ECSEL Joint Undertaking
Electronic Components and Systems for European Leadership

AI4DI

R&D Project

Moore ++ AI
for native AI computing

More Moore ++ AI
for native AI algorithm

More than Moore ++ AI
for native AI perception and actuation

ICITI 2019
Taipei 27.08.2019
Reiner John

AI4DI - Platform for cross-cutting requirements of AI in Digitizing European Industry to facilitate a common roadmap

V1.0

Multi-national consortium contributes to aligned AI-methods and harmonized Requirements for competitve digital value chains in the manufacturing for the succes in global markets

Taiwan as window to Asia

https://ec.europa.eu/epsc/publications/strategic-notes/rethinking-strategic-autonomy-digital-age_en

News
July 2019

European Commission

EPSC Strategic Notes

Issue 30
July 2019

Rethinking Strategic Autonomy in the Digital Age

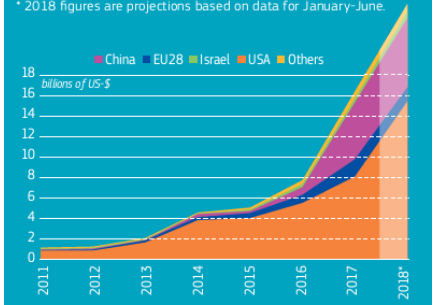
European **Political Strategy** Centre

In the 21st century, **those who control digital technologies are increasingly able to influence economic, societal and political outcomes.** Policymakers around the world are waking up to the critical imprint that digital technologies have on their countries' strategic autonomy and a global race for technological leadership has ensued.

Figure 3: EU outspent on private sector investment in AI

Total estimated equity investments in AI start-ups annually, 2011 to 2018, by start-up location.

* 2018 figures are projections based on data for January-June.



Source: OECD estimates, based on Crunchbase (July 2018)

Critical digital infrastructure: high risks require extra caution

While open markets and competition must remain the key drivers of innovation and efficiency, the growing importance of digital technologies for most of Europe's critical infrastructure warrants the application of a more precautionary stance towards reliance on foreign components, especially those coming from authoritarian states. This is particularly clear as regards 5G technology, where stricter review mechanisms should be applied to manage potential network vulnerabilities.

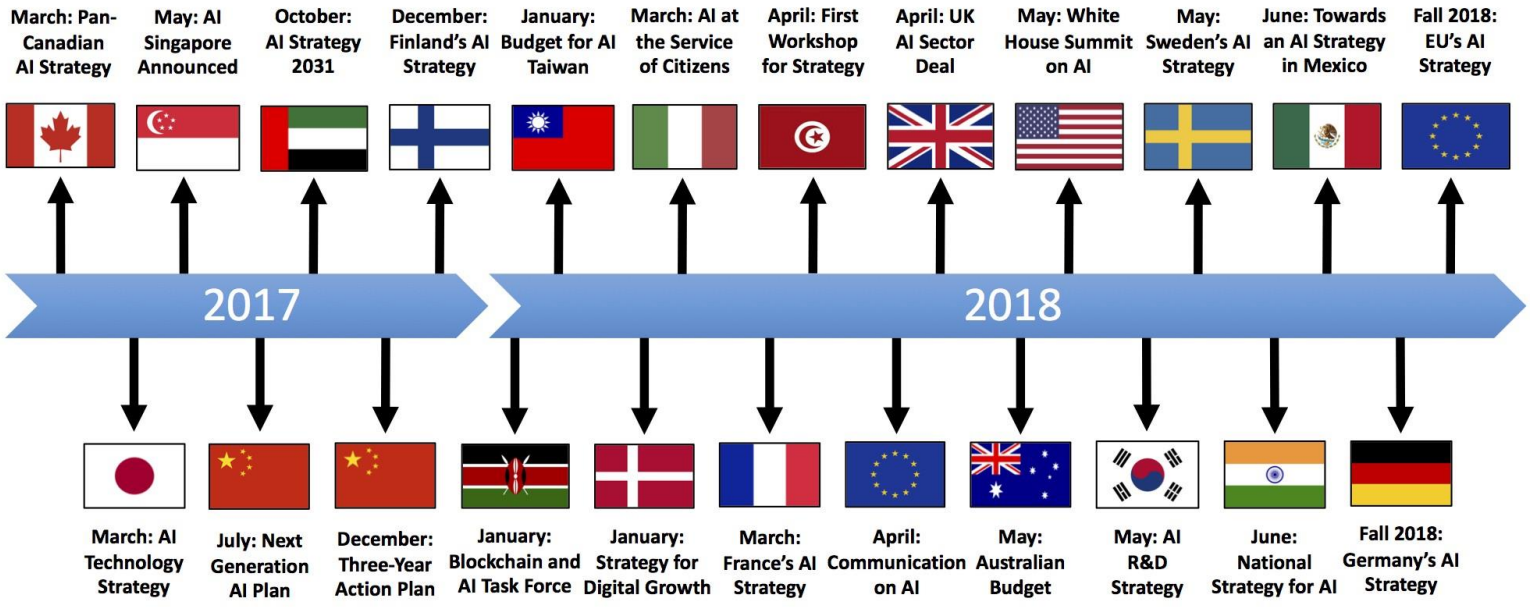
A strong tech sector is a prerequisite

Without a strong industrial base, built on a common tech strategy and pooled resources, Europe will be unable to domestically produce the technologies it needs to stay at the forefront of global competition – be it in economic or defence terms. Foreign imports will remain necessary, but collateral risks – e.g. supply chain disruptions or compromised equipment penetrating Europe's critical infrastructure and digital systems – need to be managed.

Alliances are a must

In an interconnected world of global value chains, where trust is becoming a rare commodity, there is a real need to build forward-looking alliances around digital strategic paradigms. Europe is spearheading this approach, e.g. in its partnerships with the US, Japan or NATO, and with its efforts to craft rules on data governance and ethical uses of AI. But its ability to shape international norms and standards in a way that reflects its interests and values will be a function of its technological edge and genuine demand for its products.

