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Fraunhofer Institute for Experimental Software Engineering IESE

Dynamisch veränderliche Systeme und die Folgen für die Qualitätssicherung: Herausforderungen und Lösungsansätze

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Institutsleiter Fraunhofer-Institut für Experimentelles Software Engineering IESE

Wissenschaftlicher Sprecher, Forschungsbeirat Industrie 4.0

Vorstandsrat Mathematik / Informatik der Gesellschaft Deutscher Naturforscher und Ärzte (GDNÄ)

TAV oder T_{Av}

- **T_{Av}**: Durchsicht der Programme der vergangenen 49 TAV-Treffen führt zu der Erkenntnis, dass …
  - Testen mit weitem Abstand den größten Raum einnimmt,
  - Analysieren selten vorkommt,
  - Verifizieren praktisch nicht diskutiert wird.
- **$_{TA}V$**: In der Lehre ist …
  - Verifikation in der Breite vorhanden,
  - Analyse durchaus ein Thema,
  - Testen leider oft nur ein Randthema (Achtung: Einige sehr löbliche Ausnahmen).

Die FG TAV wirkt hier positiv, und das ist gut!

TAV 39: 2016

Vom Softwaretest zu sicheren Cyber-Physical Systems: Herausforderungen und Lösungsansätze

Prof. Dr.-Ing. Peter Liggesmeyer

Lehrstuhl Software Dependability,
Technische Universität Kaiserslautern

Geschäftsführender Direktor,
Fraunhofer-Institut für Experimentelles Software Engineering

Präsident Gesellschaft für Informatik

Schlussfolgerungen

- Die Qualitätssicherung wird in der Lage sein müssen, mit Smart Ecosystems umzugehen (Autonomie, Heterogenität, Datengetriebenheit, …)
- Viele Tätigkeiten, die bisher durch Menschen zur Entwicklungszeit mit statischen, geschlossenen Systemen erfolgen, werden in Zukunft durch die Systeme selbst zur Laufzeit unter Beachtung ihrer Offenheit und Veränderlichkeit erfolgen müssen.
- Autonomie bietet Chancen, bringt aber auch Risiken
- Zum Teil existiert noch erheblicher Forschungsbedarf (z.B. Umfassende Sicherheit in offenen Systemen)
- Daten sind der zentrale „Rohstoff“: Datennutzungskontrolle!

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Digital Transformation




Spotify



PayPal

Technology changes
Media & Data
with **Digital Products**

Technology changes
Markets & Industries
with **Digital Processes**

Technology changes
Economy & Society
with **Digital Business Models**

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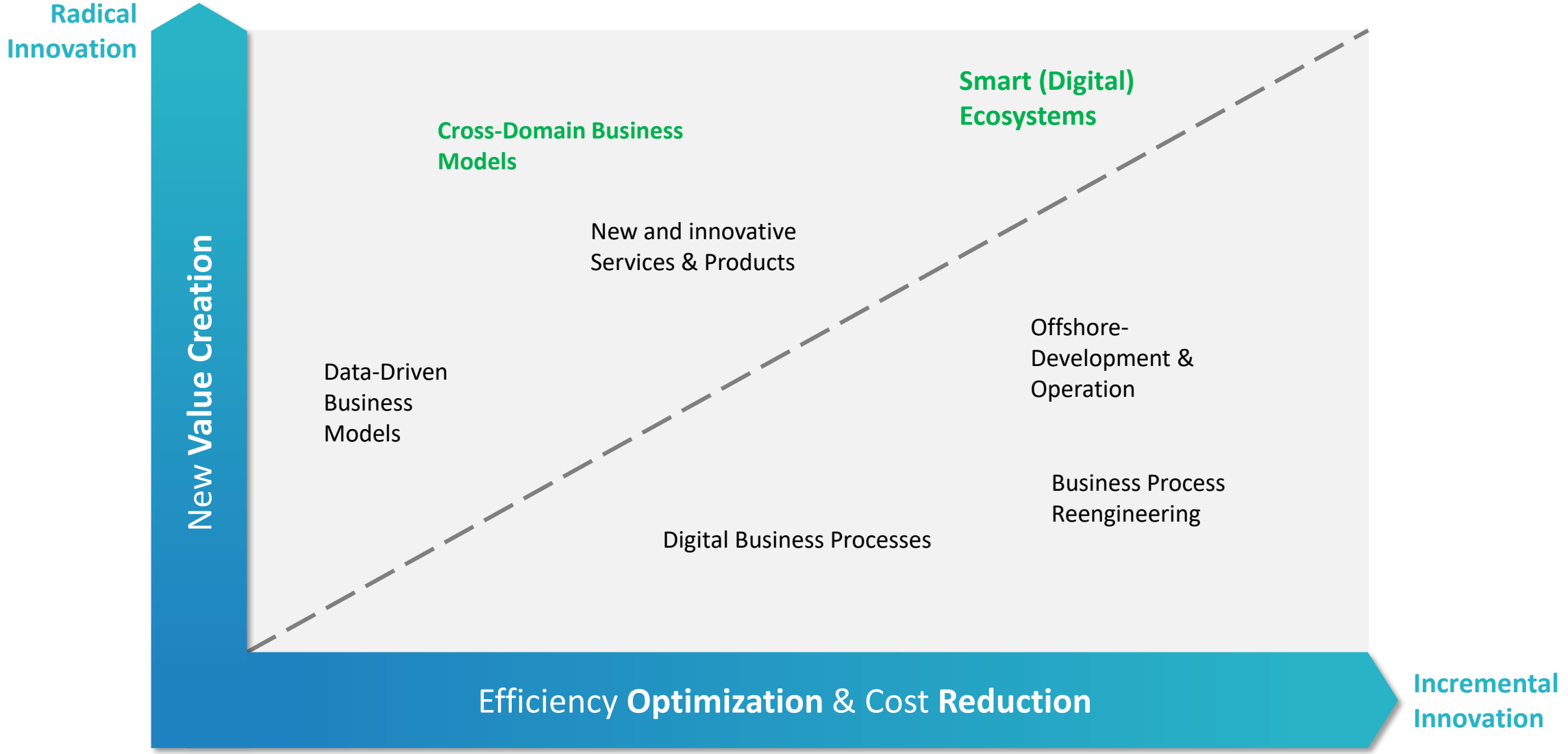
Digitization | Digitalization | Digital Transformation



