Industry 4.0: The fusion of IOT and AI

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WHAT IS
A.I.?

Artificial Intelligence

- The intelligence demonstrated by machines is known as Artificial Intelligence.
- Artificial Intelligence has grown to be very popular in today's world. It is the simulation of natural intelligence in machines that are programmed to learn and mimic the actions of humans.
- These machines are able to learn with experience and perform human-like tasks.
- As technologies such as AI continue to grow, they will have a great impact on our quality of life.

Artificial Intelligence

- Artificial Intelligence is composed of two words Artificial and Intelligence, where Artificial defines "man-made," and intelligence defines "thinking power", hence AI means "a man-made thinking power."
- So, we can define AI as:
  - "It is a branch of computer science by which we can create intelligent machines which can behave like a human, think like humans, and able to make decisions."

Artificial Intelligence

- The short answer to What is Artificial Intelligence is that it depends on who you ask.
- A layman with a fleeting understanding of technology would link it to robots.
- They'd say Artificial Intelligence is a terminator like-figure that can act and think on its own.
- If you ask about artificial intelligence to an AI researcher, (s)he would say that it's a set of algorithms that can produce results without having to be explicitly instructed to do so. And they would all be right.

Artificial Intelligence

- So to summarise, Artificial Intelligence meaning is:
- Artificial Intelligence Definition
  - An intelligent entity created by humans.
  - Capable of performing tasks intelligently without being explicitly instructed.
  - Capable of thinking and acting rationally and humanely.

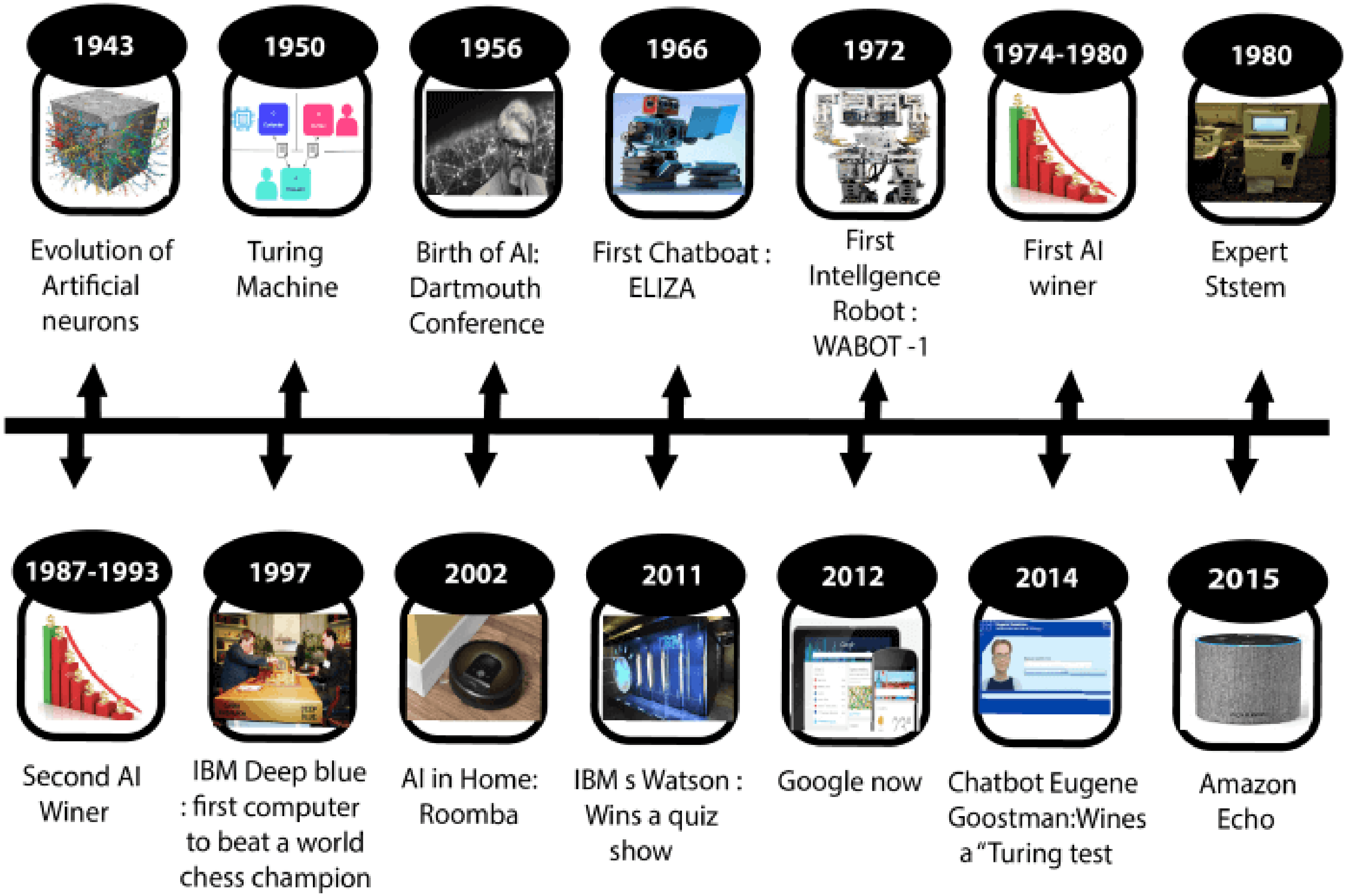
Artificial Intelligence : Design Goals

- Teach machines to reason in accordance to perform sophisticated mental tasks like playing chess, proving mathematical theorems, and others.
- Knowledge representation for machines to interact with the real world as humans do — machines needed to be able to identify objects, people, and languages. Programming language Lisp was developed for this very purpose.
- Teach machines to plan and navigate around the world we live in. With this, machines could autonomously move around by navigating themselves.

Artificial Intelligence : Design Goals

- Enable machines to process natural language so that they can understand language, conversations and the context of speech.
- Train machines to perceive the way humans do- touch, feel, sight, hearing, and taste.
- General Intelligence that included emotional intelligence, intuition, and creativity.

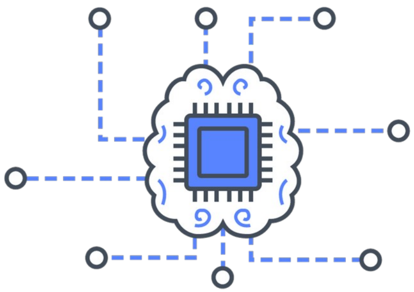
Artificial Intelligence : Evolution



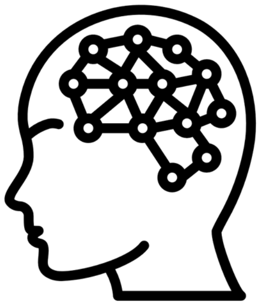
Branches Of Artifical Intelligence

- Artificial Intelligence can be used to solve real-world problems by implementing the following processes/ techniques:
  - Machine Learning
  - Deep Learning
  - Natural Language Processing
  - Robotics
  - Expert Systems
  - Fuzzy Logic
  - Computer Vision

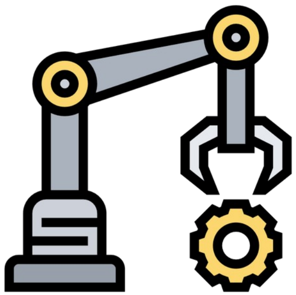
Branches Of Artifical Intelligence



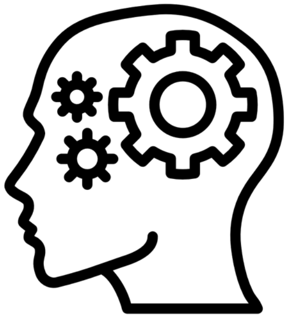
Machine Learning



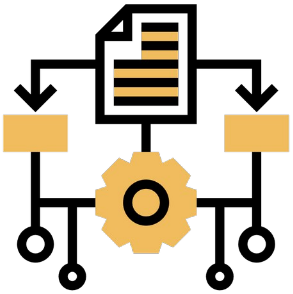
Neural Networks



Robotics



Expert Systems



Fuzzy Logic

Natural Language Processing

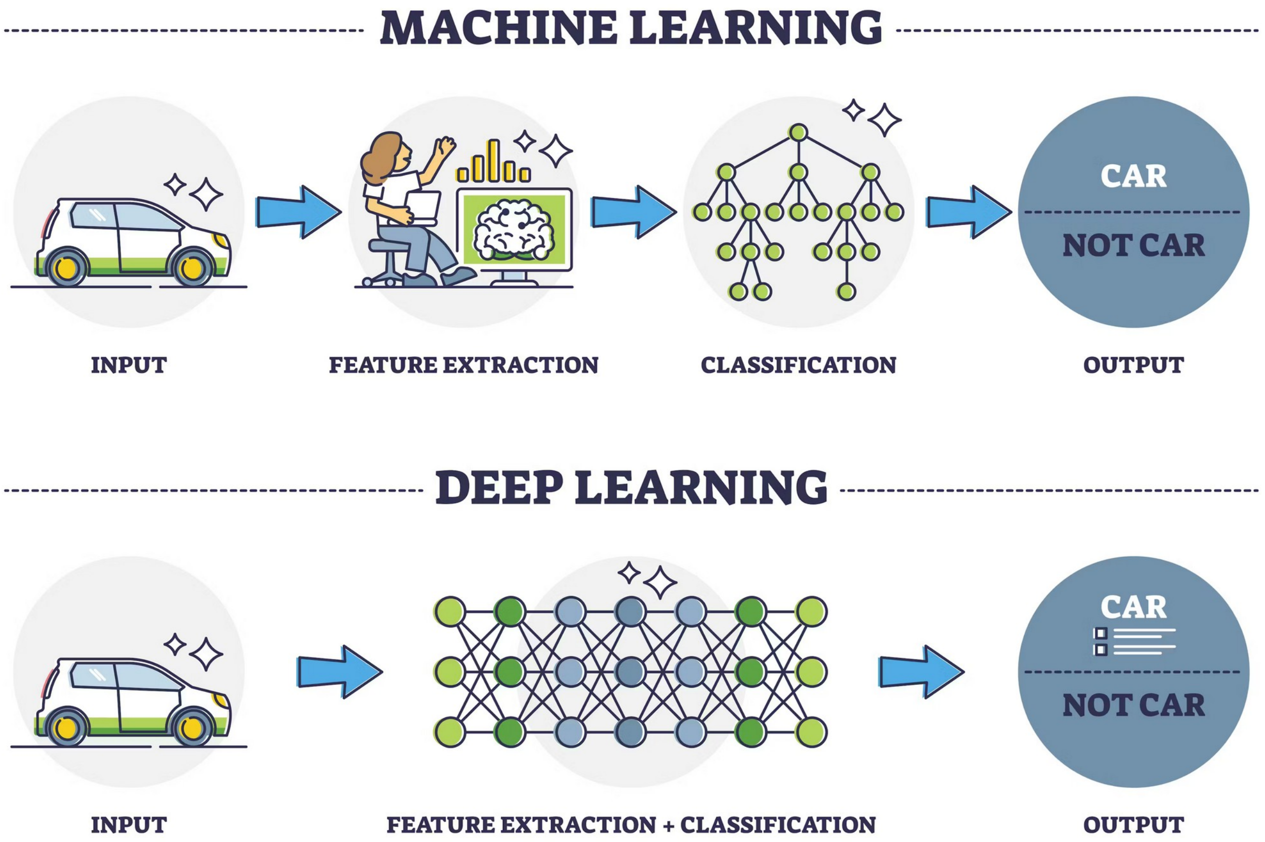
Machine Learning

- Machine Learning is the science of getting machines to interpret, process and analyze data in order to solve real-world problems.
- Under Machine Learning there are three categories:
  - Supervised Learning
  - Unsupervised Learning
  - Reinforcement Learning

Deep Learning

- Deep Learning is the process of implementing Neural Networks on high dimensional data to gain insights and form solutions.
- Deep Learning is an advanced field of Machine Learning that can be used to solve more advanced problems.
- Deep Learning is the logic behind the face verification algorithm on Facebook, self-driving cars, virtual assistants like Siri, Alexa and so on.