Artificial Intelligence Strategies



Guan-xi

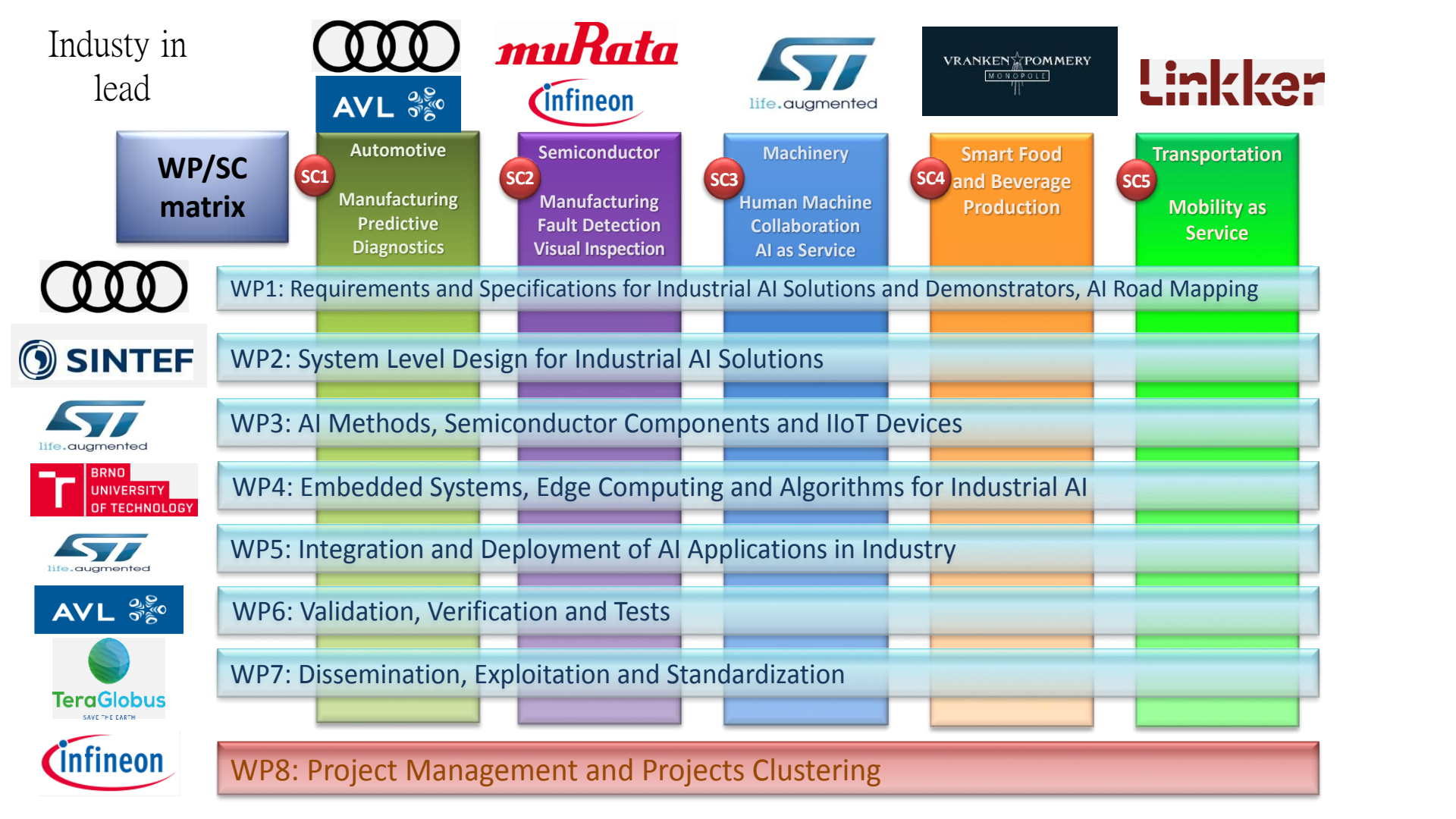
Trust in People is the key to success in collaboration

Step by step to aligned ideas and collaboration

Collaborative R&D on AI for the Transition in the Digital Industry along the value chain

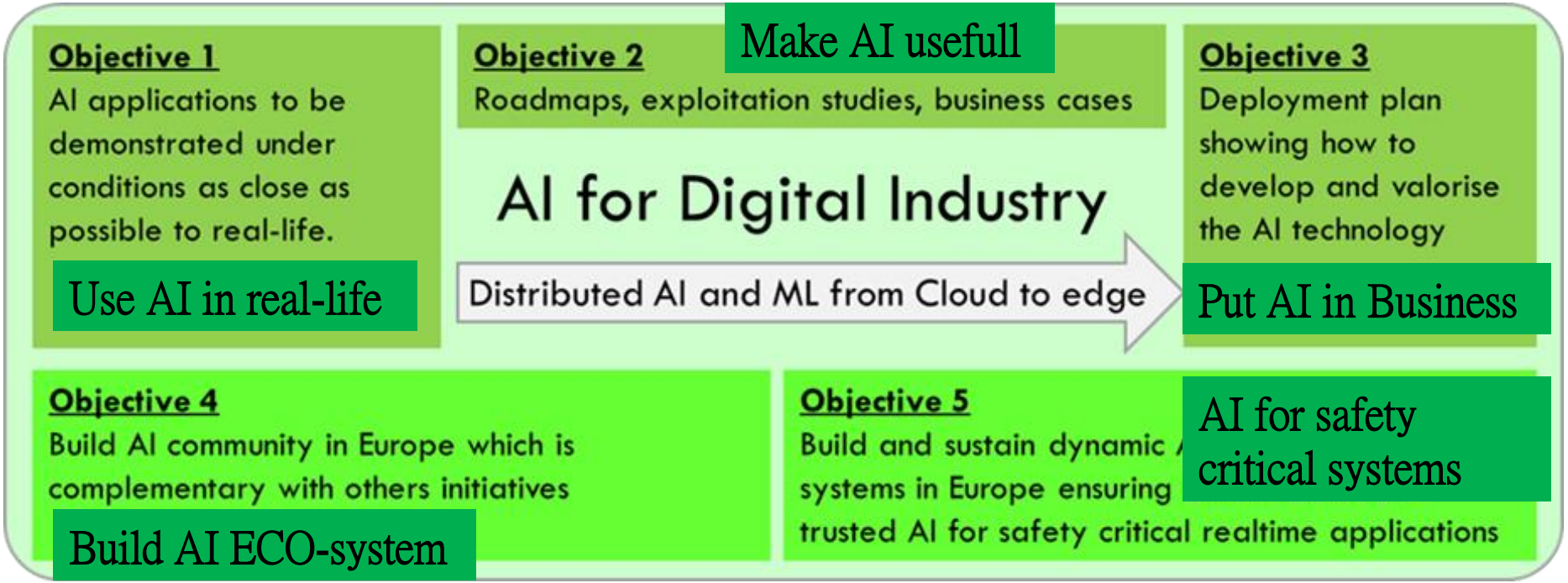
AI4DI

Industry
SME &
Data-
analysts
Institutes
University


Industy in lead
AVL
muRata
infineon
life.augmented
VRANKEN POMMERY MONOPOLE
Linkker
WP/SC matrix
SC1
Automotive
Manufacturing
Predictive Diagnostics
SC2
Semiconductor
Manufacturing
Fault Detection
Visual Inspection
SC3
Machinery
Human Machine Collaboration
AI as Service
SC4
Smart Food and Beverage Production
SC5
Transportation
Mobility as Service
SINTEF
BRNO UNIVERSITY OF TECHNOLOGY
TeraGlobus
WP1: Requirements and Specifications for Industrial AI Solutions and Demonstrators, AI Road Mapping
WP2: System Level Design for Industrial AI Solutions
WP3: AI Methods, Semiconductor Components and IIoT Devices
WP4: Embedded Systems, Edge Computing and Algorithms for Industrial AI
WP5: Integration and Deployment of AI Applications in Industry
WP6: Validation, Verification and Tests
WP7: Dissemination, Exploitation and Standardization
WP8: Project Management and Projects Clustering

AI4DI = AI for Digital Industry

Vision, Mission, Objectives, Key targets, Pillars, Contributions, Ontology, Semantics, Impact, ….

