IP for Smart Objects

@ 4th FRUCT Seminar

Prof. Jose L. Martinez Lastra
lastra@ieee.org

TAMPERE UNIVERSITY OF TECHNOLOGY

Promoting the use of IP in networks of Smart Objects

Sensor/Control Networks are everywhere … with a vast scope of applications


Predictive maintenance

Energy Saving (I2E)

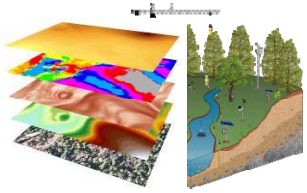



Intelligent Building

Defense


Improve Productivity

Enhance Safety & Security



Enable New Knowledge


High-Confidence Transport and assets tracking


Food & H20 Quality

Healthcare

Smart Home

The Current Trend: a poor adoption choice

- In terms of technology there are many ad-hoc alliances and proprietary protocols
- The results: a very fragmented market with NO interoperability
- Push from customers to access these networks using IP
- One PHY will not fit all of the needs and requirements
- Use of protocol translation gateways are unworkable
  - Non-scalable and inefficient
  - Hard to operate and manage
  - Expensive to install and maintain
  - Break end-to-end security and integrity

One solution: IP

- IP is independent of physical layer
- IP works on 8 and 16 bit micro-controllers
  - limited memory, processing, battery operated
- Stack requires only 4k of RAM, less than 32K of Flash
- Leverage existing IP protocols

The solution:

IP for Smart Objects

Objectives of IPSO

- Create awareness of available and developing technology with IP for Smart Objects
- Generate tutorials, white papers and highlight use cases
- Complement the IETF which defines standards, but does no marketing
- Link companies that support IP based sensing and control systems
- Coordinate and combine member marketing efforts
- Support and organize interoperability events

Structure of the IPSO Alliance

- Simple 2 tier structure
  - **Promoter** – voting rights, elect and serve on BoD
  - **Contributor** – participate in all events and committees
- Fees: $5000 for Promoter; $2500 for Contributor
- Board of Directors – Define Alliance strategy, external communications, direct internal activities
- Technical Advisory Board – Review technical publications, oversee technical committees
- Committees (to date):
  - MarCom; Interoperability; Membership

Founding members

- Arch Rock
- Atmel
- Cimetrics
- Cisco
- Duke Energy
- Dust Networks
- Électricité de France R&D
- Eka Systems
- Emerson Climate Technologies
- Ericsson
- Freescale
- Gainspan
- IP Infusion
- Jennic
- Kinney Consulting
- Nivis
- PicosNet
- Proto6
- ROAM
- SAP
- Sensinode
- SICS
- Silver Spring Networks
- Sun Microsystems
- Tampere University of Tech.
- Watteco
- Zensys

Alliance Actions

Support Activities

- 6LoWPAN Working Group
- ROLL Working Group
- ISA100 Industrial Wireless
- IEEE Working Groups

On-going Activities

- Interoperability Testing
- Architecture Design
- Technology Demonstrations
- Use Cases / White Papers
- Tutorials and Educational Materials

Summary

- Internet Protocol
  - Time tested standard for interoperability
  - Open and Scalable
  - Leverage – No need to reinvent the wheel
  - Efficient for these small devices
- Purpose of the Alliance
  - Member companies coming together to realize the benefits of embedded IP solutions
  - Spread the word and demonstrate the technology

