



SIEMENS
Ingenuity for life

Profinet

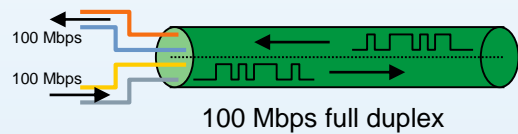
Unrestricted © Siemens AG 2020

[siemens.com/switches](https://www.siemens.com/switches)

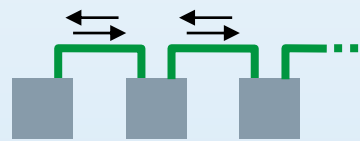
PROFINET on 100% Ethernet

PROFINET is Ethernet

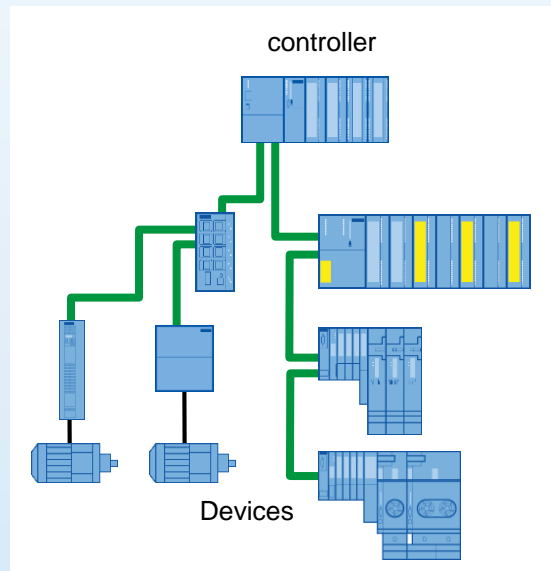
- Ethernet is an established standard in the IT world for fast data transfer (IEEE 802.3)
- PROFINET is always full duplex → simultaneous communication in both directions



- PROFINET is always "switched Ethernet"

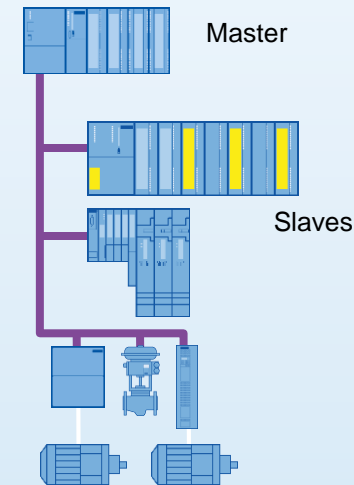


- The topology can be influenced network load



For comparison: PROFIBUS

- One line of "cable" to which everyone is connected
- → Performance depends on the number of devices



PROFINET take full advantage of the possibilities offered by Ethernet

Profinet Vs. Profibus

Profinet works on the same principle as Profibus.

Except :

- Higher carrier frequency 100-600MHz (3-20MHz)
- 2-4 twisted pair cable
- Bandwidth 10-1000Mbps (0,184-12Mbps)
- Different cables can be used in the same application
- Maximum length 100m and with flexible cables 80m



Cable technology – FastConnect (electric/twisted pair) Industrial Ethernet/PROFINET

Industrial Ethernet/PROFINET:

For quick installation

- **RJ45 liittimet 2 x 2 and 4 x 2**

Stripping Tools!

Link to Video:

<https://youtu.be/9e4G5DPPXHM>



Link to Video:

<https://youtu.be/XQjVYFMR8Mk>



- **M12 plugs** (using stripping tool)
IE FC cables: 4 ja 8- wires



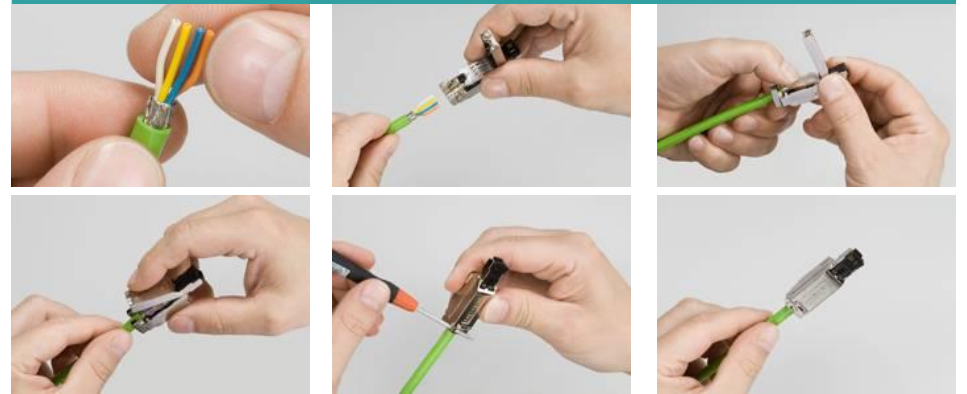
Link to Video:

<https://youtu.be/CSwDQptulds>

Stripping



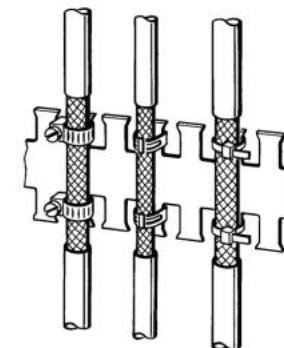
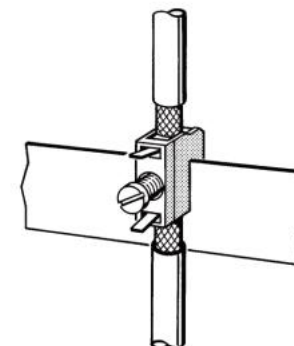
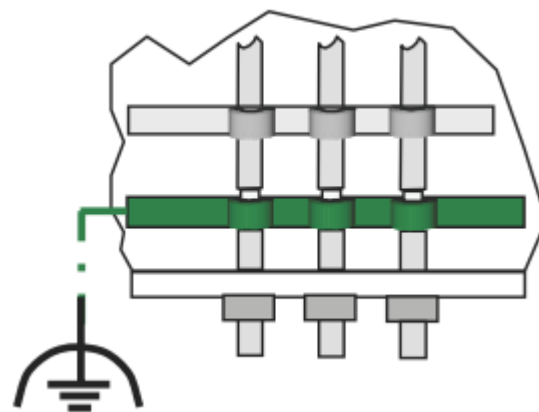
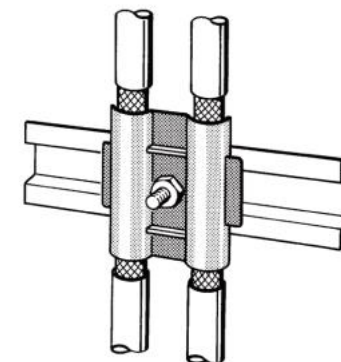
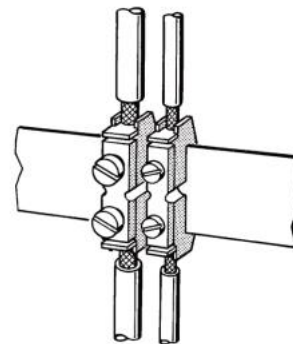
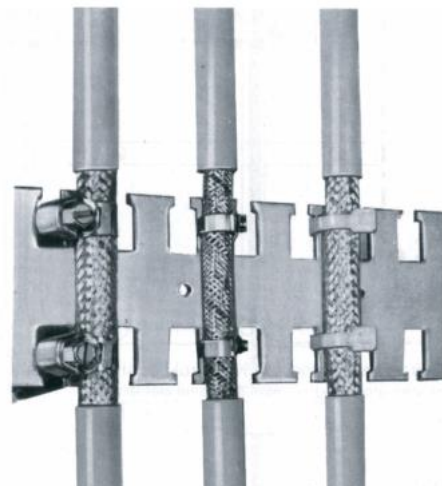
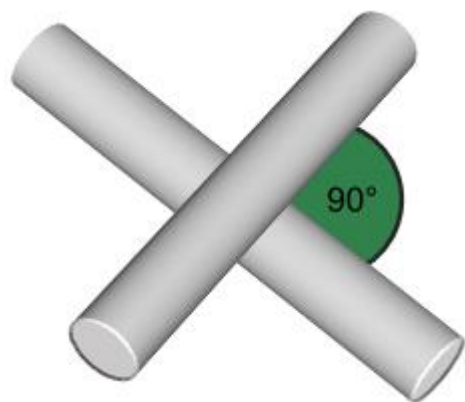
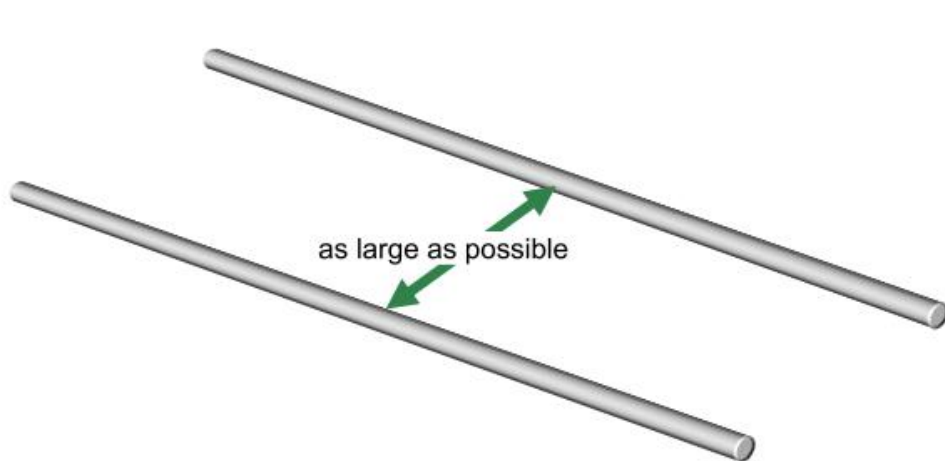
Install RJ45



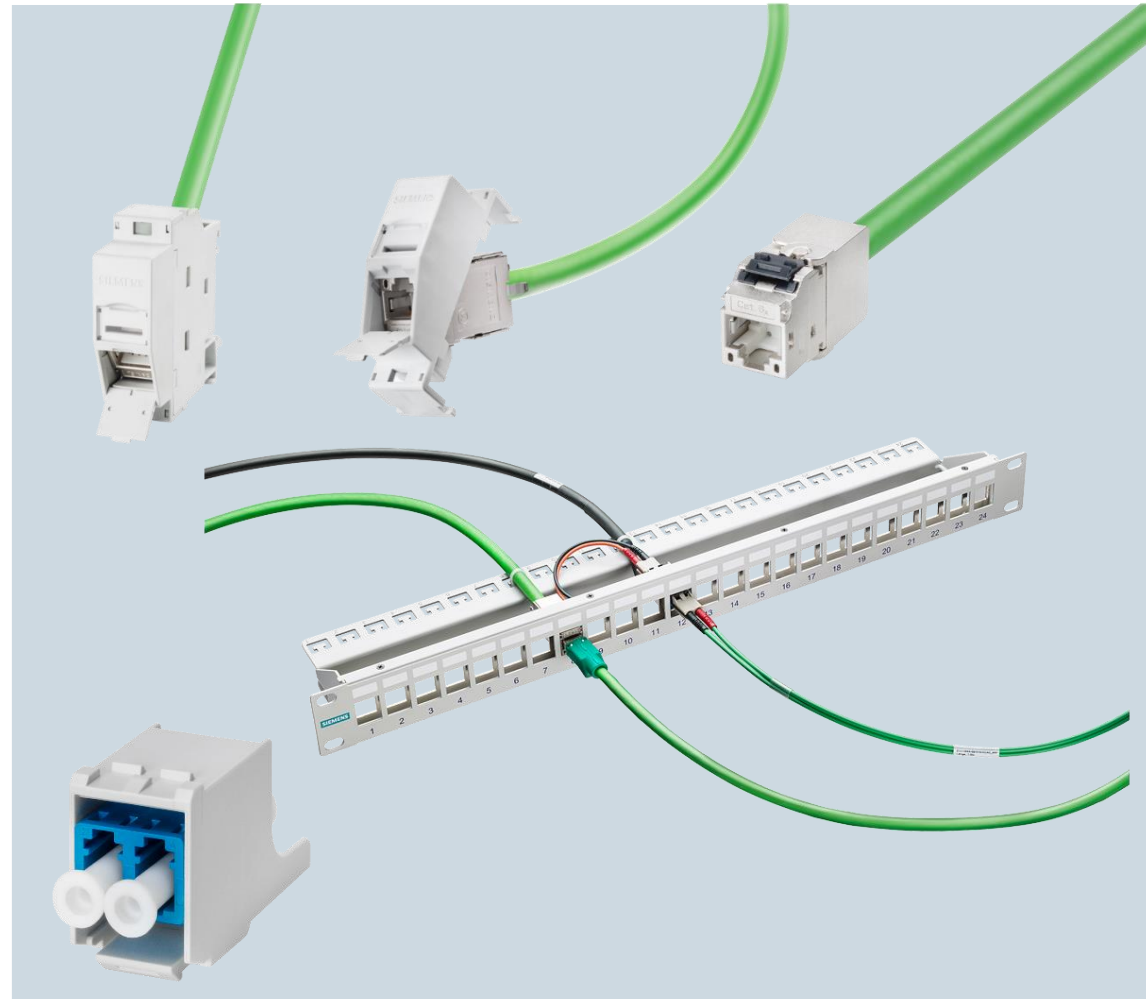
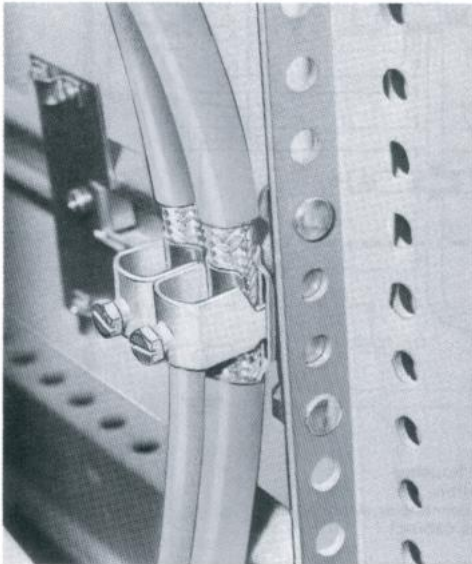
Install M12



