

# FROM RFID TO THE INTERNET OF THINGS

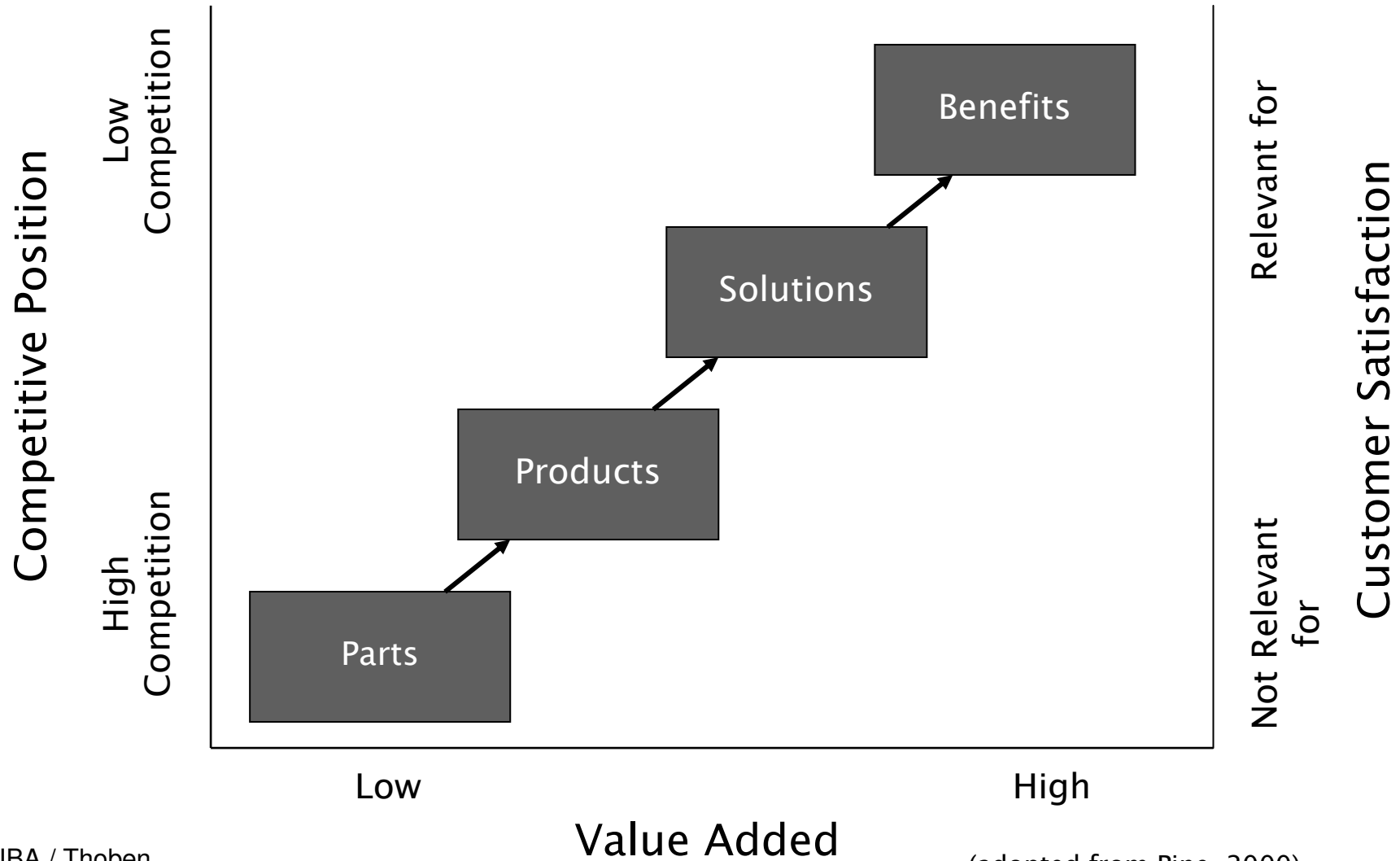
Pervasive Networked Systems

Intelligent and Networked Products  
A product and manufacturing perspective

Klaus-Dieter Thoben  
tho@biba.uni-bremen.de

**BIBA**

# The Progress of Competitive Advantage



© BIBA / Thoben

(adopted from Pine, 2000)

# Achieving customer satisfaction: Complex offerings require complex processes

---

Providing Solutions/Benefits require:

- complex offerings/products
  - Extended Products
  - Product Service Systems
  - Hybrid Product Service bundles
  - ...
- complex processes:
  - „End to End“ solutions
  - „From Cradle to Grave“ solutions
  - „From Field to Fork“ solutions
  - ...
- Customisation:

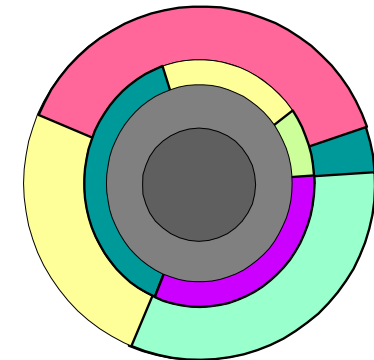
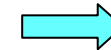
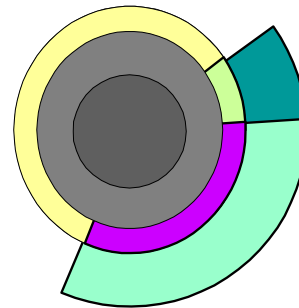
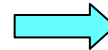
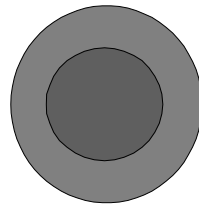
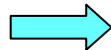
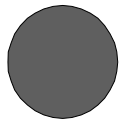
# Evolving the Traditional Concept of a Product



