Landtechnik im Wandel des 21. Jahrhunderts
Mobile Arbeitsmaschinen werden zu „Cyber-Physical Systems (CPS)"

Prof. T.Herlitzius, Lehrstuhl Agrarsystemtechnik

Today high performance agricultural machines establish productivity by

- growing working width,
- higher operational speed,
- larger storage volumes,

which expands engine power, weight & size.

Today weight and dimension are becoming a major limitation (NA, EU)

Machines become smarter by

Process Automation

- Internal System-and Process Control
- Machine Fleet Management
- Process Chain Control
- Autonomous Machine Control

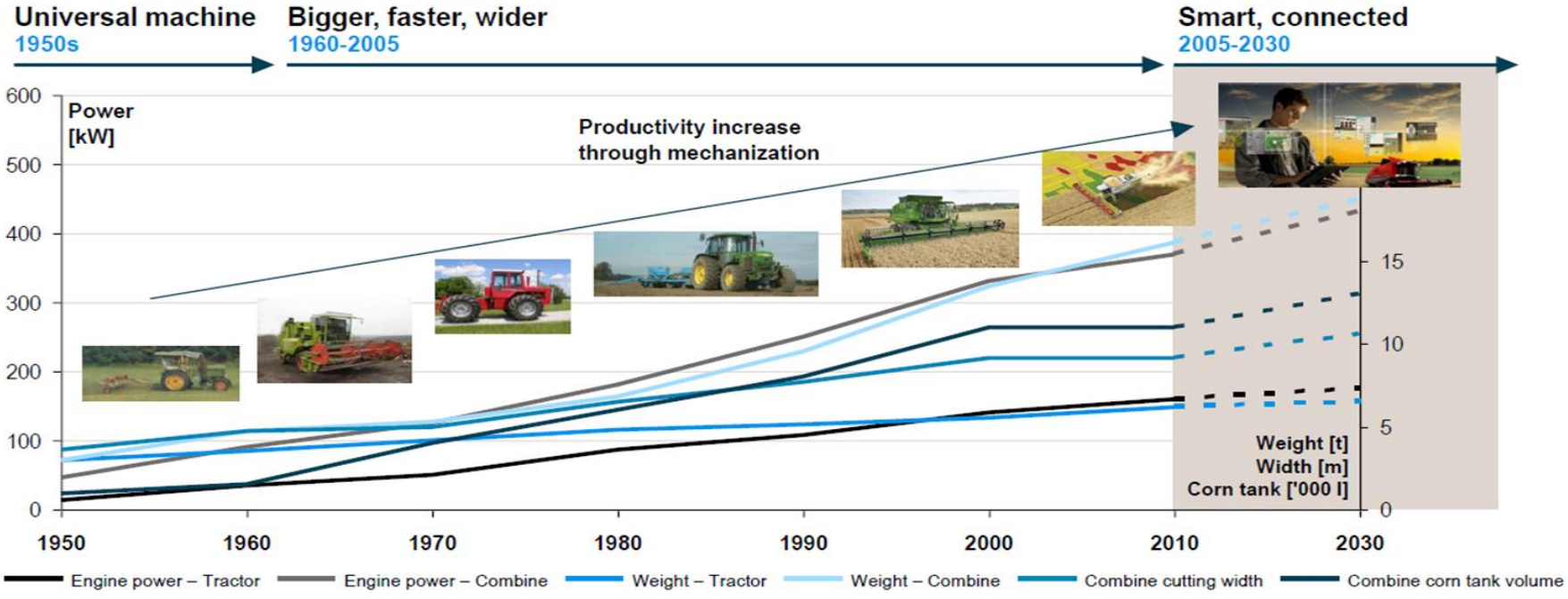
yet immature

Evolution to smart & connected

Source: Roland Berger Consultants

After a steady increase in machinery parameters in the past, agricultural machinery is becoming smarter and more connected

Evolution of agricultural machinery, past and future (Europe)



Future information and communication technology could change agricultural production processes in a unprecedented way !

