

# PROFINET Diagnostics Software and Tools

Dr. Xiu Ji



Manchester  
Metropolitan  
University



[www.mmu.ac.uk/profibus](http://www.mmu.ac.uk/profibus)

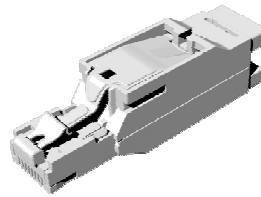
## Content



- Static wiring test, diagnostics
- Live system diagnostics
- Basics of PROFINET

## What is PROFINET?

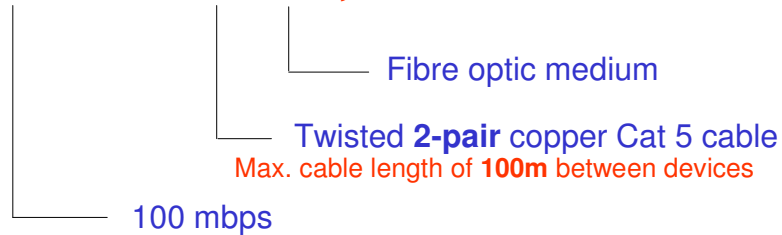
- PROFINET is Standard Ethernet (IEEE 802.3).
- PROFINET is based on the “Fast Ethernet” or 100 BASE TX/FX.
- PROFINET is an Industrialised Ethernet, optimised for speed, determinism and durability.



## Important IEEE 802.3 specs

Spec number	Speed	Standard description
IEEE 802.3 (a,b,i,j)	10 Mbps	<b>10 Base Ethernet</b> (there are different numbers associated with copper, fiber, coax and variants)
IEEE 802.3u	100 Mbps	<b>100 Base TX / FX</b> Fast Ethernet for copper (TX) and fiber (FX)
IEEE 802.3z IEEE 802.3ab	1000 Mbps	<b>1000 Base X</b> - Gigabit Ethernet over fiber (z) and copper (ab)
IEEE 802.3ae	10000 Mbps	<b>10BaseLR (etc..)</b> Ten Gigabit Ethernet over Fiber
IEEE 802.3x		Flow Control / Full Duplex

## PROFINET is based on 100BASE-TX/FX, i.e. Fast Ethernet

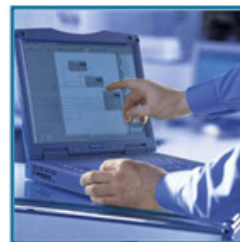
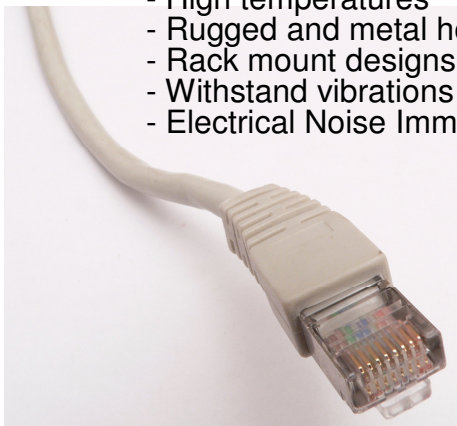


X: means any medium, copper or fibre, but redundant with 'T' or 'F'.  
 100BASE can also use un-twisted enhanced Cat 5 cable, i.e. Cat 5e.  
 STP: Shielded Twisted Pair, e.g. 100BASE-TX, STP. PROFINET only uses STP cables.  
 UTP: Unshielded Twisted Pair, e.g. 100BASE-TX, UTP.

## What is Industrial Ethernet?

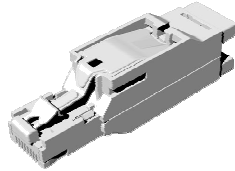
### ➤ Is this fit ?

- High temperatures
- Rugged and metal housing
- Rack mount designs
- Withstand vibrations
- Electrical Noise Immunity



# Connectors

**IP20 RJ45**



**IP65 RJ45**



**IP65 M12**

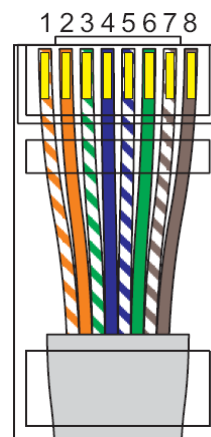
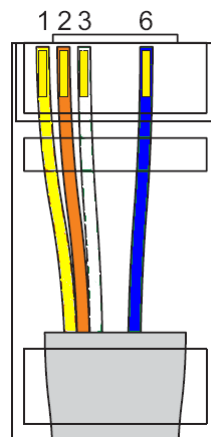


**Customised  
heavy-duty**

## 4 wires or 8 wires?



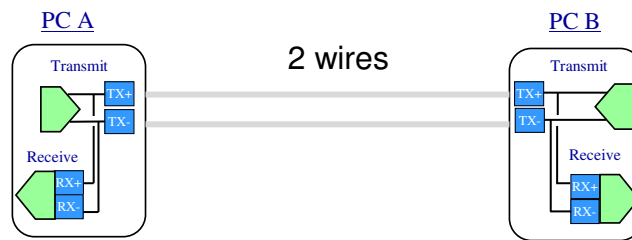
Pin	Functionality
1	Data (TX +)
2	Data (TX -)
3	Data (RX +)
4	e.g. Ground (-)
5	e.g. Ground (-)
6	Data (RX -)
7	e.g. Power (+)
8	e.g. Power (+)



## Half Duplex

### Half duplex Mode

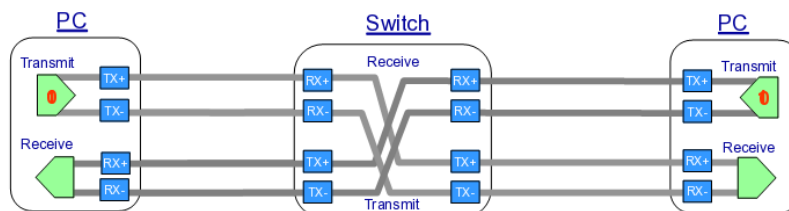
- Data transmission can take place only in one direction at the same time
- uses two wires, twisted