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Industry 4.0

Smart Farming

Smart Mobility

SMART Ecosystems

Smart Health

Smart Energy

Smart Rural Areas

Smart X

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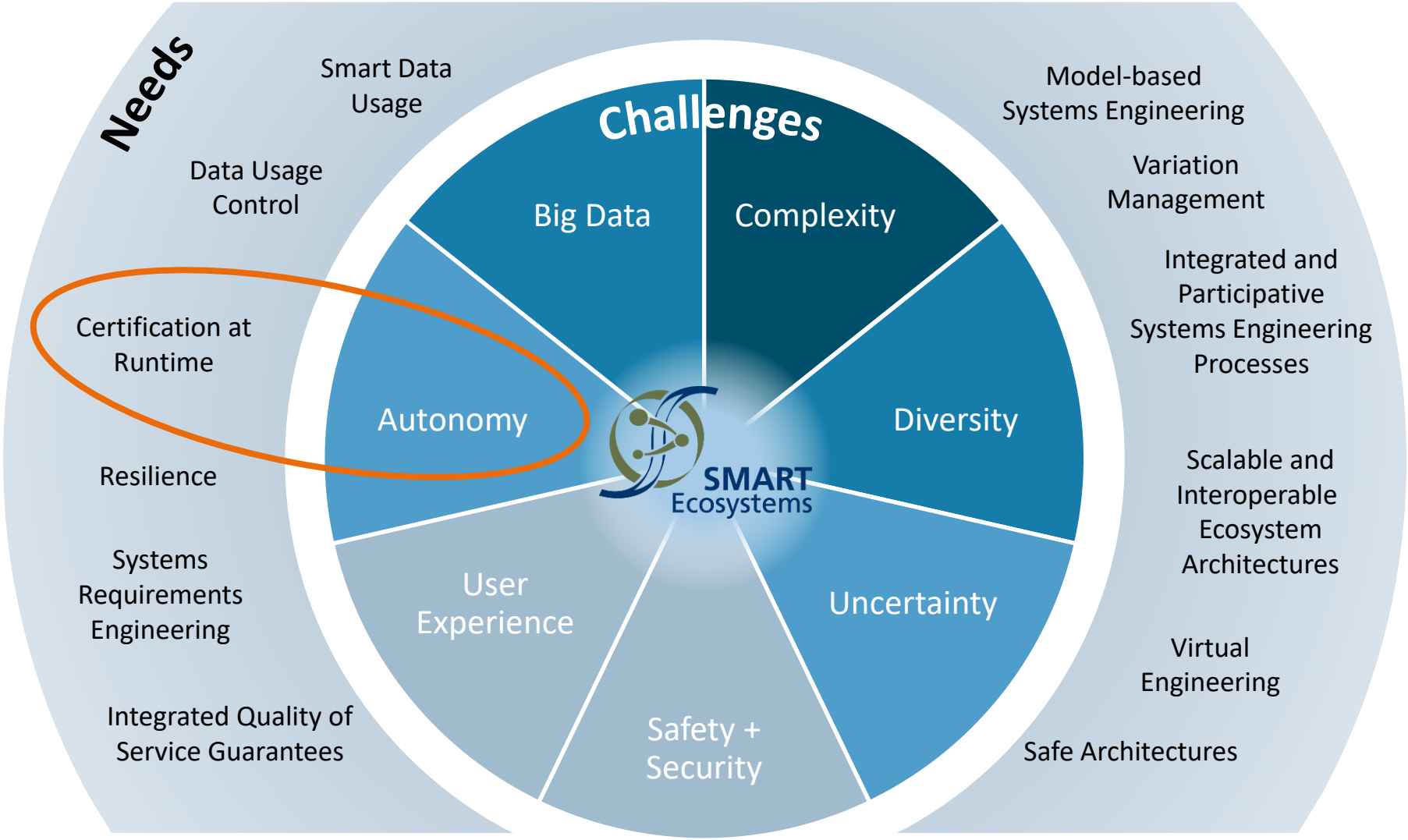
Example Challenges and Needs for Smart Ecosystems



