THE NORTHERNMOST UNIVERSITY
of Technology in Scandinavia

IoT and System of Systems Engineering in Energy Systems

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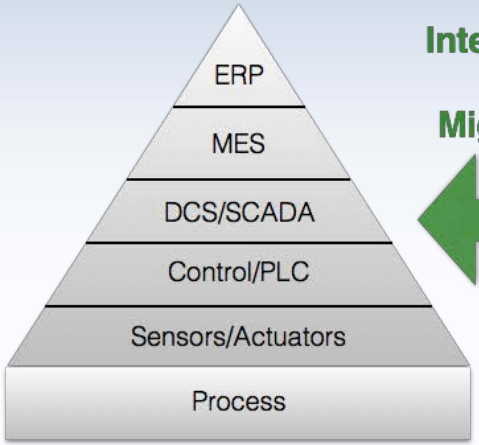
ProcessIT
Luleå University of Technology

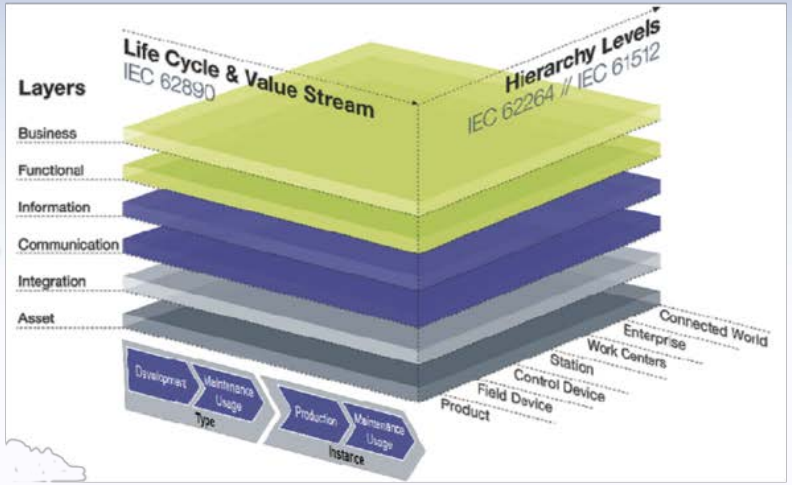
The automation technology transition

ISA-95

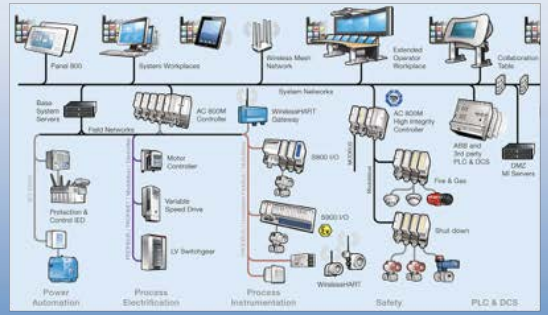


Integration & Migration

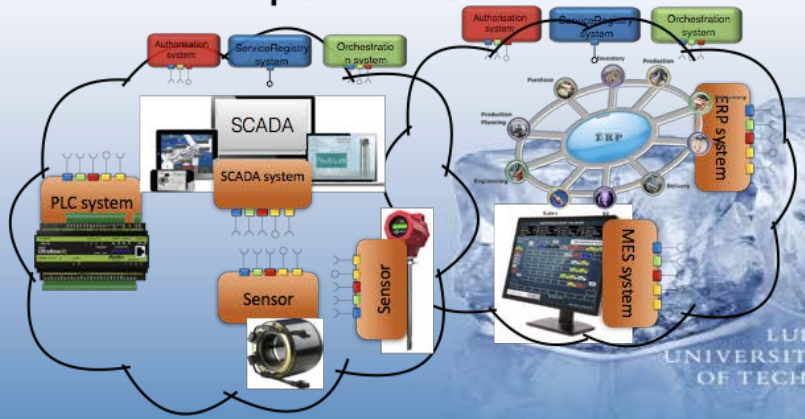
RAMI4.0



Hierarchical system implementation



