Analytics in Industry 4.0

IR 4.0 and Key Technologies (Pillars)

Industrial Revolution

IR 4.0

A collective term for technologies and concepts of value chain organization. Based on the technological concepts of **cyber-physical systems**, the Internet of Things and the Internet of Services, it facilitates the vision of the NextGen Transformation.

IR 4.0

Americans prefer to call this concept- smart factory and Europeans call it- Industry 4.0 (Germans came up with the term). So don't be baffled when you hear terms like smart factory and Industrial IOT. They all refer to Industry 4.0 as there is no consensus about how we call it.

It refers to the current and developing environment in which digital technologies are changing the way we live and work. More commonly used in industrial and operational context.

Ubiquitous connectivity of people, machines and real time data
Today

First programmable logic controller (PLC) – Modicon 084
1969

First production line, slaughter-houses in Cincinnati
1870

First mechanical loom
1784

IR4.0 – Digital-Physical Systems
Use of cyber physical technologies

IR3.0 – Automation
Use of electronics and IT to further automate the production

IR2.0 – Electrification
Introduction of mass production based on the division of labor and help of electrical energy

IR1.0 – Mechanization
Start of mechanical production facilities using water and steam power

End of 18th century | **Beginning of 20th century** | **Beginning of the Seventies** | **21st Century**

Key drivers

Maturation of new cyber physical technologies (artificial intelligence, 3-D printing, robotics)

Pervasive sensing and actuation

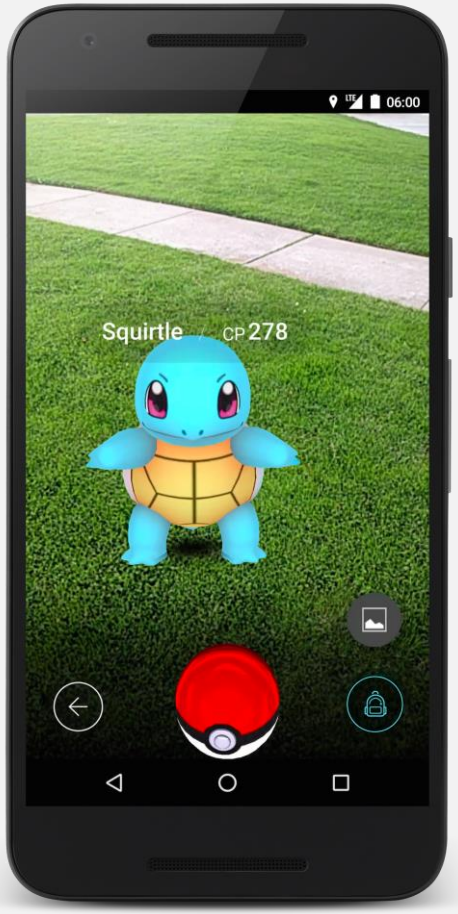
Data analytics driving efficacy and effectiveness and new business models

Unprecedented levels of data and increased computing powers

Time to reach 100 Million Customers

Telephone	75 Years
Web	7 Years
Facebook (Meta)	4 Years
Instagram	2 years
Pokémon Go	1 month

Industrial Revolution

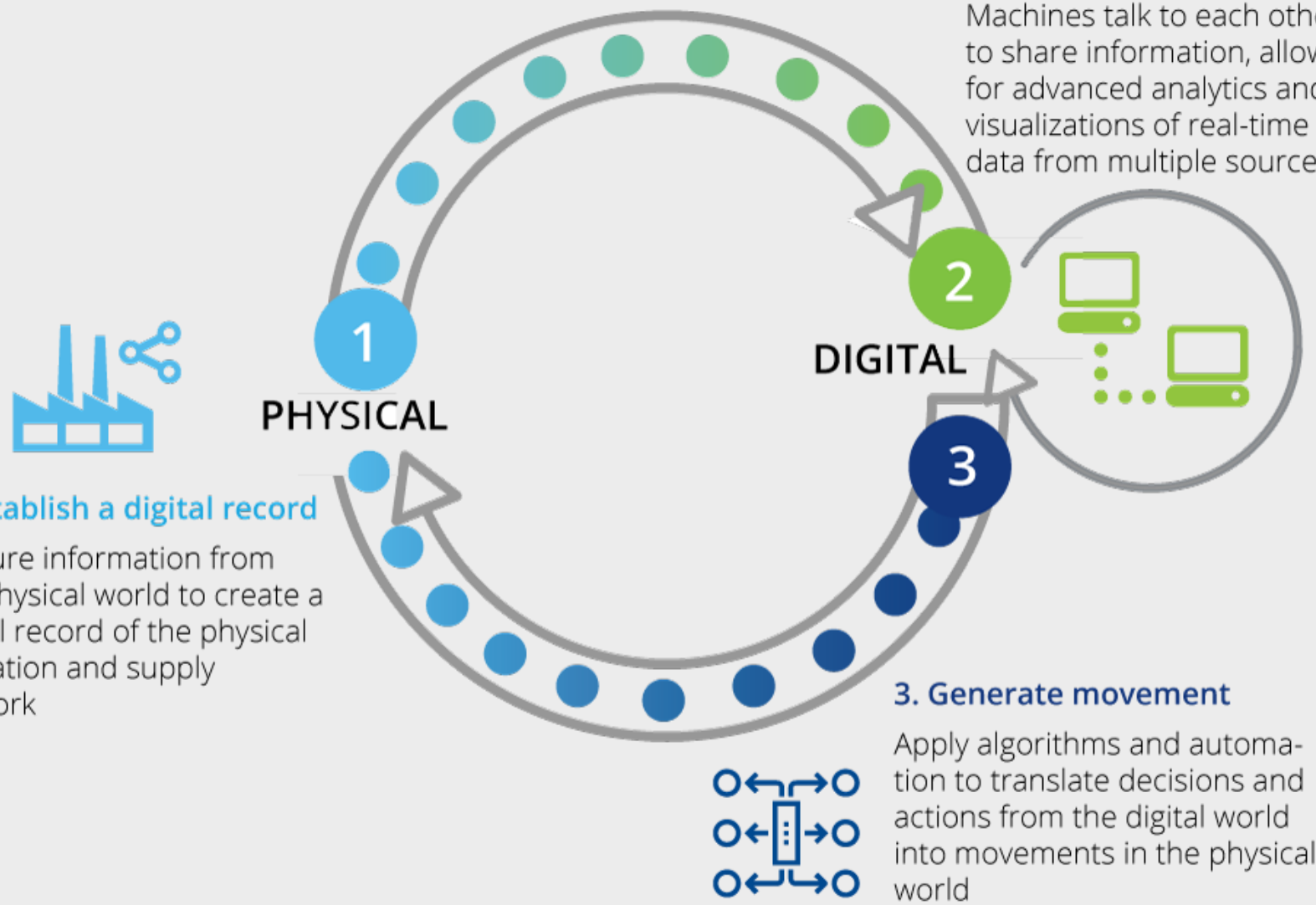


Why?

