EtherNet/IP
Ultimate OT Connectivity

- Products
- Diagnosis
- Monitoring
- Training
- Consulting
- Network Services



EtherNet/IP™

PROmesh Switches

superior quality performance and versatility in the application

+ Keep an eye on the condition of the system or the network section – seamless and traceable at all times.

+ Localize detected interference sources - without additional measuring devices or Loss of time due to manual measurement effort.



Content

Industry 4.0 – New challenges for automation ..... 4 - 5
Basics 6
Standards and guidelines 7
EtherNet/IP Design and Commissioning Guideline 7
Parameters for network planning ..... 8 – 9
PROnetplan network planning software V2 ..... 10 – 11
ETHERtest V5 and PROlinetest cable tester 12
PROscan® Active V2 acceptance test and validation software ..... 13 – 16
EtherNet/IP-INspektor® NT analysis and diagnostic tool ..... 17 – 20
PROmanage® NT network monitoring software ..... 21 - 23
Configuration example (permanent network monitoring) 24
EtherNet/IP Integrations 25
EtherNet/IP Agent - Packet diagnostics 26
PNMA II / PNMX TAPS (Test Access Points) 27
PROmesh Switch product families 28
Increased network diagnostics with the PROmesh P product family 29
19" switches - the connection to IT 30
SIEDS Sensor 31
D *Bridge - "Bridge to digitization" 32
EmCheck® LSMZ I leakage current measuring clamp 33
EmCheck® MWMZ II mesh resistance measuring clamp 34
EMC/EMV INspektor® 35
EtherNet/IP Products Index (by art. no) ..... 36 - 42
Network Services ..... 43 - 46

Industry 4.0 – New challenges for automation

The 4th industrial revolution – also known as Industry 4.0 – describes a development where production companies increase the degree of networking and automation in their value creation chain so high that intelligent machines and systems can process digital product information automatically for the most part and increasingly organise processes autonomously. In this manner, even single pieces can be manufactured according to individual sizes (so-called batch size 1) within a reasonable economical range and thus open up new markets.

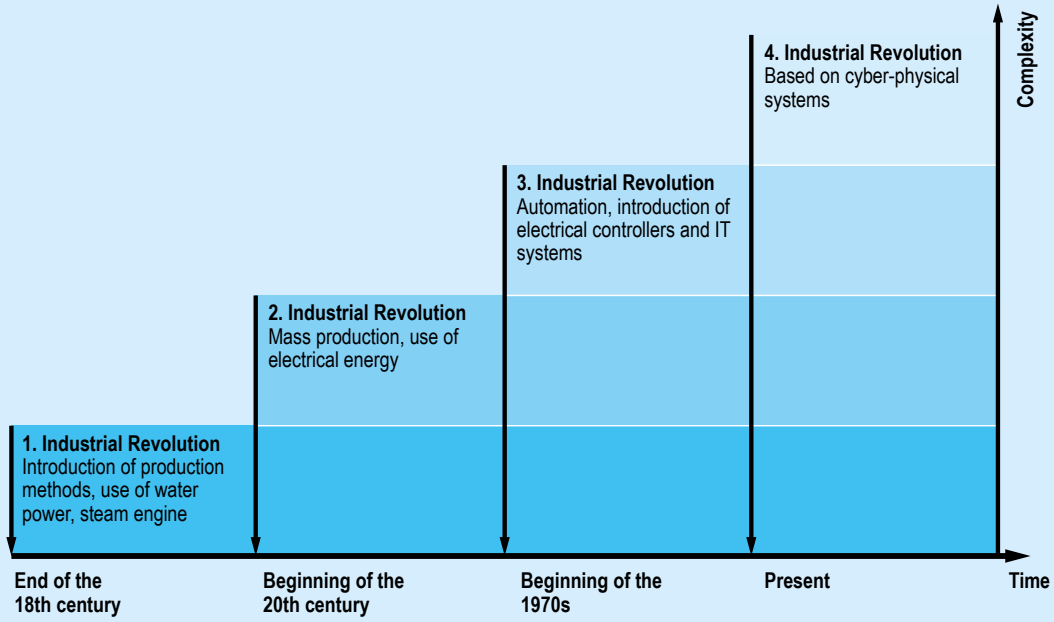


Fig. 1: Schematic presentation of the four industrial revolutions

Source: DFKI

Prof. Dr. Henning Kagermann (German Academy of Sciences), Prof. Dr. Wolf-Dieter Lukas (Federal Ministry for Education and Research) and Prof. Dr. Wolfgang Wahlster (German Research Centre for Artificial Intelligence) went public in 2011 with the "Initiative Industry 4.0" and thus coined a term that has found rapid increased use since. By establishing the "Platform Industry 4.0" (2013) for the coordination of the developments, the federal government has declared this as a topic for top management.

In practical application, it is becoming clear that Ethernet-based networks such as EtherNet/IP will gradually replace field-bus technology and thus become the pathfinder for Industry 4.0 at the production level (operational technology, OT). Networks, which still have a mostly local structure today, will in the future grow together from the classically hierarchic structure of the automation pyramid into a large, complex network of decentralised distributed intelligences (so-called cyber-physical systems, CPS) (see Fig. 2 and 3).

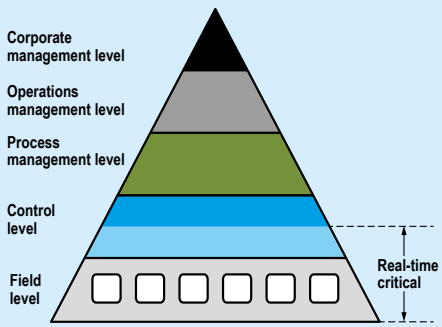


Fig. 2: Automation pyramid

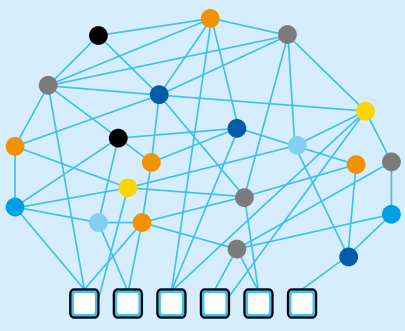


Fig. 3: CPS-based automation

Source: VDI

In the face of a vast array of solutions offered by industrial Ethernet-applications, the challenge lies in finding a common system without communications obstacles that satisfies all requirements. It is becoming clear that in the future more interest will be focussed on standard Ethernet and different, parallel existing protocols will drop away. The IEEE task force TSN (Time Sensitive Networking) was created to give real-time capability to standard Ethernet.

Security aspects are gaining importance as well (see below). Thanks to the advances of digitisation, production is increasingly controlled by data that is provided by intelligent sensors and devices. This data can be retrieved directly from the office level (information technology, IT), which likewise communicates via Ethernet. External (unauthorised) access is possible just as well however.

In order to understand data flows under the conditions of an increasing blending of IT and OT and to ensure security, it is becoming increasingly important to know:

Who communicated what with whom when by which means?



Security for Automation 4.0

The blending with IT however does not permit the acceptance of its security measures for the automation technology. The task for IT is rather to prevent unauthorised external access to data whereas automation technology places its focus on attacks „from inside“. Whether they are own staff or visiting service technicians – they can, possibly even unintentionally, cause quality-relevant incidences by supposedly harmless actions such as an active network scan or the loading of firmware updates.

Currently such accesses to the network cannot be regulated without endangering its availability. The correct concept by IT of shielding off to the outside for protecting the data is, however, in direct contrast to the point of view of automation technology with its idea of increasing networking of customers and producers in the whole world. The events need to be recorded though to recognise their causes and to even notice such attacks.

Today's approach by Indu-Sol is based on the log analysis by permanent network monitoring (PNM). In combination with the network monitoring software **PROmanage® NT** (see page 21), the passively operating measurement and diagnostic tool **EtherNetIP-INspektor®** (see page 17) thereby analyses the logical data traffic in the network. Anomalies, such as unknown participants in the network or delays in the data transmission (so-called jitters, see page 8), are reported immediately.

When these quality-relevant events are recorded additionally and kept on hand, the operator knows at any time what is going on in his network.

Basics

EtherNet/IP is a universal, Ethernet-based communication network that can be used in all areas of automation technology. Built on standard, unmodified Ethernet, EtherNet/IP enables speedy vertical and horizontal data exchange across all levels – including the corporate control level – providing the foundation for successful systems concepts.

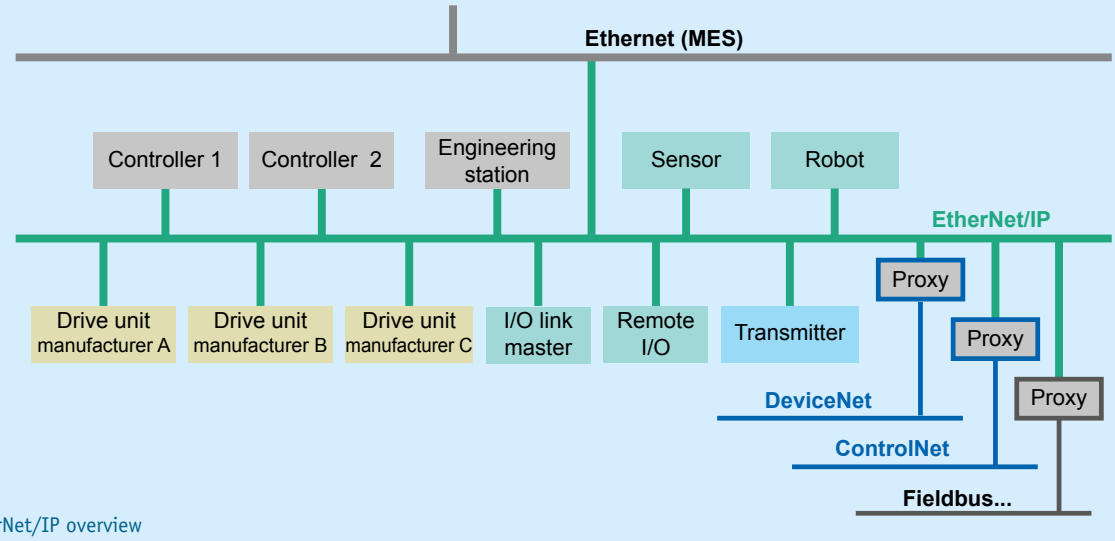


Fig. 4: EtherNet/IP overview

EtherNet/IP uses the Common Industrial Protocol (CIP) to manage both explicit messaging (acyclical, non-time-critical data) and implicit messaging (cyclical, time-critical I/O data). The protocol supports a producer-consumer model for efficient multicast communication, where one device can broadcast data to multiple consumers simultaneously. This results in a high degree of flexibility because update rates are scalable based on application requirements (see Fig. 5).

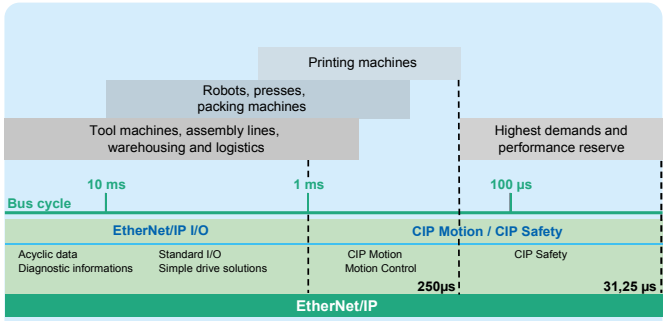


Fig. 5: Scalable bus cycle times in EtherNet/IP

Data in EtherNet/IP networks is highly varied. Besides prioritized, cyclical I/O data using implicit messaging, acyclical data (e.g. TCP/IP, explicit messages for configuration and diagnostics, or SNMP requests) can be transmitted (see Fig.6).

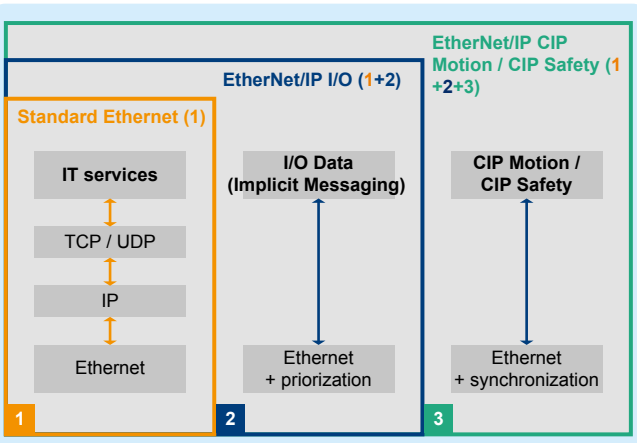


Fig. 6: Communication model in EtherNet/IP

EtherNet/IP devices are described using Electronic Data Sheets (EDS files), which define the device's communication capabilities, supported features, and configuration parameters. These standardized device descriptions enable seamless integration of multi-vendor devices into EtherNet/IP networks.

Network topologies in EtherNet/IP derive from the requirements of the systems to be networked. The most common structures are star, line, tree and ring-shaped (with Device Level Ring for redundancy). In practice, systems usually are a mix of the above structures. They can be implemented either with copper or fiber-optic cables.

Standards and guidelines

Criteria for quality evaluation in EtherNet/IP networks are based on the following list of standards and guidelines as well as the experience of Indu-Sol GmbH. Observing them is the basis for any measurement, planning, acceptance and commissioning.

- EtherNet/IP Media Planning & Installation Manual – ODVA PUB00213R1 – Latest version
- EtherNet/IP Network Infrastructure Deployment Guideline – ODVA
- EtherNet/IP Specification – ODVA PUB00001 – Latest version
- EtherNet/IP Conformance Test Specification – ODVA
- The CIP Networks Library, Volume 1 & 2 – ODVA
- EN 50173 / ISO IEC 11801 – Structured cabling systems
- EN 50310 – Application of equipotential bonding and earthing in buildings with information technology equipment
- VDI / VDE Guideline 2184 – Reliable operation and maintenance of fieldbus systems
- TIA-1005-A (Telecommunications Infrastructure Standard for Industrial Premises)

ETHERNET/IP Design and Commissioning Guideline

The extensive options for configuration and utilization of a network necessitate careful planning and practice-oriented commissioning of the system. The Open DeviceNet Vendors Association (ODVA) has defined quality criteria for planning, acceptance and commissioning, as well as the metrological evaluation of a network in its Media Planning & Installation Manual and related technical guidelines. These are intended as guidelines for all persons and organizations involved in the planning, installation, operation and maintenance of such systems.

In the planning stage, network utilization should be considered in addition to structure. For this purpose, it is important to know the relationships between update rate, line depth and network structure. Practical planning tools like **PROnetplan** by **Indu-Sol** can be used to display such relationships in an interactive graphic to avoid weak spots.

Moreover, it is useful to define the requirements for devices in advance. EtherNet/IP devices support various communication profiles and features such as simultaneous connections to multiple controllers (multi-client capability), support for Device Level Ring (DLR) or Parallel Redundancy Protocol (PRP) for network redundancy, device-level diagnostics, and support for demanding applications with short cycle times and deterministic performance.

The selection and placement of network components in the network structure depends on the performance requirements and network topology. Proper network segmentation and managed switch selection ensure optimal performance and network reliability (see planning guidelines).

The years of experience with fieldbus technology have shown that the extensive diagnostic options of controllers in the area of device diagnostics should be expanded by an additional measurement to verify the quality of communication. The measurements serve as dual purpose, namely a description of the EtherNet/IP network on the one hand and ensuring operational reliability on the other. Special attention should be paid to assuring the quality of the line connections (test when plant is stopped) as well as the transmission during operation.

RECOMMENDATION

In order to ensure reliable long-term functionality of the plant, measurements to verify compliance with the quality requirements (pages 9 and 19) are urgently recommended.

Parameters for network planning

Planning the network structure

The key properties of EtherNet/IP are a variable network structure and the unlimited combinations provided by exploiting all topological shapes of standard Ethernet. The topology results from the following criteria:

- Spatial arrangement of the components
- Distances to be bridged
- Requirements for the use of primary infrastructure /increased availability
- Consideration of network load (bandwidth planning) and TCP/IP traffic
- Requested Packet Interval (RPI) in consideration of network topology
- Communication quality and packet traffic
- Requirements for potential isolation/EMC

Sources: ODVA EtherNet/IP Media Planning & Installation Manual (PUB00213R1)
The CIP Networks Library, Volume 2 (ODVA)

Requested Packet Interval (RPI)

The Requested Packet Interval (RPI) is the rate at which data is exchanged between the controller (scanner) and I/O devices (adapters). It is set individually for each device connection in the controller configuration (typically 2-100 ms, with high-performance applications supporting sub-millisecond intervals). Indu-Sol recommends setting each device's RPI based on actual process needs and the controller scan time, following the principle **"Update only as necessary – not as much as possible."**

Whether the RPI is met depends on each device's switching behavior and on the network topology, meaning the number of switches and network segments between the controller and the devices. More network hops can add latency and variation in packet delivery. That variation, the difference between when a packet actually arrives and the requested interval, is called **"jitter"** and can be measured in microseconds or as a percentage. Measuring RPI compliance and jitter gives a basis for assessing system stability and can flag potential weak spots early.

