

#### Engineering IoT based System of Systems Automation for Smart Grids

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#### Heathrow terminal 5

5 million connected points!!



#### The automation challenge

Annual growths more than 10% and over 500 billion connected devices are expected worldwide by 2025. - Cisco 2013

Massive automation systems not possible with current technologies

Not enough many engineers on the globe to do the job with current technology



#### Arrowhead Process and energy system automation

4 years project 68M€ 78 partners Coordinated by



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ARTEMIS Industry Association The association for R&D actors in embedded systems

Collaborative automation

#### To be demonstrated in real world applications



# Classical automation system characteristics/properties

Centralised controllers, DCS, SCADA, PLC,
Pull based - time slotted streaming of all data
Hard real time

Design time bindings

Seams to have an upper bound of X\*10<sup>5</sup> I/O's



#### Automation systems in to the cloud?



Arrowhead Grand challenges

Enabling the interoperability of services provided by almost any device.

Enabling the integrability of services provided by almost any device.



## The global cloud approach



Jerker Delsing, and Peter Priller, SOCNE workshop at ETFA 2015, Luxemburg

#### Collaborative automation in the cloud

Automation is local - requirements on;

Real time

Security and safety

Continuous engineeringScalability

Local clouds are beneficial to:
Latency - real time
Security - supporting safety
Less engineering dependencies

Inter cloud service exchange enables scalability





### Street lamps







#### UCEEB scheme







# Flexoffer work flow



# System implementation



#### System savings



#### Global savings - examples

- Estimates of flexibility savings:
  - 5% reduction of peak load in USA will save 35 billion USD over 20 years
  - 1.5 billion USD savings in Denmark over 10 years corresponding to total private households costs
  - Due to savings in balancing costs, backup power costs, long distance line costs
- Benefits
  - Private households: cheaper energy through variable tariff
  - BRP's and aggregators: lower balancing costs
  - DSO's TSO's: lower grid reinforcements



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#### Automation engineering time

Automation is a service based on products

Simplicity of automation service engineering is market key

Arrowhead Framework reduces engineering time
From 5-6 days -> 6-8 hours (Abelko)
From 4-5 weeks to 1 week (BnearIT)



# Design of large systems Orchestration from "PlantDescription"



### **Flexoffer tutorial**

Will ba available at Arrowhead Framework wiki



### Arrowhead Framework wiki

Open source technology enabling local automation clouds A mean of enabling Device interoperability at service level

System of Systems design and implementation



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# Necessary technologies for large automation systems in local clouds

Robust communication, wired or wireless IoT sensors, actuators, PLC:s, etc. DCS and SCADA functionality' MES and ERP functionality

Cloud integration technology Engineering tools for cloud automation systems Test tools and simulators for debugging Migration of cloud automation into legacy production system Suitable security



# Can we build Arrowhead automation systems today?

**Robust communication** IoT sensors, actuators, PLC:s, etc. DCS and SCADA functionality MES and ERP functionality **Cloud integration technology** Engineering tools cloud automation Test tools and simulators Migration to cloud automation Suitable security

- ➡Products on the market
- ➡Some products on the market
- ➡First products on the market
- ➡Demonstrated in industrial env.
- ➡Some products on the market
- ➡Demonstrated in industrial env.
- ➡First products on the market
- ➡Demonstrated in industrial env.
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