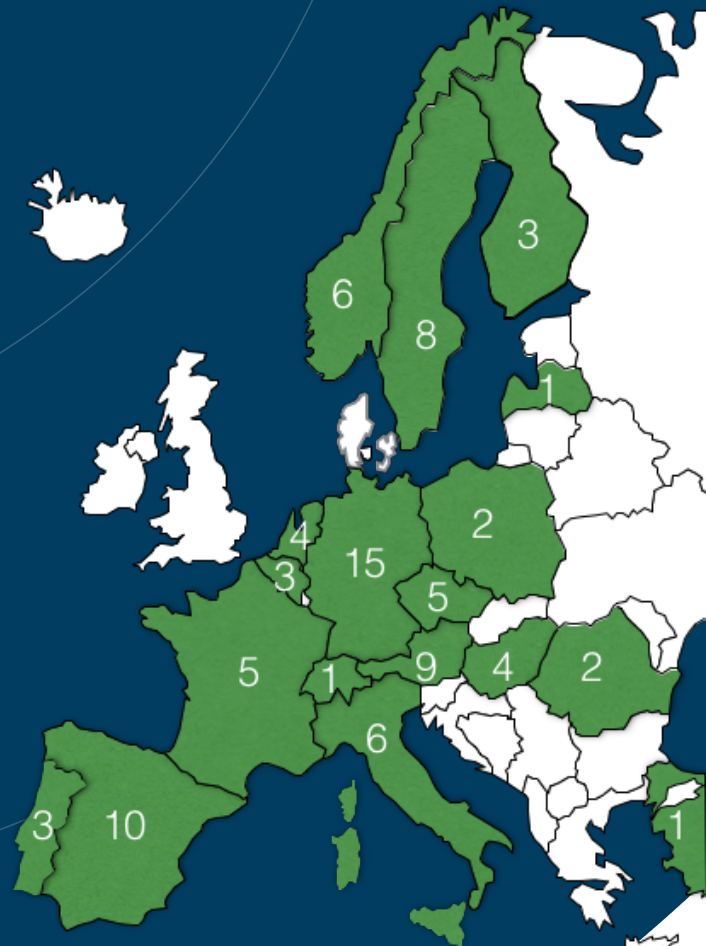# Arrowhead Tools

A European Investment for Automation and Digitalisation Leadership

ARROWHEAD
TOOLS

Arrowhead Tools

Joint European effort in 18 countries

Coordinator: Prof. Jerker Delsing,
Lulea University of Technology

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Arrowhead Tools

Europes larges Automation and Digitalisation Engineering project

80 partners

90 M€ budget

Duration 2019-2022

Partners: Bosch, ABB, Infineon, ST-Microelectronics, Philips, ASML, Mondragon, Volvo, Boliden, …..
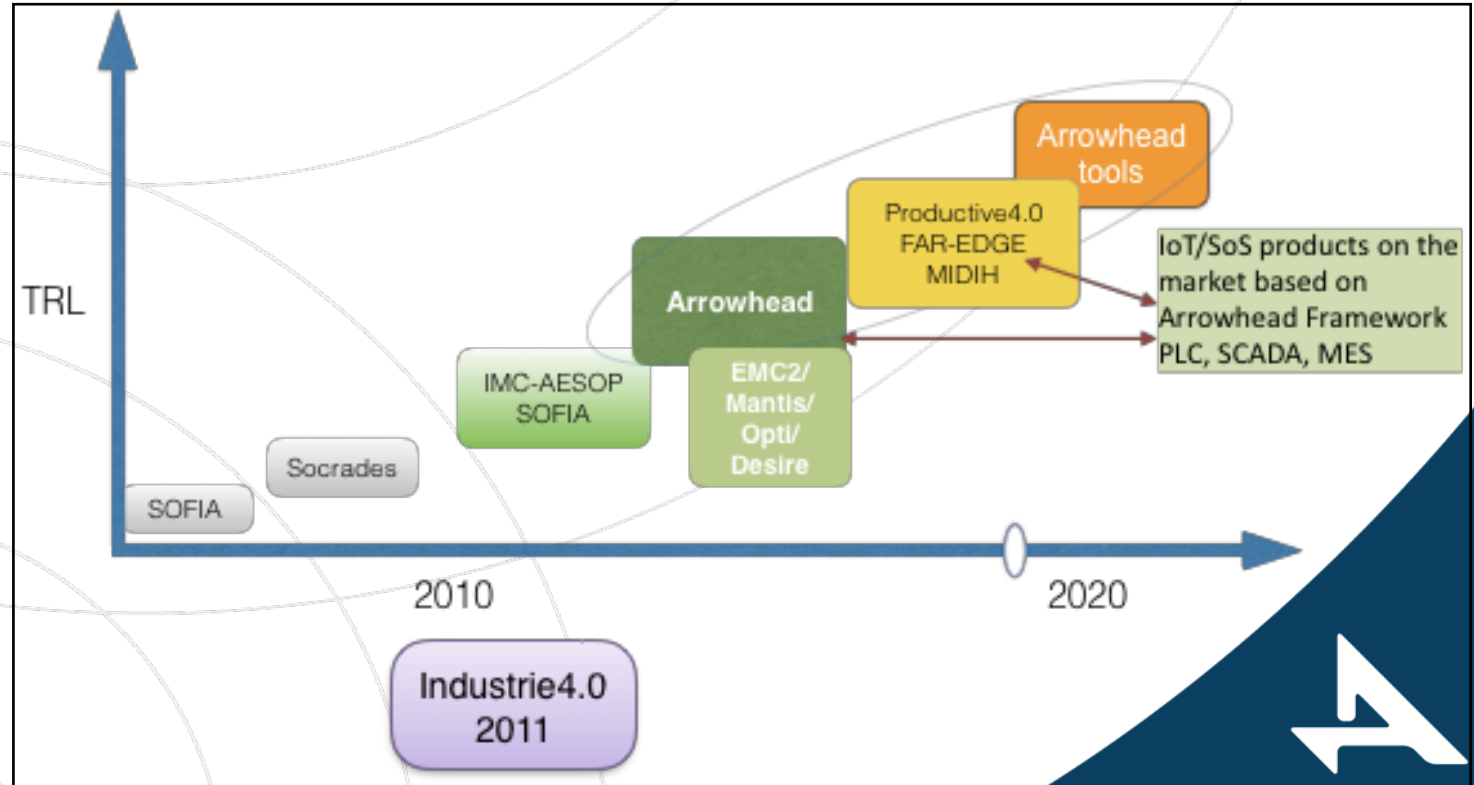
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EU and Industry project investments

