



PLCopen UA Functionblocks MES Communication via OPC UA

- Success story -



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October 09, 2012 1



Agenda

- Cooperation with PLCopen
 - Motivation
 - Timeline
 - Results
 - Demo
 - Team members
 - Current status
- Cooperation with MES
 - Motivation
 - Team members
 - Success story
 - Vision

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October 09, 2012 2

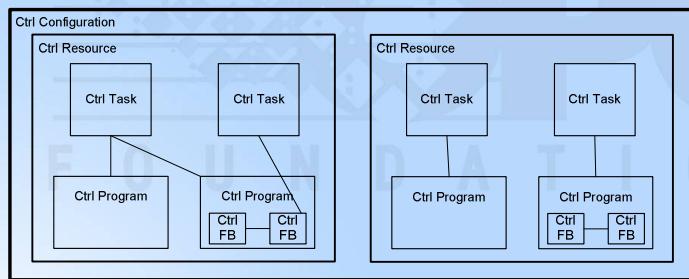
PLCopen Overview



PLCopen : www.plcopen.org

PLCopen
for efficiency in automation

- Global standard for Industrial Control Programming
- IEC61131-3: Global standard for Industrial Control Programm
- Languages: ST, IL, LD, FBD, structuring tool SFC
- Software model



*The prefix Ctrl is there to avoid conflicts with the OPC UA terminology



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October 09, 2012 3

PLCopen & OPC Group: Motivation



- PLC controllers executing identical PLC-IEC 61131-3 logic should
 - provide identical protocol access for data exchange
 - provide integrated standardized UA access in controller
 - provide identical complete information model about IEC6-1131-3 logic
 - Establish easier data exchange
 - Vertical: between SCADA/MES/ERP with PLC
 - Horizontal: between PLC to PLC
 - Advantages:
 - Rapidly engineering for UA – clients
 - HMI: create re-useable HMI faceplates
 - MES/ERP: identical access to data profiles in shop floor devices
- Transparent access to the information in the PLC controller in a secure way

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PLCopen & OPC Group: Timeline

2008 October: Kick off meeting common group

- Chairman Stefan Hoppe (Beckhoff)
- OPC Editor Matthias Damm (ascalab)
- PLCopen Editor Prof. Rene Simon (ifak)

2009 November: V0.9 Release Candidate available

- Live demo on SPS/IPC/Drives 2009

2010 March: V1.0 Released from both organizations

- multi vendor demo at April-2010 Light&Building and Hanover Fair

2010 December: continue with goals V2
2012 November: Live demo

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Scope joined working group

- Joined working group PLCopen and OPC Foundation
- Main scope for V1.0 is mapping of IEC 61131-3 to OPC UA
 - Focus on content of IEC 61131-3 specification
 - IEC 61131-3 software model → UA object types
 - IEC 61131-3 data types → UA data types
 - IEC 61131-3 variable qualifiers → UA properties
- UA properties and attributes → PLCopen XML export
 - OPC UA base concepts like AccessLevel not covered by IEC 61131-3

October 09, 2012 6

PLCopen and OPC: Results

PLCopen: Content „WHAT“

OPC-UA-Server: Communication „HOW“

UA-Clients: SCADA/MES/ERP Presentation

All information about IEC61131-3 project:

- FB's
- POU's
- Structures
- Tasks / Resources..

Address Space

```

Root
  Objects
    DeviceSet
      PLC1
        MAIN
          bInitDone
          fbBoiler1
          CC1001
          Drum1001
          FC1001
          LC1001
          ParameterSet
          Pipe1001
          Pipe1002
          rSetFillLevel
          rSteamDemand
        fbInput1
          fbFillLevel
            maxVal
            minValue
            rValue
            fbGeneratedParameter
            fbSteamDemand
    fbOutput1
  
```

Pure.Web.Power.

