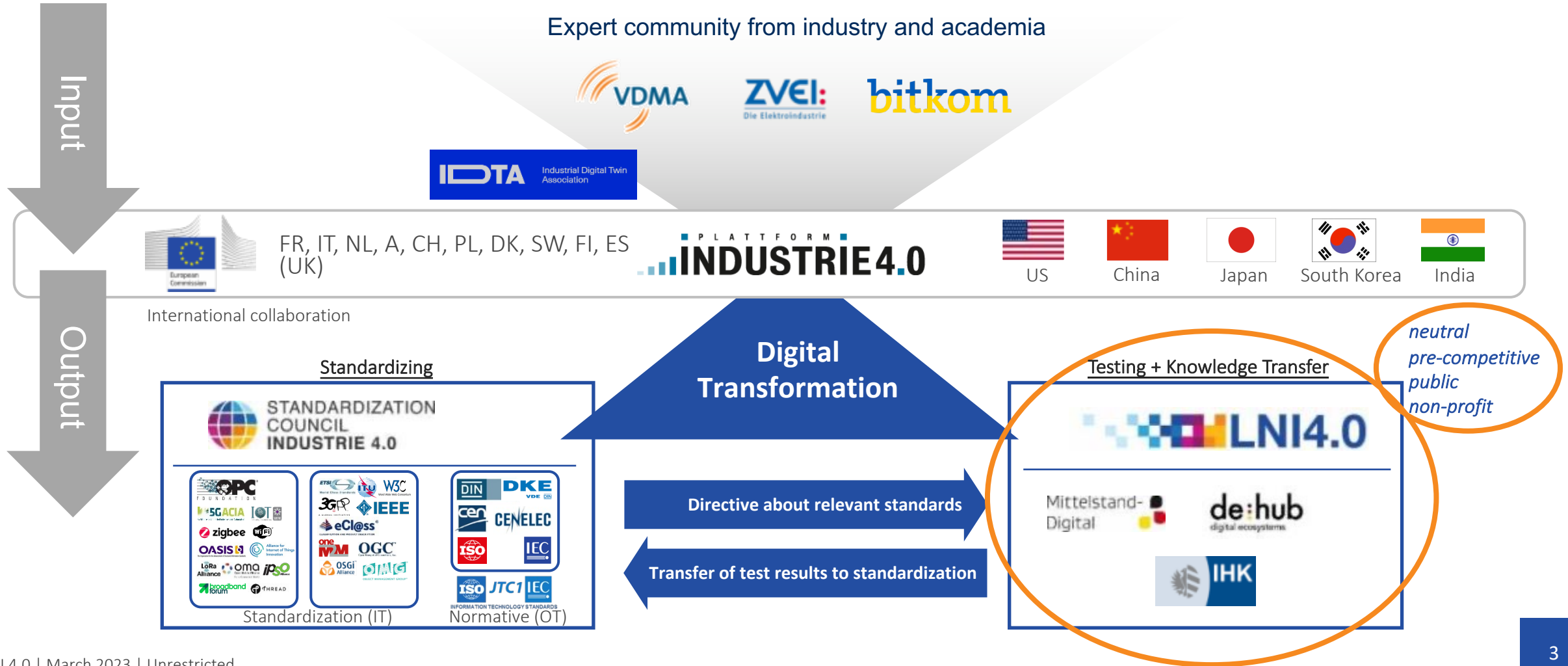# Labs Network Industrie 4.0 e.V. LNI 4.0 Testbeds

SME use cases and testbeds for Industrie 4.0 innovations – pre-competitive and non-profit (neutral) association

1.3.2023

# Industrie 4.0 Stakeholders
## Setup in Germany



Input

Output

Expert community from industry and academia

VDMA  ZVEI: Die Elektroindustrie  bitkom

IDTA Industrial Digital Twin Association

European Commission

FR, IT, NL, A, CH, PL, DK, SW, FI, ES (UK)

PLATTFORM INDUSTRIE 4.0

US  China  Japan  South Korea  India

International collaboration

Digital Transformation

Standardizing

STANDARDIZATION COUNCIL INDUSTRIE 4.0

Standardization (IT)  Normative (OT)

Directive about relevant standards

Transfer of test results to standardization

Testing + Knowledge Transfer

LNI4.0

Mittelstand-Digital  de:hub digital ecosystems

IHK

neutral
pre-competitive
public
non-profit

3

# LNI 4.0 – Roadmap belongs to Industrie 4.0 and its application development

**-> What is ‚Industrie 4.0'?**

Human, machines and products are directly networked with one another: the fourth industrial revolution has begun.