## Full Duplex

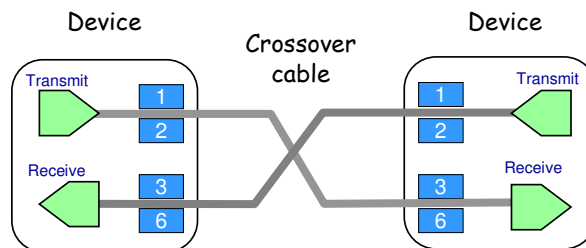
### ➤ Full duplex mode, 4 wires

- ✓ Transmission of data in two directions simultaneously
- ✓ Use of 4 wires and switching technology
- ✓ i.e. telephone



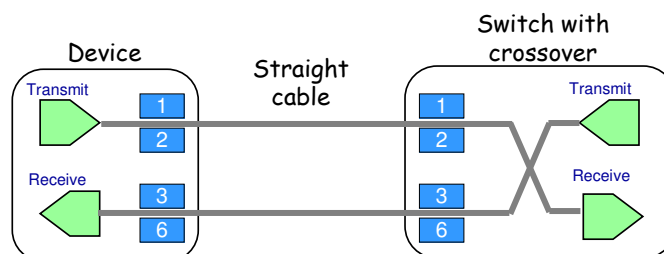
## Straight and Crossover Cables

- Ethernet devices must be connected so that the transmitter in one device is connected to the receiver in another.
- When connecting one device directly to another (e.g. a PC to a field device), a “cross-over” cable is required:



## Straight and Crossover Cables

- When using a switch or hub to connect devices, the switch normally provides the crossover for us.
- Therefore, when using switches, “straight” cables are used to connect the device to the switch:



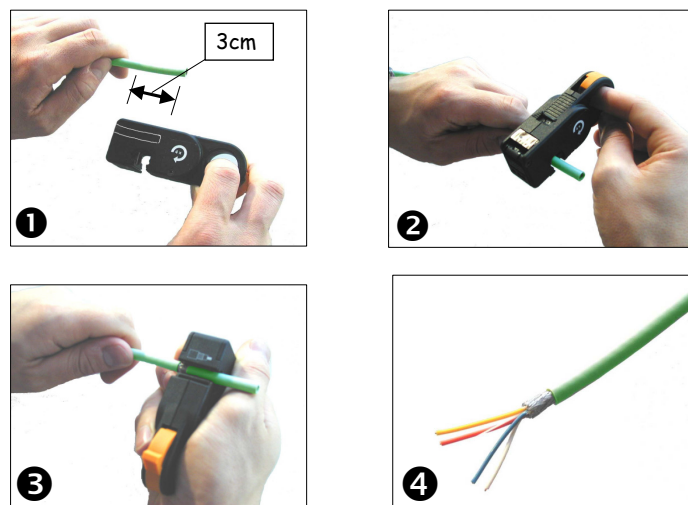
Modern switches provide “auto-crossover”, where they are able to automatically provide crossover as required.

## Cable Test Tools

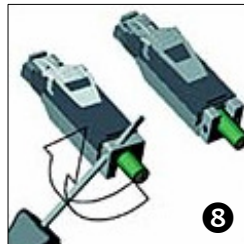
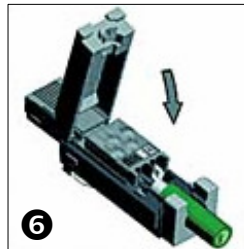
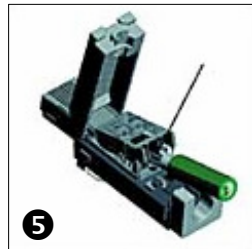
- There are many different cable test tools available for checking Ethernet cables.
- These range in price from less than £100 pounds to over £3000.



## Stripping Tools



## Insulation Displacement Connectors



## Cable Tester

- Connect the test plug at one end and the tester at the other end.
- Detect many wiring faults:
  - ✓ Wire break
  - ✓ Short circuit
  - ✓ Swapped wires





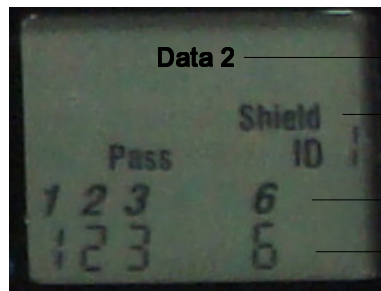
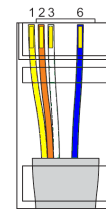
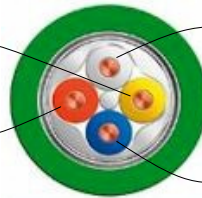
## Good wiring

Pin 1  
Yellow (TD+)

Pin 2  
Orange (TD-)

Pin 3  
White (RD+)

Pin 6  
Blue (RD-)



Data 2

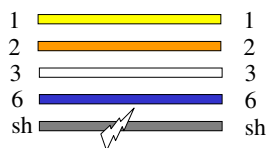
Select this Mode

Shield present

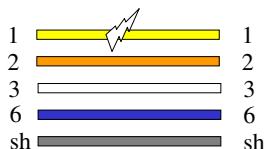
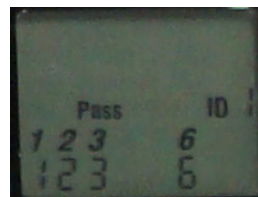
Upper line: Connector at the tester

Lower line: Connector at the plug

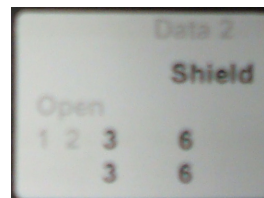
## Wiring faults



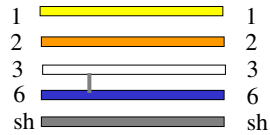
No shield or  
Shield broken



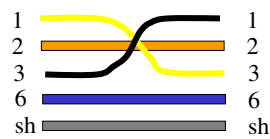
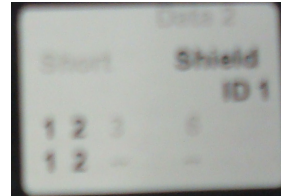
Wire break and  
Effectuated pins