CPS

A cyber-physical system (CPS) is a system of collaborating computational elements controlling physical entities.

Cyber-Physical System



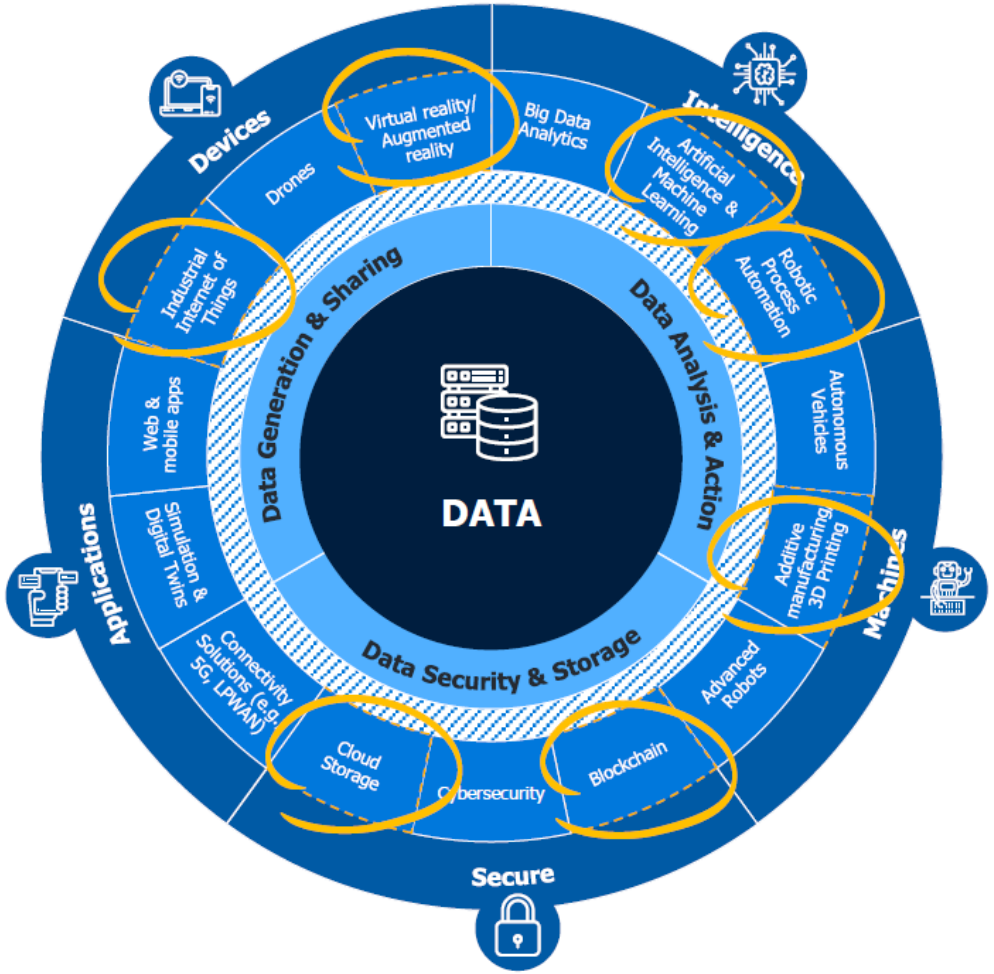
Source: Center for Integrated Research.

Cyber-Physical System

The Pillars of Industry 4.0

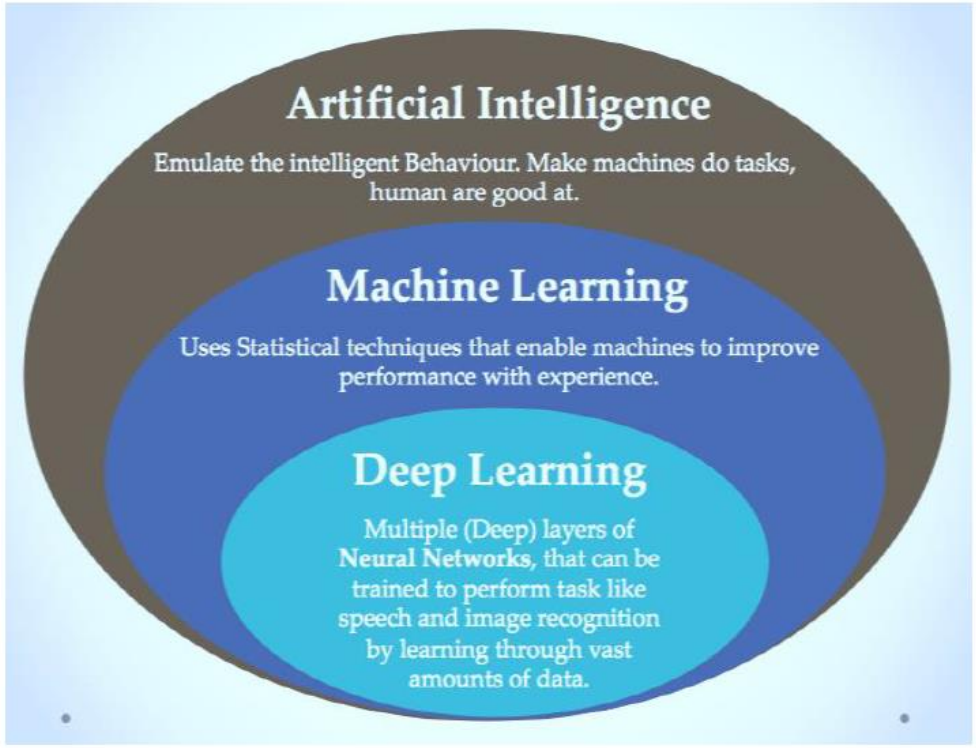
Data is at the core of most of the new disruptive technologies today