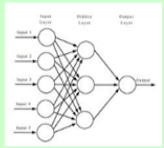


Vision: **Silicon-Born-AI**

for Accelerated AI in Embedded Control for Edge Computing and IoT/IIoT devices in industry

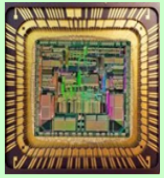
Dedicated AI methods for the industry according to the AI-attributes

to tackle big amounts of data out of the real industrial world



Dedicated AI Software on improved AI hardware architectures for the industry

Enhanced connectivity for fast communication



Dedicated CPU + AI in Silicon components

Silicon-Born-AI

Moore Law ++ AI
For native AI computing

More Moore ++ AI
For native AI algorithm

Dedicated Sensors + AI in Silicon components (Sensors, MEMS)

Sensing and preparing the edge data

Silicon-Born-AI

More than Moore ++ AI
For native AI perception and actuation

Accelerated AI on every level

New value opportunities for automotive OEMs along the value chain enabled by AI.
AI4DI addresses supply chain management and manufacturing, the most promising areas along the whole value chain

By facilitating the generation of new insights and automation of processes, AI enables OEMs to capture new value opportunities at each stage of the value chain

Value potential from bottom-line effects in percent of costs in the corresponding part of the value chain
Value potential from top-line effects in percent of total revenue

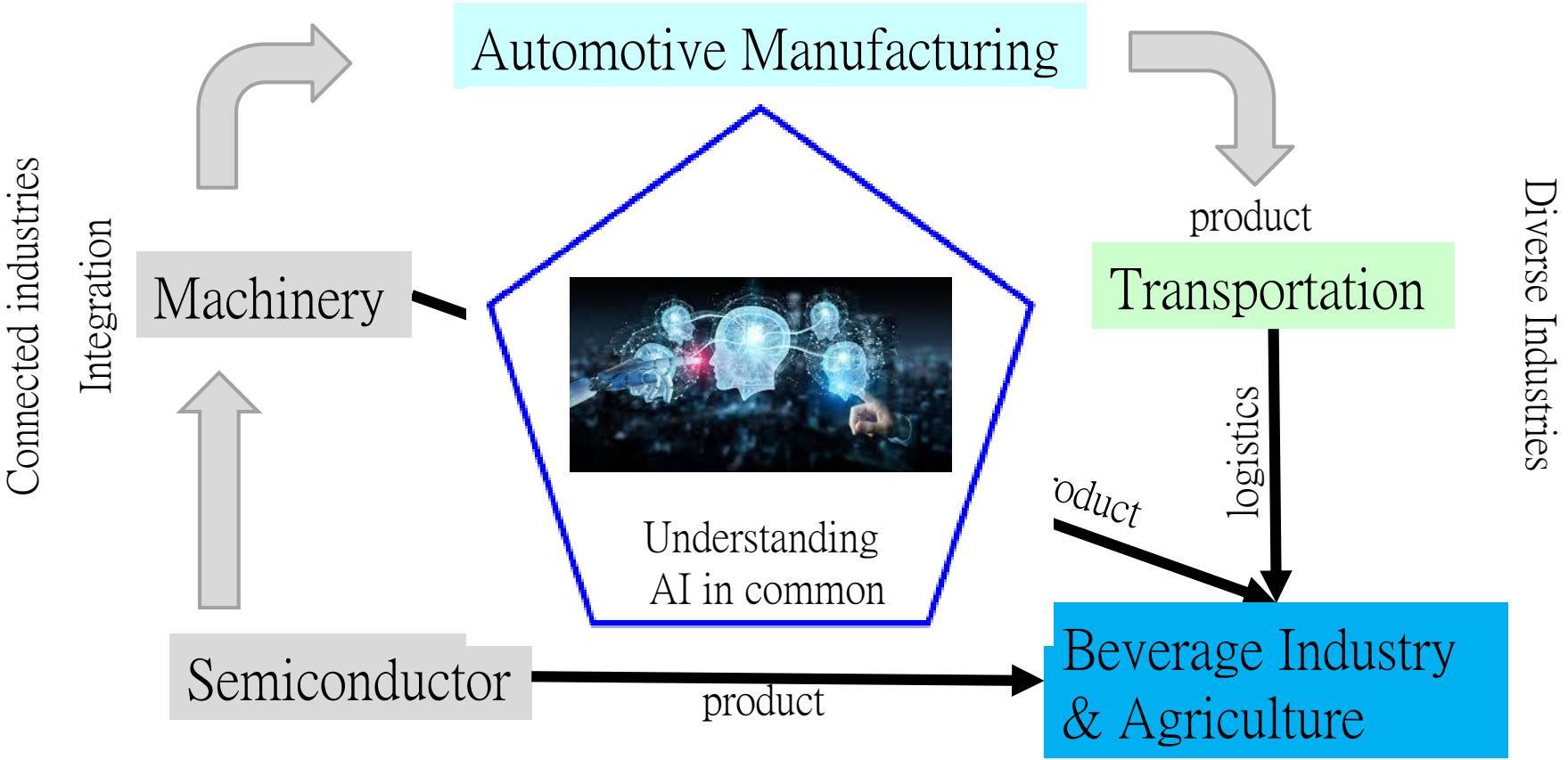
AI4DI addresses areas where the introduction of AI will have maximum impact by 2025

	Research and development	Procurement	Supply chain management	Manufac-turing	Sales and marketing	Aftersales and services	Support functions
Value potential	7%	4%	15%	15%	12% | 0.9%	5% | 0.3%	19%
Data-based insight generation	R&D prioritization and performance improvement, e.g., using outcome prediction for experiments Data-driven design-to-value to improve product to customer fit Wear and tear analytics Optimization of product features to production process	Advanced spend intelligence/ analytics-based spend optimization Supplier performance scorecard Procurement organizational performance scorecards Cleansheet analysis for parts and index-based parametrization	Closed-loop planning, e.g., integrated pricing and inventory mgmt. across channels, incl. planning forecasts SC simulation and risk management Automation of warehousing based on real-time information Improved utilization of transport capacity based on real-time information	AI-based predictive maintenance of assets through monitoring of parameters In-line digital quality mgmt, e.g., visual control for real-time process optimization	End-to-end predictive analytics for sales, e.g., build-to-stock Postpurchase cross- and upselling Programmatic/personalized marketing Cross-channel customer relationship management AI-supported lead mgmt, e.g., by providing guidance for managing customer interactions	Early recall detection and software updates Predictive service recommendations, incl. pulling customers to own/ licensed garage Assortment and storage level optimization for spare parts Remote maintenance for problems and breakdowns	Analytics of financial data and reports to enhance decisions Credit risk optimization by computation of customer risk score AI-based prediction of IT problems to minimize downtime
Value potential	3%	4%	7%	6%	9%	2%	3%
AI-based process automation	Automated documentation of product data across product life cycle Automated data transfer between different systems Virtual prototyping and testing Digital project life cycle model	Procure-to-pay work flow processes, e.g., by linking procurement to back-office finance Comparative document analysis to convert documents into text and perform analysis Automated compliance management	Automated guided vehicles and indoor navigation Automatic order placement and mgmt., esp. where algorithm can handle special situations	Advanced process control for real-time optimization Autonomous guided vehicles for intralogistics Visual quality control for final product or incoming parts	Automation of order process, from configuration to order processing and communication of delivery date Automatic placement of advertisements across channels	Automated order regis-tration, handling, and payment Optimized document mgmt. and automated processing AI-based visual inspection for 1st assessment of service effort	Automated prefilling of invoices Automation of accounts payable Automated claims mgmt Automated billing via scans or pictures
Value potential	4%	< 1%	8%	9%	3%	3%	16%

SOURCE: McKinsey

McKinsey&Company 2018.

