Integrating IoT for Industrial Applications using IEC61499
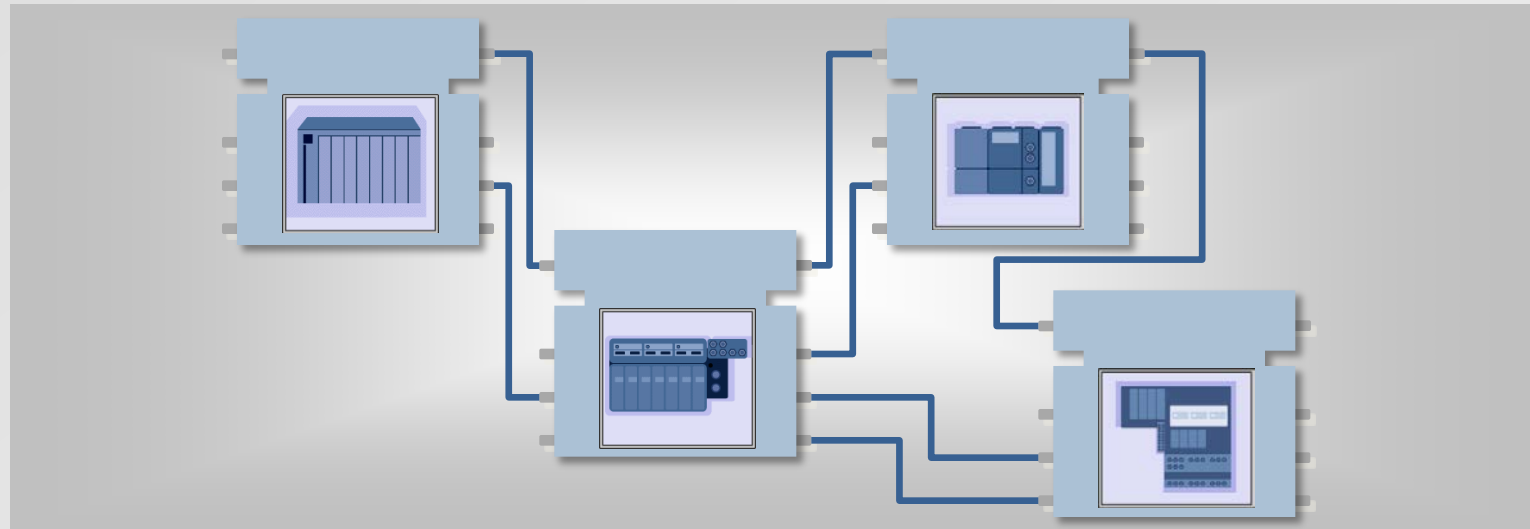
Federico Pérez, Marga Marcos, Darío Orive, Isidro Calvo

Contents

❏ **Introduction**

❏ **Vertical Integration**

❏ Requirements

❏ Methods and technologies

❏ **CPPS Architecture**

❏ General Architecture

❏ Model on OPC UA

❏ **4DIAC Implementation**

❏ **Summary**

Introduction

❑ **Worldwide initiatives**

- ❑ Factory of the Future (UE)
- ❑ Industrie 4.0 (D)
- ❑ Advanced Manufacturing (US), etc.

❑ **Smart Manufacturing based on**

- ❑ Internet of Things (IoT)
- ❑ Cyber-Physical Systems (CPS)
- ❑ Internet of Services (IoS)

❑ **Connectivity among systems and equipment**

SMART FACTORY

Introduction

❑ **Cyber-Physical Production Systems (CPPS):**

- ❑ Computation and process for production systems
- ❑ Collaborative entities communicating in factory automation environments
- ❑ Industrial communications
    - ❑ Complex
    - ❑ Different solutions at the different layers
- ❑ Middleware solutions
    - ❑ OPC UA: OPC Unified Architecture
- ❑ Trends:
    - ❑ Open software and hardware
    - ❑ Assorted communication technologies
    - ❑ Miniaturization of the hardware (Single Board Computer – SBC)
    - ❑ Reduction of cost

OPC UA: OPC Unified Architecture

OPC UA (Unified Architecture) is a set of specifications trying to cover real-time requirements to exchange information and use commands in industrial control.

