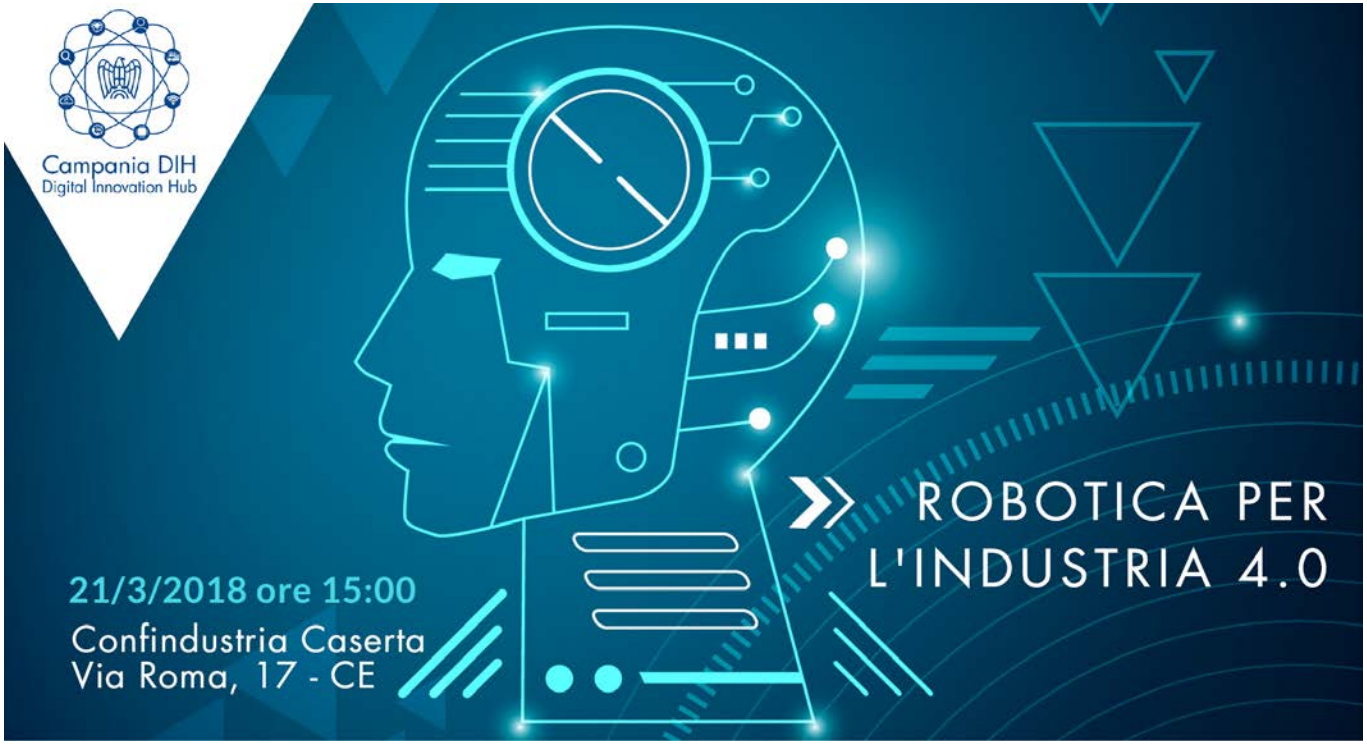

Presente e Futuro della Robotica Industriale

Bruno SICILIANO

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DIPARTIMENTO DI INGEGNERIA ELETTRICA E TECNOLOGIE DELL'INFORMAZIONE

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The PRISMA Team

The ICAROS Center

Our Research Projects

COOPERATION

IDEAS

erc

HORIZON 2020

Funding of 10 M€ ☺

European ROBOTICS Research Network EURON

ethicbots
EMERGING TECHNOETHICS OF HUMAN INTERACTION WITH COMMUNICATION, BIONIC, AND ROBOTIC SYSTEMS

euRobotics coordination action

ROCKeu

ROCK eu²

PHRIENDS

DEXMART

SAPHARI
SAFE AND AUTONOMOUS PHYSICAL HUMAN-AWARE ROBOT INTERACTION

