

# Industry 4.0

## Robot and Automation

Smart Products

Communication  
and  
Services

Cloud

Server

Data Analysis  
and  
Planning

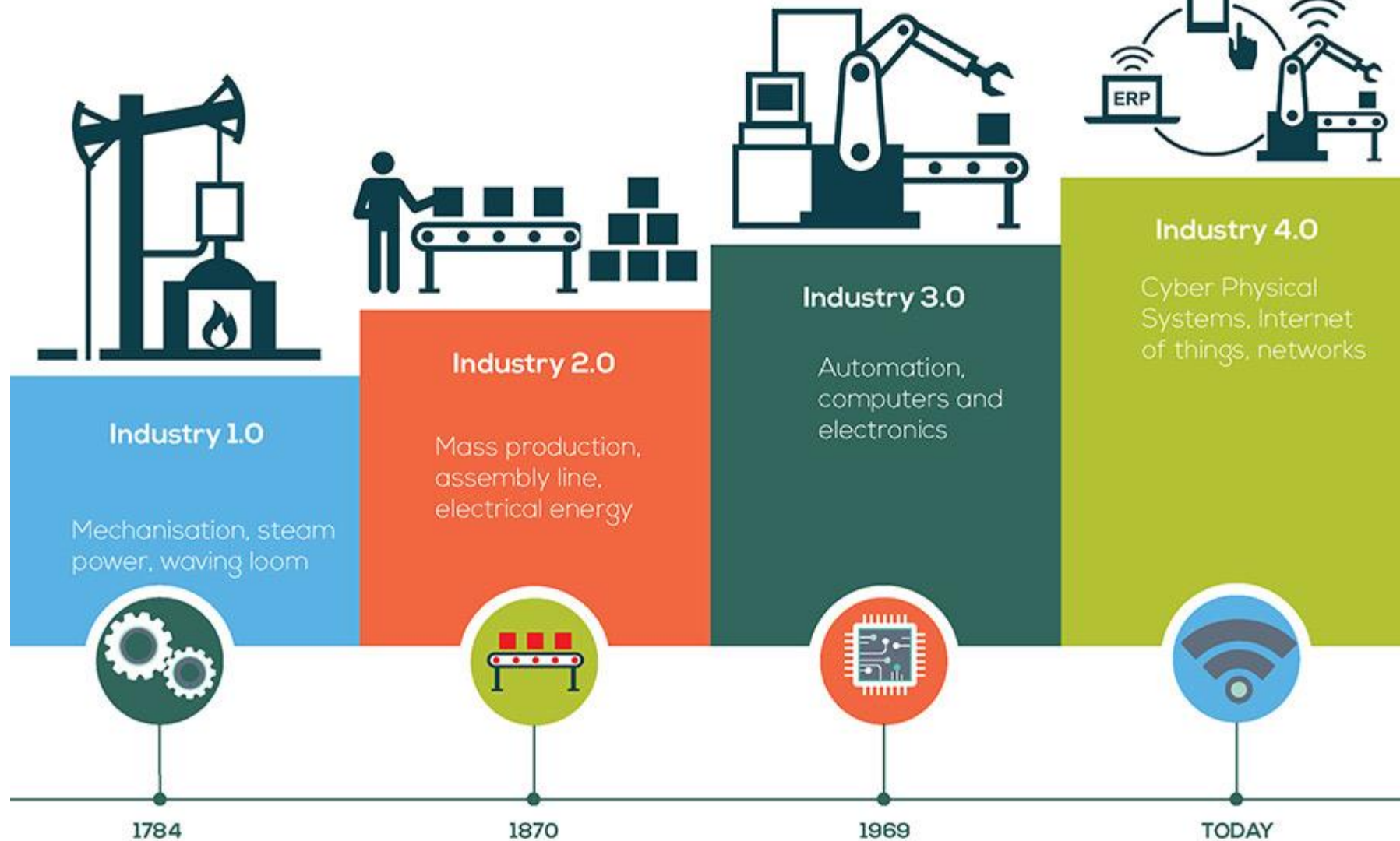
Sensors

Smart Manufacturing

Logistic



# Industrial Revolution



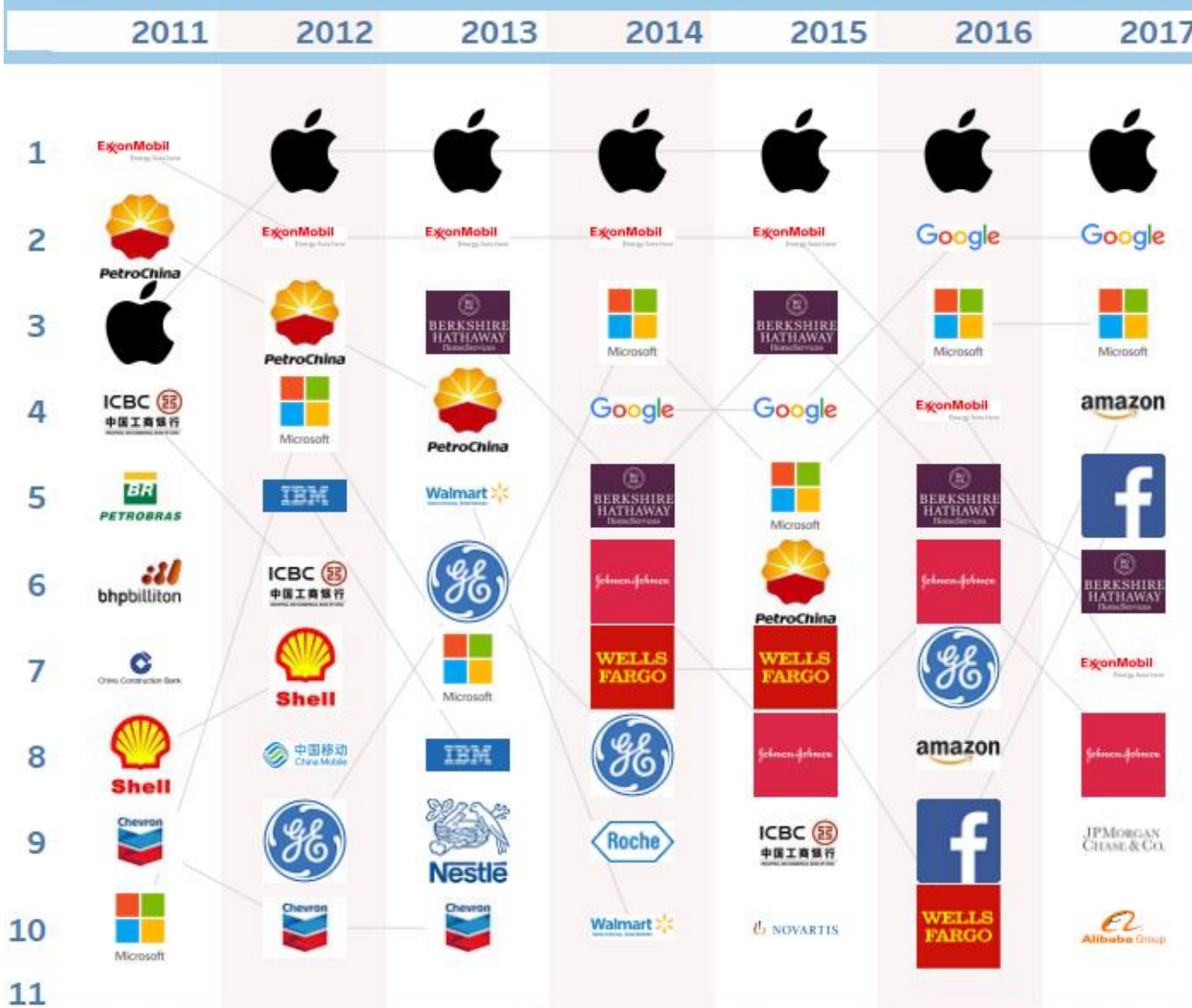


# Data is the New Oil: The Oil Barons have been repalced by Technology Companies.

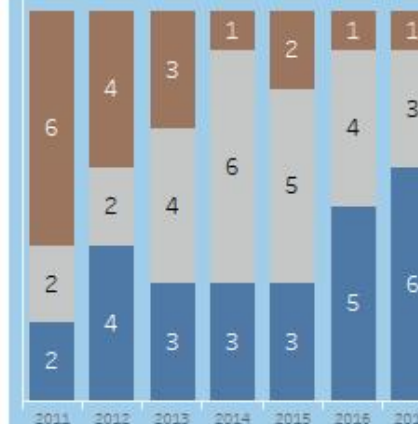
By definition, the largest companies by market cap are the most valued by investors in absolute terms. A snapshot of the largest companies at a given time tells us what the market valued the most.  
Q1 2011 six of ten of the largest companies where in the oil business.  
Fast forward to Q1 2017: six tech companies in the top 10 and only one oil company left (Exxon)



