INDUSTRY 4.0

Digital Transformation

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Outline

- Four Phases of Industrial Revolution
- 4^{th} Industrial Revolution
- Building Blocks of Industry 4.0
- Digital Enterprises/Smart Factories
- Internet of Things/Cyber Physical Systems
- Technologies Reshaping the Production
- A Smart Factory Example: Bosch Rexroth Case
- Recap/Discussions/Questions

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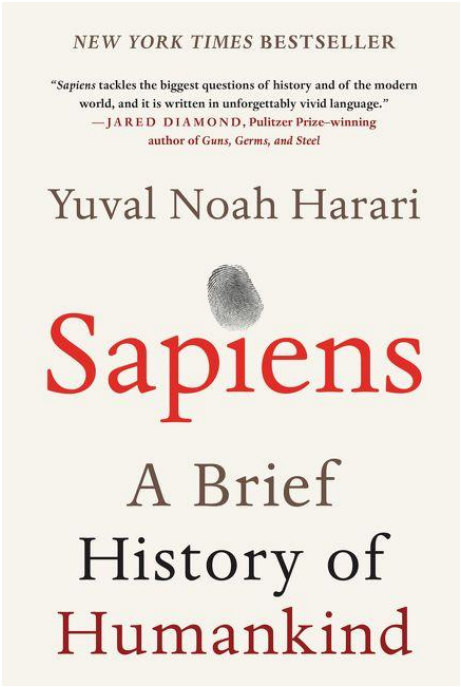
The Role of Wheat in the History of Mankind



- Wheat was domesticated by 8000 BC.
- Humans learned to turn wheat into flour and then into bread.

