»Quo Vadis Logistik 4.0«
A Short Sketch of Changes and Future Trends in Transportation and Logistics

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Transporeon GmbH
I. Introduction – What is Transport-Logistics 4.0?
- 4.0 – a revolution of artificial intelligence
- About 4.0 breakthroughs and emerging mega trends
- From Industry 4.0 to Logistics 4.0

II. The main competences of Logistics 4.0
- Digitalization
- Network collaboration
- Service-level extension

III. Future Perspectives & Summary
- Robotization
- Urbanization
- 3D fabrication
- The End!!
... leading to the 4th industrial (r)evolution...

Breakthroughs - A new era of artificial intelligence

Communication technology
bandwidth and computational power

Embedded systems
miniaturization

Semantic technologies
information integration

Watson 2011

Google Car 2012

Systems of “human-like” complexity
Communication technology
bandwidth and computational power

Semantic technologies
information integration

Embedded systems
miniaturization

... leading to the 4th industrial (r)evolution...

Breakthroughs - Everybody and everything is networked

- Car2Infrastructure
- Smart Grid
- Swarm Robotics
- Team Robotics
- Smart Factory

IMA ZLW IfU

27.04.2016
S. Jeschke
... towards a networked world

The “Information Revolution”

Everybody and everything is networked. - Big Data & Cyber-Physical Systems

“Internet of Things & Services, M2M or Cyber Physical Systems are much more than just buzzwords for the outlook of connecting 50 billions devices by 2015.”

Dr. Stefan Ferber, Bosch (2011)

Vision of Wireless Next Generation System (WiNGS) Lab at the University of Texas at San Antonio, Dr. Kelley

Weidmüller, Vission 2020 - Industrial Revolution 4.0
Intelligently networked, self-controlling manufacturing systems

around 1750
around 1900
around 1970
today

1st industrial revolution
Power revolution
Digital revolution
Information revolution

Mechanical production systematically using the power of water and steam
Centralized electric power infrastructure; mass production by division of labor
Digital computing and communication technology, enhancing systems’ intelligence
Everybody and everything is networked – networked information as a “huge brain”

„local“
to „global“
„local“
to „global“
... towards a networked world

And how do these systems work?

Communication technology
bandwidth and computational power

Embedded systems
miniaturization

Semantic technologies
information integration

?? Steering - Controlling ??

Towards intelligent and (partly-) autonomous systems AND systems of systems

around 1750

1st industrial revolution
Mechanical production systematically using the power of water and steam

around 1900

Power revolution
Centralized electric power infrastructure; mass production by division of labor

around 1970

Digital revolution
Digital computing and communication technology, enhancing systems’ intelligence

today

Information revolution
Everybody and everything is networked – networked information as a “huge brain”
... towards a networked world
Not restricted to industry: cyber physical systems in all areas

Back to: “The earth converted into a huge ‘brain’ ”... (Tesla 1926)

Integrating complex information from multiple heterogeneous sources opens multiple possibilities of optimization:
e.g. energy consumption, security services, rescue services as well as increasing the quality of life

Building automation
Smart grid
"house 4.0"
"power grid 4.0"
Smart environment
"Logistics 4.0"
"mobility 4.0"
"health 4.0"
"education 4.0"
Room automation
"room 4.0"
Smart metering
"metering 4.0"
... and more
What is Logistics 4.0?
How will be the future of logistics or Logistics 4.0?

Definition along two different time scales:

1. **short-term:**
   - data-driven, highly networked processes between heterogeneous players
   - (optimization, efficiency, transparency of processes, ...)

2. **medium-term:**
   - autonomous systems
   - and self-organization of systems of systems
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Digitalization
Where do the data live?

Big Data Processing through Intelligent Cloud Solutions

Here, the term “cloud” is used in a maximum liberal style, namely as a solution for data storage and analysis somewhere outside of the place where the data are originally generated.

Cloud Functionalities

<table>
<thead>
<tr>
<th>Information integration</th>
<th>Cooperate</th>
<th>Granularity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complex data integrated and processed by platform services</td>
<td>Information exchange between cloud and teams</td>
<td>Access to single data and aggregated information</td>
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</table>

User Interaction

<table>
<thead>
<tr>
<th>Availability of information</th>
<th>Client Access</th>
<th>Omnichannel Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information available through powerful web services</td>
<td>Access to information from anywhere and at any time</td>
<td>Data access through various ways for heterogenous systems</td>
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</table>

The future of information access is service-oriented and omnipresent. “No access” is neither an option nor is it an allowed excuse...
Digitalization

Big Data induce “intelligence”: from Big Data to Smart Data...