## Top 10 2011-2017: Largest Companies by Market Cap (Hover to highlight)

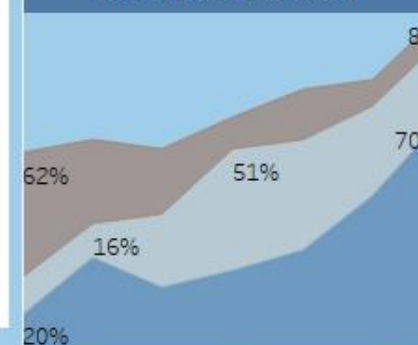


## Top 10 Ranking 2011: 6 Oil & 2 Tech companies 2017: 6 Tech Companies for 1 Oil



Oil Companies  
Other Sectors  
Tech Companies

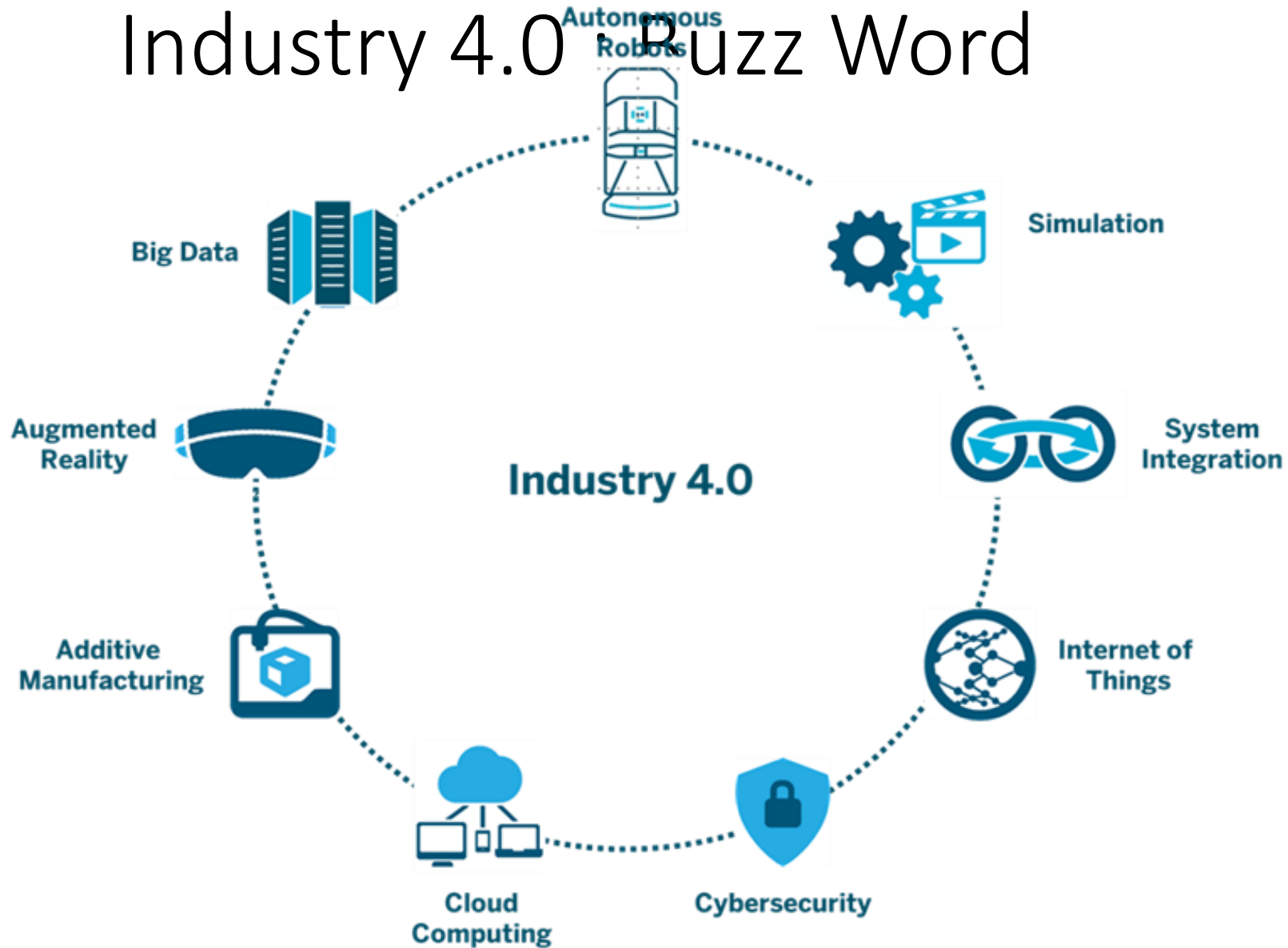
## TOP 10 Market Cap 2011: 62% Oil & 20% Tech 2017: 70% Tech & 8% Oil



