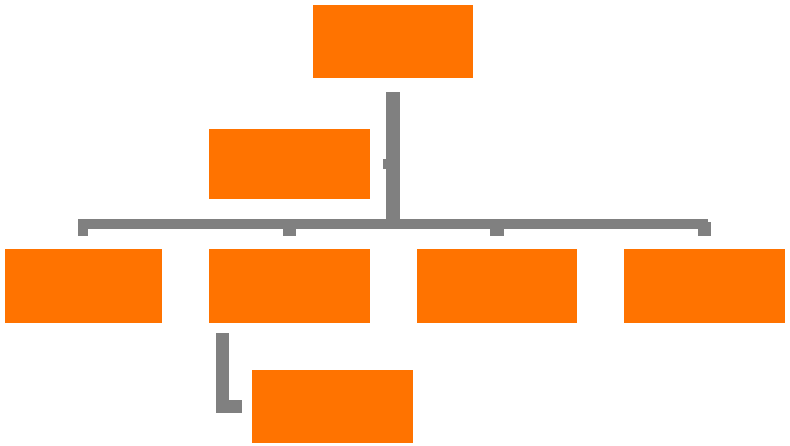

KUKA

LEAN 4.0
Wie Lean Production durch Industrie 4.0 weiter verbessert werden kann

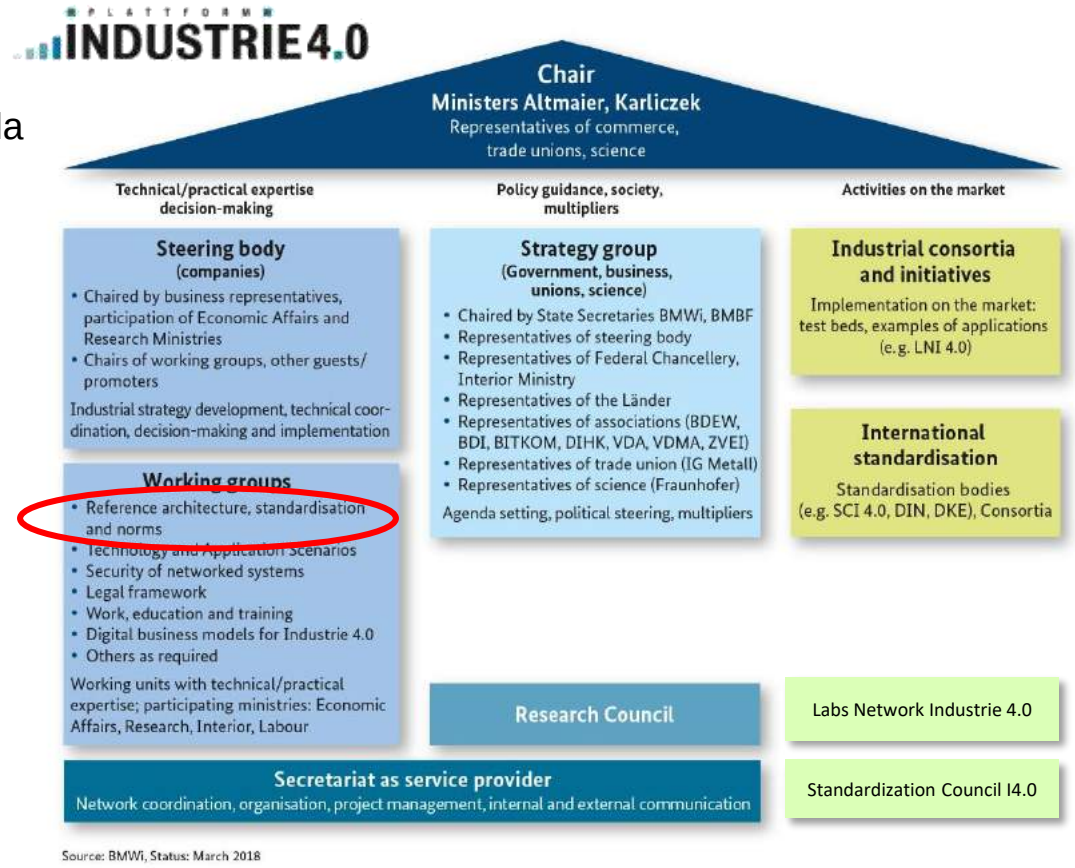


Heinrich.Munz@KUKA.com
Lead Architect Industry 4.0

Strategic Technical Consultant

Industry 4.0 was invented in Germany

- Industry 4.0 is one of ten „Future Projects" of the German Government
  - 1000 Mio. € grants
  - Controlled by the German Government
    - Supervised by Chancellor Angela Merkel (visited KUKA in 03/15)
    - Minister for Economic Affairs & Energy Altmaier
    - Minister for Education & Research Karliczek
  - KUKA is a member of the "Reference Architecture and Standard-ization" working group (Heinrich Munz)



KUKA Robotic Product Portfolio

Robots for payloads from 3 to 1.300 kg

Light Weight Robot (LWR)
„IIWA“
for Human Robot Collaboration (HRC)

Small robots „Agilus“

Low payload

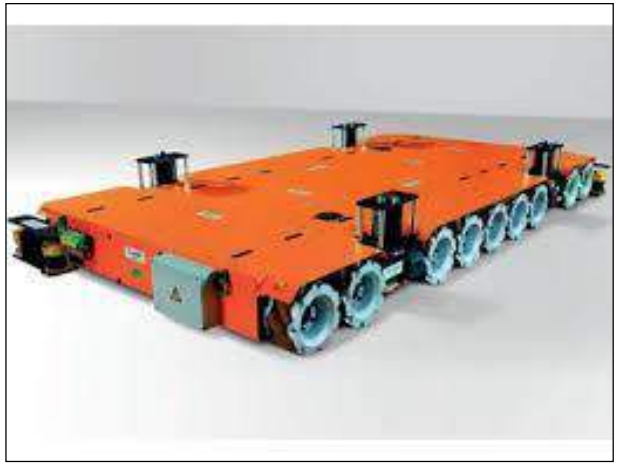
Middle payload

High payload

Highest payload „Titan“

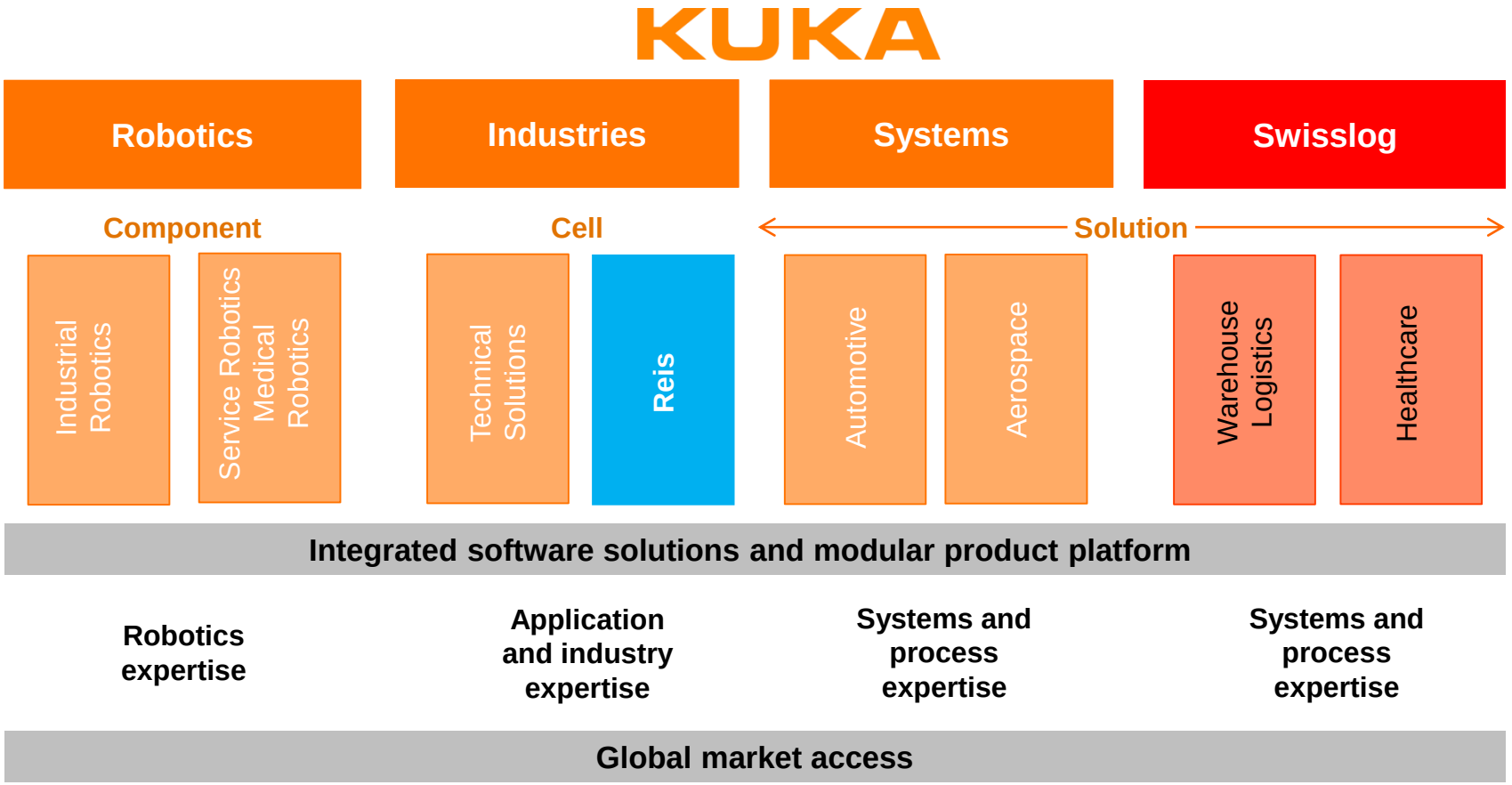
Special mechanics

KUKA Mobile Products

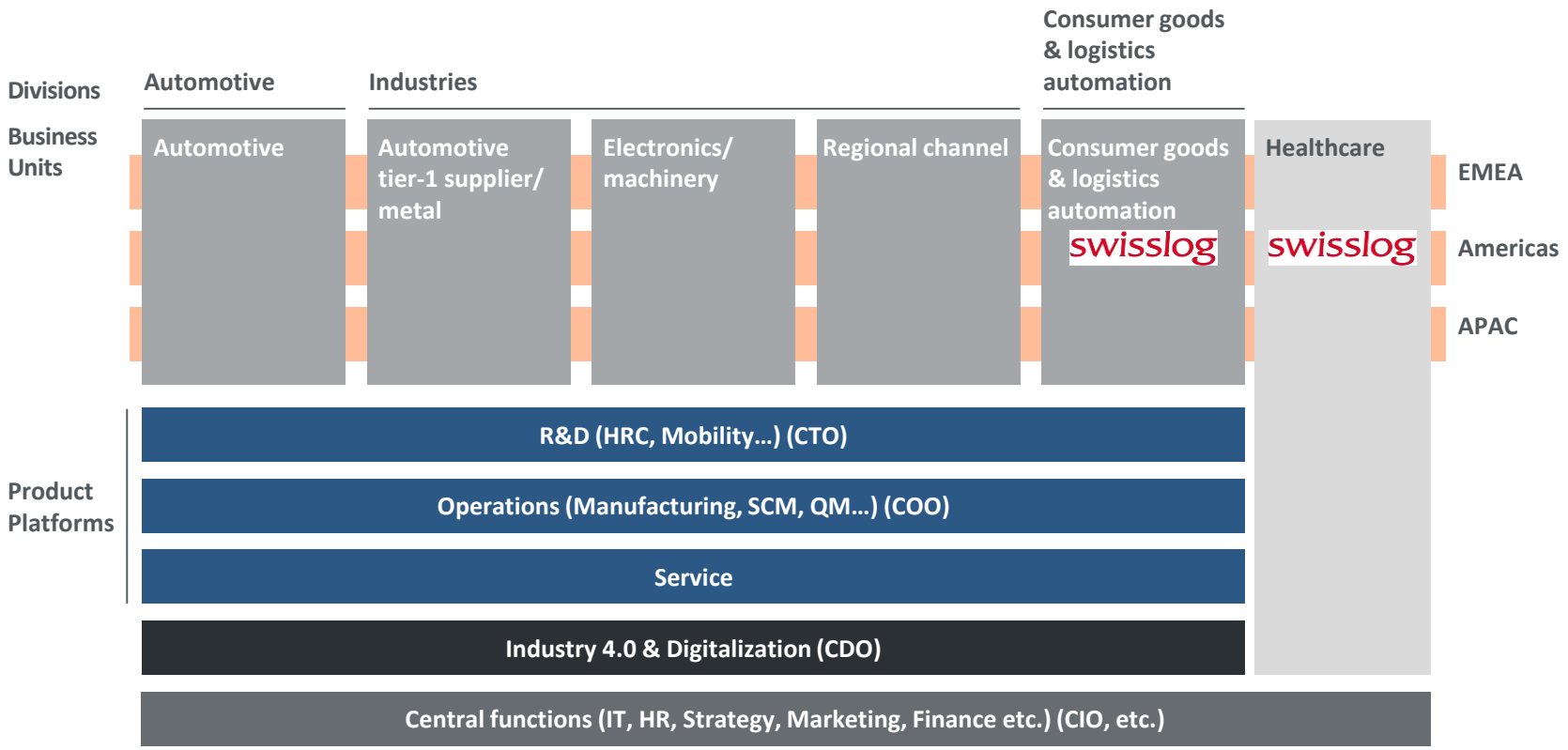


- Mobile products, machines and tools are a very important part of Industry 4.0

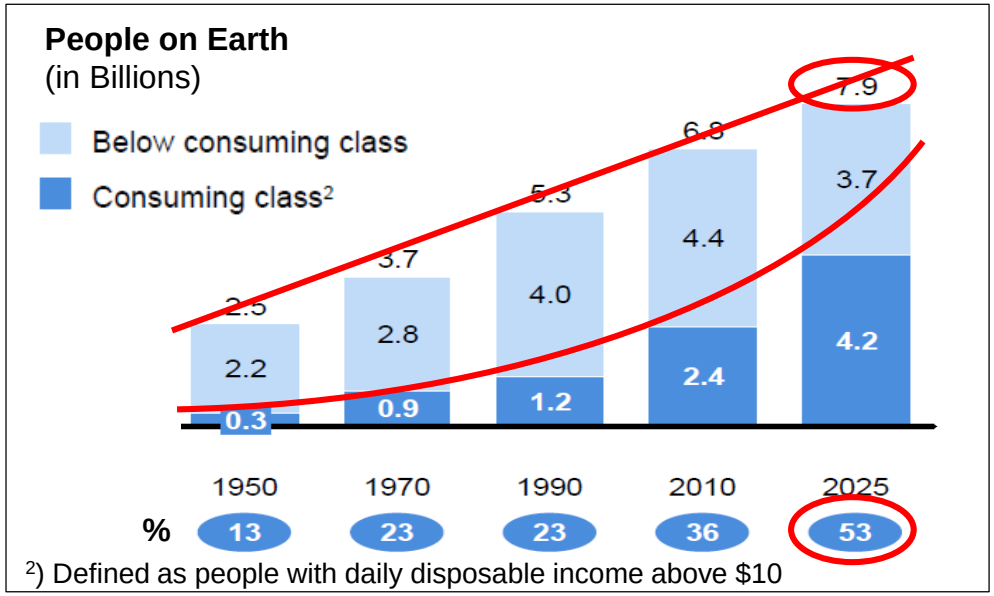
The KUKA Group (old)



The KUKA Group (new) : Customer Centric Organization (CCO)