## Wiring faults



Short circuit,  
Second  
line indicated  
as --

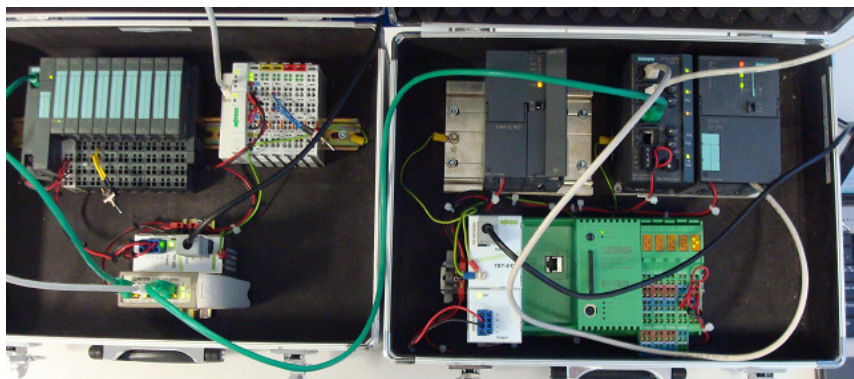


Yellow and White  
swapped

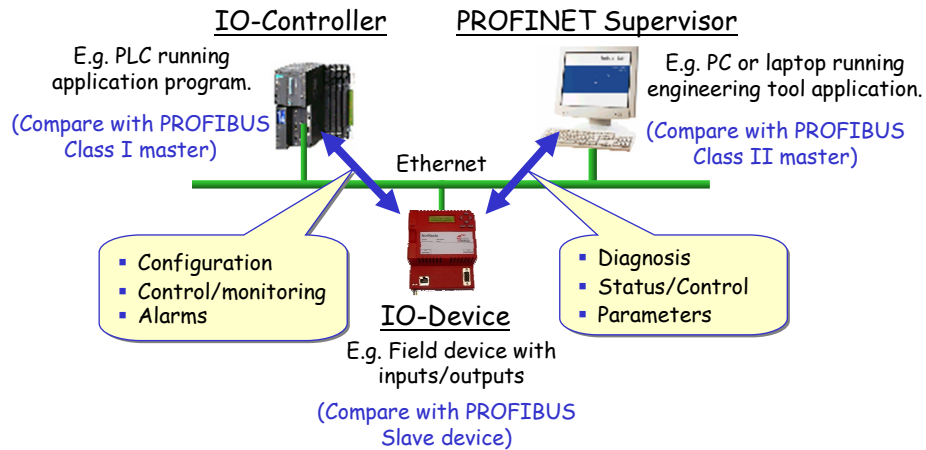


## Practical Exercise

- Make up a cable and test on a live system.
- Watch for the connectivity indicators on the switch.



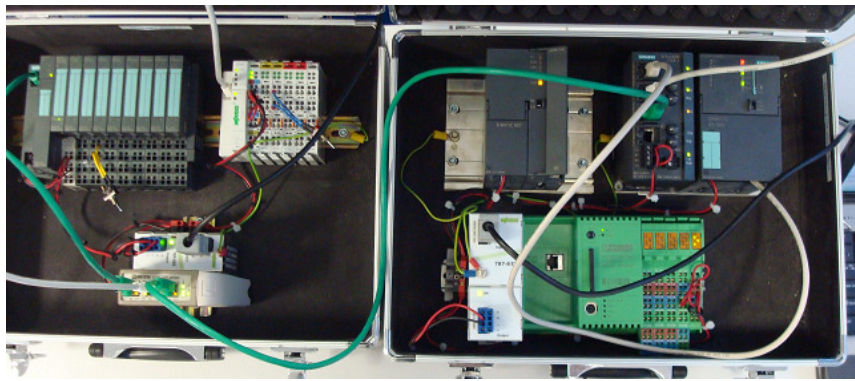
## Configuration: PROFINET IO Systems



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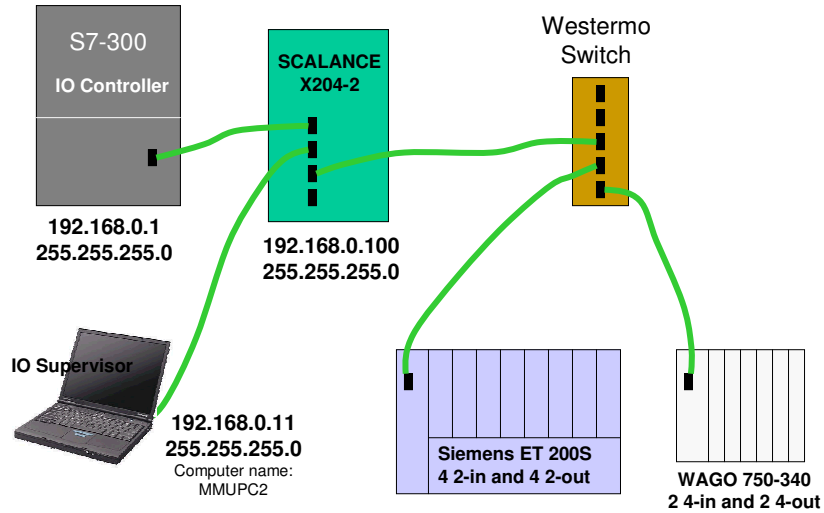
## A PROFINET IO System

- Siemens S7-300 CPU 315-2 PN/DP Controller
- Siemens managed switch, SCALANCE X204-2
- Westermo 5-port unmanaged switch, SDW-500



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## Step 1



## “Drag & Drop” and Assign Device Name

- IO Controller automatically assign IP addresses based on its domain addresses.

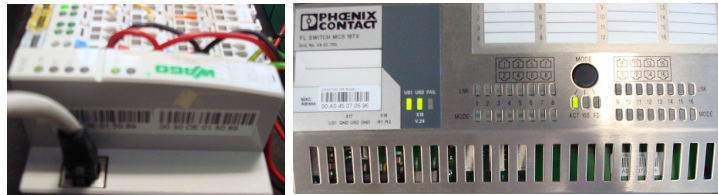
**Configuration is similar to PROFIBUS!**

The screenshot shows the configuration software interface. The main window displays a network topology with a CPU 315-2 PN/DP connected to a PROFIBUS-DP system. The configuration table below shows the details of the WAGO device.