OPC UA promoted by OPC Foundation and standarized as IEC 62541

OPC UA as the enabler for IIoT and I4.0

❑ **Interoperability insights for the Internet of Things and Industrie 4.0**

- ❑ System integration
- ❑ Connect devices and machines
- ❑ Secured services and data
- ❑ Infrastructure for the modeling of information and big data
- ❑ Reliable from small sensors up to IT Enterprise level
- ❑ Provides interoperability from sensors to cloud

Vertical Integration - Connectivity

❑ **Connectivity among systems and equipment**

- ❑ Vertical integration
- ❑ Horizontal integration
- ❑ Throughout the LifeCycle
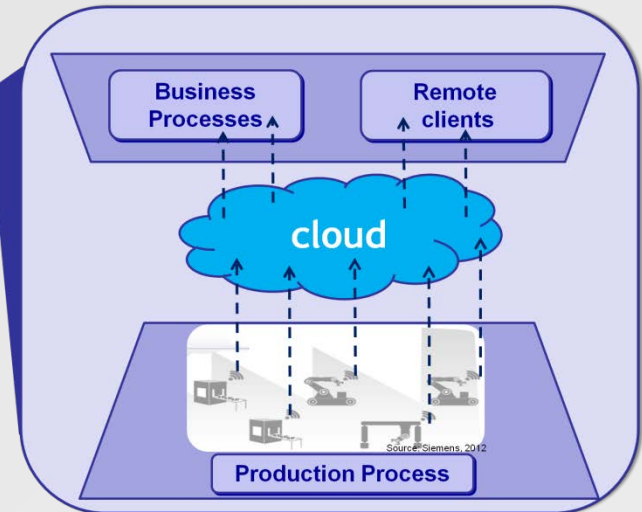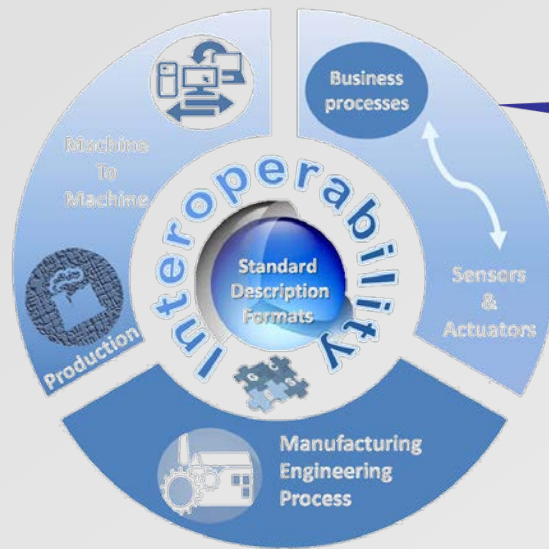
Vertical Integration – Requirements

	USER point of view	IMPLEMENTATION point of view
WHAT?	Magnitudes, units, range, etc.	Describing the data to be collected
WHERE?	Location of data in the plant	Means for describing the plant
HOW?	One shot, (a)synchronously, etc.	Defining the acquisition mechanism

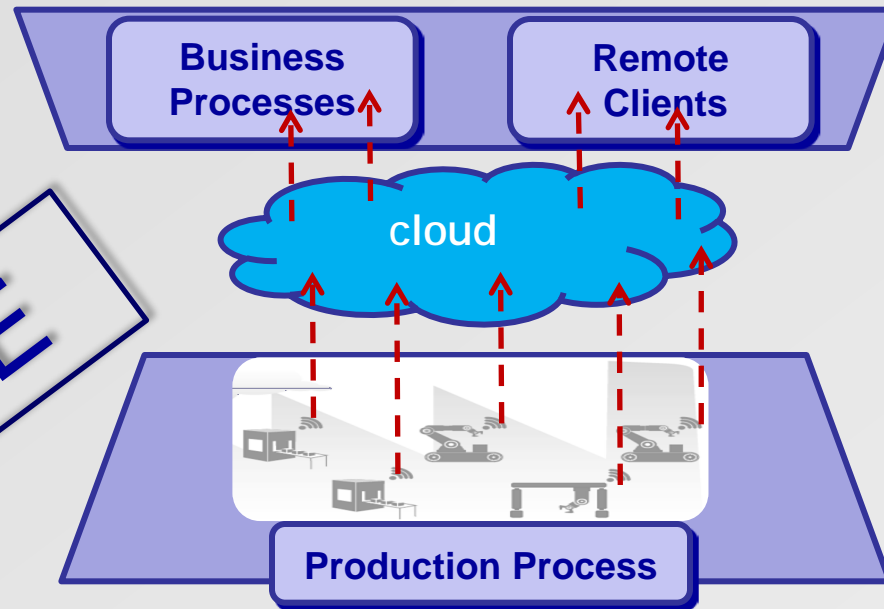# Vertical Integration – Methods and Technologies