- **Software Key Enabling Technologies**
- **Solution engineering efficiency and platforms key for fast industrialisation**
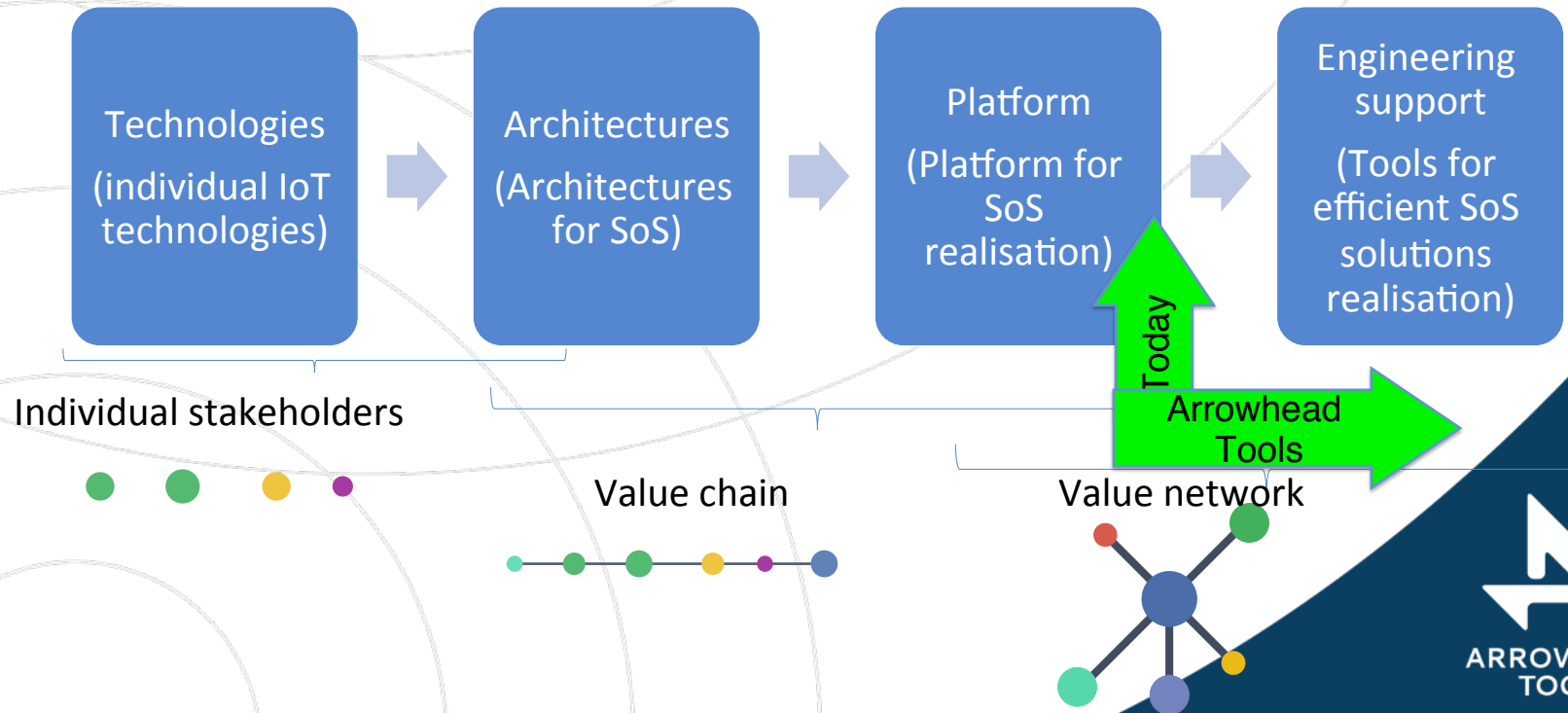