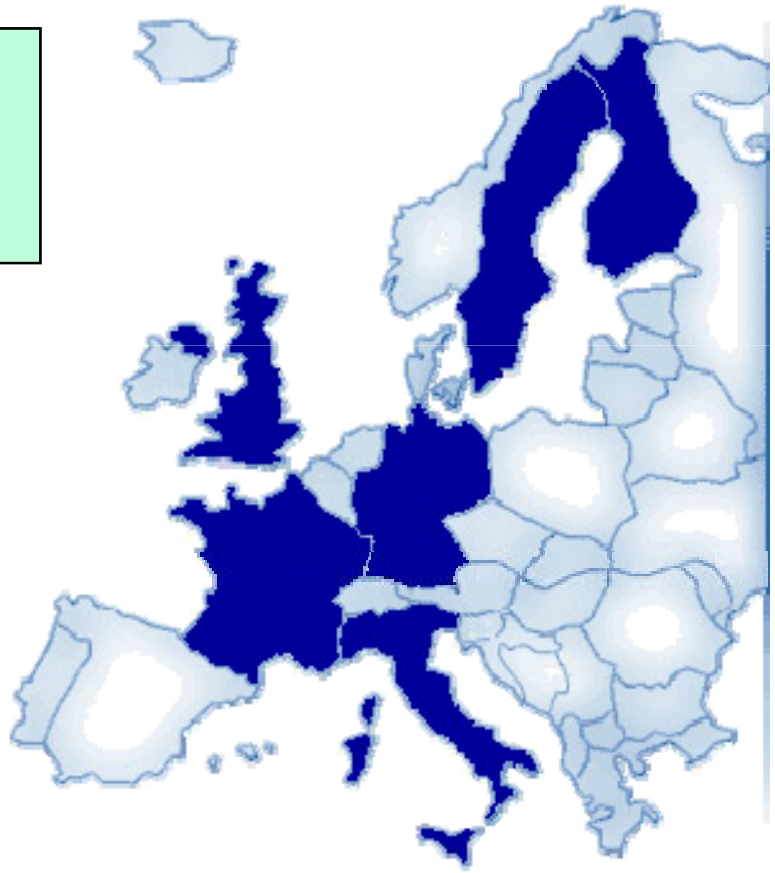
The IPSO Alliance will extend the reach of IP into "Internet of Things"

The EU FP6 IP SOCRADES

Service-Oriented Cross-Layer Infrastructure for Distributed Smart Embedded Devices

Unprecedented constellation of all major European ICT players of the industrial value chain
(Coordinated by SE)

3-years Project (01.09.2006-31.08.2009)
15 Partners from 6 European Countries
Effort: 1100 PM
Total Budget: 13.746.808 €
Contact: Dr. Armando W. Colombo (PC)
armando.colombo@de.schneider-electric.com



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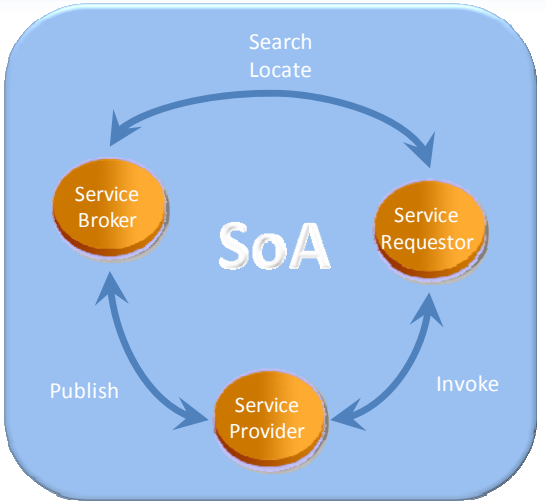
SOCRADES.EU

Services and Web Services

- A ***Service*** is a **software interface** that encapsulates the functionality of a device or process

- ***Service-Oriented Architecture*** (SOA)
  - Service provider
  - Service requestor
  - Service broker



- ***Web Services***
  - Specific technology for SOA, XML-based
  - SOAP for invocation (XML/HTTP)
  - WSDL for Service Advertisements (publish/locate)