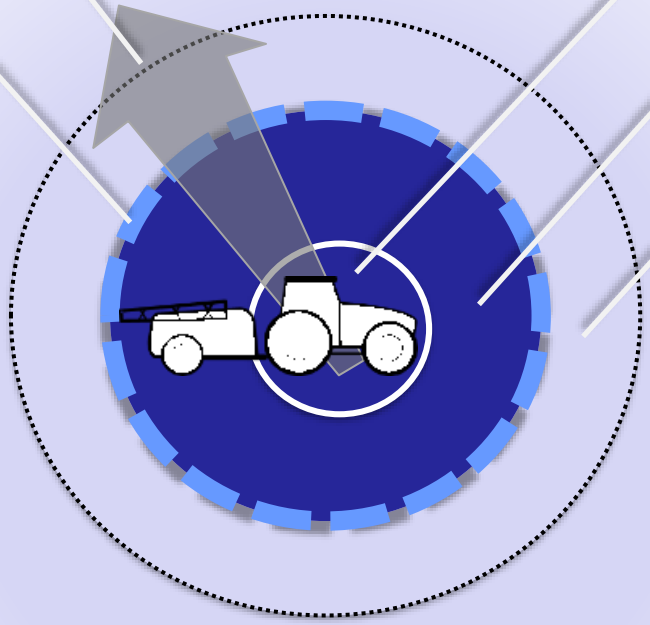
- **5G mobile communication**
- Internet of Things – automated data exchange between devices
- Mobile/Cloud Computing – Smart Phones, Tablets
- Consumers Electronics – Wearables