Further information – please refer to the Plattform Industrie 4.0:
https://www.plattform-i40.de/IP/Navigation/DE/Industrie40/WasIndustrie40/was-ist-industrie-40.html

Action Fields



**2030 VISION FOR INDUSTRIE 4.0**
Shaping Digital Ecosystems Globally

**Autonomy**
Self-determination and free scope for action guarantee competitiveness in digital business models
● Technology development ● Security ● Digital infrastructure

**Interoperability**
Cooperation and open ecosystems permit plurality and flexibility.
● Regulatory framework
● Standards and integration
● Decentralised systems and artificial intelligence

**Sustainability**
Modern industrial value creation ensures high standard of living.
● Decent work and education
● Climate change mitigation and the circular economy
● Social participation

| Machine Interoperability | Human Integration | Data Management & Analytics | Digital Economy Drivers | Digital Business Models |
|---|---|---|---|---|



**Industrie 4.0 Communication of Machines:**
• Machines talk to each other in an interoperable manner in networked digital ecosystems

**Human-Machine-Process Interaction:**
• Human work together with machines and in processes as companions
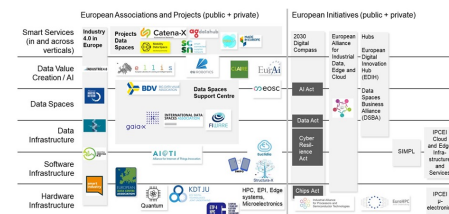• Immersive integration of human, using Industrie 4.0 technologies

**Data Spaces for Industrie 4.0:**
• Global agreement on similar/ uniform reference architectures
• Use of higher-level metadata models including the associated infrastructure services

**Digital Economy Drivers:**
• Carbon reporting
• Supply chain resilience
• Circular economy
• Data Act, AI Act, Cyber Resilience Act, EU Data Governance Act, etc

**Industrie 4.0 BizMo:**
• Value creation in the context of digital transformation
• Development of customer benefits based on digital technologies (e.g. peer to peer tender)

# LNI 4.0 Offerings

Status January 2023

Community LNI 4.0

LNI 4.0  Use Cases
(continuously)

LNI 4.0  Testbeds
general Assembly
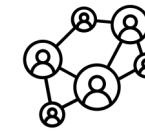incl. Information for
specific topics
(monthly)

LNI 4.0 Testbed
Workshops + Plugfests
(4-6 x yearly)

Associated test
labs and partner
networks
(on demand)

Conferences,
presentations and
sessions
(on demand)