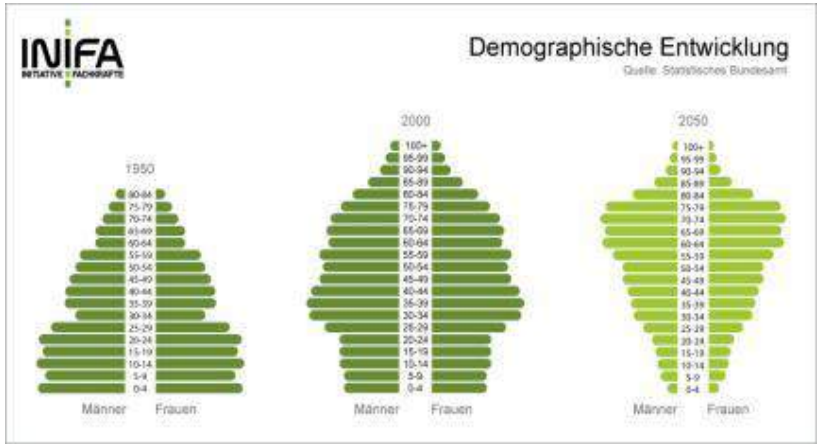


Why Industry 4.0? Challenges of the future



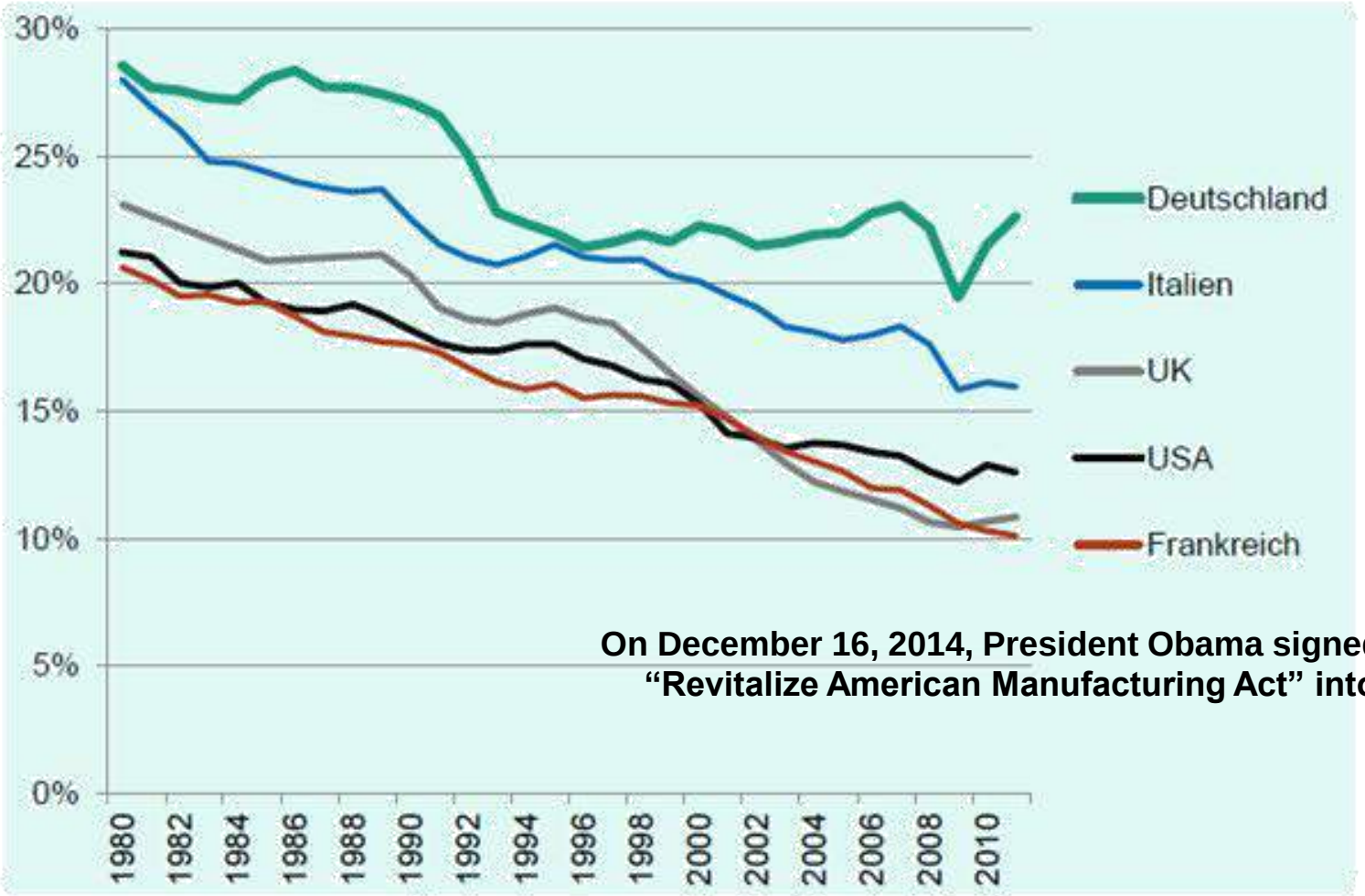
²) Defined as people with daily disposable income above $10

Source: McKinsey: Urban world: Cities and the rise of the consuming class



- In 2025 there are ~8 Billion people on earth, >half of them in the „Consumer-Class“
- People are getting older, in Germany we are getting less
- Consequences for Germany: Keep automated manufacturing in Germany, export products, export manufacturing technologies and manufacturing know how
- Robots and other machines as assistant systems for humans (Human Robot Coop.)
- Information sources and decision helpers through IT-systems like Smart Devices

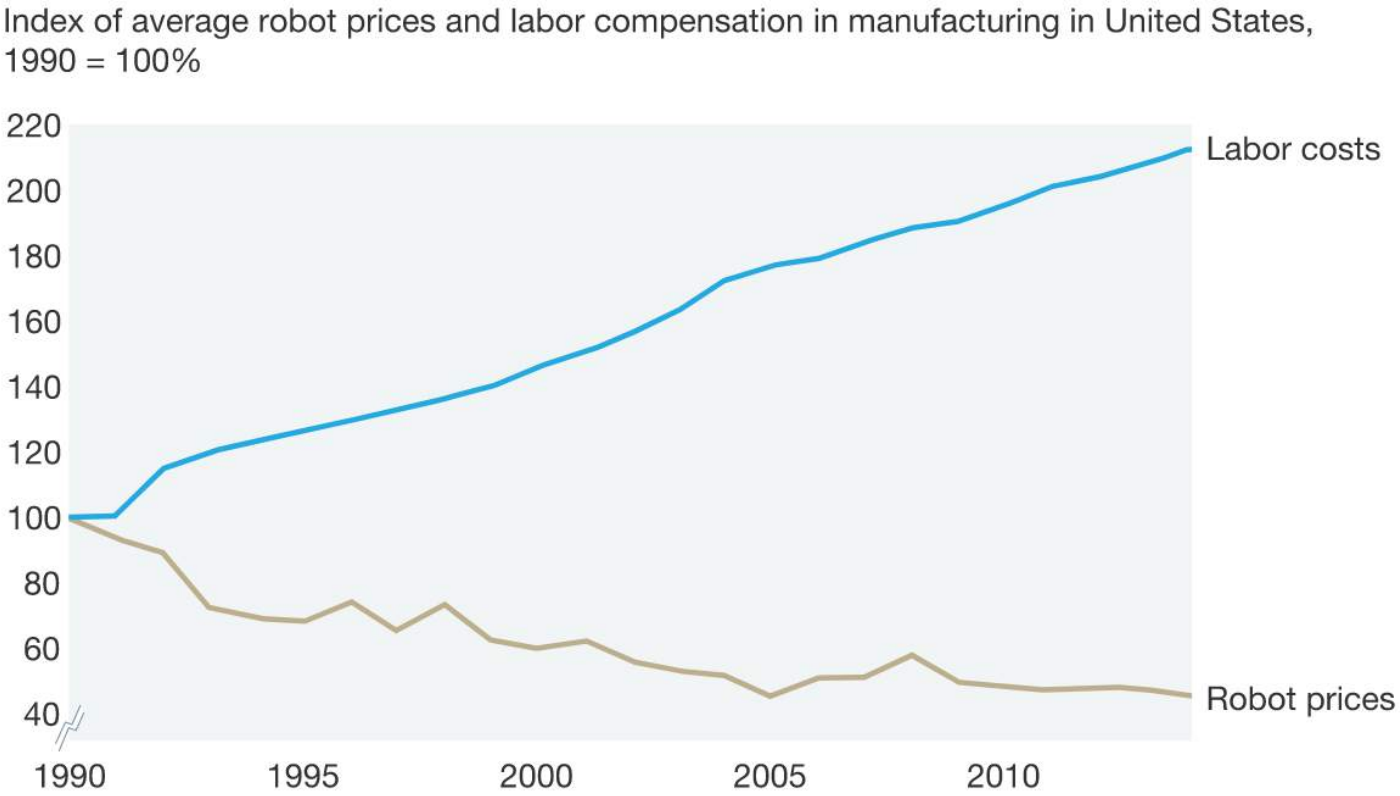
Why Industry 4.0? Countries must Revitalize Manufacturing



On December 16, 2014, President Obama signed the "Revitalize American Manufacturing Act" into law

Quelle: UNData: Gross Value Added Manufacturing/Total Gross Value Added

Why Industry 4.0? Big Price drop on Industrial Robots ➔ Full Automation

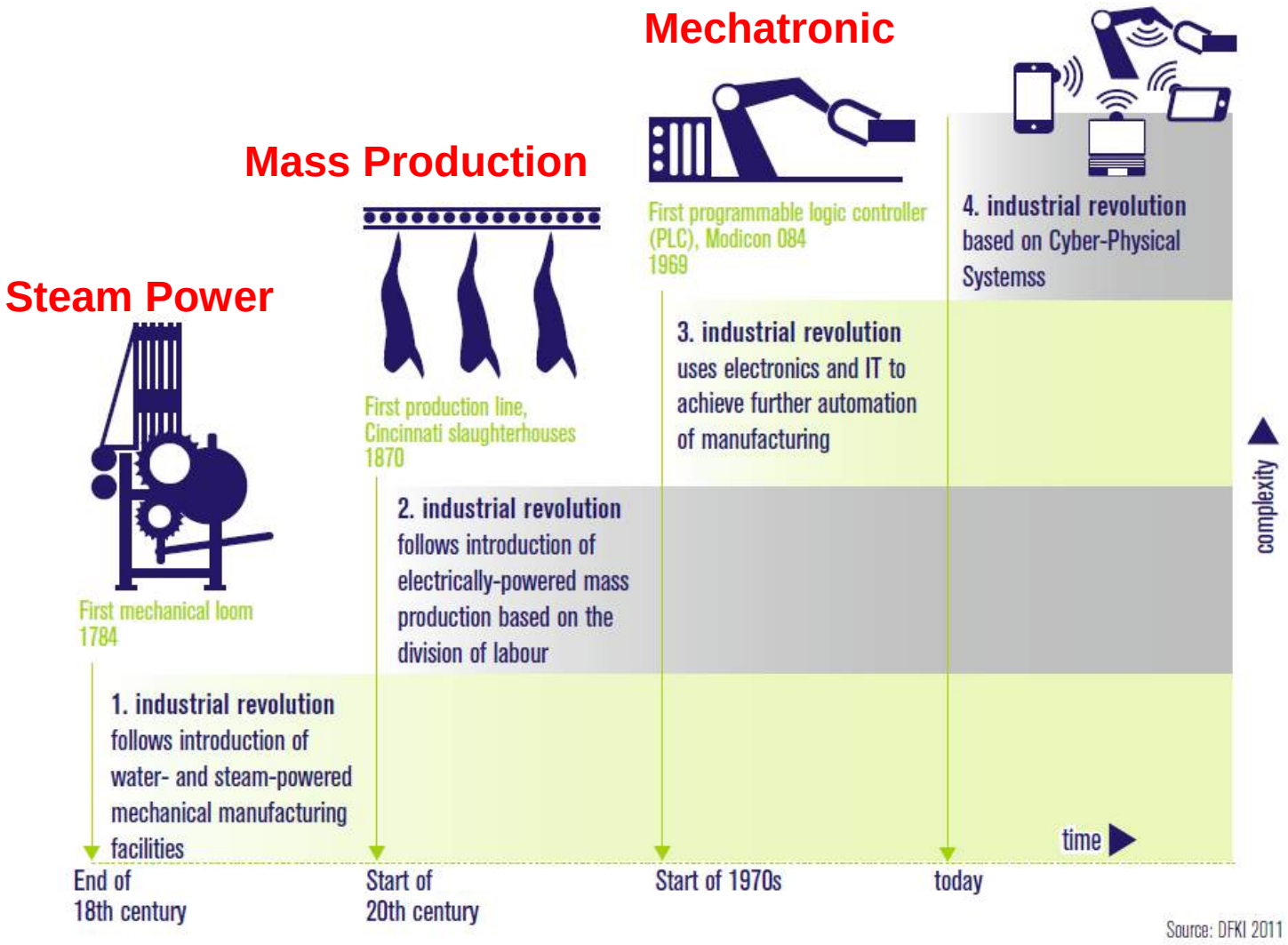


Source: Economist Intelligence Unit; IMB; Institut für Arbeitsmarkt- und Berufsforschung; International Robot Federation; US Social Security data; McKinsey analysis

- Mechanics easily can be copied
- Huge competition, especially in the low price segments

What is Industry 4.0?

Cyber Physical Systems

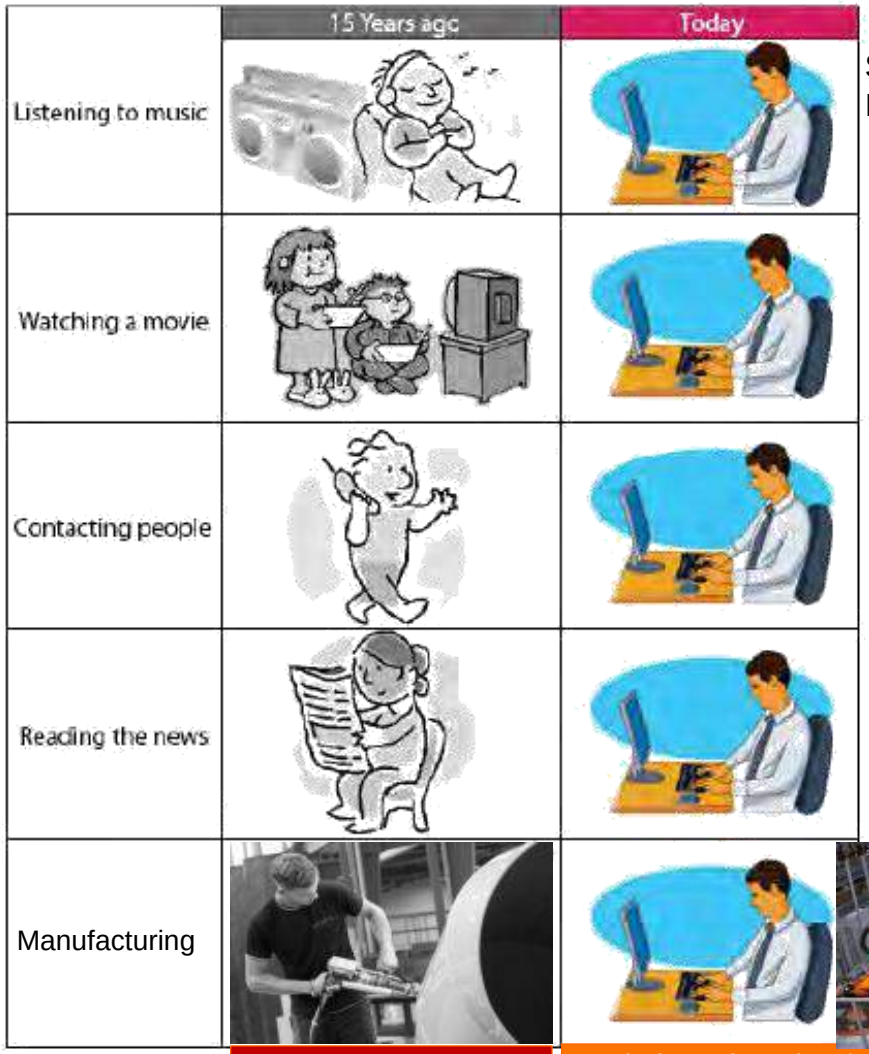


Industry 4.0 is the thorough Digitalization of the Manufacturing Industry

“A fundamental new rule for business is that the Internet changes everything.”