Core Product

Tangible Product

Tangible and Intangible Product Assets



**Manufacturing of Parts**

**Offering of Products / Systems**

**Offering of Solutions**

**Provision of Benefits**

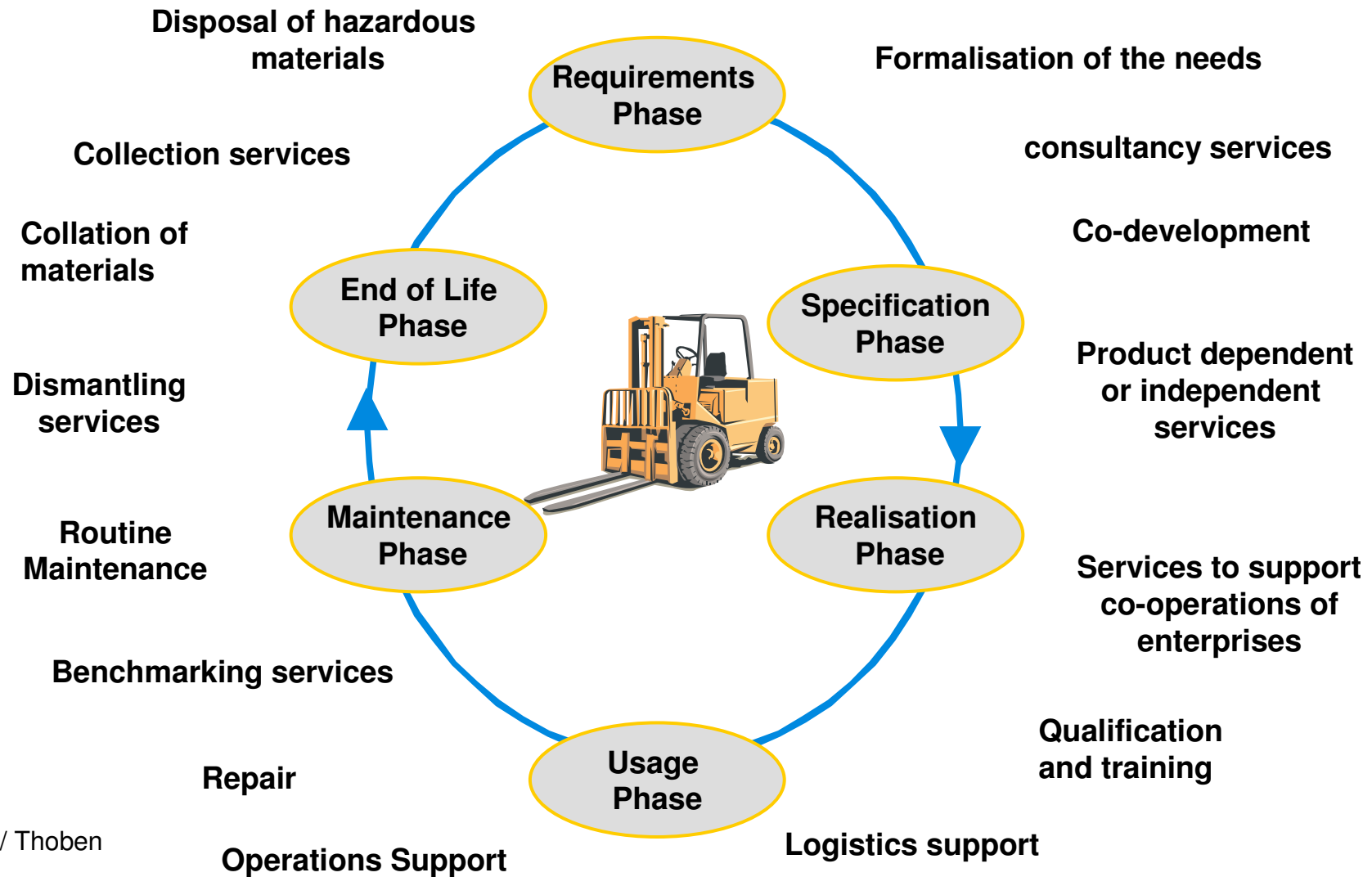
**Shift of Business Focus**

© BIBA / Thoben

**BIBA**

FROM RFID TO THE INTERNET OF THINGS  
Brussels, Belgium, March 6th. and 7th.  
Klaus-Dieter Thoben {tho@biba.uni-bremen.de}

# Potential Services Along the Product Life-Cycle



© BIBA / Thoben

**BIBA**

FROM RFID TO THE INTERNET OF THINGS  
 Brussels, Belgium, March 6th. and 7th.  
 Klaus-Dieter Thoben {tho@biba.uni-bremen.de}

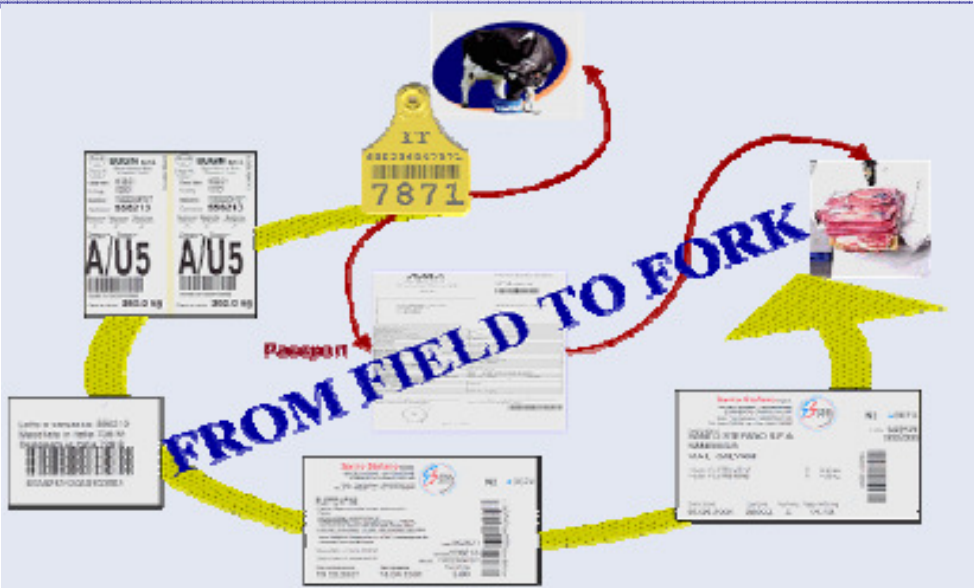
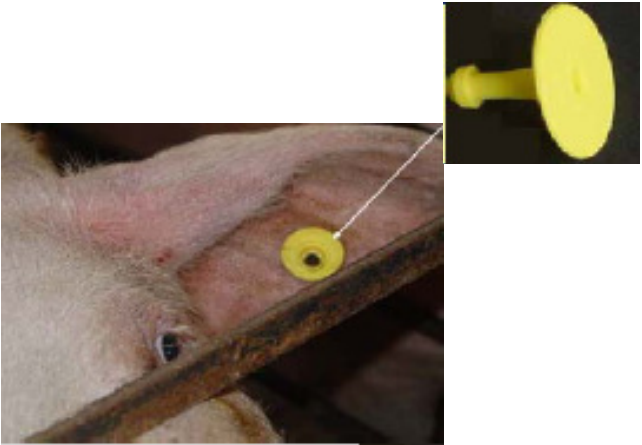
# Achieving customer satisfaction: Complex offerings require complex processes