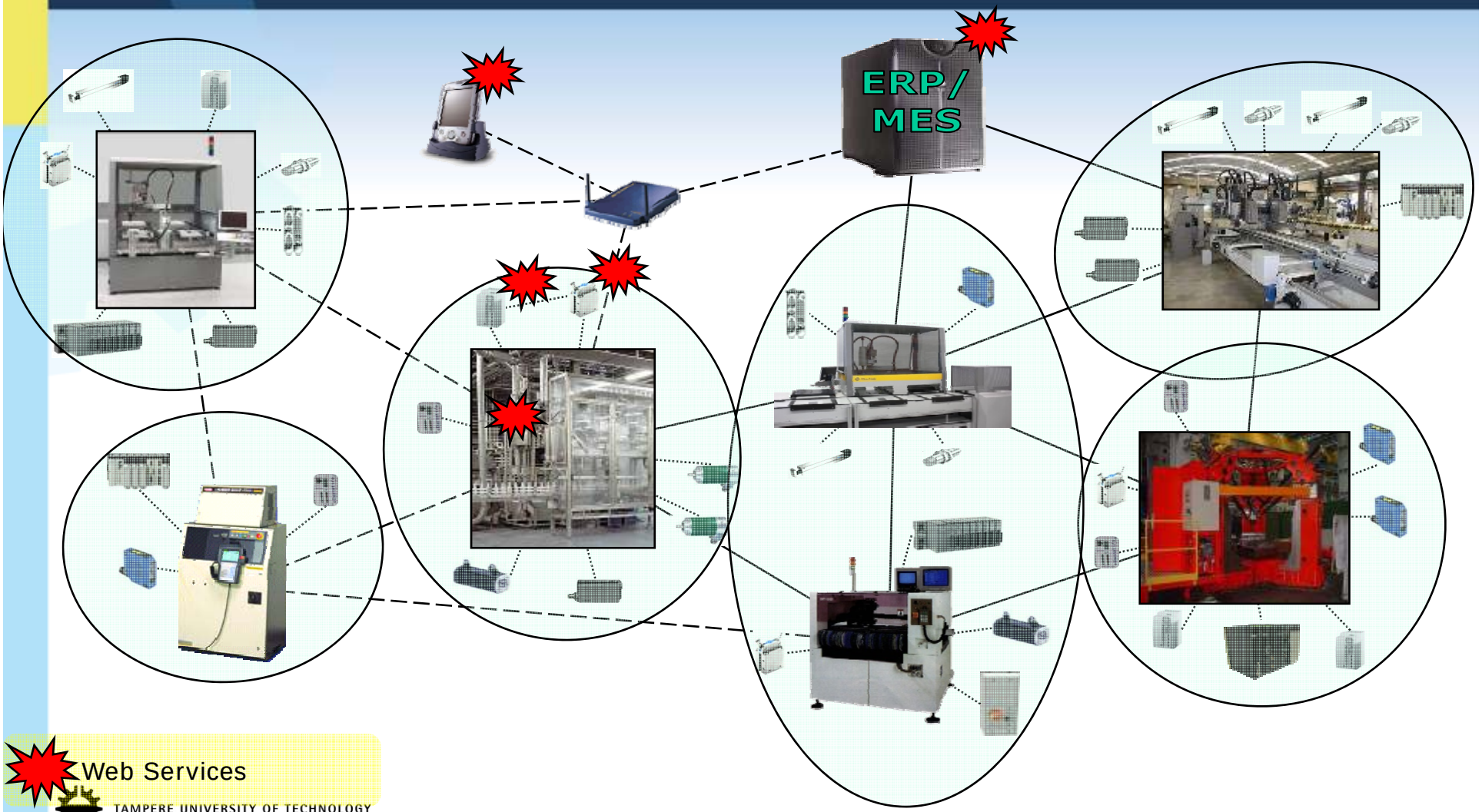
Semantic Web Services

- ***Web*** – Distributed repository of data
  - Processed and interpreted by humans
- ***Semantic Web*** – Distributed repository of machine-interpretable knowledge, using ontology
  - Processed and interpreted by software entities