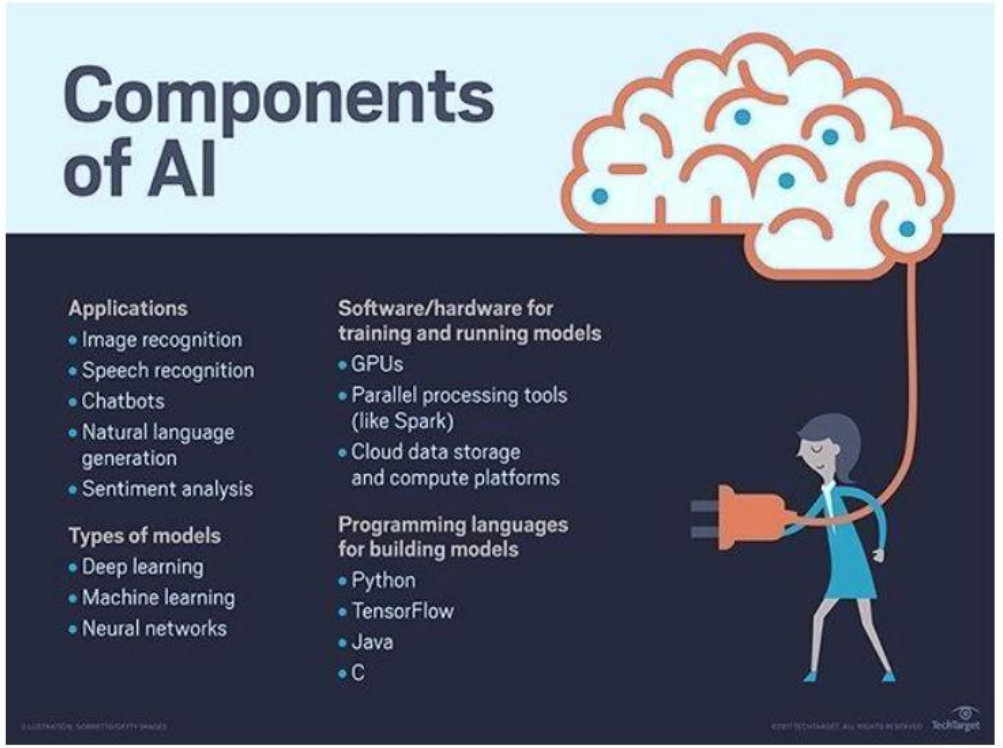
Overview of Industry 4.0 Technology Landscape



1. Artificial Intelligence and Machine Learning

AI is the simulation of human intelligence processes (e.g., learning, reasoning) by machines, especially computer systems. Growth propelled by advanced in computing power & storage and explosion of data.





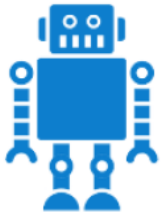
1. Artificial Intelligence and Machine Learning

There is value in having the Best of Both

Humans are better in…

- Displaying empathy and humor
- Flexible, adapting skills to different situations
- Understanding context, picking up cues
- Critical thinking, defining problems and creative pursuits
- Refine motor skills and dexterity

Machines are better in…



- Performing repetitive work
- Working in predictable, structured environments
- Processing huge data with speed and accuracy
- Working 24/7 without breaks or distractions
- Gross motor skills, doing dangerous work such as underwater rescue or bomb disposal

<20% — **Degree of automation** — >80%

Examples

- Care Providers/Counsellors
- Hairstylist
- Creatives

Examples

- Data entry, Accounting
- Warehouse Stockist
- Bomb Disposal

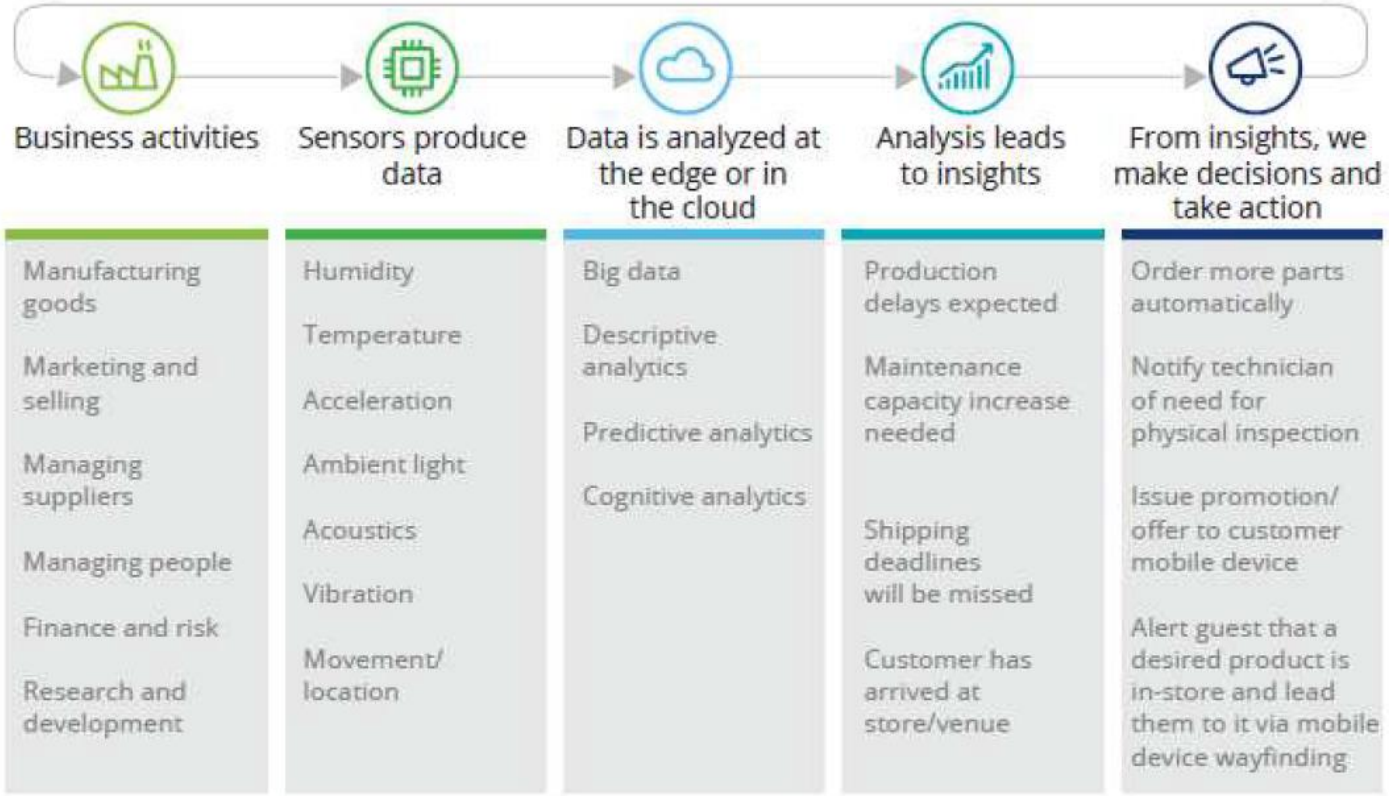
1. Artificial Intelligence and Big Data Analytics