Slot	Module	Order Number	I Address	Q address	Diagnostic ad...	Comment
0	Wago-device	750-340			2047	
1	750-402 4DI(+4 BIT I)	750-402	4			
2	750-402 4DO(+4 BIT O)	750-402	750-340			
3	750-504 4DI(+4 BIT I)	750-504		4		
4	750-504 4DO(+4 BIT O)	750-504		5		

## Addressing

- Device addresses are NOT set by DIP switch. Instead, “Device Name” concept is used.
- IO devices much have a device name.
- Every device has a unique MAC address. (Media Access Control)
- MAC Address must be printed on every IO device.
- MAC Address is used for real-time communication.
- IP Address is used only for non-real-time data exchange, e.g. configuration and parameterisation.
- IP addresses are allocated by IO Controller every time during start-up or restart.



## Addressing

- Start-up always takes place over the non-real-time TCP/UDP/IP channel.
- MAC addresses and device names (at default or if assigned) are revealed at this stage.
- IP addresses are then allocated based on their MAC addresses.
- The device name is vital in setting up IP addresses.
- Device name must be set correctly.
- Once the device name and IP address are correct the IO controller can initiate communication with the device.

## Download or change device name

- There are tools available for changing device names.
- Changing device names within a configuration tool stores the names within the project.

**Properties - IM151-3PN**

General | IO Cycle

Short Description: IM151-3PN  
PROFINET IO device interface module IM 151-3 PN for ET 200S electronic modules

Order No.: 6ES7 151-3AA10-0AB0  
Family: ET 200S  
Device Name: ET200S IO-1

Node / PN IO system:  
Device Number: 1 PROFINET-IO-System (100)  
IP Address: 192.168.0.2 Ethernet...  
☒ Assign IP Address via IO Controller

Comment:

OK Cancel Help

## Initial Communication

- Communication between Controller and Supervisor
  - ✓ via LAN
  - ✓ Supervisor: Laptop with Siemens S7 HW-Config application
  - ✓ Controller: Siemens S7-300 CPU with RJ45 interface
  - ✓ **Scan or Browse Network**: MAC address and device name are revealed.

**Browse Network - 5 Nodes**

Start Stop

☒ Fast search Refresh

IP address	MAC address	Device type	Device name	Subnet mask
192.168.0.2	08-00-06-6C-02-30	ET 200S	dev1-freeth	....
192.168.0.3	00-30-DE-01-50-92	WAGO I/O-SYSTEM 750/753	DEVICE-WAGO	....
0.0.0.0	00-30-DE-01-50-89	WAGO I/O-SYSTEM 750/753	PNR1-Wago	....
192.168.0.1	00-0E-8C-89-5E-35	S7-300	prio	....
192.168.0.100	00-0E-8C-A1-59-17	SCALANCE X200	dev3-freeth	....

MAC address:

OK Cancel Help

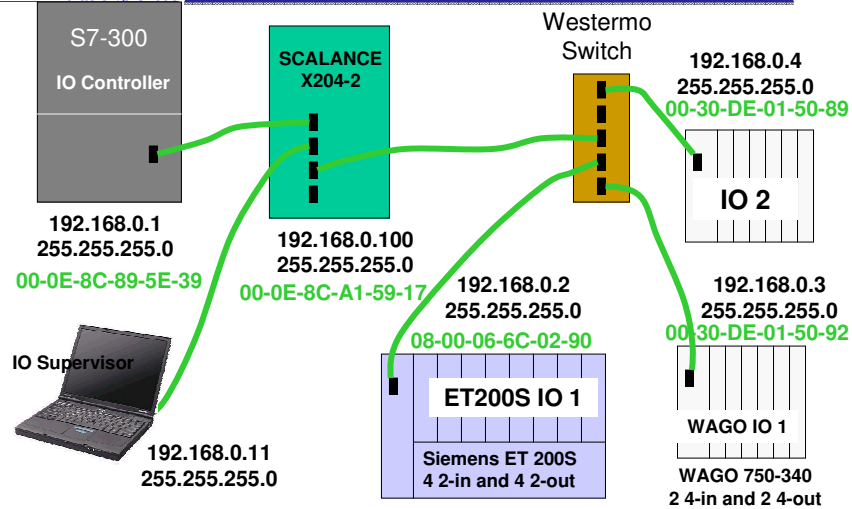
## MAC address and device name

- Assign IP Address manually or via Controller automatically.

PROFIB

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## Step 2





## Step 3a: Write a program

- Write a simple program in OB1 and download it to Controller.

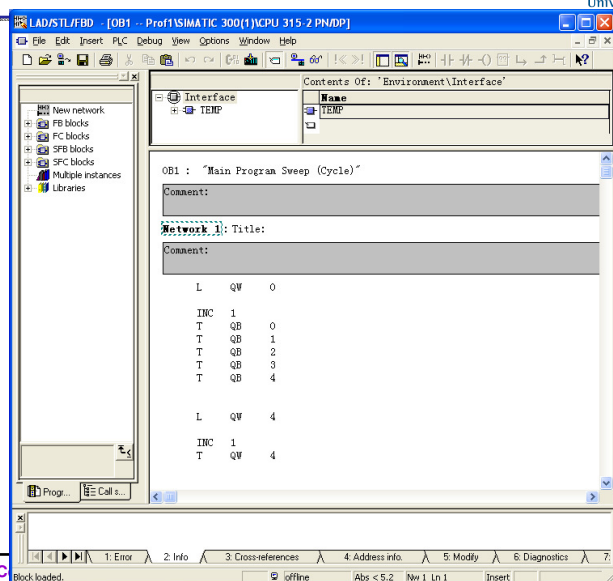
```

L   QW0      //load Output Word 0
INC 1        //increment it with 1
T   QB0      //write it to Output Byte 0
T   QB1      //write it to Output Byte 1
T   QB2      //write it to Output Byte 2
T   QB6      //write it to Output Byte 3
T   QB7      //write it to Output Byte 4
T   QW8      //load Output Word 4

L   QW4      //load Output Word 4
INC 1        //increment it with 1
T   QW4      //write it to Output Word 4
    
```

