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OF TECHNOLOGY

Exercise 5: Interfacing with OPC and IEC 60870-5-104

Nicholas Honeth (nicholash@ics.kth.se)

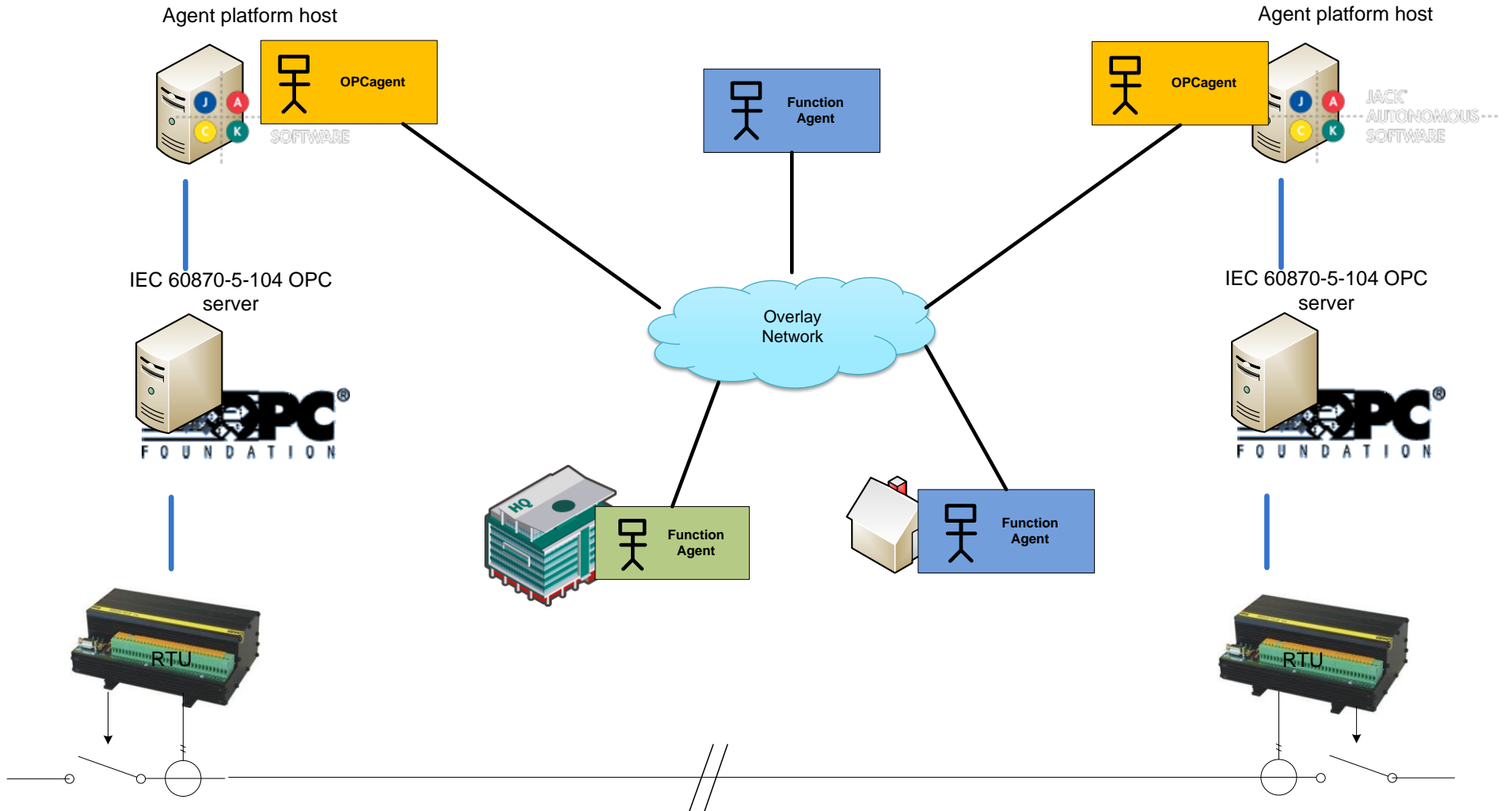
Outline

- Lab architecture
- Recap of last lecture
- RTU configuration
- WAN connectivity
- OPC server configuration
- OPC client connection
- Java OPC client and the OPCagent



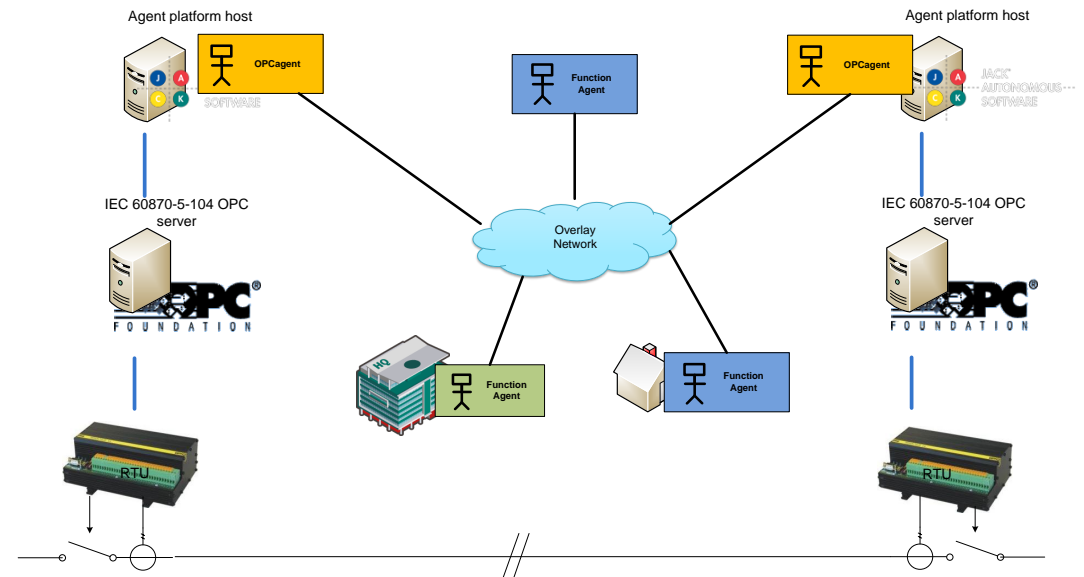
Recap: Lab logical architecture

OPCagent: OPC interfacing from JACK



Outline

- Lab architecture
- Recap of JACK interfacing with OPC – the OPCagent
- RTU configuration
- WAN connectivity
- OPC server configuration
- OPC client connection
- Java OPC client





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OLE for Process Control (OPC)



Agent platform host



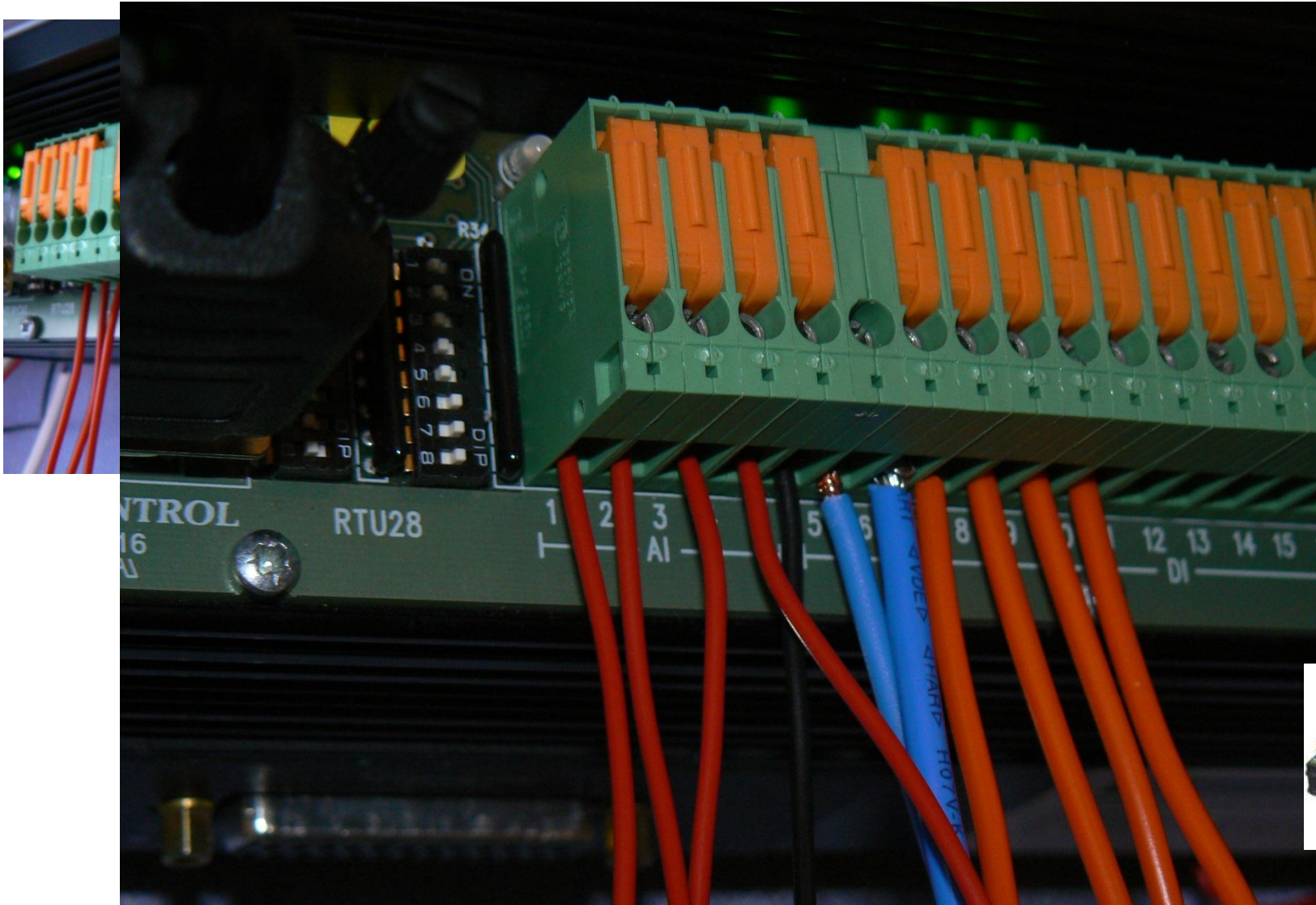
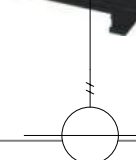
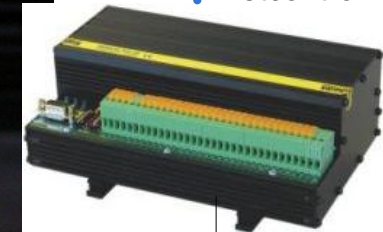
JACK
AUTONOMOUS
SOFTWARE