AIRobots

ARCAS

SHERPA

RoDyMAN

ECHORD

European Robotics Challenges

REFILLS

AEROARMS

HYFLIERS

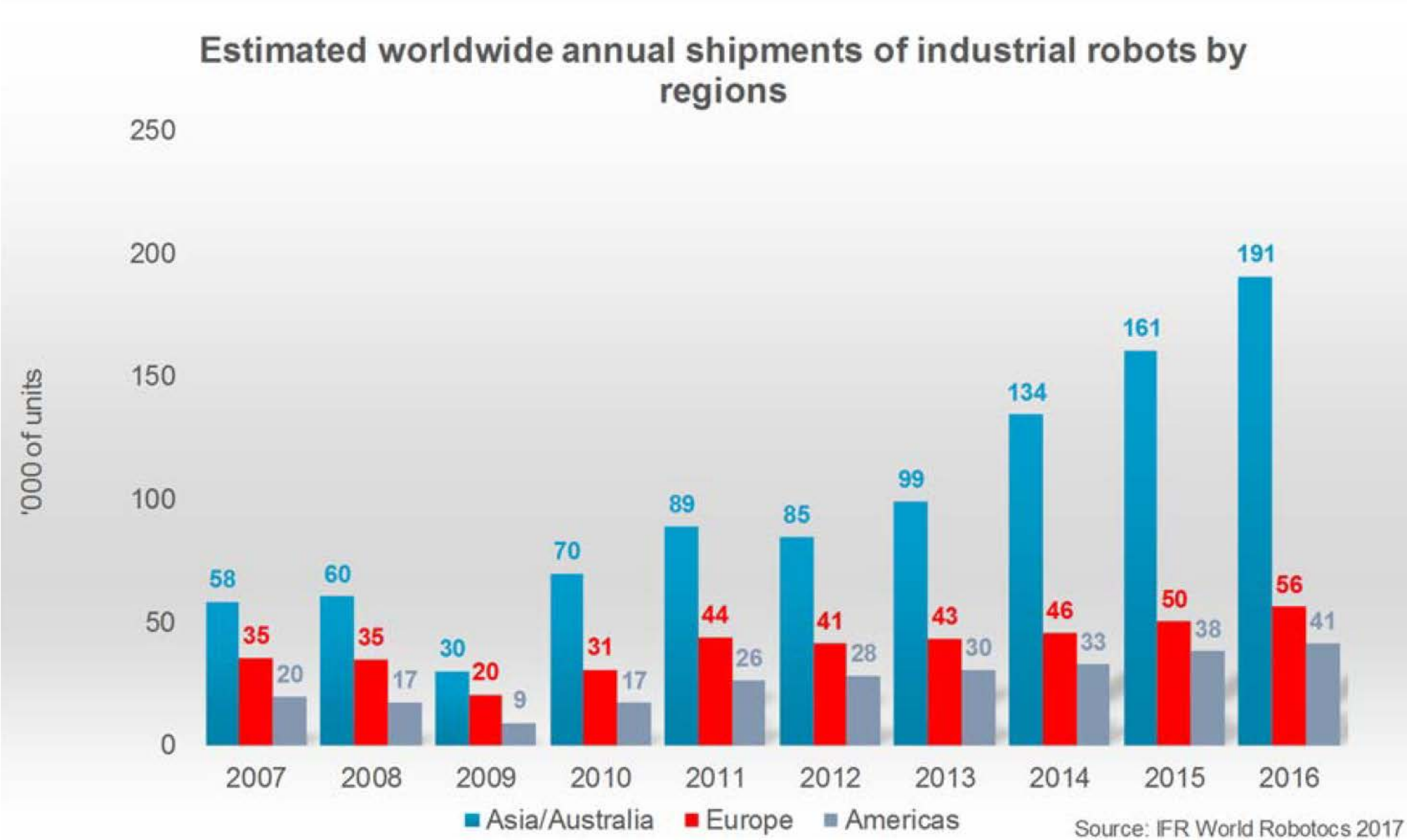
RoMoLo

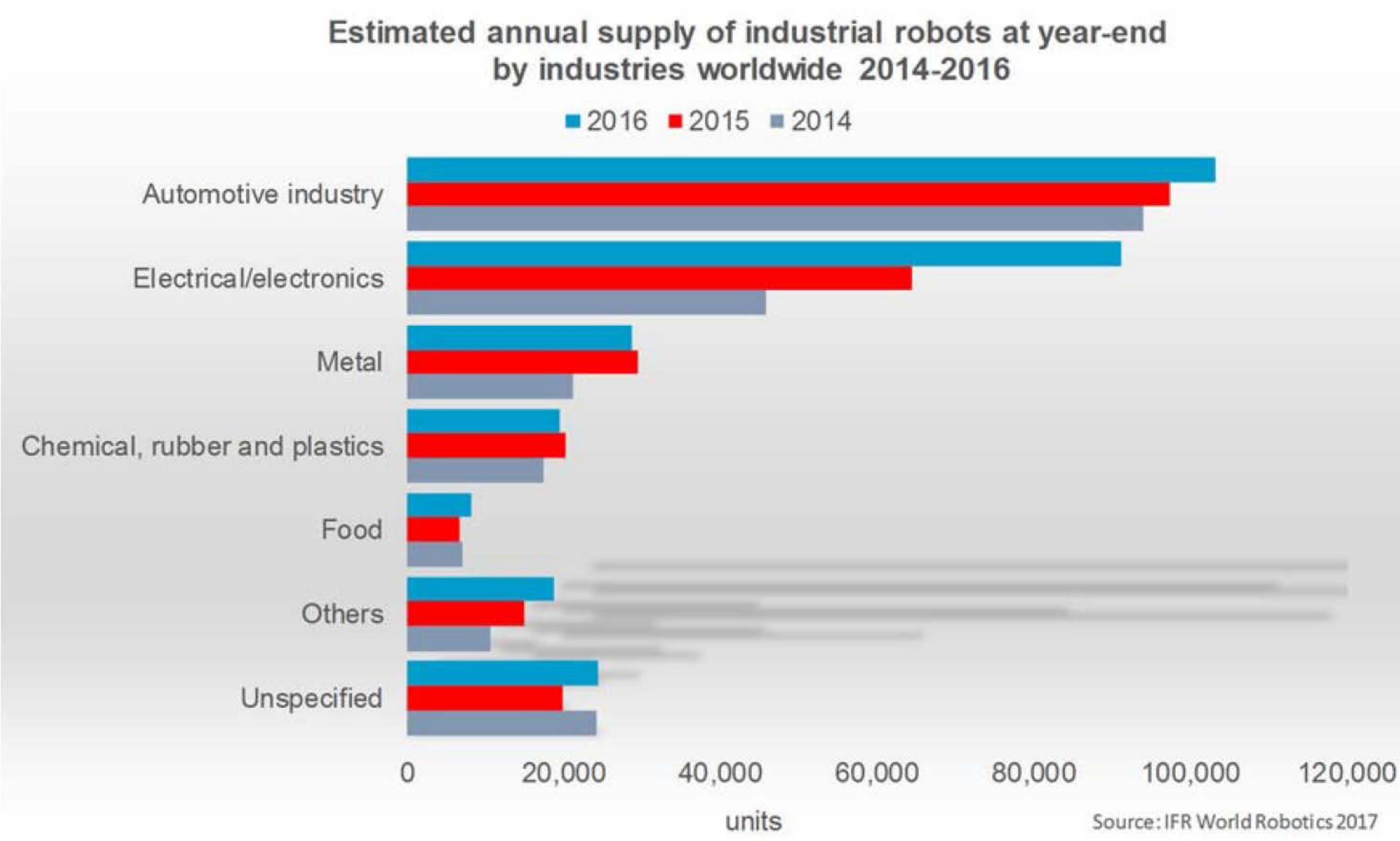
MUSHA

World Statistics

- Data up to 12/2016 (2017 report by International Federation of Robotics)
  - 1.8 million of robots at work worldwide (+12%)
  - By far the highest volume ever recorded
  - Global market of 13.1 billion $ (+18%)
  - Estimated market of 40 billion $
  - Largest markets: China, Korea, Japan, USA, Germany (74%)
  - Average global robot density ~74 industrial robots installed per 10,000 employees (Korea, Singapore, Germany, Japan)