Collaborative work to understand the Requirements for the Digital Transformation of connected and diverse industrial sectors on an abstract level



European industries in transition

Machinery

Automotive Manufacturing

Collaborative

Understanding AI in common

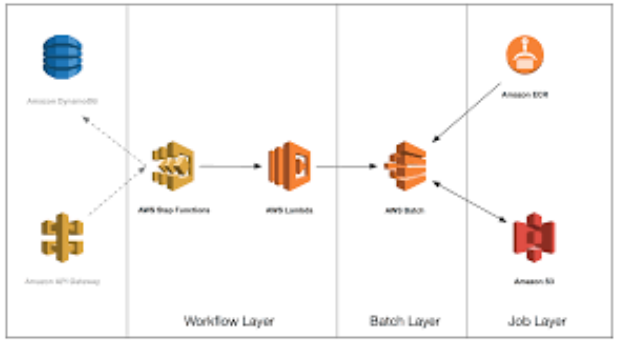
Semiconductor-Industry

Beverage Industry & Agriculture

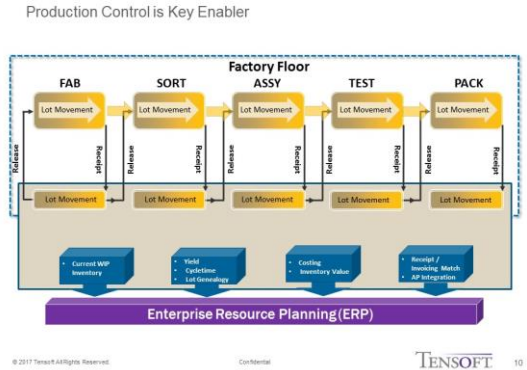
Transportation

Co-Modal Mobility

Machinery

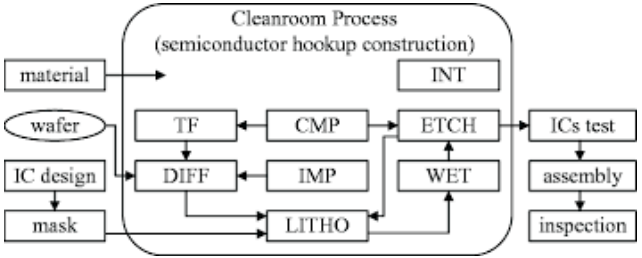


Automotive Manufacturing

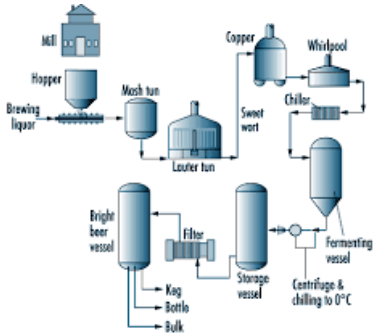


Collaborative Requirements Digital layer and twinning

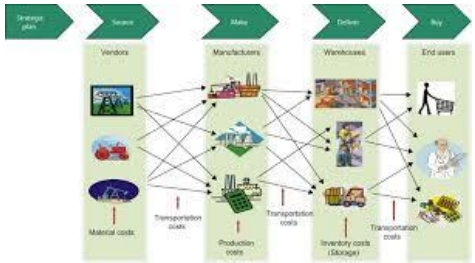
Semiconductor-Industry



Beverage Industry & Agriculture



Transportation



Use cases

Machinery

Wood machinery with innovative HMI interface	AI enhanced Augmented reality based on object recognition on tracking, Deep Learning with a special focus on the edge computing solution, AI-specific hardware and software architectures for ultra-low power DCNN SoC
Smart robot	Convolutional Neural Networks for object detection, NN using supervised learning, Inference on FPGA-based SoC, Automatic generation of synthetic training data, Augmentation of training data
Learning systems distributed over computationally heterogeneous resources	Reservoir Computing and Deep Learning technologies

Automotive Manufacturing

AI supported automotive manufacturing and logistics (Robotic controlled island manufacturing)	Evolutionary algorithms for optimization, Machine learning for pattern recognition, Data Mining for coherence analysis of large amounts of data, Neural networks for learning heuristics, Deep learning for quality and safety assurance, Reinforcement learning for robotics control, Transfer learning with digital twins
Real time predictive maintenance	Reinforcement learning, Model based reasoning based on physical damage models
Autonomous reconfigurable battery systems	Evolutionary algorithms for optimization of the control strategy and for controlling the reconfigurable system, Machine learning for pattern recognition, Data Mining for coherence analysis of large amounts of data, Neural networks for learning heuristics

Semiconductor-Industry

AI based FMEA generator	Deep Learning for Natural Language Processing, Light weight ontologies for knowledge representation
AI based 3d visual inspection for quality assurance	Deep Neuronal Networks for sample classification of 3d images
Fault Package detection	Ternary Neutral Networks, Convolutional Neuronal Network, Deep Learning
Automatic Interpretation of SEM images from semiconductor devices and Silicon package fault	Addressed AI Methods: Deep Neuronal Networks for sample classification of SEM as well as X-Ray and Optical images, Generative adversarial networks for image conversion

Beverage Industry & Agriculture

Beverage production - Champagner	Convolutional neural network for analysis of sensor data, Deep Learning Neural Networks for quality prediction, Edge computing devices, Low power AI, neuromophic computing, off line training, machine learning framework binary quantization module.

Transportation

	Deep learning, Artificial neural networks/convolution neural networks, Reinforcement learning, Cognitive computing and machine learning, digital twin and AI modelling, low latency communication, edge computing, and IIoT devices facilitating near real time decision management, AI algorithms, AI embedded platforms and AI training platforms, and autonomous vehicle/robotic processes automation are AI technologies addressed for predictive maintenance and vehicle routing optimization.

