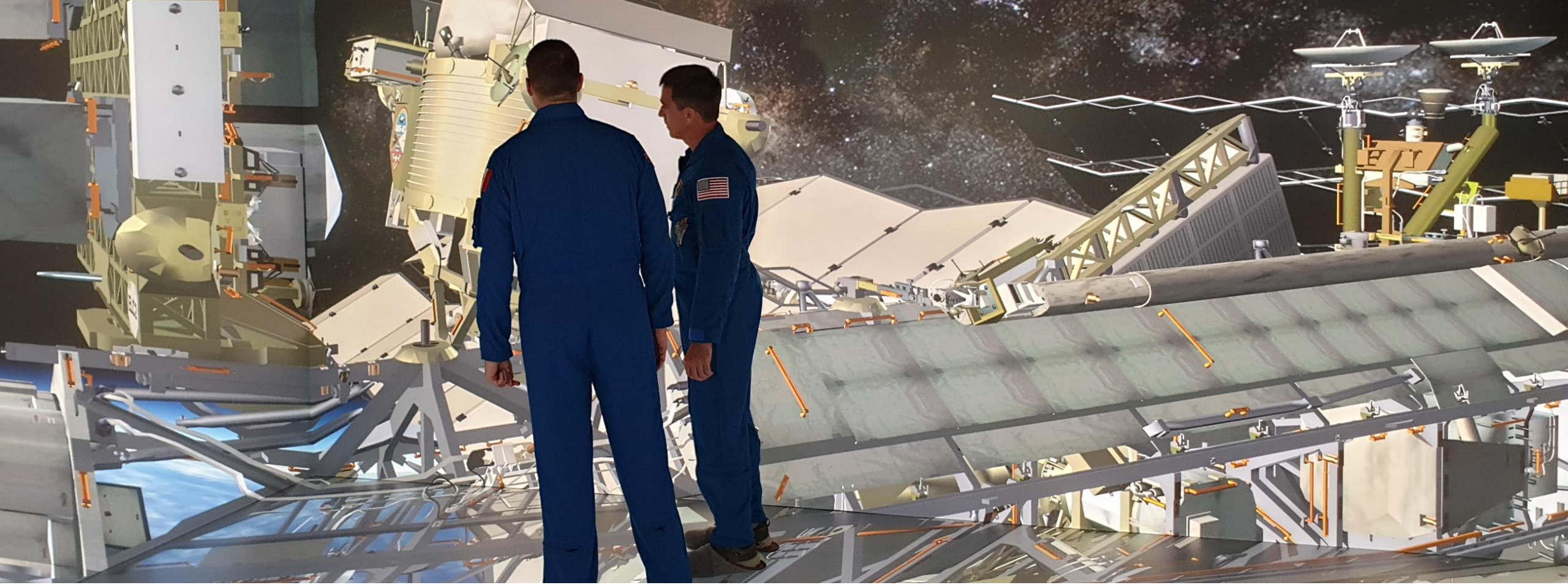


Digital Twins – in Industry, Space and Forestry

An introduction to the Institute for Man-Machine Interaction
RWTH Aachen University, Germany
InnovaWood Virtual General Assembly 2020, 08.07.2020

Institute for Man-Machine Interaction
RWTH AACHEN UNIVERSITY

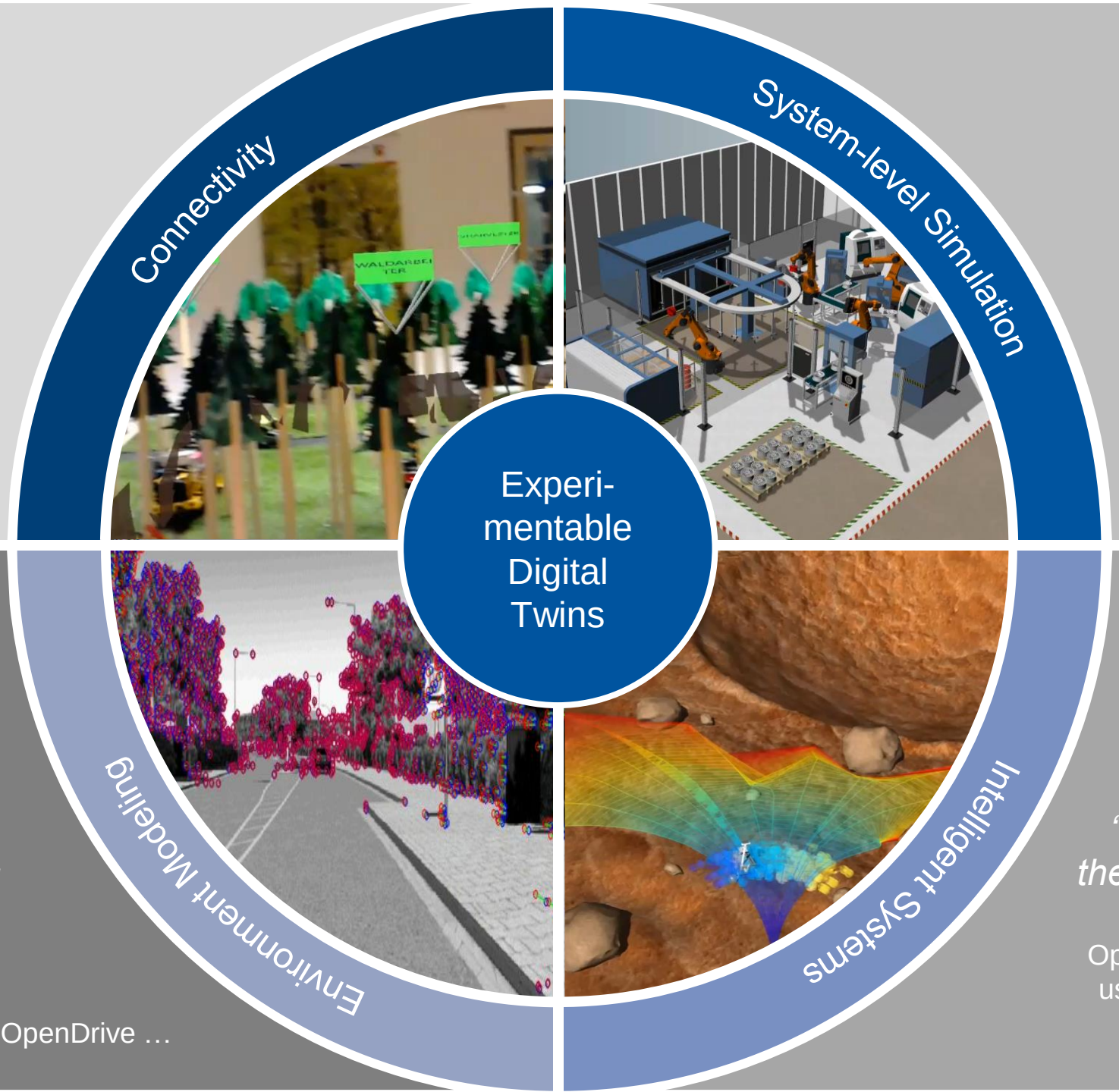
The Institute for Man-Machine Interaction

“Digital Twins are the nodes of the IoTSP!”