- Use ontology to describe Web Services

  → ***Semantic Web Services***
- Software Agents can process service ontologies:
  - Discover machines/devices
  - Select machines/devices
  - Invoke machines/devices
  - ***Using inference – without previous knowledge on the services***

The Target: Cross-Layer Infrastructure based on Semantic Web Services (SOCRADES)

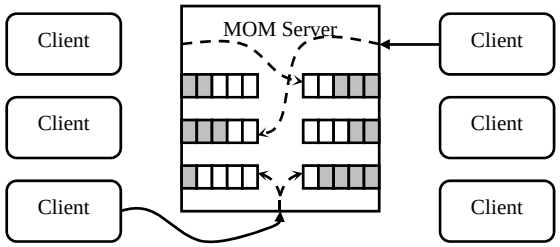


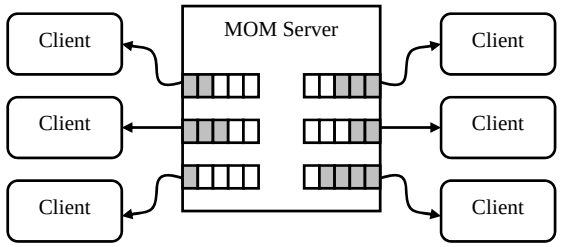
Industrial State of the Art in Middleware

Own experiences in the Electronics manufacturing Domain

IPC/CAMX MOM

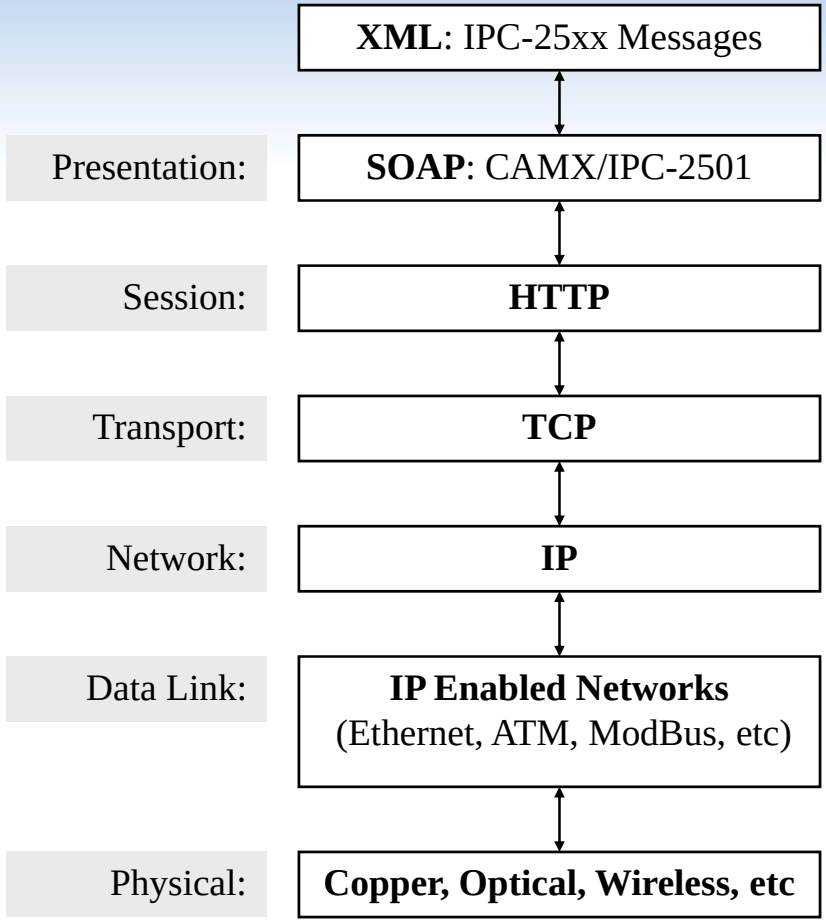
- CAMX MOM is based on SOAP
- Provided communication models:
  - publish/subscribe messaging channels: messages associated to topics, for one-to-many communication
  - point-to-point messaging channels: for one-to-one communication
- Guaranteed Message Delivery
- Messaging channels have a MOM server as an intermediary
  - Asynchronous communication
  - Processes don’t need to wait on other processes





