In-depth market report sizing the opportunity of the fast growing Industry 4.0 & Smart Manufacturing market from 2018-2023. The 375-page report includes market forecasts across 7 regions, 6 supporting technologies, and 6 connected industry building blocks. The report also details 38 case studies, profiles 350+ leading suppliers, describes 79 trends, and analyzes 12 key use cases.
INDUSTRY 4.0 & SMART MANUFACTURING 2018-2023

Date: November 2018

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1 Executive Summary

The term Industrie 4.0 (I4.0) was introduced by German thought leaders at the 2011 Hannover Fair Exhibition and has since been adopted around the globe as the common term to describe the 4th industrial revolution. While there is no single widely-accepted definition of the I4.0 market, this report defines the overall I4.0 market as the sum of the Connected Industry building blocks market (the manufacturing subset of the Industrial Internet of Things [IIoT]) and the market for other I4.0 supporting technologies.

This report highlights how manufacturers are implementing these Connected Industry building blocks and the six other I4.0 supporting technologies (additive manufacturing, AR/VR, collaborative robotics, connected machine vision, drones/UAVs, and self-driving vehicles) to realize twelve key use cases that are driving the 4th industrial revolution.
1.1 Overall Highlights

- The overall I4.0 market reached $XXB in 20XX, with Connected Industry building blocks comprising XX% of the market ($XXB) and supporting technologies (13B).
- The overall I4.0 market is growing at a CAGR of 37%, led by growth in the Connected Industry building blocks subset (XX% CAGR).
- Advanced digital product engineering will be the largest use case in the market.
- Additive production and augmented operations are expected to be the fastest growing use cases (~XX% CAGR).
- Growth in I4.0 adoption is largely driven by three types of value generated by I4.0 use cases:
  1. Efficiency gains across the whole organization (DanLJ industrial organizations haƚe estimated productiƚ gains in I4.0 technologies to be ΕXX%.
  2. New revenue streams (KD$s are leƚeraging /d.od technologLJ to create neƚ džͲasͲaͲserǀice business models better align OEMs with customers’ objectives by incentiƚng KDs to ŵaŬe sure their ŵachines are operating properlLJ.
  3. More flexible, customer centric operations that XXX: I4.0 technologies enable manufacturers to be more xxxx.

---

1 IoT Analytics Interview: Manufacturing end-users believe this number is possible and set it as goal.
2 Introduction

Industry 4.0\(^2\) (I4.0) and the Industrial Internet of Things (IIoT) are both terms describing disruptive technology trends in industrial settings. The terms are sometimes used interchangeably; however, in order to fully comprehend the content of this report, it is important to understand the differences between Industry 4.0 and IIoT.

IIoT is the industrial subset of the Internet of Things (IoT). At a high level, IoT is about adopting the internet in almost all economic activities, and it focuses on the technology backend for cross category connectivity and interoperability. The emergence and swift development of the IoT is driven by the six major technological developments shown in Exhibit 1:

1. Increased adoption of mobile devices
2. Declining costs for hardware such as sensors\(^3\)
3. Declining costs of bandwidth
4. Declining costs of data handling, such as processing ($/MIPS\(^4\)) and data storage ($/GB)
5. Decreased size of hardware elements
6. Increased maturity of big data tools and infrastructure

\(^2\) From now on used synonymously with Industry 4.0
\(^3\) Through the economies of scale potential from e.g. smartphone production and operation.
\(^4\) Million Instructions Per Second
EXHIBIT 1: Technology drivers behind the Internet of Things

The Industrial IoT (IIoT) refers to heavy industries such as manufacturing, energy, oil and gas, and agriculture in which industrial assets are connected to the internet. Within IoT, different segments are more “industrial” than others, and “Connected Industry”, which specifically focuses on manufacturing, is on the most industrial end of the spectrum as shown in Exhibit 2.
Connected Industry is also the largest segment within IoT, comprising over 30% of the market in 2017. Connected Industry overlaps with the overall I4.0 market, but I4.0 has a broader scope; it aims to optimize the entire manufacturing value chain and includes other I4.0 supporting technologies. Exhibit 3 illustrates the overlap of I4.0 with IoT and highlights the other I4.0 supporting technologies.

**EXHIBIT 3:** Comparison of IoT and Industry 4.0 in terms of industry and technology scope (adapted from Plattform Industrie 4.0)

**Industry 4.0** market can be viewed as the combination of the building blocks that make-up the **Connected Industry** market plus the market for other **I4.0 supporting technologies**:
3 Industry 4.0 Market Analysis 2018-2023

Chapter Overview

This section quantifies the overall I4.0 market size as well as the market sizes for the two subsets of the overall I4.0 market:

1. Connected Industry Building Blocks
2. Supporting Technologies

Section Overview

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Chapter Takeaways

1. The overall industry 4.0 market reached $XXB in 20XX and is expected to reach $XXX by 20XX, resulting in a CAGR of XX%. Connected Industry building blocks made up XX% ($SX) and supporting technologies made up XX% ($XXXX).