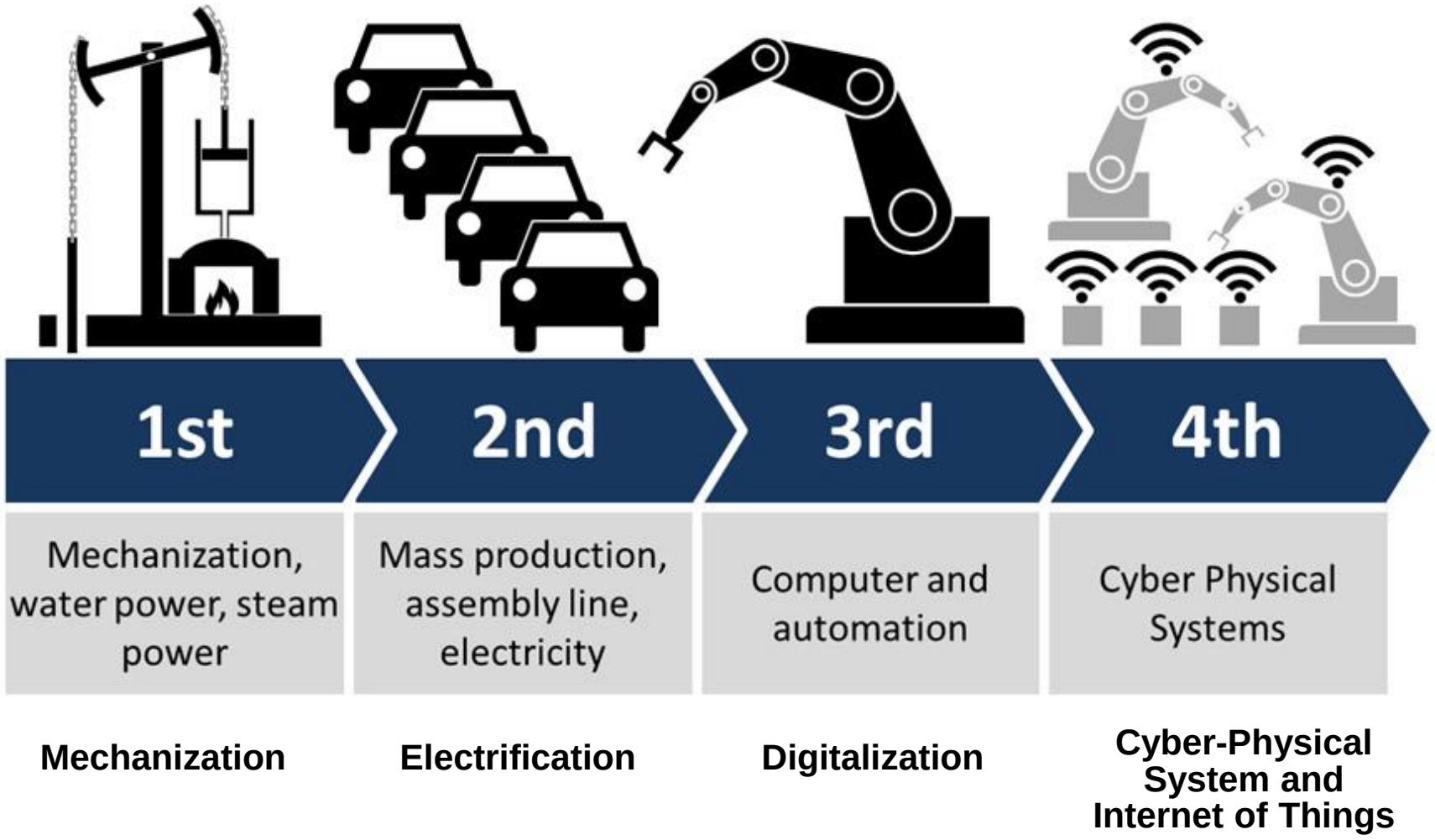
Roman Grinding Stone

Water Mills (Water Wheels)