- location based monitoring – GIS information, UAS
- Big Data – Linked Open Data

Evolution of machines from embedded to cyber–physical systems

increasing complexity

communication wall between machine system and the world

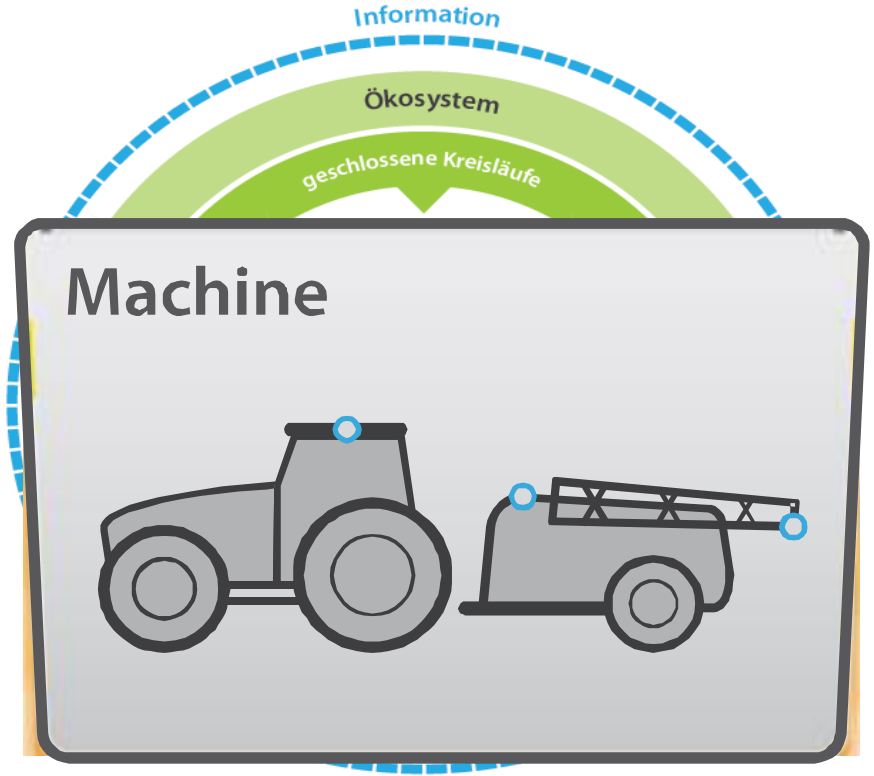


Embedded System
e.g. hitch controller

Controllernetzwerk
e.g.traktor-implement - ISO-Bus

Cyber-Physical System
e.g. M2M, Telematics

Vision:
Internet of Things
Data & Services



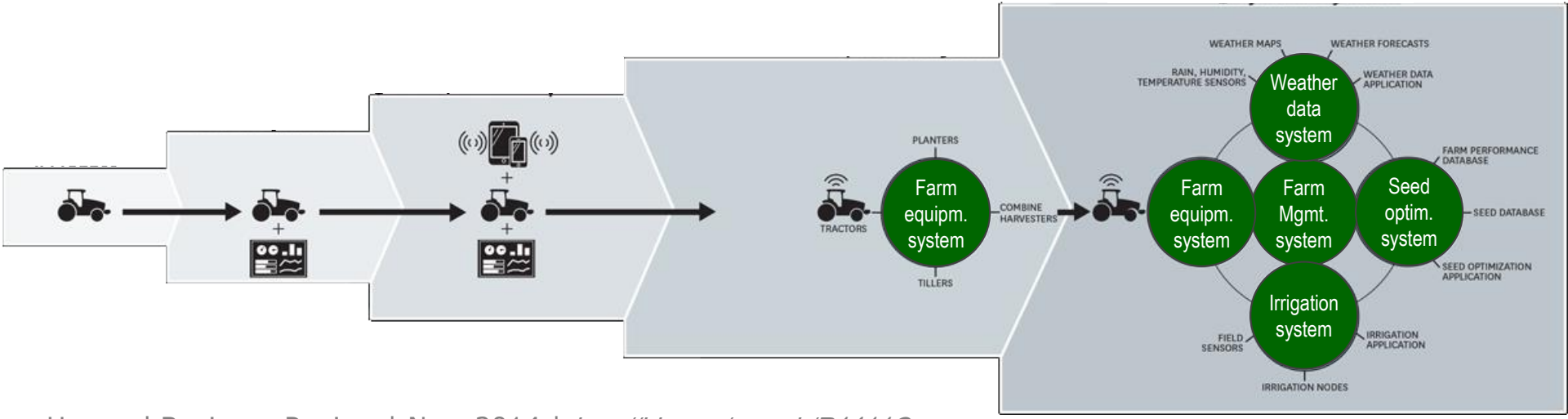
productivity
peak performance
process quality
cost of ownership

connectivity

sustainability
resource recirculation
biodiversity

How Smart, Connected Products Are Transforming Competition

product → smart product → smart,connected product → product system → system of systems



Harvard Business Review | Nov. 2014 | *http://hbr.org/search/R1411C*

Michael E. Porter is a University Professor at Harvard, based at Harvard Business School in Boston
James E. Heppelmann is the president and CEO of PTC

product → smart product → smart,connected product → product system → system of systems

Definition Edward A. Lee, 2008 [1]**:**

„Cyber-Physical Systems (CPS) are integrations of computation with physical processes.

Embedded computers and networks monitor and control the physical processes, usually with feedback loops where physical processes affect computations and vice versa."

Acatech research agenda, 2012 [2]**:**

Connection of physical system with information technology utilizing open global networks (e.g. Internet)

