



## The Emerging IIC Verticals Taxonomy Landscape

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## 1. INTRODUCTION

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Many of the ideas, concepts, models and technologies concerning the Industrial Internet are widely applicable across industrial sectors. The Industrial Internet, as described by the Industrial Internet Consortium's (IIC's) Industrial Internet Reference Architecture is "an internet of things, machines, computers and people, enabling intelligent industrial operations using advanced data analytics for transformational business outcomes. It embodies the convergence of the global industrial ecosystem, advanced computing and manufacturing, pervasive sensing and ubiquitous network connectivity." However, when being applied, these "things" may need to be adopted, extended or specialized for a specific industrial sector based on its detailed requirements. As such, we need a "Rosetta Stone"-like set of terms to be used universally to identify, describe and refer to these industrial sectors.

## 2. ESTABLISHING A VERTICALS TAXONOMY LANDSCAPE

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Establishing and maintaining a stable list of industry sectors and sub-sectors, hereafter referred to as *verticals*, will help coordinate the IIC's work and discussions with its partner communities and industries. Using many sources, the IIC Use Case Task Group has developed and adopted a baseline for the envisioned scope and breadth of vertical business areas of particular interest for Industrial Internet of Things (IIoT). This active document is referred to as the Verticals Taxonomy Landscape.

One priority in the Verticals Taxonomy Landscape is to make extensive use of external industrial classifications, which are current perspectives on IIoT business context. Adapting outside classifications to the IIC context, this "Rosetta-Stone"-like verticals taxonomy enables consistency in work products and facilitates the discussions with those working on them. It helps the IIC provide consistent messaging about our activities to outside audiences, and provides them with harmonious and stable descriptions, so they and their members can map their own communities of practice work to the work of the IIC.

## 3. DETERMINING AN INDUSTRIAL INTERNET SYSTEM

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We determine whether a system is an Industrial Internet system by examining *Use Case* requirements on key system characteristics, as shown in Figure 1. A *Use Case* is a list of actions or event steps, typically defining the interactions between a role (known in the Unified Modeling Language as an actor) and a system, to achieve a goal. The actor can be a human or other external system.

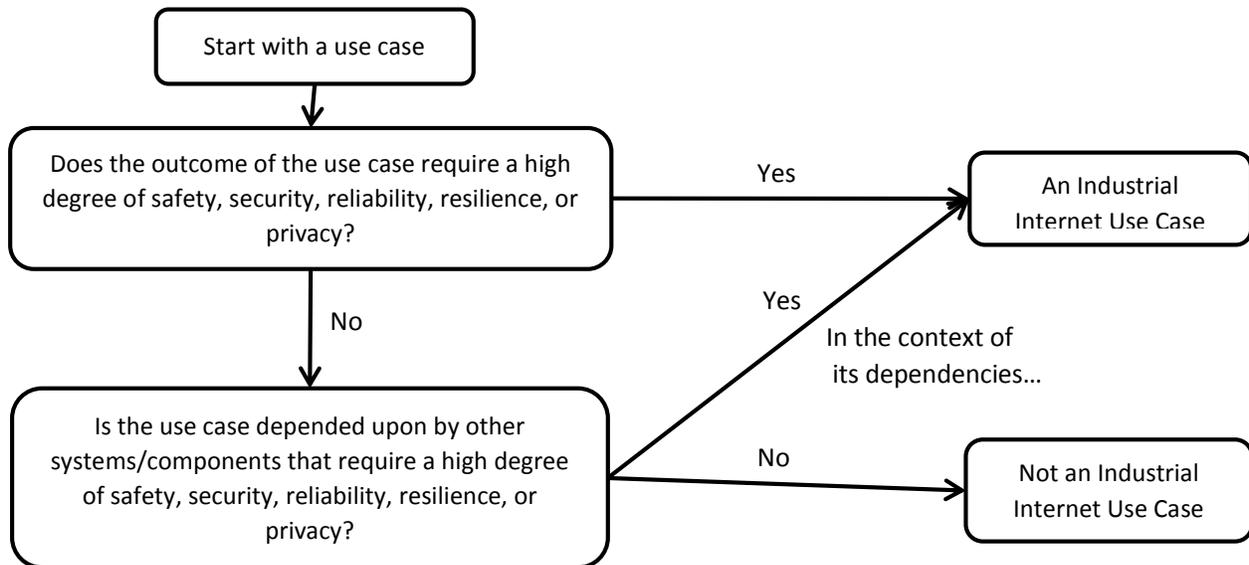


Figure 1 shows a decision process that illustrates the prevailing IIC Technical Perspective regarding the classification of a use case as an "Industrial Internet Use Case".