✓ Modeling techniques

✓ Based on the use of consolidated standards
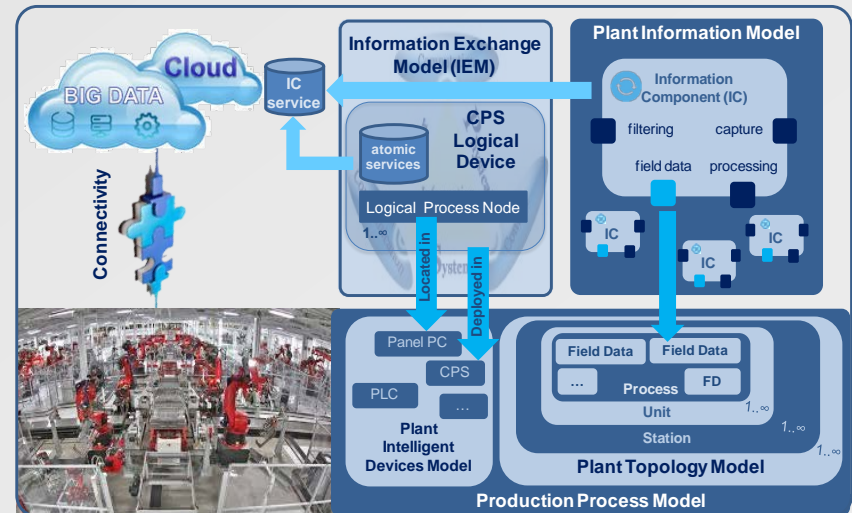
CPPS Architecture

❑ **Production Process Model**

  ❑ Plant Topology Model

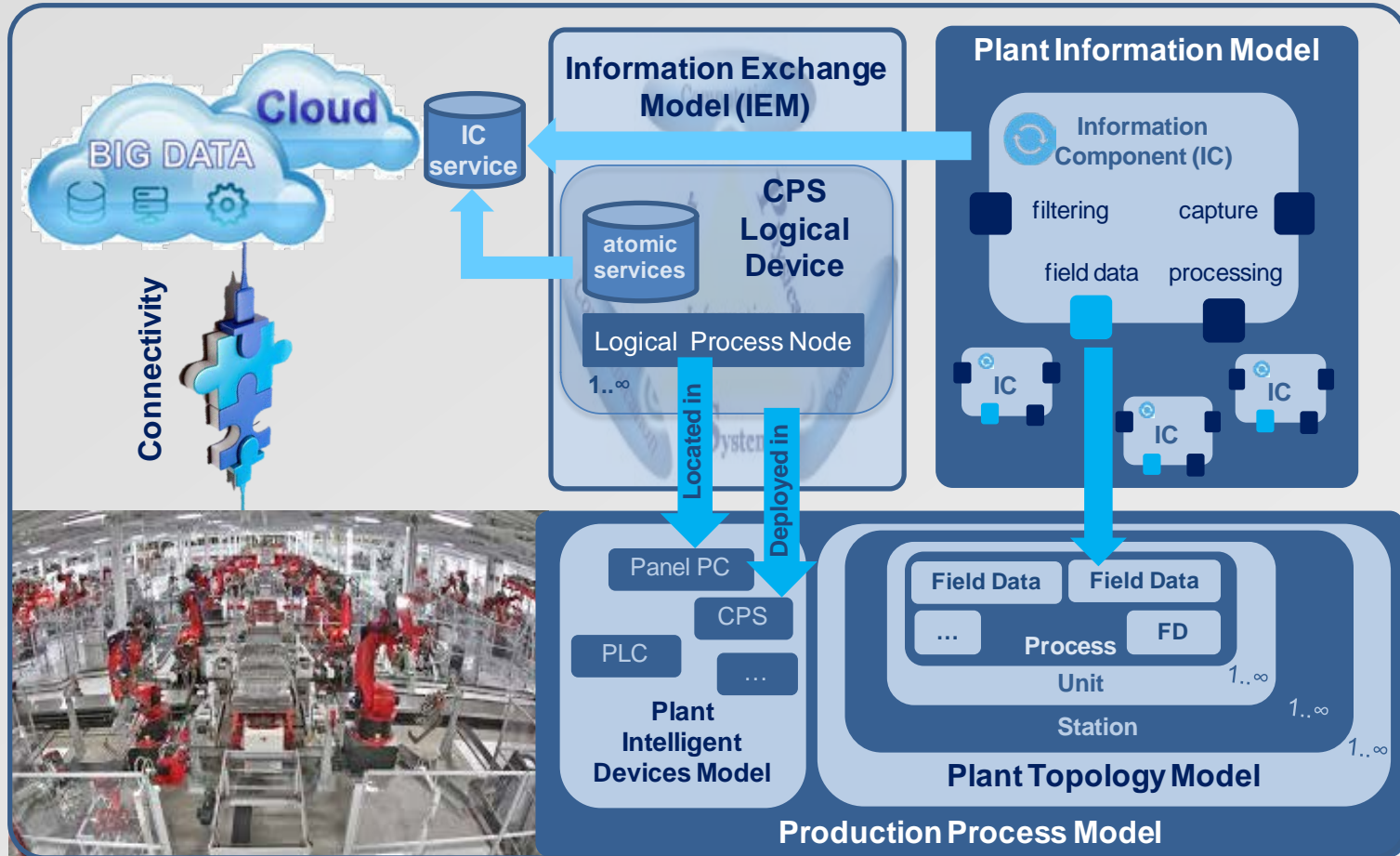 ❑ Plant Intelligent Device Model

❑ **Information Exchange Model**

  ❑ Atomic Services

  ❑ Logical Process Nodes

  ❑ CPS Logical Devices

❑ **Plant Information Model**

CPPS Architecture

CPPS Architecture in OPC UA

❑ **CPPS model included as an OPC UA specific layer**

Vendor Specific Extensions

Specifications of Information Models or Organizations — IEC, ISA, EDDL, FDT, PLCopen

