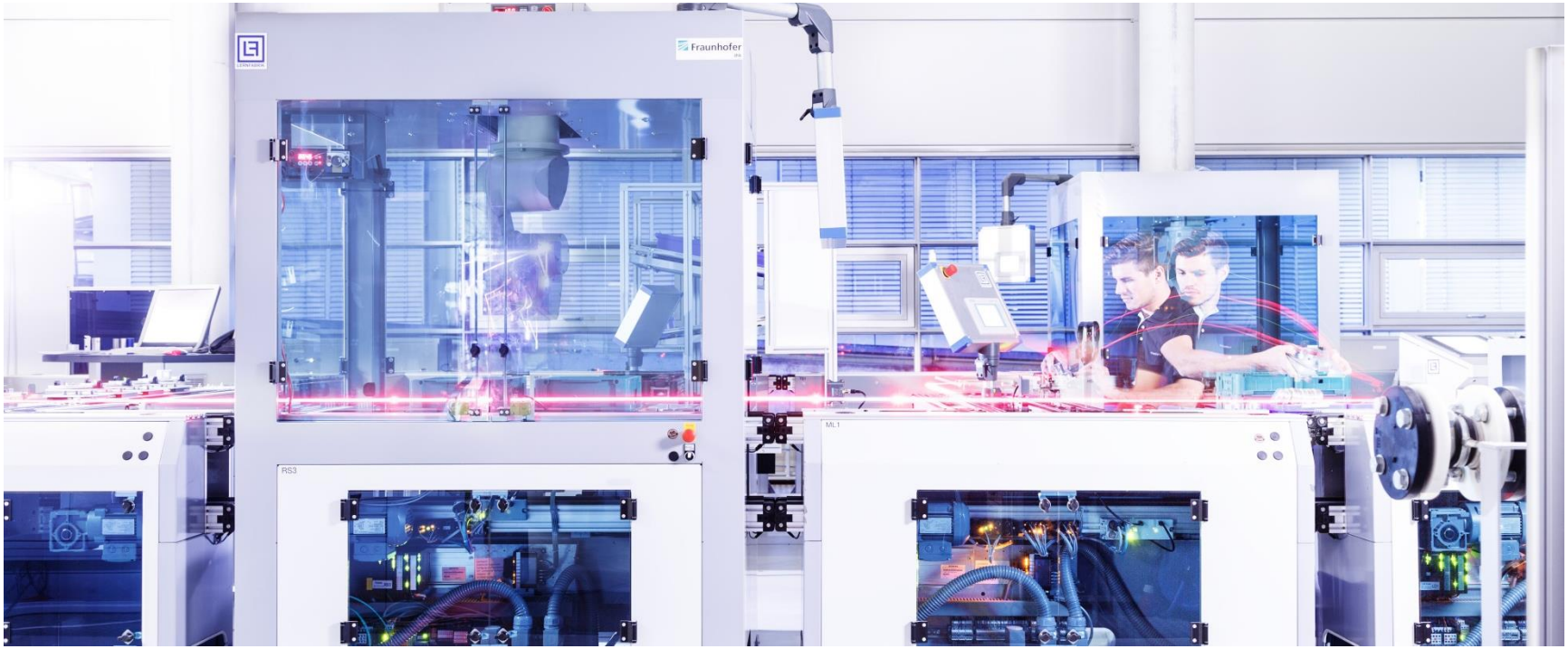
BIG DATA DISRUPTIONS: HOW INDUSTRIE 4.0 WILL IMPACT INDUSTRIAL ROBOTICS

Prof. Dr.-Ing. Thomas Bauernhansl
March 4, 2015



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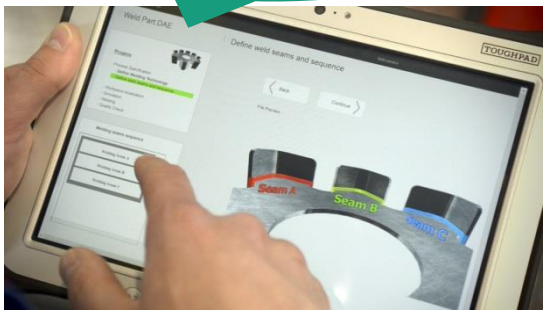
Fraunhofer Institute for Manufacturing Engineering and Automation IPA in Stuttgart