- Standardized UA access
- Identical namespace
- Complete information model

Advantages:

- Re-useable HMI Faceplates“
- Rapidly engineering
- Transparent PLC controller

October 09, 2012 7

PLCopen and OPC: Results

Beckhoff
„PLC1“

Bosch-Rexroth
„Logic“

Different entry point

Address Space

```

Root
  Objects
    DeviceSet
      PLC1
        MAIN
          bInitDone
          fbBoiler1
          CC1001
          Drum1001
          FC1001
          LC1001
          ParameterSet
          Pipe1001
          Pipe1002
          rSetFillLevel
          rSteamDemand
        fbInput1
          fbFillLevel
            maxVal
            minValue
            rValue
            fbGeneratedParameter
            fbSteamDemand
    fbOutput1
  
```

Address Space

```

Root
  Objects
    DeviceSet
      Logic
        Application
          GVL
        MAIN
          bInitDone
          bLight
          fbBoiler1
          CC1001
          Drum1001
          FC1001
          LC1001
          Pipe1001
          Pipe1002
          rSetFillLevel
          rSteamDemand
          fbDimmer1SwitchEco
        Server
        Types
        Views
  
```

... but semantic identical objects!

October 09, 2012 8

Entry points into Address Space

The slide displays three side-by-side screenshots of OPC UA Address Space visualizers:

- Object types based on Function Blocks:** Shows a tree view of objects under the 'Root' node, including 'Objects', 'DataTypes', 'EventTypes', and 'ObjectTypes'. Under 'ObjectTypes', there is a 'FB_Boller' folder containing various function block instances like 'CC1001', 'Drum1001', etc.
- Full object hierarchy below DeviceSet:** Shows a more complex hierarchy. The 'Root' node has 'Objects', 'Counter', and 'DeviceSet'. 'DeviceSet' contains 'MyConfiguration' which further contains 'Resources'. 'Resources' contains 'PLC1' and 'MAIN'. 'PLC1' contains 'GlobalVars' (with items like 'bAutoMode', 'counter', 'rMaxFeedwaterPressure', etc.) and 'Programs'. 'MAIN' contains 'fbBoiler1' and 'fbBoiler2'.
- Entry point for DA Clients like HMI:** Shows a simplified hierarchy. The 'Root' node has 'Objects', 'Counter', 'DeviceSet', and 'HelloWorld'. 'DeviceSet' contains 'PLC1'. 'PLC1' contains 'GlobalVars' and 'Programs'. 'Programs' contains 'MAIN'. 'MAIN' contains 'fbBoiler1' which in turn contains 'CC1001', 'Drum1001', etc.