World Statistics

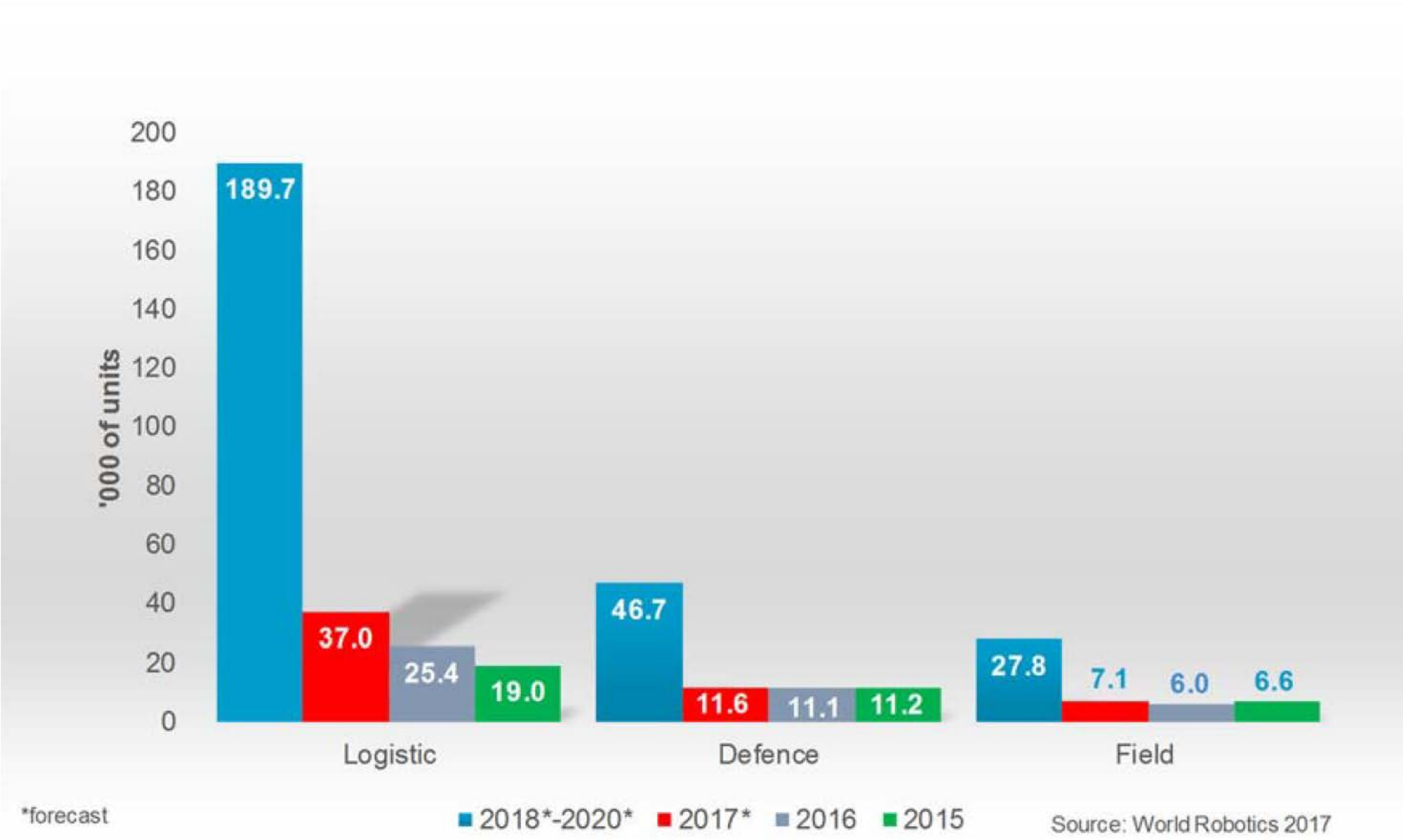



Estimated annual supply of industrial robots at year-end
by industries worldwide 2014-2016
2016
2015
2014
Automotive industry
Electrical/electronics
Metal
Chemical, rubber and plastics
Food
Others
Unspecified
0
20,000
40,000
60,000
80,000
100,000
120,000
units
Source: IFR World Robotics 2017