Local automation cloud implementation



LULEÅ UNIVERSITY OF TECHNOLOGY

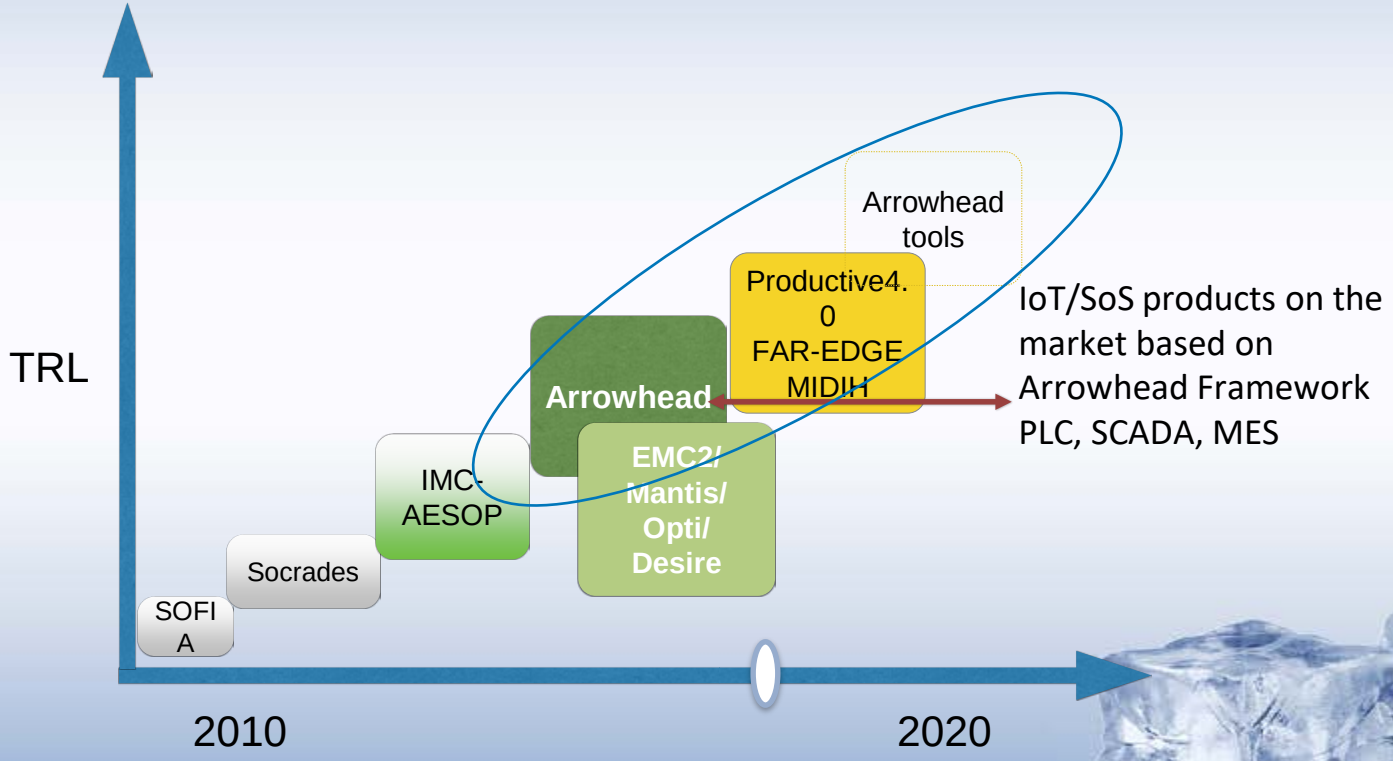
Automation requirements

- Seamless interoperability between devices and systems
- Scalability
- Real time performance
- Security
- Engineering simplicity
- Evolvable System of Systems

Emerging requirements RAMI4.0

- Flexible automation
- Run-time management
- Integration along value chain
- Integration along product life cycle
- Integration to across stakeholders
  - Maintenance
  - Other stakeholders