Connecting humans, devices and machines via OPC UA, MQTT, AR/VR …

“Digital Twins are driven by simulation!”

Interdisciplinary multi-domain 3D simulation, including multi-body dynamics, sensors, kinematics, data processing …

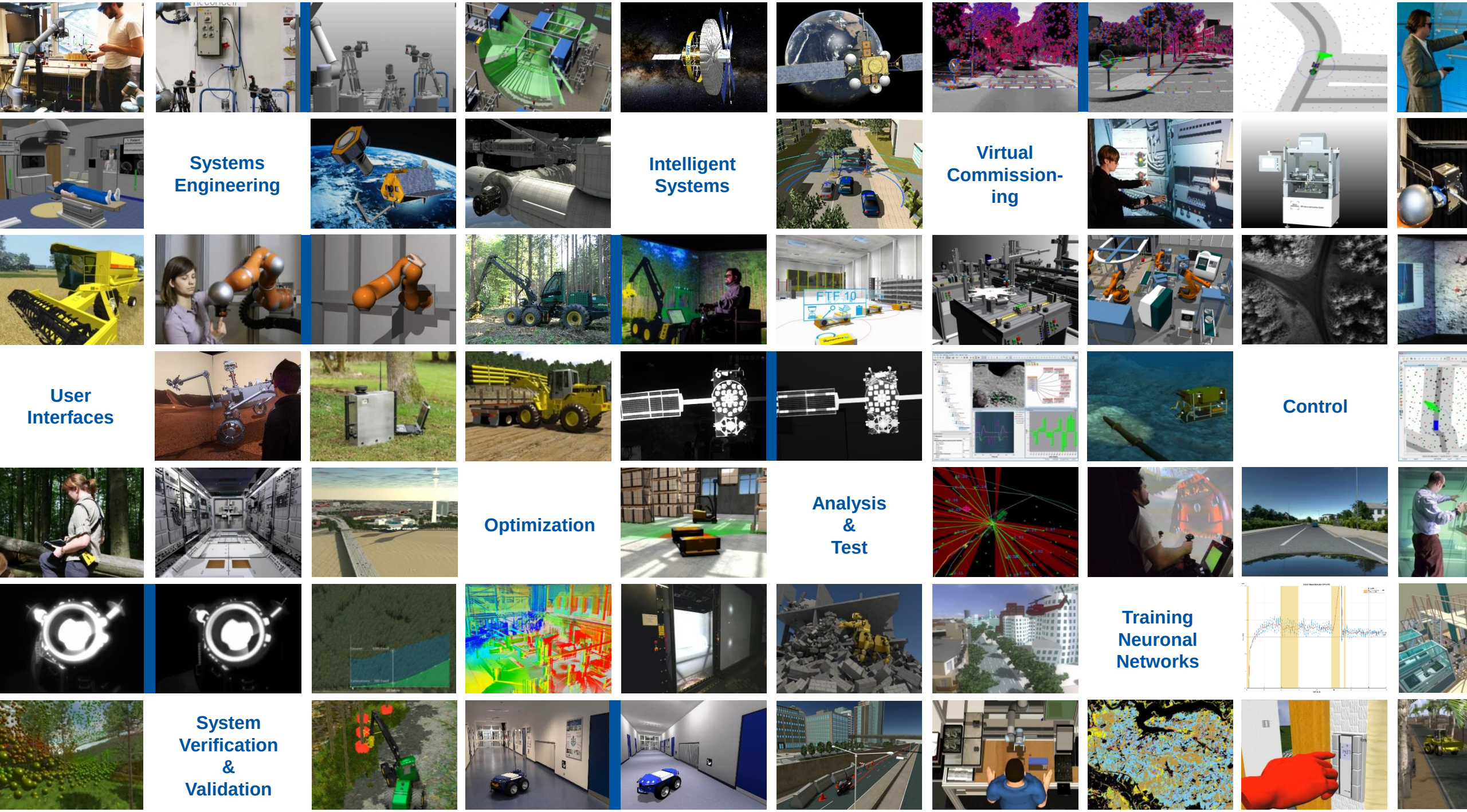


“Digital Twins are 1-to-1 replica of the real world!”

Environmental mapping and localization with data from engineering, BIM, 4D GIS, OpenDrive …

“Digital Twins can predict their future and adapt to it!”

Optimization and decision support using simulation, Big Data and AI for mental models


Systems Engineering
Intelligent Systems
Virtual Commission-ing
User Interfaces
Control
Optimization
Analysis & Test
Training Neuronal Networks
System Verification & Validation

From Research to Application

Innovations and technology transfer with industrial partners

Product
(safety, market research, …)

Development and optimization
(prototypes, robustness, …)

Process-oriented research
(study, …)

