

Robotics impacts Industry and Society: What are the Numbers and Trends?

ROS-Industrial Conference 2019; Stuttgart, 10-12 December 2019



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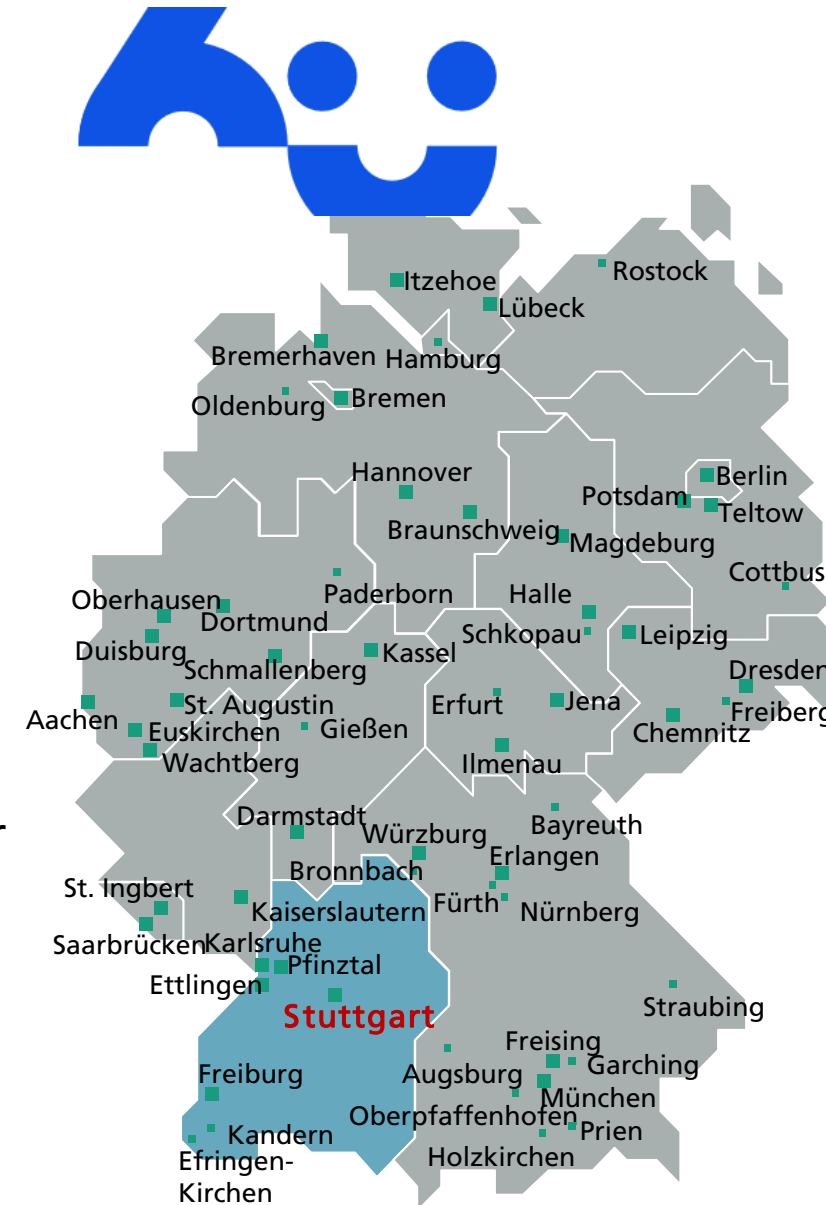
Web <https://www.ipa.fraunhofer.de/en/expertise/robot-and-assistive-systems.html>

Fraunhofer IPA

as part of the Fraunhofer-Gesellschaft

Fraunhofer Institute for Manufacturing Engineering and Automation IPA

- One of the largest institutes of the Fraunhofer-Gesellschaft
- IPA located in Stuttgart, the capital of federal state of Baden-Württemberg
- IPA: More than 1,000 employees
- 60 years of experience implementing innovations for the industry
- Main customers are equipment/ machinery and automotive industry
- 74 M€ Budget in 2018, 28 M€ industrial revenues



