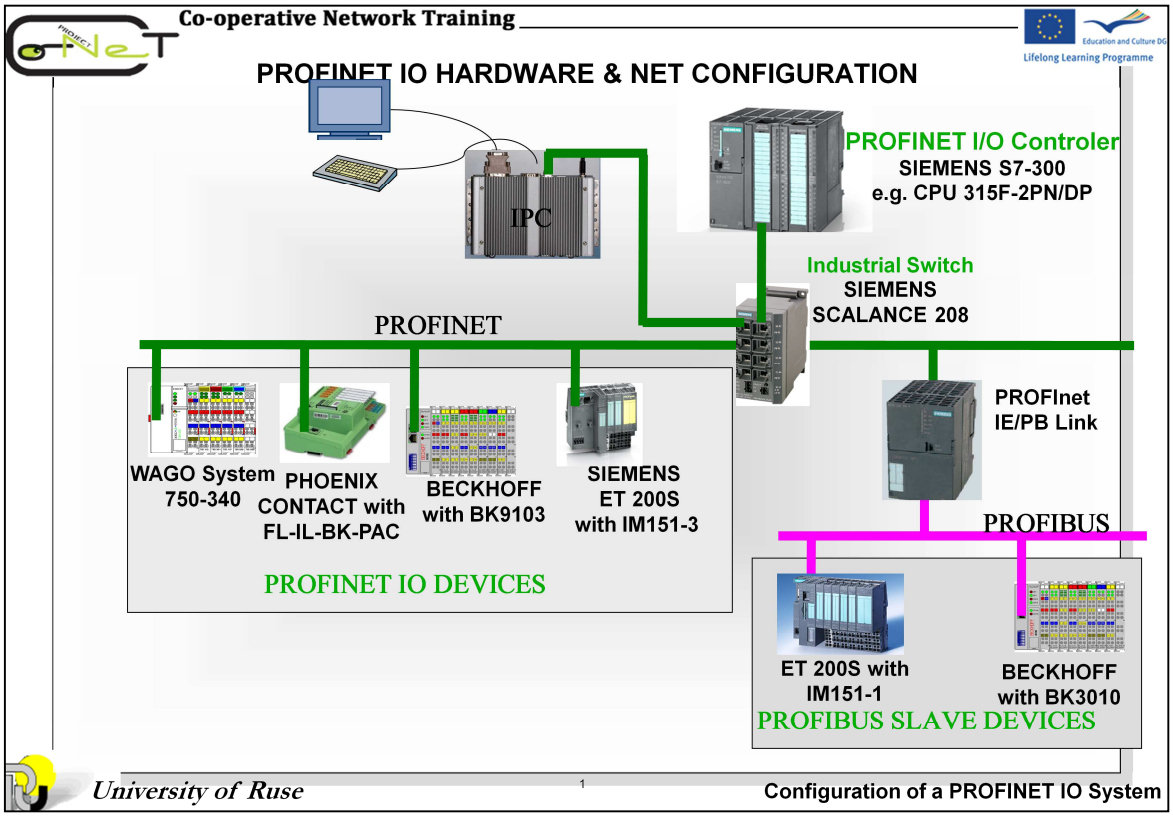
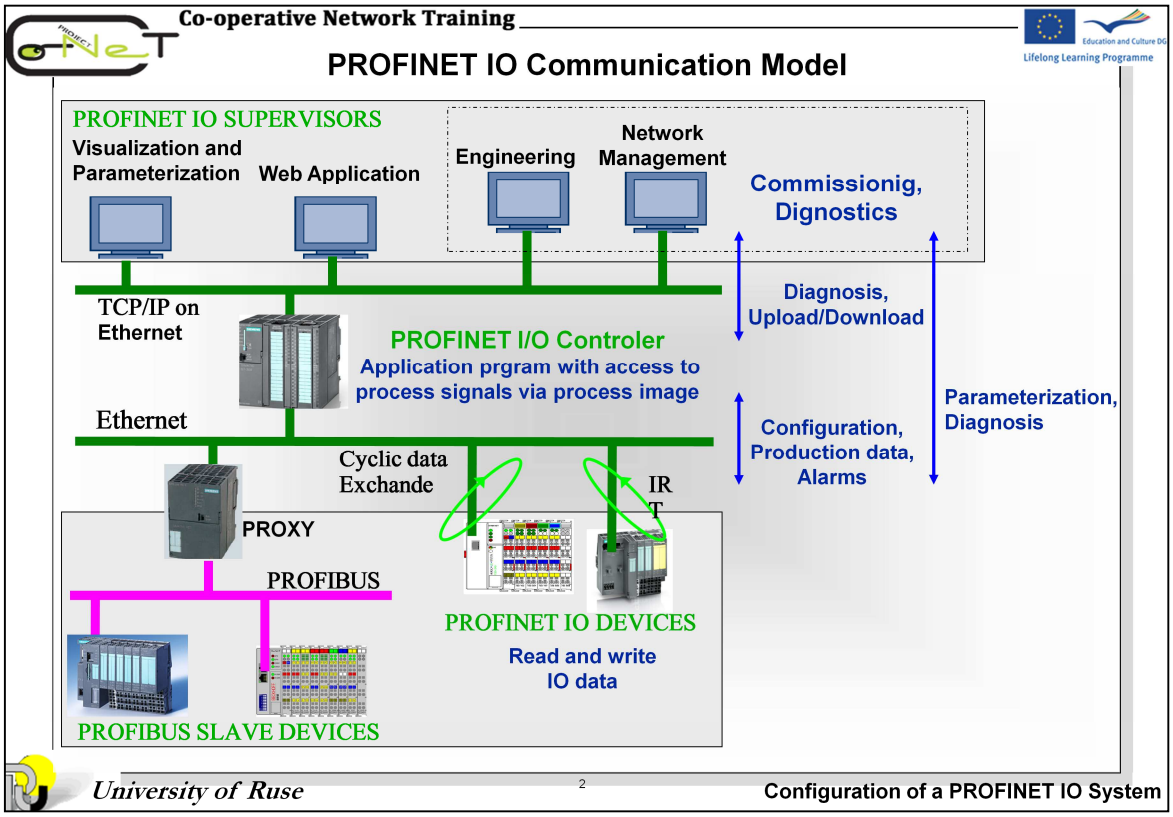
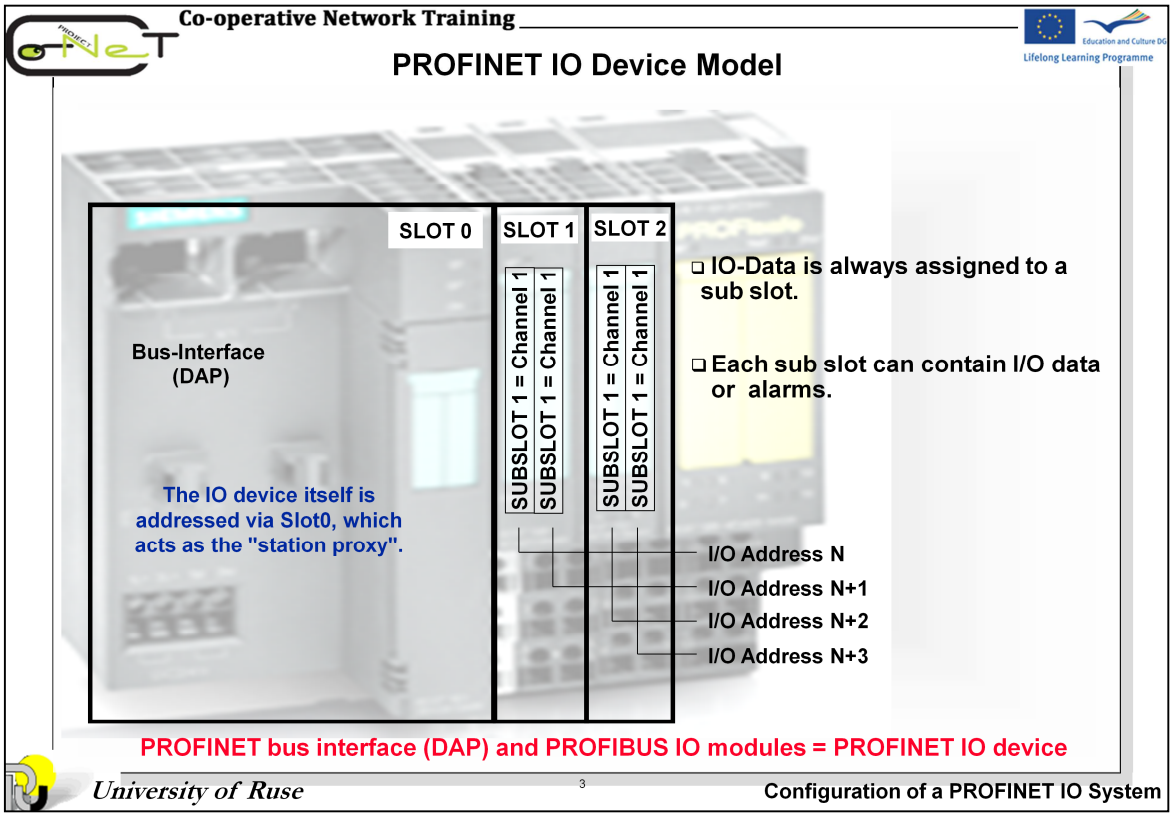

Co-operative Network Training
Lifelong Learning Programme
PROFINET IO HARDWARE & NET CONFIGURATION
IPC
PROFINET I/O Controler
SIEMENS S7-300
e.g. CPU 315F-2PN/DP
Industrial Switch
SIEMENS
SCALANCE 208
PROFINET
WAGO System
750-340
PHOENIX
CONTACT with
FL-IL-BK-PAC
BECKHOFF
with BK9103
SIEMENS
ET 200S
with IM151-3
PROFINET IO DEVICES
PROFInet
IE/PB Link
PROFIBUS
ET 200S with
IM151-1
BECKHOFF
with BK3010
PROFIBUS SLAVE DEVICES
University of Ruse
1
Configuration of a PROFINET IO System



PROFINET IO is used for data exchange between PLC (*I/O controllers*) and field devices (*I/O devices*). PROFINET IO uses the proven communication model and application view of PROFIBUS DP and extends it by Ethernet as the communication medium. Among other benefits, this provides a greater bandwidth and allows more stations on the network. The PROFINET IO specifications define a protocol and an application interface for exchanging I/O data, alarms and diagnostics and for transmitting data records and logbook information.

To exchange I/O data and alarms, PROFINET IO is based directly on the Ethernet protocol. This real-time (RT) solution allows response times in the range of 5 ms, which corresponds to today's PROFIBUS DP applications. If it has to be even faster and if data exchange should be performed isochronously (IRT), a special chip is used, which also supports switch functions. "Normal" Ethernet communication is of course also possible when using the chip. The solution consists in reserving bandwidth for the isochronous data exchange and bandwidth for "the remainder." Innovations have also been made with regard to the device description in that XML is used for structuring the information.

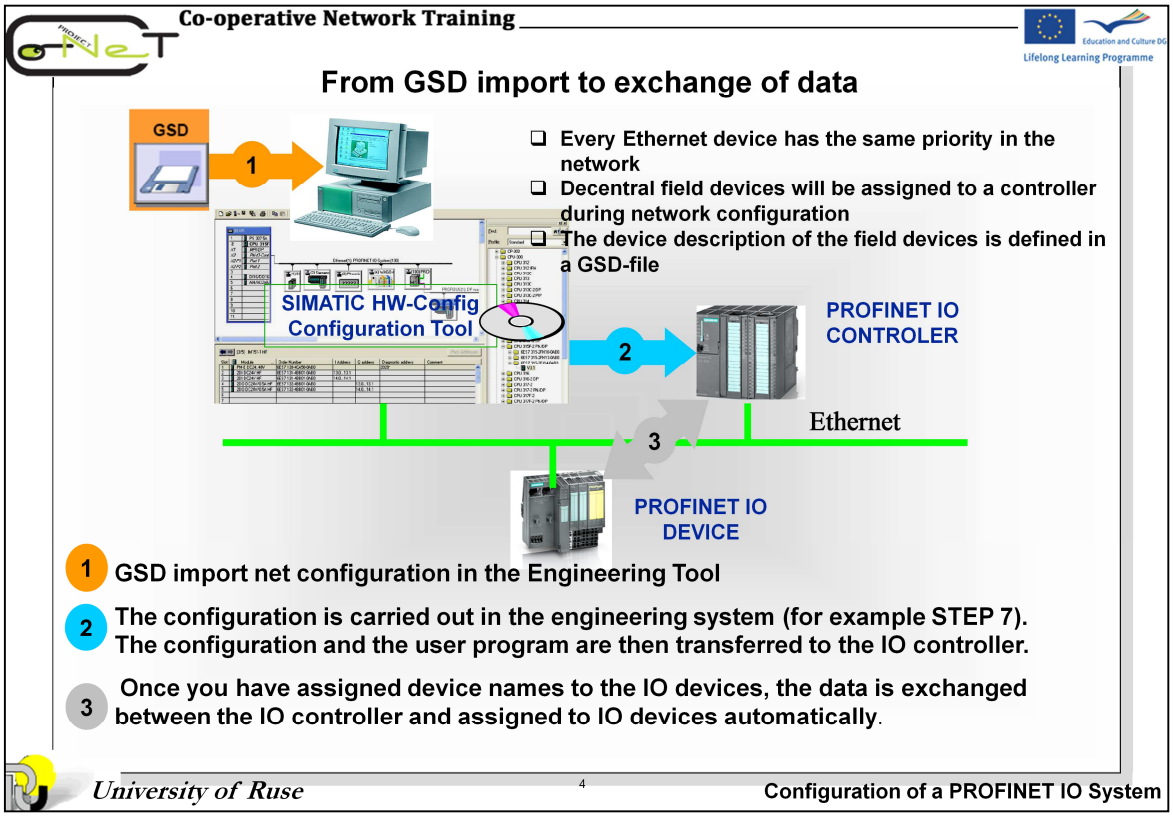
For all that is new, however, the existing has not been forgotten or dispensed with. The integration of existing fieldbus devices will be performed via proxies, and PROFIBUS profiles will also be available for PROFINET IO. PROFIdrive and PROFIsafe will be the first to be revised.



PROFINET I/O is based on a consistent model of the IO device structure and capabilities. An IO device may be modular and is composed of one ore more slots, which may have subslots. Each slot or subslot represents an IO module and has a fixed number of input and output bits. The input data of the IO device is the sequence of all inputs of slots and subslots, according to their position in the device. The same holds for the output data.

Slot 0 and subslot 0 do not represent IO modules and have no IO data and it is used to address the IO device. Subslot 0 is used to address its corresponding slot.

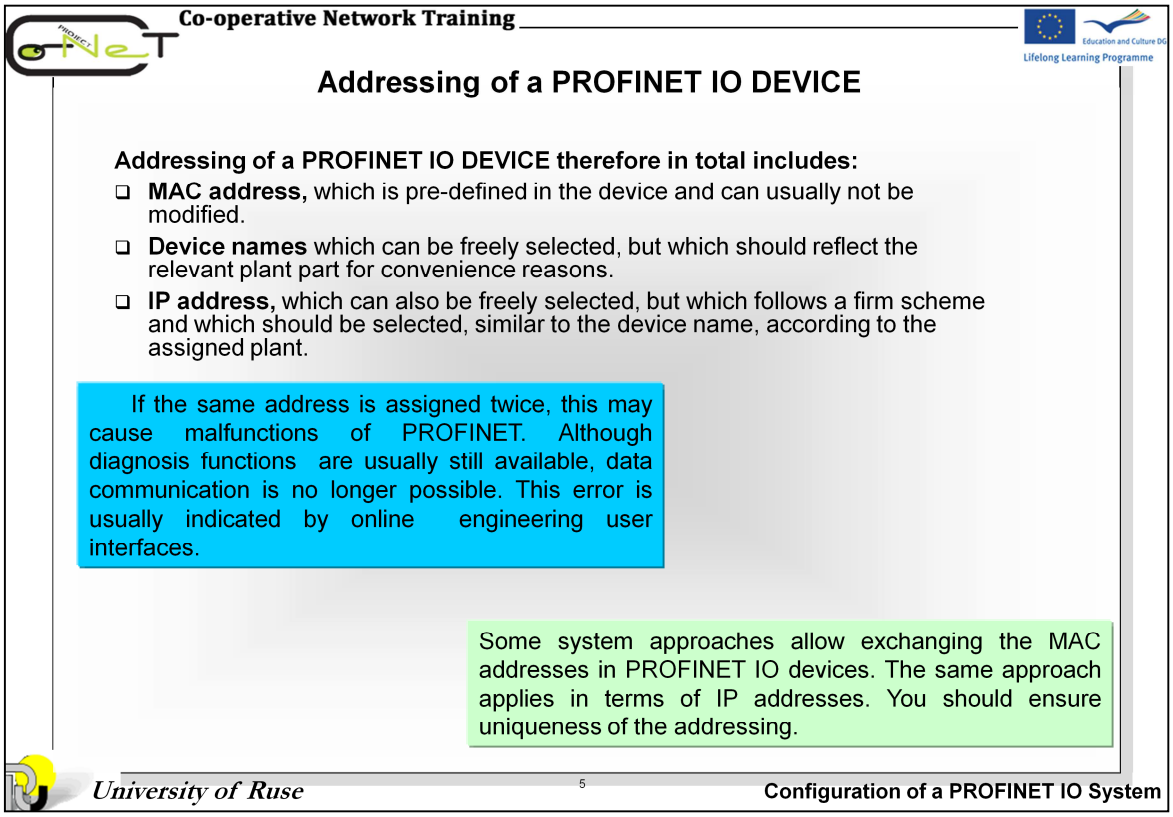
Also all diagnostic or alarm data reference slots or subslots.

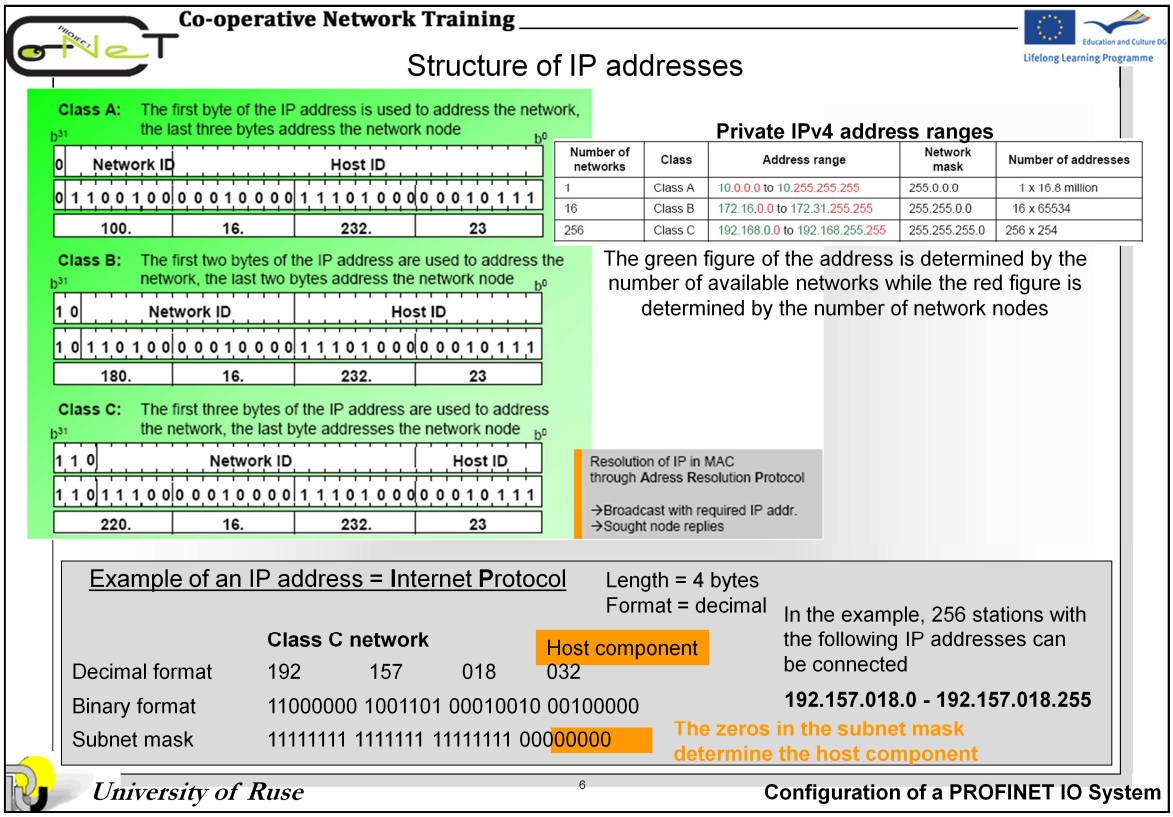


PROFINET nodes are integrated into projects using device description files. This is a standardized type of file which describes the properties of the PROFINET nodes. The device description file for PROFINET is usually abbreviated “GSD file”. GSD stands for “General Station Description” while the extension ML indicates the use of XML).

A GSD file for a device contains standardized information on its properties. It is important to use the correct GSD files in your PROFINET system. Each PROFINET device has an individual device ID. The device ID is allocated by the manufacturer and, in combination with the manufacturer ID allocated by the PROFIBUS user organization it is globally unique for each device type. The GSD file has to match the device ID of the configured device. The device ID consists of 16 bits. This information can be retrieved from the GSD file.

- When using devices from different manufacturers, the relevant GSD files must be imported to the configuration tool. This is usually done by simply copying the GSD files in the relevant directory
- When using the GSD files, make sure that the used GSD file matches the version of the PROFINET node. Otherwise some features may not be available to you.
- The GSD files of the used PROFINET nodes are available from the manufacturers. Some of the files are also available for download via the website of the PROFIBUS user organization at **www.PROFINET.com.**


Co-operative Network Training
Lifelong Learning Programme
Addressing of a PROFINET IO DEVICE
Addressing of a PROFINET IO DEVICE therefore in total includes:
MAC address, which is pre-defined in the device and can usually not be modified.
Device names which can be freely selected, but which should reflect the relevant plant part for convenience reasons.
IP address, which can also be freely selected, but which follows a firm scheme and which should be selected, similar to the device name, according to the assigned plant.
If the same address is assigned twice, this may cause malfunctions of PROFINET. Although diagnosis functions are usually still available, data communication is no longer possible. This error is usually indicated by online engineering user interfaces.
Some system approaches allow exchanging the MAC addresses in PROFINET IO devices. The same approach applies in terms of IP addresses. You should ensure uniqueness of the addressing.
University of Ruse
5
Configuration of a PROFINET IO System



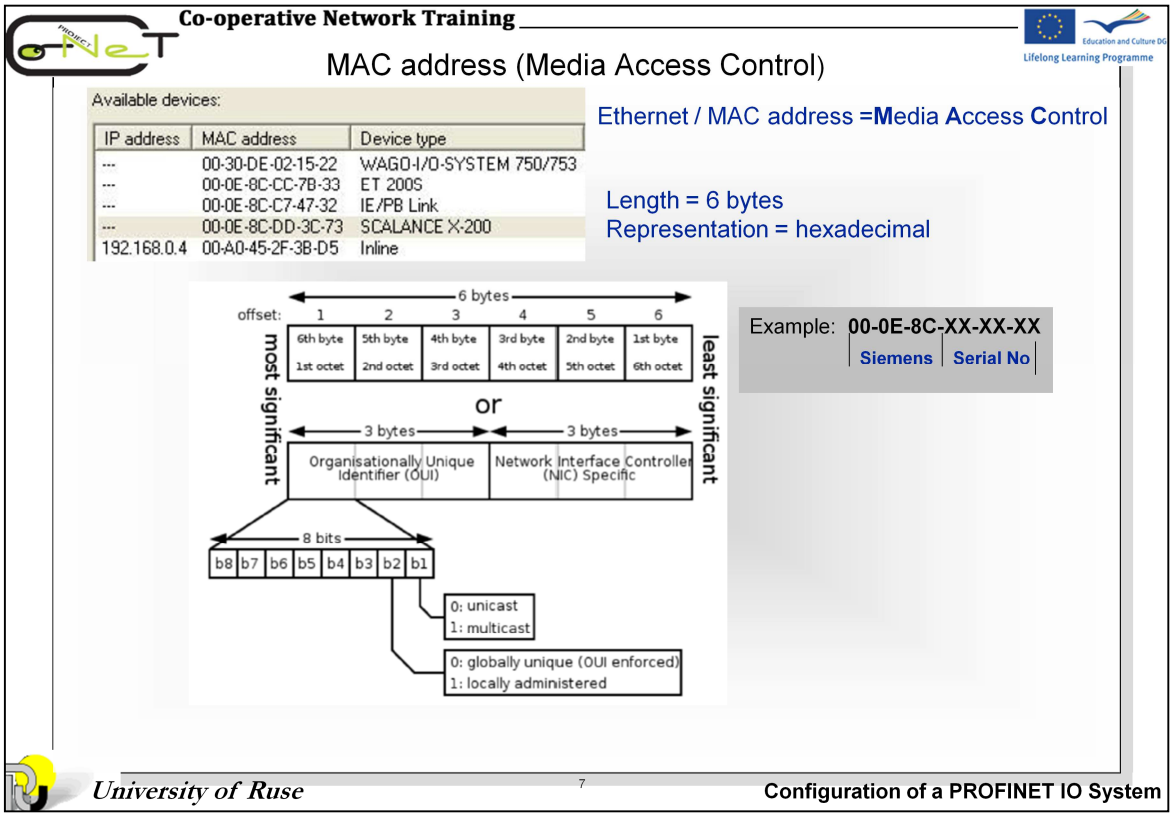
To allow a PROFINET device to be addressed as a node on Industrial Ethernet, this device also requires an IP address that is unique on that network. The IP address is made up of 4 decimal numbers with a range of values from 0 through 255. The decimal numbers are separated by periods. The IP address is made up of the following:

- Address of the network and
- Address of the node (generally called the host or network node).

In addition to the IP address, a PROFINET IO device requires a network mask in order to communicate in PROFINET. The notation of this so-called network mask is identical to the notation of IP addresses. Networks are subdivided into individual ranges using this network mask, also called subnet mask. The most common subnet masks correspond to the network masks as shown in table.