Application-oriented research

Problem-oriented basic research

Basic research

Describe Create

Digitalization, Networking, Automation in Forestry

The Virtual Forest

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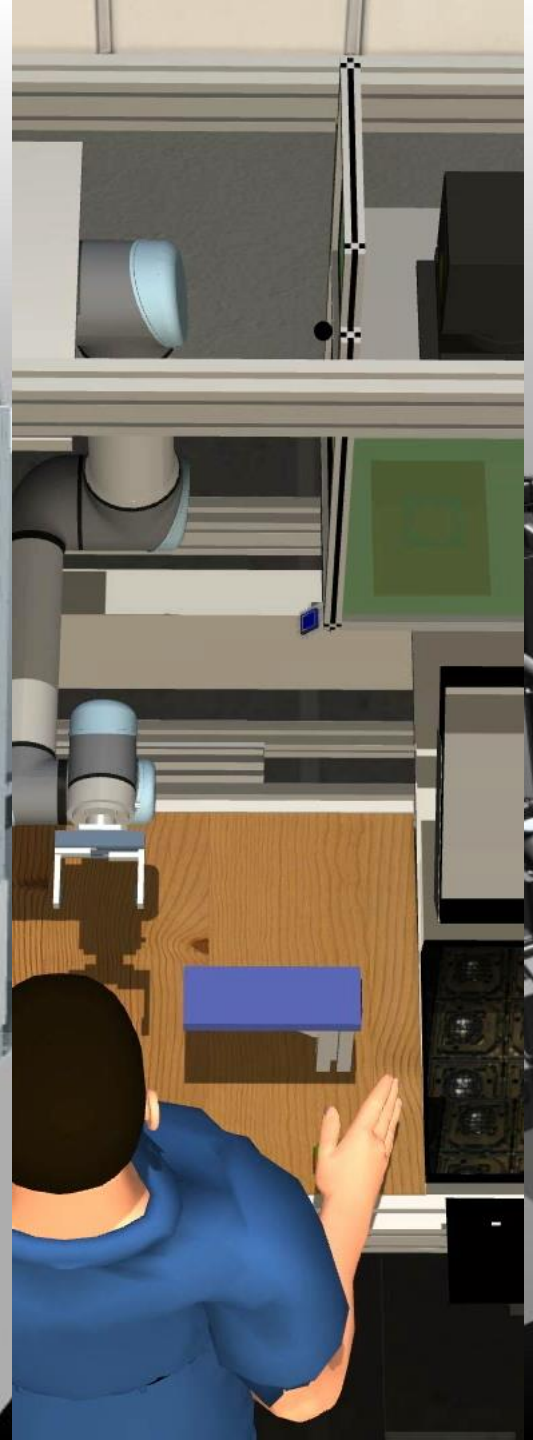