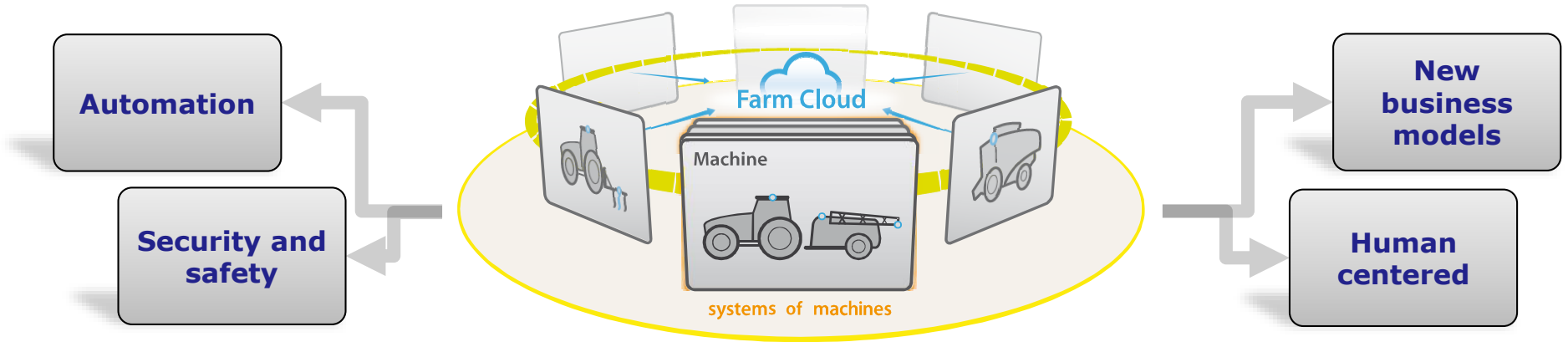
Typical examples "Smart Grids", „Car-to-X"

[1] Cyber Physical Systems: Design Challenges", E. A. Lee, Technical Report No. UCB/EECS-2008-8; http://www.eecs.berkeley.edu/Pubs/TechRpts/2008/EECS-2008-8.html

[2] Integrierte Forschungsagenda Cyber-Physical Systems, Acatech 2012; http://www.acatech.de/?id=1405

Future creation of added value takes place with many and in real time communicating players in closely connected networks .

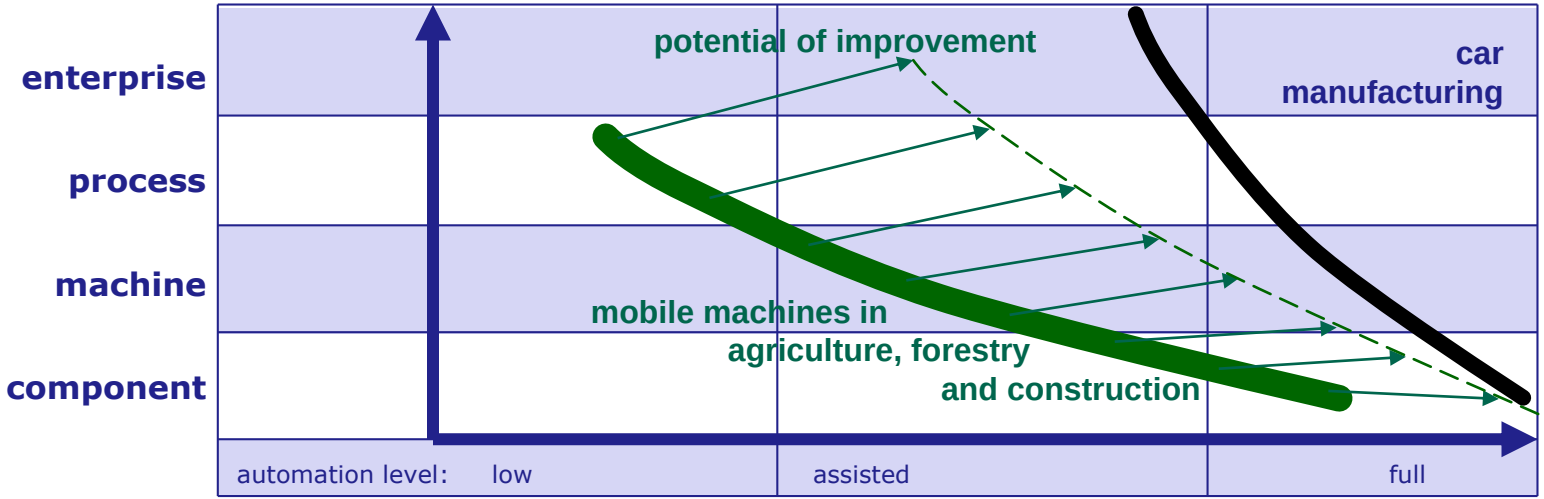
Roland Berger Strategy Consultants / BDI, 2015
DIE DIGITALE TRANSFORMATION DER INDUSTRIE