- 60 mil Euro total budget
- 22.3 mil industrial revenue
- more than 1,000 employees
- Business Units
  - Automotive
  - Machinery and Equipment Industry
  - Power Industry
  - Electronics and Microsystems
  - Medical Engineering and Biotechnology
  - Process Industry
- Research Highlights
  - ARENA2036
  - Virtual Fort Knox
  - Fast Storage BW
  - Care-O-bot® 4

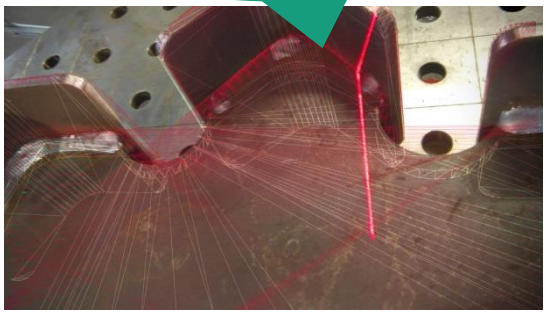
Robots: The Tomorrow Tool for Personalized Productions

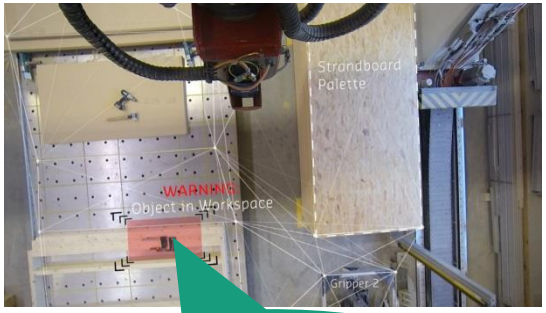
Cost efficient

CAD-support, planning tools

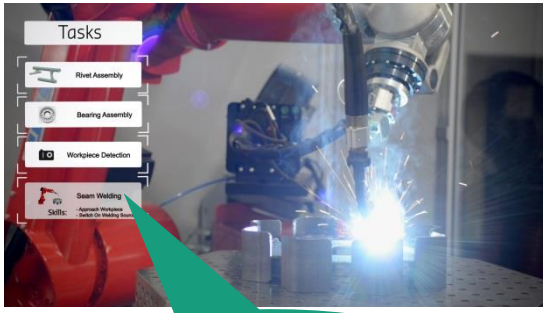


Reaction to uncertainties





Cognition



Skills

Handle exceptions

Source: video.smerobotics.org, "SMErobotics in 100 seconds"

