

NEWSLETTER

Industry 4.0

Smart Manufacturing

Achieving Excellence Through Cyber-Physical Production System

December 2019

EXECUTIVE SUMMARY

The manufacturing industry has been continuously evolving from human-machine production to digital-human-machine model. Industrial production has become very dynamic in line with ever-changing demands of end-customers. Industry 4.0 is the assimilation of various burgeoning technologies, which is an ongoing trend that drives automation, and data exchange in manufacturing technologies and processes. The optimal functioning of all equipment/machineries is crucial for maintained the expected production levels. Any critical equipment damage is costly to manufacturers in terms of repairs and downtime and loss of productivity.

The transformation in the industrial manufacturing activities is backed by various factors such as Growing enhancement in production through predictive maintenance, increasing integration of IoT in Industry 4.0, increasing focus from B2B to B2B2C, leveraging supply chain for competitive advantage, continuous improvement in processes through ERP systems, gaining visibility through big data, gaining excellence with AR/VR through winning man-machine partnerships, and faster and cheaper production through 3D printing (3DP).

The manufacturers are establishing precedence against their peers through continuous improvements in the production process. Such strategic initiatives drive enhancement in the value chain and necessitates market participants to continuously look out for novel technologies to further innovate the production cycle. Major technologies having potential to change the future of manufacturing industry include cobots, digital twins, big data analytics, and small batch and mixed manufacturing.

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Globally, manufacturing industry is witnessing continuous change due to the ongoing focus of manufacturers on digital transformation. Manufacturers from various sectors are restructuring their businesses to move ahead in the digital age and enhance their business model.

The most critical issues for businesses include data management and cybersecurity that encourage strategists to consider taking required steps to get over from such challenges and contemplate the company's future directions. The manufacturing businesses are changing from traditional model new digital models. The manufacturers are focusing on digital platforms, pay-by-use subscription-based services, and data monetization activities to scale up the production processes and in-turn achieve business excellence.

1

Introduction

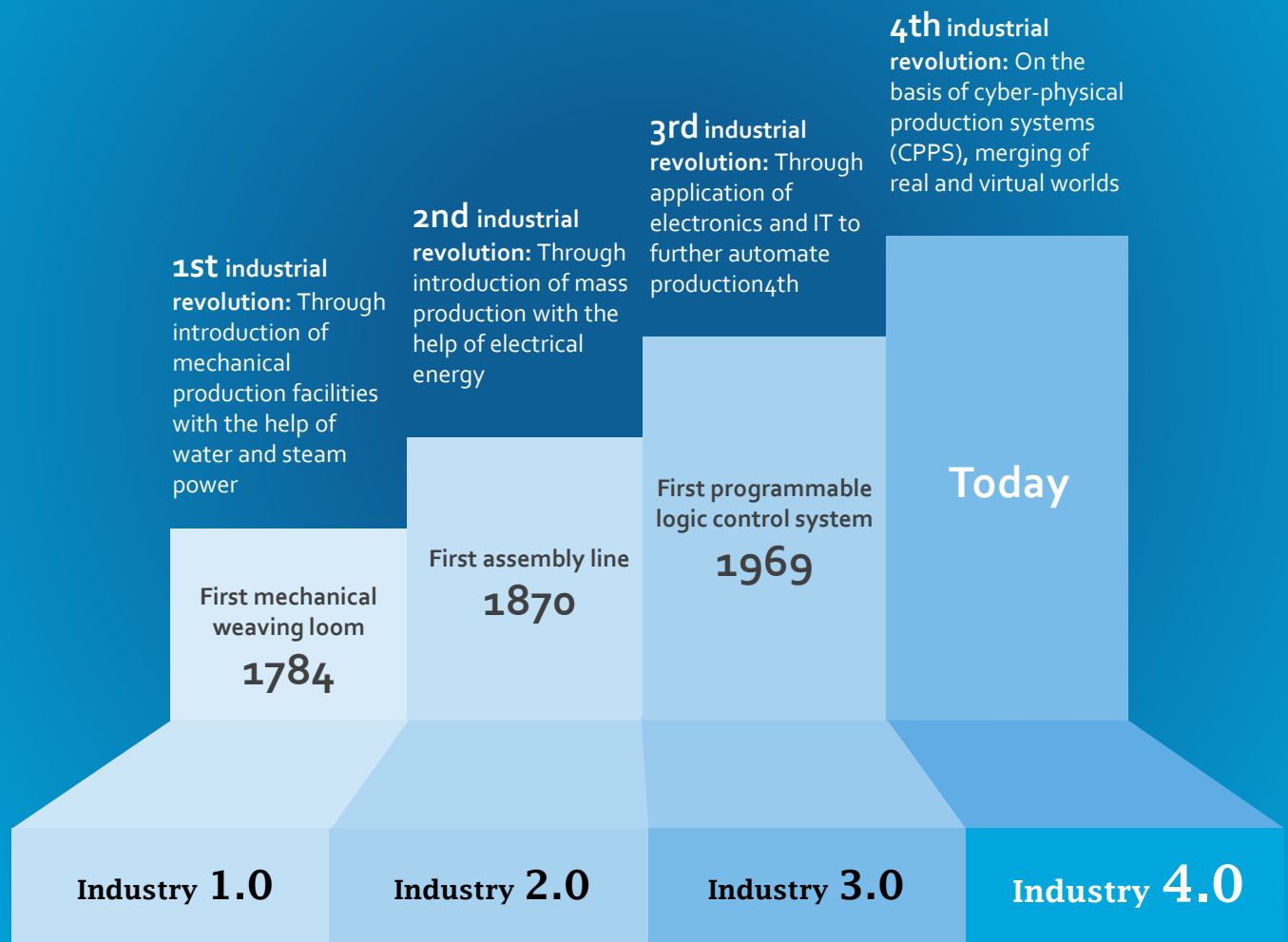


What is Industry 4.0?

The fourth industrial revolution—fourth in terms of its innovative and qualitative nature—is transforming the way the entire manufacturing process works. The term industry 4.0 refers to further advancements in the organization and management of the entire value chain process across various verticals in the manufacturing industry. Industry 4.0 is being widely used in the European region, predominantly in the Germany's manufacturing sector. Additionally, the concept is also referred to as internet of things, the internet of everything, and industrial internet.

The large scale adoption of industry 4.0 concepts within the conventional production operations of information and communications technology (ICT) and across the manufacturing industry is automating the various manufacturing processes.

Evolution of Industry 4.0





The Industry 4.0 Environment

The smart machines are efficient in sharing insights about current stock levels, problems or faults, and changes in order/demand levels. The insights is helpful in coordinating processes and deadlines for enhancing capacity utilization and quality in development boosting efficiency and optimizing throughput times, production, marketing and purchasing.

The Industry 4.0 Environment



Internet of Things



Internet of Data



Internet of Services



Internet of People



Smart Mobility



Smart Grid



Smart Logistics



Business Web



Social Web



Smart Homes



Smart Buildings



Smart Factory



CPPS

Industry 4.0 offers an interface with smart infrastructures such as smart mobility, smart logistics, smart grid, and smart homes and buildings. The interface integrates the business web and the social web, and play a vital role in the digital transformation to industry 4.0. This ongoing transformation is still at its nascent stage in some manufacturing companies and industrial sectors; however, major manufacturing sectors are restructuring their production process through integrating industry 4.0 driven technological advancements.

Traditional industrial economies, such as Germany and the US, expect this fourth industrial revolution to bring many advantages, ranging from enhanced global competitiveness to a reversal of the trend to relocate production to low-wage countries and the opening of more domestic production locations in Europe and North America.

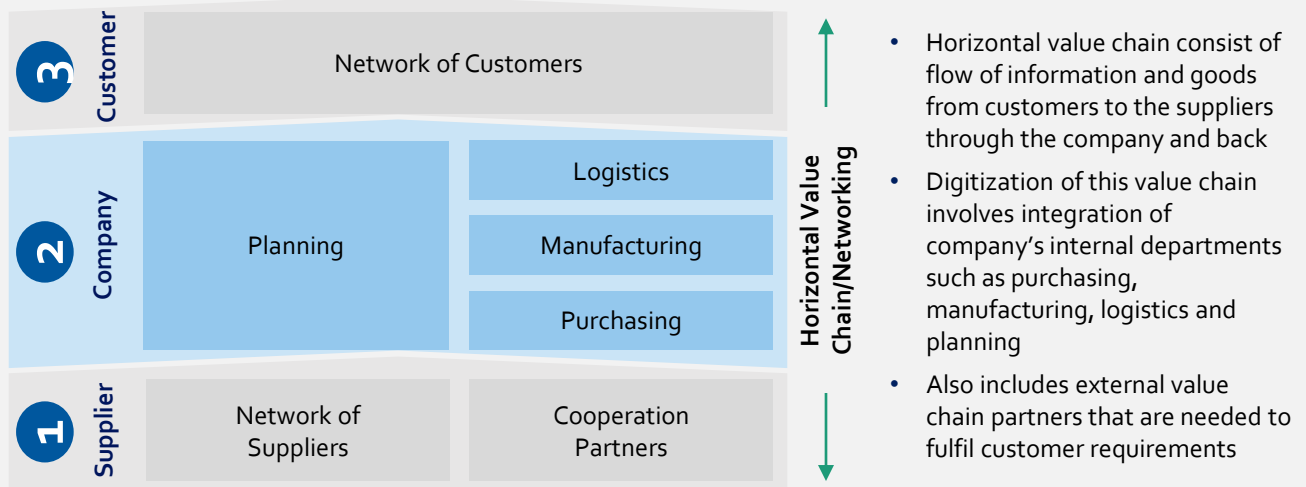
“Using 3D printing for rapid prototyping is like using a computer to write letters. While it is certainly useful, it significantly underutilizes the true potential of the technology. When the experience changes, there will be rapid adoption.”

Dr. Girish Nadkarni, ABB Venture Capitals, Managing Director

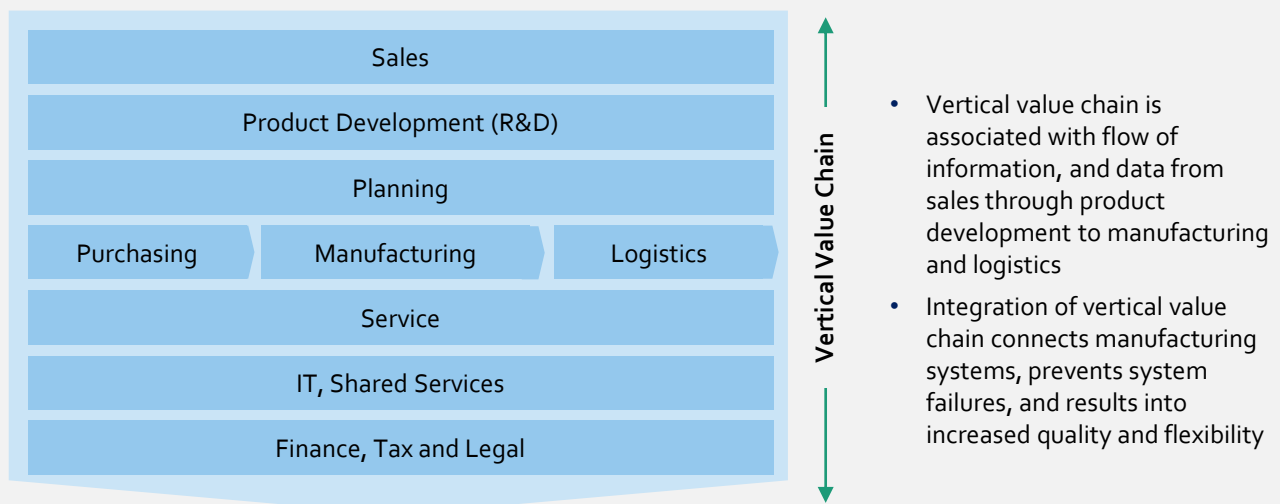
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Industry Solutions

Horizontal Value Chain



Vertical Value Chain



Through-engineering



- Industry 4.0 will enable integrated engineering throughout the value chain and throughout product and customer life cycles
- Digital transformation to industry 4.0 will make it possible to improve efficiency of innovation management in strategy, project portfolio management and product development
- Transformation to industry 4.0 also provides relevant data for life cycle management at any time and from anywhere

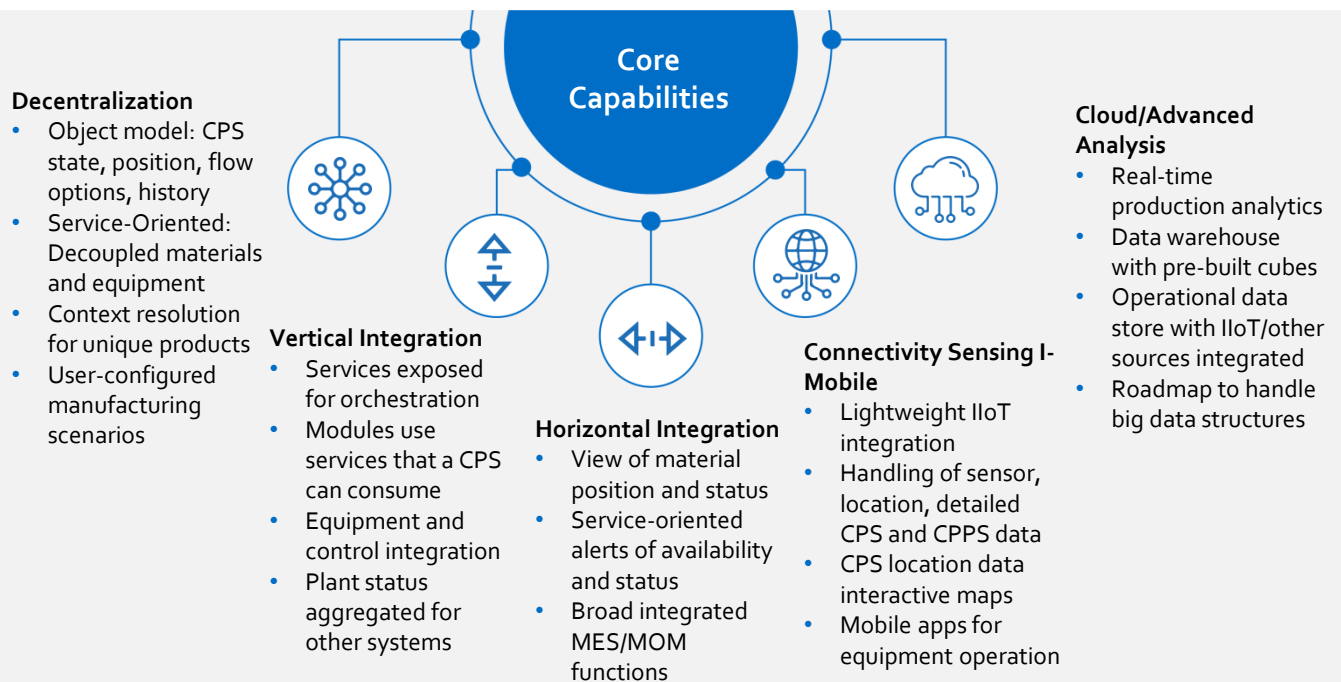
Exponential Technologies



- Corporate Venturing: offers opportunities for investing in new trends at an early stage and for benefitting from disruptive innovation and exponential technologies
- The learning organization: companies need to become learning organizations in order to make use of the potential of exponential technologies in achieving the digital transformation to industry 4.0



Capabilities of Industry 4.0



Decentralization

- Basis for providing market solutions that integrate all stages from suppliers' value chains to end customers and allows innovation beyond products
- Cloud-based applications delivers universal, anytime access to important data
- This makes it simpler to gather, monitor, distribute and analyze data between factories and also across the entire global value chain network



Vertical Integration



IT Integration

New IT solutions need to be developed integrating sensors, modules, control systems, communication networks, business applications and customer-facing applications



Analytics & Data Management

Need for developing new business processes on the basis of the insights gathered from analyzing big data



Cloud-based Applications

Networking of cloud-based solutions offers efficient use of the big data generated



Operational Efficiency 2.0

Digital transformation to industry 4.0 results into improved operational safety, work processes, servicing and maintenance

Horizontal Integration



Business Model Optimization

Companies should build innovative approaches to business rather than merely improving established business models



Smart Supply Chains

Aims at aligning R&D, procurement & purchasing, production & sales functions



IT Security Management

Aims at providing a risk management system and a cyber security strategy improving operational security and protection from attack across the value chain
Existing factories will have to be equipped and have to develop secure solutions for the new networks



New Intellectual Property (IP) Management:

New business models that arise as a result of digital transformation will require individual solutions to the digital IP issue



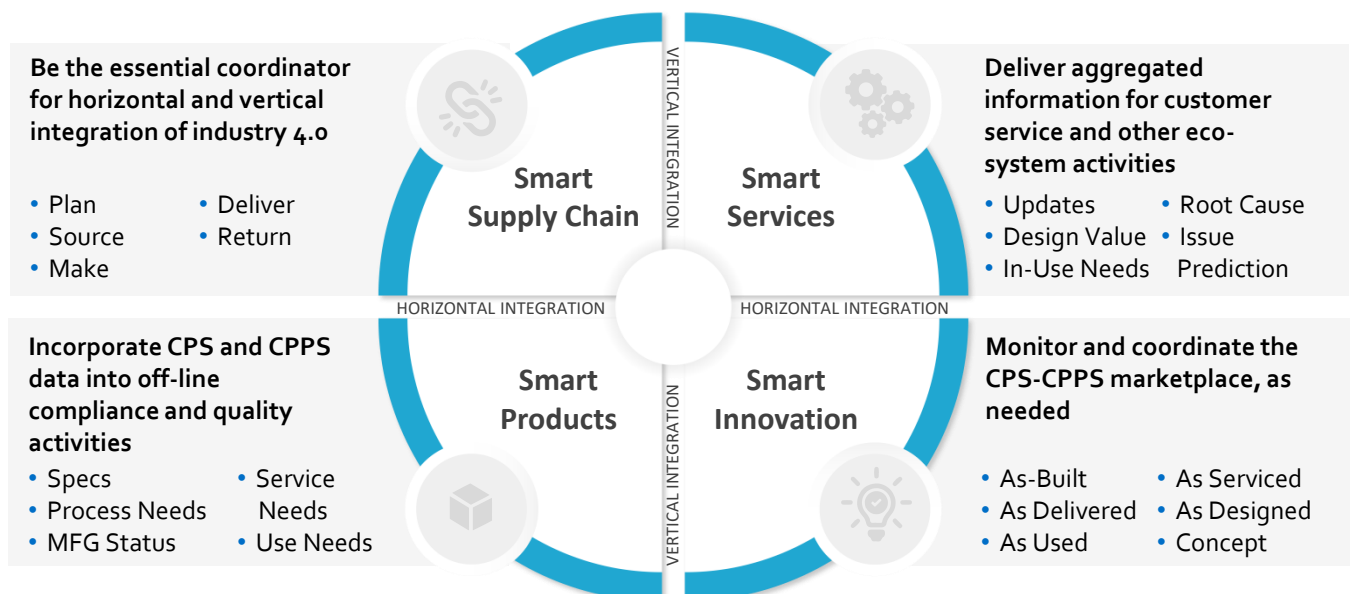
Connectivity

- Enterprises implementing Industry 4.0 need fast, reliable, secure wireless connectivity solutions
- Secure wireless connectivity empowers factory automation, making industrial automation possible on a much larger scale
- Due to advancements in IoT and mobile communication, Cyber-Physical Systems (CPS) can interact and exchange data with other CPS anytime and anywhere



Cloud Advanced Analysis

- Manufacturing analytics is a new Industry 4.0 category of software that brings predictive analytics, big data and industrial internet of things to manufacturing companies
- Focused on collecting and analyzing manufacturing data than only process control
- Enables automatic integration, collection and analysis from manufacturing data sources
- Manufacturing analytics is different from BI (business intelligence) tools, MES or SCADA systems



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Market Analysis

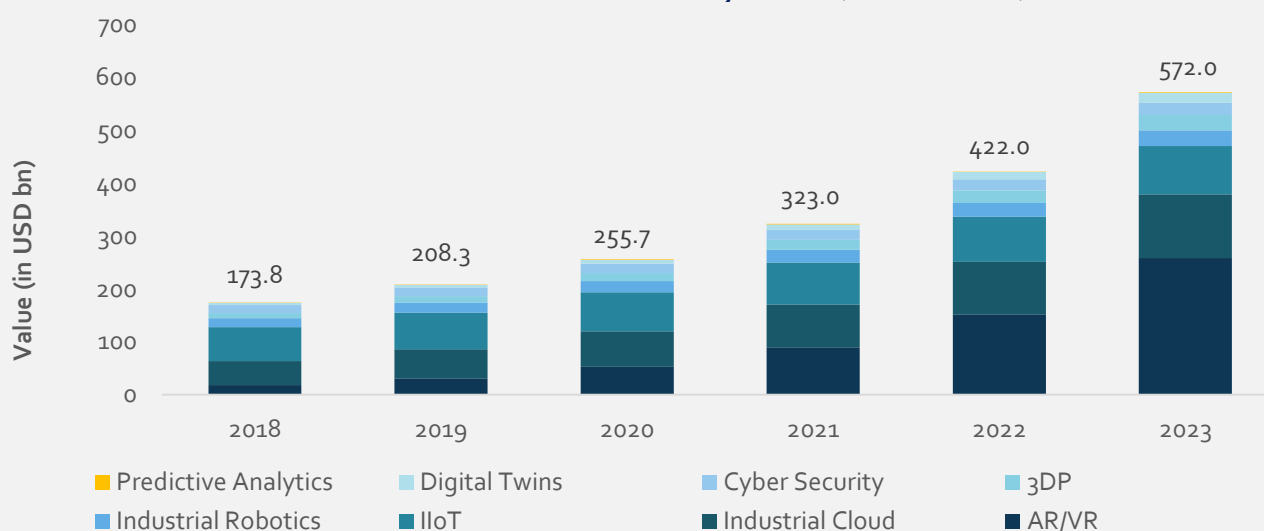


Market Size

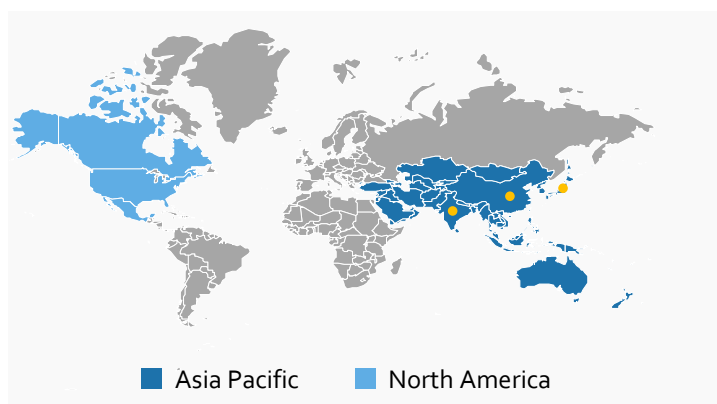
- The global industry 4.0 market was valued at USD173.8 bn in 2018 and is expected to reach USD572 bn by 2023, growing at a CAGR of ~26.9% during 2019-2023.
- Factors such as growing adoption of IoT in digital transformation of manufacturing and related industries, and the proportionally higher spend in the Industrial Internet of Things, the rise of industrial robotics are contributing towards the growth in the industry 4.0 technology market
- Industrial equipment segment led the market of the global industry 4.0 market in 2017 and is anticipated to maintain the similar trend during



Global Industrial 4.0 Market by Value (2018 - 2023)



Geographic Landscape



- Asia Pacific is expected to be the largest market for Industry 4.0 during 2019-2022
- Government initiatives taken by countries including China, Japan, and India such as Make in India, Industrial Value Chain Initiative in Japan, and Made in China 2025 are promoting the emergence of Industry 4.0 in these countries
 - The APAC region is anticipated to showcase the strongest growth during the forecast period
- Further, North America is expected to witness significant growth during 2019-2022



Key Technologies

1

Augmented Reality (AR)/ Virtual Reality (VR)

- AR for maintenance, logistics, and all kinds of SOP
- Display of supporting information e.g., through glasses

2

Industrial IoT

- Network of machines and products
- Multi-directional communication between networked objects

3

Robotics

- Autonomous, cooperating industrial robots
- Numerous integrated sensors and standardized interfaces

4

Big Data

- Full evaluation of available data (e.g., from ERP, SCM, MES, CRM, and Machine data)
- Real-time decision-making support and optimization

5

Cloud Computing

- Management of huge data volumes in open systems
- Real-time communication for production systems

6

3D Printing

- 3DP, particularly for spare parts and prototypes
- Decentralized 3D facilities to reduce transport distances and inventory

7

Digital Twins

- Simulation of value networks
- Optimization based on real-time data from intelligent systems

9

Cyber Security

- Operation in networks and open systems
- High level networking between intelligent machines, products, and systems

USD258.4 bn

The forecasted global market for visualization technologies such as AR/VR by 2023 growing at a CAGR of 70% during 2019-2023

USD5.2 bn

The projected spending from AR/VR on industrial maintenance activities by 2021, and public infrastructure maintenance USD3.6 bn.