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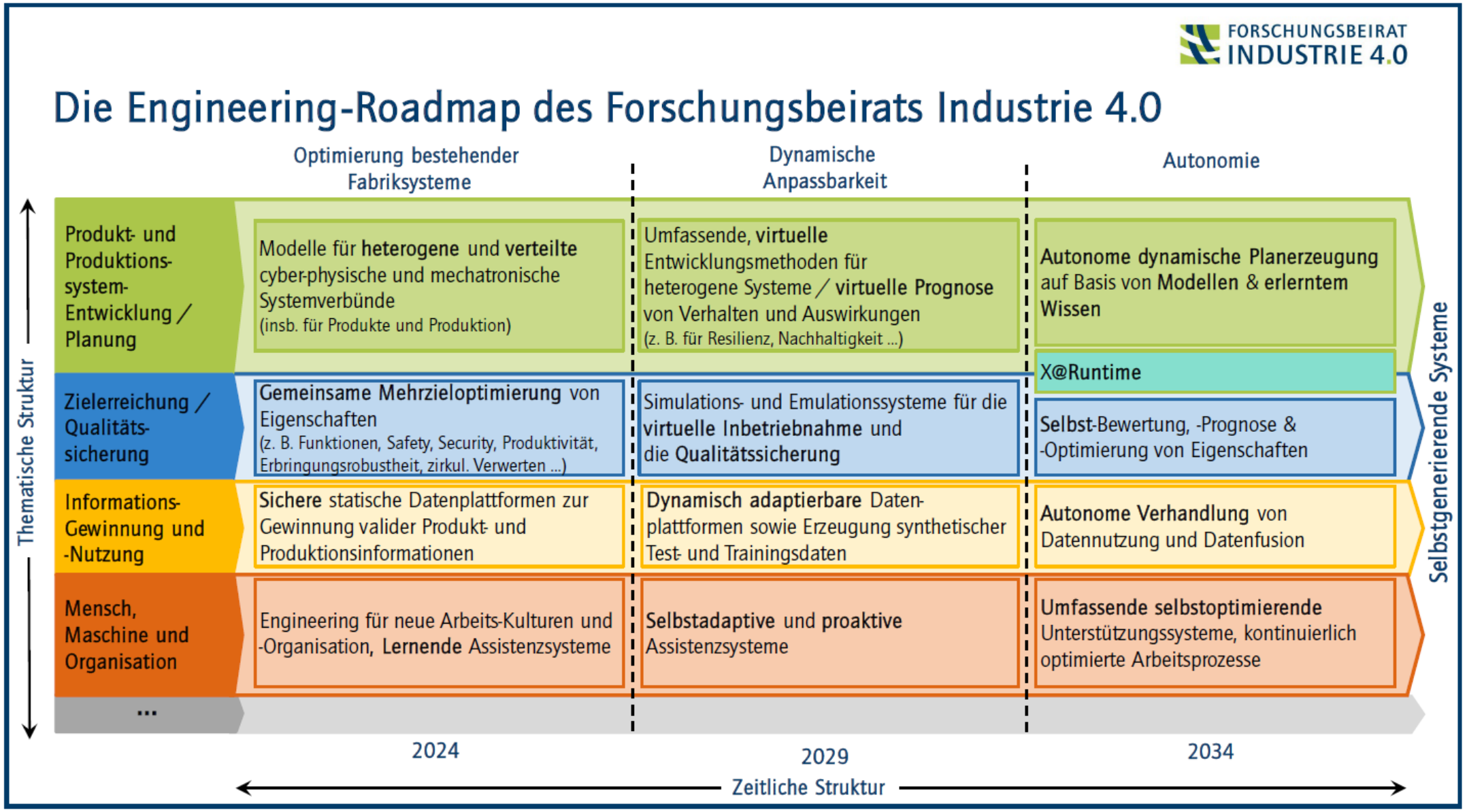