Sources: ODVA EtherNet/IP Media Planning & Installation Manual (PUB00213R1)
The CIP Networks Library, Volume 2 (ODVA)

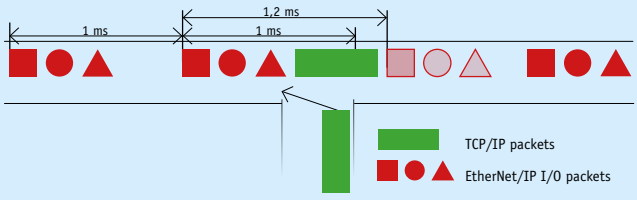


Fig. 7: Illustration of packet jitter

Network load

Cyclical network load from all EtherNet/IP devices peaks on the link between the controller and the first switch, so plan and monitor bandwidth to keep the network running reliably. Industry best practices recommend the following network utilization guidelines:

Netload	Recommendation
< 20%	No action required
20% ... 50%	Review of planned netload is recommended
> 50%	Take action to reduce netload

It can be seen from practical applications that the existing network load consists of both EtherNet/IP implicit I/O messaging and other traffic (explicit messages, TCP/IP communication, SNMP, etc.). Although EtherNet/IP I/O data is generally prioritized at managed switches using Quality of Service (QoS) mechanisms, other traffic may impact overall bandwidth availability. The load ratio (EtherNet/IP I/O to other communication) provides insight into network utilization patterns. Since different network loads (peak loads) affect the compliance with RPI settings, demonstrating the network quality in consideration of utilization is especially important during the acceptance test or troubleshooting of a system.

Sources: ODVA EtherNet/IP Media Planning & Installation Manual (PUB00213R1)
ODVA EtherNet/IP Network Infrastructure Deployment Guideline

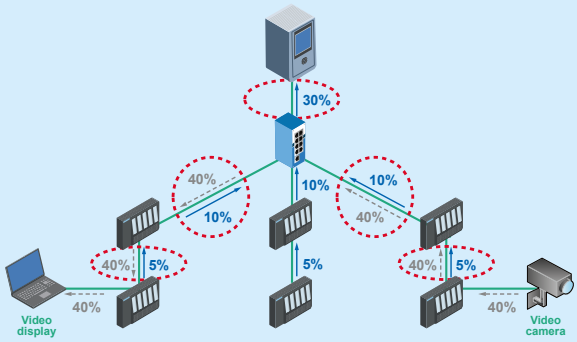


Fig. 8: TCP/IP devices are connected unfavorably → higher network load

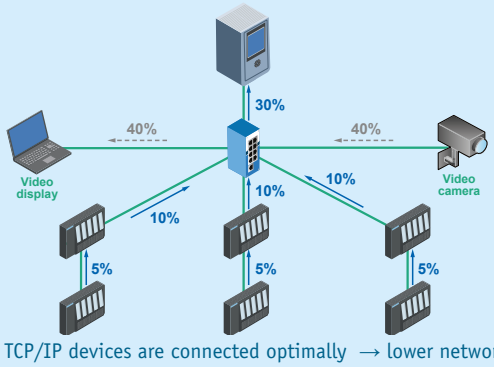


Fig. 9: TCP/IP devices are connected optimally → lower network load

Network topology depth (line depth)

In EtherNet/IP networks, each switch introduces latency based on its switching mode (store-and-forward or cut-through). This delay must be considered when designing a network in the planning phase.

The maximum number of switches between controller and end device depends on the RPI setting and the switch forwarding performance. While EtherNet/IP does not impose strict limits on topology depth, practical considerations include cumulative latency and jitter. Indu-Sol recommends limiting network depth based on application timing requirements and switch performance characteristics.

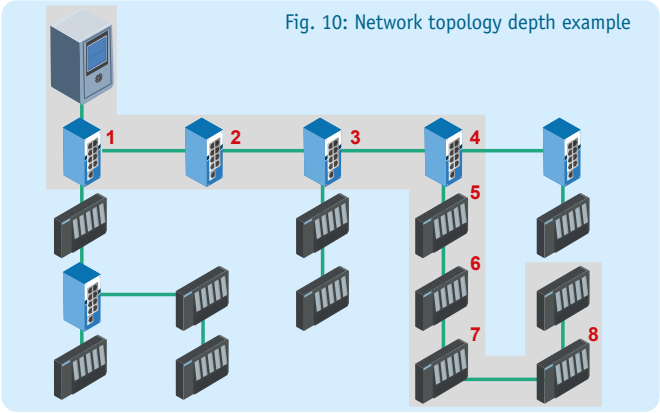


Fig. 10: Network topology depth example

Store-and-forward switches

Source: ODVA EtherNet/IP Media Planning & Installation Manual, Industry Best Practices

Recommended maximum switch hops for RPI of			
1 ms	2 ms	4 ms	8 ms
8	16	30	60

Cut-through switches

Recommended maximum switch hops for RPI of			
1 ms	2 ms	4 ms	8 ms
50	100+	100+	100+

Access points

When planning EtherNet/IP networks, best practices recommend passive access points (TAPs) for network diagnostics.

Why?

- During commissioning or maintenance, to analyze the network traffic or read out devices
- To connect diagnostic devices during running operation without interruption
- For troubleshooting or long-term diagnosis/preventative maintenance of the network condition

How?

- Using passive, feedback-free TAPs
  (e.g. **EIP measuring points PNMA II / PNMX** – see page 27)
- Using a smart TAP
  (e.g. **EtherNet/IP-INspektor** ® – see page 17-20)

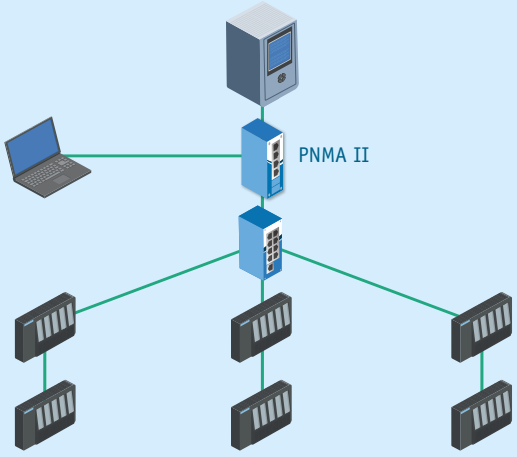


Fig. 11: Network diagnosis via access point (TAP) – e.g. PNMA II

Please note:

In principle, an initial rough analysis of the network traffic (packet analysis) is also possible via a mirror port on the switch using analysis software (e.g. Wireshark). However, this port only delivers 100 Mbps.
But the cable carries incoming data to the controller at 100 Mbps on one wire pair and outgoing data from the controller at 100 Mbps on the other wire pair. Thus the port of the switch cannot diagnose more than one half of the data flow.

RECOMMENDATION - Quality values

Recommendations on the quality values in EIP by **Indu-Sol**

Jitter (deviation from the requested RPI)	**≤ 50 %**
Packet loss (missing packets)	**0**
Error packets (defective packets)	**0**
Load ratio (I/O to other traffic)	**100 : 1**
Network load (in 100 Mbps)	**< 20 %**

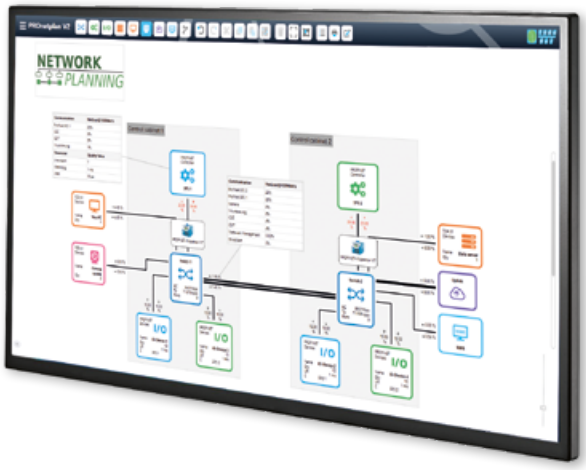
Network planning software PROnetplan V2

The PROnetplan V2 software supports the user with the planning of Ethernet based networks, e.g. EtherNet/IP. PROnetplan does not only allow a rough planning of the network, but also a detailed planning including port assignment, support for correct switch selection and transmission speeds.

Due to the integrated diagnostic mode, which evaluates the network based on the EtherNet/IP guidelines, incorrect planning of the network is hardly possible and subsequent changes are a thing of the past.

With PROnetplan V2 the user has the possibility to integrate his planned applications like EtherNet/IP, but also camera monitoring and SCADA systems into the network in order to estimate which infrastructure components are necessary to integrate all applications in the best possible way. In addition to the bandwidth of the network, the port utilization and the respective transmission media are evaluated.

In the diagnostic mode, the IP addresses of the network devices are checked for correctness and address duplication. The topology created with PROnetplan V2 can be used for network optimization, as a discussion platform with the with the client as well as a document for a network installation.



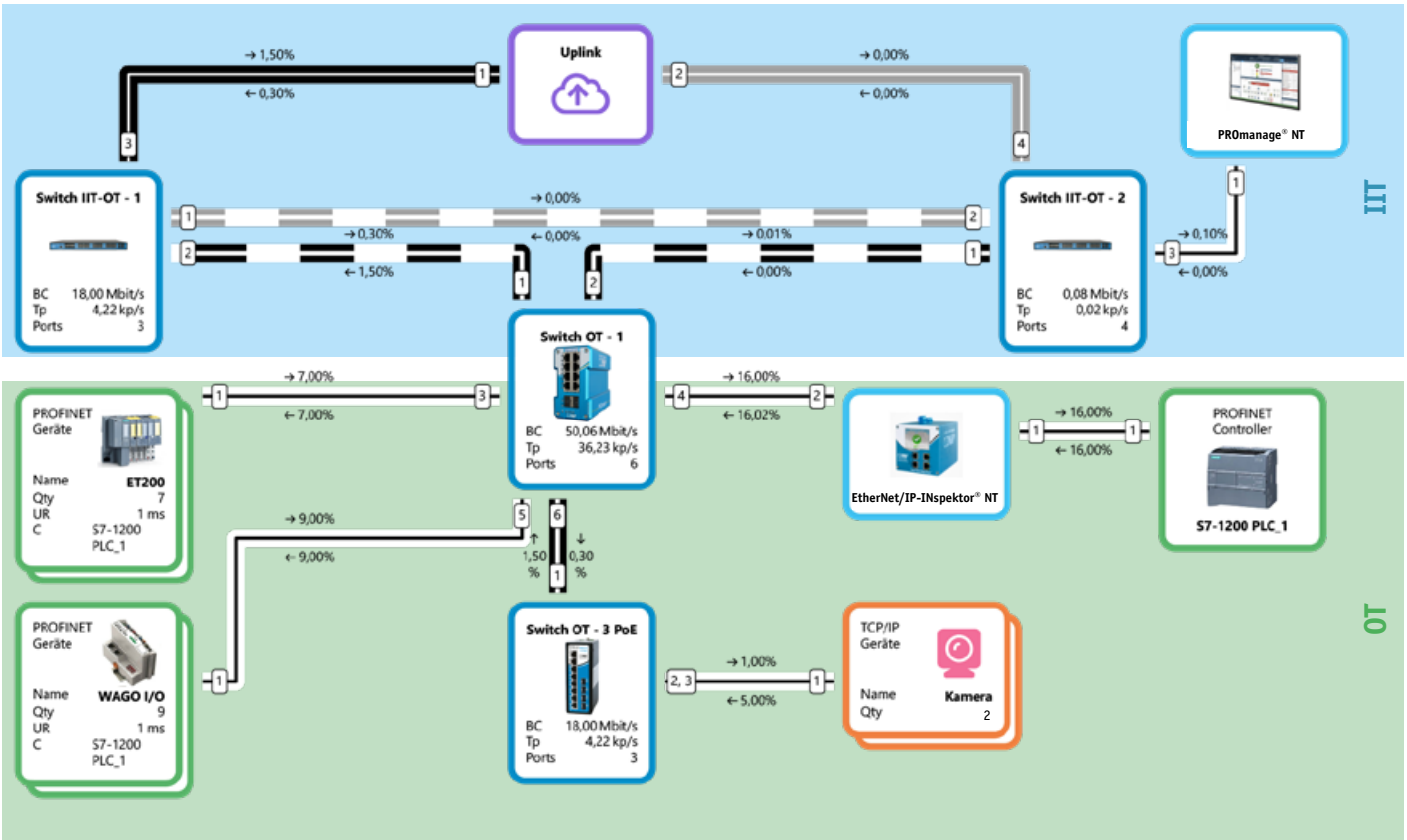
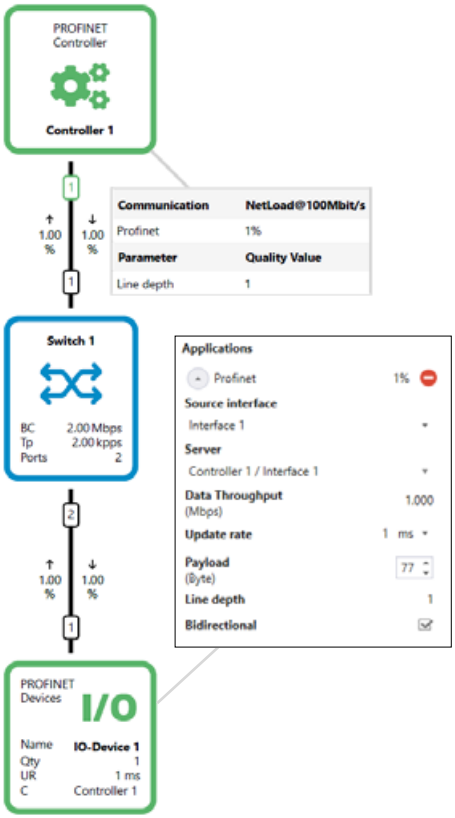


Abb. 12: Network displayed in PROnetplan V2



Netload

PROnetplan V2 shows dynamically for each connection in the network the resulting load. This also applies to complicated structures and to several controllers as well as arrangement to the IT level.

Line depth

To display the line depth, the EtherNet/IP communication relationship between the controller and the assigned I/O device is always determined with the most device transitions.

Backplane capacity and data throughput

To select the appropriate switch, the necessary performance is dynamically and displayed directly in the network.

Update rate and payload

The update rate and payload can be set individually for each device, but also uniformly for device groups.

Diagnostic mode

By means of the diagnostic mode PROnetplan V2 evaluates briefly the created network and gives first hints what should be changed.

Diagnosis **Current State** 4 Errors

Netload	16,02 %	
Line depth		2 Errors
IP address		2 Errors

network device	IP address	Diagnosis
ET200	192.168.10.12	duplication
WAGO I/O	192.168.10.12	duplication

Port properties

Highlights

- Planning according to PI guideline
- Individual application planning (e.g. EtherNet/IP, PROFINET, SCADA and monitoring)
- Planning from machine to company network (OT, IIT, IT)
- Calculation of network load for each connection
- Calculation of switch performance parameters
- Port planning

PROnetplan in conjunction with PROscan® Active V2

The topologies scanned with the PROscan® Active V2 analysis software (see page 13) can easily be fed into PROnetplan.

This enables a comparison between the plan and reality. This procedure is very useful during planning an expansion or optimization of the network.

ETHERtest V5 and PROlinetest cable tester

Certification and acceptance

The **ETHERtest V5 (V5.1/V5.3)** cable tester provides all measurements required for the acceptance and certification of network cables up to Class FA/Category 6A (1000 MHz). Not only line length but also attenuation, resistance, crosstalk (NEXT), delays, shielding and the proper contacts (connection schematic) are measured and evaluated. These measurements ensure compliance with TIA-568 and ISO/IEC 11801 standards required for EtherNet/IP installations. Beyond the certification of copper cables, attenuation and OTDR can be measured for single and multi-mode fiber optic cables by means of additional adapters (**ETHERtest V5.1**).

All recorded values are displayed graphically, which enables the error sources to be identified and localized with an accuracy of 10 centimeters. All measurements are stored automatically in the device and can be retrieved as measurement report using PC software.

Verification and troubleshooting

PROlinetest is an indispensable tool for all those who install or troubleshoot EtherNet/IP systems. The device detects any wiring errors and tests the wires and wire pairs for continuity, breaks, short-circuits, cross-wiring and exceeded maximum cable lengths.

Knowing the measurement of the total cable length and the distance to the error location significantly simplifies troubleshooting. The adapter can also be used to check Drive-Cliq and M8/M12 cable systems.