---

Providing Solutions/Benefits require:

- complex offerings/products
  - Extended Products
  - Product Service Systems
  - Hybrid Product Service bundles
  - ...
- complex processes:
  - „End to End“ solutions
  - „From Cradle to Grave“ solutions
  - „From Field to Fork“ solutions
  - ...
- Customisation:

# From Field to Fork



© BI

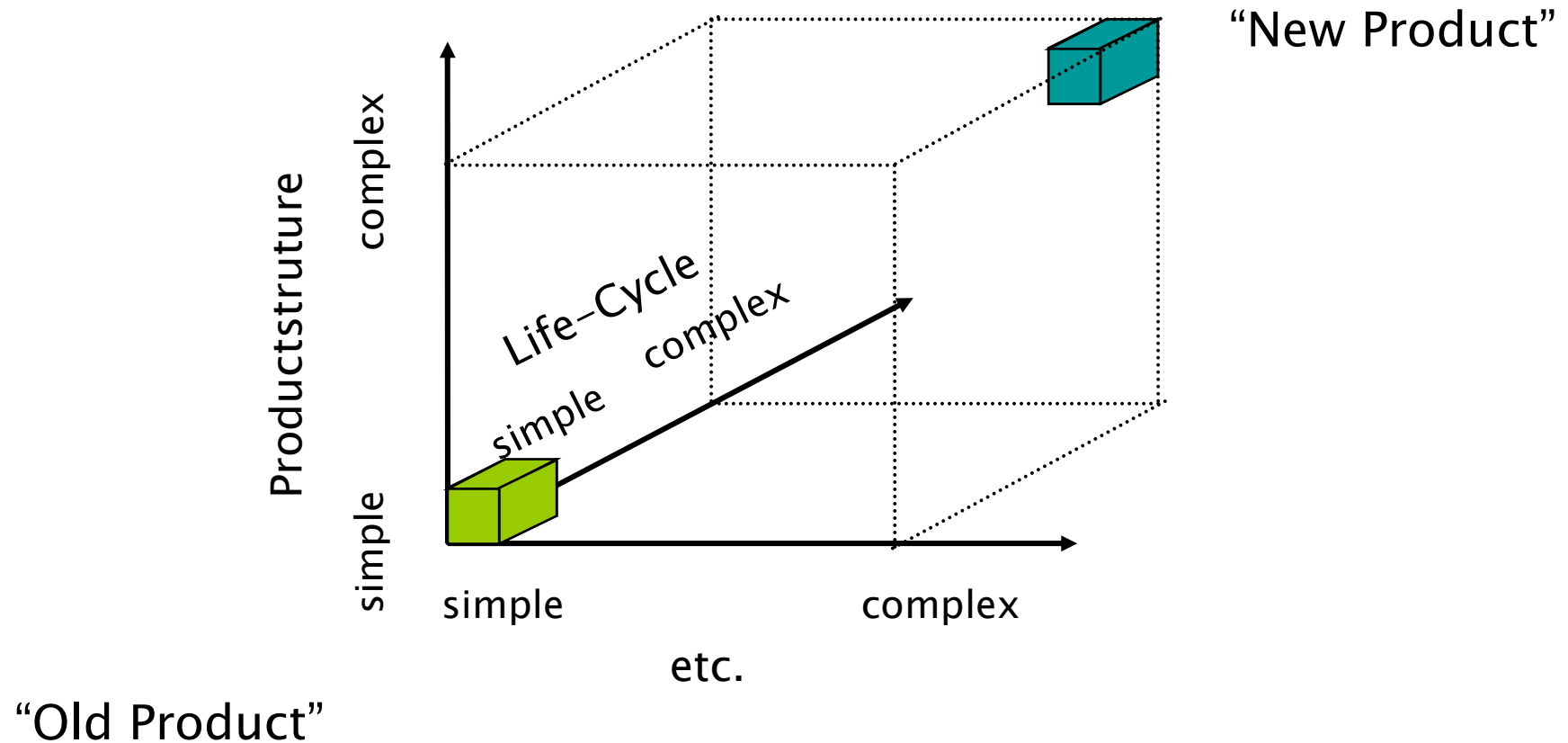


FROM RFID TO THE INTERNET OF THINGS  
 Brussels, Belgium, March 6th. and 7th.  
 Klaus-Dieter Thoben {tho@biba.uni-bremen.de}

(Source: C. Aguilera / ISOIN / 2005)

# New Products: Dimensions to be considered!

---



© BIBA / Thoben

**BIBA**

FROM RFID TO THE INTERNET OF THINGS  
Brussels, Belgium, March 6th. and 7th.  
Klaus-Dieter Thoben {tho@biba.uni-bremen.de}