Deep Learning



Natural Language Processing

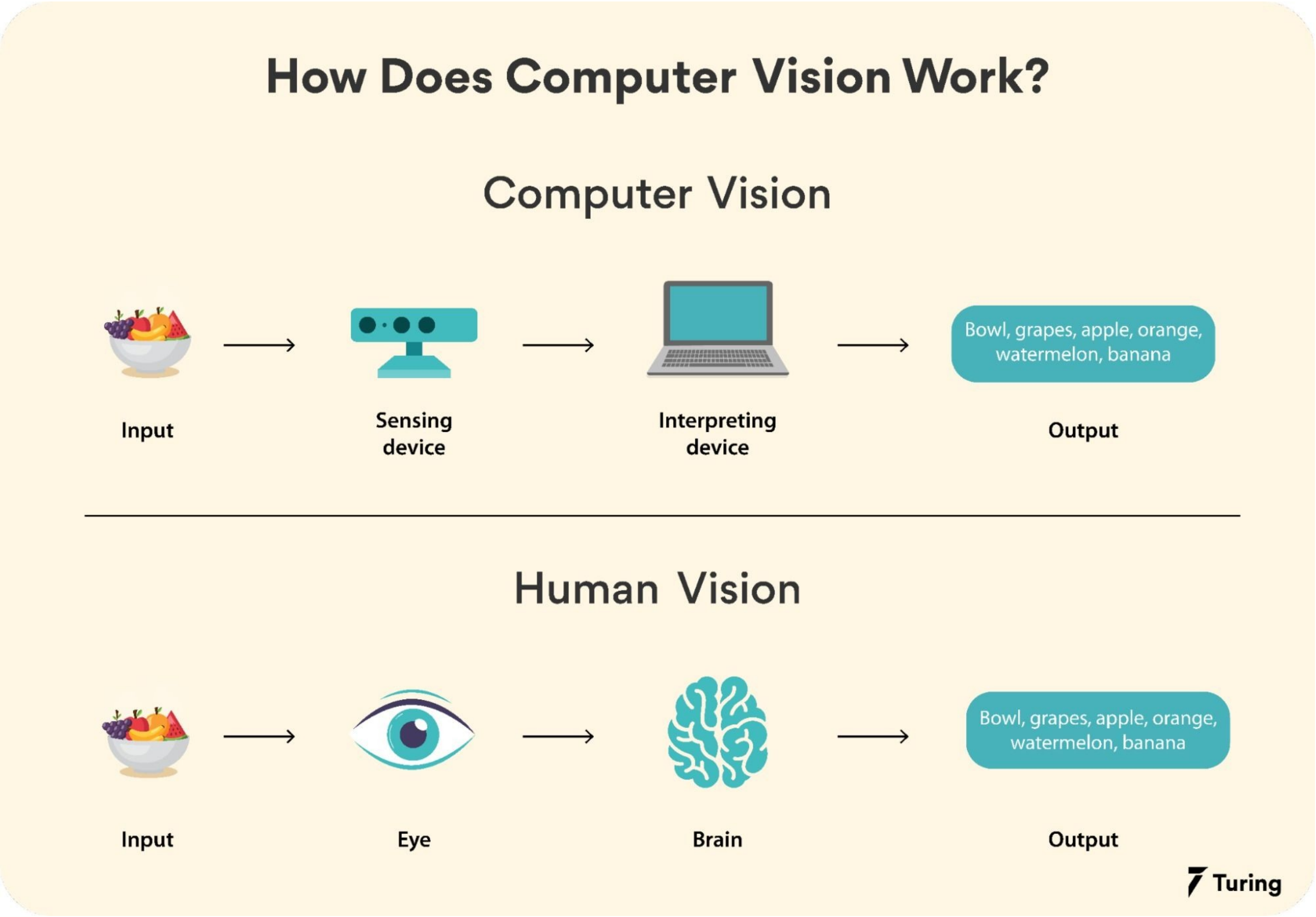
- Natural Language Processing (NLP) refers to the science of drawing insights from natural human language in order to communicate with machines and grow businesses.
- Twitter uses NLP to filter out terroristic language in their tweets, Amazon uses NLP to understand customer reviews and improve user experience.

Natural Language Processing

Computer Vision

- Computer vision is one of the fields of artificial intelligence that trains and enables computers to understand the visual world.
- Computers can use digital images and deep learning models to accurately identify and classify objects and react to them.
- Computer vision in AI is dedicated to the development of automated systems that can interpret visual data (such as photographs or motion pictures) in the same manner as people do.

Computer Vision: How?



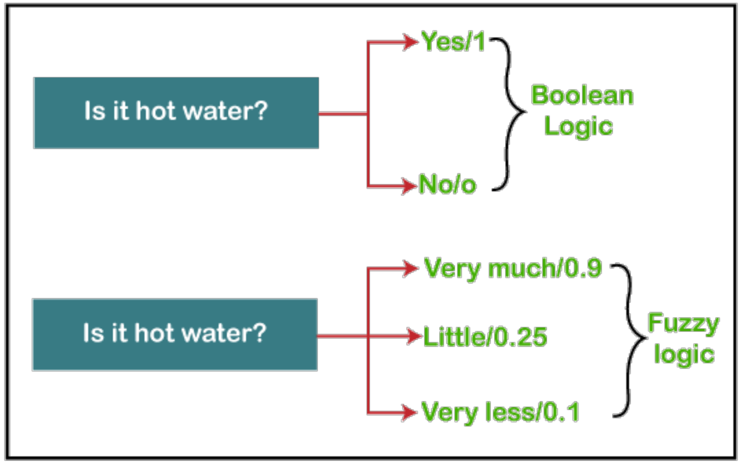
Robotics

- Robotics is a branch of Artificial Intelligence which focuses on different branches and application of robots.
- AI Robots are artificial agents acting in a real-world environment to produce results by taking accountable actions.

Robotics

Fuzzy Logic

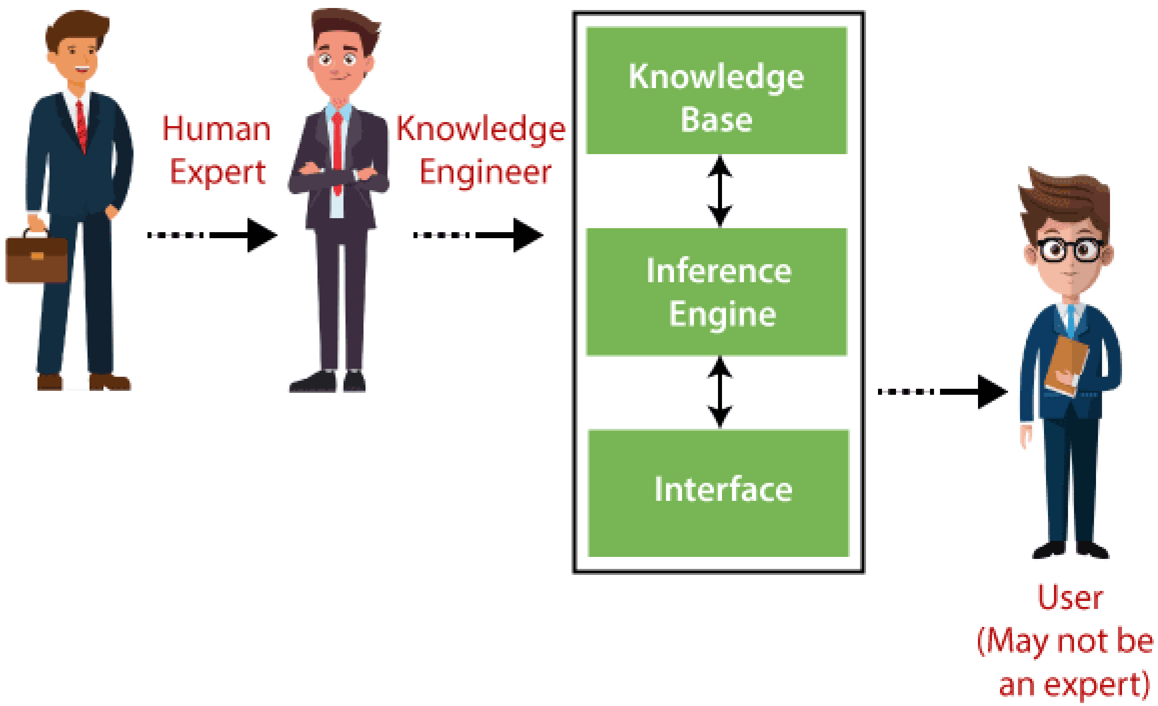
- Fuzzy logic is a computing approach based on the principles of “degrees of truth” instead of the usual modern computer logic i.e. boolean in nature.



Expert Systems

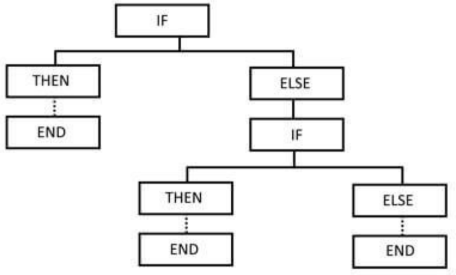
- An expert system is an AI-based computer system that learns and reciprocates the decision-making ability of a human expert.
- Expert systems use if-then logical notations to solve complex problems. It does not rely on conventional procedural programming.
- Expert systems are mainly used in information management, medical facilities, loan analysis, virus detection and so on.