EU project landscape
IoT/SoS Automation/Digitalisation for production



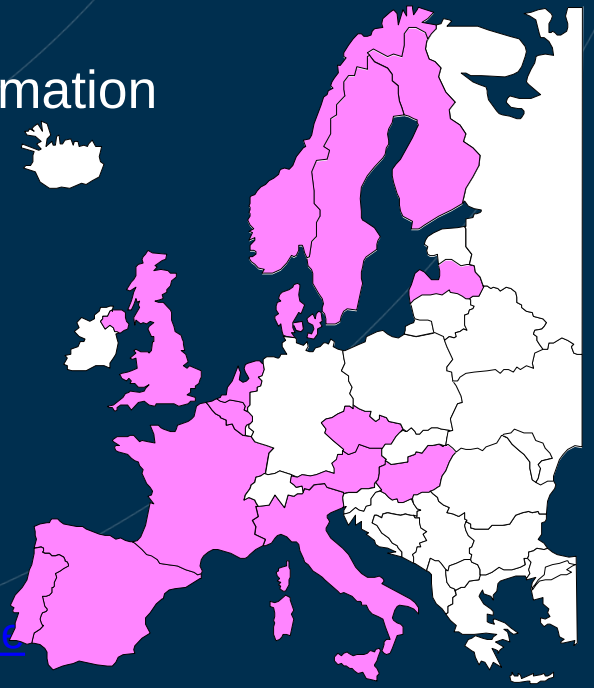
Arrowhead

Process and energy system automation

4 years project
68M€
78 partners
Coordinated by

processit.eu
Automation for process industries

an ARTEMIS CoIE



www.arrowhead.eu - jerker.delsing@ltu.se

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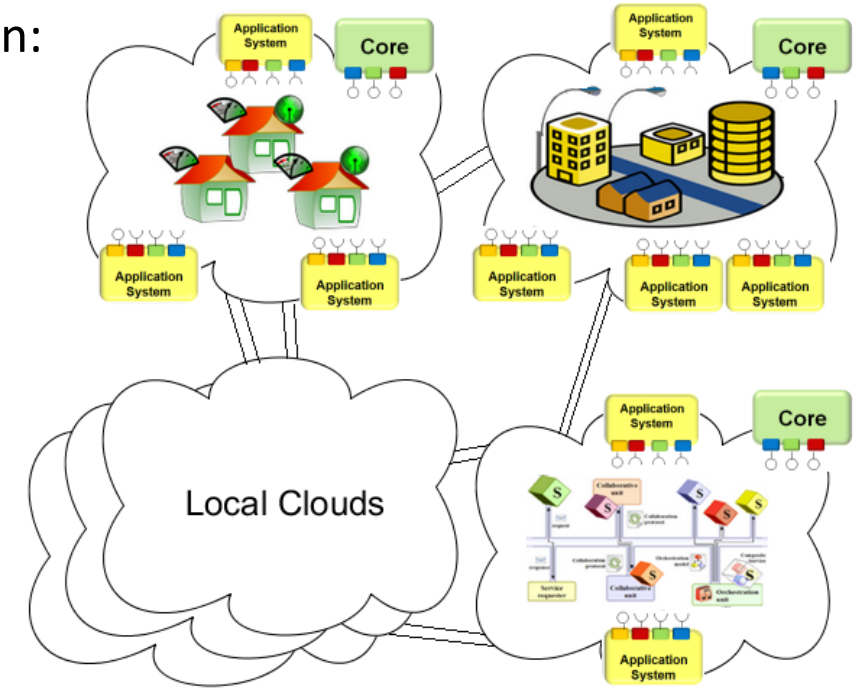
Collaborative automation in the cloud

- Automation is local - requirements on:
  - Real time
  - Security and safety
  - Continuous engineering
  - Scalability

- Autonomous local clouds provides:
  - Protective fence enabling
    - Latency - real time
    - Security - supporting safety
    - Less engineering dependencies
  - Scalability through inter cloud service exchange