# Products: From “passive objects” to “intelligent subjects”

---

**New Products provide new/additional features. New products can**

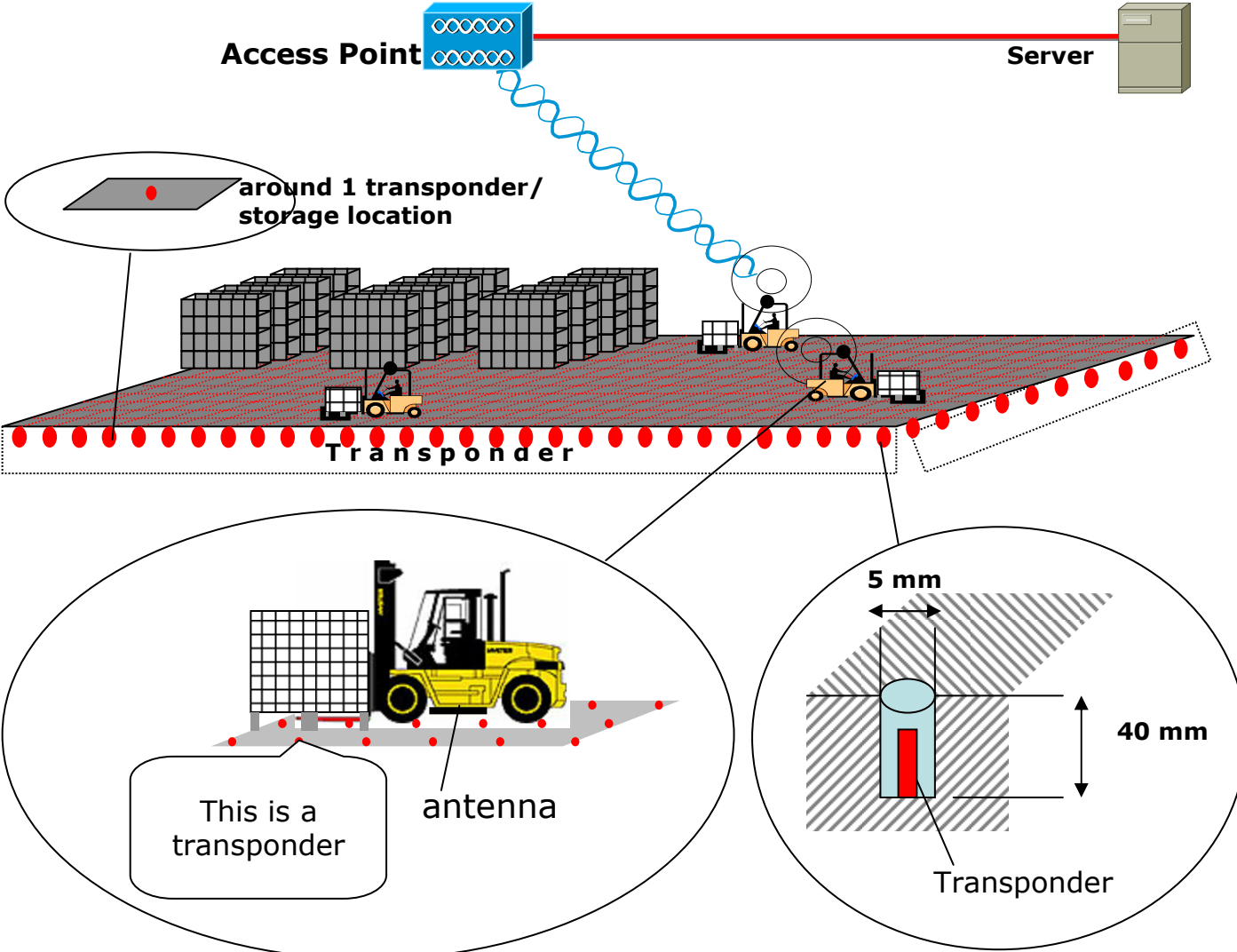
- be identified (have an identity)
- be localized
- communicate with
  - each other; users; environment
- aggregate data about itself (using sensors)
- provide data (e.g operational, status) about itself
- ...

**How to make best use of new product features / capabilities and increase competitiveness?**

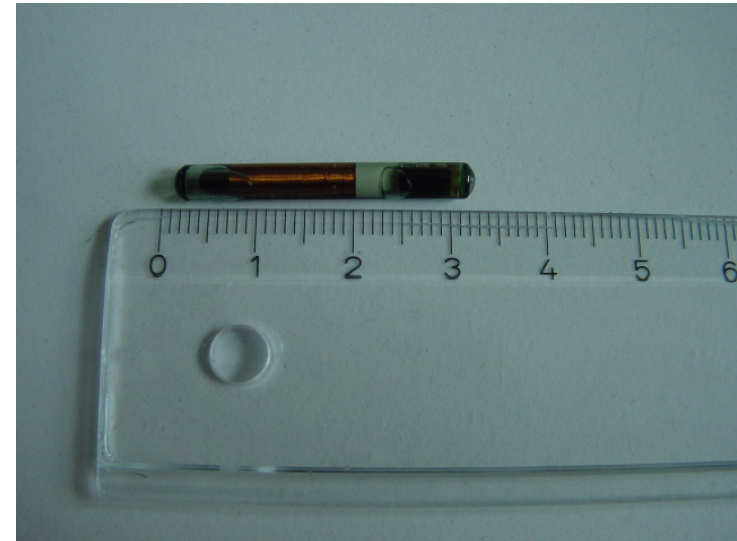
**Examples to follow:**

© BIBA / Thoben

# RFID supported Tracking and Tracing



# Tracking and Tracing Infrastructure



**BIBA**

FROM RFID TO THE INTERNET OF THINGS  
Brussels, Belgium, March 6th. and 7th.  
Klaus-Dieter Thoben {tho@biba.uni-bremen.de}

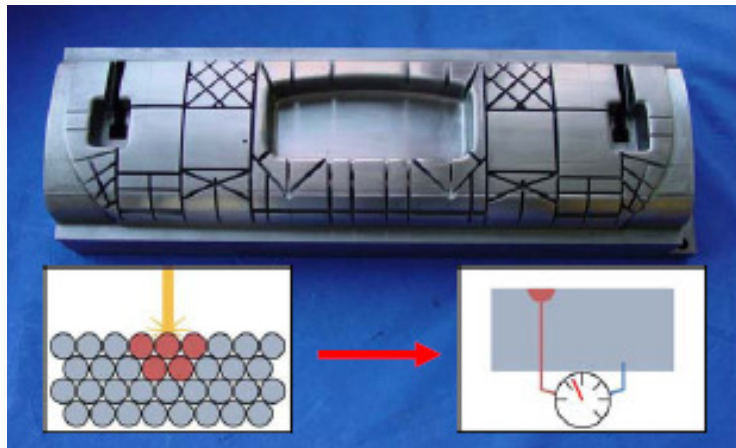


# WLAN supported tools for efficient warehouse management



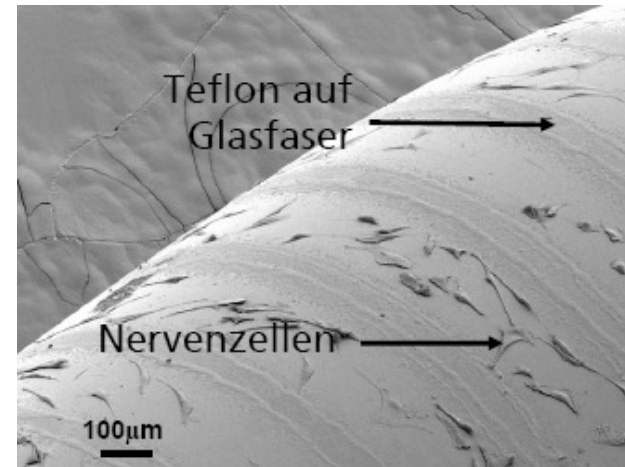
# Smart materials enabling smart products