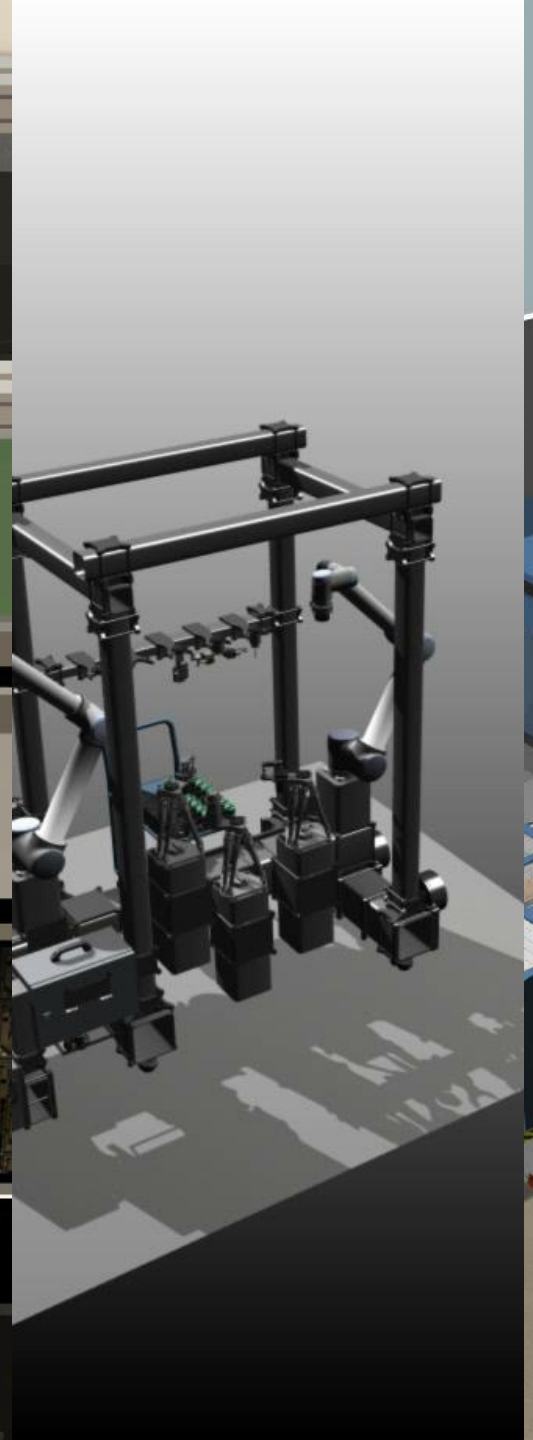

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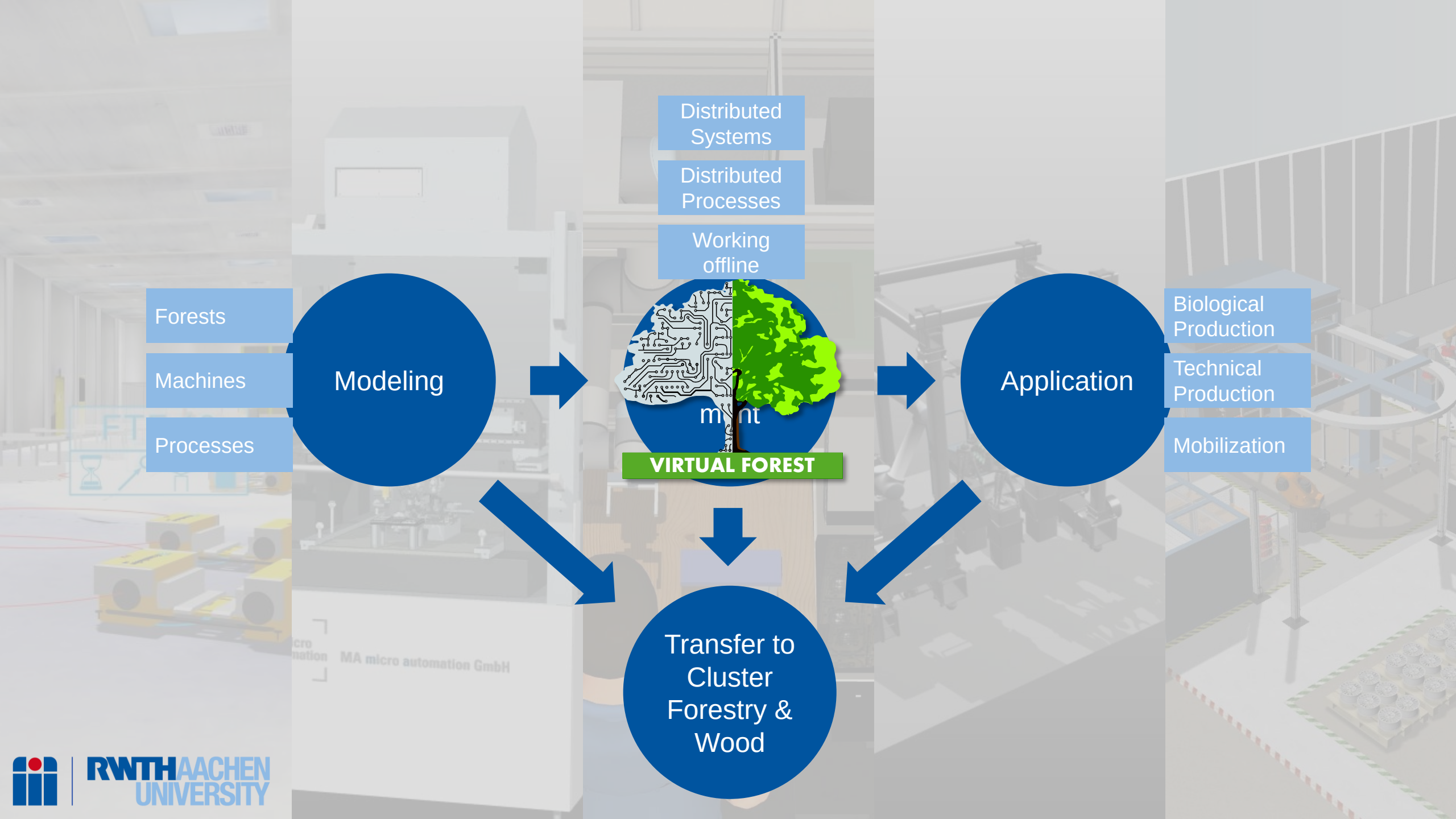
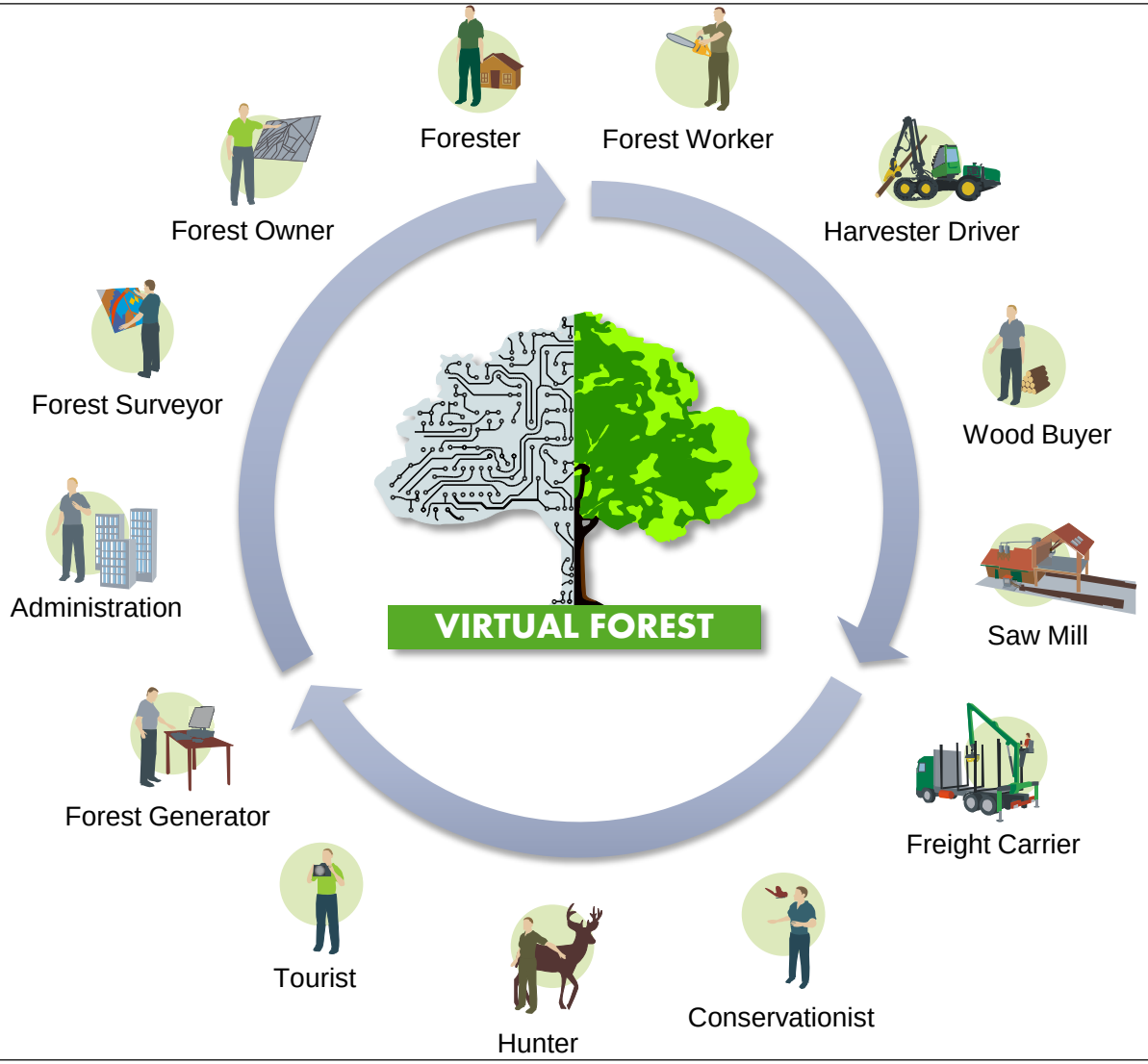
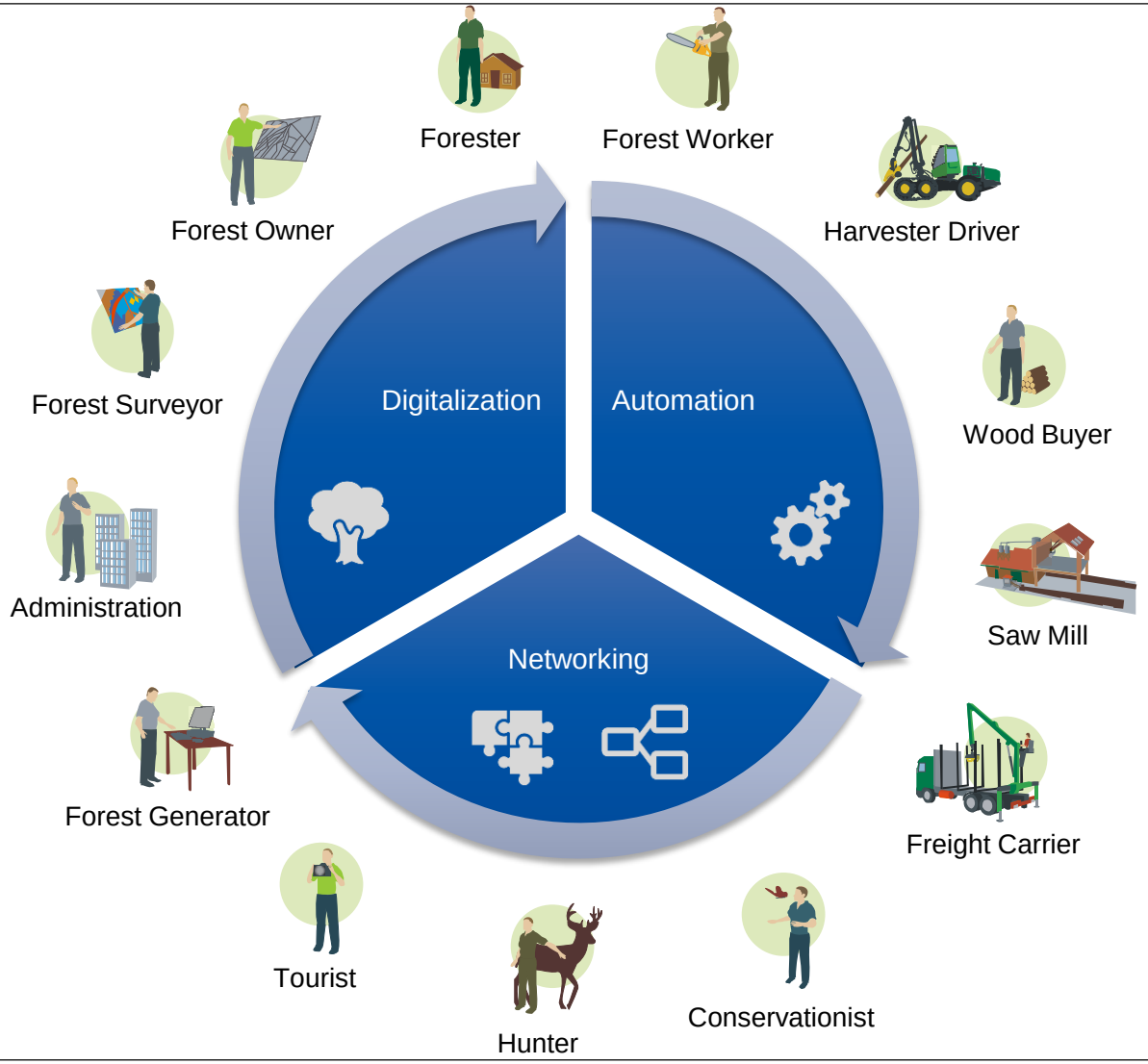