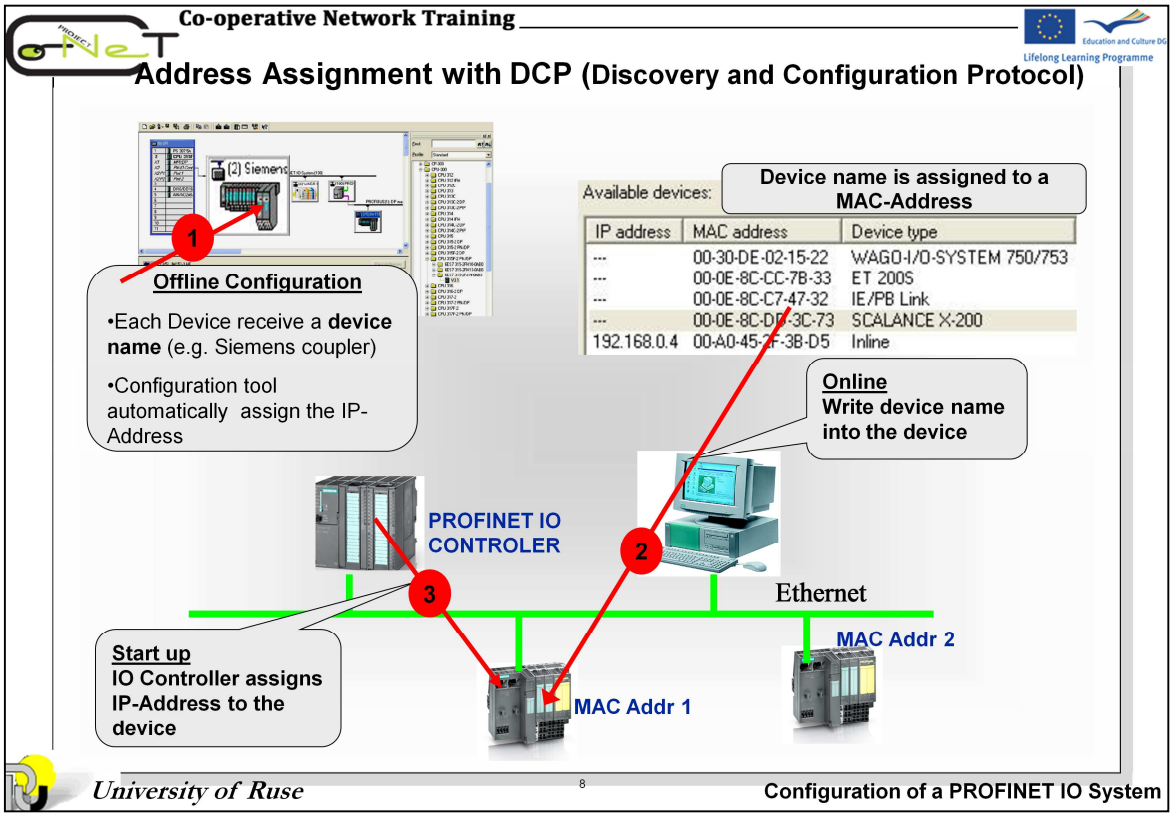
Another way of subdividing networks into smaller logical segments is called “subnetting”, which means that the network mask is modified according to a special procedure. This makes sure that no direct communication between network nodes is possible within a network unless these nodes are members of the same “subnetwork”. As a consequence, the number of network nodes in a “subnetwork” is reduced.

In most cases, addressing using the private class C address range is sufficient. For special cases where a larger address range than provided in class C is required, it is possible to switch to other classes. The described subnetting offers additional possibilities for subdividing networks. This should only be done by qualified, experienced personnel.



Every PROFINET device is assigned a worldwide unique device identifier at the factory. This 6-byte long device identifier is the MAC address. The MAC address is consists of:

- 3-byte vendor identifier and
- 3-byte device identifier (consecutive number).

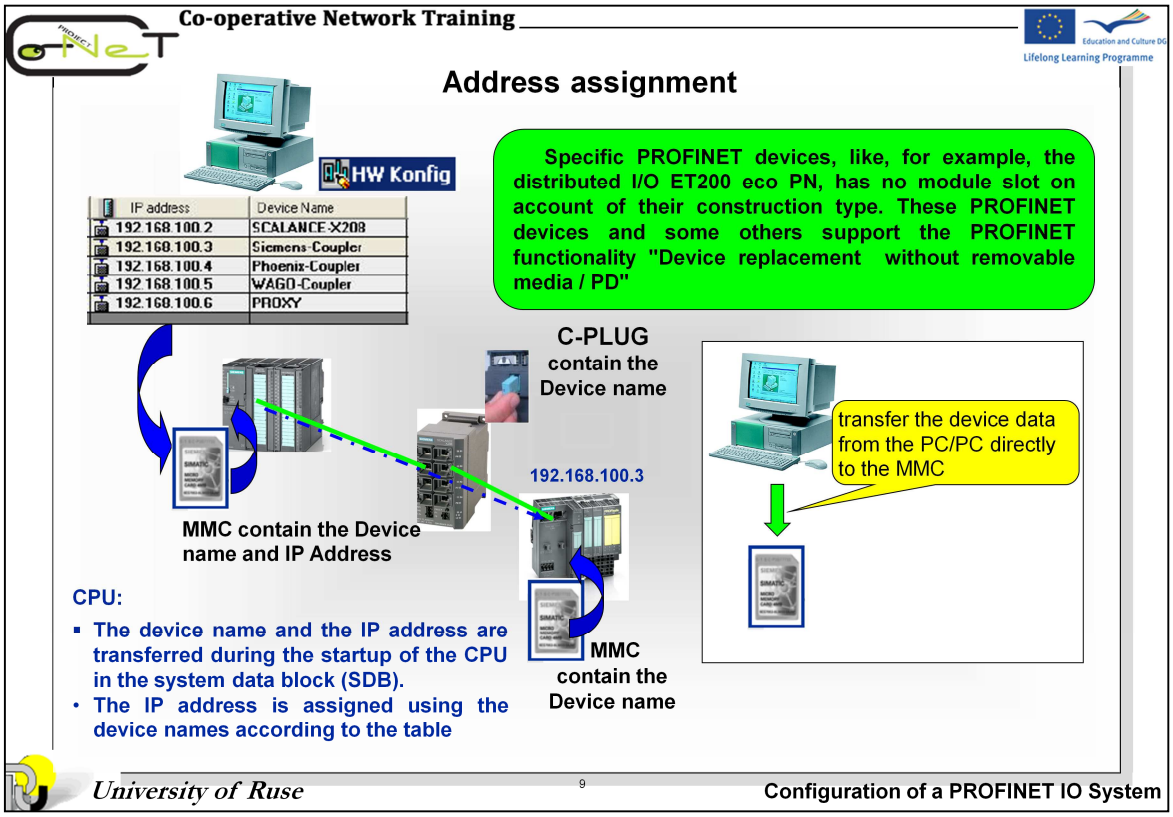


Before an IO device can be addressed by an IO controller, it must have a device name. In PROFINET, this method was selected because it is simpler to work with names than with complex IP addresses.

In their original delivery status, PROFINET IO devices do not have a device name, but only a MAC address. This address is persistently stored in the device; it is globally unique and can usually not be changed.

- Some manufacturers have proprietary tools which allow for a MAC address to be changed in case a device has to be replaced.
- Many PROFINET devices have the MAC address printed on the housing or on the rating plate.

A PROFINET IO device can only be addressed by a PROFINET IO controller after having been allocated a device name, usually for the acyclic transfer of planning data (among others the IP address) or when starting the PROFINET IO device. Cyclical exchange of data is realized using the MAC address, if the PROFINET IO Controller and the PROFINET IO-Device are placed in the same subnet.

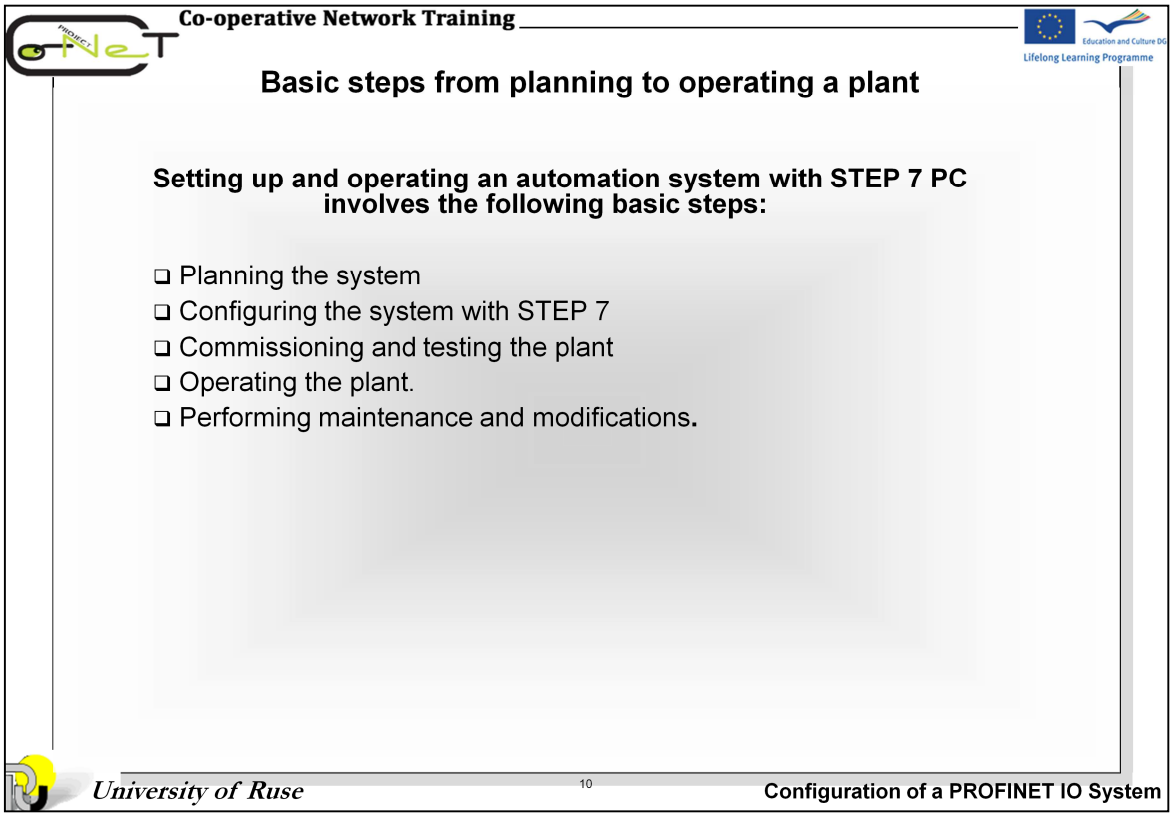


By downloading the hardware configuration, the valid IP address is obtained for the IO devices. This assignment is implemented via the specific "device name". The device names are saved on the Micro Memory Card to support module replacement without a PG/PC.

If you remove the memory card / C-Plug from a PROFINET controller and plug it into a different PROFINET device, you will transfer the device-specific information and the IP address to the device.

If an IO device has to be replaced in its entirety due to a device or module defect, the IO controller automatically assigns parameters and configures the new device or module. The cyclic exchange of user data is then restarted. In addition to this, before the network on of the IO device, the Micro Memory Card with the valid name is removed from the faulty IO device and added to the exchanged device.

The MMC card / C-Plug allows modules to be replaced without a programming device/PC in the event of a fault in a PROFINET device. You can also transfer the device data from the PC/PC directly to the MMC (for the ET200S/PN IO device, for example).



Setting up and operating an automation system with STEP 7 or NCM PC involves the following basic steps:

1. **Planning the system** - The system planner specifies the scope of functions of the automation system and the type and scope of the implemented automation devices

2. **Configure the system with STEP 7** -The configuration engineer creates the project by:

– Opening an available or setting up a new project;

– Importing new PROFINET devices into the hardware catalog using GSD files, if necessary;

– Inserting more PROFINET devices in the project;

– Networking the automation devices in the network view;

– Assigning device names (not necessary for IO devices where the PROFINET Function "Device replacement without removable media / PD" has been configured);

– Creating the user program;

– Checking the configuration;

3. **Commissioning and testing the plant** -The commissioning engineer performs the following tasks:

– Commissioning the automation devices

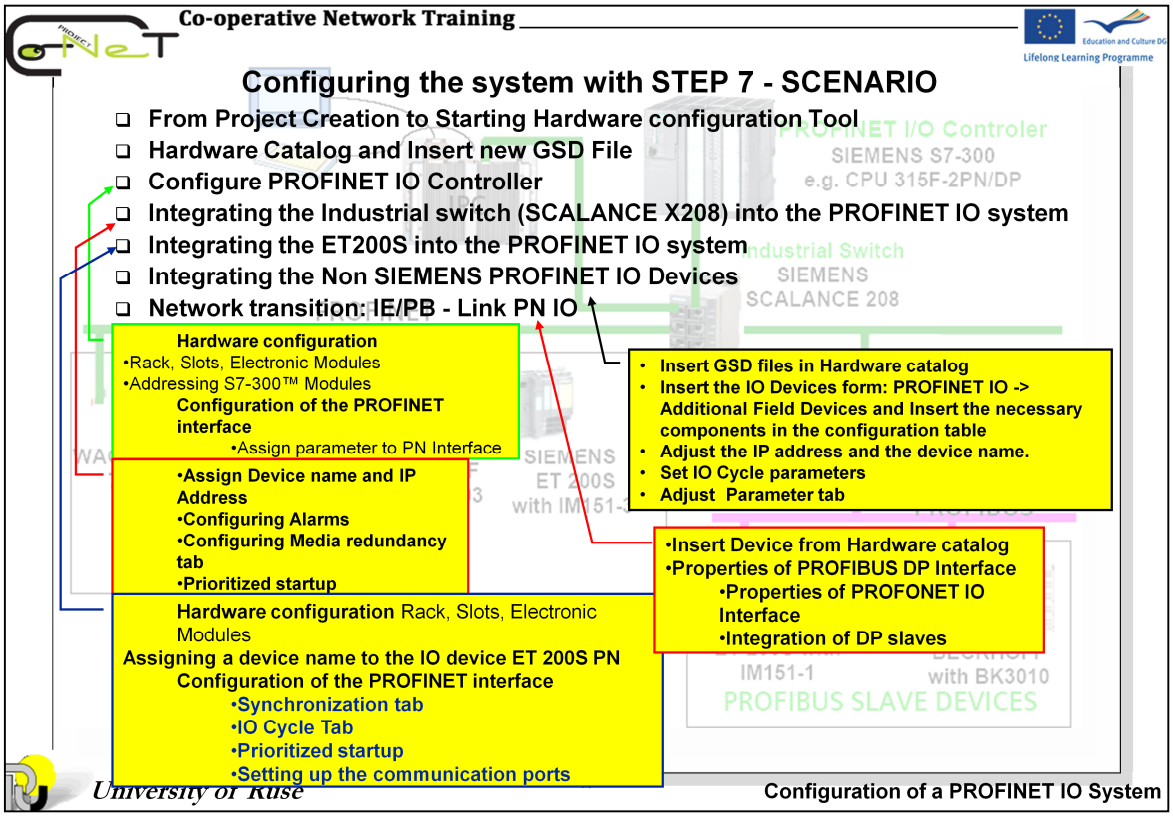
– Downloading the project data to the automation devices of the system. The device name is then assigned to a real device with a MAC address.

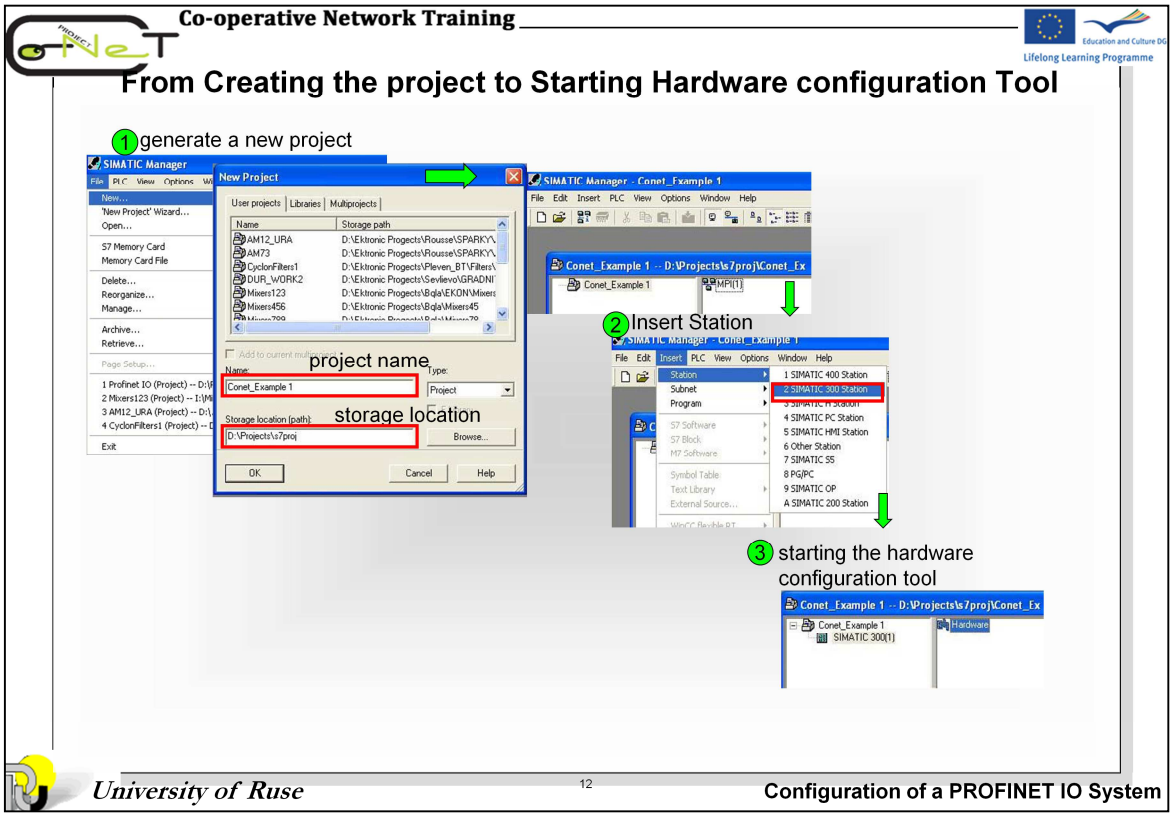
– Revising the configuration and / or the user program in STEP 7, if necessary

– Testing the system

4. **Operating the plant** - The plant operator performs the monitoring and changing the process data online, running diagnostics on the system; operator control and monitoring

5. **Performing maintenance and modifications.**


Co-operative Network Training
Lifelong Learning Programme
Configuring the system with STEP 7 - SCENARIO
From Project Creation to Starting Hardware configuration Tool
Hardware Catalog and Insert new GSD File
Configure PROFINET IO Controller
Integrating the Industrial switch (SCALANCE X208) into the PROFINET IO system
Integrating the ET200S into the PROFINET IO system
Integrating the Non SIEMENS PROFINET IO Devices
Network transition: IE/PB - Link PN IO
Hardware configuration
•Rack, Slots, Electronic Modules
•Addressing S7-300™ Modules
Configuration of the PROFINET interface
•Assign parameter to PN Interface
•Assign Device name and IP Address
•Configuring Alarms
•Configuring Media redundancy tab
•Prioritized startup
Hardware configuration Rack, Slots, Electronic Modules
Assigning a device name to the IO device ET 200S PN
Configuration of the PROFINET interface
•Synchronization tab
•IO Cycle Tab
•Prioritized startup
•Setting up the communication ports
Insert GSD files in Hardware catalog
Insert the IO Devices form: PROFINET IO -> Additional Field Devices and Insert the necessary components in the configuration table
Adjust the IP address and the device name.
Set IO Cycle parameters
Adjust Parameter tab
•Insert Device from Hardware catalog
•Properties of PROFIBUS DP Interface
•Properties of PROFONET IO Interface
•Integration of DP slaves
PROFINET I/O Controler
SIEMENS S7-300
e.g. CPU 315F-2PN/DP
Industrial Switch
SIEMENS
SCALANCE 208
IM151-1
with BK3010
PROFIBUS SLAVE DEVICES
University of Ruse
Configuration of a PROFINET IO System



Creating a Project: Select the menu options *File -> New* or the symbol in the toolbar to open the "New" dialog box for creating a new project or a new library. Enter the project name in the "Name" box and click the "OK" button to confirm.

Notes

1. The "Storage location (path)" displays the path that was preset in the SIMATIC Manager under *Options -> Customize*.

2. As of STEP 7 V3.2, the 'New Project' Wizard helps you create a new project.

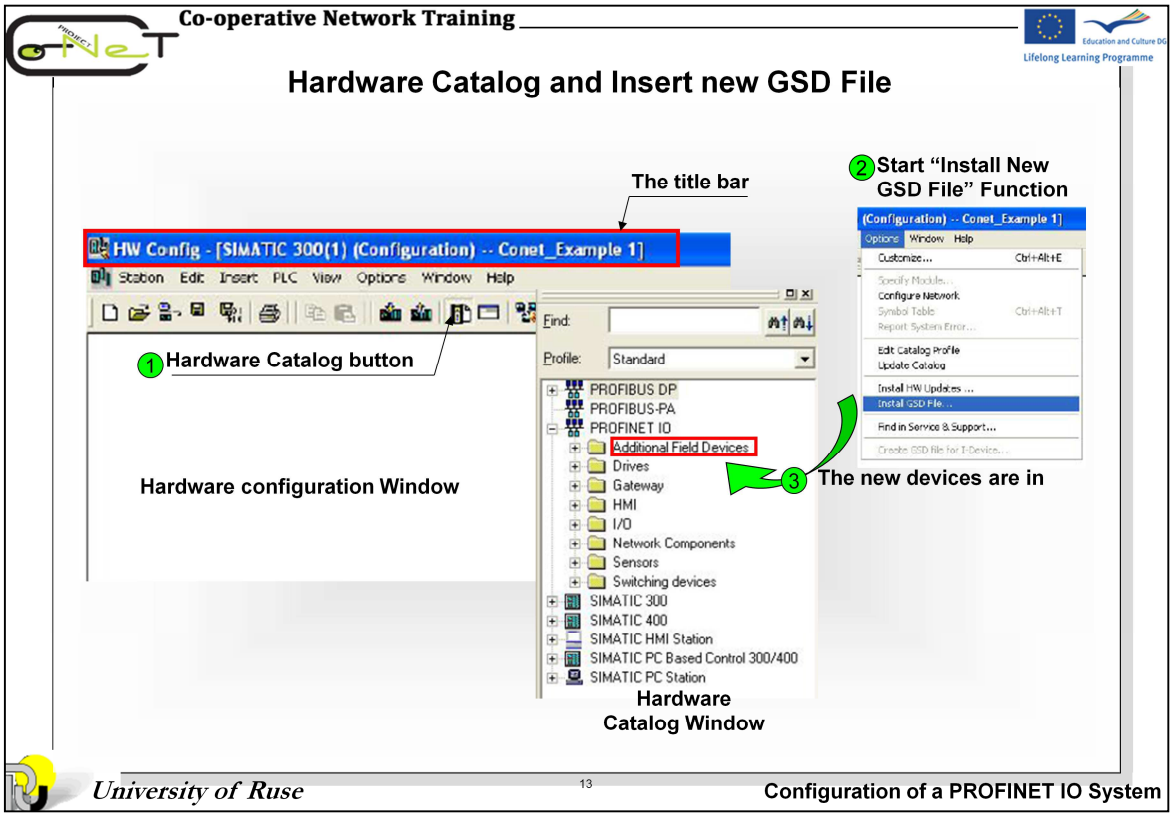
Insert Station: You insert a new station in the current project by selecting the menu options *Insert -> Station -> SIMATIC 300 Station or SIMATIC 400 Station*.

You can then change the name that is automatically given to this station - "SIMATIC® 300 (1)" - to one of your choice.

HW Config tool helps you configure, assign parameters to and diagnose the hardware. To start the HW Config tool:

• select a hardware station in the SIMATIC Manager and choose the *Edit --> Open Object* menu or

• double-click the hardware object.



Hardware configuration: is a window in the "HW Config" application you use for inserting components from the **"Hardware Catalog"** window. The title bar of this window contains the name of the project and the station name.

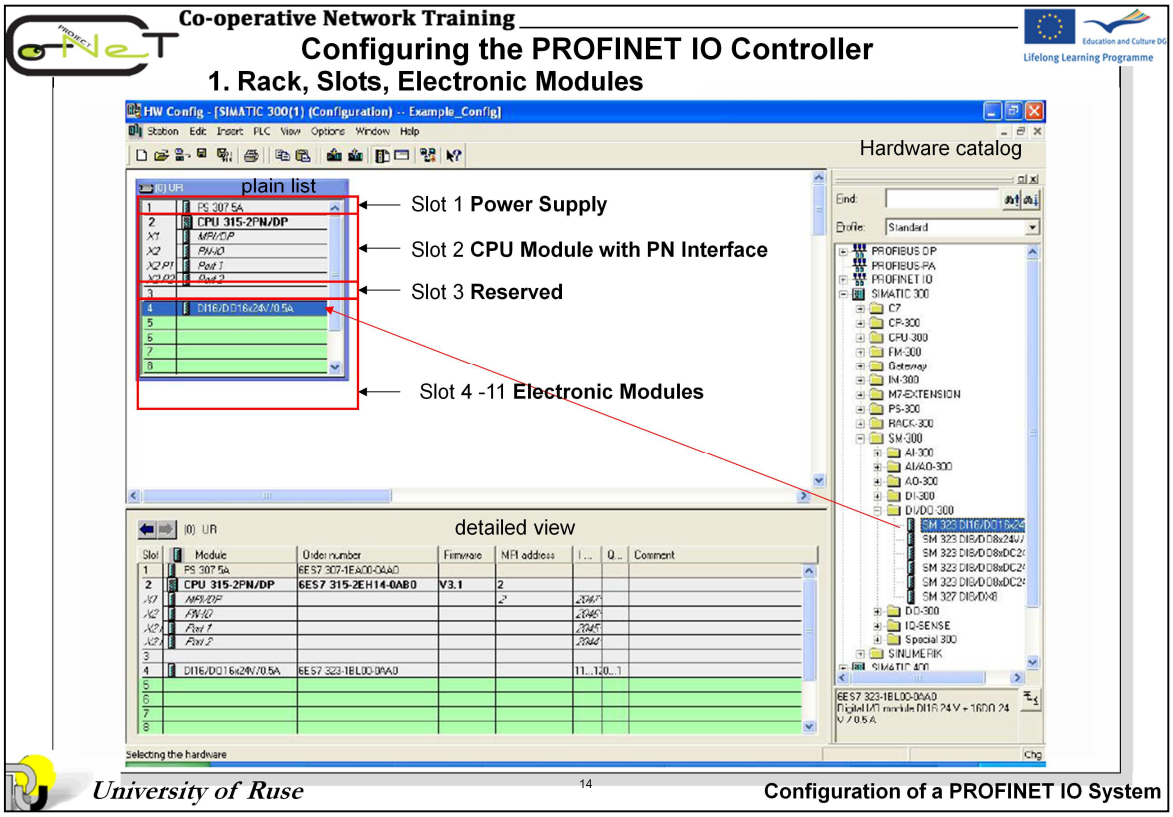
To open the "Hardware Catalog":

- select the *View -> Catalog* menu or
- click the icon in the toolbar.