IoT and Industry 4.0 project time line
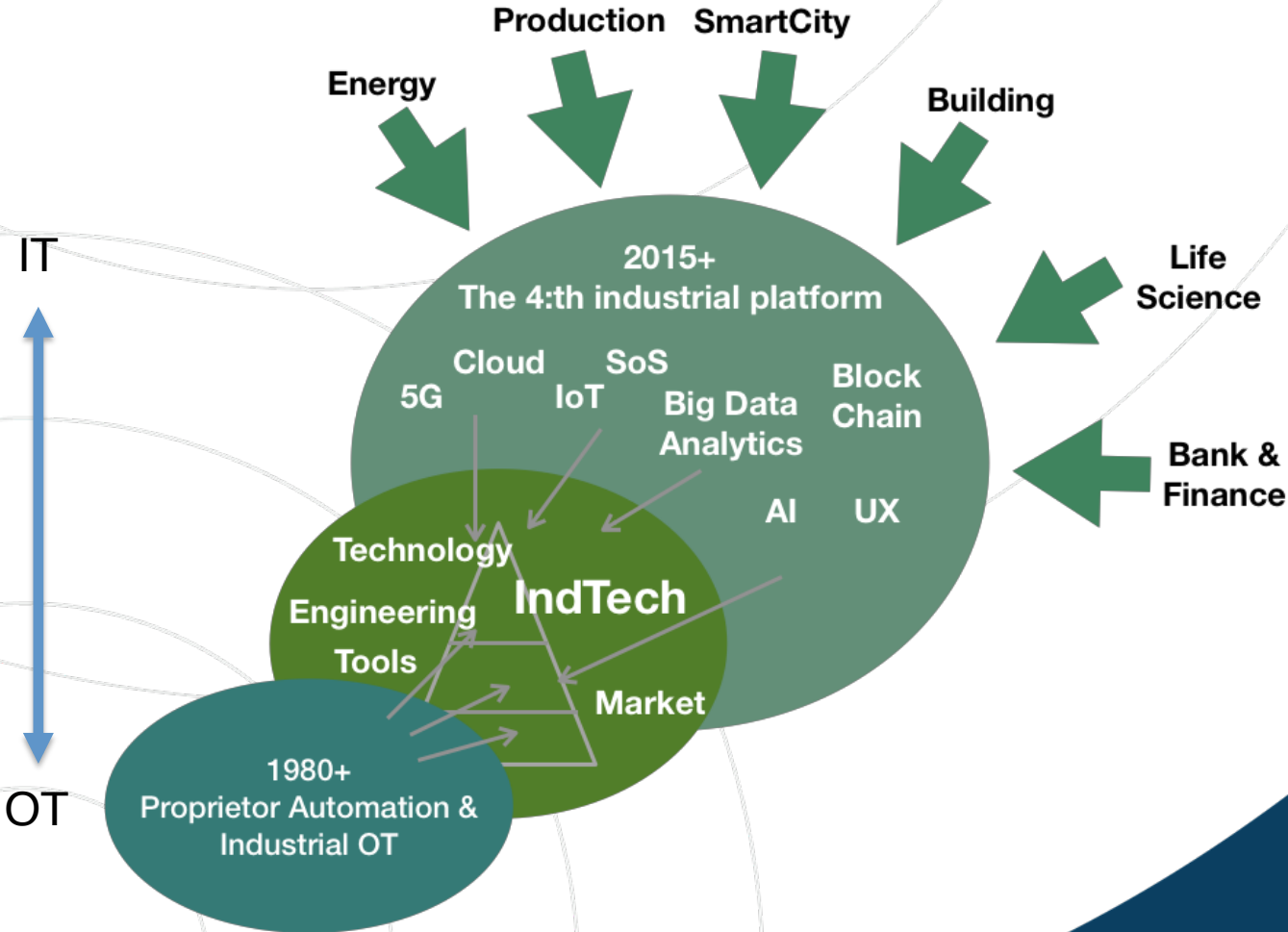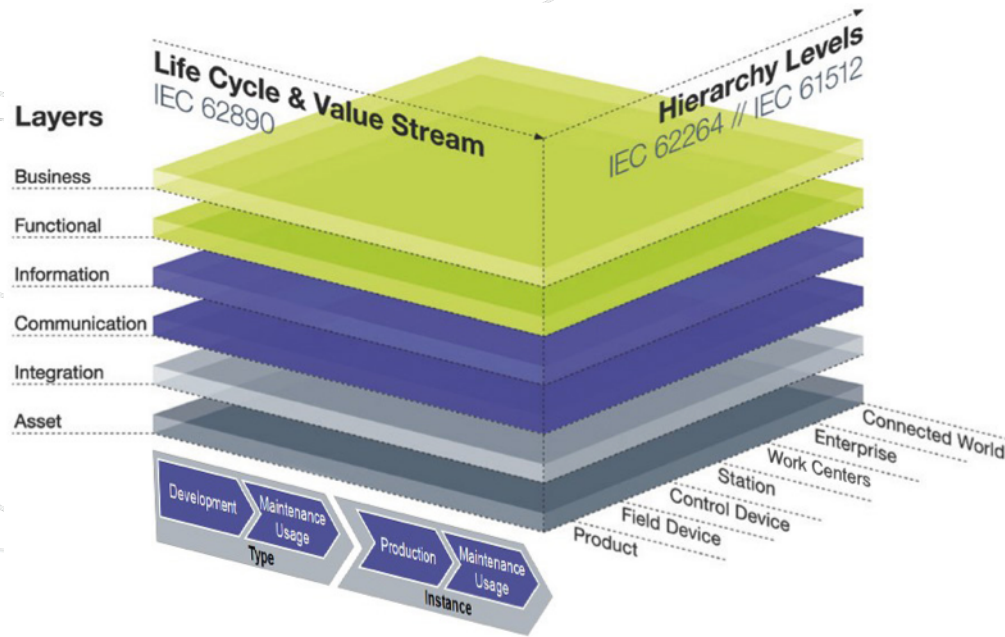
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Focus