## Mould knowing its temperature



Integration of sensors by  
Selective Lasersintering or 3D-  
Printing

## Cell meets Surface



Printing and structuring of  
cells onto technical  
surfaces through Maskless  
Mesoscale Material  
Deposition (M<sup>3</sup>D)



# Autonomous Cooperating Logistic Processes: A Paradigm Shift and its Limitations

---

## Collaborative Research Centre (CRC)



- Long-term university (basic) research project (up to 3 x 4 years = 12 years)
- Cross-disciplinary research programme,
- Consists of 10-15 sub-projects (from 10 research groups)

## Overall Approach:

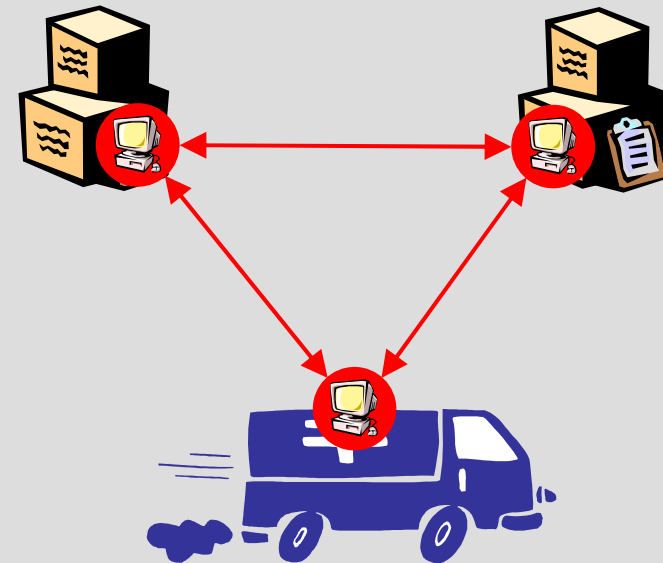
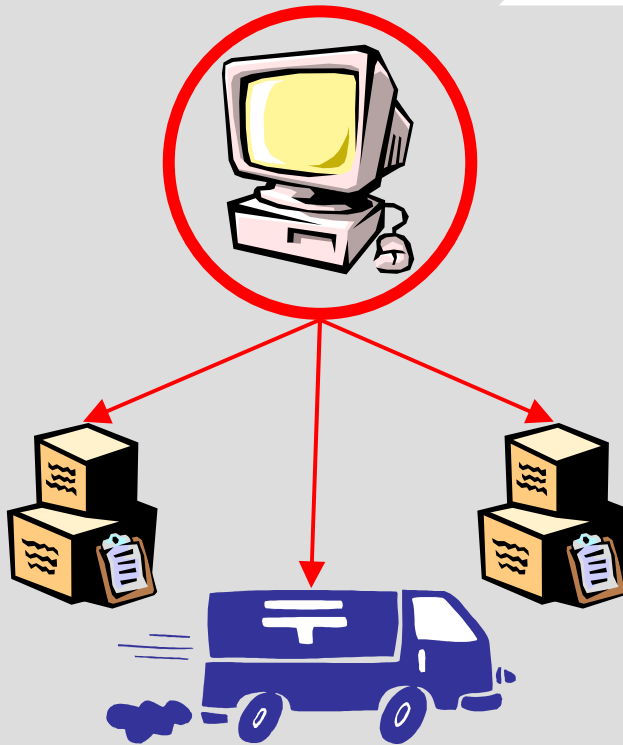
- To provide autonomy to logistic objects and enable them to make decisions by themselves to route autonomously through a logistics network.
- Investigation of the impacts of the autonomy paradigm on logistics systems and their future development using modified control methods

# From Hierarchical to Autonomous Control

- Hierarchical IT structure
- Global information processing
- Centralised control

**Paradigm Shift**

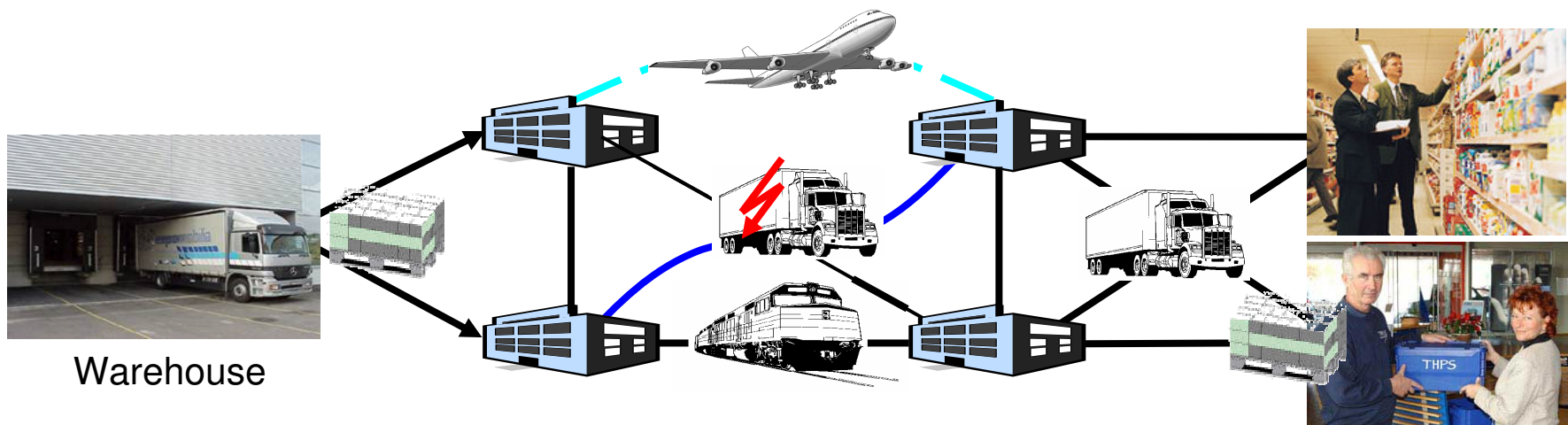
- Distributed IT structure with global communication
- Local information processing
- Autonomous decentralised control