2. The Connected Industry building blocks market reached $XXB in 20XX and is expected to grow to $XXX in 20XX, with applications ($XX) followed by hardware ($XX).

3. The supporting technologies market reached $XXB in 20XX and is expected to grow to $XXX by 20XX, with the biggest supporting technologies ($XX) followed by connected manufacturing ($XX).

4. Growth is driven by 3 types of value derived from use cases:
   1. Efficiency
   2. New revenue streams
   3. Improved, customer-centric operations that reduce time-to-market.
3.1 Overall I4.0 Market

The global market for Industry 4.0 solutions reached $48B in 2017 and is expected to grow at a CAGR of XX% to $XX in 20XX. The Connected Industry building blocks subset of the market is expected to grow from $XXX in 20XX to $XXX in 2023 with a CAGR of 40% (due to the relative maturity of the technologies that make up this subset). The growth of the market for the supporting technologies subset is projected to grow from $XX in 2017 to $53B in 2023 with a more modest CAGR of 26% due to the relative maturity of the technologies that make up this subset.

The growth of the I4.0 market is largely driven by three types of value delivered from the I4.0 use cases:

1. Efficiency gains across the whole organization
   - Danilo Technologies has estimated productivity gains of 5% due to investments in I4.0 technologies.
   - Example: FANUC + Cisco

   Danilo is an IoT manufacturer and is believed to have set the same productivity goal.

   Source: Cisco

Note: The overall market for I4.0 refers to global spending on the six connected industry building blocks and six I4.0 supporting technologies.

Source: IoT Analytics – October 2018

EXHIBIT 10: Global I4.0 market 2017-2023 (Source: IoT Analytics)
4 Connected Industry Building Blocks

Chapter Overview
This chapter explores the six connected industry building blocks that comprise the modern IIoT technology stack:

1. Hardware
2. Connectivity
3. Cloud, Platform, & Analytics
4. Applications
5. System Integration
6. Cyber Security

Section Overview

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Chapter Takeaways

1. XXXXX. T
2. Companies are XXXXXXXXXX. IoT platforms hosted solely on-premise are declining. The market share of IoT platforms hosted solely on-premise is projected to drop from 3% in 2017 to 3% in 2018. IoT platform vendors are increasingly including analytics tools (e.g. Microstrategy, Microstrategy, etc.) which allows customers to track performance easily at scale.
3. IoT platforms are increasingly adding platform-specific edge computing agents. Platform-specific edge computing agents are becoming more common. IoT platforms are increasingly adding computing and storage capabilities at the edge (e.g., VxWorks, etc.) which is leading to more hybrid deployments with both edge and cloud architectures in place.
4. AI algorithms still require domain-specific expertise. AI algorithms still require domain-specific expertise. Suppliers of AI technologies hope to eventually develop models that can be easily adapted between companies and use cases; however, that vision has not yet been realized. Models are still very dependent on industry-specific training datasets and input subject matter experts.
5. Low cost/risk POCs gaining in popularity. Low cost/risk POCs are gaining in popularity. Users are reluctant to allocate large budgets to I4.0 projects. For example, systems integration firms like XXXXX, XXXXX, and XXXXX have allocated large budgets to XXXX 14.0 projects. For example, systems integration firms like XXXXX, XXXXX, and XXXXX have allocated large budgets to XXXX 14.0 projects. For example, systems integration firms like XXXXX, XXXXX, and XXXXX have allocated large budgets to XXXX 14.0 projects.
6. LoRa is the 2017 market leader in LPWAN technologies, followed by Sigfox, and NB-IoT.
5 Disruptive Trends

Chapter Overview

I4.0 is commonly thought of as an evolution rather than a revolution, but I4.0 has the potential to disrupt a number of standards and industries in the long run. This chapter shows how the well-defined 5-layered technology architecture is already being disrupted with new connectivity models, and how other industrial processes and industries will also likely see significant changes.

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Chapter Takeaways

1 Major trends:
A. The migration of software applications to the cloud
B. The convergence of SCADA, MES, and ERP systems
C. New devices connecting directly to the cloud

2 New XX FieldEdge cloud adoption. Advances in cellular communication, cyber security, and industrial gateways are making it more technically viable for companies to move their SCADA and MES systems to the cloud.

3 Manufacturers where edge connectivity is advertised online, the emerging manufacturing-as-a-service ecosystems allows connected manufacturers to sell their excess manufacturing capacity online to customers equipped with digital product designs.

4 Machine-as-a-Service business models bring new revenue and accounting challenges. More machines are being sold to manufacturers as services. Investors and KDs are grappling with the revenue and accounting implications of manufacturing customers switching to higher OPEX and lower CAPEX businesses.
6  Supporting Technologies

Chapter Overview
This chapter explores the six I4.0 supporting technologies that are contributing (to varying degrees) to the rapid growth of the overall I4.0 market:
1. Additive Manufacturing
2. Augmented and Virtual Reality
3. Collaborative Robotics
4. Connected Machine Vision
5. Drones/UAVs
6. Self-Driving Vehicles

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Chapter Takeaways

1. **Additive Manufacturing** market. With revenue at $9 billion in 2017 and a projected $17 billion in 2025, additive manufacturing is and will XXXXXX XXXXX companies adopt the technology for more than just prototyping.