If "Standard" is selected as the catalog profile, all racks, modules and interface modules are available in the "Hardware Catalog" window.

You can create your own catalog profiles containing frequently used elements by selecting the menu options *Options -> Edit Catalog Profiles*.

You can add PROFINET IO Device that do not exist in the catalog later on. To add the device, you use GSD files that are provided by the manufacturer of the device. To include the Device in the hardware catalog, use the *Options -> Install New GSE Files* menu and then *Options -> Update Catalog.* You will find the new devices in the catalog under PROFINET IO, Additional Field Devices.



Generating a Controller Configuration: This means specifying how the modules are to be arranged in the rack. This configuration specified by the user is referred to as the setpoint configuration.

When you open a SIMATIC 300 station in the hardware catalog. Opening the "RACK-300" contains an icon for a DIN rail. You can insert this in the "Hardware Configuration" window by double-clicking it (or using drag & drop).

Two rack component lists then appear in the two-part window: a plain list in the top part and a detailed view with order numbers, MPI addresses and I/O addresses in the bottom part.

If a load current power supply is required, you insert the appropriate "PS-300" module at slot No. 1 in the list with a double click or by drag & drop.

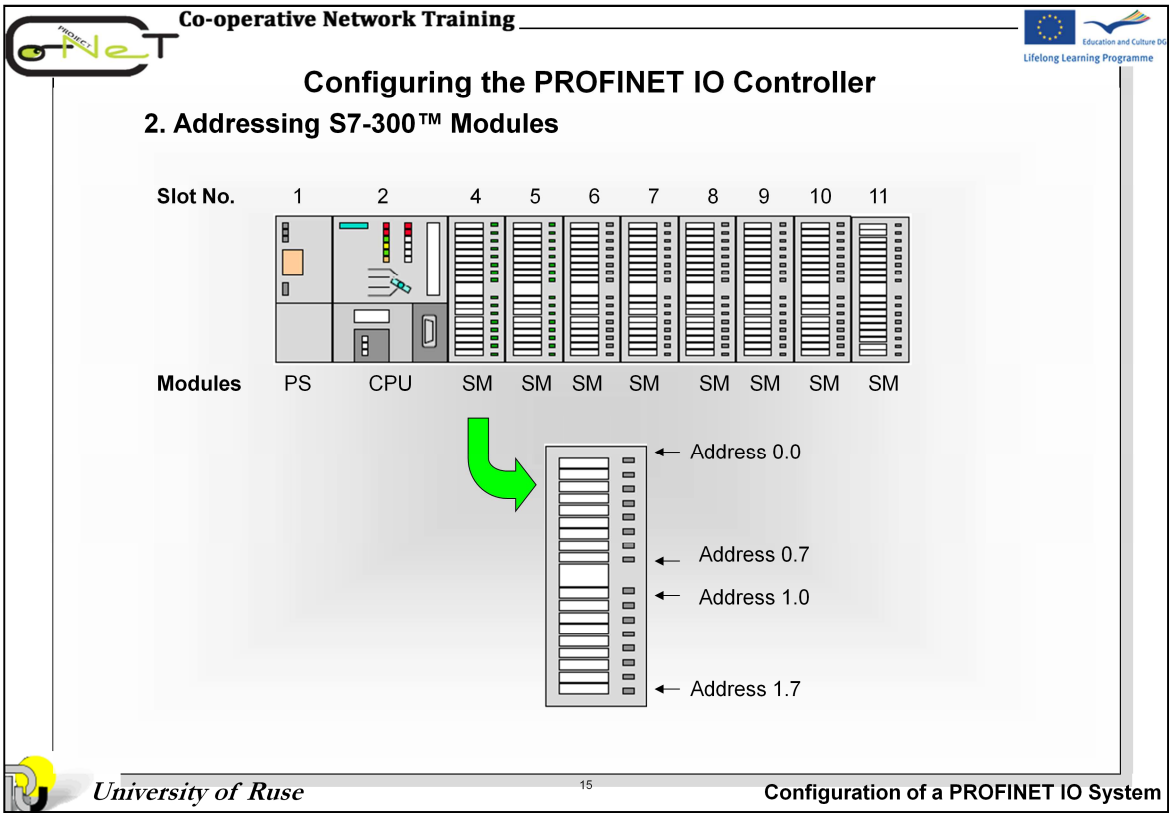
You select the CPU from the "CPU-300" catalog, for example, and insert it in slot 2 with a double click.

Slot 3 is reserved as the logical address for an interface module (for multi-tier configurations). If this position is to be reserved for installation of an IM at a later date in the actual hardware configuration, a DM370 dummy module must be inserted.

From slot 4 onwards you can insert a choice of up to 8 signal modules (SM), communications processors (CP) or function modules (FM).

You insert modules in a selected slot in the list by double-clicking the module you want in the catalog.

Or you can insert modules anywhere in the list using drag & drop.



Slot Numbers The slot numbers in the rack of an S7-300™ simplify addressing in the S7-300™ environment. The position of the module in the rack determine the first address on a module.

Slot 1 - Power supply. This is the first slot by default. A power supply module is not absolutely essential. An S7-300™ can also be supplied with 24V directly.

Slot 2 - Slot for the CPU.

Slot 3 - Logically reserved for an interface module (IM) for multi-tier configurations using expansion racks. Even if no IM is installed, it must be included for ddressing purposes. *You can physically reserve the slot (such as for installing an IM at a later date) if you insert a DM370 dummy module*.

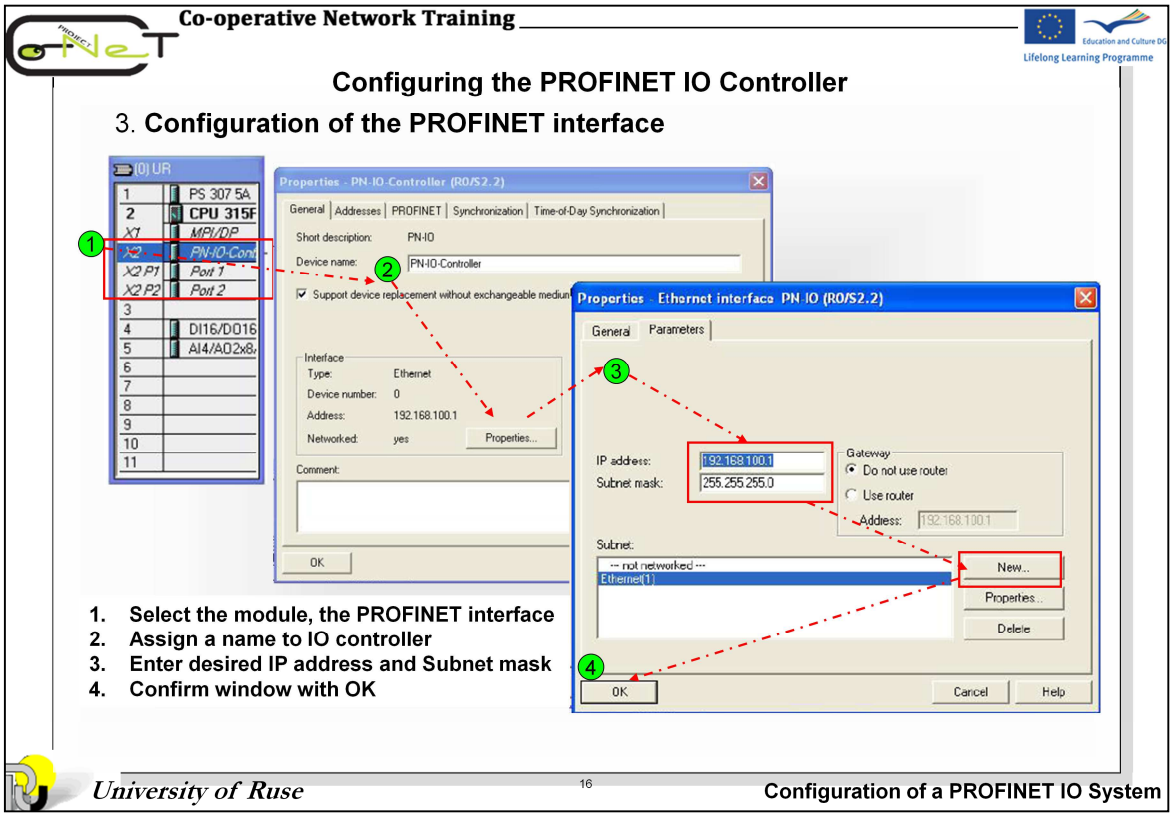
Slots 4-11: Slot 4 is the first slot that can be used for I/O modules, communications processors (CP) or function modules (FM).

Addressing examples:

- A DI module in slot 4 begins with the byte address 0 .
- The top LED of a DO module in slot 6 is called Q8.0 .

Note

1. Four byte addresses are reserved for each slot. When 16-channel DI/DO modules are used, two byte addresses are lost in every slot!
2. With the S7-300™ (CPUs with integrated DP interface) and with the S7-400™, you can assign parameters to the starting addresses of the modules



Select the module, the PROFINET interface of which should be configured. This is shown exemplarily by the CPU 315F-2 PN/DP control.

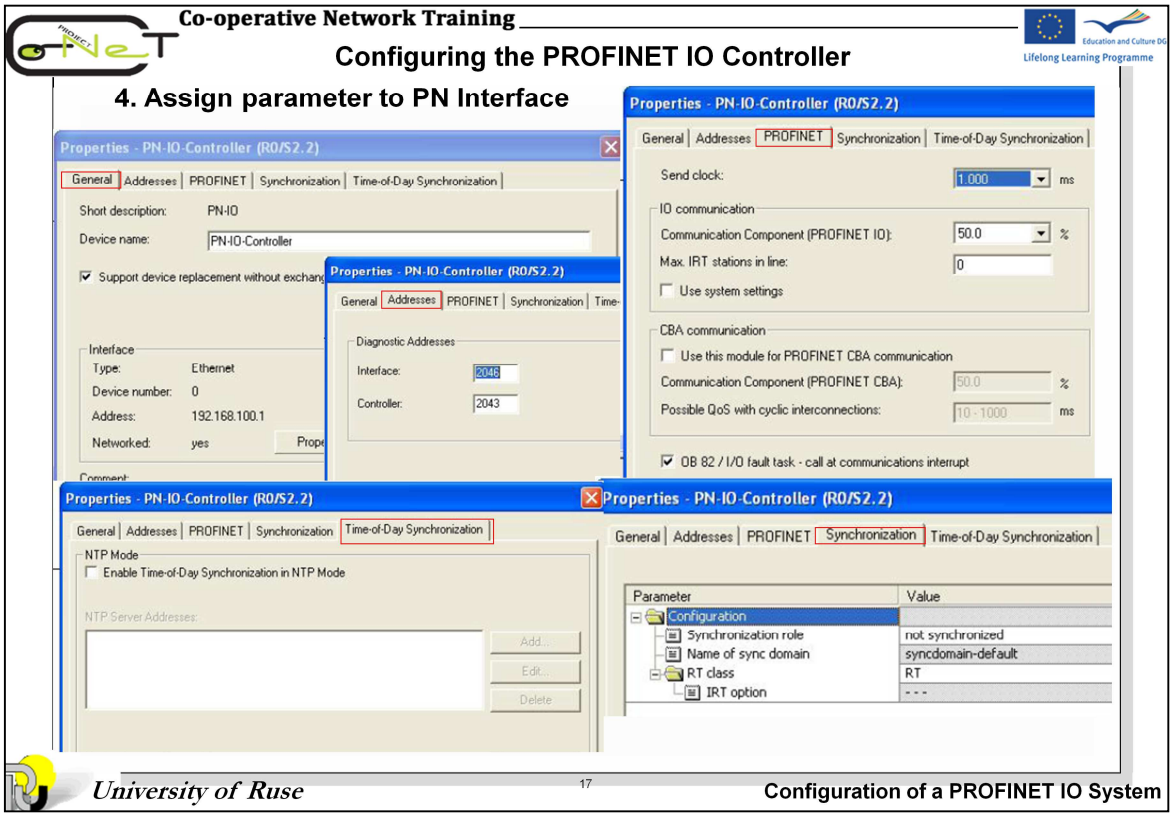
Call the "Properties" dialog box of the PROFINET interface or its port(s) by double-clicking:

- PN-IO (PROFINET interface X2)
- Port 1 (port 1 of interface X5: X5 P2)
- Port 2 (port 2 of interface X5: X5 P2)

Assign a name to IO controller

The window with the Ethernet properties of the CPU opens. Enter the desired IP address and Subnet mask. Click on New to create a new Industrial Ethernet subnet. Use the suggested entries and confirm all windows with OK.

The CPU has been inserted into the S7 controller with PROFINET IO network.



The following PN interface parameters can be edited or displayed via the describing tab:

- **General**

– Name of the interface of the IO controller

– IP address

– Subnet mask

– Gateway

- **Addresses**

– Diagnostics address of the interface of the IO controller and of the IO controller itself

- **PROFINET**

– Send clock (can only be edited in the "Synchronization" tab, if the PN device is not configured in a sync domain)

– IO communication traffic of PROFINET IO and PROFINET CBA

– Call OB 82 for communication alarm

- **Synchronization**

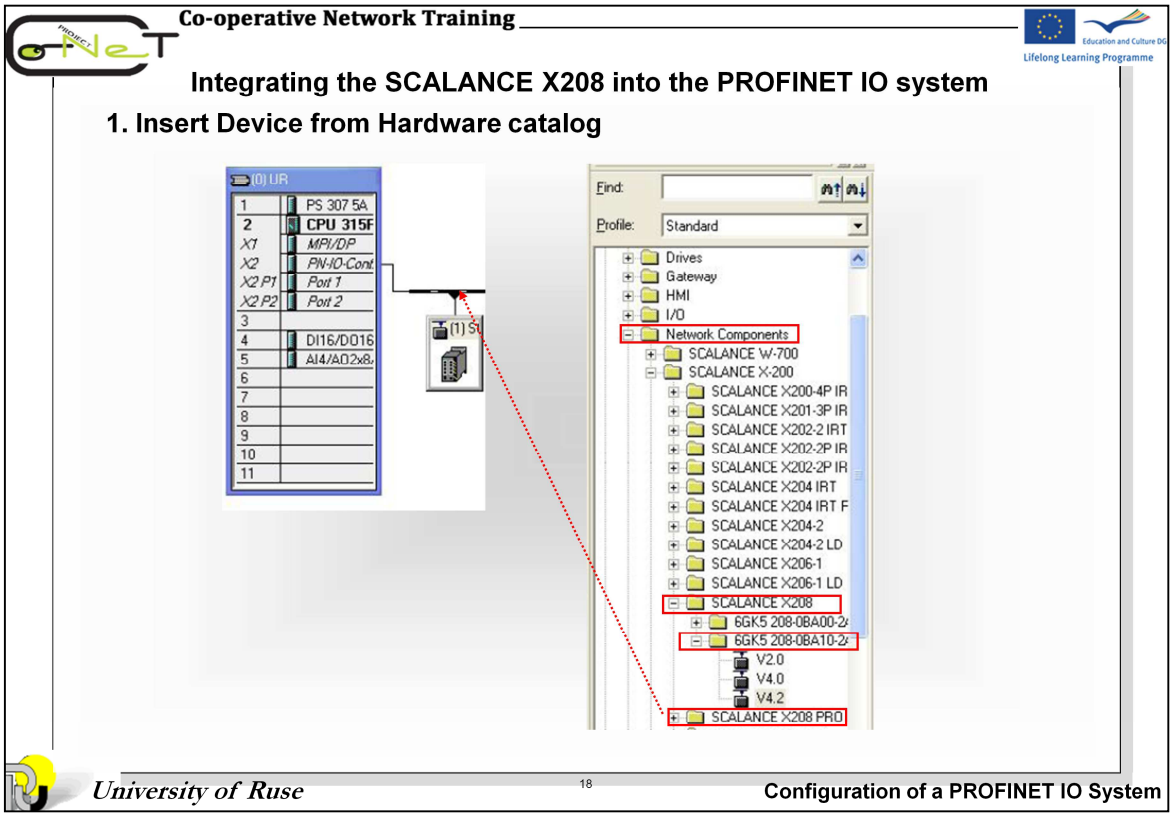
– Synchronization role

– Name of the sync domain (can be edited in the PROFINET IO domain management)

– RT class and IRT option

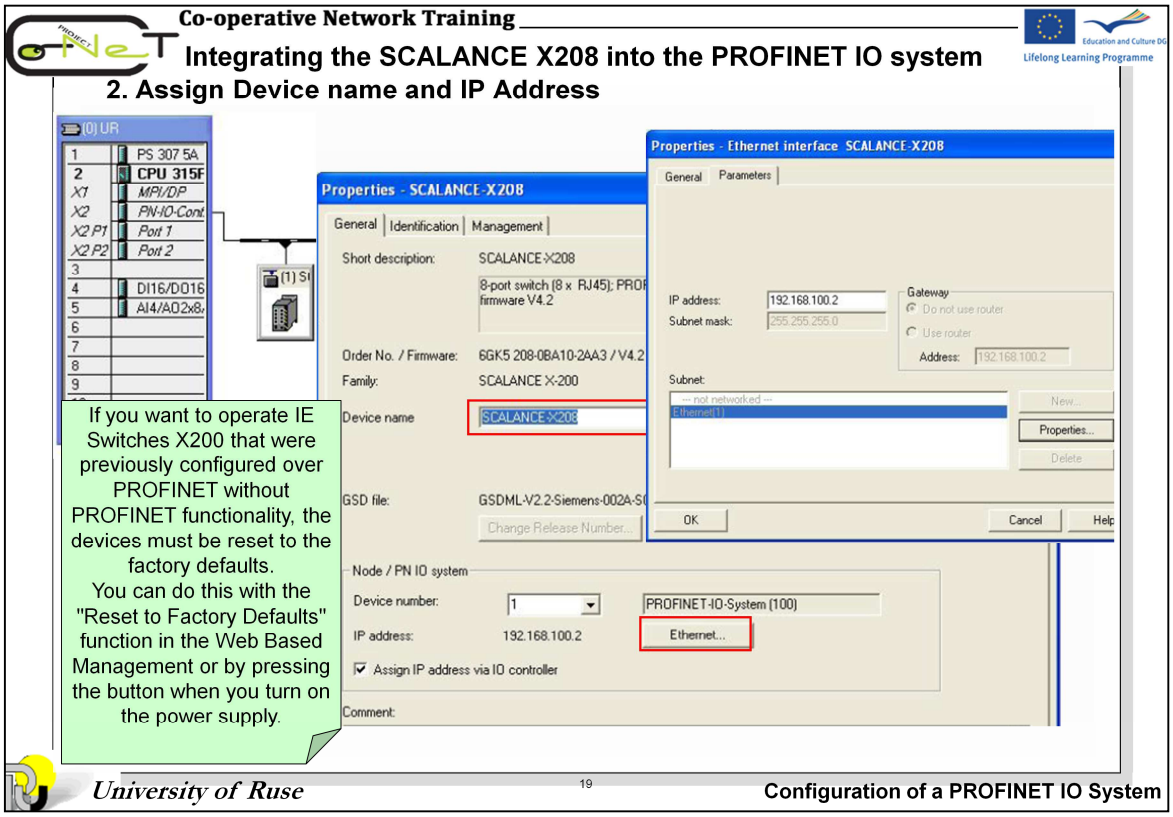
- **Time synchronization**

– NTP process with update interval



In the hardware catalog, navigate to PROFINET IO -> Network Components -> SCALANCE X-200 -> SCALANCE X208 Select order number and version of your switch.

Use drag & drop to move it to the PROFINET network.



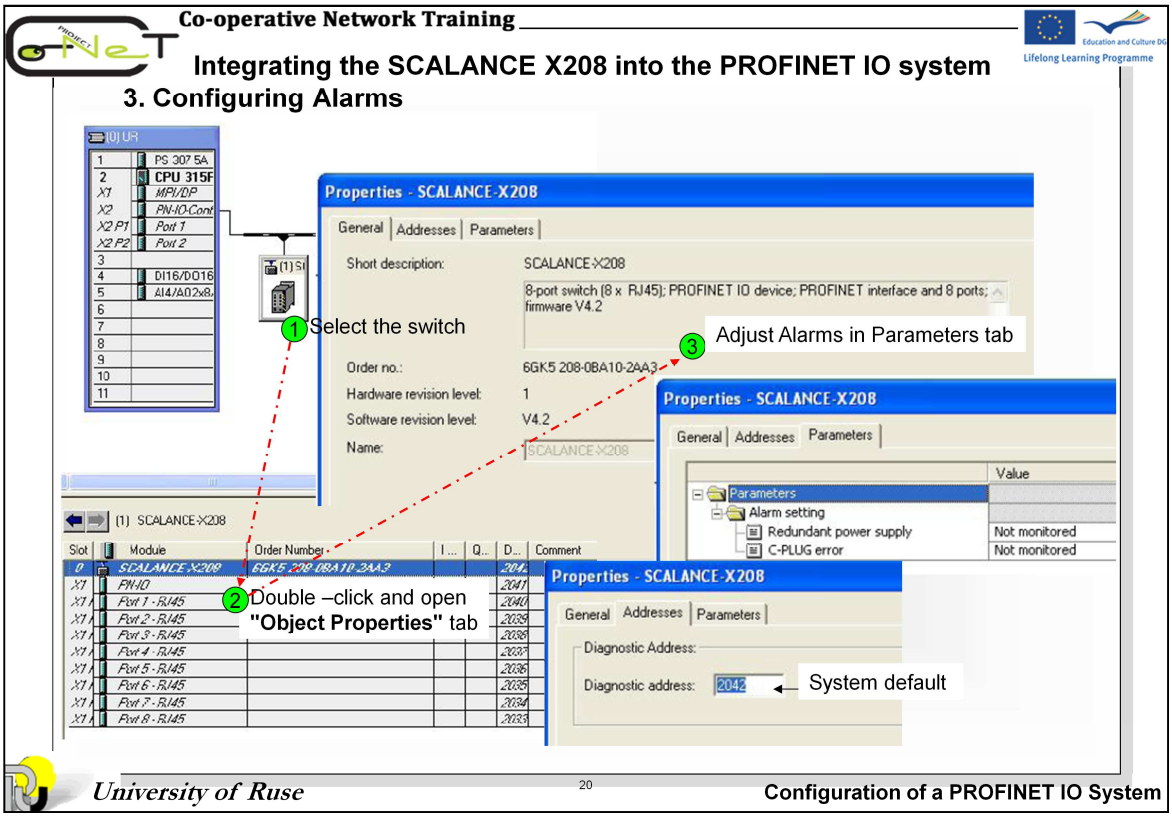
Double-click on the module to open the Properties dialog box of the module. In this dialog box, you can enter

- the device name,
- the GSD XML file to be used and
- the IP address to be assigned.

To change the device name, enter the new name in Device Name.

Use the Change Release Number… button to select the GSD XML file to be used by the system. It is recommended that the most current version be used. Close the window with OK

Use the Ethernet… button to enter the IP address of the SCALANCE X208. The system specifies a free IP address in the STEP7 project, it can be adjusted as desired. The address is dynamically assigned during startup of the controller. Close the dialog boxes with OK.



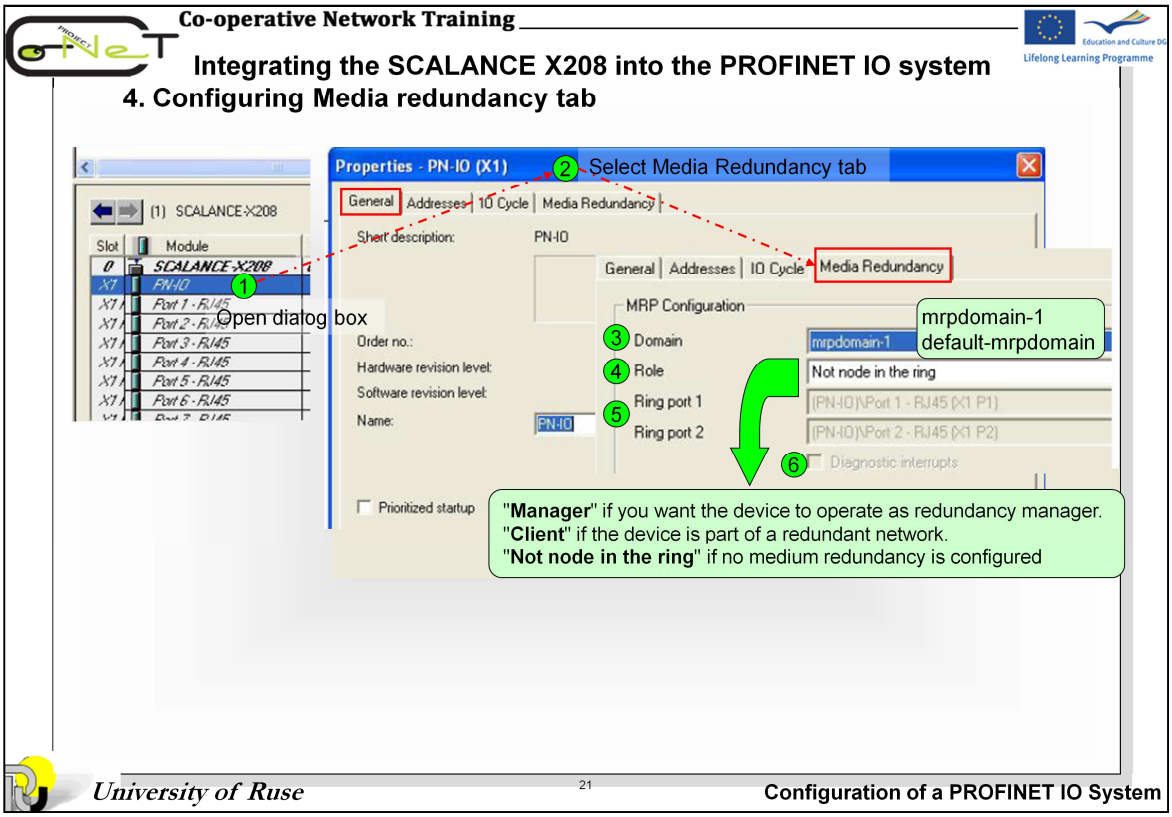
1. To open dialog with the general settings, select the device whose settings you want to change. In the lower half of the station window, there is a detailed view of the selected device.
2. Double-click on slot 0 to open the properties dialog of the PROFINET interface. As an alternative, the properties dialog can also be opened by right-clicking on slot 0 and selecting the "Object Properties" entry from the context menu.
3. Then select the "Parameters" tab. Here, you can make the following settings:

   Redundant power supply:

   - Not monitored -The failure of one of the two power supplies does not cause an alarm to be generated.
   - Monitored -The failure of one of the two power supplies causes an alarm.