Bill Gates, 1999

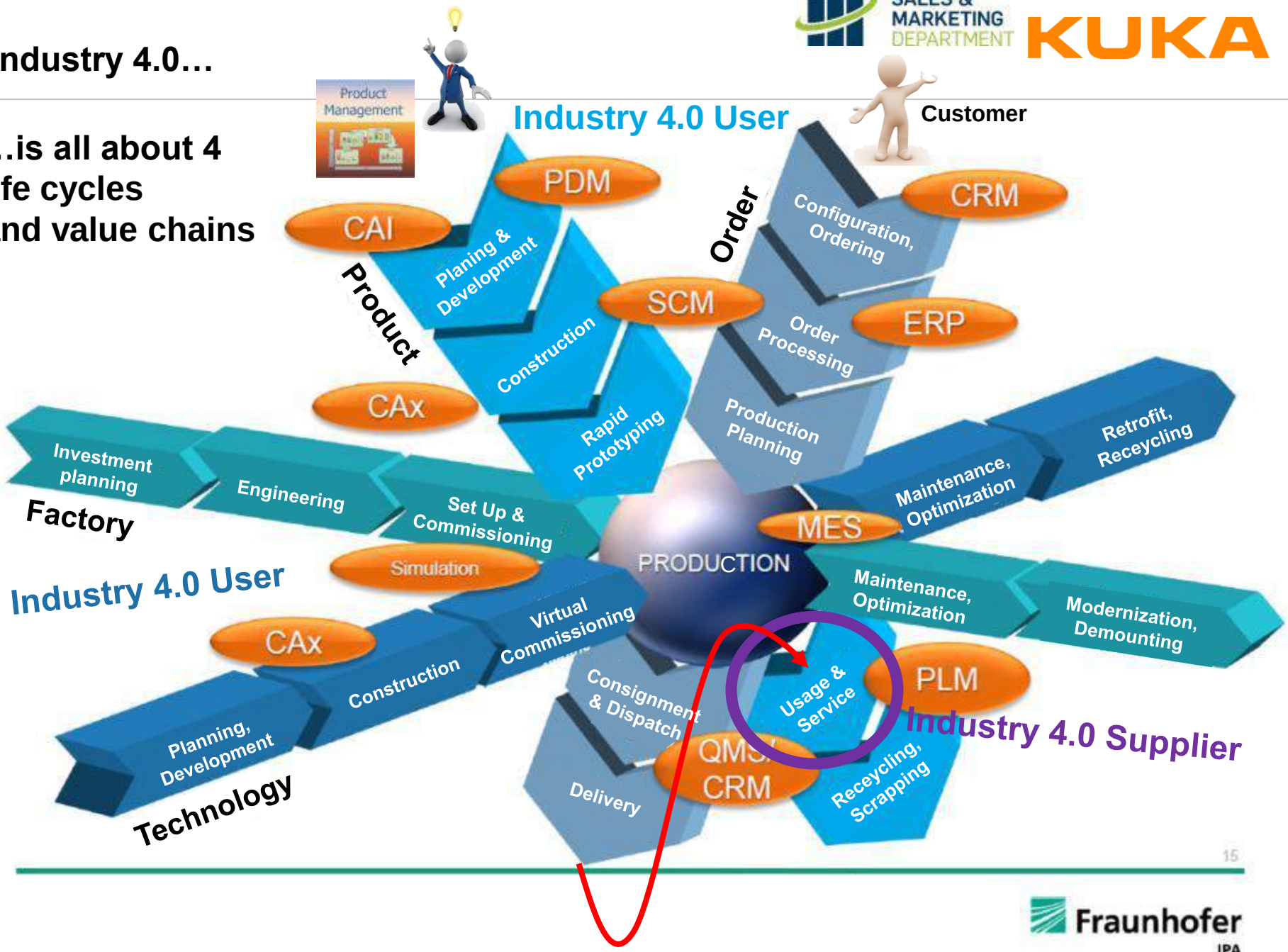
- …but in 1999 this only addressed the internet of **people**!
- The **Internet of Things (IoT)** will change much more!
- I.e. Manufacturing



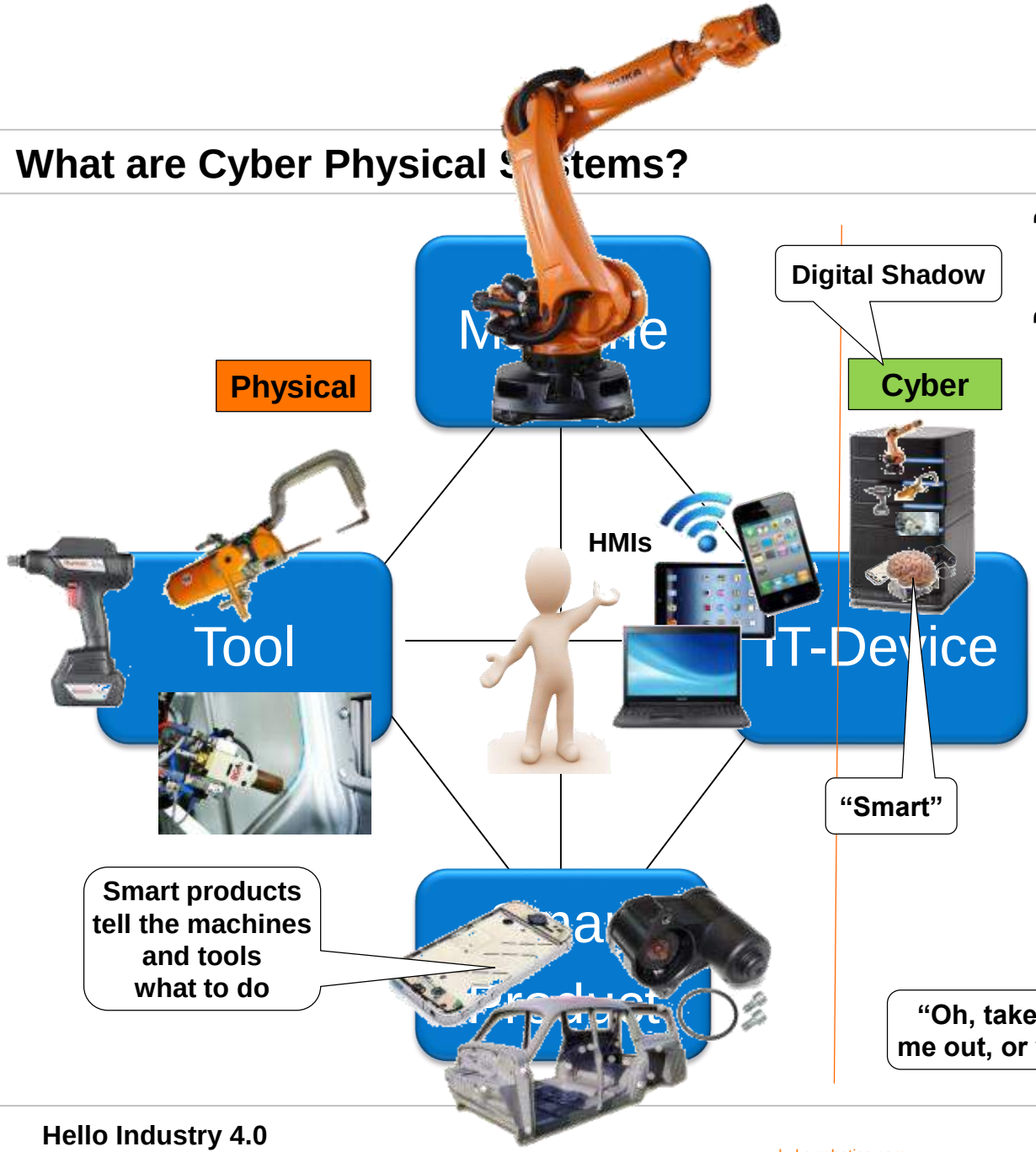
Source: IIC

Industry 4.0…

…is all about 4 life cycles and value chains



What are Cyber Physical Systems?



"Smart products" are not new:

Brothers Grimm

"Mother Hulda" (Frau Holle)

Megatrends Change the World

- Everything that can be digitalized, will be digitalized ! “Digitalization”
- Everything that can be connected, will be connected ! “Internet of Things”
- Everything that can be automated, will be automated ! “Industry 4.0”

Digitalization

Insurances

Lawyers, Judges, Courts

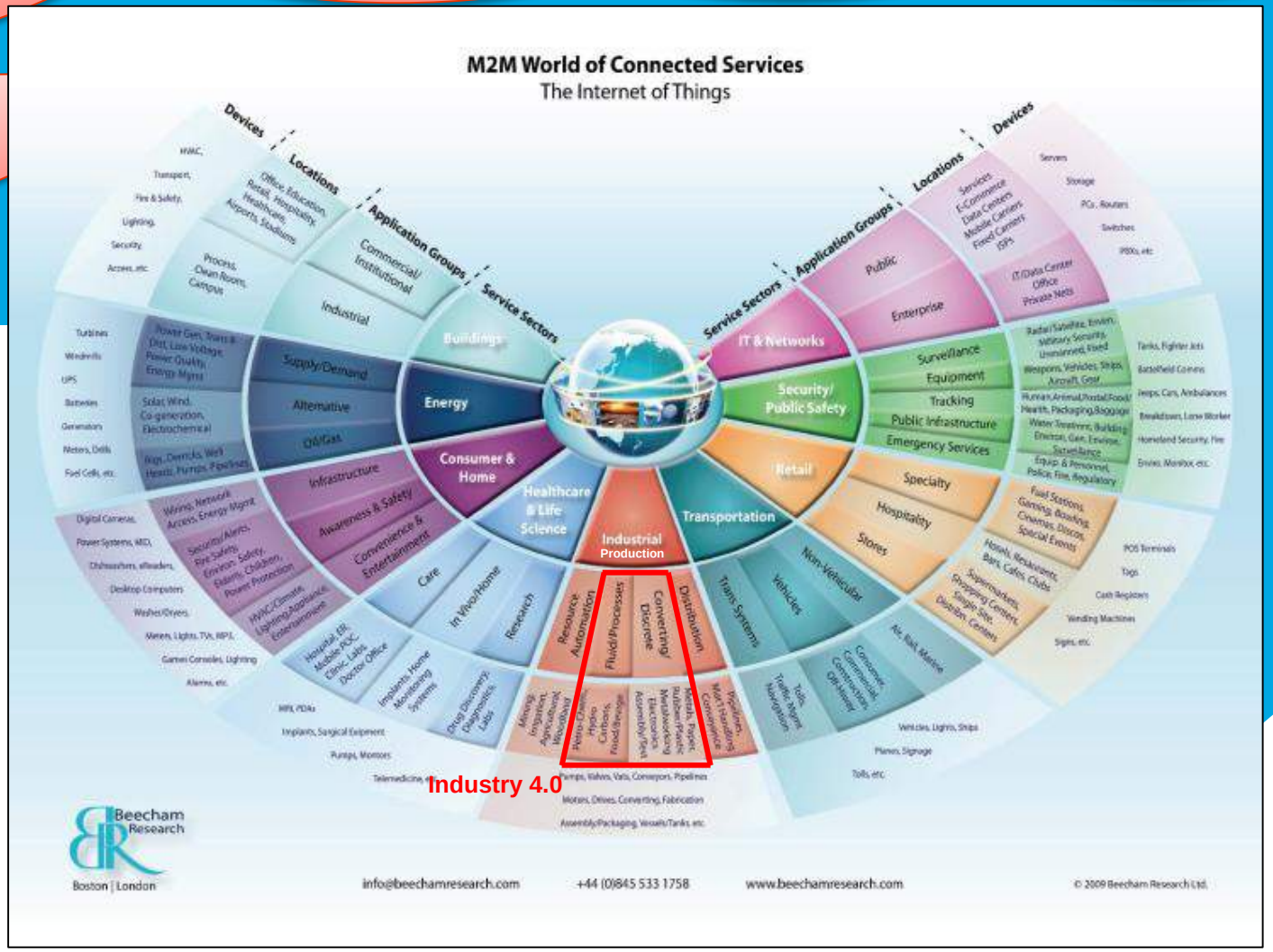
Chemical, Pharma

Administrations

Retail

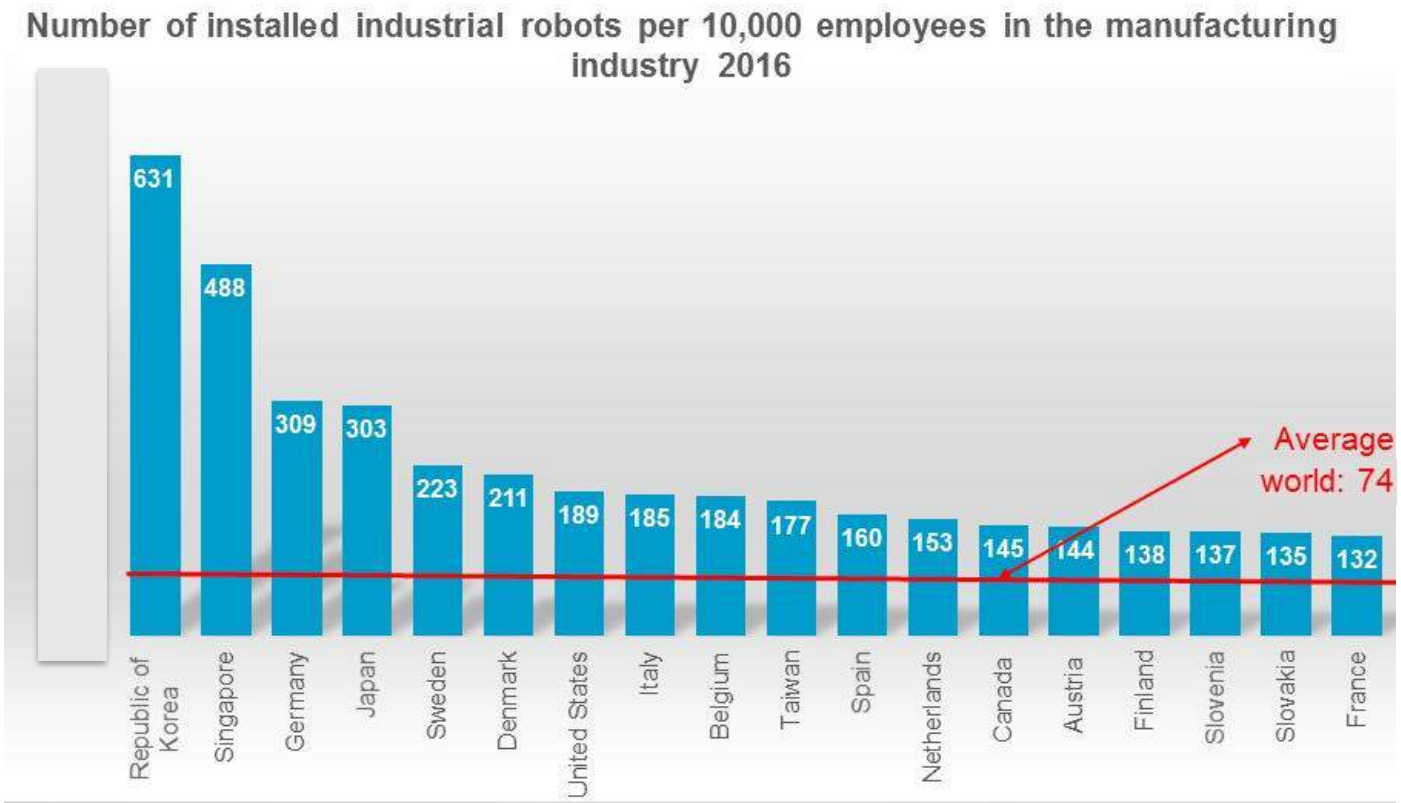
Banks

- The IoT is just a subset of Digitalization
- Industry 4.0 is just a subset of the IoT



