1 ° Seminario residenziale imprenditori Confindustria Emilia

- 6 febbraio 2026 -

Bruno Siciliano

Focus Robot

The Impact of Robotics & AI in the Industry

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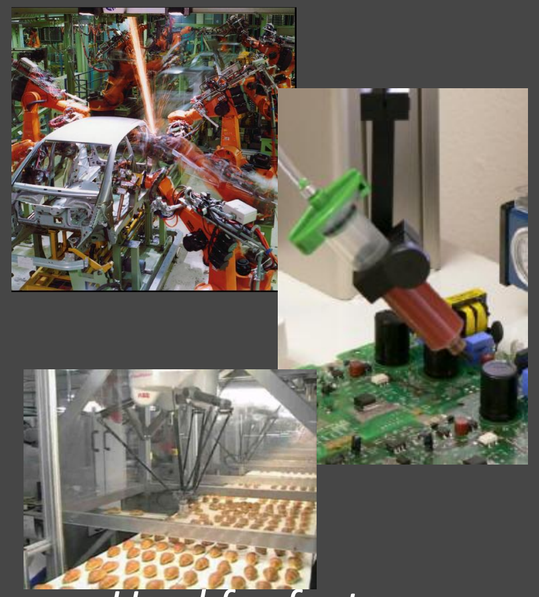
Robot Classification

Industrial robots



Used for factory automation (mainly manufacturing): automotive, electrical/electronics, metal & machinery, plastic & chemical, food

Service robots

Perform useful tasks for humans or equipment excluding industrial automation

Professional service robots

Used for commercial tasks by trained operators: cleaning public places, delivery in offices or hospitals, fire-fighting, rehabilitation, surgery

Personal service robots

Used for non-commercial tasks by untrained persons: house cleaning, automated wheelchairs, personal mobility assist robots, pet exercising robots

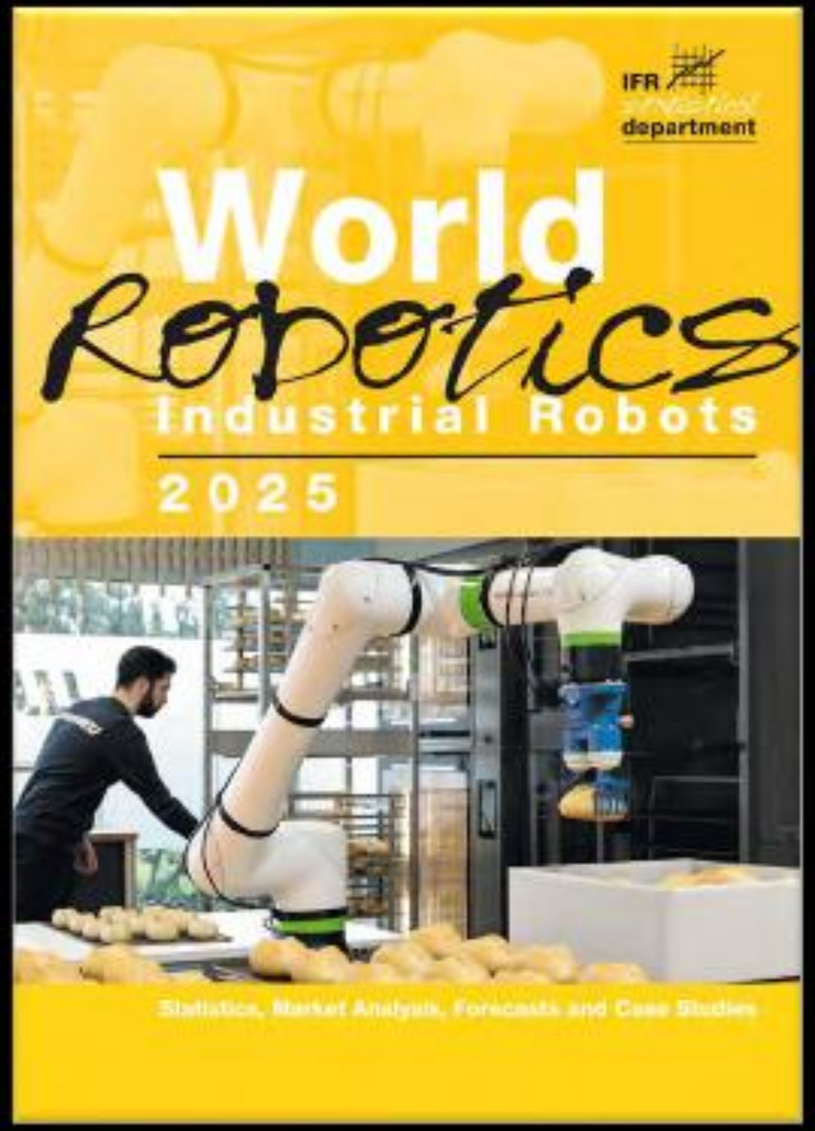
IFR International Federation of Robotics

https://ifr.org

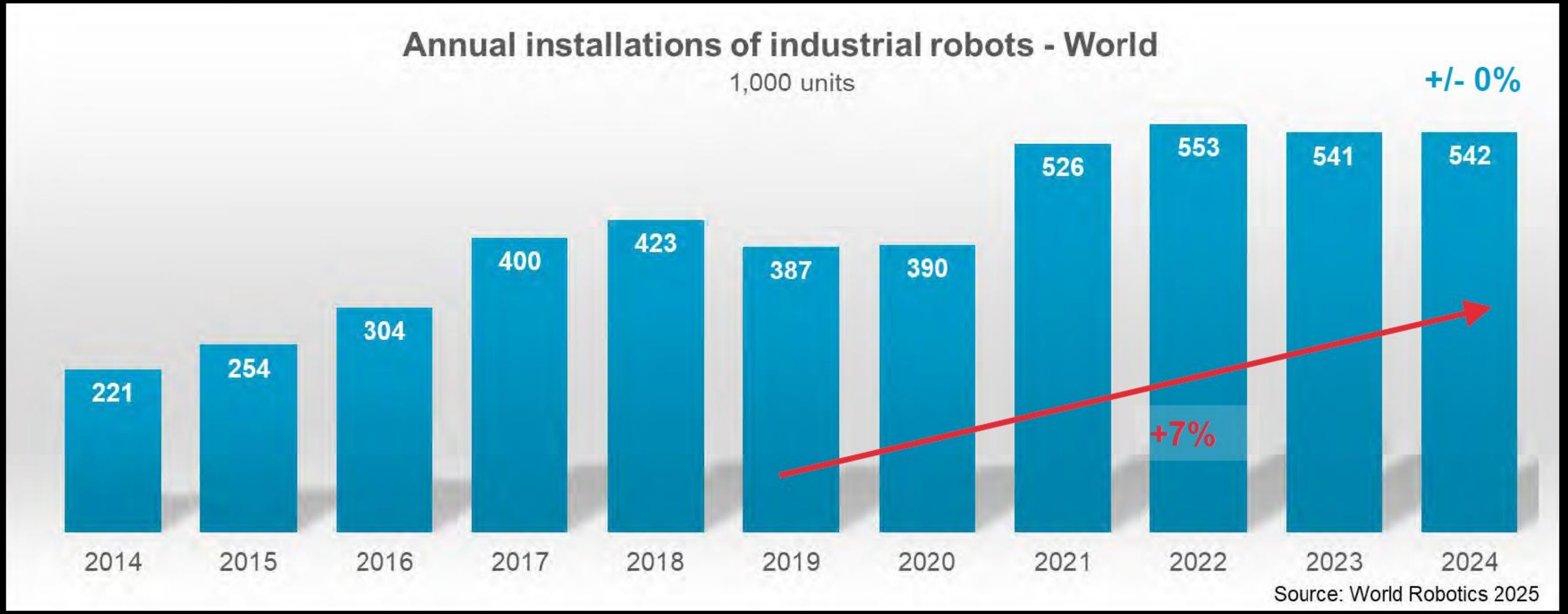
👉 *The classification of a robot is done according to its intended application*