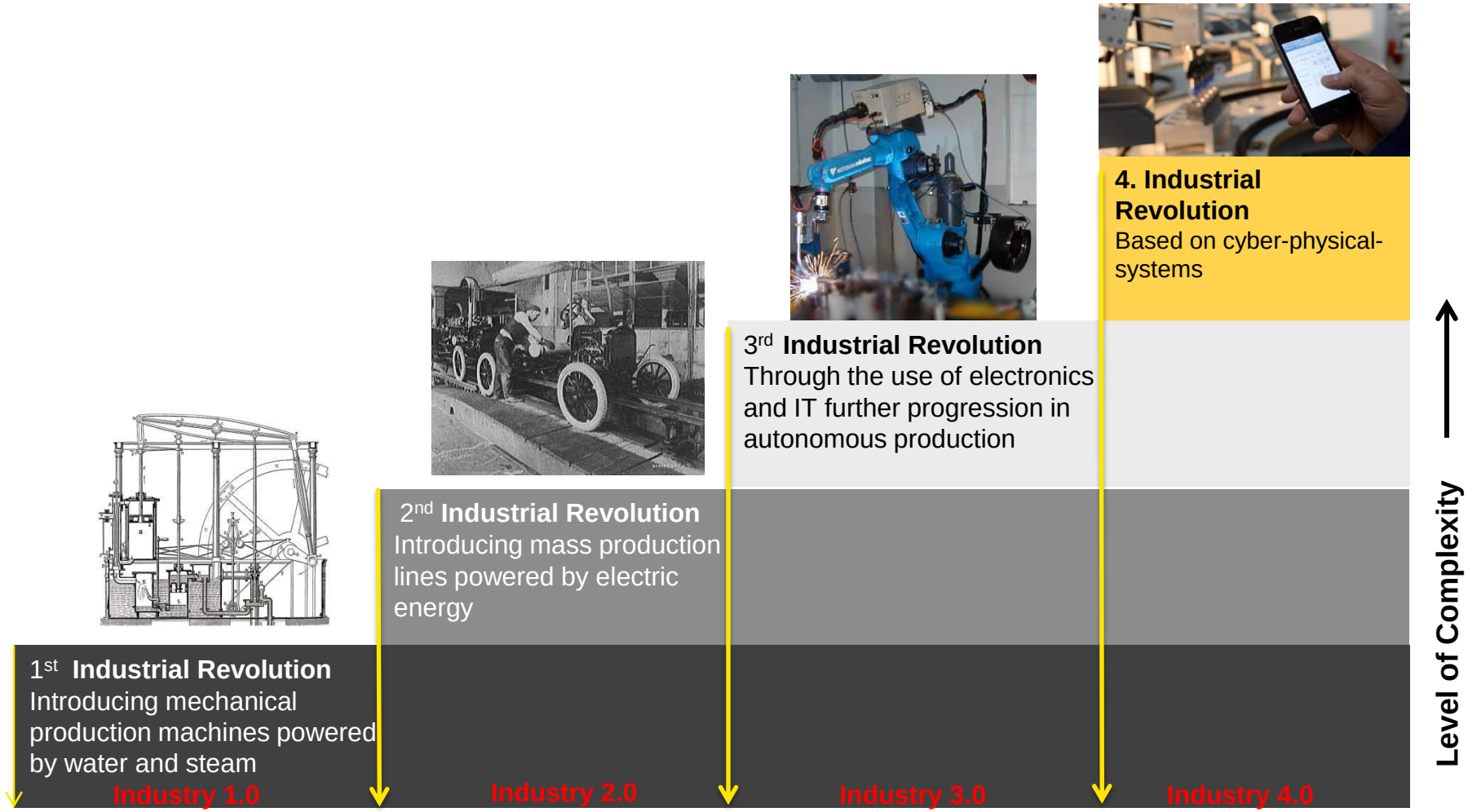
Electric Powered Flour Mills

Modern Flour Mills

Four Stages of the Industrial Revolution

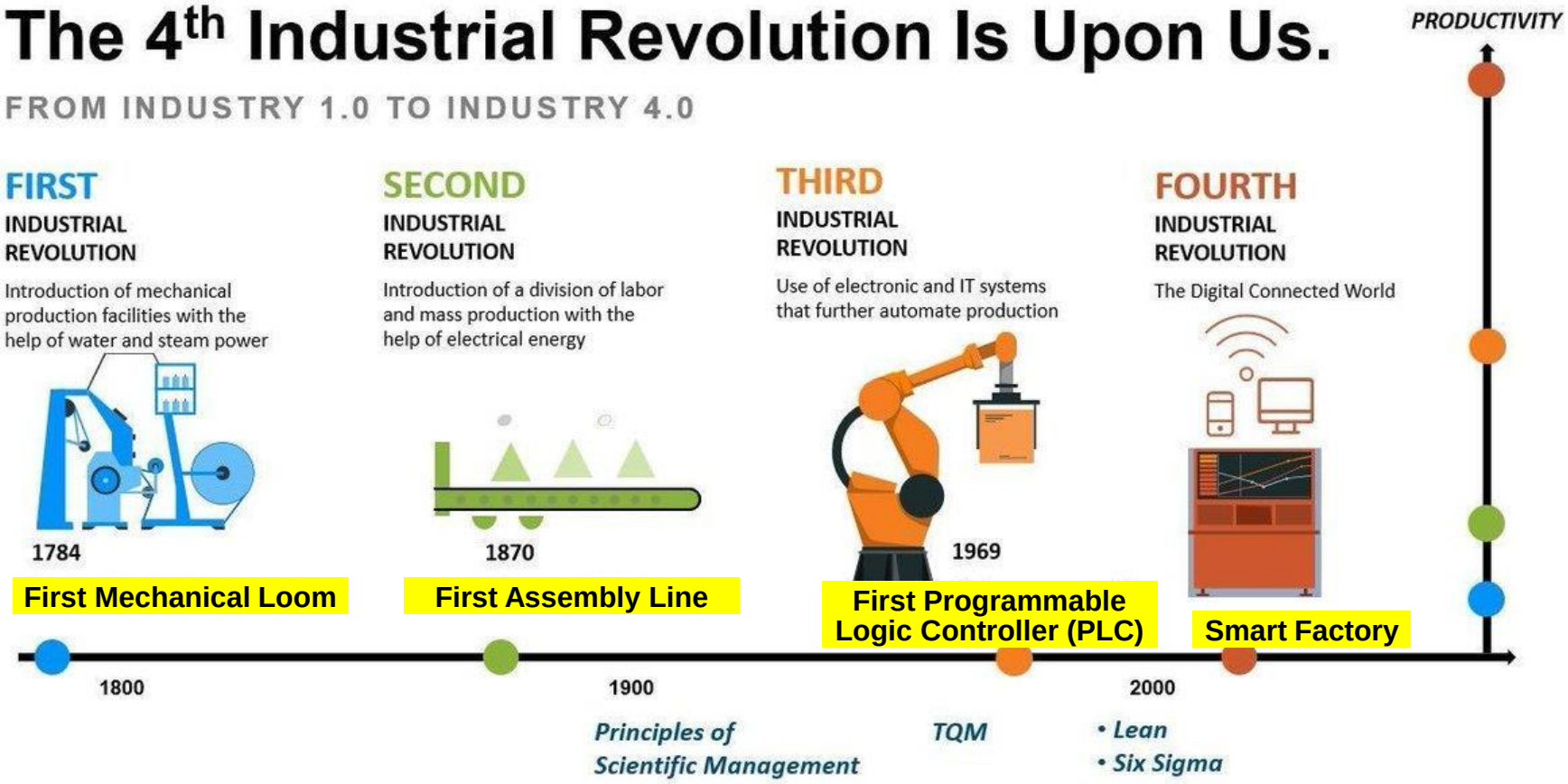


Industrial Revolution Time Line



Source: DFKI/Bauer IAO

Milestones of Industrial Revolutions



Industry 4.0

- The fourth industrial revolution, also known as Industry 4.0, is affecting almost every industry worldwide.
- It is rapidly transforming how businesses operate.
- Industry 4.0 uses transformative technologies to connect the physical world with the digital world.

Transformative Technology

Disruptive Technology

Disruptive Technologies: Advances that will transform life, business, and the global economy (McKinsey)

- ✓ A disruptive technology supersedes an older process, product, or habit.
- ✓ It usually has superior attributes that are immediately obvious, at least to early adopters.
- ✓ The automobile, electricity service, and television all were disruptive technologies in their own times.

*** Another term that can be used is transformative technology. Because a disruption, once accepted, can become transformative.

Disruptive Technologies

The parade of new technologies and scientific breakthroughs is relentless and is unfolding on many fronts.

Yet some technologies do in fact have the potential to disrupt the status quo, alter the way people live and work, rearrange value pools, and lead to entirely new products and services.