IEC 870-5-104 OPC server

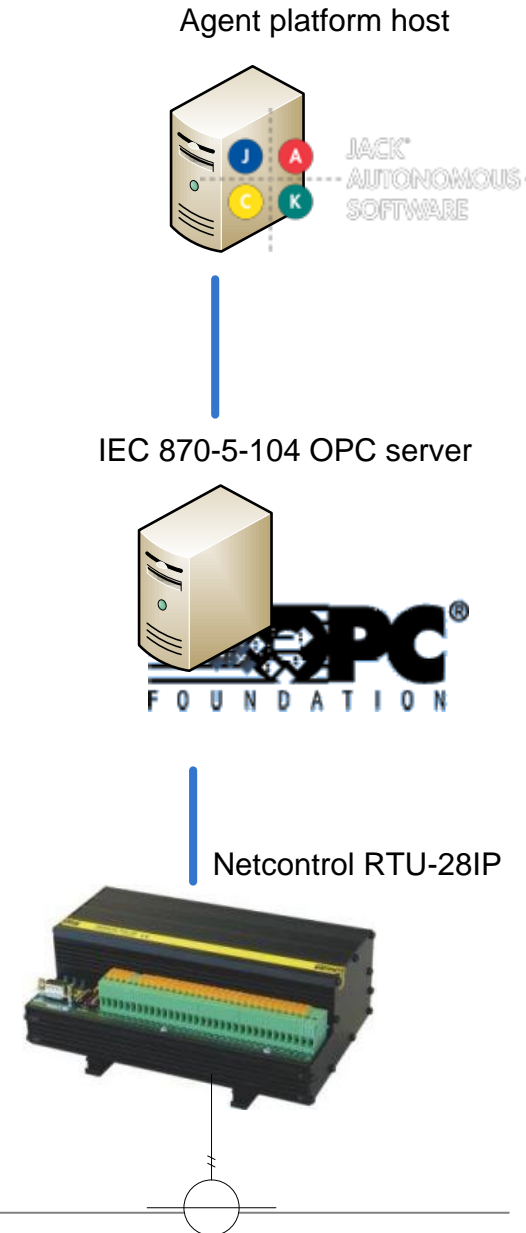


Netcontrol RTU-28IP



OLE for Process Control (OPC)

- Object Linking and Embedding (OLE)
- Originally developed to provide an interface between:
 - Windows software applications and
 - Process control hardware.
- A few specifications (versions):
 - OPC Data Access (DA)
 - OPC Alarms & Events
 - OPC Data eXchange (DX)
 - OPC Commands
 - OPC XML-DA
 - OPC Unified Architecture (UA)

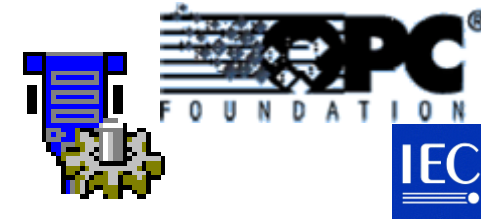




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OPC Servers

CybServer870M-10x OPC Servers

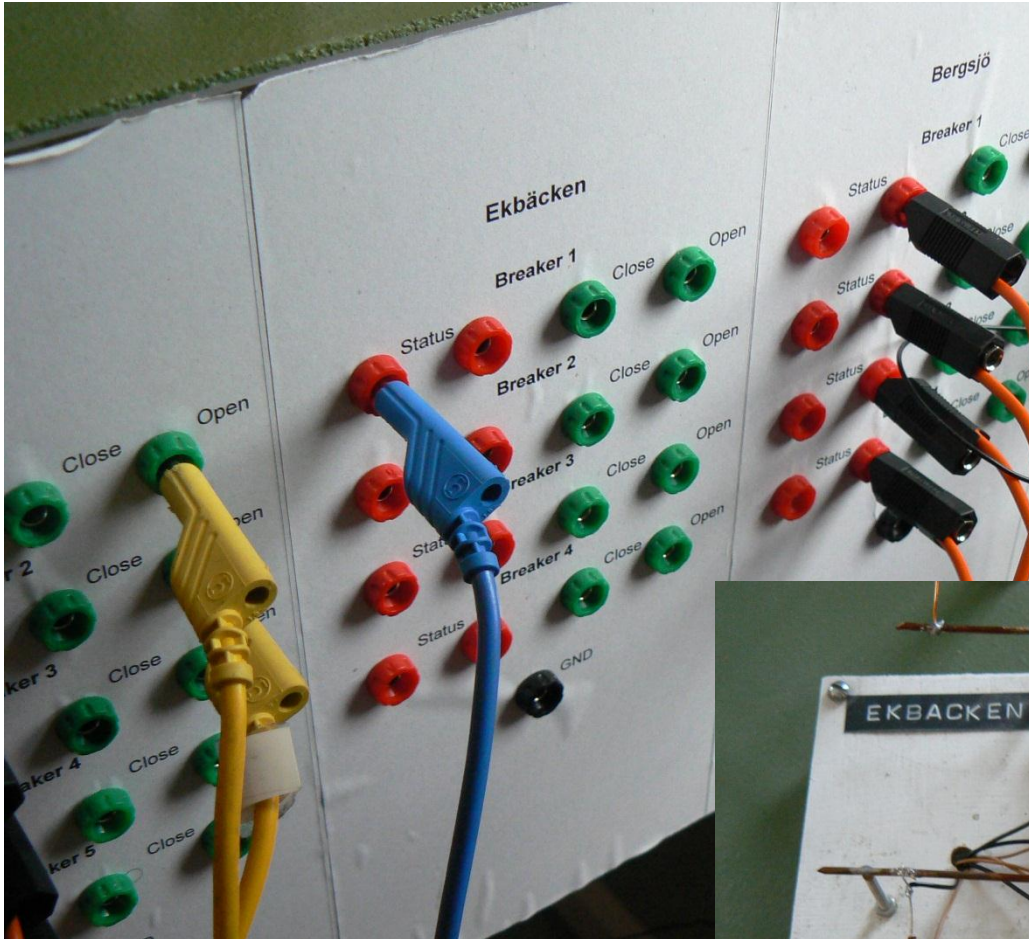


- Client to communicate with:
 - IEC 60870-5-101 (Serial)
 - IEC 60870-5-104 (IP)
- Server for OPC DA
- Makes RTU data accessible:
 - Status
 - Measurements
 - Commands
 - Map tag names to "870 addresses"

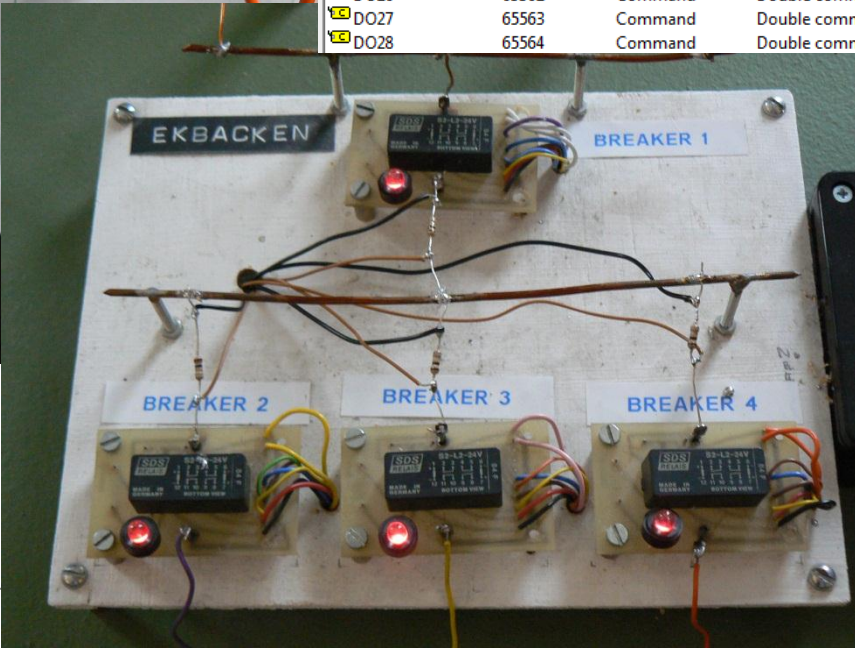
IEC 870-5-104 OPC server

Tag	870 Address	Type	Category
CommStatus	-	System	CommStatus
CommLink	-	System	CommLink
DI5	65541	Acquisition	Boolean
DI6	65542	Acquisition	Boolean
DI7	65543	Acquisition	Boolean
DI8	65544	Acquisition	Boolean
DI9	65545	Acquisition	Boolean
DI10	65546	Acquisition	Boolean
DI11	65547	Acquisition	Boolean
DI12	65548	Acquisition	Boolean
DI13	65549	Acquisition	Boolean
DI14	65550	Acquisition	Boolean
DI15	65551	Acquisition	Boolean
DI16	65552	Acquisition	Boolean
DI17	65553	Acquisition	Boolean
DI18	65554	Acquisition	Boolean
DI19	65555	Acquisition	Boolean
DI20	65556	Acquisition	Boolean
DO21	65557	Command	Double command
DO22	65558	Command	Double command
DO23	65559	Command	Double command
DO24	65560	Command	Double command
DO25	65561	Command	Double command
DO26	65562	Command	Double command
DO27	65563	Command	Double command
DO28	65564	Command	Double command

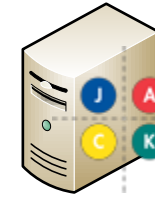
OLE for Process Control (OPC)