Expert Systems



Major AI Approaches

- Two Major AI Techniques
  - Logic and Rules-Based Approach



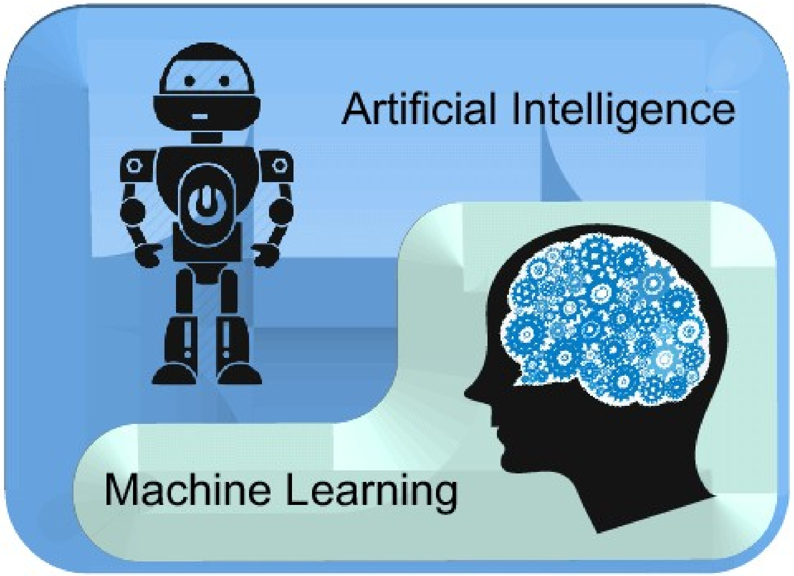
  - Machine Learning (Pattern-Based Approach)

Rules based approach

- A system designed to achieve artificial intelligence (AI) via a model solely based on predetermined rules is known as a rule-based AI system.
- The makeup of this simple system comprises a set of human-coded rules that result in pre-defined outcomes. These AI system models are defined by ‘if-then’ coding statements (i.e. if X performs Y, then Z is the result).
- Two important elements of rule-based AI models are “a set of rules” and “a set of facts” and by using these, developers can create a basic artificial intelligence model.
- These systems can be viewed as a more advanced form of robotic process automation (RPA).

Learning vs. Designing

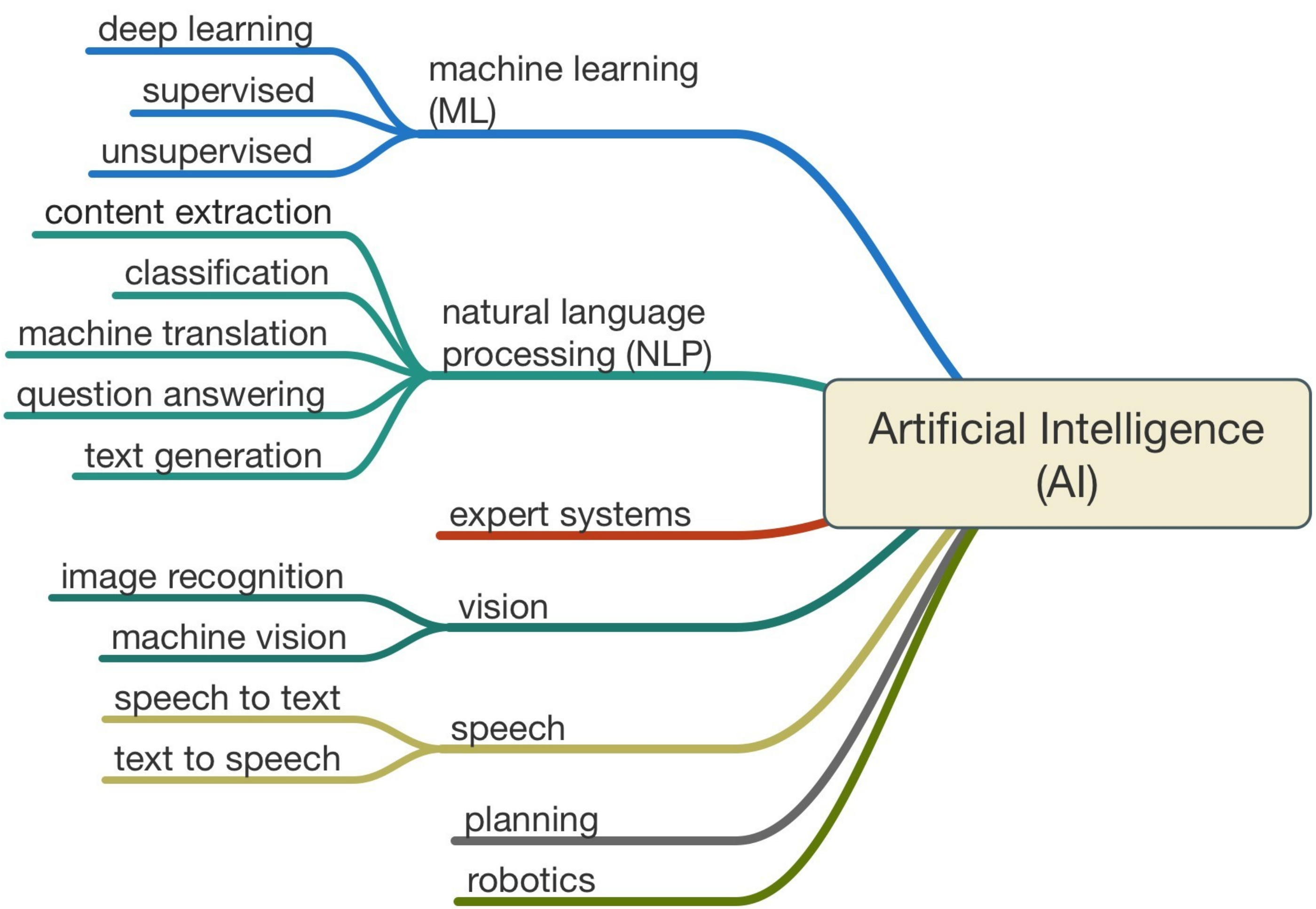
- AI is a bigger concept to design intelligent machines that can simulate human thinking capability and behavior, whereas, machine learning is an application or subset of AI that allows machines to learn from data without being programmed explicitly.



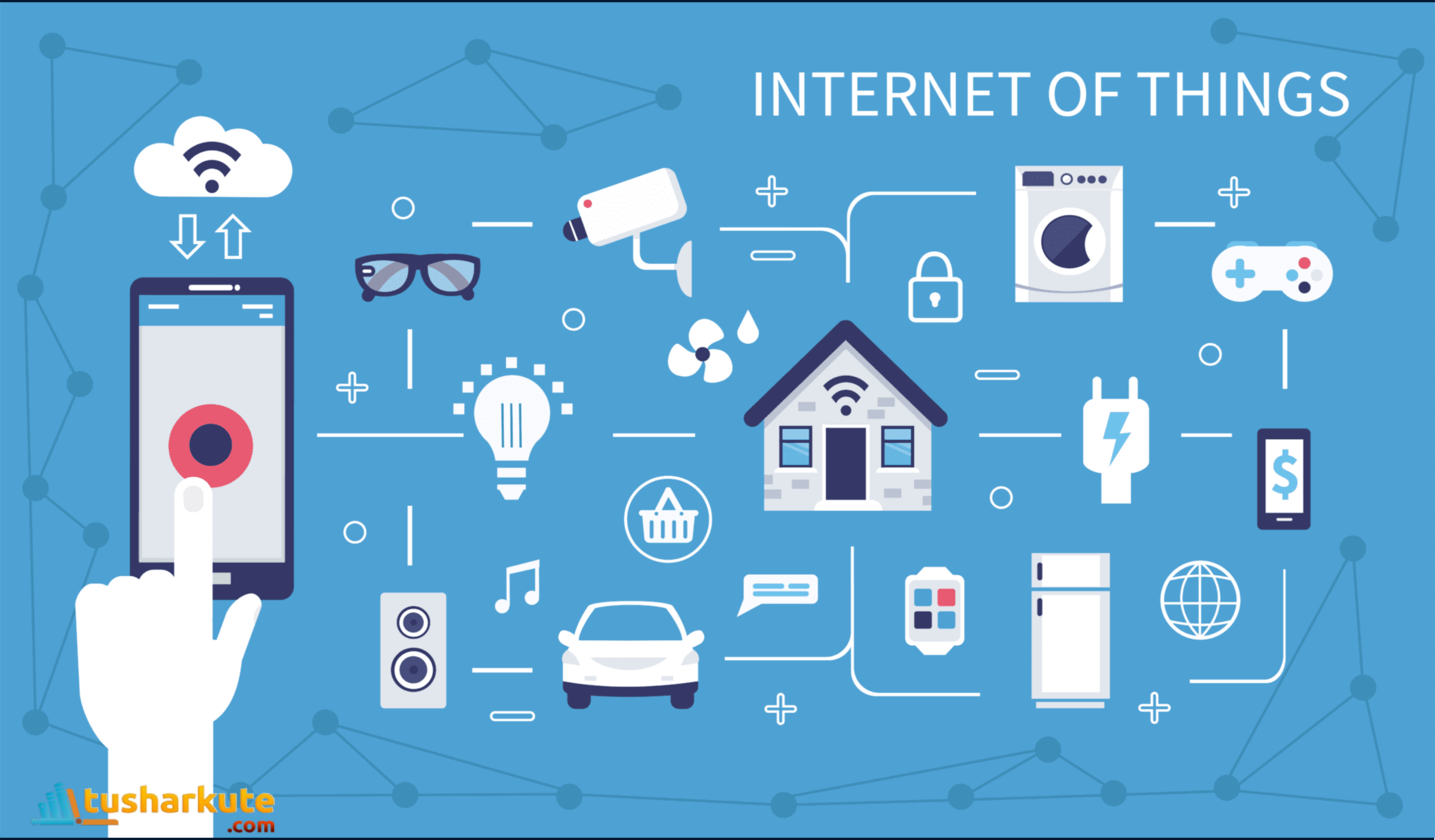
Machine Learning

- Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed. Machine learning focuses on the development of computer programs that can access data and use it learn for themselves.
- The process of learning begins with observations or data, such as examples, direct experience, or instruction, in order to look for patterns in data and make better decisions in the future based on the examples that we provide.
- The primary aim is to allow the computers learn automatically without human intervention or assistance and adjust actions accordingly.

Summary


deep learning
supervised
unsupervised
machine learning (ML)
content extraction
classification
machine translation
question answering
text generation
natural language processing (NLP)
expert systems
Artificial Intelligence (AI)
image recognition
machine vision
vision
speech to text
text to speech
speech
planning
robotics

What is IoT ?



What is IoT ?