CAMX Protocol Stack

- Computer Aided Manufacturing using XML
- Simple Object Access Protocol
- eXtensive Markup Language
- Hyper Text Transfer Protocol

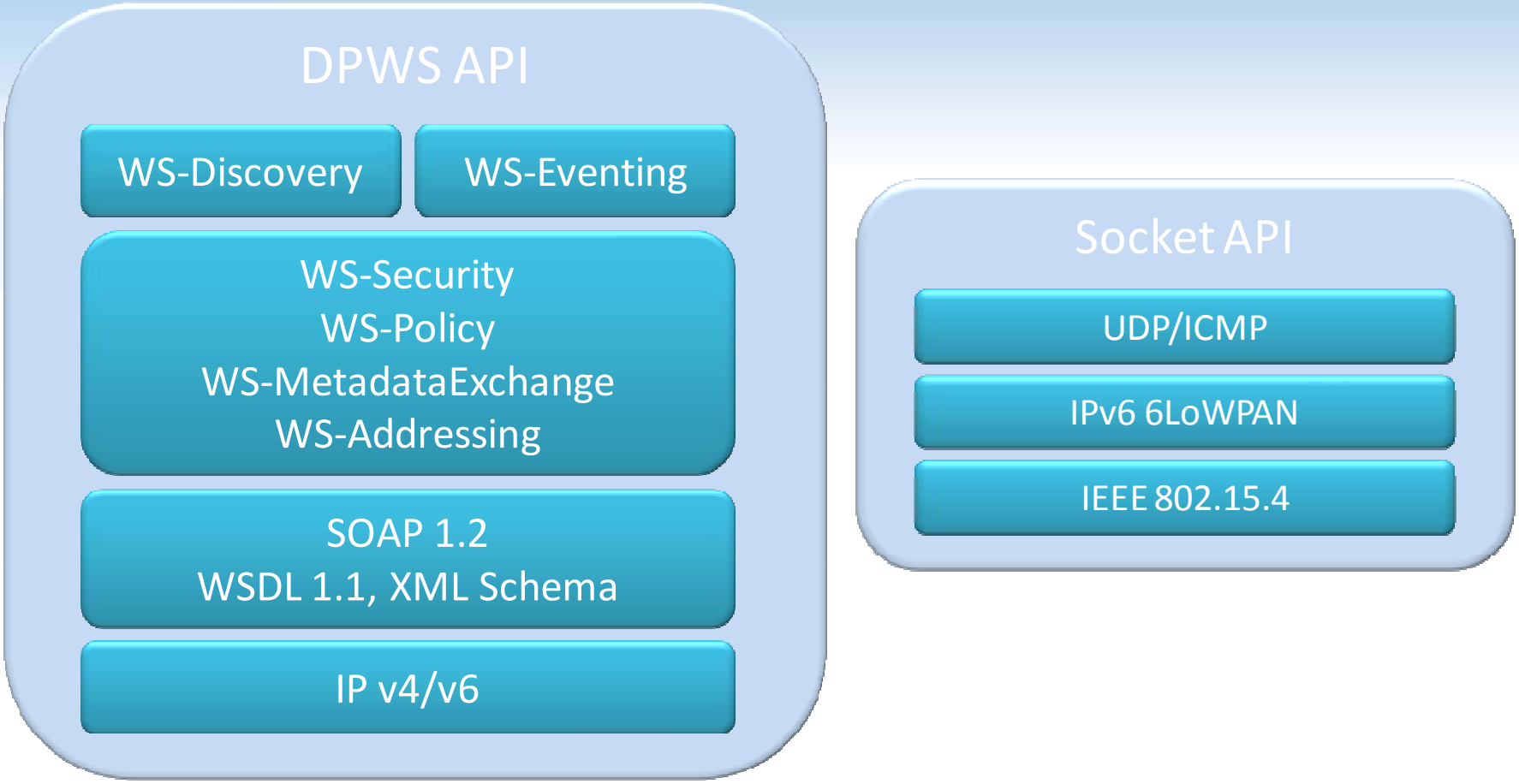


CAMX Limitations

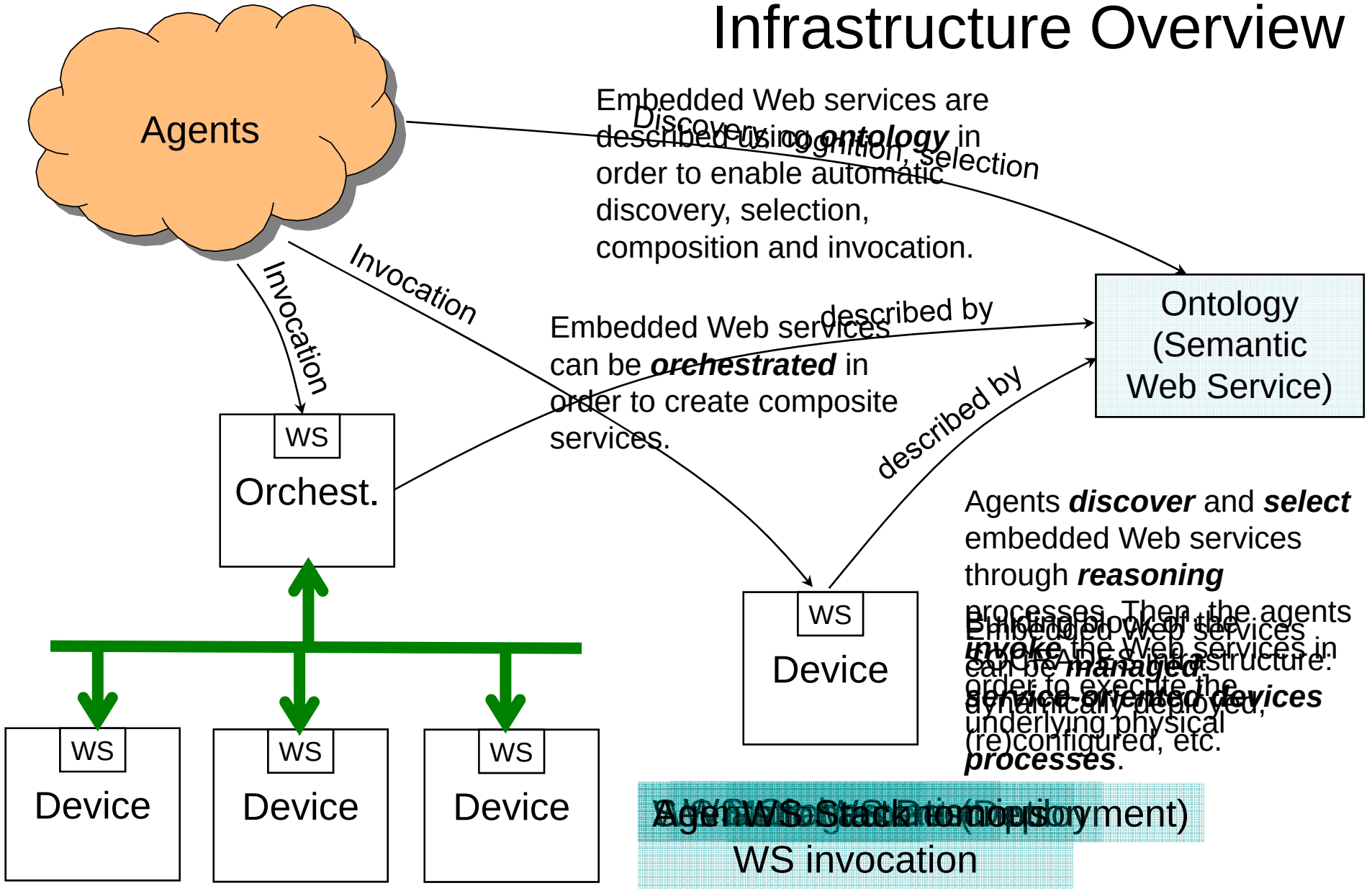
- Missing mechanisms/standards for:
  - Discovery (of new CAMX “clients”)
  - Security (by mistake different CAMX clients were addressed equally in the domain configuration)
  - The abstract models are a great starting point, but the UML Class diagrams are not enough descriptive and they do not capture formally the existing knowledge -> need for ontologies
  - No QoS provissions
  - Scalability
  - ...
- **HOWEVER**: today CAMX provides still an advantage for industries and industries are in their way to adopt it