   C-PLUG

   - Not monitored -No alarm results from a C-PLUG error.
   - Monitored - A C-PLUG error causes an alarm.
4. On the Diagnostic Address, the Switch reports for synchronization errors or media redundancy errors of the IO controller using this diagnostic address providing that the IO controller supports this function.



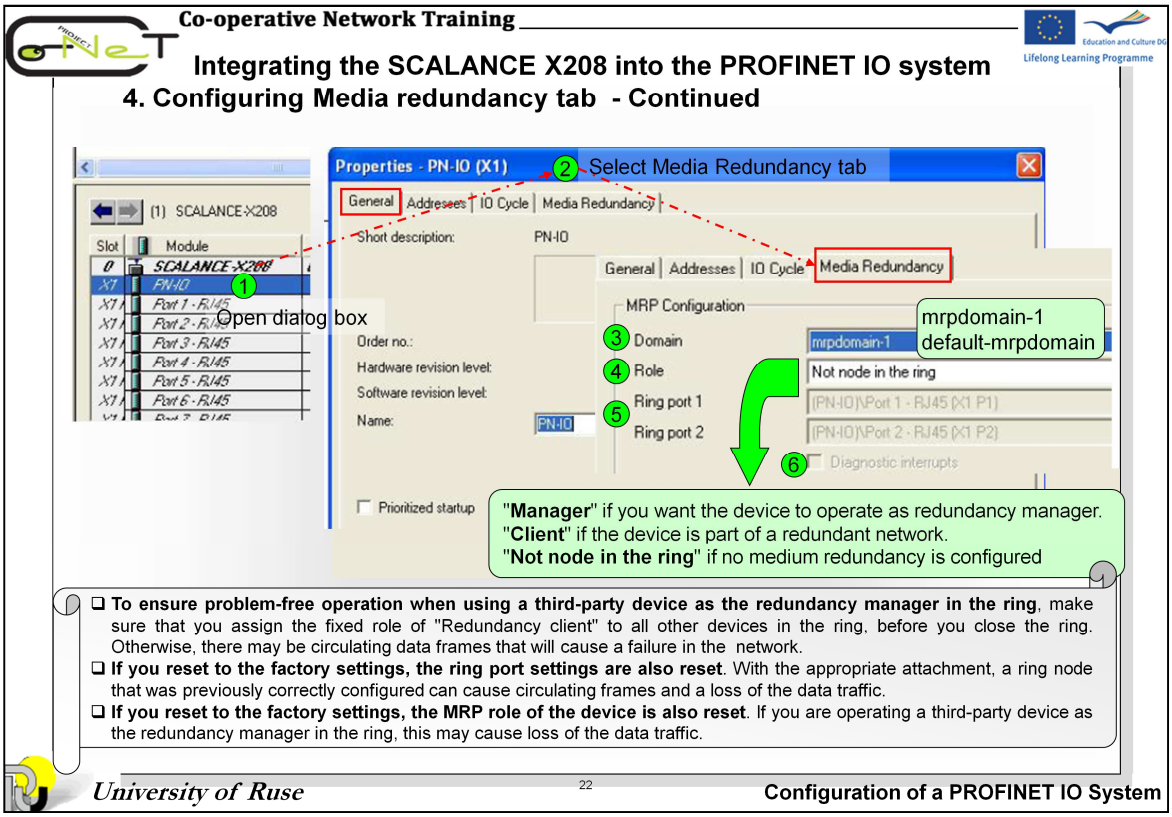
1. Open the properties dialog of the PROFINET interface by double-clicking on the PN-IO slot in the lower half of the station window (detailed view of the selected device). As an alternative, the properties dialog can also be opened by right-clicking on the PN-IO slot and selecting the "Object Properties" entry from the context menu.
2. And go to the "Media Redundancy" tab. You can set the following parameters in the "MRP configuration" box to configure MRP for the device:

● Domain

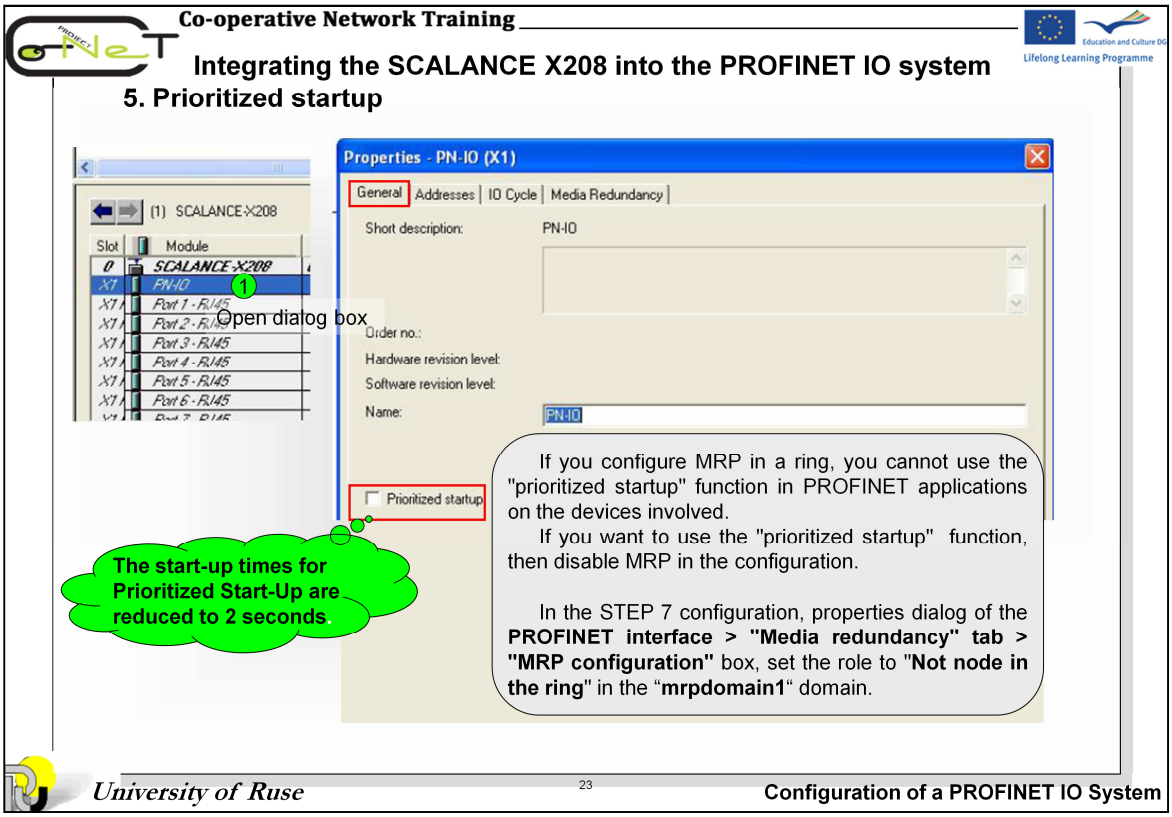
- All devices configured in a ring with MRP must belong to the same redundancy domain. A device cannot belong to more than one redundancy domain. Select the same domain for all devices of your ring from the drop-down list ("mrpdomain-1").
- If you leave the setting for "Domain" as the factory set "default-mrpdomain", the factory settings for "Role" and "Ring ports" also remain active.
- *The MRP settings remain in effect following a restart of the device or following a power down and hot restart*.

● Role The choice of role depends on the following uses:

- You want to use MRP in a ring topology *only with Siemens devices* and without monitoring diagnostic interrupts - Assign all devices to the "default-mrpdomain". The device that actually takes over the role of redundancy manager, is negotiated by Siemens devices automatically.
- You want to use MRP in a ring topology that also includes third-part devices or you want to receive diagnostic interrupts relating to the MRP status from a device (see "Diagnostic interrupts") - Select the "Manager" role for one device (and one only) that will be redundancy manager in the ring. With all other devices in the ring topology, select the role of "Client".
- You want to disable MRP - Select the option "Not node in the ring" if you do not want to operate the device within a ring topology with MRP.



- **Ring port 1 / ring port 2** - Here, select the port you want to configure as ring port 1 and ring port 2. The drop-down list shows the selection of possible ports for each device type. If the ports are specified in the factory, the boxes are grayed out.
- **Diagnostic interrupts** Select the "Diagnostic interrupts" option, if you want diagnostic interrupts relating to the MRP status to be output on the local CPU. The following diagnostic interrupts can be generated:
    - **Wiring or port error** - Diagnostic interrupts are generated if the following errors occur at the ring ports:
        - ✓ A neighbor of the ring port does not support MRP
        - ✓ A ring port is connected to a non-ring port
        - ✓ A ring port is connected to the ring port of another MRP domain.
    - **Interruption / return** (redundancy manager only).If the ring is interrupted and when the original configuration returns, diagnostic interrupts are generated. The occurrence of both interrupts within 0.2 seconds indicates an interruption in the ring.



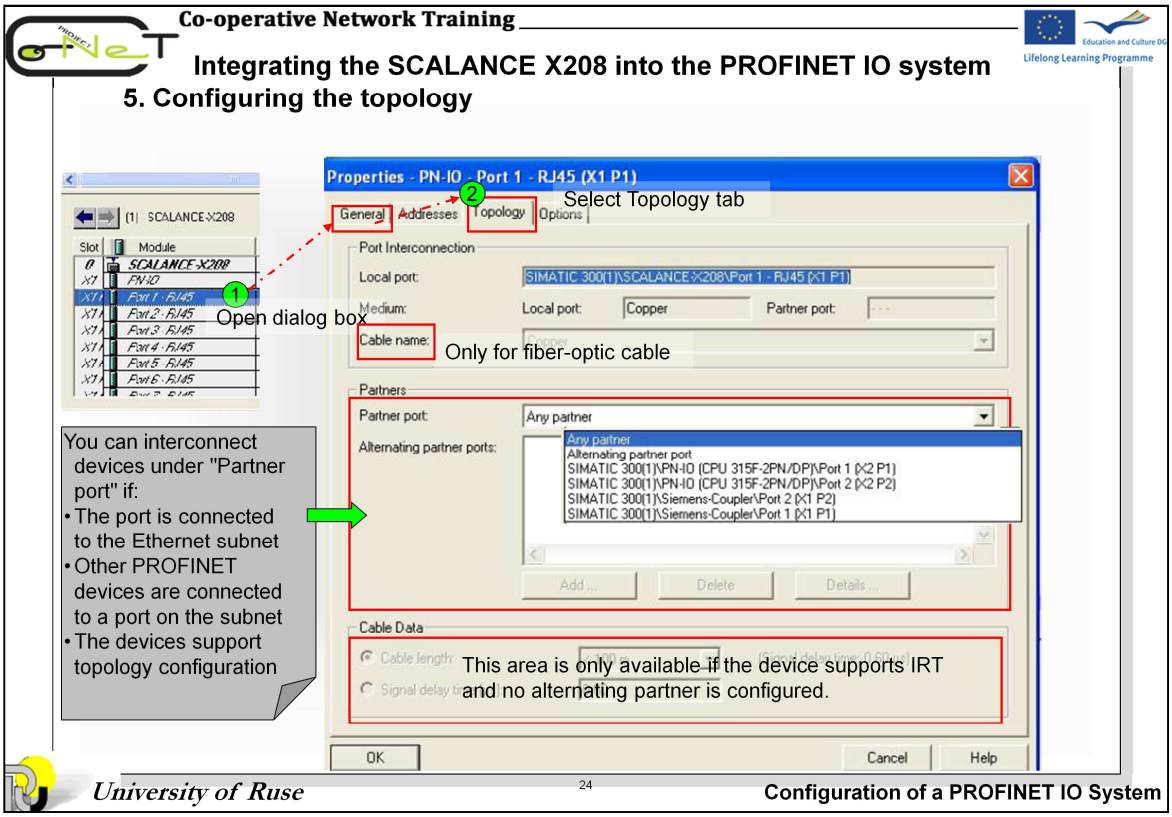
Prioritized startup

Select the "Prioritized startup" check box to speed up the startup of the IO device (earlier entry into data exchange between controller and device). The check box can only be selected in the following situations:

- The IO controller you are using can prioritize selected IO devices during startup.
- The IO device you are using supports prioritization.

Within a PROFINET IO system, you can only prioritize a certain maximum number of IO devices that depends on the IO controller you are using. To achieve the fastest startup times, you should also keep the following points in mind:

- In the port properties of the IO device, select a concrete transmission medium (for example TP/ITP at 100 Mbps full duplex) and select the "Disable autonegotiation" check box. This can save up to three seconds startup time. Note: This requires, in particular, the use of dedicated cable.
- If supported by the IO device, use a fixed IP address assignment for the IO device. You can do this by deselecting "Assign IP address via IO controller" on the IO device and initializing the IO device using the "Primary Setup Tool" or the "Lifelist".
- Where possible, use fast starting IO modules in modular IO device (for details, refer to the relevant module description).



Procedure

1. Double-click on the required port to open its properties dialog. As an alternative, the properties dialog can also be opened by right-clicking on the relevant port and selecting the "Object roperties" entry from the context menu.
2. Then select the "Topology" tab.

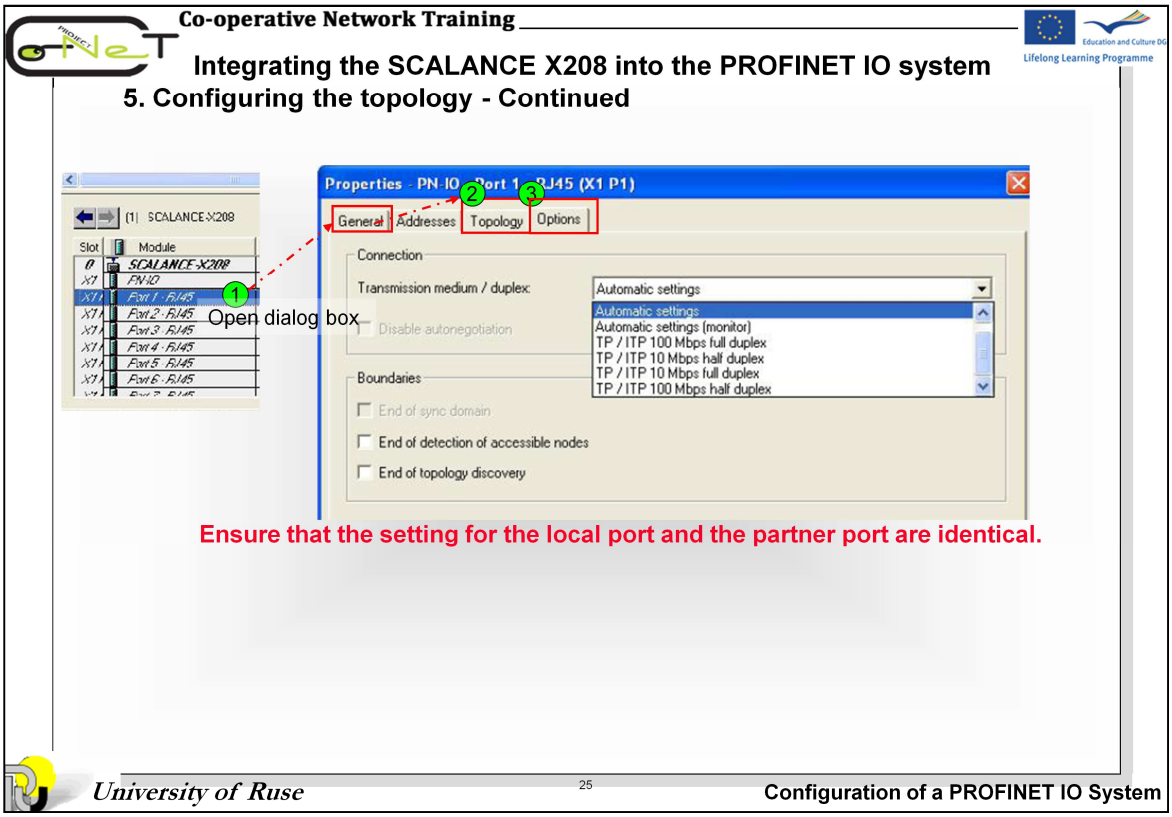
Partner-Port

Here, you can configure the appearance of the topology to be monitored. To do this, select the port of another device from this configuration in the "Partner Port" menu that is connected to the currently selected port:

- if you want alternating ports to be monitored, select the entry "Alternating partner port".
- If you do not want to monitor the topology, select "Any partner". This is also the default setting.

Alternating partner ports

Here, select all the ports you want to be monitored as alternating partner ports.



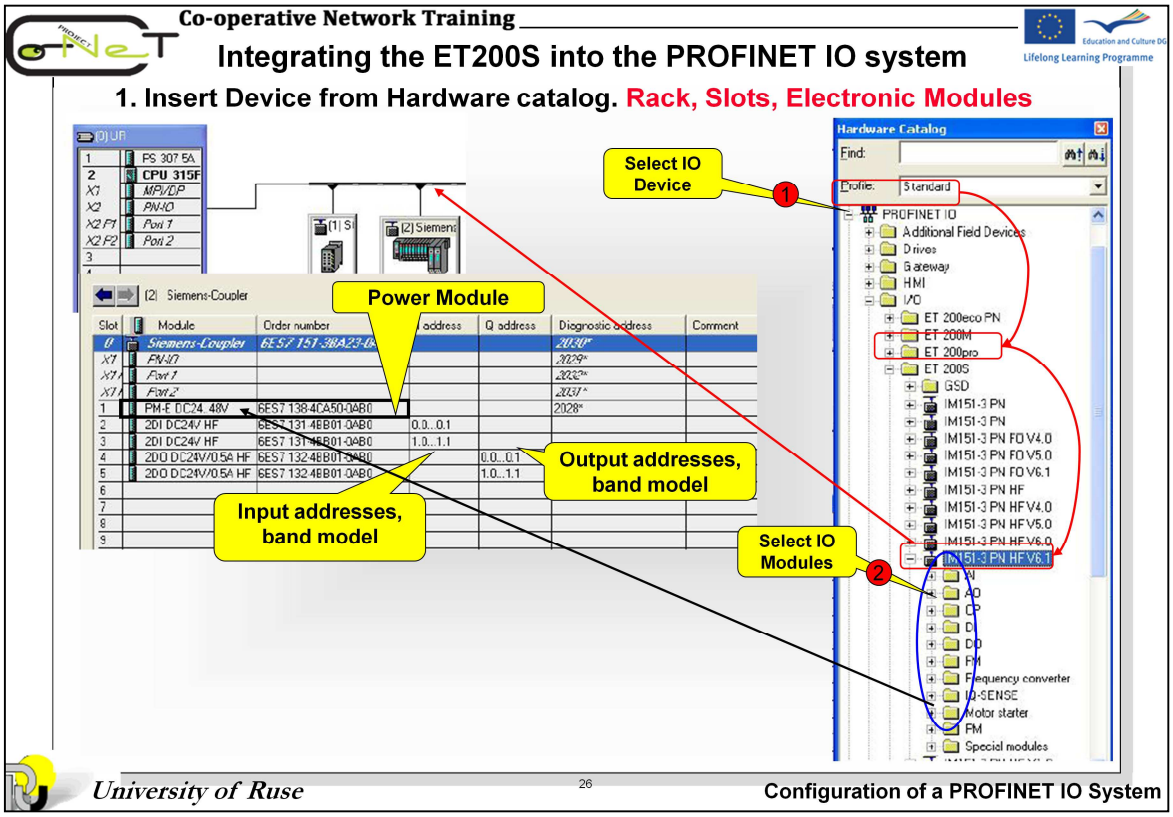
Connection: If necessary, you can enter fixed port settings here. By default, "Automatic setting" is already selected. Usually, this setting will provide smooth, problem-free communication.

Automatic settings: Recommended default setting for the port. The transmission settings are automatically "negotiated" with the partner port. "Autonegotiation" is also automatically enabled with this setting.

Automatic settings (monitor): diagnostics. Examples of port diagnostics: the link status is monitored, in other words, diagnostic information is generated for link down and the link power budget is monitored for fiber-optic ports.

TP / ITP at x Mbps full duplex (half duplex): Sets the transmission speed and full duplex / half duplex mode. The effect depends on the setting "Disable auto-negotiation ".

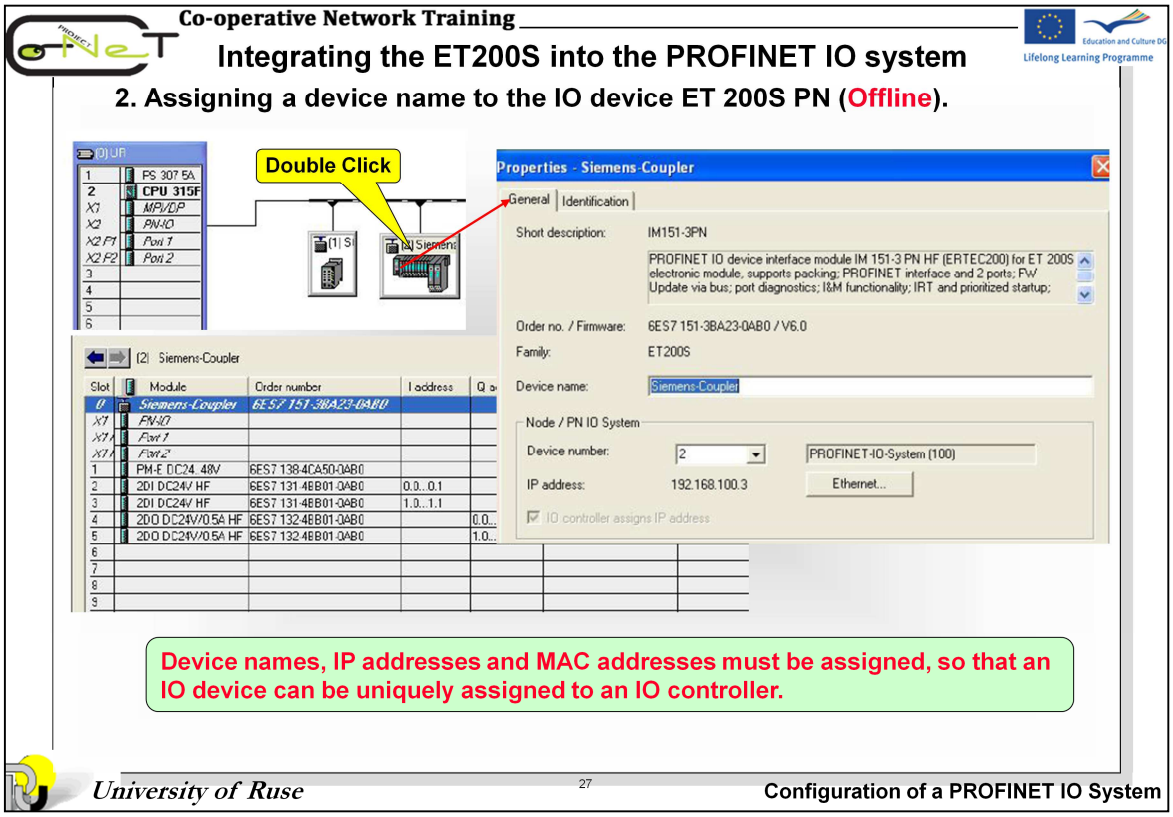
Disabled: Depending on the module type, the "disabled" option may be offered in the drop-down list. You then, for example, prevent access to an unused port for security reasons.



Drag-and-drop IM151-3 PN from the PROFINET IO > I/O > ET 200S catalog to the PROFINET IO system.

From the hardware catalog, drag-and-drop the various ET 200S modules into the configuration table, according to the physical installation of the PROFINET IO devices.