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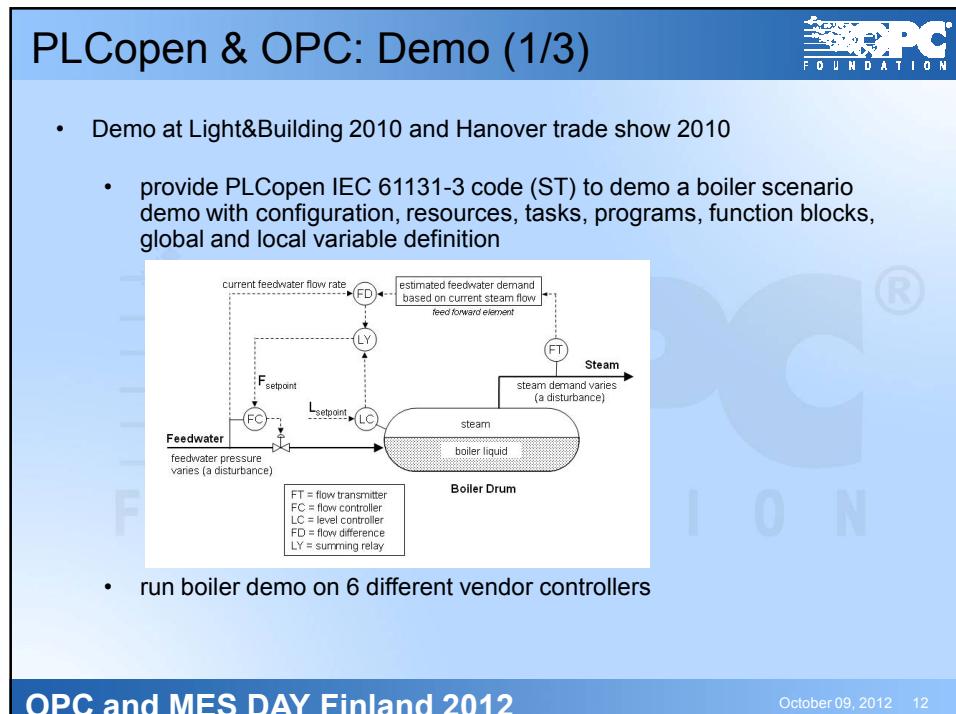
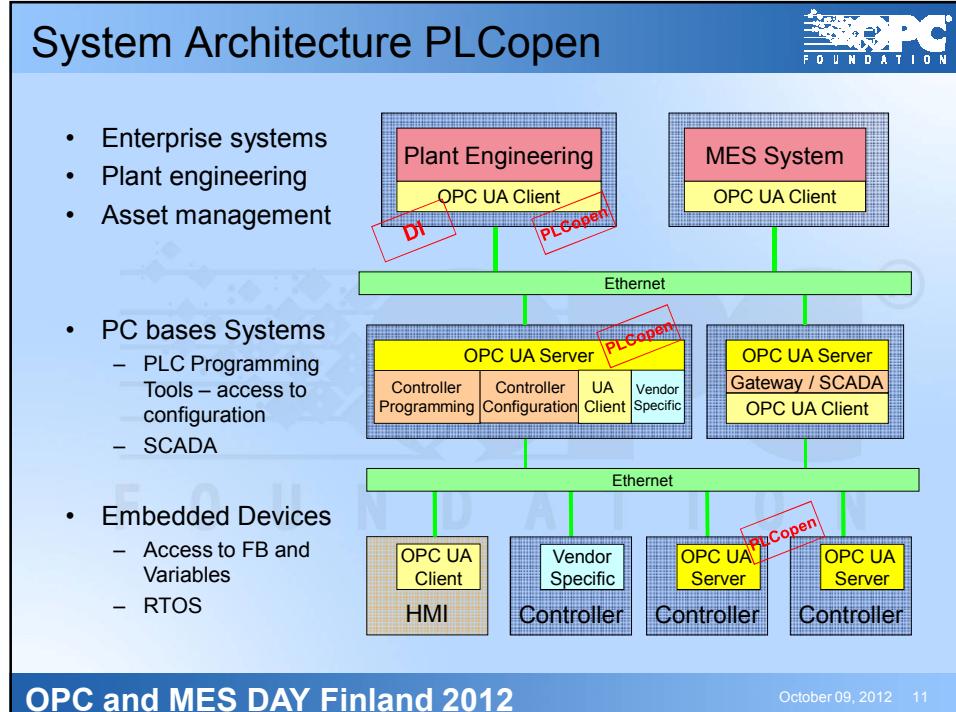
October 09, 2012 9

Adoption of PLCopen Model

- OPC UA Server**
 - Servers embedded in PLCs or Servers aggregating PLC data on a PC need to implement the PLCopen model and the mapping of Function Blocks to OPC UA object types and instances
 - Full information for Use Cases Engineering and Service is only provided by special servers that have also access to PLC engineering
- OPC UA Client**
 - Clients for Use Cases Observation and Operation (HMI) do not need to know anything about the PLCopen model**
 - But HMI clients can benefit from the object model for rapid HMI configuration
 - OPC UA HMI clients can be embedded too
 - Only engineering clients need to know the PLCopen model

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PLCopen and OPC: Demo

PLCopen for efficiency in automation → ← **OPC** FOUNDATION

CERTEC, Allmendinger, iconics, ascolab, COPADATA, INOPUT, BECKHOFF, Rexroth Bosch Group, ifak, KW software, logi.cals, Unified Automation

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PLCopen and OPC: Team members

PLCopen & OPC UA: Interoperability On The Next Level

- Enables OPC interfaces in embedded controller
- PLC information model in a standardized format
- Rapid engineering for HMI / MES / ERP
- Moving information from shop floor to enterprise
- Secure, remote “out-of-the-PLCopen-box” communication

ABB, SIEMENS, BECKHOFF, HIMA, ifak, B&R, Rexroth Bosch Group, logi.cals, Allmendinger, COPADATA, SAP