“Augmented Reality reduces the error rate for an assembly task by 82%.” ”

—Virtual and Augmented Reality Applications in Manufacturing by A. Tang, C. Owen and W. Mou

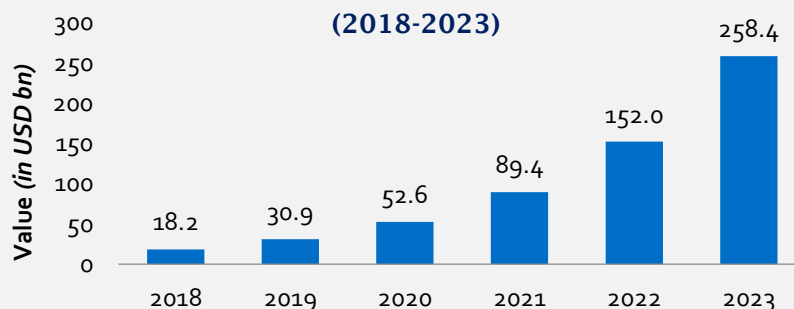
Source: Real World-One, i-Scoop, E&Y, Minsait



Market Overview

- The manufacturing industry is witnessing growing application of AR/VR with increasing focus on training and safety
- The industry is showcasing rise in the application across other potential areas such as process manufacturing, discrete manufacturing, and maintenance in the US and Western Europe
- Additionally, investments on on-site assembly and safety is likely to reach USD362 mn, while that of process manufacturing is expected to reach USD309 mn by 2021

Global AR/VR Market by Value
(2018-2023)



Geographic Landscape

- According to Allied Market Research, North America held the major market share of 37% in 2017 and is expected to continue leading the market during 2019-2025
- Large-scale adoption of AR/VR solutions by players in the region to cater to the growing demand for innovative technologies such as digital twins
- Further, Asia-Pacific is expected to register the fastest growth of 66.7% during 2019-2025 on the face of proliferation of smartphones, surge in the number of startups dealing in AR/VR, and advancements in connectivity in this region

Global Industrial 4.0 Market



AR Technologies

Marker Based

- Use active/passive physical marker placed in the real world which is recognized by the device's cameras. At that moment, the application sets the digital experience in motion

Non-Markers Based

- Does not require markers launching digital experience
- Recognized based on processed images including image patterns, and outlines or models such as heatmap, and textures



VR Technologies

Not Immersive

- VR is developed using applications run on generic devices such as PC and Tablet

Partially Immersive

- VR is developed using applications run on high-resolution devices such as TV, and projector

Completely Immersive

- VR is developed using applications run on wearable devices such as glasses



Investments in AR/VR

- By October 2019, the US became the largest country by funding raised for AR worth over USD5.0 bn, followed by Europe (USD1.0 bn)
- Further, the US and China will spearhead the AR/VR spending trend in 2019 to reach USD6.6 bn and USD6.0 bn respectively, followed by Japan (USD1.8 bn), and Western Europe (USD1.7 bn)
- Canada, US and China will register the fastest AR/VR spending growth during 2017-2022 growing at a CAGR of 83.7%, 77.1% and 76.2% respectively
- By 2021, spending from AR/VR on industrial maintenance activities is expected reach USD5.2 bn and public infrastructure maintenance USD3.6 bn
- Additionally, investments on on-site assembly and safety is likely to reach USD362 mn, while that of process manufacturing is expected to reach USD309 mn by 2021



Key Players

Augmented and Virtual Reality



- The AR/VR market is showcasing strong potential with the inclusion of major technology players
- The market players are expected to focus on further consolidation in line with ongoing initiatives such as joint ventures, collaborations, expansions, mergers & acquisitions, and partnerships to gain a strong position in the industry

Source: Real World-One, i-Scoop, Minsait

Industrial IoT

USD91.4 bn

According to a research firm MarketsandMarkets, the IIoT market is expected to reach by 2023 from an estimated USD64.0 bn in 2018, growing at a CAGR of 7.4% during 2019-2023

84 mn

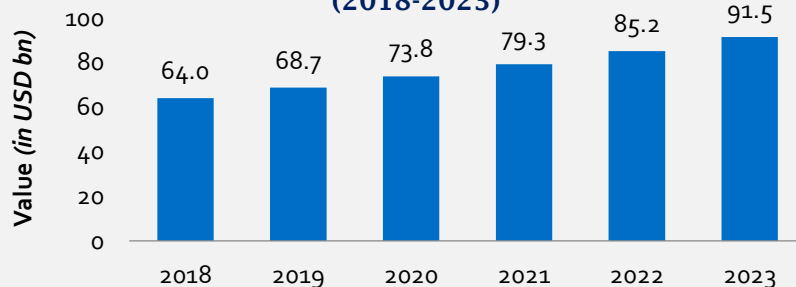
The estimated number of new industrial IoT connections by 2022 as against 66mn in 2017



Market Overview

- The global manufacturing vertical is transforming with the introduction of new approaches and technologies, such as smart factories, cyber-physical systems, and intelligent robotics
- Governments in countries such as Germany, the UK, France, the US, China, and India have taken several initiatives for the development of their manufacturing verticals
- Based on end-use applications, agriculture sector is expected to grow at the highest growth rate during 2019-2025

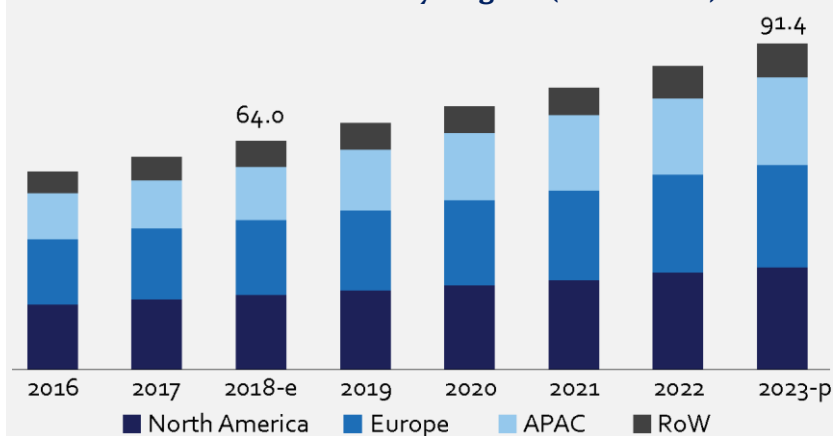
**Global IIoT Market by Value
(2018-2023)**



Geographic Landscape

- The industrial IoT market in APAC is expected to witness highest growth rate during 2019-2023
- Growing infrastructural and industrial development in emerging economies such as India, China, and South-East Asia is pushing further growth in industrial IoT in APAC region
- Industrial IoT market is witnessing growing demand from energy, metals and mining, manufacturing, retail, oil & gas, healthcare, transportation, and agriculture sectors

Global IIoT Market by Region (2016-2023)



Source: Real World-One, i-Scoop, MarketsandMarkets

Industrial IoT Market Opportunity (2020 – 2030)

2020

(by total economic value)

USD110.0 bn

IoT Market by 2020
from USD90.0 bnSource: Morgan
Stanley (2015)

USD123.0 bn

IoT Market by 2021

Source: Industry ARC
(2016)

USD14.2 tn

Estimated economic value
to be added by 2025

Source: Accenture IIoT Study

CAGR-7.3%

Average growth rate in
IIoT during 2015-2020Source: Global IIoT
Market report

2030

(by total country value)

USD7.1 tn

United States

USD1.8 tn

China

USD700 bn

Germany

USD531 bn

United Kingdom



Key Players

Industrial IoT Platforms

ADAMOS

ALTIZON

CISCO

amazon

BOSCH

Honeywell
THE POWER OF CONNECTED

EXOSITE

Google

Hitachi Vantara

IBM

Microsoft

ORACLE

PLEX
THE MANUFACTURING CLOUD

ptc

relayr.

SAMSUNG

SAP

Schneider
Electric

SIEMENS

software AG



intel

ABB

Rockwell
Automation

arm

Atmel
MICROCHIP

SYNOPSYS

- The market is highly competitive with growing focus of industry players on expanding their customer base
- Intel, ARM, Atmel, Synopsys and Siemens as some of the biggest companies who are implementing Industrial Internet of Things in their business

Industrial Robotics

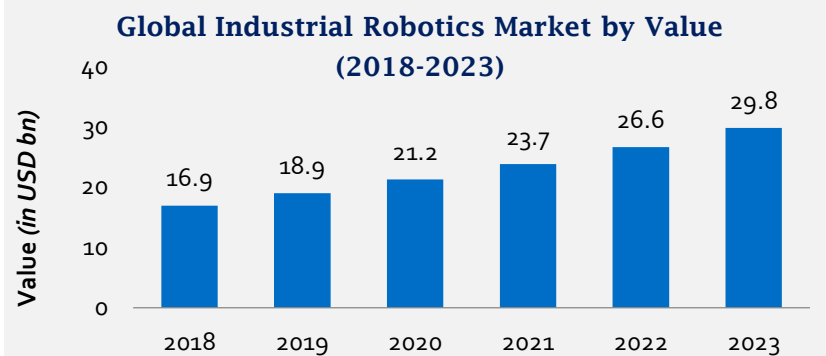


Market Overview

Increased adoption of automation in all industrial fields with the inclusion of powering drones & humanoids and advancement in sensors, hydraulics and artificial intelligence in the field of machine learning have resulted in strong growth in the industrial robotics market

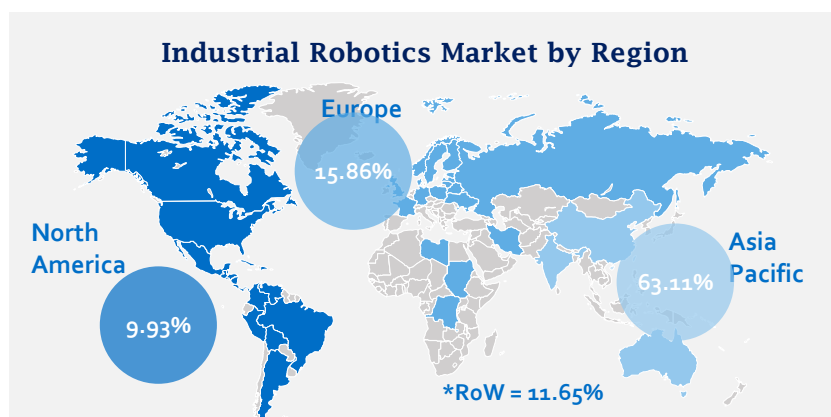
USD29.8 bn

The projected size of industrial robotics market by 2023 from USD16.9 bn in 2018, registering a CAGR of 12.0% during 2019 - 2024.



Geographic Landscape

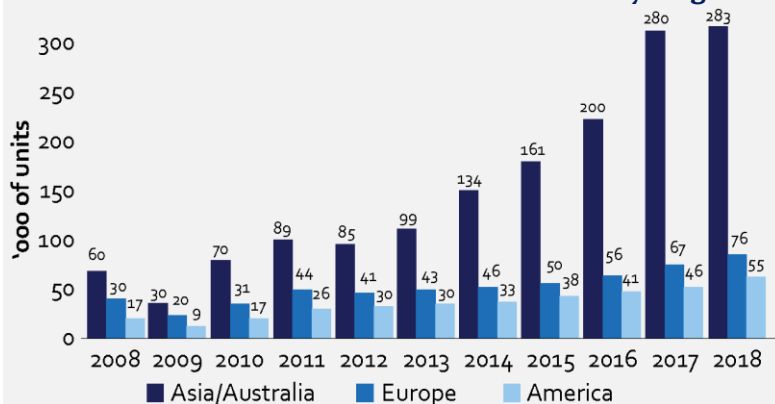
- APAC is expected to remain the key market with holding ~63% share (by value)
 - China is likely to be the major market due to increased subsidies on robotics expenditure and government initiatives
- The North American region is expected to showcase significant growth bolstered by strong growth in Canada due to governments major initiatives including lowered taxes on new investments, trade agreements and major government expenditure on new technologies in automotive sector



Note: The 2019 Market Shares are Estimated.
*RoW = Rest of the World

- In Asia and Australia almost 283,000 robots were installed in 2018 out of which more than 154,000 industrial robots were installed in China
- Since 2016 the America showed the fastest growth in installation of industrial robot, the annual installation grew by almost 34% since 2016
- The European region showed a stable growth when it comes to industrial robots as much as 78,000 robots were installed in 2018

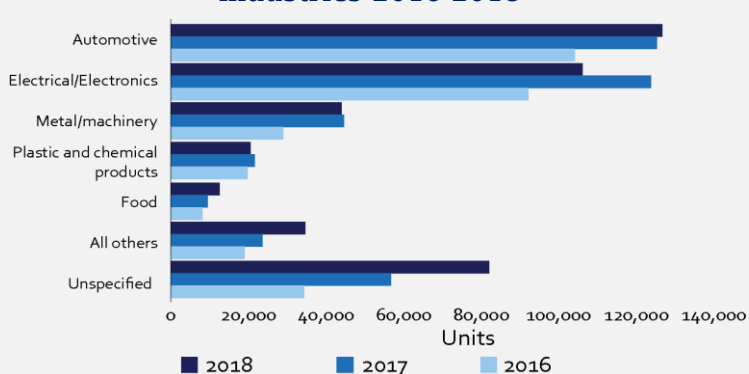
Annual Installations of Industrial Robots by Regions



Key Applications

- Automotive remains leading segment even after a stagnant growth when it comes to installation of robots as many as 128,000 units of robots were installed in 2018 for automation in automotive industry i.e., 44% of total robot installations
- Food and other unspecified segment are the fastest growing segments registering more than 30% of growth in the number of robots installed globally
- Whereas electrical segment witnessed negative growth of 14% in installation of robots in 2018

Global Annual Installations of Industrial Robots by industries 2016-2018



Robots by Mechanical Structure



Cartesian Robot: Anticipated to grow at approximately 9% and is expected to reach USD2.27 bn by 2023, majority of growth is derived from their complete linear movement and heavy demand from automotive industry



SCARA Robot: Expected to show a steady growth of around 5% while producing 54.25 thousand units of robots by 2021, majority of growth is derived from compliance assembly and palletizing operations



Parallel/Delta Robot: Expected to show a steady growth of approximately 6% by 2020, majority of growth is derived from packaging operations in food processing industry



Cylindrical Robot: Expected to show very mild growth due to increased competition from other industrial robots including articulated robots, Cartesian robots, and SCARA robots



Articulated Robot: Supposed to grow at approximately 16% between 2019 and 2023, majority of growth is derived from their increased adoption in automotive sector

Source: International Federation of Robotics, Technavio, MarketsandMarkets, GII Research, Mordor Intelligence, E&Y



Robotic Process Automation (RPA)

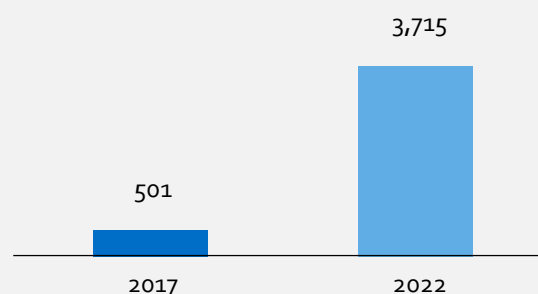
- RPA is expected to grow at 49.3% during 2017 to 2022
- Majorly used for finance operations, supply chain management, accounting and other repetitive tasks including data entry and purchase order issuing



Hardware Robotics

- Hardware robotics market has taken up a rapid pace with continuous advancement in AI and machine learning with better computing power
- Korea, Singapore, Japan, Sweden, and Germany are amongst the most advanced nations when it comes to automation through robotics
- While China and Japan are leading the market with regular government support and initiatives
- The worldwide projected robotics spending in 2019 is USD103.4 bn

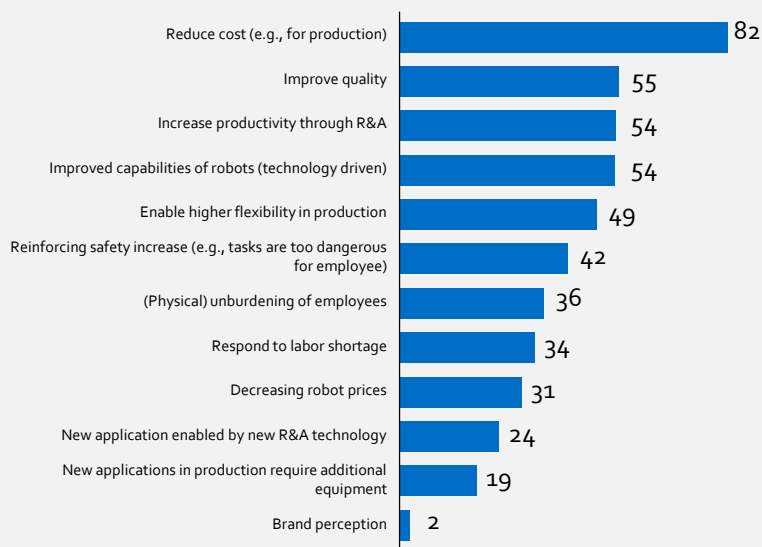
Global RPA Software Revenue (USD mn)



Drivers

- Hardware robotics market has taken up a rapid pace with continuous advancement in AI and machine learning with better computing power
- Korea, Singapore, Japan, Sweden, and Germany are amongst the most advanced nations when it comes to automation through robotics
- While China and Japan are leading the market with regular government support and initiatives

Drivers Triggering Investment in Robotics and Automation Solutions

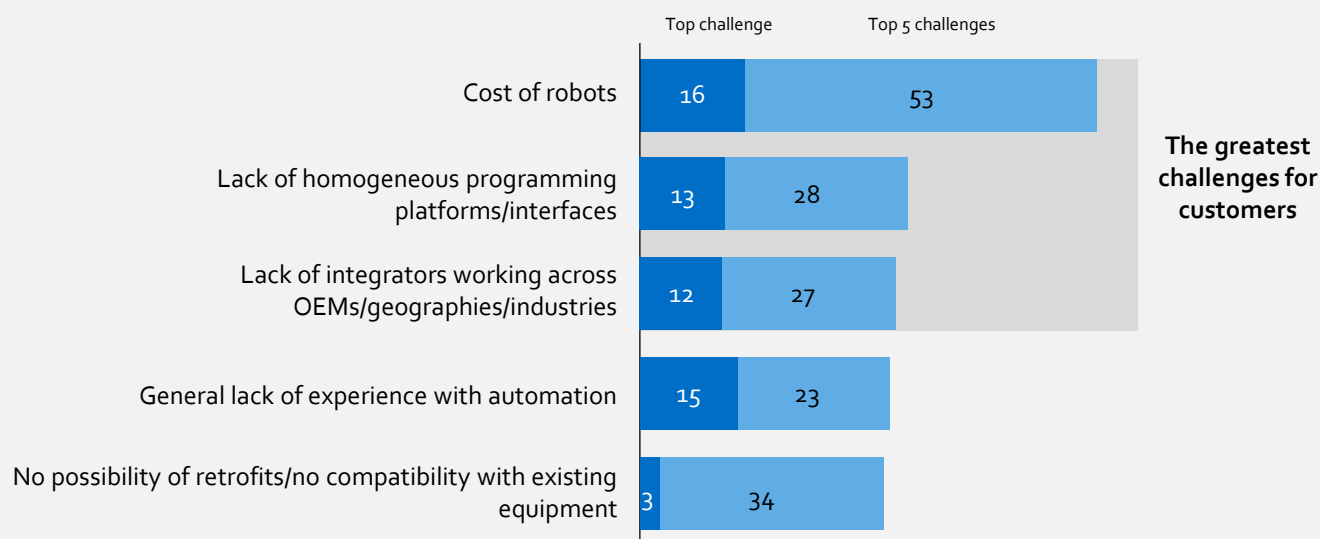




Challenges

- The heavy installation cost associated to installation stays as the major challenge in the path of growth of automation through robotics
- With multiple programming platforms and interfaces the usage of robots remains very complex
- The state of readiness amongst the stakeholders stays a major hindrance in the growth of robotics

Major Challenges in Automation Through Robotics



Key Players



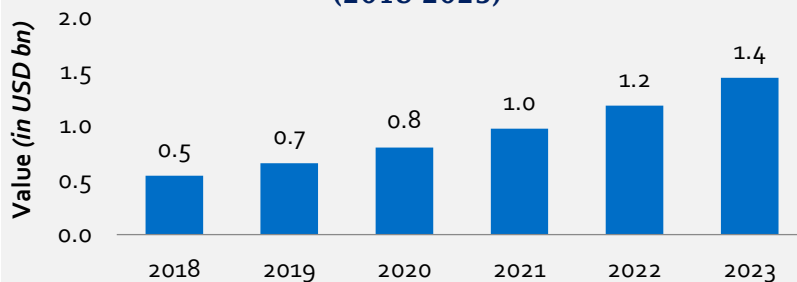
- The industrial robotics market is highly competitive with few major players dominating the market aiming to capture customer base in foreign markets
- Strategic and collaborative initiatives are expected to happen in order to capture the market share