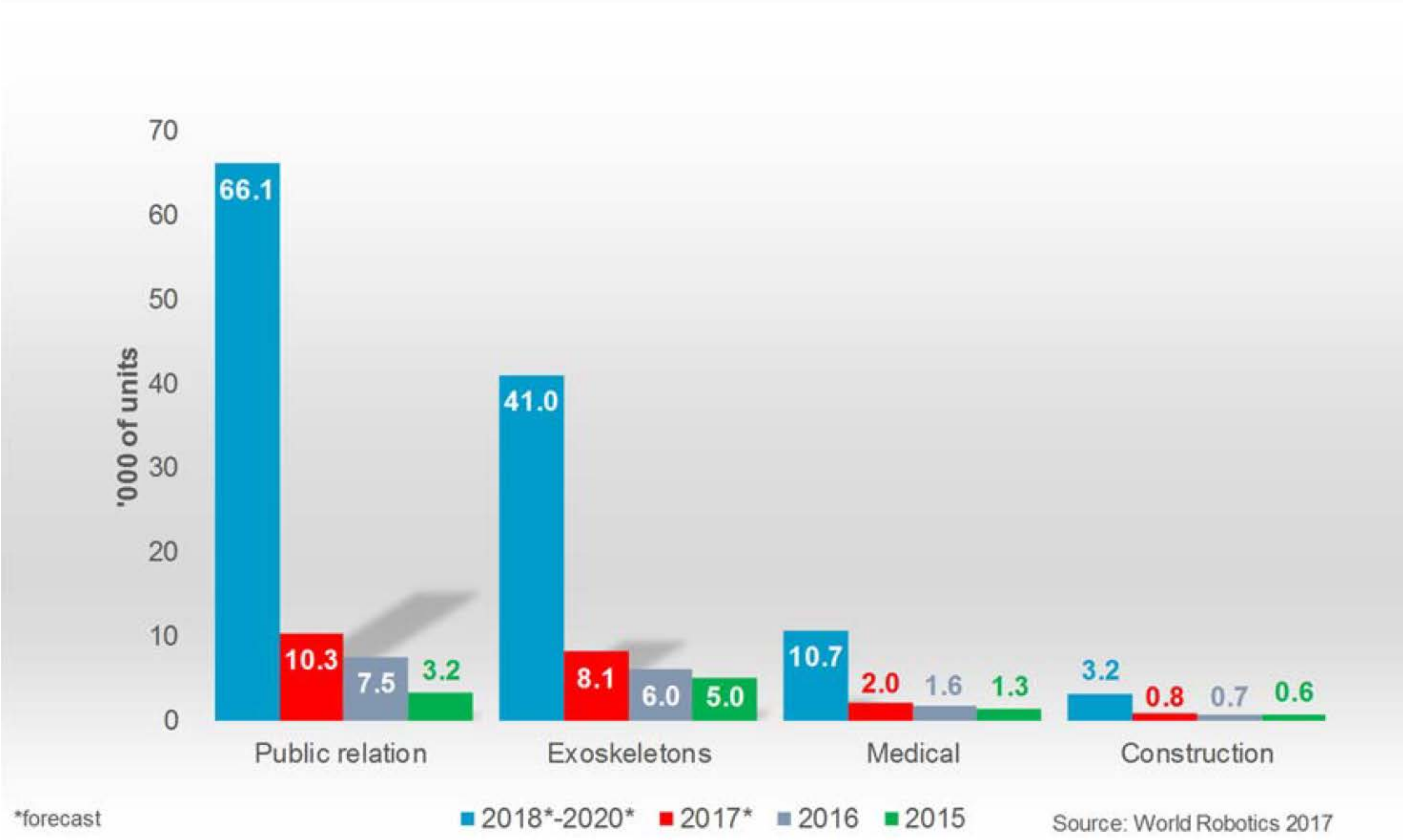
Robots for Non-industrial Applications

- Service robots for professional use
  - 59.700 new installations in 2016
  - Logistic systems, defense robots, field robots, public relations robots, powered human exoskeletons, medical robots, construction robots
- Service robots for personal use
  - 6,700,000 robots for domestic applications (+24%)
  - 2,100,000 robots for entertainment