SOURCE: McKinsey Global Institute analysis

Characteristics of Disruptive Technologies

1. Disruptive technologies typically demonstrate a rapid rate of change in capabilities in terms of price/performance relative to substitutes and alternative approaches.

2. To be economically disruptive, a technology must have broad reach. (Touching companies and industries and affecting (or giving rise to) a wide range of machines, products, or services)

3. An economically disruptive technology must have the potential to create massive economic impact.

4. Technologies that matter have the potential to dramatically change the status quo.

Today’s Disruptive Technologies

Mobile Internet

Automation of knowledge work

The Internet of Things

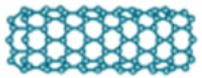
Cloud technology

Advanced robotics

Autonomous and near-autonomous vehicles

Next-generation genomics

Energy storage



Advanced materials

3D printing

Advanced oil and gas exploration and recovery

Renewable energy

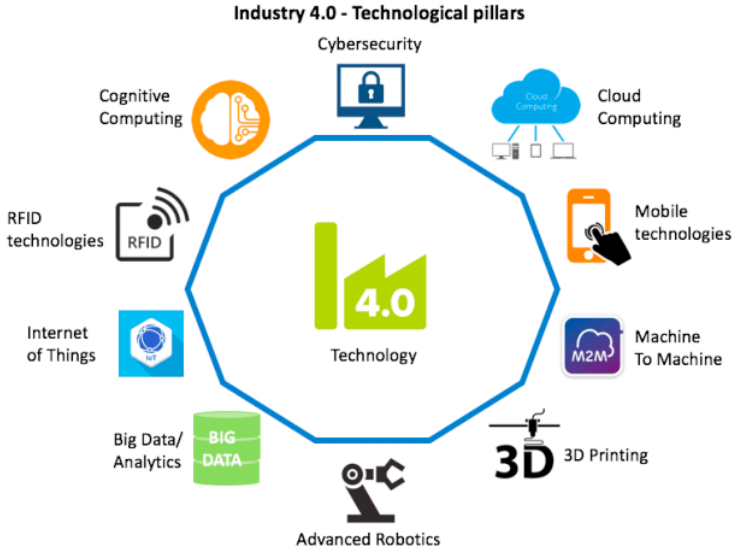
SOURCE: McKinsey Global Institute analysis

Industry 4.0 and Its Building Blocks

The term Industry 4.0 refers to the combination of several major innovations in digital technology.

These technologies include:

- Advanced Robotics
- Artificial Intelligence
- Sophisticated Sensors
- Big Data Analytics
- Cloud Computing
- The Internet of Things
- Digital Fabrication (incl. 3D Printing)
- Autonomous Vehicles
- Virtual Reality and Augmented Reality



Smart Factory Concept

- Smart Factories are fully connected flexible manufacturing systems that autonomously run the entire production system with less or no human interaction.
- Smart factories are:
  1. Visible (Traceable through IoT, sensors)
  2. Connected (via Cyber-Physical Systems)
  3. Autonomous (run and make decentralized decision independently)

Smart Factories/Digital Enterprises

- The smart factory represents a leap forward from more traditional automation to a fully connected and flexible system (Deloitte Insights)

Smart Factory Concept

The Internet of Things (IoT): A concept that refers to connections between physical objects like sensors, machines and the Internet.

Physical Objects
+
Controller, Sensors and Actuators
+
Internet
=
Internet of Things (IoT)

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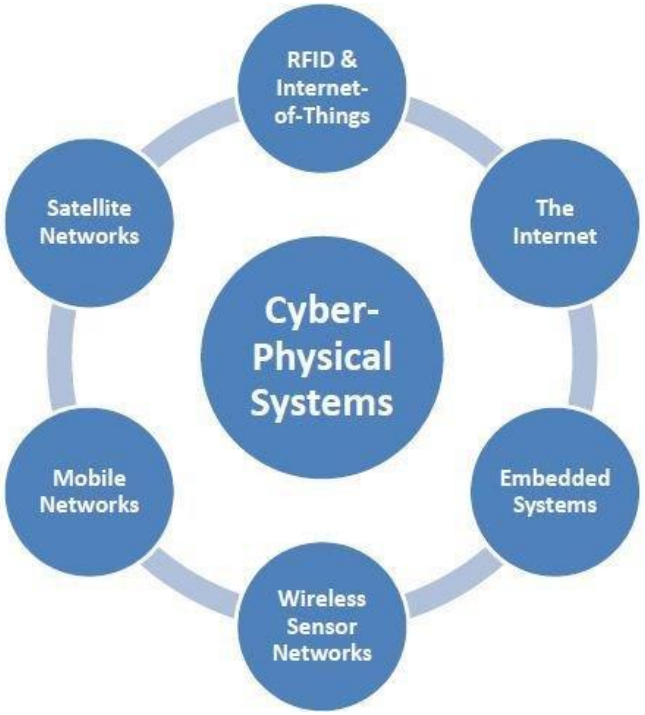
Smart Factory Concept