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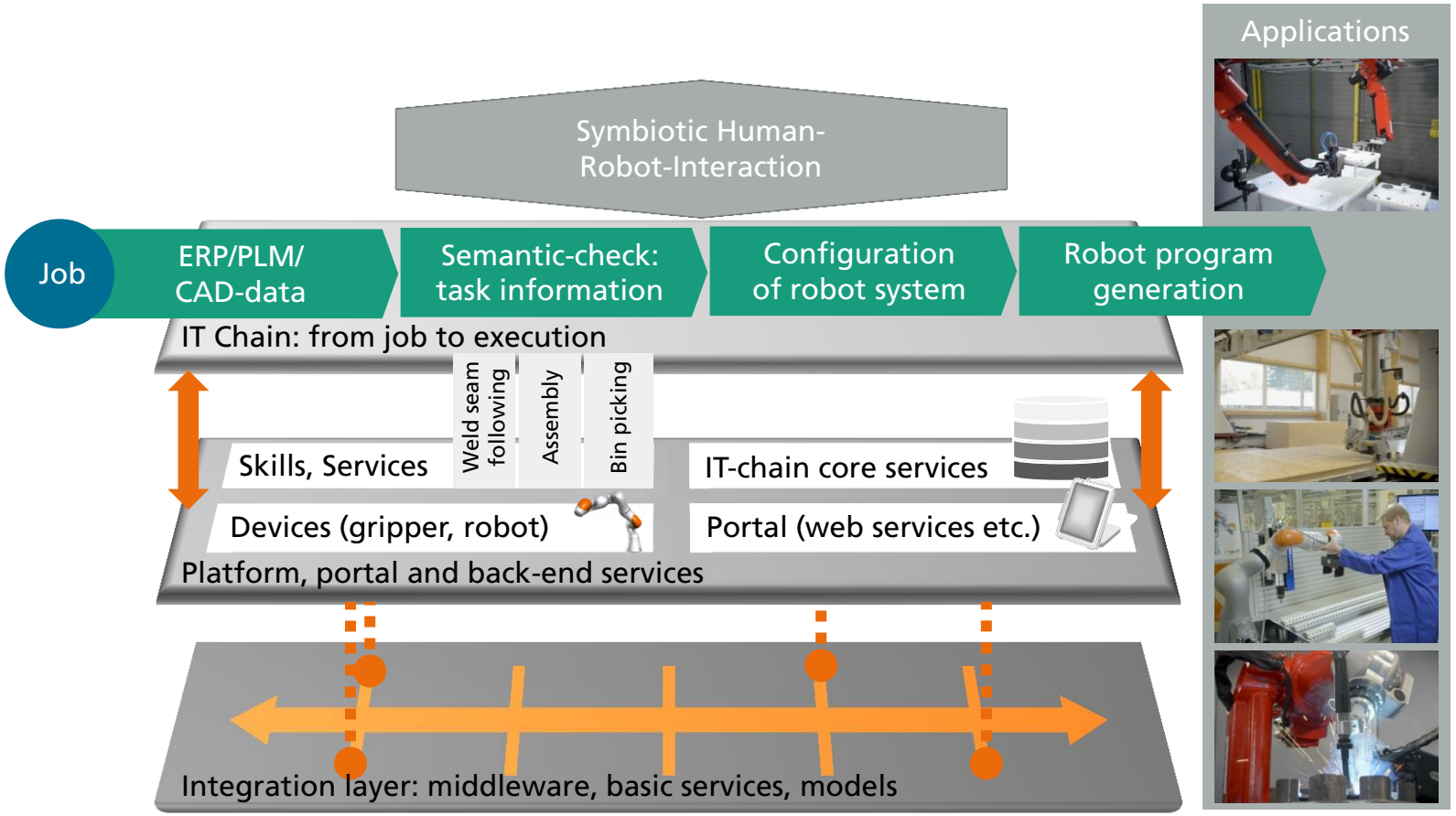