World Statistics

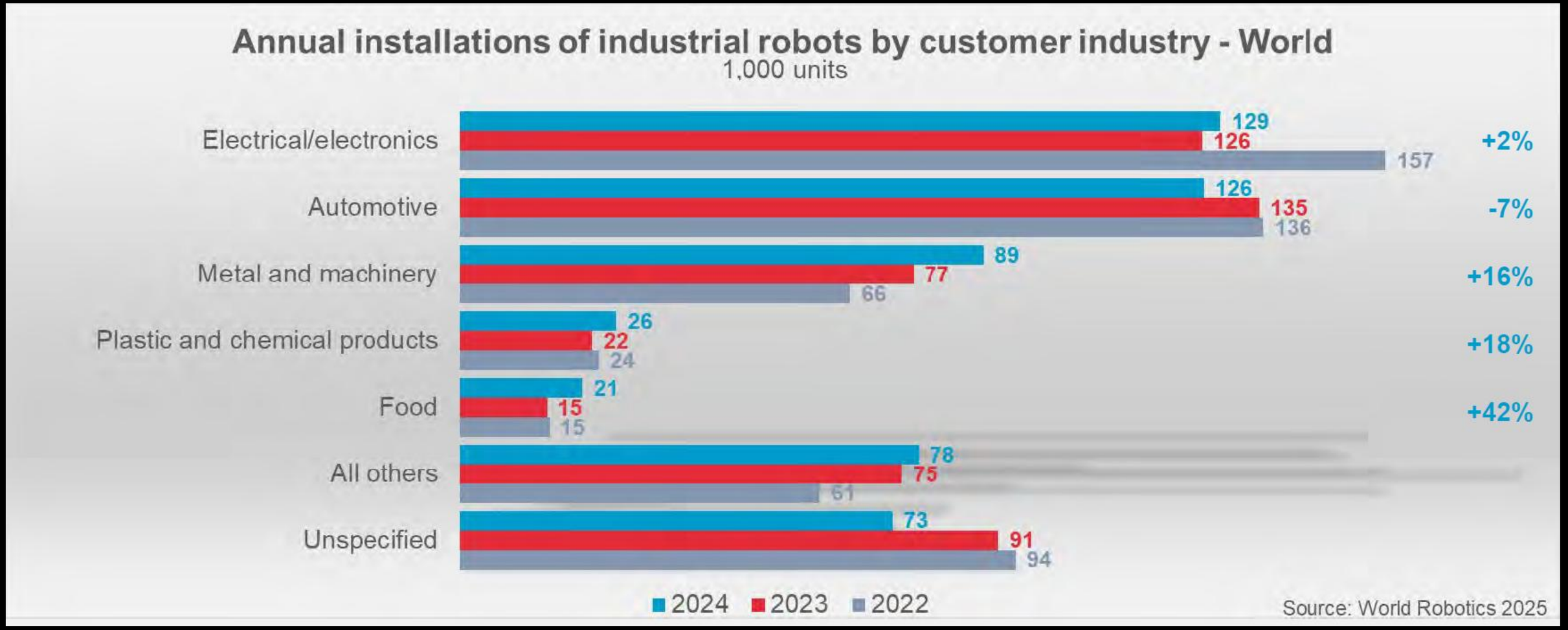
- ✓ *4.6 million of robots @ work worldwide (+10%), CAGR 2019–2024 +8%*
- ✓ *542.000 new installation in 2024 (±0%)*
- ✓ *Largest markets: China, Japan, USA, Korea, Germany, Italy (90%)*



Robots At Work



Application Sectors



Technological Trends

Physical, Analytic & Generative AI

- ✓ *Physical AI coined as the new term*
- ✓ *Generative AI is opening up new applications*

Single Purpose Humanoids

- ✓ *Few commercial deployments announced*
- ✓ *True multipurpose humanoids are far off yet*

Market Trends

Sustainability and Energy Consumption

- ✓ *Long-term policy goals for carbon neutrality*
- ✓ *Reconsideration of supply chains and closeness to customers*

New Fields of Business and Customer Segments

- ✓ *New customer segments beyond manufacturing*
- ✓ *New business models evolving*

Robots Addressing Labor Shortage

- ✓ *Flexible applications to fill gaps when and where needed*

Service Robots

New professional service robots (incl. AMRs)