## Step 3b: Write a program

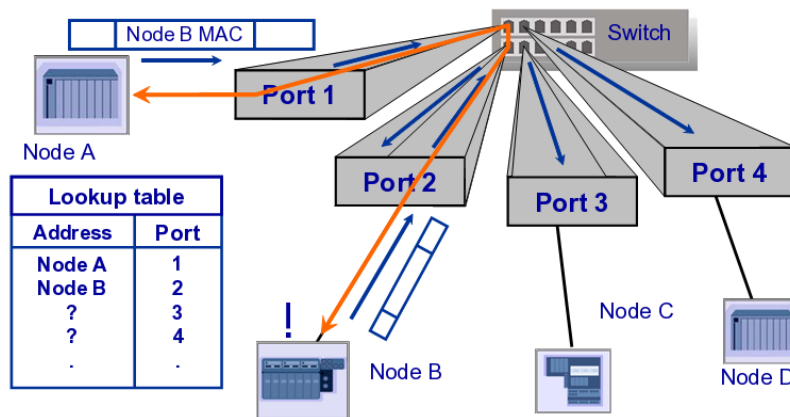
- Program:





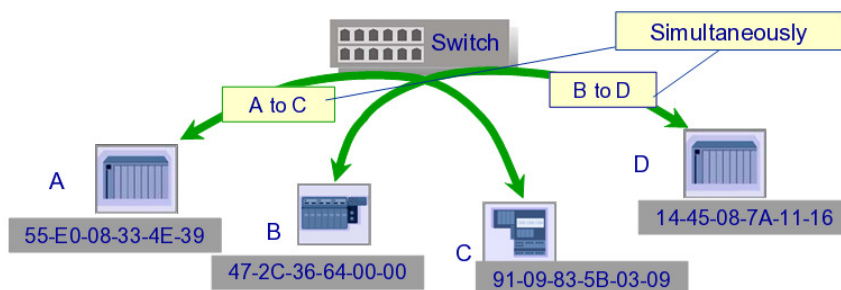
## Learning MAC Addresses

- Switch knows which device is on which port and hence directs traffic/data to where is intended to be rather than flooding the network.



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## Switching Technology



### A switch remembers the ports:

- If swapping plugs, it takes time to re-figure out the ports
- Power off a device first, swap plugs if required, and then power on the device.

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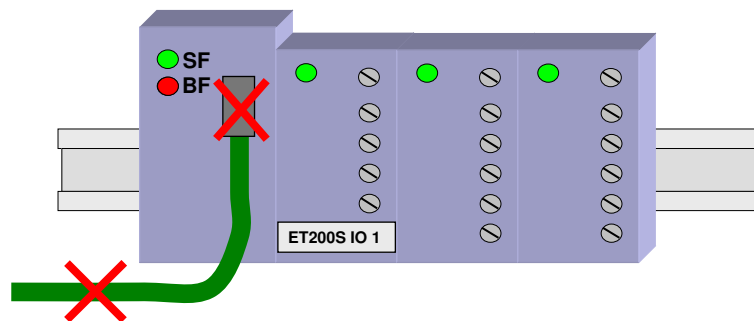
## Diagnostics

- PROFINET provides fast and thorough diagnostics covering almost every component of a PROFINET network.
- Diagnostics are structured hierarchically, starting with the device information and moving down to the ladder to the module and channel diagnostics.
- Network and system status are also available.
- In case of a fault, the station name, module number, channel number, channel type, and information about the error itself are displayed and can be accessed.

**Diagnostics are similar as in PROFIBUS!**

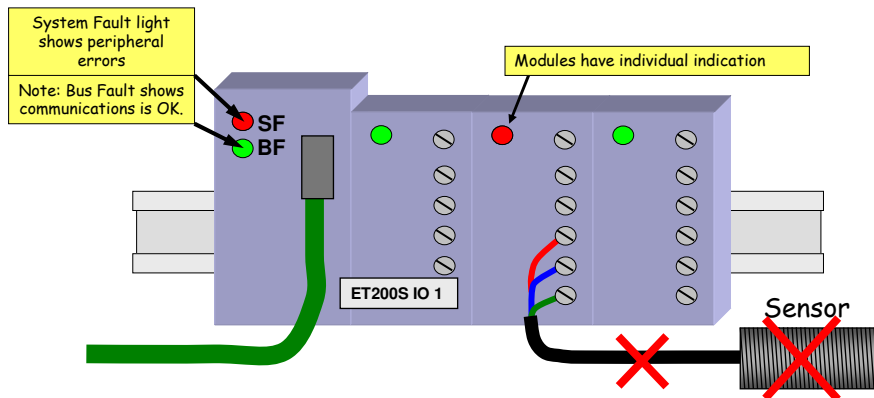
## Communication faults

- Mainly caused by poor network wiring or layout or cable/connector deterioration.
- Can be permanent or intermittent.



## Peripheral faults

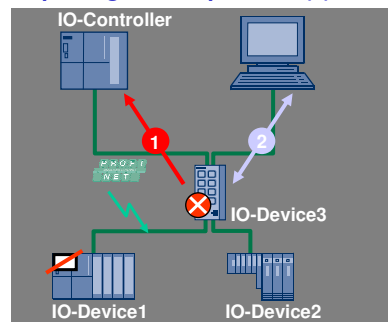
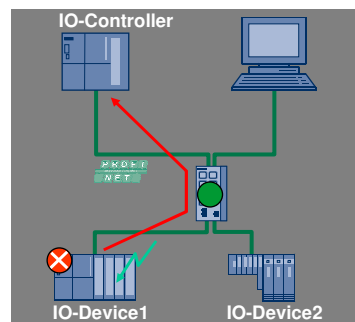
- Caused by sensor/actuator failure or wiring faults.
- Again faults can be intermittent.