Market Overview

- Increased focus of companies towards collecting, analyzing, and sharing data across all functional domains has lead to enormous growth in big data market
- Banking, discrete manufacturing, professional services, process manufacturing and government are the major consumers of big data related services and products

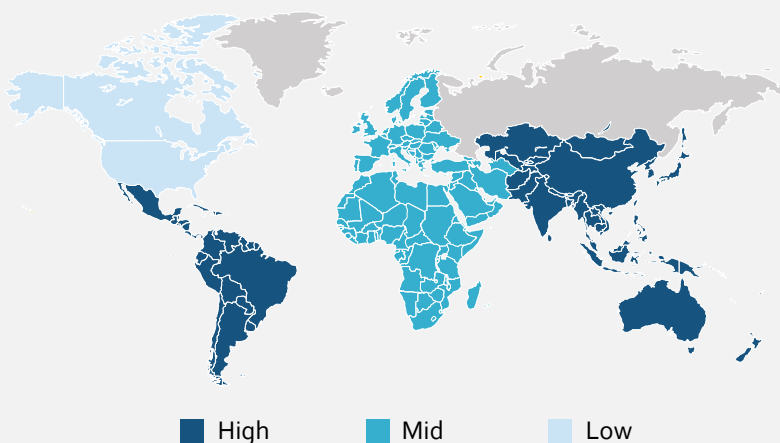
Global Predictive Analytics Market by Value (2018-2023)



Geographic Landscape

- APAC and Australia will showcase significant growth due to high rate of penetration of smartphones and internet users, region is expected to conduct 54.9% smart manufacturing by 2023
- North-America has a low growth rate and highest adoption rate for big data analytics in manufacturing industries, region is expected to conduct 67.1% smart manufacturing by 2023
- Further, Europe and Africa are expected to attain a stable growth during 2019-2024

Big Data Analytics In Manufacturing Industry Market - Growth Rate by Region (2019-2024)



USD1.4 bn

The size of global industrial predictive analytics market by 2023 as compared with USD535.0 mn in 2018 growing at a CAGR of 21.7% during 2019-2023

“The availability of data, a new generation of technology, and a cultural shift toward data-driven decision making continue to drive demand for big data and analytics technology and services”

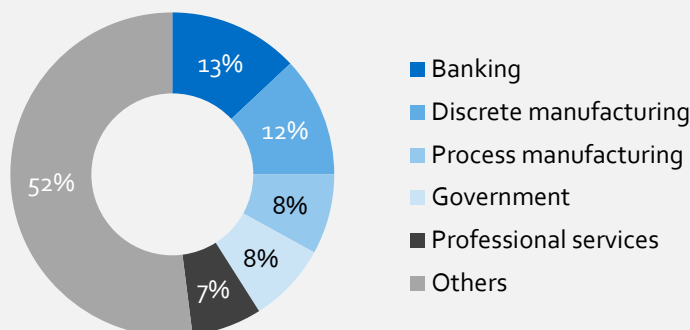
-Dan Vesset (IDC)



Key Applications

- Banking sector is the leading segment for big Data analytics with market share of USD20.8 bn in 2016
- Securities and investment services and retail will show prominent growth of 15.3% and 15.2% respectively
- Further, 20% of revenue of big data is generated through manufacturing sector whether discrete or process
- Due to high volume and variety of data the government has started considering big data analysis which has lead to 8% of total big data market share captured by government

Major Applications



Annual Installations of Industrial Robots by Regions

	Government	Healthcare Providers	Manufacturing & Natural Resources	Retail	Transportation	Utilities	Wholesale Trade
Volume of Data	Very Hot	Hot	Very Hot	Hot	Hot	Hot	Low
Velocity of Data	Hot	Very Hot	Very Hot	Hot	Hot	Hot	Low
Variety of Data	Very Hot	Hot	Hot	Moderate	Moderate	Moderate	Very Low

Potential big data opportunity in each dimension is:

- Very Hot (compared with other industries)
- Hot
- Moderate
- Low
- Very Low (compared with other industries)



Drivers

- Data generated in industries like manufacturing, natural resources and government is huge in volume with higher variety and velocity leading to increased demand of big data analytics
- Big data enables cost saving through its advanced analytics, it is estimated that use of analytics could potentially save around USD300 bn in healthcare. Further big data helps retailers to boost their profit margin up to 60%
- Higher penetration of smartphones and internet users generates high volume of data which leads to better quality and design of products and services provided to end customer

“Digital transformation is a key driver of BDA spending with executive-level initiatives resulting in deep assessments of current business practices and demands for better, faster, and more comprehensive access to data and related analytics and insights.”

- Dan Vesset, VP-IDC



Challenges

- Complexity of data requires specialized expertise in analytics
- Generating valuable insights from big data in timely manner is tricky
- Huge talent gap because of insufficient knowledge and acceptability of big data
- High cost associated with the installation of big data analytics
- Validating and securing data gets very tricky because of hackers and advanced persistent threats (APTs)



Key Players



- The big data market represents robust competition with key players focusing on technological up gradation to capitalize on the expanding market
- Development of predictive analytics and data science tools will have a positive effect on expanding the big data

Source: i-Scoop, Tyrone Systems

Industrial Cloud Computing

USD120.2 bn

The projected size of cloud computing market by 2023, as compared with USD45.4 bn in 2018 (Source: According to Cloudtech Industry), growing at a CAGR of 21.5% during 2019-2023

Asia-Pacific

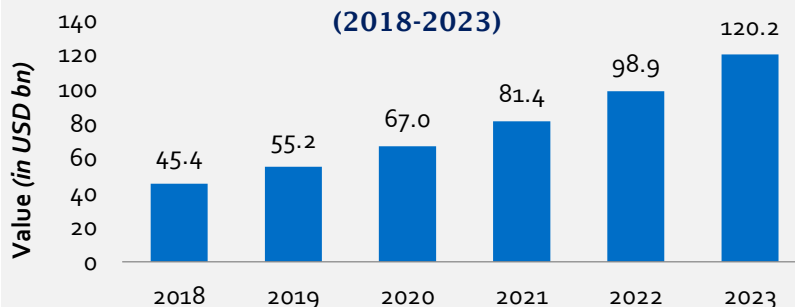
Market is expected to deliver high growth with increased market share on account of increased automation boosting the market growth



Market Overview

- Industrial cloud market will keep growing as the industrial cloud users have started expect specific capabilities in their solutions with industry expertise from cloud service providers
- Manufacturing, retail, government, healthcare and agriculture are amongst five major industries capturing the largest investments in industry cloud solutions

Global Industrial Cloud Computing Market by Value (2018-2023)



Geographic Landscape

- North America covers majority of industrial cloud computing market share. Further due to the technological advancement with better infrastructure and higher adoption of cloud services the region will register high growth
- United States has shown stable growth while making up close to the overall market growth in 2018
- Japan and China are expected to show highest growth rate of 54% and 47% respectively on y-o-y basis
- Latin America and the Middle East & Africa are expected to show strong growth and are also expected to outperform their own 2018 growth rates



Key Applications

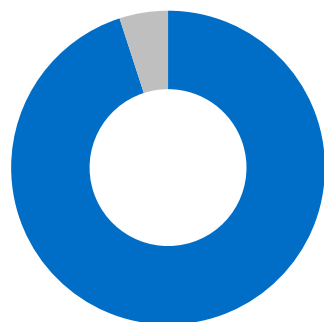
- Healthcare being the segment with largest spending is expected to grow at a CAGR of 20.6% due to the utility of cloud computing in keeping track of patients' data, care, behavior, and health progression
- Manufacturing segment is expected to grow at the highest rate of 26.3%, majorly because of the automated processes
- Further, due to the impact of cloud computing on core retail management systems the retail segment is supposed to show a significant growth of 24.6%

Worldwide Industrial Cloud Spending		
Industry	2018 Total Industry Cloud Spend (USD bn)	2019/2018 Growth (%)
Finance	7.3	22.8
Healthcare Provider	12.1	20.6
Manufacturing	3.6	26.3
Public Sector	8.4	17.3
Retail/Wholesale	6.1	24.6



Drivers

- Growing trend for industrial automation and the increased reliability of digital data creation and collecting process
- Government support for digitalization across the globe has resulted in growing demand for industrial cloud facilities
- Increased adoption of hybrid cloud service is boosting growth opportunities in cloud computing market
- Better security measures are established by industrial cloud providers, it is expected that only 5% of total cloud security failures will be a result of cloud issues and rest would be due to users' fault



Gartner predicts that, through 2020,
95%
Of cloud security failures will be the customer's fault.

94% of business claimed saw an improvement in security after switching to the cloud. 91% said it the cloud makes it easier to meet government compliance requirements.



“This growth is being driven by rapidly-digitizing industries like healthcare, financial services, and manufacturing, where industry clouds are becoming the cornerstones for next-generation growth and innovation strategies.”

-Frank Gens (Senior VP, IDC)



Challenges

- Data hacking issues related to industrial cloud platform hinders the growth
- Shortage of skilled technicians required for the adoption and maintenance of industrial clouds will restrain the growth
- Improper documentation of cloud strategy hampers the optimization of tool, it is estimated that only one-third of enterprises have a proper documented cloud strategy
- Unavailability of standardized security requirement results in poor due diligence on cloud service providers
- Isolated data and network technology hampers the optimal usage of cloud



Competitive Landscape



- The Industrial Cloud market has shown significant growth in previous years with high demand for industrial cloud in developing regions
- The betterment in technological innovation has resulted in high competition and users activities for which vendors have started providing specific application merchandise for end-users

3D Printing

USD28.8 bn

The projected size of global 3DP market by 2024 as compared with USD9.9 bn in 2018, growing at a CAGR of 23.8% during 2019 – 2024

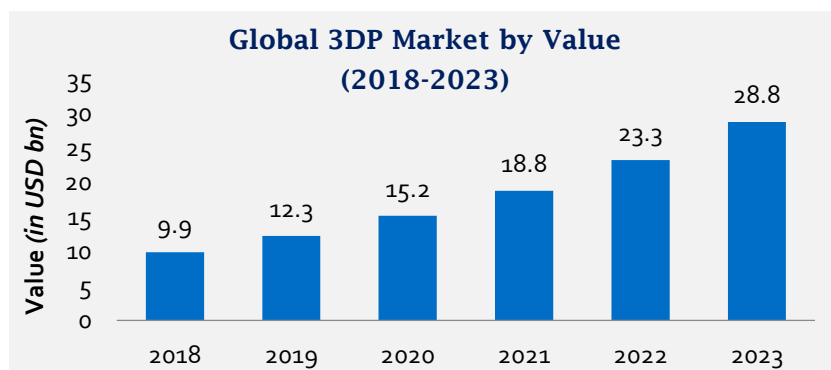
North America

Market is expected to hold the largest share (by value) of the global 3DP market, while APAC is expected to register the highest growth worldwide



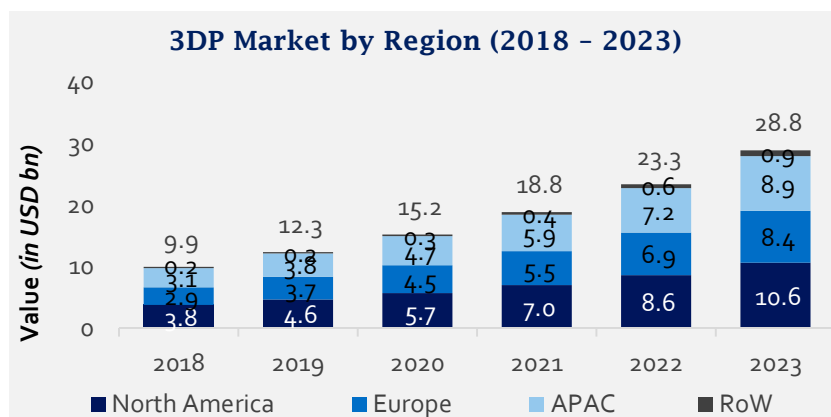
Market Overview

- Key factors facilitating the growth of 3DP market include ease in development of customized products, reduction in manufacturing cost and process downtime, government investments in 3DP projects, and development of new industrial-grade 3DP materials
- The 3DP applications are moving away from just prototyping to functional part manufacturing in various verticals, such as automotive, medical devices, aerospace and consumer goods



Geographic Landscape

- In **North America**, there have been a series of new product launches, mergers and acquisitions in the 3DP space, also various government organizations, such as NASA and Air Force Research Laboratory, are investing heavily in 3DP technologies
- With the presence of many global automotive OEMs, **Europe** enjoys the broad-scale implementation of 3DP technology for design formulation and R&D applications in the automotive industry
- In **APAC**, the governments of China, Japan and Singapore have committed millions of dollars to develop and commercialize 3DP, driving the growth of the market



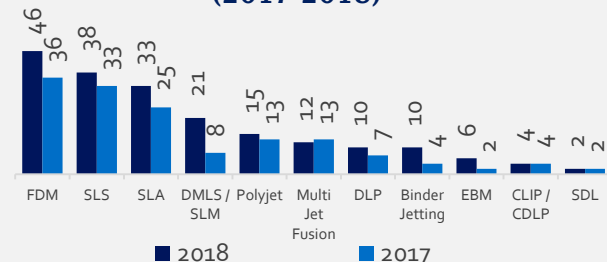
Source: MarketsandMarkets Research, Forbes



Technology Overview

- According to Sculpteo's The state of 3DP 2018 report, Fused Deposition Modeling (FDM), the first 3DP technology, is still the most used 3DP technology, followed by Selective Laser Sintering (SLS)
- These are the most common technologies used by professionals due to their cost effectiveness, lower complexity and ease of use for any project
- In case of metal 3DP, DMLS and SLM 3D printers are the most commonly owned and used

Leading 3DP Technologies, by %, Global (2017-2018)



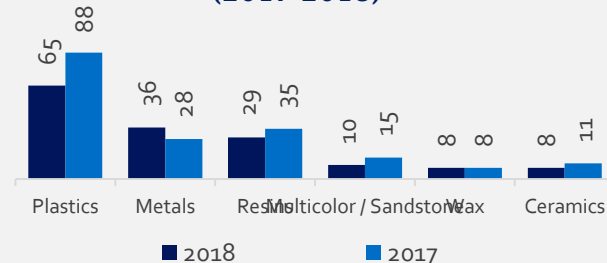
Source: Sculpteo – The state of 3D printing 2018 report



Advances in material technology

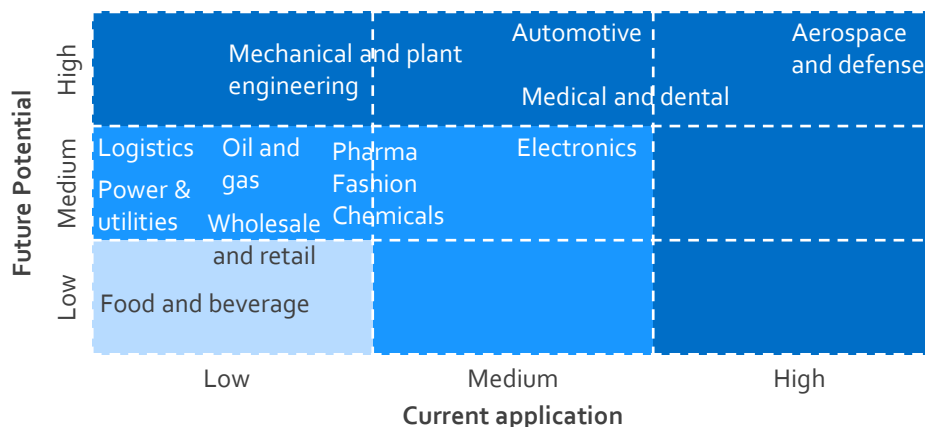
- 3DP and materials are directly correlated, as advancement in one generates the need for disruption in the other
- Currently 3DP uses a broad range of materials, that include plastics, porcelain, ceramics, stainless steel, carbon, graphene, titanium among others
- The 3DP wave has resulted in the creation of next wave ceramics, and techniques such as honeycombing
 - Honeycombing generated metallic micro lattice, one of the lightest metallic structures ever made, is already being leveraged by the automotive and aerospace industries

Leading 3DP Materials, by %, Global (2017-2018)



Source: Sculpteo – The state of 3D printing 2018 report

3DP's Futuristic Applications are Expected to Affect Manufacturing Processes Across Industries



Select 3DP Use Cases

- Aerospace:** Reduces aircraft weight, strengthens materials and streamlines design
- Automotive:** Allows newer designs, reduced lead times and decreased costs
- Medical:** Offers customized prosthetics, and enables bio-printing, where scientists print human-sized bones, cartilage and muscle



Key Players



- The 3DP technology patents of US-based Stratasys and 3D Systems for their fused deposition modeling (FDM) and stereolithography (SLA) technologies, respectively, has expired
- This has opened several opportunities for emerging companies, as new entrants can easily get access to Additive Manufacturing (AM) technology and make modifications based on their unique requirements

Digital Twins



Market Overview

- Growth in IoT and cloud-based platforms, surge in adoption of 3DP technology in the manufacturing industry and objective to reduce project cost are some of the major factors driving the growth for the digital twin market
- Digital twin technology is being implemented in various industries such as manufacturing, energy & power, aerospace, oil & gas, automobile, and others, offering advanced testing and measurement solution on a real-time basis.

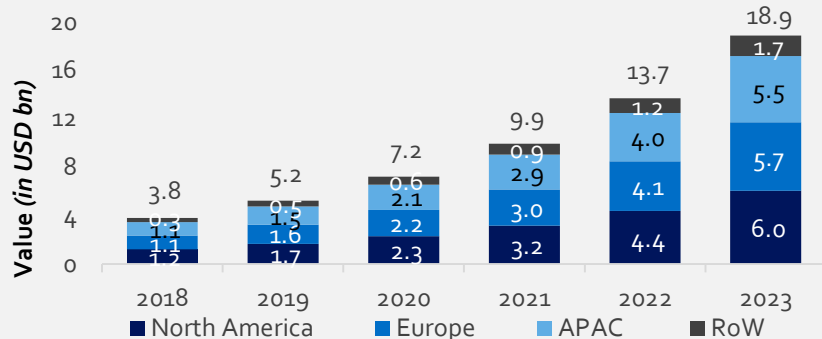
USD18.9 bn

The projected size of global digital twin market in 2025 as compared with USD3.8 bn in 2018, growing at a CAGR of 37.8% during 2019 – 2025

North America

Market is expected to hold considerable shares (by value) in digital twin technology, as the IoT industry in aerospace, automotive and manufacturing is mainly dominated by North America

Digital Twins Market Size by Region (2018 – 2023)



Source: MarketsandMarkets Research



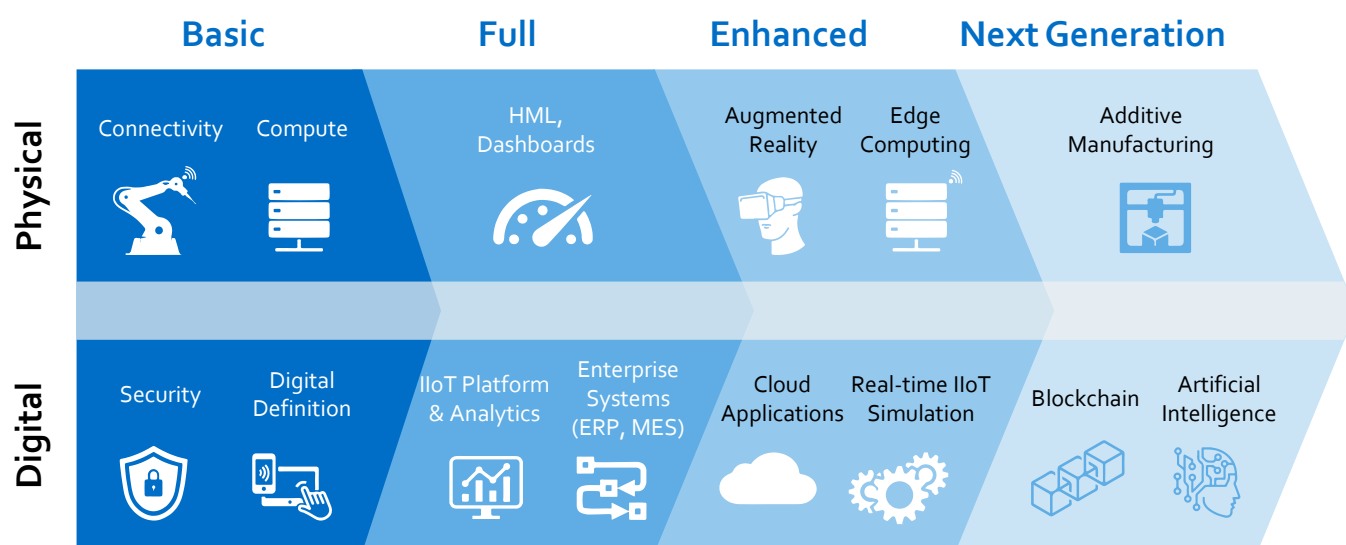
Geographic Landscape

- **APAC** is expected to be the fastest growing region due to the high rate of adoption of digital twins capable of connecting data collected from sensors with IoT cloud
- The North American and European regional markets together accounted for more than 50% of the global market share
 - As these regions have some of the most prominent technology giants and also possess a unique research ecology