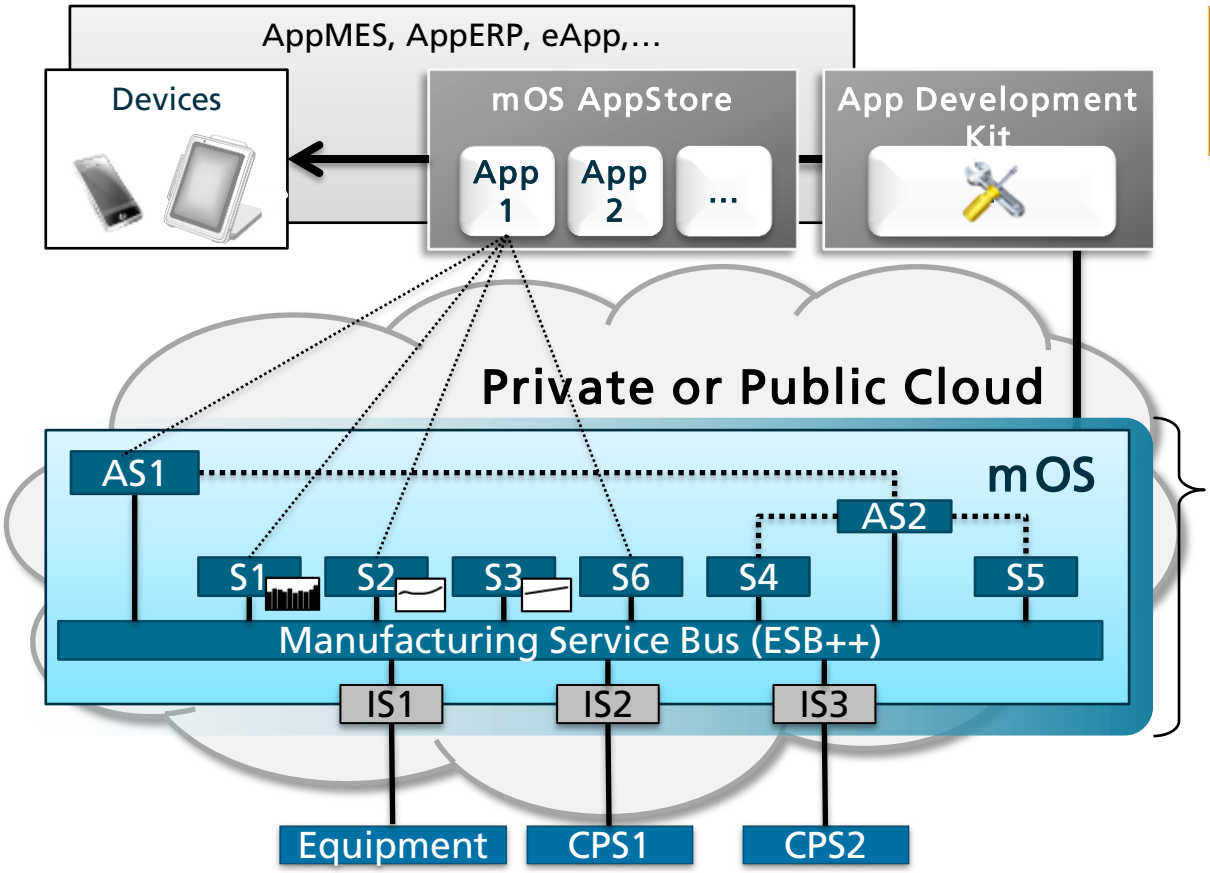
Robotics “IT-Chain“ – From Job to Execution in small lots…