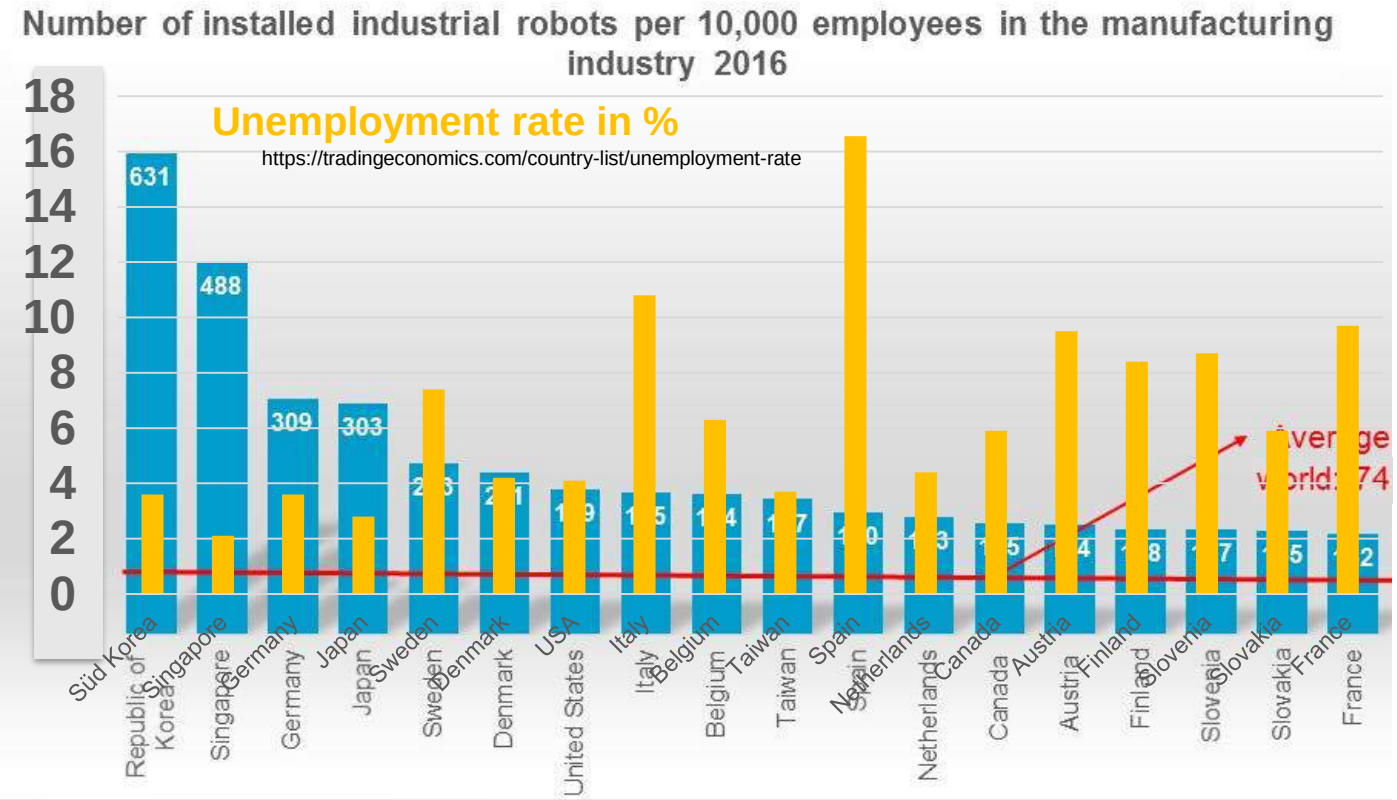
Robots & Full Automation create Jobs !

https://ifr.org/ifr-press-releases/news/robot-density-rises-globally



Robots & Full Automation create Jobs !

https://ifr.org/ifr-press-releases/news/robot-density-rises-globally

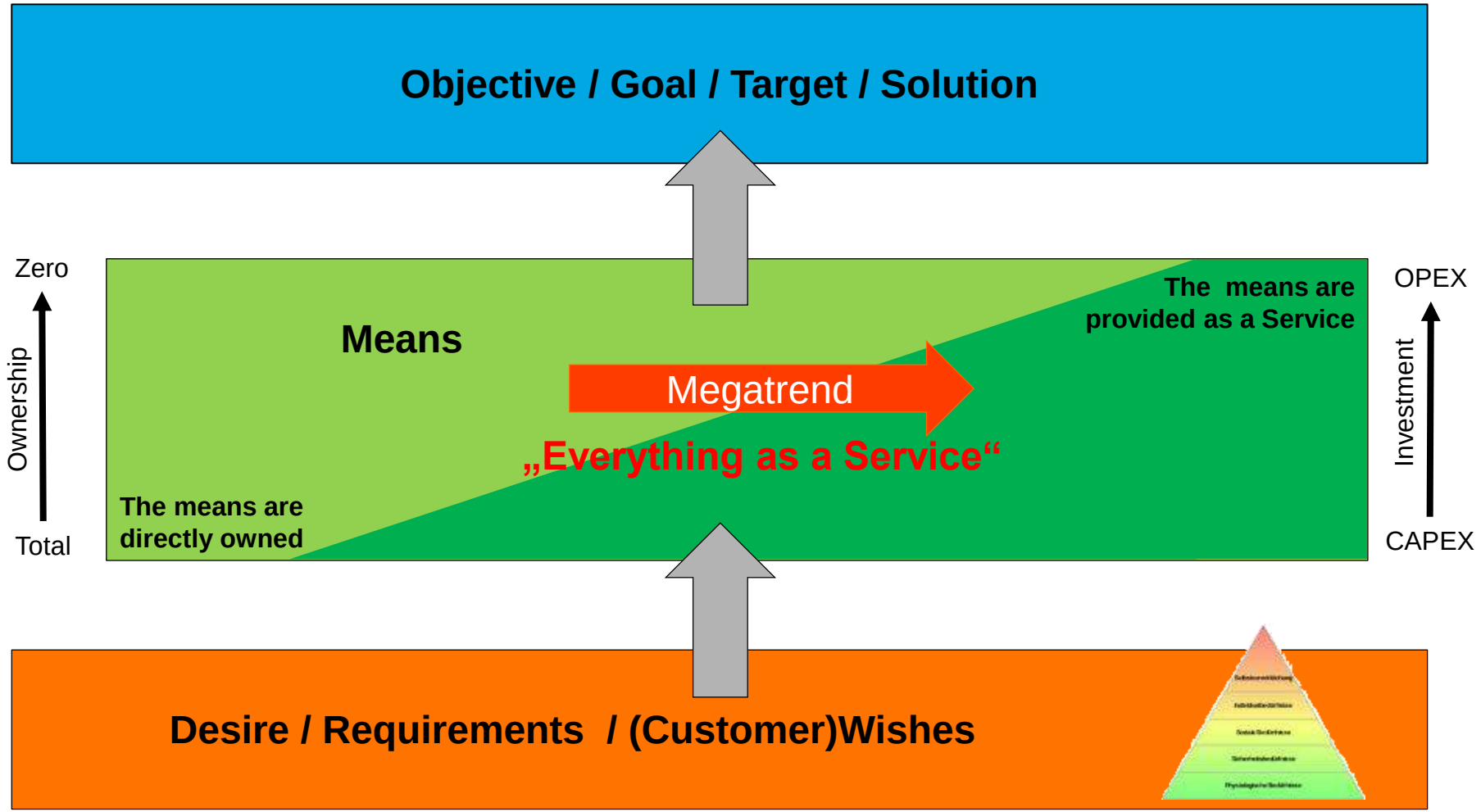


What is Industry 4.0 good for?

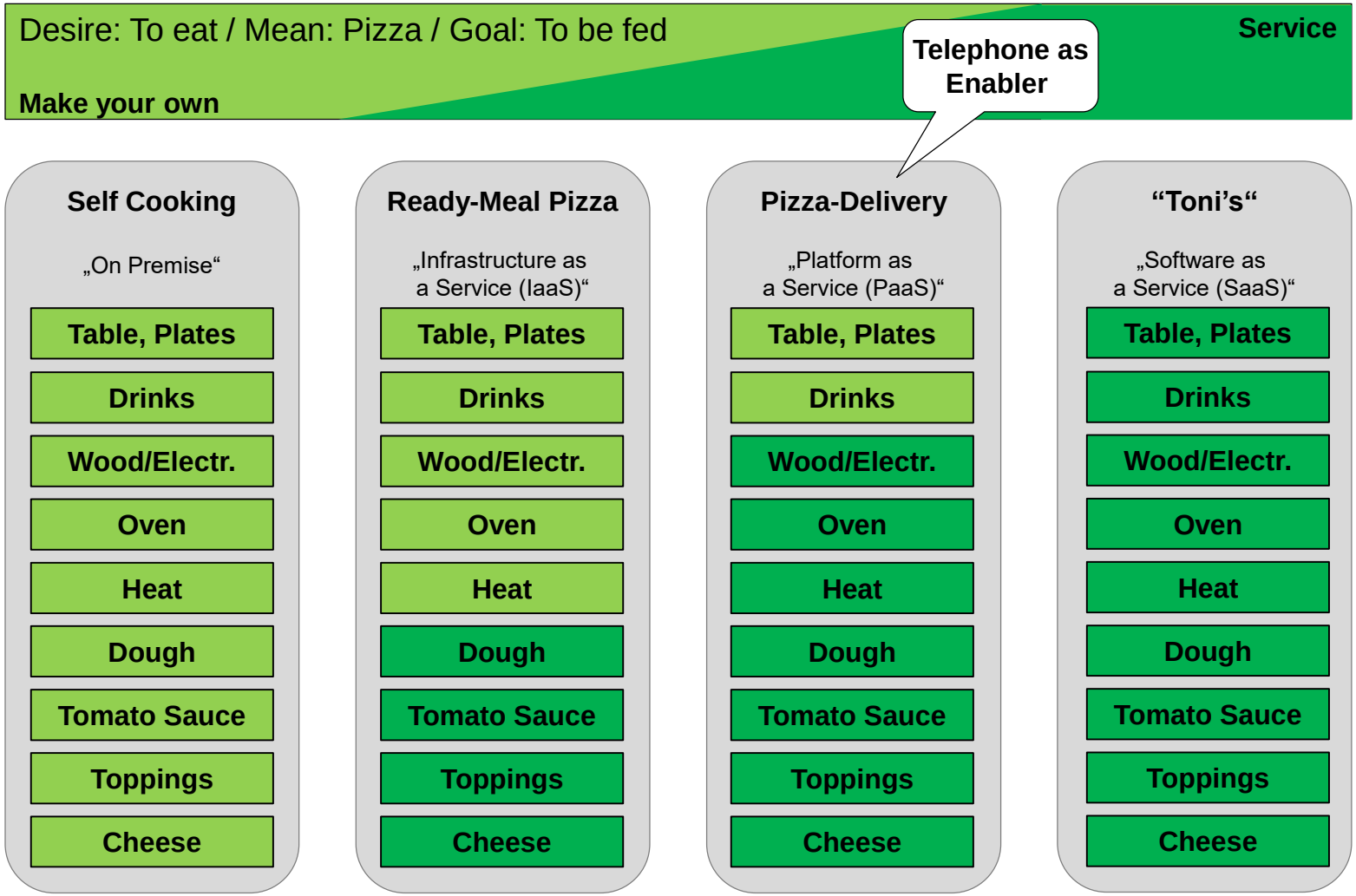
- Briefly said: **“Improve your production”** with:
- Standardized Information & Communication Technologies (OPC UA, TSN, AML…)
- Asset Management (Where are my assets?)
- Condition Monitoring (In which shape are my assets?)
- Predictive Maintenance, no unnecessary cyclic maintenance
- Information down to the fingertips of the workers
- What will Machine Learning & Artificial Intelligence bring?
- Lot size one: Individualized products by keeping full mass production
- More efficient collaboration and value chains with suppliers, partners and customers based on modern IT platforms and the Cloud
- Better life cycle management of the assets (Industry 4.0 user) and products at the customers (Industry 4.0 supplier)
- New Control Technologies from the Edge/Cloud
- New Business Models

“Things” in the IoT

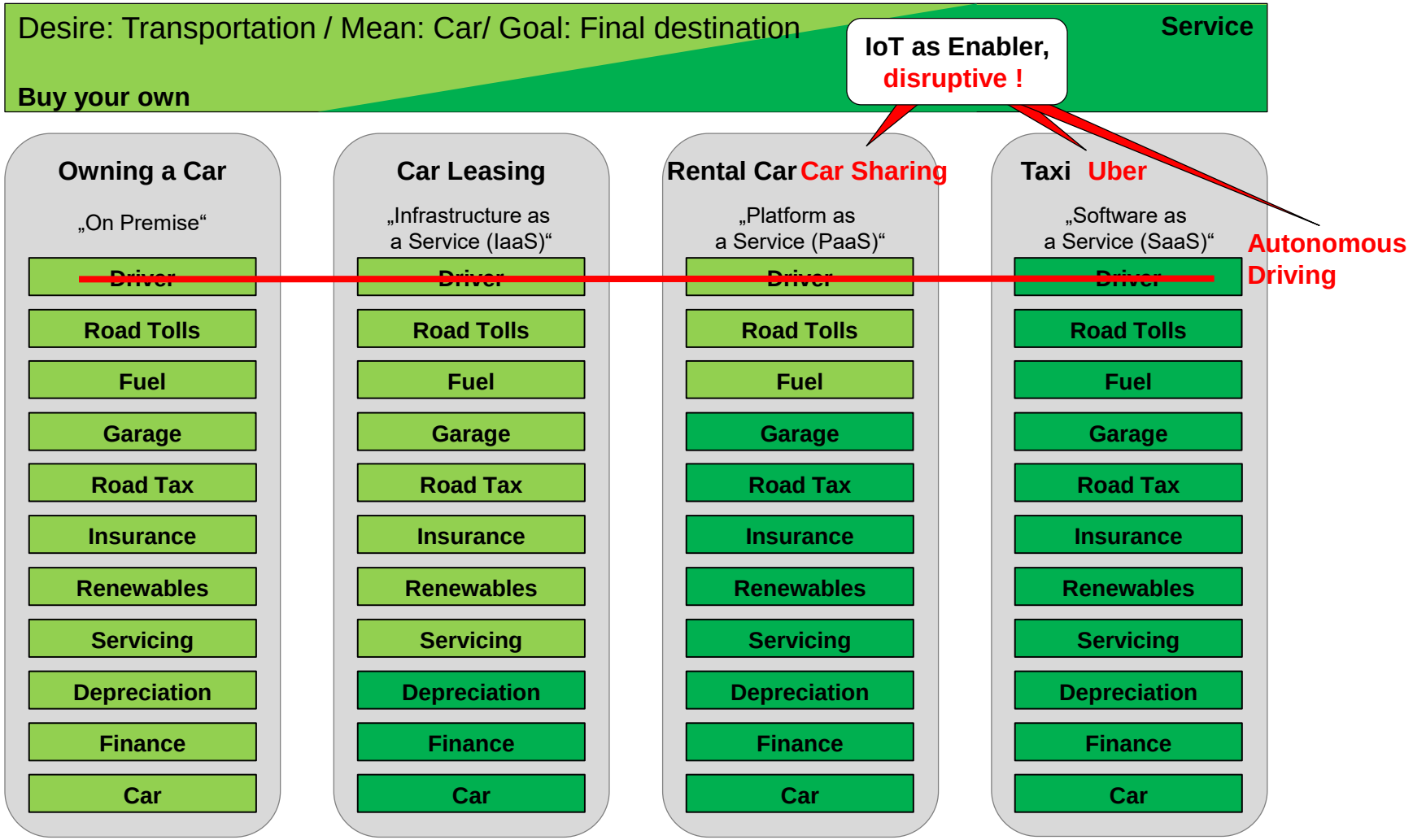
Megatrend: Use instead of own = Everything as a Service