Four kinds of applications for Artificial Intelligence and Machine Learning

	Descriptive What happened?	Diagnostic Why did it happen?	Predictive What will happen?	Prescriptive What to do about it?
APPLICATIONS	• Integrating and processing structured and unstructured data from disparate sources • Statistical analysis and modeling • Data visualization and dashboards	• Root-cause-analysis • Find hidden correlations • Identify characteristic patterns • Segmenting Customers and Employees	• Predictive models for forecasting and preemptive failure diagnosis • Learning algorithms can adapt to new data and conditions • Categorizing based on behavior, Forecasting Demand/Sales	• Optimization models to improve operation and performance • Data-driven recommendations on actions and strategies • Product Recommendation, Route Optimization
METHODS	Data wrangling Extraction, scrapping, aggregation, cleaning, transformation, filtering Feature engineering Statistical analysis, feature extraction and selection, image processing, dimensionality reduction Data visualization	Clustering K-Means, mixture models, density-based spatial, hierarchical Pattern recognition Kalman filter, dynamic time warping, hidden Markov, graph based Probabilistic modeling Bayesian, ANOVA, stochastic correlation	Classification Naïve Bayes, SVM, kNN, random forest, neural networks, deep learning Regression Time series modeling, linear / logistic / multivariate regression, decision tree Bagging, boosting, ensemble learning	Optimization Stochastic gradient descent, simulated annealing, evolutionary algorithms Simulation Markov models, agent-based, Monte Carlo, DES, PDES, fuzzy logic Recommender systems Collaborative filtering, graph based
TOOLS	Big data and cloud infrastructure Azure, Hadoop, Spark, Hive, SQL, NoSQL, MongoDB, InfluxDB	Visualization and interfaces Plotly, Tableau, D3.js, JavaScript, PowerBI, React, Graphana, Qt	Data analysis and Machine Learning Python, Numpy, SciPy, Matplotlib, OpenCV, Keras, TensorFlow, XGBoost, R, RapidMiner	Modelling and simulation Matlab, Mathematica, Aspen

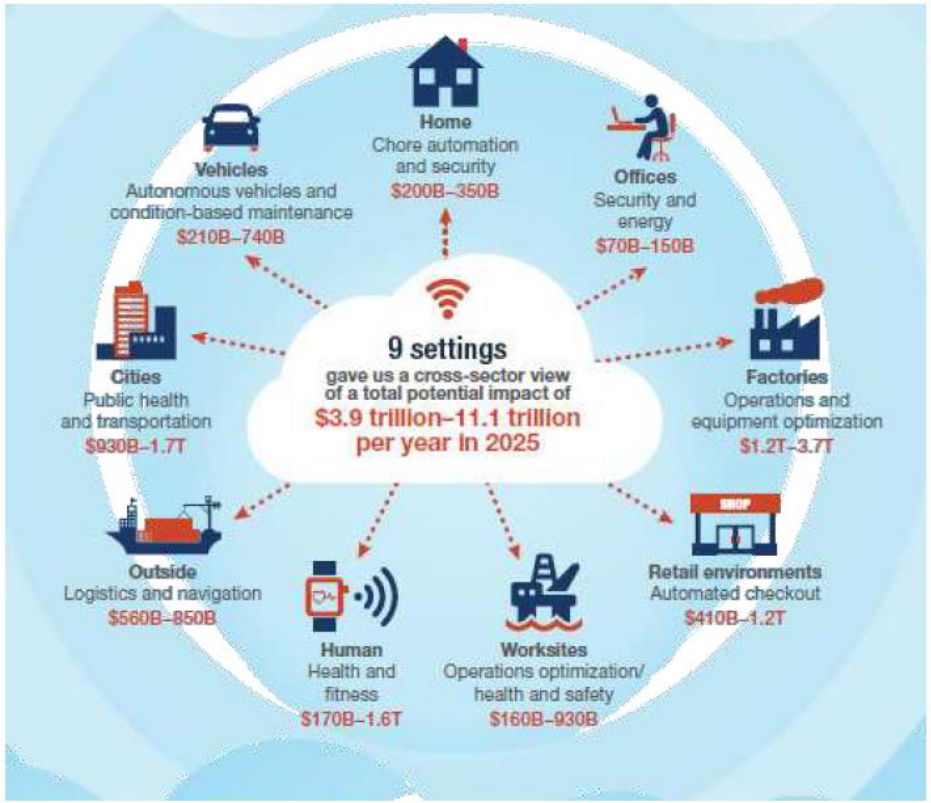
2. Internet of Things (IoT)

IoT offers the ability for physical objects or humans to generate and communicate meaningful data (e.g., about their condition, position) for analysis and subsequent action



2. Internet of Things (IoT)

Major use cases and applications



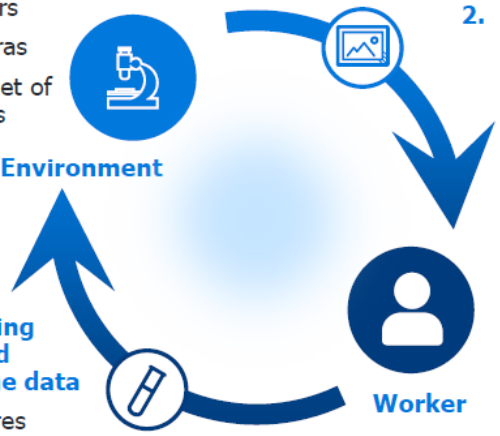
Setting		Description	Examples
	Human	Devices attached to or inside the human body	Devices (wearables and ingestibles) to monitor and maintain human health and wellness; disease management, increased fitness, higher productivity
	Home	Buildings where people live	Home controllers and security systems
	Retail environments	Spaces where consumers engage in commerce	Stores, banks, restaurants, arenas—anywhere consumers consider and buy; self-checkout, in-store offers, inventory optimization
	Offices	Spaces where knowledge workers work	Energy management and security in office buildings; improved productivity, including for mobile employees
	Factories	Standardized production environments	Places with repetitive work routines, including hospitals and farms; operating efficiencies, optimizing equipment use and inventory
	Worksites	Custom production environments	Mining, oil and gas, construction; operating efficiencies, predictive maintenance, health and safety
	Vehicles	Systems inside moving vehicles	Vehicles including cars, trucks, ships, aircraft, and trains; condition-based maintenance, usage-based design, pre-sales analytics
	Cities	Urban environments	Public spaces and infrastructure in urban settings; adaptive traffic control, smart meters, environmental monitoring, resource management
	Outside	Between urban environments (and outside other settings)	Outside uses include railroad tracks, autonomous vehicles (outside urban locations), and flight navigation; real-time routing, connected navigation, shipment tracking

3. Augmented and Virtual Reality

AR is an interactive experience of a real-world environment where the objects that reside in the real world are enhanced by computer-generated perceptual information

1. Source of the data
- Sensors
- Cameras
- Internet of Things

2. Presentation of the data
- Visual overlay
- Auditory cues
- Live video



3. Interacting with, and using, the data
- Gestures
- Voice commands
- Gaze and attention

COMMON DEVICES

Smartphones, tablets and handheld devices:
Most AR is consumed via smartphone apps
- **AR games** (e.g., Pokémon Go, Real Strike, Harry Potter Wizards Unite)
- **Social media apps** (Snapchat and Facebook)
- **Third-party AR platforms and apps** (Thyng, Blippar, Zappar, HP Reveal)
- **GPS and navigation apps** (Sygic, AR City) and branded apps (Ikea, Sephora)