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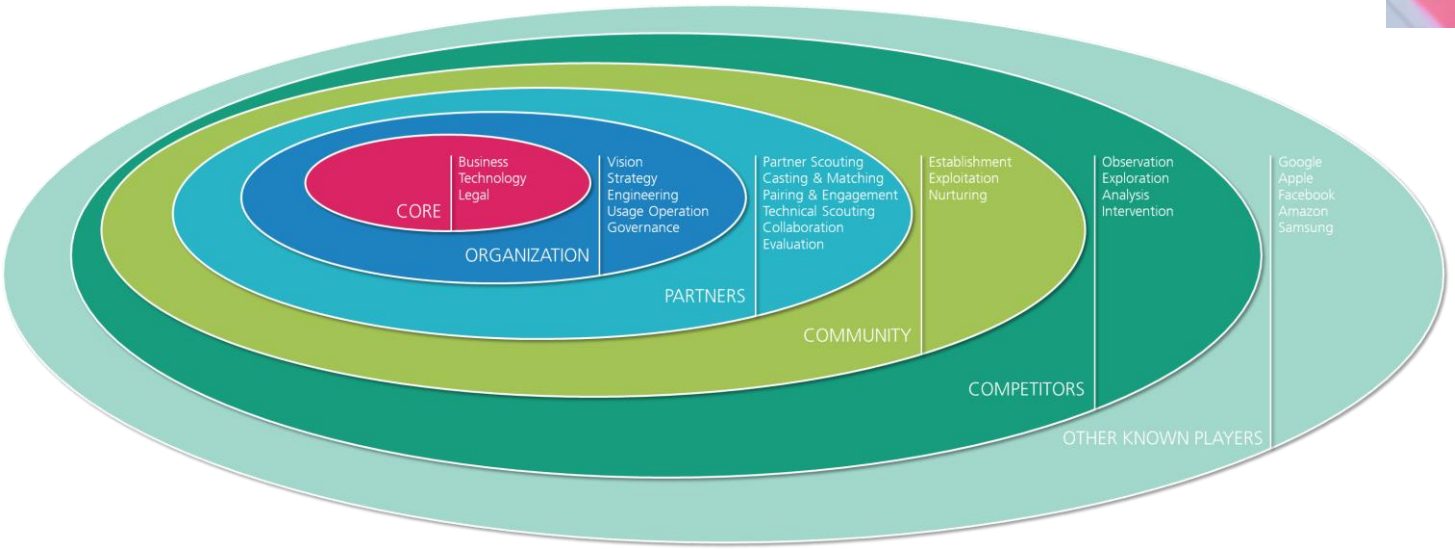
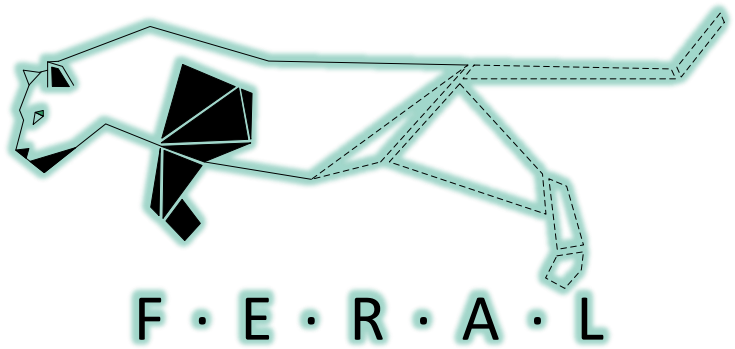
Challenge1: Complexity, Diversity, Uncertainty, User Experience
Shaping & Simulating Ecosystems

1. Initial ***Shaping*** of Ecosystems

2. Holistic Modelling of ***Ecosystems Facets***



3. Continuous ***Simulation*** of Ecosystems



Challenge 2: Autonomy, Safety
Runtime-Adaptivity and Certification at Runtime

ISO 26262: ASIL D: 1 fatal accident per 10^8 hours ~ 5 bill. km at 50 km/h

Tesla: 210 mill. km of autonomous driving; target missed by a factor of 20, BUT:

Driving distance between fatal accidents in Germany: 219 Mio. km (2015)

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Three categories of autonomous systems:

1: Manual operation possible; autonomy as an improvement of comfort

2: Manual operation possible; autonomy necessary for acceptance

3: Manual operation is impossible (from a technical or economical viewpoint); system requires autonomous solution

Autonomy requires to balance availability and risks (e.g., safety) in order to maintain acceptance

Autonomous systems

that are available and unsafe will not be accepted,

that are unavailable and safe will not be accepted,

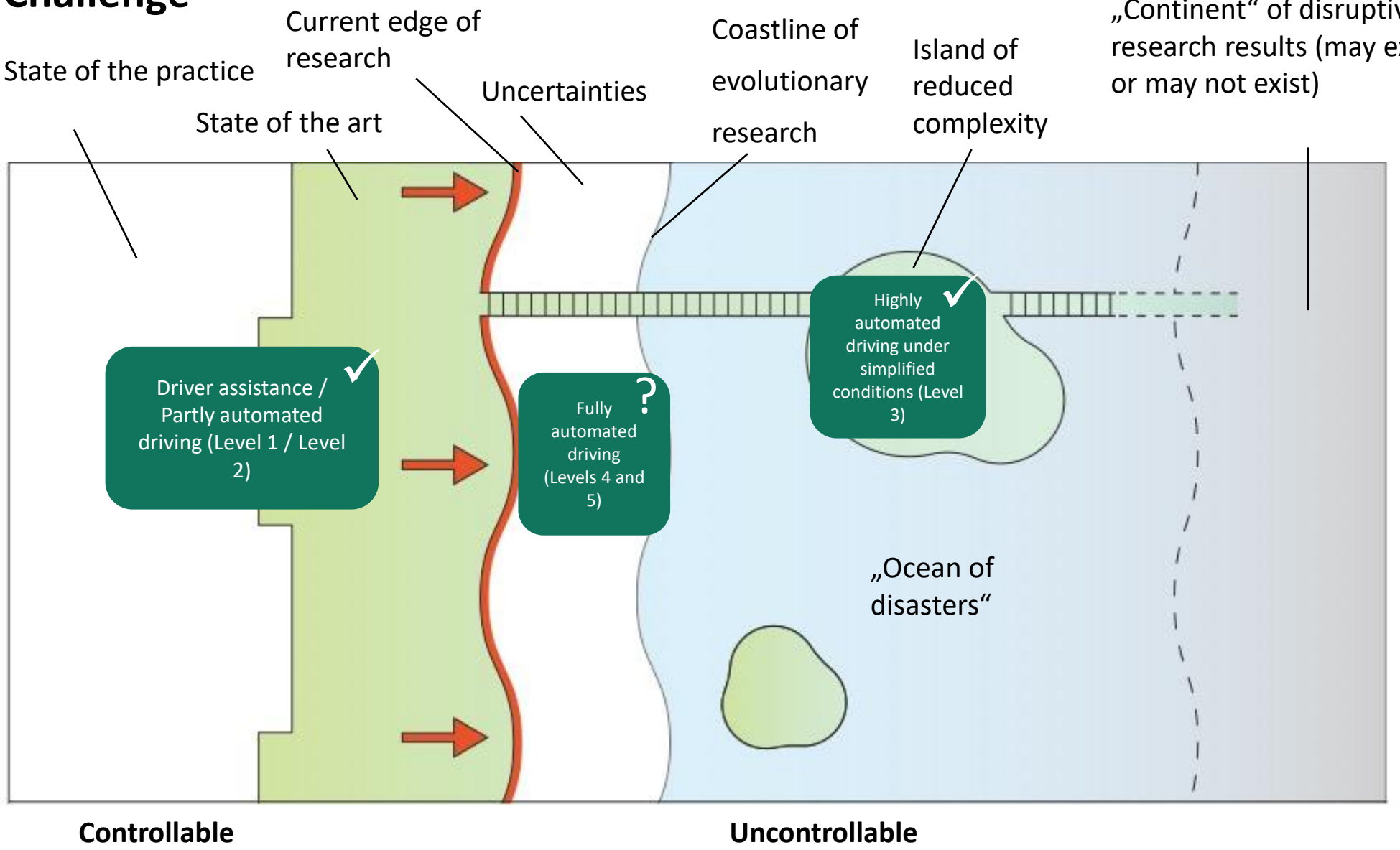
that are available and safe might be accepted,
if certain additional preconditions are fulfilled (performance, privacy, usability, …).