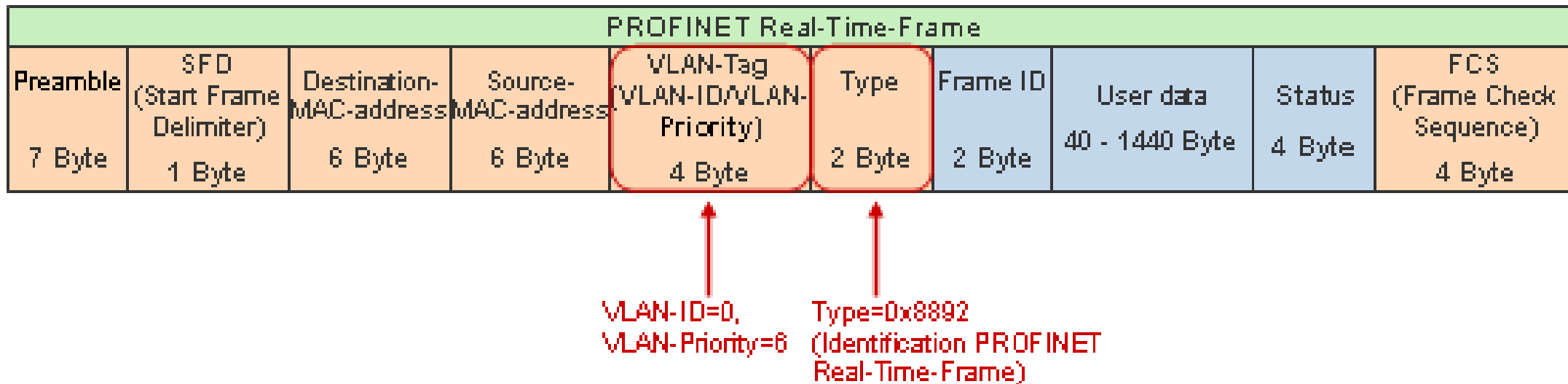
Installation and grounding



Installation and grounding



Profinet telegram – no TCP/IP frame – no roaming



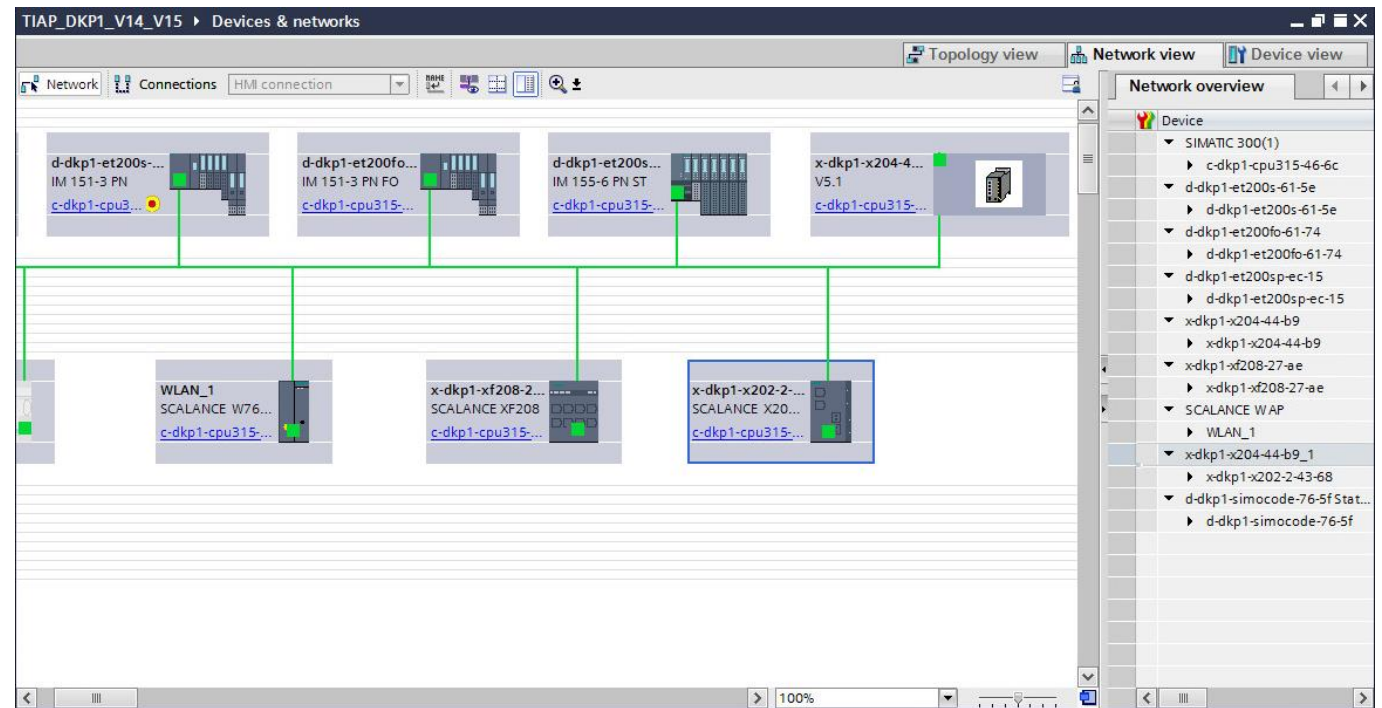
PROFINET device configurations and topology in TIA Portal

TIA Portal – PROFINET

- PROFINET devices (including network products) are configured using the TIA Portal.
- These settings are transferred to the SIMATIC CPU and from there to the PROFINET devices.
- The CPU defines IP addresses and PN names according to the topology made in the TIA Portal. Also for network devices.
- In the topology, all devices must support the Profinet mechanism.

PROFINET TIA in Portal

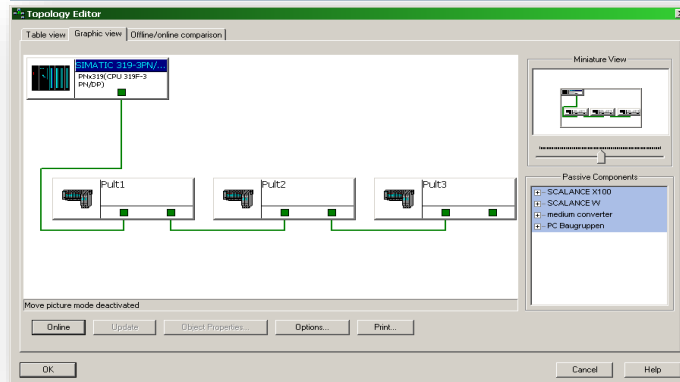
All parameters relevant to PROFINET are defined in the TIA portal and then transferred to the SIMATIC CPU.



Topology definition allows automatic configuration

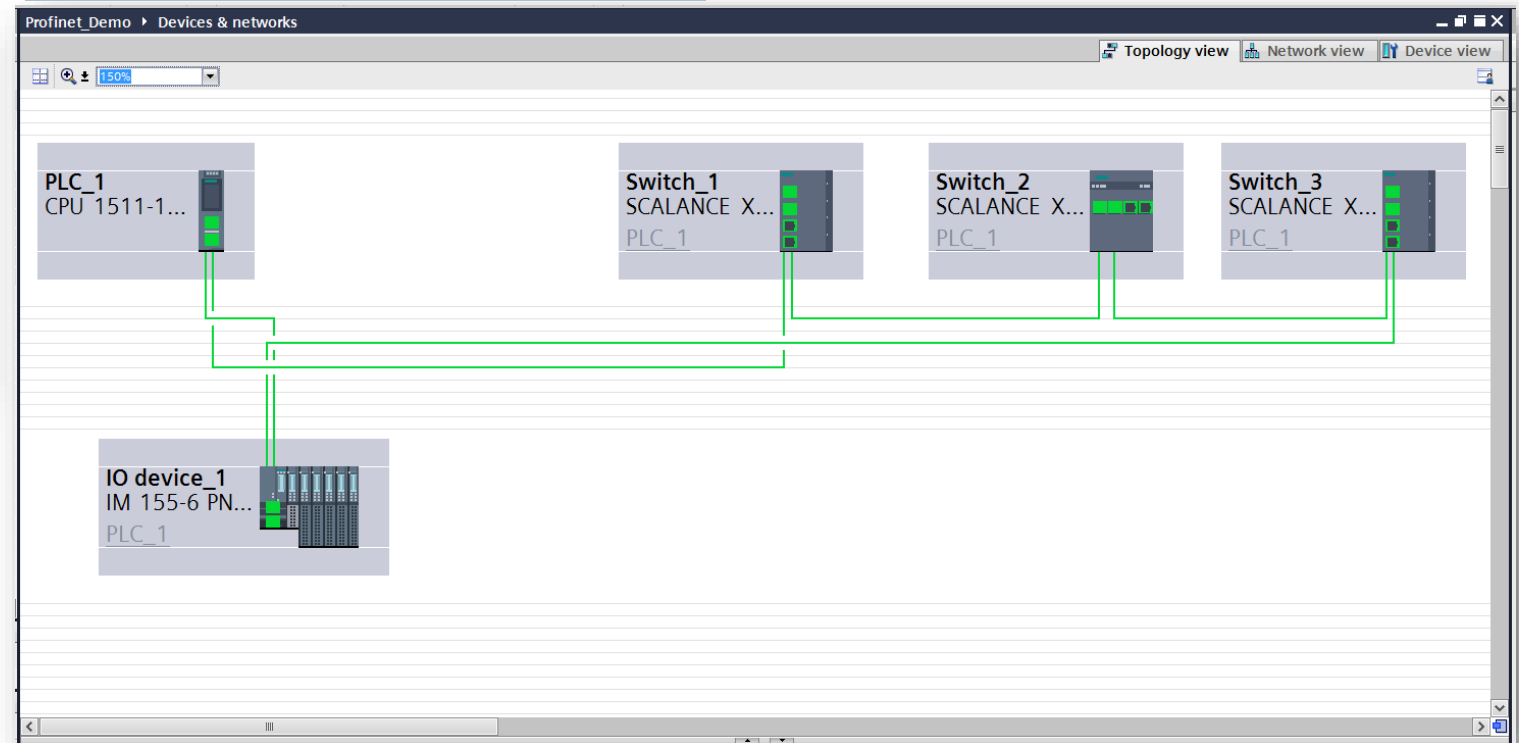
Topology editor (Classic STEP7)