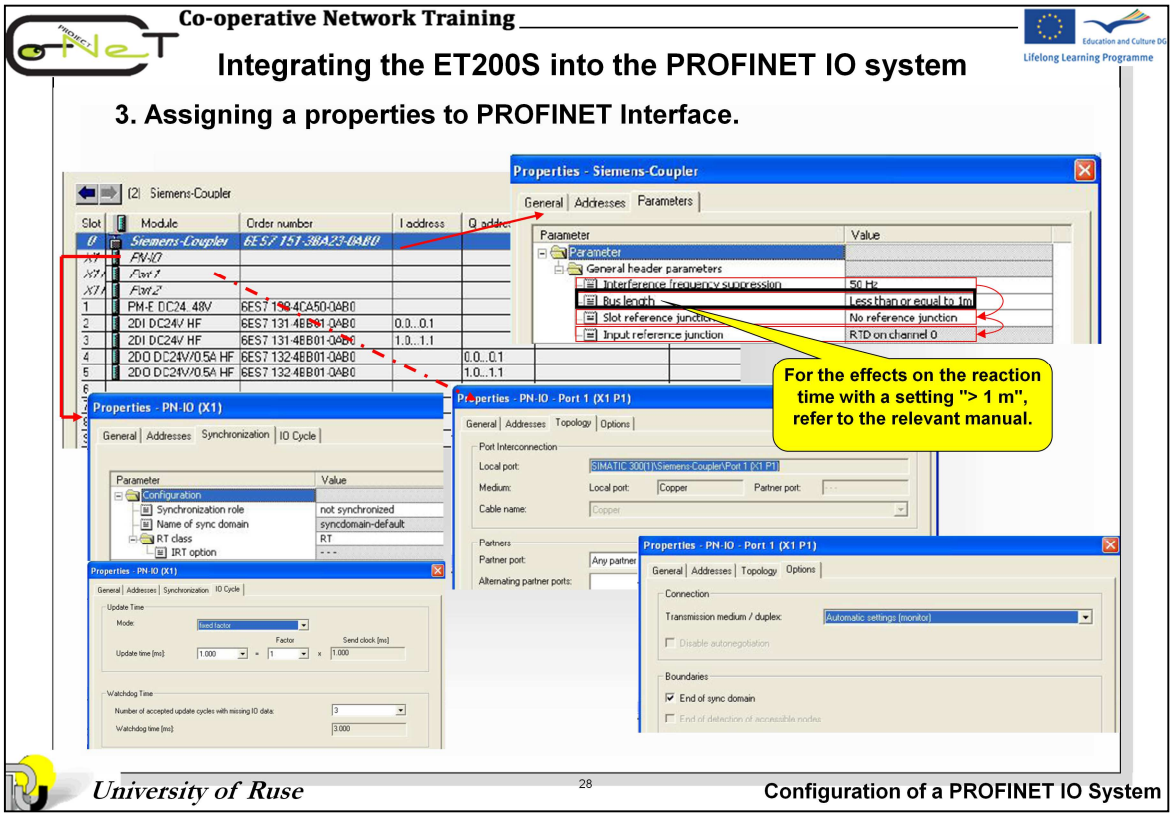
In the field devices (IO Devices) of type ET 200S requires placement of power modules in accordance with the required input / output configuration



Double-click on the IM 151-3 station to open the Properties window of the head module. In this window, you can adjust the IP address or the device name. The device name Siemens-Coupler is used here. Confirm with OK.

The CPU 31x-2 PN /DP will automatically assign further IP addresses in ascending numerical order starting from the configured base IP address (IO controller) provided this option is not deactivated.

The IP address can be changed within the permissible range in the "Edit IP addresses" window, if necessary.



1. Double-click on slot 0 to open the properties dialog of the PROFINET interface. As an alternative, the properties dialog can also be opened by right-clicking on slot 0 and selecting the "Object Properties" entry from the context menu.
2. Then select the "Parameters" tab. Here, you can make the following settings:

Bus length

≤ 1 m: The default setting for the maximum bus length is 1 m.

> 1 m: The bus length of the ET 200S is > 1 m and can be up to 2 m. However, this setting will increase the response time of the ET 200S.

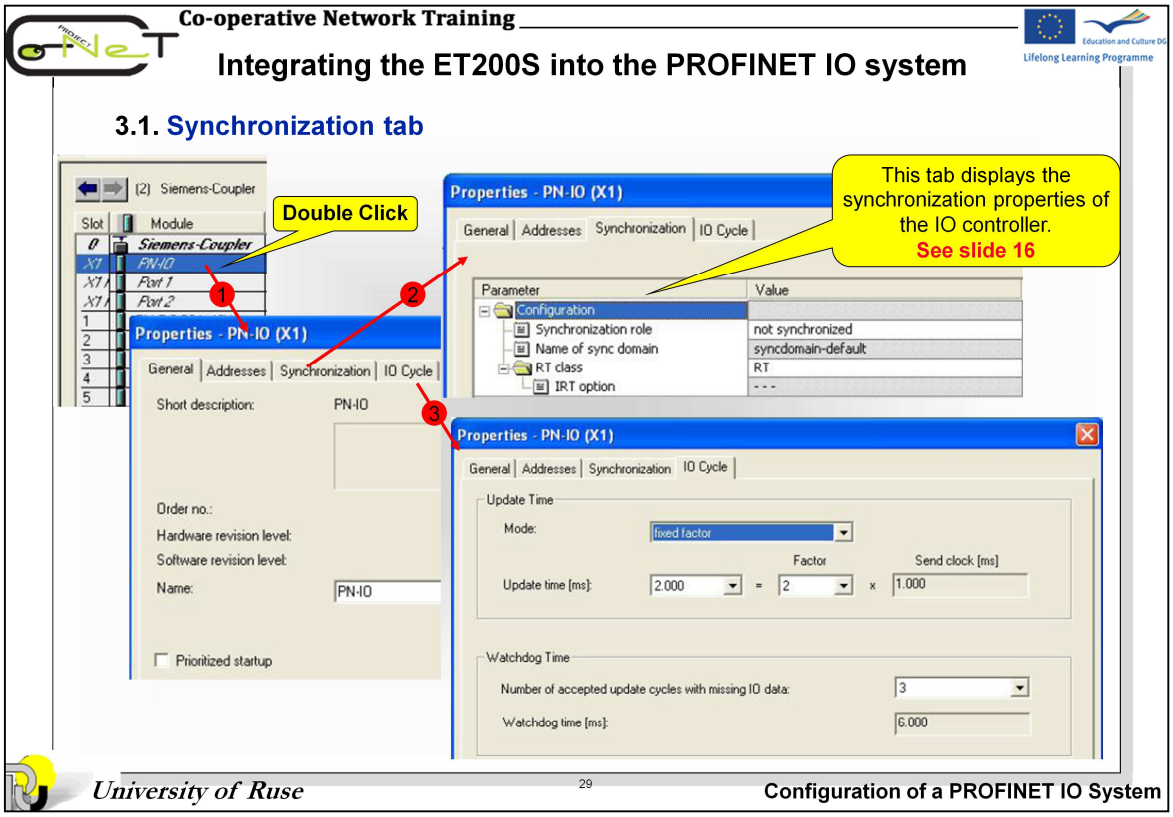
Interference frequency suppression

The interference frequency suppression parameter applies to all analog electronic modules. This parameter is also used to specify the integration and conversion time of the various modules.

See the technical data for the analog electronic modules.

Reference junction slot -This parameter allows you to assign a slot (none, 2 to 63) with a channel for measuring the reference temperature (calculation of the compensation value).

Reference junction input -This parameter can be used to set the channel (0/1) for measuring the reference temperature (calculation of the compensation value) for the assigned slot.



Synchronization tab displays the synchronization properties of the IO controller.

Synchronization Role: The role of the PROFINET device with respect to synchronization: A **"sync master"** transmits sync signals at equal time intervals; **"sync slaves"** synchronize themselves with this signal. "**Not synchronized**" is selected, if the device is not to take part in synchronized data exchange (IRT).

In the synchronization role "**not synchronized**", the RT class "RT" is set. If "sync master" or "sync slave" is selected as the synchronization role, RT class "IRT" is set automatically.

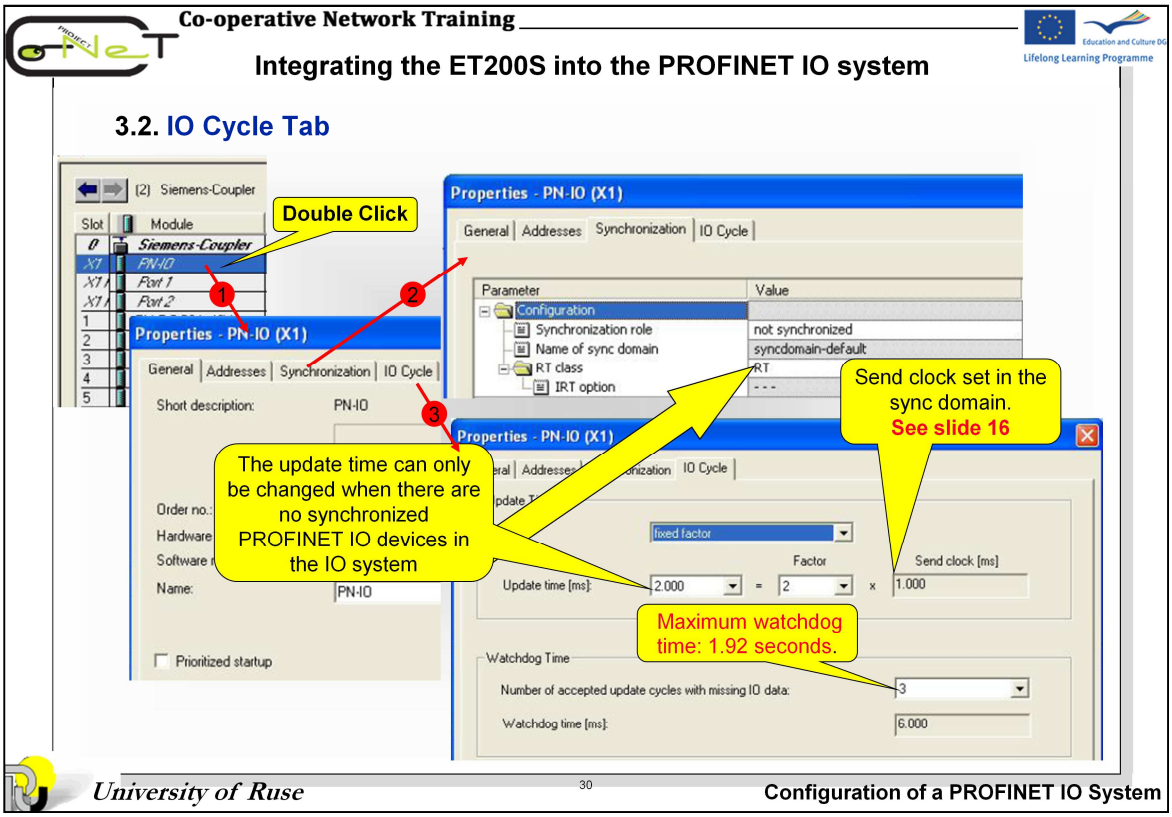
The name of Sync Domain matches the name specified in the IO controller:

With RT class you can only select classes supported by the device. The following real-time classes are available:

- **RT:** Transfer of data in prioritized Ethernet frames, not in isochronous mode. The required bandwidth is in bandwidth reserved for cyclic data.
- **IRT:** Transmission of data in isochronous mode with high stability for time-critical applications (for example motion control). The required bandwidth is in bandwidth reserved for cyclic data.
- **IRT*:** Transmission of data in isochronous mode with high stability for time-critical applications (for example motion control). The topology must be planned.

IRT option can be selected only for IRT classes. The two available options differ in terms of deterministic:

- **High flexibility**: A fixed bandwidth is reserved in the transmission resources for real-time communication. The "high flexibility" allows simple planning and expansion of the plant.
- **High performance**: A fixed bandwidth is reserved in the transmission resources for real-time communication. Topology planning optimizes the data traffic and speeds it up further. The "high performance" option requires configuration of the topology.



Mode:

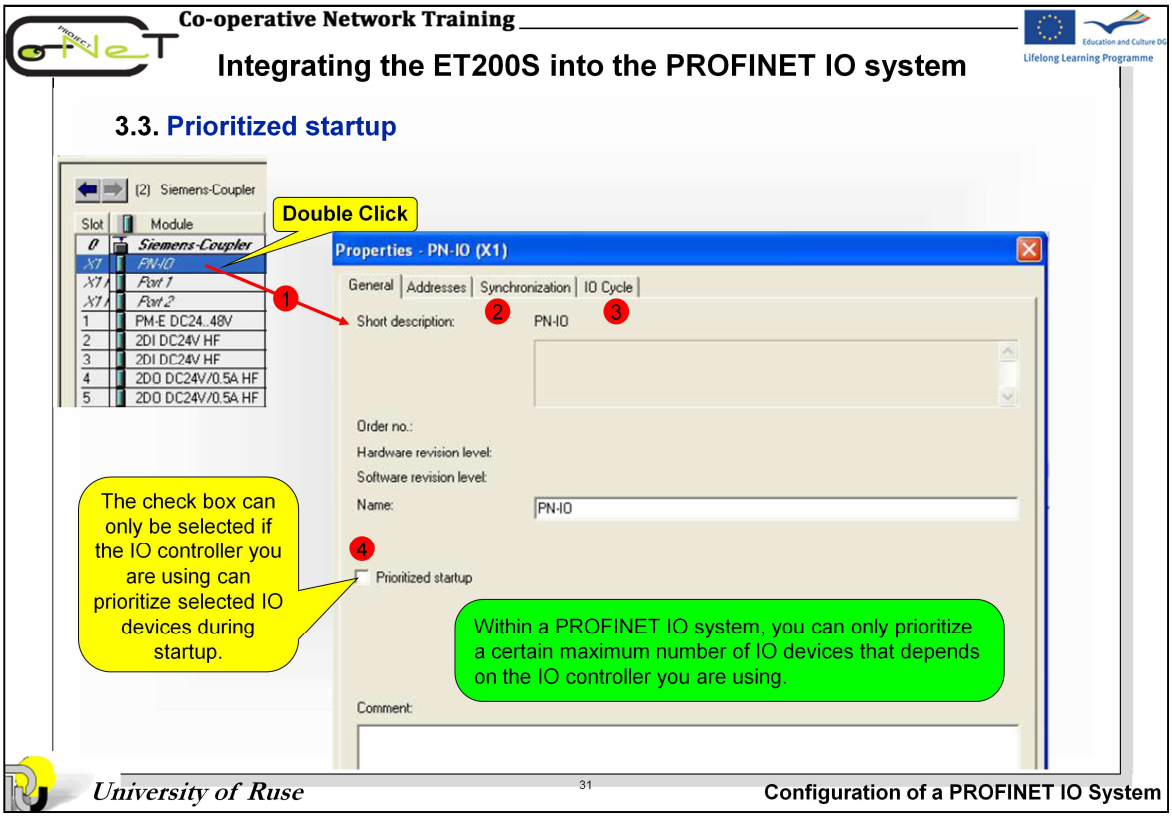
The following can be set:

- **"Automatic":** STEP 7 finds the best solution for the user. The update time is kept as short as possible and as high as necessary, so that no errors or warnings can occur.
- **"fixed update time":** The update time of the IO device is set to a fixed value by the user. With this setting, errors are possible in the consistency check.
- **"fixed factor":** The user sets the reduction ratio with which the IO device is updated (for example, factor 2 for updating on every second clock pulse sent).

Factor - Reduction ratio.

Number of accepted update cycles with missing IO data -To make adaptations in problem situations, you can change the default number of accepted update cycles with missing IO data (for example during commissioning). This action will also indirectly change the watchdog time. Exceeding the watchdog time will result in an error reaction (the IO device switches its outputs to a safe state).

Watchdog Time - Product of "Update Time" x "Number of accepted update cycles with missing IO data". Maximum watchdog time: 1.92 seconds.



Prioritized startup

Select the "Prioritized startup" check box to speed up the startup of the IO device using device-internal functions (data exchange between controller and device starts earlier).

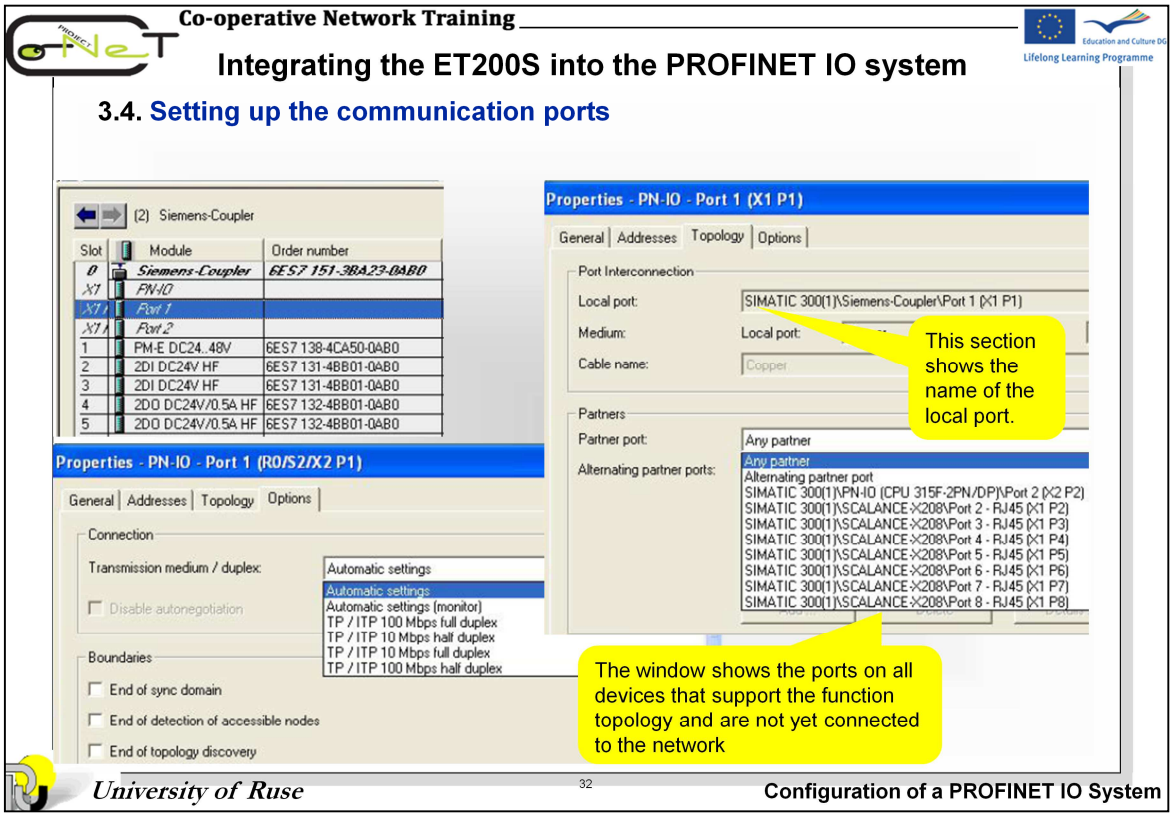
The check box can only be selected if the IO controller you are using can prioritize selected IO devices during startup.

Within a PROFINET IO system, you can only prioritize a certain maximum number of IO devices that depends on the IO controller you are using.

To achieve the fastest startup times, you should also keep the following points in mind (in some situations, the individual actions will speed up the startup even without selecting the "Prioritized startup" check box):

- In the port properties of the IO device, select a concrete transmission medium (for example TP/ITP at 100 Mbps full duplex) and select the "Disable autonegotiation" check box. This can save up to three seconds startup time.

  Note: This requires, in particular, the use of dedicated cables.
- If supported by the IO device, use a fixed IP address assignment for the IO device. You can do this by deselecting "Assign IP address via IO controller" on the IO device and initializing the IO device using the "Primary Setup Tool" or the "Life list".
- Where possible, use fast starting IO modules in modular IO device (for details, refer to the relevant module description).



Setting the communication ports is done by filling in the tables "Topology" and "Options". See slides 23 and 24

Port Interconnection tab shows the name of the local port.

Partners tab - Select the required partner port from the "Partner port" drop-down list. You can interconnect devices under "Partner port" if:

- The port is connected to the Ethernet subnet
- Other PROFINET devices are connected to a port on the subnet
- The devices support topology configuration

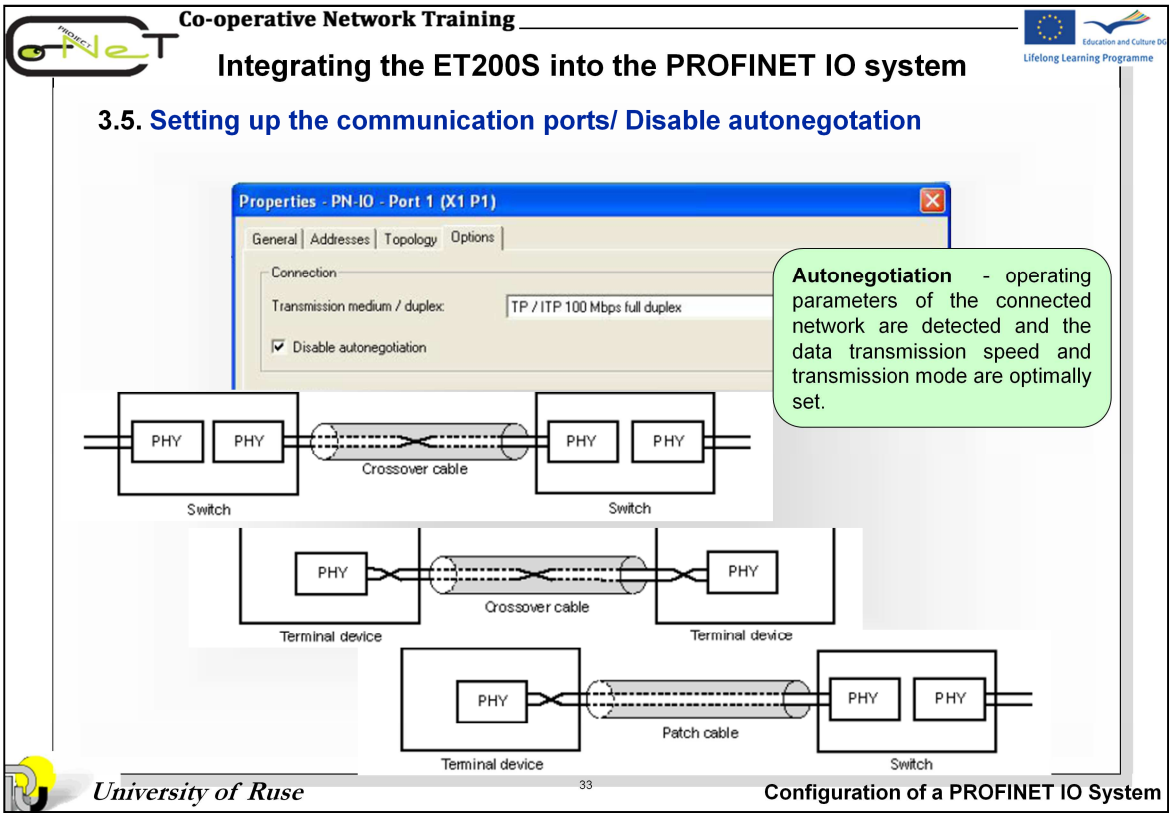
In Option tab/Connection - you can enter fixed port settings here. By default, "Automatic setting" is already selected. Usually, this setting will provide smooth, problem-free communication.

Boundaries are the boundaries for the transfer of certain Ethernet frames. The following boundaries can be set at a port:

- **"End of sync domain"** - Sync frames transferred to synchronize nodes within a sync domain are not forwarded.
- **"End of detection of accessible nodes"** -**DCP** frames for detecting accessible nodes are not forwarded. Ports downstream of this port can then no longer be displayed in the list of accessible nodes. Ports downstream from this port can no longer be reached by the controller.
- **"End of topology discovery"** - **LLDP** frames for topology discovery are not forwarded.

Note the following restrictions:

- The individual check boxes can only be set if the port supports the corresponding feature.
- If a partner port was selected for the port, the following check boxes cannot be set:
  - "End of detection of accessible nodes"
  - "End of topology discovery"
- If the "Disable autonegotiation" check box was selected, none of the boundary check boxes can be selected.



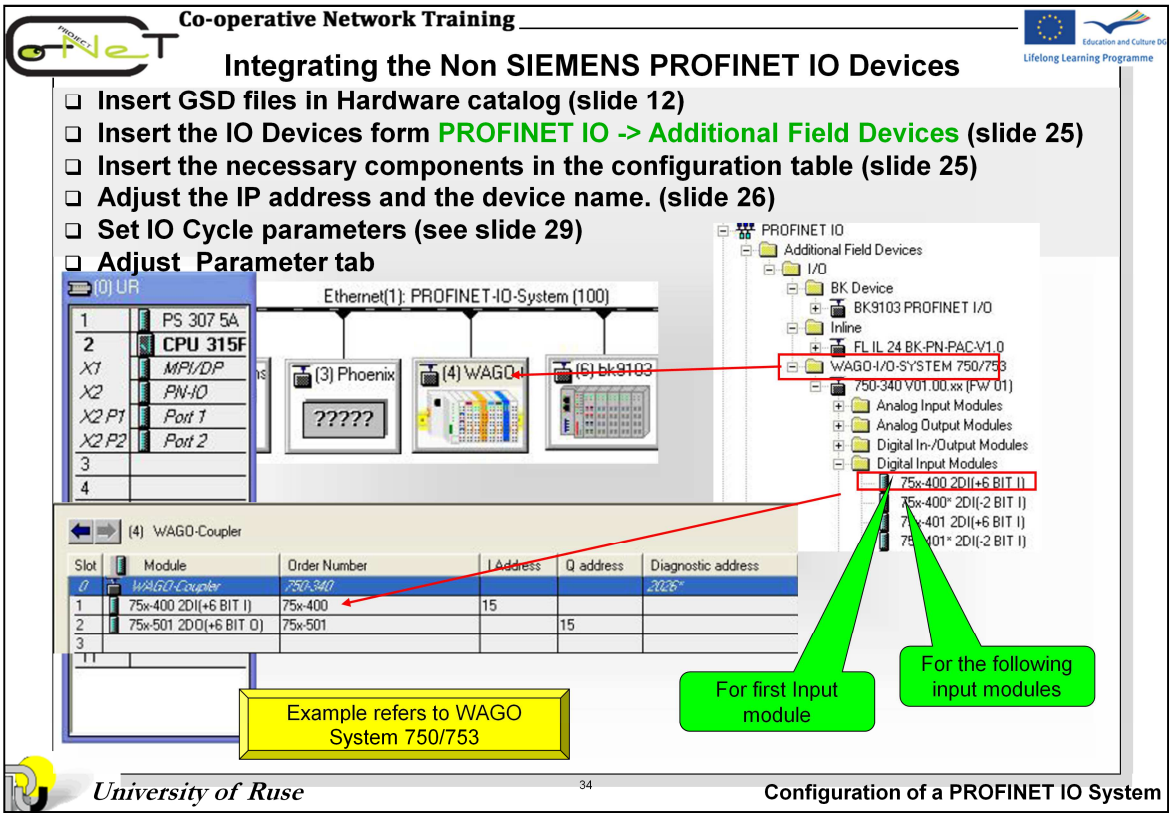
Disable autonegotiation check box can only be controlled when you have selected a concrete medium (such as TP/ITP with 100 Mbps full duplex). The check box has no effect with the automatic setting.