# Autonomous Cooperating Logistic Processes: Scenario: Transportation Logistics

<p><b>Flexibility:</b> Cargo is able to choose route A or B.</p>	<p><b>Local decision-making:</b> Cargo uses rules and decides autonomously, e.g., choose the route with the lowest costs.</p>	<p><b>Identification:</b> Cargo, trucks etc. are able to identify themselves.</p>	<p><b>Measuring ability:</b> Cargo recognises a road blocking using sensors on it.</p>	<p><b>Decentralised data processing:</b> Cargo processes its sensor data decentralised by itself and informs other actors in its environment about its situation.</p>
--	---	---	--	---

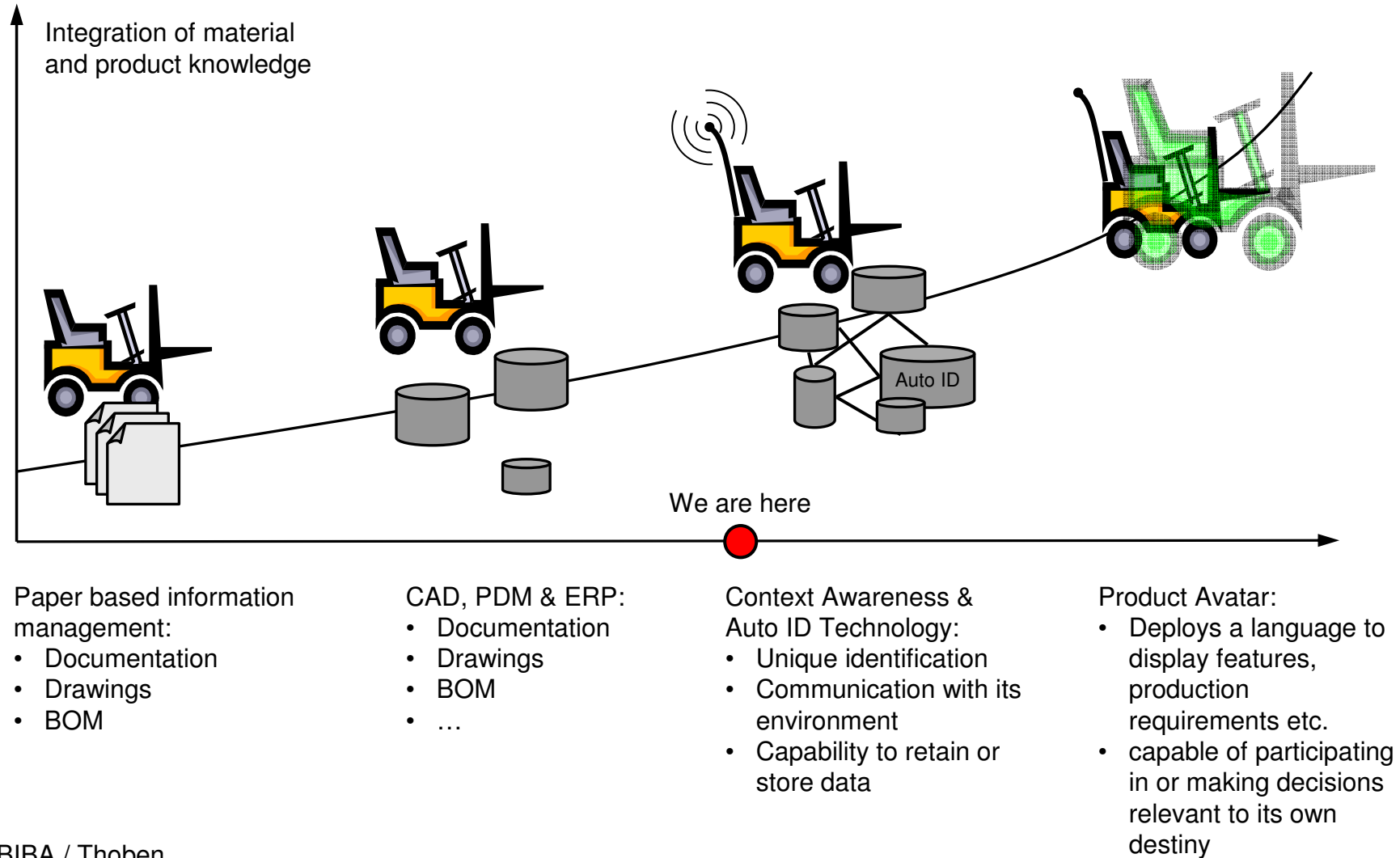


<p><b>Alternatives for decisions:</b> Cargo can be transported via hub A as well as via hub B .</p>	<p><b>Decentralised keeping of data :</b> Every part of cargo contains its product data and transportation data.</p>	<p><b>Ability to interact:</b> Single packages or pallets communicate with each other, e.g., to assemble a cargo.</p>	<p><b>Local, dynamic system of objectives:</b> Adaptation of system's objectives of truck A because of the road blocking, e.g., from "cheapest route" to "due-date delivery".</p>
---	--	---	---