PLCopen
ERP | MES | HMI
IEC 61131-3
C | T | R | L
OPC UA

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PLCopen & OPC: Current status



- 2010 March: V1.0 released by both organizations
- 2010 November Extended Demo with more vendors
 - SPS / IPC / Drives show in Nuremberg / Germany
 - Manufacturing Open Forum 2010 in Tokyo / Japan
- 2010 End Year: First meetings for future activities
 - Additional standardization of PLCopen and OPC
 - Focus on additional features
 - Mapping of Sequential Function Charts (SFC)
 - Standard PLC-UA communication function blocks
 - Standard function blocks for Alarm handling and mapping to OPC UA Alarms and Conditions
 - Best practice guidelines for using OPC UA concepts like Methods, Events, Alarms & Conditions, Historical Access and Programs

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PLCopen & OPC: Current status



Define IEC-FB's

for UA-client communication functionality

for UA diagnostic (UA client and UA server)

for file transfer via OPC-UA

Define PLCopen/OPC-UA Interoperability project

At OPC-UA IOP we have all same "IEC-UA-Server" test project

Automatic test-client is next step

Certification of PLCopen/OPC-UA spec can be tested easily

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PLCopen & OPC: Current status

FUNCTIONSBLOCKS

Data Communication

UaConnect
 UaNodeGetHandle
 UaNodeReleaseHandle
 UaNodeGetInfo
 UaMonitoredItemCreate
 UaMonitoredItemDelete
 UaRead
 UaReadList
 UaWrite
 UaWriteList
 UaMethodGetHandle
 UaMethodReleaseHandle
 UaMethodGetInfo
 UaMethodCall

```

    graph LR
      subgraph UAConnect [UAConnect]
        direction TB
        Execute[Execute] --> UAC[UAConnectionHdl]
        URL[URL] --> UAC
        SessionConnectInfo[SessionConnectInfo] --> UAC
        UAC --> Connected[Connected]
        UAC --> Done[Done]
        UAC --> Busy[Busy]
        UAC --> Error[Error]
        UAC --> ErrID[ErrID]
      end
      subgraph UARead [UA_Read]
        direction TB
        Execute[Execute] --> UAConnHdl[ConnectionHdl]
        UAConnHdl --> Done[Done]
        UAConnHdl --> Busy[Busy]
        UAConnHdl --> Error[Error]
        UAConnHdl --> ErrID[ErrID]
        UAConnHdl --> Variable[Variable]
        ConnectionHdl[ConnectionHdl] --> UAConnHdl
        NodeHdl[NodeHdl] --> UAConnHdl
        IndexRange[IndexRange] --> UAConnHdl
        Timeout[Timeout] --> UAConnHdl
        ANY[ANY] --> UAConnHdl
      end
  
```

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PLCopen & OPC: Current status

Scenarios for data communication:

The diagram illustrates the OPC-UA communication architecture. It shows two main components: "Plant Engineering" and "MES System", each with its own "OPC UA Server". These servers are connected via bidirectional arrows labeled "OPC-UA". Below them, three fieldbus systems are shown: "ODVA", "EtherCAT", and "PROFINET". Each of these fieldbus systems has a vertical stack of industrial controllers or drives. Bidirectional arrows labeled "OPC-UA" connect the "OPC UA Server" of the Plant Engineering system to each of the three fieldbus stacks. The "MES System" server is also connected to the "EtherCAT" and "PROFINET" stacks via "OPC-UA" arrows.

PLCopen & OPC-UA-FB's:
 - Vertical communication
 - Horizontal communication
 - Fieldbus independent

It's fast – but not a fieldbus!

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PLCopen & OPC: Current status

Scenarios for data communication:

OPC-UA is not a fieldbus (not deterministic) - but fast!

Client : UA Expert (Ascolab) on Linux OS
 Server : TwinCAT-PLC (Beckhoff) on Windows Embedded CE®
 Time : in average 1.8ms (1 node with 256bytes)

The diagram illustrates a data communication scenario. On the left, a box labeled "OPC UA Client" is shown inside a larger box labeled "Linux". A green arrow labeled "Ethernet with OPC-UA" points from the client to the right. On the right, there is a graphic of a PLC (Programmable Logic Controller) with various modules and components, representing the "UA-Server integrated".