Social Media
(continuously)
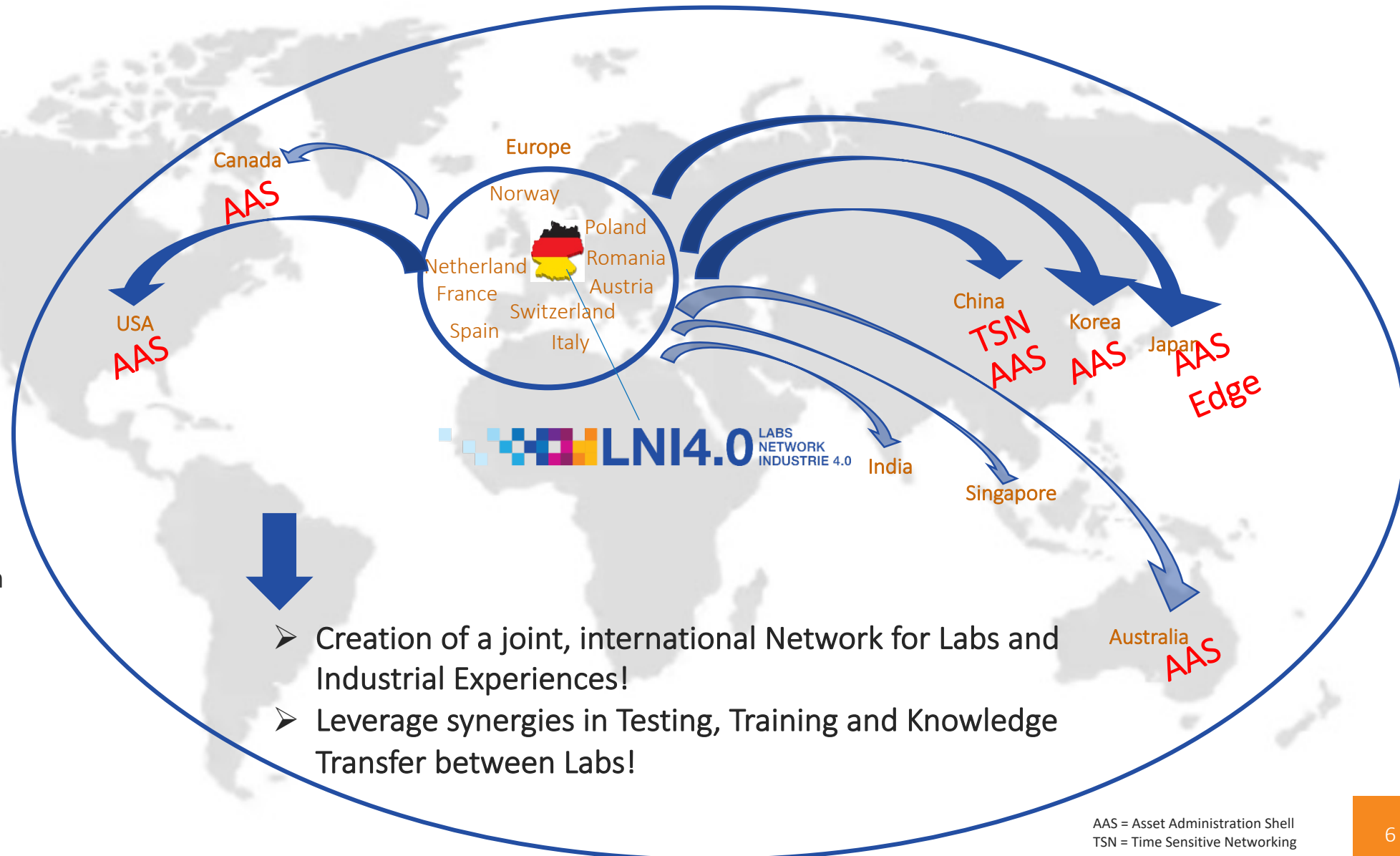
LNI 4.0 Newsletter
(3-4 x yearly)

LNI 4.0 Website
(continuously)

# The international network of LNI 4.0 – together towards Industrie 4.0



**Network for international cooperation:**

- Create international use cases & test scenarios
- Facilitate knowledge exchange
- Coordinate standardization effort

Canada — AAS
Europe
Norway
Poland
Romania
Netherland
Austria
France
Switzerland
Spain
Italy
USA — AAS
China — TSN AAS
Korea — AAS
Japan — AAS Edge
India
Singapore
Australia — AAS

➢ Creation of a joint, international Network for Labs and Industrial Experiences!
➢ Leverage synergies in Testing, Training and Knowledge Transfer between Labs!

AAS = Asset Administration Shell
TSN = Time Sensitive Networking

# LNI 4.0 test environment in Germany

## A) Use Case testing facilities (Labs)



## B) 26 Industrie 4.0 Competence Centers

Supported by:

Federal Ministry for Economic Affairs and Climate Action

on the basis of a decision by the German Bundestag

Mittelstand-Digital
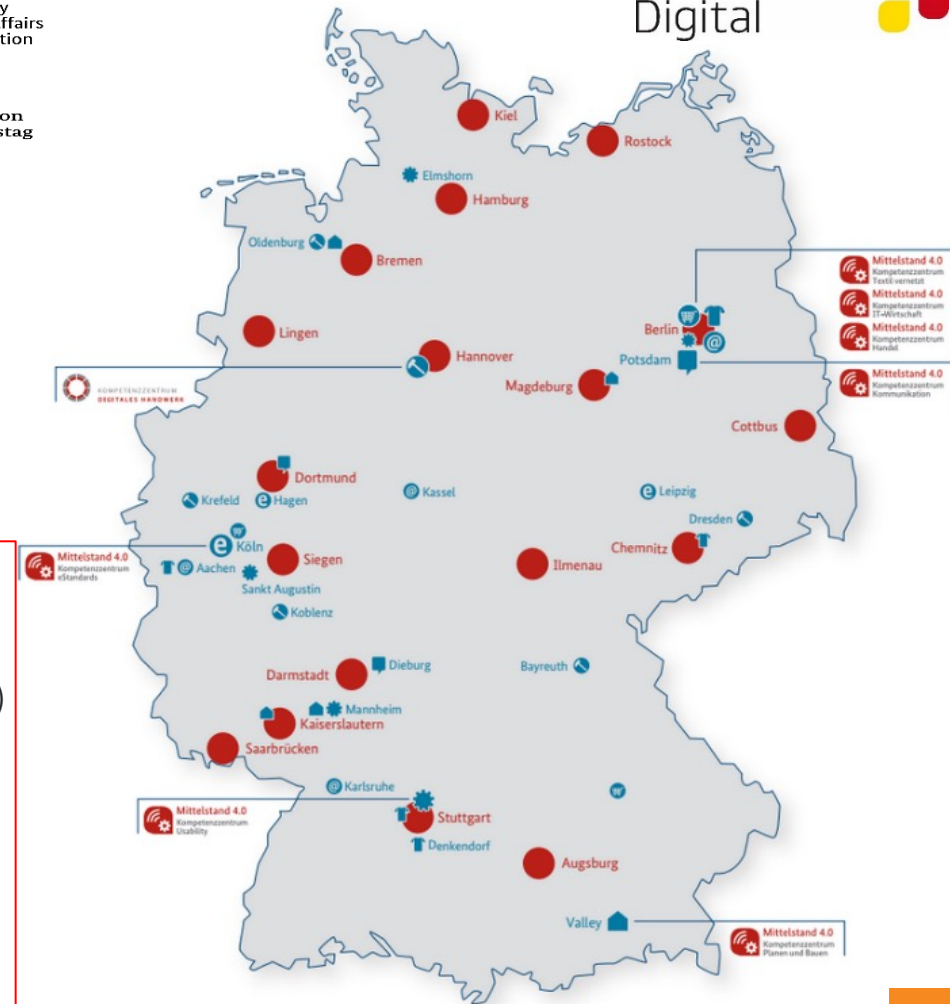


## C) LNI 4.0 Testbeds

- AAS - Asset Administration Shell (Hannover)
- TSN - Time-Sensitive Networking (Augsburg)
- Edge management (Hattersheim am Main)
- OPC UA companion specification validation (RWU Weingarten -> TU Darmstadt)
- Human–Machine–Process-Integration (XR Hub Würzburg)
- Cross-Testbed: Data Management, Data Spaces + Analytics
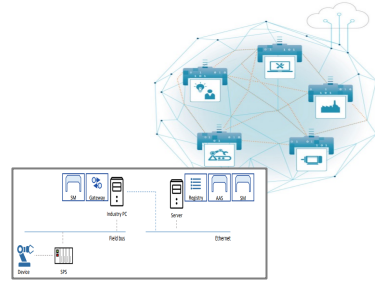
# LNI 4.0 Testbeds at a Glance

## Two LNI-Testbeds with direct link to industrial communication
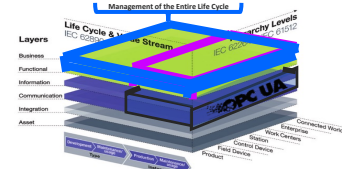
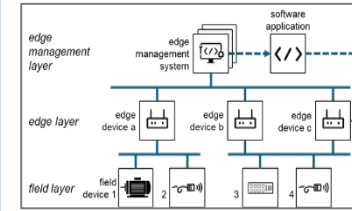### Machine Interoperability