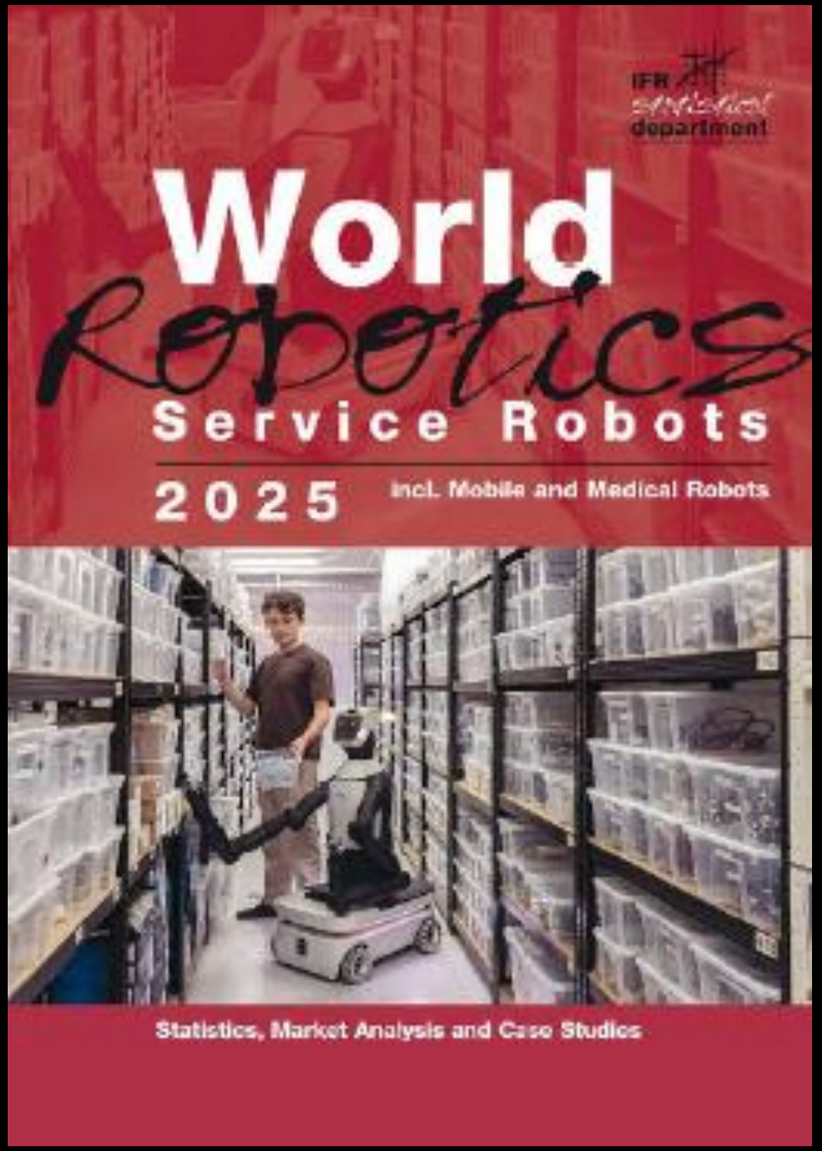
✓ *199,000 units (+9%)*

New medical robots

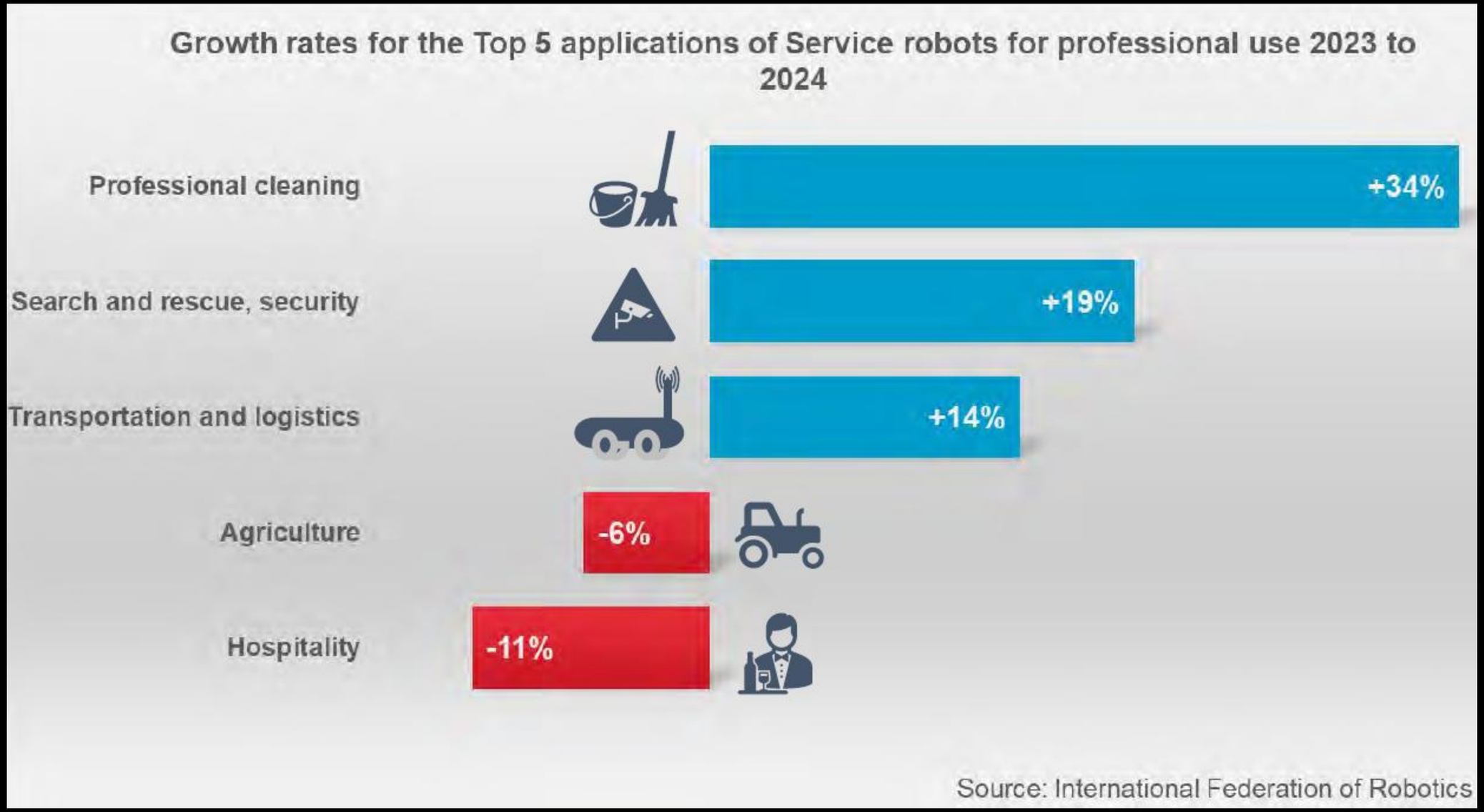
✓ *16,700 units (+91%)*

New consumer service robots

✓ *20.1 million units (+11.1%)*



Application Sectors



Medical Robots

Surgery

Image: Kawasaki

+41%

Rehabilitation & non-invasive therapy

Image: Life Science Robotics

+106%

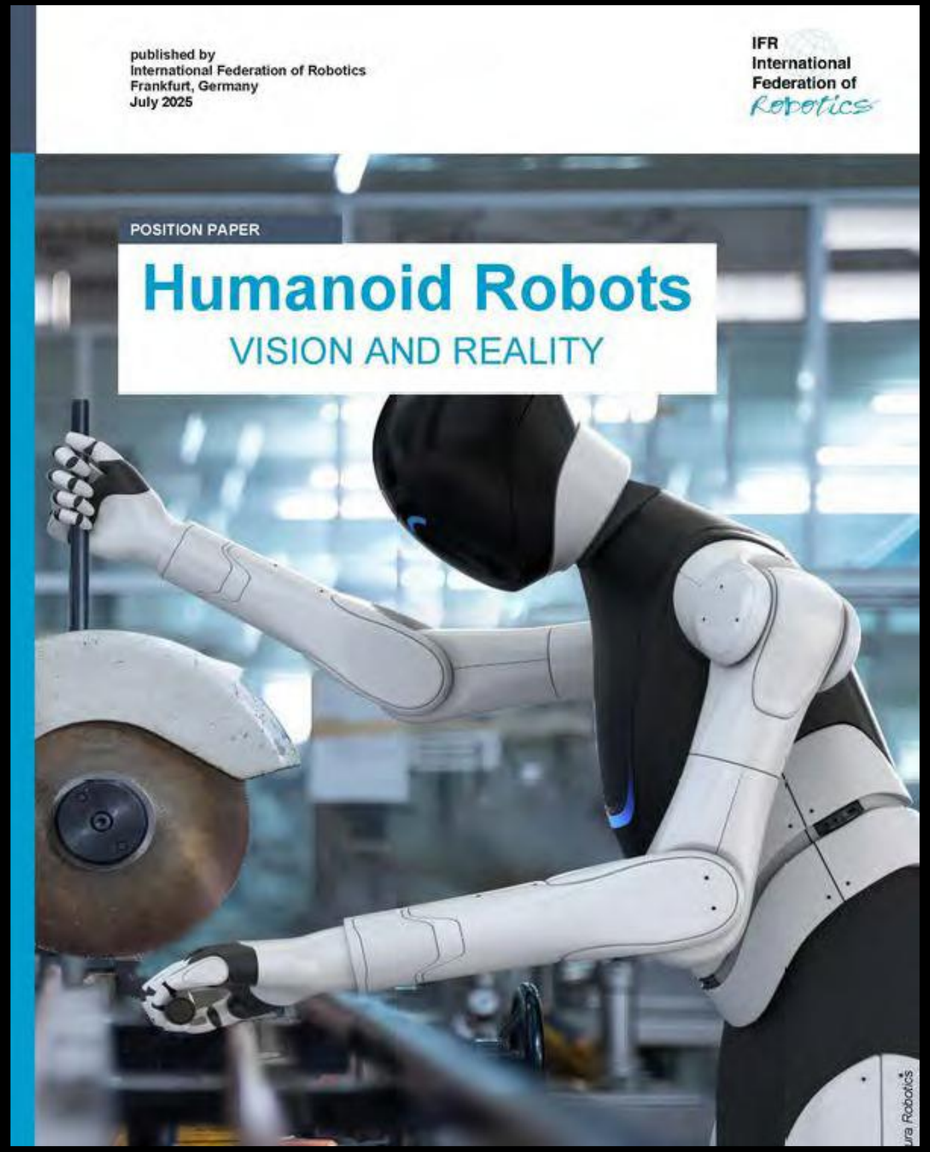
Diagnostics & Medical laboratory analysis

Image: ABB Robotics

+610%

Humanoid Robots

- ✓ *There is no massive use today but serial production in preparation*
- ✓ *Manufacturers are building humanoid robots for R&D purposes for several years and producing on demand*
- ✓ *New companies in the market do build humanoids at a demonstrator or prototype stadium for first trial applications*
- ✓ *Application fields of humanoids still have to be determined and proven in practice*



Outlook

- ✓ *Good growth market with excellent long-term prospects*
- ✓ *Key drivers: Demographic change and lack of skilled workers*
- ✓ *Investments are postponed due to uncertain global economic conditions*
- ✓ *RaaS business models lower adoption barriers considerably*
- ✓ *Trend towards multi-purpose service robots*