Diversity of Research Missions

Main Pillars



Application oriented Research

Application



Universities

Research and Education



Pursues the long-term research goals of state and society



Knowledge-driven and applied basic research



MAX-PLANCK-GESELLSCHAFT

Basic research – curiosity driven

Basics

CyberValley

A cluster for artificial intelligence and robotics

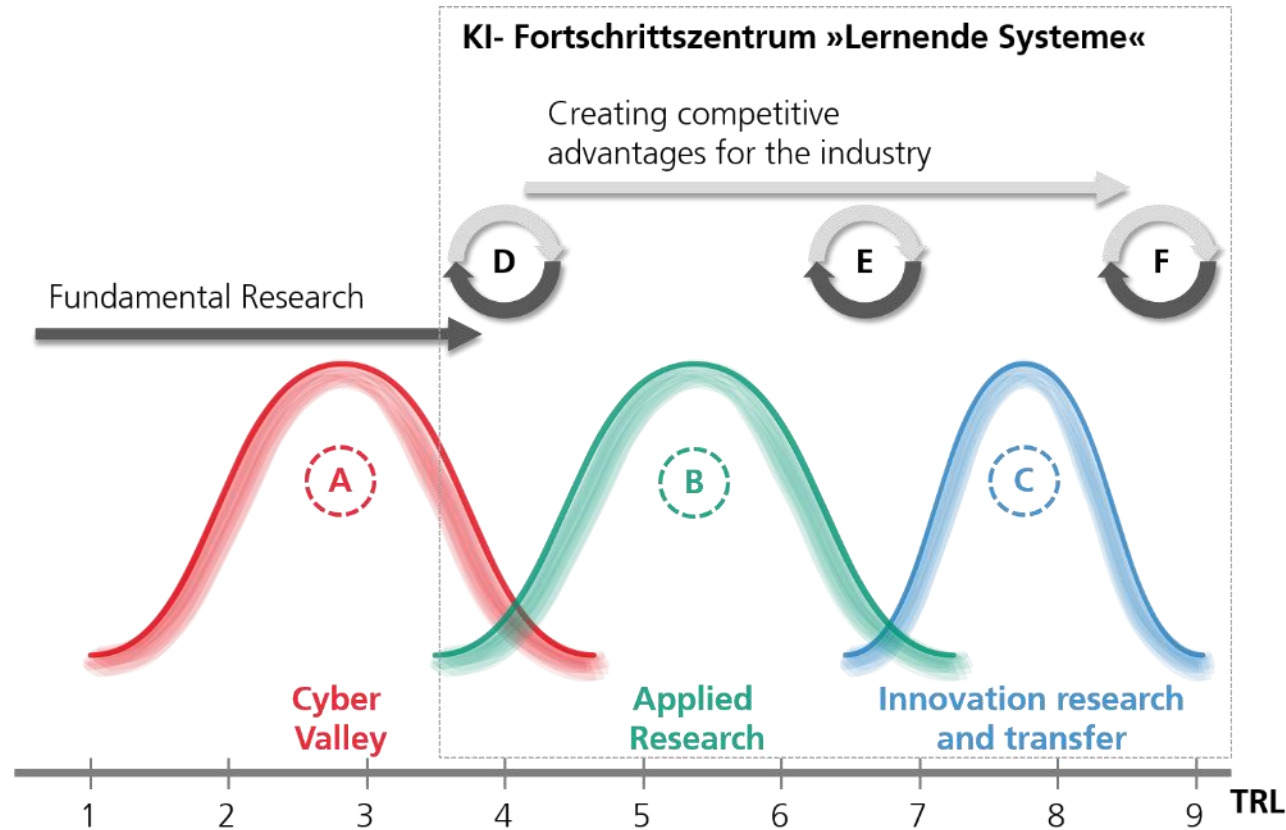
- Europe's largest research consortium for artificial intelligence
- Partners from **academia, business, and society**
- Attracts researchers from **around the world**
- Offers a European perspective

Spokesperson:
Dr. Michael J. Black
MPI for intelligent systems



AI innovation center Learning Systems

Overview



Example from Max-Planck Institute
for Intelligent Systems: Learning control



Technical equipment and laboratories

In tune with the times



Application Center
Industrie 4.0



Motion laboratory



Machine vision laboratories



Biomanufacturing
laboratory



Factory planning and
production laboratory



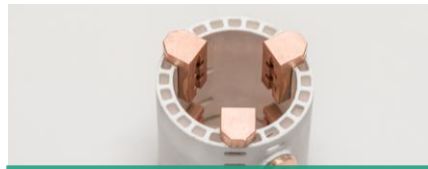
Future Work Lab



Electroplating laboratory



Intervention room



Labs for additive
manufacturing



Labs for cutting, joining and
sawing



Coating technology center



nICLAS
Laboratory automation



Cleanrooms & cleanliness
rooms



Robotics experimentation
area



Model factory for functional
coatings



Virtual Orthopedic Lab

Worldwide shipments of industrial robotics in 2018

Most relevant industrial application areas and processes

Handling (42%)



Clean Room (10%)



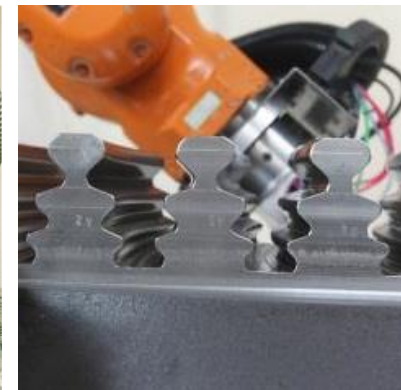
Welding (21%)



Assembly (11%)



Machining (1%)



Dispensing (3%)