→ Who the heck needs BIG data? - Let’s make sense out of them...

→ The Big Data analysis pipeline...

- transfers big data (many…) into smart data (meaningful data)
- accumulates intelligence from information fragments
- is a pipeline of aggregating (artificial) intelligence.

Acquisition / Recording → Extraction / Cleaning / Annotation → Integration / Aggregation / Representation → Analysis / Modeling → Interpretation / Prediction

BIG DATA + SMART DATA → INTELLIGENCE / DECISION / INSTRUCTION
Digitalization

Lateral thinking - what’s next?

Who is in the center of this development? Who is hosting the data?

What is the role of traditional logistics companies, and how / to which degree do IT- and cloud providers enter the scene?
How and to which degree do IT- and cloud providers enter the scene?

**New transportation management companies**

▶ Developing IT logistics solutions using transport data for flexible logistics and intelligent decisions

For example in transport execution and delivery

- Mobile Order Management
- Transport Assignment
- Time Slot Management
- Transport Visibility
- Real-time Data
- Time Slot Management Retail
- Reporting
Decentralized systems are usually modelled by concepts all close to “Multi Agent Systems”

“A multi-agent system (MAS) is a (usually) computerized system composed of multiple interacting intelligent (and potentially heterogeneous) agents within an environment.

... 3 important characteristics:

- **Autonomy:** the agents are at least partially independent, self-aware, autonomous
- **Local views:** no agent has a full global view of the system, or the system is too complex for an agent to make practical use of such knowledge
- **Decentralization:** there is no designated controlling agent (or the system is effectively reduced to a monolithic system)”

[Wooldridge 2002]
Network collaboration
2009: Truck robot platoons – **distributed** intelligence

The KONVOI project (several institutes from RWTH & industry partners)

- 2005-2009
- automated / partly autonomous transportation, e.g. by electronically coupling trucks to convoys
- several successful tests with trucks: Chauffeur, KONVOI, SARTRE (EU), Energy-ITS (Japan), ...

- Advanced driver assistance system for trucks
- short distances between vehicles of approx. 10m at a velocity of 80 km/h
- Energy-ITS: 4m ! (2013)
- KONVOI:
  - Car2infrastructure components!
  - Model of multi agent systems

- expected improvements: beyond safety, reduction of fuel consumption and gained road space
Network collaboration
Transfer of the agent idea to smart logistics

**macroscopic**

society design

Matching of local optimization goals of agent and global optimization goals. Altruistic vs. egoistic behavior.

→ Managed as a global network; Community rules: global optimization

**microscopic**

agent and service design

How to build agents that are capable of autonomous action in order to successfully carry out the tasks that we delegate to them?

→ Synchronize all supply chain actors and their different single services: local optimization
Network collaboration
Lateral thinking - what’s next?

I’m the BOSS

Will there be a net of federal networks or one dominant “octopus“?

And who makes the rules?

What is the intelligence of the single entity, what is the intelligence of a node, what is the intelligence of the whole system? – Thus, what are the different roles, respectively?

versus
What is the intelligence of the whole system?

E-logistic - Optimization and control of logistic processes

→ Linking industrial and retail enterprises with their logistics service providers

Enabling **all the sequences of operations** involved in transport logistics to be performed online in a way that is both **cost effective** and **transparent**.

→ For Shippers

- Digital Supply Chain
- Agile and informed supply network (extensive information availability)
- Vertical and horizontal connection of the supply chain enabling deeper intelligence for all participants

→ For Carriers

- From network collaboration to network integration
- Efficient use of transport resources
- Most efficient and flexible connections between all different existing transport networks (different modes and different providers)

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S. Jeschke
What is the intelligence of the whole system?

E-logistic - Optimization and control of logistic processes

→ Linking industrial and retail enterprises with their logistics service providers

Enabling all the sequences of operations involved in transport logistics to be performed online in a way that is both cost effective and transparent.