… or generally: Industrie 4.0 – “Everything as a Service”



VIRTUAL FORT KNOX

SOA, WS

Legend:

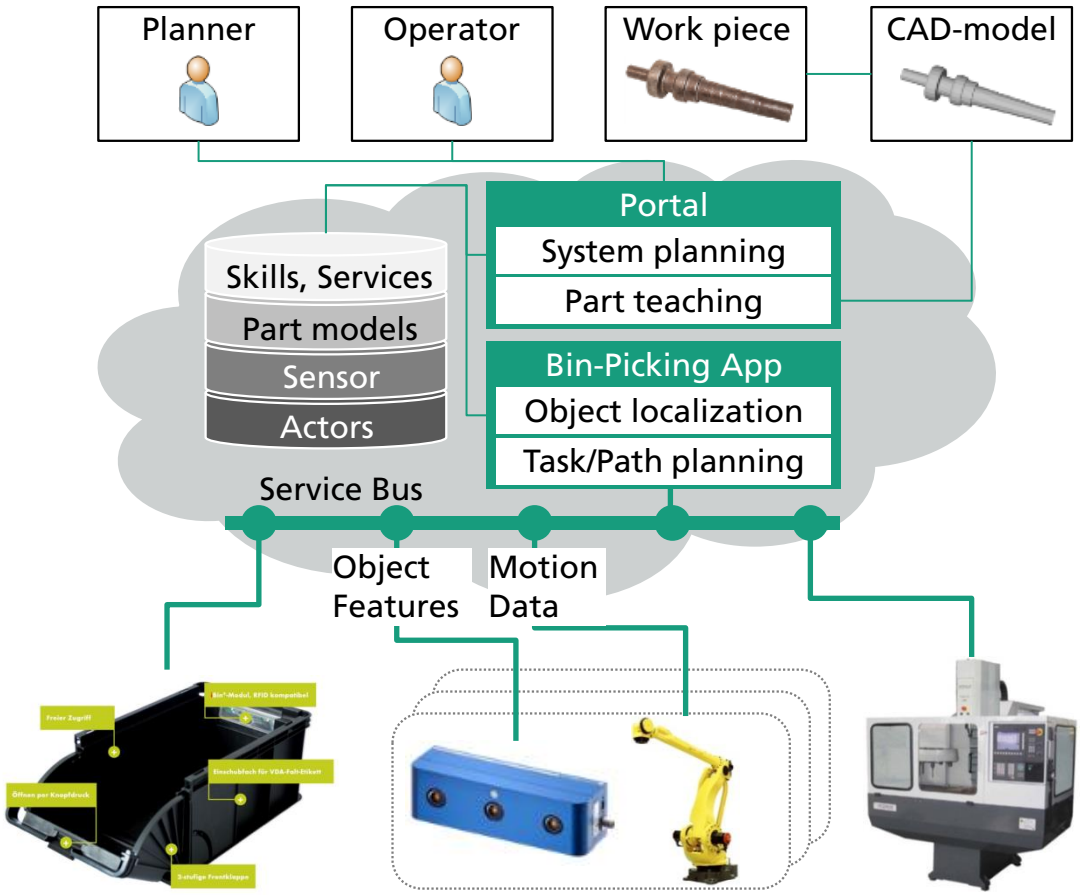
S	Service
AS	Aggregated Service
IS	Integration Service
CS	Cloud Service
CPS	Cyber-Physical-System
mOS	Manufacturing Operating System

Example 1: What if Bin-picking came out of the Cloud?

Advantage

- externalization of skills, services, maintenance
- lean robot workcell ("Lean Client")
- centralized collection of data
  - optimization by statistical learning
- best practice solutions accessible