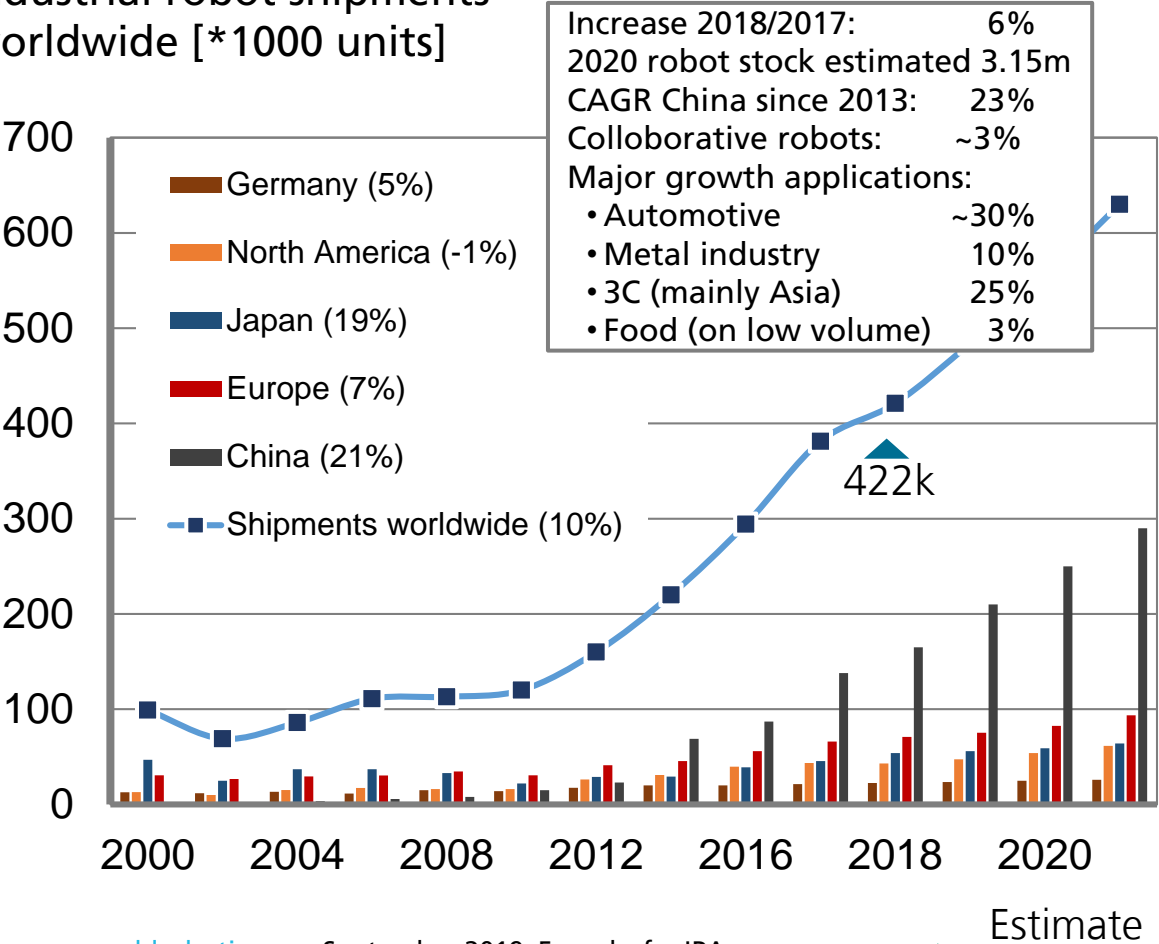


World Robotics Report; www.worldrobotics.org, Sept. 2019

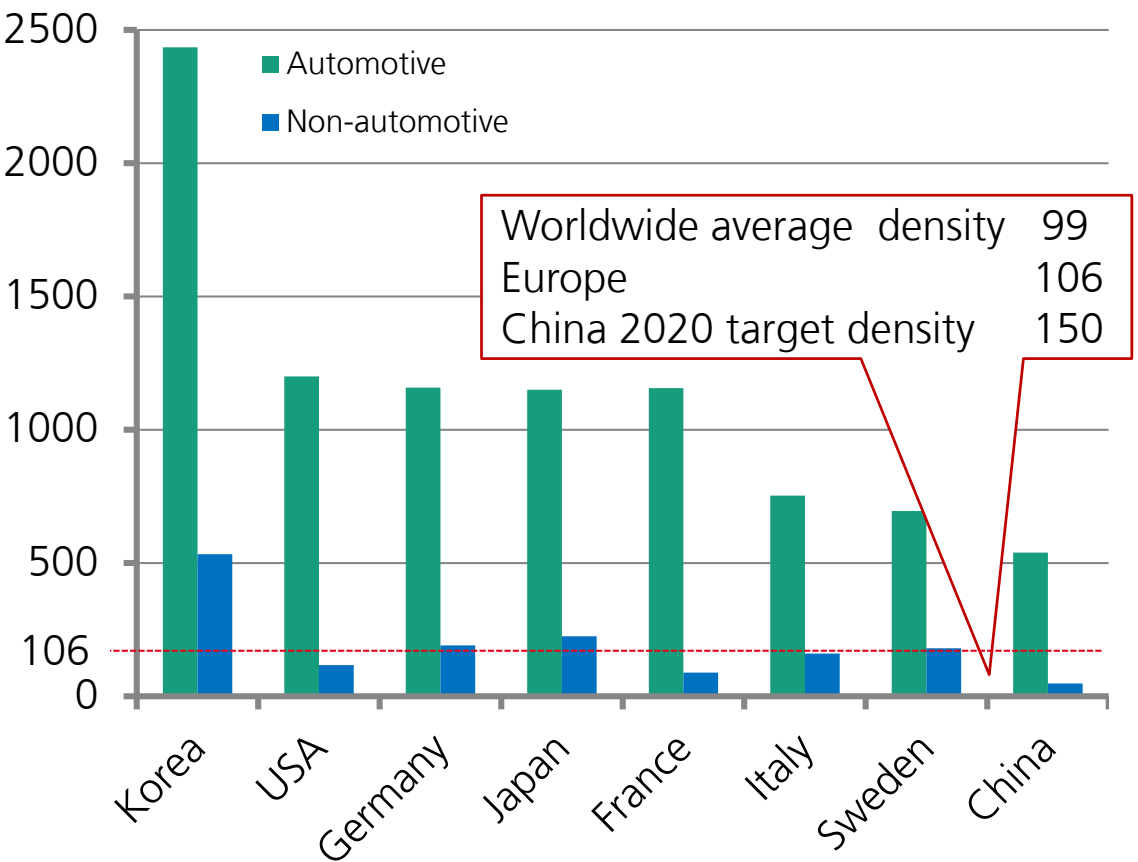
Industrial robot shipments (new installations)

All time high in 2018 and positive prospects

Industrial robot shipments worldwide [*1000 units]



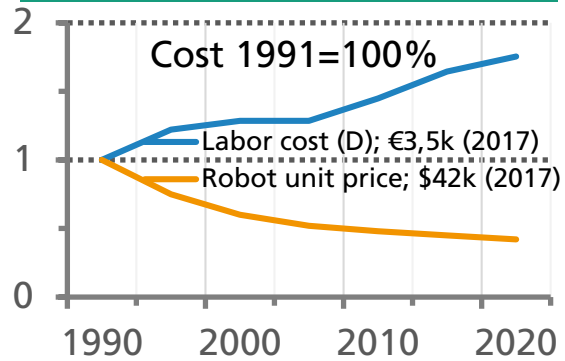
Robot density 2018: Number [units] of installed industrial robots per 10,000 employees in the respective domains



www.worldrobotics.org, September 2019, Fraunhofer IPA

Technology Trends in Industrial Robotics

Cost effectiveness



Human-Robot Collaboration



Networked → Industrie4.0



Robot Optimization by AI/Machine Learning

1 Processes, tasks

- Physical interaction
- Learning control
- Strategies, skills

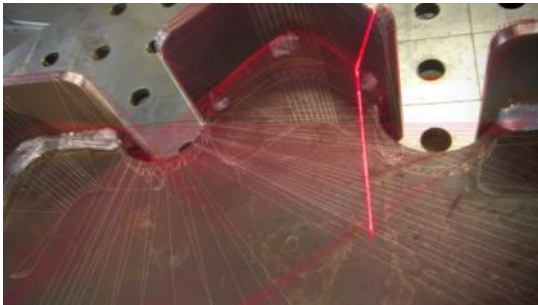
2 Program generation

- Planning
- HMI
- Behavior explanation

3 Robot performance

- Accuracy
- Dynamics
- Durability etc.