When the check box is selected, the defined setting of the port is forced, such as required for a quick start of the IO device. You need to ensure that the partner port has the same settings since the following functions are **disabled** with this option:

- Autonegotiation (operating parameters of the connected network are detected and the data transmission speed and transmission mode are optimally set)
- Autocrossover - automatic crossover of send/receive lines (depending on the devices involved)
- Autopolarity (also depending on the devices)

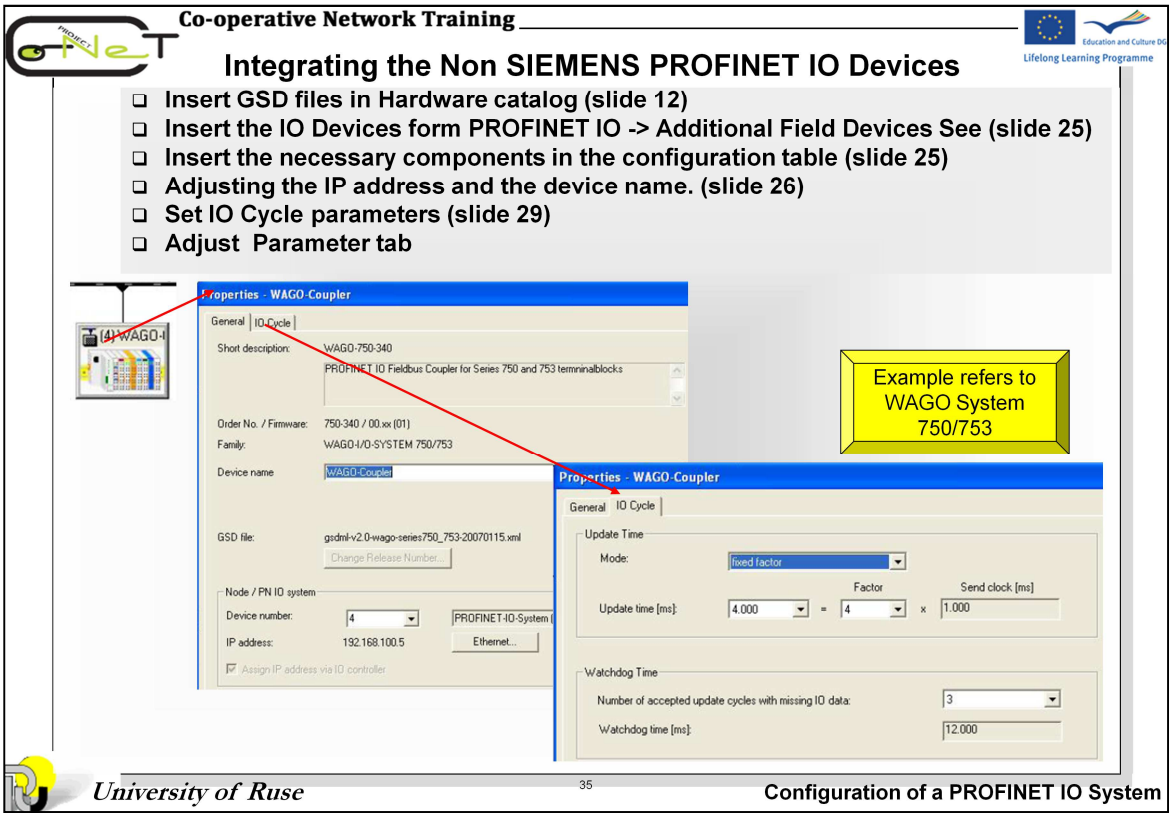
When the " Disable auto-negotiation" option is enabled:

- Make sure that you use the correct cable (see below)! Even with this setting, the port is still monitored.·
- If the above option is disabled you can use both crossover and patch cables. The transmission rate and duplex mode are set automatically and monitored as in "Automatic settings (monitor)". If the automatic settings do not match the selected setting, a diagnostic event is generated.



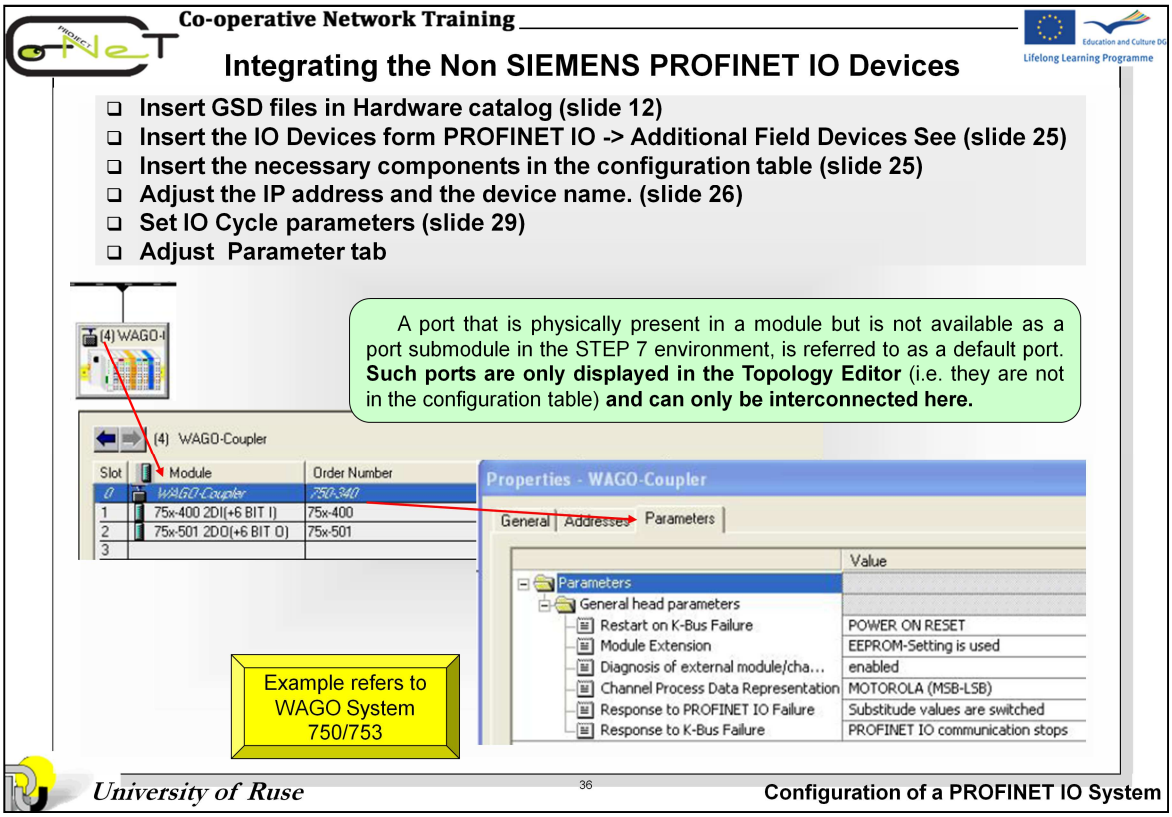
Usually GSD files PROFINET IO devices are not manufactured by SIEMENS, are not included in the hardware catalog of HW Config Tool. To add the device, you use GSD files that are provided by the manufacturer of the device. To include the Device in the hardware catalog, use the *Options -> Install New GSE Files* menu and then *Options -> Update Catalog.* You will find the new devices in the catalog under PROFINET IO, Additional Field Devices.

From the hardware catalog, drag-and-drop the various IO Device modules into the configuration table, according to the physical installation.



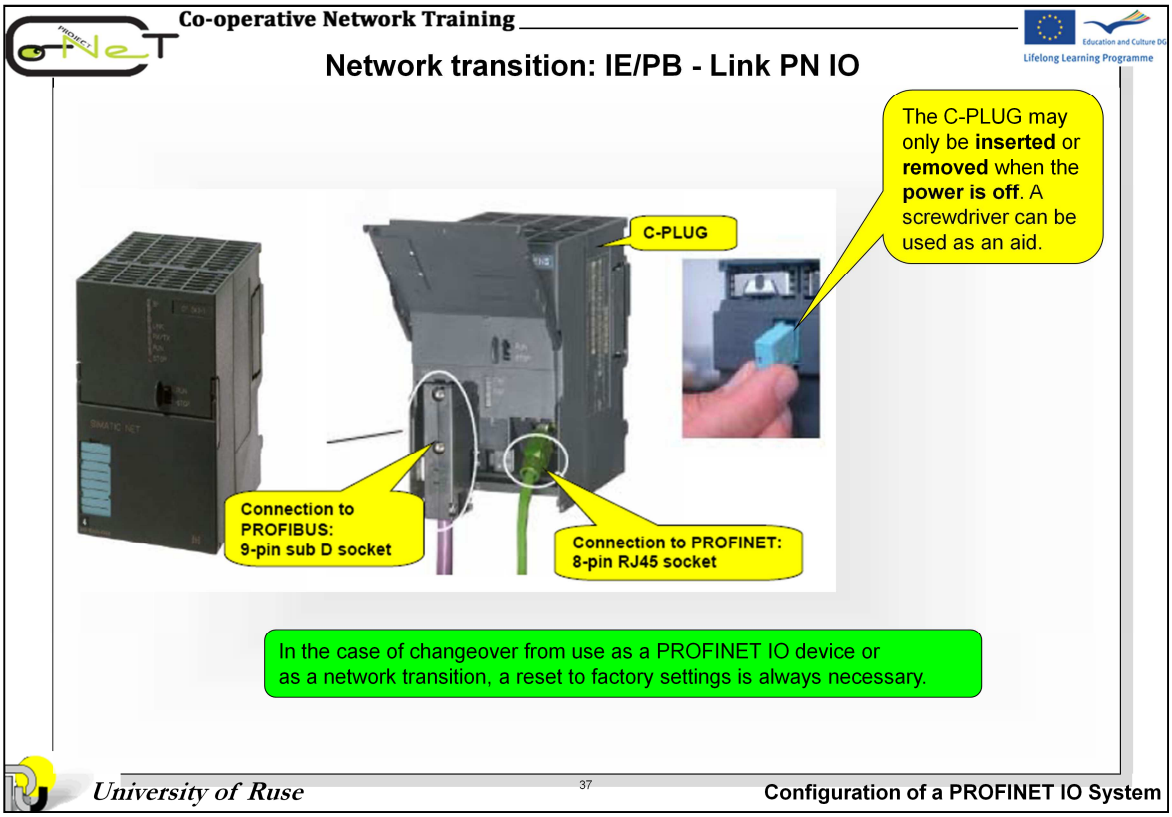
Double-click on slot 0 to open the properties dialog of the PROFINET interface. The "Parameters" tab shows you the parameters for the IO device. These parameters, their representation and the default settings are contained in the GSD file for the IO device. For explanations of each parameter, refer to the manual for the IO device.

See slide 29 for setting IO Cycle parameters



Double-click on slot 0 to open the properties dialog of the PROFINET interface. The "Parameters" tab shows you the parameters for the IO device. These parameters, their representation and the default settings are contained in the GSD file for the IO device.

For explanations of each parameter, refer to the manual for the IO device.



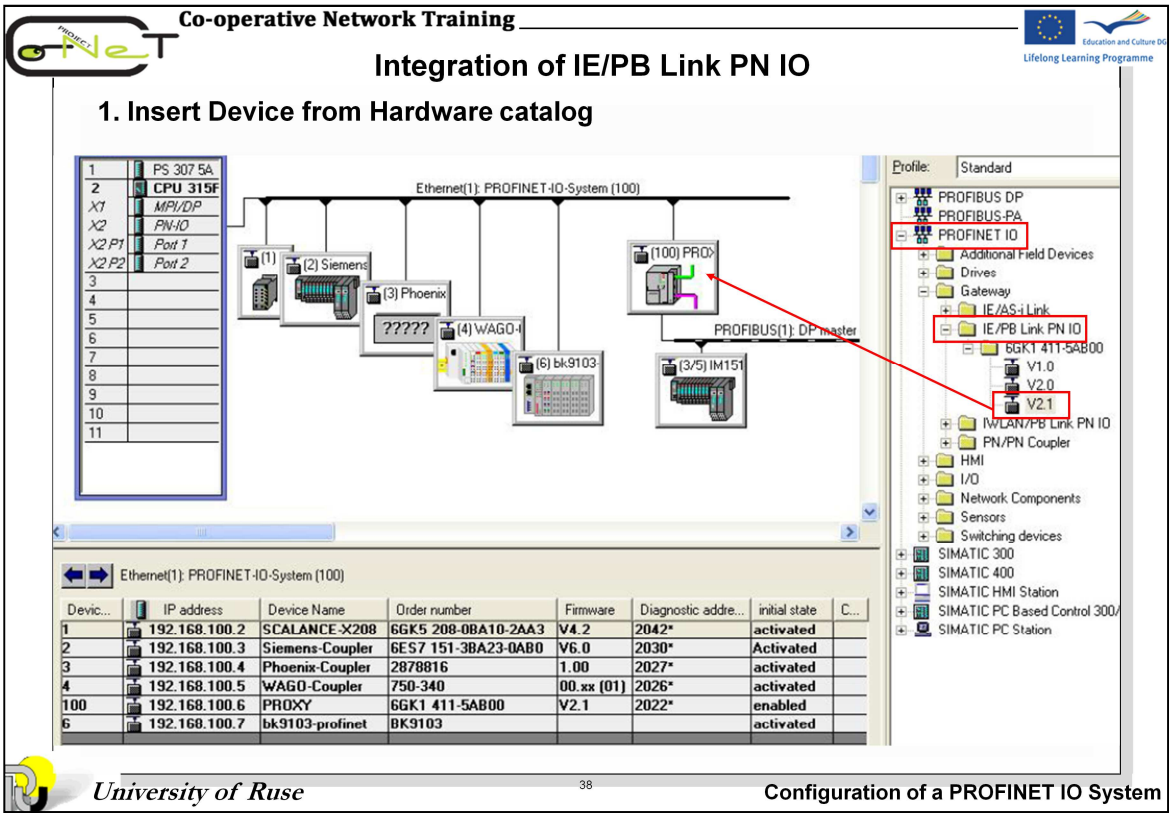
The IE/PB Link PN IO is a stand-alone component for connecting Industrial Ethernet to PROFIBUS DP. By means of the IE/PB Link PN IO as proxy, the existing PROFIBUS slaves can continue to be used and integrated into a PROFINET application.

As a PROFINET IO proxy, the link connects PROFIBUS DP slaves to PROFINET IO controllers through real-time communication (RT) with the PROFINET standard. Additional functions of IE/PB Link PN IO are S7 routing and data record routing over PROFIBUS DP.

S7 routing supports cross-network PG/OP communication. All S7 stations on Industrial Ethernet and on PROFIBUS can be remotely programmed from the programming device. SIMATIC PDM PROFIBUS field devices can be parameterized and diagnosed by means of data record routing.

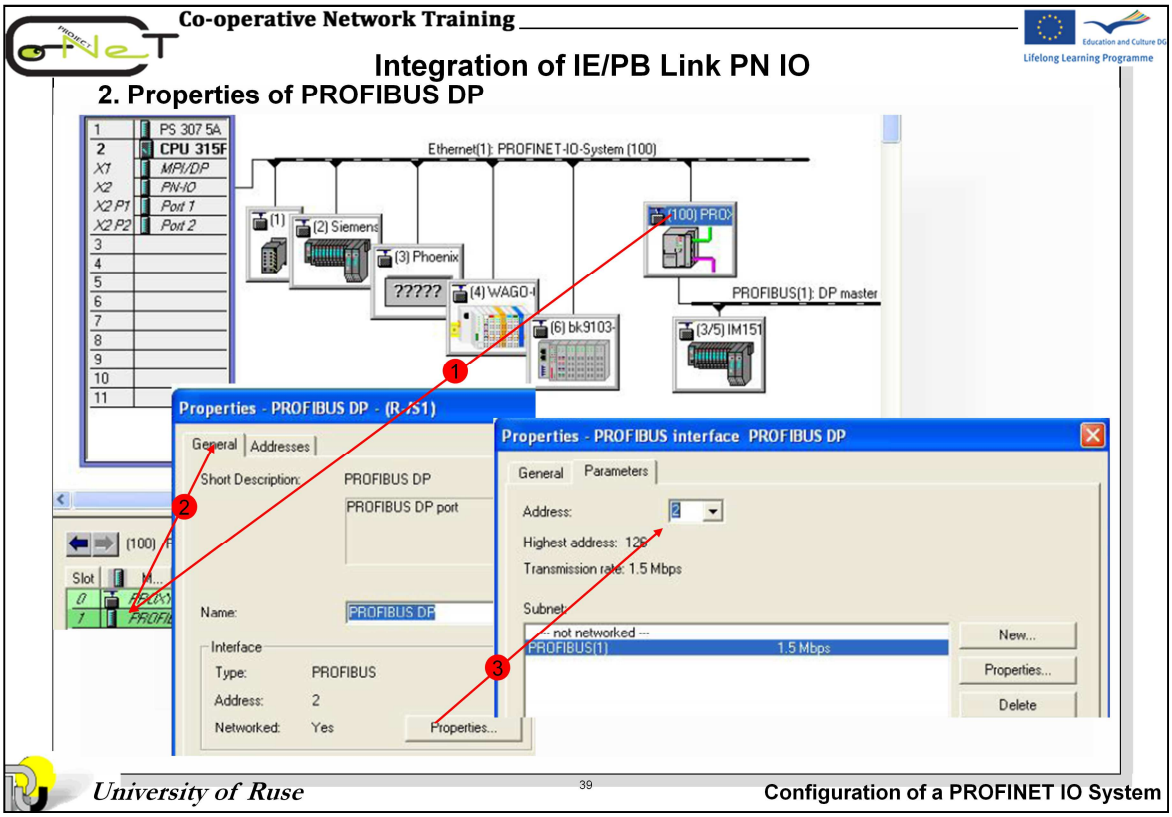
The IE/PB Link PN IO has an internal flash memory for storing the configured database. For replacement of the device without a programming device in the case of servicing, the device can be operated with a C-PLUG as a swap medium. The C-PLUG is located in a slot on the rear of the IE/PB Link PN IO and is then simply plugged into the replacement device.

If a **C-PLUG is plugged in**, the configured database is **always saved** on it. The **internal flash** memory is only used when a **C-PLUG is not** plugged in. If a C-PLUG is plugged in that has invalid formatting for the IE/PB Link PN IO or that contains a faulty database, the device will remain in the STOP state. The CPLUG must then be reformatted using NCM diagnostics or reloaded with an error free database.



Procedure:

1. Insert an IE / PB Link PN IO in your hardware configuration. Assign the PROFIBUS standard master address “2“ and insert a DP master system. Accept all default settings.

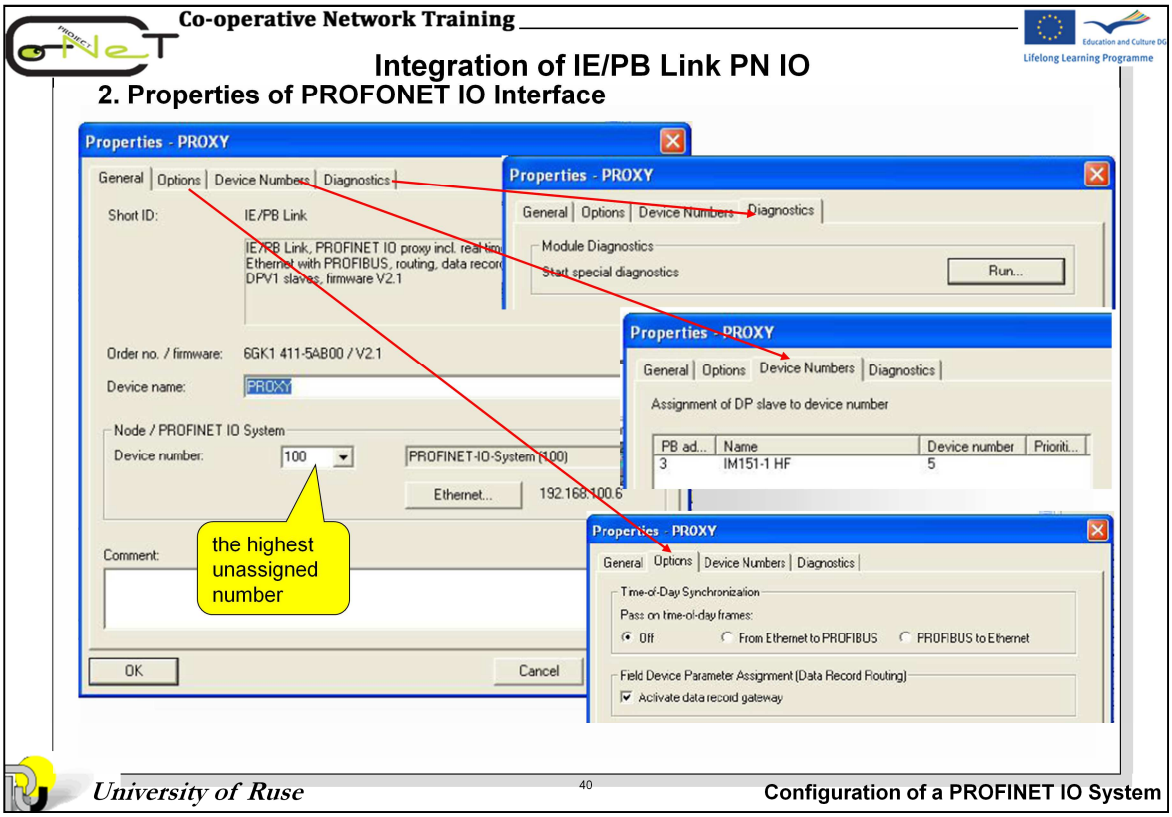


Procedure:

2. In the usual manner, assign a device name and an IP address to the IE/PB link. Check this using the menu command ***PLC -> Ethernet…***
3. Check accessibility of the IE/PB link using the PING command.
4. After downloading the configuration, the CPU automatically assigns the configured IP address during start-up of the IE/PB link. If the subnets are correctly configured and the configuration complies with the actual configuration of the IO device, the IO device is ready for cyclic data transfer on the IE and DP subnet.

Note

- The IE/PB Link PN IO can be used either as a PROFINET IO device or as a network transition.
- When it is used as a PROFINET IO device, the device name is saved retentively in the C-PLUG. The configured database is transferred whenever the PROFINET IO Controller starts up and is saved in temporary memory. If the IE/PB Link PN IO is only used as a network transition, the configured database is transferred using the download function of STEP 7.



General notes: The short ID is entered as the device name in the "General" tab sheet where it can be changed. In the current PROFINET IO, the highest unassigned number is always selected. The consistency check of the hardware configuration ensures that numbers are uniquely assigned.

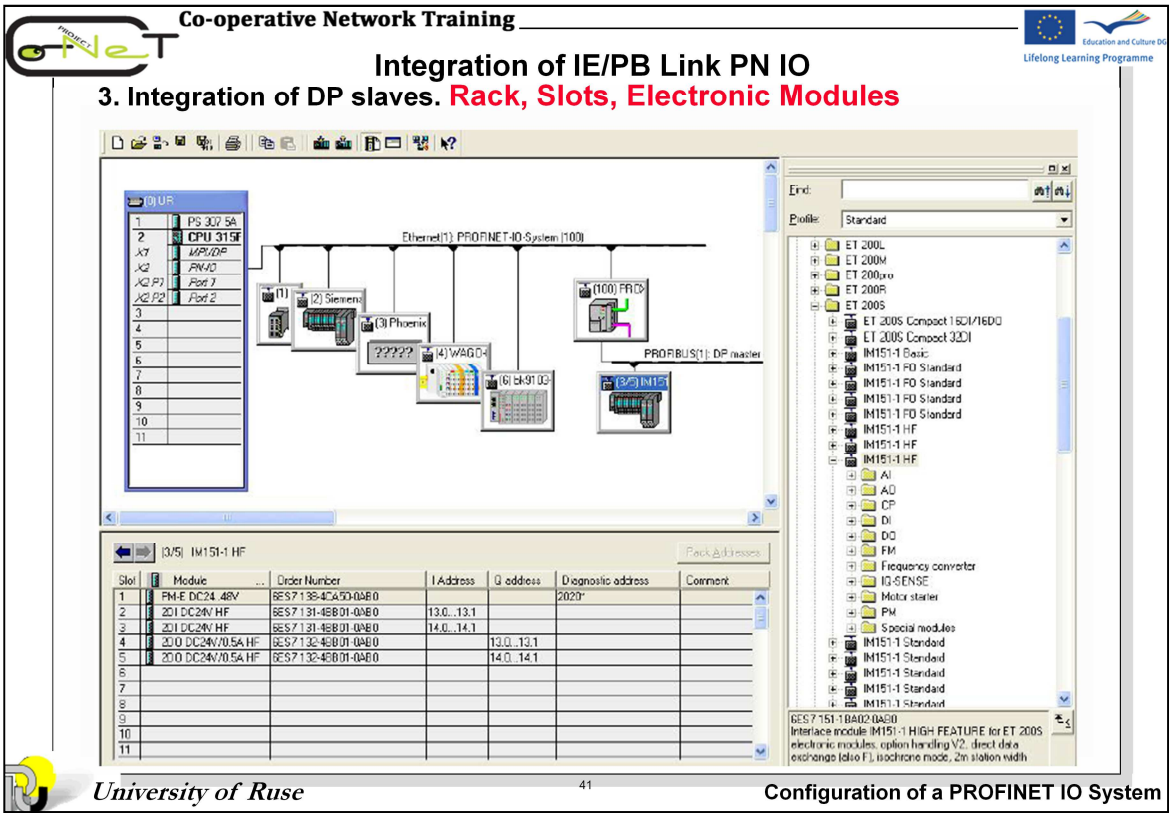
In **Options tab** sheet, two parameters can be set for field devices: time synchronization and data record routing.