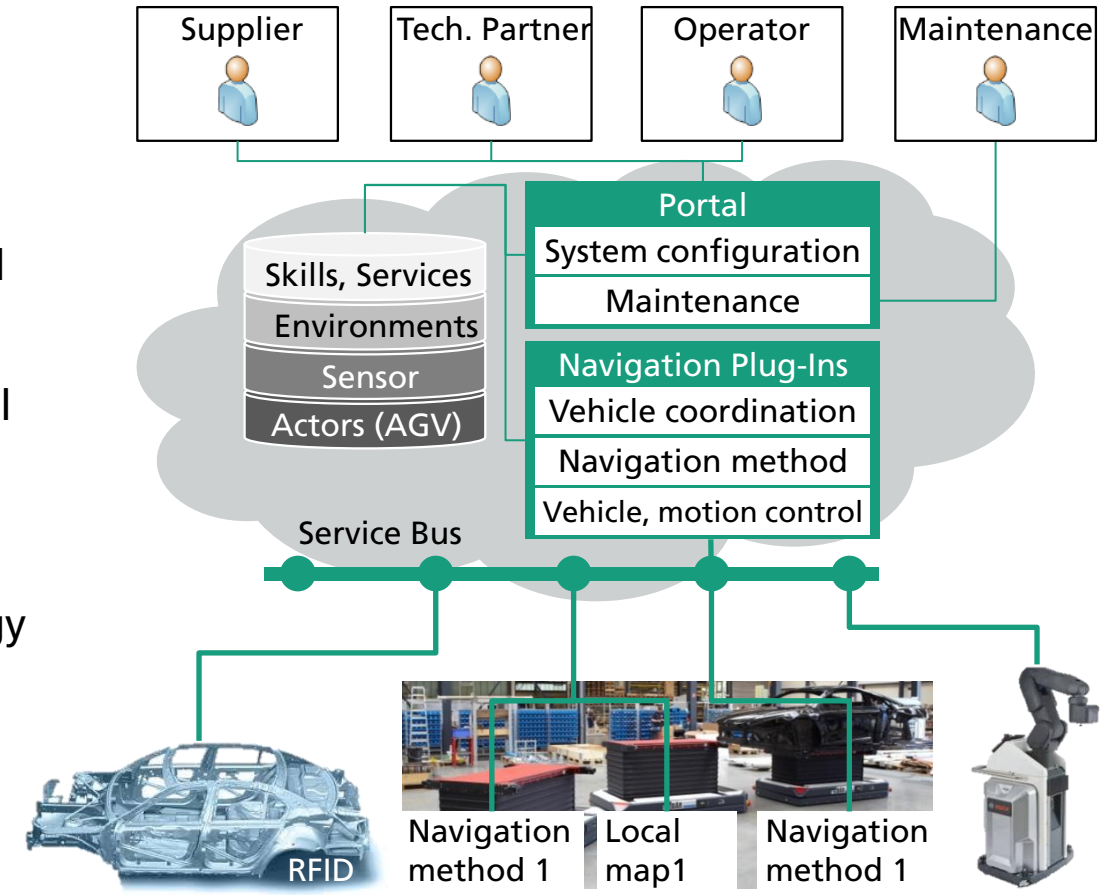
to be displayed at HMI2015



Example 2: What if there was a AGV Cloud Navigation?

Advantage

- logistics: centralized vehicle coordination (as is today)
- "Lean Client" AGVs; Navigation skills on demand
- centralized data collection
  - optimization by statistical learning (adaption of skills, condition monitoring)
- partnerships with technology providers, external services



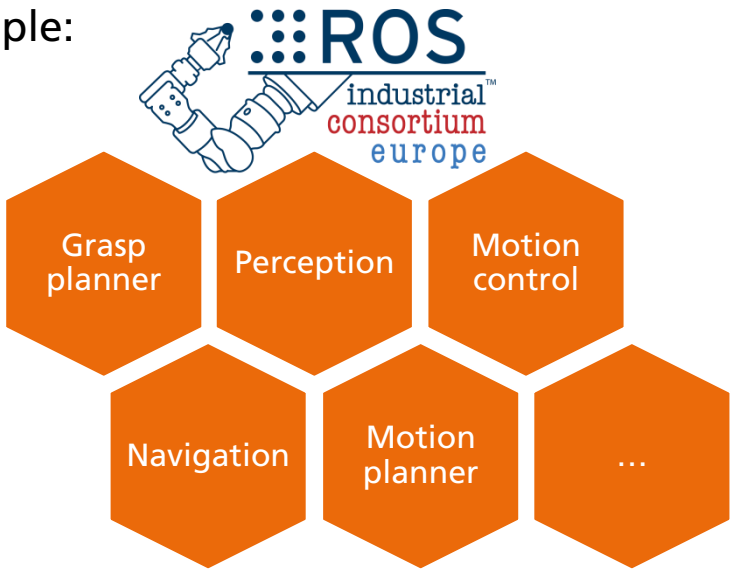
under development

Open Source as an Enabler in Industrial Robotics

Why open source in robotics?

- more than 2 mil Free/Libre Open Source Software packages (FOSS) available
- robotics research packaged and transferred in SW components access technology push
- increase in critical mass, quality, portability etc.
- supports business models particularly for SMEs
- "Rapid prototyping" of technology
- cost benefits 1/3 vs. "from scratch"–efforts[1]