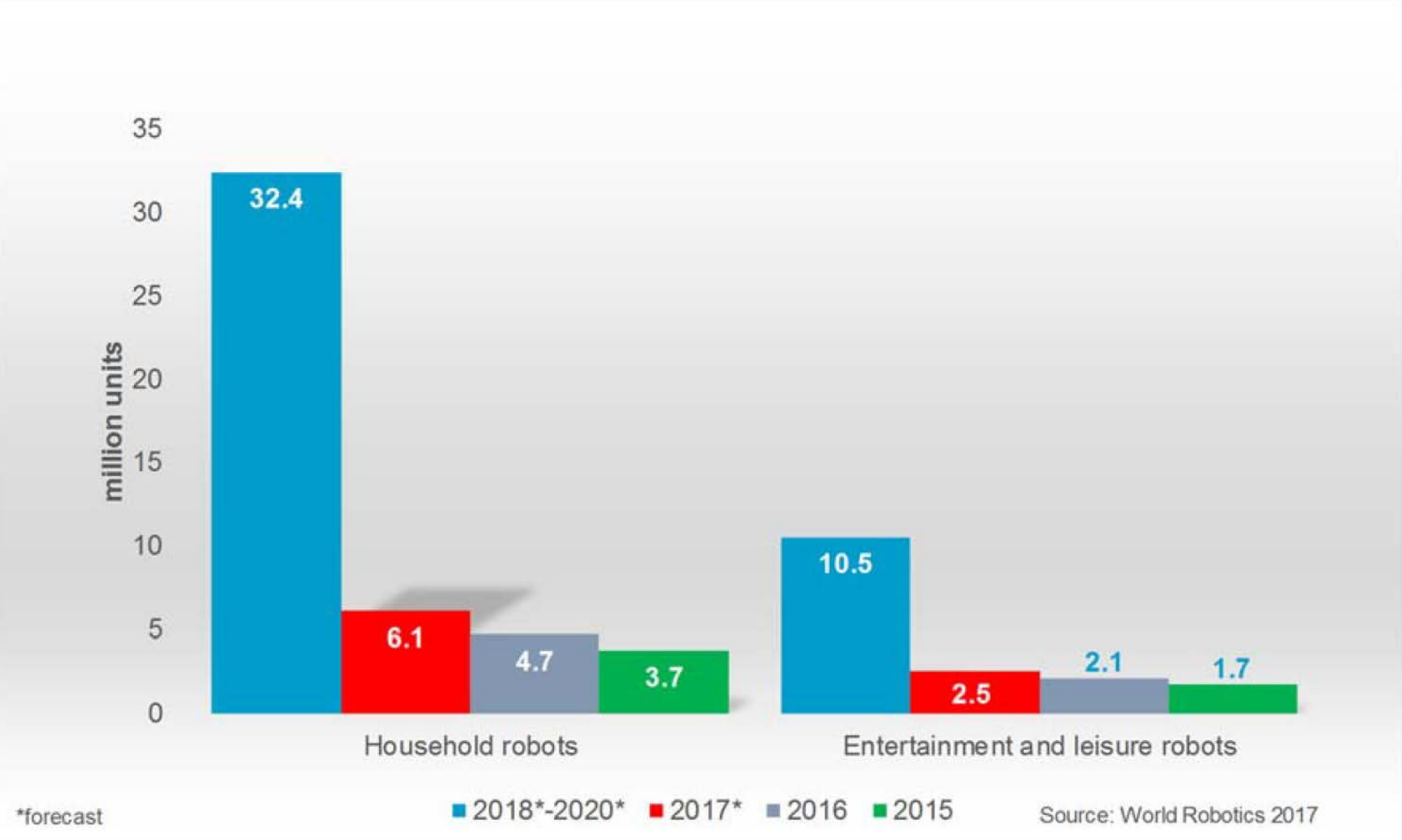
Robots for Non-industrial Applications



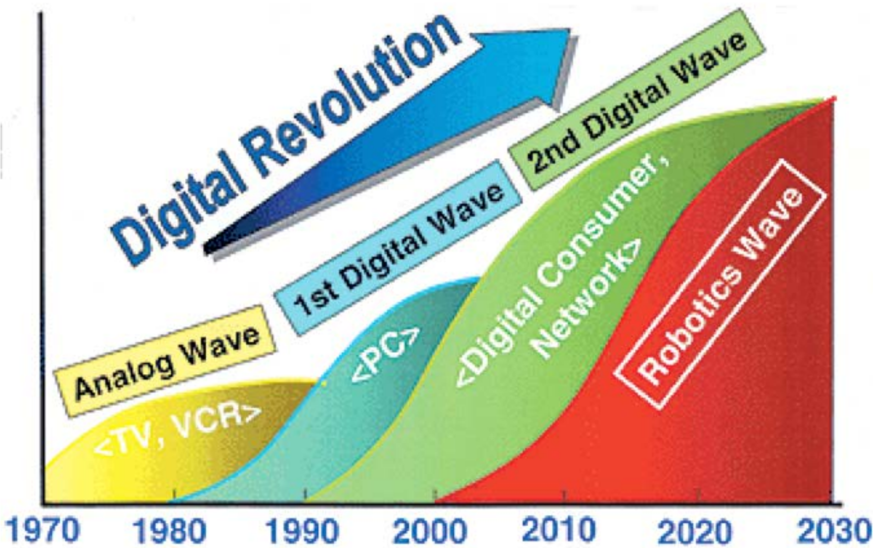
Robots for Non-industrial Applications

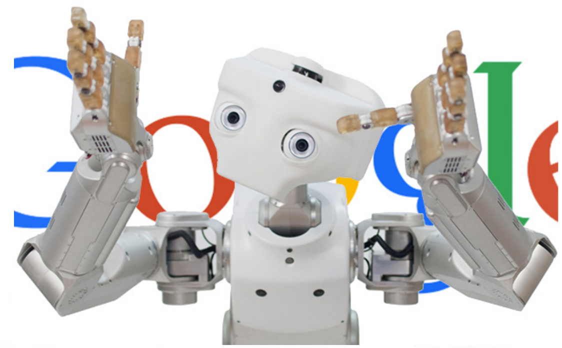


Robots for Non-industrial Applications



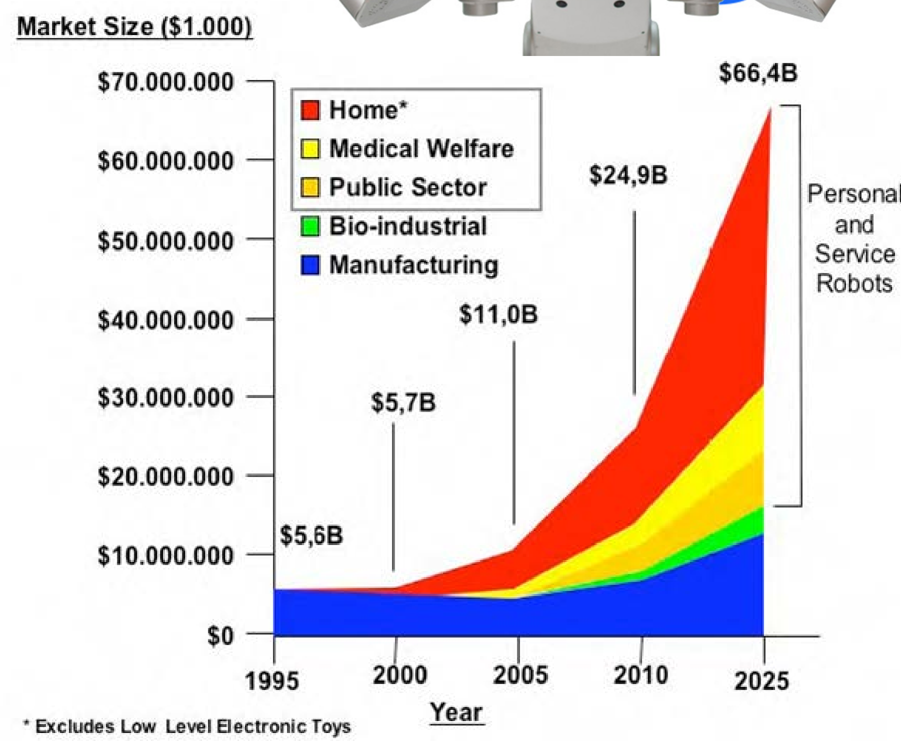
Market Prospects