DA | AC | HA | Prog — OPC UA Información Model

OPC UA Base Services — OPC UA Base Services

Transport — Web Servicios / OPC UA Binary

OPC UA Information Model — Modeling Rules — OPC UA Basis

CPPS Architecture in OPC UA

❑ **CPPS model included as an OPC UA specific layer**

CPS Information Model

OPC UA Información Model

OPC UA Base Services

OPC UA Basis

CPPS Architecture in OPC UA

❑ **CPPS model included as an OPC UA specific layer**

RESTful Services	← RestFul Adapter
CPS Information Model	← CPS Information Model
DA AC HA Prog	← OPC UA Información Model
OPC UA Base Services	← OPC UA Base Services
Transport — Web Servicios / OPC UA Binary · OPC UA Information Model — Modeling Rules	← OPC UA Basis
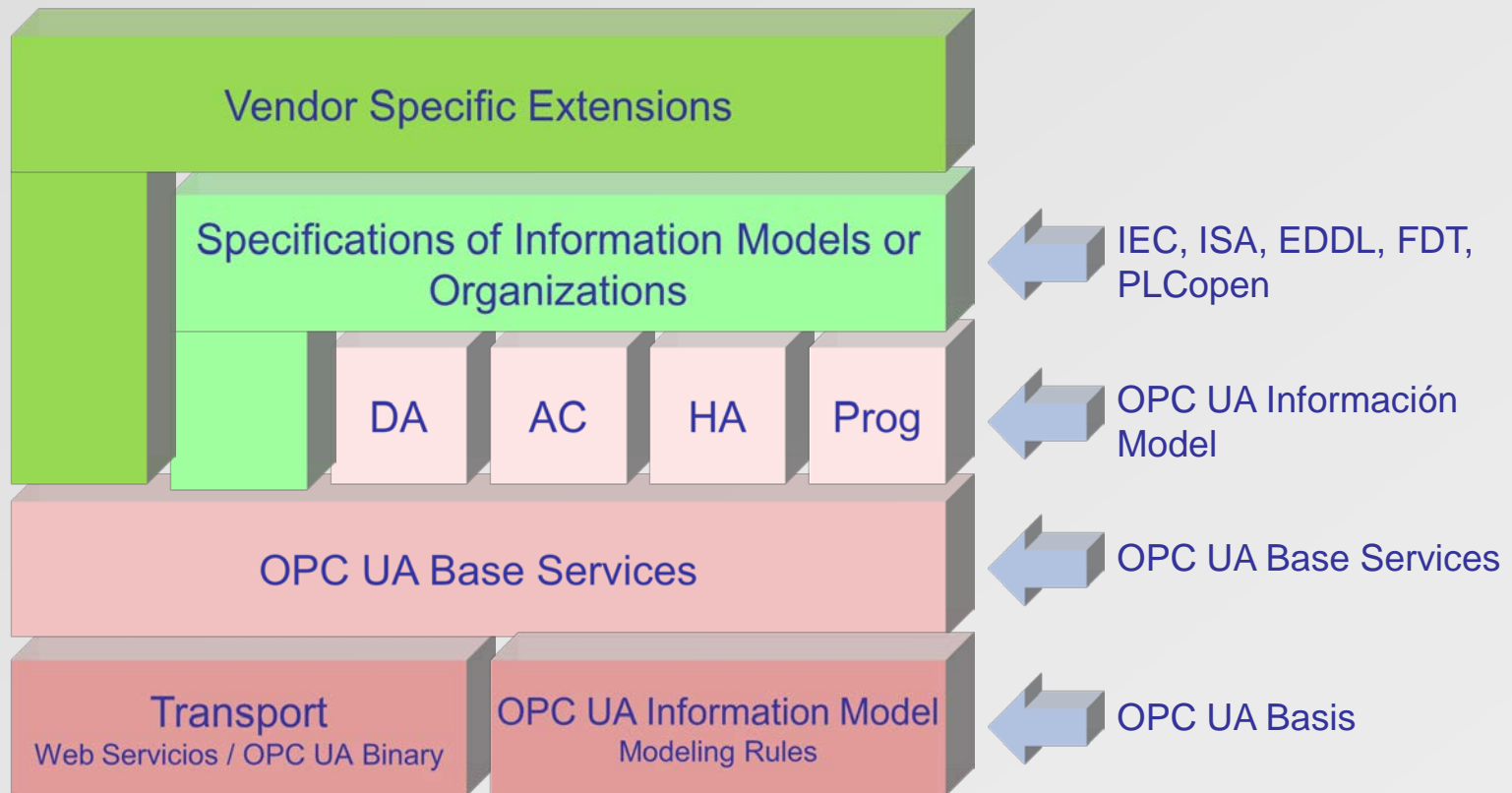
4DIAC Implementation
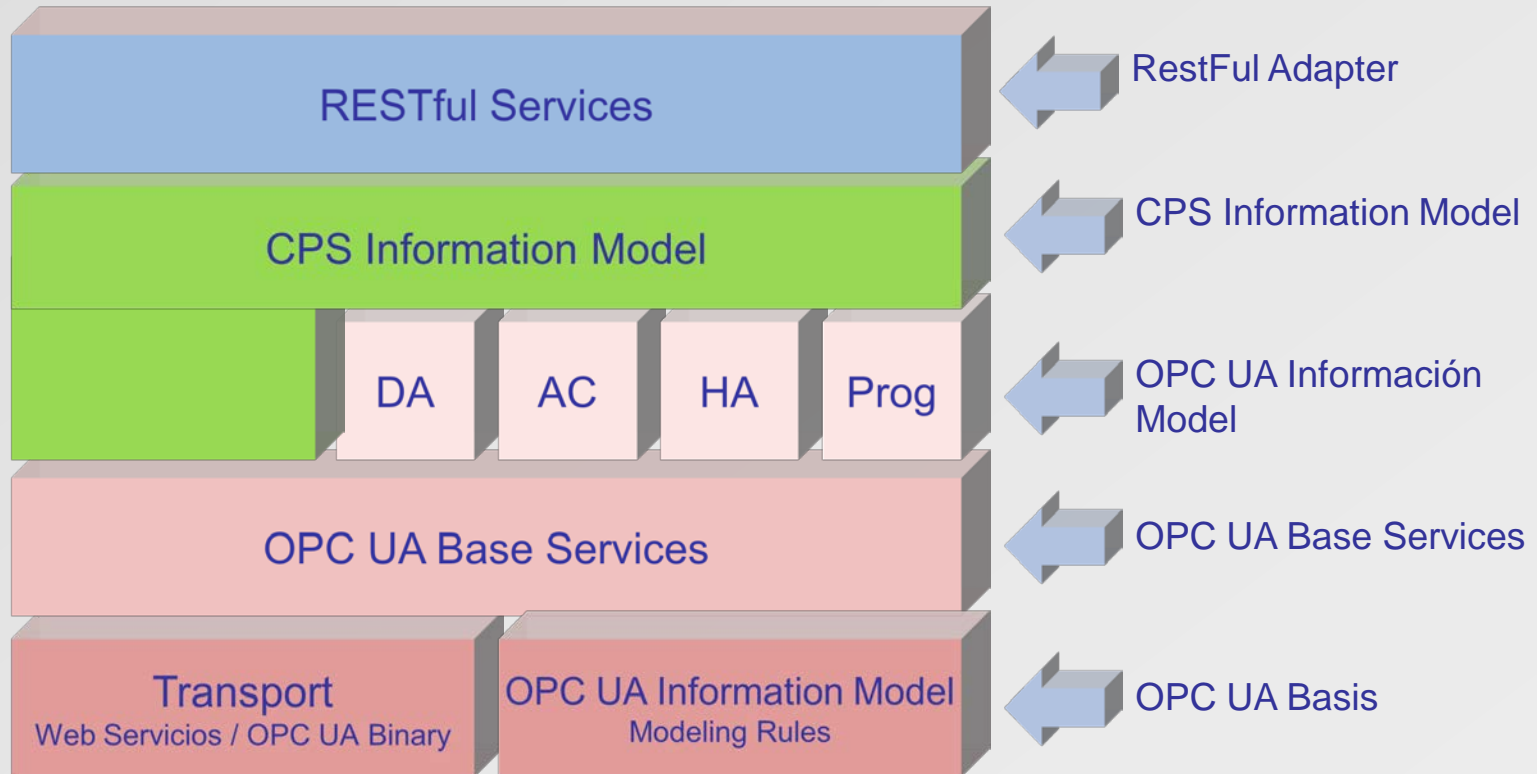
Raspberry PiFAce SIFB Set
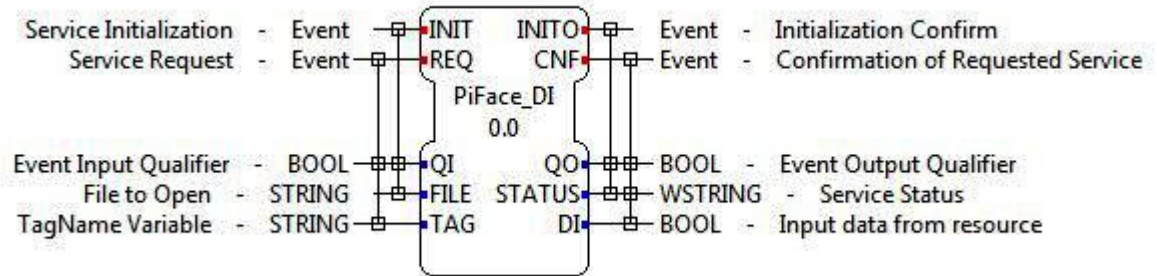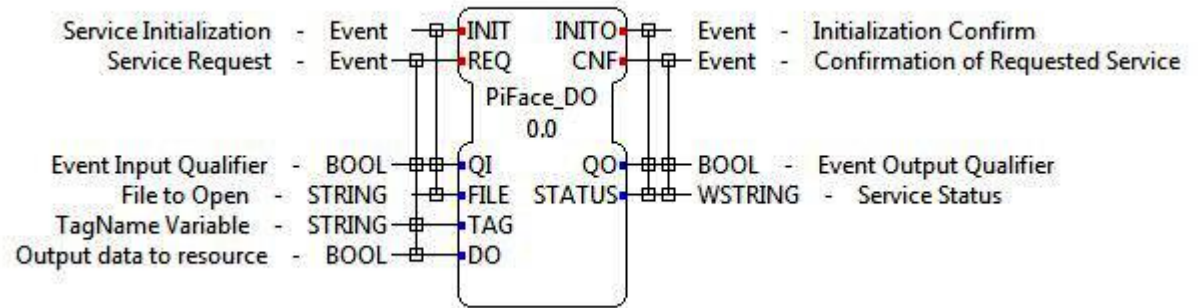
4DIAC Implementation