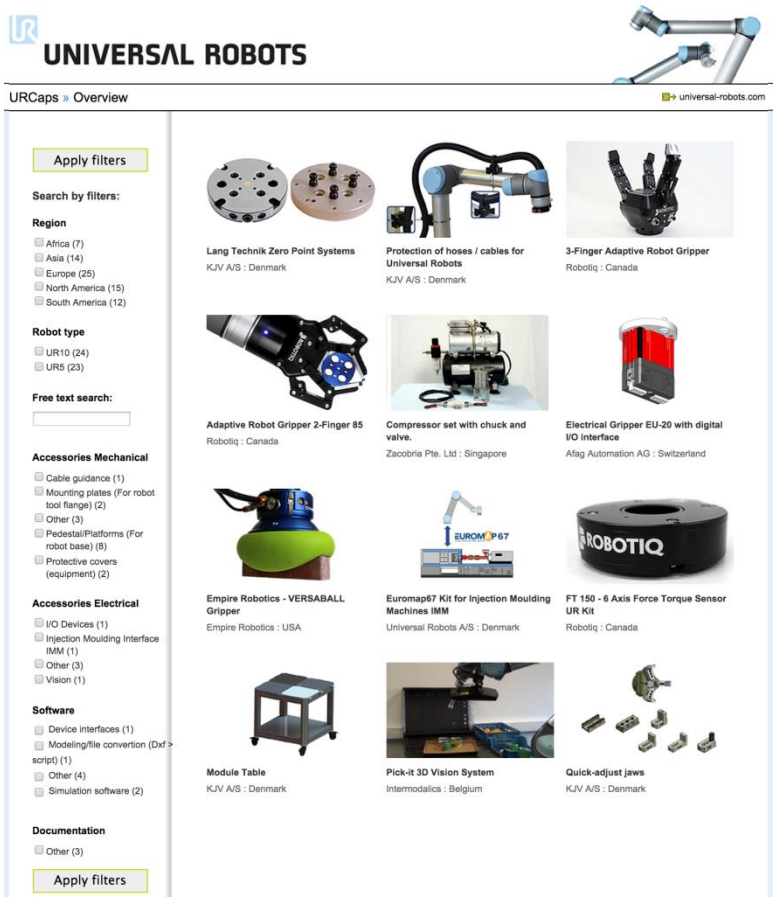
Example:



Sources: [1]N. Blümlein: Function-based System Engineering for Service Robot Prototypes (Diss Uni Stuttgart, 2013); [2]2014 Black Duck Software, Inc

Ecosystem for robotic applications
Example: URCaps

- universal Robots app store for robots
- online platform features useful accessories, hardware and software extending the capabilities
- URCaps is a platform where distributors and integrators can present accessories that run successfully at end users and are dedicated to UR robots.



Source: urcaps.com

Be part of it.

Source: youtube.com

Synergetic Link between physical and virtual Platforms are Core for service-oriented Business Models

Example: Google Project Ara

Project Ara

- modular smartphone concept
- marketing starts 2015
- endoskeleton (“endo”) is the base for the integration of all other modules
- modules such as antennas will be produced through 3D-printing

Ara Module Marketplace

- central marketing platform as Google online-store
- sale of Ara modules of hardware partners via Google
- requirement for licensing:
  - fulfillment of Google hardware specifications (MDK)
  - administrative permissions of target markets

Source: heisse.de

XaaS – Everything as a Service

Integrated service-orientation leads to new value-adding Structures

Everything as a Service (XaaS)

	Tasks	Examples
Value as a Service (VaaS)	■ personalized end to end services meeting user's needs (e.g. mobility, health)	■ Logistic as a Service (Amazon) ■ Mobility as a Service (Daimler) ■ Assembly as a Service (Foxconn)
Modules as a Service (MaaS)	■ open hardware and software modules for developing personalized services	■ Ara modules (Google) ■ Apps (Runtastic) ■ cars (Local Motors)
Platform as a Service (PaaS)	■ life cycle environment & communication for economic availability of software and hardware modules	■ App Store (Apple) ■ production platform (emachineshop) ■ Virtual Fort Knox (FhG) ■ home applications (First built)
Infrastructure as a Service (IaaS)	■ infrastructure services as base for platforms and for the application of modules	■ Cloud Infrastructure (IBM) ■ mobile Communication (Telekom) ■ electric network (ENBW)

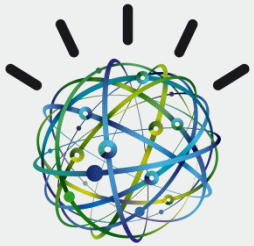
The Base: Processing power and connectivity

Moore and Metalcafe are proven right and define the Scope and Value of an Enterprise

Connectivity

Metcalfe:

"The benefit of a communication system increases with the square of the number of participants."