Midea®

SoftBank
Robotics

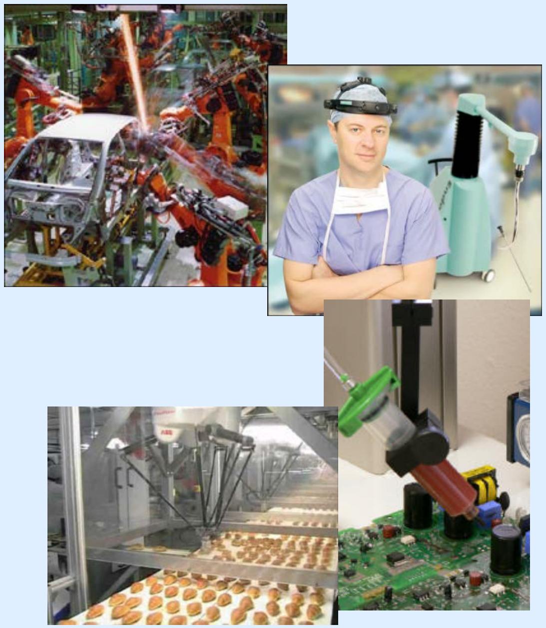


* Excludes Low Level Electronic Toys

Source : Japan Robotics Association

From Factories to Our Homes

Industry



Automotive
Chemical
Electronics
Food

Field

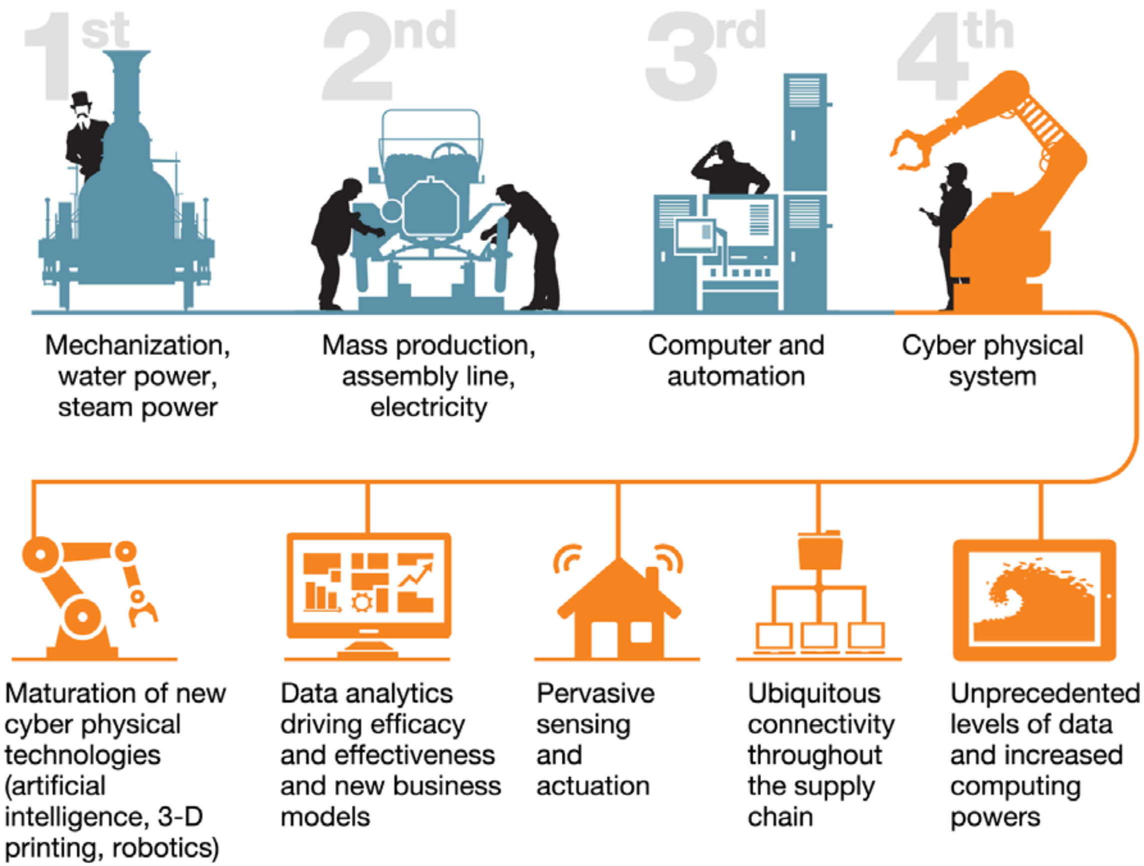
Aerial
Space
Underwater
Search and rescue