Systems at the point-of-sale:
AR accessed in a variety of locations via kiosks, mirrors and special screens to help users learn about products and try things out
- **Lego AR** kiosks shows in-store shoppers how the completed project would look
- **Uniqlo, Neiman Marcus and Rebecca Minkoff** have offered fitting rooms with AR-enabled mirrors that let shoppers learn, view different combinations and instantly place orders

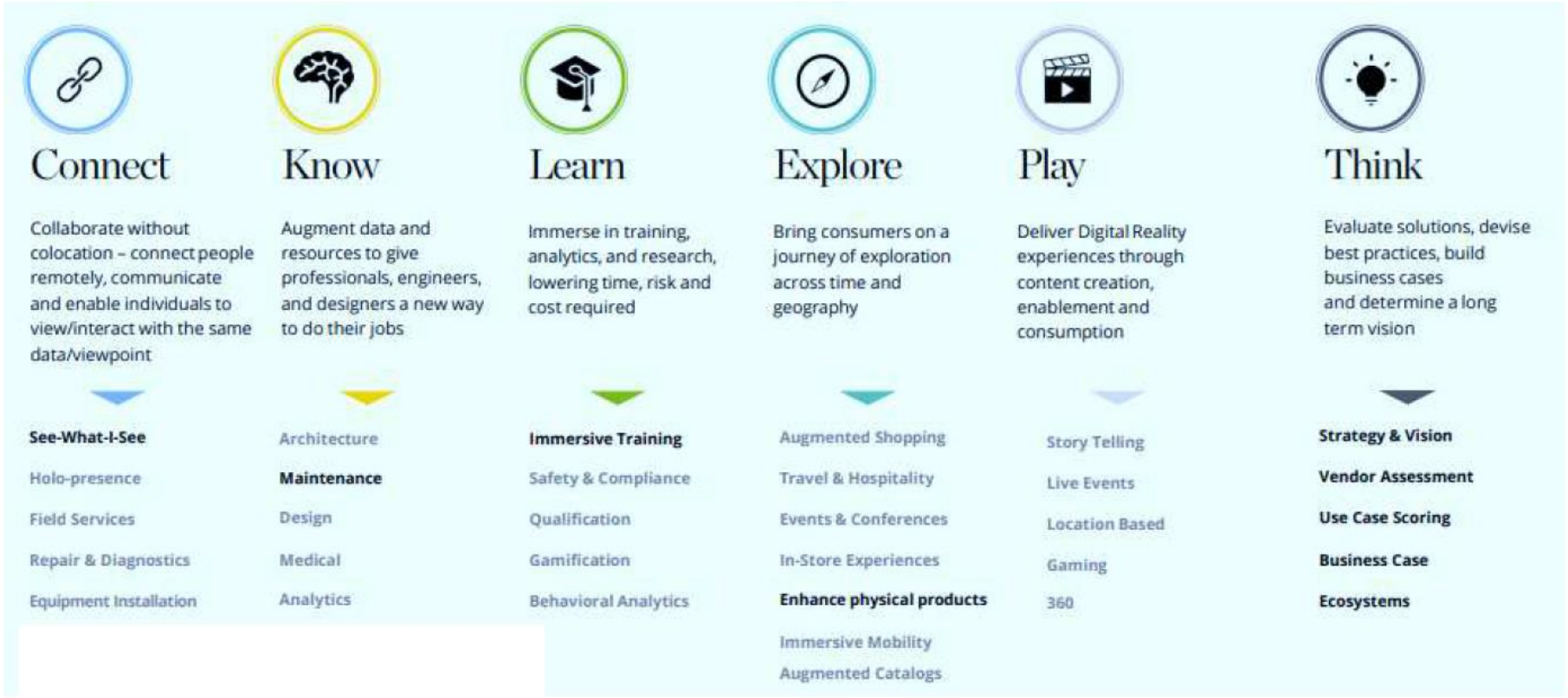
Head-mounted displays (HMDs) & glasses:
- Snapchat Spectacles camera sunglasses,
- Glass Enterprise Edition (formerly Google Glass),
- Microsoft HoloLens,
- Epson Moverio
- The Vuzix Blade AR and
- The Magic Leap One

Head-up displays:
- Transparent displays augment users' real-world views with useful data about what's in front of them

Web-based AR:
- Enables users to load and view AR experiences across different mobile and desktop browsers

3. Augmented and Virtual Reality

Use case and applications



3. Augmented and Virtual Reality

Use case and applications

RETAIL

- Augmented Shopping
- Live Events
- Behavioral Analytics
- In-Store Experiences
- Augmented Catalogs
- Immersive Training
- **Enhance physical products**

CONSTRUCTION

- Architecture
- Location Based visualization
- 360 degree experiences

MANUFACTURING

- **Immersive Training**
- Enhance physical products
- Maintenance
- **See-What-I-See**
- Field Services
- Repair & Diagnostics
- Equipment Installation

EDUCATION

- Immersive Training
- Storytelling
- Gamification

HEALTHCARE

- Immersive Training
- Safety & Compliance
- **Treatment**

GOVERNMENT

- Immersive Training
- Maintenance
- See-What-I-See
- Field Services
- Repair & Diagnostics

PHARMA

- Immersive Training
- Safety & Compliance
- Maintenance
- Visualization

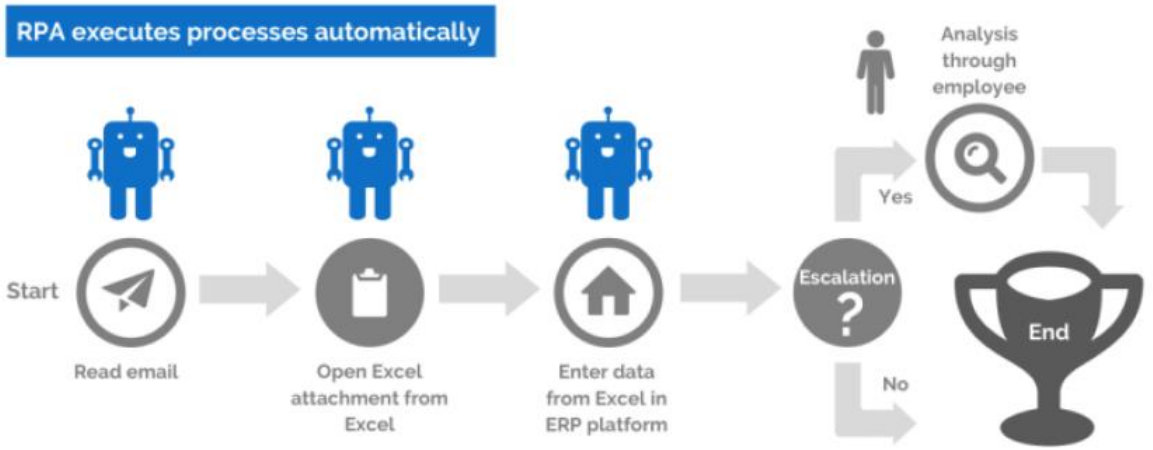
REAL ESTATE

- **Visualization**

4. Robotic Process Automation

Software based automation tool that automates routine tasks. Robot has a user ID just like an employee and can perform rules-based tasks such as accessing email and systems, performing calculations, creating documents and reports, and checking files