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PLCopen & OPC: Current status

Scenarios for data communication

The diagram shows a "Device management" box containing an "OPC UA Client" box. Two green arrows labeled "OPC-UA" point downwards from this box to two separate groups of industrial control equipment (racks of PLCs and HMI panels). To the right, a list of scenarios and target markets is provided.

- 1. Easy deployment via download
 - e.g. of PLC binary code
 - e.g. of recipes
- 2. Easy management for Upload
 - e.g. measurement data

Target market

- Building automation
- Water treatment
- Wind farms

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PLCopen & OPC: Current status



FUNCTIONSBLOCKS

for UA diagnostic (UA client and UA server)

Diagnosis

- UaConnectionGetStatus
- UaServerGetStatus
- UaServerGetInfo
- UaSessionGetList
- UaSessionGetInfo
- UaSubscriptionGetList
- UaSubscriptionGetInfo

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October 09, 2012 21

More Information



- OPC Foundation www.opcfoundation.org
 - All information about OPC-UA in general
 - Free download of PLCopen/OPC-UA specification
 - See Downloads → Specifications → OPC UA for IEC 61131-3
- PLCopen www.plcopen.org
 - Free download of introduction papers
 - See TC4 - Communication





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OPC & PLCopen: MES Connectivity







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PLCopen and OPC Foundation

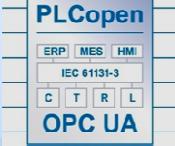
Kick-Off meeting on 17/18.11.2011
hosted by SAP AG, Walldorf, Germany

Manufacturing Execution System (MES)
Connectivity

Integration of machine and process data for
utilisation by MES based on OPC UA and
PLCopen

Supported by



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OPC & PLCopen: MES Connectivity





Start:

- 2011 November 17/18th : MES-Connectivity hosted by SAP
 - Create PLCopen FB's and complex data structures which provide MES informations to be transported via OPC-UA

Goals:

- Definition of communication mechanisms via OPC UA for MES integration
- Definition of the semantics for MES integration
- Connectivity from MES down into controllers to be easy and fully secured based on PLCopen & OPC-UA technology
- Fieldbus independent

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OPC & PLCopen: MES Connectivity



MES-Connectivity

- Team members:

3S, ABB, Ascolab, Beckhoff, Bosch, Bosch-Rexroth, Continental, EDAG, Fraunhofer- IOSB, Honeywell, ITAC, Leikon, MES-DACH, NAMUR-MES, PSI, Rockwell, RWTH Aachen, SAP, Siemens, Trebing&Himstedt, ifak, Uni Dresden, VDMA, ZVEI
- IMPORTANT:
 - PLCopen & OPCF do not define new MES standards
 - Instead cooperate with VDMA, ZVEI, others to let MES experts define the content
 - OPC-UA just provides transport & security

October 09, 2012 25

Success Story



Company Elster Germany:

Connect top floor (SAP ME)

via OPC-UA

F 0 to shop floor (Beckhoff PLC) 