2. **Connected Machine Vision**. Higher labor costs and falling robot costs are driving collaborative robot adoption. For example, Zobotics prices will continue to fall even as wages increase in both developed and developing countries.

3. **Collaborative Robotics**. Mobile collaborative robots are gaining in popularity. Companies are designing their collaborative robots to be highly portable, allowing for flexible manufacturing.

4. **Augmented and Virtual Reality**. Machine learning technology is moving closer to the edge with vision systems. Smart cameras from companies like Dassault and PTX XXXXXX are integrating with software to automatically train machine learning algorithms in order to achieve high speed pattern recognition.

5. **Drones/UAVs**. Regulations are constraining the growth of the drones/UAVs market. Beyond visual line of sight (BVLOS) regulations are constraining the growth and number of use cases for drones in certain regions.

6. **Self-Driving Vehicles**. Suppliers of traditional XXXXXX are seeking to provide fixed-path navigation guidance.
7 Key Use Cases

Chapter Overview
This chapter highlights 38 specific examples from a range of industries (10+ different end-user industries) including the automotive, consumer electronics, consumer packaged goods, and OEM industries. The examples are clustered into the 12 most common I4.0 use cases.

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<th>Augmented Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.3.1</td>
<td>Bühler reduces waiting time by 50% using AR</td>
</tr>
<tr>
<td>7.3.2</td>
<td>Hilti uses augmented reality to streamline operations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7.4</th>
<th>Data-driven Asset/Plant Performance Optimization</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.4.1</td>
<td>Audi uses advanced analytics to realize millions in cost savings</td>
</tr>
<tr>
<td>7.4.2</td>
<td>KIANA Systems uses machine vision &amp; analytics to reduce error rate</td>
</tr>
<tr>
<td>7.4.3</td>
<td>WFF Tex improves machine throughput using cloud analytics</td>
</tr>
<tr>
<td>7.4.4</td>
<td>Stanley Black &amp; Decker increases OEE by 24% and first pass quality by 15%</td>
</tr>
<tr>
<td>7.4.5</td>
<td>Maxxly uses autonomous forklifts to increase production capacity</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>7.9</th>
<th>Predictive Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.9.1</td>
<td>HPE uses edge gateways + analytics to prevent wind turbine failures</td>
</tr>
<tr>
<td>7.9.2</td>
<td>Cisco helps automotive OEM save ~$40M in downtime</td>
</tr>
<tr>
<td>7.9.3</td>
<td>Sybre Labs helps O&amp;G operator save hundreds of man-days of work</td>
</tr>
</tbody>
</table>

Chapter Takeaways
1. Out of the 12 digital product engineering use cases, predictive maintenance will be the largest use case with increased customer demand for customized parts. Additionally, additive manufacturing and AR/VR adoption, advanced analytics and edge computing will be the fastest growing use cases from 2018 to 2023, driven by the need for increased operational efficiency and cost savings.

2. The adoption of predictive maintenance and edge computing will drive the fastest growing use cases, as companies seek to reduce costs and improve the reliability of their operations. The combination of additive manufacturing and AR/VR technologies is expected to transform the manufacturing industry, allowing for faster product development and improved quality control.

3. The examples cited in this chapter demonstrate the potential impact of these technologies across a range of industries, from automotive and consumer electronics to consumer packaged goods and OEM industries. These examples serve as a roadmap for companies looking to leverage digital product engineering to drive innovation and productivity gains in their operations.
8 I4.0 Adoption Strategies

Chapter Takeaways

1. XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX are more likely to adopt IoT products and strategies.

2. XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX XXXXXXXXXX are key focuses of smart factory initiatives.

3. XXXXXXXXXX XXXXXX are leading the way in I4.0 readiness due to their offerings and investments in various Connected Industry building blocks and I4.0 supporting technologies.

8.1 OEMs

Section Overview

OEMs across a variety of industries are creating connected products and services to differentiate their offerings and create new service revenue streams.