# Data is the new oil ;ML-DL is the Refinery



# Industry 4.0 : Buzz Word



## Top 10 Strategic Technology Trends for 2019

### Intelligent



Autonomous Things



Augmented Analytics



AI-Driven Development

### Digital



Digital Twin



Empowered Edge



Immersive Experience

### Mesh



Blockchain



Smart Spaces



Privacy and Ethics



Quantum Computing

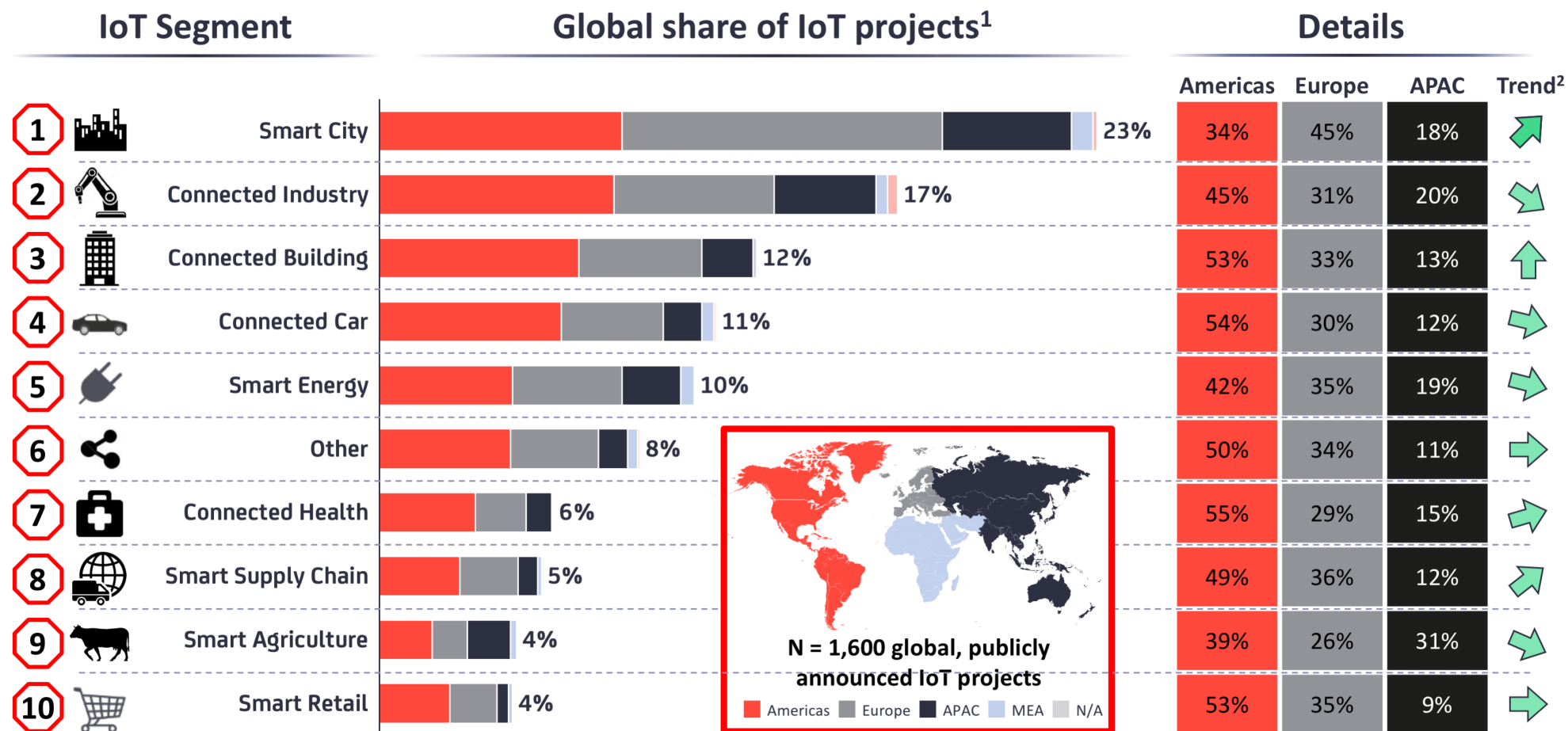
[gartner.com/SmarterWithGartner](https://gartner.com/SmarterWithGartner)

Source: Gartner

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Gartner.