Pillars of Next Generation Robotics

The Factory, Reimagined

NDT, Autonomous

European Commission

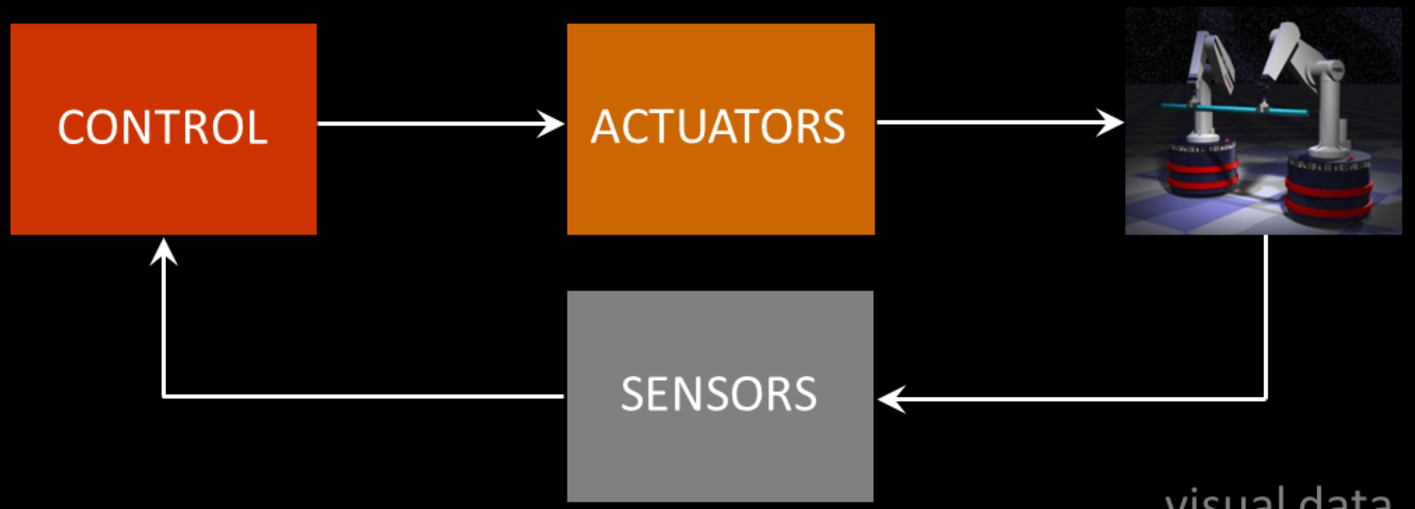
euROBIN

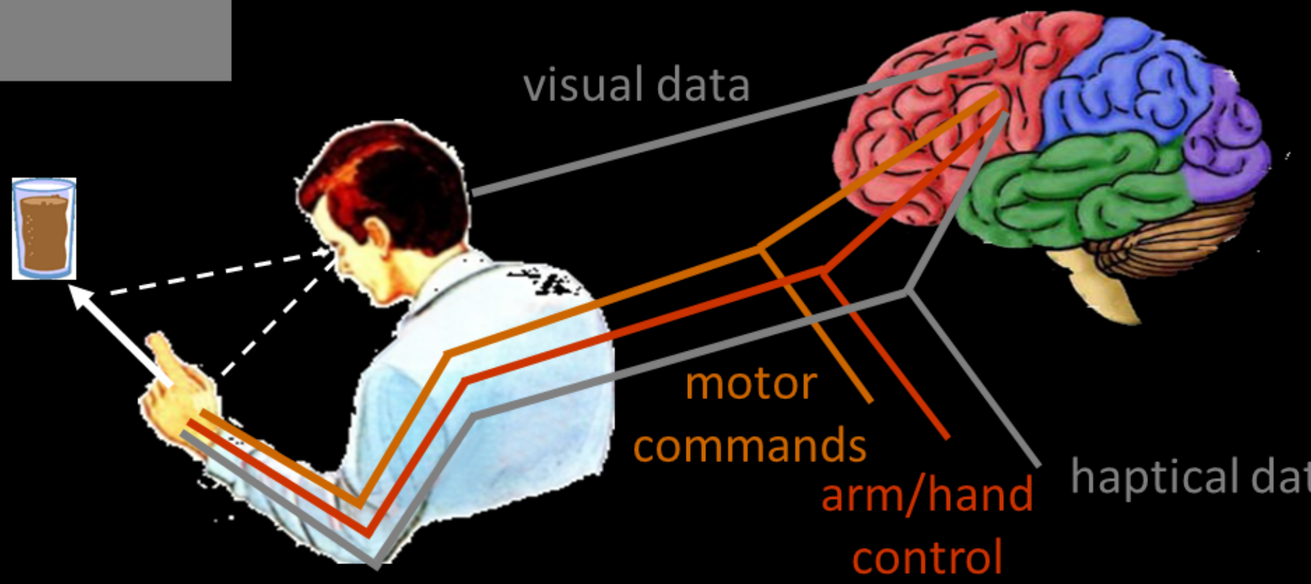
Healthcare, Revolutionized

Field Robots, Unthetered

Robotics

intelligent connection of perception to action