Raspberry PiFAce Configuration – XML File

```xml
<?xml version="1.0" encoding="UTF-8"?>
- <esquema>
  - <tag1>
      <name>1S1</name>
      <pin>1</pin>
      <type>BOOL</type>
      <description>Horizontal cylinder sensor 1</description>
    </tag1>
  - <tag2>
      <name>1S2</name>
      <pin>2</pin>
      <type>BOOL</type>
      <description>Horizontal cylinder sensor 2</description>
    </tag2>
  - <tag3>
      <name>2S1</name>
      <pin>3</pin>
      <type>BOOL</type>
      <description>vertical cylinder sensor 1</description>
    </tag3>
```
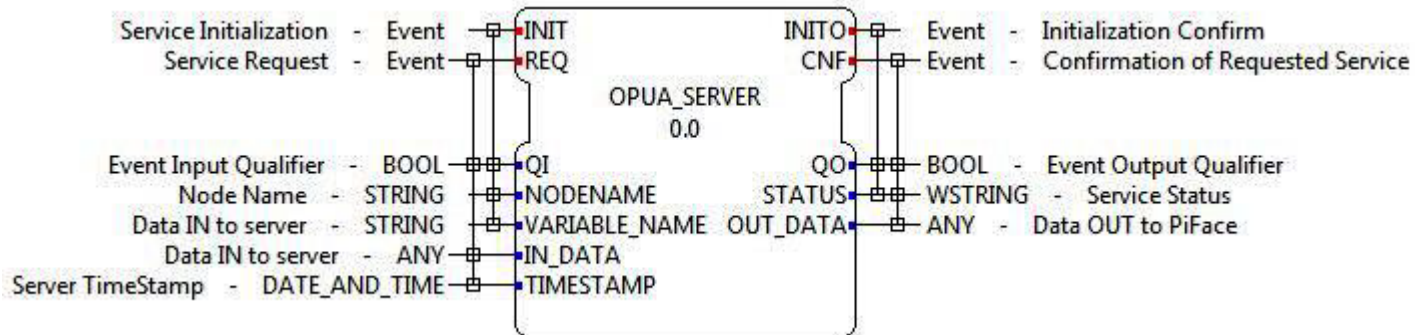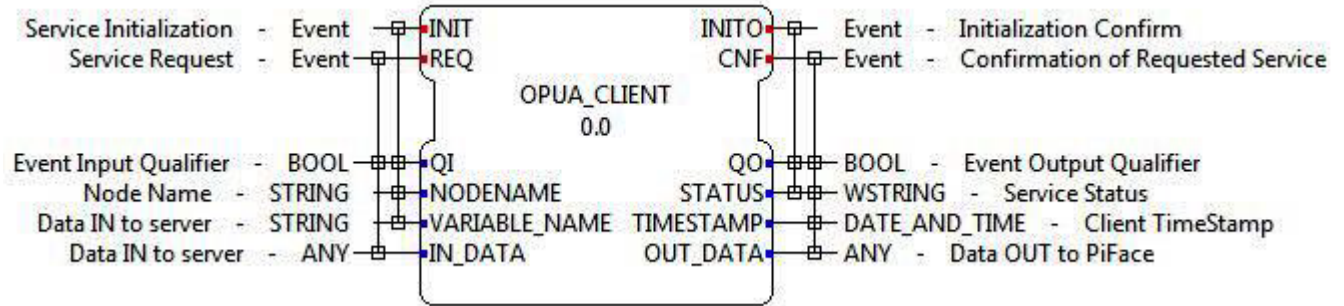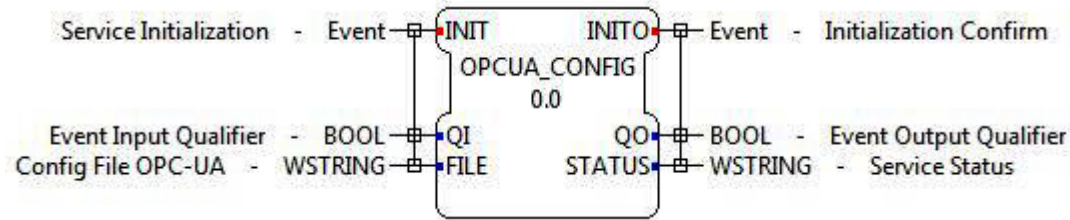
4DIAC Implementation