Vision of Dynamic Risk Management

Autonomous systems have to consider the right balance of properties in their algorithmic decision making.

Due to dynamic adaptation at runtime, this cannot be done completely at design time. Risks are to be estimated, assessed, and controled at runtime.

The Research Challenge



Cost reduction of cellular cancer therapy through flexible automated production

Copyright: Emily Whitehead Foundation

- **High market potential – increasing costs for the healthcare system**
  e.g., CAR-T-cells in immuno-oncology: ~ ¼ million EUR / commercial product caused by labor-intensive manual production due to required flexible production processes
- **Solution: Digital automated flexible production**
  - Digitally controlled individualized production processes based on Industry 4.0 principles
  - Virtualization (production and quality control) and automated screening
  - GMP conformity

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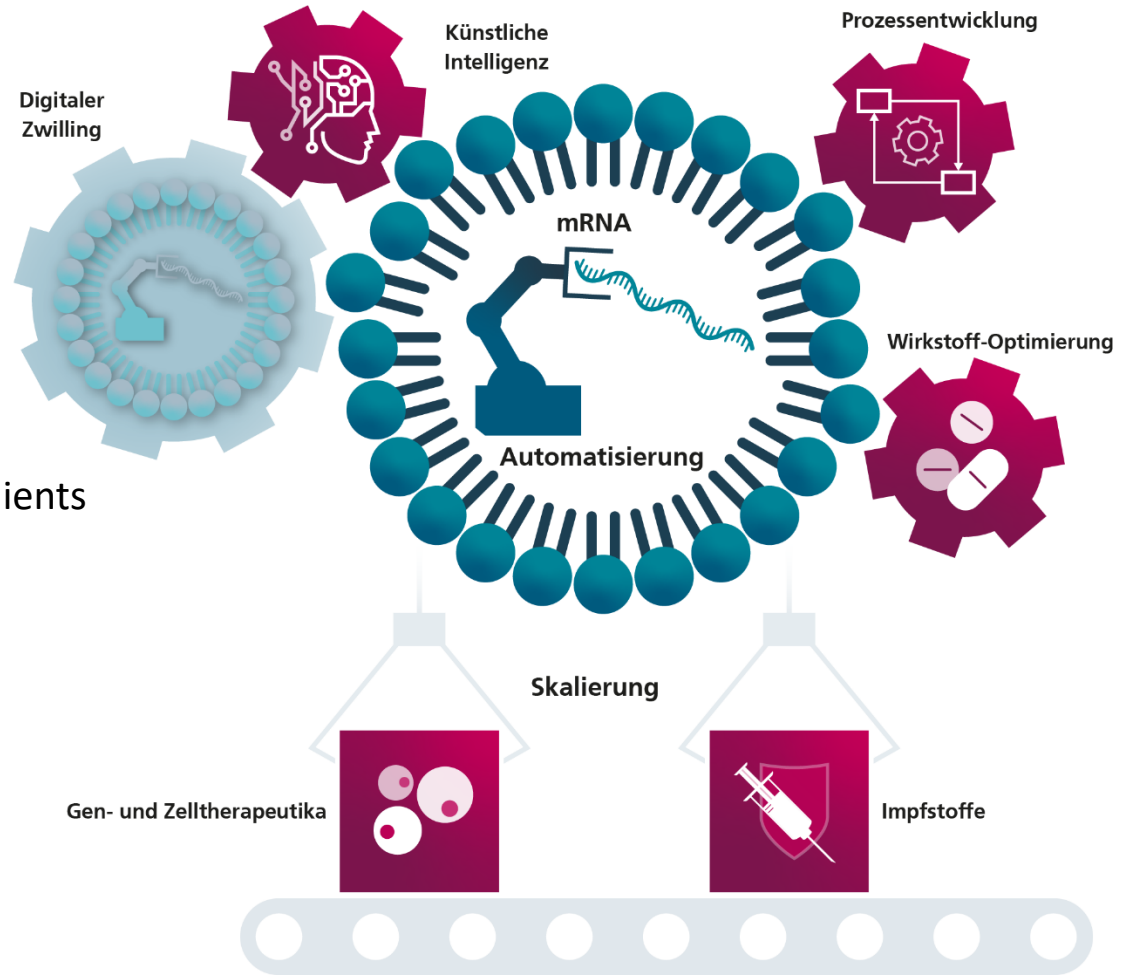
Lighthouse project RNAuto 2022-2025