- The Internet of Things (IoT) is the network of physical objects or "things" embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data.
- IoT allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration between the physical world and computer-based systems, and resulting in improved efficiency, accuracy and economic benefit.

What is IoT ?

- "Things," in the IoT sense, can refer to a wide variety of devices such as heart monitoring implants, biochip transponders on farm animals, electric clams in coastal waters, automobiles with built-in sensors, DNA analysis devices for environmental/food/pathogen monitoring or field operation devices that assist fire-fighters in search and rescue operations.
- These devices collect useful data with the help of various existing technologies and then autonomously flow the data between other devices.

History of IoT

- 1999: The Term "Internet of Things"
  - Kevin Ashton: The term "Internet of Things" was coined by Kevin Ashton, a British technologist, while working at Procter & Gamble. He used it to describe a system where the internet is connected to the physical world via ubiquitous sensors.
- Early 2000s: Initial Developments
  - MIT Auto-ID Center: Researchers at the MIT Auto-ID Center developed standards for RFID and other sensors, which were critical for the development of IoT.

Examples of IoT Devices

- Smart homes: Thermostats, lights, security systems, and appliances.
- Wearables: Fitness trackers, smartwatches, and health monitors.
- Automotive: Connected cars with features like remote diagnostics and autonomous driving.
- Industrial: Sensors for monitoring equipment, supply chain management, and predictive maintenance.

How IoT Works ?

- Devices: Everyday objects are equipped with sensors and software.
- Connectivity: These devices connect to the internet, forming a vast network.
- Data Collection: Sensors gather data about their surroundings or their own state.
- Data Transmission: Collected data is sent to a central system or cloud.
- Analysis: Data is processed and analyzed to extract valuable insights.
- Action: Based on the analysis, devices or systems can be controlled or adjusted automatically.

How IoT Works ?

Sensors

Collecting data

Connectivity

Sending data to cloud

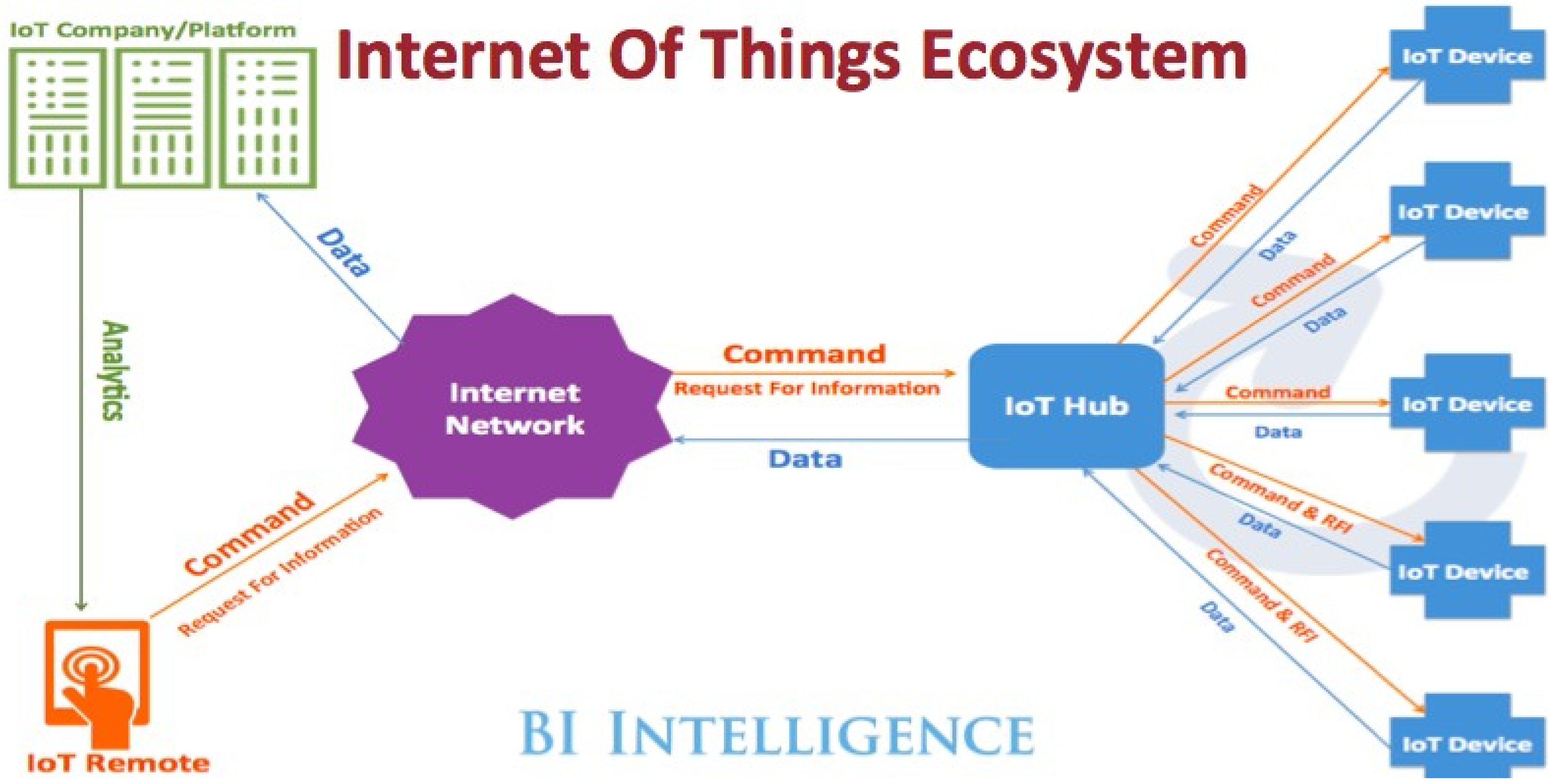
Data Processing

Making data useful

User Interface

Delivering information to user

IoT Echosystem



Structure of IoT

- The IoT can be viewed as a gigantic network consisting of networks of devices and computers connected through a series of intermediate technologies where numerous technologies like RFIDs, wireless connections may act as enablers of this connectivity.
  - Tagging Things : Real-time item traceability and addressability by RFIDs.
  - Feeling Things : Sensors act as primary devices to collect data from the environment.
  - Shrinking Things : Miniaturization and Nanotechnology has provoked the ability of smaller things to interact and connect within the "things" or "smart devices."
  - Thinking Things : Embedded intelligence in devices through sensors has formed the network connection to the Internet. It can make the "things" realizing the intelligent control.

Key features

- Connectivity
  - Internet Access: Devices are connected to the internet, enabling them to communicate with each other and with centralized systems.
  - Networking Protocols: Utilizes standard networking protocols such as Wi-Fi, Bluetooth, Zigbee, and cellular networks to ensure reliable communication.

Key features

- Sensors
  - Data Collection: Embedded sensors in IoT devices collect real-time data from their environment.
  - Types of Sensors: Includes temperature sensors, motion detectors, GPS, accelerometers, and more, depending on the application.

Key features

- Automation and Control
  - Remote Control: Users can control devices remotely via smartphones, tablets, or computers.
  - Automation: Devices can perform tasks automatically based on predefined rules, schedules, or triggers (e.g., turning on lights when motion is detected).

Key features

- Data Processing and Analysis
  - Edge Computing: Data is processed closer to the source (on the device or local server) to reduce latency and bandwidth use.
  - Cloud Computing: Centralized data processing and storage in the cloud for more complex analysis and scalability.
  - Machine Learning and AI: Utilizes advanced algorithms to analyze data, detect patterns, and make intelligent decisions.

Key features

- Scalability
  - Large-Scale Deployment: IoT systems can scale from a few devices to millions, supporting extensive networks.
  - Interoperability: Ability to integrate with other systems and devices, often using open standards and APIs.

Key features

- Real-Time Operations
  - Instant Feedback: Provides real-time data and alerts, enabling immediate responses to changes or anomalies.
  - Continuous Monitoring: Constant monitoring of systems and environments for ongoing insights and improvements.

Key features

- Energy Efficiency
  - Low Power Consumption: Many IoT devices are designed to consume minimal power, often using energy-efficient protocols and hardware.
  - Battery Management: Optimized for long battery life, crucial for remote or hard-to-reach devices.

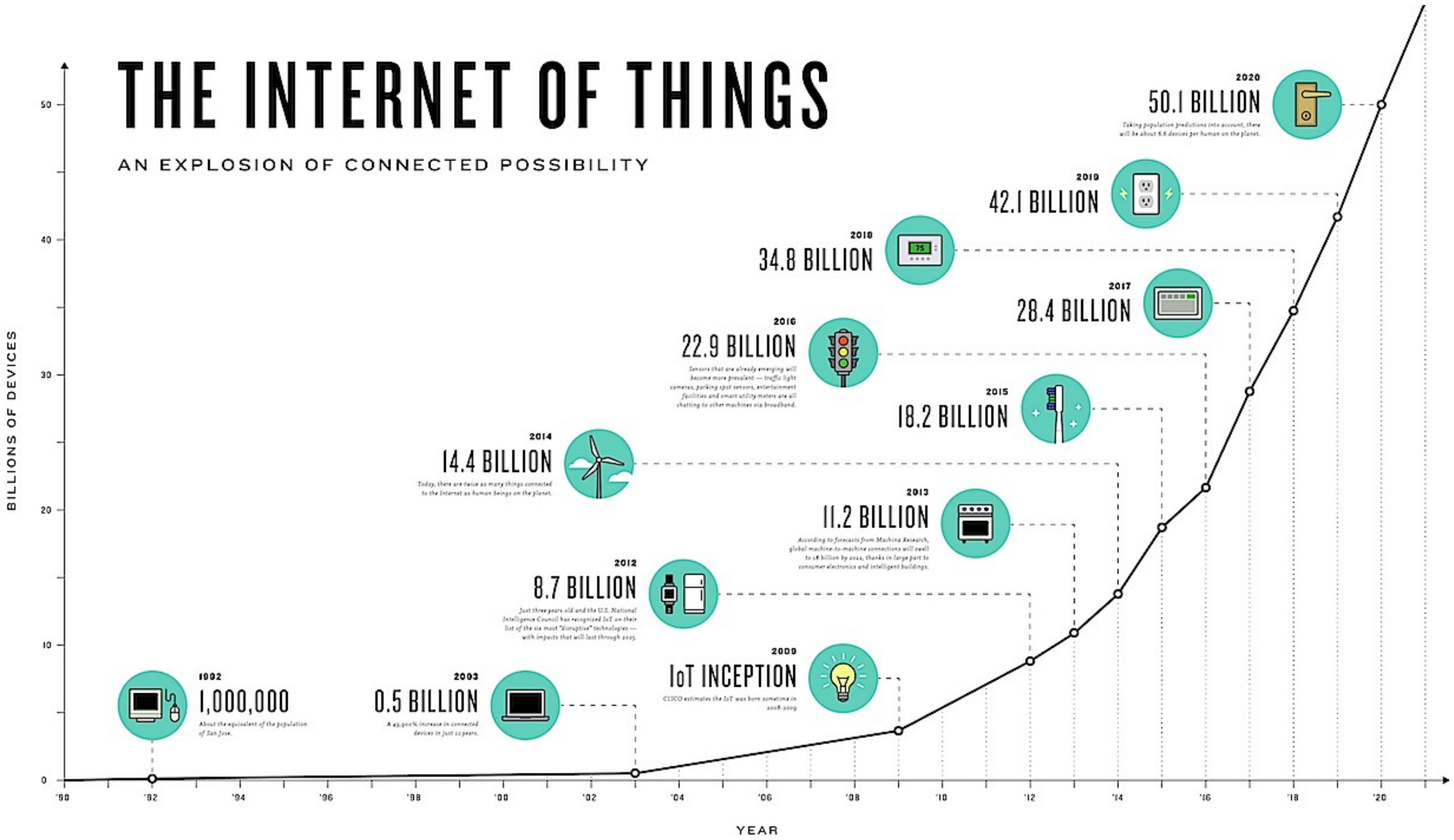
Key features

- Security and Privacy
  - Data Encryption: Ensures that data transmitted between devices and systems is encrypted and secure.
  - Access Control: Implements authentication and authorization measures to prevent unauthorized access.
  - Privacy Policies: Adheres to privacy regulations and standards to protect user data.