Artificial Intelligence

Cortical homunculus

Computers mimicking functions and logics of human mind

Body vs Mind

Embodiment

Manipulation

Cognition

Physical Artificial Intelligence

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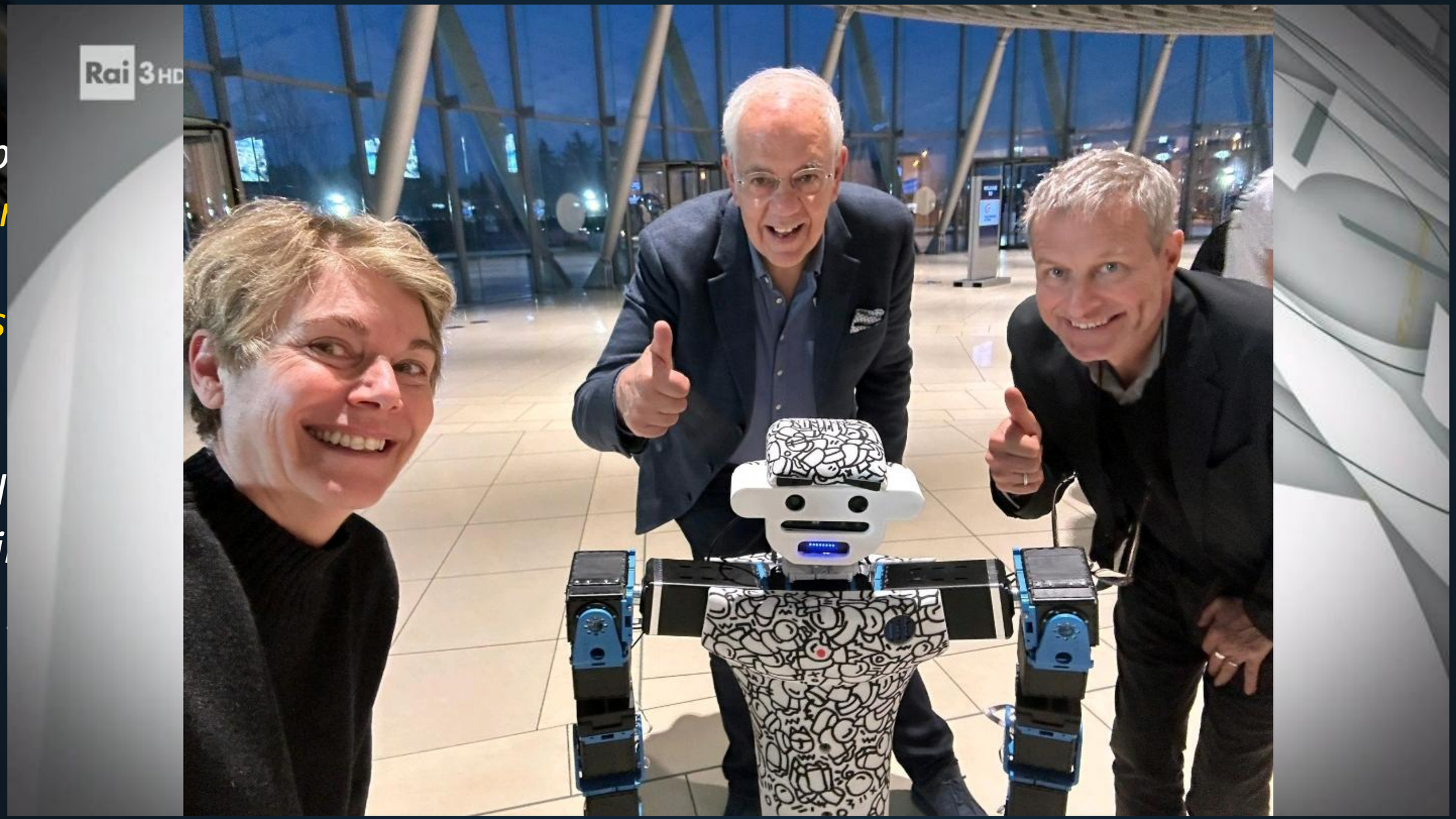
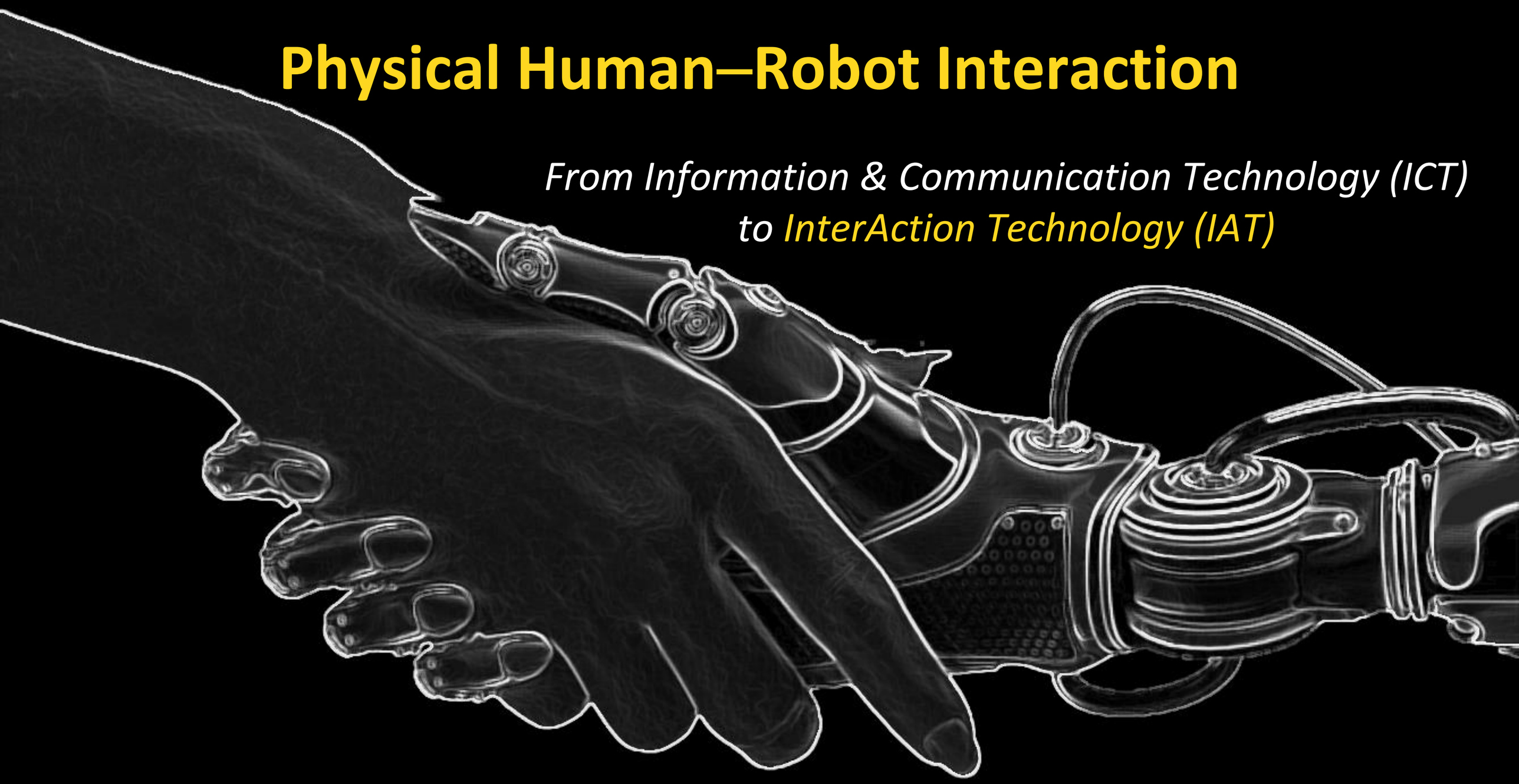