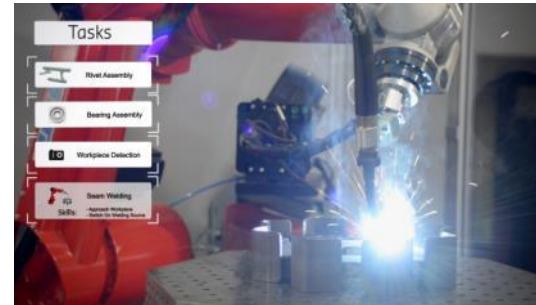
Sensors



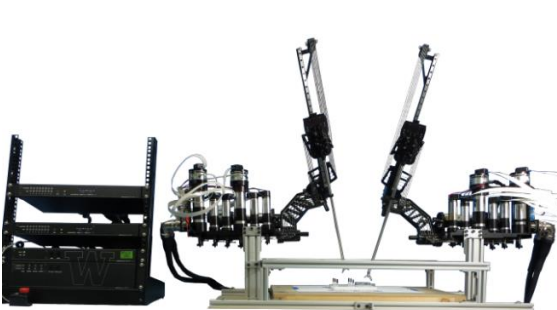
Cognitive capabilities



Skill-based, intuitive robot instruction



Service Robots for Professional Use I

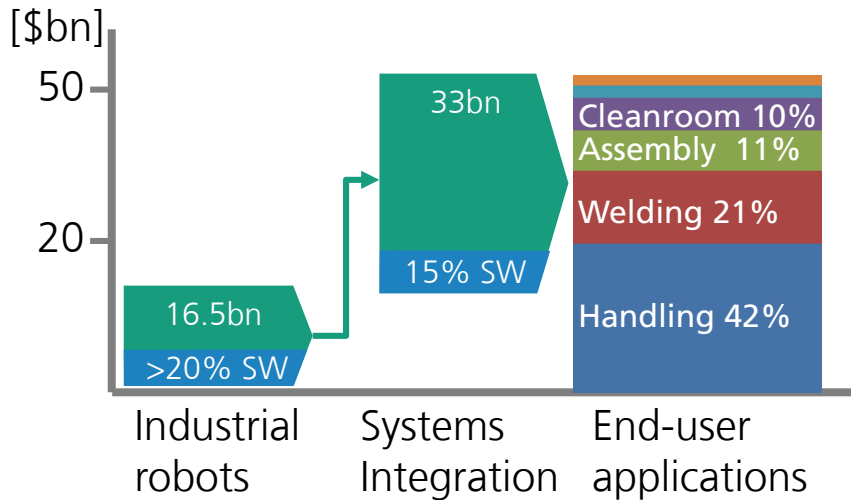


Service Robots for Professional Use II



Industrial and service robotics supply industries

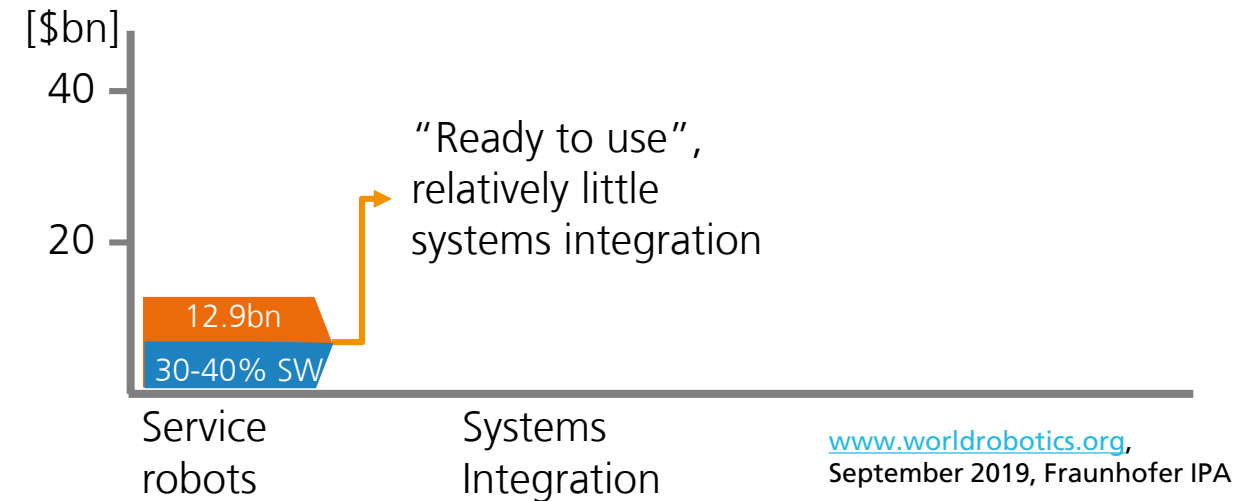
Industrial Robotics annual turn-over



Key figures Industrial Robotics IR (est.)

