or contact info@iiconsortium.org.

Industrial Internet Consortium membership as of July 29, 2014