Physical Human–Robot Interaction

From Information & Communication Technology (ICT)
to InterAction Technology (IAT)

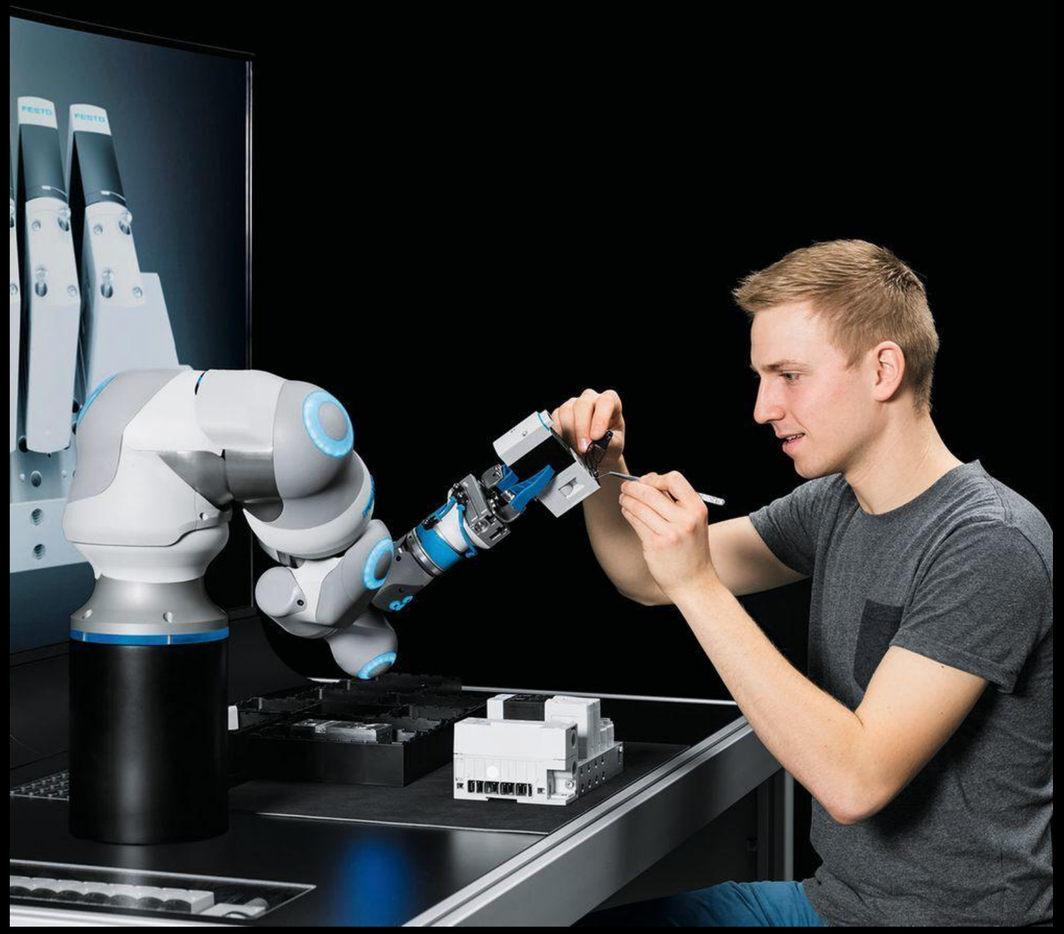


Nature Italy, Antonio Bicchi & Bruno Siciliano (2021)

Collaborative Automation

Collaborative robot (Cobot)

- ✓ *Usable safely in space shared with humans*
- ✓ *Special mechanics, exteroceptive sensors, advanced control system*
- ✓ *Intuitive programming and communication interface*
- ✓ *Fast setup, commissioning, and reconfiguration*
- ✓ *Digital twin to reduce time-to-market smart maintenance*
- ✓ *Low costs (<20k) and suitable for SMEs*