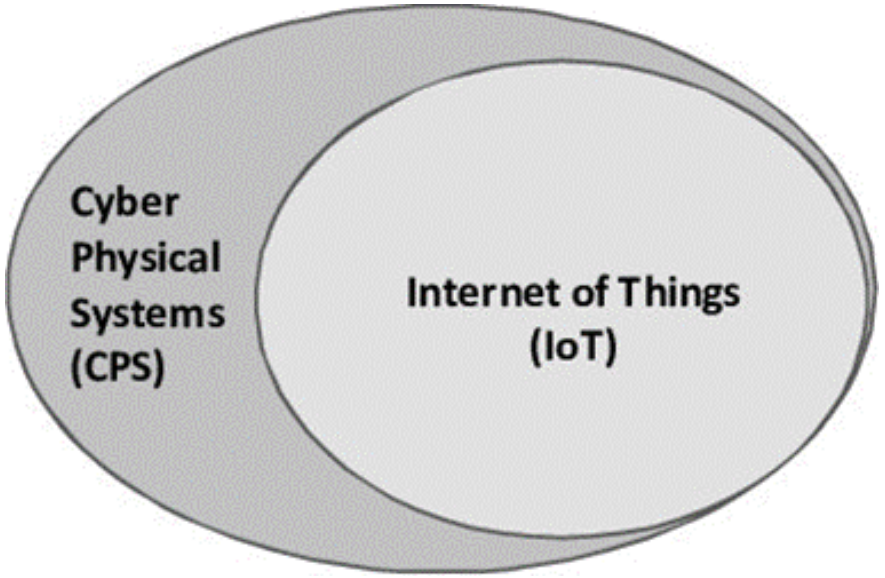
Cyber-Physical Systems (CPS): (aka. cyber manufacturing) Refers to an Industry 4.0-enabled manufacturing environment that offers real-time data collection, analysis, and transparency across every aspect of a manufacturing operation.



Relationship of IoT and CPS

-- Internet of Things (IoT) is the key foundation of Cyber Physical Systems (CPS).

-- The IoT **allows objects** to be remotely **sensed** and **controlled across existing network infrastructure.**



In a Nut Shell…

** Internet of Things is about connecting "Things" (Objects and Machines) to the internet and eventually to each other; while Cyber Physical Systems (CPS) are integration of computation, networking and physical processes.