# Enablers for Intelligent Products

## Product related knowledge representations



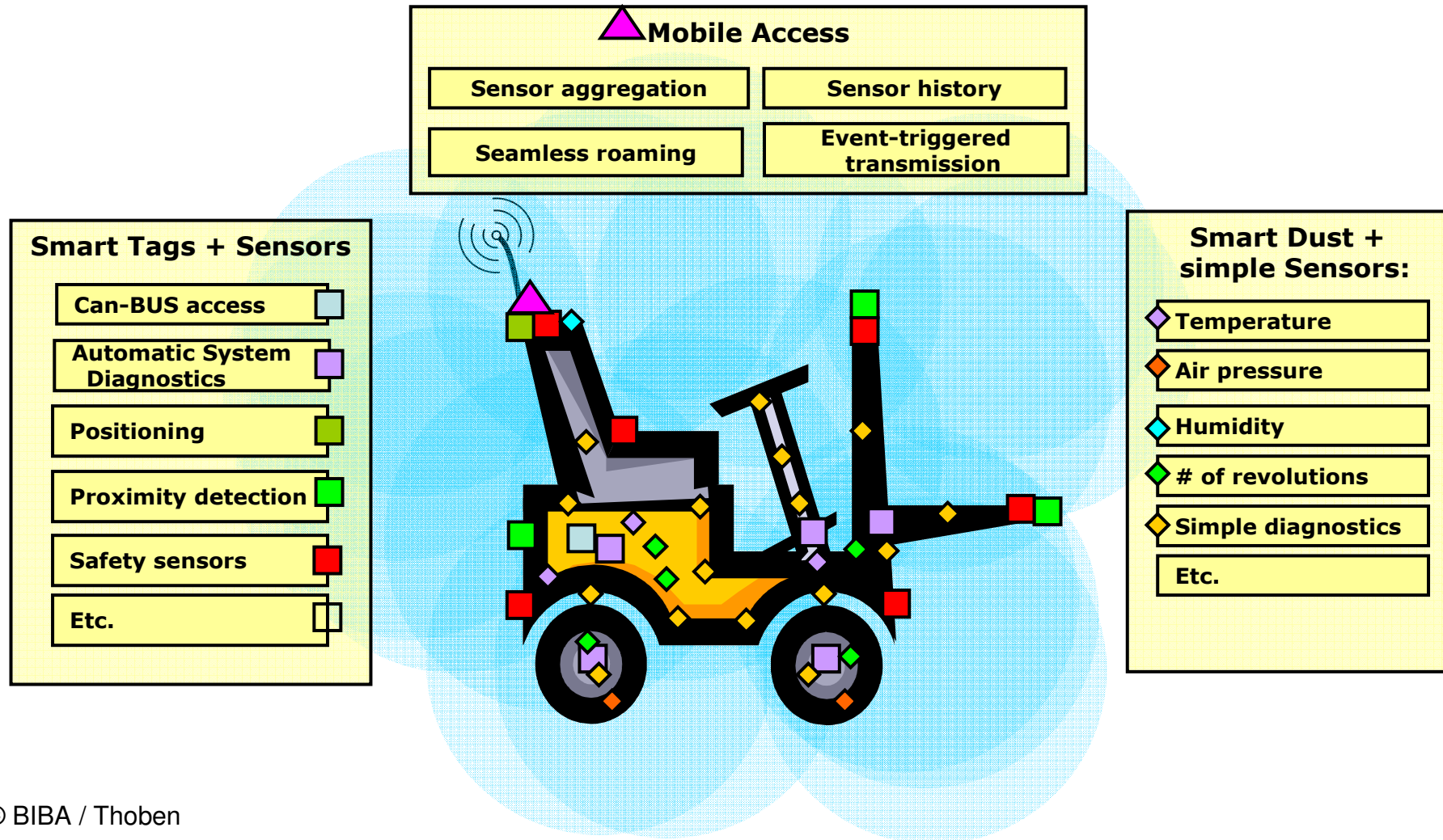
© BIBA / Thoben

**BIBA**

FROM RFID TO THE INTERNET OF THINGS  
 Brussels, Belgium, March 6th. and 7th.  
 Klaus-Dieter Thoben {tho@biba.uni-bremen.de}