- US\$16.5bn turn-over Industrial Robots (IR)
- 55 IR manufacturers worldwide
- 1k systems integrators
- \$50-55bn total turnover IR industries
- 15% CAGR until 2020+ (estimated)
- Average unit price US\$53k (2012) → 42k (2017)

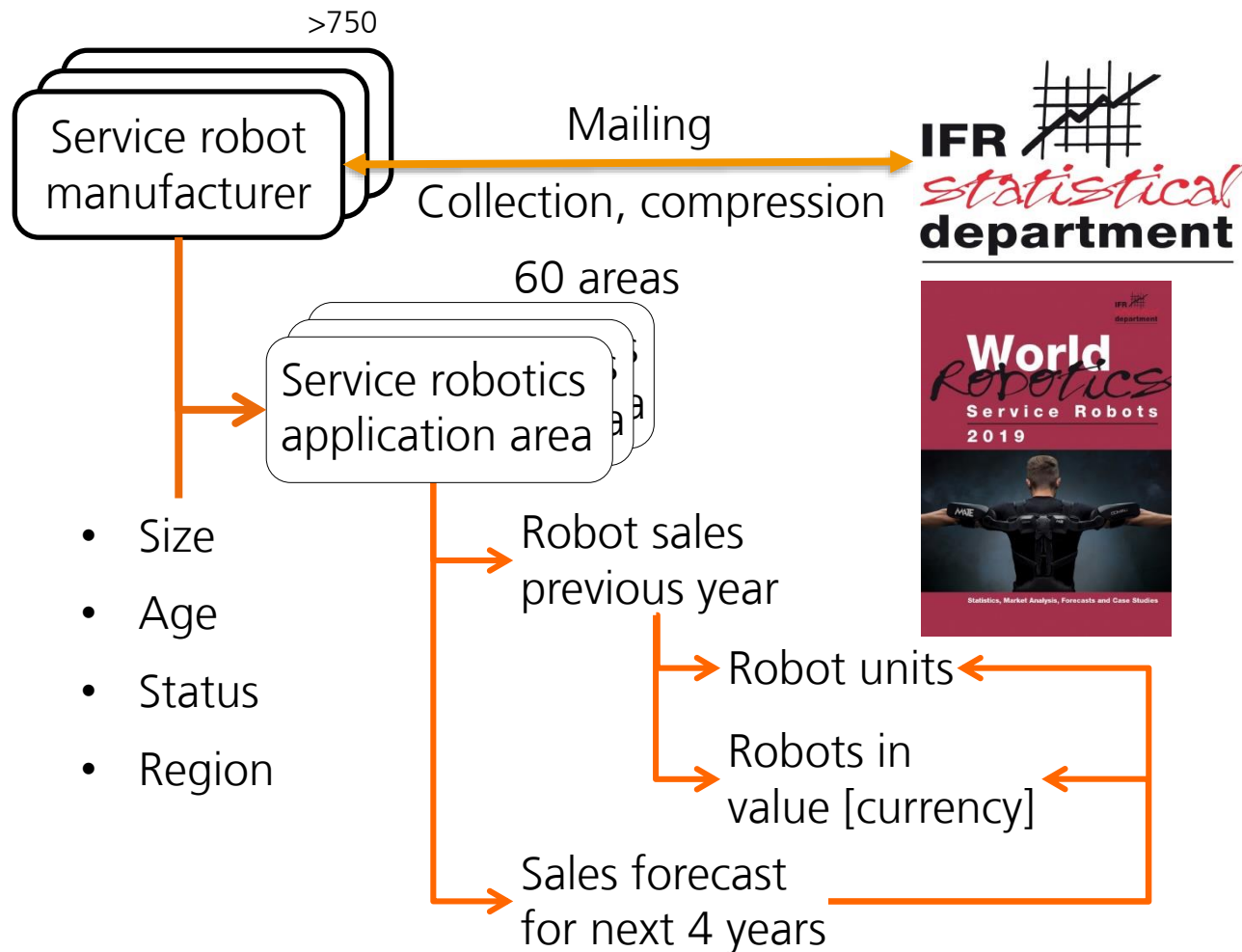
Service Robotics annual turn-over



Key figures Service Robotics SR

- >\$12.9bn turn-over (US\$9.2bn professional service robotics, 3.7bn in “domestic/personal”)
- >750 suppliers/manufacturers of SR, ~25% start-ups (max. 5 years)
- 70% use ROS in one form or the other (estimated)
- 41% CAGR (estimation until 2022) for professional SR
- 46% CAGR (estimation until 2022) for domestic/personal SR