Source: ODVA EtherNet/IP Media Planning & Installation Manual (PUB00213R1)
TIA-568 Commercial Building Telecommunications Cabling Standard



Fig. 13: ETHERtest V5



Fig. 14: PROlinetest

RECOMMENDATIONS – Evaluation based on cable length

Compliance with the limits set out in ISO IEC 11801 Class D and TIA-568 is always evaluated over a maximum distance of 100 m by the measuring equipment, e.g. 24 dB insertion loss. This means that in case of shorter cables (e.g. 10 m), it is also only compliance with an insertion loss of 24 dB that is monitored, which means that weak spots are not detected in advance.

This is why all measuring equipment should be evaluated based on length in accordance with the tables below in regard to the reserve insertion loss and the near-end crosstalk. By assessing the reserve, this procedure is independent from the standards and limits that are used.

Cable length	Max. insertion loss acc . to class D for 100 MHz	Length-dependent min. insertion loss	Length-dependent recommended min. insertion loss
100 m	24 dB	0 dB	3 dB
50 m	24 dB	3 dB	6 dB
25 m	24 dB	6 dB	9 dB
12 m	24 dB	9 dB	12 dB
6 m	24 dB	12 dB	15 dB
3 m	24 dB	15 dB	18 dB
1,5 m	24 dB	18 dB	21 dB

The qualitative evaluation of **insertion loss (IL)** should be performed while taking the line length into account.

Cable length	Min. near-end cr osstalk acc. to class D for 100 MHz	Length-dependent min. near-end cr osstalk	Length-dependent recommended min. near-end cr osstalk
100 m	27,7 dB	27,7 dB	30,7 dB
50 m	27,7 dB	30,7 dB	33,7 dB
25 m	27,7 dB	33,7 dB	36,7 dB
12 m	27,7 dB	36,7 dB	39,7 dB
6 m	27,7 dB	39,7 dB	42,7 dB
3 m	27,7 dB	42,7 dB	45,7 dB
1,5 m	27,7 dB	45,7 dB	48,7dB

The qualitative evaluation of the **near-end crosstalk (NEXT)** should be performed while taking the line length into account.

PROscan® Active V2 acceptance test and validation software

Online analysis / topology scan

With the **PROscan® Active V2** software you can generate a detailed description of your EtherNet/IP networks online during running production at any time. Thanks to devices' integrated LLDP protocol (detection of neighborhood relationships) it is possible to generate a complete topology map including all designations and connections in an extremely short time, and thereby simultaneously perform an initial simple diagnosis (line interruptions, device failures etc.) during operation. Other strengths of this product include flexible options for integration into existing plants and a simple, intuitive user interface.

The software helps to efficiently organize a complex network and, if required, perform necessary maintenance in a timely and direct manner. Its low resource requirements enable **PROscan® Active V2** to be installed on any commonly available touch panel.

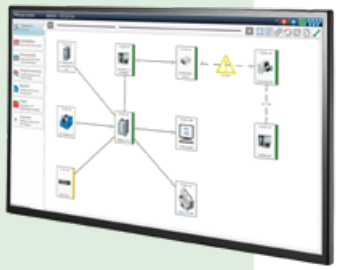
Source: ODVA EtherNet/IP Media Planning & Installation Manual
Industry Best Practices for Network Documentation

Highlights

- Easy to use
- Diagnostics mode
  - Connection statistics
  - Version statistics
  - EMC statistics
- Acceptance report
- Asset Management



- Network / device information
  - Current port assignments
  - Port operating mode
  - Port speed
  - Device version / name
  - IP- / MAC addresses
  - Software / Hardware versions
  - Error packets
  - Rejected packets (discards)



- Suitable for EIP and Industrial Ethernet networks

› Advanced printing and export functions (PDF) › comprehensive documentation options

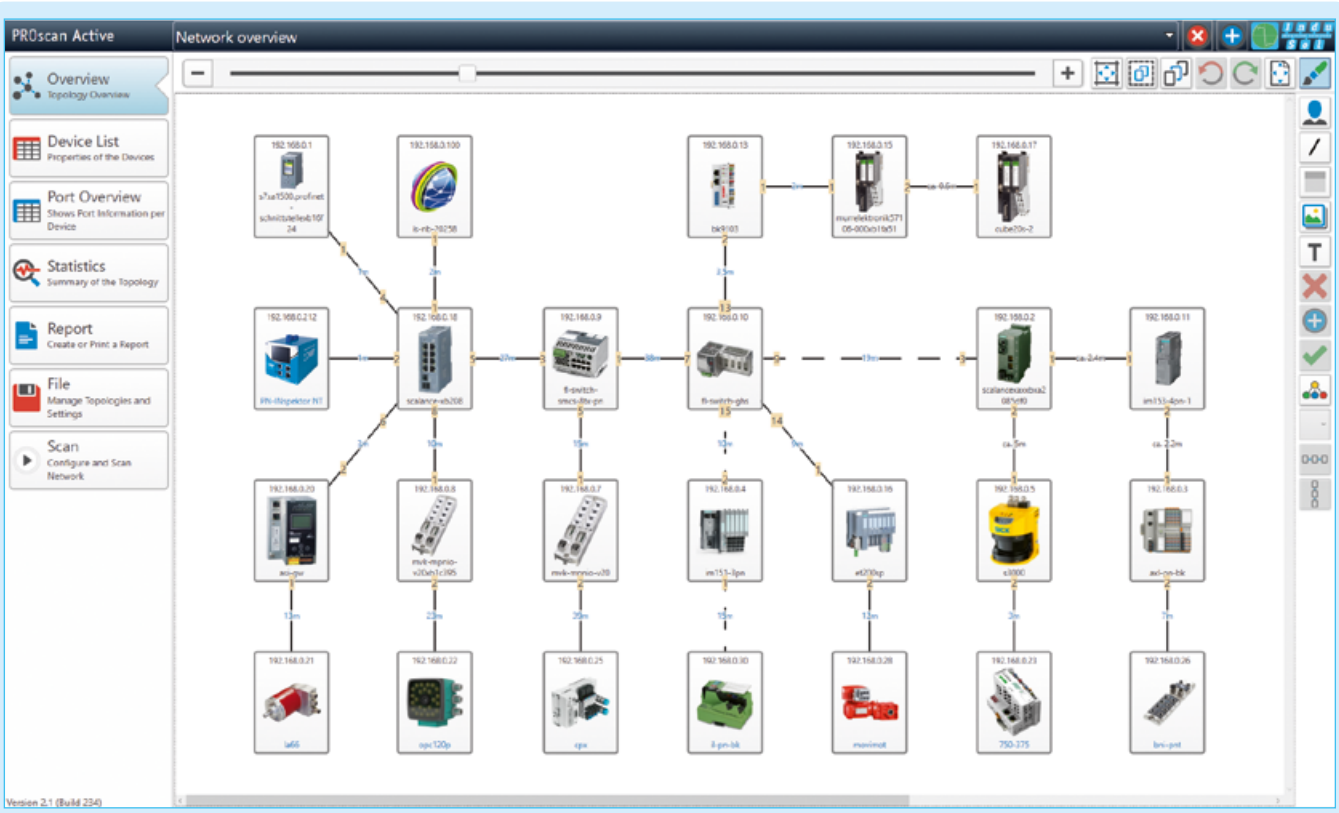


Fig. 15: PROscan® Active V2 - Example topology visualization - works with all LLDP-enabled devices

PROscan® Active V2 acceptance test and validation software

Device list

In addition to the device information (manufacturer, ordering details), the automatically generated device list also gives a quick overview of the hardware and firmware versions of all devices used (including device extensions), allocating the device names, IP and MAC addresses accordingly. The evaluation of this data can be exported into an acceptance-relevant log or for documentation as a CSV file at the push of a button.

Device List
Properties of the Devices

Actions	Device type	IP adresses	Subnet	Gateway	MAC adress	Device name	HW version	SW version	Device type name	Order number	Controller name	Device Class	EIP Role
	EtherNet/IP	172.20.1.51	255.255.255.0	172.20.1.51	00:1B:1B:72:7E:89	x208-cu-zeile4	6	V4.5.0	SCALANCE X-200	6GK5 208-0BA10-2AA3	scanner-panel	RTClass2	Device
	EtherNet/IP	172.20.1.54	255.255.255.0	172.20.1.54	00:A0:45:68:20:F9	phoenix-switch-zeile3	5	V3.80.0	FL SWITCH SMCS 8TX-PN	2989103	scanner-panel	RTClass2	Device
	EtherNet/IP	172.20.1.55	255.255.255.0	172.20.1.55	00:1B:1B:34:83:A6	x202-pof-zeile2	5	V5.0.22	SCALANCE X-200	6GK5 202-2BH00-2BA3	scanner-panel	RTClass2	Device
	EtherNet/IP	172.20.1.56	255.255.255.0	172.20.1.56	00:1B:1B:1E:1B:21	et200s-pn-pof-zeile3	2	V7.0.1	IM151-3	6ES7 151-3BB23-0AB0	scanner-panel	RTClass2	Device
	EtherNet/IP	172.20.1.58	255.255.255.0	172.20.1.58	00:0E:8C:D7:E3:32	x208-cu-zeile1	4	V4.5.1	SCALANCE X-200	6GK5 208-0BA10-2AA3	scanner-panel	RTClass2	Device
	EtherNet/IP	172.20.1.59	255.255.255.0	172.20.1.59	00:1B:1B:24:DA:80	et200m-pn-zeile1	2	V4.0.0	IM153-4	6ES7 153-4AA01-0XB0	scanner-panel	RTClass2	Device
	EtherNet/IP	172.20.1.60	255.255.255.0	172.20.1.60	00:1B:1B:3A:EC:7E	x208-cu-zeile5	6	V4.5.1	SCALANCE X-200	6GK5 208-0BA10-2AA3	scanner-panel	RTClass2	Device
	EtherNet/IP	172.20.1.64	255.255.255.0	0.0.0.0	00:80:63:66:54:B0	octopus-zeile7	130	V4.2.3	Hirschmann OCTOPUS	6GK5 208-0BA10-2AA3	scanner-panel	RTClass2	Device
	EtherNet/IP	172.20.1.65	255.255.255.0	172.20.1.65	00:16:77:00:8F:A1	pn-asi-gw-zeile5	2	V2.0.0	AS-i	BWU1912	scanner-panel	RTClass2	Device

Slot	Subslot	Modul ID	Submodul ID	Vendor-ID	Order number	Serial number	HW version	SW version
1	1	0x00016001	0x00000000	42	6ES7 155-5AA00-0AC0	S C-HONX24052016	2	V3.0.1
2	1	0x00006D20	0x00000003	42	6ES7 521-1BH00-0AB0	S C-HDMX36262016	3	V2.1.2
3	1	0x00006D18	0x00000003	42	6ES7 522-1BH01-0AB0	S C-HDNK33432016	1	V1.0.0

	EtherNet/IP	172.20.1.71	255.255.255.0	172.20.1.71	00:90:E8:3D:1D:BD	eds-510e	100	V4.0.0	MOXA EtherDevice Switch	0054-000510-E000	scanner-panel	RTClass2	Device
	EtherNet/IP	172.20.1.74	255.255.255.0	172.20.1.74	00:01:05:16:EE:87	bk9103			BK Device				Device

Port overview

In addition to the device list with all device-relevant data, a list of port relevant data for each device is also available. The overview shows both the cable lengths of copper and polymer fiber connections as well as the attenuation reserve of polymer fiber connections.

Information on error packets or rejected packets (CRC error or discards) is important for detecting weaknesses and to perform an error analysis.

Port Overview
Shows Port Information per Device

Number	Name	Connected with	Line type	Length	Send power budget	Remote power budget	Connection	InDiscards	OutDiscards
172.20.1.200 (controller-tafel)									
2	port-002	172.20.1.55 (x202-pof-zeile2)	Copper	ca. 58,6m			100BaseTXFD	0	78
172.20.1.54 (phoenix-switch-zeile3)									
1	port-001	172.20.1.60 (x208-cu-zeile5)	Copper	17,2m			100BaseTXFD	0	0
2	port-002	172.20.1.51 (x208-cu-zeile4)	Copper	47,1m			100BaseTXFD	0	0
3	port-003	172.20.1.248 (inblox)	Copper	5,0m			100BaseTXFD	0	0
4	port-004	172.20.1.82 (ASi-INspektor)	Copper	5,0m			100BaseTXFD	0	0
5	port-005	172.20.1.81 („PB-INspektor V2“)	Copper	5,0m			100BaseTXFD	0	0
172.20.1.55 (x202-pof-zeile2)									
1	port-001	172.20.1.200 (controller-tafel)	Copper	ca. 58,6m			100BaseTXFD	0	0
2	port-002	172.20.1.71 (eds-510e)	Copper	10,5m			100BaseTXFD	0	0
3	port-003	172.20.1.56 (et200s-pn-pof-zeile3)	Fibre-optic Cable	20,5m	4,2 dB	10,8 dB	100BaseTXFD	0	0
172.20.1.56 (et200s-pn-pof-zeile3)									
1	port-001	172.20.1.55 (x202-pof-zeile2)	Fibre-optic Cable	20,5m	10,8 dB	4,2 dB	100BaseTXFD	0	0

Explanations (Discards/Error packets)

Data packets may be discarded by the switch, e.g. because of malfunctions, transmission errors or queue overflow at the switches.

PROscan® Active V2 determines the number of such discards (rejected packets) and the number of defective packets (CRC errors) from the devices and displays them in a table. This provides clues as to potential causes of error.

During the analysis of such information special attention needs to be paid to devices in communication lines with high load, e.g. Switches of the primary infrastructure. (see Fig. 16)

Source: ODVA EtherNet/IP Network Infrastructure Deployment Guideline
IEEE 802.3 Ethernet Standards

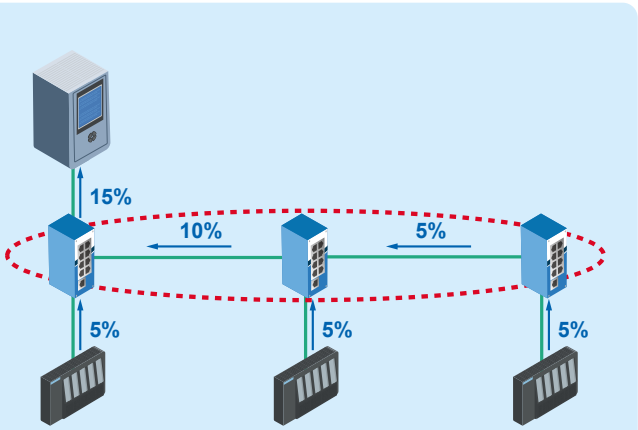


Fig. 16: Reading out switch components for discards



Checking the system reserve for optical cabling

If using polymer optical fiber (POF), the optical system reserve (power budget) of every single connection can be determined in online operation. It is a measure for the available optical power reserve between transmitter and receiver to ensure trouble-free operation. It can be read out and displayed as a diagnostic value. If the attenuation reserve of a POF connection falls below 5 dB, it is immediately apparent where transmission problems might occur.

These are represented by an exclamation mark ⚠ in the connection. This enables you to detect and remedy the weaknesses in your system at any time.

Source: ODVA EtherNet/IP Media Planning & Installation Manual
ISO/IEC 11801 Cabling Standards

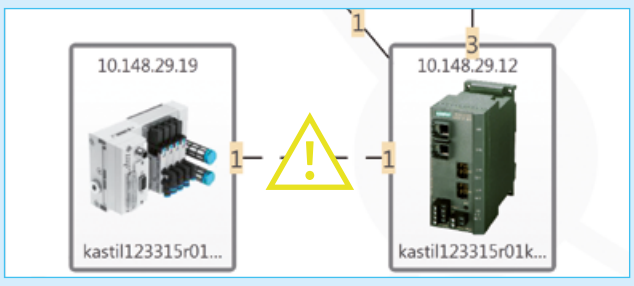


Fig. 17: Display when transmission problems occur

System reserve	Evaluation
> 6 dB	The value is above the measurement range. No action required.
> 2 dB to 6 dB	The value is within the valid measurement range. Trouble-free communication is ensured. Typical values for cabling without other plug-in connections: • 5 dB for cable lengths up to 30 m • 3,5 dB for cable lengths from 30 m to 40 m • 2,5 dB for cable lengths from 40 m to 50 m In case of deviation from the listed value ranges a cable inspection is recommended (check for additional plug-in connections, attenuation check).

PROscan® Active V2 acceptance test and validation software

Diagnostics mode

An overview immediately shows the user all anomalies detected by the network scan. In the connection statistics, for example, device ports are listed with accumulated discards or error packets as well as a too low optical fibre system reserve. Additionally, a statistic of the software and hardware statuses of all devices (including device extensions) quickly reveals whether there are discrepancies between devices of the same type.