Example of RPA process



Common tasks for RPA

1. **Highly transactional**
   Processes which have a high volume of transactions, are performed frequently, and are typically repetitive in nature
2. **Time consuming**
   Processes with a high volume of manual interventions and labor-intensive steps
3. **Highly scalable**
   Processes that experience seasonal changes in transaction volumes
4. **Low-complexity rules**
   Processes with steps that can be governed by simple, unambiguous business rules and do not involve judgement or fuzzy logic
5. **Highly standardized**
   Processes that are stable over time with limited exceptions in the execution of steps

4. Robotic Process Automation

Use case and applications

FINANCE

- Accounts Receivable / Payable processing
- Account / Bank Reconciliations
- Financial Planning and Analysis
- Financial review preparation

IT

- Software installation
- Application Testing
- Ongoing Server application monitoring
- Automated Reporting

CALL CENTERS

- Customer set up and maintenance
- Call Center reporting
- Customer reporting
- Ongoing customer engagement

SUPPLY CHAIN

- Supplier Risk Management
- Procurement Data Management
- Requisition to Pay
- Strategic Sourcing

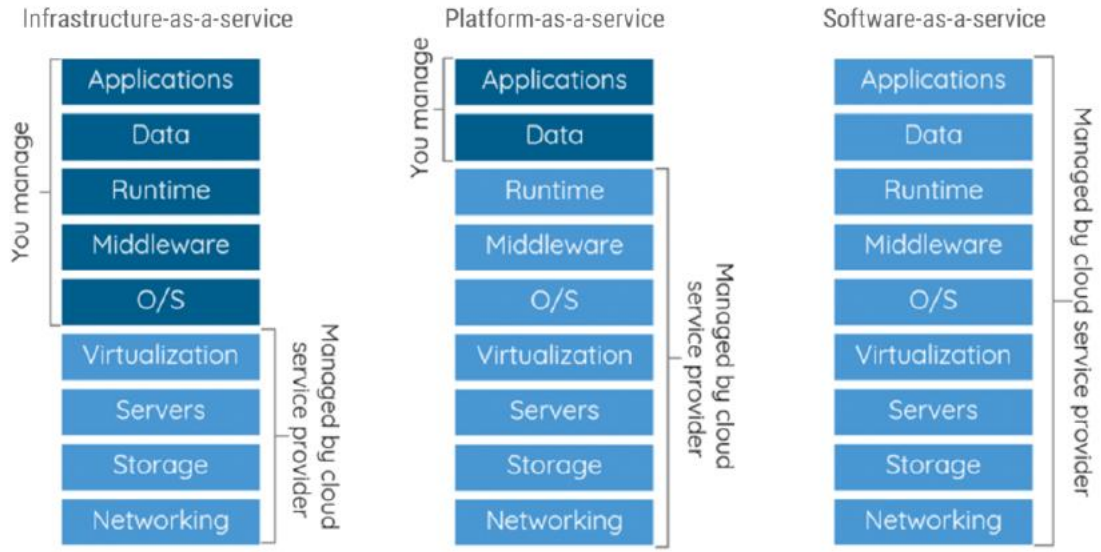
HR

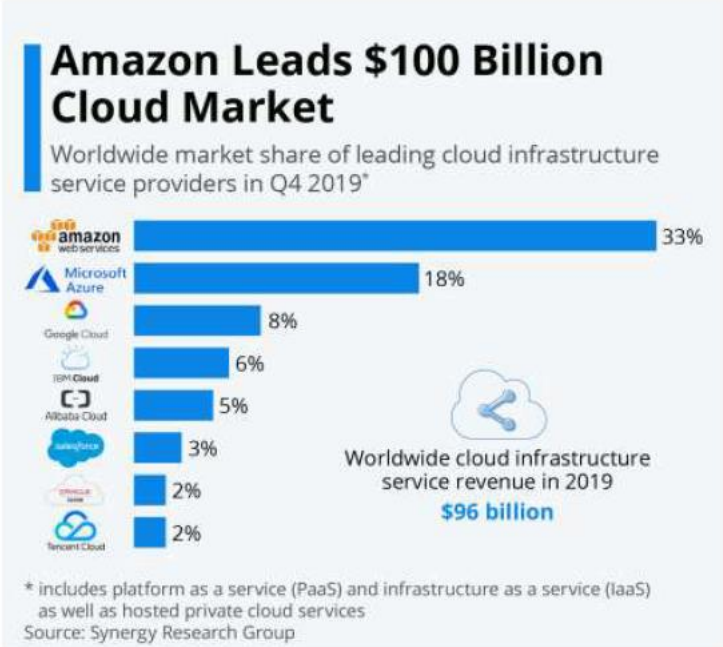
- On Boarding
- Payroll batch import & validation
- Employee Master Data
- HR Spend Analytics & Reporting

5. Cloud Storage

Accessing computing resources —including servers, storage, databases, networking, software, analytics, and intelligence—over the Internet and offering real time interaction. Can be private or public.