Service

Domestic
Edutainment
Rehabilitation
Surgical

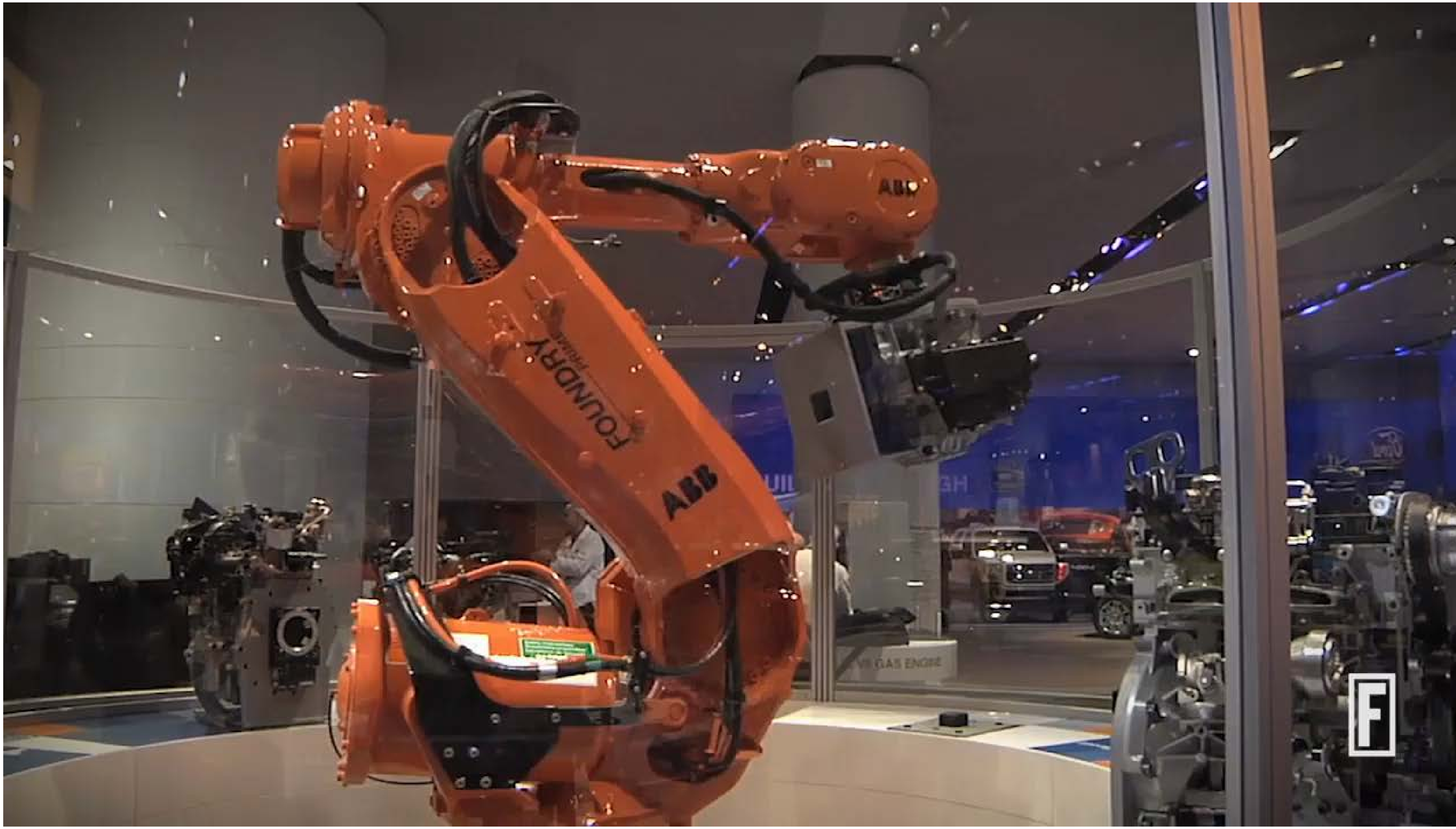
Level of Autonomy

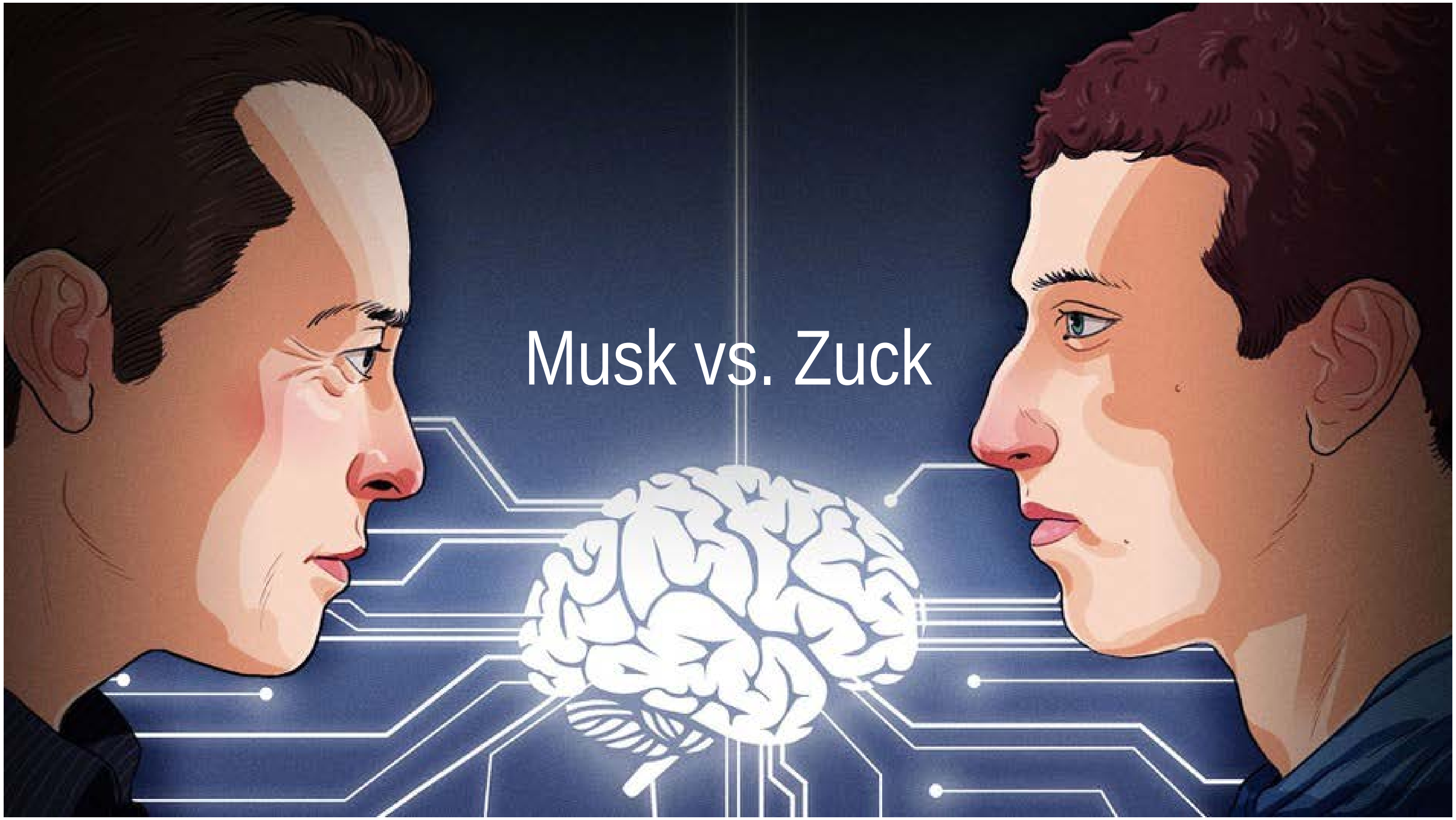
In the fourth industrial revolution, digital analytics enables a new level of operational productivity.