Automated production technologies mRNA derived vaccine and cell & gene therapies

- Scalable production modules
- Digitally controlled and AI-based/supported, automated production and monitoring/surveillance
- Virtualisation(Manufacturing/Production und quality assurance)
- Automated screening systems for an optimal composition of active ingredients
- Compatibility with the good production practice (GMP)
- mRNA-mass production of vaccines
- Automated manufacturing/production of allogenic cancer therapies (CAR-NK-Cells) with mRNA as raw material



KI: Künstliche Intelligenzc

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Eclipse BaSyx – Plug&Play im Vergleich zur IT Welt

Plug & Play
in the consumer world

Standard USB Driver
Download from the Internet

Plug & Play Principle

Standard Operating System

Eclipse BaSyx in the industry

Industry Device

Asset Administration Shell
as I4.0 Driver

Unified Interface & Integration

Standard I4.0 Operating System

BaSyx

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AAS Dataspace for Everybody – About

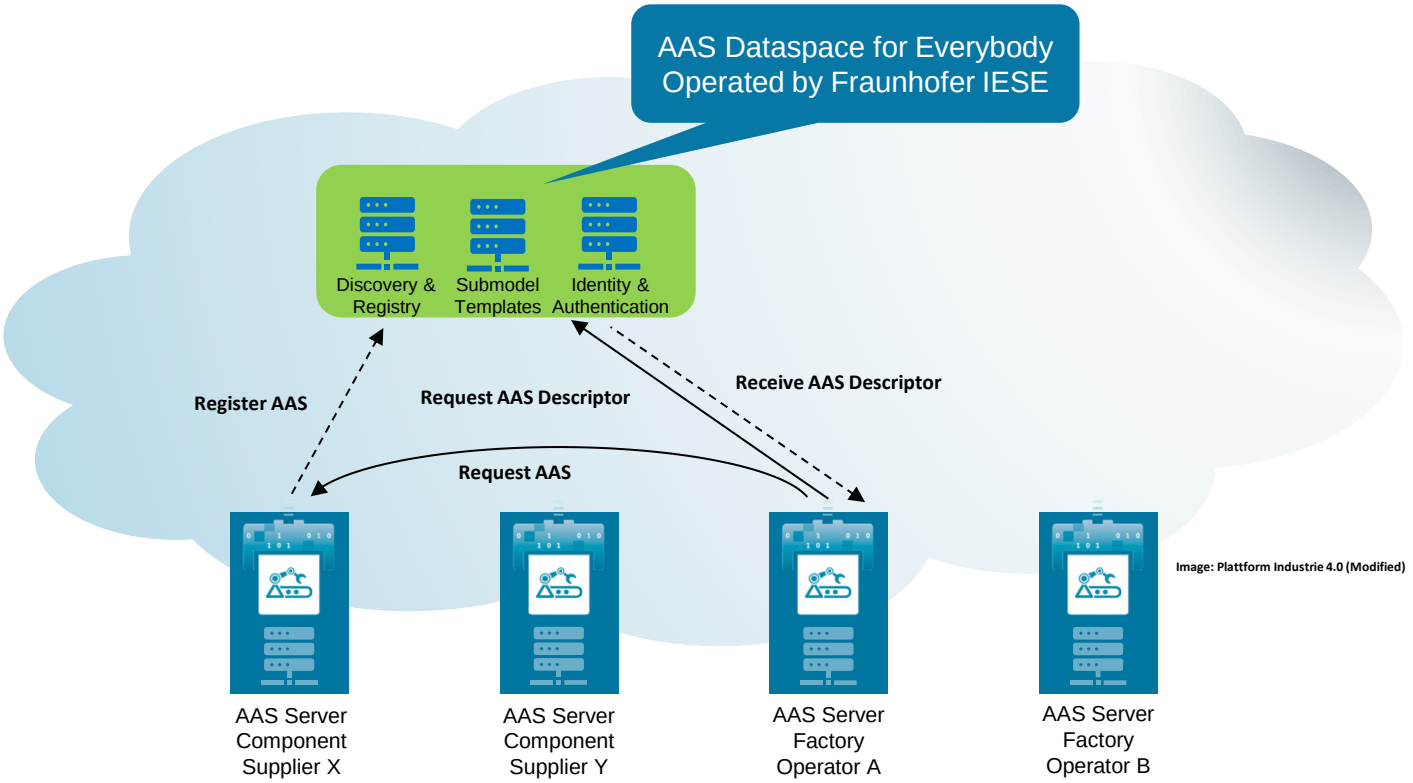
Simplify sharing of AAS based Digital Twins