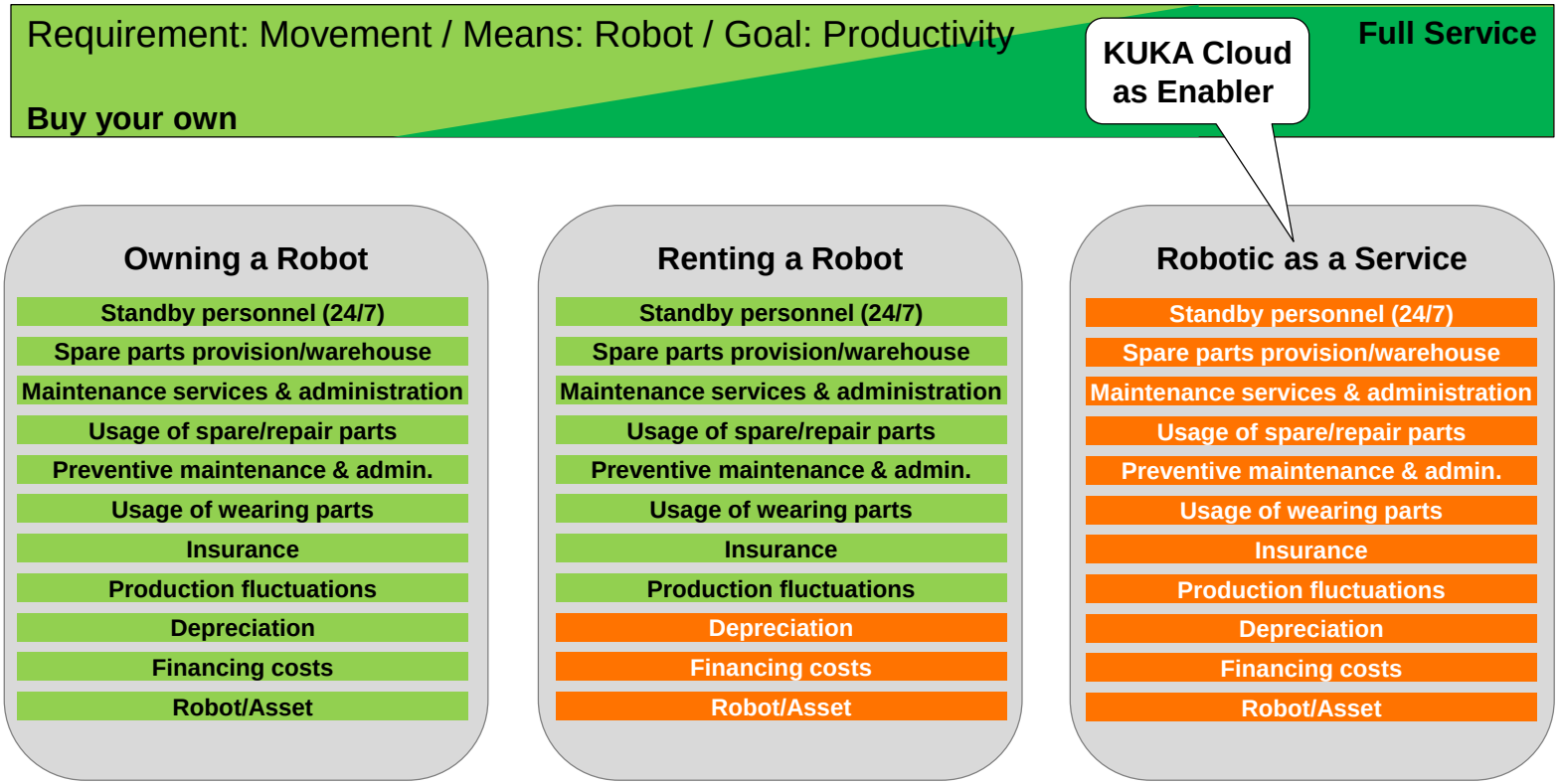
Example: „Pizza as a Service“



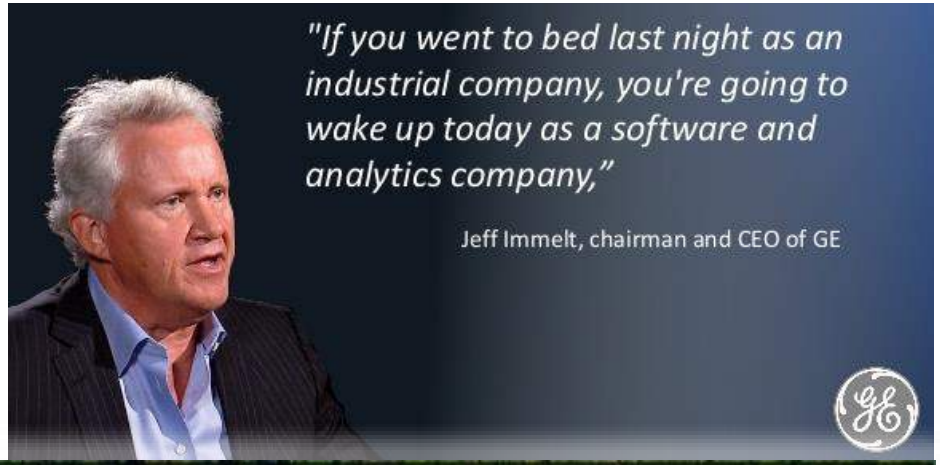
Example: „Car as a Service“

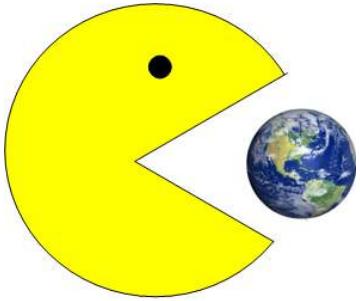


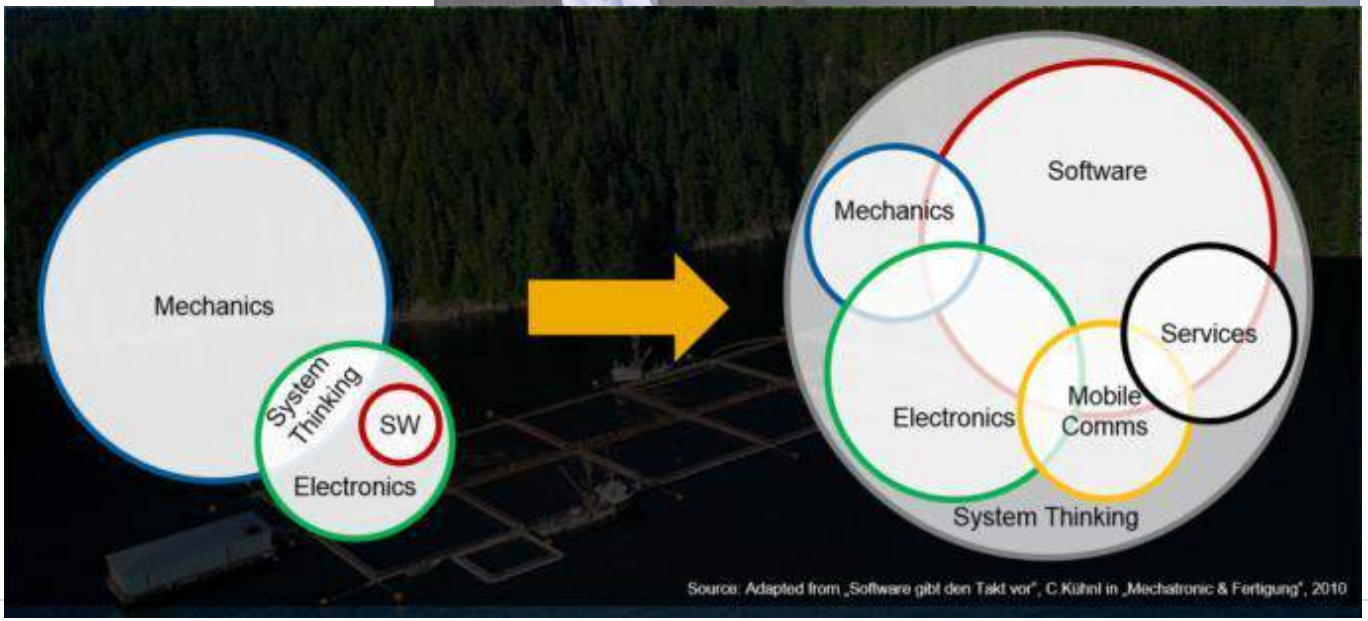
New Business Model: „Robotic as a Service“



Megatrend: Software is Eating the World…







Megatrend: Software Defined Everything

- “Software Defined…
  - …Networks”
  - …Storage“
  - …Data Center“
  - …Radio“ (SDR)
  - …Cars“

IT-Topics

Tesla-Email vom 25. Oktober 2015

Es ist unser Anspruch, unermüdlich an der Weiterentwicklung des Model S zu arbeiten. Mit der Softwareversion 7.0 und der Erweiterung der Autopilot-Funktionen ist uns jetzt ein weiterer wichtiger Schritt in diesem Bestreben gelungen. Das aktuelle Software-Update nutzt die einzigartige Kombination aus Kameras, Radar, Ultraschall-Sensoren und Daten, um das Model S in der Fahrspur zu halten, einen Spurwechsel durchzuführen und die Geschwindigkeit an die Verkehrslage anzupassen.

Single driving lane

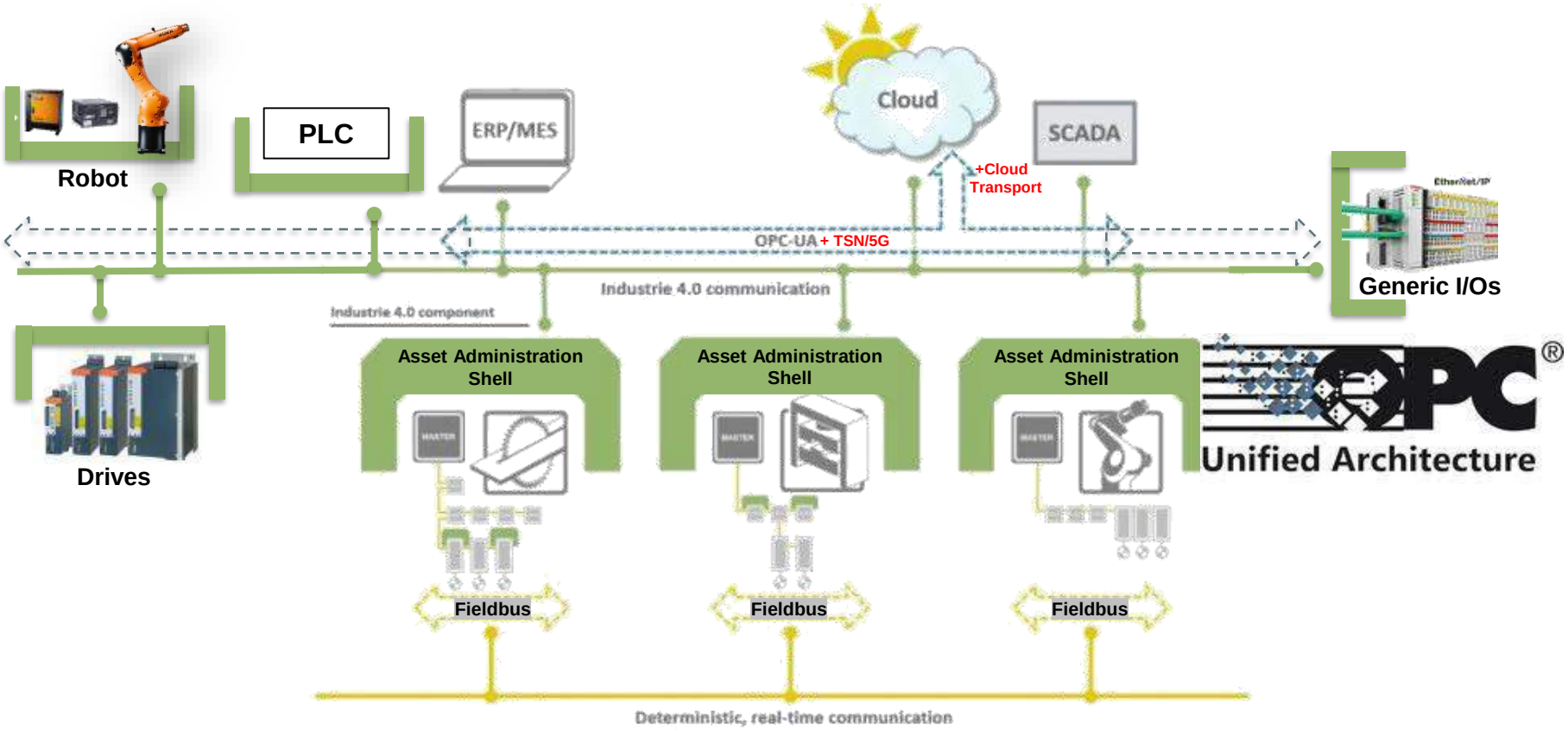
Changing lanes

Speed adjustment

Am Zielort scant das Model S die Gegend nach einem freien Parkplatz und führt auf Ihren Befehl hin den Längsparkvorgang eigenständig durch.

Automated Parking

Megatrend: Software Defined Machines

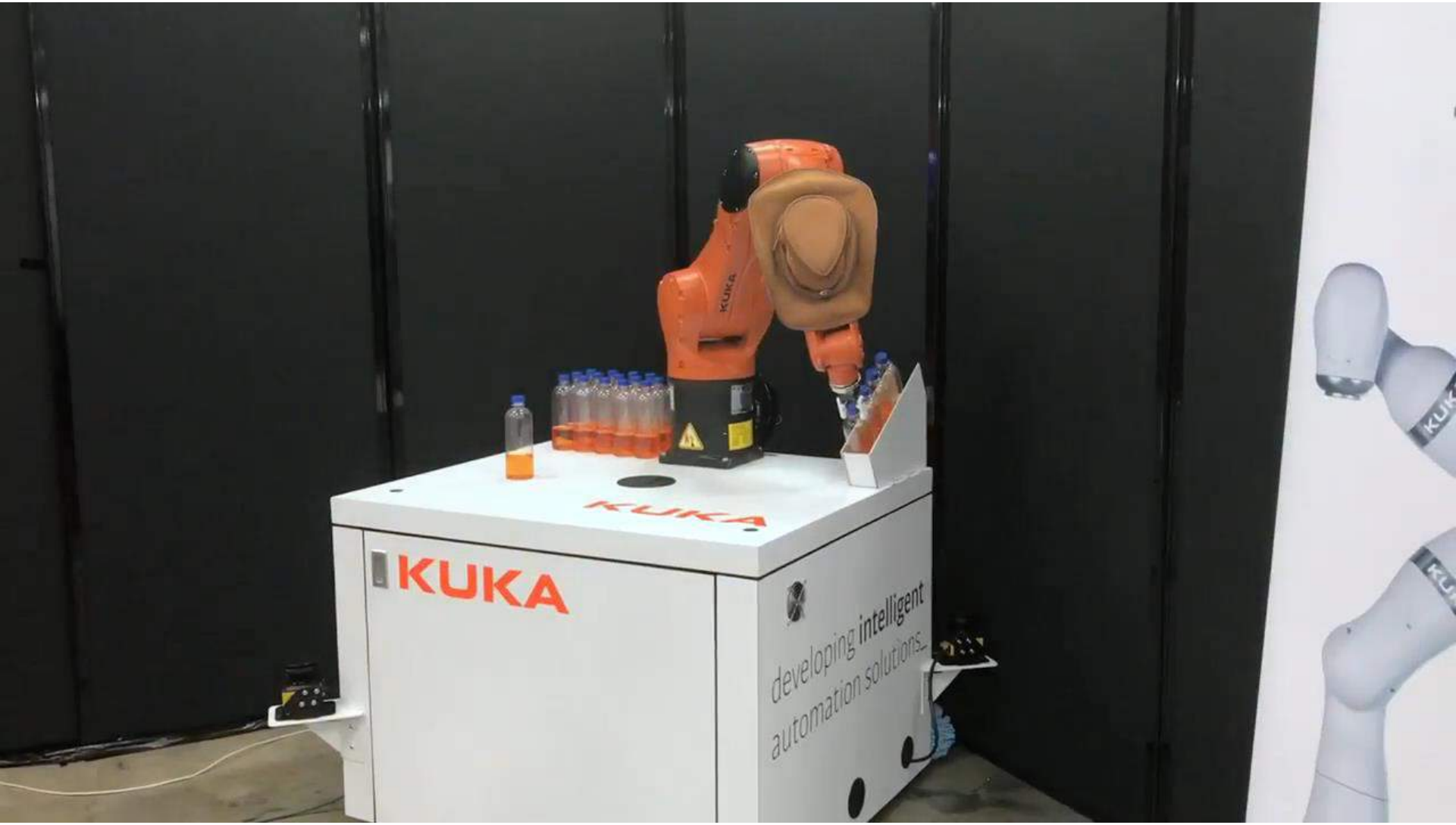


- All automation devices and machines have their semantic self description in the Asset Administration Shell using the Industry 4.0 M2M standard OPC UA