# Enablers for Intelligent Products

## Sensors, actuators, etc.

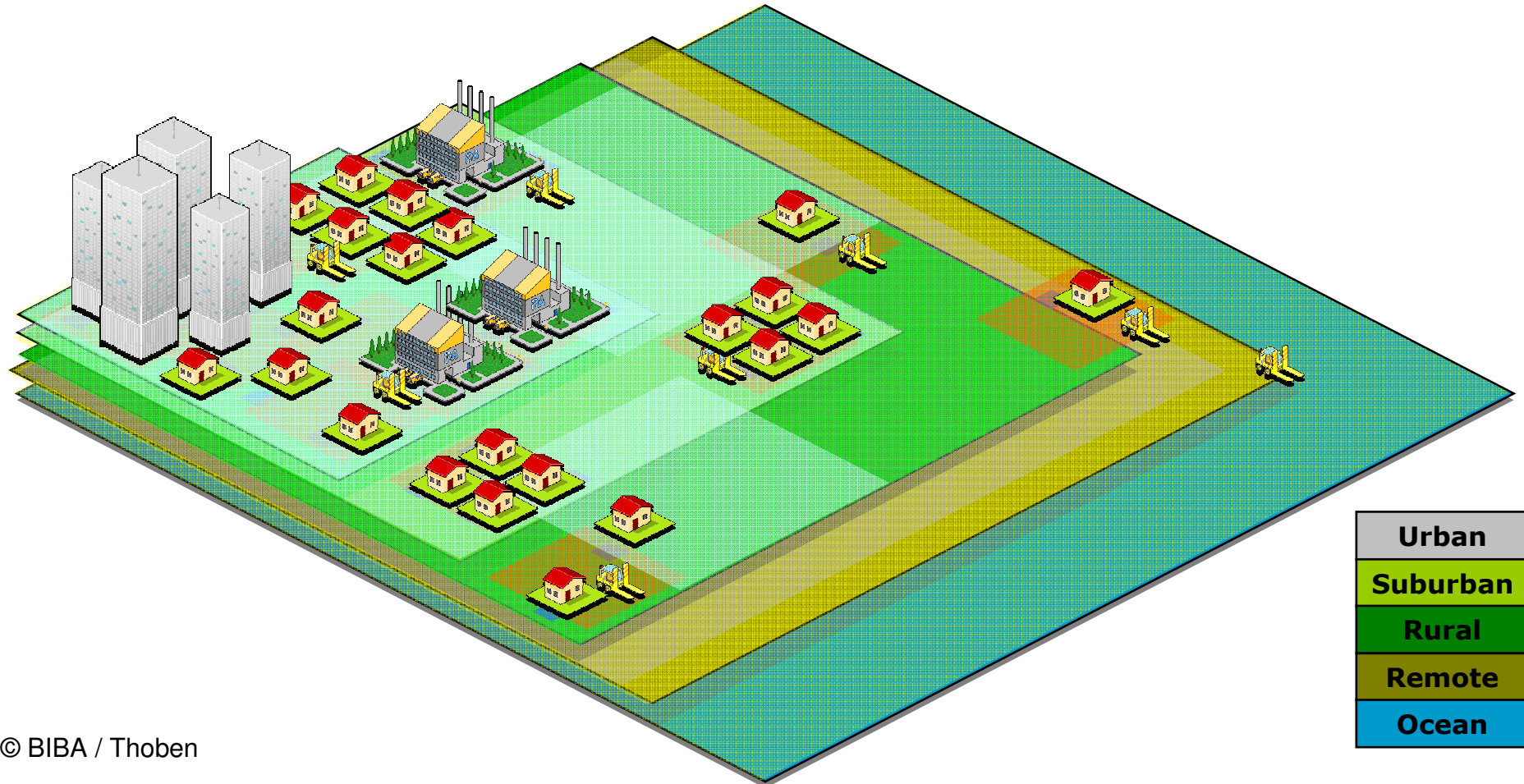


© BIBA / Thoben

**BIBA**

FROM RFID TO THE INTERNET OF THINGS  
Brussels, Belgium, March 6th. and 7th.  
Klaus-Dieter Thoben {tho@biba.uni-bremen.de}

# Enablers for Intelligent Products: e.g. Ubiquitous Access

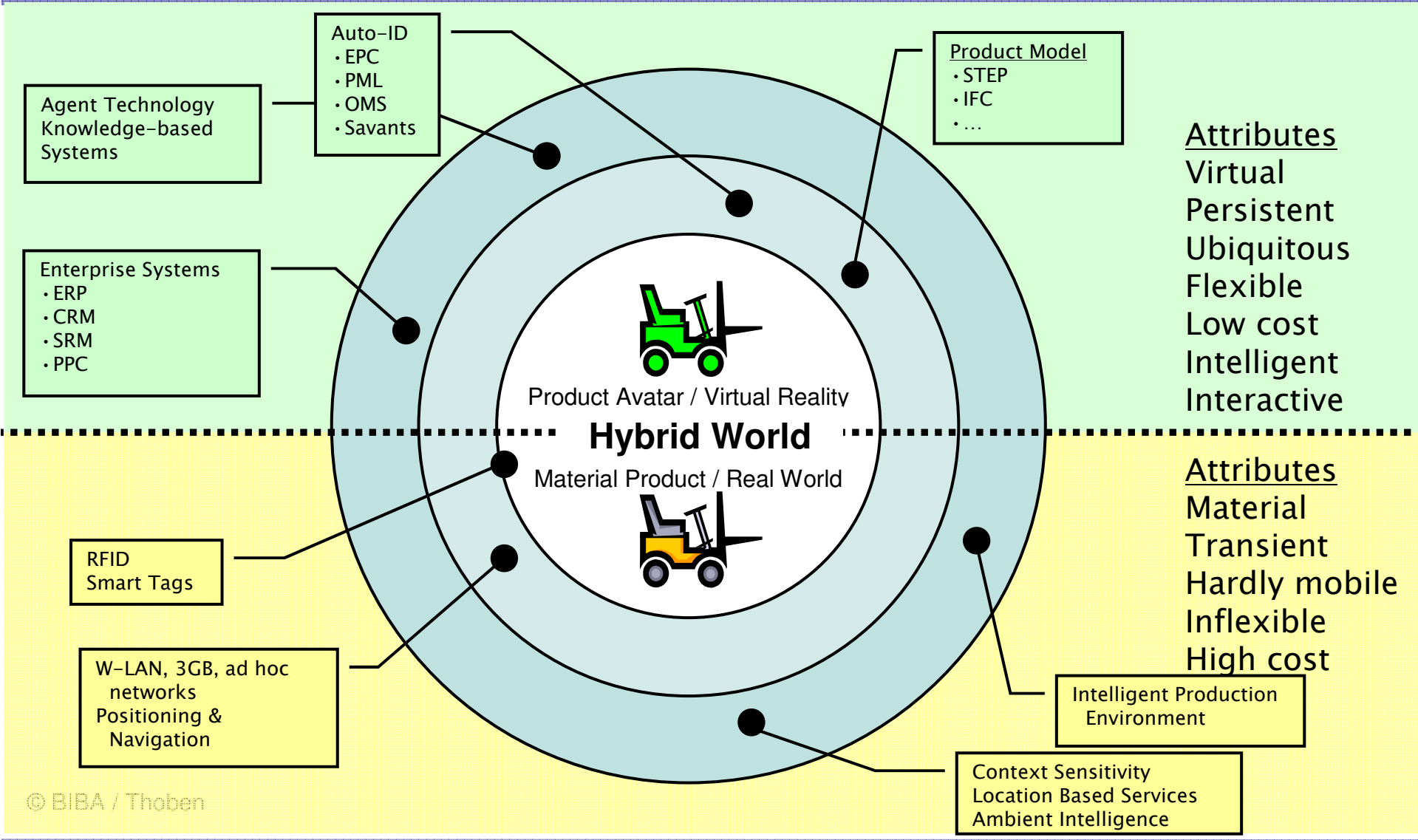


© BIBA / Thoben

**BIBA**

FROM RFID TO THE INTERNET OF THINGS  
Brussels, Belgium, March 6th. and 7th.  
Klaus-Dieter Thoben {tho@biba.uni-bremen.de}

# Enablers for Intelligent Products: Standards and technologies in hybrid world



© BIBA / Thoben



FROM RFID TO THE INTERNET OF THINGS  
Brussels, Belgium, March 6th. and 7th.  
Klaus-Dieter Thoben {tho@biba.uni-bremen.de}

# What is required to provide „new products“?

---

- A long lasting life cycle oriented integrated strategy
- A sophisticated communication infrastructure
- Companies that care about their product – beyond warranty
- Concepts, strategies and technologies to enable / support long lasting customer relationship
- To establish a lasting communication channel between Customer and producer
- A central access point to product related data (for producers, service providers and the customers)
- Provision of live-time communication contact with intelligent products ...

---

# Thank you for your attention!

---

Contact:  
K.-D. Thoben  
BIBA, Bremen  
tho@biba.uni-bremen.de  
Tel.: 0421-218-5529