Statistics
Summary of the Topology

Main modules	Order number	SW Version	HW Version	Num. of devices
AXL BK PN-ME	2688132	V1.2.0	5	1
BNI PNT-502-102-Z015	BNI006C	V2.2.0	5	1
		V2.3.0	5	1
Cube20S	57106	V1.3.6	1	1
ET200SP	6ES7 155-6AU00-0CN0	V3.1.0	4	1
FL SWITCH GHS 4G/12	2700271	V2.62.0	6	1
FL SWITCH SMCS 8TX-PN	2989103	V4.40.0	5	1
FTS3100-A	20781104000	V2.2.2	256	1
Helmholz PN-Switch	700-850-4PS01		0	1
IM151-3	6ES7 151-3BB23-0AB0	V7.0.5	3	1
IM153-4	6ES7 153-4AA01-0XB0	V4.0.0	2	1
EIP-INspektor NT	124030100			1
PROscanActive	117000014	2.0.0.218		1
S7-300	GES7 318-3FL01-0AB0	V3.2.6	5	1
SCALANCE X-200	6GK5 208-0BA10-2AA3	V5.1.0	6	1
		V5.1.3	6	1
SICK-S3000PROFIsafe	1064234	V1.11.0	0	1
WAGI-I/o-SYSTEM 75x	750-370	V2.5.10	4	1
wenglor ident	weQube	V1.1.4	100	1

Fig. 18: Version statistics

IP-Adress	Device	Port	Value
Connections/Ports with IN DISCARDS			
10.1.9.5	fl-switch-ghs	port-001-00009	2
10.1.9.6	bk9103-1-1	port-001	4
10.1.9.6	bk9103-1-1	port-002	164
10.1.9.18	bnipnt502102z015-1	port-001	187206
10.1.9.18	bnipnt502102z015-1	port-002	383429
10.1.9.19	bnipnt502102z015	port-002	427308
10.1.9.21	wenglor-cam	port-001	2
10.1.9.94	iPNMA	Pa????	6
10.1.9.96	eip-inspektor-nt	port-passive	4
10.1.9.97	EIP-INspektorNT5	port-passive	17
Connections/Ports with IN ERRORS			
10.1.9.2	eip-io	port-002	869365
10.1.9.3	scalance-x208	port-003	874391
10.1.9.3	scalance-x208	port-005	949
10.1.9.3	scalance-x208	port-006	21172
10.1.9.4	fl-switch-smcs-8tx-pn	port-001	23
10.1.9.5	fl-switch-ghs	port-001-00009	4
10.1.9.15	im153-4pn-1	port-002	1
10.1.9.17	helmholz-pn-switch	port-001	1
10.1.9.17	helmholz-pn-switch	port-004	1
10.1.9.18	bnipnt502102z015-1	port-001	1189
10.1.9.21	wenglor-cam	port-001	3
10.1.9.62	mobmesse-x208	port-004	59
10.1.9.96	eip-inspektor-nt	port-passive	17
10.1.9.97	EIP-INspektorNT5	port-passive	22
Connections with too low attenuation reserve			
10.1.9.9	im151-3pn	port-001	16,4
Connections/Ports with OUT DISCARDS			
10.1.9.17	helmholz-pn-switch	port-001	60
10.1.9.17	helmholz-pn-switch	port-003	49
10.1.9.17	helmholz-pn-switch	port-004	330474
10.1.9.21	wenglor-cam	port-001	5
Connections/Ports with OUT ERRORS			
10.1.9.21	wenglor-cam	port-001	6

Fig. 19: Connection statistics

Acceptance log

PROscan® Active V2 is able to create a complete acceptance log with only a few clicks.

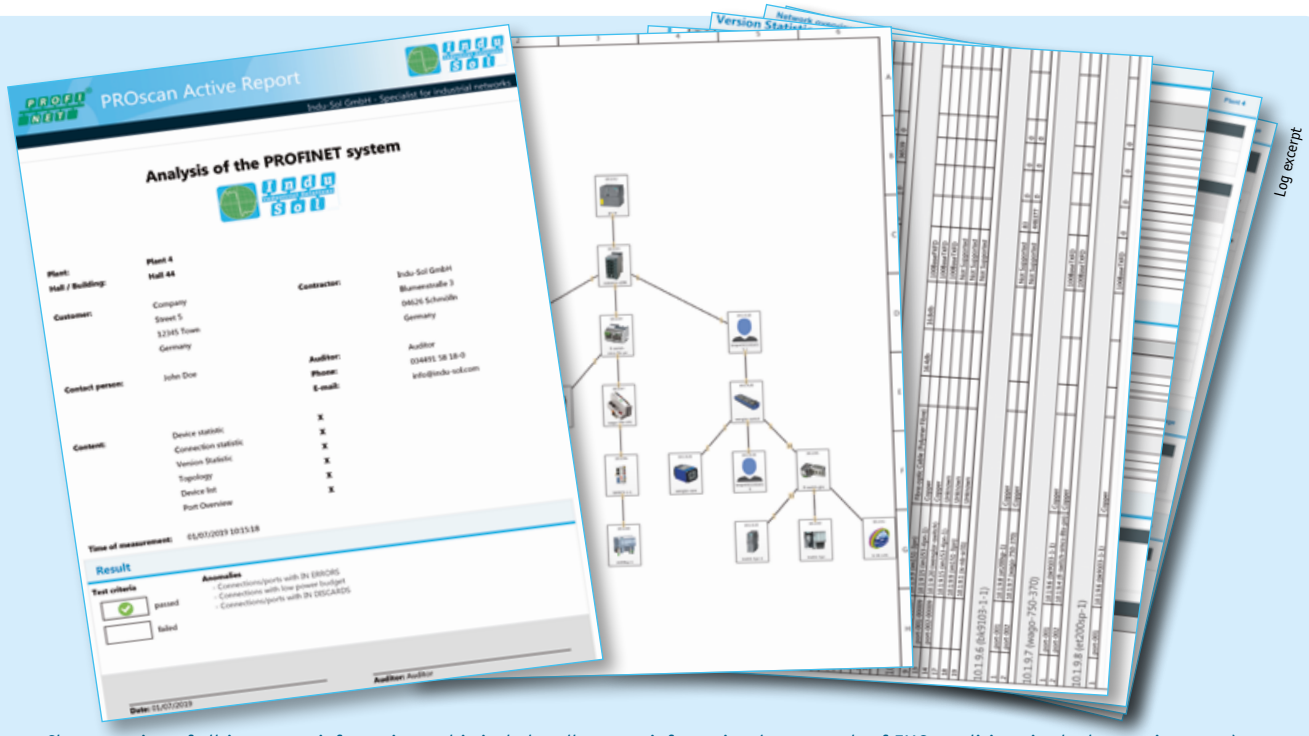


Fig. 20: Clear overview of all important information – this includes all system information (e.g. records of EMC conditions in the bus environment)

EtherNet/IP-INspektor® analysis and diagnostic tool

The **EtherNet/IP-INspektor® NT** is an intelligent, passive measurement and diagnostic tool for temporary or permanent monitoring of EtherNet/IP networks. Due to its passive and feedback-free behavior it is highly suitable for online analysis.

The **EtherNet/IP-INspektor® NT** is both a full-featured measuring device for network acceptance and a tool for condition monitoring.

Highlights

- Ease of use, well-structured handling
- Automated evaluation through traffic light function
- Passive, feedback-free diagnostics
- Cyclical topology detection
- OPC UA Server

SECURITY

- Alarms in case of unknown devices
- Network anomaly detection
- Detection of programming accesses to the controller

Network parameters – Quality parameters

User-friendly display of network conditions with traffic light colors and time graphs enable any user to respond quickly in an emergency and ensure a good general overview.

All subsequently listed quality parameters are detected as events, evaluated, cached and displayed in a clear overview.

- Packet loss
- Packet jitter
- Packet reordering
- Error packets
- Connection timeout intervals (CIP timing)
- Network load
- Load ratio
- Device diagnoses
- Device failures
- Device restarts

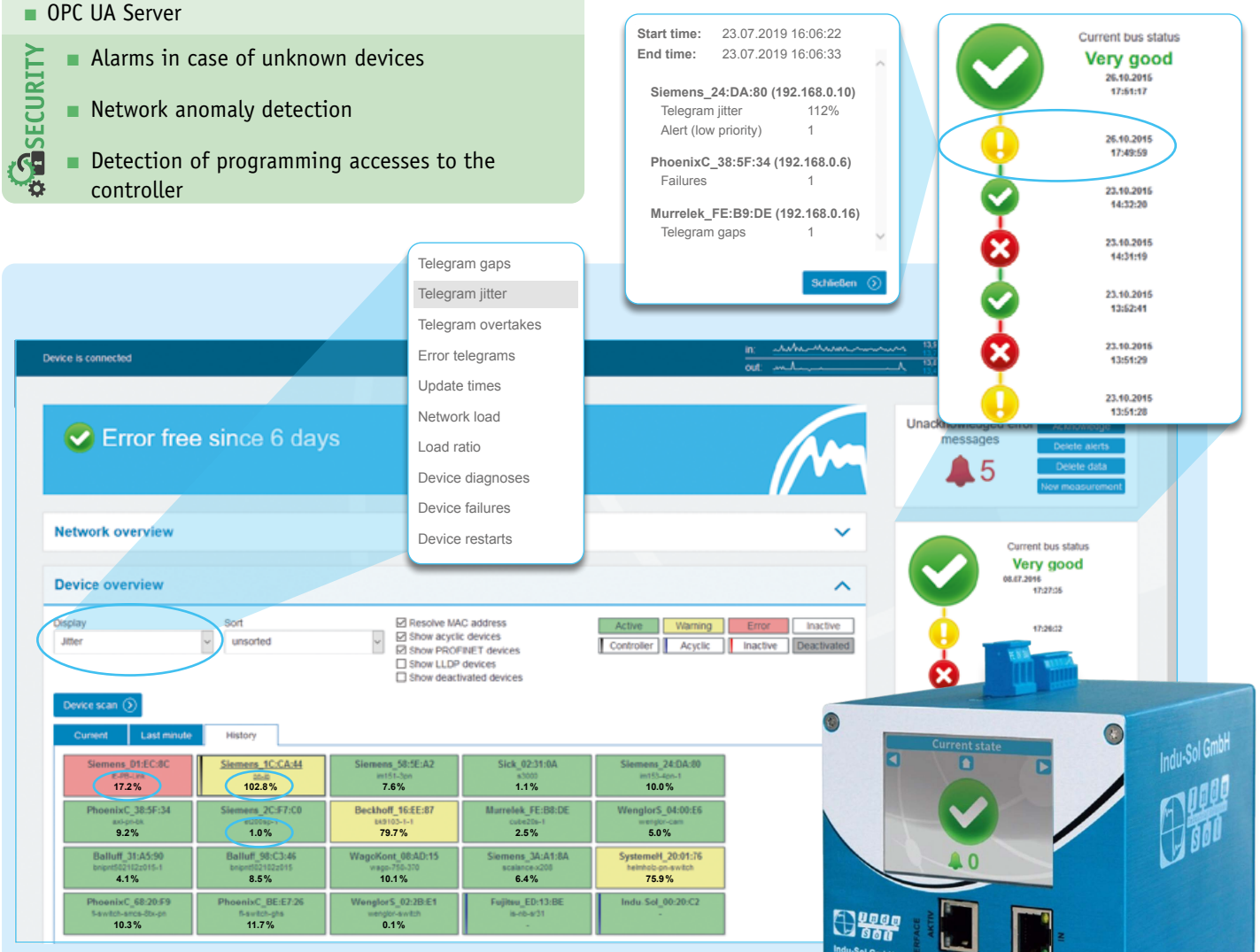


Fig. 21: Clear, detailed device overview - Example interface

EtherNet/IP-INspektor® NT

EtherNet/IP-INspektor® analysis and diagnostic tool

Device information

	Last minute			History		
MAC address	PhoenixC_38:5F:34					
IP address	10.1.9.10					
Name	axl-pn-bk					
Alias						
Vendor	AXL BK PN-ME					
Vendor ID	Phoenix Contact GmbH & Co. KG (176)					
Device ID	4096					
Device role	Device					
Alert (low priority)	0			0		
Alert (high priority)	0			0		
Failures	0			0		
Restarts	0			0		
Frame gaps	0			0		
Concurent frame gaps	0			0		
Frame overtakes	0			0		
Error frames	0			0		
Jitter	8.4%			122.0%		
	min	avg	max	min	avg	max
Update rate	0.25ms	-	0.25ms	0.25ms	-	0.25ms
Measured update rate	0.23ms	0.25ms	0.27ms	0.01ms	0.25ms	0.56ms
Payload (sent)	174,90 B	176,00 B	177,14 B	108,72 B	176,00 B	226,69 B
Payload (received)	174,90 B	176,00 B	177,14 B	108,72 B	176,00 B	226,64 B
Netload (sent per sec)	2.16% 270,30 kB	2.18% 272,00 kB	2.19% 273,77 kB	1.34% 168,10 kB	2.18% 272,00 kB	2.80% 350,27 kB
Netload (received per sec)	2.16% 270,30 kB	2.18% 272,01 kB	2.19% 273,77 kB	1.34% 168,03 kB	2.18% 272,01 kB	2.80% 350,34 kB

Network statistics

	Last minute	History
Load ratio	>500 : 1	>500 : 1
Broadcasts (of these PROFINET)	0 (0 | 0%)	0 (0 | 0%)
Multicasts (of these PROFINET)	0 (0 | 0%)	0 (0 | 0%)
Frames (sent) (of these PROFINET)	239.997 (239.999 | 100.00%)	100.176.240 (100.176.132 | 100.00%)
Frames (received) (of these PROFINET)	240.000 (240.000 | 100.00%)	100.177.025 (100.176.916 | 100.00%)

Network load visualization (see Fig. 22)

While other diagnostic devices determine the network load by the second or even the minute, the **EtherNet/IP-INspektor® NT** measures network load by the millisecond and displays it. This makes even minimal load changes in a network detectable. Even in the millisecond range peak loads may cause significant disturbances in the network which would not be detectable without this analysis.

Such short-term peak loads may be caused, e.g. by erroneous hardware settings or active diagnostic tools that continuously send queries into the network.

The network should always be monitored for a consistent network load and any sources of disturbances should be removed. Continuous, passive analysis as provided by the **EtherNet/IP-INspektor® NT** is an indispensable prerequisite.

Please note:

According to industry best practices, EtherNet/IP devices should be designed to handle network loads with appropriate margin for peak traffic. Managed switches with QoS capabilities help ensure deterministic performance during load variations.

Source: ODVA EtherNet/IP Network Infrastructure Deployment Guideline
Industry Best Practices for Network Performance

Topology determination

The **EtherNet/IP-INspektor® NT** not only determines all relevant device information (device details and port statistics), but even the real wiring (topology). This can also be done remotely without having to establish a direct network access via a service computer or HMI. The scan can easily be started and saved remotely or by using the integrated web-server of the **INspektor®** from the company network.

The determined topology can then be conveniently opened and evaluated on your own computer using the software **PROscan® Active V2** (see page 13). In addition to manual topology determination, there is the option to set up a regular scan in order to detect changes in the network structure and the devices integrated into the network in good time and to document these in a trackable form. These topologies are recorded centrally with the help of the software **PROmanage® NT** (see page 21) and remain accessible for a period of up to one year.