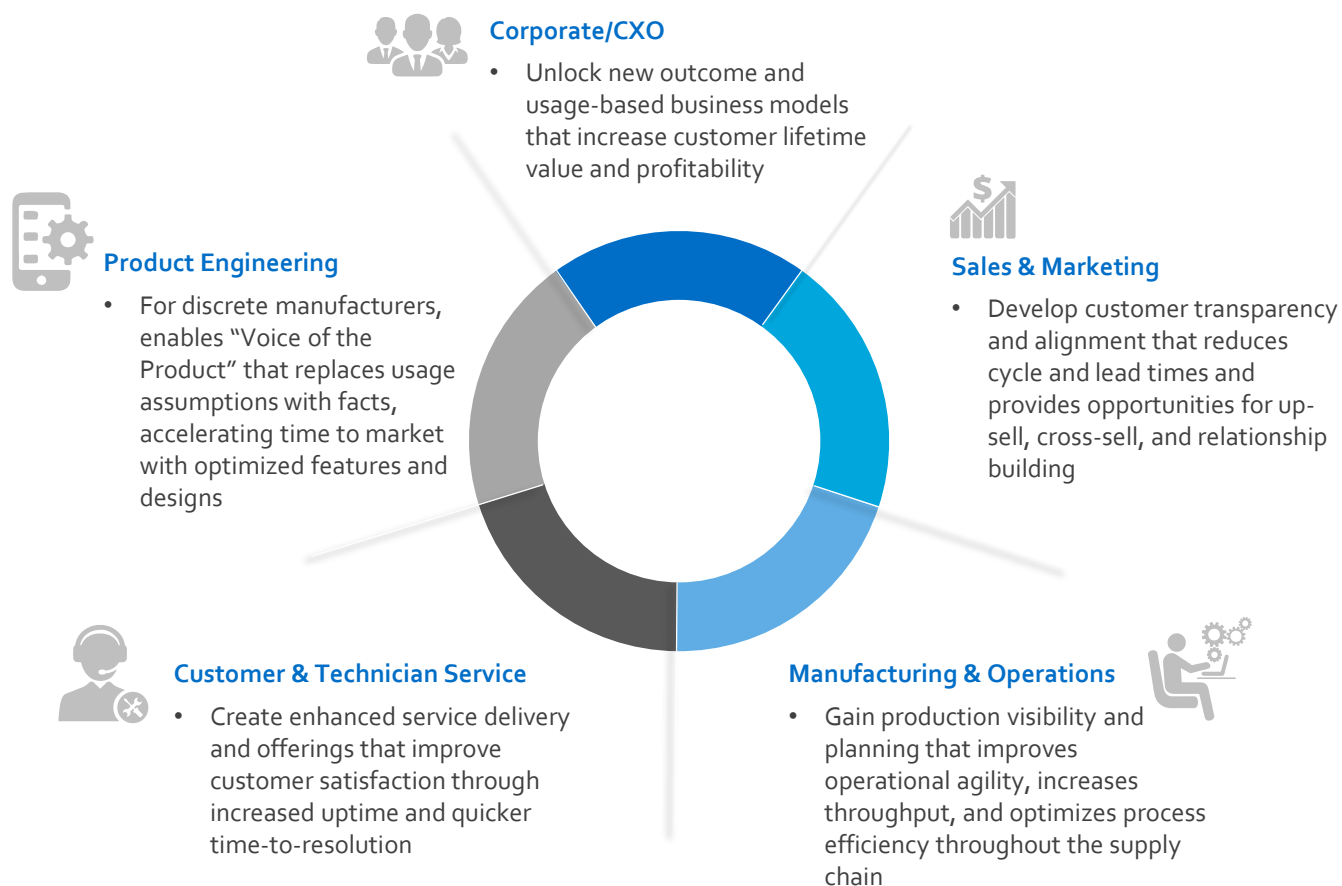
Technology Overview

- Various emerging technologies span the digital twin stack creating tangible business value for smart connected products and operations
- However each technology differs in some form of functionality, complexity and integration
- The more technology systems added, the more 'full' the twin becomes, creating a digital thread, which adds challenges and opportunities for enterprise adopters and technology providers alike



Basic	Full	Enhanced	Next Generation
• The physical asset must have the compute power to generate data and access to servers or the cloud for further processing and storage • The means to transmit this data requires reliable connectivity, through a LTE cellular network or a local wide area network	• As the digital twin matures, there needs to be another layer of control and actionability • For this, an IIoT platform is required to connect, contextualize and interact with the physical systems to create a digital twin equipped with real-time sensor data and predictive analytics	• Edge computing enables the physical connected asset to locally process data, only sending prudent data off the device • Locally available twin data could then be extended to front-line worker's through augmented reality (AR) headsets • IIoT simulation predicts real-time outcomes	• Product designers equipped with real-world operational performance can adapt virtual product models and 3D print the next rendition of products • Artificial Intelligence (AI) can reveal new operational insights and improve asset efficiencies from the integrated twin data sources

Key Digital Twin Applications Across the Value Chain



Key Players



ANSYS

SIEMENS



- As many regional and global players are competing to gain a share in the market with their technological expertise in digital twin solution, the global market for digital twin is expected to be fragmented
- In February 2019, Rescale became a partner with Siemens PLM to offer digital twin solutions through Siemens' Simcenter on Rescale's ScaleX cloud platform. This partnership is expected to provide a seamless offering of digital twin solutions on a cost-effective cloud platform.
- In March 2019, Siemens signed an acquisition agreement with a Saab Medav Technologies GmbH (Germany) for noise, vibration, and harshness (NVH) end-of-line quality testing business of Saab. This acquisition improved the quality testing for Siemens product digital twin
- In June 2018, ANSYS and SAP (Germany) partnered to build unique solutions for predictive maintenance of industrial assets, enabled by ANSYS Twin Builder

Source: PTC, Mordor Intelligence, MarketsandMarkets

Industrial Cyber Security

USD27.3 bn

Market for cybersecurity in 2025 as compared with USD15.1 bn in 2018, growing at a CAGR of 8.8% during 2019 - 2025

North America

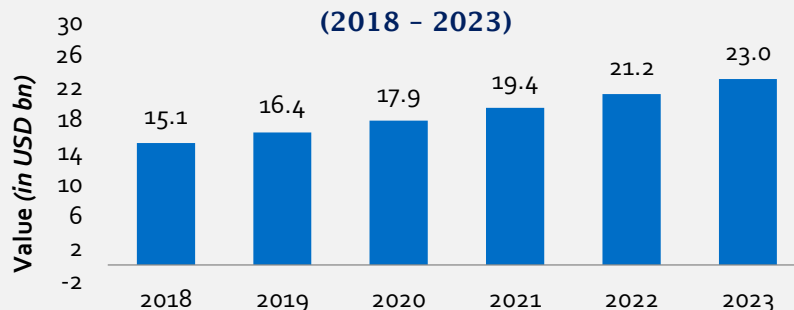
accounts for 53% of the market due to its leading position in advancements in technology, manufacturing processes and industrial infrastructure



Market Overview

- For the effective implementation of Industry 4.0 technologies, it is imperative to deploy cybersecurity strategies that are secure, vigilant and resilient, as well as fully integrated into organizational strategy from the start
- The market is majorly driven by the adoption of machine-to-machine (M2M) communication in smart factories and the implementation of Industrial Internet of Things (IIoT)

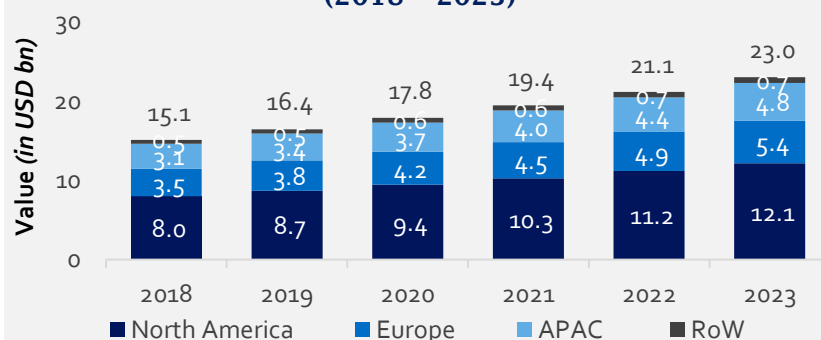
Global Industrial Cyber Security Market by Value (2018 - 2023)



Geographic Landscape

- Also, it is the hub for large number of companies which are early adopters of IIoT and other technologies
- Europe** is the second largest market, with UK, France and Germany making significant investments, as reports suggest that cyber-attacks in EU5 countries have expanded five times between 2013 and 2017
- APAC** is a close third in terms of market share and is also expected to register the highest CAGR, due to the major technology-driven manufacturing hubs in China and the software service industry in India

Industrial Cyber Security Market by Region (2018 - 2023)



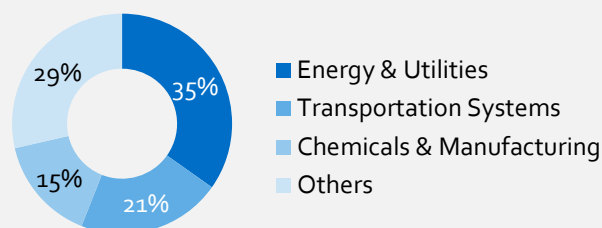
Source: Verified Market Research



Technology Overview

- The market for Transportation Systems is expected to grow at the highest CAGR
- Transport networks have become increasingly digital, with a wide range of data flowing across systems, tracking and monitoring digital and physical networks
- As more devices and control systems are connected online, more vulnerabilities will appear, increasing the potential for disruption to physical assets
- Energy & utilities is the largest market as cyber-attack on a power generation plant can prove catastrophic
- For instance, in 2009, a malware manipulated the speed of centrifuges in a nuclear enrichment plant, causing them to spin out of control. This malware, now known as Stuxnet, was introduced into stand-alone networks via flash drives, and it autonomously spread across production networks
- Stuxnet's sophistication serves as a powerful example of cyberattacks' potential as weapons in the world of connected physical factories

Industrial Cyber Security Market, by End Users (2018)



Source: Verified Market Research

Smart Production Life Cycle and Cyber Risk

The modern connected digital supply networks, smart factories and connected devices themselves face several unique cyber risks. The actions operations and information security executives can take to address cyber risks are given below.

Production Life Cycle Stage	Categorization	Cyber Imperative	Objective
Digital Supply Network 	Secure, vigilant, resilient	Data sharing	Ensure integrity of systems so private, proprietary data cannot be accessed
	Secure, vigilant, resilient	Vendor processing	Maintain when processes cannot be validated
Smart Factory 	Vigilant	Health and safety	Ensure safety for both employees and the environment
	Vigilant, resilient	Production and process resilience	Ensure continuous production and recovery of critical systems
	Vigilant, resilient	Instrumentation and proactive problem resolution	Protect the brand and reputation of the organization
	Secure, resilient	Systems operability, reliability and integrity	Support the use of multiple vendors and software versions
	Vigilant, resilient	Efficiency and cost avoidance	Reduce operating costs and increase flexibility with remote site diagnostics and engineering
	Secure	Regulatory and due diligence	Ensure process reliability
Connected Objects 	Secure	Product design	Employ secure software development life cycle to produce a functional and secure device
	Vigilant	Data protection	Maintain the safety of sensitive data throughout the data life cycle
	Resilient	Remediation of attack effects	Minimize the effects of an accident while quickly restoring operations and security

Source: Deloitte University Press – "Industry 4.0 and cybersecurity", IoT Analytics



Key Players



- A number of industrial cybersecurity start-ups have popped up over the past few years trying to capture market share, as a result the market is expected to be fragmented in the short term
- For instance, Claroty, with investments from Schneider Electric, Siemens, and Rockwell Automation, has created a diverse cast of highly strategic investors that should help it grow its business

4

Market Dynamics

Key Market Trends



Enhancing Production through Predictive Maintenance

Optimal functioning of all equipment/machineries is crucial for maintaining the expected production levels. Any critical equipment damage is costly to manufacturers in terms of repairs and downtime and loss of productivity. Predictive maintenance technology is helping manufacturers significantly reduce costs, which in-turn is reshaping the entire manufacturing process. According to Information Technology Intelligence Consulting, an hour's downtime costs over USD100,000.

Predictive analytics, in association with IoT data, has created enormous opportunities for organizations working with machinery or various other tools that capture sensor data. Predictive maintenance is becoming the most sought-after integration for manufacturers that delivers a steady reduction in cost of capturing data and calculating predictive outputs.

Predictive maintenance programs monitor equipment using any number of performance metrics. By automating the data collection process through the use of IoT technology, manufacturers can develop a better understanding of how systems work and when they will fail. The ability to predict when maintenance should be performed saves manufacturers valuable time, money, and resources. Typically, monitoring tests can be conducted while equipment is in operation, which means there is no loss of production due to equipment shutdown.



According to McKinsey & Company, widespread adoption of predictive maintenance technologies could reduce maintenance costs by 20%, unplanned outages by 50%, while extend machinery life by years.

Manufacturing Analytics

Costs



- Waste rates
- Inventory turns
- Value-added analysis
- Cost productivity
- Overhead efficiency
- System complexity

Lead times



- Cycle times
- Setup times
- Material availability
- Machine uptime
- Customer service time

Production quality



- Vendor quality
- Production quality
- Data accuracy
- Cost of quality

Delivery reliability



- Vendor delivery performance
- Schedule adherence
- Order and schedule changes
- Lost sales



Increasing Integration of IoT in Industry 4.0

The manufacturers are capitalizing on the potential of the Internet of Things (IoT), which allows the integration of unique devices within an existing internet infrastructure. Such integration enables industry participants to achieve various goals such as increased efficiency, cost reduction, improved safety, product innovation, and meeting compliance requirements. IoT's existence is primarily due to three factors: widely available Internet access, smaller sensors, and cloud computing.

The industry participants worldwide are recognizing the potential of IoT that empowers them to make informed strategic decisions by providing critical information in real-time. According to MPI Group, ~34% manufacturers have implemented a company strategy or initiated their plans to introduce IoT technologies to their processes, while ~32% manufacturers have embedded IoT technologies into products.



According to The MPI Group, ~31% of production processes, and equipment and ~30% of non-production processes and equipment already incorporate smart device/embedded intelligence.

How IoT is changing Manufacturing Industry?

Predictive Maintenance

Predictive maintenance gathers data from various sources such as enterprise resource planning (ERP) systems, critical equipment sensors, production data, and computerized maintenance management systems (CMMS). Additionally, predictive maintenance helps in an early and real-time detection of deviations before occurrence of anomalies.

Remote Production Control

Large data sets can be analyzed through reallocating a company's computational resources to a custom cloud or connecting the device with PAAS/BAAS. It helps in monitoring various field devices such as valves, switches, and additional indication elements.

Asset Tracking

IoT-based asset management solutions eliminates manual asset tracking and errors bound to such manual data-input methods by offering real-time data business location, assets, statuses, and movements.

Logistics Management

Management of vehicle fleet through IoT-based devices helps auto manufacturers in reducing the costs associated with vehicles, staff, and transportation and achieving greater efficiency.

Digital Twins

IoT enhances efficiency by predicting failures in production process before affecting manufacturing targets. Additionally, it reduces service costs and improves customer satisfaction by enabling remote diagnostics and commissioning of products.

“IoT and predictive analytics are having a major impact on manufacturing, offering exciting new opportunities for connecting operations and transforming business processes. Innovation is driving business growth, and technology is enabling manufacturers to evolve with an increasingly digital-first business landscape.”

Michael Strand, Senior Vice President – Hitachi Solutions America



Increasing Focus from B2B to B2B2C

Business-to-business-to-consumer (B2B2C) is an integration of B2B and B2C business relationships for a complete product/service transaction. Manufacturers are shifting their focus towards B2B2C from the conventional B2B business model due to the underlying benefits it offers.

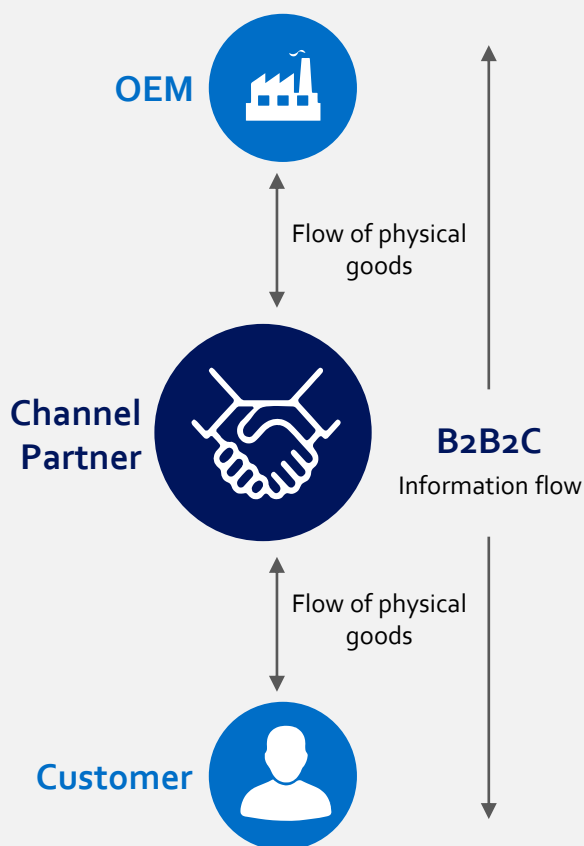
Manufacturers are finding it easier to directly sell to their customers with the emergence of eCommerce solutions. For instance, Tesla doesn't have dealerships for receiving and distributing cars, where customers buy directly from the manufacturers in a B2C environment. Contrary to its advantages, B2C model creates a lot of complexity for several manufacturers and customers.

Setting up direct-to-consumer B2C channels enables the manufacturer to talk directly to the end user and also allows consumers to gain direct and personalized buying experience. Additionally, such direct selling enables manufacturers to directly compete with their wholesalers and distributors.



B2B2C model is gaining stronghold with the convergence of B2B and B2C business models and becoming the new norm to run a business. The model is offering underlying opportunities within end customer engagement domain.

Benefits of B2B2C Business Model



Revenue

- Timely contract renewals
- Cross-selling and upselling
- Lead generation

Profit

- Cost reduction with predictive maintenance

Cash flow

- Timely invoicing with digital payments

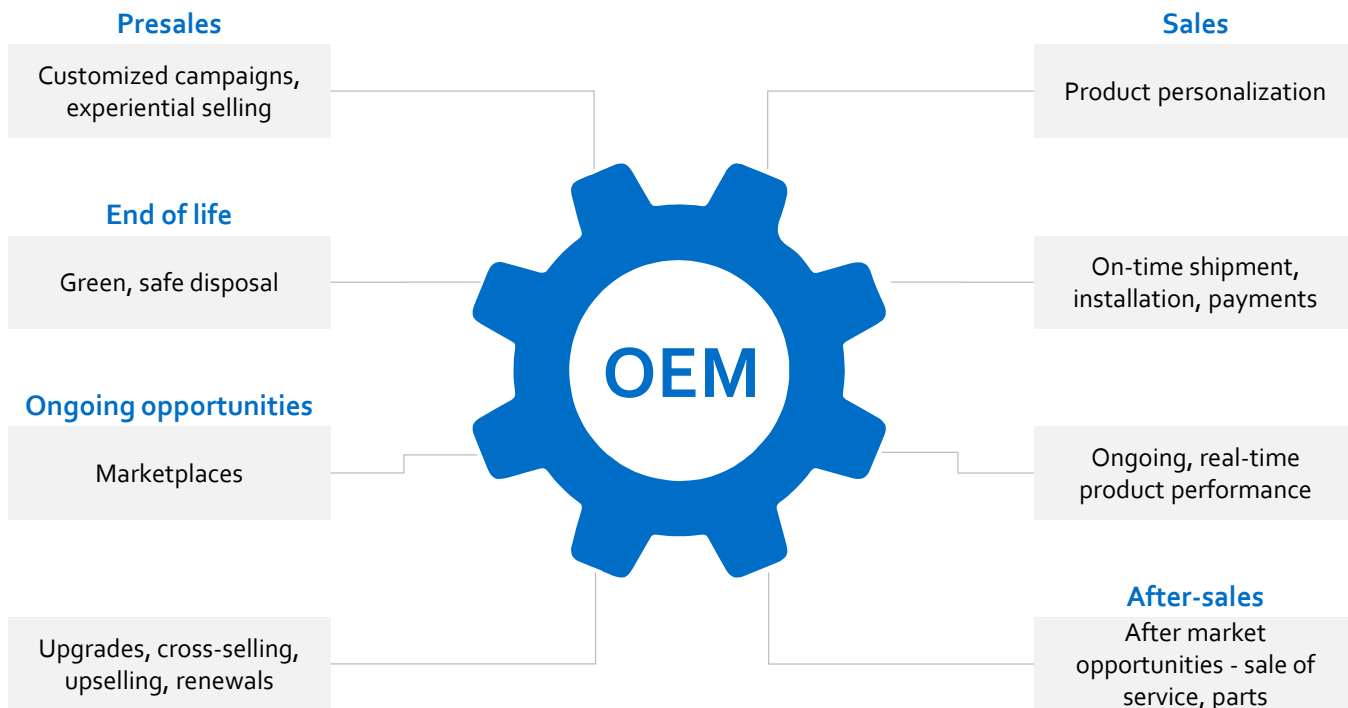
Customer engagement

- Brand recall
- Feedback for new products, offerings

Productivity

- Cycle time reduction for business processes

Opportunities for Customer Collaboration Enabled by B2B2C



B2B2C model enhances profitability through remote monitoring of products and on-time action to avoid downtime. The model improves profitability, encourage faster product marketing, creates better brand and price control, more efficiently manages customer data.



Leveraging Supply Chain for Competitive Advantage

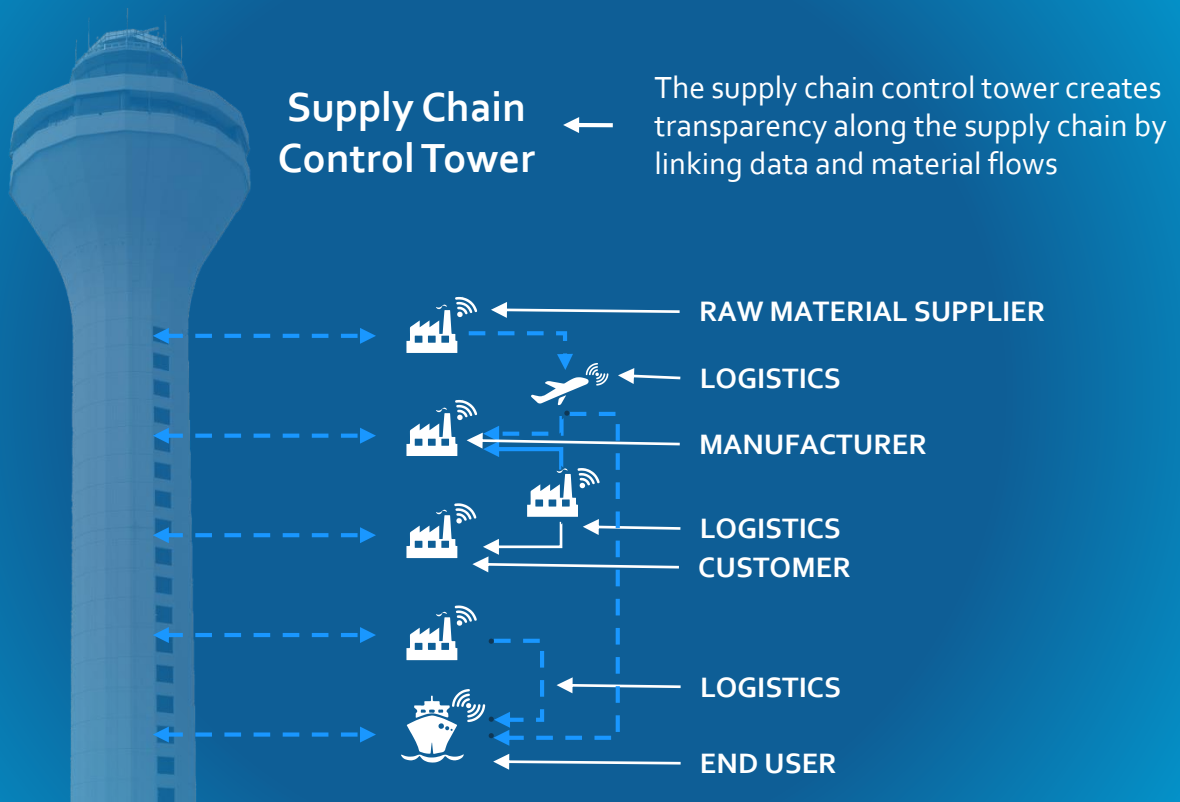
The Industry 4.0 revolution is redefining conventional manufacturing processes. The manufacturing industry is heading towards a more automated, digitized, efficient, and agile operation through offering enhanced supply chain network. The advanced supply chain integrates manufacturing, product development, and distribution networks into the fully transparent and digitized system. Fully automated and integrated supply chain help manufacturers in bring their supply chain online. Advancements in the supply chain technology solutions address manufacturing requirement in a variety of areas, including:



Industry 4.0 offers greater transparency and accuracy, data-backed decision making and cost saving, increased interconnectedness and collaboration, improved warehouse management, intelligent supply chain, and greater agility.