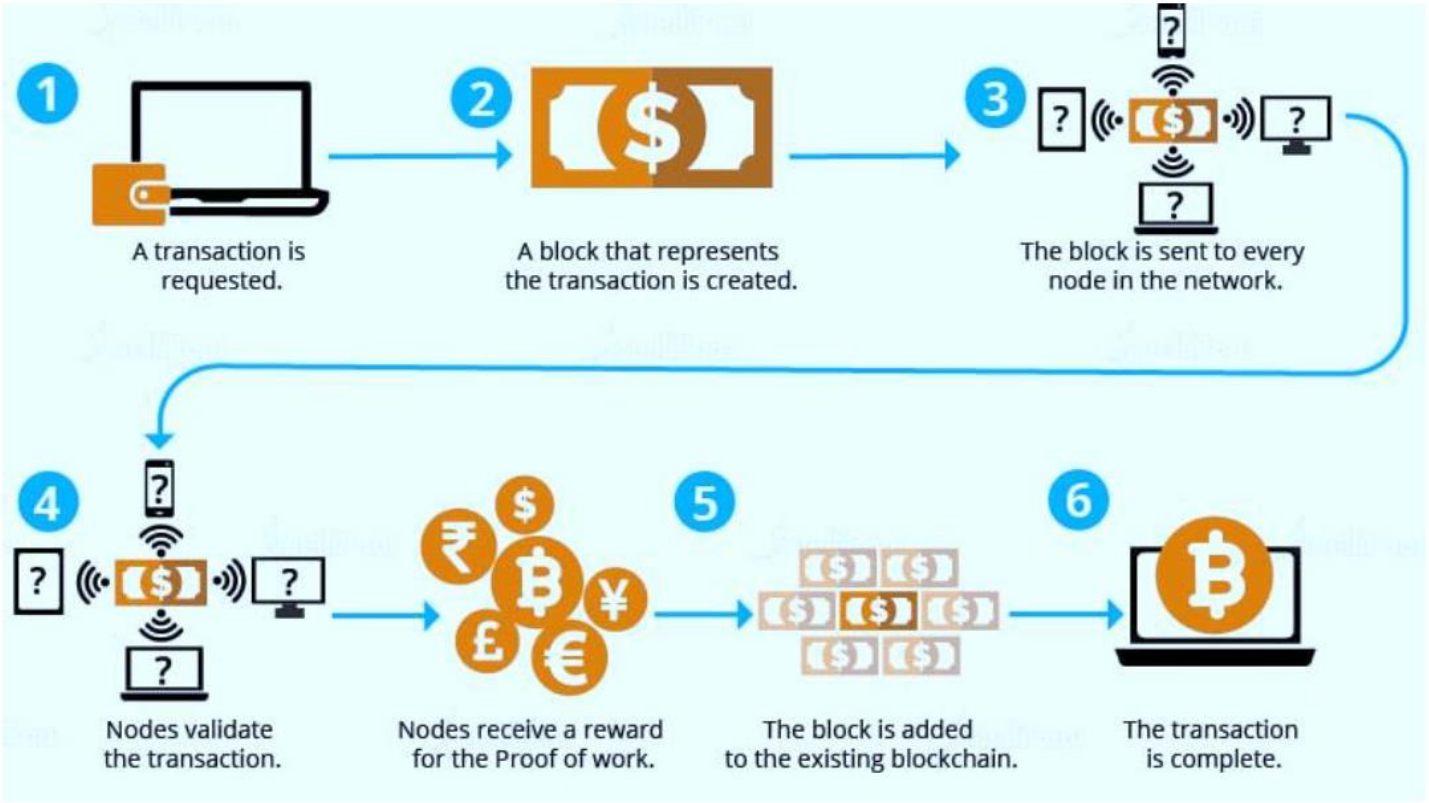
TYPICAL CLOUD MODELS





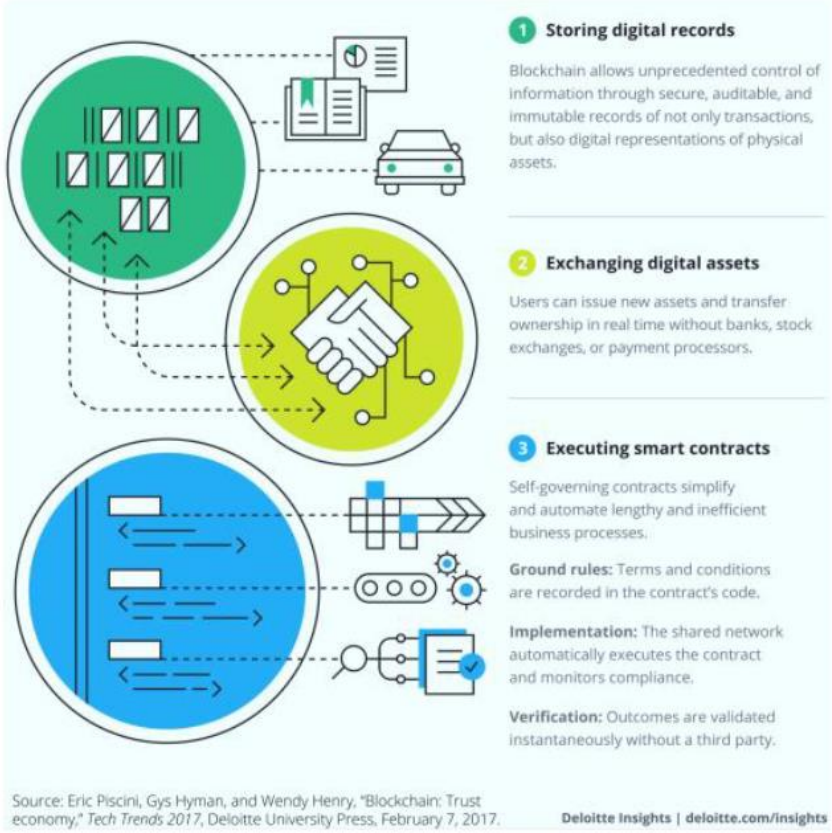
6. Blockchain

Blockchain is a digital and distributed ledger of transactions, recorded and replicated in real time across a network of computers or nodes. Every transaction must be cryptographically validated via a consensus mechanism executed by the nodes before being permanently added as a new "block" at the end of the "chain."



6. Blockchain

Use case and applications



1 Storing digital records

Blockchain allows unprecedented control of information through secure, auditable, and immutable records of not only transactions, but also digital representations of physical assets.

2 Exchanging digital assets

Users can issue new assets and transfer ownership in real time without banks, stock exchanges, or payment processors.

3 Executing smart contracts

Self-governing contracts simplify and automate lengthy and inefficient business processes.

Ground rules: Terms and conditions are recorded in the contract's code.

Implementation: The shared network automatically executes the contract and monitors compliance.

Verification: Outcomes are validated instantaneously without a third party.

Source: Eric Piscini, Gys Hyman, and Wendy Henry, "Blockchain: Trust economy," *Tech Trends 2017*, Deloitte University Press, February 7, 2017.

Deloitte Insights | deloitte.com/insights

Table 1. Blockchain and its applications across industries

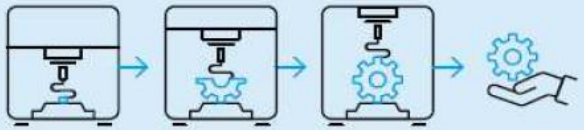
Industry	Blockchain-based applications
Financial services	• International payments in a faster, cheaper, and more secure way with lower counterparty risk[17] • Registry for better Know Your Customer (KYC) checks and compliance[18] • Trade finance blockchain platform to improve and accelerate the financing of international trade
Health care	• Ability to share clinical trial launches and enrollments in real time to better match patients and prevent double enrollments • Smart contracts to connect different parties—such as providers, insurers, vendors, and auditors—and automate transactions[19]
Public sector	• Registry to manage the digital identity of people and the ownership and transaction information on different assets such as real property and vehicles to increase efficiency and reduce fraud[20] • Enhanced security and transparency of voting in public election[21]
Energy and resources	• Smart contracts for more efficient and faster execution of energy trades and payments[22] • Managing and recording oil and gas transactions and connecting suppliers, shippers, contractors, and authorities via blockchain to improve supply chain processes[23]
Technology, media, and telecom	• Storing cryptographic hash of original music, linked to digital identities of owners, and using smart contracts to facilitate compensation for music[24] • Supporting data storage and interaction among a large number of IoT devices in a cryptographic format to help mitigate security concerns[25]
Consumer and industrial products	• Better management of loyalty points programs in retail and travel and hospitality[26] • Streamlining the vehicle buying and leasing process with less documentation and automated payments[27] • Enhanced supply chain management, especially traceability across products from its inception at manufacturer to usage by end customer[28]