Subsection Overview

Case Studies

<table>
<thead>
<tr>
<th>#</th>
<th>Company</th>
<th>Industry</th>
<th>Strategy Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Liebherr</td>
<td>Construction equipment</td>
<td>LiDAT fleet management for construction equipment</td>
</tr>
<tr>
<td>2</td>
<td>Rolls-Royce</td>
<td>Aircraft engines</td>
<td>Condition monitoring for aircraft engines</td>
</tr>
<tr>
<td>3</td>
<td>Kärcher</td>
<td>Agriculture machinery</td>
<td>Cleaning machinery fleet management</td>
</tr>
<tr>
<td>4</td>
<td>Heidelberg</td>
<td>Print industry</td>
<td>Connected printing machines</td>
</tr>
<tr>
<td>5</td>
<td>TRUMPF</td>
<td>Manufacturing</td>
<td>Sheet metal &amp; laser cutting tools</td>
</tr>
<tr>
<td>6</td>
<td>Heidelberg</td>
<td>Printing presses</td>
<td>Connected printing machines</td>
</tr>
<tr>
<td>7</td>
<td>Krones</td>
<td>Food &amp; beverage</td>
<td>Bottling and packing machines</td>
</tr>
<tr>
<td>8</td>
<td>Engel</td>
<td>Manufacturing</td>
<td>Injection molding machines</td>
</tr>
<tr>
<td>9</td>
<td>thyssenkrupp</td>
<td>Elevator</td>
<td>Elevator OEM I4.0 adoption strategy</td>
</tr>
<tr>
<td>10</td>
<td>KONE</td>
<td>Elevator</td>
<td>Elevator OEM I4.0 adoption strategy</td>
</tr>
<tr>
<td>11</td>
<td>Otis</td>
<td>Elevator</td>
<td>Elevator OEM I4.0 adoption strategy</td>
</tr>
<tr>
<td>12</td>
<td>Schindler</td>
<td>Elevator</td>
<td>Elevator OEM I4.0 adoption strategy</td>
</tr>
</tbody>
</table>

Section Takeaways

1. Tier 2/component suppliers and industries with moveable equipment, remote/high value assets, or data-driven products are more likely to adopt IoT products and strategies.

2. Construction equipment, elevator, and agricultural machinery OEMs are leading the way in I4.0 adoption, implementing best in class solutions.
9.1 Plattform Industrie 4.0

Plattform Industrie 4.0

www.plattform-i40.de

Founded: 2013

Members: 6000+ via the associations

The Plattform Industrie 4.0 was founded by the three German associations VDMA (Mechanical Engineering Industry Association), ZVEI (regulatory and economic policy authority of the electrical and electronics industry) and BITKOM (Germany’s digital association) and in 2015 extended by stakeholders from politics (Federal Government Ministries of Education & Research, Economics & Technology), research (Fraunhofer Gesellschaft, National Academy for Science and Engineering, German Research Center Artificial Intelligence) and highly innovative companies like

![Partners of Plattform Industrie 4.0]

Our research and interviews with industry experts revealed that RAMI 4.0 is watched with interest, but seems currently too academic and theoretical.

- 1. reference architectures, standards and norms
- 2. research and innovation
- 3. security of networked systems
- 4. legal framework
- 5. training, education and training

In December 2016, a collaboration with the Industrial Internet Consortium (IIC) was announced. Further cooperations have been made with Japan (Oct. 2015) and with China via the Sino-German Symposium (Oct./Nov. 2015). “Competitive” (not developing market solutions), thus providing a safe and neutral layer to discuss and resolve common problems.

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164 Source: Plattform Industrie 4.0 (engl.)
10 Appendix

10.1 Market definition, sizing, and methodology

10.1.1 Industry 4.0 definition:

The term Industrie 4.0 (I4.0) was introduced by German thought leaders at the 2011 Hannover Fair Exhibition and has since been adopted around the globe as the common term to describe the 4th industrial revolution. While there is no single widely-accepted definition of the I4.0 market, this report defines the overall I4.0 market as the sum of the Connected Industry building blocks market (the manufacturing subset of the Industrial Internet of Things [IIoT]) and the market for other I4.0 supporting technologies.

10.1.2 IoT definition:

The Internet of Things (IoT) is defined as a network of Internet-enabled physical objects, which aims at integrating every object for interaction via embedded systems, network communications, backend computing, and applications typically in the cloud. It allows objects to communicate with each other, access information on the Internet, capture store and retrieve data, and interact with users as well as other systems and applications, creating smart connected environments.
10.1.3  IIoT and Connected Industry definition:

Industrial IoT (IIoT) is a subset of the Internet of Things (IoT) which refers to heavy industries such as manufacturing, energy, oil and gas, and agriculture in which industrial assets are connected to the internet. Within IoT, different segments are more “industrial” than others, and “Connected Industry”, which specifically focuses on manufacturing, is on the most industrial end of the spectrum as shown in the exhibit below:

10.1.4  Connected Industry building blocks definition:

The Connected Industry market can be broken down in to six building blocks that together form Connected Industry solutions:

1. **Cyber Security**: security tools, technologies, and methods used throughout all building blocks
2. **Hardware**: the chips, sensors, & gateways used to build and connect smart devices
3. **Connectivity**: the protocols and services required to achieve connect industrial equipment
4. **Cloud, Platform, & Analytics**: hosting environments, IoT platforms, and data analytics & AI
5. **Applications**: software programs that are built on top of IoT platforms
6. **System Integration**: the services associated and with designing, planning, building, and operating I4.0 solutions
The table below describes the sub-elements of each Connected Industry building block:

<table>
<thead>
<tr>
<th>Cloud, Platform, &amp; Analytics</th>
<th>IoT AEP Platforms</th>
<th>AEPs have specific features that offer rule engine &amp; event management, APIs for business apps, integration SDKs for endpoints, integrated development environment and application marketplace.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cloud, Platform, &amp; Analytics</td>
<td>IoT DM Platforms</td>
<td>DM platforms support device monitoring and management, bidirectional command &amp; control, over-the-air updates and application management</td>
</tr>
<tr>
<td>Cloud, Platform, &amp; Analytics</td>
<td>IoT Cloud backends (public, private)</td>
<td>Software backend that aggregates inbound streaming data, handles processing and storage in databases for multiple data models/formats (e.g., relational, non-relational, key-value, etc.) and scales as required</td>
</tr>
<tr>
<td>Cloud, Platform, &amp; Analytics</td>
<td>IoT Connectivity Platforms</td>
<td>Connectivity platforms support different protocols/data formats, ensuring bidirectional communication with all devices and ability to monitor network usage generating notifications and alerts</td>
</tr>
<tr>
<td>Cloud, Platform, &amp; Analytics</td>
<td>Advanced analytics</td>
<td>Advanced Analytics platforms have specific features that allow for advanced analytics on IoT data through AI/machine learning, streaming analytics and complex algorithms</td>
</tr>
<tr>
<td>Communications</td>
<td>Cellular - Licensed M2M (traditional - 2G-4G)</td>
<td>Operator services related to 2G, 3G and 4G technologies in the licensed spectrum</td>
</tr>
<tr>
<td>Communications</td>
<td>Cellular - Licensed LPWAN</td>
<td>Operator services related to LPWAN technologies in the licensed spectrum (NB-IoT, LTE-M)</td>
</tr>
<tr>
<td>Communications</td>
<td>Cellular - Unlicensed LPWAN</td>
<td>Operator services related to LPWAN technologies in the unlicensed spectrum (e.g., Lora, Sigfox, Ingenu, etc.)</td>
</tr>
<tr>
<td>Communications</td>
<td>Cellular - 5G</td>
<td>Operator services related to 5G technologies in the licensed spectrum</td>
</tr>
<tr>
<td>Communications</td>
<td>Satellite</td>
<td>Operator services related to satellite technologies</td>
</tr>
<tr>
<td>Communications</td>
<td>Wireline</td>
<td>Operator services related to wireline technology/Wi-Fi</td>
</tr>
<tr>
<td>Communications</td>
<td>Other</td>
<td>Other operator service revenue (e.g., mesh networks, etc.)</td>
</tr>
<tr>
<td>Hardware</td>
<td>Chips</td>
<td>Semiconductors used in IoT devices and communications equipment</td>
</tr>
<tr>
<td>Hardware</td>
<td>Sensors</td>
<td>Sensors used in IoT devices</td>
</tr>
<tr>
<td>Hardware</td>
<td>Operating System</td>
<td>Operating systems used in IoT devices</td>
</tr>
<tr>
<td>Hardware</td>
<td>Edge applications</td>
<td>Applications that are developed and run specifically on gateways and devices</td>
</tr>
<tr>
<td>Hardware</td>
<td>Edge analytics</td>
<td>Analytics services that are developed and run specifically on gateways and devices</td>
</tr>
<tr>
<td>Hardware</td>
<td>Communications modules</td>
<td>Package of antenna, chipset, etc. that allows for connectivity</td>
</tr>
<tr>
<td>Hardware</td>
<td>SIM cards</td>
<td>SIM cards</td>
</tr>
</tbody>
</table>

**Table 81:** Connected Industry building block sub-elements
Hardware | Routers & Gateways | Routers & Gateways
---|---|---
Hardware | Boards and small components | Circuit boards, transistors, capacitors and other electronics equipment
Hardware | Other hardware components | Other hardware required for IoT devices (e.g., screens, speakers, lamps, etc.)

System Integration | Consulting | Consulting services are advisory services by outsourced providers that help businesses identify IoT opportunities; create business cases and roadmaps; assesses organizational readiness, governance, risk, legal ramifications, security and business process redesign; and select the product, vendor or technology. In doing so, these services help align technology strategies with business or process strategies. These services support IoT initiatives by providing strategic, architectural, operational and implementation planning.

System Integration | Implementation | Implementation services customize or develop IoT solutions, assets and processes, and then integrate these solutions, assets and processes with existing infrastructure and processes. They also include product engineering of sensors/embedded devices, sensor installation, hardware/software/network implementation, and application and device testing in various conditions.

System Integration | Operations | Operations services provide day-to-day management and operation of IoT assets and processes. These include related software and hardware support services, as applicable. They may include infrastructure management, application management, device management, performance monitoring, remote diagnostics, authentication, billing and customer support. Analytics operations, which seek to leverage data associated with sensor readings and networked systems’ operational state data, are a key part of operations. The analytics efforts seek to synthesize raw operational data, as well as create predictive algorithms into actionable information and recommendations.