- | | |
|--|---|
| ➤ Manufacturing Optimization | ➤ Logistics Optimization |
| ➤ Sales and Operations Planning | ➤ Product Lifecycle Management |
| ➤ Business Intelligence | ➤ Network and Inventory Optimization |
| ➤ RFID | ➤ Procurement |

Industry 4.0 Supply Chain



Continuous Improvement in Processes through ERP Systems

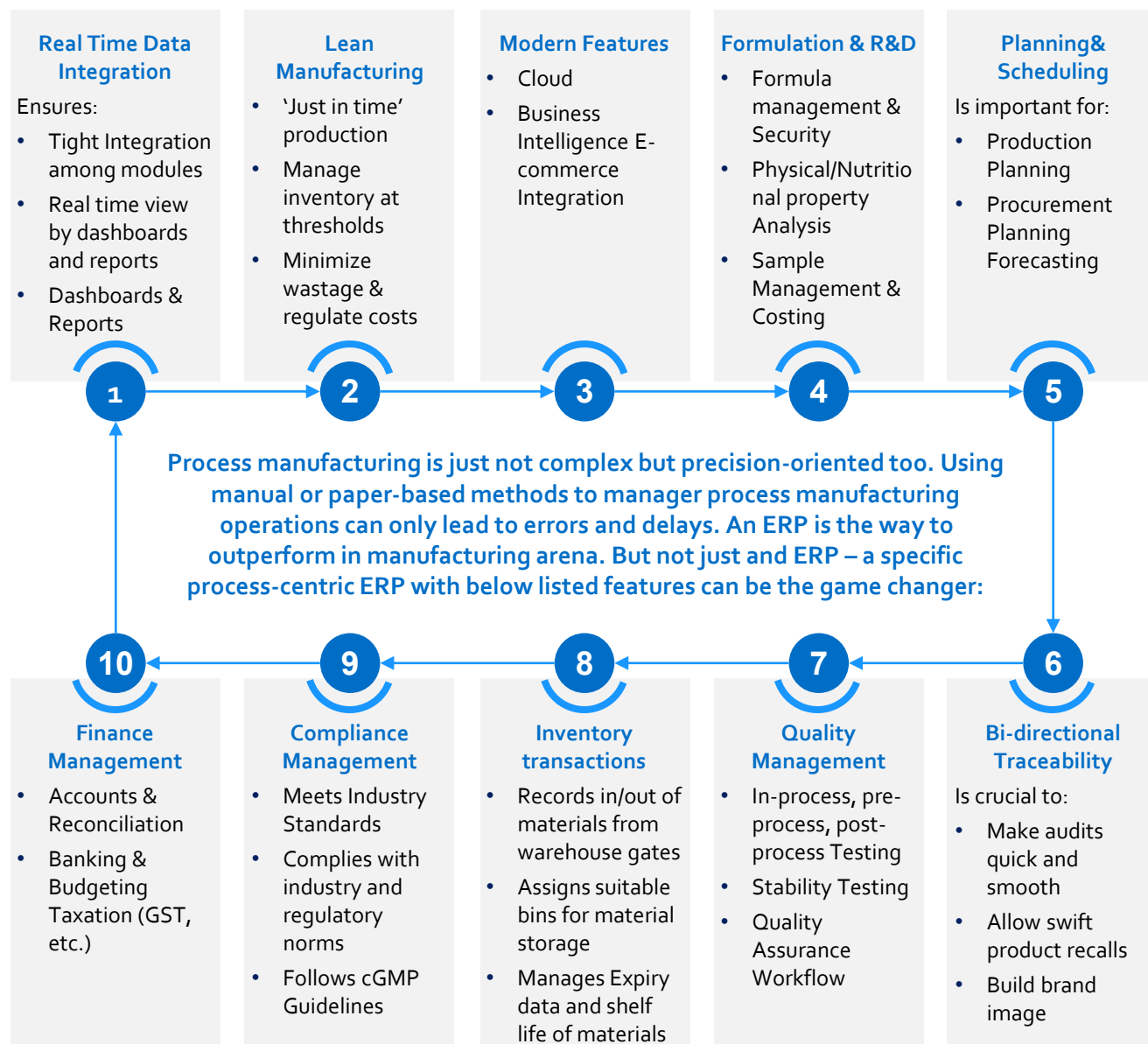
Enterprise resource planning (ERP) systems streamline processes by automating all business operations and providing accurate, and real-time information. Additionally, ERP systems reduce administrative and operational costs through providing accurate, and real-time information. Such benefits are allowing manufacturers to manage operations, prevent disruptions and delays, break up information roadblocks, and help users make quick decisions.

The lengthy implementation of traditional ERP systems can be frustrating for manufacturers. Now, however, companies have the option to choose a rapid implementation ERP system, which can be up and running much faster and more affordably than traditional ERP systems.



According to an ERP Software Market Report by Allied Market Research report, the global market is expected to garner USD41.69 bn by 2020.

Features of ERP Software in Manufacturing



Benefits of ERP in Manufacturing Industry

➤ Respond to Market Conditions Quicker

➤ Enhance Customer Satisfaction

➤ Strategic Decision Making

➤ Automates and Streamlines Business Processes with greater Adaptability

➤ Reduce Costs



Gaining Visibility through Big Data

IoT collects data from various sources in conjunction with cloud computing that allows big data to transform every surface into a sensor for collecting data and providing real-time insights for manufacturers. Manufacturers can churn out data based on their requirement to have a thorough understanding of their business that is helpful in improving production, addressing issues before problems arise, and optimizing operations.

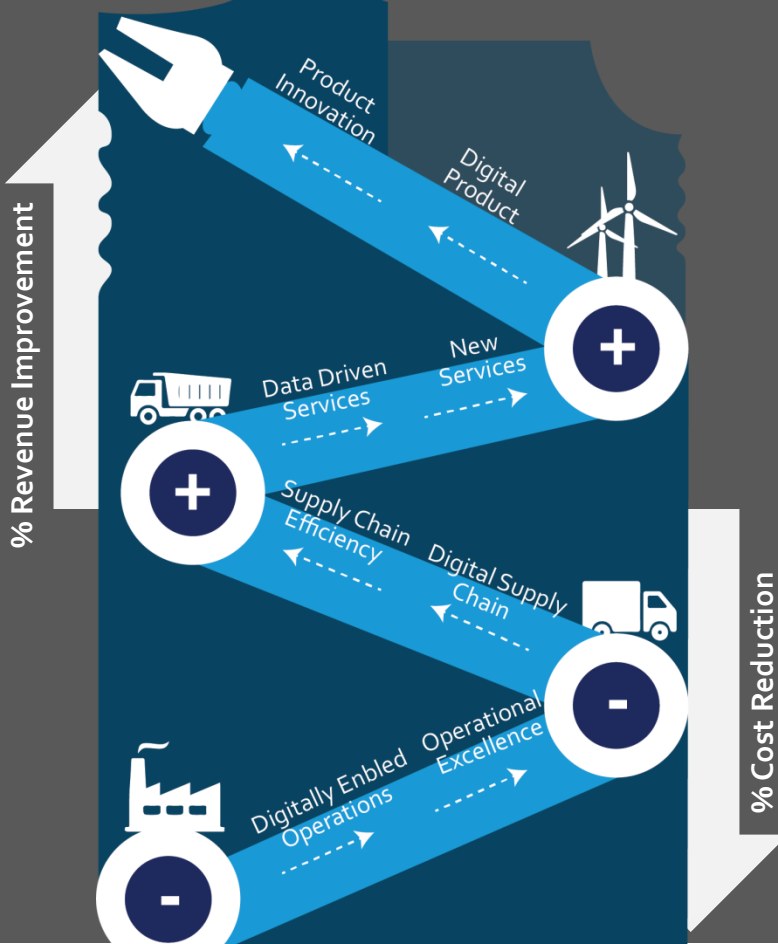
For instance, process manufacturing has a voluminous data stored since decades, which is underutilized as intricate access makes it difficult to generate actionable insights. Similarly, in asset-intensive manufacturing industry, big data can reduce breakdowns by ~26% and unscheduled downtime by ~23%.



According to Forbes, big data analytics can reduce breakdowns by as much as 26% and unscheduled downtime by as much as 23%.

Industry 4.0 and Big Data

Industry 4.0 Digital Transformation



Use Cases of Big Data in Manufacturing

- Risk Management
- Build to Order Configuration
- Improve Product Quality
- After-Sales
- Track Daily Production
- Data-Driven Enterprise Growth
- Predictive and Preventive Maintenance
- Overhead Tracking
- Testing and Simulation of New Processes
- Logistics

Source: Deloitte, Capgemini, Actify, Thrive



VR and AR are Forging Winning Man-Machine Partnerships

Assistive technologies, such as virtual reality (VR) and augmented reality (AR) are expected to benefit manufacturers through creating partnerships between man and machine. VR software helps product developers through seamless interfacing with computer-aided designs to make the required modifications and additions to products during designing phase. Additionally, AR/VR significantly reduce inspection time, help in detecting errors, and enhance workers' sight line, that allow developers to complete tasks faster.

For instance, computer-generated graphics in a worker's field of vision offer real-time assistance while performing a task by using AR devices including electronic glasses or goggles. Additionally, AR technology could be used with sensors and cameras for quickly training unskilled workers on executing a task and feeding data.



Industrial applications of AR are bringing new possibilities through transforming the product designing process. Computer simulations provide a better insight into the behavior of materials and equipment in the real world.



Faster and Cheaper Production through 3DP

3DP will benefit manufacturers through faster, and less expensive production. 3DP is gaining stronghold worldwide with proven applications including prototyping and product development, low-volume manufacturing, production-grade mechanical parts manufacturing, and mechanical applications such as implants, models, guides, and dental.

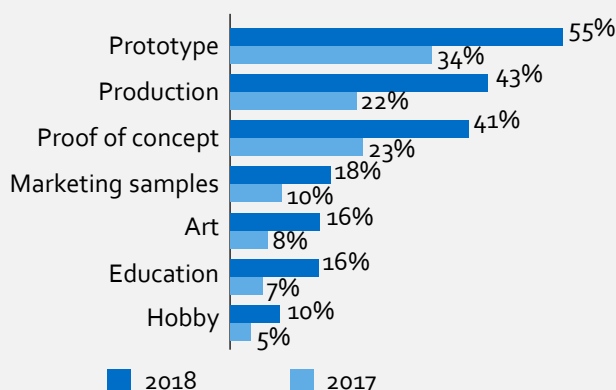
3DP offers cost-effective and fast prototyping for product designers for testing and troubleshooting their products. Further, it enables manufacturers for efficient on-demand. 3DP allows cost-effective completion of on-site. Major industries such as automotive and aerospace manufacturing industries have recognized the potential of the technology and are in the process of further implementation.

According to A.T. Kearny, estimates, the global 3DP industry will exceed USD17 bn by 2020. In 2018, over 18% of manufacturing companies were using 3DP and the industry is showcasing an increasing rate of adoption.

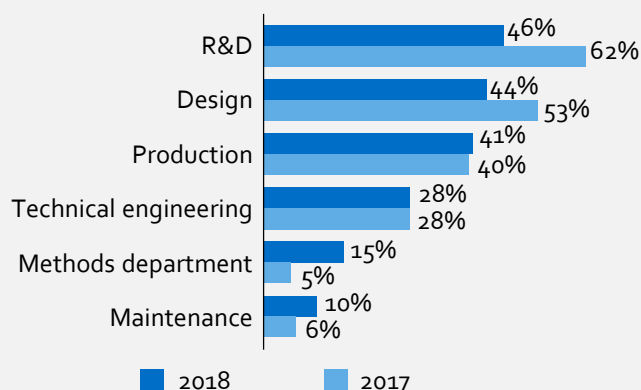


According to a report by PwC Strategy&, the 3DP technology is entering an era of major growth with the industrial market for 3D printed products and technologies expected to exceed USD26 bn within a decade.

3DP by Applications



3DP Users by Department



Source: Deloitte, Leyton, Immersa Labs

Technology Innovations in Factory Automation



Factory Automation

- Technical integration of cyber-physical systems (CPS) into Production and Logistics and the use of the Internet in industrial processes
- Includes making production lines more efficient, making more effective use of resources, and improving productivity



Virtual, Augmented & Mixed Reality

- Enables workers to access digital information and communicate that information with the physical world
- Applied in product design, production line development, driving OEE improvements, technical & engineering support, inventory management etc.



Digital Twins

- A Digital Twin is an exact virtual replica, updated in real-time, of a physical object, process, or product
- Engineers can run simulations on digital twins and can predict breakdowns, plan maintenance schedules, improve OEE, and more



Cyber-Physical Systems

- CPSs are integrations of computation, networking, and physical processes
- Complete integration is achieved with the use of sensors and digital twins
- With the combination of digital twins and CPS, industries see what happens to the process at real time



Big Data Analytics

- An advanced machine learning algorithm analyzes process data collected from production systems
- Analysis provides warning for anomalies and system failures and predicts product quality



Cobots

- A cobot or a collaborative robot
- Physically interacts with humans in a shared workspace
- Enable further automation in a way that human workers are not replaced but enhanced to perform more intricate roles



Small Batch & Mixed Manufacturing

- Offers customers individual product customization options
- Also creates new business opportunities

Challenges



Challenges and Barriers

The application and development of advanced technologies is quite expensive and also involves risk of uncertain returns; however, it ensures considerable savings, thus increasing revenue for those who make the decision early. Key manufacturing industries such as automotive, and electronics progress, develop and rapidly deploy applications to stay competitive. Some factors may hold back or obstruct the spread of Industry 4.0. The biggest obstacle to the implementation of Industry 4.0 is the lack of a clear digital strategy in value-creating across production and logistics processes, and supporting for corporate executives for the introduction of digital technology.

Data security is the critical point for development that requires secured access control for networks, sensors, and devices. New entrants can also appear with smart products with market-related services to implement and innovate a new type of customer-centric business model, and possibly extend the boundaries of the industry. The production of smart products requires a new kind of technology, capabilities and processes throughout the value chain. The businesses are required to realistically visualize the gap between the kind of capabilities they may develop and what requires to develop those capabilities. Additionally, companies are required to understand what requires to be involved with an external partner.

Factors Preventing the Spread of Industry 4.0

Cultural Market Obstructing Factors	Labor Market Obstructing Factors	Organizational Obstructing Factors	Technological Obstructing Factors
Distrust	Inadequate quality workforce	Lack of digital strategy	Expensive technologies
Uncertainty	Shortages among workforce	Risky investment	Lack of standards
Realistic judgement of the abilities of the organization	Old-fashioned training	Fear of loss of control over intellectual property	Security of data, uncertainty regarding the level of encryption
Lack of demand for continuous learning		Partners do not have the technology	Underdeveloped data analysis
		Failure to develop data-based services	
		Lack of senior management support	



5

Market Outlook

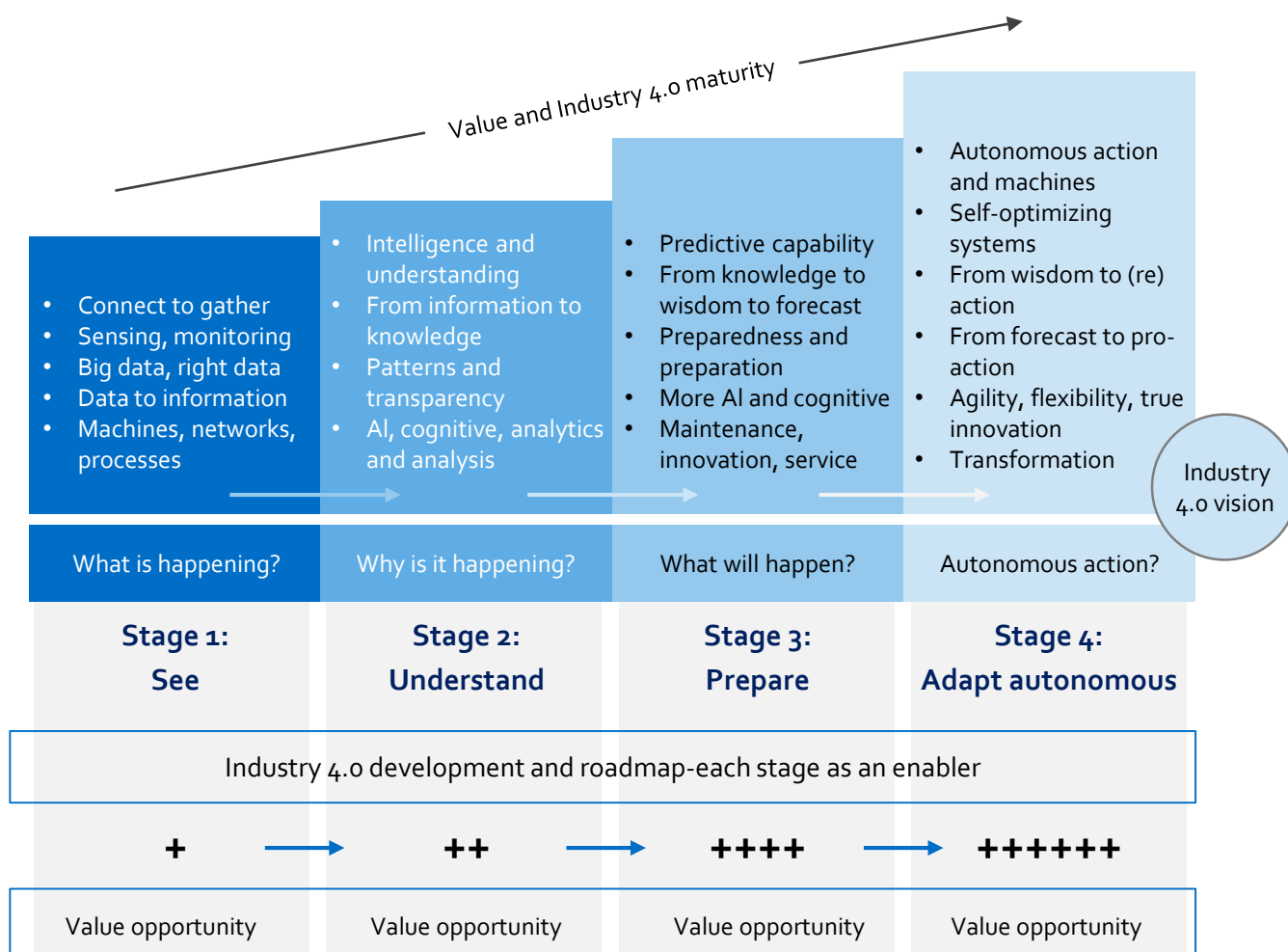
Market Outlook



Where Industry 4.0 is Heading

According to a study, The Industrial Internet of Things, conducted by PricewaterhouseCoopers, USD6 tn will be spent on IoT solutions during 2015 - 2020 (compounded). Further, business investment will grow from USD215 bn to USD832 bn versus consumers at USD72 bn in 2015 to USD236 bn in 2020. Additionally, combined businesses, governments and consumers will invest ~USD1.6 tn to install IoT solutions in 2020. Moreover, software and application development are predicted to make up the majority of the investment.

Evolution of Industry 4.0 in Future



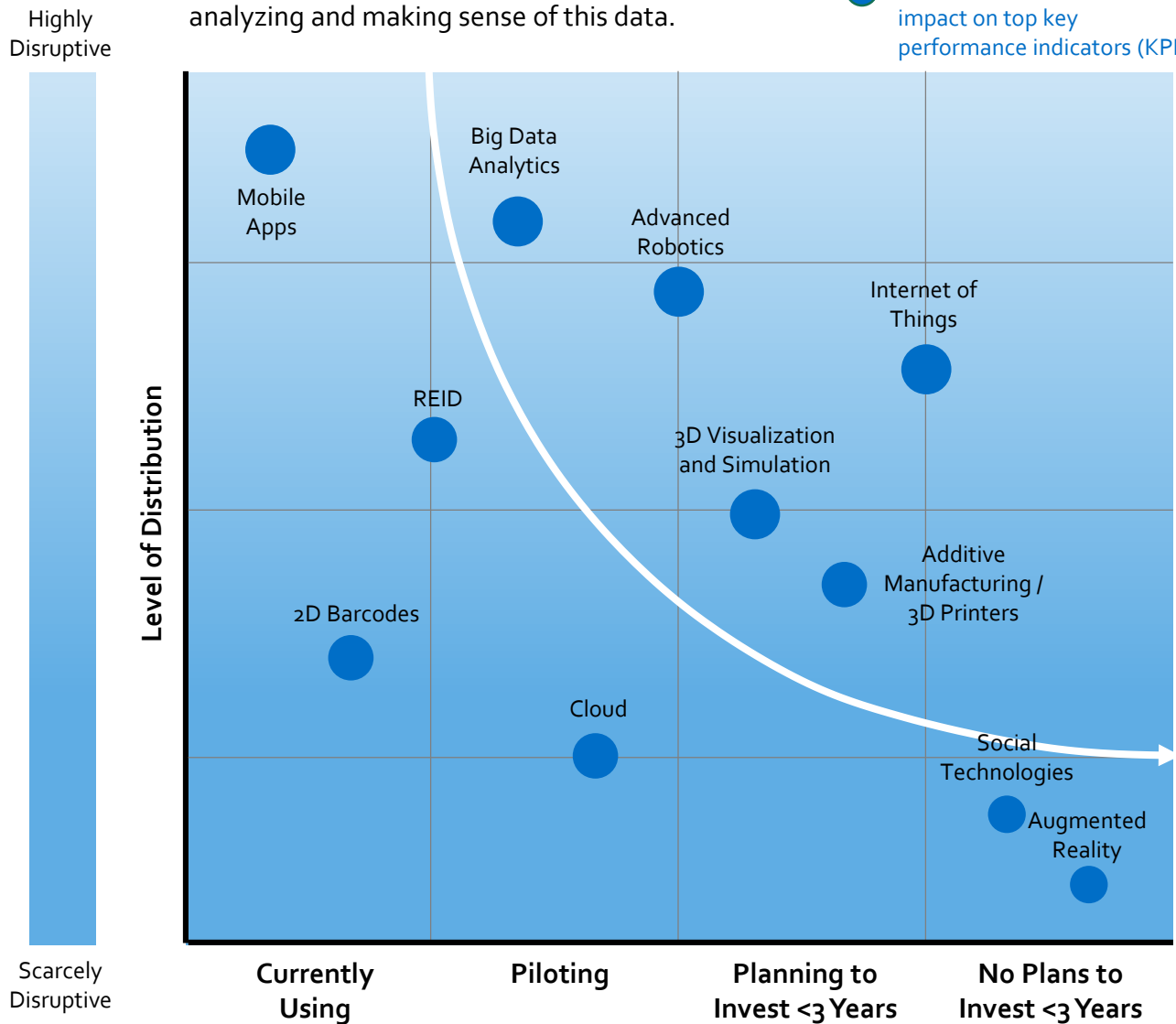


Potential Technologies by Investments

Investment Priority Timeline

Companies are already heavily investing in analyzing and making sense of this data.