With a database of existing use cases catalogued by their level of required key system characteristics, each prospective use case can be evaluated in comparison with the known profiles of Industrial Internet systems.

Figure 2 illustrates key system characteristics of a known IIoT Use Case, along with the level of key system characteristics for the prospect<sup>1</sup>. The IIRA highlights the characteristics that are particularly important for IIoT systems: Safety, Security, Reliability, Resiliency and Privacy, but there are others that may be important for any particular IIoT System. Simply put, if a use case requires some mixture of safety, security, reliability, resiliency and privacy, then it's likely an Industrial Internet use case.

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<sup>1</sup> The chart is merely an illustration of a particular methodology, not meant to be taken literally.

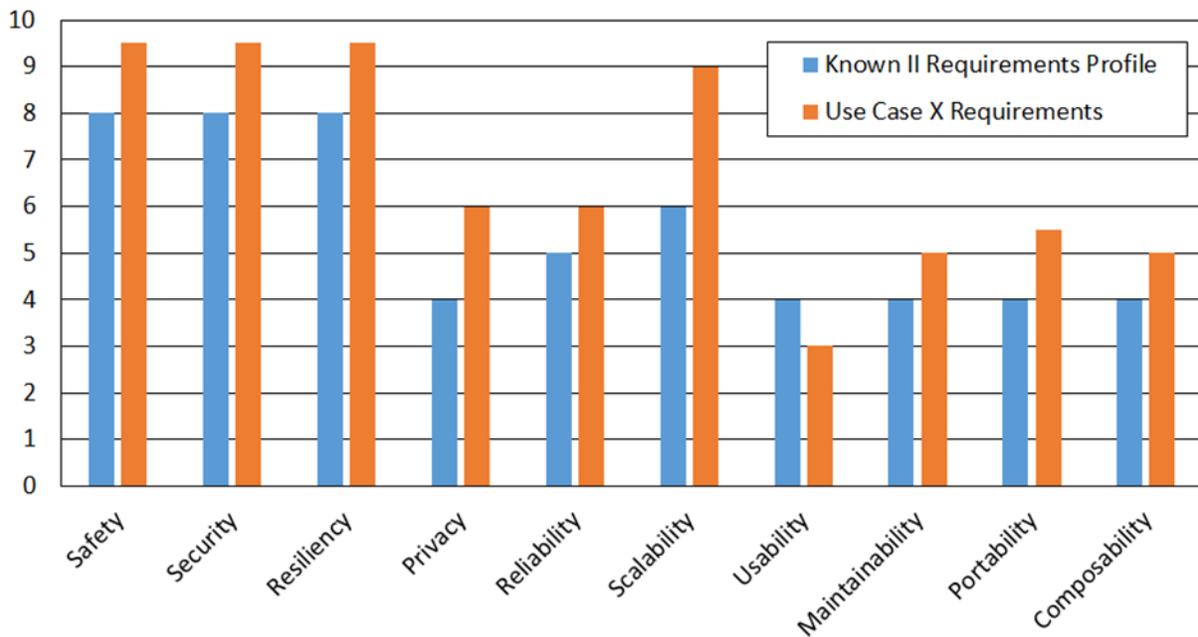


Figure 2 illustrates one method for evaluating whether a use case or system is “Industrial Internet”

As IIC members share use cases, testbeds and anecdotes, a well-defined Verticals Taxonomy Landscape will help IIC members and other organizations within vertical industries to define requirements, identify opportunities, avoid duplicating efforts and efficiently contribute to the work of the IIC.