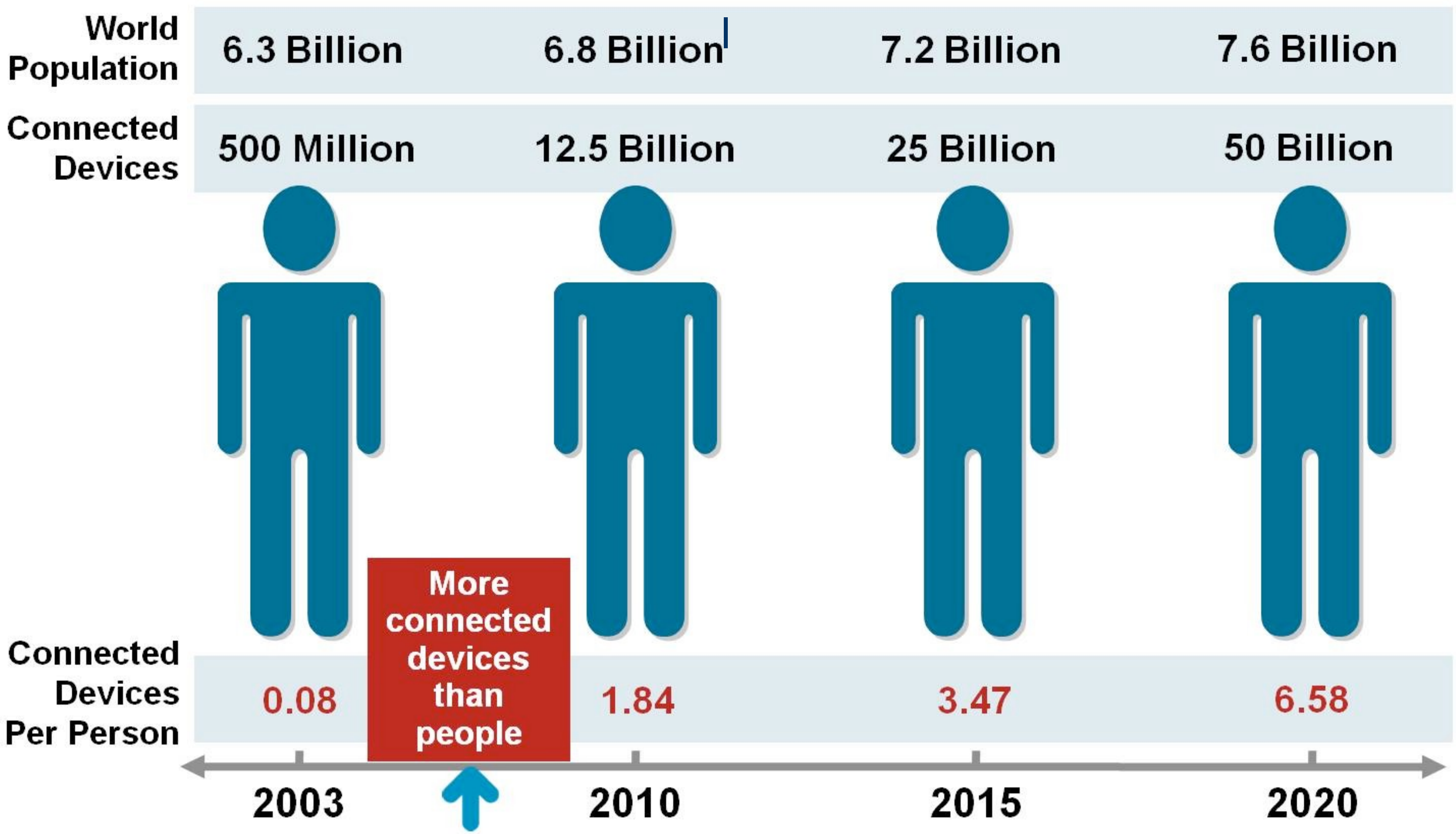
Key features

- User Interface
  - Mobile Apps: Provides user-friendly interfaces through mobile applications for easy control and monitoring.
  - Dashboards: Centralized dashboards offer comprehensive views of all connected devices and their statuses.