**1 Time-Sensitive Networking (TSN)**
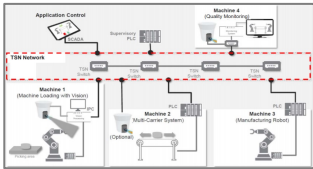


**2 Asset Administration Shell (AAS) (IEC63278)**



**3 Shopfloor Communication via OPC UA**



**4 Neutral and open Edge Management**



### Human Integration (new)

**5 Human – Machine – Process-Integration (HMPI)**



### Data Management & Analytics (new)

**6 Network of Data Labs & Analytics**



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**Column 1 (TSN):**

- TSN is a **toolbox** to **enable Time-Sensitive Networking of machines and devices**
- Further validation of **extensions to the IEEE 802.1 standard family** for time-sensitive networking (TSN)
- **Further participation at**
  - OPC UA PubSub TSN prototyping
  - Inter-domain stream establishment, distributed or centralized domain control
  - TSN application in 5G
- *Continuous plug-festivals based on SME requirements and LNI 4.0 Use Cases.*
- Evaluation of a **simple approach for production lines,** fostering **stepwise collaboration** between **automation system integrators** and **machine builders**

**Column 2 (AAS):**

- **Asset Administration Shell** is a **Metamodel with UML class diagram** and **related Infrastructure Services**
- **Initiation, testing and valida**tion of **further Modules in the AAS (**energy efficiency, de-carbonization, etc.) and **providing input for its standardiza**tion
- *Build up of a AAS Demonstrator and Network to other demonstrators*

**Column 3 (Shopfloor Communication):**

- Validation of **Horizontal and vertical communication network of machines** via semantic of **OPC UA Companion Specifications**
- **Extension** by **commercial business aspects (reg. MES, ERP)**
- *Evaluation of Use Cases for different manufacturers tested with OPC UA client/server*

**Column 4 (Edge Management):**

- **Edge computing technology** as **distributed computing paradigm** and the **decentralized data processing** at the edge of the network, from the field devices to the Management System layer
- Finalization of **Functional and Implementation view**
- **Compatibility test** of the **Implementation View** on **different products and devices**
- *Validation of the proposal for standardization of the management of edge and field devices*

**Column 5 (HMPI):**

**Creation and Validation** of proposals for **intelligent and immersive human machine integration and interaction**

*Entry point for the integration of humans:*
= *technical solutions and applications, whilst Linking to existing initiatives from the overall context (e.g. ethical, social, legal activities)*