Megatrend: AGVs instead of Conveyors, The KUKA Matrix

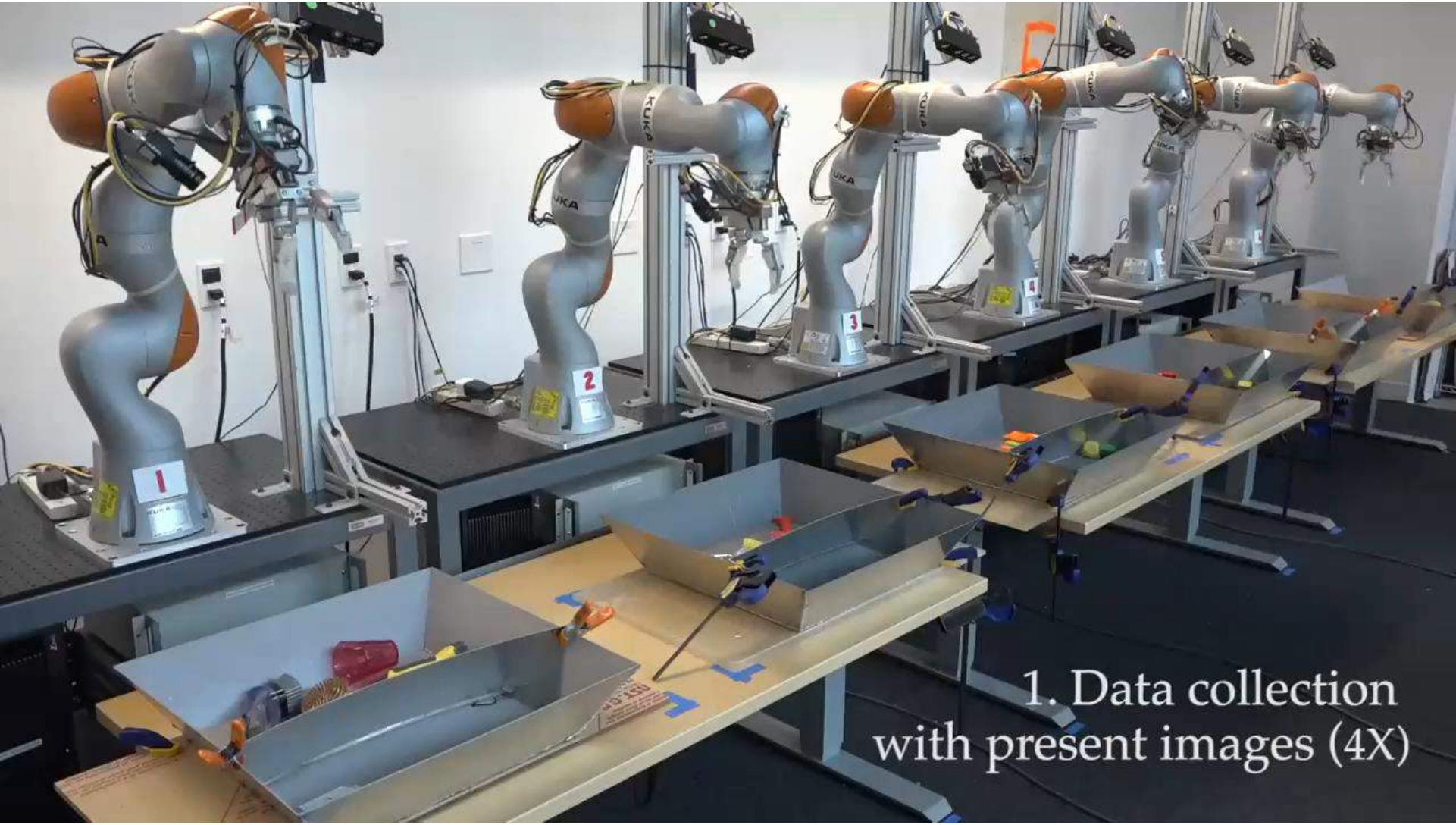
https://www.youtube.com/watch?v=ol_vrpc-n2E

Megatrend: Artificial Intelligence



https://www.youtube.com/watch?v=Pyb7kBCKxJc

Megatrend: Artificial Intelligence



https://www.youtube.com/watch?v=WR5WUKXUQ8U&feature=youtu.be

Megatrend: „Platformization“ in the Cloud

Examples for Platform-based business:

- Apple iTunes, later App Store (“Mother” of all Platforms)
- Facebook, Amazon, Ebay, Google, WhatsApp, SnapChat, Flickr, Netflix, Spotify, LinkedIn, …
- **“Shareconomy”** and “**Prosumers**” are based on platforms
  - Uber: Biggest Taxi company without a single car
  - Airbnb: Biggest hotel chain without a single hotel
  - Wikipedia: Biggest library without a single book
  - Open Source on Github, etc.: Biggest Software source Code Collection
  - Solar Panels on private houses
  - Distributed Ledgers like Blockchain, IOTA: The “Mediators” are getting obsolete, i.e. Currencies without Banks (Bitcoin), Land Registers, any Administration, etc.
  - …

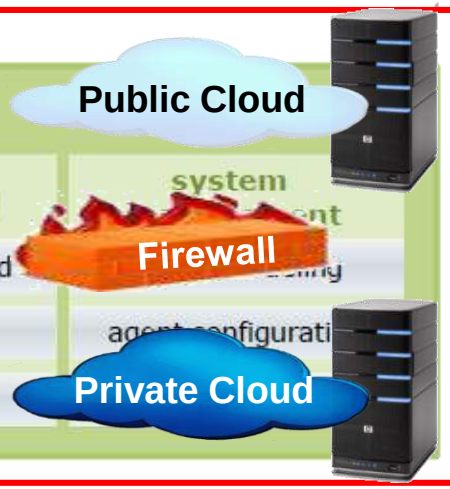

DATA
IS THE NEW
OIL
Customers
Production
Data

Typical IoT Architecture: Siemens

Applications & Services Eco System

Fleet Service Management	Predictive Maintenance	Energy Analytics & Optimization		
device management	vibration monitoring & analytics	consumption modeling		
helpdesk & ticketing	model-based failure prediction	energy reporting	tuning advisory	...

Public or Private Cloud



device management	data management	analytics / rules	visualization	system
onboarding	data acquisition	rule engine	cockpit/dashboard	
status monitoring	pre/post processing	analytics engine	reporting	agent configurati
remote access	big data store	events / notifications	mobile UI's	

Source: Siemens

Device Connectivity

Plant Floor

Typical IoT Architecture: Device Insight

FRONTEND

CENTERSIGHT® STANDARD APPLICATION

PLUG-IN RUNTIME	APPLICATION SUITE	
ADMIN	ALARMING	TR
LAYOUTS	VISUALISATION	ANA
VIEWS	DASHBOARD	REP

API NORTHBOUND

MIDDLEWARE

CENTERSIGHT® MIDDLEWARE (SERVICE LAYER)

CORE		PLUG-IN RUNTIME	
USER SERVICE & AUTHENTICATION	TASK SCHEDULER	PREDICTIVE MAINTENANCE	COMPLEX EVENT PROCESSING
MASTER DATA STORAGE	NOTIFICATION	BIG DATA ANALYTICS	SIM MANAGEMENT
DEVICE MANAGEMENT	EVENT BUS	WORKFLOW ENGINE	CONDITOM MONITORING
VALUE & TIME SERIES STORAGE	(...)	LOCATION SERVICES	(...)

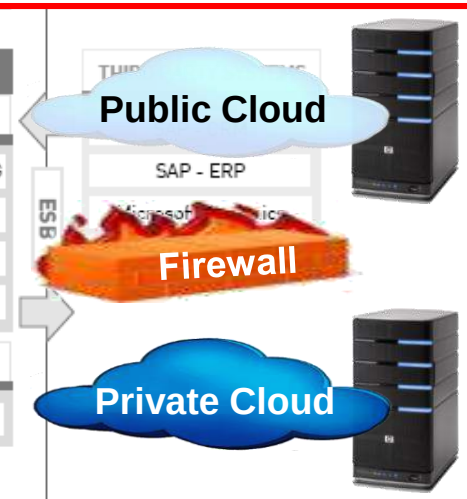
DEVICE COMMUNICATION		INTEGRATION FRAMEWORK	
JSON / XML	MQTT	IMPORT / EXPORT	PROTOCOL CONNECTOR
HTTPS	OPC-UA		

API SOUT ND

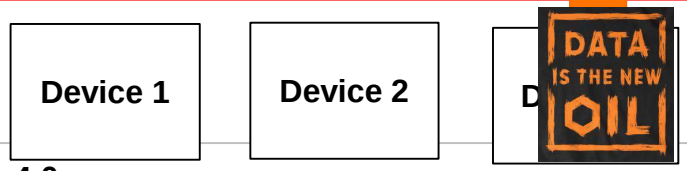
HARDWARE

CENTERS ® AGENT

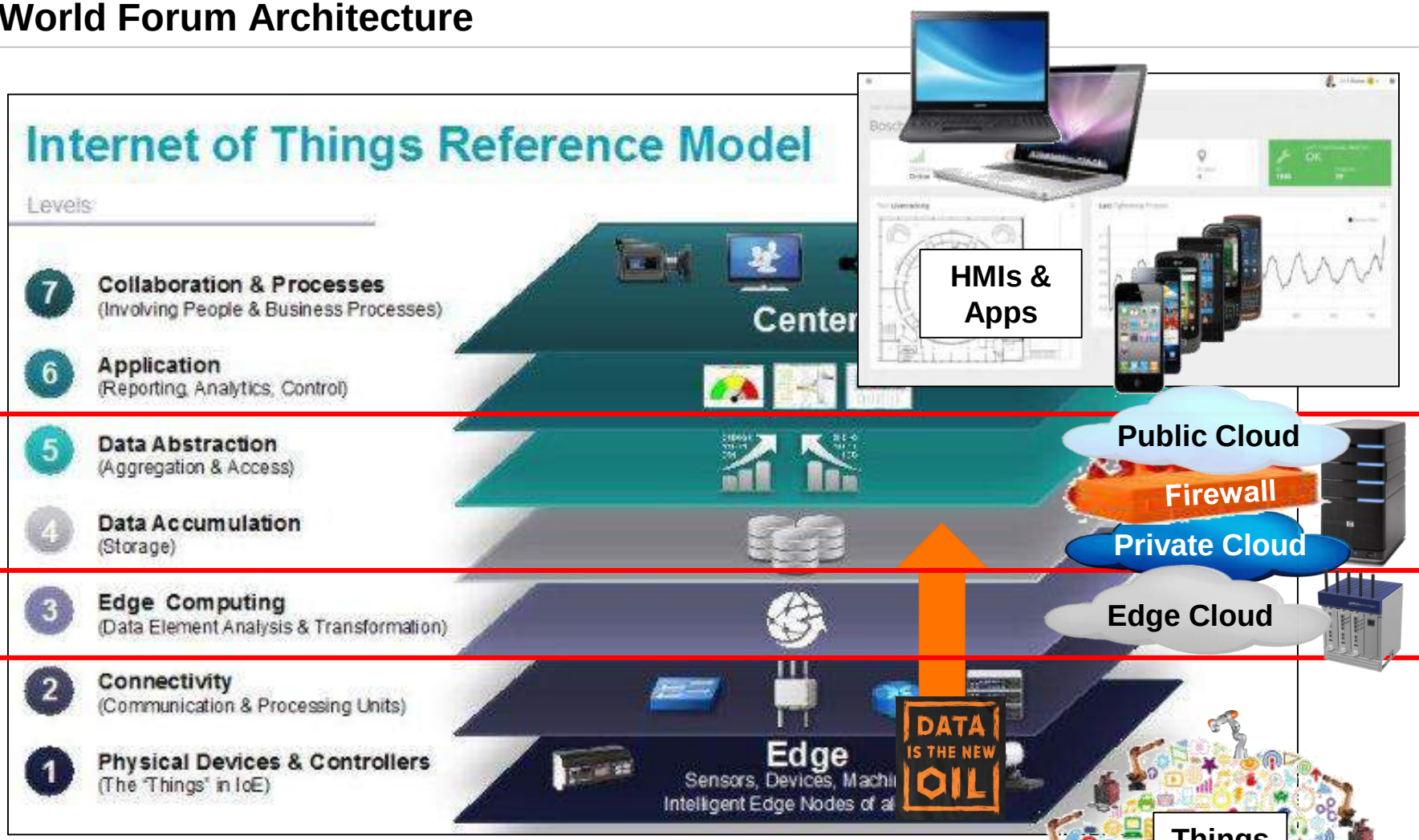
M2M GATEWAY HARDWARE			
	PROTOCOL	LOGGING	LOCATION
	LOCAL RULES	I/OS	(...)
	FIELDBUS	ALARM	