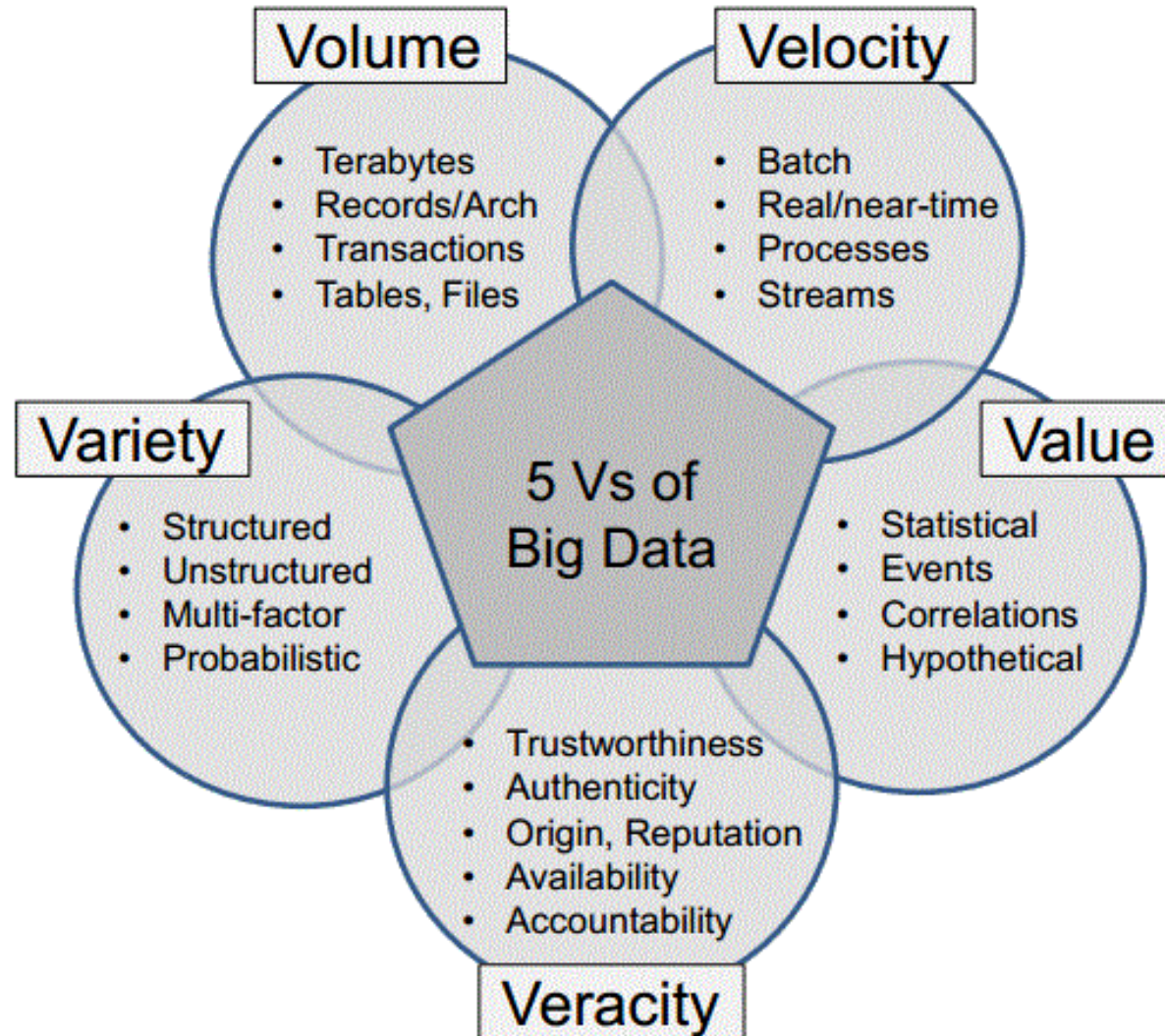




1. Based on 1,600 publicly known enterprise IoT projects (Not including consumer IoT projects e.g., Wearables, Smart Home). 2. Trend based on comparison with % of projects in the 2016 IoT Analytics Enterprise IoT Projects List. A downward arrow means the relative share of all projects has declined, not the overall number of projects 3. Not including Consumer Smart Home Solutions. **Source:** IoT Analytics 2018 Global overview of 1,600 enterprise IoT use cases (Jan 2018)

**Source:** IoT Analytics, Jan 2018

# Big Dat



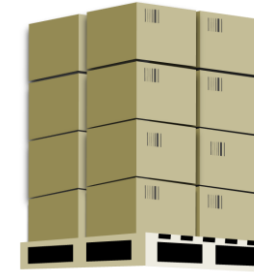
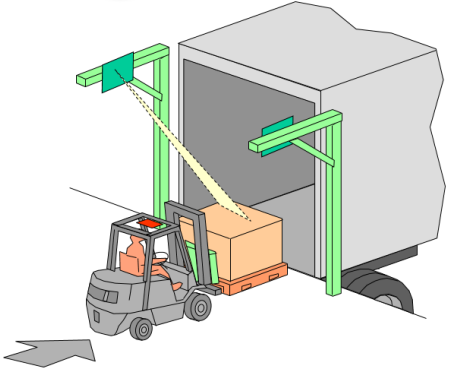
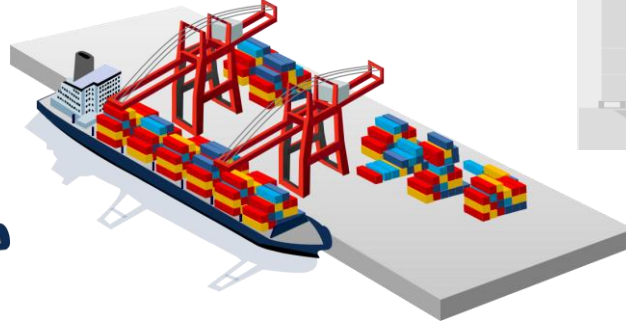
# Manufacturing Ecosystem Data Resources



ERP-MRP Üretim Talepleri

Siparişin Geçilmesi

Hava-Kara Nakliye Firmaları





## Simulation and Digital Twin: Definitions

### The **Digital Twin**

- integrates all data, models (engineering, data-based, simulation), and otherwise structured information
- of a product, plant, or infrastructure system
- generated during engineering, commissioning, operation or service
- and that can leverage existing and create new business opportunities

**Simulation** is the execution of a model of a real world system to study its behavior, e.g.

- 3D CAE models with attached physics
- Models of logical behavior and effect-based models „(1D)“ of the system
- Test-based models, data driven models
- System simulation as a mixture of all

## Digital Twin: Origin

The **Digital Twin** has developed from concepts at **USAF** (modeling with high fidelity the **as-built** system) and **NASA**:

*The Digital Twin, integrates ultra-high fidelity simulation with the vehicle's on-board integrated vehicle health management system, maintenance history and all available historical and fleet data to mirror the life of its flying twin and enable unprecedented levels of safety and reliability.*

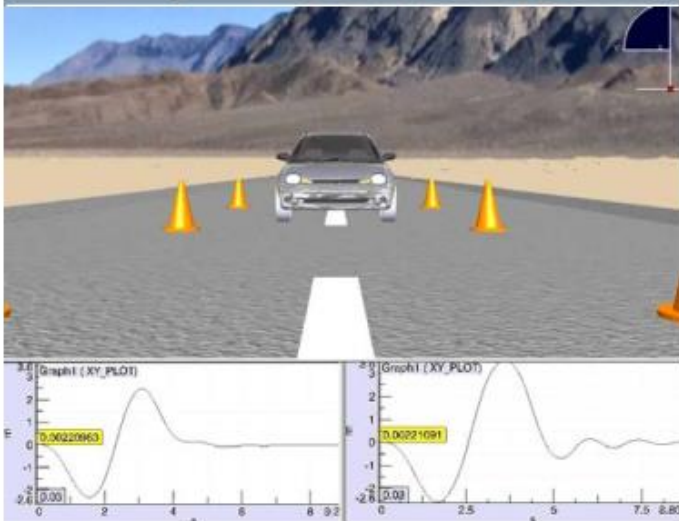
NASA (2012): [\*The digital twin paradigm for future NASA and U.S. air force vehicles\*](#). 53rd AIAA/ASME/ASCE/AHS/ASC

Since then it has developed to widely adopted term but often with widely differing interpretations.