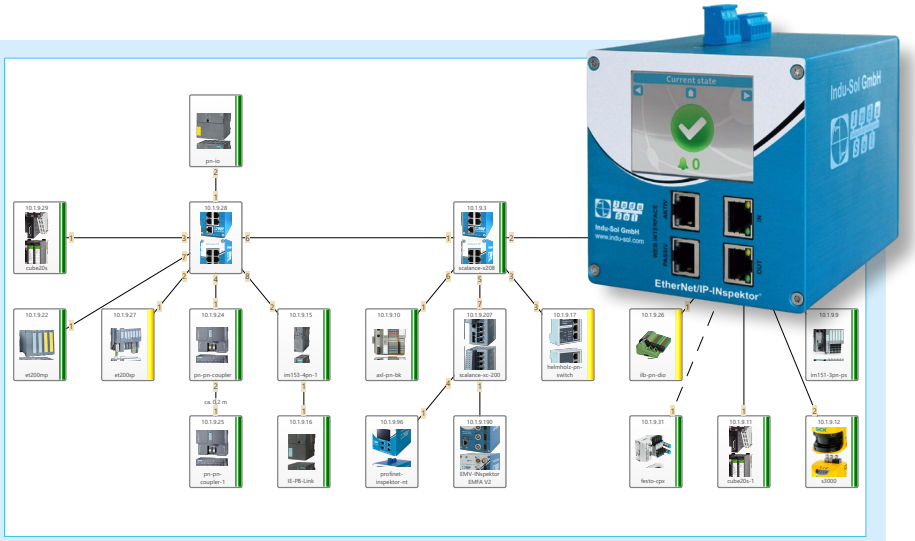


Fig. 22: Topology determination with the EtherNet/IP-INspektor®

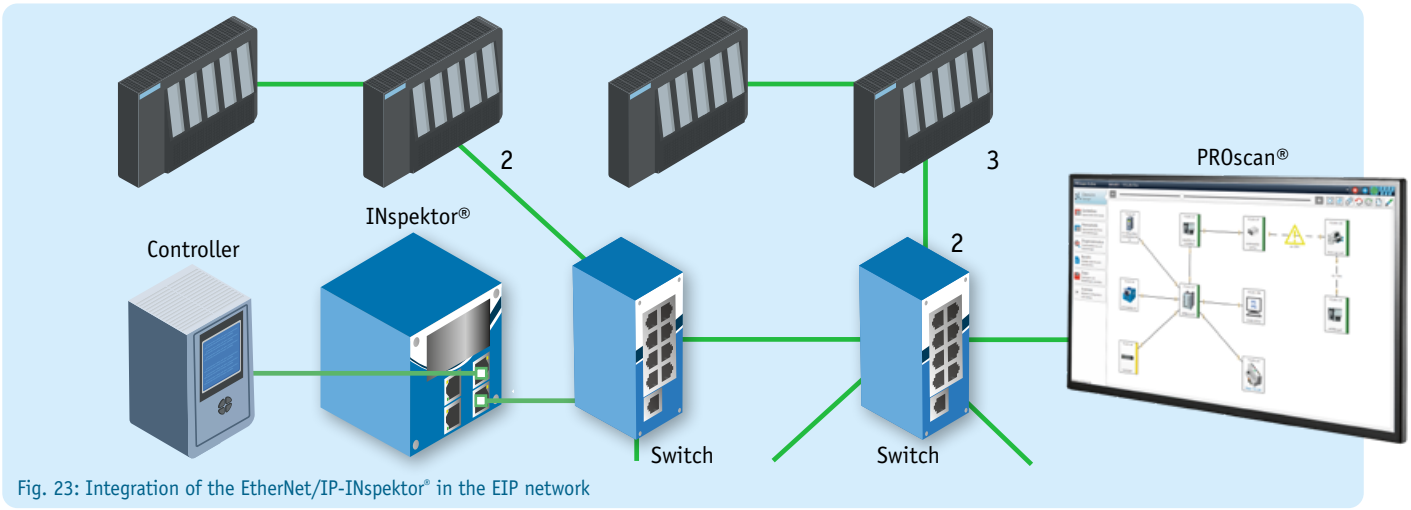


Fig. 23: Integration of the EtherNet/IP-INspektor® in the EIP network

Trigger function – Alarms

Trigger functions enable the setting of quality parameters for the network as a whole, but also individually for each device if required. In the event of changes that exceed the preset thresholds alarm messages (SNMP, OPC UA, email, web interface) are sent or displayed directly via a potential-free contact.

Type	Device	Event	Date	
Status change	00:01:05:16:EE:87	Jitter	26.10.2019 17:49:59.316	
Status change	28:63:36:2C:F7:C0 192.168.0.6		23.10.2019 14:32:20.171	
Status change	28:63:36:85:B1:B8 192.168.0.1	Telegram gaps	23.10.2019 14:31:21.983	
Status change	28:63:36:2C:F7:C0 192.168.0.6	Bus node failure	23.10.2019 14:31:18.777	
Status change	28:63:36:2C:F7:C0 192.168.0.6		23.10.2019 13:52:41.164	
Status change	28:63:36:85:B1:B8 192.168.0.1	Telegram gaps	23.10.2019 13:51:32.572	
Status change	28.63.36.2C.F7.C0 192.168.0.6	Bus node failure	23.10.2019 13:51:27.861	
Status change	28:63:36:2C:F7:C0 192.168.0.6	Alert (low)	23.10.2019 13.51.27.665	

The **EtherNet/IP-INspektor® NT** has an integrated web server and a freely selectable IP address. This enables a visualization of the network condition by means of an Internet browser on any PC, on site or remotely.

In addition to each alarm message, packet copies are stored on the **INspektor**® and can be downloaded via the web interface for a more detailed error evaluation.

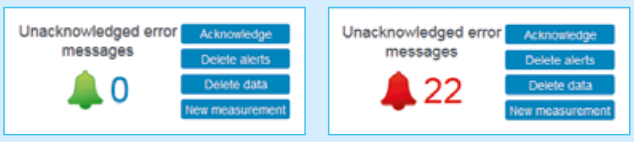


Fig. 24: Display of alarms in the overview screen

User-friendly display of network conditions with traffic light colors and time graphs enable any user to respond quickly in an emergency and ensure a good general overview.

RECOMMENDATION – Quality values

Recommendations on the quality values in EIP by **Indu-Sol**

Jitter (deviation from the requested RPI)	**≤ 50 %**
Packet loss (missing packets)	**0**
Error packets (defective packets)	**0**
Load ratio (I/O to other traffic)	**100 : 1**
Network load (in 100 Mbps)	**< 20 %**

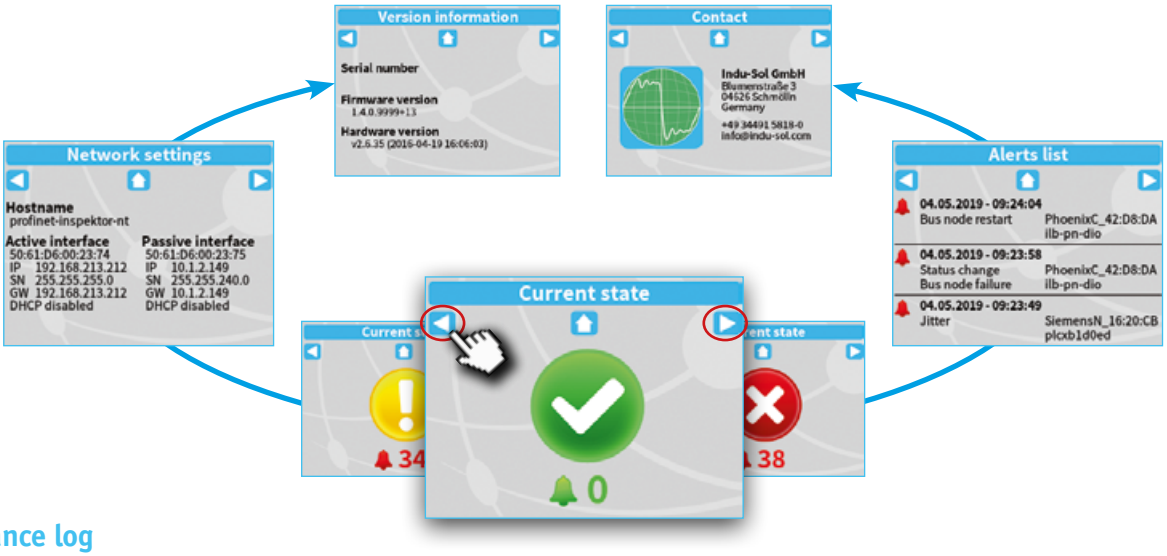
EtherNet/IP-INspektor® analysis and diagnostic tool

Touchscreen

The display serves primarily to show the current status of the network and the accumulated faults. This information makes it possible, without an additional computer, to make an assessment about the status of the network.

Much important system information of the **EtherNet/IP- INspektor® NT** is displayed as well. Thus, the network settings are needed to connect to the web interface and to view further detail information. Notes on firmware and hardware versions can be accessed via the display as well.

Navigation between the individual windows is done by touch control via the arrow buttons.



Acceptance log

Just like with **PROscan® Active V2**, the **EtherNet/IP-INspektor® NT** provides the option to have a comprehensive acceptance log generated with just a few clicks.



Fig. 25: Clear overview of all important information – this includes all system information (e.g. records of EMC conditions in the bus environment)

EtherNet/IP
permanent network monitoring

PROmanage® NT network monitoring software

For preventative, condition-oriented maintenance of EtherNet/IP networks, **Indu-Sol** has developed a strategy for permanent network monitoring (referred to as PNM in the following). It provides for condition monitoring with the goal of **"warning before failure"**.

The concept of PNM provides for a continuous network analysis with a decentral, passive data collector, the **EtherNet/IP-INspektor® NT**. Whenever preset threshold values are exceeded, this event is stored together with a time stamp. The installation is between the controller and the first switch port. Each controller therefore requires an **INspektor®**.

With **PROmanage® NT,** all external **INspektors®** are integrated in the monitoring via the existing Ethernet network, and the network conditions are bundled centrally on a server. The network-specific events are pre-processed by the **EtherNet/IP-INspektor® NT** and provided chronologically by the **PROmanage® NT** network monitoring software for further processing and evaluation.

PROmanage® NT enables the evaluation, analysis and long-term storage of condition data for your fieldbuses and other industrial networks. For this purpose, **PROmanage® NT** retrieves the port statistics of manageable switches and the events of the decentral data collectors (**INspektors®**), evaluates them and displays them graphically.

This sophisticated method of analysis makes irregularities immediately apparent. When a value exceeds or falls below a configurable threshold value, an alarm activates. The statistic function keeps data exact to the minute available up to one year. This means historical events can be opened up for viewing at any time for cause analysis, e.g. of sporadic failures.

Highlights

- Central monitoring of all fieldbuses and networks
- Avoid system failures
- Timely warning via OPC, SNMP trap or email in case of irregularities
- Data exact to the minute available up to one year
- Quick installation
- Easy device set-up due to automatic and manual device scan

To improve system availability the following targets are set for a PNM system:

- Continuous monitoring of real communication
- Complete monitoring and detection of causes of network weaknesses
- Automatic alarms when negative developments occur
- Central overview of all networks



PROmanage® NT

Topology

The software **PROscan® Active V2** and/or a decentralised data collector such as the **EtherNet/IP-INspektor® NT** determine the topologies of the individual networks. With the help of the software **PROmanage® NT**, these can be recorded at a central point, can be bundled, and therefore be displayed to the user in a clear manner, including all device information and statistics that were obtained.

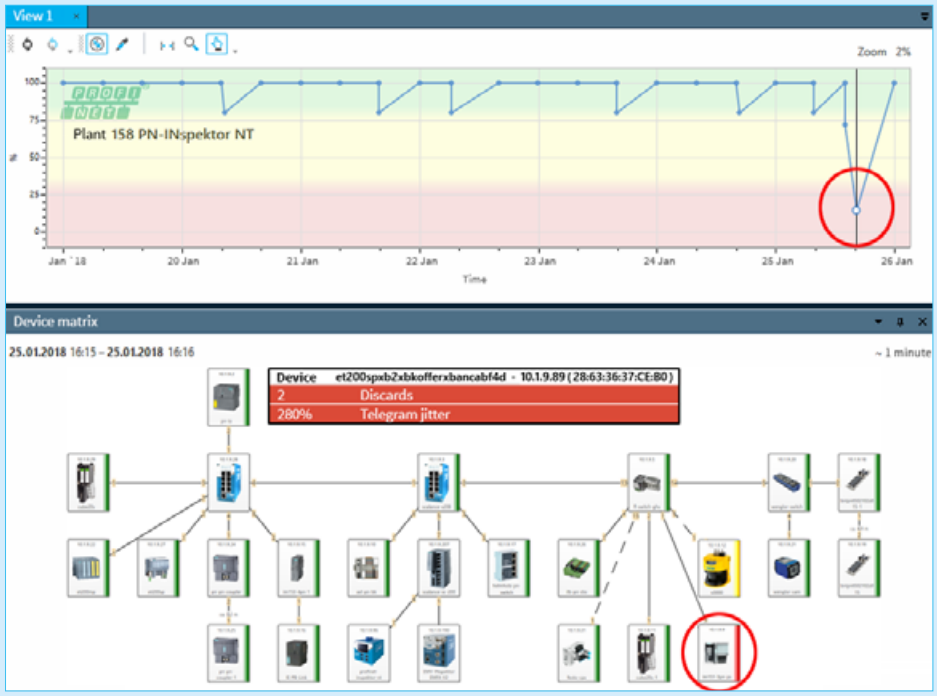


Fig. 28: Central topology detection in PROmanage® NT

This creates a permanent, up-to-date, real overview of which devices are located where in the network and what their status is. This allows for the affected devices being located quickly in case of incidents in the network. If changes are made to the wiring of the network, the respective times can be determined through the continuous recording of the topology. The anomalies that can be detected in this manner include removed and newly added devices as well as changes in port allocation of the switches in question.

Plant layout

In order to get a better overview of the real plant layout, individual devices in the topology can be allocated to individual system parts or installation locations for example, control cabinets, robots, etc. This allows for a comparison of the determined network layout (see Figure 29). This function allows for the mapping of complete assembly lines or a complete floor plan, so that a central contact point is available for the condition monitoring system.

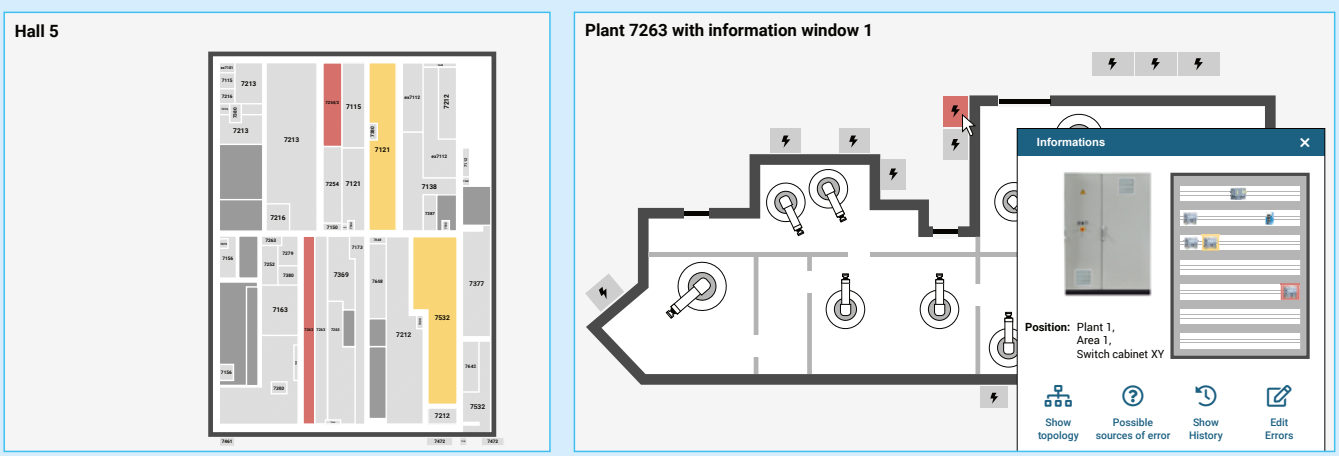


Fig. 29: Display of the recorded network structure in the real plant layout

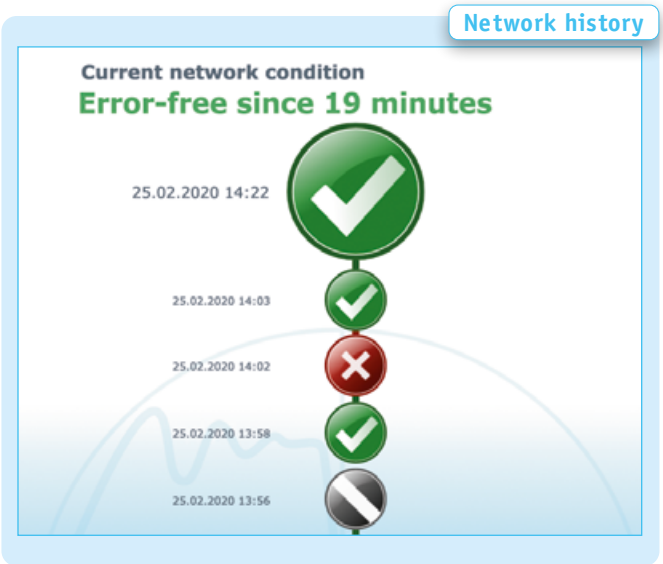
EtherNet/IP
permanent network monitoring

Network history

How is my network?