→ For Shippers
  ¬ Time Slot Management
  ¬ Transport Assignment
  ¬ Transport Visibility
  ¬ Product overview
  ¬ Mobile Order Management

→ For Carriers
  ¬ APP for Drivers
  ¬ Telematics
  ¬ Carrier interfaces
  ¬ Freeway
  ¬ Carrier reporting
What is the intelligence of the whole system?

Solutions and information of the complete Supply Chain

<table>
<thead>
<tr>
<th>TRANSPORT SOURCING</th>
<th>TRANSPORT WORKFLOW ADMINISTRATION</th>
<th>TRANSPORT EXECUTION AND DELIVERY</th>
<th>TRANSPORT DATA ANALYSIS</th>
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<tbody>
<tr>
<td>Tendering</td>
<td>Rate-Management</td>
<td>Mobile Order Management</td>
<td>Billing</td>
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<td>Time Slot Management</td>
<td>Check</td>
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<tr>
<td>Carrier + Rate</td>
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Time Slot Management Retail

Real-time Data

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Services become available and experts become obsolete!

As information becomes more and accessible, experts lose information power. This observation is inline with all earlier changes along the information chain, starting with the book printing ...

- Expert Knowledge
- Tourist Guide
- Real Estate
- Salesman
- Information and knowledge transparency
- Travel Agent
- Smartphone: single point of contact for all information
- Informed Customer
- Profound Decisions

Expert systems losing ground: Experts and service providers lose their unique selling proposition

Management of services: The new business model

Services Innovations

Businesses in the customer’s pockets: the „Service Society“
Logistics 4.0 or „Logistics as a Service“ (LaaS)

The terminology is based on concepts as Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS) .... up to Anything-as-a-Service (XaaS). It is sometimes referred to as "on-demand XY", without hosting or owning the necessary infrastructures and tools.

The philosophy behind it is: “Just do it – I don’t care how!”

Managing Platforms

Cloud Service Request

Carrier Request

Delivery Information

Delivery Customer

Delivery Service

End Consumer

Requests and Status Updates

B2B relations still lacking generic services like in B2C relations

Mobile Apps

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Which new business models are about to break through?

Will the product be delivered to customer before it has been ordered, ”Anticipatory Shipping“?

Send medicine before a disease spreads...

Who is ordering?

Which kind of foresight do Big Data Technology will come up with in the future?

GILD: “Roboter Recruiting”; selecting employees on a purely algorithmic basis.
Which new business models are about to break through?

Current and short term developments on the way to logistic 4.0

Integration of all service providers and their vehicles for full transparency of the "last mile“ – the “MOBLE ORDER MANAGEMENT” approach
Which new business models are about to break through?

Transporeon Future Vision – TransportLogistic 4.0

- Full digitalization
- Network collaboration
- Service innovations
- Synchro-modal transport
- Sustainable transport
- Artificial Intelligence
  - Google Deepmind
- Autonomous driving
- Automation of supply chain
- Green Logistics

- Big Data
- Cost Savings
  - PROVEN ROI
- Real Time Visibility
  - Reduce Idle Time
- Efficiency Gains
Outline

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Some even more “out of space” concepts

The new driver

„My colleague the robot...“

Again more: In a few years, automated driving might outcompete human drivers. Security issues, the demographic change, and the decreasing attractiveness of the job may add to a fast change.

Google

Daimler

DHL

Rolls Royce

rail-bound caps
Some even more “out of space” concepts

The third dimension

“In 2030, 70% of all humans will live in cities. Already then, about 10% will live in megacities (i.e., more than 10 Mio people). Escalating…”

The megacities of the future

At a certain point, due to purely mathematical reasons, extended 3-dimensional building structures can no longer be served by purely 2-dimensional (street) networks.

Source: National Geographic Magazine

[freestyle translation, source pwc studies]
Some even more “out of space” concepts

The new construction

“Digital warehouses are replacing physical spare parts storages“
[freestyle translation, source Logistik magazine]

„3D printing is on its way to leave the somewhat ‘restricted’ areas of spare part business, tool making etc. and is about to become a serious challenger for all traditional manufacturing models“.
[source Prof. Erman Tekkaya, TU Dortmund]

Water carbonators reaching high sales figures

3D printing of house (source Univ. of Southern California 2013)

3D print of pasta – Barilla (tests since 2015)

Harbor Rotterdam – 3D printer farm for metal printing (after piloting, now roll-out in 2016)

“plastics instead of parcels?” - UPS moving from logistics to 3D printing (tests since 2013)
Summary
... in four steps!