- Define cabling

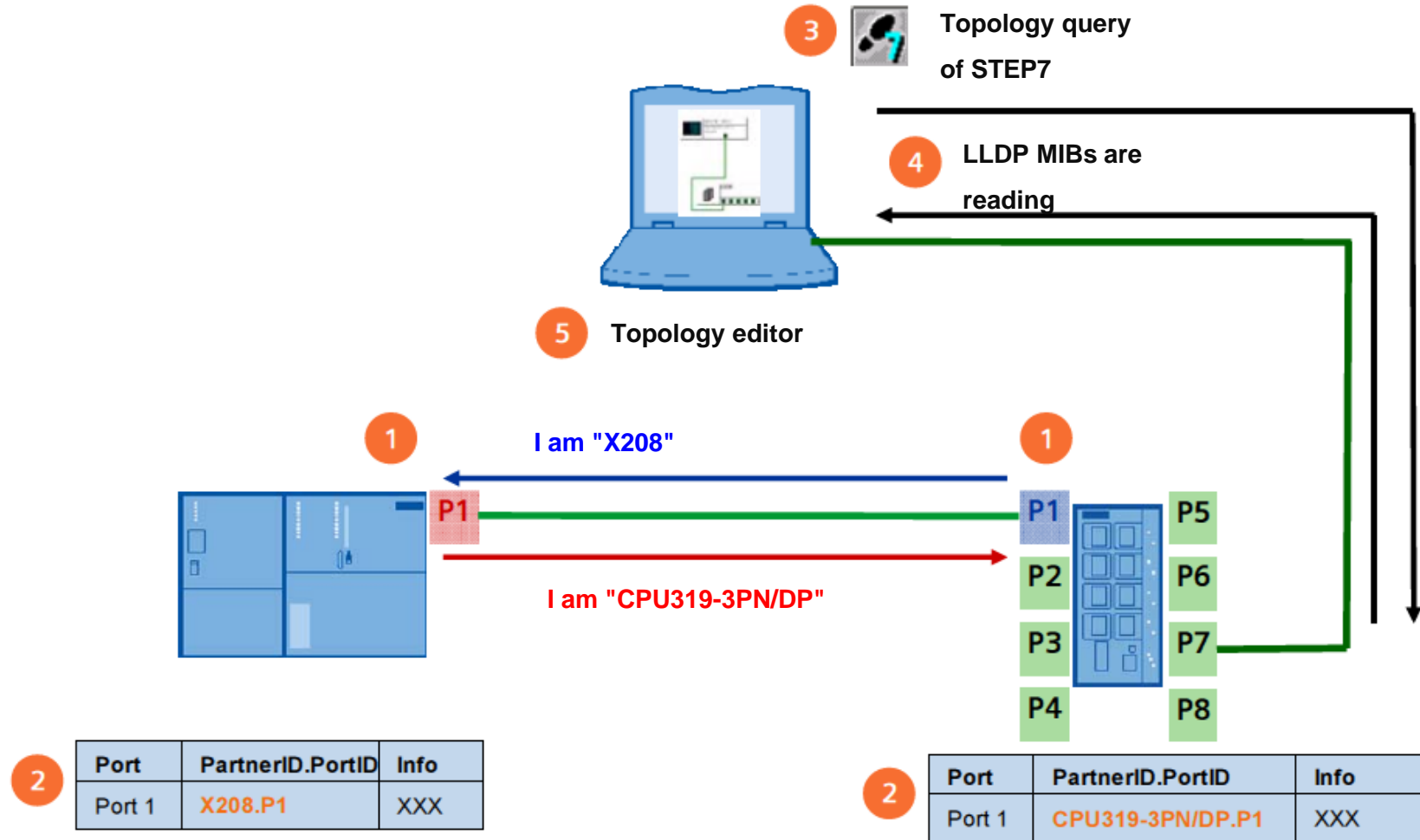


Topology editor (STEP7 – TIA Portal)

- Define cabling



Topology detection uses LLDP communication



Topology Defined - Automatic Configuration

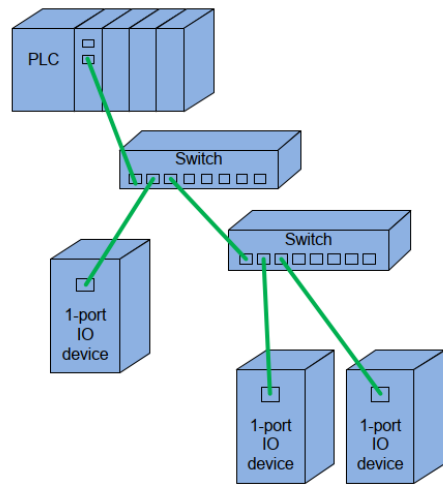
- WITH PROFINET YOU ALWAYS HAVE USE MANAGERED SWITCHES!

- Automatic configuration saves time and minimizes errors

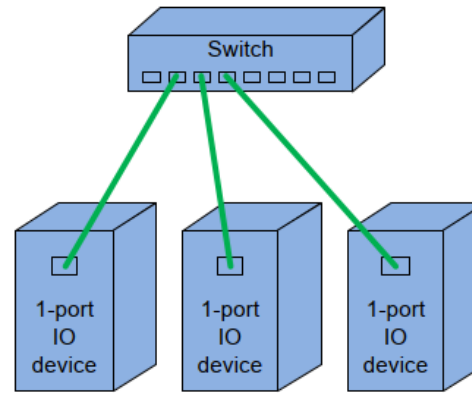
- With this function, the PROFINET IO controller automatically enters the IP address and device name of the PROFINET IO devices without a programming device (PG).

- The requirements for automatic configuration are :
 - The IO controller and IO devices must support the PROFINET function "Device replacement without exchangeable medium / PG".
 - In STEP7, you must select the option "Replacing the device without removable media" –"Device replacement without exchangeable medium"
 - The devices must be reset to factory settings – factory reset.
 - **Profinet GSDxml device description must be found on all devices - including switches!**
 - **The configured topology must correspond to the actual topology!**

Profinet network topologies

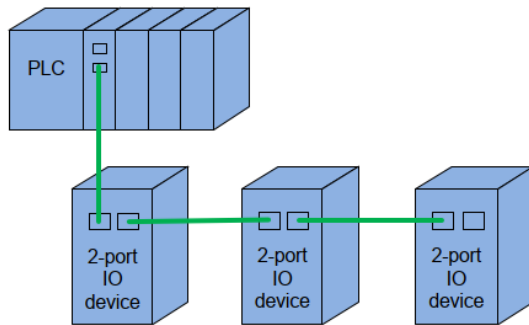


Tree



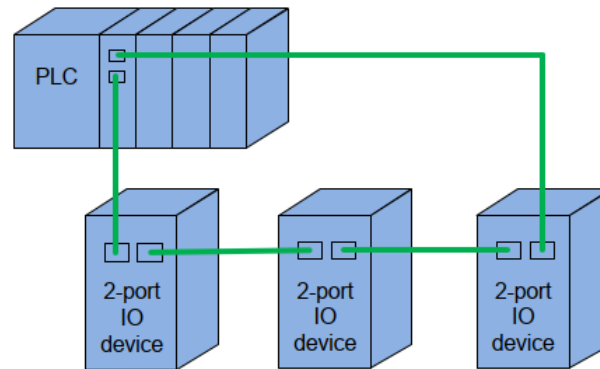
Star

(typically motor centers - Simocode)



Linear

Linear topology



Ring - MRP

Ring topology

Response time in line topology – 14 stations (1.8 ms)

Siemens Profinet IO device with “cut through” switch – Ertec Asics circuit has been used for interface.



Tt = Transmission time of minimum frame = approximately 7 μ s

Rtb = Run time of bit on the cable at 100 Mbps and 100 m cable between two nodes -> 0,5 μ s

TPTswitch = Throughput time through a switch. For RT_Class_1 approximately 10 μ s (in GSD file)

Basic calculation:

Length of minimum frame: 64 bytes including process data
 Including preamble and SFD: 08 bytes as header
 Idle time: 12 bytes after each Ethernet frame
Total: 84 bytes

This calculation can only be used with Siemens devices. It has been found that some other manufacturers has used standard “store and forward” switches in device Profinet interface. These do not guarantee a stable response time.

RT Minimum/maximun transmission time without wait times

Bytes	Tt [μ s]	Nn (asemien määrä ketjussa)	Rtb [μ s]	TPTswitch [μ s]	Tt_min [ms]	Tt_max [ms]
84	6,7	14	0,5	10	0,154	1,729

TPTswitch [μ s]	Tx [μ s]
10	153,72

Response time in line topology – 20 stations (2,6 ms)

Siemens Profinet IO device with “cut through” switch – Ertec Asics circuit has been used for interface.



Tt = Transmission time of minimum frame = approximately 7 μs

Rtb = Run time of bit on the cable at 100 Mbps and 100 m cable between two nodes -> 0,5 μs

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RT Minimum/maximun transmission time without wait times

Bytes	Tt [μs]	Nn (asemien määrä ketjussa)	Rtb [μs]	TPTswitch [μs]	Tt_min [ms]	Tt_max [ms]
84	6,7	20	0,5	10	0,217	2,527

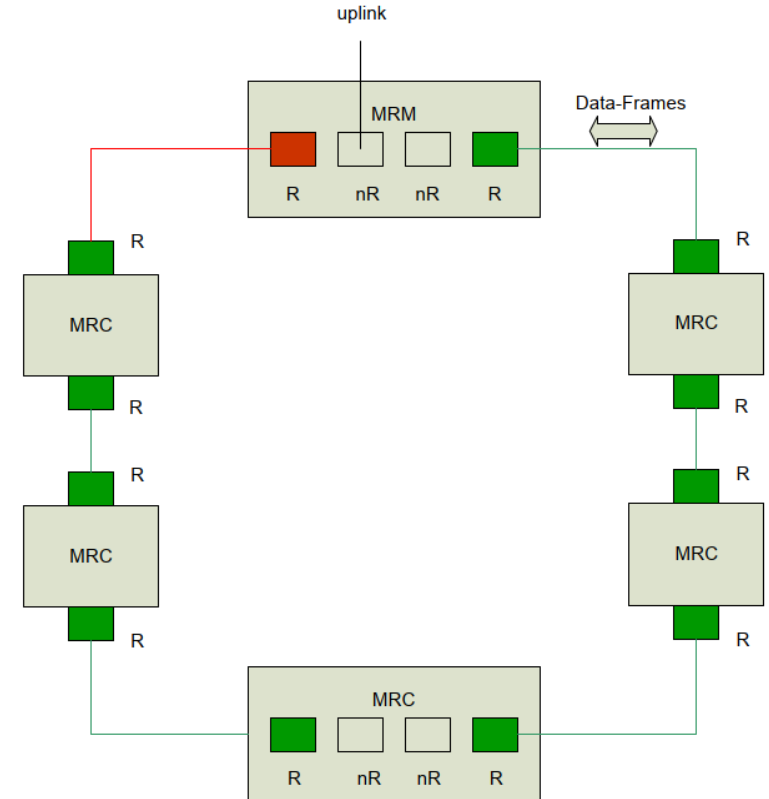
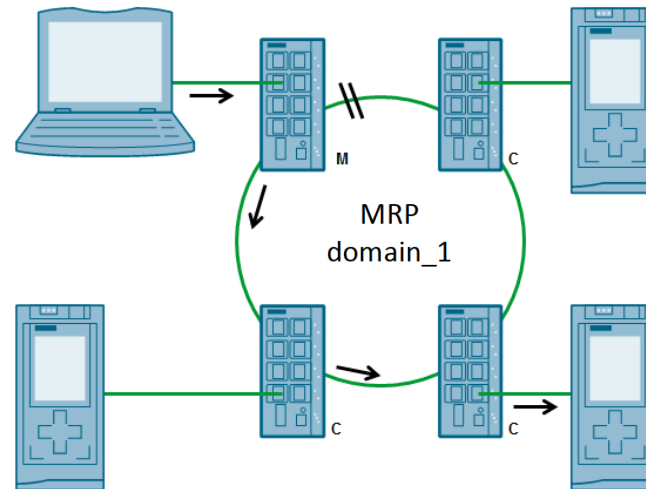
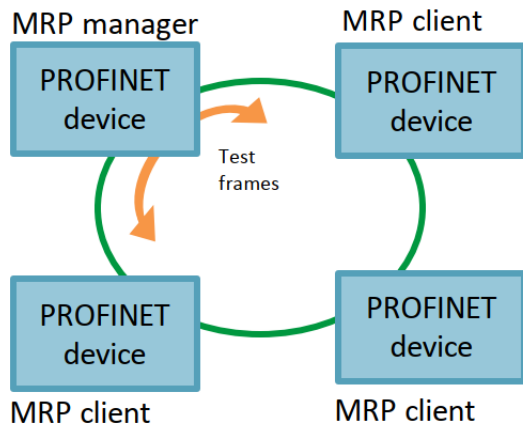
TPTswitch [μs]	Tx [μs]
10	216,72

RT: Media Redundancy Protocol (MRP)

1/2

MRP is a ring redundancy method used in Profinet applications. The redundancy manager sends test messages from each of its ring ports as long as the messages arrive at the other ring port. This way the manager knows that the ring is intact. At the same time, it prevents messages from circulating indefinitely in the ring, closing one of the ring ports.