The network history provides a quick and clear overview of:

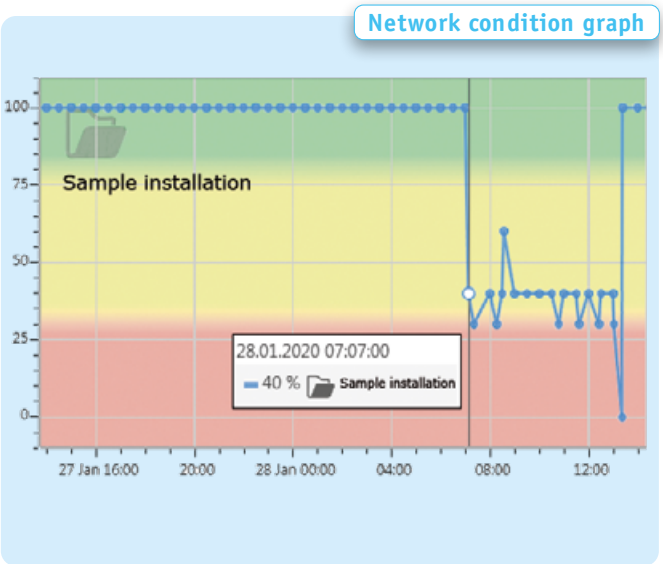
- The current network status
- How long a network has run without error
- When the last error occurred (with time stamp)



Network condition graph

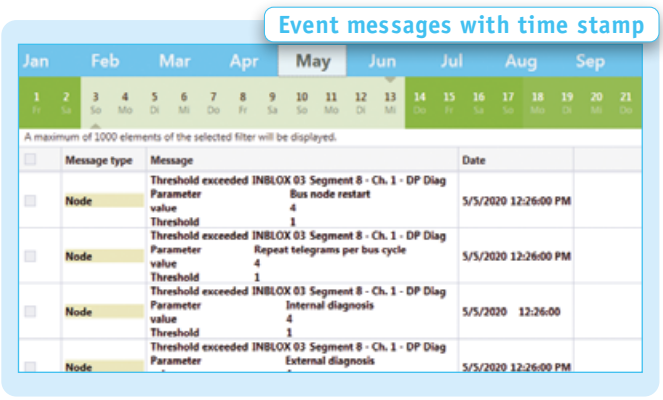
A user-friendly interface can be used to display and evaluate the information. The interface can be adapted to your unique needs and spread over several physical screens for better overview.

Various parameters of different devices such as device temperature and failures can be compared in a graph to detect links in the event of malfunction.



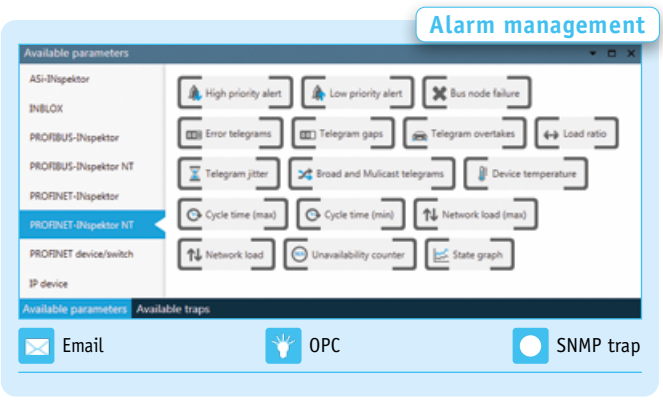
Event messages with time stamp

With the integrated threshold management, threshold values can be defined for every network parameter. When a limit is reached, an entry with a time stamp and event description is made automatically in the event list. Information about network errors can be retrieved from the event list with a mouse click.

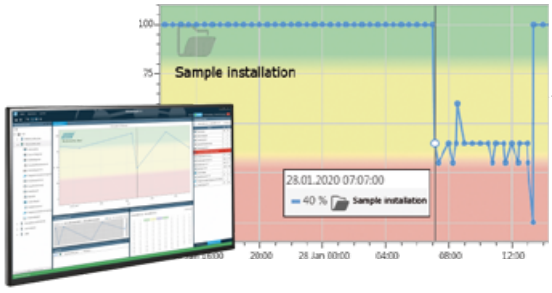


Alarm management

Integrated alarm management enables automatic forwarding of device notifications. By selecting suitable information medium (email, message services, OPC, SNMP) all messages can be transmitted to the responsible persons in a timely fashion. This shortens notification paths and prevents undesired plant breakdowns.



Configuration example (PNM)



PROmanage®NT - external

Remote external

Remote Service
Maintenance and Service

WORLD WIDE WEB

Alarm (external)
„Failure network"
Maintenance / Services

Network analysis
Remote access
via VPN

Report (internal)
„Failure network"
Plant operator

SNMP Trap

Client

Client

Control system

Visualisation server

Email Server

Guidance system network/
IT network
(Ethernet TCP/IP)

SWITCH

PROmanage®NT OPC Server

Control level

Firewall

PROmanage®NT - internal

SNMP request

Process network /
OT network
(Ethernet)

SWITCH

SNMP request

SNMP request

SNMP request

Functional group level

EIP-INspektor®NT

EIP-INspektor®NT

EIP-INspektor®NT

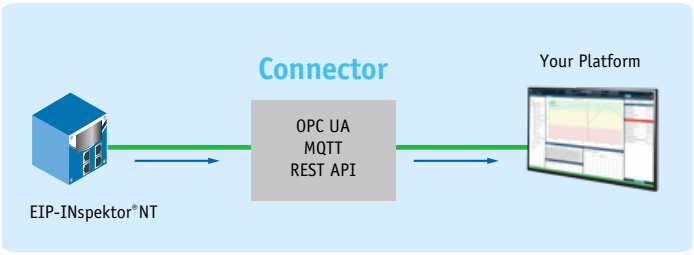
EtherNet/IP

EtherNet/IP Integrations

APM + CMMS + EAM + ERP + MES + SCADA Connectors

Connect to the systems you already run

Already running a SCADA, CMMS or MES? Keep it. Our connectors send EtherNet/IP network health data from your INspektor® NT devices straight into the platforms your team already uses, via OPC UA, MQTT and REST API. Your team gets network alerts and history in the same place they handle everything else, with no new screens to learn.



Technology Partners

MaintainX
An AUTODESK Company

ZABBIX

Limble

AVEVA

Ignition!

Available connectors

- MaintainX
- AVEVA
- Zabbix
- Ignition by Inductive Automation
- Limble
- IBM Maximo
- SAP Manufacturing
- Plex by Rockwell Automation
- Fiix by Rockwell Automation
- Senseye by Siemens
- Splunk by Cisco
- Microsoft Manufacturing
- Brightly Asset Essentials
- LLumin

Typical applications

Catch failures before they stop the line

INspektor® data feeds your predictive maintenance tools, so a degrading cable or connector gets flagged before it causes downtime.

See network health next to production data

Put network condition into your SCADA or MES dashboards to link downtime and quality issues to network faults.

Trigger work orders automatically

When a threshold is exceeded, your CMMS opens a work order that names the affected device and its location. No one has to watch a screen.

Keep your history in one place

Your platform stores network events with timestamps next to your production records, so finding the cause of a sporadic fault takes minutes instead of days.

EtherNet/IP Agent - Packet diagnostics

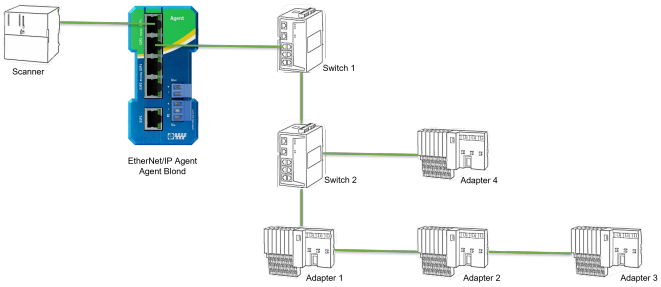
The EtherNet/IP Agent - "Agent Blond" combines the functionality of an EtherNet/IP measurement point with EtherNet/IP analysis. In doing so, relevant parameters—such as missing update rates ("packet loss")—are recorded, which accelerates the identification of actual weak points within the EtherNet/IP system.

The evaluation of the recorded data does not take place on the device itself; instead, all data is transferred to the PLC.

The EtherNet/IP Agent is intended to be permanently installed within the network connection between the PLC and the first switch, as this connection carries the cyclic EtherNet/IP communication to all Ether-Net/IP devices. Two network ports (X2P1 and X2P2) are available for this purpose.



To enable a non-intrusive connection of an analysis tool (e.g., Ether-Net/IP-INspektor® NT) for deeper network analysis, two mirroring ports (X3P1 and X3P2) are provided.





Packet analysis cycle

Devices	Packet loss
Switch 1	0
Switch 2	1
Adapter 1	11
Adapter 2	43
Adapter 3	310
Adapter 4	5

Devices	Packet loss
Switch 1	0
Switch 2	0
Adapter 1	0
Adapter 2	0
Adapter 3	0
Adapter 4	0

Packet Loss (Before/After)

EtherNet/IP TAPs - PNMA II / PNMX

The PNMA II provides feedback-free access for telegram recording in the EtherNet/IP and other Ethernet-based networks during running production. We recommend installing the PNMA II measuring point permanently in the network connection between the automation device (controller) and the first switch, because the major part of the communication typically passes through here.

The measurement point with the PNMX version and IP 67 protection can be installed in rough production environments without any protective housing. Diagnostic tools are connected via M12 measurement jacks (M12 D-coded).

Function

For the feedback-free connection of an analysis tool (e.g. **EtherNet/IP-INspektor® NT** or laptop) two monitor sockets (M1 and M2) are available on the **PNMA II / PNMX** for diagnostics. This means both communication directions can be monitored simultaneously.

An analysis tool is connected to the monitor sockets by means of two network cables. For analysis and evaluation of the measurement results the telegrams from both communication directions can be overlaid. The **PNMA II / PNMX** does not discard error telegrams. Instead, it forwards them.

Highlights

- If connecting a **EtherNet/IP -INspektor® NT** via a **PNMA II**, only two additional patch cables are needed (no crossover cable required).
- In case of a power supply failure the EIP communication via the **PNMA II** remains intact.
- Power supply of additional analytic tools via the UOUT (24VDC) connector
- **PNMX IP 67** for rough production environments

Properties

- Monitoring of all protocols
- Supports all packet sizes
- No packet loss
- All connection ports on the front panel
- No additional effort to connect a measuring device
- Tested interaction with the **EtherNet/IP -INspektor® NT**
- No free switch port necessary
- Bi-directional data transmission up to 100 Mbps
- No network interruption when connecting diagnostic tools

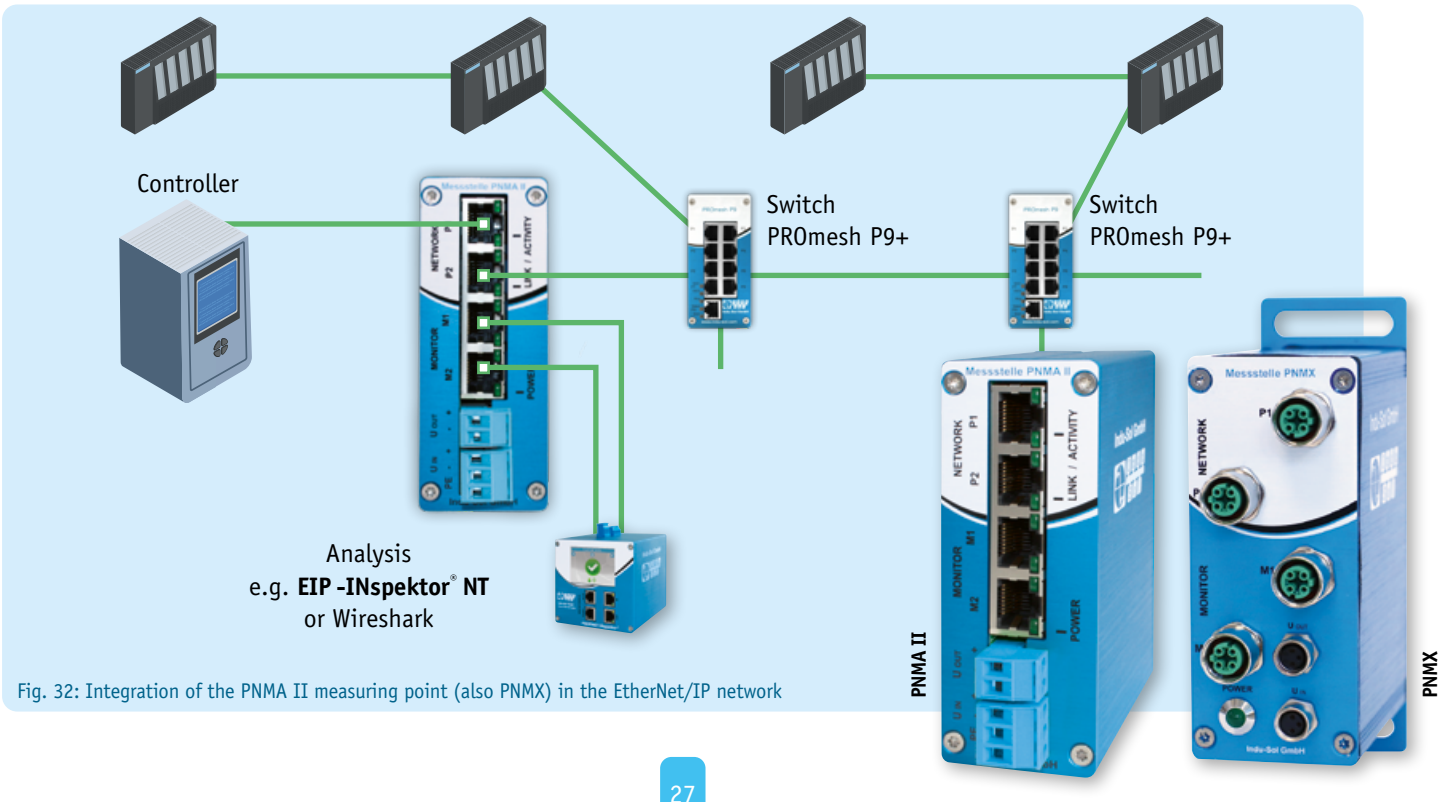


Fig. 32: Integration of the PNMA II measuring point (also PNMX) in the EtherNet/IP network

PROmesh Switch product families

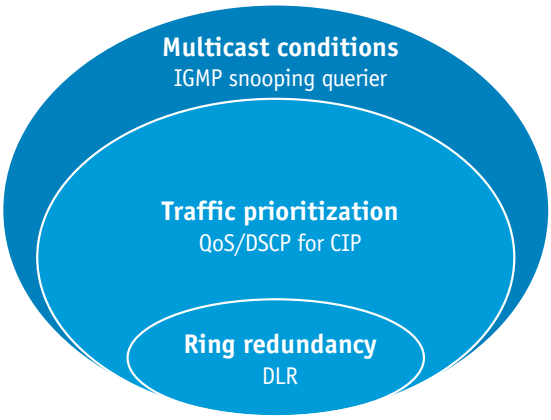
EtherNet/IP Switches

The Indu-Sol EtherNet/IP switch family, PROmesh, comprises switches, which have been matured and specialized based on market needs so that with the PROmesh series any EtherNet/IP network can be built without any problems. The switches support the network services an EtherNet/IP system depends on: IGMP snooping with querier for controlled distribution of multicast I/O traffic, and QoS prioritization (DSCP) so that time-critical CIP data is forwarded ahead of general TCP traffic.

The manageable PROmesh switches can be integrated into the automation system (e.g. Studio 5000 Logix Designer) via EDS file or Add-On Profile in order to enable network diagnostics. With this feature among other things, these necessary and useful functions are supported:

- Device and port diagnostics to the controller via CIP explicit messaging
- Neighborhood detection (LLDP)
- Port-related network statistics (CIP Ethernet Link Object)
- Network diagnostics via IT mechanisms (SNMP)

In addition, the EtherNet/IP switches are designed for high data volumes: multicast traffic is contained by IGMP snooping rather than flooded across the network, and cyclic CIP I/O is prioritized over acyclic and IT traffic. Conformance with the EtherNet/IP specification is verified in accordance with ODVA.



Network Load

EtherNet/IP transmits cyclic I/O data as multicast. Without control at the switch, this traffic is flooded to every port and consumes bandwidth on devices that have no use for it. This is the most common cause of load problems in EtherNet/IP networks.

Infrastructure components must therefore contain multicast traffic (IGMP snooping with an active querier) and prioritize time-critical CIP data ahead of TCP-based IT

Functionality

ODVA publishes Recommended Functionality for EtherNet/IP Devices, which defines the properties an infrastructure component should provide in order to operate reliably in a CIP network.

For switches, the decisive functions are IGMP snooping and querier, QoS prioritization of CIP traffic, port diagnostics via the CIP Ethernet Link Object, and in cases where ring topologies are used, DLR.