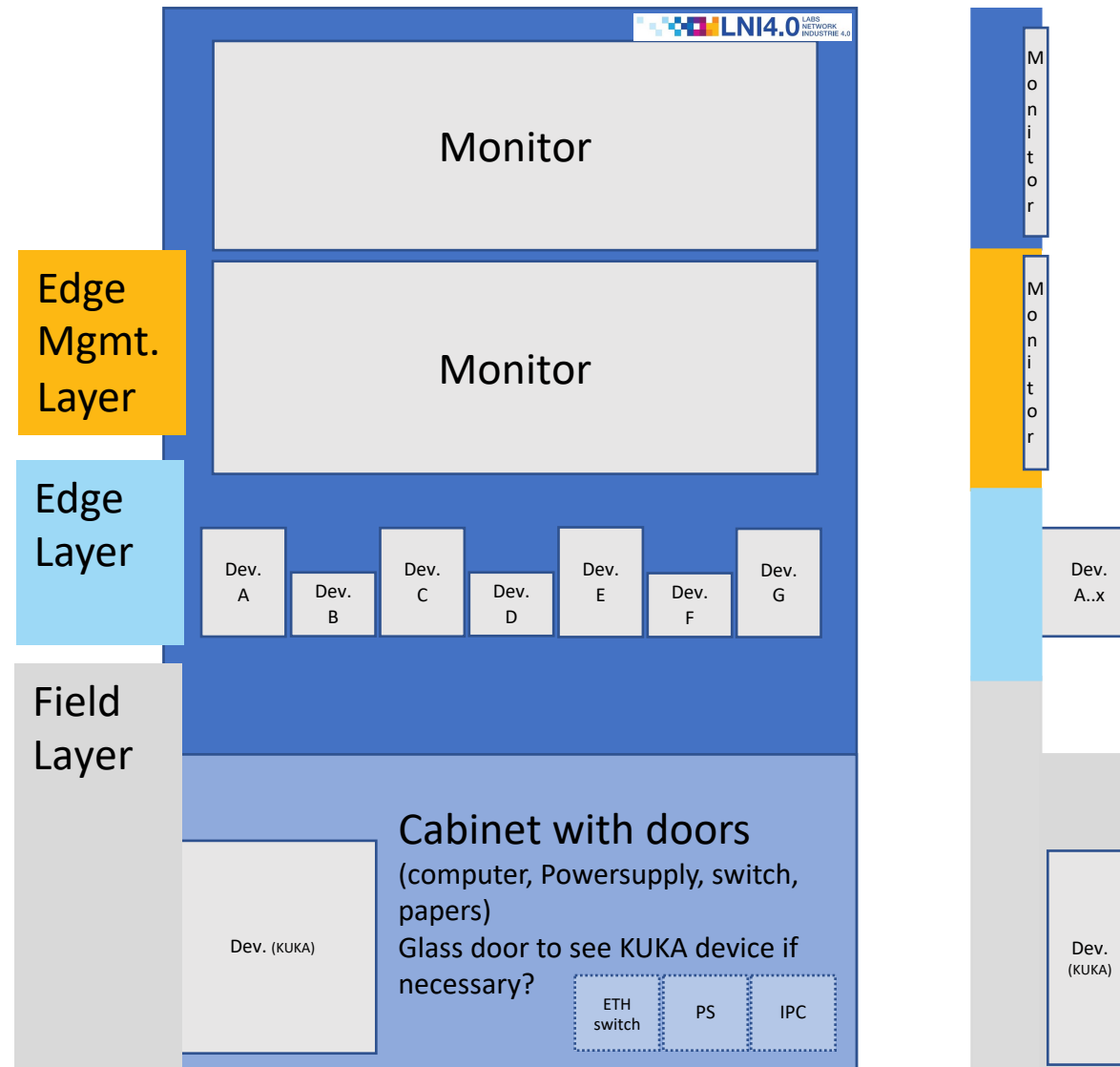**Column 6 (Network of Data Labs):**

- *Data Management as fundamental basis for Industrie 4.0*
- *Network of existing activities at German and European level*
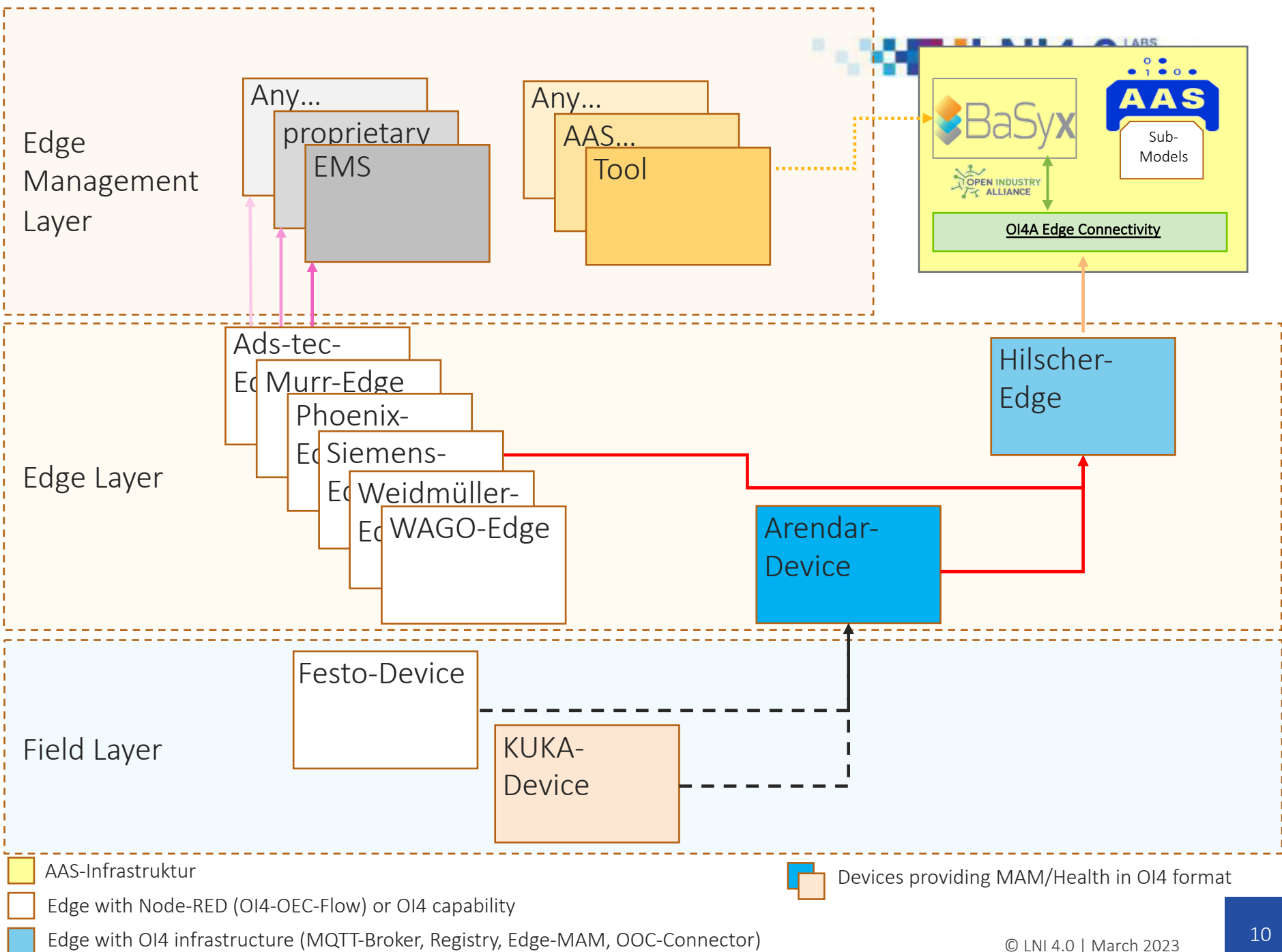- *Extension to Artificial Intelligence and Digital Twin / Simulation*