J. Delsing, et.al., Enabling IoT automation using local clouds, Proc. IEEE WorldForum on IoT 2016, Reston, USA

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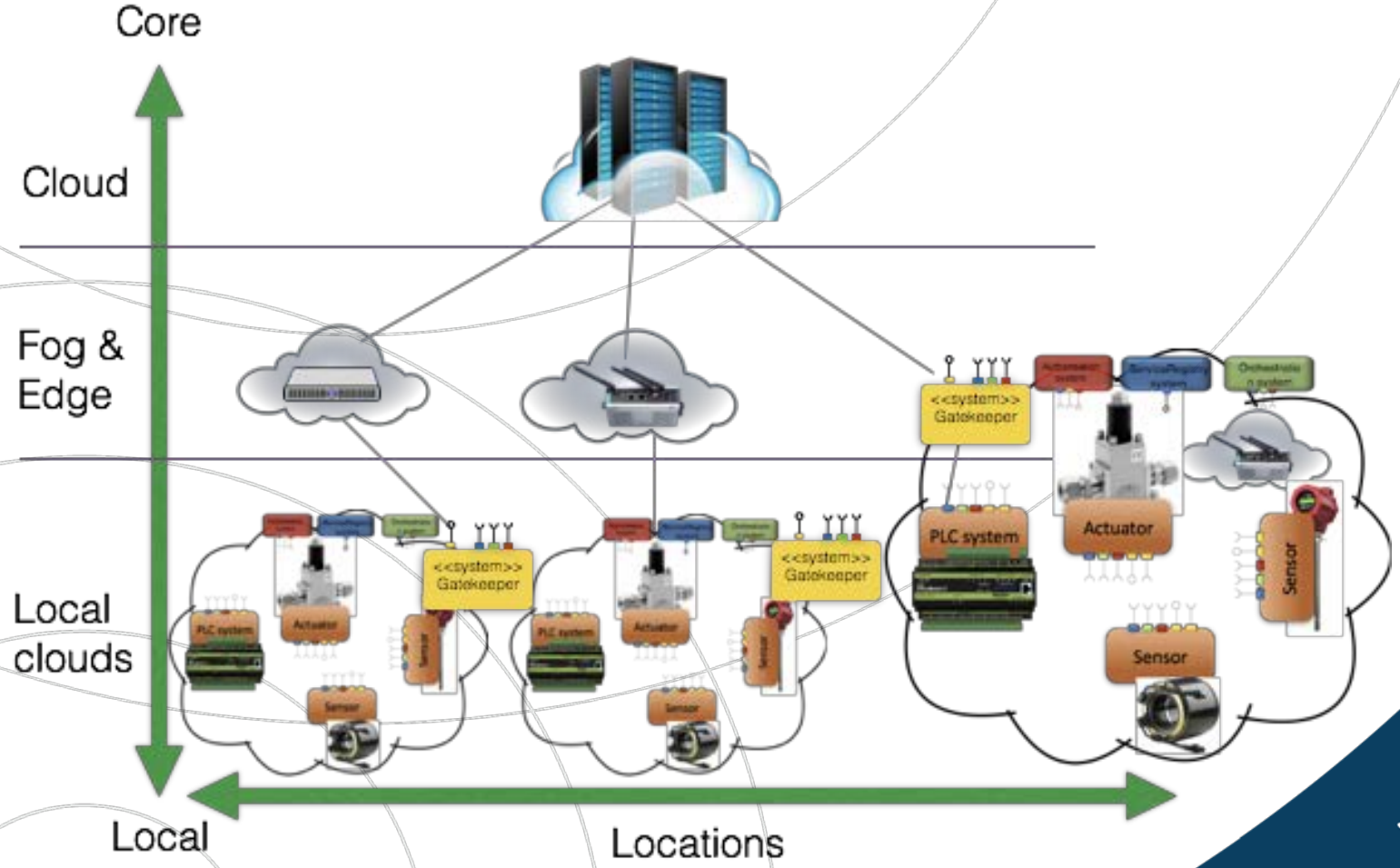
Automation in cloud technology



A Survey of Commercial Frameworks for the Internet of Things. Hasan Derhamy, Jens Eliasson, Jerker Delsing, and Peter Priller, SOCNE workshop at ETFA 2015, Luxemburg