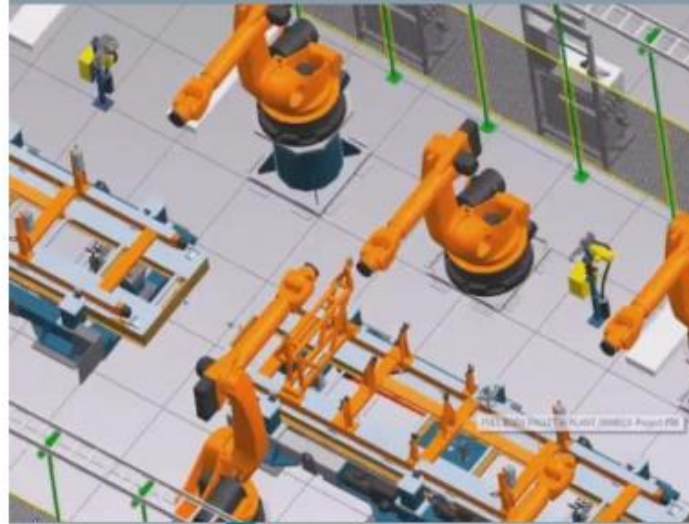
It has an entry in **Wikipedia**, it is a **Gartner** trend...

feed back insights to continuously optimize product and production

Digital **Product** Twin



Digital **Production** Twin



Digital **Performance** Twin

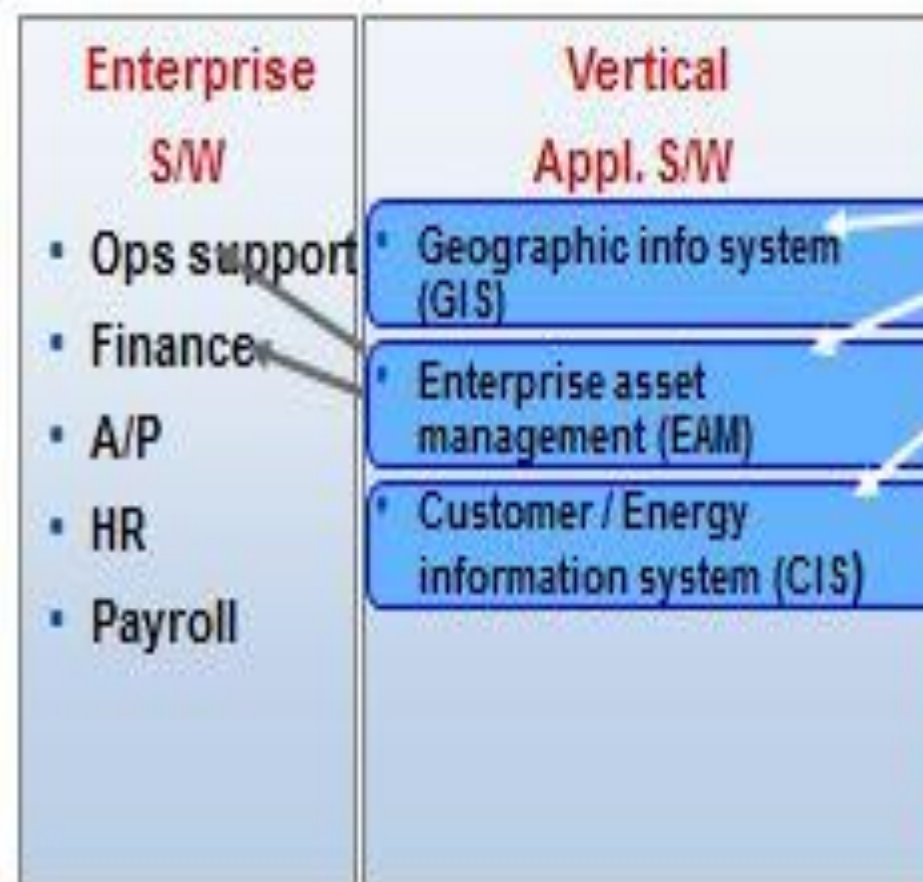


Push forward knowledge from engineered models

According to Gartner, a digital twin is a “digital representation of a real-world entity or system”. What makes this technology astonishing is that the digital representation (i.e. the digital twin) could potentially function in real time, leveraging AI and big data analytics to interact with and evaluate all kinds of ‘what if’ scenarios. Gartner estimates that by 2020, digital twins will exist for potentially billions of things.