OT meets IT

Real and efficient implementation of next generation automation architecture - Industry4.0

RAMI4.0

Implementation and integration

Service Oriented Architecture

Implementation and Integration Frameworks

Arrowhead Framework

Autosar

BaSys

FiWare

IDS

IoTivity

lwM2M

OCF

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Technology comparison

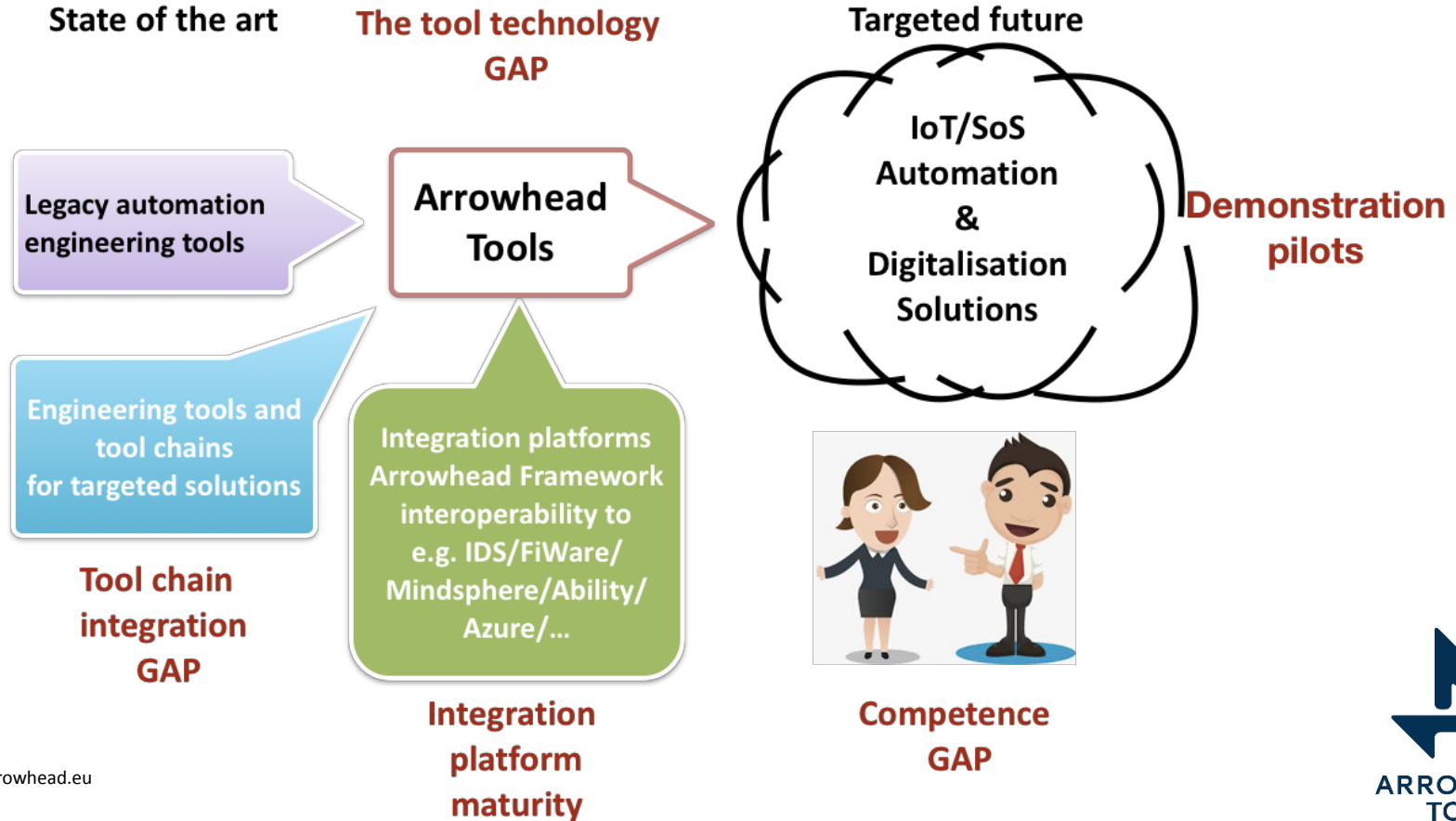| Features	Arrowhead	AUTOSAR	BaSyx	FIWARE	IoTivity	LWM2M	OCF
Key principles	SOA, Local Automation Clouds	Runtime, Electronic Control Unit (ECU)	Variability of production processes	Context awareness	Device-to-device communication	M2M, Constrained networks	Resource Oriented REST, Certification
Real-time	Yes	Yes	No	No	Yes (IoTivityConstrained)	No	No
Run-time	Dynamic orchestration and authorization, monitoring, and dynamic automation	Runtime Environment layer (RTE)	Runtime environment	Monitoring, dynamic service selection and verification	No	No	No
Distribution	Distributed	Centralize	Centralize	Centralize	Centralize	Centralize	Centralize
Open Source	Yes	No	Yes	Yes	Yes	Yes	No
Resource accessibility	High	Low	Very low	High	Medium	Medium	Low
Supporters	Arrowhead	AUTOSAR	Basys 4.0	FIWARE Foundation	Open Connectivity Foundation	OMA SpecWorks	Open Connectivity Foundation
Message patterns	Req/Repl, Pub/sub	Req/Repl, Pub/sub	Req/Repl,	Req/Repl, Pub/sub	Req/Repl, Pub/sub	Req/Repl	Req/Repl
Transport protocols	TCP, UDP, DTLS/TLS	TCP, UDP, TLS	TCP	TCP, UDP, DTLS/TLS	TCP, UDP, DTLS/TLS	TCP, UDP, DTLS/TLS, SMS	TCP, UDP, DTLS/TLS, BLE
Communication protocols	HTTP, CoAP, MQTT, OPC-UA	HTTP	HTTP, OPC-UA	HTTP, RTPS	HTTP, CoAP	CoAP	HTTP, CoAP
3rd party and Legacy systems adaptability	Yes	Yes	Yes	Yes	No	No	No
Security Manager	Authentication, Authorization and Accounting Core System	Crypto Service Manager, Secure Onboard Communication	--	Identity Manager Enabler	Secure Resource Manager	OSCORE	Secure Resource Manager
Standardization	Use of existing standards	AUTOSAR standards	Use of existing standards	FIWARE NGSI	OCF standards	Use of existing standards	OCF standards