## 4. THE EVOLUTION OF THE VERTICALS TAXONOMY LANDSCAPE

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The IIC Verticals Taxonomy Landscape is a two-layer industry classification comprising *sectors* and *verticals*. A sector is a logical grouping of verticals. Existing regulations, standards, funding and even companies are organized by sector and vertical, and that business context is necessary for IIC technical work and in communicating about that work to others.

The Industrial Internet Classification is a way to show how Industrial Internet requirements are similar between economic environments and the ways they differ. The purpose of the industrial classification is to:

- produce a set of common definitions of sectors and verticals by explicitly describing the rules for grouping, where that’s necessary (e.g. a crude oil pipeline is part of the Transportation sector because it deals with transporting crude oil),
- enable gap analysis by indexing Industrial Internet use cases, testbeds and anecdotes used in technical reports. (e.g. “the IIC is currently lacking enough agricultural use cases”) and

# The Emerging IIC Verticals Taxonomy Landscape

- reconcile member perspectives with external classifications, such as regulators, academic analysis efforts and especially those relied upon by funding organizations, such as grant funding, PE funding and venture funding.

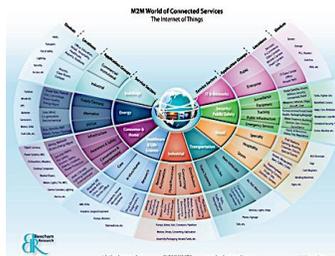
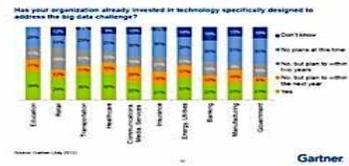
The verticals taxonomy is principally derived from nine industrial classifications of private and public sources<sup>2</sup> (see Figure 3) that were reviewed and leveraged as sources.



## IIC Use Cases

- Smart Agriculture
- Smart Farm
- Smart Cities
- Smart Factory
- Smart Financing
- Smart Health Care
- Smart Energy
- Smart Logistics
- Smart Transportation
- Smart Entertainment
- Smart Building
- Smart Home
- Smart Retail
- Smart ProServices
- Smart Water
- Smart Education
- Smart Military
- Smart Government

## Big Data Investments by Industry



## International M2M Council

<b>HEALTHCARE</b> <ul style="list-style-type: none"> <li>Care Provider</li> <li>Medical Device Manufacturer</li> <li>Health Insurance</li> </ul>	<b>LOGISTICS</b> <ul style="list-style-type: none"> <li>Asset Tracking Services</li> <li>Shipping</li> </ul>
<b>ENERGY UTILITIES</b> <ul style="list-style-type: none"> <li>Electricity, Water, Waste</li> <li>Automation</li> <li>Water Manufacturer</li> <li>Power/Energy Management</li> </ul>	<b>PUBLIC INFRASTRUCTURE</b> <ul style="list-style-type: none"> <li>Traffic Control</li> <li>Facilities Management</li> <li>Emergency Services</li> <li>Security/Defense</li> </ul>
<b>BUILDING CONSTRUCTION</b> <ul style="list-style-type: none"> <li>Energy Management</li> <li>Security</li> </ul>	<b>TRANSPORTATION</b> <ul style="list-style-type: none"> <li>Autonomous/Intelligent Transportation</li> <li>Fleet Management</li> <li>Transportation Insurance</li> <li>Mass Transportation</li> </ul>
<b>RETAIL/COMMERCE</b> <ul style="list-style-type: none"> <li>Apparel/Electronics/Books</li> <li>Personal Device Manufacturer</li> <li>Shopping</li> <li>Marketing</li> </ul>	<b>RESEARCH</b> <ul style="list-style-type: none"> <li>Manufacturing/Production</li> <li>Laboratory/Pharma</li> <li>Agribusiness/Farming</li> </ul>

<http://www.im2mc.org/imcmarts>

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- Smart Buildings
- Smart Grid
- Security and Surveillance
- Healthcare
- Entertainment
- Agriculture
- Industrial Automation
- Smart City