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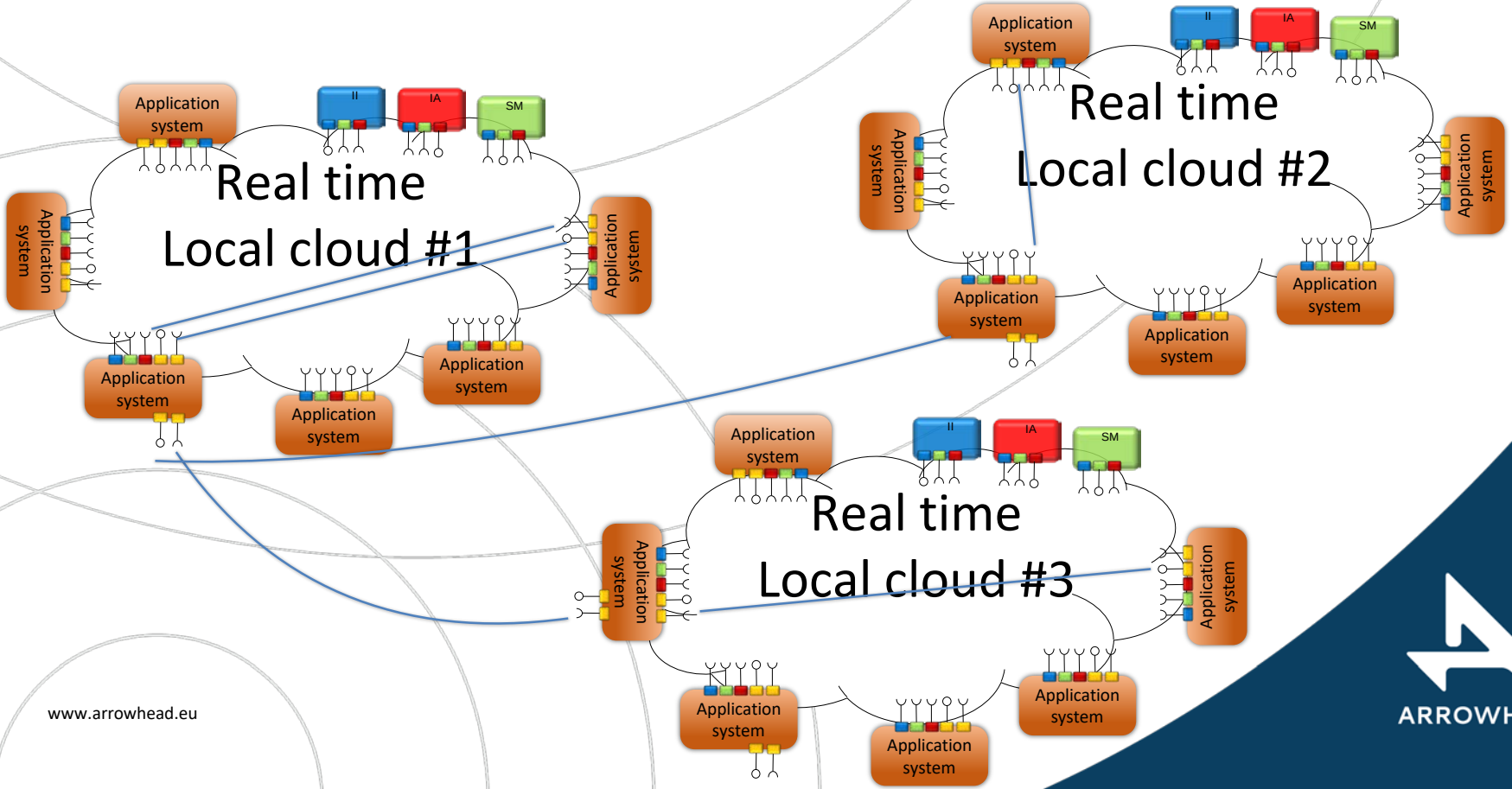
A service based approach to Real time local cloud automation Scalability - inter cloud interaction



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Test at Volvo Trucks, Gothenburg

PLM

VMQ

FCS

VMQ

VMQ

AAS

VMQ

VD

Custom

DEV

VMQ

FCS Adapter

S R O

CK

HTTP/CoAP/MQTT

n + 1

2

Station 16 A

S R O

CK

Work station

3

Presentation

CoAP/MQTT

n

Display

n

n

Nutrunner (adapter)

1

Scanner (adapter)

User input

Station 16 B

S R O

CK

Work station

3

Presentation

n

Display

n

n

Nutrunner (adapter)

1

Scanner (adapter)

User input

Digital assembly instruction

☐	Tightening	5		5/5
☐	Part assure	1		Ok
☐	Verify	-	-	
☐	Complete	-	F9	

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Arrowhead district heating automation