- R: Ringport
- nR: non-Ringport
- Forwarding port
- Blocked port

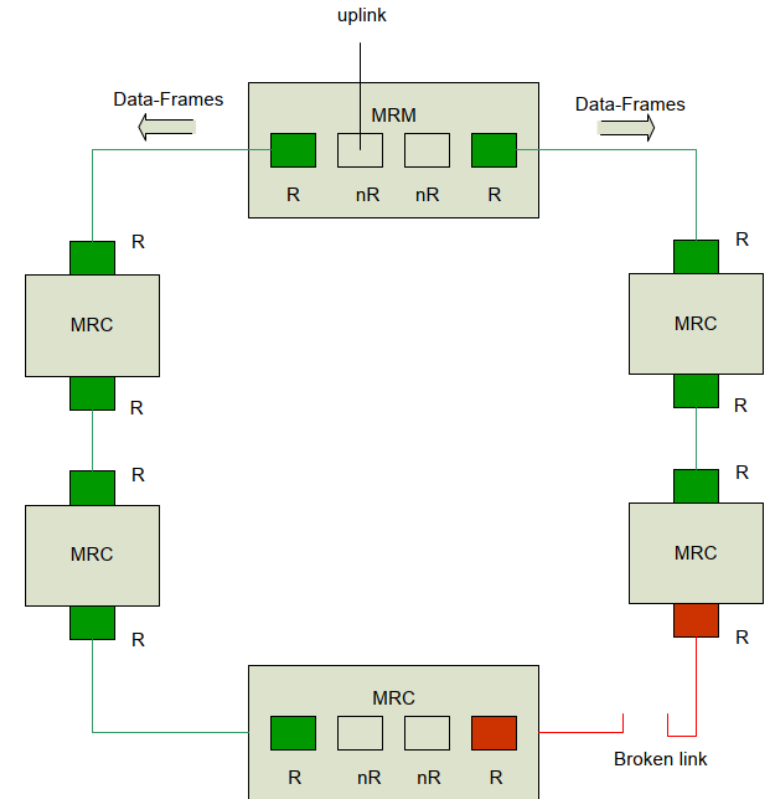
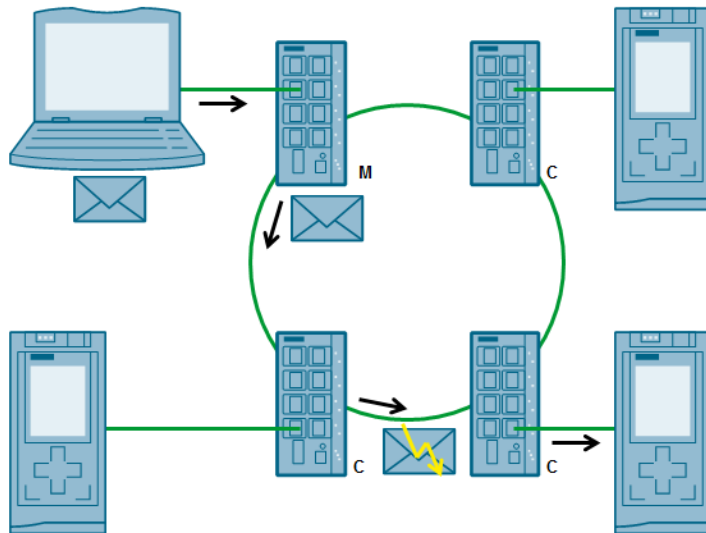


RT: Media Redundancy Protocol (MRP) 2/2

When test messages no longer arrive at another ring port, such as a damaged cable, the manager opens the closed ring port. In this case, post-break subscribers are available.

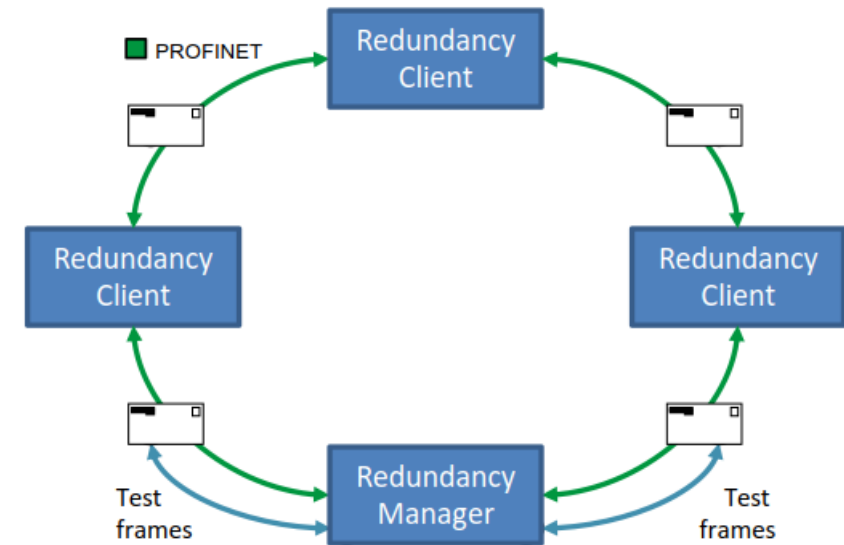
Network recovery (reconfiguration) takes up to 200 m (50 subscribers).

- R: Ringport
- nR: non-Ringport
- Forwarding port
- Blocked port



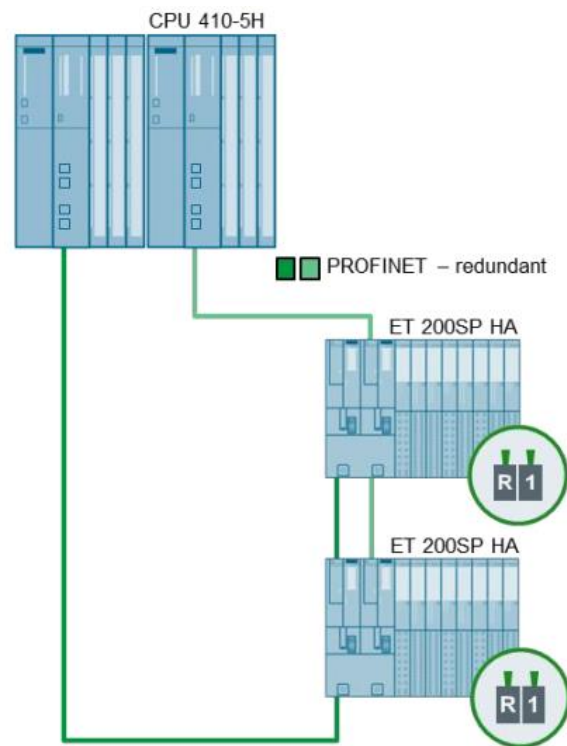
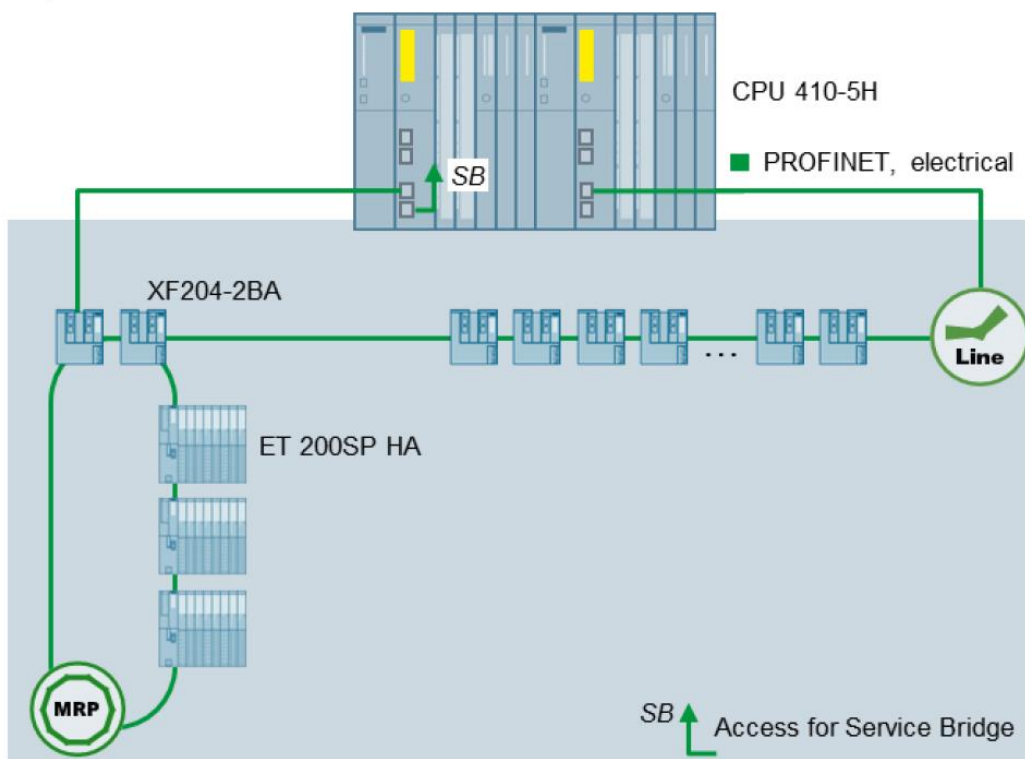
IRT: MRPD seamless ring. Max. 32 devices

The MRPD mechanism is based on IRT and MRP. A reconfiguration time of 0ms is possible by sending cyclic IRT packets duplicated in both directions on the ring. The recipient receives the same IRT frame twice if there are no errors on the network.

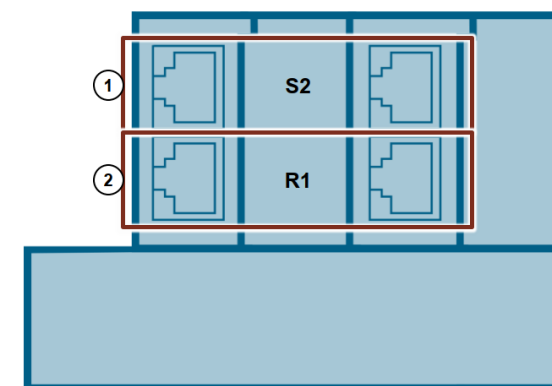


The devices receive this information on both ring ports, so there is no ring remodeling time. As with MRP, redundancy management prevents loops.

Redundancy example

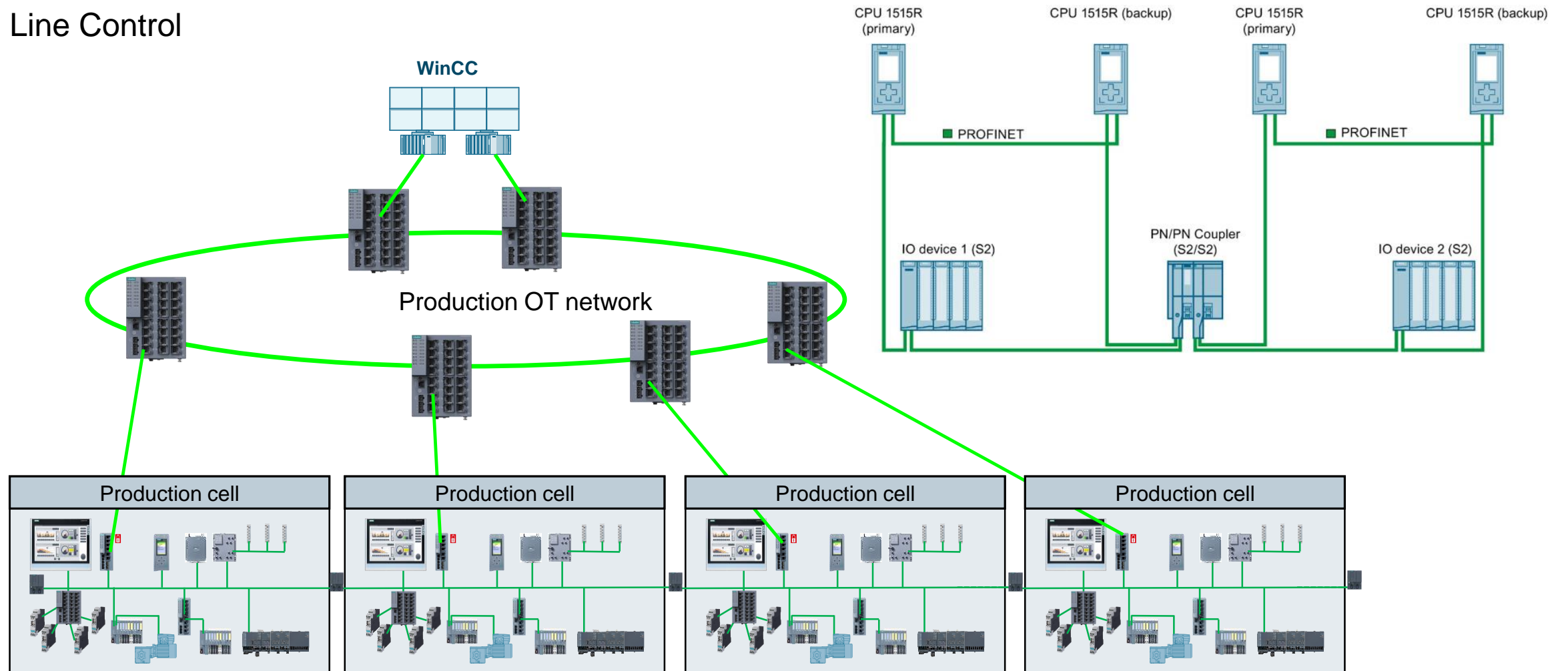


Symbols	PROFINET function
	Single PROFINET configuration S1
	Media redundancy with MRP
	System redundancy S2
	Redundant PROFINET configuration R1
	Configuration in RUN (CIR)
	High-precision time stamping (SoE - Sequence of Events)
	PA ready