4.0: Revolution of a distributed artificial intelligence

- IT driven
- characterized by “everything is connected to everything anywhere anytime”

Logistics 4.0 – I: Data-driven revolution

- New possibilities of optimization and business models are mainly data-driven.
- Globalization has its additional effects on speed and plurality...

Logistics 4.0 – II: Automation-driven revolution

- Autonomous carrier systems
- Fluent transition within logistics, intralogistics, and production
- New, intuitive intelligent interaction with humans...

We are right in the middle of a 4th Industrial Revolution.

“Green is beautiful”

... even if strict measures against “environmental bad guys” are rare today, there is an increasing pressure on everybody and all business models to cope with sustainability issues accordingly; and the “Generation Y” is adding to this effect!
Thank you!

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<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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<tbody>
<tr>
<td>1968</td>
<td>Born in <strong>Kungälv/Schweden</strong></td>
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<tr>
<td>1991 – 1997</td>
<td>Studies of <strong>Physics, Mathematics, Computer Sciences</strong>, TU <em>Berlin</em></td>
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<tr>
<td>1994</td>
<td>NASA Ames Research Center, Moffett Field, <strong>CA/USA</strong></td>
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<tr>
<td>10/1994</td>
<td>Fellowship „Studienstiftung des Deutschen Volkes“</td>
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<td>1997</td>
<td>Diploma Physics</td>
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<td>2000 – 2001</td>
<td><strong>Lecturer</strong>, Georgia Institute of Technology, <strong>GA/USA</strong></td>
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<td>2001 – 2004</td>
<td><strong>Project leadership</strong>, TU Berlin, Institute for Mathematics</td>
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<tr>
<td>04/2004</td>
<td><strong>Ph.D.</strong> (Dr. rer. nat.), TU Berlin, in the field of <strong>Computer Sciences</strong></td>
</tr>
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<td>2004</td>
<td>Set-up and leadership of the Multimedia-Center at the TU Berlin</td>
</tr>
<tr>
<td>2005 – 2007</td>
<td><strong>Juniorprofessor</strong> „New Media in Mathematics &amp; Sciences“ &amp; Director of the <strong>Multimedia</strong>-center MuLF, TU Berlin</td>
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<tr>
<td>2007 – 2009</td>
<td><strong>Univ.-Professor</strong>, Institute for IT Service Technologies (IITS) &amp; Director of the Computer Center (RUS), Department of <strong>Electrical Engineering</strong>, University of <strong>Stuttgart</strong></td>
</tr>
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<td>since 06/2009</td>
<td><strong>Univ.-Professor</strong>, Head of the Institute Cluster IMA/ZLW &amp; IfU, Department of <strong>Mechanical Engineering</strong>, RWTH <strong>Aachen</strong> University</td>
</tr>
<tr>
<td>since 10/2011</td>
<td><strong>Vice Dean</strong> of the Department of <strong>Mechanical Engineering</strong>, RWTH <strong>Aachen</strong> University</td>
</tr>
<tr>
<td>since 03/2012</td>
<td><strong>Chairwoman VDI Aachen</strong></td>
</tr>
<tr>
<td>since 05/2015</td>
<td><strong>Supervisory Board of Körber AG</strong>, Hamburg</td>
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</table>
Peter Förster

1975  Born in Bad Windsheim/Germany
1995 – 2000  Studies of Industrial Engineering in Kempten, Neu-Ulm and Ulm
2000  Foundation of TRANSPOREON in Ulm; now Managing Director

Peter Förster studied Industrial Engineering in Kempten/Neu-Ulm and Ulm with strong focus on Marketing. Following graduation he joined Siemens ICN Information and Communications Networks as Junior Marketing Consultant, simultaneously establishing the TRANSPOREON GmbH with his university friends. The company was founded in the year 2000. As Managing Director, Mr. Förster focuses primarily on product and innovation management.

TRANSPOREON Group’s transportation platform allows manufacturers, retailers and carriers to fully digitize their transportation logistics processes. Today, the TRANSPOREON Group is the European market leader, linking over 1,000 shippers, 55,000 carriers and 100,000 users in over 100 countries.