Tag	870 Address	Type	Category
CommStatus	-	System	CommStatus
CommLink	-	System	CommLink
DI5	65541	Acquisition	Boolean
DI6	65542	Acquisition	Boolean
DI7	65543	Acquisition	Boolean
DI8	65544	Acquisition	Boolean
DI9	65545	Acquisition	Boolean
DI10	65546	Acquisition	Boolean
DI11	65547	Acquisition	Boolean
DI12	65548	Acquisition	Boolean
DI13	65549	Acquisition	Boolean
DI14	65550	Acquisition	Boolean
DI15	65551	Acquisition	Boolean
DI16	65552	Acquisition	Boolean
DI17	65553	Acquisition	Boolean
DI18	65554	Acquisition	Boolean
DI19	65555	Acquisition	Boolean
DI20	65556	Acquisition	Boolean
DO21	65557	Command	Double command
DO22	65558	Command	Double command
DO23	65559	Command	Double command
DO24	65560	Command	Double command
DO25	65561	Command	Double command
DO26	65562	Command	Double command
DO27	65563	Command	Double command
DO28	65564	Command	Double command



Agent platform host



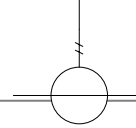
JACK
AUTONOMOUS
SOFTWARE

IEC 870-5-104 OPC server



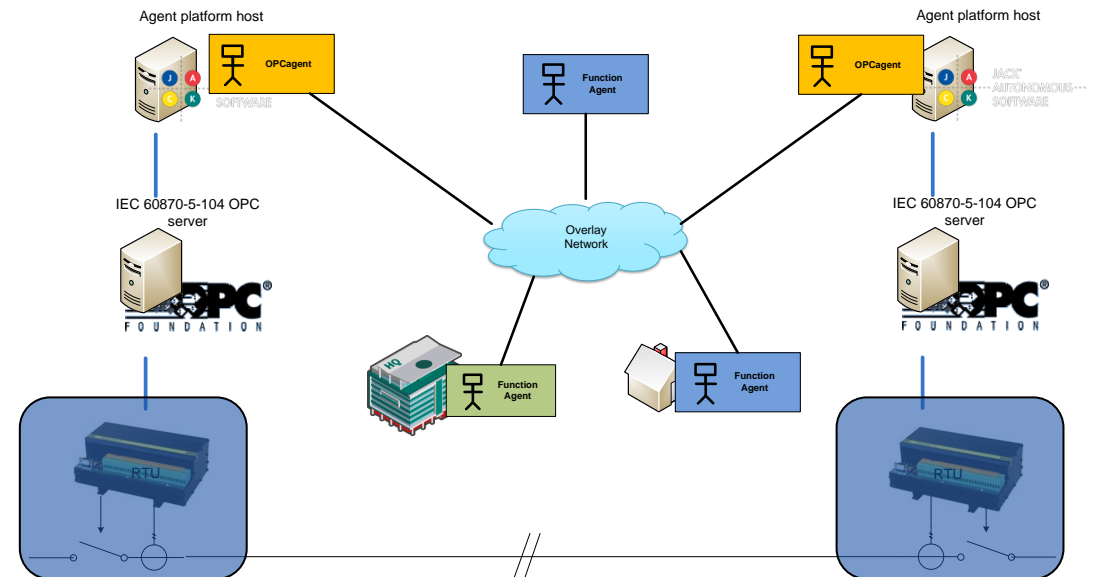
OPC
FOUNDATION

Netcontrol RTU-28IP



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RTU configuration

IEC 60870-5-104 communications config

NETCON Configuration Utility - C:\Documents and Settings\Karl\Desktop\2012 pre-course RTU config\20121026 RTU2 NFE config.NCU

File View Settings Telnet Help

NETCON

- Download_15:05:00 (Generic)
 - Port5 (Netcon500 I/O Bus)
 - Rack0
 - Board1 (Unknown)
 - Station1
 - TCP/IP port
 - IEC104/s V2 (Channel i104)
 - NFELink

IEC-104/s (V2) | Pulse lengths / scaling | Channel / Commonaddress | Cross-reference (XR2)

Redundancy groups

Parameters common to all RGs

Startup delay: 10 s Remote IPs (1-4): 2

Redundancy group: 1 Commands: [v]

Redundancy group (RG) parameters

Use RG group

Send APDUs timeout (t1):	15	s	Use DST:	No
Ack/no data timeout (t2 < t1):	10	s	File transfer:	No
Idle test timeout (t3):	20	s	Send end of init:	Common
Command timeout:	0	s	Time transmission:	No
Max. connection OK delay:	30	s	Deadband type:	Absolute
Log transmit frequency:	0	min	Timesync master:	Yes
Max. outstanding msgs (k):	12		Counter history:	Off
Max. ack outstanding:	8		Counter priority:	2
Max. sequence number:	32767		Timestamps on AI:	Off
Secondary buffer size:	250		GI read type:	normal
Primary buffer size:	250			
Send cmd confirmations:	On	[v]		
Double point inverted:	No	[v]		
Double commands inverted:	No	[v]		
Compensate UTC to local:	0	h		
DST occurs at UTC hour:	0	h		

Remote IPs

Remote IP 1:	10 . 0 . 1 . 45
Remote IP 2:	10 . 0 . 2 . 45
Remote IP 3:	0 . 0 . 0 . 0
Remote IP 4:	0 . 0 . 0 . 0

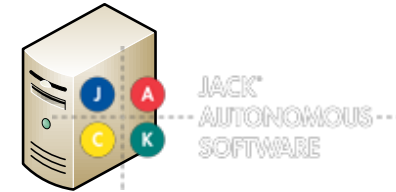
Download_15:05:00 / Port5 / Ch 5 (iec870/m) / IO conflict detected: Rack 0, Board 1 I/O, npcline:0x01000000 (Mainline status) <-> Station 1 I/O, npcline:0x01000000 (Mainline status)

Download_15:05:00 / Port5 / Ch 5 (iec870/m) / IO conflict detected: Rack 0, Board 1 I/O, npcline:0x01000000 (Mainline status 2) <-> Station 1 I/O, npcline:0x01000000 (Mainline status 2)

Download_15:05:00 / Port5 / Ch 5 (iec870/m) / IO conflict detected: Rack 0, Board 1 I/O, npcline:0x01000000 (Mainline control) <-> Station 1 I/O, npcline:0x01000000 (Mainline control)

Project saved

Agent platform host



IEC 870-5-104 OPC server



Netcontrol RTU-281P





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RTU configuration

IEC 60870-5-104 signal mapping

NCU2 - Netcon Configuration Utility - C:\Documents and Settings\Karl\Desktop\2012 pre-course RTU config\20121026 RTU2 NFE config.NCU

File View Settings Telnet Help

NETCON

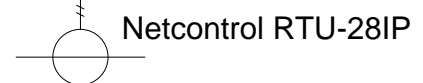
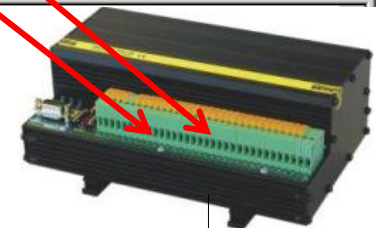
- Download_15:05:00 (Generic)
- Port5 (Netcon500 I/O Bus)
 - Rack0
 - Board1 (Unknown)
 - Station1
 - TCP/IP port
 - IEC104/s V2 (Channel i104)
 - NFELink

IEC-104/s (V2) | Pulse lengths / scaling | Channel / Commonaddress | Cross-reference (XR2)

Redundancy group (RG): 1

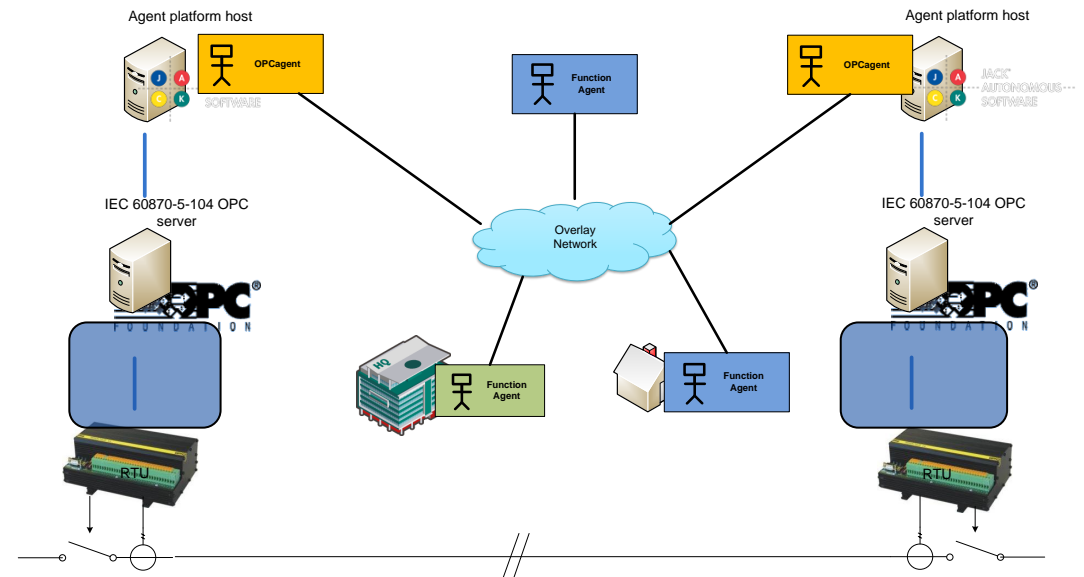
Host address format (IOA):
 Structured Unstructured Hexadecimal

	Use	Host type	Host	Native	Count	Invert	Double
1				Channel 5 (Netcon500 ...			
2	<input type="checkbox"/>	sc (single command)	055:000.000.001	0x01000C00	1	<input type="checkbox"/>	<input type="checkbox"/>
3	<input type="checkbox"/>	dp (double-point indication)	055:000.000.002	0x01000800	1	<input type="checkbox"/>	<input type="checkbox"/>
4	<input checked="" type="checkbox"/>	sp (single-point indication)	055:000.000.100	0x01000000	2	<input type="checkbox"/>	<input type="checkbox"/>
5	<input type="checkbox"/>	sc (single command)	055:000.000.003	0x01000000	1	<input type="checkbox"/>	<input type="checkbox"/>
6	<input type="checkbox"/>	nv (measurand, normalized)	055:000.000.004	1:000.000.001	1	<input type="checkbox"/>	<input type="checkbox"/>
7	<input type="checkbox"/>	nv (measurand, normalized)	055:000.000.005	1:000.000.002	1	<input type="checkbox"/>	<input type="checkbox"/>
8	<input type="checkbox"/>	nv (measurand, normalized)	055:000.000.006	1:000.000.003	1	<input type="checkbox"/>	<input type="checkbox"/>
9	<input type="checkbox"/>	nv (measurand, normalized)	055:000.000.007	1:000.000.004	1	<input type="checkbox"/>	<input type="checkbox"/>
10	<input type="checkbox"/>	sp (single-point indication)	055:000.000.008	1:000.000.005	1	<input type="checkbox"/>	<input type="checkbox"/>
11	<input type="checkbox"/>	sc (single command)	055:000.000.009	1:000.000.021	1	<input type="checkbox"/>	<input type="checkbox"/>
12	<input type="checkbox"/>	sc (single command)	055:000.000.010	0x01FA0000	1	<input type="checkbox"/>	<input type="checkbox"/>