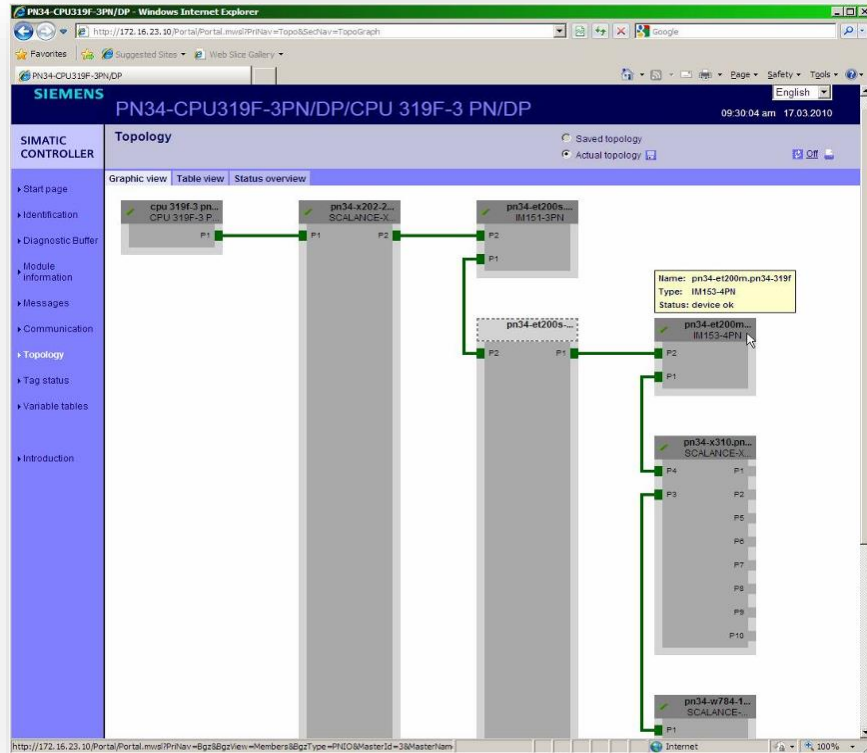


Segmented production network – PN/PN Coupler

Line Control



Web extension - Network topology - graphical view



CPU319 - Microsoft Internet Explorer

Address: http://192.168.1.21/Portal/Portal.mwsl?PriNav=Bgz&BgzType=DP&MasterName=PROFIBUS(1): DP master system (1)&MemberName=IM1

SIEMENS CPU319/CPU 319F-3 PN/DP 01:36:49 pm 21.11.2008

English

SIMATIC CONTROLLER Module information Slot Filter

CPU319 - PROFIBUS(1): DP master system (1) - IM151-1 HF

Slot	Symbol	Name	Order number	I Address	O Address	Comment
0	✓	IM151-1 HF	Details 6ES7 151-1BA02-0AB0	8177		
1	✓	PM-E DC24..48V	Details 6ES7 138-4CA50-0AB0	8176		
2	✓	4/8 F-DI DC24V	Details 6ES7 138-4FA03-0AB0	300.0	300.0	
3	✗	4/8 F-DI DC24V	Details 6ES7 138-4FA03-0AB0	306.0	306.0	
4	✓	4 F-DO DC24V/2A	Details 6ES7 138-4FB02-0AB0	312.0	312.0	
5	✓	PM-D F PROFIsafe	Details 3RK1 903-3BA01	10.0	10.0	
6	✓	F-DS1e-x 0.3-3A HF	Details 3RK1 301-0AB13-0AA4	15.0	4.0	

Module information

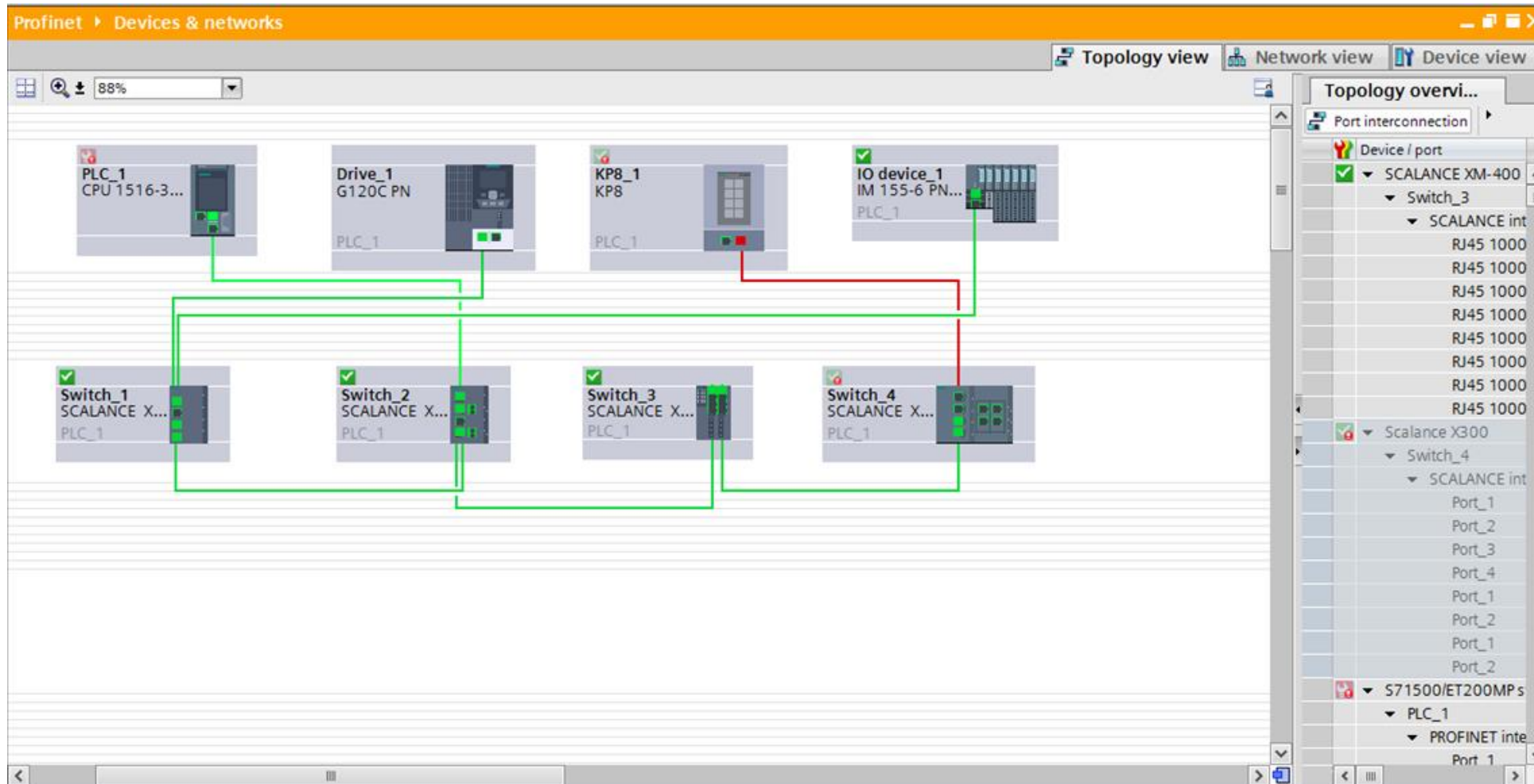
Start page Identification Diagnostic Buffer Messages PROFINET Topology Tag status Variable tables Introduction

Status Identification

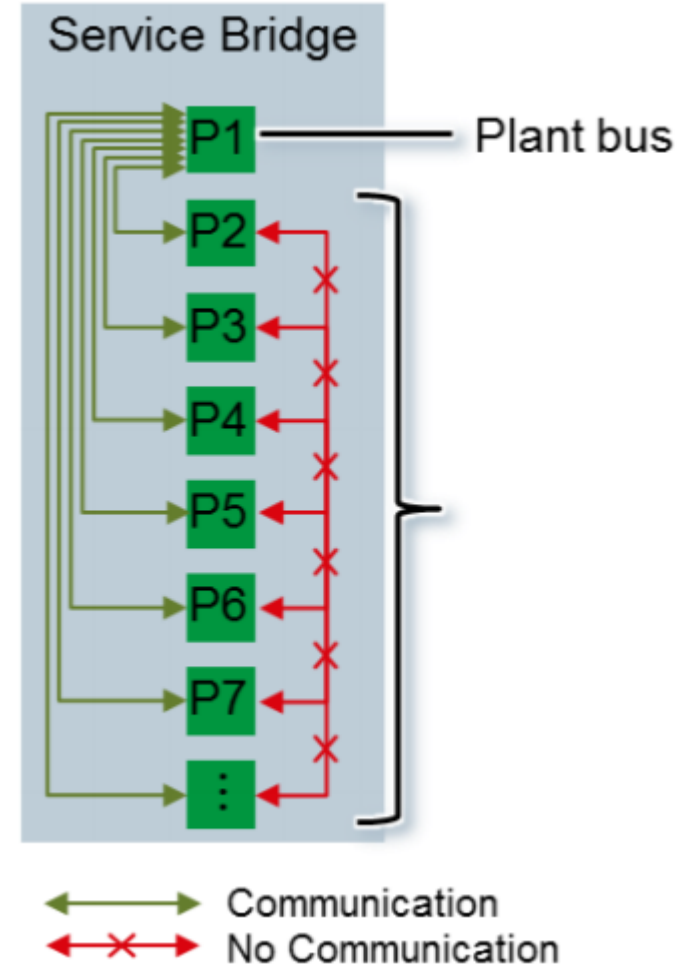
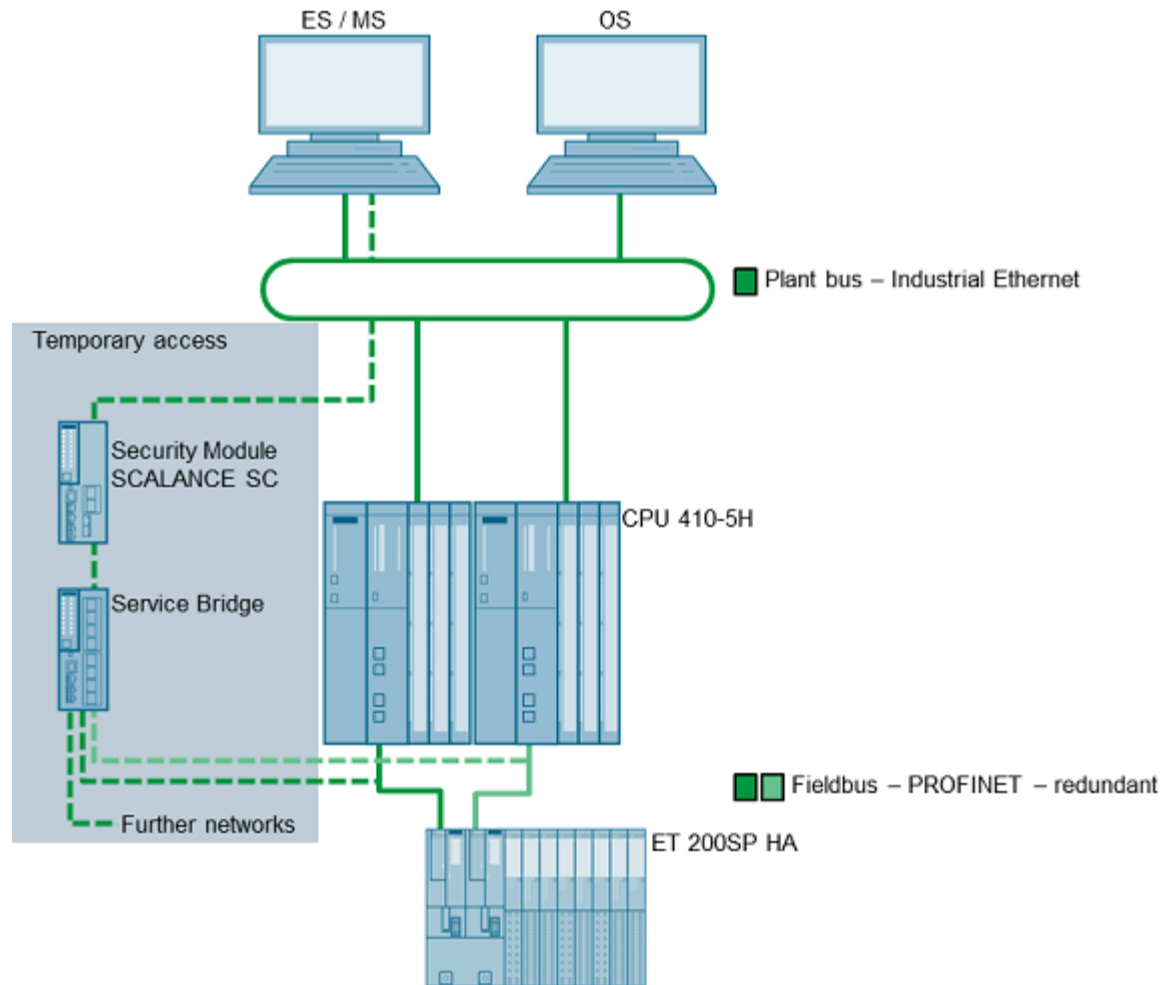
PB slave 31 on PB system 1, Slot 3: Module removed Name: IM151-1 HF Module: 4/8 F-DI DC24V I/O address: I306