## Diagnostics

- ✓ The switch passes on the PROFINET diagnostics of an IO device to CPU.
- ✓ CPU evaluates and report the diagnostics

- ✓ The switch reports network disturbances as PROFINET-diagnostics to the IO-Controller (1)
- ✓ Configuration of the Switch as IO-Device (GSDML)
- ✓ Additional SNMP channel, e.g. for reporting on a Supervisor (2)



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### A lost station

Ethernet(1): PROFINET-IO-System (100)

General Diagnostic Buffer Memory Scan Cycle Time Time System

Events: ☐ Filter settings active ☐ Time including CPU/local time difference

No.	Time of day	Date	Event
1	02:06:54.639 AM	11/27/1995	PROFINET IO module removed/cannot be addressed
2	02:05:59.889 AM	11/27/1995	PROFINET IO: station return
3	02:02:29.458 AM	11/27/1995	PROFINET IO: station Failure
4	02:02:08.058 AM	11/27/1995	Mode transition from STARTUP to RUN

Slot: (0) UR

Slot	Module	Order
1		
2	CPU 315-2 PN/DP	6E
X1	MPI/DP	
X2	PN-IO	
X2 P1	Port 1	
3		
4		
5		
6		

Name: General IO Device Diagnostics

Version:

IO controller device number: 0

Standard diagnostics:

Module missing in slot: 9

Status: Module available and o.k.  
Error LED (SF)

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### Diagnostics using analysers

Manchester Metropolitan University

- Free tool, Wireshark.
- The alarms are captured.

USB2.0 to Gigabit Ethernet Adapter (Microsoft's Packet Scheduler) : Capturing - Wireshark

File Edit View Go Capture Analyze Statistics Help

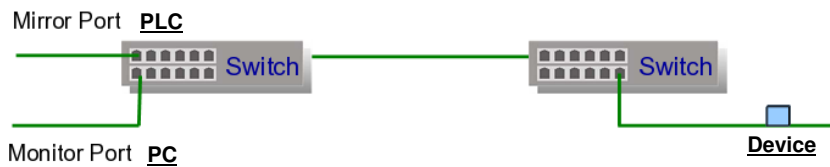
Filter: Expression... Clear Apply

No.	Time	Source	Destination	Protocol	Info
232	18.350774	wagoKont_01:50:89	SiemensA_89:5e:35	PNIO	RTCL, ID:0xc000, Len:...
233	18.430231	SiemensA_89:5e:35	Siemens_6c:02:90	PNIO	RTCL, ID:0xc000, Len:...
234	18.431144	SiemensA_89:5e:35	wagoKont_01:50:92	PNIO	RTCL, ID:0xc010, Len:...
235	18.432140	SiemensA_89:5e:35	wagoKont_01:50:89	PNIO	RTCL, ID:0xc010, Len:...
236	18.622398	Siemens_6c:02:90	SiemensA_89:5e:35	PNIO-AL	Alarm Low, Src: 0x0...
237	18.623020	SiemensA_89:5e:35	Siemens_6c:02:90	PNIO-AL	Alarm Low, Src: 0x3...
238	18.626222	SiemensA_89:5e:35	Siemens_6c:02:90	PNIO-AL	Alarm Low, Src: 0x3...
239	18.626763	Siemens_6c:02:90	SiemensA_89:5e:35	PNIO-AL	Alarm Low, Src: 0x0...
240	18.689043	Siemens_6c:02:90	SiemensA_89:5e:35	PNIO	RTCL, ID:0xc001, Len:...
241	18.747602	wagoKont_01:50:92	SiemensA_89:5e:35	PNIO	RTCL, ID:0xc002, Len:...
242	18.862765	wagoKont_01:50:89	SiemensA_89:5e:35	PNIO	RTCL, ID:0xc000, Len:...
243	18.942035	SiemensA_89:5e:35	Siemens_6c:02:90	PNIO	RTCL, ID:0xc000, Len:...
244	18.943010	SiemensA_89:5e:35	wagoKont_01:50:92	PNIO	RTCL, ID:0xc010, Len:...
245	18.944050	SiemensA_89:5e:35	wagoKont_01:50:89	PNIO	RTCL, ID:0xc010, Len:...

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## Port Mirroring

- **Port Mirroring** is used on a switch to send a copy of network packets seen on one switch port (or an entire VLAN) to a network monitoring connection on another switch port.
- Defining a mirror port duplicates all traffic on the mirror.
  - √ incoming and outgoing traffic
- Useful for monitoring the switch traffic on a certain port, the monitor port **for diagnostic reasons**.
  - √ e.g. with Ethereal / Wireshark analyser
- **Available in managed switches or as a dedicated device.**



## Setup Switch for Monitoring

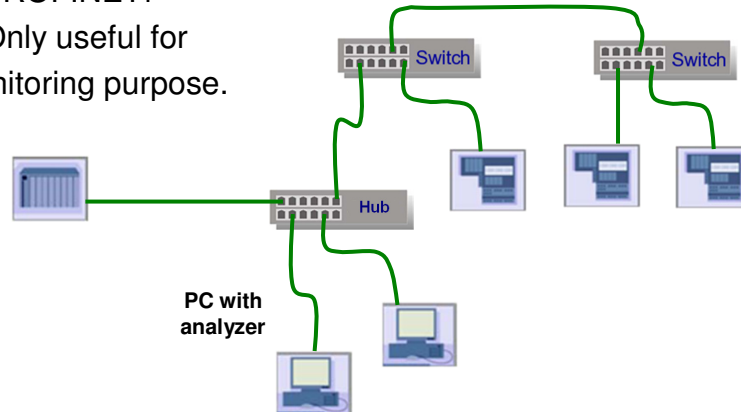
**Swiath Configuration**

☐ Mirroring Enabled

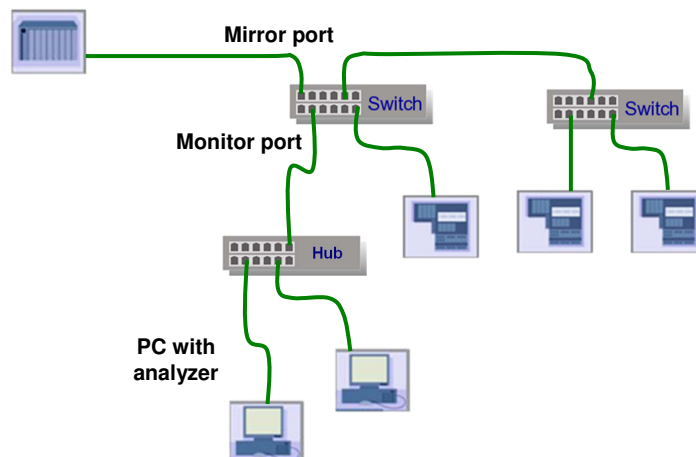
Mirroed Port:  Monitor Port:

## Monitoring

- Hubs should NOT be used  
In PROFINET!
- Only useful for  
monitoring purpose.