<http://www.slideshare.net/CiscoPublicSector/cisco-iiot-for-hawaii-tech-day>

## Enterprise View of the Internet of Things

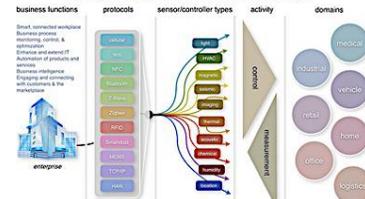


Figure 3: Nine sources taken into account to create the IIC Verticals Taxonomy Landscape. [References 1-9]

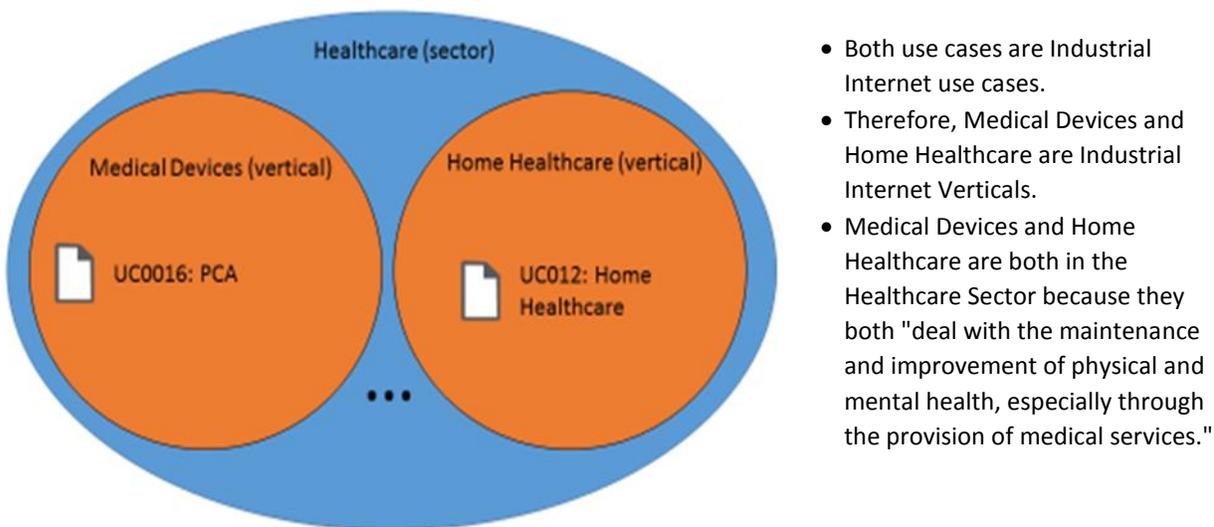
The Verticals Taxonomy needs to support different applications. For example, a nuclear reactor supplier might find that the strict safety processes developed to manufacture reactors allows them to also build nuclear warheads. For this supplier, it may make sense to have a taxonomy where missiles and nuclear reactors are grouped together, but the overall IIC would like to classify them separately (e.g. a reactor is in the energy sector and missiles are in the defense sector).

<sup>2</sup> List sources: Beecham, ICS, et. al. References 1-9.

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This classification also helps identify verticals markets that can be used to organize and discuss technical requirements. A vertical is a market in which vendors offer goods and services that meet a particular set of usage, technical or regulatory requirements.



*Figure 4: The organization scheme of the Verticals Taxonomy Landscape in regards to its application to two existing IIC use cases.*

Figure 4 (above) shows the organization scheme of the Verticals Taxonomy Landscape in regards to its application to two existing IIC use cases.

Theoretically, use cases within a vertical will share requirements, but that is not always the case. For example, the healthcare sector has many verticals such as medical devices (see: IIC UC0016) and home healthcare monitoring (see: UC012). As another example, the IIC Safety Task Group may choose 4-5 "safety critical verticals" that will sufficiently cover the safety requirements that might arise in the Industrial Internet. Table 1 below, is an initial set of the Verticals for the identified Sectors.