Time synchronization - specifies whether the time transferred from the time-of-day transmitter will be accepted by the IE/PB Link data record routing. When the option is deactivated, the link uses an internal system clock.

Device numbers:

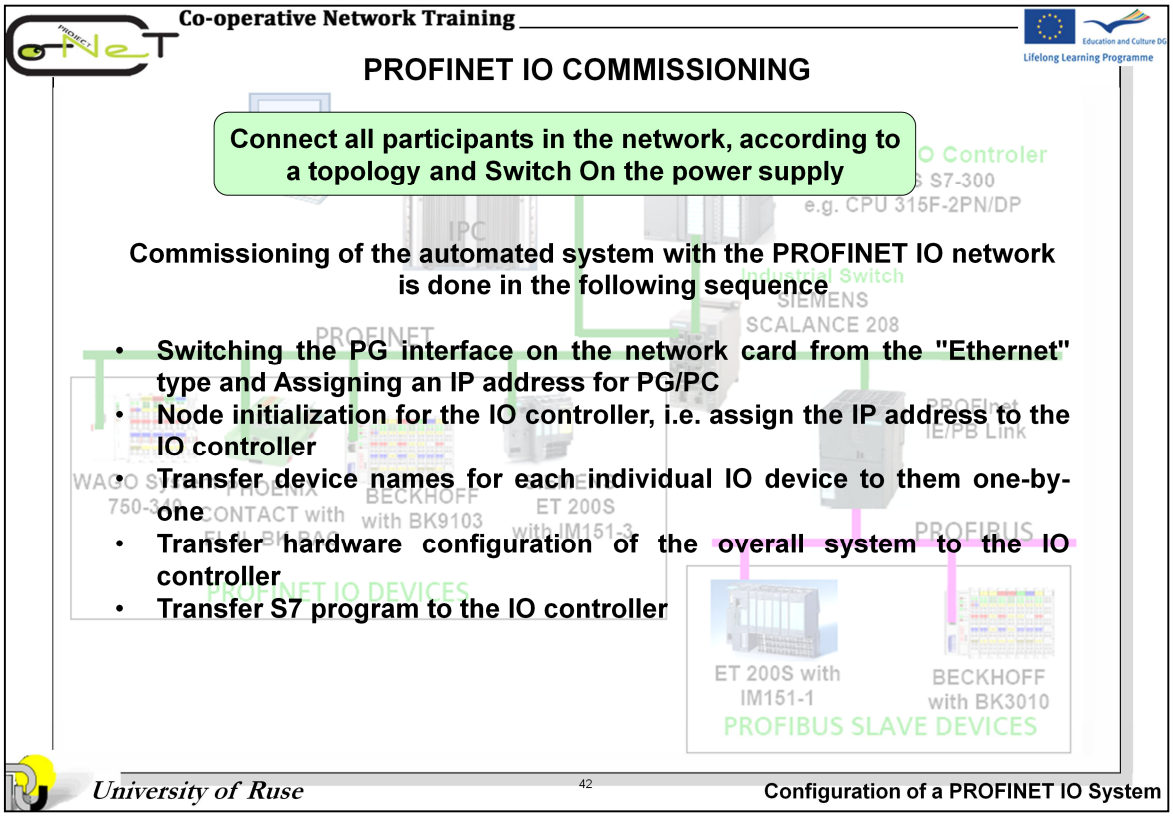
- Addresses are assigned to the DP slaves by the PROFINET IO controller using the PROFINET IO device number in the same manner as IO devices.
- The tab sheet initially displays the automatically assigned device number of the DP slave and it can be edited here. The consistency check of the hardware configuration ensures that numbers are uniquely assigned.
- Multiple assignment of device numbers can occur when PROFIBUS addresses are assigned and automatic incrementing of the device number is set.

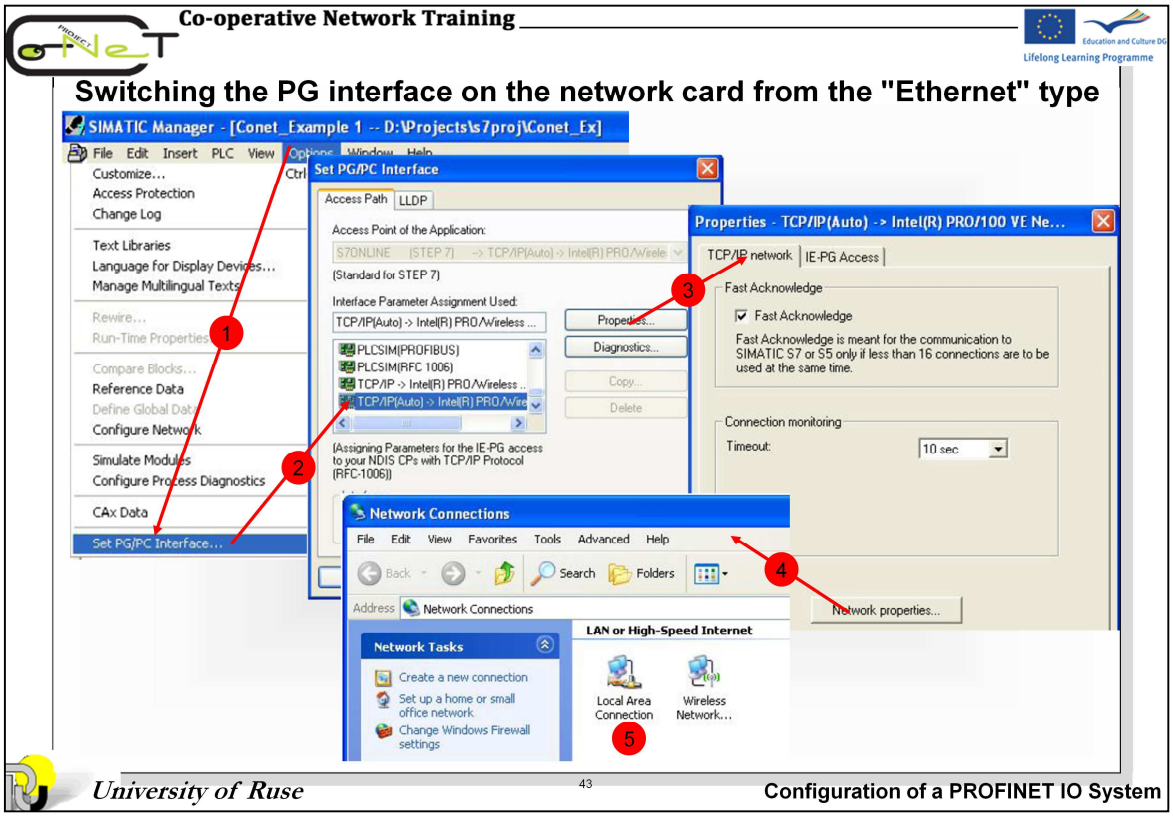
Diagnostics: The diagnostics can only be activated when the programming device can access the IE/PB Link online. NCM diagnostics can be started as a standalone program by clicking the "Run" button.



Addresses are assigned to the DP slaves by the IO controller using the PROFINET device number in the same manner as IO devices. STEP 7 tries to assign the same numbers when adding DP slaves to the master system.

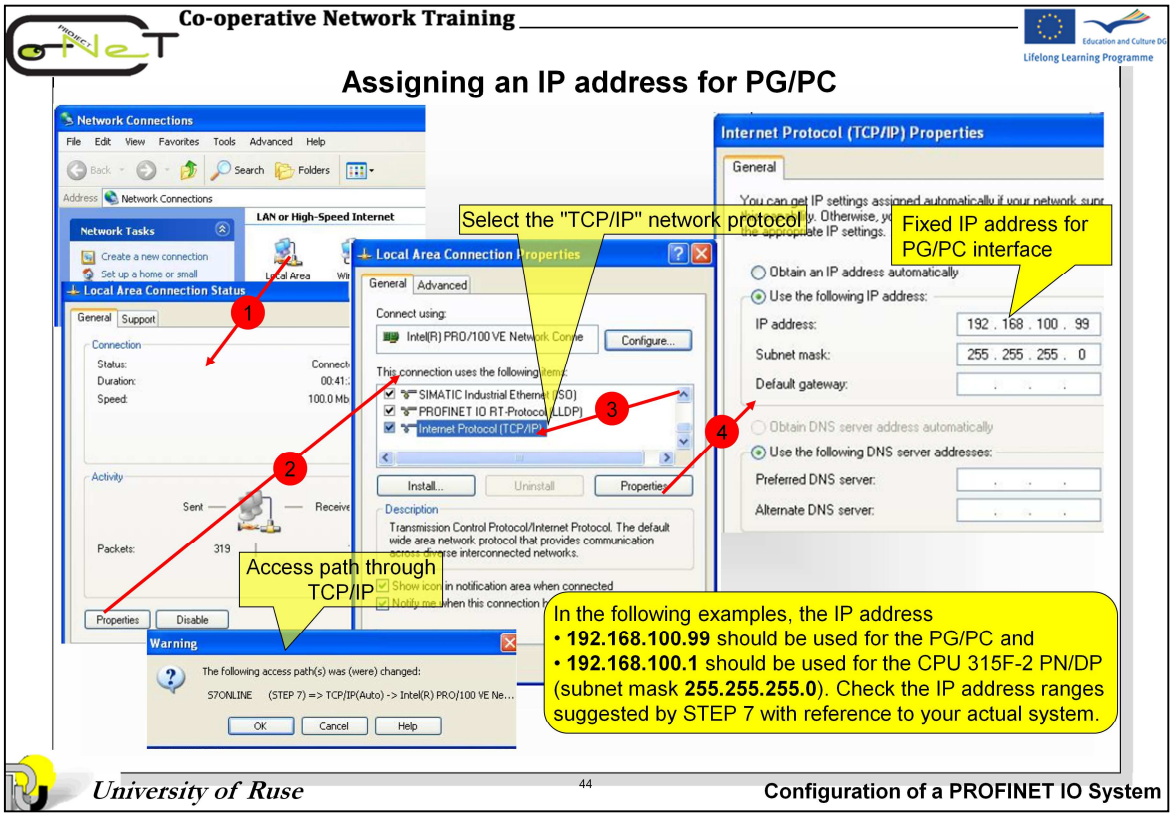
Within a PROFINET IO system, all the device numbers must be unique.


Co-operative Network Training
Lifelong Learning Programme
PROFINET IO COMMISSIONING
Connect all participants in the network, according to a topology and Switch On the power supply
Commissioning of the automated system with the PROFINET IO network is done in the following sequence
• Switching the PG interface on the network card from the "Ethernet" type and Assigning an IP address for PG/PC
• Node initialization for the IO controller, i.e. assign the IP address to the IO controller
• Transfer device names for each individual IO device to them one-by-one
• Transfer hardware configuration of the overall system to the IO controller
• Transfer S7 program to the IO controller
IPC
SIEMENS
SCALANCE 208
PROFINET
BECKHOFF
with BK9103
ET 200S
with IM151-3
PROFIBUS
ET 200S with
IM151-1
BECKHOFF
with BK3010
PROFIBUS SLAVE DEVICES
University of Ruse
42
Configuration of a PROFINET IO System



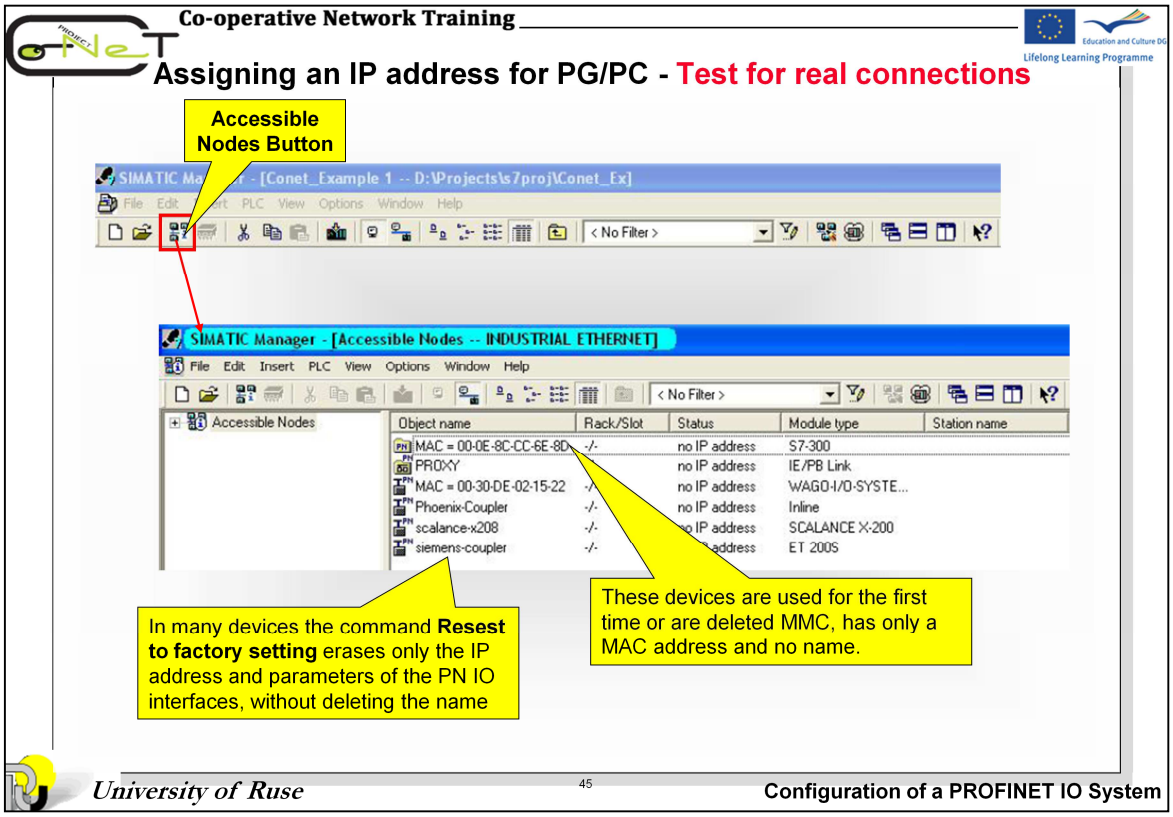
Open the window with the PG/PC-interface settings by selecting **Options** -> **Set PG/PC Interface** and Select the network card you are using.

By clicking the button "Network properties..." you will reach the Control Panel of Windows, "Network Connections" window (**Start taskbar -> Control Panel -> Network Connections**). Here you can access the settings of the network components of your PC

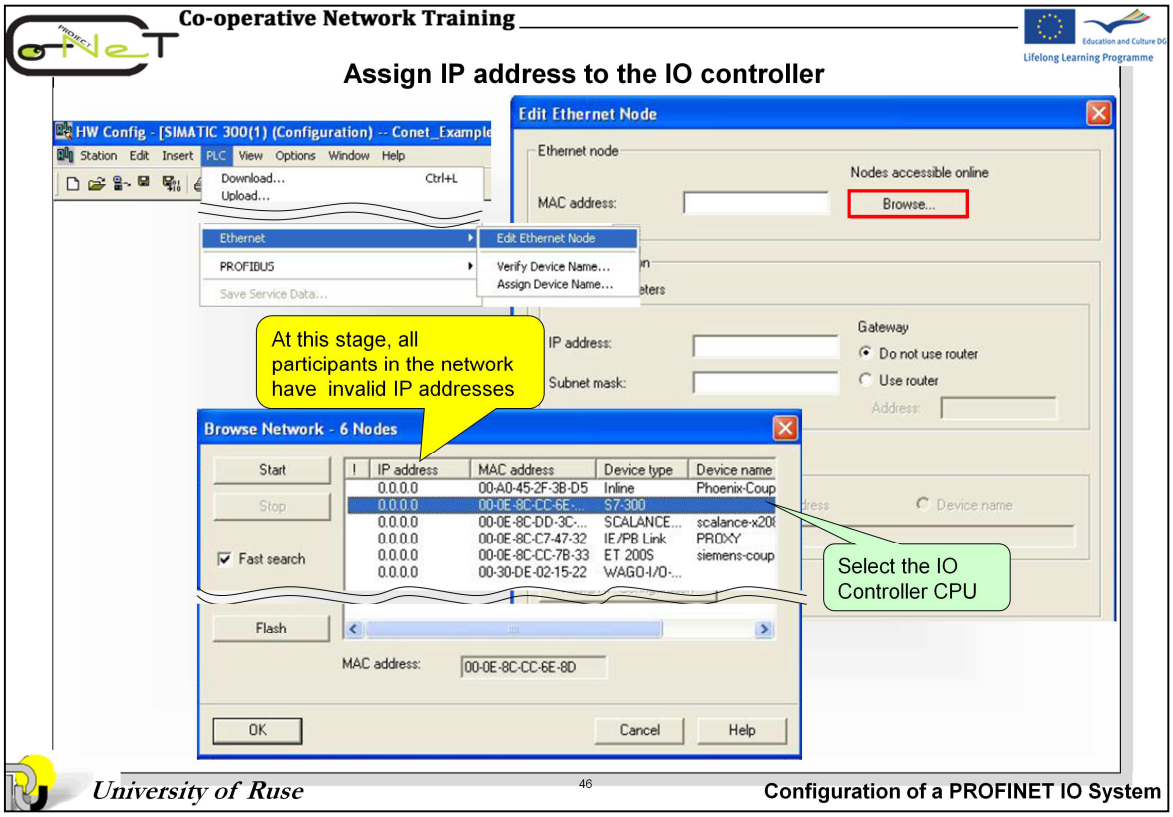


The following example describes how you can set the IP address. The setting in the field "Primary network login" has no effect on the planned change of IP address. Proceed as follows to change the IP address:

- Select the "TCP/IP" network protocol in the list box “This connection uses the following items".
- Click the "Properties" button. The window “Internet Protocol Properties" appears for TCP/IP.
- Select the "General" tab and the option "Use the following IP address".
- Enter the required address and the subnet in the field "IP address". (192.168.100.99 and subnet mask 255.255.255.0)
- Confirm all open windows with OK



If the CPU 31x-2 PN/DP is connected to the PG/PC by means of a "cross-over cable" or through the SCALANCE X208 switch, the CPU can be accessed through the Industrial Ethernet (IE) interface. Use the function "Accessible nodes" in SIMATIC Manager for this purpose and check the contents of the block container.



The IP addresses of the IO devices are generated by STEP 7 and assigned to the IO devices when the CPU starts up (see slide 8).

In addition to this, special (**independent**) IO devices, e.g. **SCALANCE X**, **S7 300** and **CPs**, support an option for assigning the IP address not from the IO controller during the startup.

This procedure can be done in three ways for the IO controller:

- By direct recording of the project in MMC;
- By loading the hardware configuration in MPI or PROFIBUS interface;
- By the function Edit Ethernet node on the HW_Config Tool.

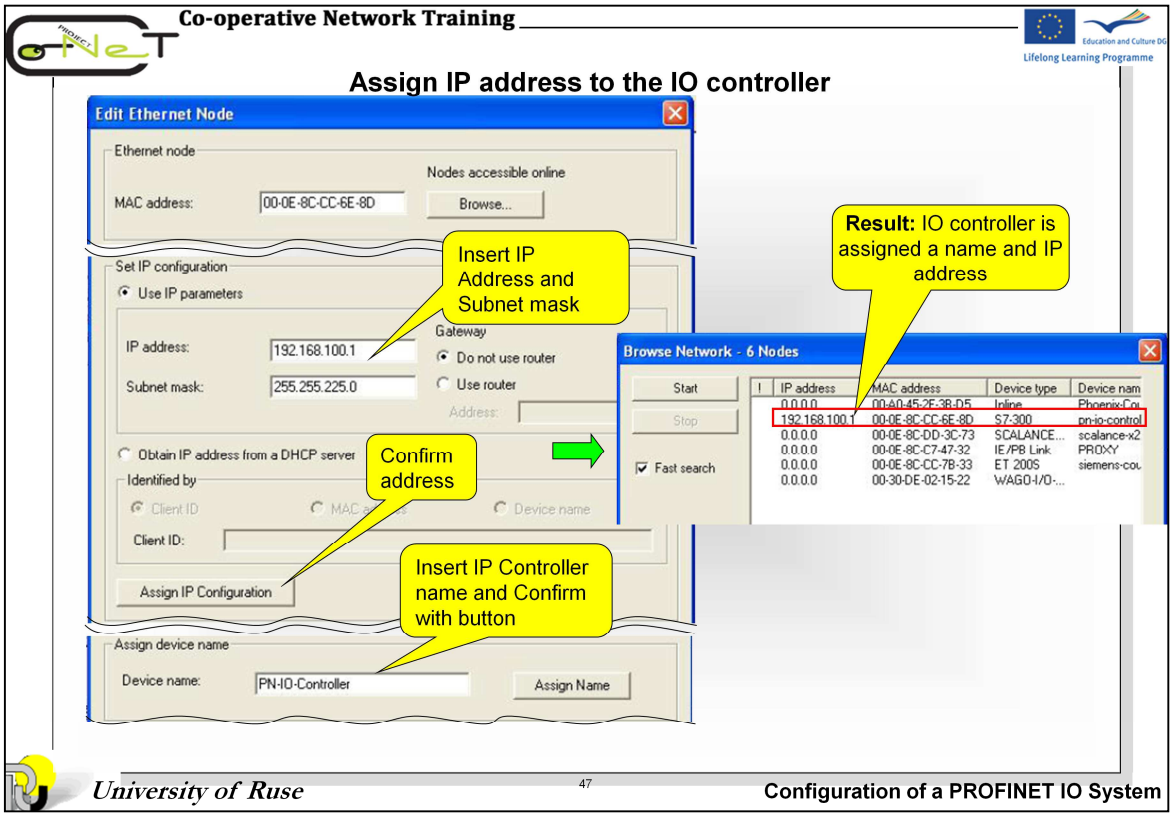
If your PROFINET device is equipped for a memory card (MMC), plug the MMC into your programming device/PC and save the hardware configuration together with the configured IP address on the MMC. Then insert the MMC into the PROFINET device. When you plug in the MMC, the PROFINET device automatically adopts the IP address.

If your PROFINET device has an MPI or PROFIBUS DP interface, connect your programming device directly to the PROFINET device via the MPI or PROFIBUS DP interface. From STEP 7, assign an IP address to the device (actually assigned when the hardware configuration is downloaded).

In the **HW Config**, select **PLC -> Ethernet -> Edit Ethernet Node**. *The interface of the PD/PC must be set to TCP/IP (Auto) mode*.

To select the IO Controller by its MAC address, click **Browse ...** button, to start the search for participants in the network.

New dialog with all the nodes that were found in the network appears. Select CPU (**device type: S7-300**) and click **OK**. Appears known box "Edit Ethernet node" with the selected MAC address



Here, you can assign an IP address and IP parameters to a module the first time or you can reassign the IP address and IP parameters. You can also specify whether or not the IP address will be obtained from a DHCP server.

The module is then accessible over the IP address set here, as an example for downloading project engineering data or for diagnostics.

If you operate a device as a PROFINET IO device, you can also assign the PROFINET device name here. Remember, however, that the device name should ideally be set in the Properties dialog so that it is stored in the project engineering data.

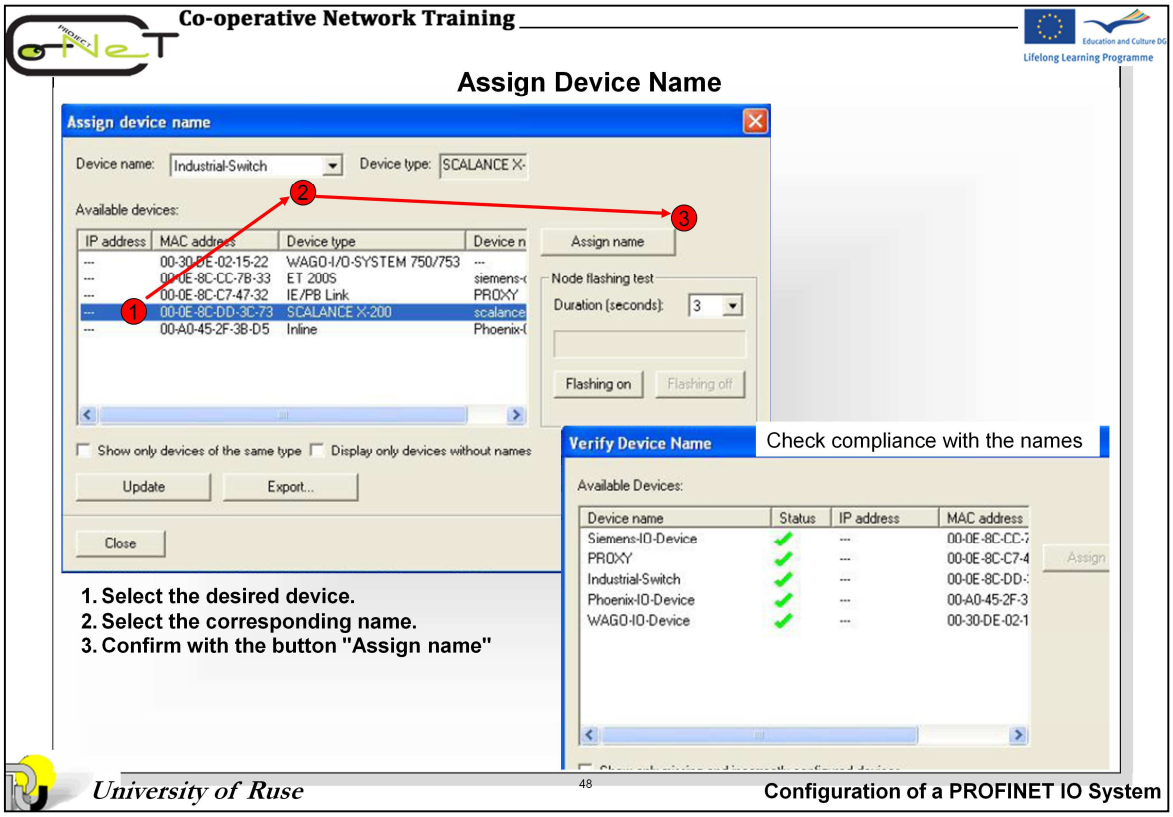
For setting up the IP configuration you can select from the following alternatives:

Use IP parameters - If you opened the dialog based on a selected module, the IP address already has the values configured for the module. Otherwise, you must enter the IP address, subnet mask and if applicable the gateway.