Forests
Machines
Processes
Modeling
Distributed Systems
Distributed Processes
Working offline
VIRTUAL FOREST
Application
Biological Production
Technical Production
Mobilization
Transfer to Cluster Forestry & Wood

Cluster Forestry and Wood – Heterogeneous, complex, large



Cluster Forestry and Wood – Heterogeneous, complex, large



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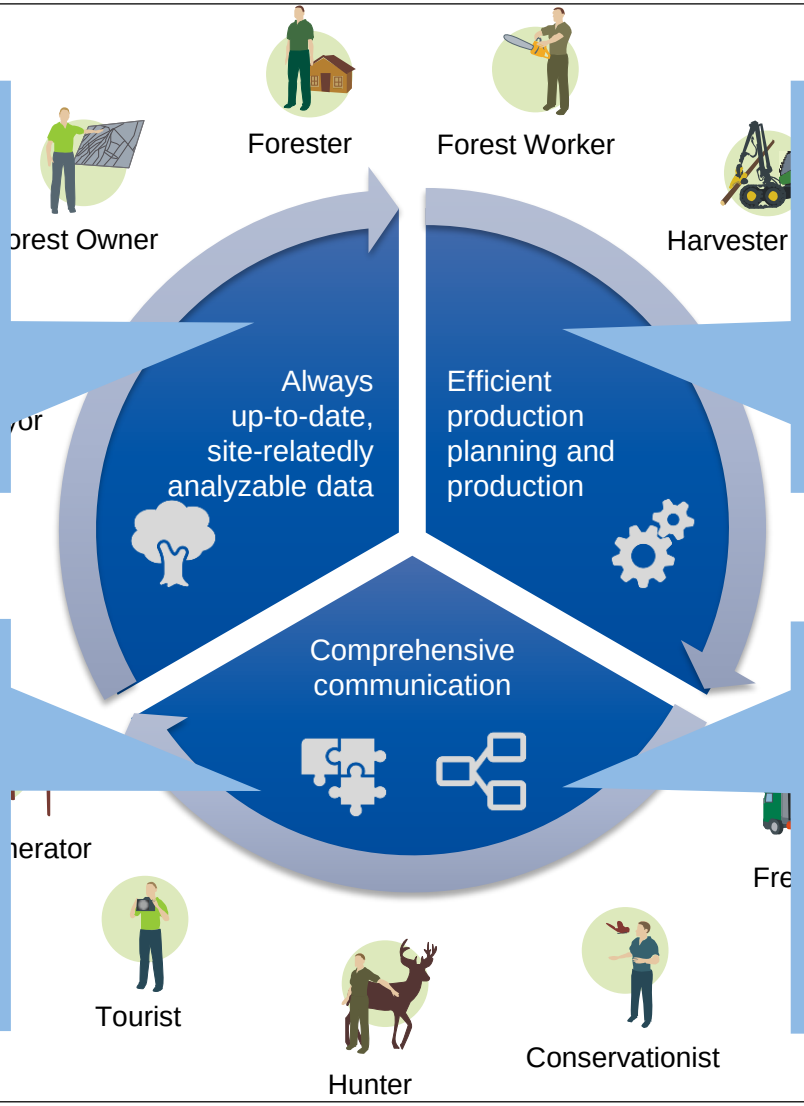
The concrete benefit for the user is manifold

- Establish comprehensive database („Single Point of Truth“)
- Reduce data collection effort
- Ensure data quality

- Plan activities
- Support work
- Automate processes



- Enable new applications
- Create broad methodic basis

- Standardize data and data exchange
- Optimize communication
- All information and methods at any time at any place