Internet

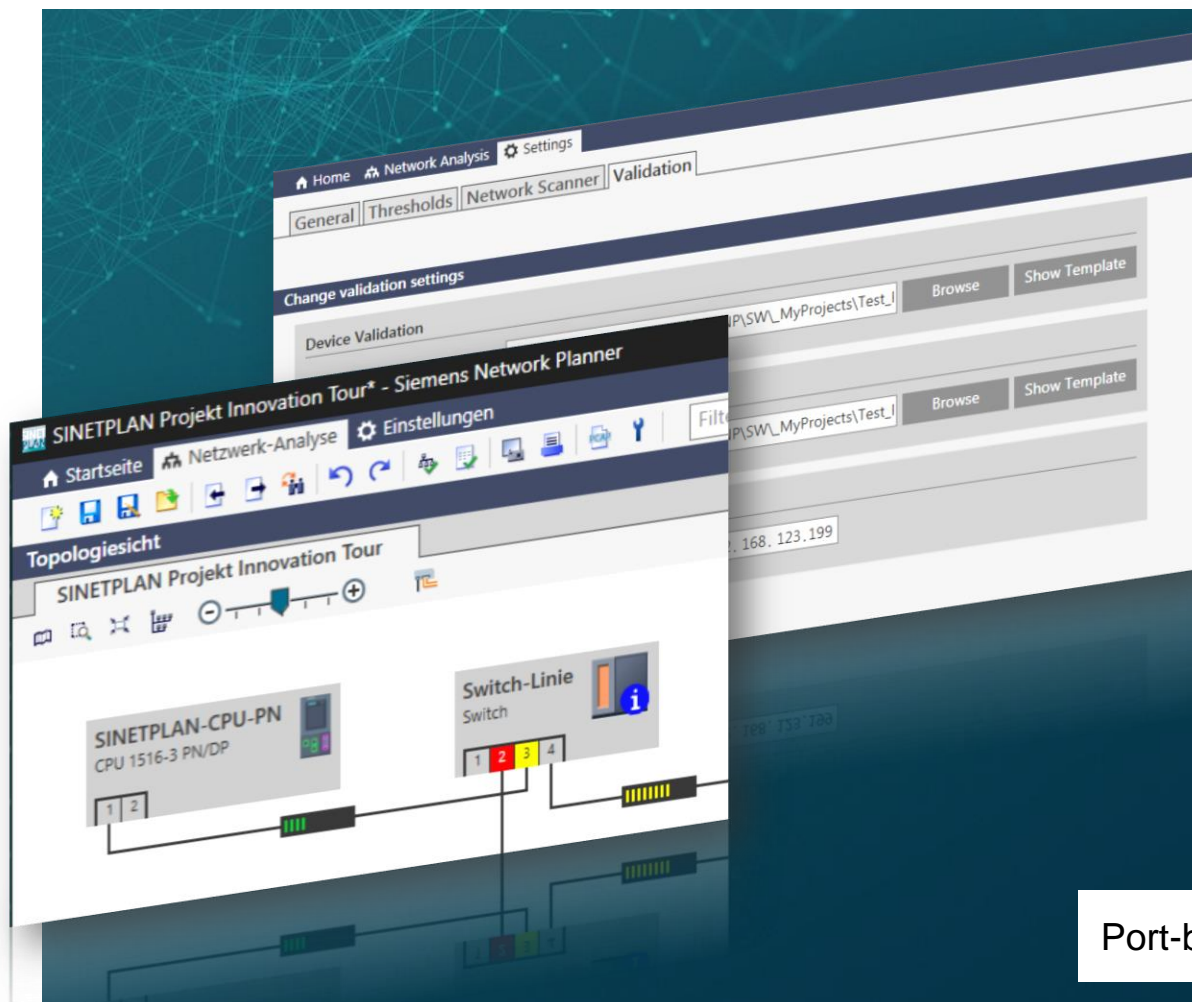
Online view on the TIA Portal.



Service bridge (Scalance XC200 series)



Sinetplan – Offline simulation for load in Profinet network



The image displays several overlapping screenshots of the SINETPLAN software interface. The top-left screenshot shows the 'Validation' tab with options for 'General', 'Thresholds', and 'Network Scanner'. Below it, a 'Change validation settings' dialog is visible. The middle-left screenshot shows the 'Topologiesicht' (Topology view) with a network diagram featuring a 'SINETPLAN-CPU-PN CPU 1516-3 PN/DP' and a 'Switch-Linie Switch'. The right side of the image features a 'Network report' window with a table of project details and a 'Company Login' button.

Project:	MyProject
System supplier:	MySystem
Plant designation:	MyDesignation
Plant:	MyPlant
Hall:	MyHall
Factory:	MyFactory
Station:	MyStation
Company:	MyCompany
Contact:	MyContact
Contact details:	29.01.2018 07:51:00
Generated on:	My comments - See 1 - my comments - my comments
Comments:	My comments - See 2 - my comments - my comments
	My comments - See 3 - my comments - my comments

- Report function with detailed results ✓
- Validation of the PROFINET planning guideline ✓
- Online scan function ✓
- Import of the configuration with AutomationML ✓
- Import of STEP7 & TIA Portal projects ✓
- Port-by-port simulation ✓

Sinetplan



SINETPLAN Projekt Innovation Tour* - Siemens Network Planner

Startseite Netzwerk-Analyse Einstellungen Filter für Geräte

Topologiesicht

SINETPLAN Projekt Innovation Tour

Kataloge

Geräte Datenfluss-Vorlagen Gerätegruppen

1516-3

Controller

SIMATIC S7-1500

CPU

CPU 1516-3 PN/DP

6ES7516-3AN01-0AB0 V2.6

Details

CPU 1516-3 PN/DP

6ES7516-3AN01-0AB0 V2.6

CPU mit Display, Arbeitsspeicher 1MB Code und 5MB Daten; 10ms Bitoperationszeit; 4-stufiges Schutzkonzept; Technologiefunktionen: Motion Control, Regeln, Zählen/Messen; Tracing; 1. Schnittstelle: PROFINET IO-Controller, unterstützt RT/IRT, Performance Upgrade PROFINET V2.3, 2 Ports, I-Device, MRP, MRPD, Transportprotokoll TCP/IP, secure Open User Communication; S7-Kommunikation; Webserver; DNS-Client; OPC UA; Server DA, Client DA, Methoden, Companion Spezifikationen; Taktsynchronität, Routing; 2. Schnittstelle: PROFINET IO-Controller, unterstützt RT, I-Device, Transportprotokoll TCP/IP, secure Open User Communication, S7-Kommunikation, Webserver, DNS-Client, OPC UA; Server DA, Client DA, Methoden, Companion Spezifikationen; Routing; 3. Schnittstelle: PROFIBUS DP-Master, S7-Kommunikation, Taktsynchronität, Routing; Runtime Optionen, Firmware V2.6

Gerätename

CPU 1516-3 PN/DP

1 2 1

Bearbeiten

Topologiesichtdetails

Geräteübersicht Datenflüsse Ergebnisse Info Pcap-Datenflüsse

Alle zeigen Non-Real-Time-Datenflüsse einbeziehen

Verbindungen mit hoher durchschnittlicher Bandbreitenauslastung

Quelle	Ziel	Quellgerät-Auslastung [%]	Zielgerät-Auslastung [%]
Switch15-Robot	Switch16-Robot	7.81	1.29
SMC-Ventil7	Switch06	7.62	1.10
IO-Dez-System7	MP 377-01	6.62	0.09
Switch17-Robot	Switch-Linie	4.04	10.53
SINETPLAN-CPU-PN	Switch-Linie	4.01	4.04
Switch15-Robot	Switch17-Robot	2.85	9.34
Switch13-Robot	Switch15-Robot	1.55	1.53

Ports mit hoher Warteschlangen-Auslastung

Gerät	Interface	Port	Warteschlangen-Auslastung [%]
Switch-Linie	Switch-Linie.Interface 1	Port 2	100,00
Quality camera 1	Camera 1.Interface 1	Port 1	20,15
Switch15-Robot	Switch15-Robot	Port 2	13,72
Switch17-Robot	Switch17-Robot	Port 2	12,00
Switch13-Robot	Switch13-Robot	Port 2	6,82
Switch-Linie	Switch-Linie.Interface 1	Port 3	4,66
LaserScannerX4	LaserScannerX4	Port 1	4,58

SIEMENS

Network report

SINETPLAN - Siemens Network Planner
01.00.00_09.01

Project: SINETPLAN Example Projekt_v4

System supplier: My system supplier
Plant designation: My plant designation
Plant: My plant
Hall: My hall
Factory: My factory
Station: My station

Company: Siemens AG
Author: M. Himmler
Contact details: DF FA AS E&C-PRM 6
Gleiwitzer Str. 555
90475 Nürnberg, Deutschland

Generated on: 6/14/2016
Comments: mailto: matthias.himmler@siemens.com
SINETPLAN - a great tool for network simulation!

Proneta (PROFINET network analyzer - free!)

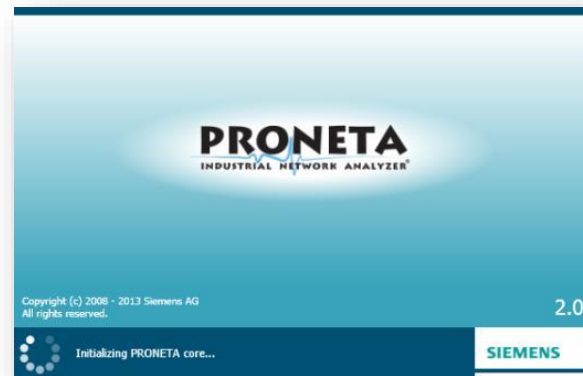
Requirements

- Easy to set up devices and network without PLC “tools”
- Detects devices and topology automatically
- Address settings
- IO testing

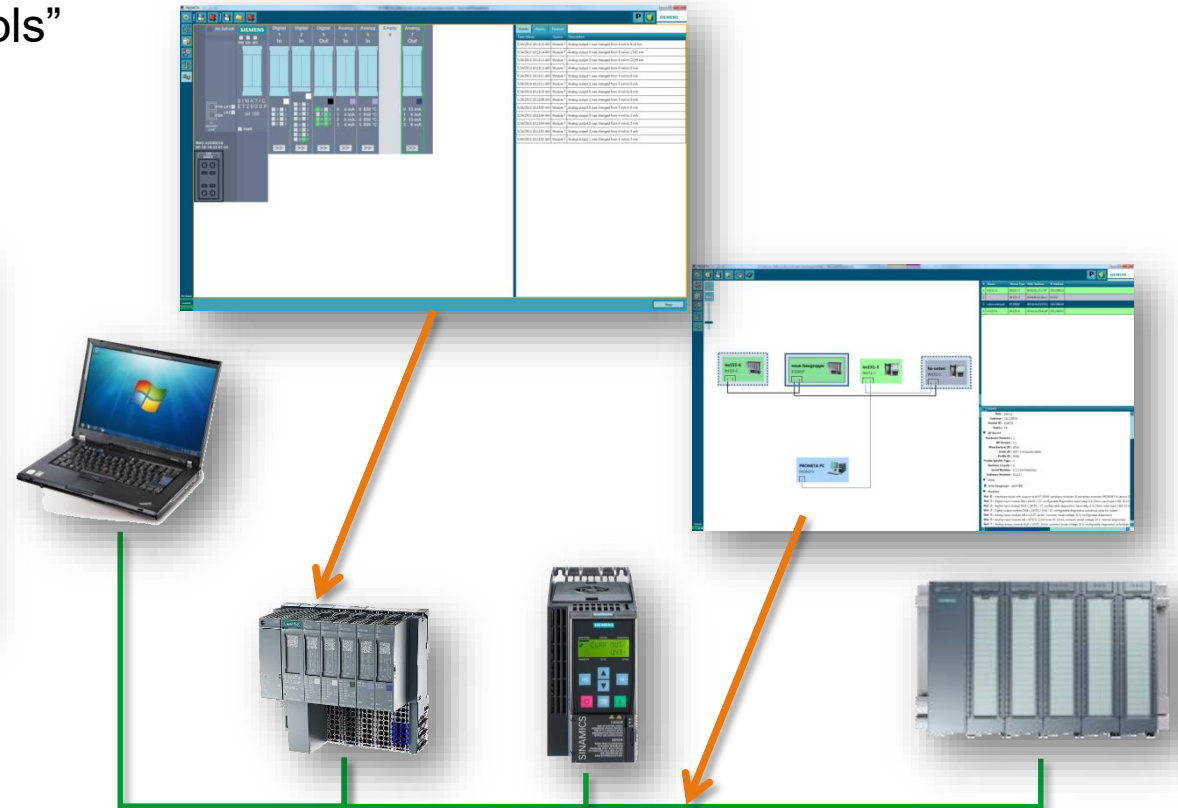
Used to

- cabinet manufacture
- Commissioning

- www.siemens.com/proneta



OEM



SINEC PNI Basic – for free



SINEC PNI is a program that can be set for a network-specific parameter to SCALANCE and RUGGEDCOM devices

The configuration can be performed simultaneously for multiple devices.