Applications | Smart phone applications | Building and maintaining applications that make use of IoT data on smartphones (esp. Android and Apple)

Applications | Web based applications | Building and maintaining applications that make use of IoT data in web-browser environments

Applications | Application development environments | Specific development tools that let computer scientists program, test, and deploy applications in the cloud and on the device

Applications | Backend integration | Integration of IoT applications and data to other enterprise services (e.g., ERP, CRM systems) including programming of standard APIs and SDKs and other data translation.

*Table 81 (Continued):* Connected Industry building block sub-elements
<table>
<thead>
<tr>
<th>Applications</th>
<th>Other applications</th>
<th>Specific applications that make use of IoT data which are not programmed on the web or in the smartphone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyber Security</td>
<td>Device security</td>
<td>Specific security features including hardware (e.g., TPMs, circuit shielding) and software solutions (e.g., secure boot) that enhance the level of security on the device layer.</td>
</tr>
<tr>
<td>Cyber Security</td>
<td>Communications security</td>
<td>Specific security features that ensure data is safely encrypted while in transit (e.g., AES, SSL) and unwanted intrusions are detected/prevented (e.g., firewalls, IDS/IPS)</td>
</tr>
<tr>
<td>Cyber Security</td>
<td>Cloud security</td>
<td>Specific security features that protect sensitive information stored in the cloud (i.e., disk encryption for data at rest) and ensures only authorized access is granted (i.e., platform/application/3rd party verification)</td>
</tr>
<tr>
<td>Cyber Security</td>
<td>Lifecycle management</td>
<td>Continuous processes required to keep the security of an IoT solution up-to-date from deployment to decommissioning (e.g., activity monitoring, regular security updates/patches)</td>
</tr>
</tbody>
</table>

**Table 81 (Continued):** Connected Industry building block sub-elements
Supporting technologies definition:

There are six supporting technologies that are deployed alongside Connected Industry building blocks in I4.0 solutions:

- **Additive Manufacturing**: the process of joining materials (polymers, metals, ceramics, etc.) from 3D models to make industrial prototypes or low volume products

- **Augmented and Virtual Reality**: tools that immerse users in digital worlds in order to help them design and operate industrial products and systems

- **Collaborative Robotics**: smart, flexible, easy to train robots which enable safe human-machine interaction in factories without the need for fences or cages

- **Connected Machine Vision**: advanced industrial cameras that simultaneously communicate with industrial control systems and higher-level image management and analytics systems

- **Drones/UAVs**: remotely controlled aerial vehicles frequently equipped with cameras and other sensors to collect data from hard to reach industrial assets

- **Self-Driving Vehicles**: a subset of the automated guided vehicle (AGV) market that incorporates I4.0 technologies such as machine vision and advanced analytics to flexibly navigate factory floors without dependence on physical markers and fixed paths

The supporting technologies market is segmented into these six categories and includes all products and services associated with I4.0 applications of the technology.

### 10.1.5 Market Sizing:

IoT Analytics’ market sizing for the **overall I4.0 market** is based on a data model augmented by the input of industry experts and a thorough review of economic and revenue data to form multi-year projections on expected revenue changes. The Connected Industry building blocks portion of the market is segmented by both building block and region, and the supporting technologies portion of the market is segmented by supporting technology only. The overall I4.0 market model is based on the sum of the Connected Industry building blocks market and the supporting technologies market.
The **Connected Industry building blocks market model** for 2017 is based on both a top down as well as a bottom-up approach. The top-down approach starts with the overall IoT market and then estimates the proportion of that market that falls under the Connected Industry category. The overall IoT market is based on IoT Analytics global forecast model that has been developed and validated with various industry experts over the last 5 years. The bottom-up approach is based on various IoT Analytics deep-dives (e.g., IoT Platforms, Predictive Maintenance) in which actual and estimated revenue numbers from key market participants were added up to form a total market size. Regional and building block splits are based both on the results of the interview questionnaire as well as through the use of web indicators for regional and segment specific IoT activity (e.g., number of employees working on IoT solutions in a specific country).

The **supporting technologies market model** for 2017 is based on a top-down approach and is calculated based on various expert inputs and an estimation of the I4.0 proportion of each supporting technology market. For instance, the “Drones/UAVs in I4.0 use cases” market is developed by taking the overall drones/UAVs market and subtracting out all of the non-I4.0 use cases, such as military drones and consumer applications. Inputs to the supporting technologies market model include expert interviews, publicly available financial statements, 3rd party research reports, and IoT Analytics internal intelligence.