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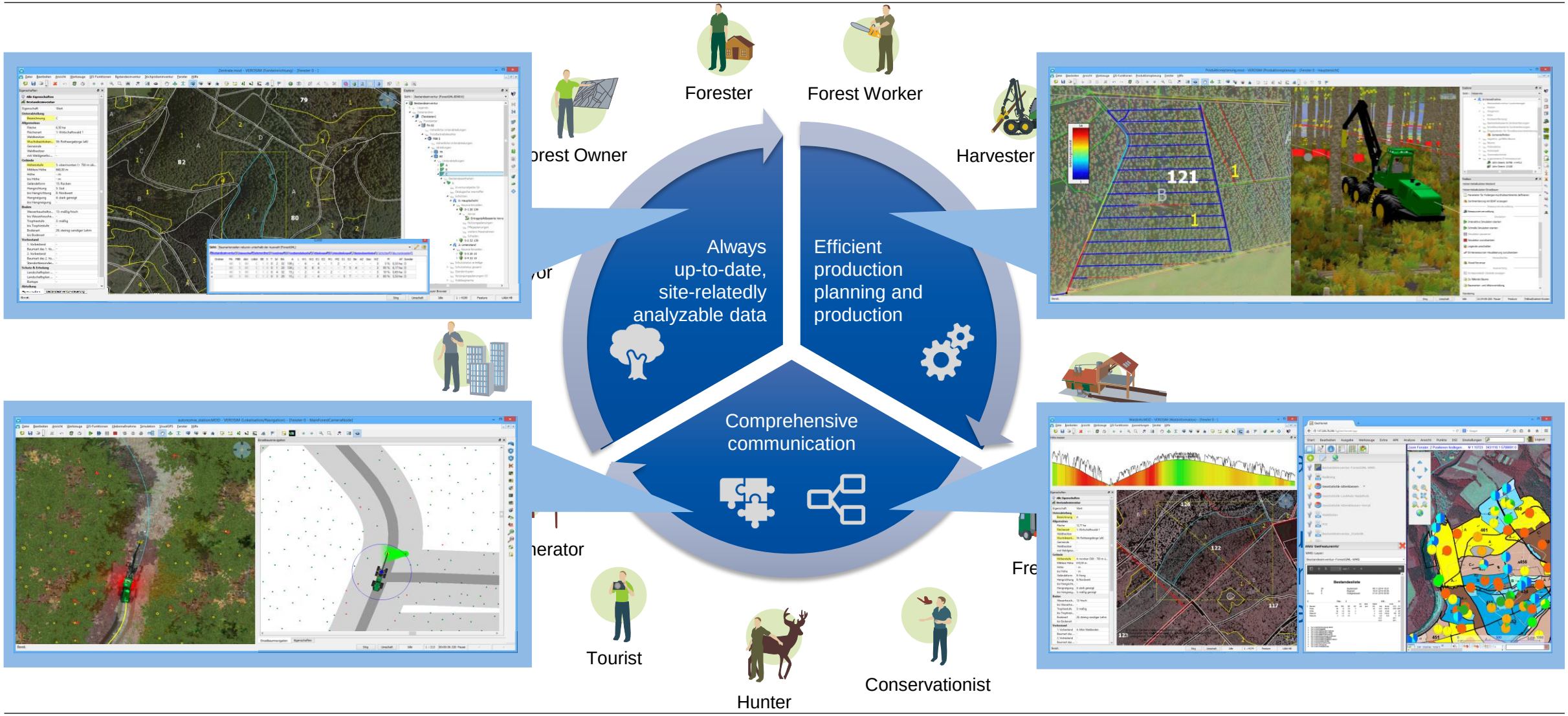
Central components are available today



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KWH4.0
Kompetenzzentrum Wald und Holz 4.0

Landesbetrieb Wald und Holz Nordrhein-Westfalen

KlimaWIS.NRW-FE

KWH4.0
2018-2021

2019-2021
iWald

GRIPS-RLP

Landesforsten Rheinland-Pfalz

2016-2019
ClusterWIS

Wide area forest information system
Data modeling and process integration
Integration of biological and technical production
Mobilization and provision of raw material

2010-2014
Virtual Forest-III

VIRTUAL FOREST

2007-2008
Virtual Forest-II

Remote sensing based stand inventory
Localization
KWF Demo Fair in Schmallenberg

2005-2006
Virtual Forest-I

Feasibility study remote sensing based single tree inventory

2003
OPTIMUS

Optimization of information and material flow

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Digital Twins and Forestry 4.0