Statistics Scheme and Classification of Service Robots by Application Areas



www.worldrobotics.org,
September 2019, Fraunhofer IPA

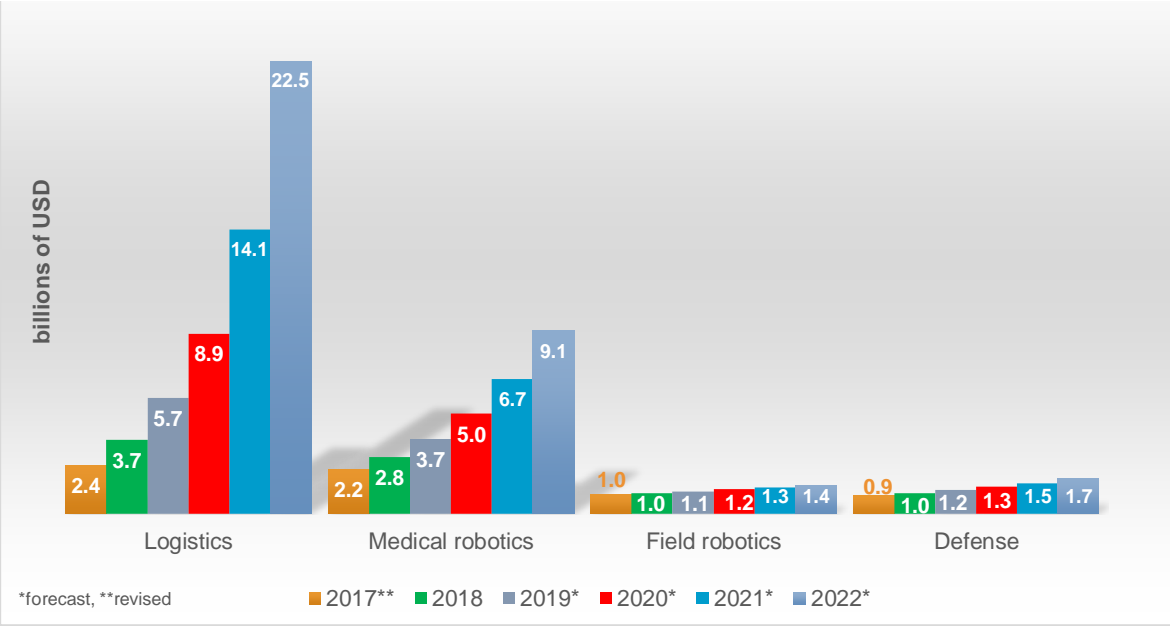
Professional use

- 16-21 Field robotics
- 22-26 Professional cleaning
- 27-29 Inspection, maintenance systems
- 30-33 Construction and demolition
- 34-38 Logistic systems
- 39-42 Medical robotics
- 43-45 Rescue & security applications
- 46-50 Defense applications
- 51 Underwater systems (civil/general use)
- 52 Powered Human Exoskeletons
- 53 Mobile Platforms in general use
- 54-58 Underwater systems (civil/general use)
- 59 Other

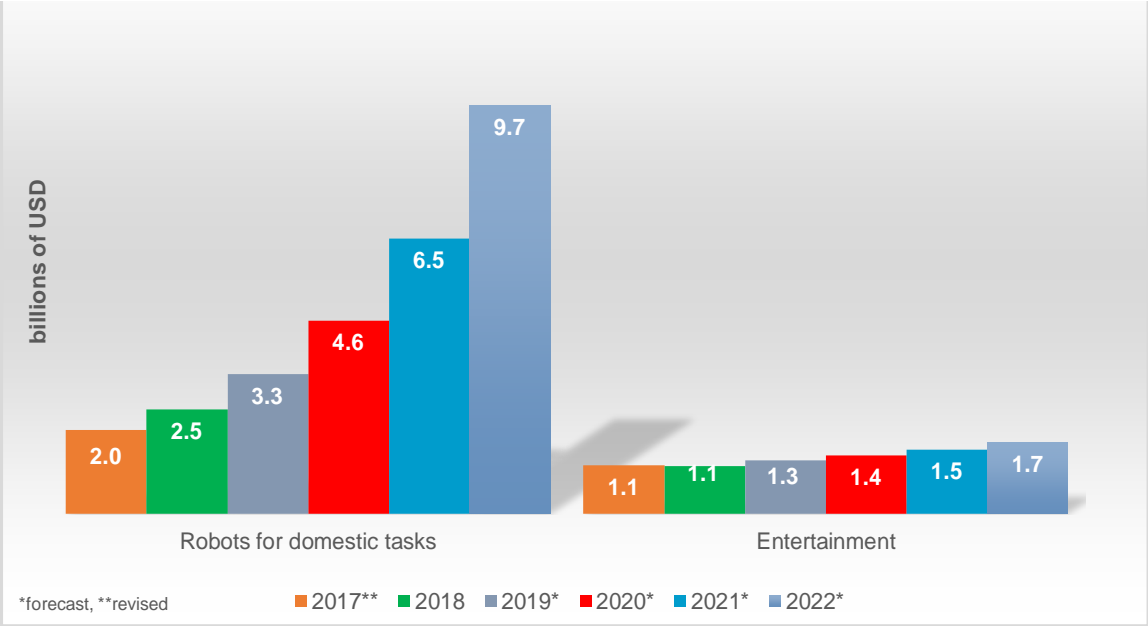
Service Robots for Professional and Domestic Use (Main Applications)