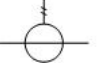
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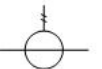
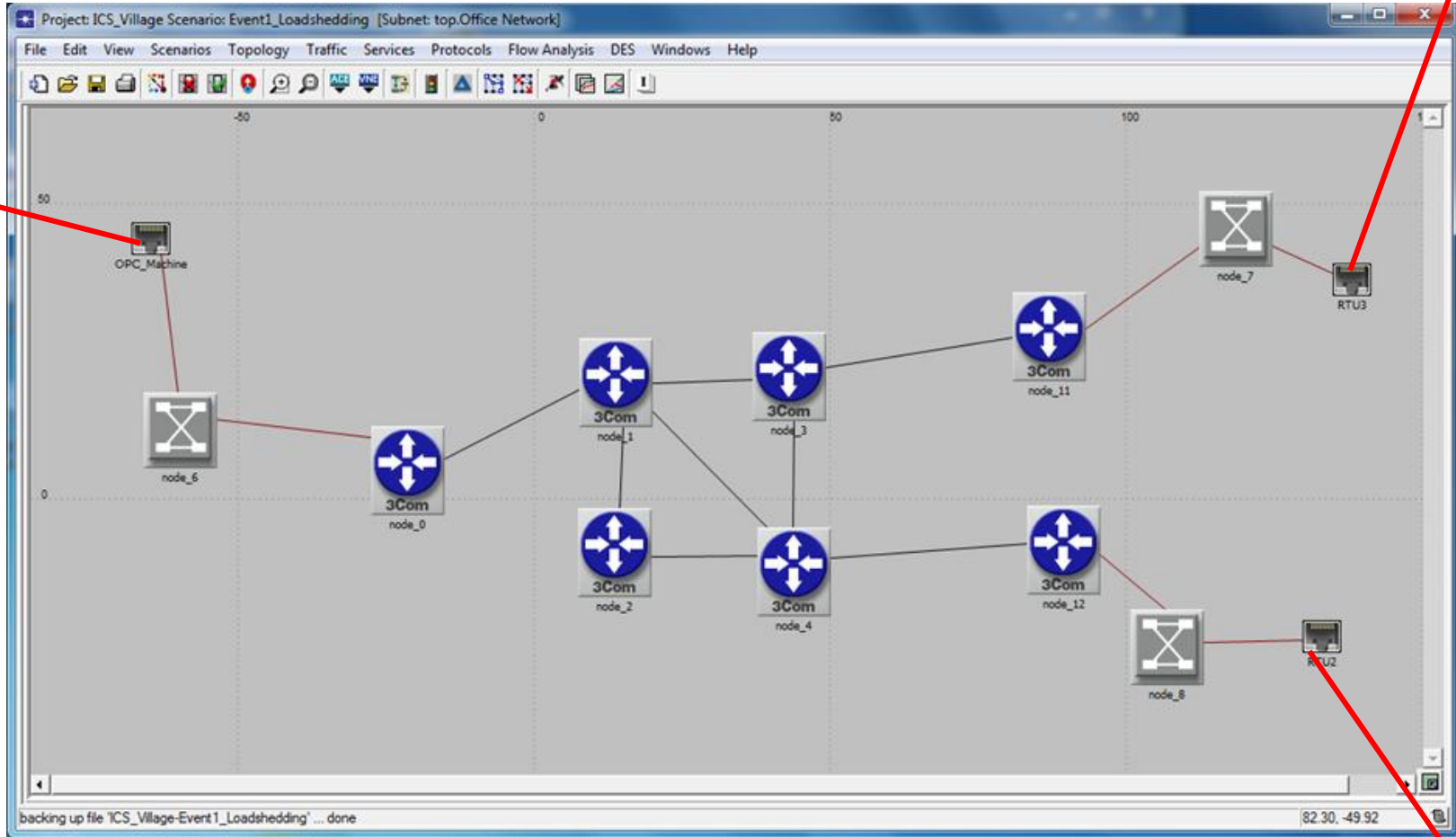


WAN connectivity

WAN emulation through OPNET



IEC 870-5-104 OPC server



WAN connectivity

Check connectivity over IP – Using "Ping"

```
c:\ Command Prompt
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

C:\Documents and Settings\Karl>ping 10.0.3.8

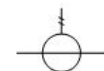
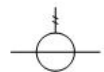
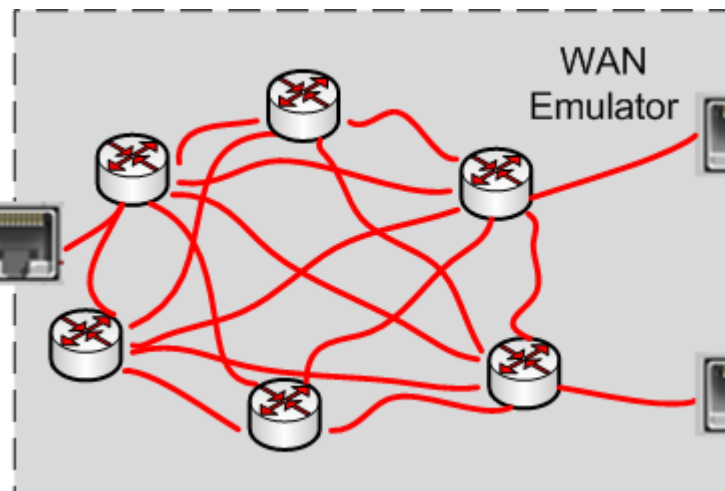
Pinging 10.0.3.8 with 32 bytes of data:

Reply from 10.0.3.8: bytes=32 time=120ms TTL=251
Reply from 10.0.3.8: bytes=32 time=56ms TTL=251
Reply from 10.0.3.8: bytes=32 time=56ms TTL=251
Reply from 10.0.3.8: bytes=32 time=41ms TTL=251

Ping statistics for 10.0.3.8:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 41ms, Maximum = 120ms, Average = 68ms

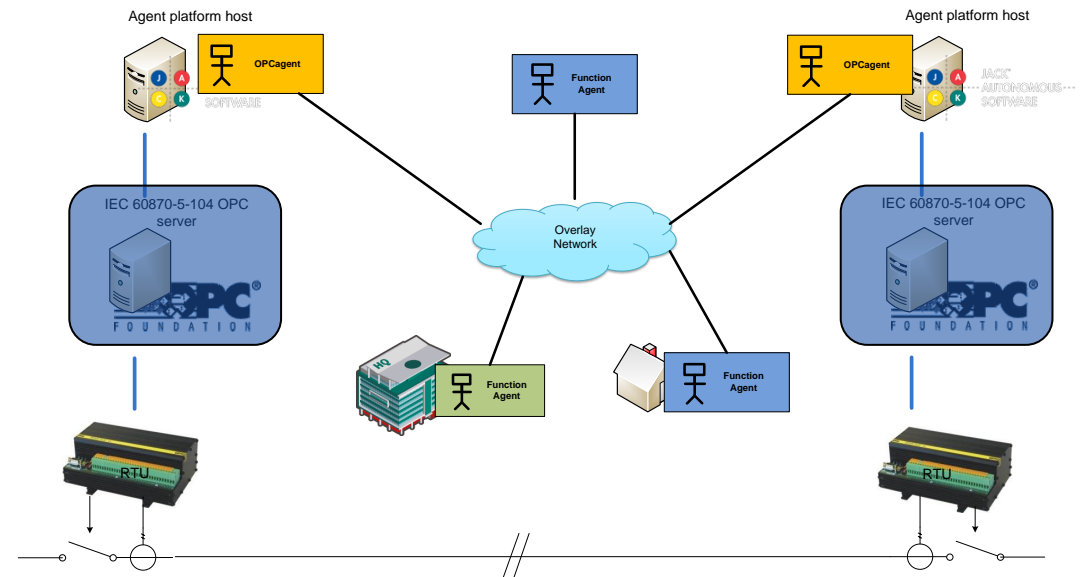
C:\Documents and Settings\Karl>_
```