Industrialisation

We need Engineering tools

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The engineering tool GAP Arrowhead Tool focus

State of the art

The tool technology GAP

Targeted future

Legacy automation engineering tools

Arrowhead Tools

IoT/SoS Automation & Digitalisation Solutions

Demonstration pilots

Engineering tools and tool chains for targeted solutions

Tool chain integration GAP

Integration platforms Arrowhead Framework interoperability to e.g. IDS/FiWare/ Mindsphere/Ability/ Azure/…

Integration platform maturity
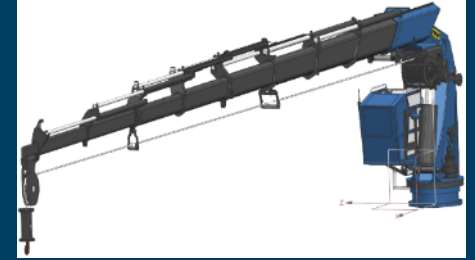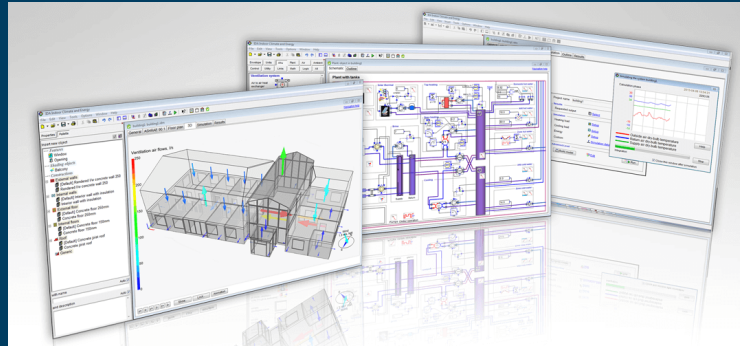
Competence GAP

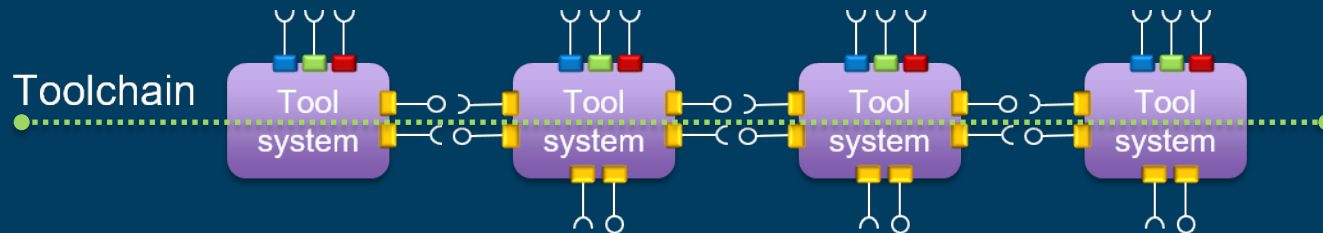ARROWHEAD TOOLS

Engineering efficiency improvements
Validation and verification in 21 advanced use cases