Robust and economical viable automation is pre-condition for autonomous systems

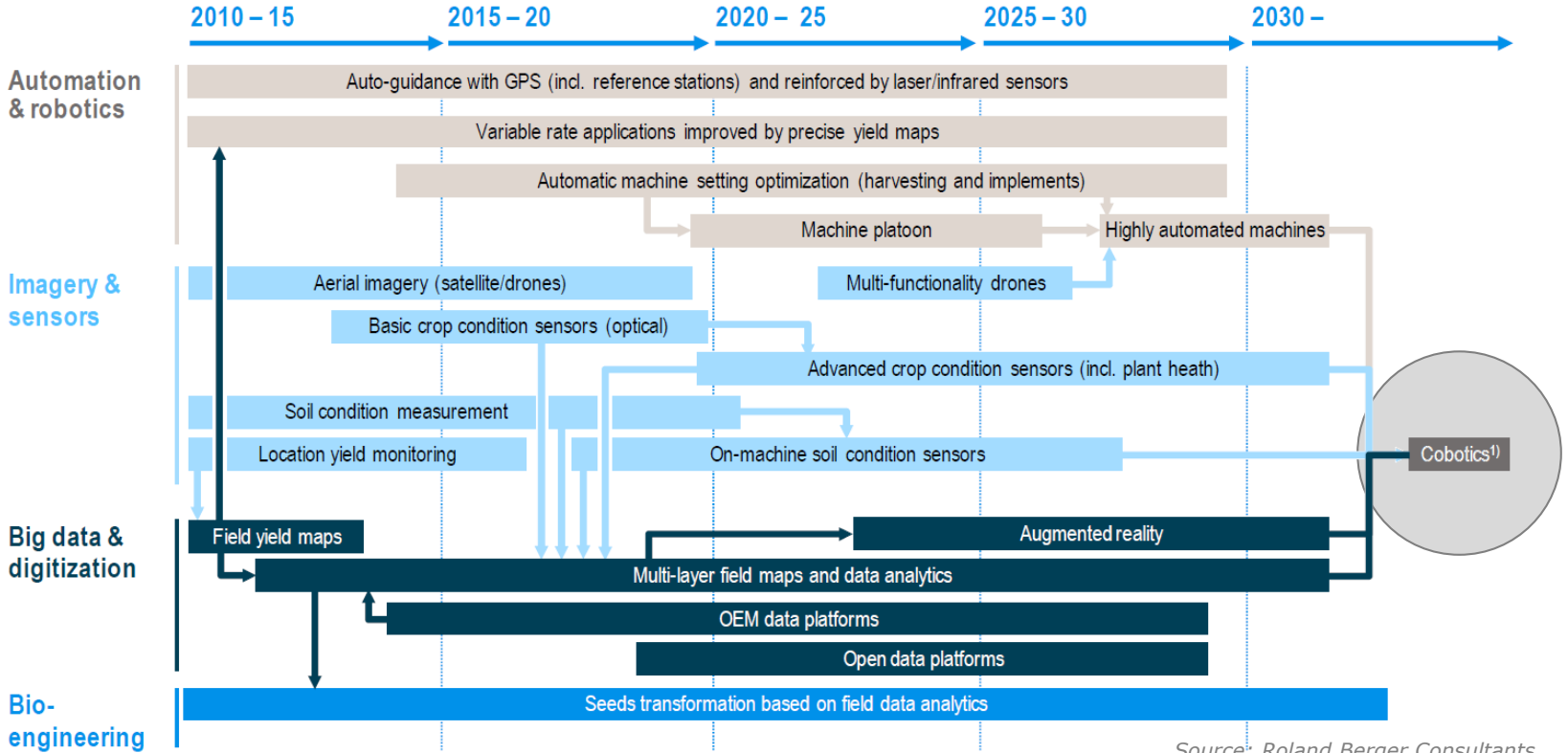
Problem of automation in biobased value chains:

- many disturbances and strong variation of inputs
- lack of sensors and process knowledge
- huge diversity of machines and execution of processes



Griepentrog (2015), modified

Technology roadmap for developments driven by enhanced connectivity

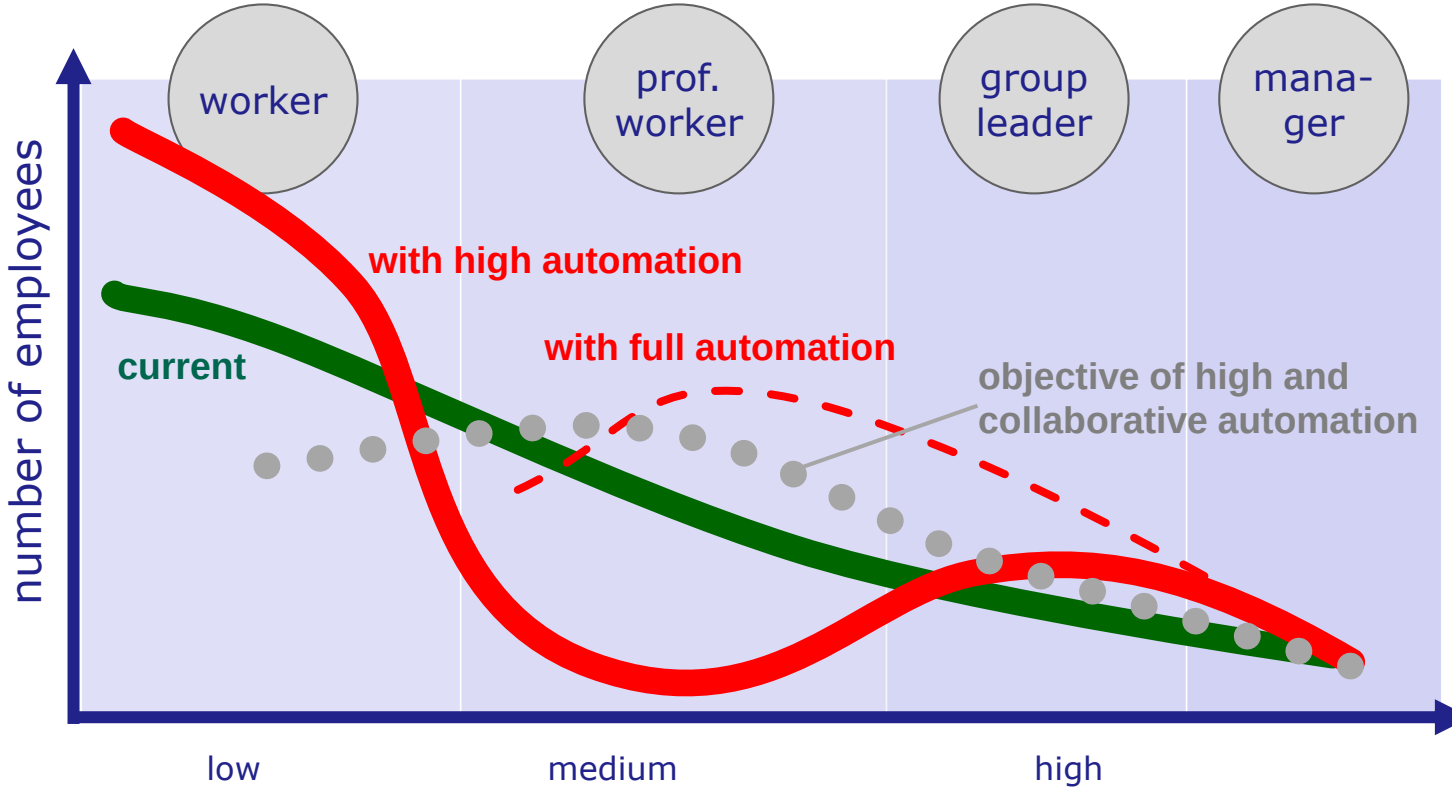


Source: Roland Berger Consultants

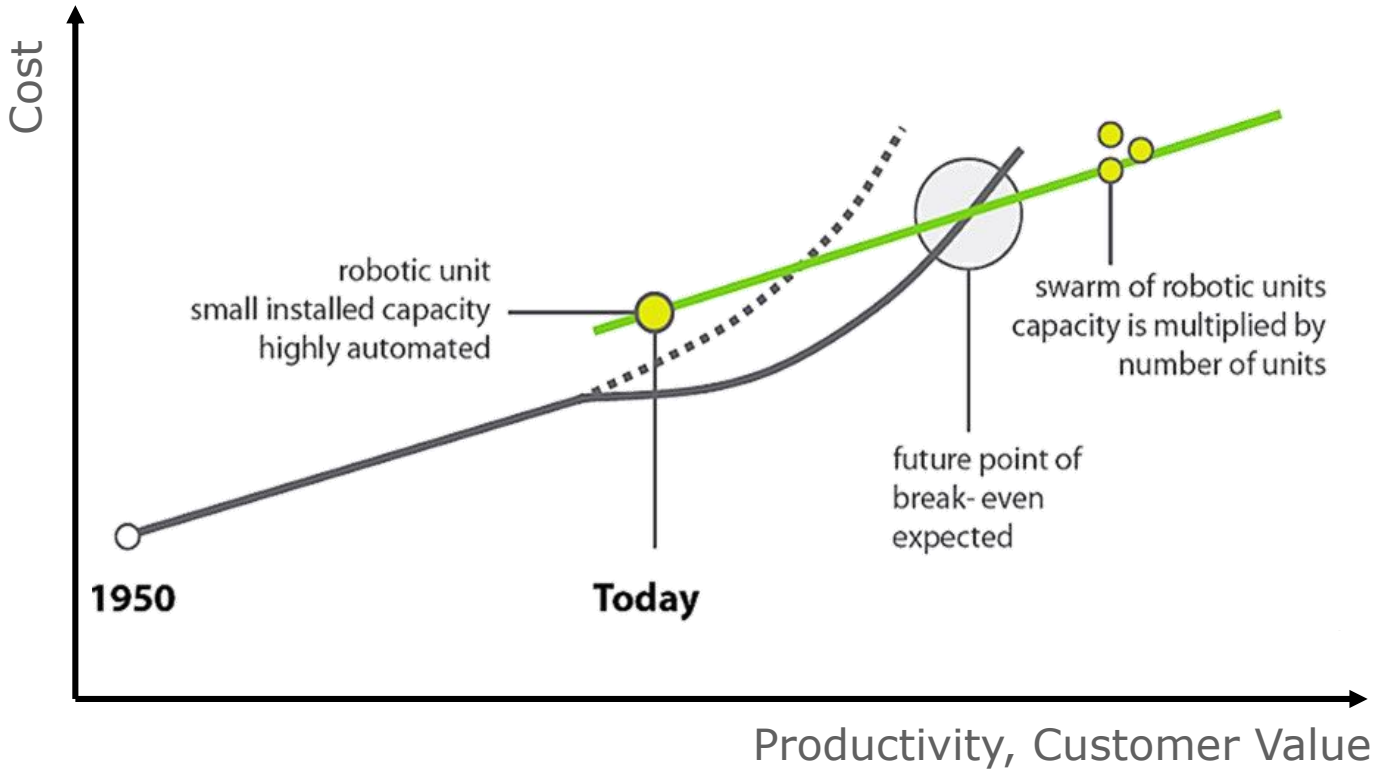
1) Collaboration of humans and machines

Challenge of Automation

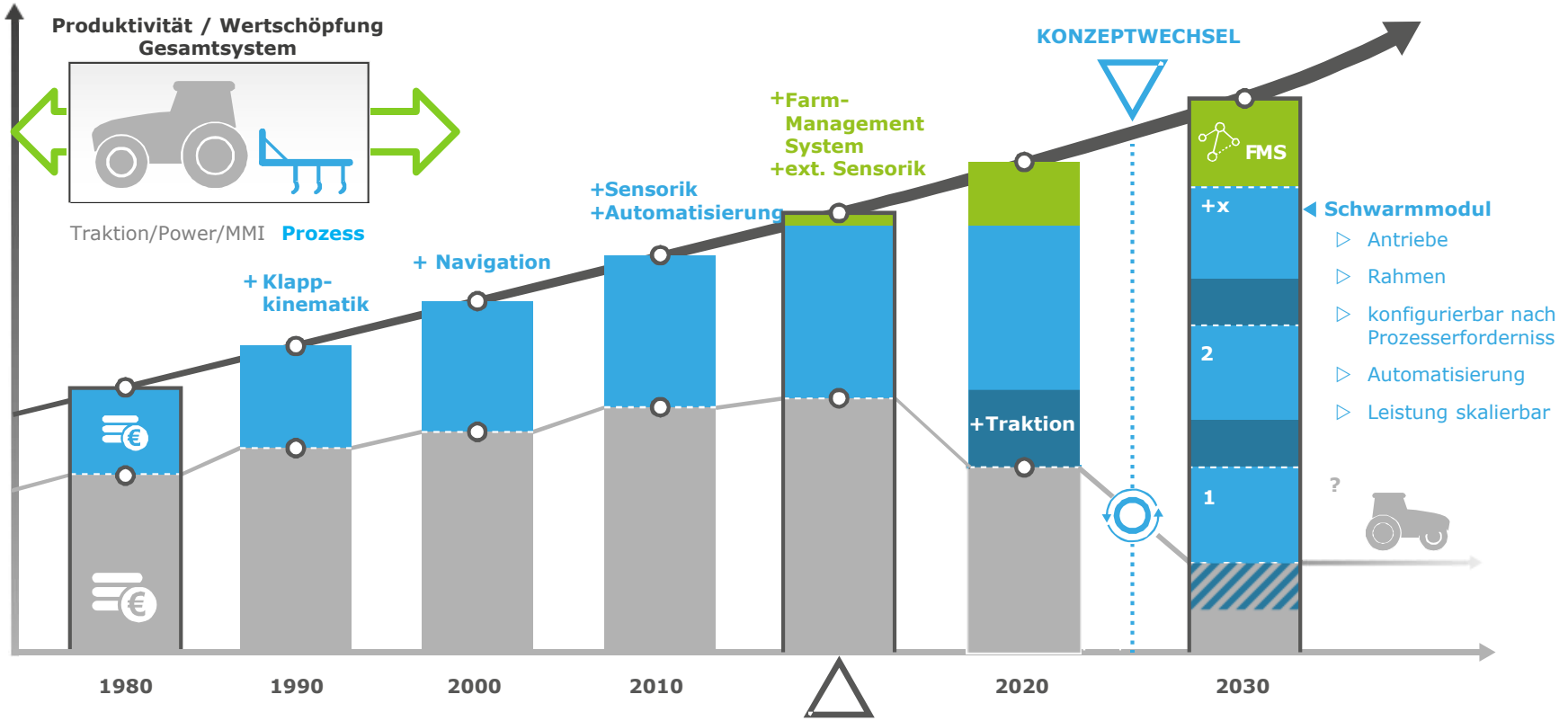
considering human as part of the system vs. a limitation



Vision of systems of machines towards robotic swarms



Evolution von Traktor Geräte Systemen



Thank you for following through

the future world of cyber-physical systems