# Edge Management Testbed and Demonstrator

On display at:

Hannover Fair 2023

Hall 8, D26

# Edge Management Demonstrator



**Edge Management Layer**

Any…
proprietary
EMS

Any…
AAS…
Tool

BaSyx
AAS Sub-Models
OPEN INDUSTRY ALLIANCE
OI4A Edge Connectivity

**Edge Layer**

Ads-tec-Edge
Murr-Edge
Phoenix-Edge
Siemens-Edge
Weidmüller-Edge
WAGO-Edge

Hilscher-Edge

Arendar-Device

**Field Layer**

Festo-Device

KUKA-Device

## Legend

| | |
|---|---|
| → (red) | MQTT (OPC UA PubSub JSON) |
| ⇢ (black dashed) | OPC UA |
| → (orange) | AAS style (**OI4** flavored) |
| ⋯→ (orange dotted) | AAS REST API |
| → (pink) | Proprietary EMS API |

AAS-Infrastruktur

Edge with Node-RED (OI4-OEC-Flow) or OI4 capability

Edge with OI4 infrastructure (MQTT-Broker, Registry, Edge-MAM, OOC-Connector)

Devices providing MAM/Health in OI4 format

# Next: Manufacturing-X connecting industrial verticals internationally, using AAS, etc.



- Resilience
- Sustainability
- Competitiveness

**Ideation**

**Building blocks for a Manufacturing-X data space** (R&D)
Aim: "Establishing an autonomous Manufacturing-X data space, with Catena-X as the blueprint"

1. Flagship projects and use cases
2. Synchronisation project

**Building blocks for transfer** (widespread impact)
Aim: "Integrating small and medium-sized enterprises with help of needs-based application strategies"

3. Transformation hubs and transformation projects
4. Transfer management

**Building block for community-building** (embedding)
Aim: "Internationalizing by implementing global standards for a comprehensive data economy"

5. Governance in Manufacturing X

**Focus today**

Chemical & Pharma

Automobile (Catena-X)

Engineering

**Manufacturing-X**
Smartly networked industry

Electro

Food

Further industries …

International Partners, e.g.

DATES — European Data Space for Tourism

EONA-X

Catena-X Automotive Network

SC SN — smart connected supplier network

Mobility Data Space / Data Sharing Community

# Contact

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# Industrie 4.0 is not just another tool, but above all represents an entry point into the future digitized world and must therefore support the future role of your company in Industrie 4.0