- **Automotive**
- **Mining**
- **Electronics**
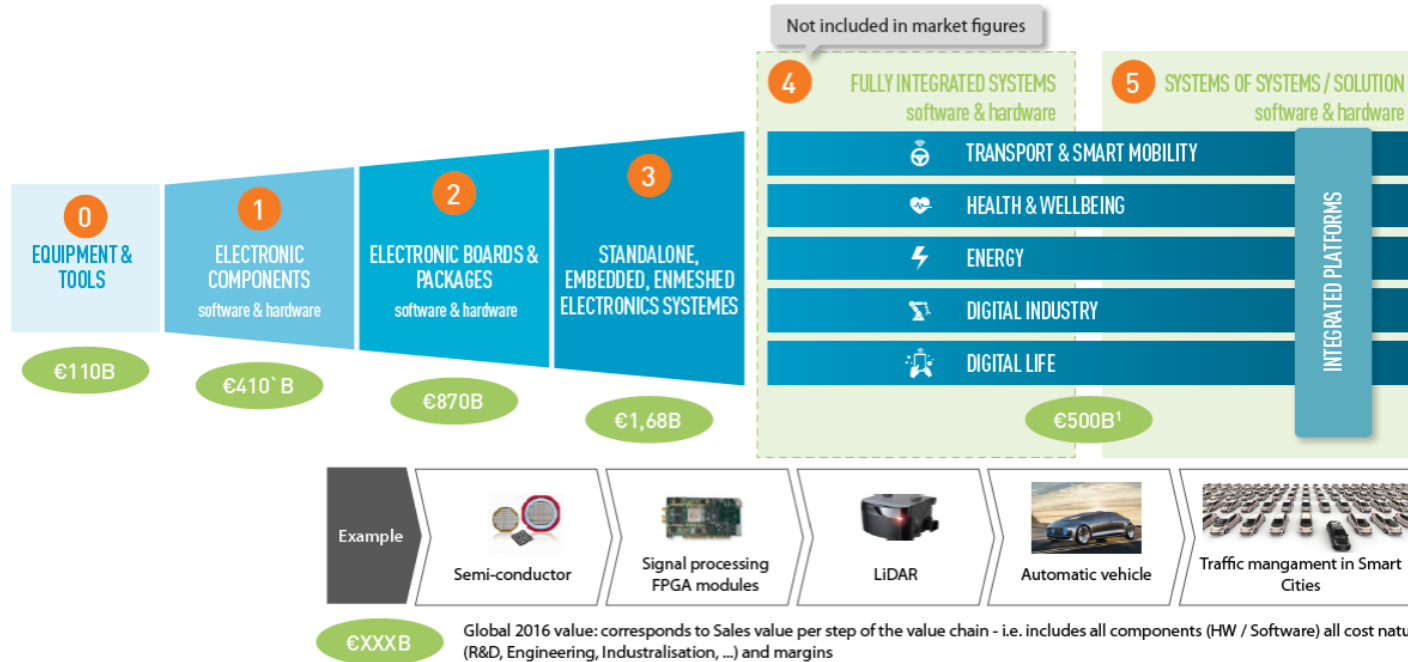
- **Software**
- **Building Sector**
- **Offshore**

Toolchain

ARROWHEAD TOOLS

Market

Value is shifting across the CPS value chain (1/2)
Today value is concentrated at 75% upstream

ARTEMIS Industry Association

advancy

Not included in market figures

4 FULLY INTEGRATED SYSTEMS
software & hardware

5 SYSTEMS OF SYSTEMS / SOLUTION
software & hardware

0 EQUIPMENT & TOOLS

1 ELECTRONIC COMPONENTS
software & hardware

2 ELECTRONIC BOARDS & PACKAGES
software & hardware

3 STANDALONE, EMBEDDED, ENMESHED ELECTRONICS SYSTEMES

- TRANSPORT & SMART MOBILITY
- HEALTH & WELLBEING
- ENERGY
- DIGITAL INDUSTRY
- DIGITAL LIFE

INTEGRATED PLATFORMS

€110B

€410`B

€870B

€1,68B

€500B[1]

Example | Semi-conductor | Signal processing FPGA modules | LiDAR | Automatic vehicle | Traffic mangament in Smart Cities

€XXXB — Global 2016 value: corresponds to Sales value per step of the value chain - i.e. includes all components (HW / Software) all cost natures (R&D, Engineering, Industralisation, ...) and margins