IEC 870-5-104 OPC server



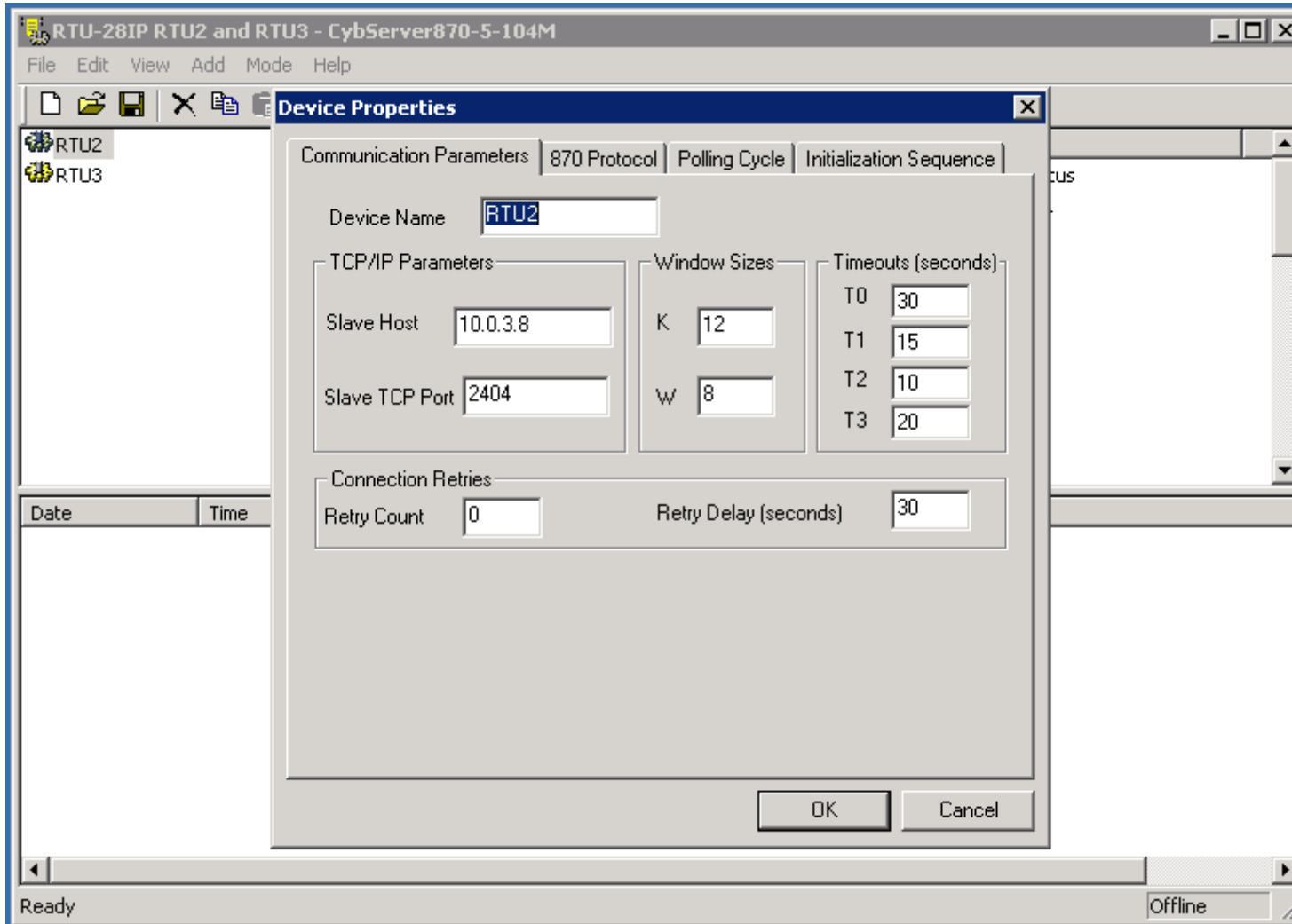
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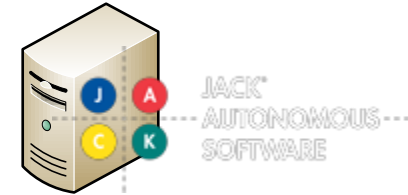


OPC server configuration

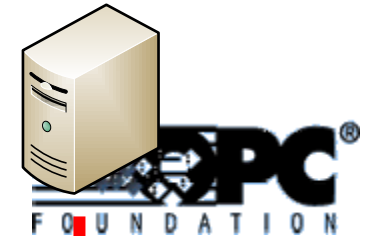
Creating new device profile



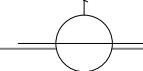
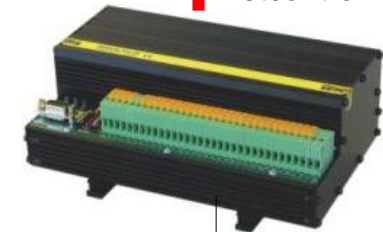
Agent platform host



IEC 870-5-104 OPC server



Netcontrol RTU-28IP





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OPC server configuration

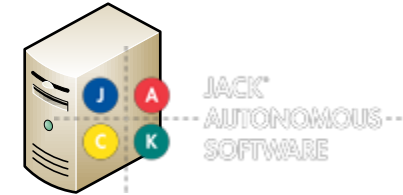
Mapping OPC tag names to IEC 60870-5 addresses

Tag	870 Address	Type	Category
DO23	23	Command	Single command
DO22	22	Command	Single command
DO24	24	Command	Single command
DO25	25	Command	Single command
DO26	26	Command	Single command
DO27	27	Command	Single command
DO28	28	Command	Single command
AI01	1	Acquisition	Single Float
AI02	2	Acquisition	Single Float
AI03	3	Acquisition	Single Float
AI0			

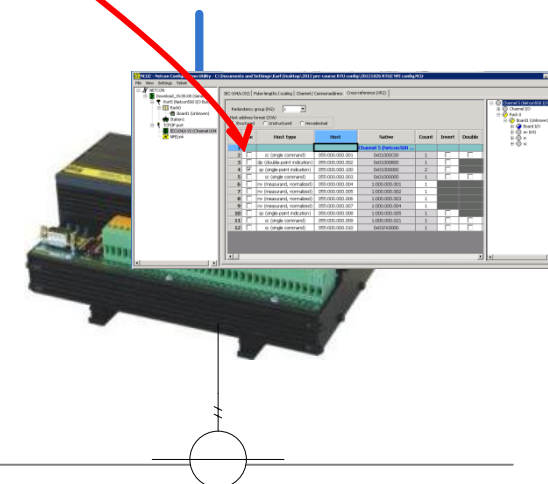
Tag Properties

Name: AI01
Address: 1
Type: Acquisition Command Parameter
 Enable event queuing
Category: Single Float

Agent platform host

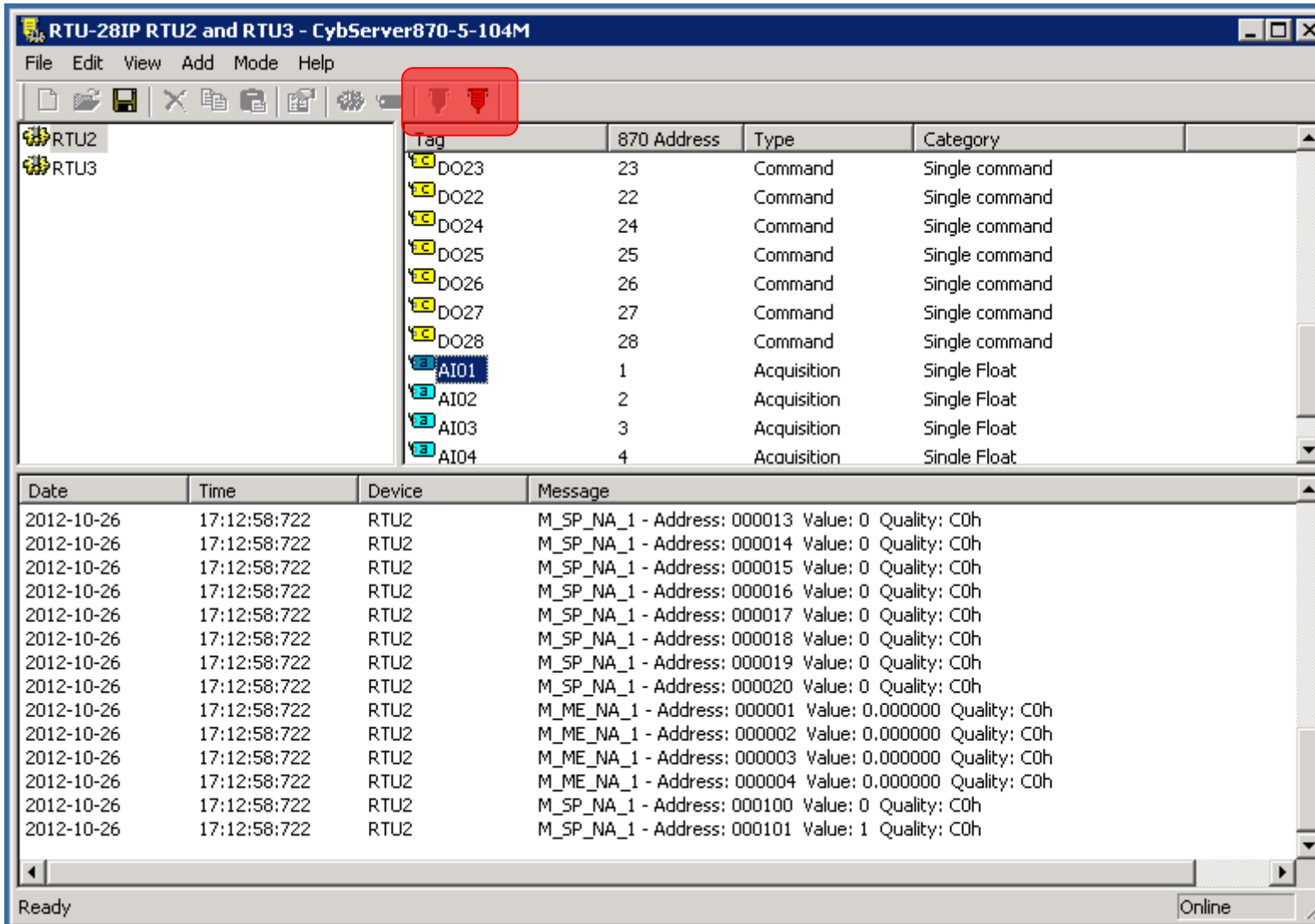


IEC 870-5-104 OPC server



OPC server configuration

Starting the OPC server



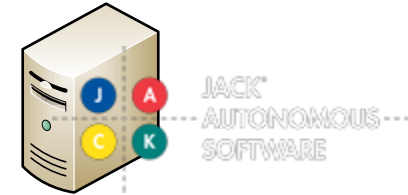
The screenshot shows the 'RTU-28IP RTU2 and RTU3 - CybServer870-5-104M' window. The 'Tag' list is as follows:

Tag	870 Address	Type	Category
DO23	23	Command	Single command
DO22	22	Command	Single command
DO24	24	Command	Single command
DO25	25	Command	Single command
DO26	26	Command	Single command
DO27	27	Command	Single command
DO28	28	Command	Single command
AI01	1	Acquisition	Single Float
AI02	2	Acquisition	Single Float
AI03	3	Acquisition	Single Float
AI04	4	Acquisition	Single Float

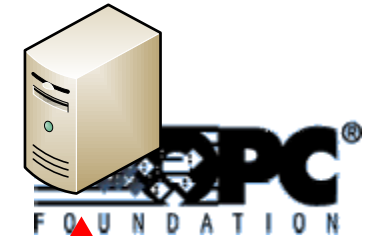
The message log at the bottom shows the following data:

Date	Time	Device	Message
2012-10-26	17:12:58:722	RTU2	M_SP_NA_1 - Address: 000013 Value: 0 Quality: COh
2012-10-26	17:12:58:722	RTU2	M_SP_NA_1 - Address: 000014 Value: 0 Quality: COh
2012-10-26	17:12:58:722	RTU2	M_SP_NA_1 - Address: 000015 Value: 0 Quality: COh
2012-10-26	17:12:58:722	RTU2	M_SP_NA_1 - Address: 000016 Value: 0 Quality: COh
2012-10-26	17:12:58:722	RTU2	M_SP_NA_1 - Address: 000017 Value: 0 Quality: COh
2012-10-26	17:12:58:722	RTU2	M_SP_NA_1 - Address: 000018 Value: 0 Quality: COh
2012-10-26	17:12:58:722	RTU2	M_SP_NA_1 - Address: 000019 Value: 0 Quality: COh
2012-10-26	17:12:58:722	RTU2	M_SP_NA_1 - Address: 000020 Value: 0 Quality: COh
2012-10-26	17:12:58:722	RTU2	M_ME_NA_1 - Address: 000001 Value: 0.000000 Quality: COh
2012-10-26	17:12:58:722	RTU2	M_ME_NA_1 - Address: 000002 Value: 0.000000 Quality: COh
2012-10-26	17:12:58:722	RTU2	M_ME_NA_1 - Address: 000003 Value: 0.000000 Quality: COh
2012-10-26	17:12:58:722	RTU2	M_ME_NA_1 - Address: 000004 Value: 0.000000 Quality: COh
2012-10-26	17:12:58:722	RTU2	M_SP_NA_1 - Address: 000100 Value: 0 Quality: COh
2012-10-26	17:12:58:722	RTU2	M_SP_NA_1 - Address: 000101 Value: 1 Quality: COh

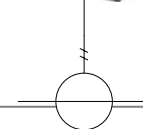
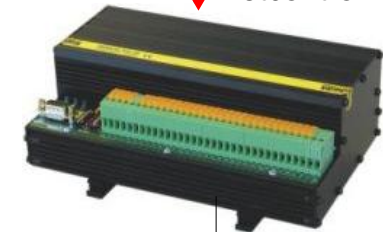
Agent platform host



IEC 870-5-104 OPC server

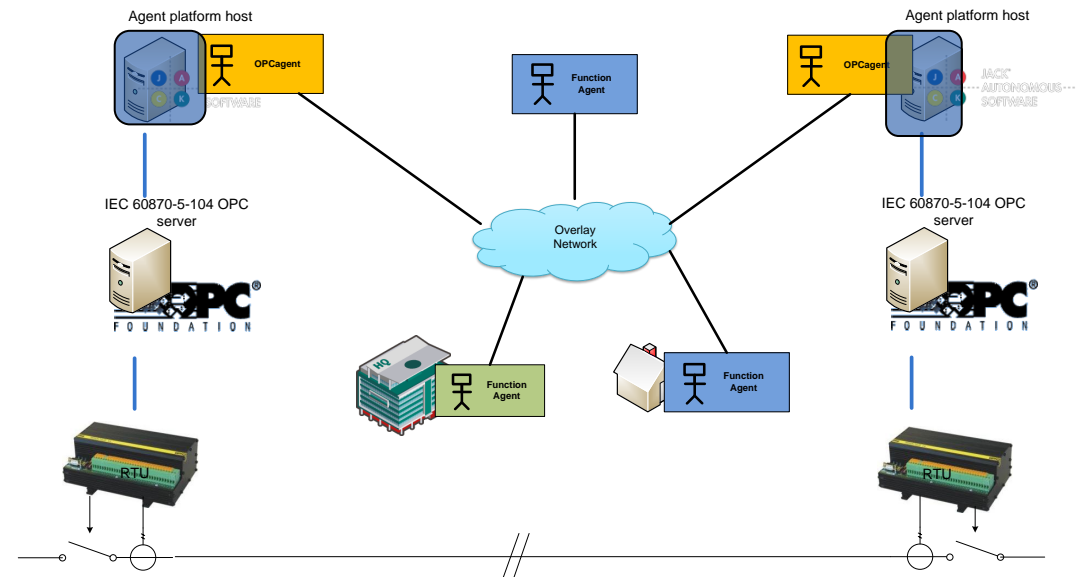


Netcontrol RTU-28IP



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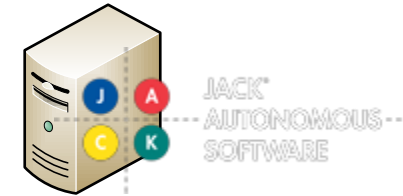
OPC client connection

Connecting to your OPC server

The screenshot shows the MatrikonOPC Explorer application window. The left pane displays a tree view of OPC servers, with 'Cybectec.IEC870-5-104M.1' selected. The main area is divided into several sections:

- OPC Server Connection Options:** Includes 'Connect', 'Add Tags', and 'Add Alarms' buttons.
- MatrikonOPC Configuration Options:** Includes 'OPC Server', 'OPC Security', and 'Licensing' buttons.
- Supported OPC Interfaces:** Shows 'DA' as supported and 'H/A', 'A/E', and 'SECURITY' as unsupported (indicated by red X marks).
- OPC Security:** Displays a warning: 'Caution: Potential Security Risk Detected. Explanation: This OPC Server does not support the OPC Security Specification. Solution: If security is a concern then protect your existing OPC Server with the MatrikonOPC Security Gateway. For more information on the MatrikonOPC Security Gateway Click Here.'
- Server Status:** Shows 'Server: Cybectec.IEC870-5-104M.1' and 'Connected: No'.
- Server Info:** Shows 'Server: Cybectec.IEC870-5-104M.1' and 'Connected: No'.
- Did you know? Explorer Tip #2:** A tip box stating 'You can configure any MatrikonOPC Server from OPC Explorer. Click For Details'.

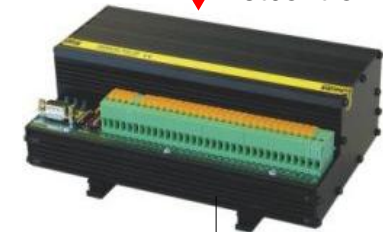
Agent platform host



IEC 870-5-104 OPC server



Netcontrol RTU-28IP



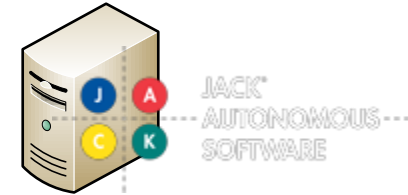


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OPC client connection

Connecting to your OPC server

Agent platform host



IEC 870-5-104 OPC server



MatrikonOPC Explorer (_NDI_Group_0)

File Edit View Browse

Tag Entry

Item ID:

Data Type: Empty/Default Create Active

Access Path:

Filter: Data Type Filter: Empty/Default

Write Access Read Access Branches Items

Available Items in Server 'Cybertec.IEC870-5-104M.1':

- RTU2
- RTU3

Available Tags

- AI01
- AI02
- AI03
- AI04
- Comml link

Tags to be added:

- RTU2.AI01
- RTU2.AI02
- RTU2.AI03
- RTU2.AI04
- RTU2.Com...
- RTU2.Com...
- RTU2.DI05
- RTU2.DI06
- RTU2.DI07
- RTU2.DI08
- RTU2.DI09
- RTU2.DI10

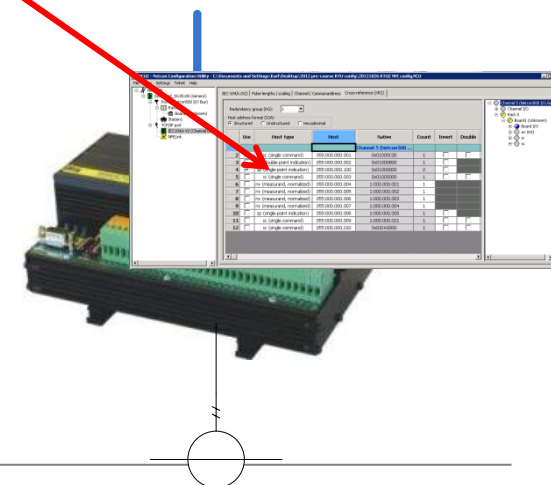
Tag: RTU2.AI01
Access Path:

Validated: Yes

Data Type: Empty/Default
Create Active: Yes

Readable: Yes
Writable: No

OK Cancel





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OPC client connection

Connecting to your OPC server

MatrikonOPC Explorer - [Untitled*]

File Server Group Item View Help

_NDI_Group_0

Contents of '_NDI_Group_0'

Item ID	Access Path	Value	Quality	Timestamp
RTU2.AI01		0,19580078125	Good, non-specific	10-26-2012 5:33:56.785 PM
RTU2.AI02		0	Good, non-specific	10-26-2012 5:28:52.191 PM
RTU2.AI03		0	Good, non-specific	10-26-2012 5:28:52.191 PM
RTU2.AI04		0	Good, non-specific	10-26-2012 5:28:52.191 PM
RTU2.CommLink		True	Good, non-specific	10-26-2012 5:28:51.801 PM
RTU2.CommStatus		True	Good, non-specific	10-26-2012 5:28:51.801 PM
RTU2.DI05		True	Good, non-specific	10-26-2012 5:28:52.191 PM
RTU2.DI06		True	Good, non-specific	10-26-2012 5:28:52.191 PM
RTU2.DI07		True	Good, non-specific	10-26-2012 5:28:52.191 PM
RTU2.DI08		True	Good, non-specific	10-26-2012 5:28:52.191 PM
RTU2.DI09		False	Good, non-specific	10-26-2012 5:28:52.191 PM
RTU2.DI10		False	Good, non-specific	10-26-2012 5:28:52.191 PM
RTU2.DI11		False	Good, non-specific	10-26-2012 5:28:52.191 PM
RTU2.DI12		False	Good, non-specific	10-26-2012 5:28:52.191 PM
RTU2.DI13		False	Good, non-specific	10-26-2012 5:28:52.191 PM
RTU2.DI14		False	Good, non-specific	10-26-2012 5:28:52.191 PM
RTU2.DI15		False	Good, non-specific	10-26-2012 5:28:52.191 PM
RTU2.DI16		False	Good, non-specific	10-26-2012 5:28:52.191 PM
RTU2.DI17		False	Good, non-specific	10-26-2012 5:28:52.191 PM
RTU2.DI18		False	Good, non-specific	10-26-2012 5:28:52.191 PM
RTU2.DI19		False	Good, non-specific	10-26-2012 5:28:52.191 PM
RTU2.DI20		False	Good, non-specific	10-26-2012 5:28:52.191 PM
RTU2.DO21		0	Uncertain, non-specific	10-26-2012 5:28:51.801 PM
RTU2.DO21_Cmd		0	Good, non-specific	10-26-2012 5:12:54.566 PM
RTU2.DO22		0	Uncertain, non-specific	10-26-2012 5:28:51.801 PM
RTU2.DO22_Cmd		0	Good, non-specific	10-26-2012 5:12:54.566 PM