McKinsey&Company | Source: *Forbes*; World Economic Forum

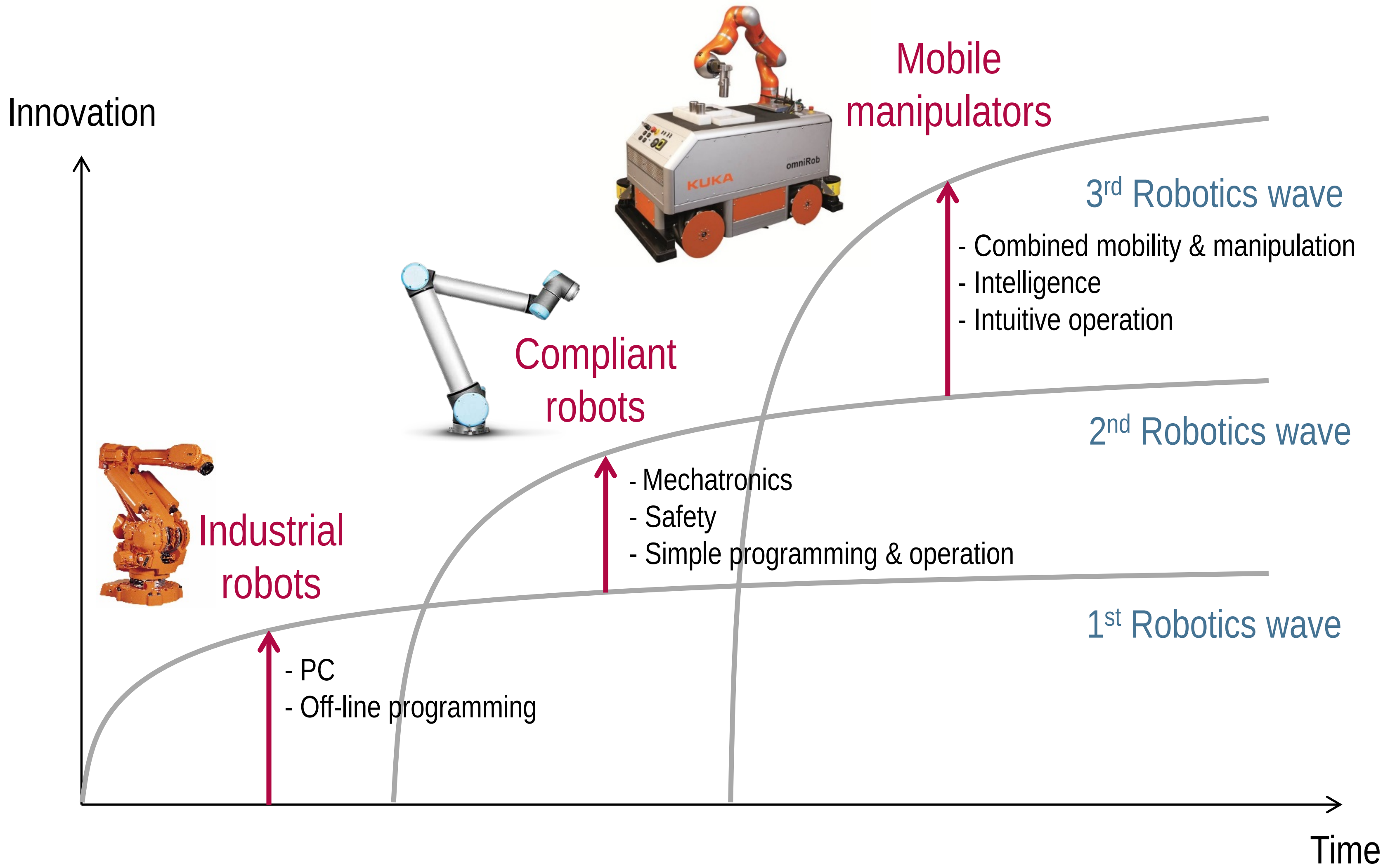
Technology Unemployment





brains … & bodies (!)

Industrial Robotics Evolution



Safety

Real-time communi-

End effectors

Planning

Mate

nsors

Which *concrete* technologies and methods should be used?

How to integrate them into a complete system?

How to achieve reliability?

⬇

Further R&D is needed!

Actuation

Sensing & Perception

Locomotion

System engineering tools

Human–machine interface

Mobile manipulation in human workspace

- The goal is to develop systems which can support a human worker with manipulation tasks
  - For seamless and flexible operation, the system has to be able to execute complex manipulation tasks in unstructured and dynamic environments
  - Need to bring together technology targets in motion planning + safety + collaboration and interaction + learning and adaptation
  - Development of new safety concepts for human−robot interaction based on existing industrial standards and regulations

Analysis of workspace sharing systems

- The goal is to define ergonomics requirements for safe human−robot interaction
  - Functioning as guidance for development of the mobile manipulator and workspace for collaborative manufacturing. The design process will be validated against the defined
  - Serving as one of the objectives to be optimised with motion planning, through e.g. use of intrinsic kinematic redundancy or task redundancy of the manipulator arm
  - Relevant technology targets are collaboration and interaction + cognitive abilities + sophisticated sensing

Technology Combinations

Rapid deployment in industry

- The goal is to quickly deploy robotic systems in realistic industrial environments
  - Current deployment strategies rely on a long set-up process by experienced system operators and are generally not automated
  - A key will be reducing the time and effort spent by operators in configuring a perception system to operate in a new application domain or a new operational environment
  - The major technological advance is expected to come from better learning capabilities and more robust solutions for interpretation, as well as synergies with more robust mapping and localisation systems in semi-structured dynamic environments
  - Important directions to investigate include limiting dependence on costly infrastructure solutions, increased transferability of experience, life-long learning as well as learning by demonstration

Robotics 2020
Multi-Annual Roadmap
For Robotics in Europe
Horizon 2020

Health
Inspection & Maintenance
Agrifood
Agile Manufacturing

The Bottom Line

- Research is important
  - Many of the technologies identified in the European Strategic Research Agenda are needed to realise advanced robots for the factory of the future
  - Develop use-case driven work
  - Reach out new market domains
- Integration is important
  - Use standard platforms to avoid re-invention of the wheel
  - Combine innovative technologies according to systems engineering approach
  - Safety and dependability are key abilities
- Challenges and competitions are important
  - Drive innovation
  - Better awareness
  - Benchmarking