AAS Dataspace

- Share AAS and AAS based Digital Twins
- Stay in control: You decide who is going to receive AAS and sub model data from your servers
- Prototyping environment for AAS based data spaces

Security

- Your AAS based digital twins remain on your servers
- The AAS dataspace provides registry, discovery, AAS sub model templates, and identity services
- Stay in control: You decide who is going to access your data
- We only keep a link - No need to upload any of your data



AAS Dataspace for Everybody – Partners

You‘ll never walk alone…

AAS & AAS Dataspace Ecosystem – Beyond Prototypes

- Digitization involves numerous components and technologies
- Ecosystem to roll out AAS based digital twins and AAS dataspaces
- Both open-Source and professionally supported end-to-end solutions
- Coordinated and integrated components provide useful solutions
- Scalable, reliable, professionally supported

How to get involved

- Kickoff Event: Join us, and get to know everybody!

  07.05.2024 at Fraunhofer IESE in Kaiserslautern

- Contact us if you want to join the Ecosystem!

SAP , …

MHP, Xitaso, …

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NetApp

CISCO congatec , …

AAS Based Industry 4.0 End-to-End solution

Integration in Business Apps

Industry 4.0 Integration
Integration ▪ Projects ▪ Professional Support

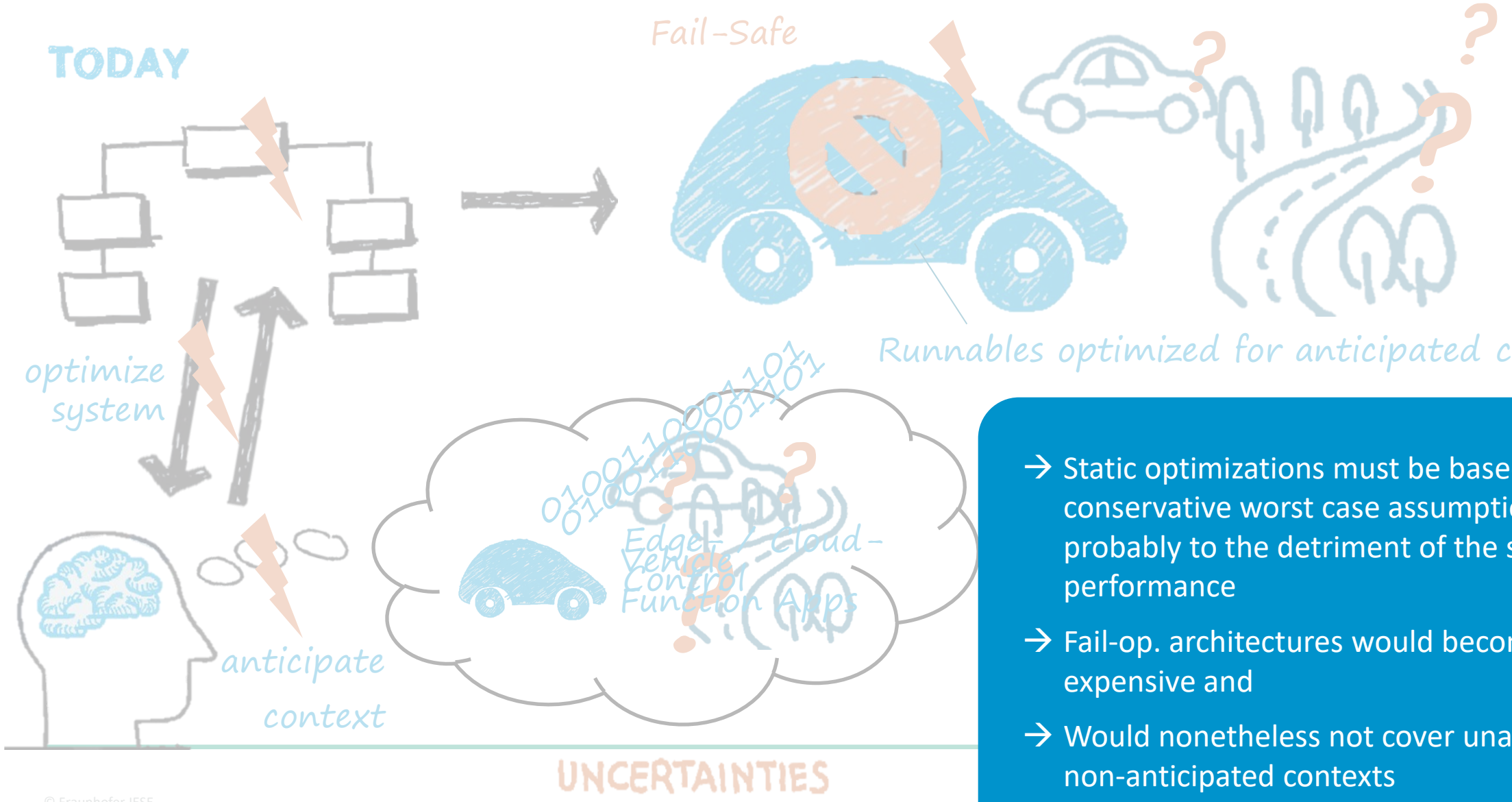
Eclipse BaSyx Middleware
Digital Twins ▪ AAS Software Infrastructure ▪ AAS