## 4.1 Verticals Taxonomy Landscape

Sector	Verticals
<i>academia &amp; research</i>	<i>higher education, research</i>
<i>agriculture</i>	<i>farming, ranching, fishing, weather</i>
<i>building</i>	<i>building/construction, smart home, office, building security, building maintenance</i>
<i>business services</i>	<i>Business consulting, business process management, marketing services, product lifecycle management, engineering product development and testing, media</i>
<i>consumer &amp; home</i>	<i>consumer products, home products, cooking (commercial), entertainment, phone &amp; network services, sporting events, travel, tourism</i>
<i>defense/aerospace</i>	<i>defense, military, aerospace</i>
<i>energy</i>	<i>energy, utilities, mining, oil and gas, smart grid</i>
<i>finance &amp; banking</i>	<i>banking, commerce, financing</i>
<i>healthcare</i>	<i>connected medical devices, hospitals, medical offices, pharmacies, medical therapy, home healthcare, disease diagnosis, continuous patient monitoring, clinical trials, assisted care, dentistry</i>
<i>IT &amp; networks</i>	<i>communications, media, services, software, computers, networks, asset management, security, development tools, testing tools</i>
<i>manufacturing</i>	<i>factory, industrial automation, smart products</i>
<i>public sector</i>	<i>education, environment, water, transportation, waste management, civil administration</i>
<i>public security &amp; public safety</i>	<i>public safety, public security, surveillance, disaster prevention. Law enforcement/police, fire, emergency and crisis response, and military.</i>
<i>retail</i>	<i>big-box, online, brick and mortar, hospitality, food &amp; beverage distribution</i>
<i>transportation</i>	<i>mobility, transportation, public transportation, vehicle, traffic infrastructure, logistics, freight management, pipelines, shipping, aeronautics</i>

Table 1: Verticals Taxonomy Landscape Sectors and Example Verticals

## The Emerging IIC Verticals Taxonomy Landscape

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In Table 2, below is an initial mapping of the IIC Use Cases and Testbeds to the verticals taxonomy landscape.

<b>Sector</b>	<b>Use Cases</b>	<b>Testbeds</b>
<i>academia &amp; research</i>		
<i>agriculture</i>		Smart Water Management
<i>building</i>		Asset Efficiency, Smart Water Management
<i>business services</i>		
<i>consumer &amp; home</i>		Connected Care
<i>defense/aerospace</i>		
<i>energy</i>	UC008 (Data Management), UC014 (Power Grid), UC022 (Wind Energy)	Communication and Control Framework for Microgrid Applications, Industrial Digital Thread
<i>finance &amp; banking</i>		
<i>healthcare</i>	UC012 (Healthcare), UC016 (Patient Controlled Analgesic)	Security Claims Evaluation, Connected Care
<i>IT &amp; networks</i>	UC006 (Asset Management), UC002 (IT Security)	High Speed Network, Software Defined Cloud INFINITE, Edge Intelligence
<i>manufacturing</i>	UC001 (Factory), UC006 (Manufacturing),	Track and Trace, Predictive Maintenance, TSN for Flexible Manufacturing, Asset Efficiency, Factory Operations visibility and Intelligence, Security Claims Evaluation, Industrial Digital Thread
<i>public sector</i>		Smart Water Management
<i>public security &amp; public safety</i>	UC013 (Emergency response)	
<i>retail</i>		
<i>transportation</i>	UC010 (Logistics)	Transportation Grand Challenge: Research Collaboration & Business Collaboration, Asset Efficiency, Industrial Digital Thread

Table 2: Verticals Taxonomy Landscape in the context of existing IIC Work Products

## 5. MOVING FORWARD WITH A COMPETITIVE ADVANTAGE

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Every ecosystem is defined by a taxonomy. If you do not have a common set of terms, it is hard to have a meaningful conversation or move projects forward without unacceptable miscommunication and rework as lack of clarity interferes with accuracy and succinctness. As the Industrial Internet Consortium ecosystem continues to grow in size and prominence, a common language and context for referring to the various contexts of that work is integral to understanding shared objectives. Therefore, the Verticals Taxonomy Landscape becomes an integral part of the IIC as a whole, reaching into other work in process almost unnoticed, but especially critical to future use case and testbed success. In today's globally and culturally diverse business environment, a Rosetta-Stone-like Vertical Taxonomy Landscape positions the IIC and its members as global thought leaders and provides a competitive advantage within the industry.

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