Raspberry OPC UA SIFB Set

4DIAC Implementation

Raspberry PiFAce Configuration – XML File

```xml
<ApplicationUri>urn:OPCUA_DISA:OPCUAUaDemoserver</ApplicationUri>
<ManufacturerName>GSIS DISA ETSI</ManufacturerName>
<ApplicationName>C++ SDK OPCUAUaDemoserver</ApplicationName>
<SoftwareVersion>1.1</SoftwareVersion>
<BuildNumber>200</BuildNumber>
<ServerUri>urn:[NodeName]:OPCUA_DISA:OPCUAUaDemoserver</ServerUri>
<ServerName>OpcUADemoServer@[NodeName]</ServerName>
- <UaEndpoint>
    <SerializerType>Binary</SerializerType>
    <Url>opc.tcp://192.168.0.199:4841</Url>
    <IsVisible>true</IsVisible>
    <IsDiscoveryUrl>true</IsDiscoveryUrl>
  - <CertificateStore>
```
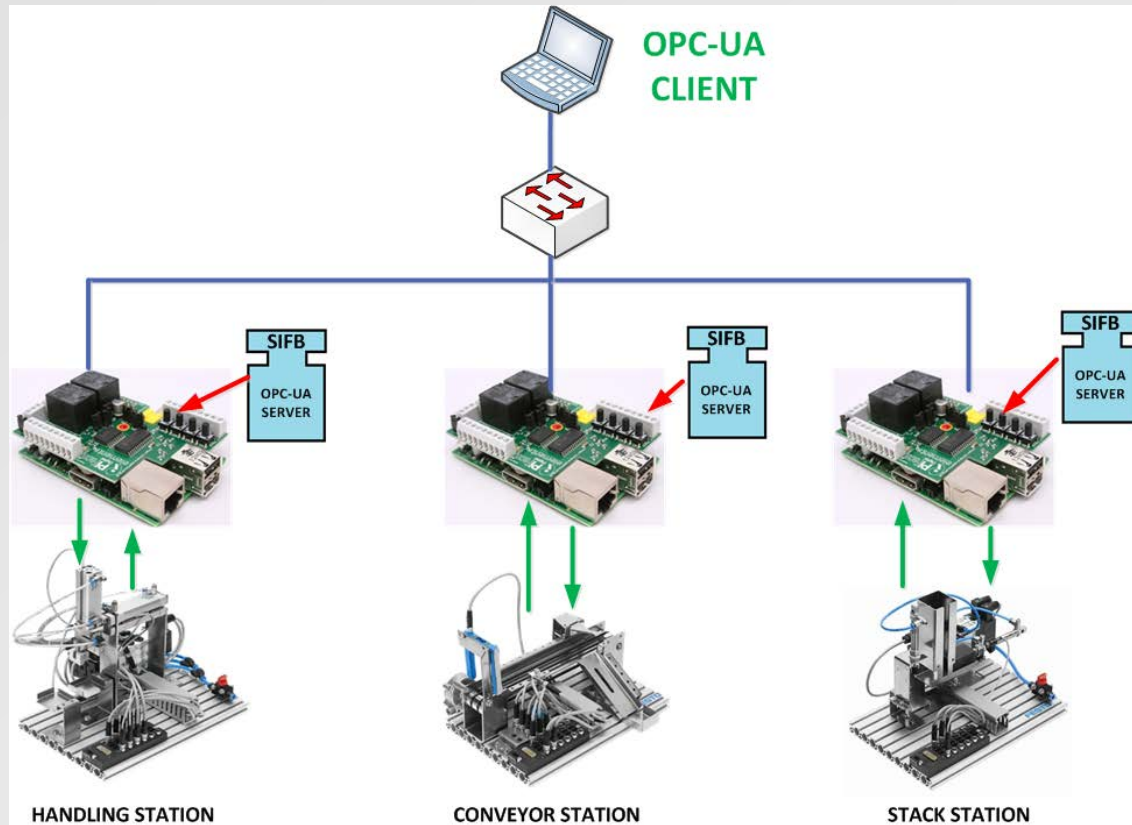
Case Study – Description