● Bubble size reflects level of impact on top key performance indicators (KPIs)



- The market participants are focusing more on the mobile apps and focusing on continuously investing in application development
- The industry 4.0 is evolving in line with ongoing research and development activities in various technologies including cloud, big data analytics, and advanced robotics
- Further, major players in manufacturing industry have identified the importance of potential technologies such as 3D visualization, additive manufacturing/3DP, and internet of things and are planning to invest in these technologies within less than three years

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Trading and Transactions

Trading Comparables

(in USD mm)	Market Cap (\$m)	Enterprise Value (\$m)	EV/Sales			EV/EBITDA			EV/EBIT			P/E			
Company			LTM	2019E	2020E	LTM	2019E	2020E	LTM	2019E	2020E	LTM	2019E	2020E	
Autonomous Robotics															
Midea Group Co. Ltd.	\$55,777	\$58,725	1.5x	1.5x	1.4x	14.5x	13.8x	12.1x	16.0x	16.3x	13.8x	16.2x	16.4x	14.5x	
ABB Ltd.	47,674	55,734	2.0x	2.0x	2.0x	16.3x	14.6x	13.2x	22.7x	19.1x	16.2x	50.1x	22.1x	20.2x	
Fanuc Corporation	39,288	34,587	6.9x	6.7x	6.4x	24.1x	22.9x	18.1x	33.4x	31.5x	28.8x	38.4x	44.8x	43.2x	
OMRON Corporation	12,749	12,075	1.7x	1.8x	1.8x	14.2x	14.9x	14.0x	20.2x	22.0x	19.9x	27.9x	33.2x	30.5x	
Teradyne, Inc.	10,670	10,189	4.7x	4.5x	4.1x	16.7x	15.7x	14.1x	20.7x	18.1x	15.9x	21.9x	22.4x	19.8x	
Yaskawa Electric Corporation	9,828	10,092	2.5x	2.6x	2.4x	23.0x	25.5x	22.4x	35.1x	35.1x	30.0x	45.4x	45.4x	37.2x	
Hyundai Heavy Industries Holdings Co., Ltd.	4,761	13,732	0.6x	0.6x	0.6x	15.2x	11.4x	8.1x	38.2x	19.1x	9.9x	NM	12.2x	6.8x	
SIASUN Robot & Automation Co., Ltd.	2,978	3,089	7.5x	6.9x	6.0x	42.4x	36.2x	33.6x	67.7x	43.2x	39.8x	50.3x	50.8x	44.5x	
Krones AG	2,222	2,522	0.6x	0.6x	0.6x	8.5x	9.2x	7.8x	17.3x	21.3x	14.4x	21.4x	25.0x	15.4x	
KUKA AG	1,735	2,160	0.6x	0.6x	0.6x	15.0x	11.2x	7.8x	154.4x	39.2x	16.3x	NM	39.4x	17.5x	
Nachi-Fujikoshi Corp.	1,186	1,867	0.8x	0.8x	0.8x	6.8x	6.6x	6.4x	15.0x	14.7x	14.7x	16.3x	15.7x	15.0x	
High			7.5x	6.9x	6.4x	42.4x	36.2x	33.6x	154.4x	43.2x	39.8x	50.3x	50.8x	44.5x	
Average			2.7x	2.6x	2.4x	17.9x	16.5x	14.3x	40.1x	25.4x	20.0x	32.0x	29.8x	24.1x	
Median			1.7x	1.8x	1.8x	15.2x	14.6x	13.2x	22.7x	21.3x	16.2x	27.9x	25.0x	19.8x	
Low			0.6x	0.6x	0.6x	6.8x	6.6x	6.4x	15.0x	14.7x	9.9x	16.2x	12.2x	6.8x	
3DP (Additive Manufacturing)															
Proto Labs, Inc.	\$2,636	\$2,503	5.4x	5.5x	5.2x	19.3x	20.6x	19.2x	29.9x	28.4x	26.2x	38.9x	35.6x	33.3x	
3D Systems Corporation	1,018	993	1.5x	1.6x	1.5x	NM	33.1x	19.6x	NM	NM	51.4x	NM	NM	118.7x	
Stratasys Ltd.	1,010	686	1.0x	1.1x	1.0x	16.7x	10.3x	9.8x	NM	18.2x	16.2x	NM	32.0x	29.2x	
Materialise NV Sponsored ADR	916	920	4.2x	4.2x	3.7x	42.4x	28.9x	23.9x	NM	59.7x	46.4x	NM	83.2x	59.4x	
Xi'an Bright Laser Technologies Co. Ltd.	543	489	10.2x	8.7x	6.7x	44.9x	43.2x	35.3x	74.5x	58.4x	46.7x	51.4x	57.4x	43.0x	
SLM Solutions Group AG	338	382	6.0x	4.5x	3.9x	NM	NM	72.6x	NM	NM	NM	NM	NM	NM	
Groupe Gorge SA	234	376	1.1x	1.2x	1.0x	13.0x	11.7x	9.6x	39.7x	31.3x	18.4x	NM	12.0x	18.4x	
Prodways Group SA	145	142	1.8x	1.8x	1.6x	43.2x	23.5x	15.0x	NM	NM	190.6x	NM	NM	110.1x	
ExOne Co.	115	112	1.8x	2.0x	1.7x	NM	NM	NM	NM	NM	NM	NM	NM	NM	
voxeljet AG Sponsored ADR	41	50	1.9x	1.8x	1.5x	NM	NA	NA	NM	NM	NM	NM	NM	NM	
CollPlant Biotechnologies Ltd	27	28	5.0x	10.3x	4.4x	NM	NA	NA	NM	NM	NM	NM	NM	NM	
Nano Dimension Ltd	12	10	1.4x	NA	NA	NM	NA	NA	NM	NA	NA	NM	NA	NA	
High			10.2x	10.3x	6.7x	44.9x	43.2x	72.6x	74.5x	59.7x	190.6x	51.4x	83.2x	118.7x	
Average			3.5x	3.9x	2.9x	29.9x	24.5x	25.6x	48.0x	39.2x	56.5x	45.2x	44.0x	58.9x	
Median			1.9x	2.0x	1.7x	30.8x	23.5x	19.4x	39.7x	31.3x	46.4x	45.2x	35.6x	43.0x	
Low			1.0x	1.1x	1.0x	13.0x	10.3x	9.6x	29.9x	18.2x	16.2x	38.9x	12.0x	18.4x	

Source: FactSet

(in USD mm)	Market	Enterprise	EV/Sales			EV/EBITDA			EV/EBIT			P/E		
Company	Cap (\$m)	Value (\$m)	LTM	2019E	2020E	LTM	2019E	2020E	LTM	2019E	2020E	LTM	2019E	2020E
Simulation														
Microsoft Corporation	\$1,159,807	\$1,109,145	8.6x	8.3x	7.5x	19.4x	18.9x	16.6x	24.4x	24.0x	21.1x	28.2x	29.7x	26.4x
Cisco Systems, Inc.	192,217	182,679	3.5x	3.6x	3.5x	11.2x	9.9x	9.8x	12.7x	10.9x	10.7x	17.5x	14.0x	13.8x
SAP SE	165,624	177,599	5.8x	5.8x	5.4x	20.8x	18.2x	15.9x	27.0x	19.7x	17.7x	43.3x	25.1x	22.7x
International Business Machines Corporation	119,641	180,316	2.3x	2.3x	2.3x	11.3x	10.2x	9.7x	17.2x	14.9x	12.8x	15.5x	10.4x	10.0x
Siemens AG	110,195	139,537	1.4x	1.4x	1.4x	11.9x	12.4x	11.7x	17.9x	17.5x	17.0x	18.9x	17.6x	16.7x
General Electric Company	99,126	169,363	1.5x	1.7x	1.8x	10.7x	15.3x	15.6x	18.6x	20.8x	20.7x	216.4x	18.3x	16.7x
Dassault Systemes SA	41,635	39,282	9.0x	8.8x	7.2x	28.2x	24.4x	20.6x	38.0x	27.6x	23.3x	59.2x	40.8x	35.2x
Autodesk, Inc.	37,506	38,670	13.2x	12.1x	9.9x	139.6x	45.8x	29.2x	236.8x	51.4x	32.0x	NM	64.9x	38.9x
ANSYS, Inc.	21,608	20,983	14.5x	13.9x	12.5x	36.9x	30.3x	27.0x	41.2x	31.1x	28.0x	49.3x	39.7x	36.4x
High			14.5x	13.9x	12.5x	139.6x	45.8x	29.2x	236.8x	51.4x	32.0x	216.4x	64.9x	38.9x
Average			6.7x	6.4x	5.7x	32.2x	20.6x	17.4x	48.2x	24.2x	20.4x	56.0x	29.0x	24.1x
Median			5.8x	5.8x	5.4x	19.4x	18.2x	15.9x	24.4x	20.8x	20.7x	35.8x	25.1x	22.7x
Low			1.4x	1.4x	1.4x	10.7x	9.9x	9.7x	12.7x	10.9x	10.7x	15.5x	10.4x	10.0x
Cloud Computing														
Alphabet Inc. Class A	\$905,560	\$799,256	5.2x	4.9x	4.2x	17.6x	13.5x	11.6x	23.3x	16.8x	14.3x	27.8x	22.7x	21.3x
Amazon.com, Inc.	890,917	921,805	3.5x	3.3x	2.8x	26.7x	22.3x	18.6x	62.8x	45.0x	36.3x	78.5x	54.3x	42.3x
Alibaba Group Holding Ltd. Sponsored ADR	520,501	524,648	8.1x	7.6x	5.8x	32.5x	24.3x	18.9x	44.7x	29.2x	22.2x	23.6x	29.1x	23.3x
salesforce.com, inc.	142,548	142,938	9.7x	8.6x	7.0x	53.1x	33.3x	27.4x	214.6x	52.2x	38.9x	150.1x	58.9x	49.1x
VMware, Inc. Class A	67,564	71,030	7.3x	7.1x	6.5x	25.9x	18.6x	17.2x	34.9x	21.6x	19.5x	10.3x	24.9x	22.6x
Hewlett Packard Enterprise Co.	20,665	30,783	1.1x	1.1x	1.1x	6.4x	5.8x	5.8x	13.3x	10.9x	10.6x	19.7x	8.6x	8.6x
Citrix Systems, Inc.	14,841	15,303	5.1x	5.1x	4.9x	19.7x	14.4x	15.7x	26.7x	17.2x	17.1x	23.2x	19.6x	20.7x
Akamai Technologies, Inc.	14,332	14,969	5.3x	5.2x	4.9x	15.0x	12.4x	11.4x	26.9x	17.9x	16.4x	31.6x	19.8x	18.4x
Twilio, Inc. Class A	14,070	12,813	12.7x	11.5x	8.8x	NM	114.5x	89.3x	NM	NM	NM	NM	NM	367.5x
NetApp, Inc.	13,810	12,608	2.2x	2.2x	2.2x	10.5x	8.8x	8.8x	12.5x	10.0x	10.1x	13.9x	13.1x	13.2x
Nutanix, Inc. Class A	6,431	6,157	5.0x	4.7x	4.0x	NM	NM	NM	NM	NM	NM	NM	NM	NM
Q2 Holdings, Inc.	4,077	3,895	13.2x	12.3x	9.4x	NM	215.9x	193.1x	NM	NM	NM	NM	NM	NM
Cloudera, Inc.	2,729	2,536	3.9x	3.4x	3.0x	NM	122.8x	40.0x	NM	NM	NM	NM	NM	NM
High			13.2x	12.3x	9.4x	53.1x	215.9x	193.1x	214.6x	52.2x	38.9x	150.1x	58.9x	367.5x
Average			6.3x	5.9x	5.0x	23.0x	50.6x	38.1x	51.1x	24.5x	20.6x	42.1x	27.9x	58.7x
Median			5.2x	5.1x	4.9x	19.7x	20.5x	17.9x	26.9x	17.9x	17.1x	23.6x	22.7x	21.9x
Low			1.1x	1.1x	1.1x	6.4x	5.8x	5.8x	12.5x	10.0x	10.1x	10.3x	8.6x	8.6x
IIoT														
Intel Corporation	\$256,215	\$273,836	3.9x	3.9x	3.8x	8.5x	8.6x	8.4x	12.6x	12.1x	11.9x	13.2x	12.5x	12.7x
Cisco Systems, Inc.	192,217	182,679	3.5x	3.6x	3.5x	11.2x	9.9x	9.8x	12.7x	10.9x	10.7x	17.5x	14.0x	13.8x
Texas Instruments Incorporated	111,360	112,440	7.6x	7.9x	8.0x	16.1x	16.9x	17.3x	18.9x	19.1x	19.5x	21.6x	22.0x	22.7x
Schneider Electric SE	56,564	65,137	2.1x	2.2x	2.1x	11.7x	12.5x	11.7x	14.9x	15.5x	14.1x	21.6x	18.4x	17.1x
Emerson Electric Co.	45,339	49,606	2.7x	2.7x	2.7x	12.5x	12.7x	12.5x	15.8x	15.0x	14.8x	19.7x	20.0x	20.2x
Rockwell Automation, Inc.	22,684	23,883	3.6x	3.5x	3.4x	16.0x	16.8x	15.6x	17.8x	17.6x	17.4x	32.6x	21.9x	21.7x
PTC Inc.	8,717	9,088	7.2x	7.0x	6.1x	46.7x	25.9x	20.6x	77.9x	32.1x	23.3x	NM	41.6x	31.8x
Cypress Semiconductor Corporation	8,716	9,240	4.1x	4.2x	3.9x	24.0x	12.5x	NA	91.4x	19.6x	17.1x	30.4x	20.4x	17.8x
Advantech Co., Ltd.	7,106	6,919	4.0x	3.9x	3.5x	21.9x	20.0x	17.8x	24.4x	22.1x	19.5x	30.2x	27.9x	24.6x
Software AG	2,492	2,299	2.3x	2.3x	2.3x	7.6x	7.5x	7.9x	9.1x	8.7x	9.3x	13.1x	13.0x	14.7x
HMS Networks AB	741	789	4.8x	4.9x	4.6x	21.8x	22.8x	19.5x	26.3x	28.3x	24.3x	38.3x	34.8x	31.8x
AcSiP Technology Corp.	14	8	3.4x	NA	NA	NM	NA	NA	NM	NA	NA	NM	NA	NA
High			7.6x	7.9x	8.0x	46.7x	25.9x	20.6x	91.4x	32.1x	24.3x	38.3x	41.6x	31.8x
Average			4.1x	4.2x	4.0x	18.0x	15.1x	14.1x	29.2x	18.3x	16.5x	23.8x	22.4x	20.8x
Median			3.7x	3.9x	3.5x	16.0x	12.7x	14.1x	17.8x	17.6x	17.1x	21.6x	20.4x	20.2x
Low			2.1x	2.2x	2.1x	7.6x	7.5x	7.9x	9.1x	8.7x	9.3x	13.1x	12.5x	12.7x

Source: FactSet

(in USD mm)	Market	Enterprise	EV/Sales			EV/EBITDA			EV/EBIT			P/E		
Company	Cap (\$m)	Value (\$m)	LTM	2019E	2020E	LTM	2019E	2020E	LTM	2019E	2020E	LTM	2019E	2020E
Cyber Security														
Palo Alto Networks, Inc.	\$21,587	\$20,603	6.8x	6.6x	5.5x	76.0x	26.4x	23.7x	NM	32.7x	29.1x	NM	40.9x	37.3x
Check Point Software Technologies Ltd.	17,861	16,176	8.2x	8.1x	7.8x	17.9x	15.9x	15.2x	18.3x	16.2x	15.6x	22.6x	19.2x	19.0x
Check Point Software Technologies Ltd.	17,861	16,176	8.2x	8.1x	7.8x	17.9x	15.9x	15.2x	18.3x	16.2x	15.6x	22.6x	19.2x	19.0x
Fortinet, Inc.	17,851	15,952	7.8x	7.4x	6.5x	33.6x	27.8x	23.0x	51.3x	30.7x	26.0x	45.3x	42.2x	36.8x
NortonLifeLock Inc.	15,581	18,387	4.3x	5.4x	6.7x	15.0x	14.1x	15.8x	27.6x	19.8x	20.2x	103.9x	25.8x	26.5x
Akamai Technologies, Inc.	14,332	14,969	5.3x	5.2x	4.9x	15.0x	12.4x	11.4x	26.9x	17.9x	16.4x	31.6x	19.8x	18.4x
Trend Micro Incorporated	7,535	5,938	4.0x	3.9x	3.7x	12.3x	15.0x	14.4x	17.3x	15.7x	14.6x	28.0x	29.1x	28.2x
Proofpoint, Inc.	6,664	6,409	7.6x	7.3x	6.1x	NM	40.8x	34.0x	NM	53.5x	43.8x	NM	63.5x	52.1x
Cloudflare Inc Class A	5,641	5,006	19.4x	17.7x	13.3x	NM	NM	NM	NM	NM	NM	NM	NM	NM
CyberArk Software Ltd.	4,694	4,188	10.1x	9.7x	8.2x	53.9x	33.0x	29.8x	62.6x	34.7x	30.9x	70.6x	46.1x	42.4x
FireEye, Inc.	3,585	3,678	4.2x	4.2x	3.9x	NM	75.2x	36.8x	NM	NM	93.4x	NM	NM	97.5x
Rapid7 Inc.	2,743	2,758	9.1x	8.5x	6.9x	NM	242.2x	103.4x	NM	NM	204.4x	NM	NM	192.9x
Tenable Holdings, Inc.	2,695	2,440	7.3x	6.9x	5.6x	NM	NM	NM	NM	NM	NM	NM	NM	NM
Computacenter Plc	2,162	2,307	0.4x	0.4x	0.3x	11.5x	11.0x	10.8x	15.2x	12.6x	12.4x	20.4x	16.9x	16.2x
SecureWorks Corp. Class A	917	827	1.6x	1.5x	1.4x	NM	193.3x	67.7x	NM	NM	NM	NM	NM	NM
Absolute Software Corporation	265	235	2.3x	2.3x	2.2x	10.8x	11.5x	10.5x	21.1x	4.3x	4.0x	27.1x	30.5x	19.7x
High			19.4x	17.7x	13.3x	76.0x	242.2x	103.4x	62.6x	53.5x	204.4x	103.9x	63.5x	192.9x
Average			6.7x	6.5x	5.7x	26.4x	52.5x	29.4x	28.7x	23.1x	40.5x	41.3x	32.1x	46.6x
Median			7.1x	6.8x	5.8x	16.4x	21.2x	19.4x	21.1x	17.9x	20.2x	28.0x	29.1x	28.2x
Low			0.4x	0.4x	0.3x	10.8x	11.0x	10.5x	15.2x	4.3x	4.0x	20.4x	16.9x	16.2x
Augmented Reality														
Microsoft Corporation	\$1,159,807	\$1,109,145	8.6x	8.3x	7.5x	19.4x	18.9x	16.6x	24.4x	24.0x	21.1x	28.2x	29.7x	26.4x
Snap, Inc. Class A	21,644	20,598	13.3x	12.0x	8.8x	NM	NM	244.7x	NM	NM	NM	NM	NM	NM
Lumentum Holdings, Inc.	5,580	5,682	3.4x	3.4x	3.1x	24.6x	11.6x	9.5x	130.0x	15.2x	12.2x	NM	16.3x	13.6x
Immersion Corporation	219	127	3.6x	3.5x	3.2x	NM	NA	NA	NM	NM	21.6x	NM	NM	33.5x
MicroVision, Inc.	102	98	16.0x	13.1x	2.2x	NM	NM	NM	NM	NM	NM	NM	NM	NM
Vuzix Corporation	72	56	8.4x	7.7x	3.0x	NM	NM	NM	NM	NM	NM	NM	NM	NM
NexTech AR Solutions Corp.	57	56	21.4x	NA	NA	NM	NA	NA	NM	NA	NA	NM	NA	NA
Intelligent Ultrasound Group Plc	27	22	2.9x	2.7x	2.4x	NM	NM	NM	NM	NM	NM	NM	NM	NM
VR Education Holdings PLC	20	17	16.7x	8.5x	6.0x	NM	NM	NM	NM	NM	NM	NM	NM	NM
XMReality AB	6	4	3.0x	3.1x	2.5x	NM	NM	NM	NM	NM	NM	NM	NM	NM
High			21.4x	13.1x	8.8x	24.6x	18.9x	244.7x	130.0x	24.0x	21.6x	28.2x	29.7x	33.5x
Average			9.7x	6.9x	4.3x	22.0x	15.3x	90.3x	77.2x	19.6x	18.3x	28.2x	23.0x	24.5x
Median			8.5x	7.7x	3.1x	22.0x	15.3x	16.6x	77.2x	19.6x	21.1x	28.2x	23.0x	26.4x
Low			2.9x	2.7x	2.2x	19.4x	11.6x	9.5x	24.4x	15.2x	12.2x	28.2x	16.3x	13.6x
Big Data														
Splunk Inc.	\$22,768	\$22,887	10.5x	9.9x	8.1x	NM	62.2x	47.8x	NM	71.4x	52.0x	NM	79.6x	61.6x
SAMSUNG SDS CO., LTD.	13,118	10,494	1.1x	1.1x	1.0x	9.3x	8.9x	8.0x	13.4x	12.8x	11.1x	23.1x	22.1x	19.3x
MongoDB, Inc. Class A	8,427	8,292	24.4x	21.6x	16.5x	NM	NM	NM	NM	NM	NM	NM	NM	NM
Alteryx, Inc. Class A	7,213	7,066	20.2x	18.0x	13.6x	274.5x	129.4x	102.6x	326.2x	135.1x	91.2x	NM	176.8x	122.1x
Elastic NV	6,314	6,030	19.8x	16.6x	11.7x	NM	NM	NM	NM	NM	NM	NM	NM	NM
New Relic, Inc.	4,012	3,729	6.9x	6.6x	5.6x	NM	44.4x	39.7x	NM	147.7x	105.3x	NM	103.2x	85.2x
Teradata Corporation	3,042	3,167	1.6x	1.7x	1.7x	14.5x	9.5x	9.4x	44.6x	19.1x	14.1x	217.3x	26.7x	18.7x
Cloudera, Inc.	2,729	2,536	3.9x	3.4x	3.0x	NM	122.8x	40.0x	NM	NM	NM	NM	NM	NM
Yext, Inc.	1,945	1,786	6.8x	6.1x	4.6x	NM	NM	NM	NM	NM	NM	NM	NM	NM
Business-Intelligence of Oriental Nations Corporation Ltd. Class A	1,729	1,744	5.6x	5.0x	4.0x	24.9x	17.9x	11.9x	23.8x	18.4x	13.9x	22.9x	19.4x	15.2x
Talend SA Sponsored ADR	1,161	1,143	4.8x	4.6x	3.9x	NM	NM	NM	NM	NM	NM	NM	NM	NM
Domo, Inc. Class B	499	464	2.9x	2.8x	2.5x	NM	NM	NM	NM	NM	NM	NM	NM	NM
High			24.4x	21.6x	16.5x	274.5x	129.4x	102.6x	326.2x	147.7x	105.3x	217.3x	176.8x	122.1x
Average			9.0x	8.1x	6.3x	80.8x	56.4x	37.1x	102.0x	67.4x	47.9x	87.7x	71.3x	53.7x
Median			6.2x	5.6x	4.3x	19.7x	44.4x	39.7x	34.2x	45.2x	33.1x	23.1x	53.1x	40.4x
Low			1.1x	1.1x	1.0x	9.3x	8.9x	8.0x	13.4x	12.8x	11.1x	22.9x	19.4x	15.2x
Overall High														
Overall Average			6.4x	5.8x	4.8x	27.2x	34.9x	28.1x	45.0x	27.4x	26.4x	41.2x	32.4x	36.5x
Overall Median			4.8x	4.9x	4.0x	16.5x	16.4x	15.7x	24.4x	19.1x	17.3x	27.8x	24.9x	21.7x
Overall Low			0.4x	0.4x	0.3x	6.4x	5.8x	5.8x	9.1x	4.3x	4.0x	10.3x	8.6x	6.8x