Note: rounded figures. (1): 2025 estimate value potential for the Internet of Things, not the full potential for ECS end-applications.
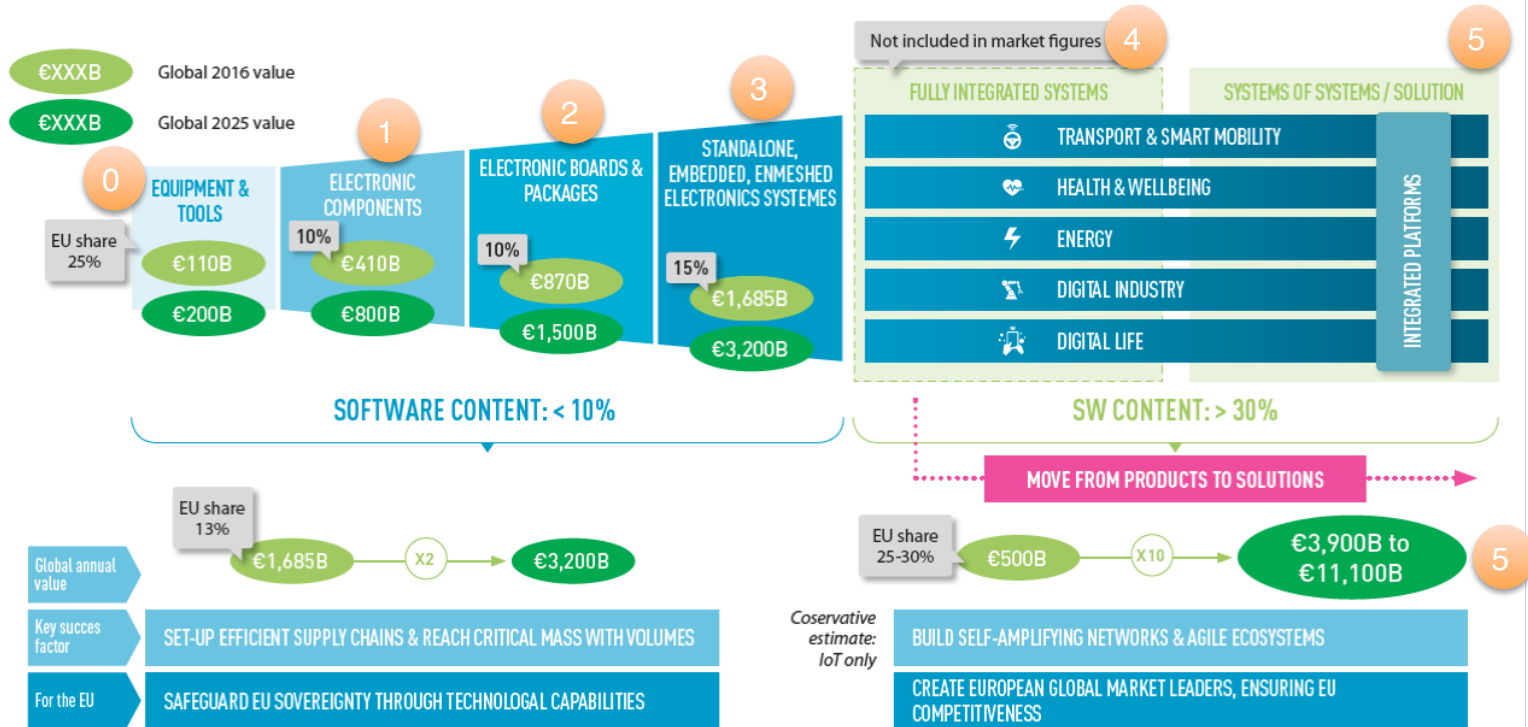Source: Decision, IDC, MGI, Advancy analysis

Value is shifting across the CPS value chain (2/2)
By 2025, 2/3rd of the value will be captured downstream

ARTEMIS Industry Association

advancy

€XXXB — Global 2016 value
€XXXB — Global 2025 value

0 — EQUIPMENT & TOOLS
EU share 25%
€110B
€200B

1 — ELECTRONIC COMPONENTS
10%
€410B
€800B

2 — ELECTRONIC BOARDS & PACKAGES
10%
€870B
€1,500B

3 — STANDALONE, EMBEDDED, ENMESHED ELECTRONICS SYSTEMES
15%
€1,685B
€3,200B

Not included in market figures

4 — FULLY INTEGRATED SYSTEMS
- TRANSPORT & SMART MOBILITY
- HEALTH & WELLBEING
- ENERGY
- DIGITAL INDUSTRY
- DIGITAL LIFE

5 — SYSTEMS OF SYSTEMS / SOLUTION
INTEGRATED PLATFORMS

SOFTWARE CONTENT: < 10%

SW CONTENT: > 30%

MOVE FROM PRODUCTS TO SOLUTIONS

Global annual value
EU share 13%
€1,685B → X2 → €3,200B

EU share 25-30%
€500B → X10 → €3,900B to €11,100B — **5**

Key succes factor
SET-UP EFFICIENT SUPPLY CHAINS & REACH CRITICAL MASS WITH VOLUMES

Coservative estimate: IoT only
BUILD SELF-AMPLIFYING NETWORKS & AGILE ECOSYSTEMS

For the EU
SAFEGUARD EU SOVEREIGNTY THROUGH TECHNOLOGAL CAPABILITIES

CREATE EUROPEAN GLOBAL MARKET LEADERS, ENSURING EU COMPETITIVENESS

Note: rounded figures. (1): 2025 estimate value potential for the Internet of Things, not the full potential for ECS end-applications.
Source: Decision, IDC, MGI, Advancy research & analysis

The Grand Challenges

The Arrowhead Tools grand challenges are:

- **Engineering cost reduction by 20-50% for a wide range of IoT and SoS automation/digitalisation solutions.**

- **Tool chains for IoT and SoS digitalisation/automation engineering and management, adapted to:**