## Monitoring



## Mirror and monitor ports

Siemens WEB Management (192.168.0.100) - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://192.168.0.100/

Most Visited Getting Started Latest Headlines Customize Links Free Hotmail Windows Marketplace Windows Media

**SIEMENS** Automation & Drives

Console Support Logout

Power CPU Port Status

F L1 RM P1 P5  
L2 P2 P6  
P3 P4

SIMATIC NET Industrial Ethernet Switch  
SCALANCE X204.2  
mmu

Switch Configuration

☒ Mirroring Enabled

Mirrored Port: 3 Monitor Port: 2

System  
X204-2  
Agent  
Switch  
Statistics

## Non-monitoring Port

- On non-monitoring port of a switch, only multicast or broadcast messages are captured.

No. -	Time	Source	Destination	Protocol	Info
840	2819.800225	SiemensA_a1:59:19	LLDP_Multicast	LLDP	Chassis Id = scalance Port
841	2824.799927	SiemensA_a1:59:19	LLDP_Multicast	LLDP	Chassis Id = scalance Port
842	2829.799422	SiemensA_a1:59:19	LLDP_Multicast	LLDP	Chassis Id = scalance Port
843	2834.799207	SiemensA_a1:59:19	LLDP_Multicast	LLDP	Chassis Id = scalance Port
844	2837.871006	SiemensA_a1:59:17	PN-MC_00:00:00	PN-DCP	Ident Req, X1d:0x2000599,
845	2838.872443	SiemensA_a1:59:17	PN-MC_00:00:00	PN-DCP	Ident Req, X1d:0x200059a,
846	2839.798824	SiemensA_a1:59:19	LLDP_Multicast	LLDP	Chassis Id = scalance Port
847	2839.872376	SiemensA_a1:59:17	PN-MC_00:00:00	PN-DCP	Ident Req, X1d:0x200059b,
848	2840.872320	SiemensA_a1:59:17	PN-MC_00:00:00	PN-DCP	Ident Req, X1d:0x200059c,
849	2841.871804	SiemensA_a1:59:17	Broadcast	ARP	Gratuitous ARP for 192.168
850	2844.798365	SiemensA_a1:59:19	LLDP_Multicast	LLDP	Chassis Id = scalance Port

Frame 844 (56 bytes on wire, 56 bytes captured)

Ethernet II, Src: SiemensA\_a1:59:17 (00:0e:8c:a1:59:17), Dst: PN-MC\_00:00:00 (01:0e:cf:00:00:00)

Destination: PN-MC\_00:00:00 (01:0e:cf:00:00:00)

Source: SiemensA\_a1:59:17 (00:0e:8c:a1:59:17)

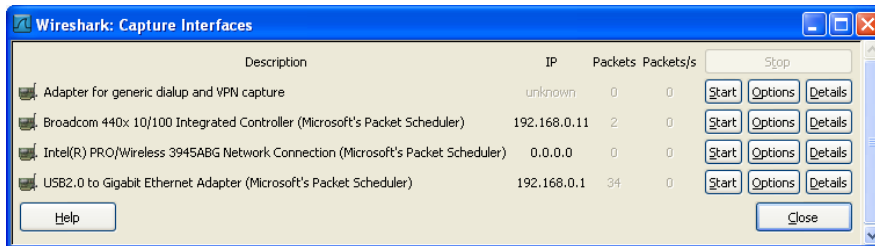
Type: PROFINET (0x8892)

PROFINET acyclic Real-Time, ID:0xfefe, Len: 40

FrameID: 0xfefe (Real-Time: DCP (Dynamic Configuration Protocol) identify multicast request)

## Recording

- Select a network interface to record telegrams/data exchange.



## Normal Data

- Priority 6, relatively low.

232	18.350774	wagokont_01:50:89	SiemensA_89:5e:35	PNIO	RTCL, ID:0xc000, Len: 40, Cycle:32800
233	18.430211	SiemensA_89:5e:35	Siemens_6c:02:90	PNIO	RTCL, ID:0xc000, Len: 40, Cycle:32800
234	18.431144	SiemensA_89:5e:35	wagokont_01:50:92	PNIO	RTCL, ID:0xc010, Len: 40, Cycle:32800
235	18.432140	SiemensA_89:5e:35	wagokont_01:50:89	PNIO	RTCL, ID:0xc010, Len: 40, Cycle:32800
236	18.622398	Siemens_6c:02:90	SiemensA_89:5e:35	PNIO-AL	Alarm Low, Src: 0x0, Dst: 0x3, D: 0x0
237	18.623020	SiemensA_89:5e:35	Siemens_6c:02:90	PNIO-AL	Alarm Low, Src: 0x3, Dst: 0x0, D: 0x0
238	18.626222	SiemensA_89:5e:35	Siemens_6c:02:90	PNIO-AL	Alarm Low, Src: 0x3, Dst: 0x0, D: 0x0
239	18.626763	Siemens_6c:02:90	SiemensA_89:5e:35	PNIO-AL	Alarm Low, Src: 0x0, Dst: 0x3, D: 0x0
240	18.689043	Siemens_6c:02:90	SiemensA_89:5e:35	PNIO	RTCL, ID:0xc001, Len: 40, Cycle:32800
241	18.747602	wagokont_01:50:92	SiemensA_89:5e:35	PNIO	RTCL, ID:0xc002, Len: 40, Cycle:32800
242	18.862765	wagokont_01:50:89	SiemensA_89:5e:35	PNIO	RTCL, ID:0xc000, Len: 40, Cycle:32800
243	18.942035	SiemensA_89:5e:35	Siemens_6c:02:90	PNIO	RTCL, ID:0xc000, Len: 40, Cycle:32800
244	18.943010	SiemensA_89:5e:35	wagokont_01:50:92	PNIO	RTCL, ID:0xc010, Len: 40, Cycle:32800
245	18.944050	SiemensA_89:5e:35	wagokont_01:50:89	PNIO	RTCL, ID:0xc010, Len: 40, Cycle:32800
246	19.201290	Siemens_6c:02:90	SiemensA_89:5e:35	PNIO	RTCL, ID:0xc001, Len: 40, Cycle:32800
247	19.259605	wagokont_01:50:92	SiemensA_89:5e:35	PNIO	RTCL, ID:0xc002, Len: 40, Cycle:32800
248	19.374727	wagokont_01:50:89	SiemensA_89:5e:35	PNIO	RTCL, ID:0xc000, Len: 40, Cycle:32800
249	19.454024	SiemensA_89:5e:35	Siemens_6c:02:90	PNIO	RTCL, ID:0xc000, Len: 40, Cycle:32800