Semiconductor Manufacturing Processes
Frontend Wafer Production

2. homogenous systems control and optimization

FURNACE

IMPLANT

DD

ETCH

PVD / MCVD

1. heterogeneous systems control and optimization

IN/OUT

TEST

3. Human Machine collaboration

6. AI tools

4. change detection -

C M P

W E T

METROLOGY

LITHO

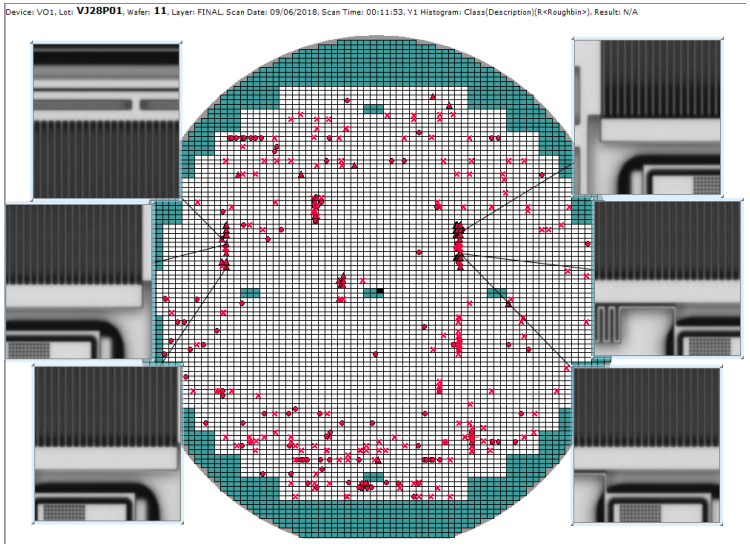
CVD

2. homogenous systems control and optimization

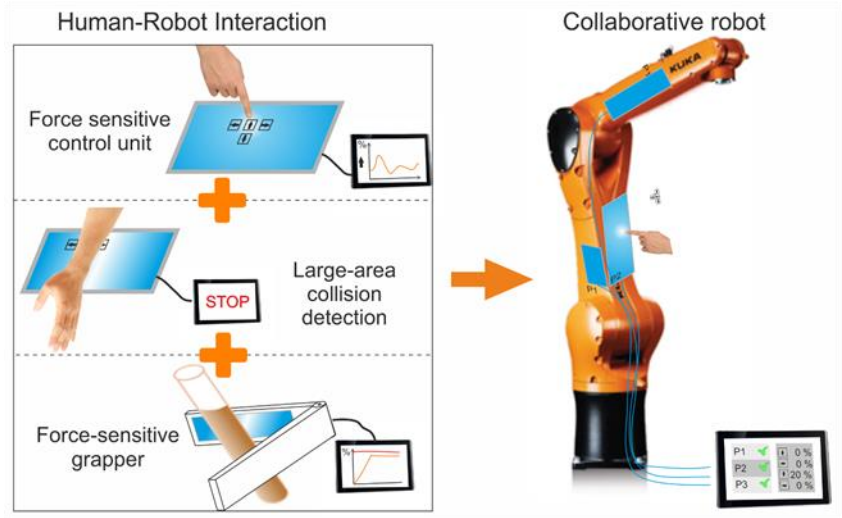
Machinery

Automotive Manufacturing

Semiconductor-Industry



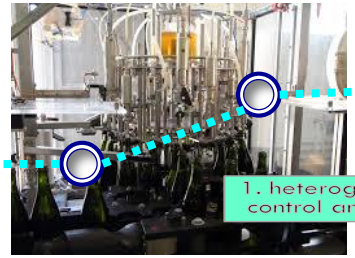
Driverless transport systems in Machinery



Champagne Manufacturing line

Maturity control

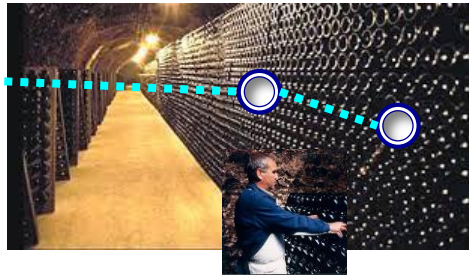
Bottle filling stage



1. heterogeneous systems control and optimization

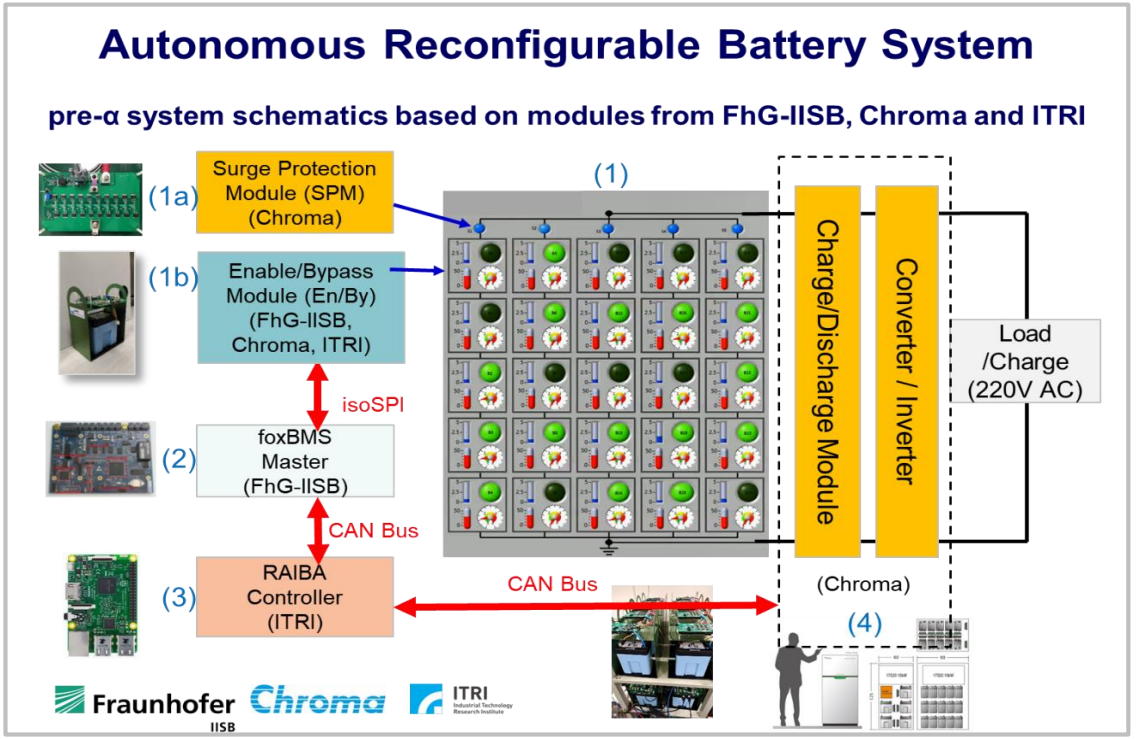
conveyor and Packaging

Aging



3. Human Machine collaboration

4. change detection -



Addressed AI Methods: : Evolutionary algorithms for optimization of the control strategy and for controlling the reconfigurable system, Machine learning for pattern recognition, Data Mining for coherence analysis of large amounts of data, Neural networks for learning heuristics

Addressed AI Attributes: : Cognition, anomaly detection, predictive maintenance, self-optimized control