The **key use cases** market model is a derivative model based on the overall I4.0 market model. The proportion of revenues associated with particular use cases are estimated based on surveys, IoT projects lists, expert interviews, and IoT Analytics internal intelligence.
10.1.6 Methodology:

The main objectives of this research are:

- To define and segment the technological components that comprise the Industry 4.0 market
- To estimate the worldwide Industry 4.0 market size with segmentation by technology (for both Connected Industry building blocks and supporting technologies) and by region (for Connected Industry only)
- To understand key I4.0 technology trends and how these trends are disrupting existing industries
- To identify how companies are implementing I4.0 technologies to realize key I4.0 use cases and estimate the market size and growth rates of those key use cases
- To examine the I4.0 adoption strategies of OEMs, factories, and industrial automation suppliers

This report is the result of almost two years of research including:

- Select insights and statistics from existing IoT Analytics reports and surveys on IoT security, IoT platforms, predictive maintenance, LPWAN, and smart cities
- Interviews of 100+ experts covering a variety of I4.0 technologies and industries, including:
  - 25+ expert interviews with key stakeholders in the IoT security market (technology vendors and technology users)
  - 20+ industry interviews and vendor briefings with executive level IoT solution experts
  - 10+ interviews and briefings with vendors and users of industrial edge connectivity solutions
  - 10+ interviews with MES vendors, integrators, and end users
  - 40+ industry interviews and vendor briefings with executive level IoT solution experts, all focused on LPWAN
  - 15+ leading IoT and I4.0 conferences (e.g., IoT Solutions World Congress, IOTHINGS Milan, Hannover Messe, Bosch ConnectedWorld, Industry of Things World, SPS IPC Drives, Internet of Manufacturing, IoT Tech Expo, IoT World, Hitachi NEXT, PTC Liveworx, etc.)
- Secondary research involved mainly desktop research examining annual reports, press releases, whitepapers, company products and services portfolios, government and economic data, regulations and roadmaps, and industry case studies.
The research is based on a rigorous process with academic and industry recognized methodologies (such as web-based analytics, trends analysis, and publicly available data on the market e.g., annual reports, company websites). The insights gained through these methodologies were enhanced by IoT expertise from internal research analysts and the consulting team.
10.2 List of Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3DP</td>
<td>3D Printing</td>
</tr>
<tr>
<td>5G FWA</td>
<td>5th Generation Fixed Wireless Access</td>
</tr>
<tr>
<td>AM</td>
<td>Additive Manufacturing</td>
</tr>
<tr>
<td>AES</td>
<td>Advanced Encryption Standard</td>
</tr>
<tr>
<td>AMQP</td>
<td>Advanced Message Queuing Protocol</td>
</tr>
<tr>
<td>AWS</td>
<td>Amazon Web Services</td>
</tr>
<tr>
<td>AEP</td>
<td>Application Enablement Platform</td>
</tr>
<tr>
<td>API</td>
<td>Application Programming Interface</td>
</tr>
<tr>
<td>AI</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>AR</td>
<td>Augmented Reality</td>
</tr>
<tr>
<td>AGV</td>
<td>Autonomous Guided Vehicle</td>
</tr>
<tr>
<td>AMR</td>
<td>Autonomous Mobile Robot</td>
</tr>
<tr>
<td>BLE</td>
<td>Bluetooth Low Energy</td>
</tr>
<tr>
<td>BPO</td>
<td>Business Process Outsourcing</td>
</tr>
<tr>
<td>Cobot</td>
<td>Collaborative Robot</td>
</tr>
<tr>
<td>CAGR</td>
<td>Compound annual growth rate</td>
</tr>
<tr>
<td>CoAP</td>
<td>Constrained Application Protocol</td>
</tr>
<tr>
<td>CRM</td>
<td>Customer Relationship Management</td>
</tr>
<tr>
<td>DCS</td>
<td>Distributed Control System</td>
</tr>
<tr>
<td>DDoS</td>
<td>Distributed Denial of Service</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Full Form</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------</td>
</tr>
<tr>
<td>ERP</td>
<td>Enterprise Resource Planning</td>
</tr>
<tr>
<td>XML</td>
<td>Extensible Markup Language</td>
</tr>
<tr>
<td>FTP</td>
<td>File Transfer Protocol</td>
</tr>
<tr>
<td>GB</td>
<td>Gigabytes</td>
</tr>
<tr>
<td>GSM</td>
<td>Global System for Mobile Communication</td>
</tr>
<tr>
<td>GSMA</td>
<td>Groupe Speciale Mobile Association</td>
</tr>
<tr>
<td>HMI</td>
<td>Human Machine Interface</td>
</tr>
<tr>
<td>HTTP</td>
<td>HyperText Transfer Protocol</td>
</tr>
<tr>
<td>Wi-Fi</td>
<td>IEEE 802.11x (Wi-Fi Alliance)</td>
</tr>
<tr>
<td>IIC</td>
<td>Industrial Internet Consortium</td>
</tr>
<tr>
<td>IIoT</td>
<td>Industrial Internet of Things</td>
</tr>
<tr>
<td>ISM</td>
<td>Industrial, Scientific, Medical</td>
</tr>
<tr>
<td>I4.0</td>
<td>Industry 4.0</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>IaaS</td>
<td>Infrastructure as a Service</td>
</tr>
<tr>
<td>IO</td>
<td>Input Output</td>
</tr>
<tr>
<td>I/O</td>
<td>Input/Output</td>
</tr>
<tr>
<td>IDE</td>