## Information Technology



Corporate IT network

## Operations Technologies

### Centralized

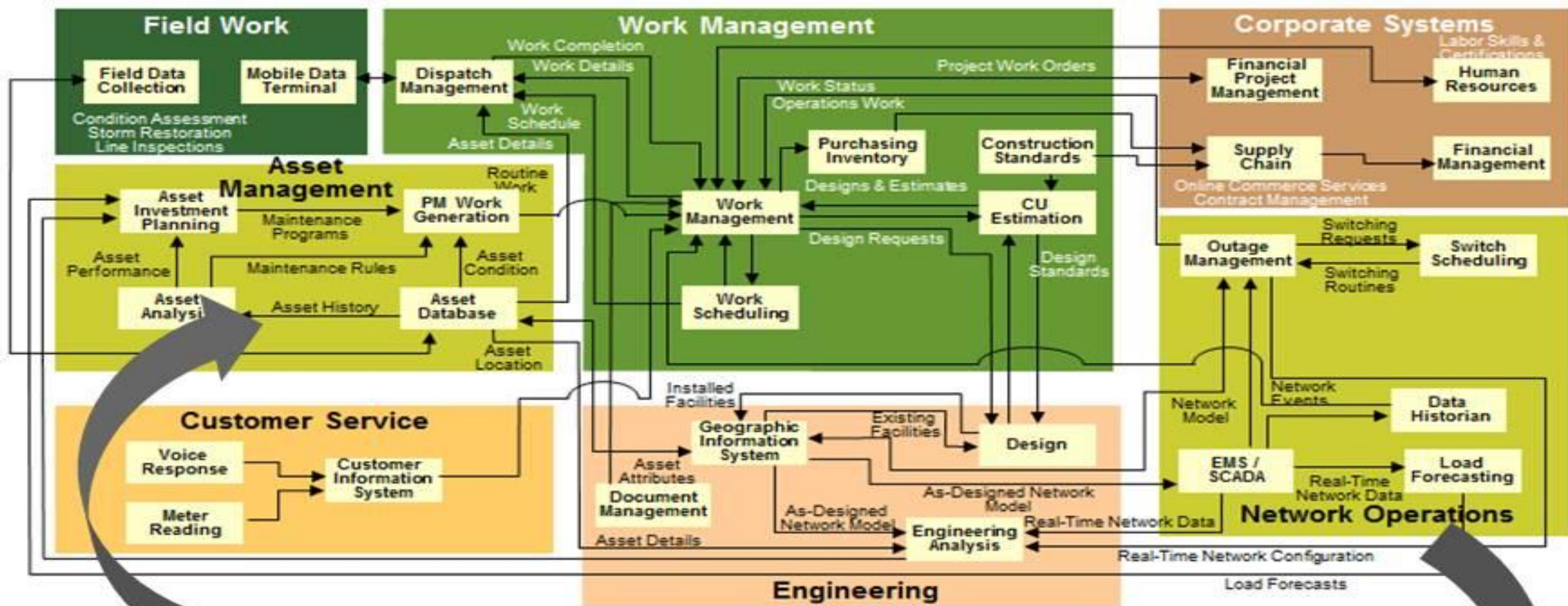
- Supervisory control & data acq. (SCADA)
- Energy mgmt. system (EMS)
- Distribution Management System (DMS)
- Outage Management System (OMS)

### Distributed

- Programmable logic controllers (PLCs)
- Advanced protection relays
- Sensors, monitors and fault indicators
- Meters
- Gateways/substation integration

Control network(s)