AAS Dataspace Operator

Data management platform
Ransomware protection ▪ Metro-Cluster ▪ Backups ▪ Scalability

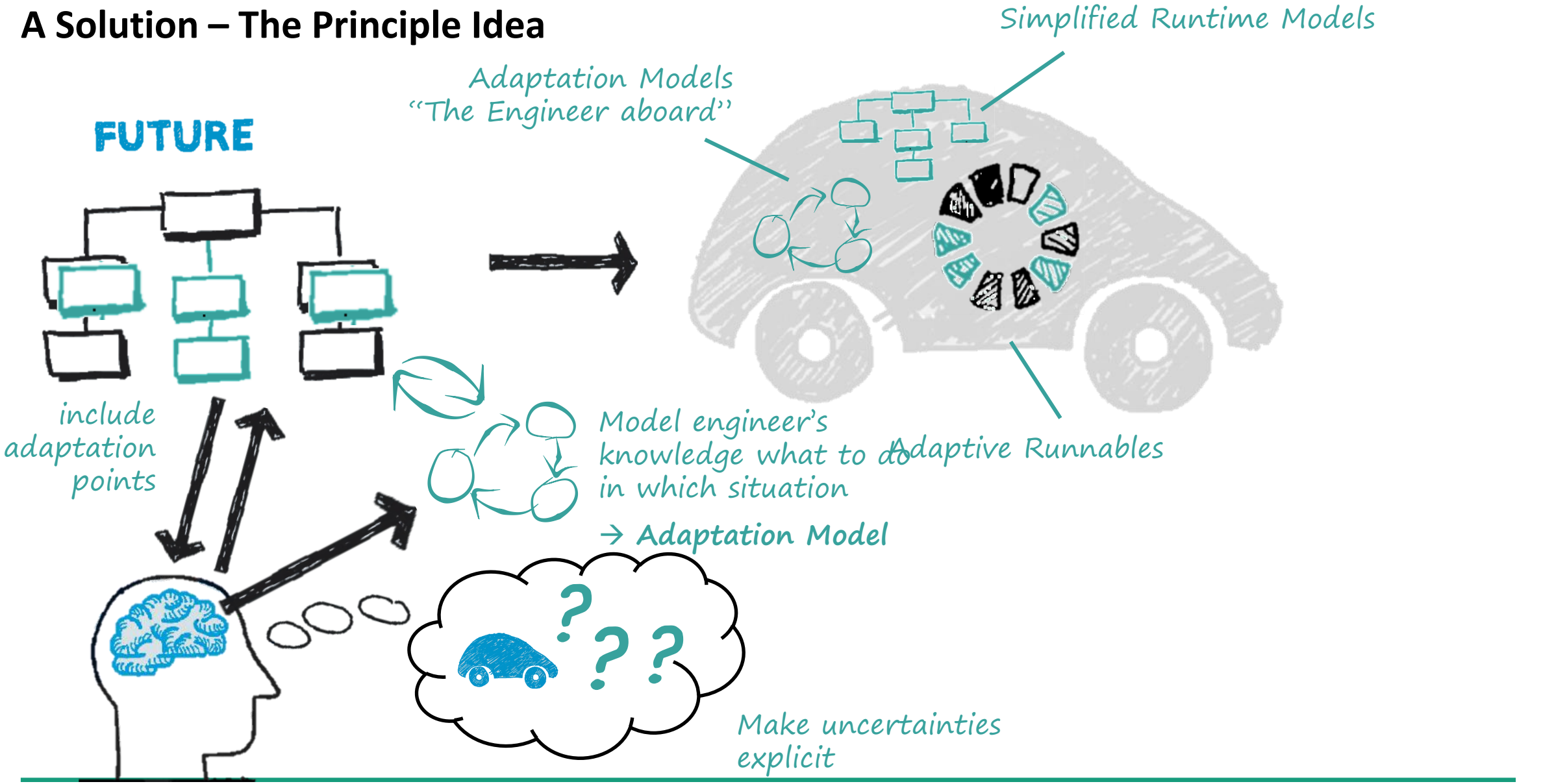
Shopfloor connectivity
IoT Devices ▪ Security ▪ OPC UA ▪ Field Busses

The Challenge – From an Engineering Point of View



- → Static optimizations must be based upon conservative worst case assumptions, probably to the detriment of the system performance
- → Fail-op. architectures would become too expensive and
- → Would nonetheless not cover unavoidable, non-anticipated contexts

A Solution – The Principle Idea



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Schlussfolgerungen

- Systeme sind heute schon interdisziplinär; es existiert aber kein von allen Disziplinen akzeptierter Zugang: Ganzheitliche heterogene Ansätze
- Systeme werden sich in Zukunft zunehmend zur Laufzeit autonom verändern: Qualitätssicherung zur Entwicklungszeit ist nicht ausreichend
- Die traditionelle Qualitätssicherung muss durch Laufzeit-Analysen bzw. -Prognosen ergänzt werden: X@Runtime
- Systeme benötigen ein Selbstbild: Virtualisierung
- Die Erzeugung eines validen Selbstbilds erfordert Informationen: Daten
- Wir müssen lernen, sichere Systeme aus teilweise unsicheren Komponenten zu bauen: ML
- Menschen müssen in der Lage sein, in diesem dynamischen Umfeld zu agieren: Verständnis einer autonom veränderlichen Umgebung