Server Info

Server: Cybectec.IEC870-5-104M.1

Connected: Yes
State: Running
Groups: 1
Total Items: 38
Current Local Time: 10-26-2012 5:34:19.597 PM
Update Local Time: 10-26-2012 5:33:57.582 PM

Did you know?
Explorer Tip #3
OPC Explorer measures your current DA throughput.
[Click For Details](#)

MatrikonOPC

Group Info

Group: _NDI_Group_0

Connected (Async I/O): Yes (2.0)

Active: Yes
Items: 38
Current Update Rate: 1000 ms
Percent Deadband: 0,00%
Data Change Rate: 0,17 Items/Sec

Agent platform host



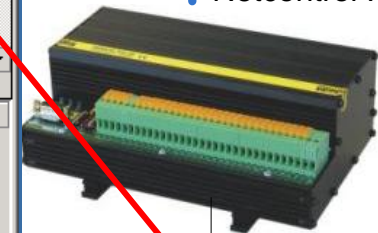
JACK AUTONOMOUS SOFTWARE

IEC 870-5-104 OPC server



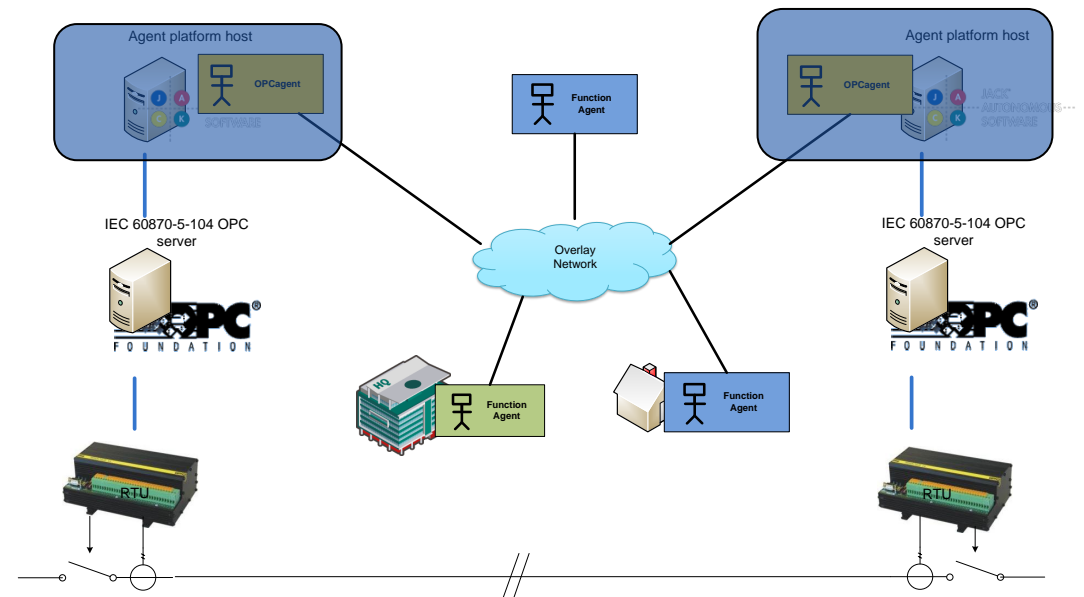
OPC FOUNDATION

Netcontrol RTU-28IP



Outline

- Lab architecture
- Recap of JACK interfacing with OPC – the OPCagent
- RTU configuration
- WAN connectivity
- OPC server configuration
- OPC client connection
- Java OPC client



Java OPC client

JEasyOPC Java class library

- Open-source java class library
- Interface with OPC servers

```
import javafish.clients.opc.JCustomOpc;  
import javafish.clients.opc.JEasyOpc;  
import javafish.clients.opc.JOpc;  
import javafish.clients.opc.asynch.AsynchEvent;  
import javafish.clients.opc.asynch.OpcAsynchGroupListener;  
import javafish.clients.opc.browser.JOpcBrowser;  
import javafish.clients.opc.component.OpcGroup;  
import javafish.clients.opc.component.OpcItem;
```

Initialization:

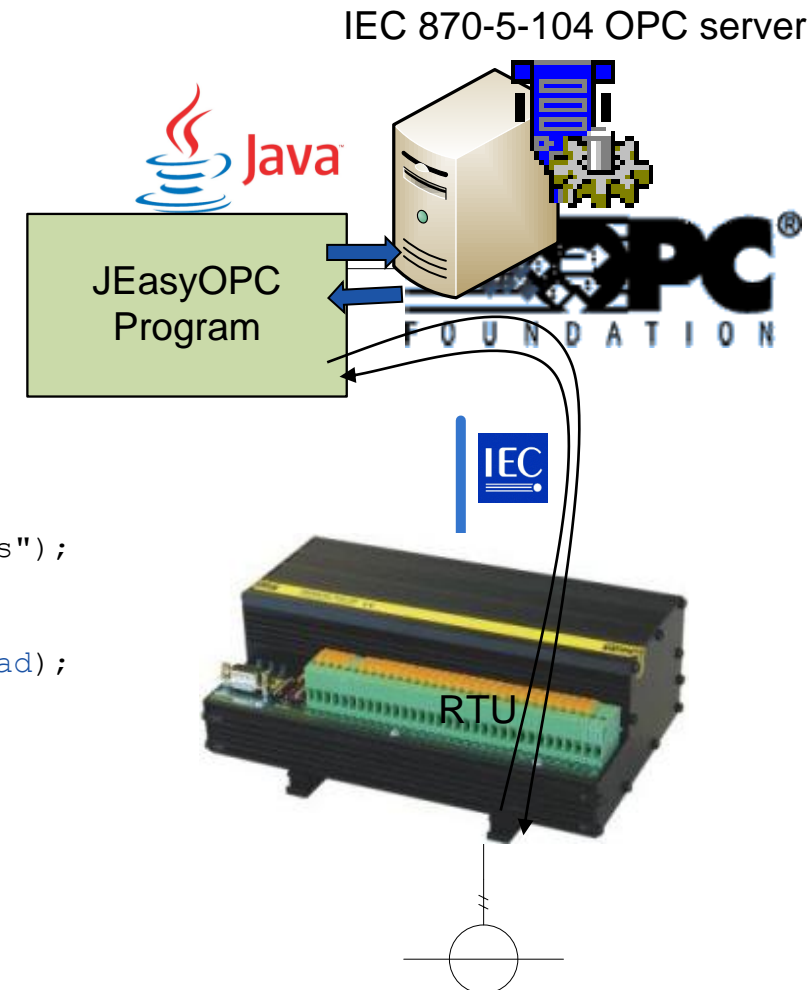
```
jopc_meas = new JEasyOpc(hostName, serverName, groupName + "_meas");
```

Reading:

```
gotItem = jopc_meas.synchReadItem(statusGroup, (OpcItem) ItemToRead);
```

Writing:

```
jopc_command.synchWriteItem(commandGroup, item);
```



Java OPC client

Making Java speak OPC

- Initialise a new JEasyOpc object
- Create groups for different readings

```
jopc_status = new JEasyOpc("localhost", "Matrikon.OPC.Simulation", "JOPC1");  
  
//commandGroup = new OpcGroup("commands", true, 20, 0.0f);  
//measGroup = new OpcGroup("meas", true, 20, 0.0f);  
statusGroup = new OpcGroup("status", true, 20, 0.0f);
```

Java OPC client

Making Java speak OPC

- Browsing the items

```
JOpCBrowser jbrowser = new JOpCBrowser(hostName, serverName, groupName);
```



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Java OPC client

Making Java speak OPC

- Synchronous reading

```
Iterator itemItr = itemVector.iterator();
while(itemItr.hasNext()) {
    try {
        OpcItem gotItem = jopc_status.synchReadItem(statusGroup, (OpcItem)itemItr.next());
        if (gotItem != null) {
            Date timeNow = new Date();
            if (gotItem.getDataType() == 11) System.out.println("Read:" + gotItem.getItemName() + gotItem.ge
                else System.out.println("Read" + gotItem.getItemName() + (float) gotItem.getValue().getFloat()
            System.out.println(gotItem);
        }
    } catch (SynchReadException e) {
        e.printStackTrace();
    }
}
```