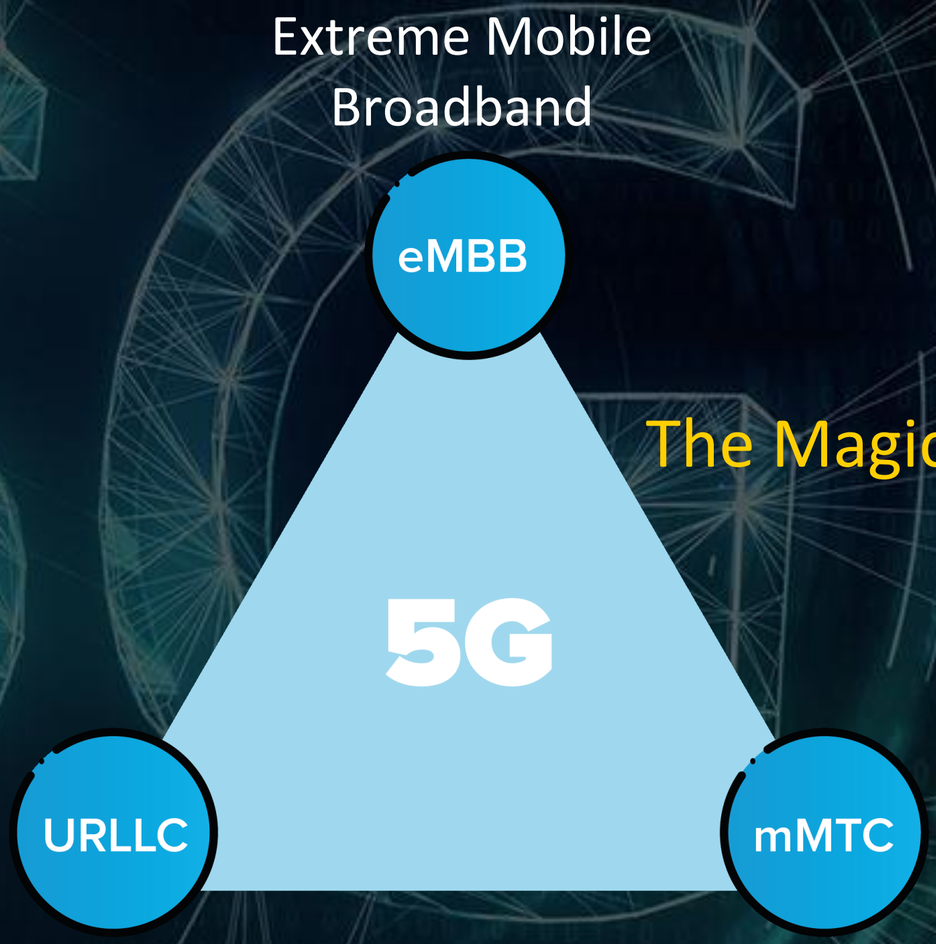


Fifth Generation of Wireless Technology

5G will pave the way for a new generation of robots

The vast computing and data storage resources of the cloud is exploited

Robots can be controlled dynamically in real time and be connected to people and machines locally and globally



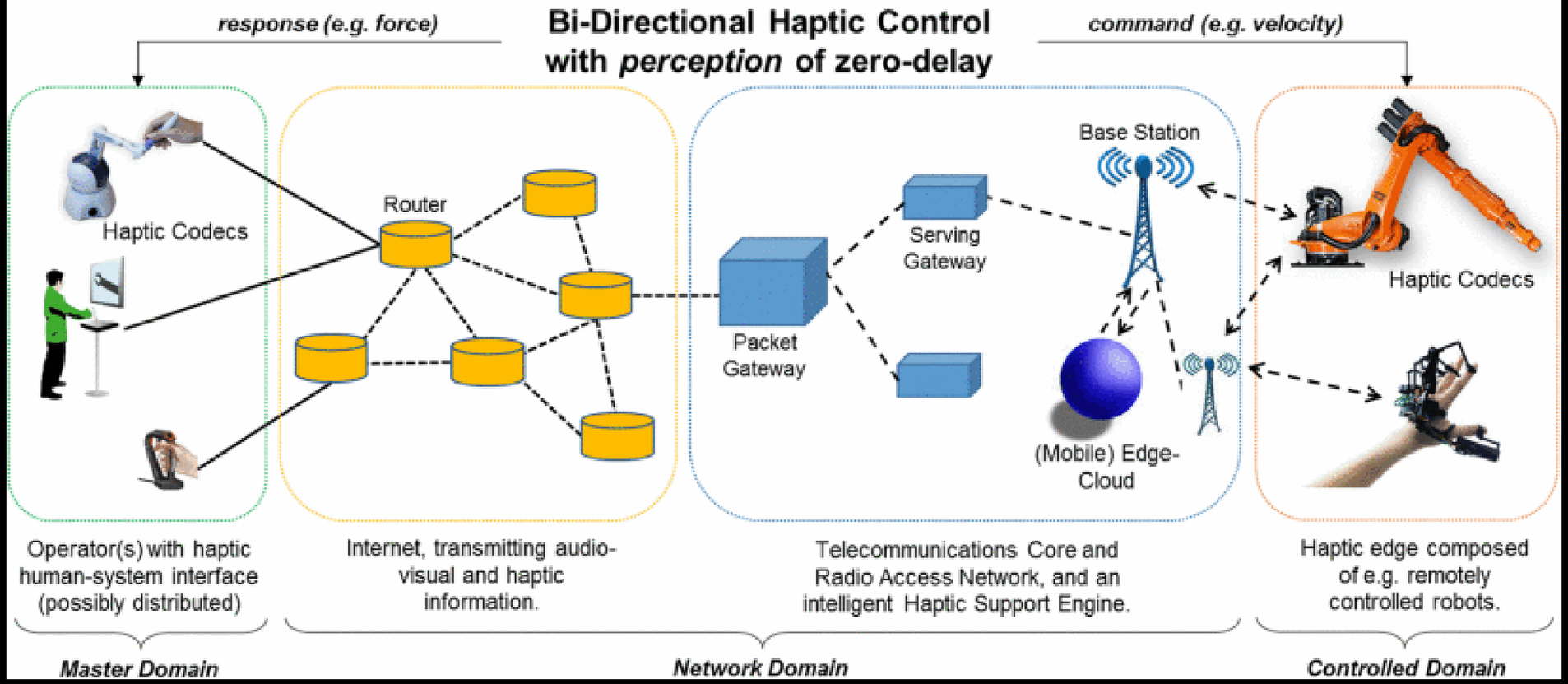
From IoT to IoS — The Phygital

1) **Ultra-Fast Networks** (Tactile Internet)

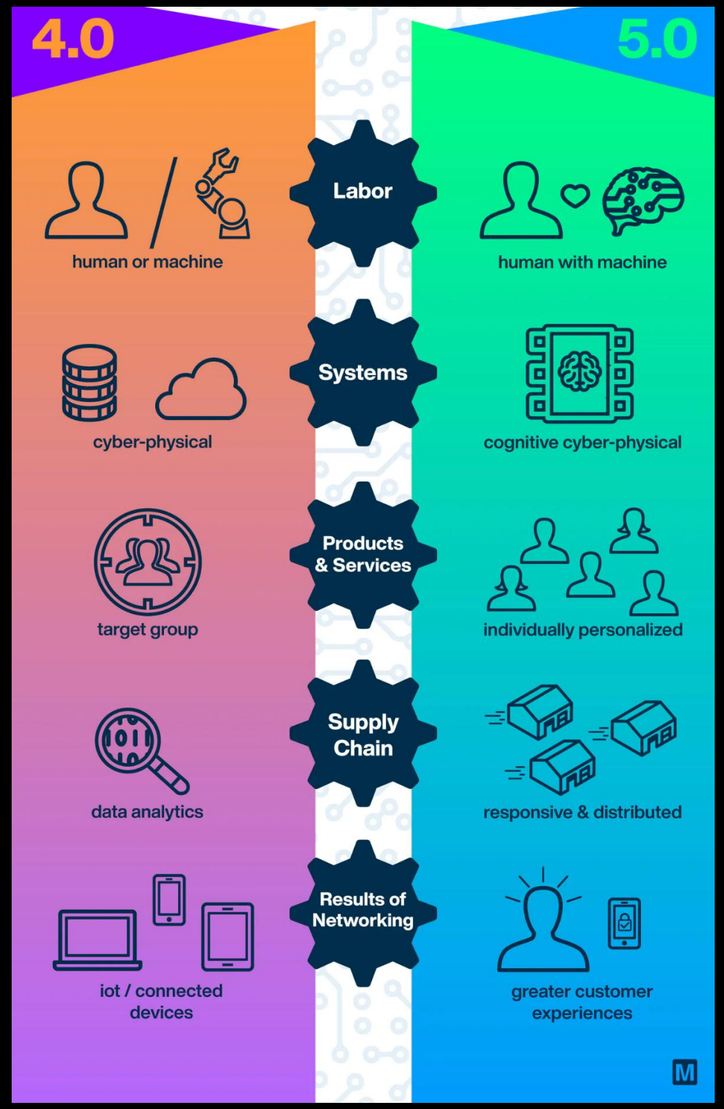
2) **Haptic Encoders** (both kinestaethic & tactile)