工業技術研究院
Industrial Technology Research Institute

SC1.3

Automotive Industry

Key Targets: 1, 4, 6, 7

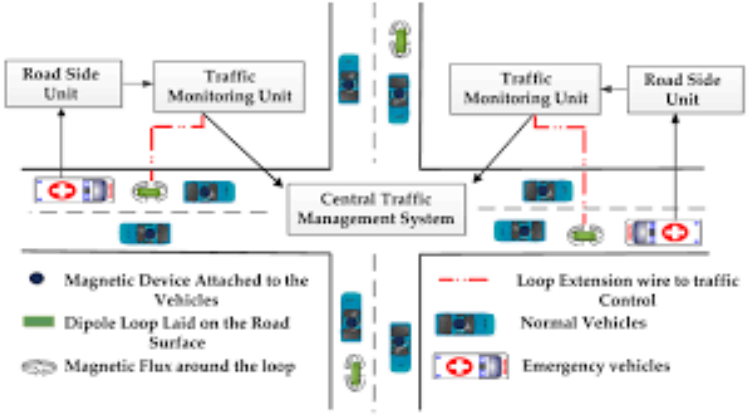
TRL Level: 4

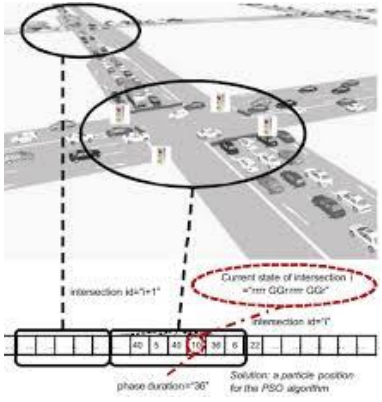
Audi

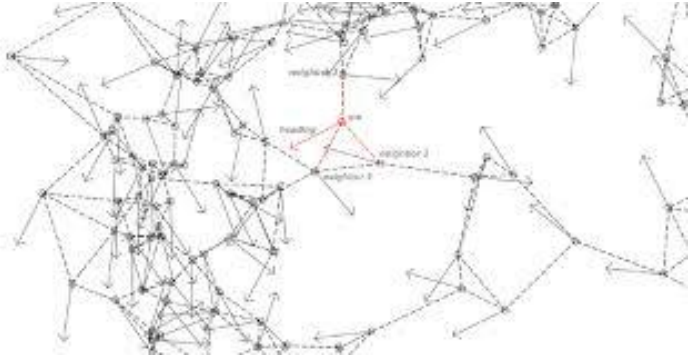
Transport

1. Taking Over Control From Highly Automated Vehicles in Complex Traffic Situations The Role of Traffic Density

- Cooperative mobile robotics: Antecedents and directions
- Multiagent systems: a modern approach to distributed artificial intelligence
- Towards robust automatic traffic scene analysis in real-time
- Computational Intelligence in Urban Traffic Signal Control: A Survey
- Agent-based control for networked traffic management systems