Java OPC client

Making Java speak OPC

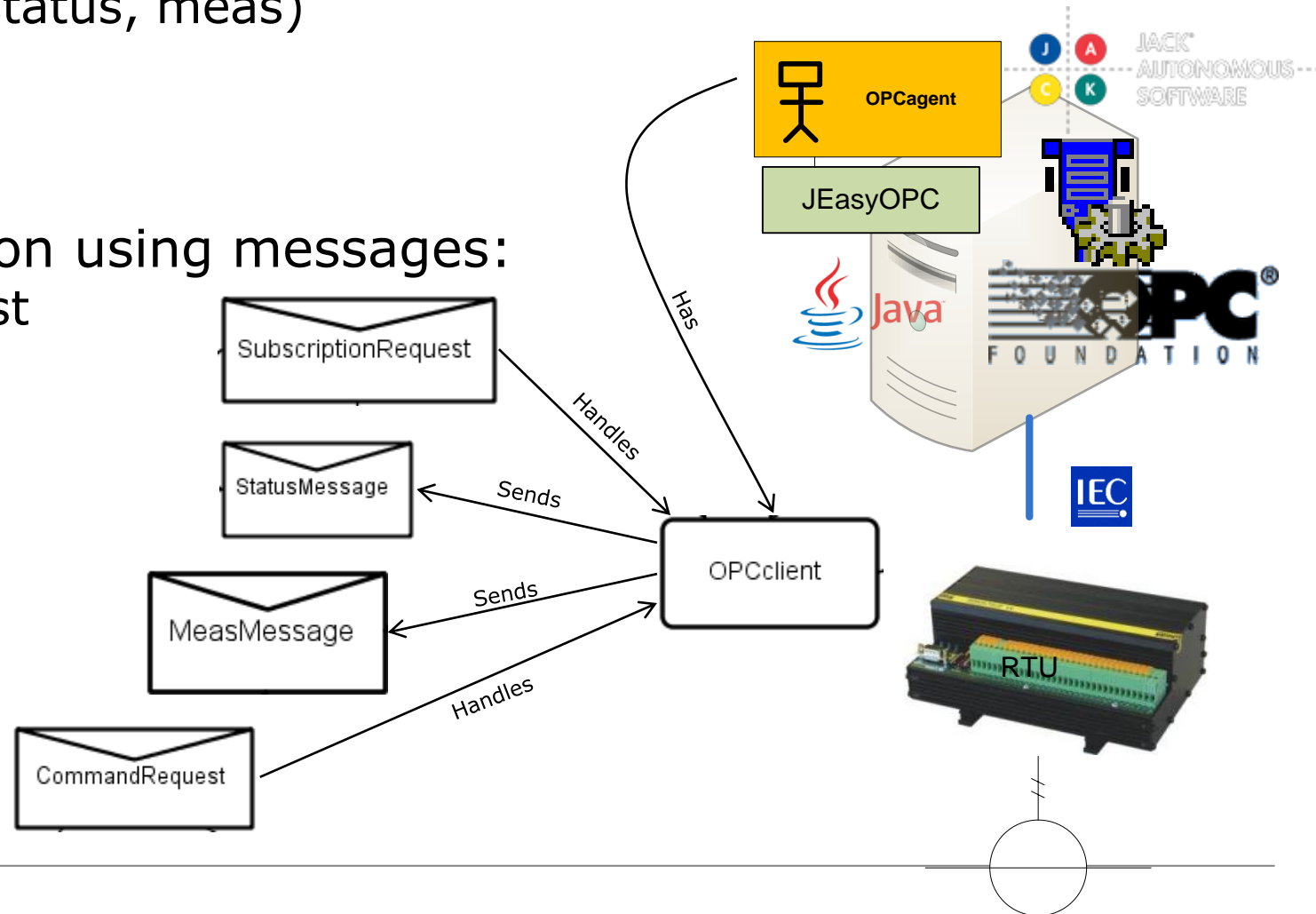
- Synchronous writing

```
jopc_command.synchWriteItem(commandGroup, item);
```

Java OPC client

OPC agent - OPC interfacing from JACK

- JACK agent with **OPC client** capability:
 - Browser OPC server
 - Listen for events (status, meas)
 - Issue commands
- Agent communication using messages:
 - SubscriptionRequest
 - StatusMessage
 - MeasMessage
 - CommandRequest



Java OPC client

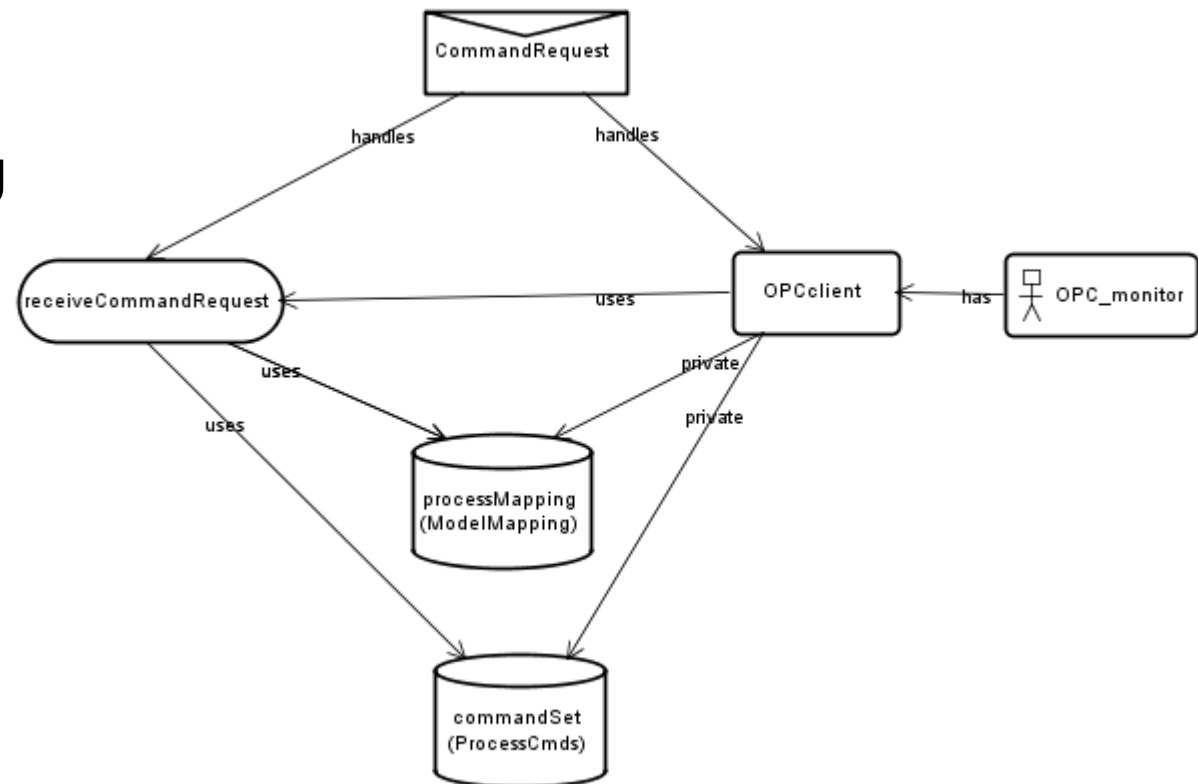
OPCagent - OPC interfacing from JACK

- JACK agent with **OPC client** capability:

- Browser OPC server
- Listen for events (status, meas)
- Issue commands

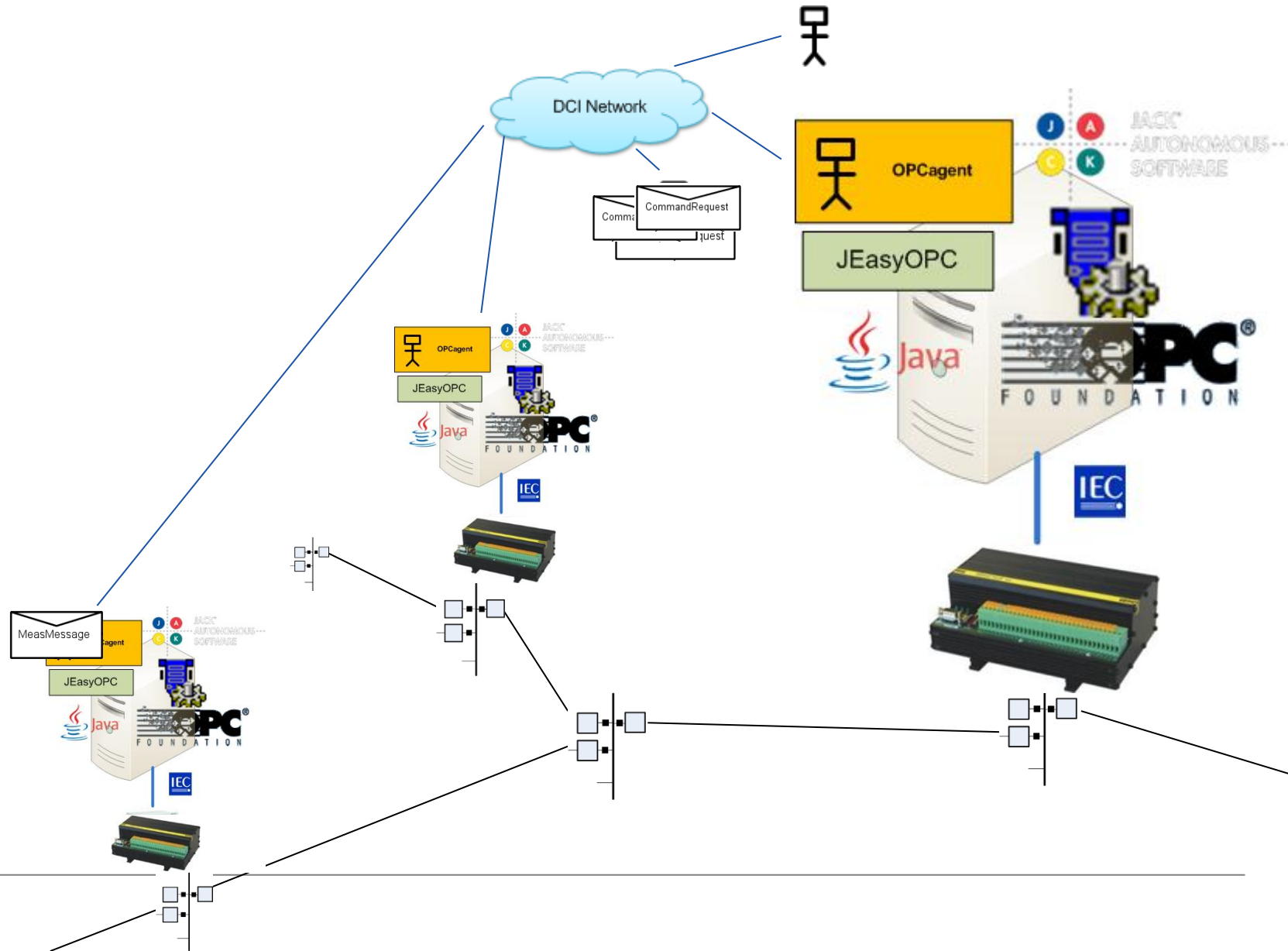
- Agent communication using

- SubscriptionRequest
- StatusMessage
- MeasMessage
- CommandRequest



Java OPC client

OPCagent - OPC interfacing from JACK



Summary

- Followed configuration process from RTUs up to application clients.
- Got a better technical understanding of what happens at the OPCagent.
- Exercise lab follows the process of how to browse, read and write to the OPC server.