7. Additive Manufacturing (or 3D Printing)

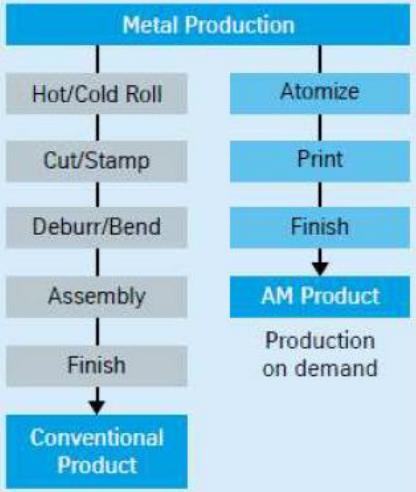
Layer by layer deposition of material to make desired object with often complex and intricate design on demand

How does AM work?

Layer-by-layer deposition of material based on a 3D model to form an object



Traditional vs AM process



Key advantages of AM

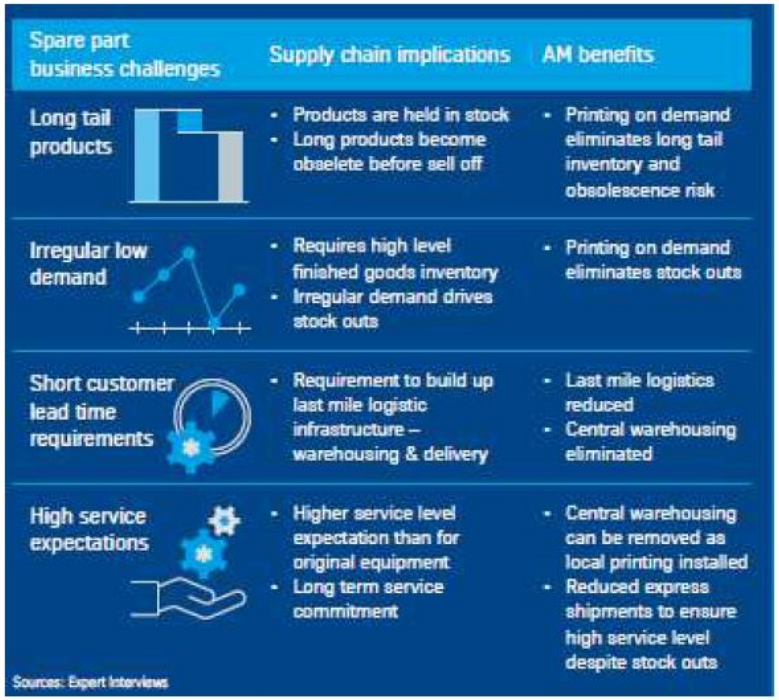
Design & Engineering
- Fast prototyping and go to market
- Enables complex shapes, lesser weight
- Greater customization

Production
- No setup time in production
- Fewer production steps, more flexibility
- Batch size of 1 economically possible
- Less material waste

Logistics & Warehousing
- Localized/Distributed production
- Less dependence on suppliers
- Reduced inventory & logistics cost

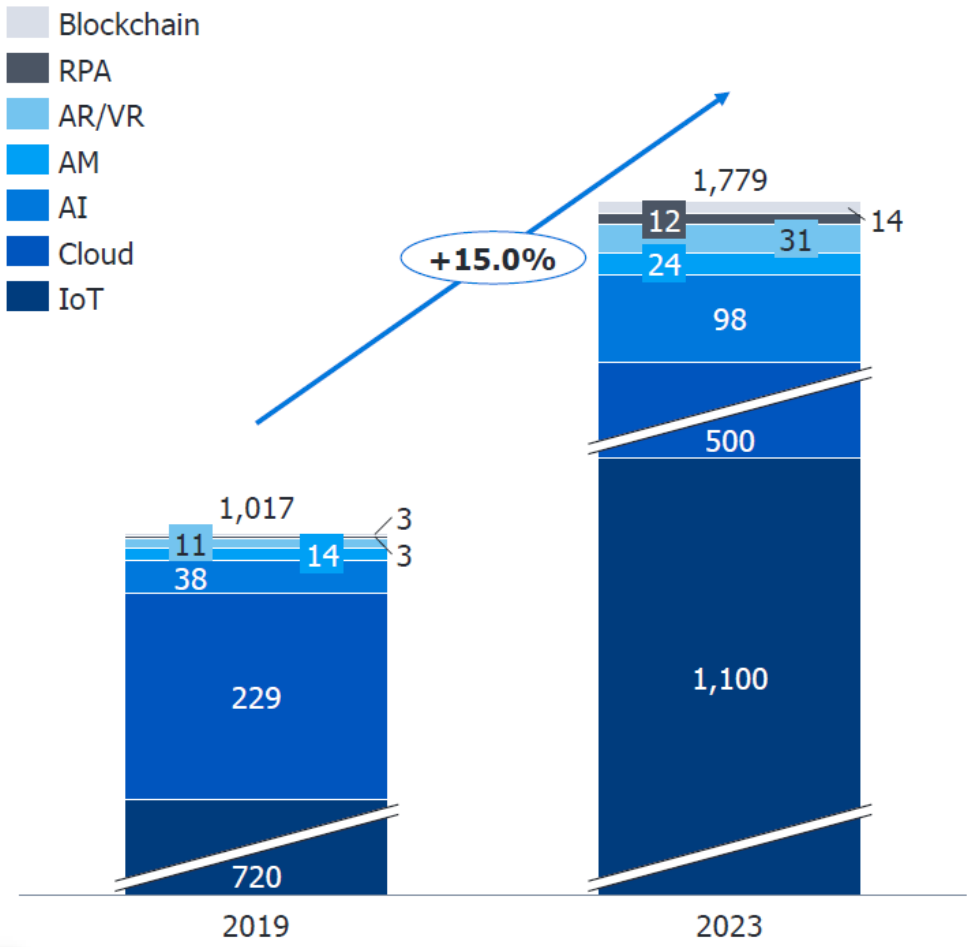
Aftermarket
- Support obsolete parts
- Reduced lead times, print on demand

Example – Application in Spare Parts



Summing it up – IoT, Cloud and AI are significantly bigger than the rest

Global Market Size of Technologies today and outlook (billion USD)



Blockchain	1x
RPA	1x
AR/VR	4x
AM or 3DP	5x
AI	~15x
Cloud	~80x
IoT	~250x

Core Technologies – For Banking

A.B.C.D

AI, Blockchain, Cloud, Data Analytics