IY
Source: Device Insight



IoT World Forum Architecture



Wind River Helix Device Cloud

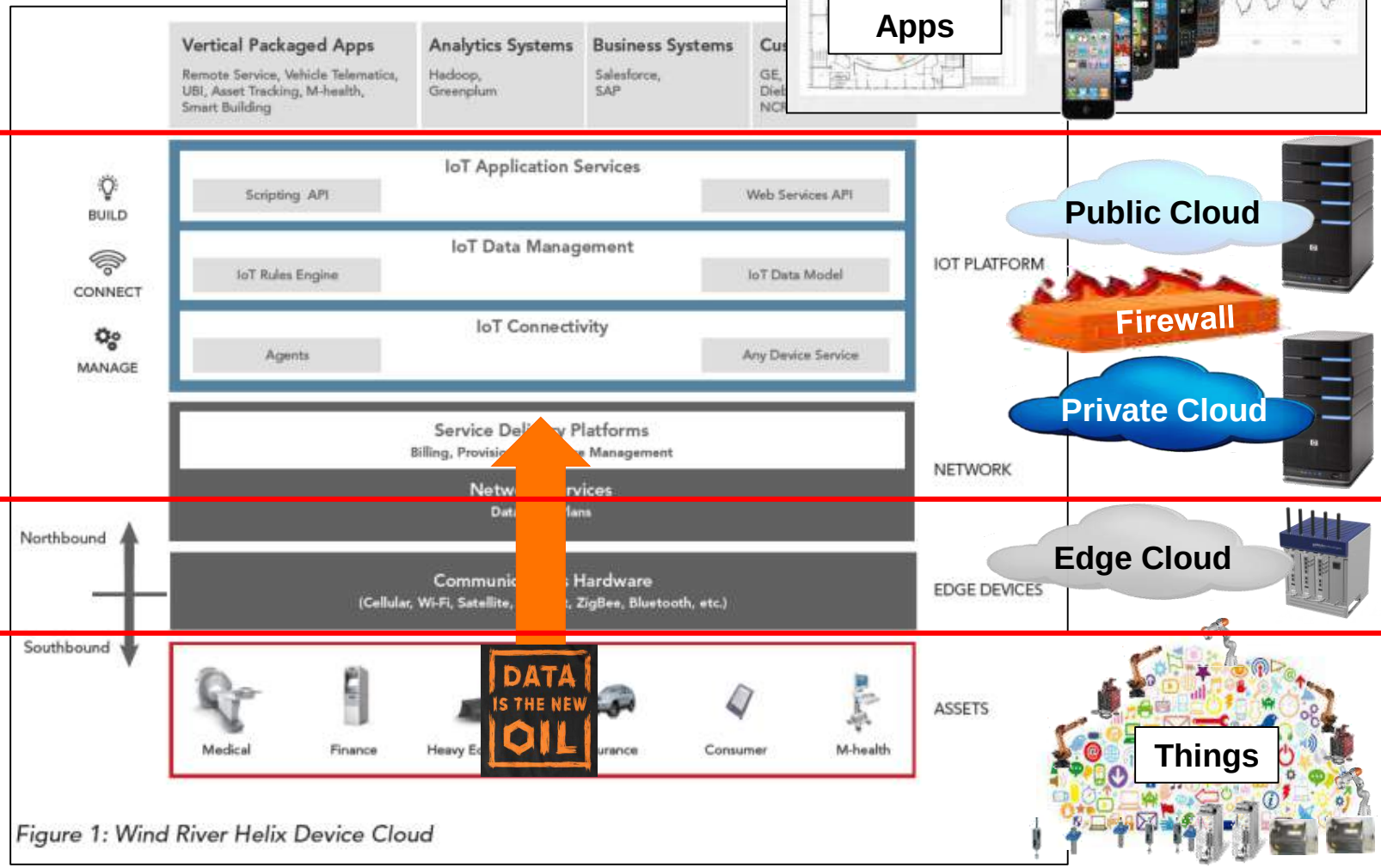
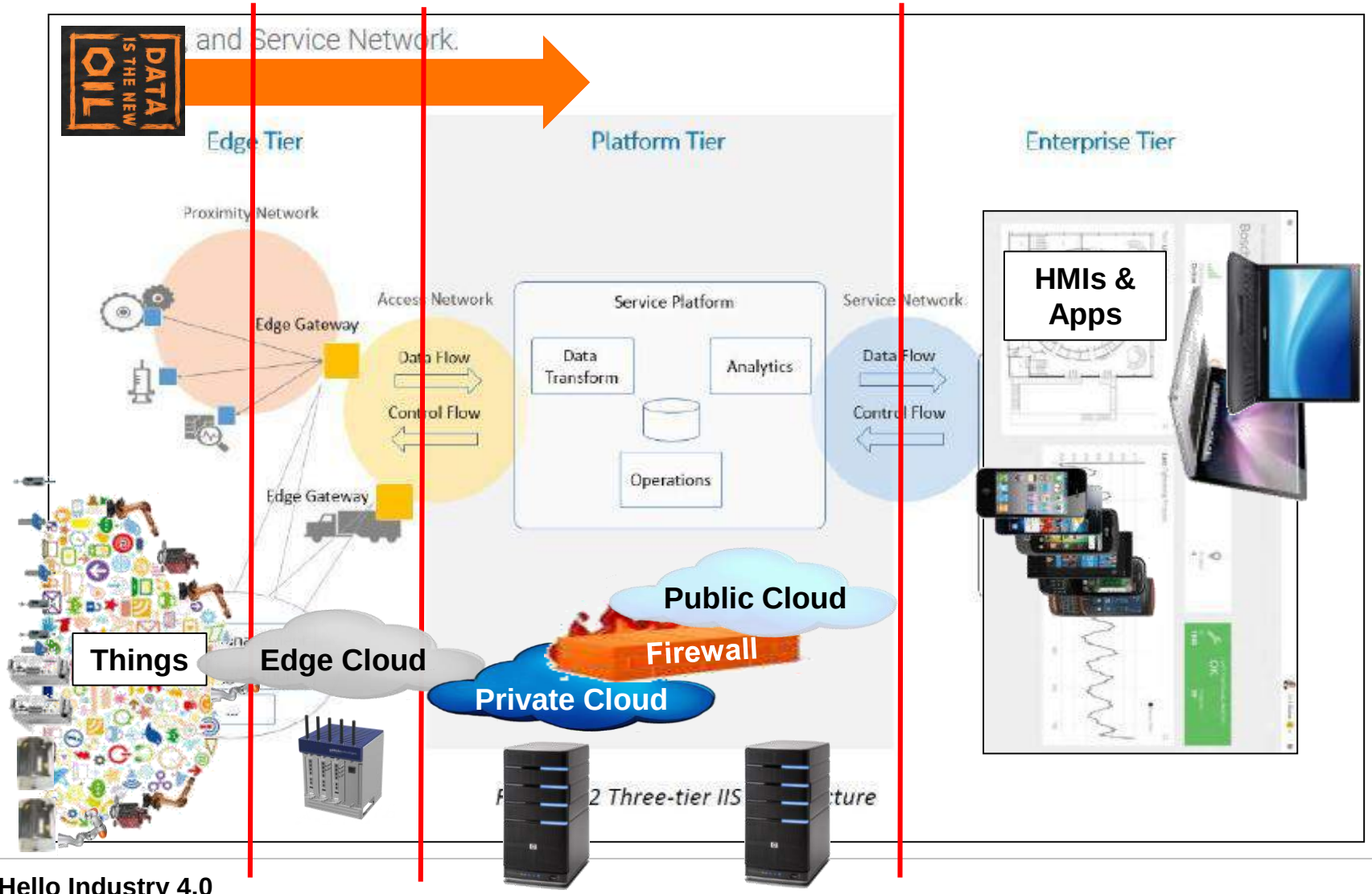
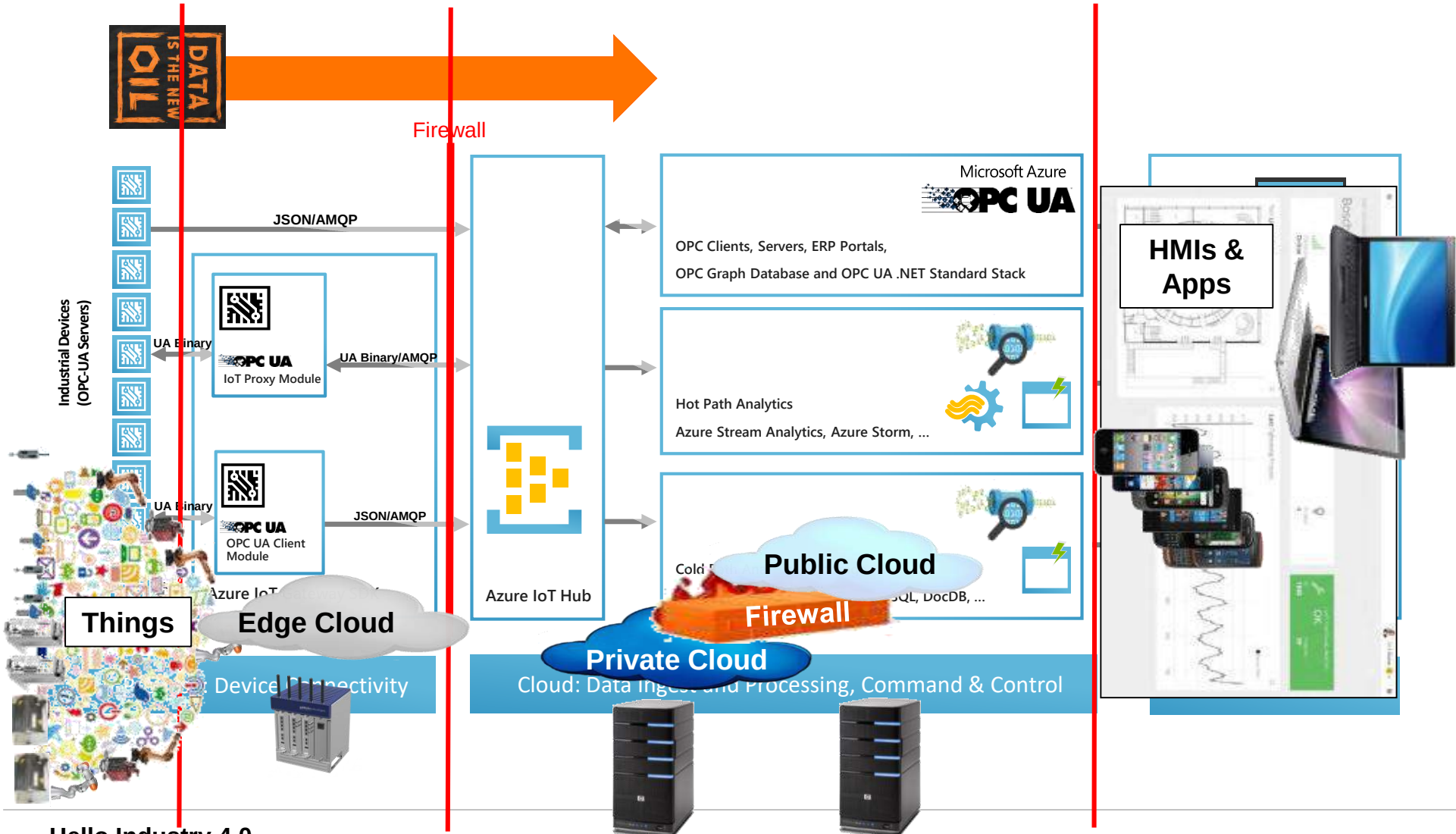


Figure 1: Wind River Helix Device Cloud

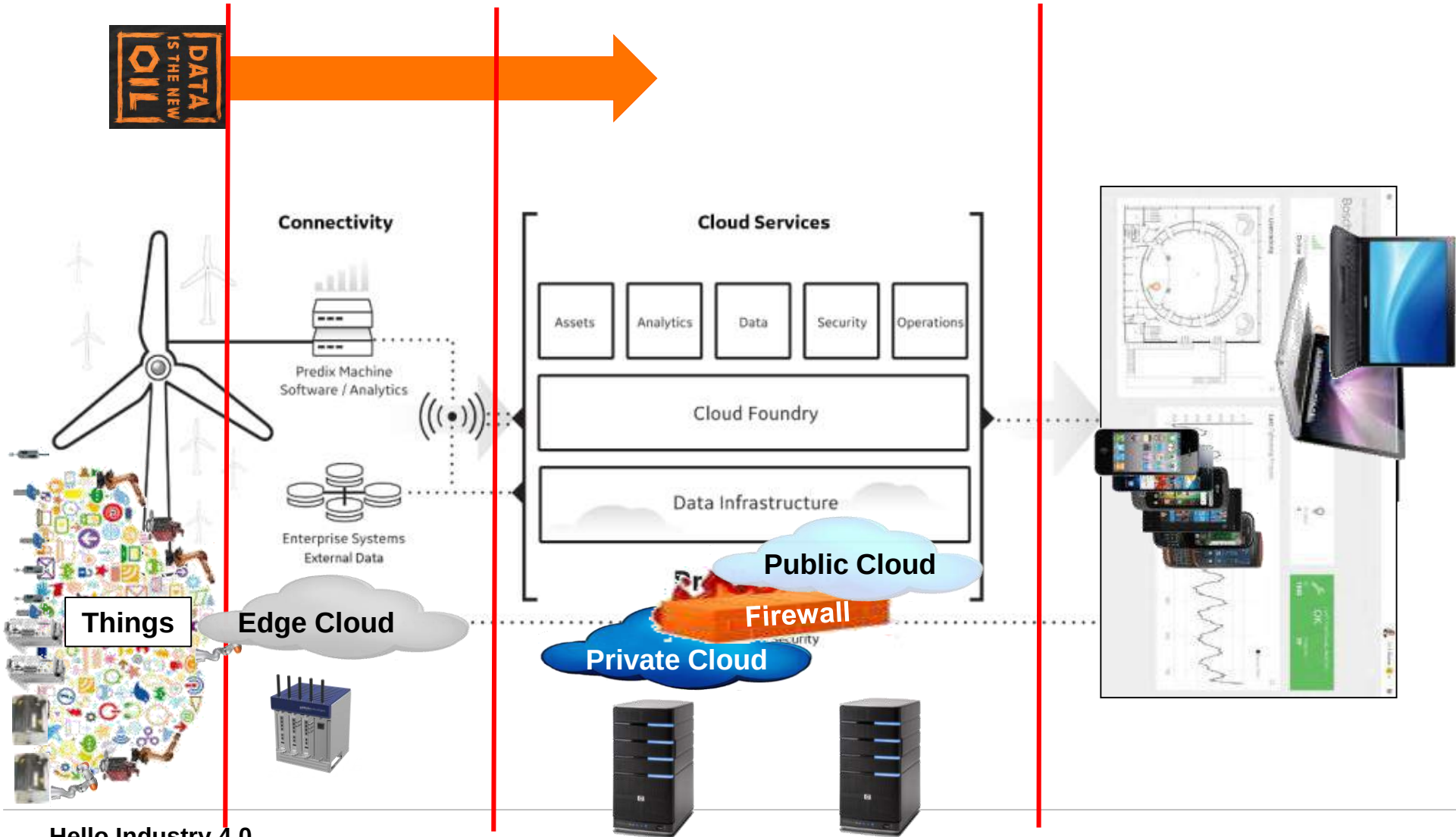
Industrial Internet Consortium Architecture (IIC)



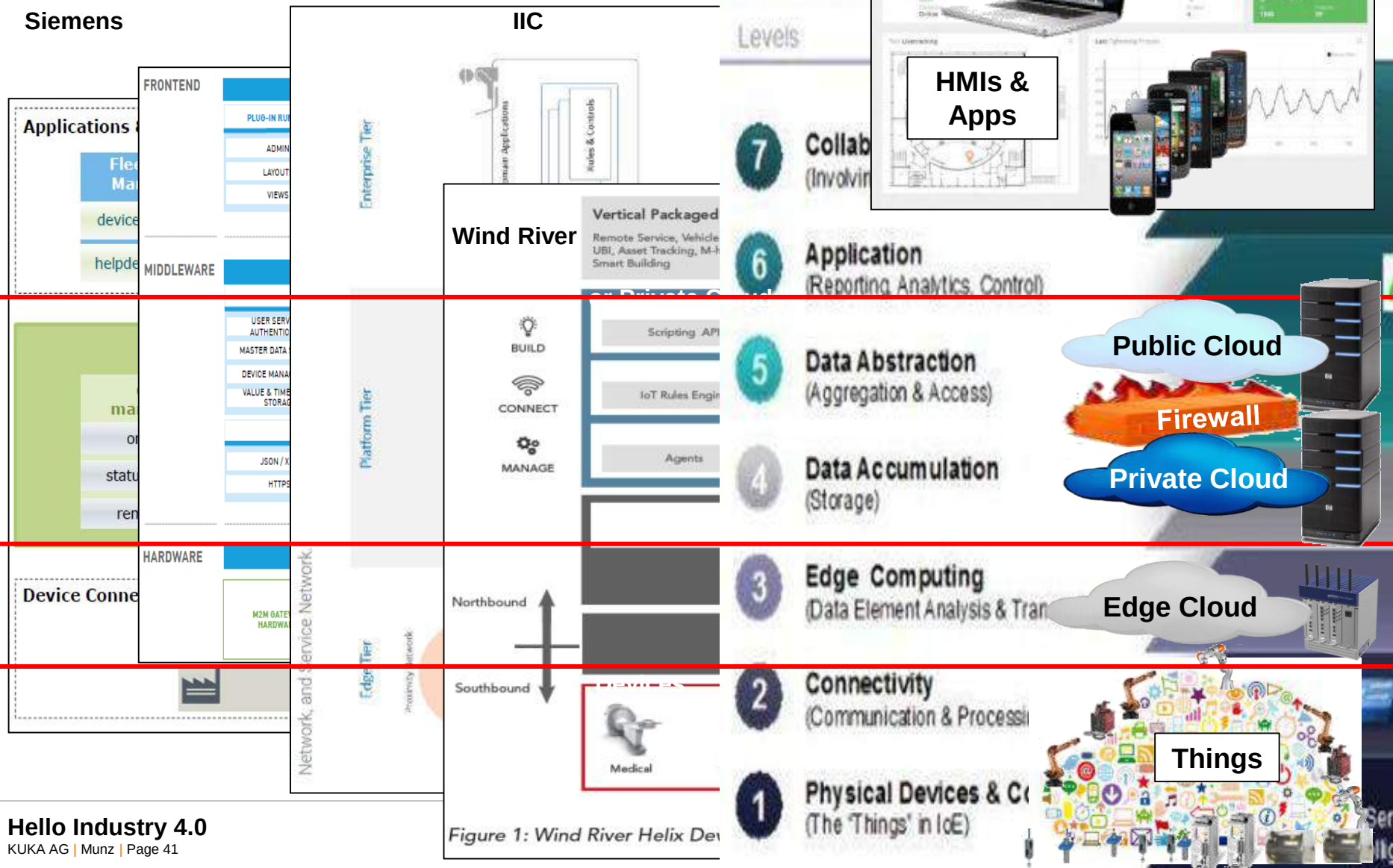
Microsoft Azure Architecture



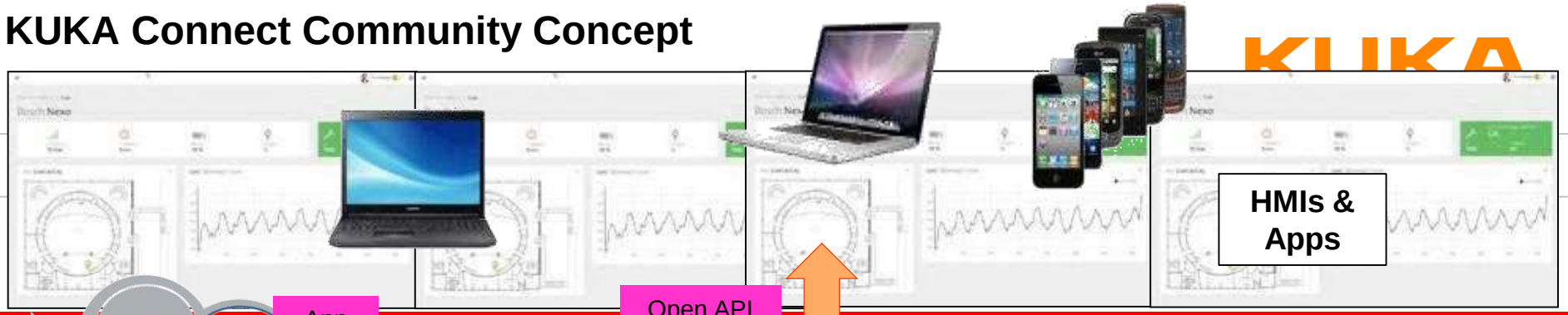
General Electric Predix Architecture



The common architecture of the Internet of Things



KUKA Connect Community Concept



App Store

Open API

Open REST APIs

KUKA proprietary

CRM
APTTUS
CPQ
Community
eCommerce
Ticketing
SALESFORCE
...