Status	Device type	PROFINET device name	IP address	MAC address	Article number	Firmware version	Serial number
OK	S7-1500 CP	c-dkp2-cp1543-1-03-66	192.168.120.69	00:1B:1B:A7:03:66			
OK	SCALANCE W-700		192.168.120.65	00:1B:1B:AB:8B:9E	6GK5 734-1FX00-0AA0	V6.3.1	VPE8174558
OK	S7-1500	c-dkp2-cpu1511-ab-e2	192.168.120.68	28:63:36:82:AB:E2	6ES7 511-1AX00-0AB0	V1.6.0	
OK	ET 200eco PN 80I	d-dkp1-et200eco-63-41	192.168.120.28	28:63:36:15:63:41	6ES7 141-6BF00-0AB0	V7.0.1	S C-E9TP94042014
OK	SCALANCE X-400	r-dkp2-xm408-67-00-mssps	192.168.120.64	00:1B:1B:9D:67:00	6GK5 408-8G500-2AM2	V6.2.2	VPE4141830
OK	SCALANCE S-600	ricky615	192.168.120.221	00:1B:1B:8B:41:98			
OK	SCALANCE X-200	x-dkp2-xf208-28-23-vx	192.168.120.63	00:1B:1B:AB:28:23	6GK5 208-0BA00-2AF2	V5.2.3	VPE8137684
OK	SIMATIC-PC	h-dkp1-ipc427d	192.168.120.40	00:1B:1B:42:91:2B			
OK	SCALANCE X-200	x-dkp1-x204-44-b9	192.168.120.27	00:1B:1B:AB:44:89	6GK5 204-0BA00-2BA3	V5.4.1	SVPE8169267
OK	ET200SP	d-dkp1-et200sp-ec-15	192.168.120.24	28:63:36:13:EC:15	6ES7 155-6AU00-0BN0	V1.1.1	S C-EBVW23142014
OK	SCALANCE W-700	ap3	192.168.120.61	00:1B:1B:A5:5C:10	6GK5 774-1FX00-0AA0	V6.3.1	VPE6177863
OK	Motor Mgmt. System	d-dkp1-simocode-76-5f	192.168.120.31	00:0E:8C:E6:76:5F	3UF7 011-1AB00-0	V1.2.2	
OK	SCALANCE XB-200	x-dkp2-xb208-a4-df-mssps	192.168.120.52	20:87:56:64:A4:DF			
OK	SCALANCE XF-200	aaaaaaaa	192.168.120.72	20:87:56:5C:92:1E	6GK5 204-2AA00-2GF2	V4.1	VPJN130163
OK	KP8 PN 8KEYS 80I/O DC24V	h-dkp2-kp8-ce-d4	192.168.120.70	28:63:36:14:EC:04	6AV3 688-3AY36-0AX0	V1.0.1	S C-E9A308162014
OK	SCALANCE X-200	x-dkp1-x202-43-68	192.168.120.26	00:1B:1B:AB:43:68	6GK5 202-2BH00-2BA3	V5.4.1	SVPE8138662
OK	S7-300	c-dkp1-cpu315-46-6c	192.168.120.21	28:63:36:14:46:6C	6ES7 315-2FJ14-0AB0	V3.2.16	
OK	IM151-3	d-dkp1-et200s-61-5e	192.168.120.22	28:63:36:14:61:5E	6ES7 151-3BA23-0AB0	V7.0.5	S C-EBW842142014
OK	SCALANCE X-200	x-dkp1-xf208-27-ae	192.168.120.30	00:1B:1B:AB:27:AE	6GK5 208-0BA00-2AF2	V5.2.3	VPE8137671
OK	IM151-3	d-dkp1-et200fo-61-74	192.168.120.23	28:63:36:0F:61:74	6ES7 151-3BB23-0AB0	V7.0.5	S C-E7UC87762014

- Network Scanning of all PROFINET and RUGGEDCOM devices
- Initialization by setting the following parameters for the devices :
 - address, subnet and gateway
 - Initial password change (Scalance ja Ruggedcom)
 - name (PROFINET)
 - I&M information to identify the device (PROFINET)
 - SysName, sysContact and sysLocation
- Activate DHCP-client
- Resets to factory settings
- Resets to the default PROFINET settings
- ping
- Flashes LEDs
- Open Web Based Management

SINEC PNI

Product editions

	No licence	Only one License per copy	
	SINEC PNI Basic (02/2020)	SINEC PNI Advanced (11/2020)	SINEC PNI Professional (03/2021)
Features	<ul style="list-style-type: none"> Step 1 <ul style="list-style-type: none"> Scan network Set IP, subnet, gateway Set DHCP Client Set PROFINET / System name Set I&M Data Reset to factory Change Default Password Flash LED Ping Step 2 <ul style="list-style-type: none"> Firmware Update Diagnostic Downloads (logs with config) Configuration copy (up/down) Set SNMP (V1, V2C, V3) 	<ul style="list-style-type: none"> + Set Time + Set DNS Proxy + Set Syslog-Client + Set NTP-Client + Set RADIUS-Client + Configure DHCP Server + Set SSID + Set WLAN Mode + Set Country + Set Channel + Set frequency + Set SSID Security + Set static VLANs + Set VLAN IP addresses 	<ul style="list-style-type: none"> + Generate SSL and SSH Keys + Set Hardening profile + Set NAT/ NAPT + Set Firewall / ACLs + Set SINEMA RC Client + Password protection
Price	Free of charge	xxx €	xxx €

SINEMA Server V14



Home screen

Topology

Event list

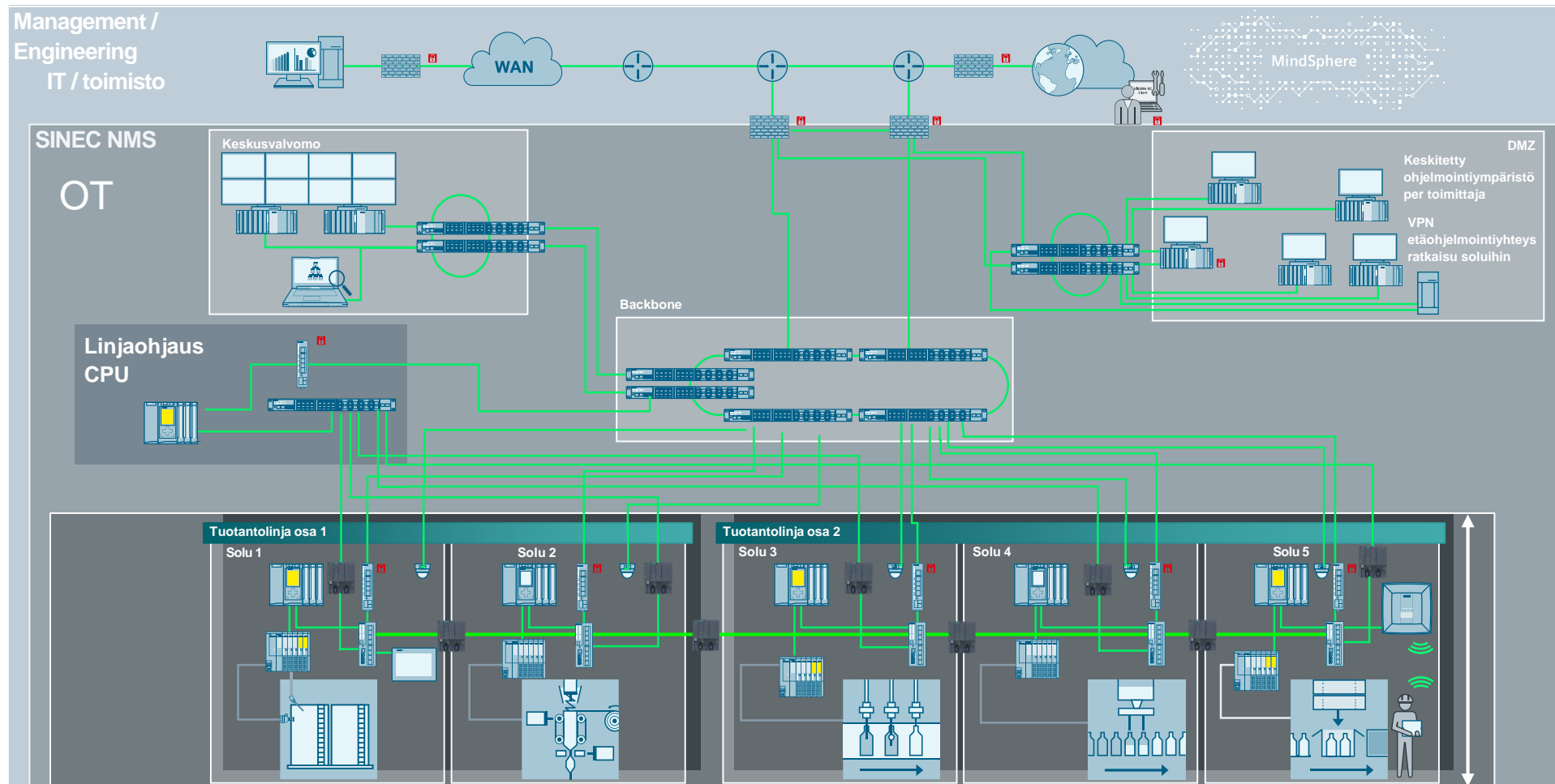
Reports

Customer-specific view

Server overview

The automation network is connected to the OT network, not directly to the IT network. **ADVANTAGE:** A more secure data transfer to the entire production line is achieved.

