The experience in the IT world

**WS standard in VISTA**

The same behaviour on the shop floor!

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**Reviewing the history: The experience in the IT world**

**The Service-oriented behavior on the shop floor?**

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**Microsoft**

Your potential. Our passion.

---

**Resolve:**

Got an Endpoint?

---

**Probe Match:**

Hey, I'm a printer!

---

**Resolve:**

Got an Endpoint?
Reviewing the history: The CMM Paradigm
Collaborative Automation and Service-oriented Architectures in Industry

Collaboration on 3 Axes:

1. **Enterprise Axis**: from Field to Business level
2. **Value chain axis**: from Suppliers to Customers
3. **Lifecycle Axis**: from Design to Support

Source: ARC
The SoA Approach towards Industrial Cyber-Physical Systems (I)
EU FP6 Collaborative Project SOCRADES

Virtualisierung der Produktion
Spezifikationen von Cyber-Physischen SW/HW-Komponenten

Service Bus (Network)

Service exposition / requesting
Dynamic Discovery
Dynamic Deployment
User Data
(Orchestration) Engine
(e.g., IEC 61131 engine, Petri nets engine)

DPWS framework
I/O module
Platform (OS, applications, and libraries)

Industrial equipment

Software Platform: Core

Hardware Platform

Ethernet hardware

Automation entity

S: Service
Service Orchestration/Composition

I/O

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Automation Entity / ICT on Device

- Service Bus (Network)
  - Device Interface
    - exposition of internal atomic services representing resources of the equipment
  - Service Framework
    - coordination of services and composition
  - Orchestration Engine
    - give support for decisions and optimization of processes
  - Decision Support System

Industrial Equipment

Smart Embedded Device
Collaborative Cross-Layer Infrastructure for CPS

Web Service  www.socrates.eu
The SoA Approach towards Industrial Cyber-Physical Systems (IV)
EU FP6 and FP7 Collaborative Projects SOCRADES and IMC-AESOP

- **SOCRADES**
- **IMC-AESOP**

- DPWA, OPC UA, COAP, EXI
- SOA ready Devices
- Information driven Interaction
- Distributed Business Processes
- Legacy Integration
- Complex Event Processing (CEP)
Networked Systems in the Cloud

- Engineering Tools
- Smart Embedded Device
- Production Execution

Service Cloud

Service Bus (Network)

High-order Services and Tools

Device Services

Factory Shop-floor

Service Orchestration/Composition

S: Service
Industrial applications can now be rapidly composed, by selecting and combining the new services and capabilities offered as service in the cloud.

SoA-Interaction manage the behavior of the whole Cyber-Physical System-of-Systems.
- Definition of SCADA Services
- Virtualization and Cloud Computing
- Each Device can be represented by one or more Services
IMC-AESOP Necessity for a Migration Approach

Emergent Behaviours

Migration Path 1

Migration Path i

Migration Path n

Current Implemented Systems

Legacy

Next Generation

SoA-based System

■ System’s property/characteristic to be migrated to SoA

➤ Inter-dependencies among migration paths due to architectural and functional relationships between system’s characteristics.

Composite / Orchestrated Services

Service Bus

IMC-AESOP: ArchitecturE for Service-Oriented Process - Monitoring and Control

Seventh Framework Programme (FP7) Theme ICT - Information and Communication Technologies

Grant agreement no: 258682 | Project Co-ordinator: Armando Walter Colombo | Schneider Electric Automation GmbH

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The SoA Approach towards Industrial Cyber-Physical Systems (IX)
EU FP7 Collaborative Project IMC-AESOP

Engineering Process: Populating the Cloud?

1. Design & Analysis
   - PN models
   - Layout configuration

2. Composition Tool
   - System models

3. Configuration Generator
   - WSDLs

4. Deployment Manager
   - Deployment files

- Smart Embedded Device
- Web Server/File Server
- Template Generator/Device Lookup Tool
- Deployment service
Collaborative Automation: A New Form of Engineering and Implementation. Component-based control system engineering

“Collaborative meeting for all engineers reviewing a single common virtual model”

“No where to hide”
The SoA Approach towards Industrial Cyber-Physical Systems (X)
EU FP7 Collaborative Project IMC-AESOP / Use Cases and Demonstrations

#1: Plant Lubrication System

#2: Oil Lubrication

#3: Plant Energy Management

#4: District Energy Management

Migration
Real plant

Event processing
Large-scale systems

Main system components

Oil Flow Measuring stations 20 pcs
Lubrication units 2 pcs
Intermediate Pumping units 6 pcs

Lubrication unit Dry End
Intermediate Pumping unit

Utility
Power

Steam power
Industrial utility
Process plant

Information models
Large-scale systems

System-of-systems
Real-time SOA
New Technology / Supporting Migration to SoA: Success History

Service Bus

Mediator

The SoA Approach towards Industrial Cyber-Physical Systems (XI)
EU FP7 Collaborative Project IMC-AESOP
Schneider Electric develops the “EcoStruxure” project to integrate Building / Power / Data centers / Industry solution in “One” Schneider solution based on SoA

EcoStruxure™ promise:

- Guaranteed compatibility / synergy / capability between the 5 domains of expertise

- Enabled by the right connecting technologies:
  - Ethernet/IP as a common highway
  - Web services as a common language (SOA architectures)

…”Web services – The Service Bus should become our next generation Modbus. Simple to use, widely accepted as a standard exchange mechanism”
Schneider Electric EcoStruxure™ - Integrating different industrial automation domains via SoA (WS) compliant devices and systems

Cross-Business Connectivity

Business agility
- Faster linking of systems
- System Interoperability
- Leverage legacy

Common Interfaces
- Device Interoperability
- Simple Plug&Play
- Harmonize data access

Accessibility

Service Bus

Web Services (WS)
Internet Protocol (IP)

Enhanced Features

Unique features through web services
- Portals
- Mobile applications
- Remote Monitoring

3rd party integration
- Integration into customer’s IT
- Enable Integrators, consultants, solution providers

External connectivity

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The business scenario:

- **Step #1**: Generate energy consumption forecasts using IONEEM based on actual and forecasted production targets in Ampla.

- **Step #2**: Bring the energy forecasts back into Ampla so that real-time production execution can be tracked or adjusted against the planned energy and production targets.

**#1: Deliver production data used in energy forecast modelling.**

**#2: Generate energy forecasts and track in Ampla against production execution.**
R&D&I-Areas of interest for New-Projects

- Cross-layer SoA-based Architectures for next generation distributed SCADA/DCS systems
- Migrating Large Scale Industrial System Monitoring, Management, Control to SOA
- Enterprise Integration via lightweight standardised and security-enabled (web) services
- Energy-driven Management e.g. inside the ISA´95 Enterprise Architecture
- Cohabitation of Legacy and Future Plant information retrieval principles and organizational models for emerging areas such as Energy, Process, Batch and Manufacturing Industry
- High performance convergence of event-driven and scan-based system execution methods
- Real-time (web) services for industrial applications
- Migration strategies towards fully SOA-driven Industry shop-floors (we need prototype applications running on Industry)
- Engineering Methods and tools for future SoS-based Industrial Solution (Heterogeneity of Systems, Interoperability among Systems, Multi-disciplinary, Cross-Domain)
- Trials and Lessons learned from large scale SOA based industrial prototypes and applications (BOTTOM-UP)
Thank You for your Attention!