Estimated Values 2017 and 2018; forecasts(*) 2019 - 2022

Professional Applications

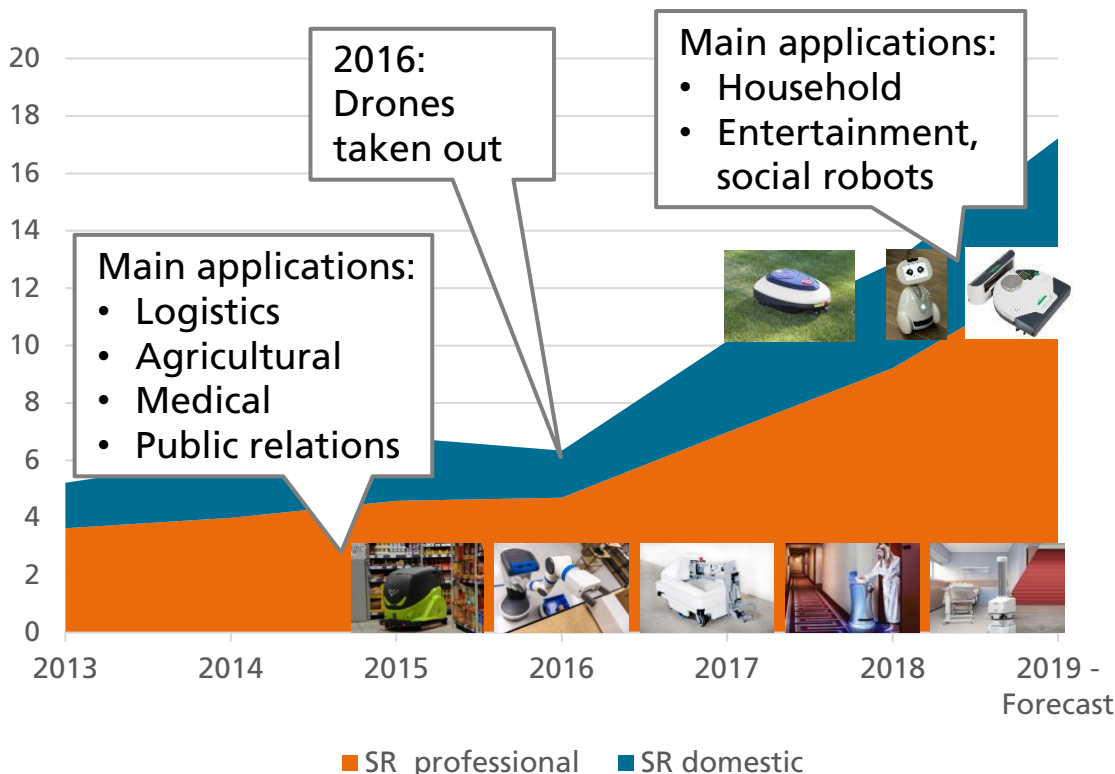


Domestic Applications

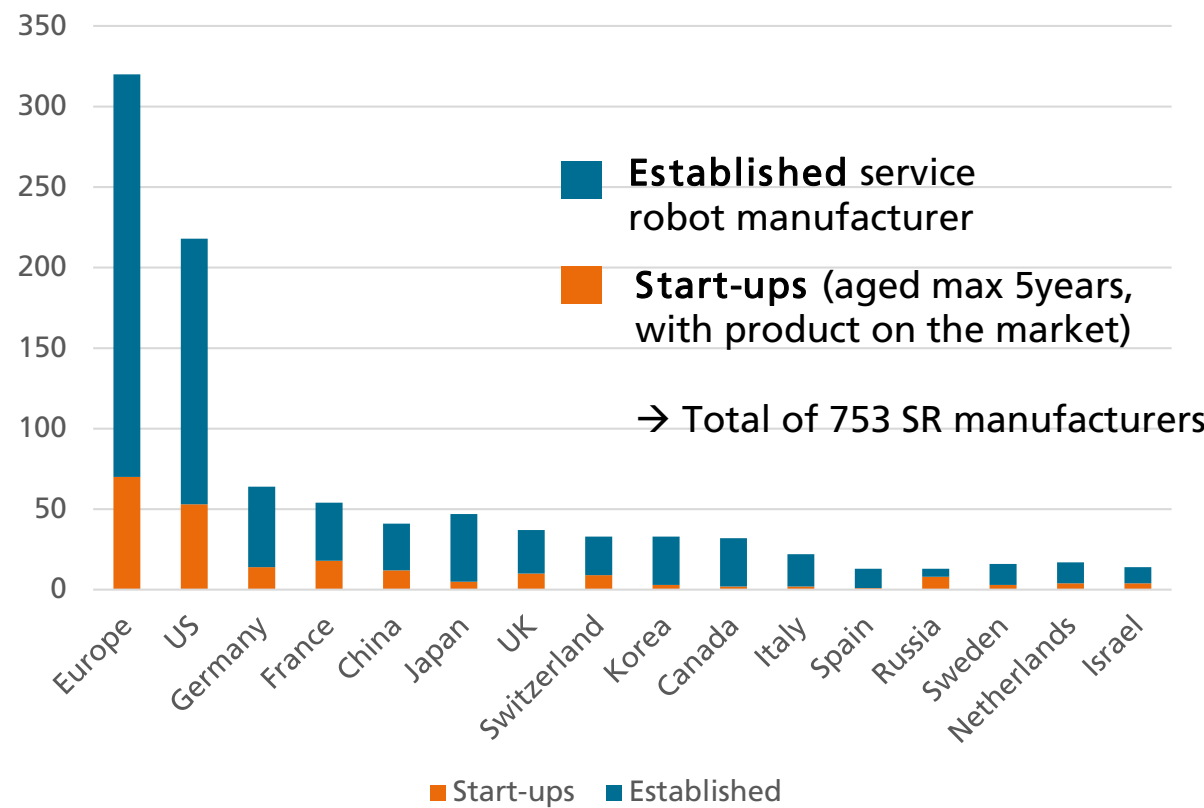


Robotics Outside the Manufacturing Scenario

Service robot (SR) annual sales worldwide for professional, domestic applications in [bnUS\$]