ERP – Enterprise Resource Planning

PLM – Product Lifecycle Management

- Produktdesign
- Produktionsplanung und Simulation
- Data Management

Managementebene

MES – Manufacturing Execution Systems



SIMATIC IT



Plant Engineering  
COMOS

Ethernet

Betriebsführungsebene



SIMATIC PCS 7  
Operator System



Maintenance/  
Asset Management



Engineering  
Station



Energie-  
management



SIMATIC WinCC  
SCADA-System

Industrial Ethernet

Steuerungsebene

TIA Portal



SIMATIC PCS 7  
Automatisierungs-  
systeme



SINUMERIK  
Computer Numeric Control



SIMOTION  
Motion Control



SIMATIC NET  
Industrielle  
Kommunikation



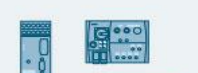
SIMATIC Controller  
Modular/PC-basiert



SIMATIC HMI  
Bedienen und Beobachten



SIRIUS  
Industrielle Schalttechnik



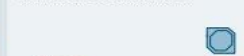
Feldebene

PROFIBUS PA

Prozessinstrumentierung



SIMATIC Ident  
Industrielle Identifikation



SIMATIC Dezentrale Peripherie



SINAMICS Antriebssysteme



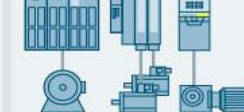
SITOP Stromversorgung



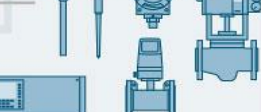
Niederspannungsverteilung



SIMOTICS Motoren



HART



IO-Link

PROFINET

Industrial Ethernet

PROFIBUS

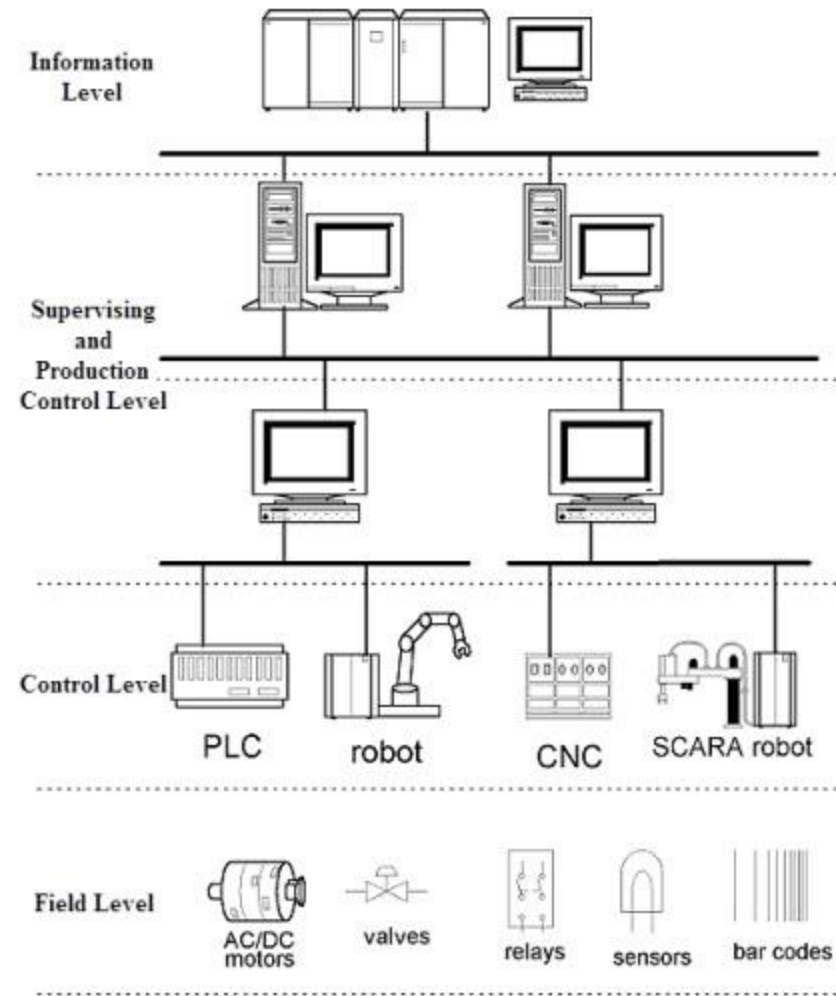
AS-Interface

KNX GAMMA instabus

Totally  
Integrated  
Automation

Totally  
Integrated  
Power







# Sensors

- Sensor as an input device which provides an output (signal) with respect to a specific physical quantity (input).
- A device that detects the changes in electrical or physical or other quantities and thereby produces an output as an acknowledgement of change in the quantity is called as a Sensor. Generally, this sensor output will be in the form of electrical or optical signal.
  - Active vs Passive
  - Electric, Biological, Chemical, Radioactive etc
  - Photoelectric, Thermoelectric, Electrochemical, Electromagnetic, Thermo optic, etc.
  - Analog and Digital

# Sensors

- Temperature Sensor
- Proximity Sensor
- Accelerometer
- IR Sensor (Infrared Sensor)
- Pressure Sensor
- Light Sensor
- Ultrasonic Sensor
- Smoke, Gas and Alcohol Sensor
- Touch Sensor
- Color Sensor
- Humidity Sensor
- Tilt Sensor
- Flow and Level Sensor

# Temperature sensors

- By definition, “A device, used to measure amount of heat energy that allows to detect a physical change in temperature from a particular source and converts the data for a device or user, is known as a Temperature Sensor.”
  - **Thermocouples:** These are voltage devices that indicate temperature measuring with a change in voltage. As temperature goes up, the output voltage of the thermocouple rises.
  - **Resistor temperature detectors (RTD):** The resistance of the device is directly proportional to the temperature, increase in a positive direction when the temperature rises resistance going up.
  - **Thermistors:** It is a temperature sensitive resistor that changes its physical resistance with the change in temperature.
  - **IC (Semiconductor):** They are linear devices where the conductivity of the semiconductor increases linearly and it takes advantage of the variable resistance properties of semiconductor materials. It can provide a direct temperature reading in digital form, especially at low temperatures.
  - **Infrared sensors:** It detects temperature by intercepting a portion of emitted infrared energy of the object or substance, and sensing its intensity, can be used to measure temperature of solids and liquids only, Not possible to use it on gases because of their transparent nature.



# Proximity sensor

- A device that detects the presence or absence of a nearby object, or properties of that object, and converts it into signal which can be easily read by user or a simple electronic instrument without getting in contact with them.
  - Capacitive Sensors : Capacitive proximity sensors can detect both metallic as well as non-metallic targets. Nearly all other materials are dielectric different from air. It can be used to sense very small objects through a large portion of target. So, generally used in difficult and complicated applications.
  - Photoelectric Sensors : Photoelectric sensor is made up of light-sensitive parts and uses a beam of light to detect the presence or absence of an object. It is an ideal alternative of inductive sensors. And used for long distance sensing or to sense non-metal object.
  - Ultrasonic Sensors: Ultrasonic sensors are also used to detect the presence or to measure the distance of targets similar to radar or sonar. This makes a reliable solution for harsh and demanding conditions.

# Accelerometer sensors

- Accelerometer is a transducer that is used to measure the physical or measurable acceleration experienced by an object due to inertial forces and converts the mechanical motion into an electrical output. It is defined as rate of change of velocity with respect to time
  - Hall-effect accelerometers : Hall-effect accelerometers are using Hall principle to measure the acceleration, it measures the voltage variations caused by changes in a magnetic field around them.
  - Capacitive accelerometers : Capacitive accelerometers sensing output voltage depends on the distance between two planar surfaces. Capacitive accelerometers are also less prone to noise and variation with temperature.
  - Piezoelectric accelerometers: Piezoelectric sensing principle is working on the piezoelectric effect. Piezo-film based accelerometers are best used to measure vibration, shock, and pressure.

# Gyroscope sensors

- A sensor or device which is used to measure the angular rate or angular velocity is known as Gyro sensors, Angular velocity is simply defined as a measurement of speed of rotation around an axis. It is a device used primarily for navigation and measurement of angular and rotational velocity in 3-axis directions. The most important application is monitoring the orientation of an object.

# Sensors