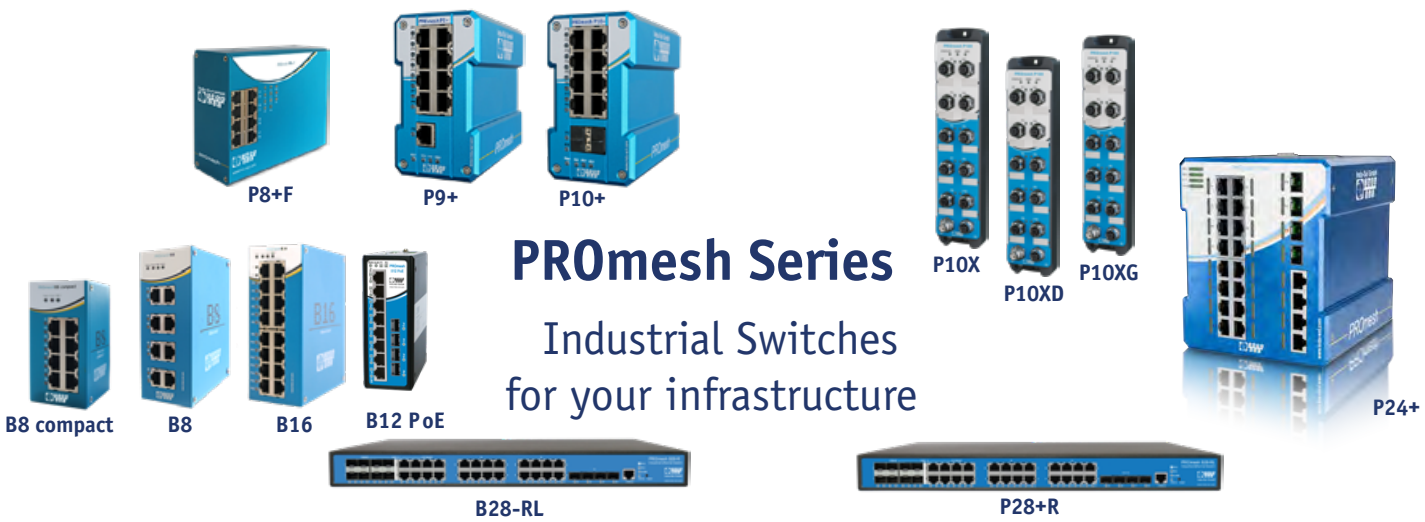


Abb. 30: PROmesh Switch product families

Increased network diagnostics with the PROmesh P product family

Permanent line diagnosis

A line certification at the commissioning of the plant is not always a guarantee that the longevity of the line and thus of the plant over the entire life cycle is guaranteed. Especially when if the lines are exposed to continuous external influences which accelerate the aging process of the line, such as for example by

- Alternating bending stresses
- Robot application
- Chemicals and other liquids

In such cases, permanent line monitoring by means of a switch, such as the PROmesh switches from the company Indu-Sol GmbH, provides a remedy. These enable a dynamic analysis of the actual condition of the directly connected lines.

Unlike well-known line testers, the PROmesh switches perform the line diagnostics permanently and during ongoing system operation. Thanks to this permanent monitoringcritical line conditions can be detected automatically and corrected by your maintenance department - before your system operation is impaired.

EMC monitoring

The cause of a communication interruption is not always a defective line, but also interfering shield currents on the data lines can also lead to a network failure.

To prevent this, the PROmesh switches of the series can permanently monitor the leakage current via the top-hat rail, alarm if the leakage current exceeds the limit and thus identify and, at best, eliminate them.

PROmesh line monitoring



19“ Switches - The connection to IT

The PROmesh P28+R rounds off the PROmesh product range as a 19-inch switch. The switch is intended for machine and plant superordinate communication.

With the switch, several individual plants can be connected without any communication problems.

Via certain Layer-3 functions in the PROmesh P28+R, it is also possible to logically separate the physical connections between the machines, if the security requirements dictate. For this purpose, the switch has NAT routing and access control list as well as 802.1X authentication.

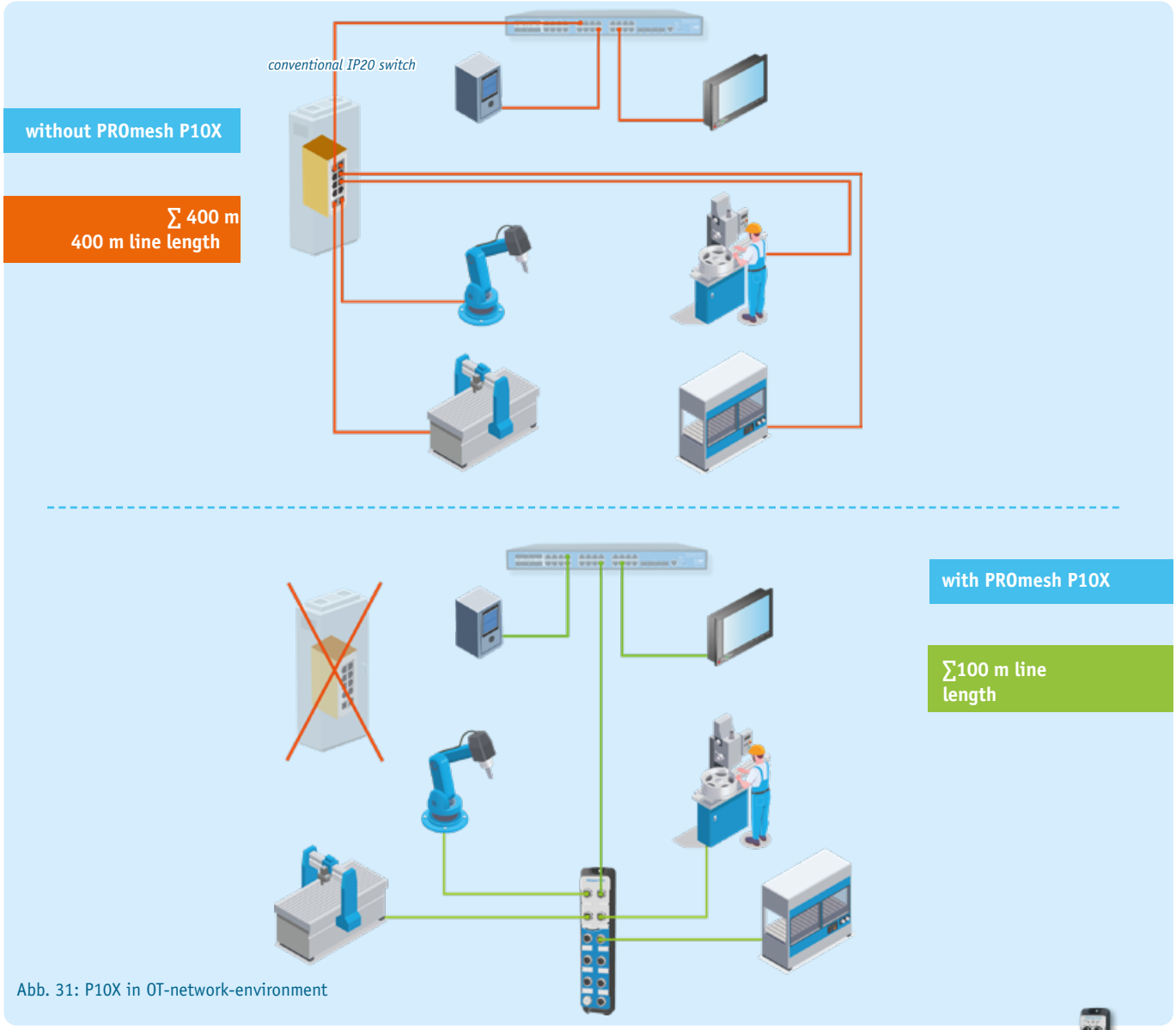


Abb. 31: P10X in OT-network-environment

IP67 range: The PROmesh P10X Series



So that not for each individual switch paired with a network diagnostics, a separate control cabinet has to be set up the PROmesh P10X combines high network performance and diagnostic options with the IP67 requirements. For the first time under the IP67 switches, the PROmesh P10X supports permanent line diagnostics.

SIEDS sensor

With its self-learning teach mode and intelligent alarm management, the SIEDS sensor can be used for any type of condition monitoring in predictive maintenance and offers the possibility to evaluate a wide variety of assets in the industrial environment.



usecase:
Condition mnitoring on motor pump combination





Monitoring Phase

SIEDS can be connected to a condition monitoring software solution.

This makes it possible to centrally monitor all relevant data from assets subject to wear and tear and other network-capable devices (other sensors, switches, frequency converters) and to use them for predictive maintenance.

Localization of wear and tear assets

What are typical assets subject to wear and tear in manufacturing companies that must be given attention at certain intervals?

Example: Motor-Pump Combination

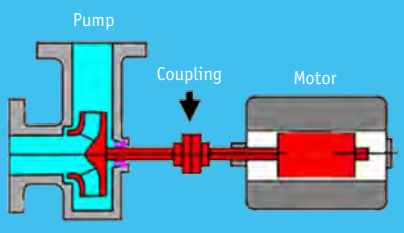
Incorrect adjustment of the motor shaft to the pump shaft increases wear.

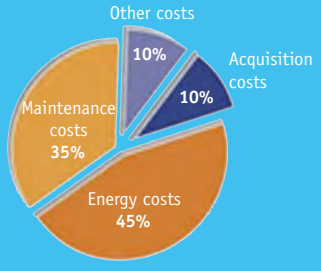
Selection of the appropriate SIEDS parameter

Which physical parameter(s) of the SIEDS can be used to analyze the asset for wear and tear?

Example: Motor-Pump Combination

Incorrect adjustment causes vibrations in the vicinity of the motor-pump combination, which has an acceleration and an acoustic sensor can be recorded.





Sensors



D*Bridge

The D*Bridge is an intelligent bridge device, which connects two or more fieldbuses on the OT level to one network. The device is used without configuration and is therefore ideal for users without a high level of IT knowledge.

Without any configuration effort both from the PLC's point of view as well as via its own interface, the D*Bridge routes the relevant data traffic and thus enables horizontal communication.

The D*Bridge increases the performance and security of the network by forwarding only the relevant data packets and and discarding unwanted or faulty packets.

Any additional data traffic is blocked, thus stabilizes the network and ensures availability. The D*Bridge has a much higher range of functions than the usual fieldbus couplers.

D*Bridge digitalisation bridge

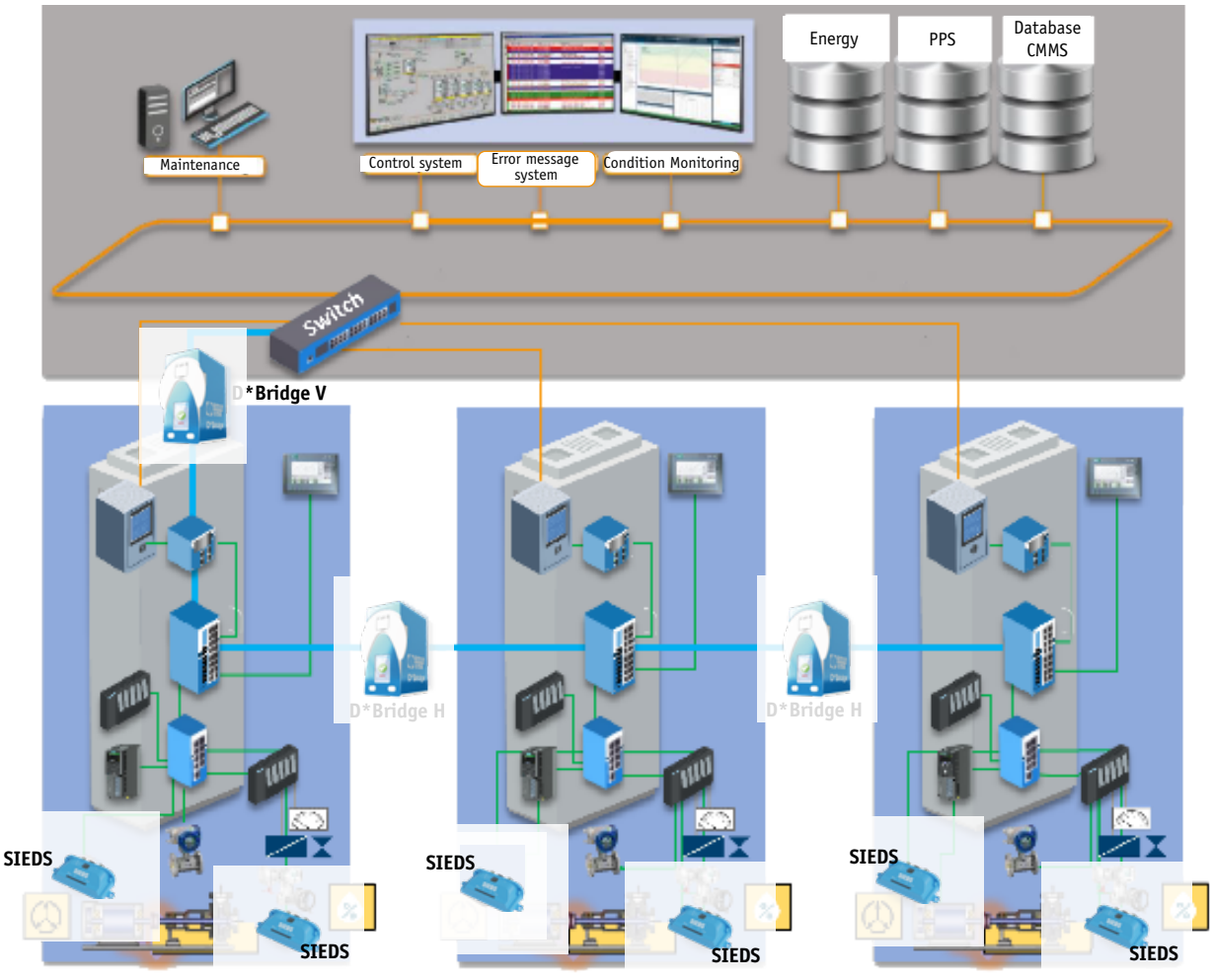


D*Bridge H

Creates secure, homogeneous convergent network structures for digitalization between fieldbuses on the the shopfloor level.

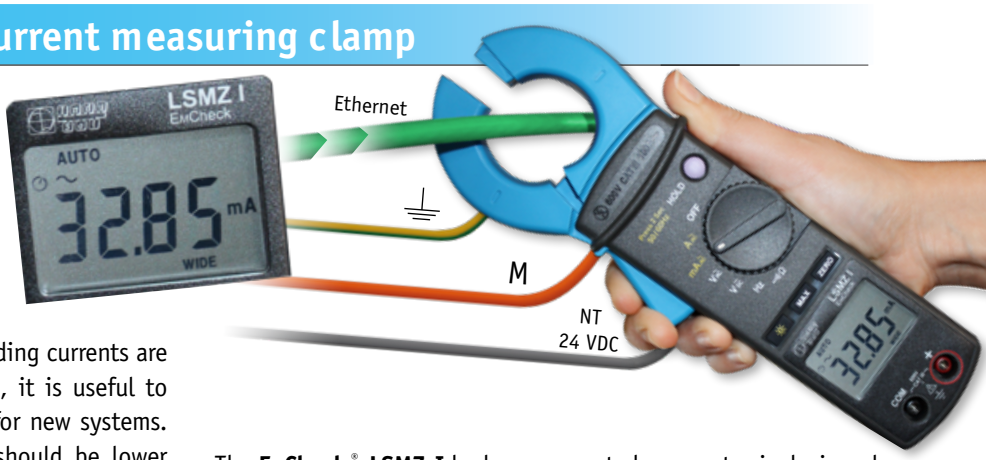
D*Bridge V

Creates the secure connection of the homogeneous convergent network structures for processing of the smart sensor data from the shopfloor directly to the SCADA level.



*With the D*Bridge, homogeneous fieldbuses are safely combined into networks. Simple, pragmatic, effective. This is how you create the basis for significant automation gains at the maintenance level.*

EMCheck® LSMZ I leakage current measuring clamp



Ever more often, compensating currents caused by high-frequency shielding currents create intermittent faults in industrial data communication systems. On one hand, these currents may disturb the transmission itself. On the other, they may damage the devices by overloading. Because such effects of high shielding currents are only noticeable after a some time has passed, it is useful to define limits and document compliance even for new systems. Shielding currents during running operation should be lower than 40 mA.

RECOMMENDATION

Independently of the system specification, experiences at Indu-Sol show that shielding currents of < 40 mA can be tolerated. The decision of what is acceptable should always be made in the context of the frequency range in order to be able to perform suitable measures to reduce shielding currents.

The **EMCheck® LSMZ I** leakage current clamp meter is designed specifically to measure leakage and shielding currents in the frequency range of 50/60 Hz or 5 Hz - 1 kHz. The adjustable measurement range can be set between 30 µA and 100 A. For measuring shielding currents on a data cable, the lower end of the range is more relevant. The **EMCheck® LSMZ I** leakage current clamp meter is also an ideal tool to find insulation faults and unplanned shutdowns caused by leakage currents and tripped FI switches. It also offers all the features of a multimeter clamp. To determine loop impedances, the **EMCheck® MWMZ II** loop impedance measurement clamp (see page 45) can be used.

EMC/EMV Troubleshooting Toolkit



EMC/EMV Troubleshooting Toolkit

Highlights

- Leakage current clamp: **EMCheck® LSMZ I**
- Mesh resistance clamp: **EMCheck® MWMZ II**
- Shield current detection: **30 µA to 100 A, 5 Hz to 1 kHz**
- Loop resistance verification: **shield, PE and bonding paths**

Correct grounding and equipotential bonding protect personnel and are a prerequisite for undisturbed automation operation. This set measures both sides of an EMC-compliant installation — loop resistance in the bonding system and shield currents on the data cable.