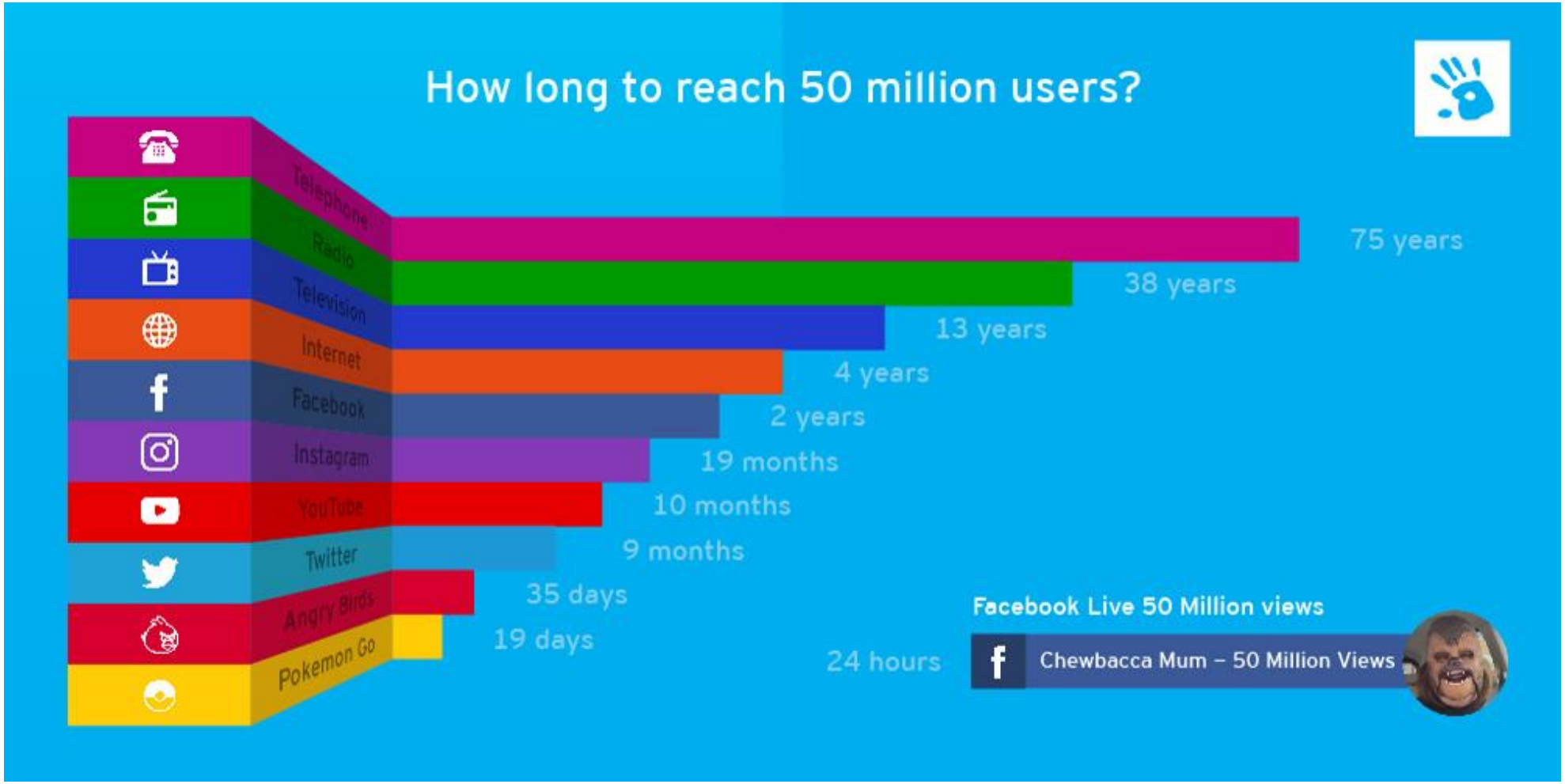
An Interesting Fact

According to Statista, a major online market research portal, the number of IoT connected devices worldwide will be just over 30 billion in 2020, **doubling in just five years**.

Another Fact: Techs did not exist in 2006

- iPhone
- iPad
- Kindle
- 4G
- Uber
- Airbnb
- Android
- Oculus
- Instagram
- Snapchat
- WhatsApp

More Facts: Time to Reach 50 million users



How is IoT related to Smart Manufacturing?

Smart manufacturing is enabled by IoT connected devices, big data, data analytics, robotics, machine learning, sensor technologies, and artificial intelligence.

Each of these technologies are used together to

1. Optimize manufacturing processes
2. Assist manufacturers
3. Keep workers safe

More Potential Effects of Smart Manufacturing

1. Greater operating efficiency

   * implement real-time solutions

2. Minimal machine downtime

   * real-time IoT sensor data can be turned into predictive maintenance insights.

3. Increased worker safety

   * people's movements and activities can be tracked and analyzed, injury risk mitigation