Frame 240 (64 bytes on wire, 64 bytes captured)  
 Ethernet II, Src: Siemens\_6c:02:90 (08:00:06:6c:02:90), Dst: SiemensA\_89:5e:35 (00:0e:8c:89:5e:35)  
 Destination: Siemens\_6c:02:90 (08:00:06:6c:02:90)  
 Source: Siemens\_6c:02:90 (08:00:06:6c:02:90)  
 Type: 802.1Q Virtual LAN (0x8100)  
 802.1Q Virtual LAN, PRI: 6, CFI: 0, ID: 0  
 110. .... = Priority: 6  
 ...0 .... = CFI: 0  
 .... 0000 0000 0000 = ID: 0  
 Type: PROFINET (0x8892)  
 PROFINET cyclic Real-Time, RTCL, ID:0xc001, Len: 40, Cycle:32800 (Valid, Primary, Problem, Run)  
 FrameID: 0xc001 (0xc000-0xc0ff: Real-Time(class=1): cyclic)  
 CycleCounter: 32800



## Alarms

- VLAN must be used. Alarms are Priority 5, higher than normal data.

232	18.350774	wagokont_01:50:89	SiemensA_89:5e:35	PNIO	RTCL, ID:0xc000, Len: 40, Cycle:
233	18.430231	SiemensA_89:5e:35	Siemens_6c:02:90	PNIO	RTCL, ID:0xc000, Len: 40, Cycle:
234	18.431144	SiemensA_89:5e:35	wagokont_01:50:92	PNIO	RTCL, ID:0xc010, Len: 40, Cycle:
235	18.432140	SiemensA_89:5e:35	wagokont_01:50:89	PNIO	RTCL, ID:0xc010, Len: 40, Cycle:
236	18.622398	Siemens_6c:02:90	SiemensA_89:5e:35	PNIO-AL	Alarm Low, Src: 0x0, Dst: 0x3, AC
237	18.623020	SiemensA_89:5e:35	Siemens_6c:02:90	PNIO-AL	Alarm Low, Src: 0x3, Dst: 0x0, AC
238	18.623222	SiemensA_89:5e:35	Siemens_6c:02:90	PNIO-AL	Alarm Low, Src: 0x3, Dst: 0x0, AC
239	18.626763	Siemens_6c:02:90	SiemensA_89:5e:35	PNIO-AL	Alarm Low, Src: 0x0, Dst: 0x3, AC
240	18.689043	Siemens_6c:02:90	SiemensA_89:5e:35	PNIO	RTCL, ID:0xc001, Len: 40, Cycle:
241	18.747602	wagokont_01:50:92	SiemensA_89:5e:35	PNIO	RTCL, ID:0xc002, Len: 40, Cycle:
242	18.862765	wagokont_01:50:89	SiemensA_89:5e:35	PNIO	RTCL, ID:0xc000, Len: 40, Cycle:
243	18.942035	SiemensA_89:5e:35	Siemens_6c:02:90	PNIO	RTCL, ID:0xc000, Len: 40, Cycle:
244	18.943010	SiemensA_89:5e:35	wagokont_01:50:92	PNIO	RTCL, ID:0xc010, Len: 40, Cycle:
245	18.944050	SiemensA_89:5e:35	wagokont_01:50:89	PNIO	RTCL, ID:0xc010, Len: 40, Cycle:
246	19.201290	Siemens_6c:02:90	SiemensA_89:5e:35	PNIO	RTCL, ID:0xc001, Len: 40, Cycle:
247	19.259605	wagokont_01:50:92	SiemensA_89:5e:35	PNIO	RTCL, ID:0xc002, Len: 40, Cycle:
248	19.374727	wagokont_01:50:89	SiemensA_89:5e:35	PNIO	RTCL, ID:0xc000, Len: 40, Cycle:

```

c
# Frame 236 (66 bytes on wire, 66 bytes captured)
# Ethernet II, Src: Siemens_6c:02:90 (08:00:06:6c:02:90), Dst: SiemensA_89:5e:35 (00:0e:8c:89:5e:35)
  # Destination: SiemensA_89:5e:35 (00:0e:8c:89:5e:35)
  # Source: Siemens_6c:02:90 (08:00:06:6c:02:90)
    Type: 802.1Q Virtual LAN (0x8100)
  # 802.1Q Virtual LAN, PRI: 5, CFI: 0, ID: 0
    101. .... = Priority: 5
    .... = CFI: 0
    .... 0000 0000 0000 = ID: 0
    Type: PROFINET (0x8892)
  # PROFINET acyclic Real-Time, Alarm Low, ID:0xfe01, Len: 46
    FrameID: 0xfe01 (Real-Time: Acyclic PN-IO Alarm low priority)

```

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## Conclusion

- Static wiring test → handheld tools.
- Configuration errors → MAC addresses, device names and IP addresses.
- Live system diagnostics
  - ✓ Software supplied with IO Controller
  - ✓ Analysers, e.g. comprehensive and easy to use → Wireshark