Performance

Moore:

"Computer performance doubles every 18 months."

Ecosystems for smart business models

Transparency

- Cyber-physical systems
- Internet of Things and Services
- Real time & at run time
- Everything as a Service

Knowledge

Sources of pictures: wikipedia.de, ibm.com, abcnews.com

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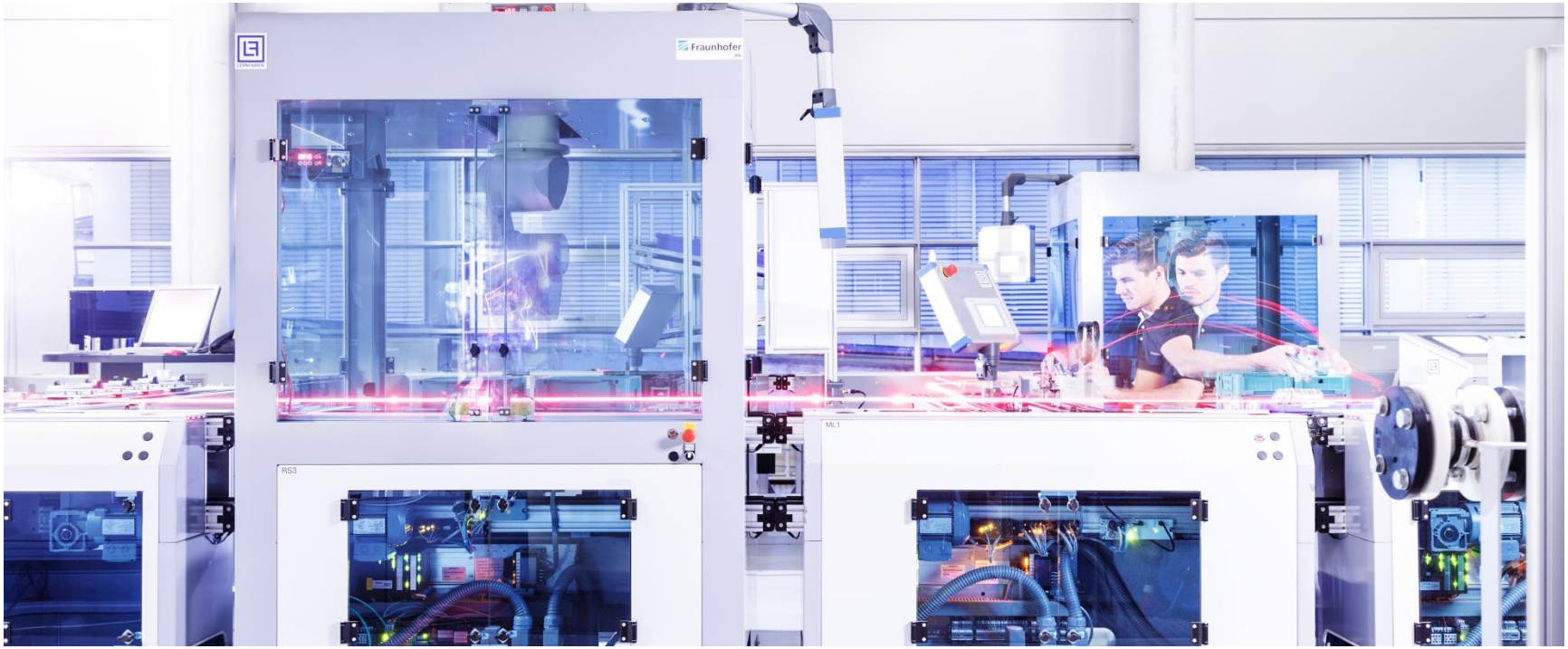

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