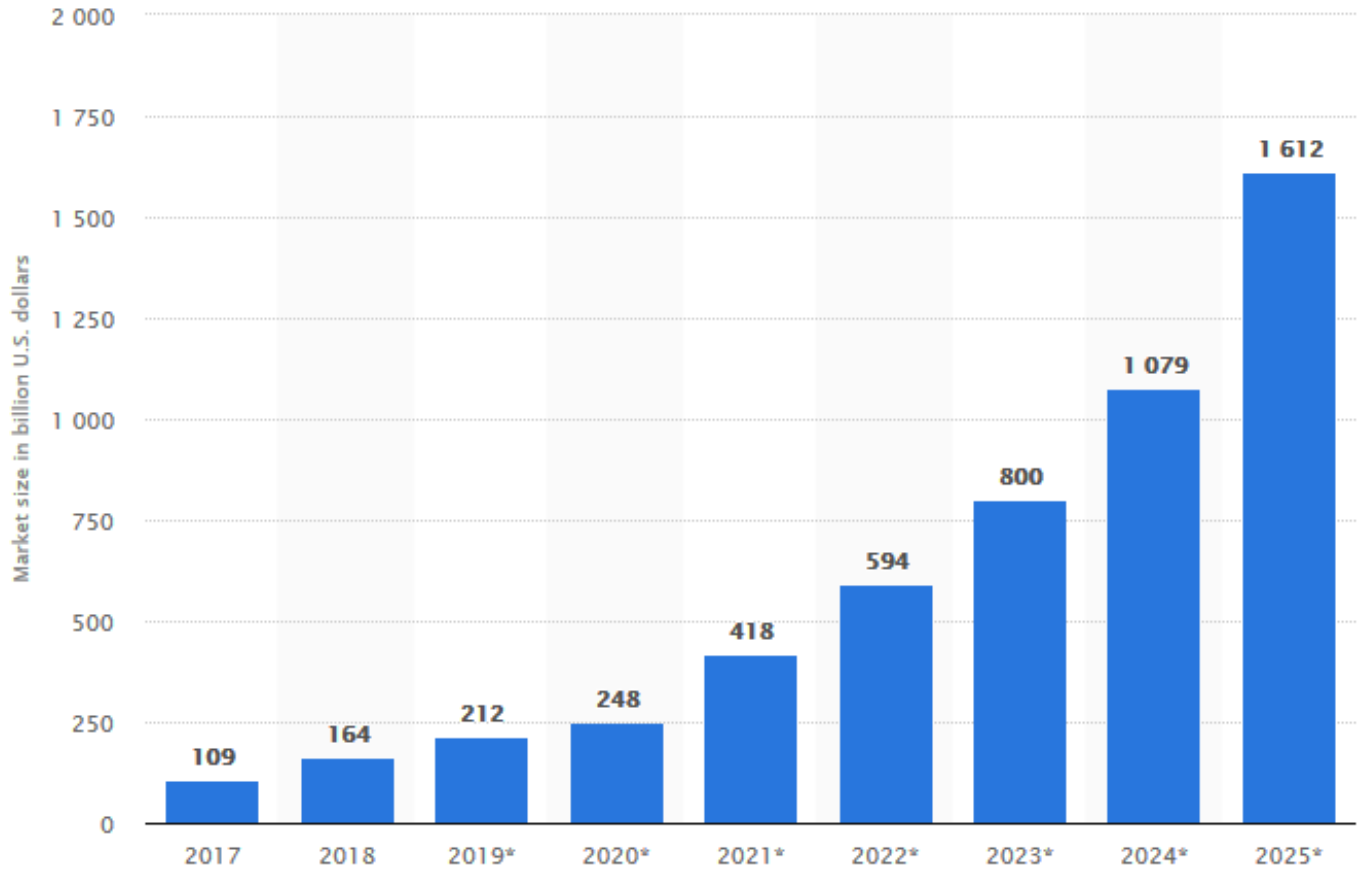
4. Optimized inventorying

   * location of parts and products before, during, and after manufacturing

5. Supply chain management

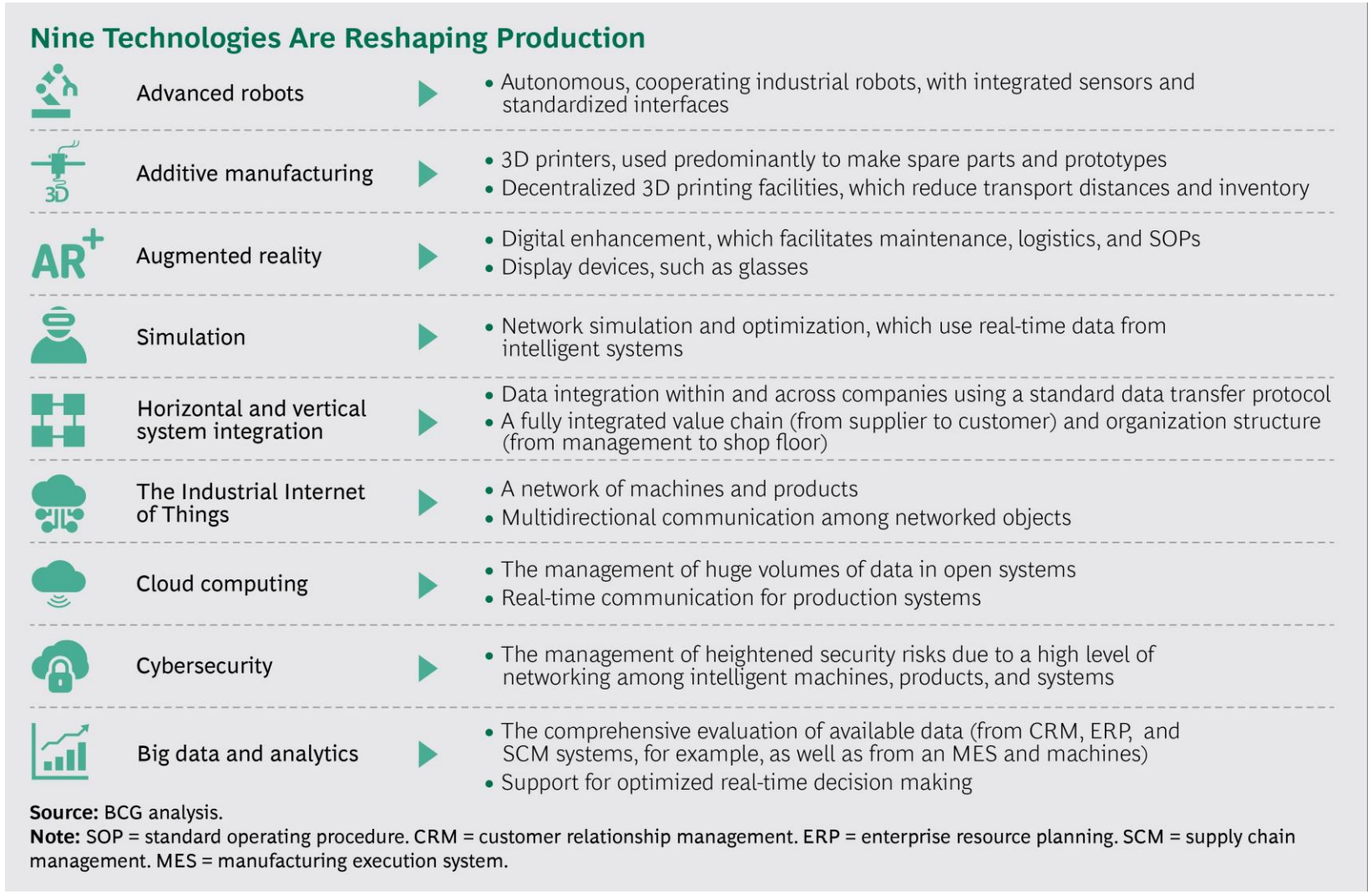
   * IoT device geolocation to track shipments, parts, and products