October 09, 2012 26

Elster on the glance

elster
Vital Connections

OPC FOUNDATION

7,000 employees

38 major locations

200 million installations in the last ten years

115 global markets

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Elster Markets

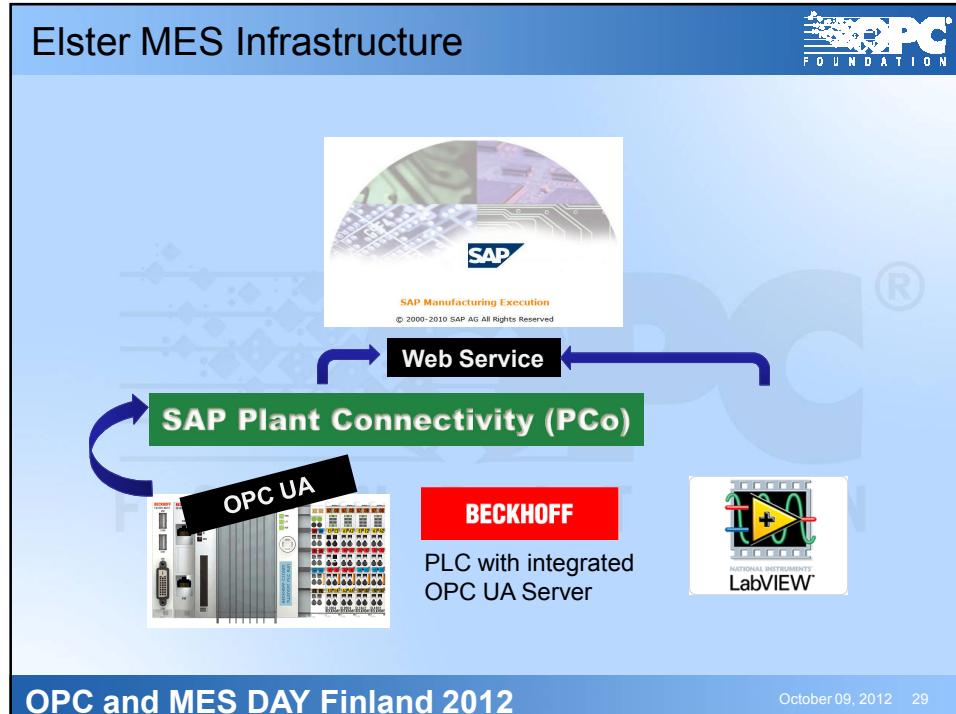
elster
Vital Connections

OPC FOUNDATION

Global Market			
Upstream	Transmission	Metering Gas, Water, Electricity	Utilization Heating, Process Heat

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Key benefits OPC UA

Roland Essmann
is responsible for the SAP MES implementation at Elster GmbH, Germany. In this role he is the key link between Manufacturing IT, MES and ERP

Benefits of OPC-UA:

- easy to use for PLC programmers and MES team
- standarized interface layer
 - that means PLC vendor and MES communicates without any customizing
 - Ethernet as common connection layer
 - includes security out of the box
- no more DCOM stuff, firewall friendly port usage
- complex data types

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Key challenges MES Interfaces



- terminology & variable structure
- speed, reliability



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Upcomming...



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From Controller to IT Level

Today: "From signal -> via data (OPC-tags) -> via functions -> to services"

The diagram illustrates the evolution of industrial communication layers:

- Device-Level:** Machine controllers (e.g., Profinet, EtherCAT) connected via Communication Layer (e.g., UMTS, WLAN).
- Control-Level:** Connected via OPC-UA (PLCopen) Communication Layer.
- MES-Level:** Manufacturing Execution System connected via Ethernet.
- ERP-Level:** Enterprise Resources connected via WLAN.

Arrows indicate the flow of data: "From signals" up to "Via data", "Via functions", and finally "To services". Specific components like "Service repository" and "Plant control room" are shown at the top levels.

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From Controller to IT Level

Soon: "From services -> to services"

The diagram illustrates a future architecture based on services:

- Customer services:** IP 103.511.10.0, connected via Portal.
- Global services:** IP 171.77..., connected via MES-services.
- Domain services:** IP 183.67..., connected via ERP-services.
- Local services:** IP 183.77..., connected via device services.
- Resource services:** IP 183.77..., connected via Process.

Communication is shown as bidirectional arrows between these service layers, indicating a fully interconnected service-oriented architecture.

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From Controller to IT Level

Today:

- HMI or MES initiate communication (act as client)
- Controller answer (act as server), variables & complex data

Soon:

- HMI or MES additionally act as server provide methods
- Controller additionally act as client call methods via FB's

MES/ERP Server

MES/ERP system

Scada

Controller

OPC UA Client

OPC UA Server

PLC initiates communication: call FC 61131 OPC UA function block to exchange data with other UA servers

MES/ERP level

Machine level

UA_MethodCall	
BOOL Execute	Done
DWORD MethodHdl	Busy
TIME Timeout	Error
ANY InputArguments	ErrorId
ANY OutputArguments	DWORD
InputArguments	ANY
OutputArguments	ANY

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Thanks!

Questions ?

PLCopen UA Functionsblocks
MES Communication via OPC UA

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October 09, 2012 36