<td>Integrated Development Environment</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electrotechnical Commission</td>
</tr>
<tr>
<td>IoT</td>
<td>Internet of Things</td>
</tr>
<tr>
<td>IP</td>
<td>Internet Protocol</td>
</tr>
<tr>
<td>Acronym</td>
<td>Definition</td>
</tr>
<tr>
<td>---------</td>
<td>------------</td>
</tr>
<tr>
<td>IDS</td>
<td>Intrusion Detection System</td>
</tr>
<tr>
<td>IPS</td>
<td>Intrusion Protection System</td>
</tr>
<tr>
<td>JSON</td>
<td>Javascript Object Notation</td>
</tr>
<tr>
<td>LAN</td>
<td>Local Area Network</td>
</tr>
<tr>
<td>LoRa</td>
<td>Long Range (low power network)</td>
</tr>
<tr>
<td>LTE</td>
<td>Long Term Evolution (of 4g communication standard)</td>
</tr>
<tr>
<td>LTE-M</td>
<td>Longer Term Evolution for Machines</td>
</tr>
<tr>
<td>LPWAN</td>
<td>Low Power Wide Area Network</td>
</tr>
<tr>
<td>ML</td>
<td>Machine Learning</td>
</tr>
<tr>
<td>M2M</td>
<td>Machine to Machine</td>
</tr>
<tr>
<td>MES</td>
<td>Manufacturing Execution System</td>
</tr>
<tr>
<td>MB</td>
<td>Megabytes</td>
</tr>
<tr>
<td>MBSE</td>
<td>Model-Based Systems Engineering</td>
</tr>
<tr>
<td>MQTT</td>
<td>Message Queueing Telemetry Transport</td>
</tr>
<tr>
<td>MEMS</td>
<td>Micro Electro Mechanical Systems</td>
</tr>
<tr>
<td>MCU</td>
<td>Microcontroller</td>
</tr>
<tr>
<td>MPU</td>
<td>Microprocessor</td>
</tr>
<tr>
<td>NEMS</td>
<td>Nanoelectromechanical Systems</td>
</tr>
<tr>
<td>NB-IoT</td>
<td>Narrowband IoT</td>
</tr>
<tr>
<td>OPC DA</td>
<td>OLE for Process Control Data Access</td>
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<tr>
<td>OPC</td>
<td>OLE for Process Control or Open Platform Communications</td>
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<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<tr>
<td>OPC UA</td>
<td>Open Platform Communications Unified Architecture</td>
</tr>
<tr>
<td>OS</td>
<td>Operating System</td>
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<tr>
<td>OT</td>
<td>Operational Technology</td>
</tr>
<tr>
<td>OEM</td>
<td>Original Equipment Manufacturer</td>
</tr>
<tr>
<td>OTA</td>
<td>Over-The-Air</td>
</tr>
<tr>
<td>OEE</td>
<td>Overall Equipment Effectiveness</td>
</tr>
<tr>
<td>PC</td>
<td>Personal Computer</td>
</tr>
<tr>
<td>PLM</td>
<td>Product Lifecycle Management</td>
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<tr>
<td>PLC</td>
<td>Programmable Logic Controller</td>
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<tr>
<td>PoC</td>
<td>Proof of Concept</td>
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<tr>
<td>RFID</td>
<td>Radio-Frequency Identification</td>
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<tr>
<td>RPMA</td>
<td>Random Phase Multiple Access</td>
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<tr>
<td>RTU</td>
<td>Remote Terminal Units</td>
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<tr>
<td>REST</td>
<td>Representational State Transfer</td>
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<tr>
<td>ROI</td>
<td>Return On Investment</td>
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<tr>
<td>SSL</td>
<td>Secure Sockets Layer</td>
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<tr>
<td>SDV</td>
<td>Self-Driving Vehicle</td>
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<tr>
<td>SaaS</td>
<td>Software as a Service</td>
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<tr>
<td>SDK</td>
<td>Software Development Kit</td>
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<td>SPC</td>
<td>Statistical Process Control</td>
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<tr>
<td>SQL</td>
<td>Structured Query Language</td>
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<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<td>Supervisory Control and Data Acquisition</td>
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<tr>
<td>SI</td>
<td>System Integrator</td>
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<tr>
<td>TSN</td>
<td>Time-Sensitive Networking</td>
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<tr>
<td>TCP</td>
<td>Transmission Control Protocol</td>
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<tr>
<td>TLS</td>
<td>Transport Layer Security</td>
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<tr>
<td>TPM</td>
<td>Trusted Platform Module</td>
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<tr>
<td>US</td>
<td>United States</td>
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<tr>
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<td>Unmanned Aerial Vehicle</td>
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<td>User Datagram Protocol</td>
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<td>VFD</td>
<td>Variable Frequency Drive</td>
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<td>Virtual Private Network</td>
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<td>VR</td>
<td>Virtual Reality</td>
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<td>WAN</td>
<td>Wide Area Network</td>
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