KUKA connyun

Micro Services
Plug In

Cloud

Firewall

On Premise

KUKA
XPert
Product Resumes
Services
iBase
SAP

OPC Unified Architecture over AMQP

Digital Twins

KUKA RT-Edge

Edge Cloud

Open API

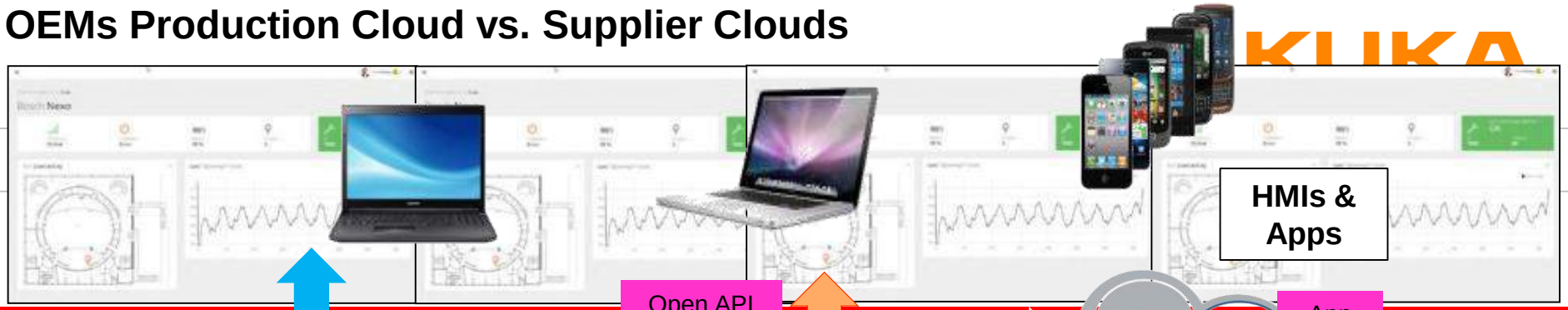
OPC Unified Architecture on TSN

Community Partner Devices

KUKA Devices

Things

OEMs Production Cloud vs. Supplier Clouds



HMIs & Apps

Open API

REST APIs

KUKA proprietary

App Store

Cloud

CRM

CPQ

Community

SALESFORCE

Customers Production Cloud

KUKA connyun
(Supplier KUKA only)

Other Suppliers
(Data separated)

KUKA

X

Firewall

Product Resume

Services

On Premise

iBase

SAP

Digital Twins

KUKA RT-Edge

Edge Cloud

Open API

OPC Unified Architecture

on TSN

Community Partner Devices

KUKA Devices

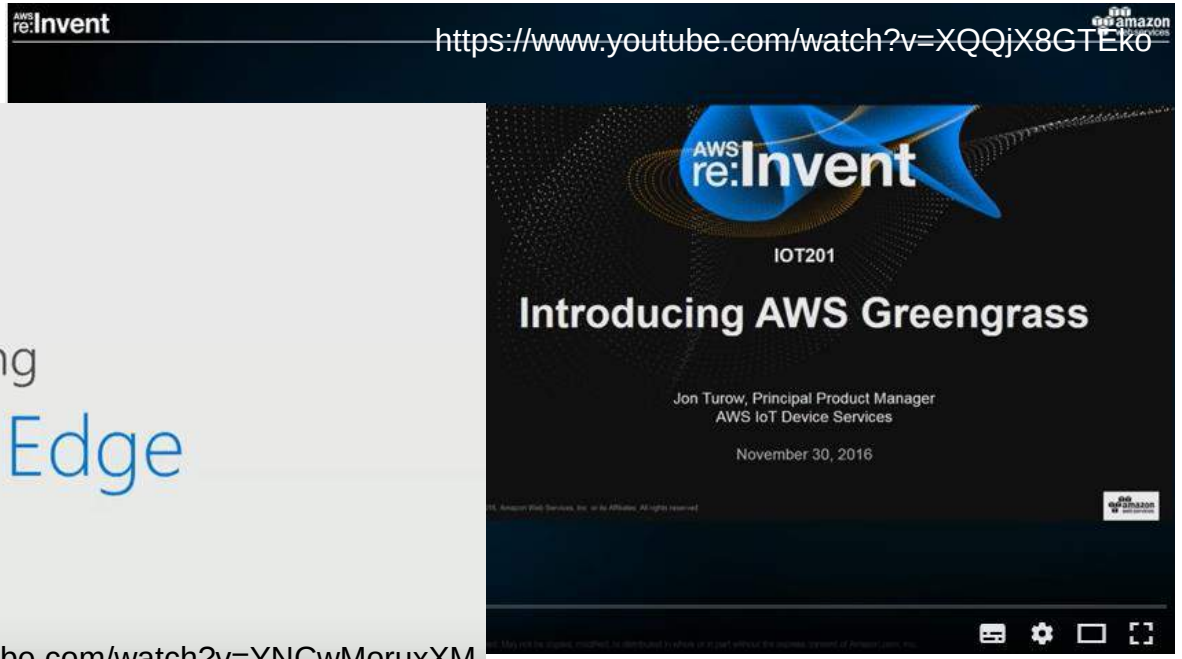
Things

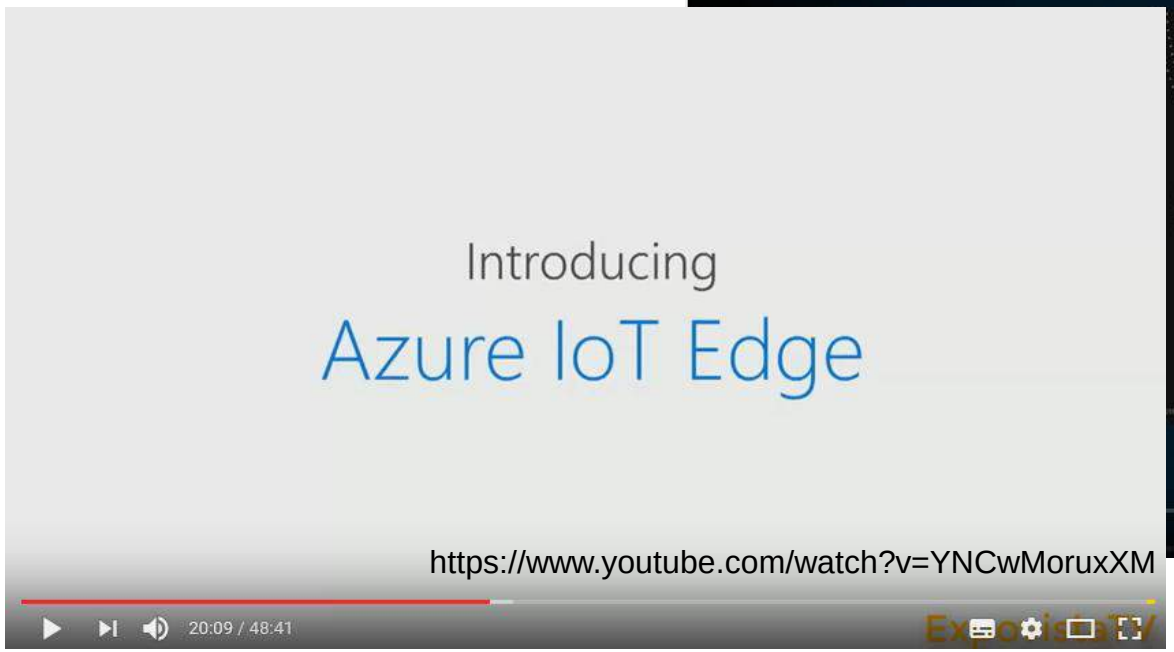
Megatrend: Edge Cloud Computing (aka Fog or Mist Computing)

Forbes / Tech

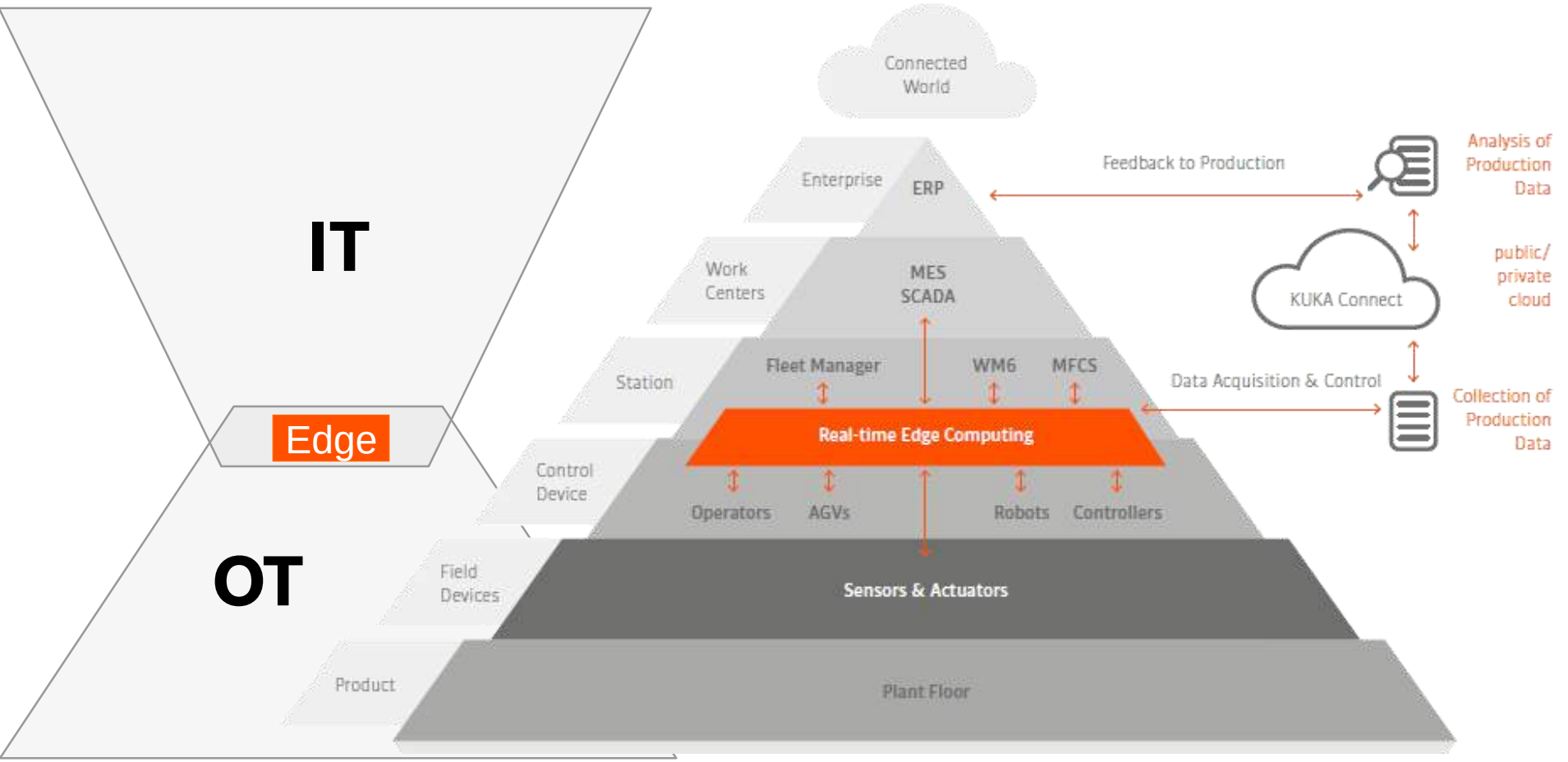
OCT 20, 2015 @ 05:38 PM 4,456 VIEWS

Dell Says The Future Of IoT Is At The Edge





The Edge: Where Operation Technology (OT) meets Information Technology (IT)



The Importance of the Edge

Open REST APIs

KUKA connyun

The (“slow”) Mastermind

Cloud

Firewall

On Premise

Trend

Decentralization of the Cloud functions **down** to the Edge (i.e. Amazon Greengrass, MS Azure IoT Edge, etc.)

OPC over AMQP
Unified Architecture

KUKA RT-Edge

Decentralized (“fast, deterministic”) Brains

Edge Cloud

Vegetative Muscles & Sensors

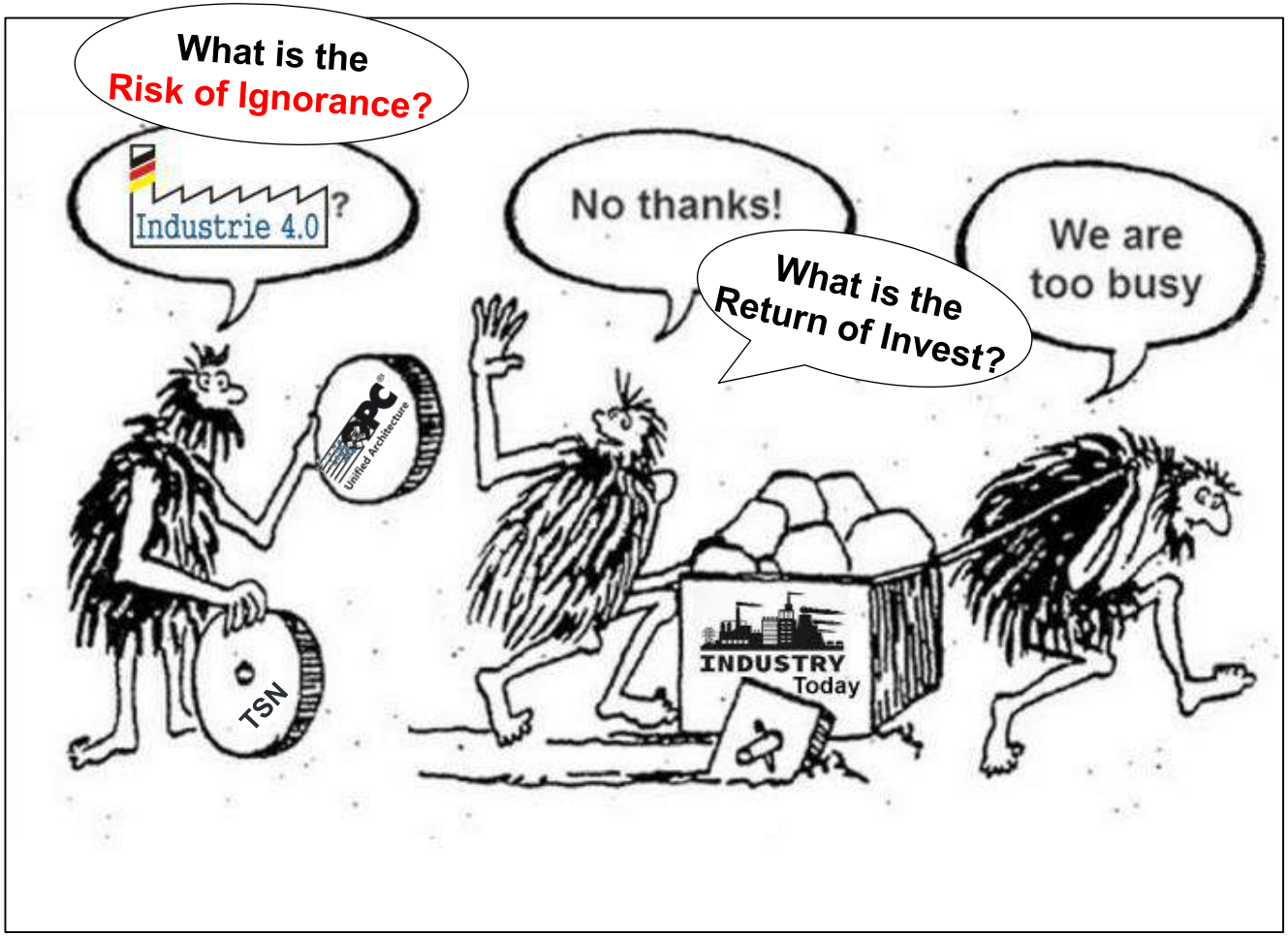
Things

Trend

Centralization of the Things functions **up** to the Edges (i.e. Robot/ Process/ PLC/ Cell Control, Safety Supervision, etc.)

Don’t ask for ROI, ask for ROI ! And of course, ask for

ROI MANAGEMENT CONSULTANTS



Thank you for your attention!