Visualization Tool

Luleå Energi

Building S

Abelko INNOVATION

Building S

Abelko INNOVATION

Adaptive Curve S

NODA

Smart Heat Grid S

3E

Forecasts S

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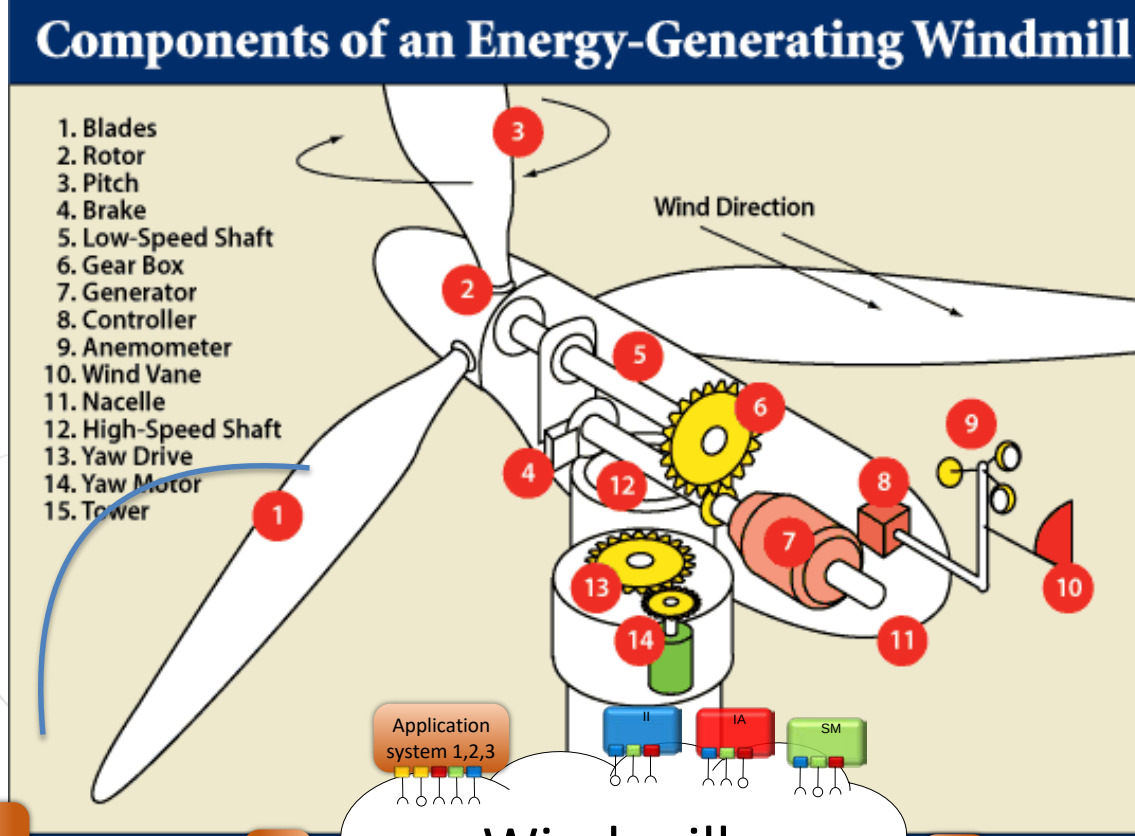
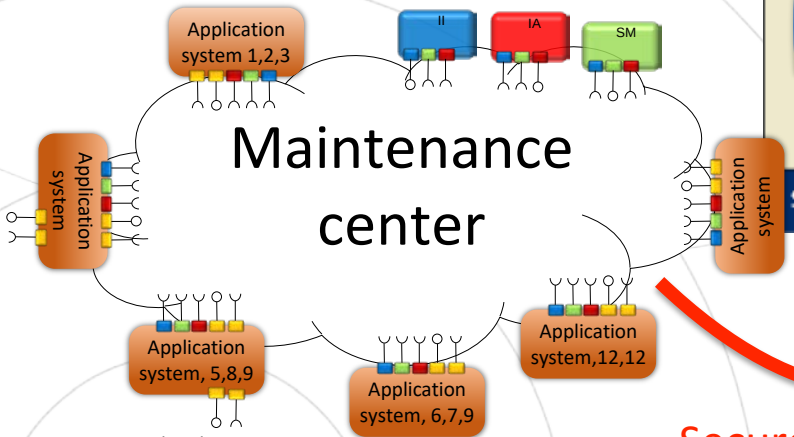
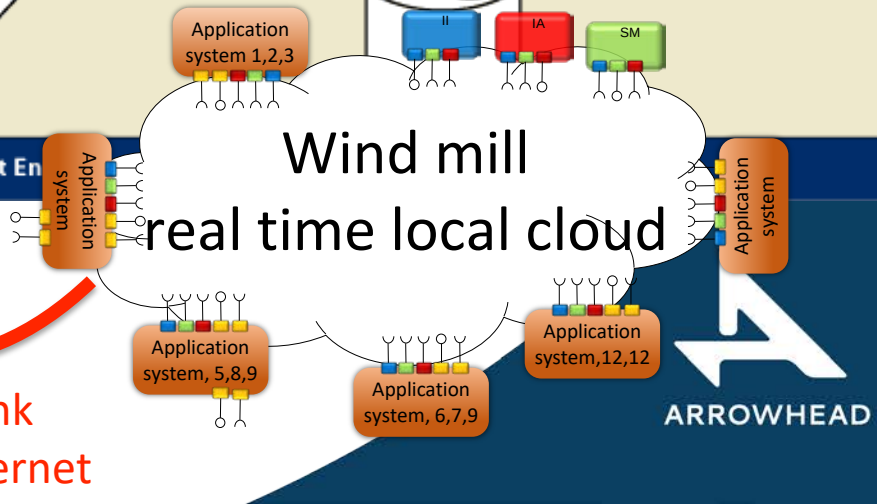
Maintenance system based on wireless IoT sensors

Secure sensor data integration to maintenance center







Secure data link over open Internet

Key properties of Arrowhead Framework

- Real time control
- ICT/OT Security
- Scalable
- IoT/SoS based
- IoT interoperability (translation system)
- Engineering simplistic
- Automation support