We moved to Semantic Web Services combined with decision support systems using multiagents

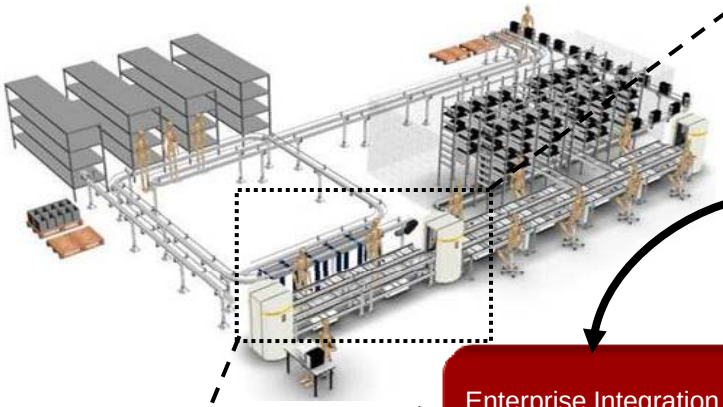
DPWS and 6LoWPAN Stacks

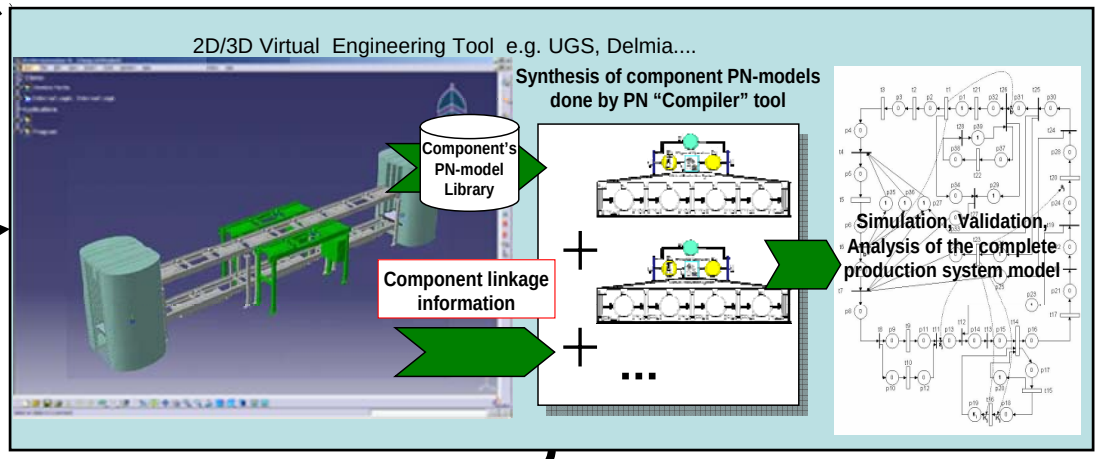


Infrastructure Overview



Typical factory layout





Enterprise Integration
MES/ERP

Daily Production List (DPL)
Active Production List (APL)
Bill of Materials (BOM)…