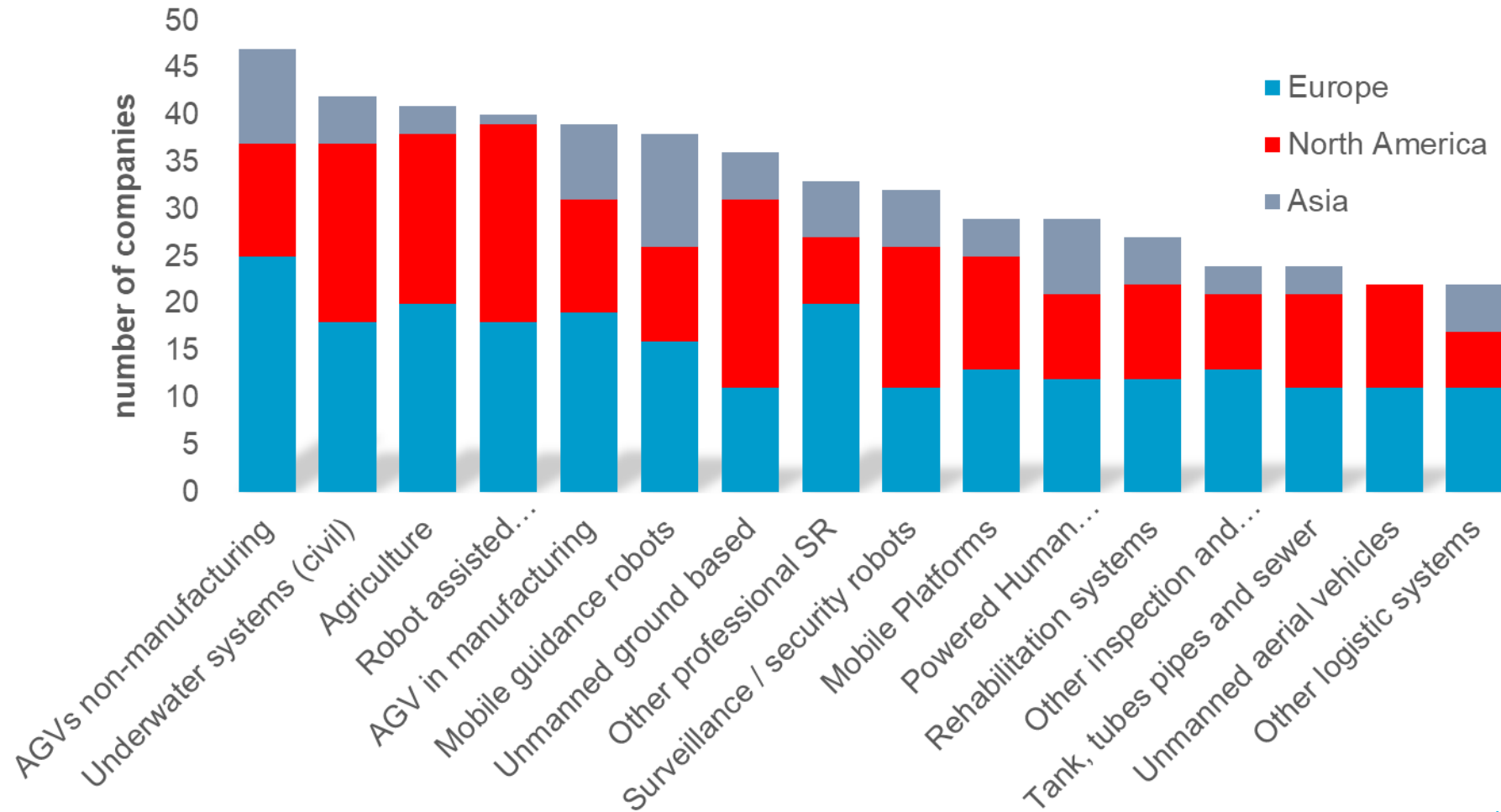


Number of service robot manufacturers (professional and domestic use) by country of origin (2019, excerpt)



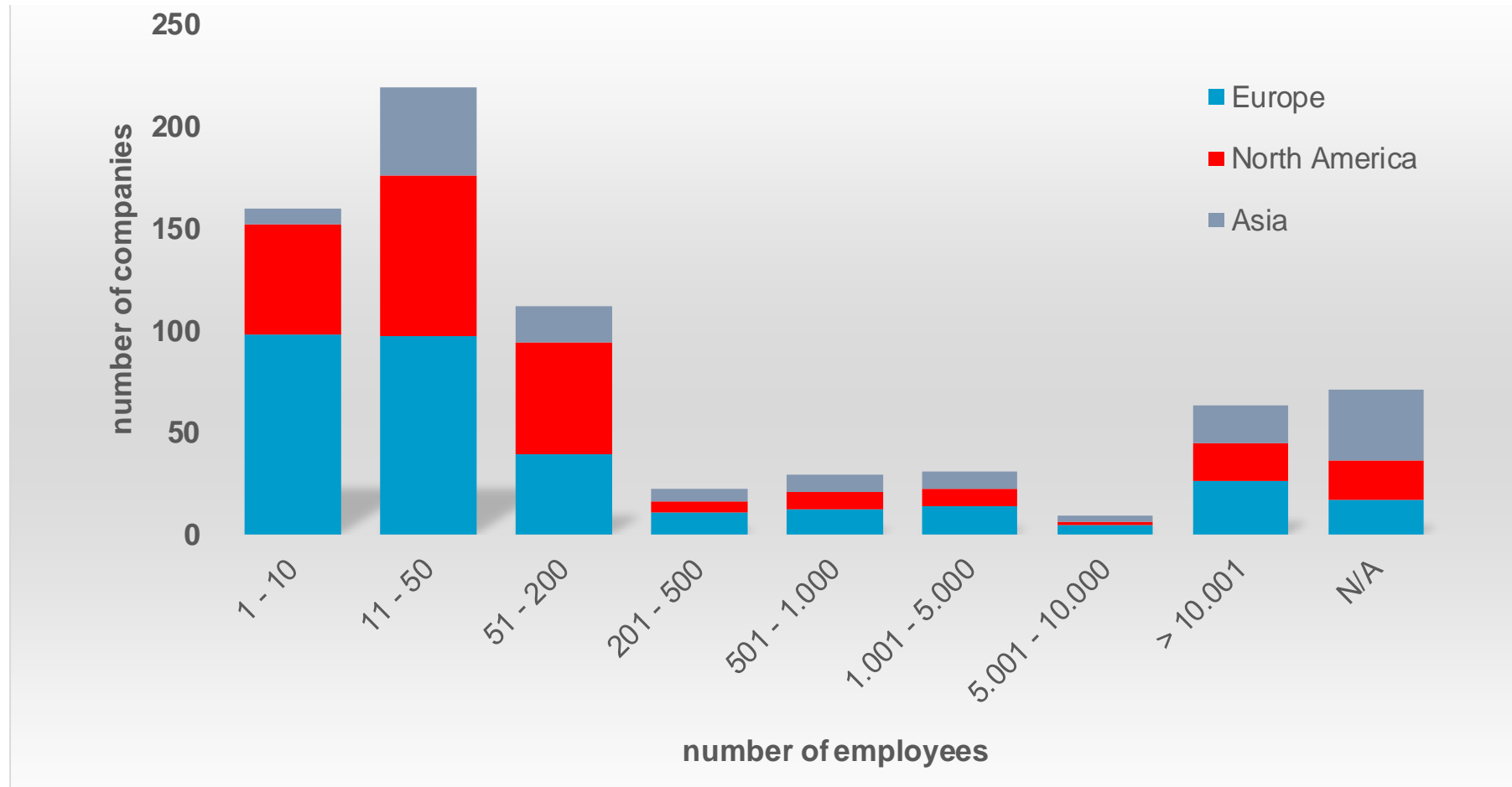
Source: World Robotics 2019; www.worldrobotics.org , Fraunhofer IPA

Number of service robot manufacturers by main types (professional use) and by region of origin, status 2018 (selection)



www.worldrobotics.org, Oktober 2019, Fraunhofer IPA

Business sizes of service robots of all types in numbers of employees (by region of origin, 2018)



www.worldrobotics.org, Oktober 2019, Fraunhofer IPA

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