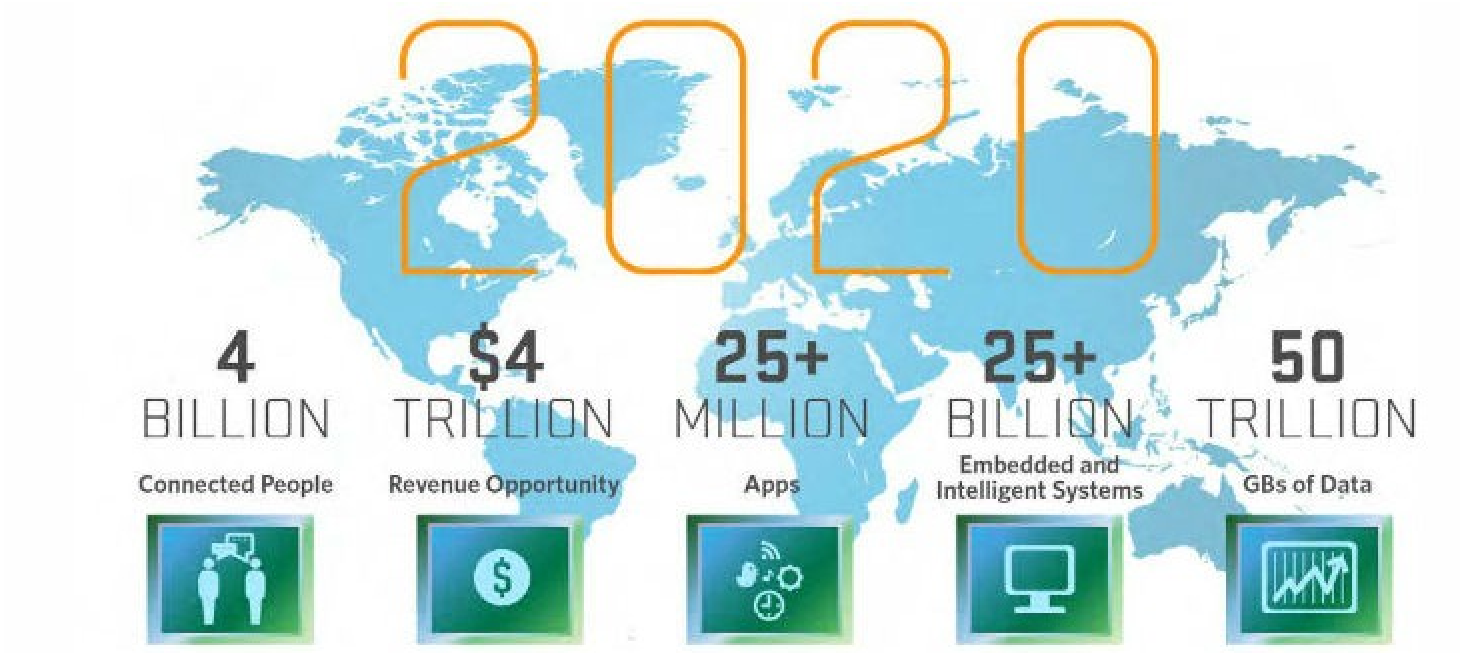
Growth of IoT



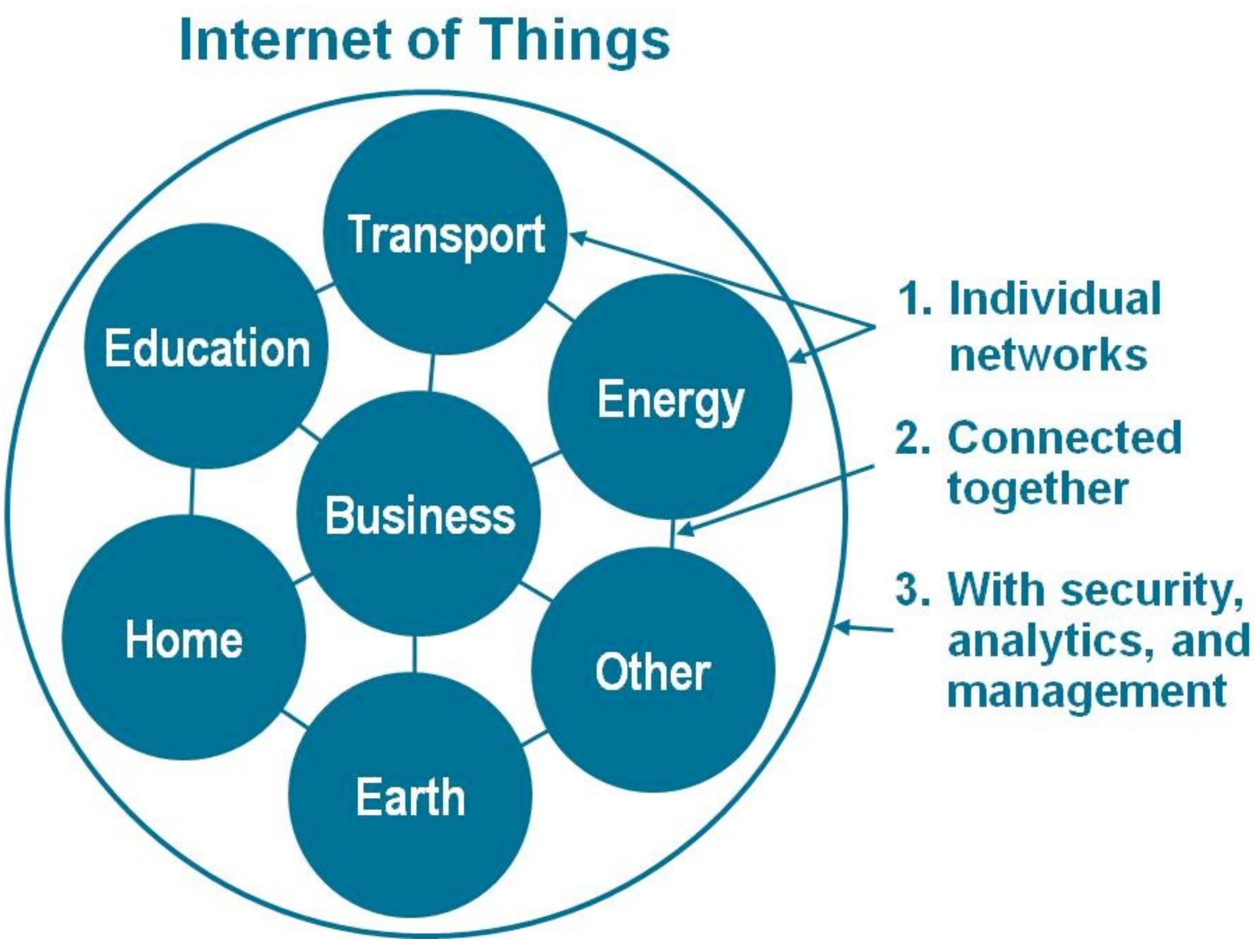
Current and Future Prospect



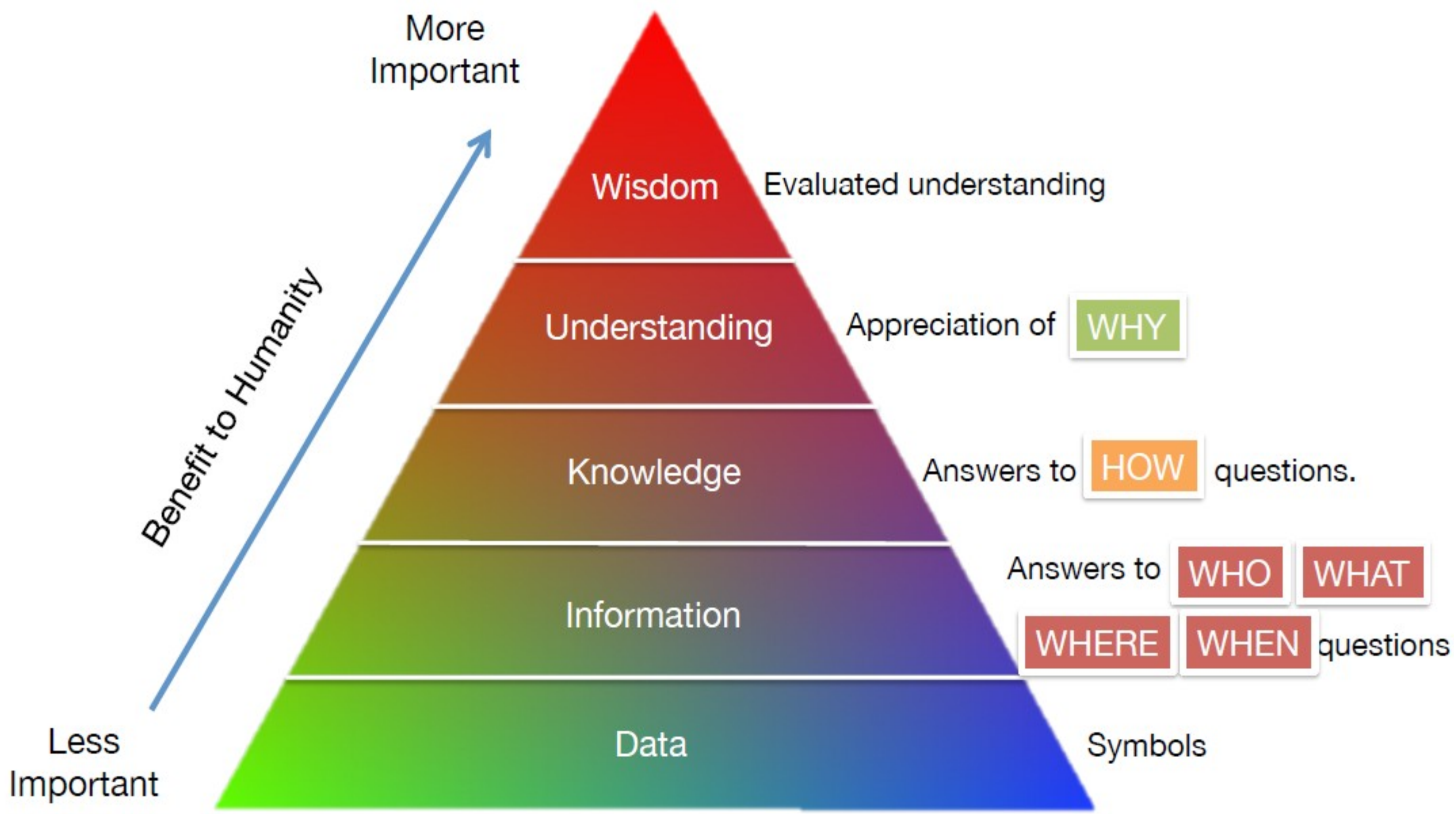
IoT Need


2020
4
BILLION
Connected People
$4
TRILLION
Revenue Opportunity
25+
MILLION
Apps
25+
BILLION
Embedded and
Intelligent Systems
50
TRILLION
GBs of Data