3 Stations:

- Handling
- Conveyor
- Stack/Store

Case Study – 4DIAC Example

Test Application

Conclusions
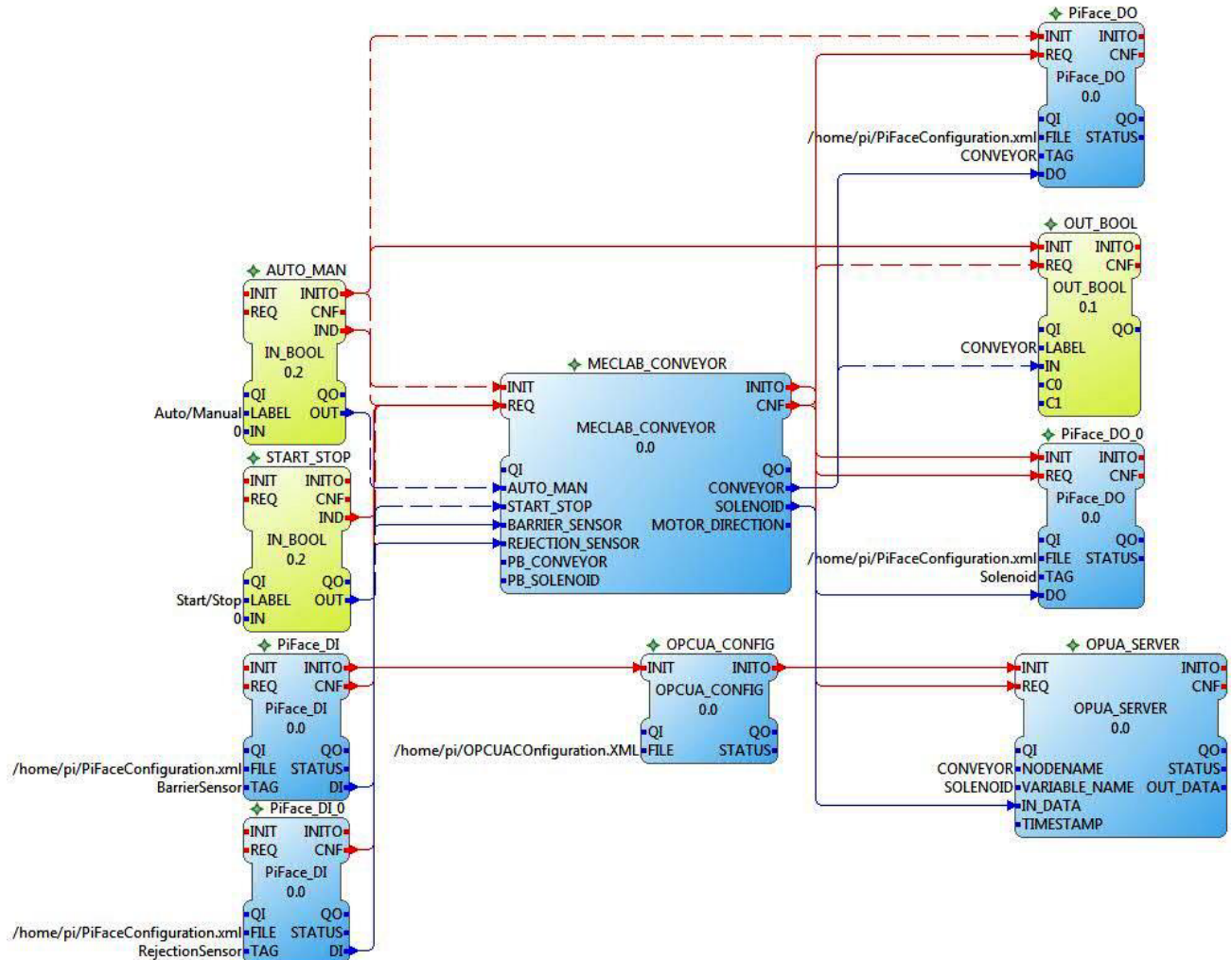
❑ **A CPPS architecture for vertical integration**

  ❑ Model-based architecture

  ❑ Making use of well-established standards

  ❑ Seamless integration within Industry 4.0 context

❑ **Future work …**

  ❑ Full implementation of the architecture

  ❑ Other integration axes

  ❑ Including mechanisms for flexibility

  ❑ Improve client and server services

Questions