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Automation support systems

- PlantDescription system
  - Transform design views to orchestration rules
- Configuration system
  - Enables configuration of individual devices, software systems and services
  - Enables software updates of devices and systems
- QoSManager system
  - Provides QoS monitoring, prediction and management
- DataManager system
  - Provides Audit capabilities
- EventHandler system
  - Enables subscriptions to Events

Arrowhead Framework v4.0

Productive 4.0

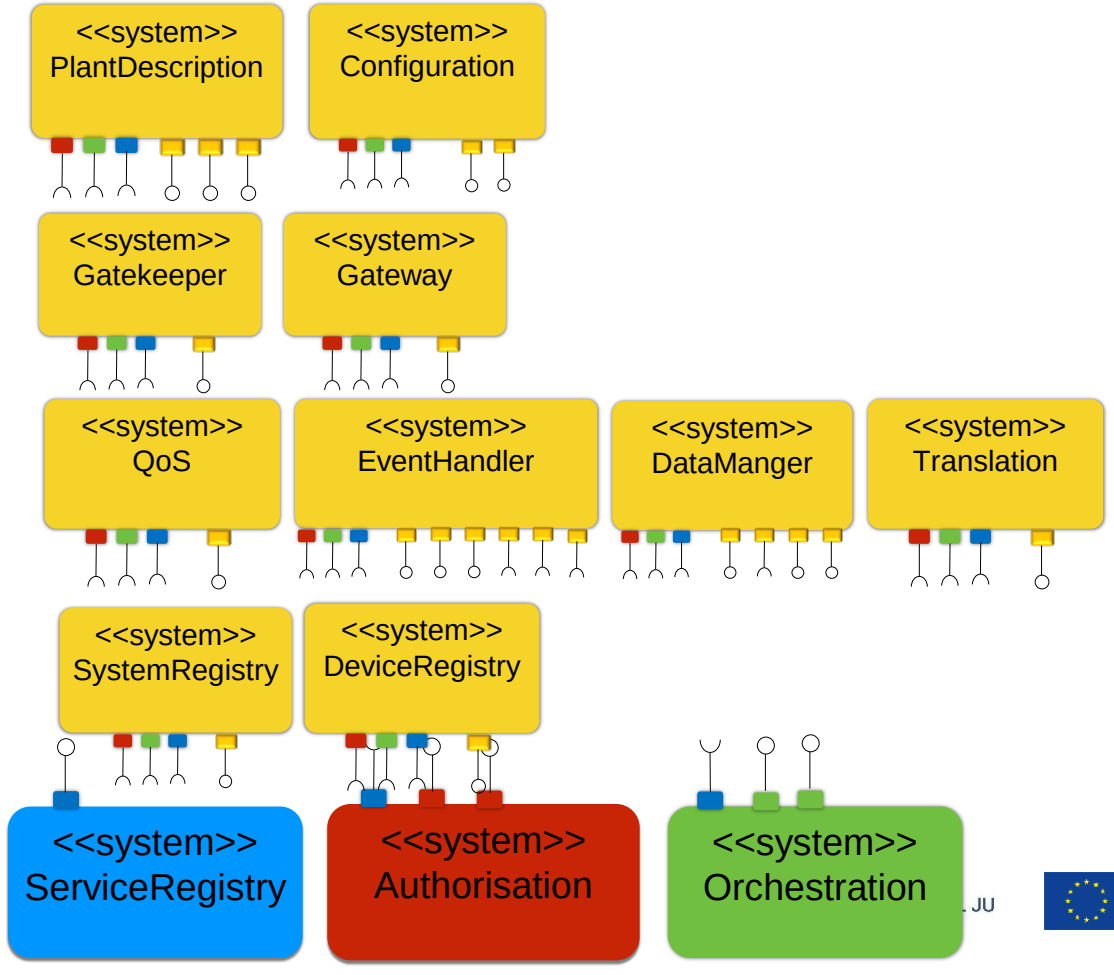
System of Systems support

Inter cloud service exchange

Service exchange support:

Secure on-boarding and infrastructure:

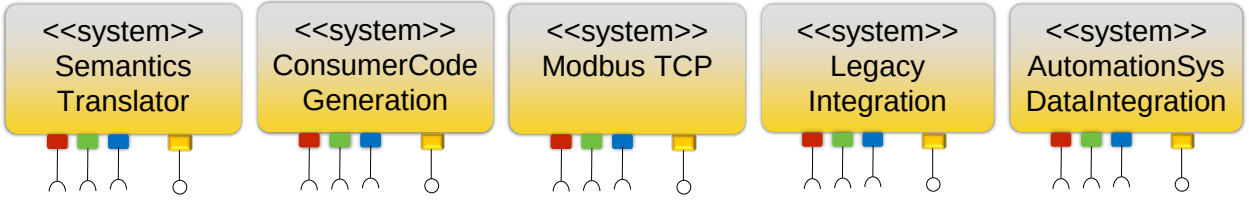
Local basic cloud properties:



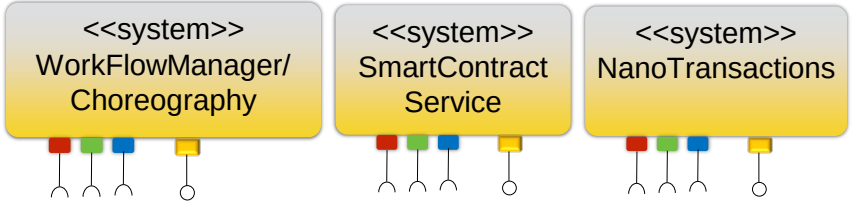
JU

Arrowhead Framework systems - new developments

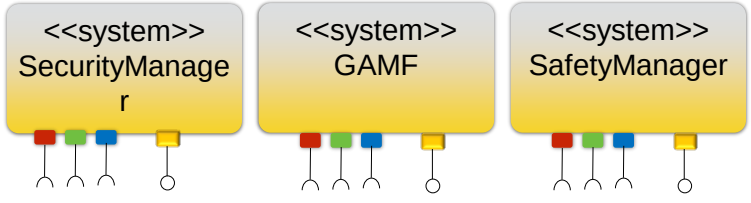
Productive 4.0



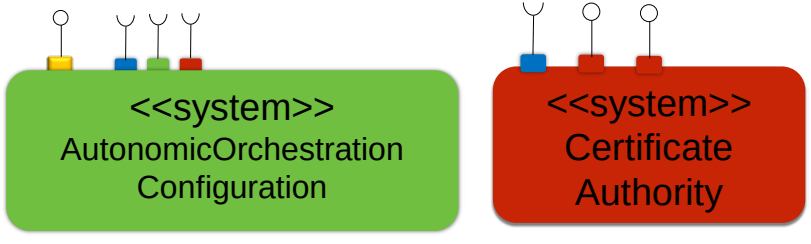
Interoperability support



Workflow, business models and transactions



Security and safety management



Complements to mandatory core systems

ECSEL JU

Automation engineering time

Application	Local cloud [h]	Legacy [h]	Gain
Building energy automation	6-8	40-48	1 : 5
Airport information automation	40	160-200	1 : 4.5
Recycling logistics	80	240-300	1 : 3.5

Data provided by

- Abelko Innovation AB
- BnearIT AB

- Supported by qualitative analysis comparing ISA95 and Arrowhead local cloud engineering
  - Oscar Carlsson, Jerker Delsing, Engineering of Service-oriented IoT Automation Systems, Submitted to IEEE System journal

Arrowhead Framework continuation

- FAR-EDGE
  - Productions optimisation
  - Integration along production stakeholder domain
  - Volvo, LTU

- Productive4.0
  - Manufacturing optimisation
  - Integration along supply chain
  - Integration along product life cycle
  - Volvo, Ericsson, SEB, Midroc, Combitech, BnearIT, LTU

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System of Systems engineering tool GAP

State of the art

The 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

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

Tool chain integration

Integration platform maturity

Competence GAP

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Arrowhead Framework continuation

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Arrowhead Tools proposal to ECSEL-JU

88 partners

e.g. ABB, Honeywell, Bosch, Philips, Volvo, Infineon, ST, Mondragon, Eurotech, AVL, ….

104M€ budget

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Lessons learned - barriers

Business case value requires more efficient and less costly implementation of new technology

The move to new technology is necessary to exploit business value

Substantial barriers are (next page)…

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Lessons learned - barriers

	Legacy - ISA-95	*IoT and SoS*
Digitalisation solutions	*€€€*	*€*
Flexibility	*Months*	*Minutes*
Engineering tools	*OT many* *ICT few*	*ICT many* *OT few*
OT and ICT competence	*OT Plenty* *ICT limited*	*ICT Plenty* *OT limited*

Conclusions

Business value – more efficient and less costly implementation of new automation technology is necessary

We experience a change/move from ISA-95 towards RAMI4.0-like architectures

The change is driven by automation requirements such as: flexibility, increased interoperability and integrability, security, faster implementation cycles with less efforts, scalability and knowledge/skills

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Thanks

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