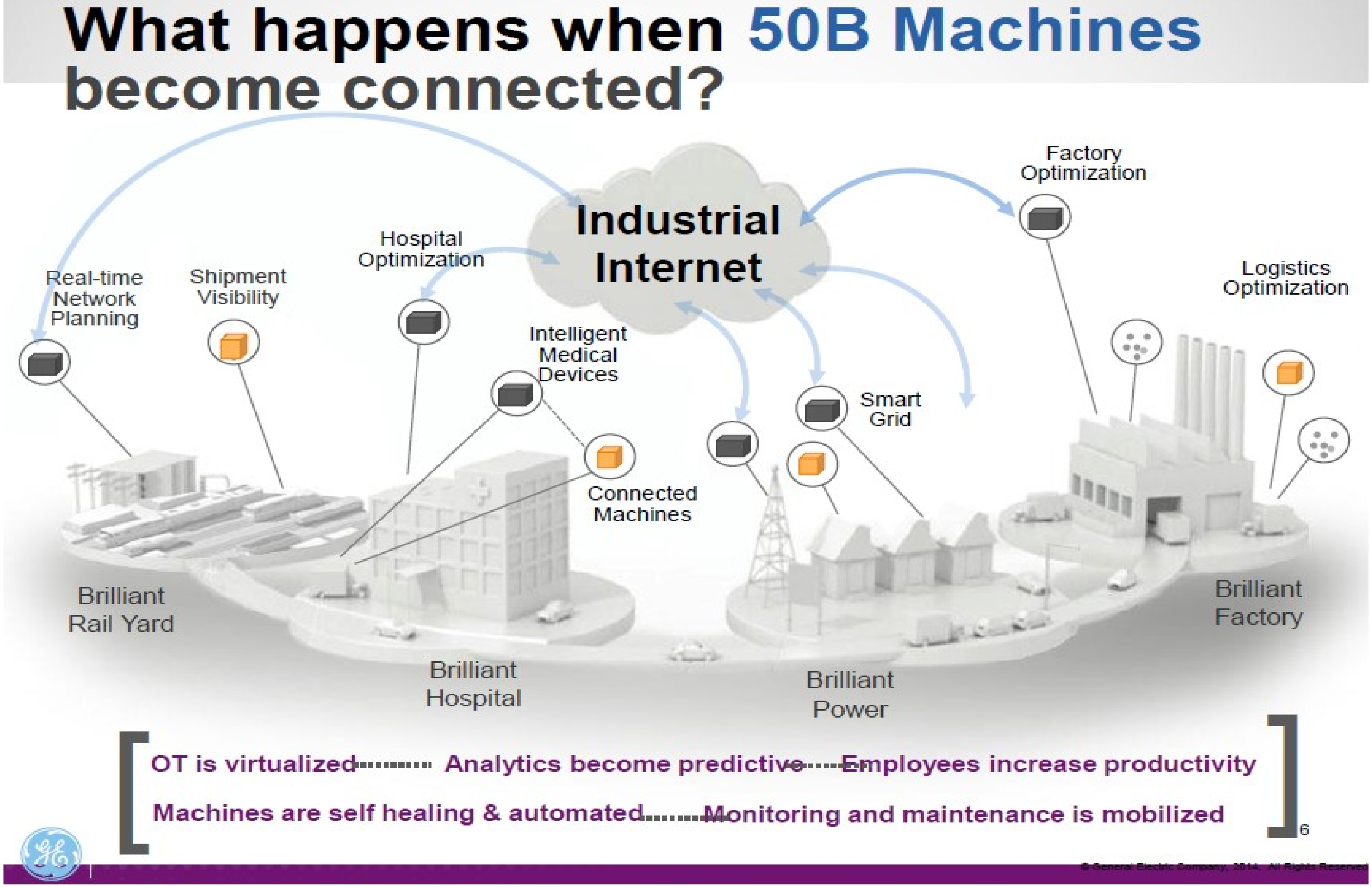
Network of Network



Turning data into wisdom



Future of IoT



Potential of IoT

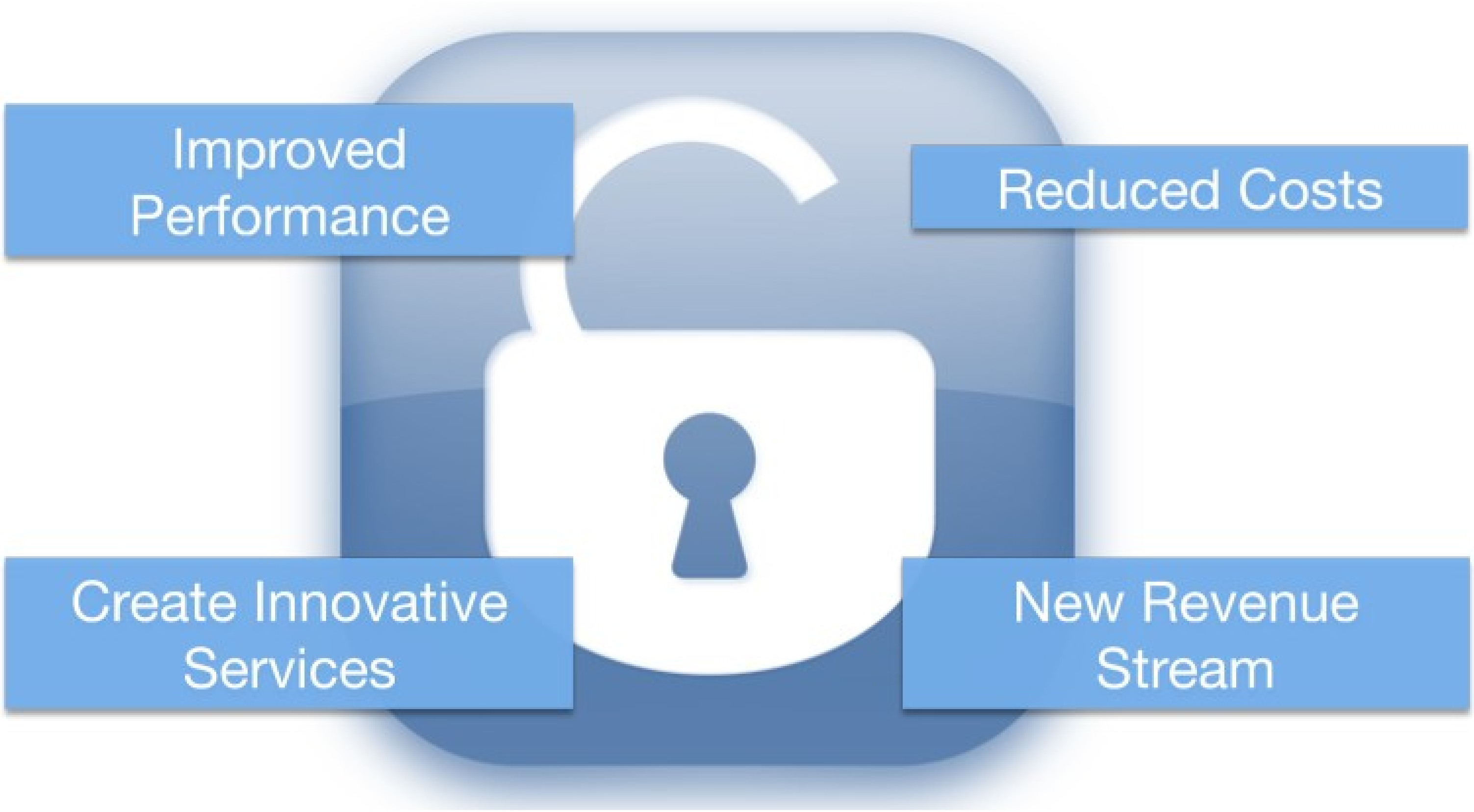
Value of Industrial Internet is huge

Connected machines and data could eliminate up to $150 billion in waste across industries

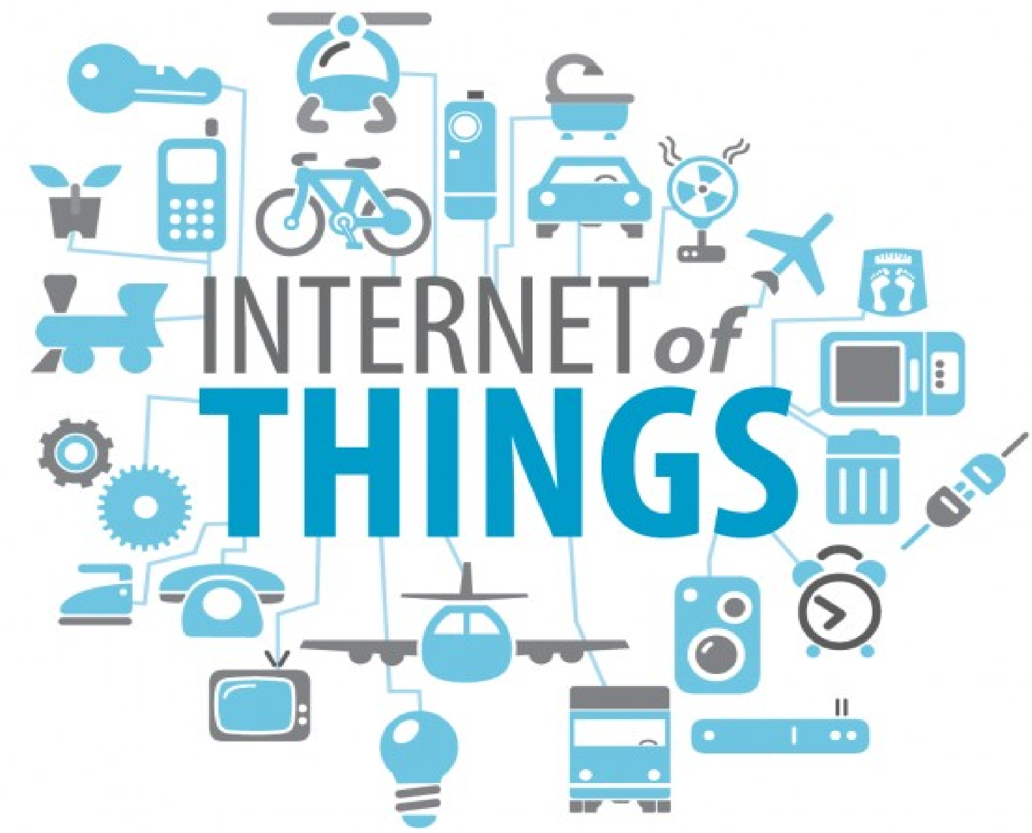
Industry	Segment	Type of savings	Estimated value over 15 years (Billion nominal US dollars)
Aviation	Commercial	1% fuel savings	$30B
Power	Gas-fired generation	1% fuel savings	$66B
Healthcare	System-wide	1% reduction in system inefficiency	$63B
Rail	Freight	1% reduction in system inefficiency	$27B
Oil and Gas	Exploration and development	1% reduction in capital expenditures	$90B

Note: Illustrative examples based on potential one percent savings applied across specific global industry sectors. Source: GE estimates