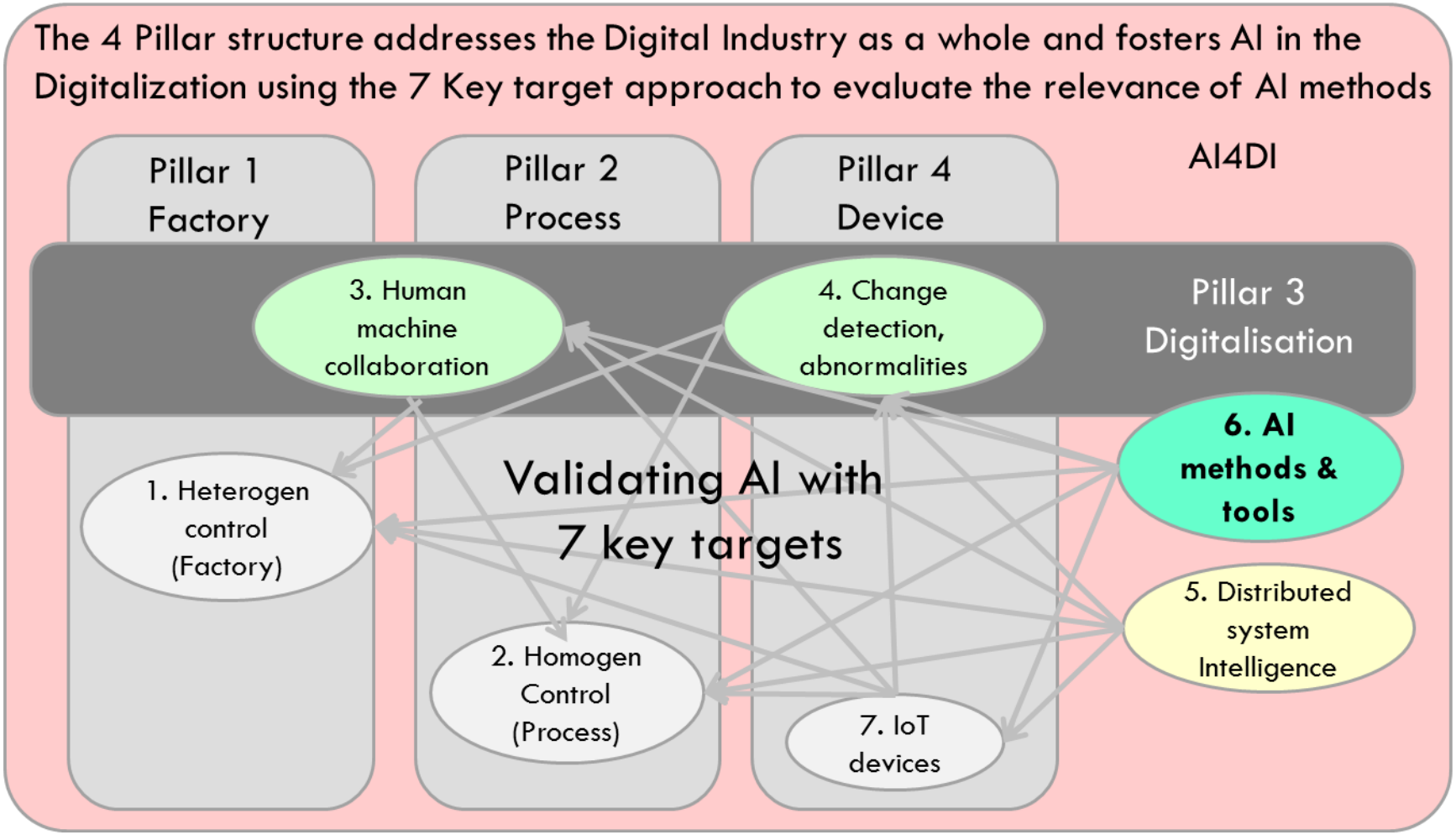


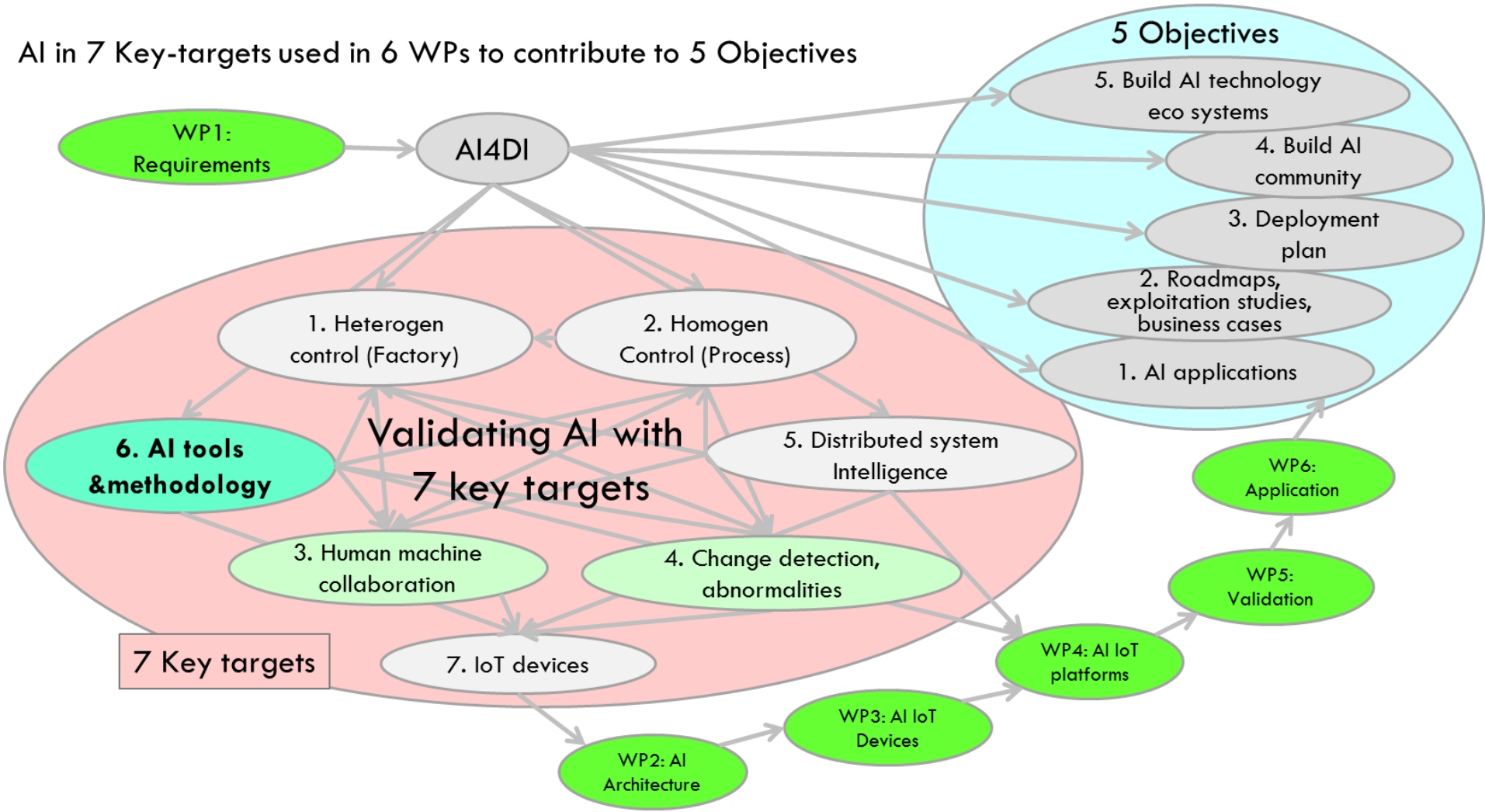


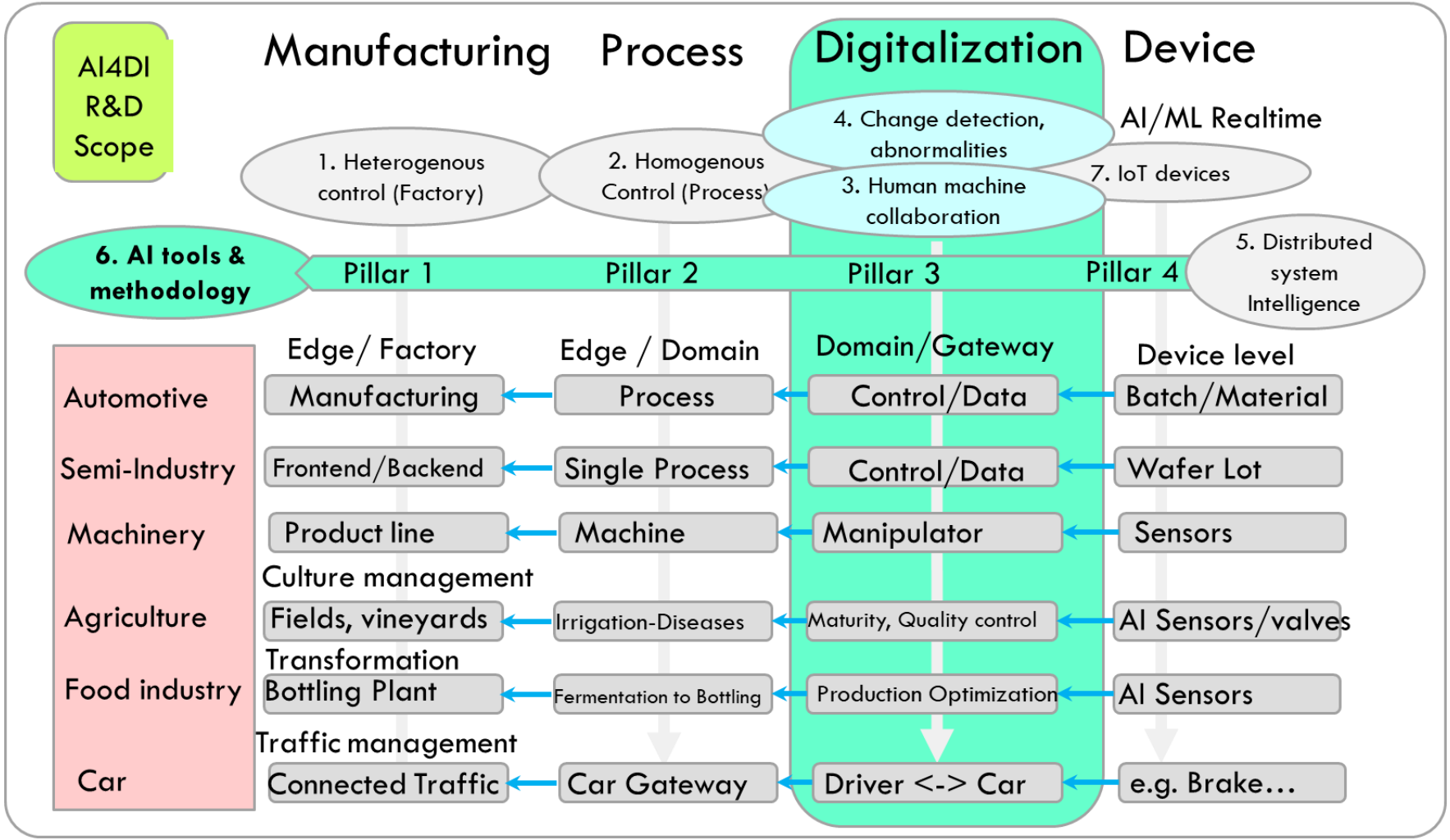


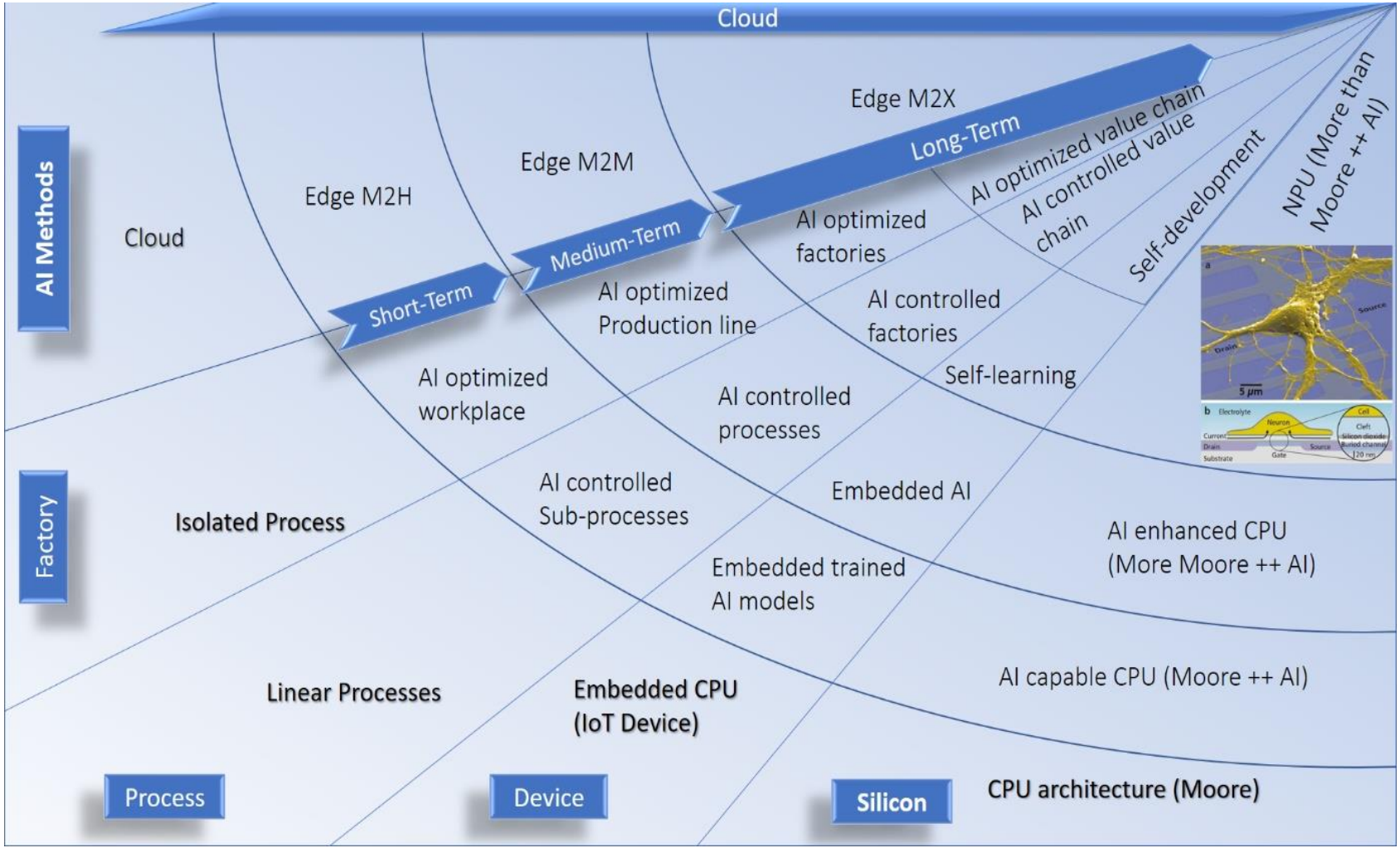
The 7 Use Cases are intended to validate the 7 KTs and contribute to the achievement of the 5 Objectives.

1. **Digital ECS value chain for virtual factory**, uses AI methods as distributed intelligence, which is scheduling slots in a manufacturing process of vehicles and also orders components from suppliers who are also using AI affecting their production process to produce and deliver the components in time.
2. **Digital Twin Factory**, aims at a Digital Twin for the AI-Based Optimization of Heterogeneous Manufacturing Processes.
3. **AI-based FMEA generator**, AI based Knowledge base that combines the knowledge of existing Technology FMEAs.
4. **Safe human interaction with robotics machinery and tools**, addresses the deployment of AI-based Human/Machine Interfaces striving the improvement of the working conditions and productivity of human operators interacting with complex stationary machines.
5. **Change detection applications**, is composed of several applications addressing the challenge of change detection in real-time sensor data using AI methods. The resulting information will be used in order to take actions to efficiently operate systems, e.g. cyber-physical systems, machines or processes.
6. **Robotics application**, is also composed of several applications addressing mobile or rather industrial robots that offer manifold manipulating tasks. AI methods are adapted in order to control the complexity associated with this flexibility as well as to improve the human machine collaboration.
7. **AI implementation**, groups the AI4DI activities on implementing AI methods on the wide range of available resources (IoT/edge/Cloud) e.g. for the purpose of an overall traffic management based on data from individual vehicles (bus or car).


The 4 Pillar structure addresses the Digital Industry as a whole and fosters AI in the Digitalization using the 7 Key target approach to evaluate the relevance of AI methods
AI4DI
Pillar 1
Factory
Pillar 2
Process
Pillar 4
Device
Pillar 3
Digitalisation
3. Human machine collaboration
4. Change detection, abnormalities
6. AI methods & tools
Validating AI with 7 key targets
1. Heterogen control (Factory)
2. Homogen Control (Process)
5. Distributed system Intelligence