Real and virtual environment

Control system

Driver

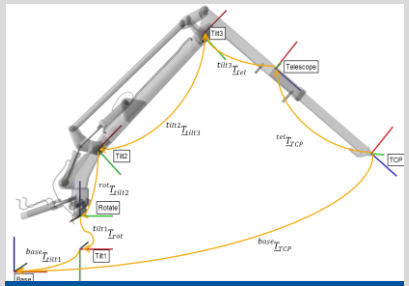
Enviroment

Communication

Virtual World

Digital Shadow

Digital Twin



Digital Model

Operational data

Communication

Modeling

Real World

Operation

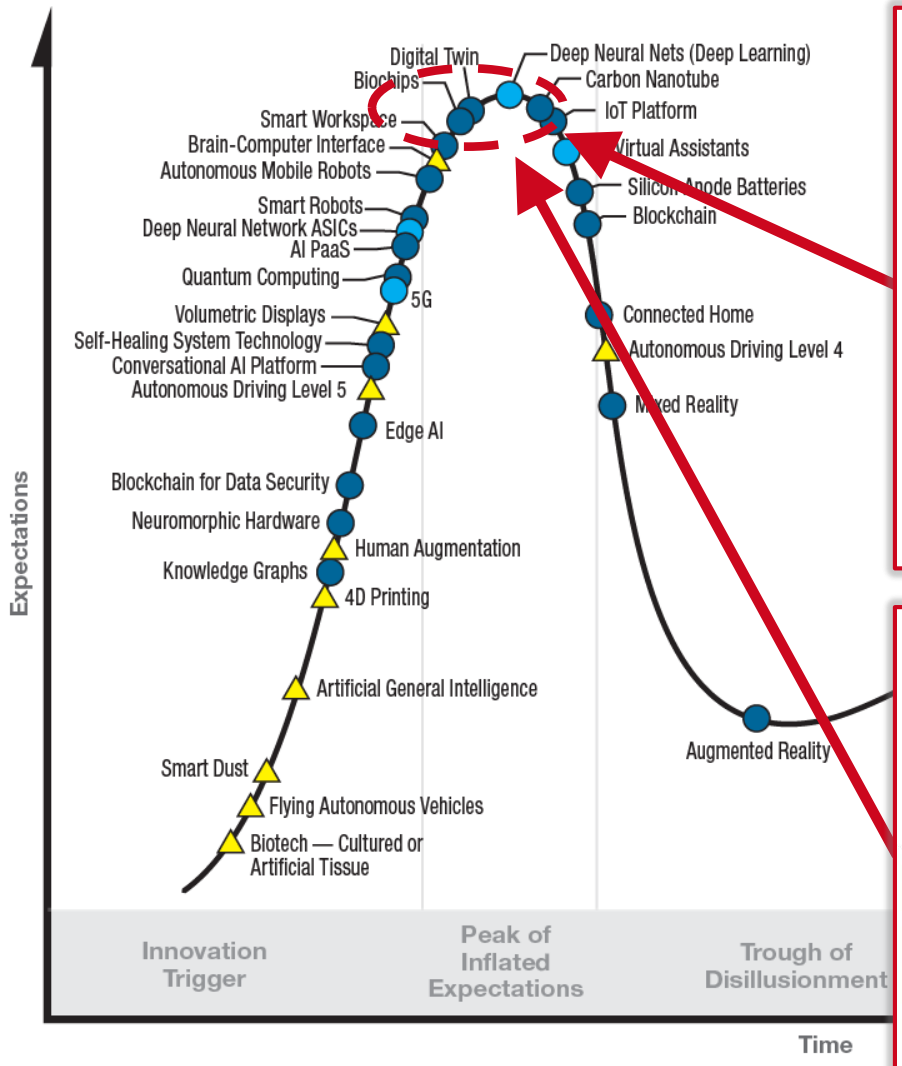
Real Twin

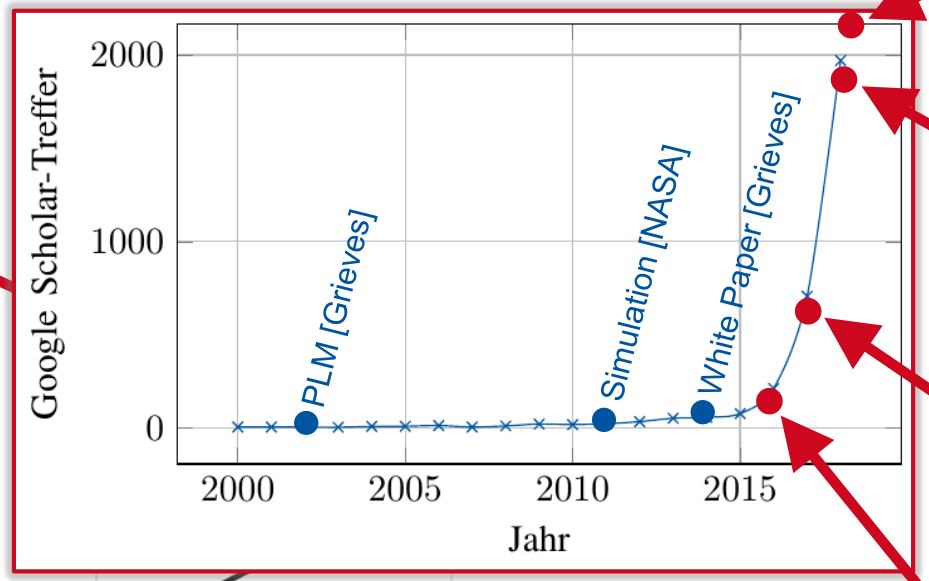
Cyber-Physical System (CPS)

Development

Starting point: Reinhart, Gunther, „Digital Twin, Synchronizing Reality and Virtuality“, 2015

Digital Twins conquer the World





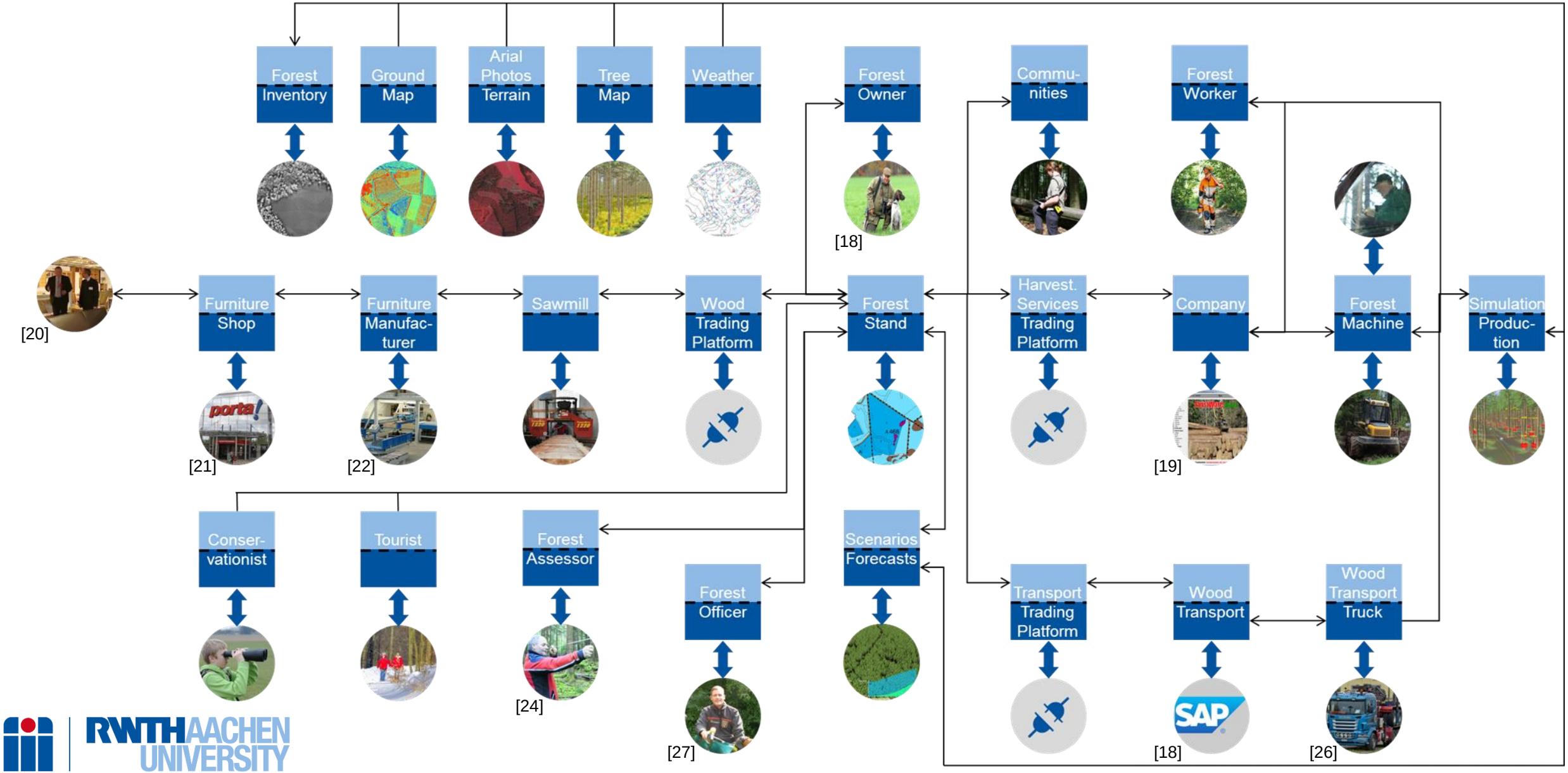
Schluse, Osterloh, Rossmann (2019): “Development of Modular Spacecrafts with Experimentable Digital Twins”, ESA-SESP