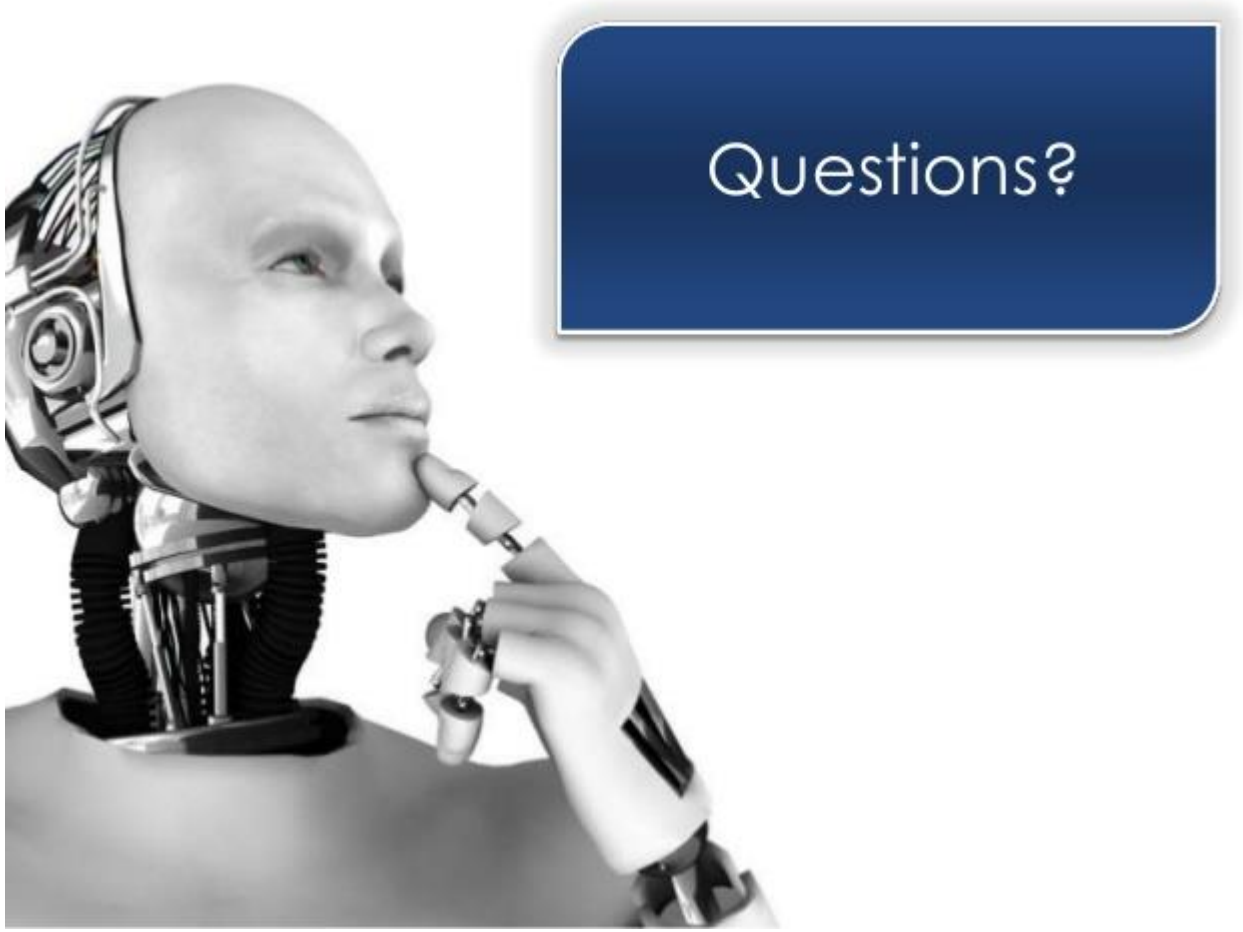
Size of the IoT market worldwide from 2017 to 2025 (in billion U.S. dollars)



Source: Statista 2019

Technologies Reshaping Production




Questions?

THANK YOU