Source: FactSet

Precedent Transactions

Autonomous Robotics

Announced Date	Target Company	Target Country	Bidder Company	Deal Value USD(m)	Enterprise Value (m)	EV / Revenue	EV / EBITDA
26-Sep-19	Servotronics Motion Control Ltd.	Israel	KUKA AG	18	18	-	-
27-Aug-19	Carl Cloos Schweisstechnik GmbH	Germany	China Renaissance Capital Investment Inc.; Nanjing Dingpai Electromechanical Technology Co., Ltd.	218	-	-	-
19-Jun-19	AutoStore	Norway	Thomas H. Lee Partners, L.P.	1,832	1,812	13.7x	39.7x
8-Nov-18	Aquatron Robotic Technology Ltd.	Israel	BWT Aktiengesellschaft AG	30	30	-	-
28-Sep-18	Hefei Sineva Intelligent Robot Co., Ltd.	China	Zhejiang Qianjiang Biochemical Co., Ltd.	92	-	-	-
29-Aug-18	OnRobot A/S	Denmark	Summit Partners LLP; Vaekstfonden	-	-	-	-
12-Jul-18	Asic Robotics AG	Switzerland	Paragon Partners GmbH	-	-	-	-
11-Jun-18	OptoForce Ltd.; Perception Robotics	USA	Vaekstfonden; Enrico Krog Iversen (Private investor)	-	-	-	-
29-May-18	Robostar Co., Ltd. (30.03% Stake)	South Korea	LG Electronics, Inc.	74	251	1.3x	20.5x
25-Apr-18	Mobile Industrial Robots ApS	Denmark	Teradyne, Inc.	271	271	21.3x	193.0x
24-Apr-18	Genmark Automation, Inc.	USA	Nidec Sankyo Corporation	26	26	1.1x	-
29-Mar-18	Hyundai Heavy Industries Holdings Co., Ltd. (5.1% Stake)	South Korea	Ki-Sun Chung (Private Investor)	332	11,392	-	-
2-Jan-18	LPK Co., Ltd. (56.81% Stake)	South Korea	AR Startech Co., Ltd.	25	37	1.6x	17.5x
6-Nov-17	Shanghai JXSS Robot Systems Co., Ltd. (60.53% Stake)	China	Zhejiang Aishida Electric Co., Ltd.	9	-	-	-
27-Sep-17	Chongqing Mechanical & Electrical Intelligent Manufacturing Co. Ltd.	China	Chongqing Machinery & Electric Co., Ltd.	20	20	2.2x	-
4-Sep-17	Shenzhen Ocean Xiangrui Machinery Co., Ltd. (45% Stake)	China	Tanac Automation Co., Ltd.	51	112	2.6x	10.8x
2-Aug-17	KB Medical SA	Switzerland	Globus Medical Inc.	32	32	-	-
25-Jul-17	Robopolis SAS	France	iRobot Corporation	169	169	1.1x	-
9-Mar-17	Toho Industrial Co., Ltd.	Japan	Yamazen Corporation	9	9	1.2x	11.5x
15-Dec-16	KUKA AG (KUKA Systems Aerospace North America)	USA	Advanced Integration Technology, Inc.	-	-	-	-
15-Nov-16	Hyundai Heavy Industries Holdings Co., Ltd.	South Korea	Hyundai Heavy Industries Co., Ltd. (Shareholders)	4,365	-	-	-
28-Sep-16	Shenzhen Ocean Xiangrui Machinery Co., Ltd. (55% Stake)	China	Tanac Automation Co., Ltd.	58	105	4.5x	-
16-Jun-16	RobotNorge AS (67.5% Stake); RobNor AB (67.5% Stake)	Sweden	PRE Robot Holding AS	-	-	-	-
18-May-16	KUKA AG (86.5% Stake)	Germany	Midea Group Co., Ltd.	4,261	4,957	1.5x	17.0x
4-Feb-16	Endeavor Robotics, Inc.	USA	Arlington Capital Partners LP	45	45	0.9x	-
19-Jun-15	KUKA Systems GmbH (Tools and Dies business unit)	Germany	Dr. Ing. h.c. F. Porsche AG	-	-	-	-
13-May-15	Universal Robots A/S	Denmark	Teradyne, Inc.	285	285	8.0x	45.0x
14-Apr-15	gomtec GmbH	Germany	ABB Ltd	-	-	-	-
3-Dec-14	KUKA AG (24.09% Stake)	Germany	J.M. Voith GmbH & Co.	658	2,331	1.1x	12.4x
14-May-14	RobotWorx	USA	Scott Technology Limited	5	5	-	-
28-Jan-14	Adtech (Shenzhen) Technology Co. Ltd	China	Shanghai Step Electric Corporation	99	99	-	-
9-Jan-14	Reis GmbH & Co. KG Maschinenfabrik (51% Stake)	Germany	KUKA AG	-	-	-	-
18-Oct-13	Rex Bionics Limited	New Zealand	Rex Bionics Plc	15	15	23.6x	-
Mean						5.7x	40.8x
Median						1.6x	17.5x

Source: MergerMarket

3DP (Additive Manufacturing)

Announced Date	Target Company	Target Country	Bidder Company	Deal Value USD(m)	Enterprise Value (m)	EV / Revenue	EV / EBITDA
18-Nov-19	Sculpteo SAS	France	BASF SE	-	-	-	-
22-Oct-19	FORECAST 3D	USA	GKN Powder Metallurgy Inc.	-	-	-	-
10-Oct-19	Proto Plastics, Inc.	USA	Thogus Products Company	-	-	-	-
1-Oct-19	Relativity Space, Inc	USA	Mark Cuban (Private Investor); Y Combinator LLC; Michael Ovitz (Private Investor); Social Capital; Jared Leto (Private Investor); Spencer Rascoff (Private Investor); Playground Global, LLC; Tribe Capital ; Bond Capital Fund, LP; Lee Fixel (Private Investor); Republic Labs	140	-	-	-
12-Sep-19	Xaar 3D Ltd (30% Stake)	United Kingdom	Stratasys Ltd	14	-	-	-
15-Aug-19	Yller Biomaterials S.A.	Brazil	Straumann Holding AG	7	7	-	-
12-Jul-19	BeamIT S.p.A. (30% Stake)	Italy	Sandvik AB	-	-	-	-
25-Jun-19	Carbon3D Inc.	USA	Temasek Holdings Pte. Ltd.; Arkema Group SA; Baillie Gifford & Co Ltd; FMR LLC; Sequoia Capital; Johnson & Johnson Innovation - JJDC, Inc.; JSR Corporation; Madrone Capital Partners, LLC; adidas Ventures B.V.	260	2,400	-	-
24-Oct-18	LPW Technology Ltd.	United Kingdom	Carpenter Technology Corporation	79	79	4.8x	-
17-Sep-18	Evolve Additive Solutions, Inc. (52.8% Stake)	USA	Stanley Black & Decker Inc; The LEGO Group	19	-	-	-
16-Jul-18	Addaero Manufacturing Company	USA	Allegheny Technologies Incorporated	10	10	-	-
1-May-18	O.R. Lasertechnologie GmbH	Germany	Coherent, Inc.	47	47	-	-
26-Feb-18	CalRAM, Inc.	USA	Carpenter Technology Corporation	13	13	-	-
27-Dec-17	Arcam AB (23% Stake)	Sweden	General Electric Company	235	985	19.6x	-
17-Jul-17	Desktop Metal, Inc.	USA	Techtronic Industries Company Limited; Saudi Arabian Oil Co; Lowe's Companies, Inc.; Kleiner Perkins; New Enterprise Associates; Vertex Venture Holdings Ltd.; Shenzhen Capital Group Co., Ltd.; Future Fund; Lux Capital; GV; GE Ventures; Data Collective; Tyche Partners LLC; Moonrise Capital	115	-	-	-
31-Jan-17	Vertex-Global Holding B.V.	Netherlands	3D Systems Corporation	38	38	-	-
27-Oct-16	Concept Laser GmbH (75% Stake)	Germany	General Electric Company	599	-	-	-
8-Sep-16	Robo 3D, Inc.	USA	Falcon Minerals Corp	63	63	14.2x	-
6-Sep-16	SLM Solutions Group AG	Germany	General Electric Company	742	742	10.0x	96.7x
6-Sep-16	Arcam AB	Sweden	General Electric Company	666	666	9.5x	74.7x
7-Jun-16	Prism Engineering, Inc.	USA	Fisher Unitech, LLC	12	12	-	-
10-Dec-15	MCAD Technologies, Inc.	USA	Computer Aided Technology, Inc.	17	17	-	-
4-Dec-15	Linear Mold & Engineering, Inc. (70% Stake)	USA	Moog Inc.	23	28	1.3x	-
24-Sep-15	netfabb GmbH	Germany	Autodesk, Inc.	43	43	-	-
6-Apr-15	Easyway Group (65% Stake)	China	3D Systems Corporation	11	-	-	-
3-Sep-14	LayerWise NV	Belgium	3D Systems Corporation	42	42	-	-
3-Jun-14	Within Technologies Limited	United Kingdom	Autodesk, Inc.	88	88	-	-
24-Apr-14	FineLine Prototyping, Inc.	USA	Proto Labs, Inc.	37	37	3.8x	-
16-Apr-14	Robtec (70% Stake)	Brazil	3D Systems Corporation	22	31	-	-
2-Apr-14	Solid Concepts Inc.	USA	Stratasys Ltd	232	232	3.6x	-
13-Dec-13	Village Plastics Co.	USA	3D Systems Corporation	6	6	-	-
13-Dec-13	AP&C	Canada	Arcam AB	19	19	-	-
20-Aug-13	CRDM Limited	United Kingdom	3D Systems Corporation	6	6	-	-
19-Jun-13	MakerBot Industries, LLC	USA	Stratasys Ltd	604	604	38.5x	-
12-Jun-13	Groupe Phenix Systems (93% Stake)	France	3D Systems Corporation	23	25	4.8x	-
22-May-13	Prodways Group (88% Stake)	France	Groupe Gorge	6	7	5.5x	-
Mean						10.5x	85.7x
Median						5.5x	85.7x

Source: MergerMarket

Simulation (Digital Twins)

Announced Date	Target Company	Target Country	Bidder Company	Deal Value USD(m)	Enterprise Value (m)	EV / Revenue	EV / EBITDA
4-Nov-19	Dynamic Systems Inc.	USA	Vishay Precision Group, Inc.	44	44	-	-
26-Sep-19	Cole Engineering Services, Inc.	USA	By Light Professional IT Services LLC	-	-	-	-
6-Sep-19	Spacemaker AS	Norway	Northzone Ventures AS; Fredensborg Norge AS; Atomico; OBOS BBL; Nordic Real Estate Partners; Round Hill Venture Partners; Construct Venture AS	25	-	-	-
28-Jun-19	Kangaloosh Limited	United Kingdom	AB Dynamics Plc	27	27	5.1x	-
15-Jan-19	Lanner Group Limited	United Kingdom	Royal HaskoningDHV	-	-	-	-
17-Oct-18	SIMSOLID Corporation	Canada	Altair Engineering, Inc.	22	22	-	-
5-Oct-18	Gamma Technologies, LLC	USA	Cove Hill Partners, L.P.	-	-	-	-
29-Aug-18	Sydac Pty Ltd	Australia	Sogeclair SA	-	-	-	-
19-Jun-18	SPRING Technologies S.A.S.	France	Hexagon AB	-	-	-	-
8-Jun-18	Esys Corporation	USA	JR Automation Technologies, LLC	-	-	-	-
25-May-18	Chelton Limited (Opera simulation software business)	United Kingdom	Dassault Systemes SA	10	10	-	-
22-Mar-18	OPTIS	France	ANSYS, Inc.	291	291	-	-
31-Jan-18	ForCity SAS	France	Caisse des Depots et Consignations; Omnes Capital; CM-CIC Capital Innovation; Axaleo Capital	10	-	-	-
25-Jan-18	I.G.E.+X.A.O. SA (53.12% Stake)	France	Schneider Electric Industries SAS	86	196	5.4x	18.7x
20-Dec-17	Visual Components Oy	Finland	KUKA AG	-	-	-	-
16-Nov-17	GeonX S.A.	Belgium	GE Additive	-	-	-	-
1-Oct-17	Immersaview Pty Ltd.	Australia	PLEXSYS Interface Products, Inc.	-	-	-	-
28-Sep-17	Exa Corporation	USA	Dassault Systemes SA	383	383	6.3x	85.6x
31-Aug-17	Coventor, Inc.	USA	Lam Research Corporation	138	138	-	-
30-Aug-17	TASS International	Netherlands	Siemens AG	-	-	-	-
15-May-17	Concurrent Real-Time, Inc.	USA	Battery Ventures LP	35	35	-	-
7-Apr-17	OKTAL S.A.S. (Automotive Simulation Assets) (35% Stake)	France	Renault SA	-	-	-	-
4-Apr-17	Bernecker + Rainer Industrie-Elektronik Ges.m.b.H.	Austria	ABB Ltd	-	-	-	-
10-Mar-17	Energy Exemplar Pty Ltd	Australia	The Riverside Company	-	-	-	-
2-Feb-17	MSC Software Corporation	USA	Hexagon AB	834	834	-	-
2-Feb-17	MWPowerLab S.r.l	Italy	Schneider Electric SE	9	9	-	-
5-Jan-17	DILIsym Services, Inc.	USA	Simulations Plus, Inc.	5	5	1.7x	-
14-Nov-16	Mentor Graphics Corporation	USA	Siemens AG	4,012	4,012	3.4x	20.6x
4-Nov-16	Rocketick Technologies Ltd.	Israel	Cadence Design Systems, Inc.	40	40	-	-
28-Jul-16	Dacolt International BV	Netherlands	AVL-List GmbH	-	-	-	-
1-Jun-16	ITI GmbH (96% Stake)	Germany	ESI Group SA	-	-	-	-
11-Mar-16	KPIT medini Technologies AG	Germany	ANSYS, Inc.	-	-	-	-
29-Feb-16	LMS India Engineering Solutions Private Limited	India	Siemens Information Systems Limited	-	-	-	-
2-Apr-15	Newmerical Technologies International Inc.	Canada	ANSYS, Inc.	11	11	-	-
17-Feb-15	Simufact Engineering GmbH	Germany	MSC Software Corporation	-	-	-	-
9-Feb-15	Delcross Technologies, LLC	USA	ANSYS, Inc.	-	-	-	-
Mean						4.4x	41.6x
Median						5.1x	20.6x

Cloud Computing

Announced Date	Target Company	Target Country	Bidder Company	Deal Value USD(m)	Enterprise Value (m)	EV / Revenue	EV / EBITDA
22-Aug-19	Pivotal Software, Inc. (84.9% Stake)	USA	VMware, Inc.	1,931	2,414	3.7x	
18-Aug-19	FixStream Networks, Inc.	USA	Resolve Systems, LLC	24	24	4.7x	
18-Jul-19	Hangzhou Hanggang Cloud Computing Data Center Co., Ltd.	China	Hangzhou Iron and Steel Co., Ltd.	138	138		
3-Jun-19	Cooladata Ltd.	Israel	Medallia, Inc.	8	8		
9-Apr-19	Kyriba Corporation	USA	Bridgepoint Advisers Limited	160	1,200	10.9x	
29-Mar-19	Compuverde AB	Sweden	Pure Storage, Inc.	75	75	26.1x	150.5x
25-Mar-19	Freschette Limited	Kazakhstan	Squire Mining Limited	18	18		
10-Jan-19	CloudEndure Ltd.	Israel	Amazon Web Services, Inc.	250	250		
1-Sep-18	Conapto AB	Sweden	Segulah Advisor AB	17	17	1.3x	6.7x
27-Aug-18	CloudHealth Technologies, Inc.	USA	VMware, Inc.	500	500		
9-Aug-18	Organised Computer Systems Limited	United Kingdom	Cancom SE	37	37	0.4x	7.7x
8-Jun-18	Chinac Co., Ltd.	China	GF Securities Co., Ltd.; Tsinghua Holdings Co., Ltd.; Shanghai Lonyer Fuels Co., Ltd.; Orient Securities Capital Investment Co., Ltd.; Shanghai Yuanxing Equity Investment Management Co., Ltd.	156	1,000		
10-May-18	MegaPath Inc	USA	Fusion Connect, Inc	72	72		
17-Apr-18	Beijing Tiandi Supercloud Technology Co., Ltd. (44% Stake)	China	China Greatwall Technology Group Co., Ltd.	34	78		
23-Jan-18	Vincit Services Oy	Finland	DataCenter Finland Oy	10	10	1.0x	
16-Sep-17	Guangdong Weiyi Network Technology Co., Ltd.	China	Nanxing Machinery Co., Ltd.	111	111	4.9x	17.1x
25-Jul-17	Sage Intacct, Inc.	USA	The Sage Group Plc	850	850	9.7x	
29-Jun-17	Cloudyn Software Ltd.	USA	Microsoft Corporation	50	50		
13-Jun-17	ViaWest, Inc.	USA	Flexential Corporation	1,712	1,712	6.7x	25.8x
20-May-17	Beijing BIH Technology Co., Ltd. (49% Stake)	China	Hangzhou Huaxing Chuangye Communication Technology Co., Ltd.	78	182	5.8x	21.6x
20-Mar-17	Guangzhou Mingcheng Computer Science and Technology Co., Ltd. (51% Stake)	China	Shenzhen Century Plaza Hotel Co., Ltd.	28	56	2.6x	
14-Dec-16	Logicworks Corporation	USA	Pamplona Capital Management LLP	135	135		
12-Nov-16	Beijing BIH Technology Co., Ltd. (51% Stake)	China	Hangzhou Huaxing Chuangye Communication Technology Co., Ltd.	74	130	6.8x	33.1x
20-Oct-16	Appirio, Inc.	USA	Wipro Limited	500	500	2.6x	
10-Oct-16	Lumagate AB	Sweden	Innofactor Plc	5	5	0.5x	20.0x
12-Sep-16	Dell EMC (Enterprise Content Division)	USA	OpenText Corporation	1,620	1,620	2.7x	
15-Aug-16	Modrus Limited	United Kingdom	NASSTAR PLC	17	17	2.1x	8.1x
28-Apr-16	Repro Diffusion Informatique	France	SPIE S.A.	9	9	0.2x	
26-Apr-16	Net Force China Co., Ltd.	China	Beijing Transtrue Technology Inc.	60	60	3.5x	43.9x
26-Mar-16	Shenzhen Inpor Cloud Computing	China	Shenzhen Comix Group Co., Ltd.	82	82	5.2x	19.3x
3-Mar-16	Le Cloud Computing Co., Ltd. (16.67% Stake)	China	Chongqing Strategic Emerging Industry Equity Investment Fund Partnership (LP)	153	915		
22-Feb-16	Ravello Systems Inc.	USA	Oracle Corporation	500	500		
3-Feb-16	Jasper Technologies, Inc.	USA	Cisco Systems, Inc.	1,400	1,400	20.0x	
26-Jan-16	Shanghai Qiniu Information Technology Co., Ltd. (34.8% Stake)	China	Harvest Fund Management Co Ltd; Shanghai Zhangjiang Hi-tech Park Development Co., Ltd.; Shanghai Zhangjiang (Group) Co., Ltd.; Telstra Ventures Pty. Limited; F&G Venture	100	287		
21-Jan-16	Kloud Solutions Pty Ltd	Australia	Telstra Corporation Limited	28	28		
30-Oct-15	HealthFusion Holdings, Inc.	USA	Quality Systems, Inc	184	184		
16-Sep-15	Beijing Zhongjin Yunwang Technology Co Ltd	China	Beijing Sinnet Technology Co., Ltd.	577	577	17.8x	
13-May-15	Opzoon Technology Co Ltd	China	Harbin Gong Da High-Tech Enterprise Development Co., Ltd.	525	525	3.0x	15.0x
30-Apr-15	Vertex Telecom, Inc.	USA	Dr. Peng Telecom and Media Group Co., Ltd.	9	9		
26-Mar-15	CloudDCS Ltd (70% Stake)	China	SZZT Electronics Co., Ltd.	10	15	13.4x	
Mean						6.5x	30.7x
Median						4.2x	19.7x