Schluse, Atorf, Priggemeyer, Rossmann (2018): “Experimentable Digital Twins – Streamlining Simulation-Based Systems Engineering for Industry 4.0”, IEEE Trans. II

Schluse, Atorf, Rossmann (2017): “Experimentable Digital Twins for Model-Based Systems Engineering and Simulation-Based Development”, IEEE SysCon

Schluse, Rossmann (2016): “From Simulation to Experimentable Digital Twins – Simulation-based Development and Operation of Complex Technical Systems”, IEEE ISSE

Industry 4.0 lays the foundation for mastering even complex structures



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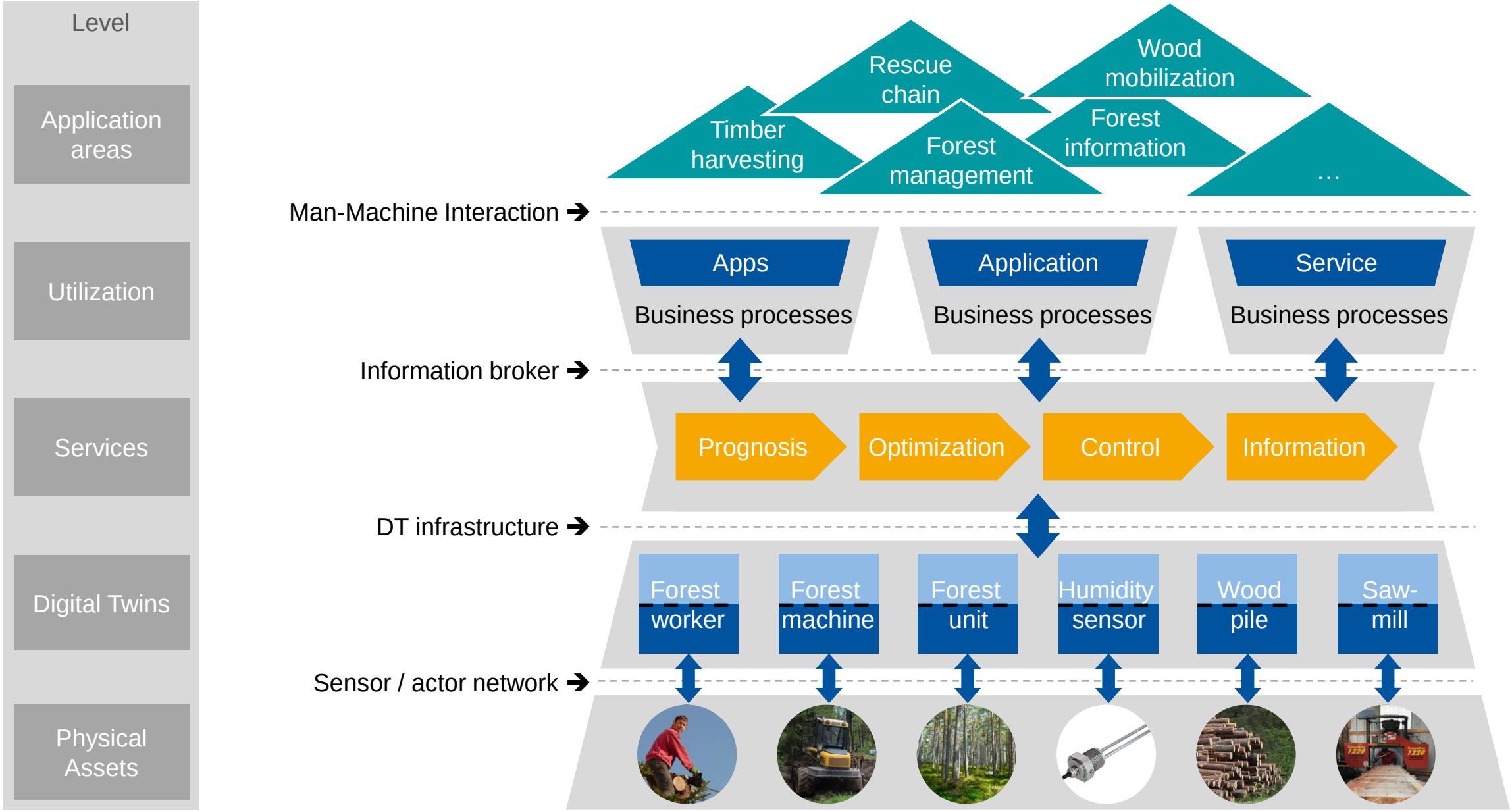

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Summary

Our expertise – Digitalization, Networking, Automation

- **Digitalization of forests and machines:**

  Digital models as a basis for recording, planning, execution, evaluation

- **Networking of actors with each other and with data and machines:**

  Standard-compliant realization of a comprehensive data management

- **Automation from subsystems to complete workflows:**

  Process integration, new sensors and integration platform

- **Provision of necessary processes, methods and tools**

  Successfully put into operation!

Our expertise – Forestry 4.0

- **New technologies:**

  Decentralized IT - the Internet of Things, Services and Persons - for a decentralized cluster forestry and wood

- **New thinking and structures:**

  The intelligent and proactive Digital Twin takes center stage

- **New business models:**

  From new types of services to comprehensive and self-organizing value added systems

Thank you very much for your attention!

Dr.-Ing. Arno Bücken

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