Orchestration Engine

Orchestration Engine

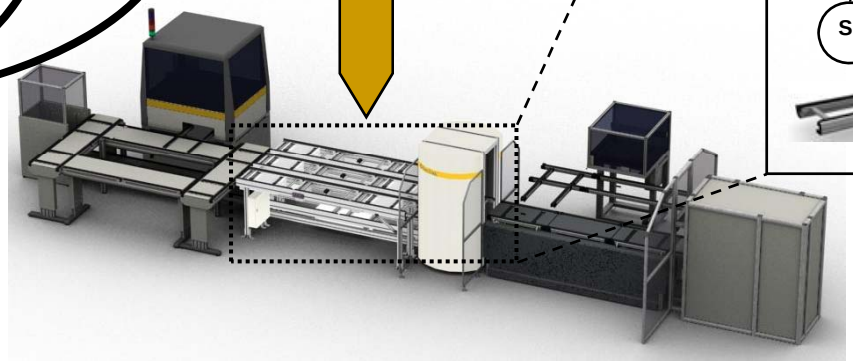
Service Cross Unit

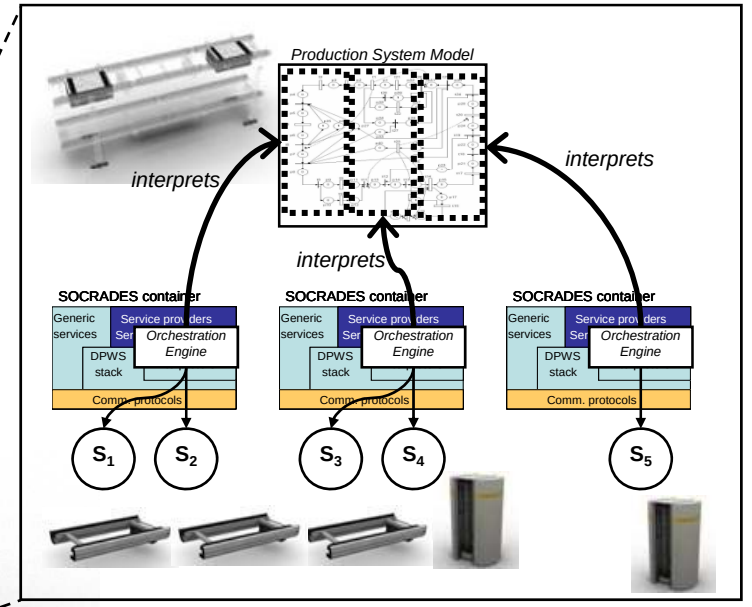
Service Conveyor

Service Lifter

Service End Lifter

Decision Support System Implementing e.g. Kanban, ...





Understanding *Semantic* Web Services

- *Semantic* Web Services are Web Services that are *augmented* by a machine-interpretable *description*
- The software implementation of the service is exactly the same
- The service is described by an *ontology* that serves as user guide for autonomous software agents
- Any Web Service can be a Semantic Web Service

”Our pragmatic Approach”

- Web Ontology Language (OWL) is used to create the proposed Product, Equipment and Services ontologies and for the Process Taxonomy
- These ontologies will become our knowledge base at run time
- The WSDL standard is used to describe services,
- … and by using SAWSDL (Semantic Annotations for WSDL) it is possible to include semantic information in the WSDL files
- This semantic information is nothing more than attributes based on the XML Schemas which contain pointers to the previously created knowledge base

Future Directions

Collaborative Automation and Service Oriented Architectures in the Industry

Web Services: Schneider Prototype Implementations (R&D Agenda)