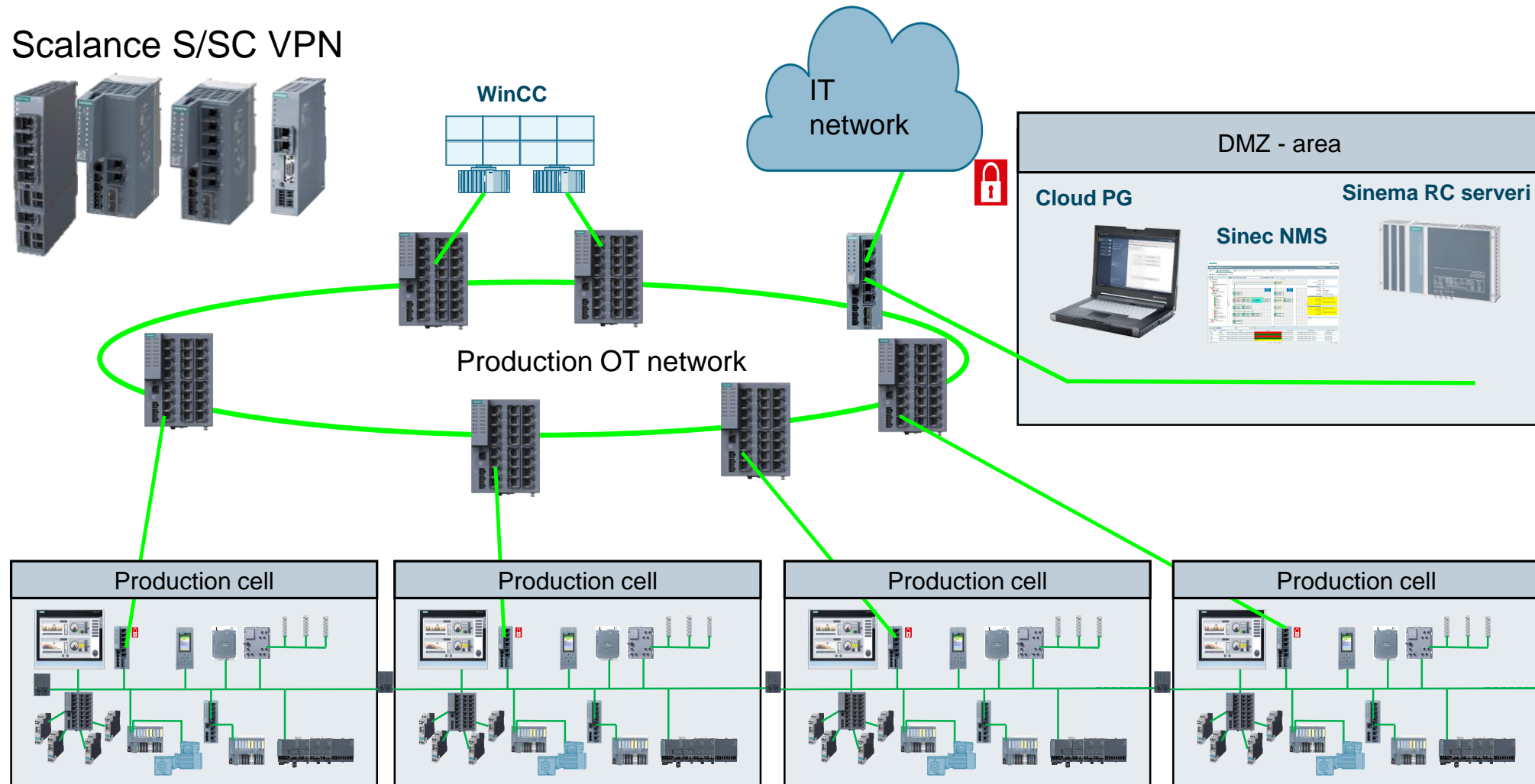
SIEMENS
Ingenuity for life



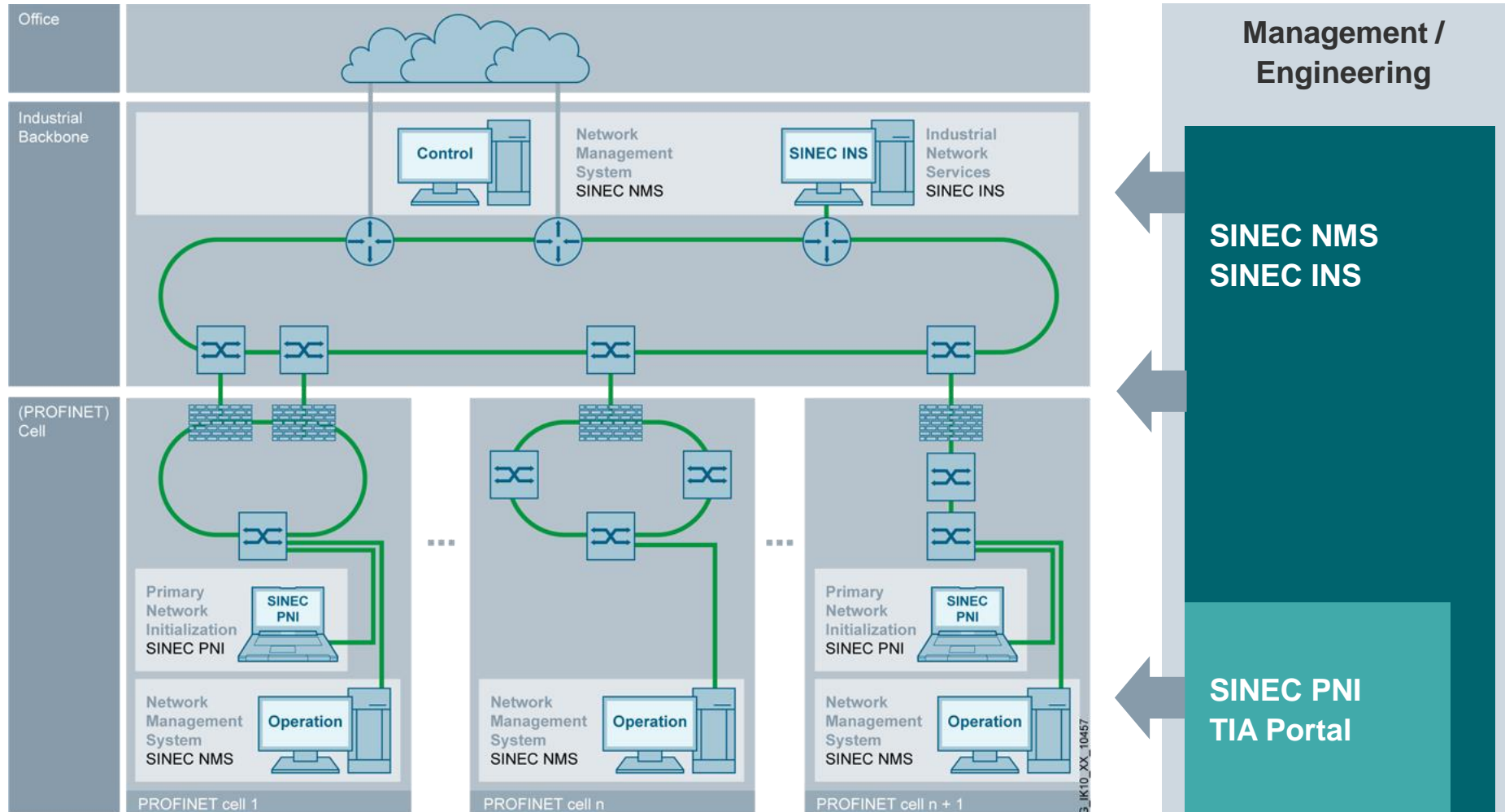
- The production cells are connected to each other with PN / PN Couplers
- Each cell is connected to the OT network with its own Firewall / VPN module
- VPN modules can be used to build a horizontal remote connection within the production line -> network monitoring and maintenance of the entire production line and, if necessary, a-cyclic data transfer between cells
- The devices on the OT network are managed and controlled centrally by Sinec NMS.
- Production network protected from IT network vulnerabilities -> trouble-free production
- The line control CPU is connected to an OT network or a separate network

Segmented production network (IEC62443)

Scalance S/SC VPN



SINEC software family (NMS, PNI & INS) Network levels (OT) – Factory automation



Sinec NMS

<https://siemens.com/sinec-NMS>



Overall System Status

- Overall Device Status: 243 Devices OK
- Deployed Policies: 100% (Active, Pending, Suspended)

Network monitoring - Topology

Overall status: Down

Monitoring setting: Down

Statistics: false

Redundancy information

- Protocol: MRP
- Port status: not connected
- Role: Ring manager
- Ring status: Maintenance demanded

Pending event (most negative)

Time stamp: 2018-08-23 07:48:28.404

Overall status: Down

Event: Redundancy status: interrupti...

Pending events (newest 5)

Time stamp: 2018-08-23 07:48:28.404

Overall status: Down

Event: Redundancy status: interrupti...

Event log

Read	Event status	Event	Event class	Time stamp	Event details	IP address - affected
No	Pending	Wireless interface quality: critical high signal strength to the connect...	Warning	2018-08-26 19:25:57.595	MAC address: 00:1b:1b:37:a4:f9_value: -34	192.168.120.82
No	Resolving	Wireless interface quality: normal signal strength to the connect...	Warning	2018-08-26 19:20:57.431	MAC address: 00:1b:1b:37:a4:f9_value: -43	192.168.120.82
No	Resolved automat	Wireless interface quality: critical high signal strength to the connect...	Warning	2018-08-26 19:15:57.544	MAC address: 00:1b:1b:37:a4:f9_value: -31	192.168.120.82
No	Resolving	Wireless interface quality: normal signal strength to the connect...	Warning	2018-08-26 19:10:57.505	MAC address: 00:1b:1b:37:a4:f9_value: -41	192.168.120.82
No	Resolved automat	Wireless interface quality: risky high signal strength to the connect...	Warning	2018-08-26 19:05:57.608	MAC address: 00:1b:1b:37:a4:f9_value: -36	192.168.120.82

Device #	IP address	Device type	Category	MAC address	Initial date	Model number	Serial number	Hardware version	Hardware version #	Configuration version #	Manager	Operator #
DK	192.168.120.24	SCALEX 4204 (SAL)	Router	281F7A437816	27-Jan-19	6405144-0000-0002	19073774	2.0.1	1	Manual	Manager	580004
DK	192.168.120.24	SCALEX 4204 (SAL)	Router	281F7A437816	27-Jan-19	6405144-0000-0002	19073774	2.0.1	1	Manual	Manager	580004

Communication Relation

Name: Time sync in cell 1

Description: All NTPS/NMPS/MATIC capable devices to Time Server

Firewall rules: 0

Flag: Down

Version: 1.0

Communication Relation Chain

- Object group: Time devices in Cell 1 (43 members)
- Firewall group: Firewall Cell to Area 1 (5 members)
- Firewall group: Firewall Area 1

Device details (192.168.40.13 / sinec-rack-et200p)

PROFINET identification:

- PROFINET IO name: sinec-rack-et200p
- Automation role: IO device
- Assigned controllers: sinec-rack-cpu

PROFINET diagnostics:

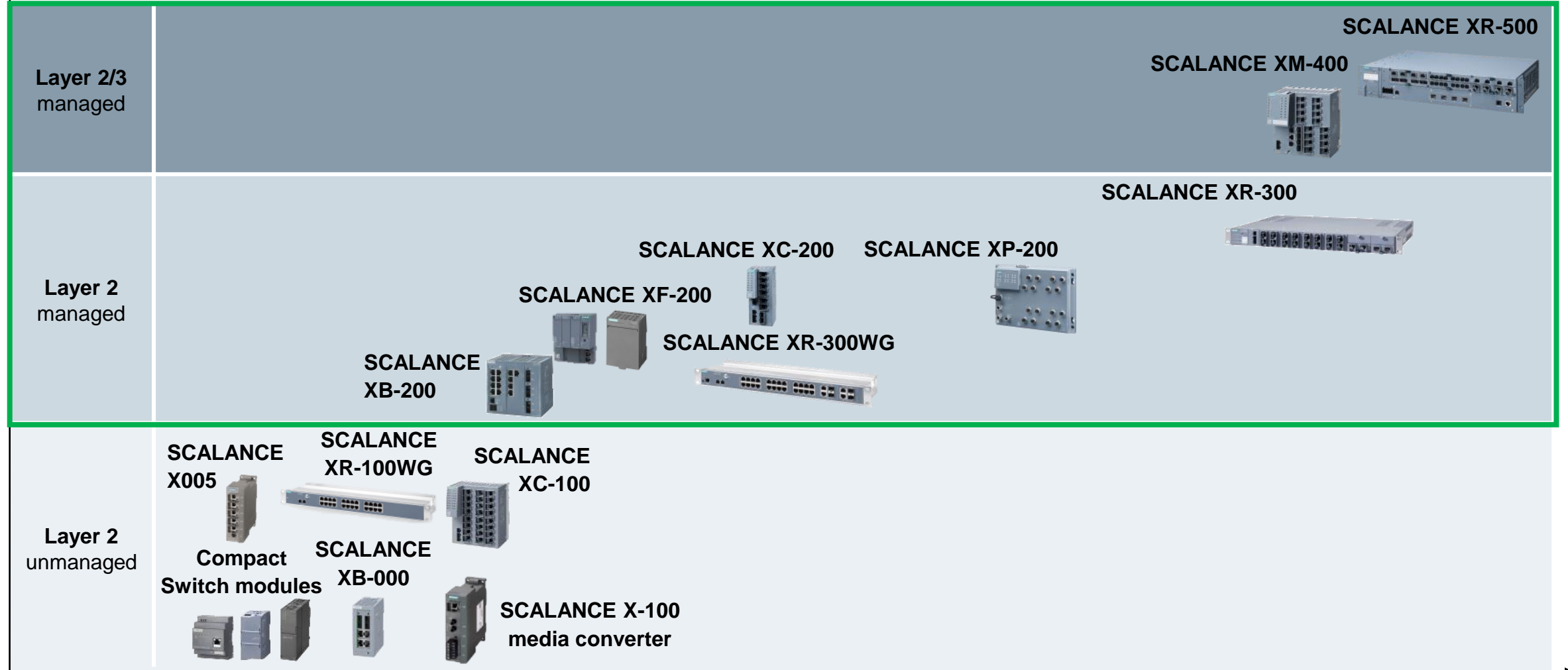
Time stamp	Slot	Subslot	Module	Text
2019-09-12 15:45:20	2	-	Module missing	
2019-09-12 15:45:20	2	-	Module missing	

SCALANCE X managed switches

Layer 2 applications (Profinet)



↑ *Function*



Thank you for your interest!

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