7. IoT devices


AI in 7 Key-targets used in 6 WPs to contribute to 5 Objectives
5 Objectives
5. Build AI technology eco systems
4. Build AI community
3. Deployment plan
2. Roadmaps, exploitation studies, business cases
1. AI applications
WP1: Requirements
AI4DI
1. Heterogen control (Factory)
2. Homogen Control (Process)
6. AI tools &methodology
Validating AI with 7 key targets
5. Distributed system Intelligence
3. Human machine collaboration
4. Change detection, abnormalities
7 Key targets
7. IoT devices
WP6: Application
WP5: Validation
WP4: AI IoT platforms
WP3: AI IoT Devices
WP2: AI Architecture


AI4DI R&D Scope
Manufacturing
Process
Digitalization
Device
AI/ML Realtime
4. Change detection, abnormalities
1. Heterogenous control (Factory)
2. Homogenous Control (Process)
3. Human machine collaboration
7. IoT devices
6. AI tools & methodology
Pillar 1
Pillar 2
Pillar 3
Pillar 4
5. Distributed system Intelligence
Edge/ Factory
Edge / Domain
Domain/Gateway
Device level
Automotive
Manufacturing
Process
Control/Data
Batch/Material
Semi-Industry
Frontend/Backend
Single Process
Control/Data
Wafer Lot
Machinery
Product line
Machine
Manipulator
Sensors
Culture management
Agriculture
Fields, vineyards
Irrigation-Diseases
Maturity, Quality control
AI Sensors/valves
Transformation
Food industry
Bottling Plant
Fermentation to Bottling
Production Optimization
AI Sensors
Traffic management
Car
Connected Traffic
Car Gateway
Driver <-> Car
e.g. Brake…


Cloud
AI Methods
Edge M2H
Edge M2M
Edge M2X
Long-Term
Medium-Term
Short-Term
Cloud
AI optimized value chain
AI controlled value chain
Self-development
NPU (More than Moore ++ AI)
AI optimized factories
AI optimized Production line
AI controlled factories
Self-learning
AI optimized workplace
AI controlled processes
Factory
Isolated Process
AI controlled Sub-processes
Embedded AI
AI enhanced CPU (More Moore ++ AI)
Embedded trained AI models
Linear Processes
Embedded CPU (IoT Device)
AI capable CPU (Moore ++ AI)
Process
Device
Silicon
CPU architecture (Moore)

AI4DI has been accepted for funding within the Electronic Components and Systems For European Leadership Joint Undertaking in collaboration with the European Union's H2020 Framework Programme (H2020/2014-2020) and National Authorities, under grant agreement n° 826060.

ECSEL Joint Undertaking
Electronic Components and Systems for European Leadership