Source: MergerMarket

Cyber Security

Announced Date	Target Company	Target Country	Bidder Company	Deal Value USD(m)	Enterprise Value (m)	EV / Revenue	EV / EBITDA
21-Oct-19	Cloud Conformity Inc.	Australia	Trend Micro Incorporated	70	70		
16-Oct-19	Orkus, Inc.; OverWatchID	USA	SailPoint Technologies, Inc.	38	38		
23-Aug-19	Jardine OneSolution Holdings (C.I.) Limited; Adura Cyber Security Services Pte Ltd	Singapore	HKBN Ltd.	50	50		
8-Aug-19	Symantec Corporation (Enterprise Security Business)	USA	Broadcom Inc.	10,700	10,700		
1-Aug-19	NC4 Inc.	USA	Everbridge, Inc.	83	83	4.6x	32.6x
5-Jun-19	Endgame, Inc.	USA	Elastic N.V.	234	234		
28-May-19	Verodin, Inc.	USA	FireEye Inc.	253	253		
13-Apr-19	Qi An Xin Group (22.59% Stake)	China	Beijing Jinhuijin Investment Group Co., Ltd.	556	2,218	6.2x	
9-Apr-19	Secarma Projects Limited	United Kingdom	Shearwater Group plc	10	10	2.0x	14.8x
28-Mar-19	Ezenta A/S	Denmark	Nixu Oyj	9	9	0.9x	21.5x
12-Feb-19	Luminate Security Ltd.	Israel	NortonLifeLock Inc.	200	200		
22-Jan-19	SLAIT Consulting, LLC	USA	ePlus Technology, Inc.	51	51		
16-Oct-18	ZenGuard GmbH	Germany	Kape plc	6	6		
10-Oct-18	Hivint Pty Ltd.	Australia	Singtel Optus Pty Limited	17	17		
18-Sep-18	Wuhan Zhongruantong Technology Co., Ltd. (51% Stake)	China	ShanDong Swan Cotton Industrial Machinery Co., Ltd.	24	47	5.2x	11.6x
5-Sep-18	Accel Systems & Technologies Pte Ltd; StarHub Ltd (Cyber Security Centre of Excellence); Ensign InfoSecurity Asia Pacific Pte Ltd	Singapore	Ensign InfoSecurity Pte. Ltd.	203	203		
17-Aug-18	Brookcourt Solutions Limited	United Kingdom	Shearwater Group plc	39	39	1.5x	21.4x
31-Jul-18	Solebit, Inc.	USA	Mimecast Limited	88	88		
24-Jul-18	Neutral Holdings Ltd	USA	Kape plc	16	16		
10-Jul-18	Ataata, Inc.	USA	Mimecast Limited	25	25		
24-Jun-18	Icebrg, Inc.	USA	Gigamon Inc.	100	100		
18-Jun-18	MWR InfoSecurity Limited	United Kingdom	F-Secure Corporation	139	139	4.9x	
7-Jun-18	Intertek NTA	United Kingdom	Intertek Group Plc	12	12	2.8x	
22-May-18	Solar Security OOO	Russia	Rostelecom PJSC	24	24		
13-Apr-18	Exclusive Networks SAS	France	Permira Advisers LLP	1,788	1,788	0.8x	
27-Feb-18	Phantom Cyber Corporation	USA	Splunk Inc.	304	304		
5-Feb-18	Skout Secure Intelligence	USA	RSE Ventures, Inc.	30	30		
10-Jan-18	Aspect Security, Inc.	USA	Ernst & Young LLP	11	11		
9-Jan-18	BISEC	Israel	UST Global, Inc.	6	6		
13-Dec-17	Acumen Security, LLC	USA	Intertek Group Plc	32	32		
3-Nov-17	Argus Cyber Security Ltd.	Israel	Continental Aktiengesellschaft	450	450		
26-Oct-17	Efflux Systems, Inc.	USA	NetScout Systems Inc	9	9		
6-Jul-17	Fireglass	Israel	NortonLifeLock Inc.	225	225		
12-Jun-17	NextNine Inc.	USA	Honeywell International Inc.	35	35		
24-May-17	Hexadite Ltd.	USA	Microsoft Corporation	100	100		
18-Apr-17	Blue Ridge Networks (Cyber security business)	USA	Blue Planet Works	63	63		
8-Mar-17	Sotera Defense Solutions, Inc.	USA	KEYW Holding Corp.	235	235		
17-Jan-17	CynergisTek, Inc.	USA	Auxilio Inc	27	27	1.8x	5.3x
23-Dec-16	HexaTier Ltd.	Israel	Huawei Technologies Co., Ltd.	42	42		
11-Nov-16	Virtual Security Research, LLC	USA	NCC Group Plc	6	6		
7-Nov-16	ITC Secure Networking	United Kingdom	C5 Capital Limited	30	30	1.7x	18.5x
21-Oct-16	Utimaco GmbH	Germany	EQT Mid Market Fund	142	142	3.4x	12.8x
29-Sep-16	Payment Software Company Inc.	USA	NCC Group Plc	19	19	2.0x	11.7x
Mean						2.9x	16.7x
Median						2.0x	14.8x

Source: MergerMarket

IIoT

Announced Date	Target Company	Target Country	Bidder Company	Deal Value USD(m)	Enterprise Value (m)	EV / Revenue	EV / EBITDA
17-Jun-19	ISA - Intelligent Sensing Anywhere, S.A (98.4% Stake)	Portugal	DataOnline Corp.				
14-Dec-17	Brueel & Kjaer EMS Pty Ltd (50% Stake)	Australia	Macquarie Capital Advisers	59			
23-Aug-17	Digital Lumens Inc.	USA	Osram GmbH				
31-Jul-17	IQP Corporation	Japan	General Electric Company	40	40		
12-Jun-17	inthin Technology Solutions, Inc.	USA	ORBCOMM Inc.	60	60		
14-Feb-17	NUB3D, S.L.	Spain	ABB Ltd	6	6		
8-Feb-17	Nurego Inc.	USA	GE Digital LLC				
29-Sep-16	Wireless System Integration Sweden AB	Sweden	Allgon AB	5	5	1.2x	14.2x
14-Dec-15	PrismTech Group Limited	United Kingdom	ADLINK Technology, Inc.	17	17	2.1x	
6-May-15	RT-RK d.o.o. (35% Stake)	Serbia	TTTech Computertechnik AG				
7-Oct-19	Creative Chips GmbH	Germany	Dialog Semiconductor Plc	103	103		
25-Sep-19	GeoSteering Technologies Ltd.	Russia	ZYFRA Oy	9			
6-Jun-19	Sensire Ltd (35.2% Stake)	Finland	Yokogawa Electric Corporation	7			
29-Mar-19	Sierra Monitor Corporation	USA	MSA Safety Incorporated	30	30	1.3x	52.4x
16-Oct-18	JSC VIST Group	Russia	ZYFRA Oy	30			
6-Aug-18	Independent Technologies Inc.	USA	DataOnline LLC				
17-Jul-18	Beck IPC GmbH	Germany	HMS Industrial Networks AB	8	8		
29-Jun-18	Echelon Corporation	USA	Adesto Technologies Corporation, Inc.	33	33	1.0x	
23-Apr-18	Idosens S.A.S	France	WIKI Alexander Wiegand SE & Co. KG				
5-Dec-17	RtTech Software (Cipher IIoT cloud software & edge connectivity assets)	Canada	Aspen Technology Inc.	12	12		
31-May-17	OSIsoft, LLC	USA	SoftBank Group Corp.				
4-May-17	VIZIYA Corporation	Canada	Quarterhill Inc.	18	18	1.4x	5.4x
17-Apr-17	International Road Dynamics Inc.	Canada	Quarterhill Inc.	48	48	1.0x	11.6x
29-Mar-17	DataRPM Corporation	USA	Progress Software Corporation	30	30		
1-Mar-16	Movilizer GmbH	Germany	Honeywell International Inc.				
Mean						1.3x	20.9x
Median						1.3x	12.9x

Big Data

Announced Date	Target Company	Target Country	Bidder Company	Deal Value USD(m)	Enterprise Value (m)	EV / Revenue	EV / EBITDA
17-Oct-19	Intersys Consulting, Inc.	USA	ASGN Incorporated	67	67		
27-Aug-19	ThoughtSpot, Inc.	USA	Silver Lake Partners; Lightspeed Venture Partners; Sapphire Ventures, LLC; Geodesic	248	1,950		
14-Aug-19	Analytics 8 LP	Australia	Accenture Plc	17	17		
8-Jan-19	OGSystems, LLC	USA	Parsons Corporation	300	300		
28-Aug-18	Epinomics Inc.	USA	10X Genomics, Inc.	22	22		
12-Jun-18	Load Delivered Logistics, LLC, Logistical Labs, LLC	USA	Capstone Logistics, LLC	100	100		
12-Jan-18	X15 Software, Inc.	USA	FireEye Inc.	20	20		
24-Oct-17	Wuhan Optics Valley Information Technologies Co., Ltd. (30.95% Stake)	China	Navtech Inc.	21	61	2.1x	15.6x
16-Oct-17	Guozhengtong Technology Co., Ltd. (90% Stake)	China	Shanghai Huaming Intelligent Terminal Equipment Co., Ltd.	250	278	6.3x	19.3x
14-Aug-17	BYIT Beijing Technology Co., Ltd. (43.12% Stake)	China	Tianma Bearing Group Co., Ltd.	38	89	5.5x	29.4x
22-Jul-17	BYIT Beijing Technology Co., Ltd. (56.34% Stake)	China	Tianma Bearing Group Co., Ltd.	50	89	5.6x	29.8x
20-Jul-17	Mobigen Inc. (40.76% Stake)	South Korea	Jiransecurity Co., Ltd.	12	18	1.2x	7.9x
7-Jul-17	InfoTrellis Inc.	Canada	Mastech Digital, Inc.	55	55		
6-Jul-17	Vision Solutions, Inc.; Syncsort, Inc.	USA	Centerbridge Partners, L.P.	1,260	1,260		
3-Jun-17	Shanghai Gongchuang Information	China	ZhongTongGuoMai Communication Co., Ltd.	58	58	5.3x	18.5x
25-Apr-17	Rankwave Co., Ltd.	South Korea	CJ E&M Corporation	10	10		
13-Apr-17	Wuhan Dialong Medical Data Service Co., Ltd. (90.17% Stake)	China	Ch-gemstone Capital Management (Beijing) Co., Ltd.	9	10	11.5x	
14-Mar-17	RAGE Frameworks Inc.	USA	Genpact Limited	124	124		
21-Nov-16	Jiangxi Zhi Rong Technology Co., Ltd.	China	Rongyu Group Co., Ltd.	36	36	31.8x	111.6x
13-Jun-16	Riaktr (30% Stake)	Belgium	Gimv NV; Endeit Capital; Fortino Capital	14	47		
8-Mar-16	Shenzhen Runan Technology Development Co., Ltd. (51% Stake)	China	Haoyun Technologies Co., Ltd.	10	20		
17-Oct-19	Intersys Consulting, Inc.	USA	ASGN Incorporated	67	67		
27-Aug-19	ThoughtSpot, Inc.	USA	Silver Lake Partners; Lightspeed Venture Partners; Sapphire Ventures, LLC; Geodesic	248	1,950		
Mean						1.3x	20.9x
Median						1.3x	12.9x

Source: MergerMarket

Key M&A Transactions

BASF acquired 3DP service provider Sculpteo

In November'19, BASF acquired Sculpteo, an online 3DP service provider. This transaction will enable BASF to provide integrated manufacturing of serial production components, individual objects, and prototypes with additive manufacturing technologies.

Formlabs acquired Spectra for 3D biomaterial production

In November'19, Formlabs acquired Spectra, an Ohio based producer of custom UV curable coatings and formulations, adhesives, and photo initiator packages. This transaction will support BASF in enabling production of biocompatible polymers.

Cognex acquired SUALAB for support in deep learning-based machine vision

In Oct'19, Cognex acquired SUALAB, a Korean-based developer of vision software for industrial applications, for a deal value of USD195mn. This acquisition extends company's deep learning capabilities and accelerates opportunities to automate difficult visual inspection tasks in industrial markets

PTC acquired Onshape for CAD and PLM industry transition to SaaS

In Oct'19, PTC acquired Onshape, a US-based developer of cloud based computer-aided design (CAD) software solutions for product design, for a purchase consideration of USD470mn. This acquisition is the logical next step in PTC's overall evolution to a recurring revenue business model, the first step of which was the company's successful transition to subscription licensing, completed in January 2019

Siemens Healthineers acquired Corindus Vascular Robotics for USD1.1 bn

In October'19, Corindus Vascular Robotics, an provider of invasive platform for neurovascular, peripheral, and coronary procedures was acquired by Siemens, for a purchase consideration of USD1.1 bn. This acquisition will provide Siemens' with surgery tools and robotics platform for digital imaging in cardiovascular disease.

Microsoft acquired Movere for providing cloud migration tool

In September'19, Microsoft acquired Movere, an cloud migration technology provider. This acquisition will help Microsoft to innovate and provide support to Azure Migrate, to make migration smoother and integrated.

Shopify acquired 6 River Systems for USD450 mn

In September'19, Shopify acquired 6 River Systems, an warehouse automation technology developer for e-Commerce and retail operations, for a purchase consideration of USD450 mn. This acquisition will support the Shopify Fulfillment Network and enable launch of "Chuck" a cloud-based software and collaborative mobile robots which will be used for moving packages across warehouse.

HPE acquired supercomputing leader Cray for USD1.4 bn

In September'19, HPE acquired Cray, a global provider of supercomputing services, for a purchase consideration of USD1.4 bn. This acquisition will support the HPE to provide end-to-end portfolio across computing, storing, software, and services in the field of artificial intelligence, machine learning, and big data analytics.

Key M&A Transactions

Salesforce acquired Tableau for USD15.7 bn

In August'19, Salesforce acquires Tableau, a provider of analytics platform, for a purchase consideration of USD15.7 bn. This acquisition will support Salesforce in driving digital transformation enabling its customers to have deeper insights while decision making and assist in providing smarter and integrated customer experiences with accelerated innovation.

Cisco acquired Sentryo to support companies in deploying Industrial IoT at scale

In August'19, Cisco acquired Sentryo, a France-based provider of cyber security solutions and asset visibility for industrial control systems, for an undisclosed consideration. By combining Cisco's intent-based network architecture with Sentryo's capabilities, customers can capture IoT benefits, manage networks and devices at scale, enable collaboration across IT and OT departments, and better protect their assets and data.

VMware acquired Carbon Black for USD2.1 bn and Pivotal for USD2.7 bn

In August'19, VMware acquired Carbon Black, an provider of cloud-native endpoint protection, for a purchase consideration of USD2.1 bn and Pivotal, a cloud-native platform provider, for a purchase consideration of USD2.7 bn. These acquisition will help VMware to provide enterprise-grade applications and in managing enterprise workloads and clients. VMware aims to boost subscription and SaaS offerings.

Google acquired analytics start-up Looker for USD2.6 bn

In June'19, Google Cloud acquired Looker, a platform for business intelligence, data applications and embedded analytics, for a purchase consideration of USD2.6 bn. This acquisition will provide Google an end-to-end analytics platform to generate and visualize data across Azure, Google Cloud, AWS, and ISV applications.

Siemens acquired NVH business from Saab Medav

In March'19, Siemens acquired noise, vibration, and harshness (NVH) end-of-line quality testing business from Saab Medav Technologies. This acquisition will improve the quality testing for Siemens digital twin products.

Yaskawa acquired Factory Automation business unit of ZF Italia

In February'19, Yaskawa acquired Factory Automation business of ZF Italia. This acquisition will help Yaskawa's to integrate its automation projects in robotics and drives, motion & controls division (DMC) with ZF Italia. The operations will be conducted in four locations: Turin, Milan, Modena and Brescia conurbations.

Amazon acquired CloudEndure for USD250 mn

In January'19, Amazon acquired CloudEndure, a disaster-recovery service provider offering live migration tools to companies for moving applications data into different cloud for USD250 mn. This acquisition will add disaster-recovery tech in AWS of Amazon.

HPE acquired big data provider BlueData

In November'18, HPE acquired BlueData, a provider of virtualization technology for big data and machine learning projects. This acquisition will extend its offering to customers in container-based service for AI, machine learning and big data analytics.

Recent Developments

GE Additive launched metal 3D printers and materials

In November'19, GE Additive launched two new metal 3DP systems: Arcam EBM Spectra L and Concept Laser M2 Series 5. These products will help in reducing surface roughness, providing better consistency for various builds and support in hardware enhancements.

EOS develops CO laser solution for industrial 3DP

In November'19, EOS develops new Fine Detail Resolution (FDR) technology with stereo lithography (SLA) resolution and selective laser sintering (SLS). This is polymer-based technology used for superfine surfaces and delicate components.

Amazon launched Alexa Voice Service Integration

In November'19, Amazon launched Alexa Voice Service Integration for AWS IoT Core. Alexa Voice Service will help integrating gadgets with cloud apps and other devices. This integrative cloud service is created to allow manufacturers to provide Alexa built-in devices.

Oracle expanded its innovation lab to advance industries

In November'19, Oracle expands its Chicago Innovation Lab to organizations for exploring new technologies and their applications. This development will provide support for various technologies including connected devices, autonomous vehicles, drones, augmented reality, visualization, and artificial intelligence tools

Microsoft launched Azure Synapse Analytics

In November'19, Google launched Azure Synapse Analytics. This development will ensure integration of enterprise data warehousing and Big Data analytics. Azure Synapse Analytics will support in ingesting, preparing, managing, and providing data for business intelligence and machine learning requirements

SAP entered into a partnership with Verizon

In October'19, SAP entered in a partnership with Verizon to provide an enterprise application. Under this partnership SAP will combine its SAP Edge Services, data management capabilities, analytics and computing, and Internet of Things (IoT) solution with Verizon's network and platform capabilities to unleash the concept of Intelligent Enterprise through its application.

ABB launched its most compact and lightweight 6-axis robot

In October'19, ABB has launched its smallest and lightest robot IRB 1100 which is designed for high productivity and quality in moving small and delicate parts mostly required by semiconductor, pharmaceutical, and electronics manufacturers

Google shifted focus to AR from VR, shuts off its Daydream VR project and started investing AR technologies

In October'19, Google announced that its invested heavily in AR experiences like Google Lens, AR walking navigation in Maps, and AR in Search to provide realistic experiences. Further it will close down its Daydream VR project and stop sale of Daydream VR headsets.

Recent Developments

FANUC, Fujitsu and NTT Com entered into partnership to provide "digital utility cloud"

In September'19, FANUC, Fujitsu and NTT Com entered into partnership to develop a new "Digital Utility Cloud" service for machine tool industry. This service is expected to be initiated in April 2020.

ABB established its regional robotics Digital Operation Center in Malaysia

In July'19, ABB established its first robotics Digital Operations Center in Malaysia. This center will include various technologies including cloud computing and big data analytics for providing support in monitoring of ABB robots across ASEAN countries, Taiwan and India.

Microsoft launched Azure Data Share to facilitate big data sharing

In July'19, Microsoft launched Azure Data Share service to provide a innovative and secure solution for sharing big data within the company. This service will support companies in governing their operations by enabling data manageability and productivity.

ANSYS and SAP entered into partnership to support predictive maintenance

In June'18, ANSYS and SAP entered into partnership to provide a unique solutions for predictive maintenance of industrial assets. This transaction will enable clients to translate insights from simulation-based digital twins enabled by ANSYS into actionable processes that will improve maintenance and operational outcomes.

Yaskawa opened new production facility in Slovenia

In April'19, Yaskawa opened new plant in Slovenia to support existing production facilities in Japan and China. This plant is expected to suffice about 80% of the demand for Motoman robots in Europe.

Rescale entered into strategic partnership with Siemens PLM

In February'19, Rescale entered into strategic partnership with Siemens PLM to offer digital twin solutions. This solution will be provided through Siemens' Simcenter with Rescale's ScaleX cloud platform. This partnership is expected to provide a seamless offering of digital twin solutions on a cost-effective cloud platform.

ABB and Dassault Systems entered into global software partnership for digital industries

In February'19, ABB and Dassault Systems entered in a partnership. This partnership will support in providing software solutions' portfolio including product life cycle management to asset health solutions. The two companies will also provide customers support in robotics automation, digital twin experiences, smart buildings and other process industry solution.

Oracle introduced Java Card to boost security for IoT devices at the edge

In January'19, Oracle announced the availability of Java Card 3.1. This card will support in enabling multi-cloud authentication and deploying security to connected devices. This update will provide better flexibility to support hardware and security requirements of secure chips and emerging Internet of Things (IoT) technologies.

7

Appendix

Appendix



References

Industrial IoT

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Abbreviations

Industry 4.0: The Fourth Industrial Revolution

ICT: Information and Communications Technology

CPPS: Cyber Physical Production Systems

CPS: Cyber Physical System

US: United States

USD: United States Dollar

UK: United Kingdom

3D: 3 Dimensional

3DP: Three Dimensional Printing

R&D: Research and Development

MES: Manufacturing Execution System

IT: Information Technology

IoT: Internet of Things

IIoT: Industrial Internet of Things

BI: Business Intelligence

SCADA: Supervisory Control and Data Acquisition

ERP: Enterprise Resource Planning

CMMS: Computerized Maintenance Management Systems

BAAS: Backend as a Service

PAAS: Platform as a Service

B2B2C: Business-to-Business-to-Customers

RFID: Radio Frequency Identification

BN: Billion

MN: Million

TN: Trillion

cGMP: Current Good Manufacturing Practices

GST: Goods and Services Tax

AR: Augmented Reality

VR: Virtual Reality

CAGR: Compound Annual Growth Rate

APAC: Asia-Pacific

SCM: Supply Chain Management

CRM: Customer Relationship Management

NASA: National Aeronautics and Space Association

FDM: Fused Deposition Modeling

SLS: Selective Laser Sintering

DMLS: Direct Metal Laser Sintering

SLM: Selective Laser Melting

SLA: Stereolithography

DLP: Digital Light Processing

EBM: Electron Beam Melting

CLIP: Continuous Liquid Interface Production

CDLP: Continuous Digital Light Processing

SDL: Selective Deposition Lamination

AM: Additive Manufacturing

OEMs: Original Equipment Manufacturers

CAD: Computer-Aided Design

BAM: Building Asset Management

NVH: Noise, Vibration, and Harshness

RoW: Rest of World

RPA: Robotic Process Automation

SCARA: Selective Compliance Assembly Robot Arm

AI: Artificial Intelligence

APTs: Advanced Persistent Threats

BDA: Big Data Analytics

KPIs: Key Performance Indicators



Select Tech Transactions



Acquisition of French Big Data and predictive analysis specialist Oak Branch by geolocation expert Deveryware

GLOBAL M&A PARTNERS

Financière de Courcelles
Advisor to the buyer




Sale of eTech Solutions Ltd, provider of mobile surveying & workflow management software to CoreLogic, Inc (CLGX)

Australia USA
United Kingdom

GLOBAL M&A PARTNERS

Cooper Parry Corporate Finance
Advisor to the seller




Silicon Mechanics, a Seattle-based manufacturer of computer servers, has been acquired by Source Code Corporation.

GLOBAL M&A PARTNERS

Meridian Capital LLC
Advisor to the seller




EVR Holdings is an AIM quoted VR company focusing on virtual reality content creation via its subsidiary MelodyVR

GLOBAL M&A PARTNERS

Zeus Capital
Advisor




About Us

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Our Tech sector team is comprised of seasoned M&A professionals from more than 18 partner countries with extensive knowledge of the dynamics and innovative changes occurring globally and locally in the Tech industry (e.g., changing consumer preferences, emerging technologies, etc.).

Our M&A activity in the Technology sector is robust and includes many cross-border transactions, driven by international growth, strategic tuck-ins, and consolidation. Given our sector experience, transaction expertise, and unparalleled access to local decision makers, we can work together to offer customized M&A solutions and premium valuations for our clients.