3) **Edge Artificial Intelligence** (to beat light-limit)

Core Technology Enablers of the "Internet of Skills"



AI & Robotics in Industry



AI, Robotics & Sustainability

Better use of Robotics and AI could result in an impressive reduction of 853 million metric tons (MMT) annually, equivalent to 18% of US CO2 emissions (CO2e), or eliminating more than half (64%) of the gas-powered vehicles on the road

Through robotics-enabled digitization, the following reductions could be achieved by 2030:

- ✓ *Oil & Gas Pipelines: 556 MMT CO2e*
- ✓ *Baseload Power Plant Reliability: 230 MMT CO2e*
- ✓ *Pulp & Paper Manufacturing: 46 MMT CO2e*
- ✓ *Maritime Transportation: 11 MMT CO2e*
- ✓ *Bridge Inspection & Maintenance: 10 MMT CO2e*

Human Augmentation

Wearable robots: Exoskeletons

- ✓ *Composed by a frame fitted with (motorised) muscles supporting parts of the human body*
- ✓ *Allow multiplying the strength of its user's or redistributing the weight*
- ✓ *Enable workers to carry out a variety of industrial tasks*
- ✓ *Protect workers from the heavy physical workload, repetitive movements and non-ergonomic postures*

arm support

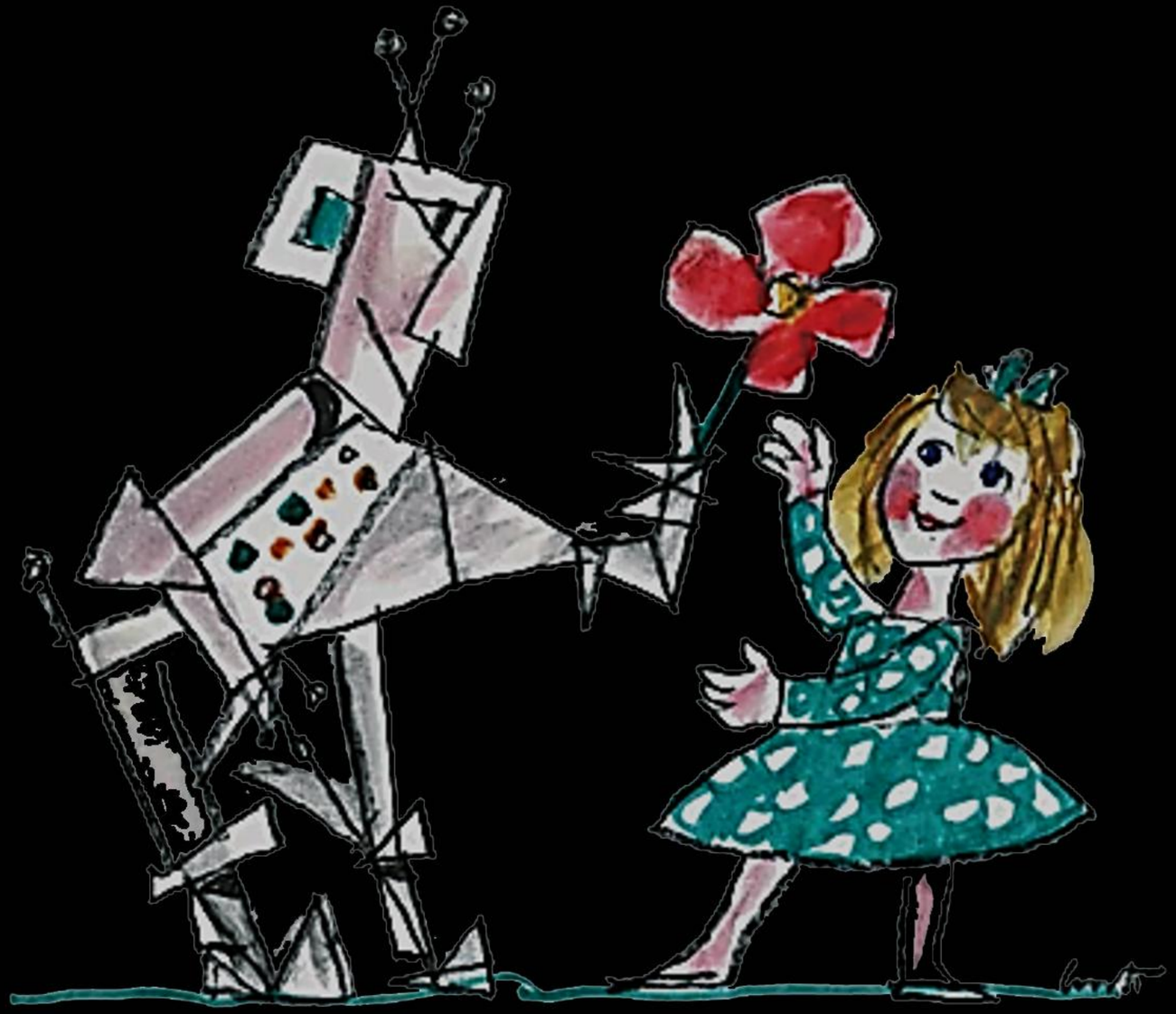
back support

legs support

tool holding

https://exoskeletonreport.com

Ethics and Safety in Augmentative Technologies



Ethical, legal, societal and economic (ELSE) issues for design, construction and use of robots

Cohabitation of humans with robots

The augmented human becomes surveilled (biometric data, continuous tracking)

With wearable technologies the body becomes a password that makes our physical identity accessible to anyone

From Research to Market

Sandwich effect

Europe crushed between two strong and aggressive innovation models:

- ✓ *the American entrepreneurial one, oriented towards business risk and concentration of large capitals*
- ✓ *the Chinese governmental one, boosting a rapid acceleration in terms of investments and technological strategies*

Europe continues to recognize the centrality of the individual as bearer of unique values, sensibility and skills. We should invest with conviction in the ability to integrate AI & robotics technology with human intelligence

Towards a Technological Humanism

«In effetti l'uomo si dimostra essere cosa divina perché dove la natura finisce di produrre le sue spetie l'uomo quivi comincia colle cose naturali a fare coll'aiutorio d'essa natura infinite spetie»

Leonardo da Vinci

«A distanza di 100 anni dall'ingresso della parola robot nel nostro lessico, la sfida e allo stesso tempo l'opportunità che il mondo della ricerca dovrà rappresentare è relativa a futuri scenari in cui la robotica diventerà un mezzo interattivo per contribuire a migliorare le condizioni di vita. In questa visione, la rivoluzione dei robot potrà aiutarci a riaffermare la caratteristica meno artificiale del nostro mondo: la nostra umanità»

Atlante Treccani, Bruno Siciliano (2020)

Robotics Goes PRISMA


keep the gradient j-)