  - existing automation and digitalisation engineering methodologies and tools
  - new IoT and SoS automation and digitalisation engineering and management tools
  - security management tools

- **Efficient training of professional engineers**

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Arrowhead Tools - technology advancement

- Mature interoperability framework - Arrowhead Framework v5.0
- Engineering tool interoperability and tool chain integration
- Engineering tools for IoT, SoS and legacy automation solution engineering
- Training material for professionals, hardware and software

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TOOLS

Engineering efficiency improvements
Validation and verification in 21 advanced use cases

- Automated Formal Verification
- Engineering processes and tool chains development of a digitalized and networked diagnostic imaging
- Integration of electronic design automation tools with product lifecycle tools
- Interoperability between (modelling) tools for cost effective lithography process integration
- Support quick and reliable decision making in the semiconductor front-end manufacturing process
- Production preparation tool chain integration
- CNC machine automation
- SoS engineering of IoT edge devices
- Machine operation optimisation
- Rapid HW development, prototyping, testing and evaluation
- Configuration tool for autonomous provisioning of local clouds
- Communications Validation & Operational Monitoring

Industrie 4.0
Smart Home
INDUSTRY
CONSUMER
INFRASTRUCTURE
Smart Car
MOBILITY
ENERGY
Smart Grid
© Infinion

- **Digital twins and structural monitoring**
- Deployment engine for production related sensor data
- Smart Diagnostic Environment for Contactless Module Testers
- Virtual Commissioning of a Cyber-Physical System for increased flexibility
- Production Support, Energy Efficiency, Task Management, Data Analytics and Smart Maintenance
- **Linking Building Simulation to a Physical Building in Real-Time**
- Secure sharing of IoT generated data with partner ecosystem
- Deployment and configuration
- Smart maintenance for industrial devices monitoring

- Elastic Data Acquisition System
- Smart testing
- **Data based digital twin for electrical machine condition**

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Engineering efficiency improvements
Validation and verification in 21 commercially motivated use cases

- Automated Formal Verification

- Engineering processes and tool chains development of a digitalized and networked diagnostic imaging

- Integration of electronic design automation tools with product lifecycle tools

- Interoperability between (modelling) tools for cost effective lithography process integration

- Support quick and reliable decision making in the semiconductor fron- tend manufacturing process

- Production preparation tool chain integration

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- SoS engineering of IoT edge devices

- Machine operation optimisation

- Rapid HW development, prototyping, testing and evaluation

- Configuration tool for autonomous provisioning of local clouds

- Communications Validation & Operational Monitoring

- Digital twins and structural monitoring

- Deployment engine for production related sensor data

- Smart Diagnostic Environment for Contactless Module Testers

- Virtual Commissioning of a Cyber-Physical System for increased flexibility

- Production Support, Energy Efficiency, Task Management, Data Analytics and Smart Maintenance

ARROWHEAD TOOLS

Technology

Arrowhead Framework and integrated
engineering tool chains

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Technology Properties

Implementation of Automation and Digitalisation solutions

   In production

   In product

Real time capabilities

Security

   Multi level security
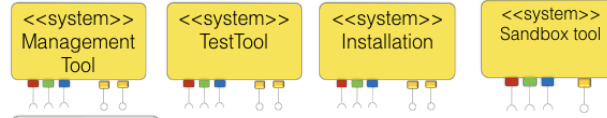
Run-time engineering

Evolvable solutions
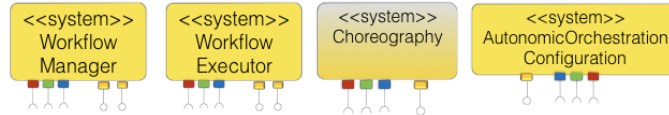
   On-site validation and verification
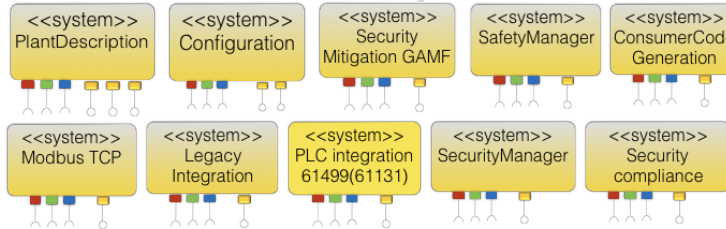
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Arrowhead Framework v4.1.3
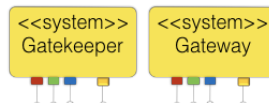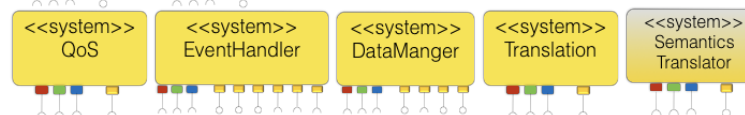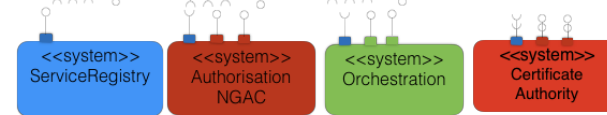
Impact

- Cost-efficient, real-world integrated large-scale digitalisation and automation!

- More automation for invested €

- Leading to production efficiency, jobs, environmental footprint reduction, ...

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