Obtaining the IP address from a DHCP server:

- If you select this option, the IP address is obtained from a DHCP server.
- Depending on the selected option, the DHCP server is informed for the MAC address for the CP, the device name, or the client ID that you can enter here.
- The client ID is a string with a maximum of 63 characters. Only the following characters can be used: a-z, A-Z, 0-9 and - (dash)
- If you specify here that the DHCP server should obtain the IP address using a device name, you must first assign the device a device name.

Click the **"Assign IP Configuration"** button.



In their original, delivered condition, IO devices have no device names. IO devices can be addressed by an IO controller only after having been assigned a name by a programming device (PG)/PC, such as for transmitting configuration data (including the IP address) at startup or for the exchanging user data in cyclic operation.

To assign the configured device name to an IO device online, select the menu command **PLC > Ethernet > Assign Device Name**.

The procedure is performed in the following sequence:

- Desired device is selected from the central window;

- From the drop down menu select the corresponding name that exists in the hardware configuration of the system;

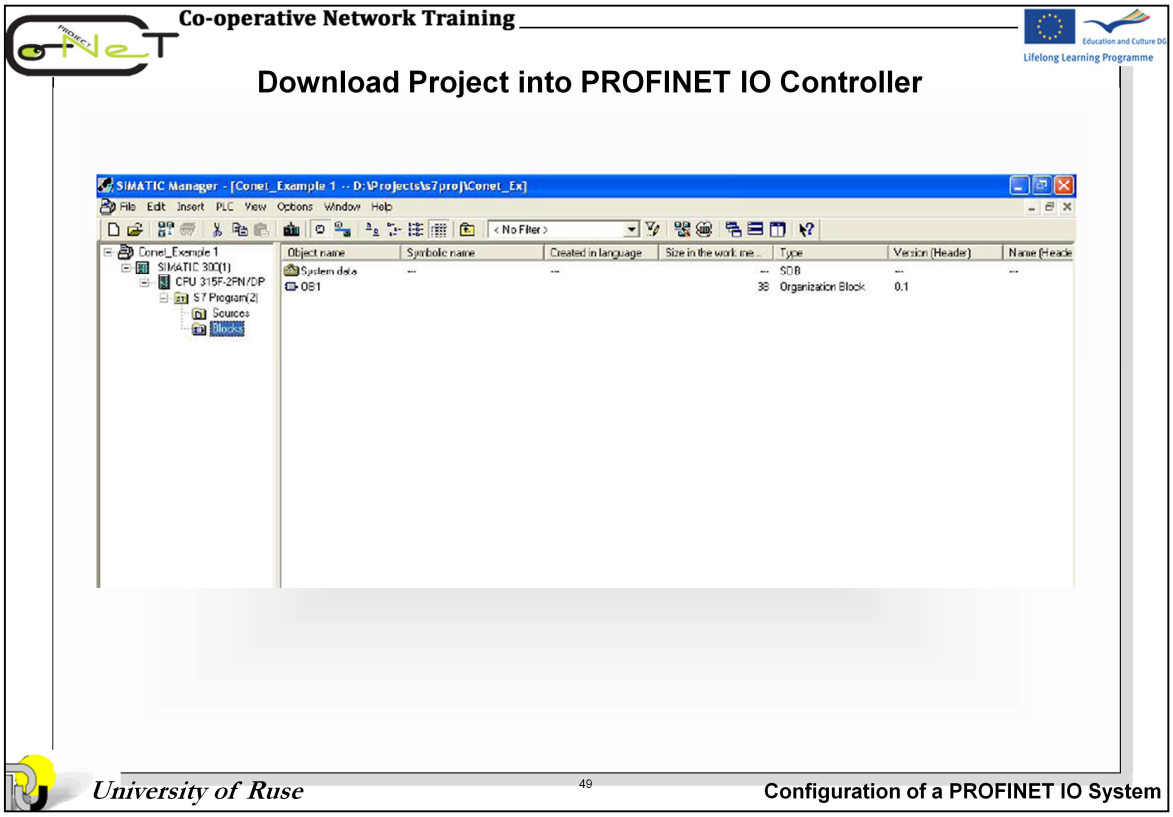
- The choice is confirmed by pressing the "Assign Name“.

*When the system has multiple identical devices to identify them can use the function "**Node Flashing Test**".*

You can also assign a device name with the menu command **PLC > Ethernet > Edit Ethernet Node**; however, the device name should be set in the Properties dialog of an IO device so that it is stored in the configuration data.

After you have configured the whole IO system, you now have to download this configuration to the CPU.

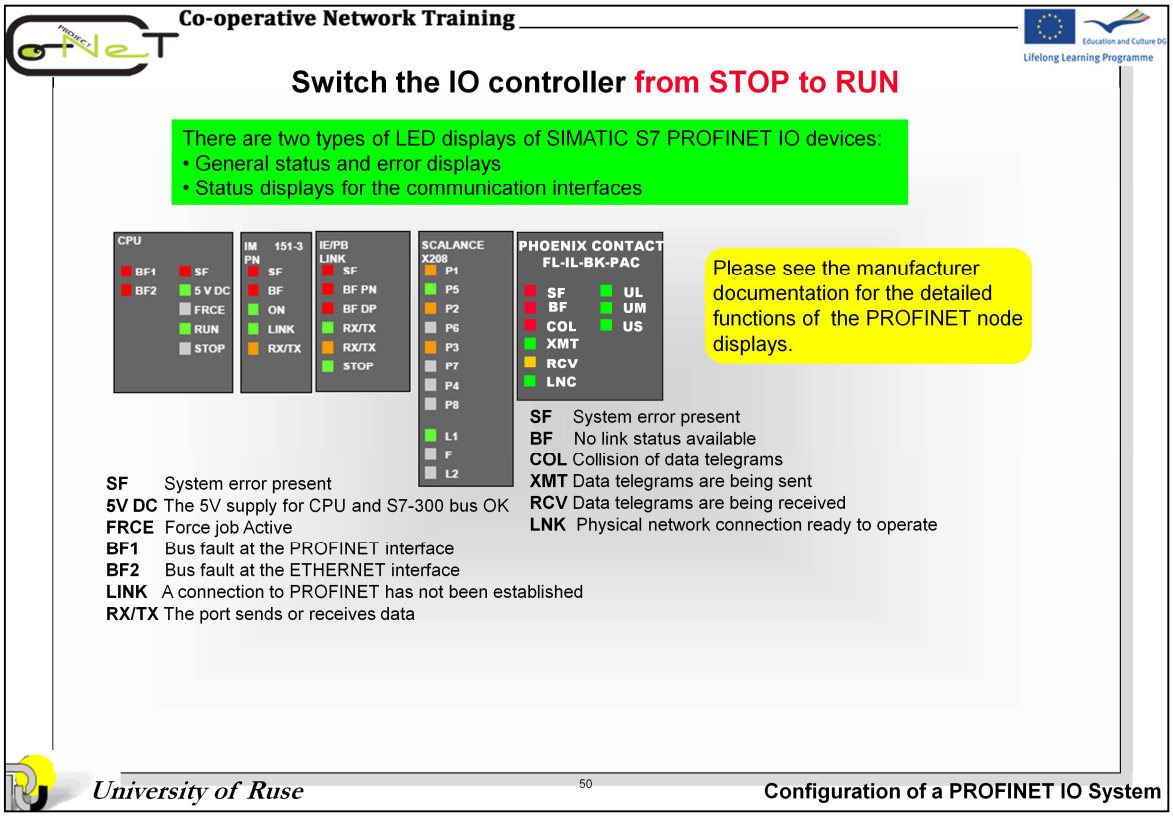
Before starting the download, you should perform a consistency check in order to have the configuration checked for addresses that have been used twice and names that are not unique. Use the function "Verify Device Name".



Find out if the CPU can receive the download for the first time via the PROFINET interface. If not, you will then have to first download the hardware configuration via the MPI interface.

The following description of the procedure presumes that there is a connection existing between the programming device (PG) and the CPU via Ethernet.

1. In the project window, select the user program or the blocks you want to download.
2. Select the modules to be downloaded to.
3. If necessary, in the "Select Station Address" dialog box, click the "Display" button to display the modules that are actually accessible (including the CPU receiving the download with its current IP address or its MAC address if an IP address is still not available).
4. In the accessible modules, select the CPU to receive the download .
   This module is then displayed in the "Enter connection to target station" field.
5. Start the download by clicking the "OK" button. During this process, the CPU (i.e. the IO controller) also gets its configured IP address assigned to it.



After loading the project data, switch the IO controller from **STOP** to **RUN** mode to establish communication between the IO controller and the PROFINET nodes. After initialization, the error free PROFINET IO devices are signaling operational readiness. You are able to check the operational status using the planning software by means of the supervisor. Some PROFINET nodes allow you to determine their status e.g. by means of LEDs.

If the red BF 2 LED (Bus Fault 2) flashes on a CPU 31x-2 PN IO, a device is faulty somewhere in the PROFINET IO system.

The LINK and RX/TX LEDs are located under the cover. A continuous **green light on the LINK LED** indicates a functional connection to the next network node. If the LED is not lit, a connection is interrupted. The **yellow RX/TX LED** indicates data communication via the interface.

Faulty devices are indicated by the SF LED lit in red.

During start-up, the red BF LED flashes, faulty connections to the next network node are indicated by continuous red light.

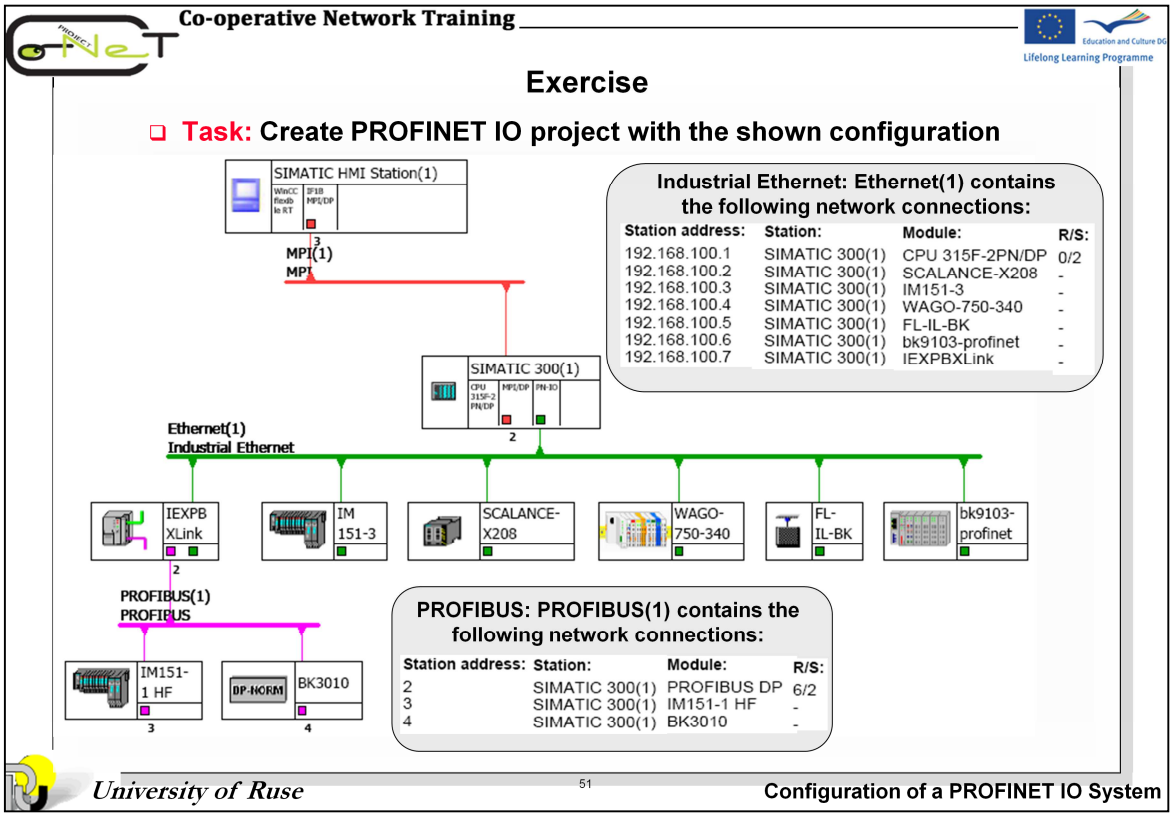
If the IO controller is in **RUN** mode, the PROFINET nodes should no longer indicate any communication problems.

In case if any stations are indicating communication problems at this stage, additional checks should be undertaken, e.g.:

• Device type correctly configured?

• Device configuration OK / Device name correctly configured?

For geographic location of the devices in the field, flashing of the Link LEDs can be activated in the same manner as for the controllers. The Link LED is located under the covers of ET 200S PN and IE/PB LINK PN IO.


Co-operative Network Training
Lifelong Learning Programme
Exercise
Task: Create PROFINET IO project with the shown configuration
SIMATIC HMI Station(1)
MPI(1)
MPI
SIMATIC 300(1)
Ethernet(1)
Industrial Ethernet
IEXPB XLink
IM 151-3
SCALANCE-X208
WAGO-750-340
FL-IL-BK
bk9103-profinet
PROFIBUS(1)
PROFIBUS
IM151-1 HF
BK3010
Industrial Ethernet: Ethernet(1) contains the following network connections:
Station address: Station: Module: R/S:
192.168.100.1 SIMATIC 300(1) CPU 315F-2PN/DP 0/2
192.168.100.2 SIMATIC 300(1) SCALANCE-X208 -
192.168.100.3 SIMATIC 300(1) IM151-3 -
192.168.100.4 SIMATIC 300(1) WAGO-750-340 -
192.168.100.5 SIMATIC 300(1) FL-IL-BK -
192.168.100.6 SIMATIC 300(1) bk9103-profinet -
192.168.100.7 SIMATIC 300(1) IEXPBXLink -
PROFIBUS: PROFIBUS(1) contains the following network connections:
Station address: Station: Module: R/S:
2 SIMATIC 300(1) PROFIBUS DP 6/2
3 SIMATIC 300(1) IM151-1 HF -
4 SIMATIC 300(1) BK3010 -
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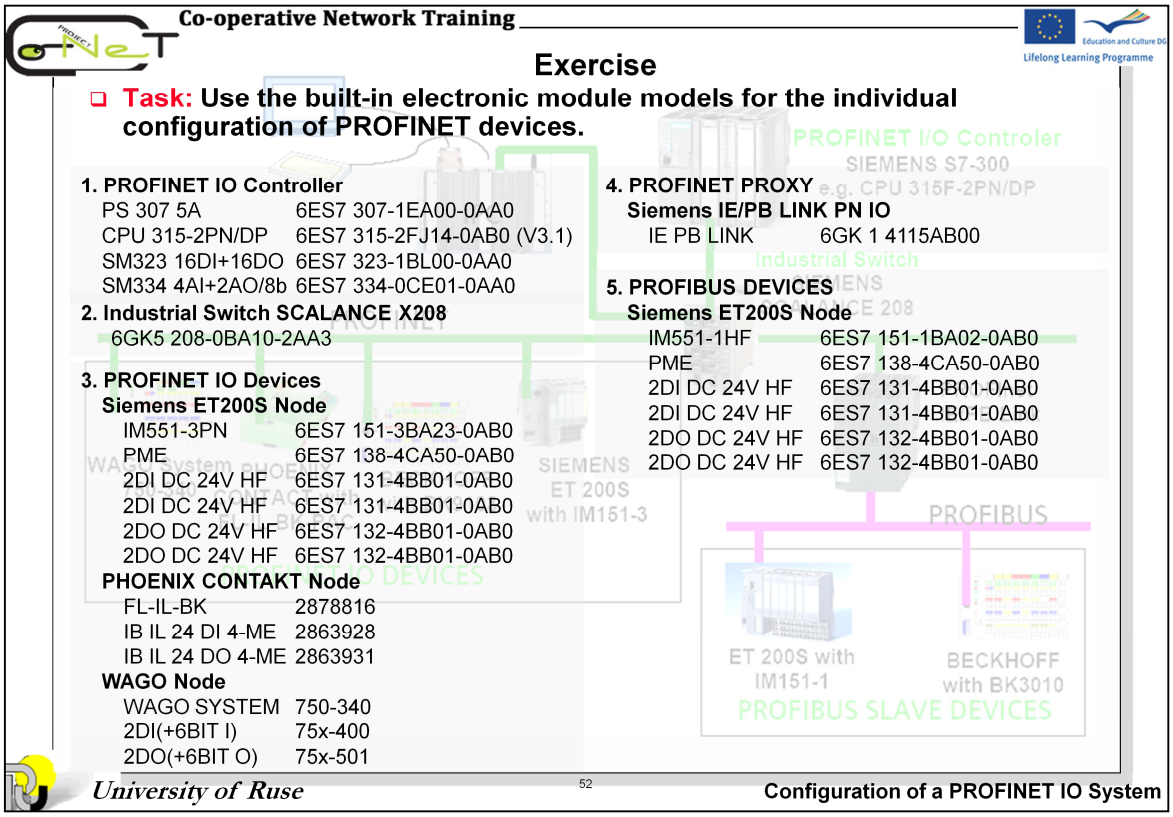
Configuration of a PROFINET IO System


Co-operative Network Training
Lifelong Learning Programme
Exercise
Task: Use the built-in electronic module models for the individual configuration of PROFINET devices.
1. PROFINET IO Controller
PS 307 5A 6ES7 307-1EA00-0AA0
CPU 315-2PN/DP 6ES7 315-2FJ14-0AB0 (V3.1)
SM323 16DI+16DO 6ES7 323-1BL00-0AA0
SM334 4AI+2AO/8b 6ES7 334-0CE01-0AA0
2. Industrial Switch SCALANCE X208
6GK5 208-0BA10-2AA3
3. PROFINET IO Devices
Siemens ET200S Node
IM551-3PN 6ES7 151-3BA23-0AB0
PME 6ES7 138-4CA50-0AB0
2DI DC 24V HF 6ES7 131-4BB01-0AB0
2DI DC 24V HF 6ES7 131-4BB01-0AB0
2DO DC 24V HF 6ES7 132-4BB01-0AB0
2DO DC 24V HF 6ES7 132-4BB01-0AB0
PHOENIX CONTAKT Node
FL-IL-BK 2878816
IB IL 24 DI 4-ME 2863928
IB IL 24 DO 4-ME 2863931
WAGO Node
WAGO SYSTEM 750-340
2DI(+6BIT I) 75x-400
2DO(+6BIT O) 75x-501
4. PROFINET PROXY
Siemens IE/PB LINK PN IO
IE PB LINK 6GK 1 4115AB00
5. PROFIBUS DEVICES
Siemens ET200S Node
IM551-1HF 6ES7 151-1BA02-0AB0
PME 6ES7 138-4CA50-0AB0
2DI DC 24V HF 6ES7 131-4BB01-0AB0
2DI DC 24V HF 6ES7 131-4BB01-0AB0
2DO DC 24V HF 6ES7 132-4BB01-0AB0
2DO DC 24V HF 6ES7 132-4BB01-0AB0
PROFINET I/O Controler
SIEMENS S7-300
e.g. CPU 315F-2PN/DP
Industrial Switch
SIEMENS
SCALANCE X208
SIEMENS
ET 200S
with IM151-3
PROFIBUS
ET 200S with
IM151-1
BECKHOFF
with BK3010
PROFIBUS SLAVE DEVICES
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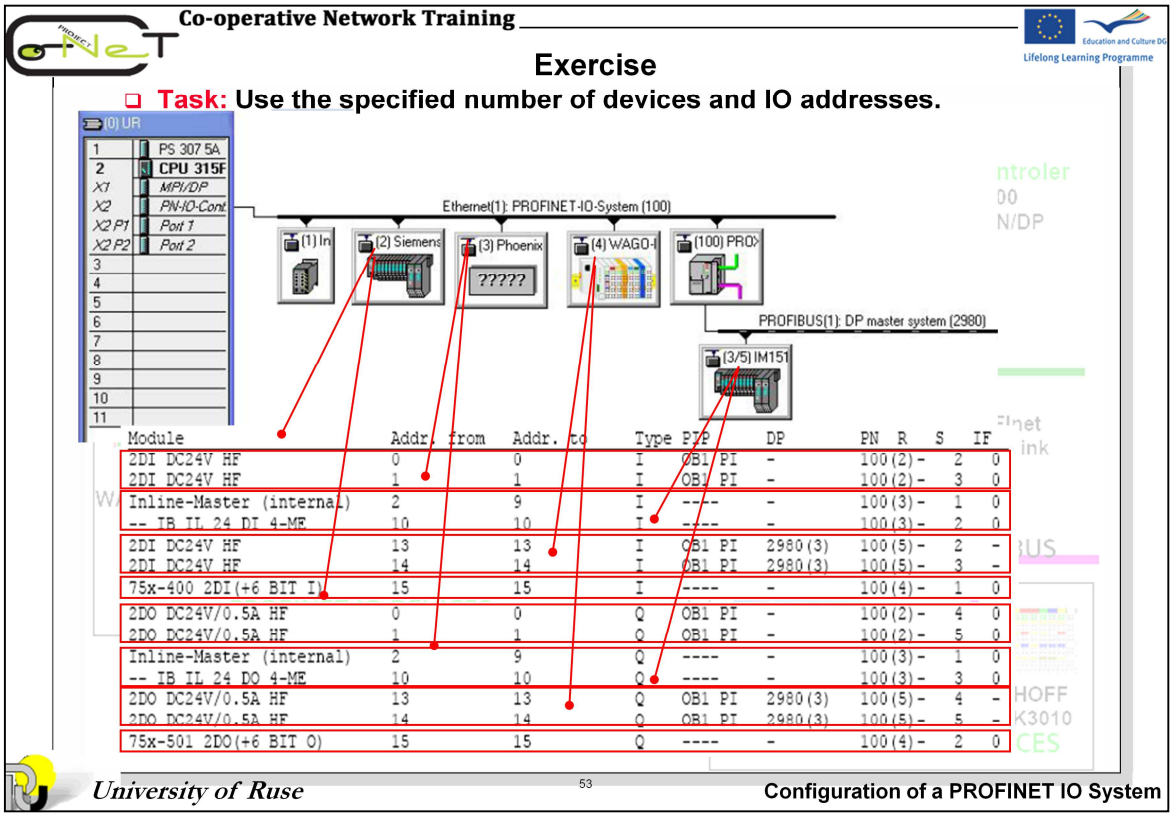
Configuration of a PROFINET IO System


Co-operative Network Training
Lifelong Learning Programme
Exercise
Task: Use the specified number of devices and IO addresses.
(0) UR
1 PS 307 5A
2 CPU 315F
X1 MPI/DP
X2 PN-IO-Cont
X2 P1 Port 1
X2 P2 Port 2
Ethernet(1): PROFINET-IO-System (100)
(1) In
(2) Siemens
(3) Phoenix
?????
(4) WAGO-I
(100) PRO
PROFIBUS(1): DP master system (2980)
(3/5) IM151
Module Addr. from Addr. to Type PIP DP PN R S IF
2DI DC24V HF 0 0 I OB1 PI - 100(2) - 2 0
2DI DC24V HF 1 1 I OB1 PI - 100(2) - 3 0
Inline-Master (internal) 2 9 I ---- - 100(3) - 1 0
-- IB IL 24 DI 4-ME 10 10 I ---- - 100(3) - 2 0
2DI DC24V HF 13 13 I OB1 PI 2980(3) 100(5) - 2 -
2DI DC24V HF 14 14 I OB1 PI 2980(3) 100(5) - 3 -
75x-400 2DI(+6 BIT I) 15 15 I ---- - 100(4) - 1 0
2DO DC24V/0.5A HF 0 0 Q OB1 PI - 100(2) - 4 0
2DO DC24V/0.5A HF 1 1 Q OB1 PI - 100(2) - 5 0
Inline-Master (internal) 2 9 Q ---- - 100(3) - 1 0
-- IB IL 24 DO 4-ME 10 10 Q ---- - 100(3) - 3 0
2DO DC24V/0.5A HF 13 13 Q OB1 PI 2980(3) 100(5) - 4 -
2DO DC24V/0.5A HF 14 14 Q OB1 PI 2980(3) 100(5) - 5 -
75x-501 2DO(+6 BIT O) 15 15 Q ---- - 100(4) - 2 0
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Configuration of a PROFINET IO System

LITERATURE

1. Mackay St., Edwin Wright, Deon Reynders, John Park, Practical Industrial Data Networks: Design, Installation and Troubleshooting, Elsevier 2004, ISBN 07506 5807X
2. Pigan Raimond, Mark Metter, Automating with PROFINET. Industrial Communication based on Industrial Ethernet, SIEMENS 2006, ISBN 3-89578-256-4
3. Configuration and Diagnostics of a PROFINET IO System, PROFINET IO Configuration Example, Application Description, SIEMENS 01/2010
4. FL IL 24 BK-PN-PAC PROFINET IO/Inline Bus Coupler, Data Sheet, PHOENIX CONTACT 07/2005.
5. Hardware and Firmware User Manual for the FL IL 24 BK / FL IL 24 BK-PAC Ethernet/Inline Bus Coupler, Revision: 05, Order No.:90 14 20 5 PHOENIX CONTACT, 09/2004.
6. SIMATIC PROFINET System Description, System Manual, A5E00298288-04, 06/2008
7. SIMATIC Configuring Hardware and Communication Connections with STEP 7, Manual, A5E00706939-01, SIEMENS Edition 03/2006.
8. SIMATIC NET Industrial Ethernet Switches SCALANCE X-200 / XF-200. Operating Instructions, A5E00349864-14, SIEMENS, 03/2009.
9. SIMATIC ET 200S distributed I/O Interface module IM151-3 PN HIGH FEATURE (6ES7151-3BA23-0AB0), Manual, A5E01584258-04, SIEMENS 08/2010
10. WAGO IO SYSTEM 750, Using the WAGO 750 -340 PROFINET Coupler as Remote I/O with a Siemens S7 PLC, Application note A115400
11. PROFINET Technology and Application – System description
    http://www.profibus.com/nc/download/technical-descriptions-books/