Unlock massive potential

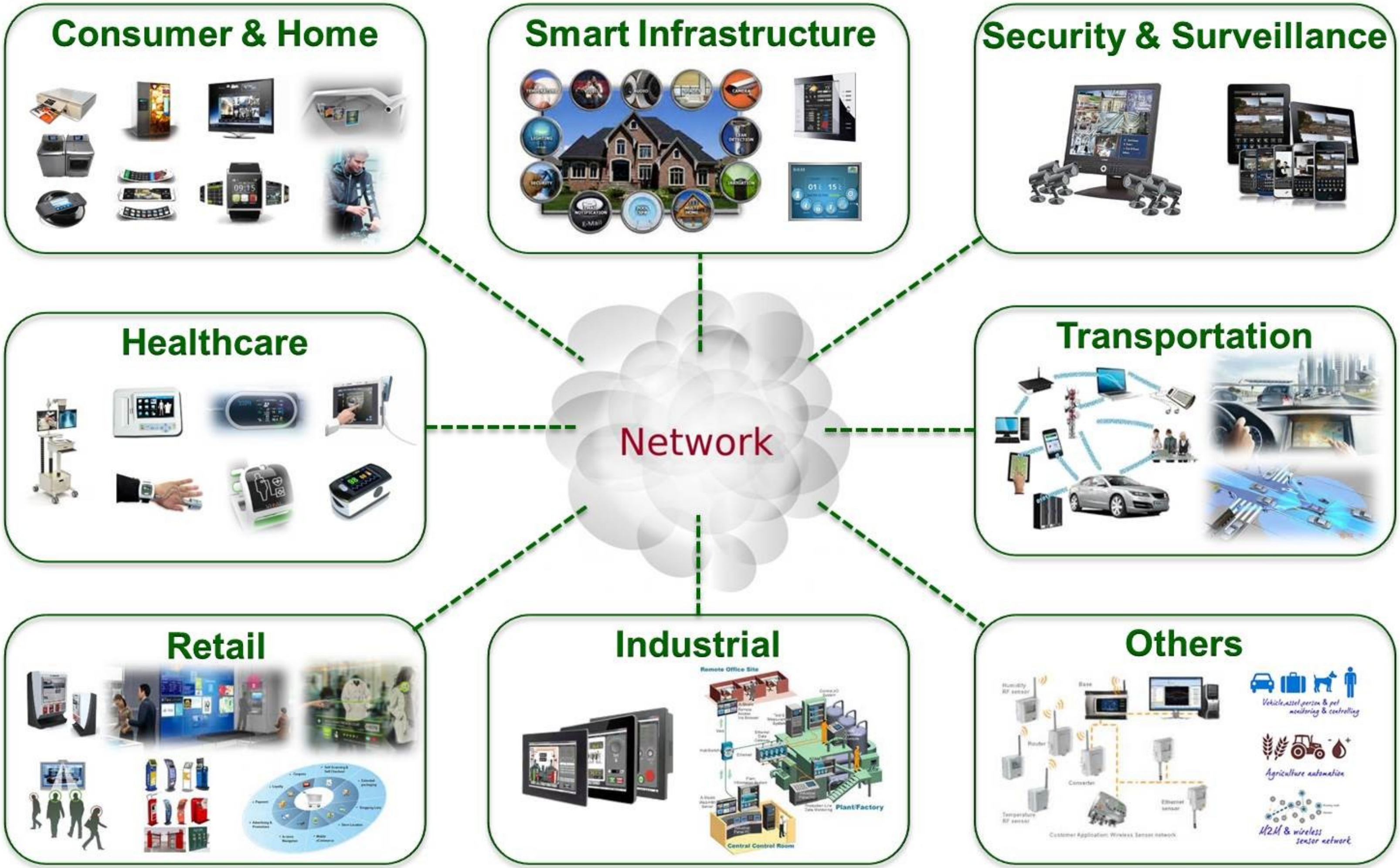


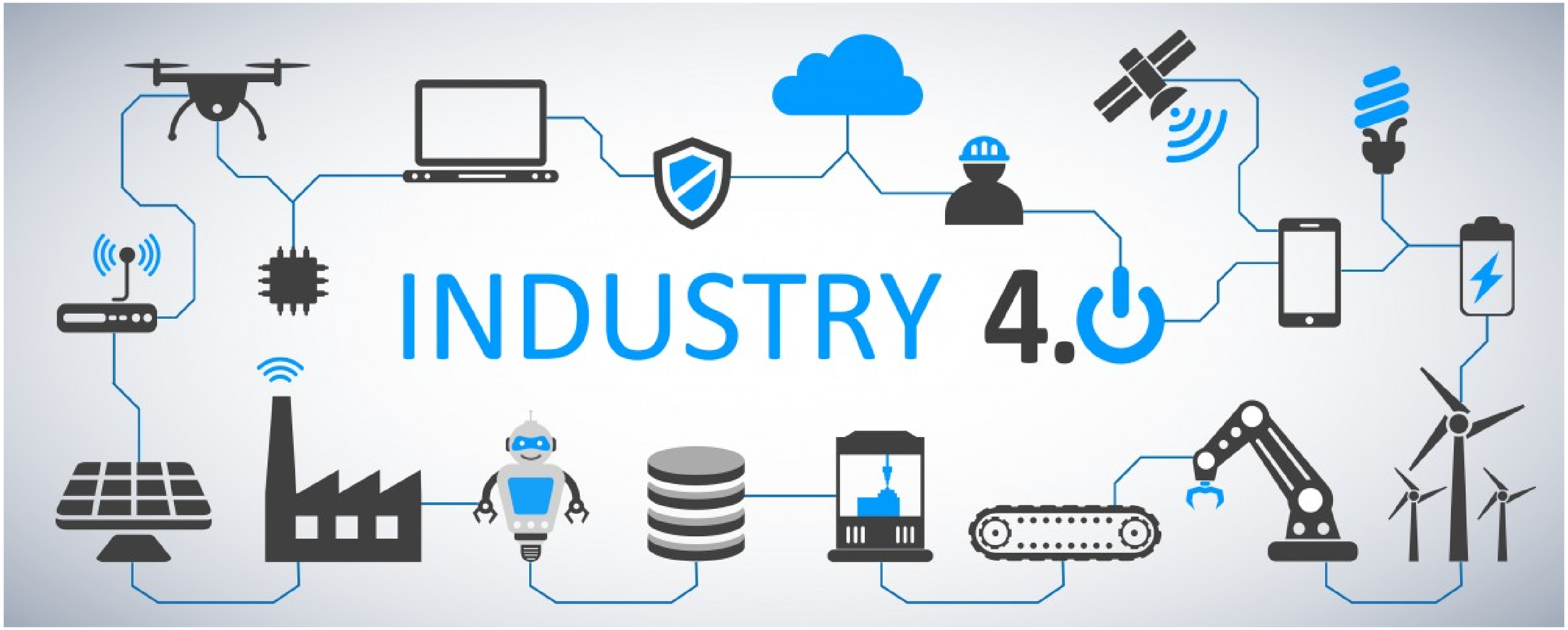
Applications of IoT



The ultimate goal of IoT is to automate human life.

Applications of IoT




INDUSTRY 4.0

Industrial Revolution

- The concept of industrial evolution refers to the progressive development and transformation of industries over time through various industrial revolutions.
- Each revolution brought significant technological advancements that fundamentally changed manufacturing processes, economies, and societies.

First Industrial Revolution
(Late 18th to Early 19th Century)

- Introduction of Mechanical Production:
  - Transition from hand production methods to machines.
  - Invention of the steam engine, which powered factories, transportation, and mining operations.
- Textile Industry:
  - Development of spinning and weaving machines, such as the spinning jenny and power loom.
- Iron and Coal:
  - Use of iron and coal as primary materials for building machinery and fueling engines.
- Urbanization:
  - Migration of people from rural areas to urban centers for factory work.

Second Industrial Revolution (Late 19th to Early 20th Century)

- Mass Production:
  - Introduction of assembly line techniques pioneered by Henry Ford.
- Electrification:
  - Widespread use of electricity for powering factories and homes.
- Chemical Industry:
  - Advances in chemical manufacturing, including the production of synthetic dyes and fertilizers.
- Steel Production:
  - Development of the Bessemer process for mass-producing steel, leading to the construction of skyscrapers and railroads.
- Telecommunications:
  - Invention of the telegraph and telephone, revolutionizing communication.

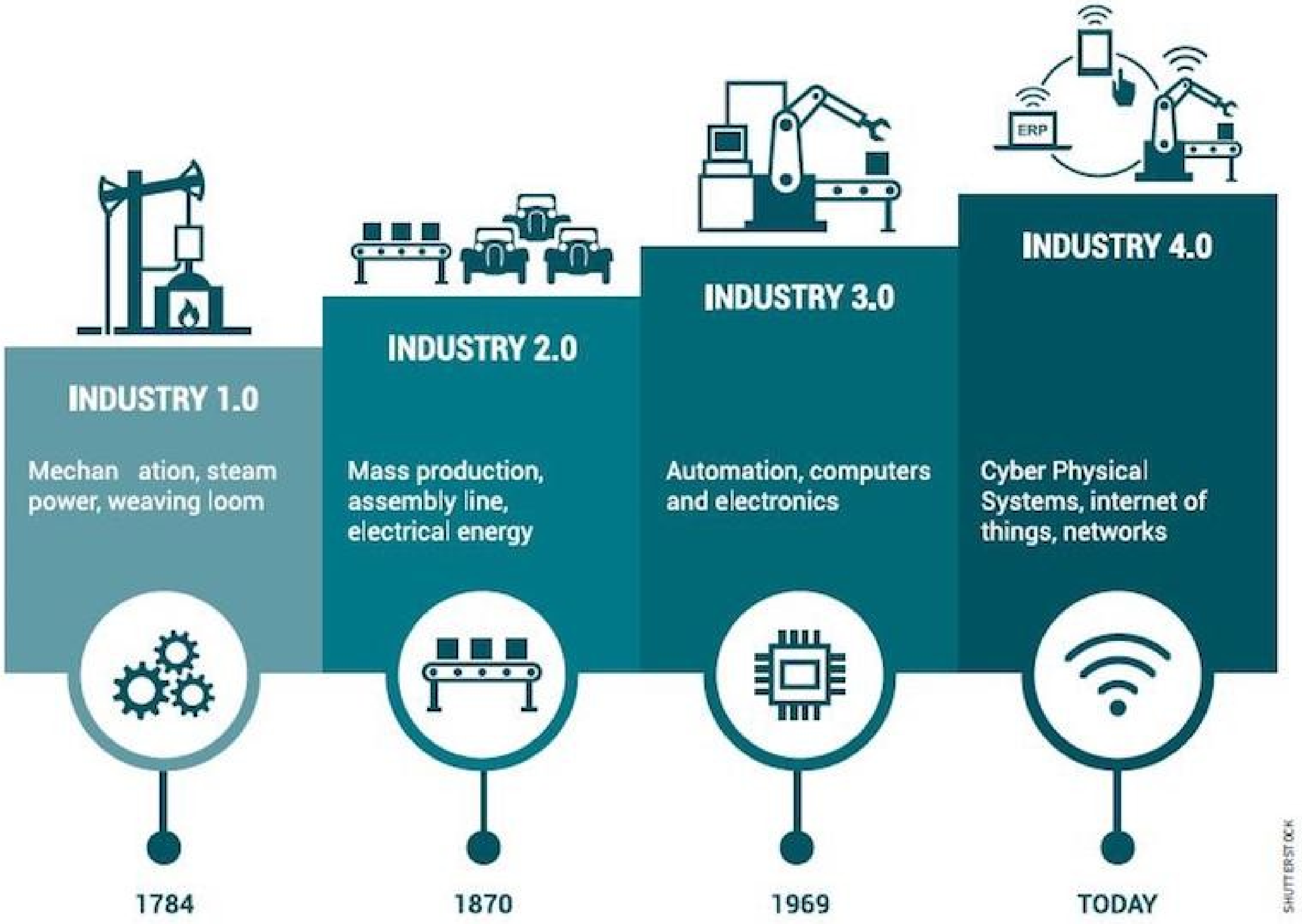
Third Industrial Revolution (Mid to Late 20th Century)

- Digital Revolution:
  - Introduction of computers and digital technologies.
- Automation:
  - Use of programmable logic controllers (PLCs) and robotics in manufacturing.
- Electronics and IT:
  - Growth of the semiconductor industry, leading to the development of personal computers, mobile phones, and the internet.
- Renewable Energy:
  - Initial steps toward the use of renewable energy sources such as solar and wind power.

Fourth Industrial Revolution (Early 21st Century to Present)

- Cyber-Physical Systems
- Big Data and Analytics
- Artificial Intelligence and Machine Learning
- Advanced Robotics
- 3D Printing (Additive Manufacturing)
- Augmented and Virtual Reality

Industry 4.0


ERP
INDUSTRY 1.0
Mechan ation, steam power, weaving loom
INDUSTRY 2.0
Mass production, assembly line, electrical energy
INDUSTRY 3.0
Automation, computers and electronics
INDUSTRY 4.0
Cyber Physical Systems, internet of things, networks
1784
1870
1969
TODAY
SHUTTERSTOCK

Industry 4.0 Key Components

- Internet of Things (IoT)
  - Devices and machinery connected to the internet, enabling real-time data collection, monitoring, and communication.
- Cyber-Physical Systems
  - Integration of physical processes with digital technologies, allowing for seamless interaction between the physical and digital worlds.
- Big Data and Analytics
  - Collection and analysis of vast amounts of data from various sources to improve decision-making and optimize processes.

Industry 4.0 Key Components

- Cloud Computing
  - Utilization of cloud services for storing and processing data, enabling scalable and flexible operations.
- Artificial Intelligence (AI) and Machine Learning
  - Implementation of AI algorithms and machine learning models to enhance automation, predictive maintenance, and decision-making.
- Advanced Robotics
  - Use of sophisticated robots capable of performing complex tasks autonomously or in collaboration with human workers.

Industry 4.0 Key Components

- Additive Manufacturing (3D Printing)
  - Production of parts and products using 3D printing technology, allowing for rapid prototyping and customized manufacturing.
- Augmented Reality (AR) and Virtual Reality (VR)
  - Applications of AR and VR for training, maintenance, and design processes, providing immersive and interactive experiences.

Industry 4.0 In-practice

- Smart Factories
  - Factories equipped with IoT devices and cyber-physical systems to enable autonomous operations and self-optimization.
- Predictive Maintenance
  - Using AI and machine learning to predict equipment failures and schedule maintenance proactively, reducing downtime.
- Digital Twins
  - Creating virtual replicas of physical assets for simulation, monitoring, and optimization purposes.
- Supply Chain 4.0
  - Enhanced supply chain operations through real-time tracking, data analytics, and automation.

More Applications

- Digital twins
- Product development
- Design customization
- Shop floor performance improvement
- Logistics optimization
- Predictive maintenance
- Generative design
- Price forecasting of raw material
- Robotics
- Quality assurance

Reference: AI Multiple

Summary

- Industry 4.0 represents a significant shift in manufacturing and industrial processes, promising to enhance efficiency, productivity, and innovation while also presenting new challenges and opportunities for businesses and workers.

Thank you

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