We will gladly provide a separate offer for individual devices (see page 45 ff.).

Mesh resistance measuring clamp EMCheck® MWMZ II

Determination of loop resistances

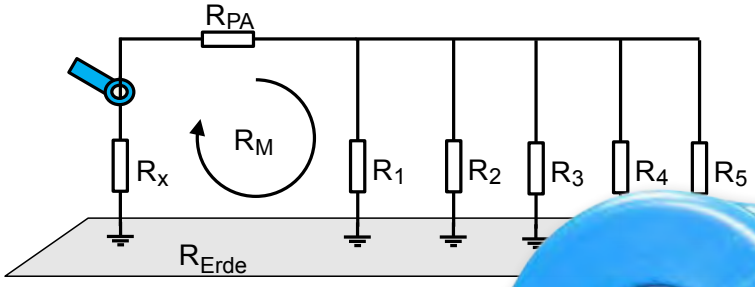
From the perspective of automation technology the function of the equipotential bonding is not put into question because the functionality is persumed and the points of contact are mostly seen in the low voltage system. However in the meantime it was exposed that a secure and solid working communication network, including the bus system, is connected to the function of the equipotential bonding. Straying currents and currents of higher frequency which are often caused by frequency converters, mostly use the shield of our data cable as return current flow instead of the intended equipotential bonding system.

The explanation is simple: *"Discharge currents of higher frequency do not use the way of lower ohmic resistance but always the way with lower impedance...!"*

Just relying on gut feeling, or making intuitive statements about the quality of existing shielding and earthing measures is rarely a good idea. The only way to ensure good equipotential bonding is proof by measurement in compliance with DIN EN 50310. The mesh resistance measuring clamp **EMCheck® MWMZ II** is the right tool for this purpose.

Reference values:

The shield loop resistance of data cables (for example: fieldbus cables) should have a maximum impedance value of 0,6 Ohm. PE/PA loop resistances should be in the range of an approximated impedance value of 0,3 Ohm.



The total resistance of each mesh will be minimized by a higher amount of meshes generated in the potential equalization.

Highlights

- Measuring of earth loop resistance and earth loop inductivity
- Measuring the screen loop impedance of the data line
- Display of contact voltage
- Alert when detecting a dangerous voltage
- Recording of up to 300 measurements incl. time stamp
- Easy handling to keep the clamp open
- Good visibility of all displayed data via OLED display

Mode of functioning and operation

The clamp consists of two coils. The first coil induces a voltage with a defined frequency 2,083 Hz. The second coil measures the current induced by coil one in the set frequency range. The ratio of these two values is used to determine and display the alternating current resistance (impedance) – and if necessary additionally calculated for 50, 60, 128 Hz. The measurement is made without any interruption and can also be carried on conductors which already carry currents during their normal operation.

EMClots® Junction V2

EMCheck® MWMZ II

EMC/EMV-INspektor® V2

With an increasing automation level of industrial productions the power density rises and thus the risk of disturbances by electromagnetic interferences. In this context interference currents occur along fieldbus cables, encoder lines, the routings of power supply and equipotential bonding systems.

EMV-INspektor® V2 is a special measuring and analysing tool to record temporarily or permanently electromagnetic interferences. It allows connecting up to four current transformers, which measured values were recorded, evaluated and compared separately. Depending on the line type different quality parameters can be configured.

Thereby it provides a specific evaluation and monitoring of each measuring channel in the interest of Condition Monitoring. The sector of industrial automation obtains a smart tool for comprehensive fieldbus analyses by the **EMV-INspektor® V2**.

Measuring rudiments:

- EMC interferences along the bus cables
- EMC interferences via the 24 VDC power supply
- EMC interferences via the 230/400 VAC low-voltage distribution system
- EMC interferences in the equipotential bonding system
- EMC interferences via the transmitter lines

Highlights

- Measuring leakage, shielding and interference currents
- Parallel inspections of multiple potentially disturbed sections
- Permanent analysis and monitoring (Condition Monitoring) with PROmanage® NT
- Data comparison of each input source
- Specific status evaluation and alerting
- Visual display of interferences via web interface
- Export of measurements on USB stick or via LAN interface
- Configuration of device software via web interface

Application

The **EMV-INspektor® V2** provides an automated, contact- and interruption-free long-term inspection. Up to four channels can be connected, measured and analyzed.
On all four channels the current course and the spectrum are captured up to a frequency of 50 kHz per channel. This makes it possible for example to detect if there is a link between fieldbus (PROFINET) malfunctions and PE/PA currents. The additional frequency data from the spectrum provide clues regarding the possible cause of the fault. Frequency components in the lower kHz range point to pulse frequencies of frequency inverters.

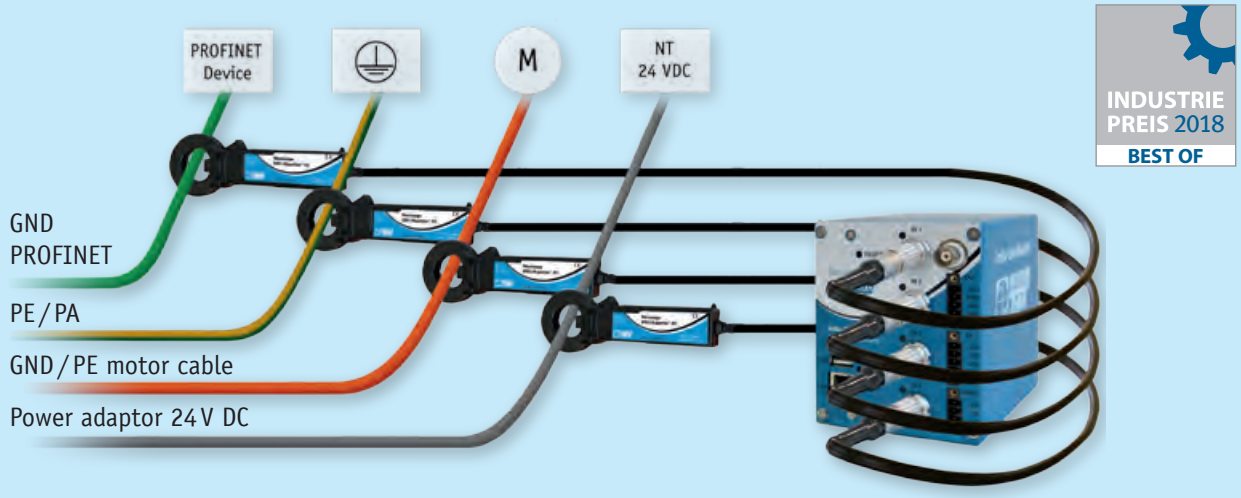


Fig. 22: Application example EMV-INspektor® V2

Analysis | Diagnostics | Measurement



EtherNet/IP-INspektor® NT (see page 17)

Analysis and diagnostic tool

Ordering Details	Art. No.
EtherNet/IP-INspektor® NT	124090000



PROscan® Active V2 (see page 13)

Active acceptance test and validation software

Ordering Details	Art. No.
PROscan® Active V2 – 1x license* (Basic license)	117000053
PROscan® Active V2 – 5x license*	117000057
PROscan® Active V2 – 25x license*	117000061
Upgrade PROscan® Active V1 to V2	117000052

*Further licences upon request



PROmanage® NT (see page 24)

Network monitoring software

*The licence defines the maximum number of network ports or devices retrieved simultaneously. (Ethernet switch: number of network ports = number of licence ports, 1 PB-INspektor® = 8 ports, 1 EIP-INspektor® = 16 ports)

Ordering Details	Art. No.
Upgrade NT to NT V2	117000100
PROmanage® NT (80 Ports*)	117000104
PROmanage® NT (320 Ports*)	117000106
PROmanage® NT (640 Ports*)	117000110

*Further licences upon request



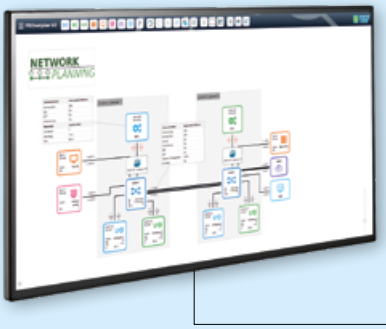
EtherNet/IP Troubleshooting Kit (see page 20)

Essential tools for commissioning and troubleshooting

- Analysis and diagnostic tool **EIP-INspektor® NT**
- Network monitoring software **PROmanage® NT**

Ordering Details	Art. No.
EIP Troubleshooting Toolkit	124090098

Network planning



PROnetplan (see page 10)

Network planning software

Ordering Details	Art. No.
PROnetplan	114010009

Analysis | Diagnostics | Measurement



ETHERtest V5 (see page 12)

Industrial Ethernet Cable tester (suitable for certification)

Ordering Details	Art. No.
ETHERtest V5.1 (extendable for FOC)	112010011
ETHERtest V5.3*	112010022



PROlinetest (see page 12)

EtherNet/IP Cable tester

Ordering Details	Art. No.
PROlinetest*	112010010



EtherNet/IP Agent (see page 12)

EtherNet/IP Diagnostic Agent simplifies commissioning

Ordering Details	Art. No.
EtherNet/IP Agent - "Agent Blond"	124090300

*All adapters for PROlinetest and ETHERtest V5.1/V5.3 on request.

Infrastructure components

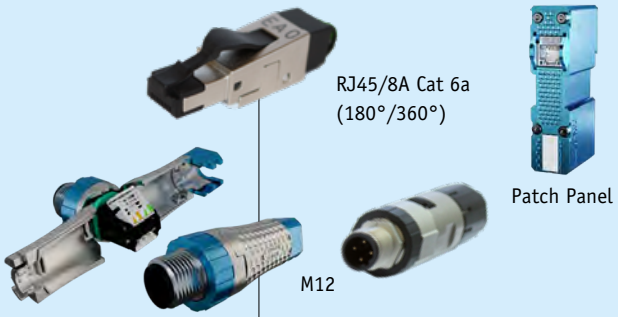


PNMA II / PNMX (see page 31)

EtherNet/IP measuring points

Ordering Details	Art. No.
PNMA II	114090100
PNMX IP 67 (for rough production environments)	114090300

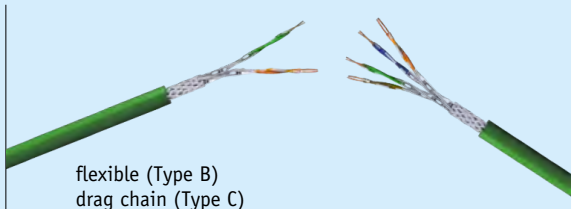




Industrial Ethernet plugs

RJ45 / M12 Fast Connect

Ordering Details	Art. No.
IE plug RJ45 (180°)	114030006
IE plug RJ45 (90°)	114030004
IE plug RJ45/8A Cat 6a (180°)	112030008
IE plug RJ45/8A Cat 6a (360°)	112030009
IE plug M12	114030002
PROconnect M12 D-coded Cat5	112030023
PROconnect M12 X-coded Cat6A	112030022
PROconnect Patch Panel for RJ45	112101000



Industrial Ethernet cable

Cat5 / Cat6A (Type B, C, and R)

Ordering Details	Art. No.
PROconnect Cat5 SF/FTP Type B	114060020
PROconnect Cat5 SF/FTP Type C	114060021
PROconnect Cat5 SF/FTP Type R	114060022
PROconnect Cat6A SF/FTP Type B	114060030
PROconnect Cat6A SF/FTP Type C	114060031
PROconnect Cat6A SF/FTP Type R	114060032

EtherNet/IP tools

Ethernet Fast Connect Stripping Tool



EMFlex Stripping Tool



Stripping Tools

Ordering Details	Art. No.
Ethernet Fast Connect Stripping Tool	112020005
EMFlex Stripping Tool	122130010

Infrastructure Components



PROconnect Patch Cables - Shielded, Type B

Available in 30cm, 50cm, 1m, 2m, 3m, 5m, and 10m

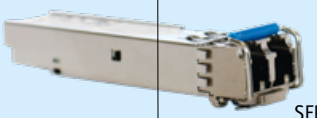
Ordering Details	Art.-No.
2x2 AWG24/7 Cat. 5 - RJ45/RJ45	140000000-0xxxx
4x2 AWG26/7 Cat. 6 - RJ45/RJ45	140000010-0xxxx
2x2 AWG24/7 Cat. 5 - M12-D/M12-D	140001000-0xxxx
4x2 AWG26/7 Cat. 6 - M12-X/M12-X	140002010-0xxxx
2x2 AWG24/7 Cat. 5 - RJ45/M12-D	140101000-0xxxx
4x2 AWG26/7 Cat. 6 - RJ45/M12-X	140202010-0xxxx

SFP-Module

Ordering Details	Art.-No.
SFP-Module 1 Gbit/s RJ45 100 m	114120003
SFP-Module 1 GBit/s 20 km SM-LC	114120004
SFP-Module 1 GBit/s 0,55 km MM-LC	114120005
SFP-Module 100 MBit/s 2 km MM-LC	114120006
SFP-Module 100 MBit/s 10 km SM-LC	114120007
SFP-Module 10 GBit/s 10 km SM-LC	114120008
SFP-Module 10 GBit/s 0,3 km MM-LC	114120009
SFP-Module 2,5 GBit/s 0,55 km MM-LC	114120020
SFP-Module 2,5 GBit/s 10 km SM-LC	114120021
SFP-Module 1 GBit/s 2 km MM-LC	114120024
SFP-Module 1 GBit/s 40 km SM-LC	114120025
SFP-Module 100 MBit/s 2 km MM-LC	114120034
SFP-Module 2.5 GBit/s RJ45 100 m	114120035



SFP-Modul RJ45



SFP-Modul SM/MM

Infrastructure components



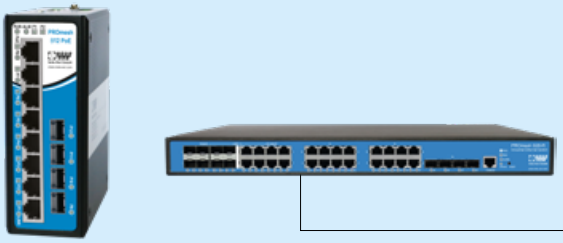
Premium EtherNet/IP Switches

Ordering Details	Art.-No.
PROmesh P8+F	114110198
PROmesh P9+	114110194
PROmesh P10+	114110204
PROmesh P10X	114110211
PROmesh P10XD	114110126
PROmesh P10XG	114110226
PROmesh P24+	114110230
PROmesh P28+R - 24RJ45-4SFP+	114110262
PROmesh P28+R - 16RJ45-8SFP-4SFP+	114110272
PROmesh P28+R - 24SFP-4SFP+	114110282



Basic EtherNet/IP Switches

Ordering Details	Art.-No.
PROmesh B8	114110501
PROmesh B16	114110510
PROmesh B8 compact	114110520



Ethernet Switches

Ordering Details	Art.-No.
PROmesh B12 PoE	114110251
PROmesh B28-RL	114110110



Unmanaged Ethernet Switches

Ordering Details	Art.-No.
PROmesh U3	114110130
PROmesh U5	114110120
PROmesh U8	114110122
PROmesh U2-G	114110131
PROmesh U5-G	114110125
PROmesh U8-G	114110126
PROmesh U16	114110124

SIEDS



SIEDS

Ordering Details	Art.-No.
SIEDS	124110000

D*Bridge



D*Bridge V



D*Bridge H

D*Bridge

Ordering Details	Art.-No.
D*Bridge V	112100101
D*Bridge H	112100100

EMC analysis | EMC diagnosis | EMC measurement



EMCheck® LSMZ I (see page 22)

Leakage current measuring clamp

Ordering Details	Art. No.
EMCheck® LSMZ I	122010005
Set of measuring clamps (LSMZ I and MWMZ II)	122010006



EMCheck® MWMZ II

Mesh resistence measuring clamp

Ordering Details	Art. No.
EMCheck® MWMZ II	122010010
Set of measuring clamps (LSMZ I and MWMZ II)	122010006



EMCheck® ISMZ I

Measuring clamp for leakage, shielding and interference

Ordering Details	Art. No.
EMCheck® ISMZ I	122010022



EMC/EMV INspektor® V2

EMC - Measuring/monitoring of leakage, shielding and interference currents

Ordering Details	Art. No.
EMC/EMV INspektor® V2	122010001



EMC/EMV Troubleshooting Toolkit

- **EMCheck® LSMZ I**
- **EMCheck® MWMZ II**

Ordering Details	Art. No.
EMC/EMV Troubleshooting Toolkit	122010097
EMCheck® Toolkit XL w/ ISMZ I	122010007

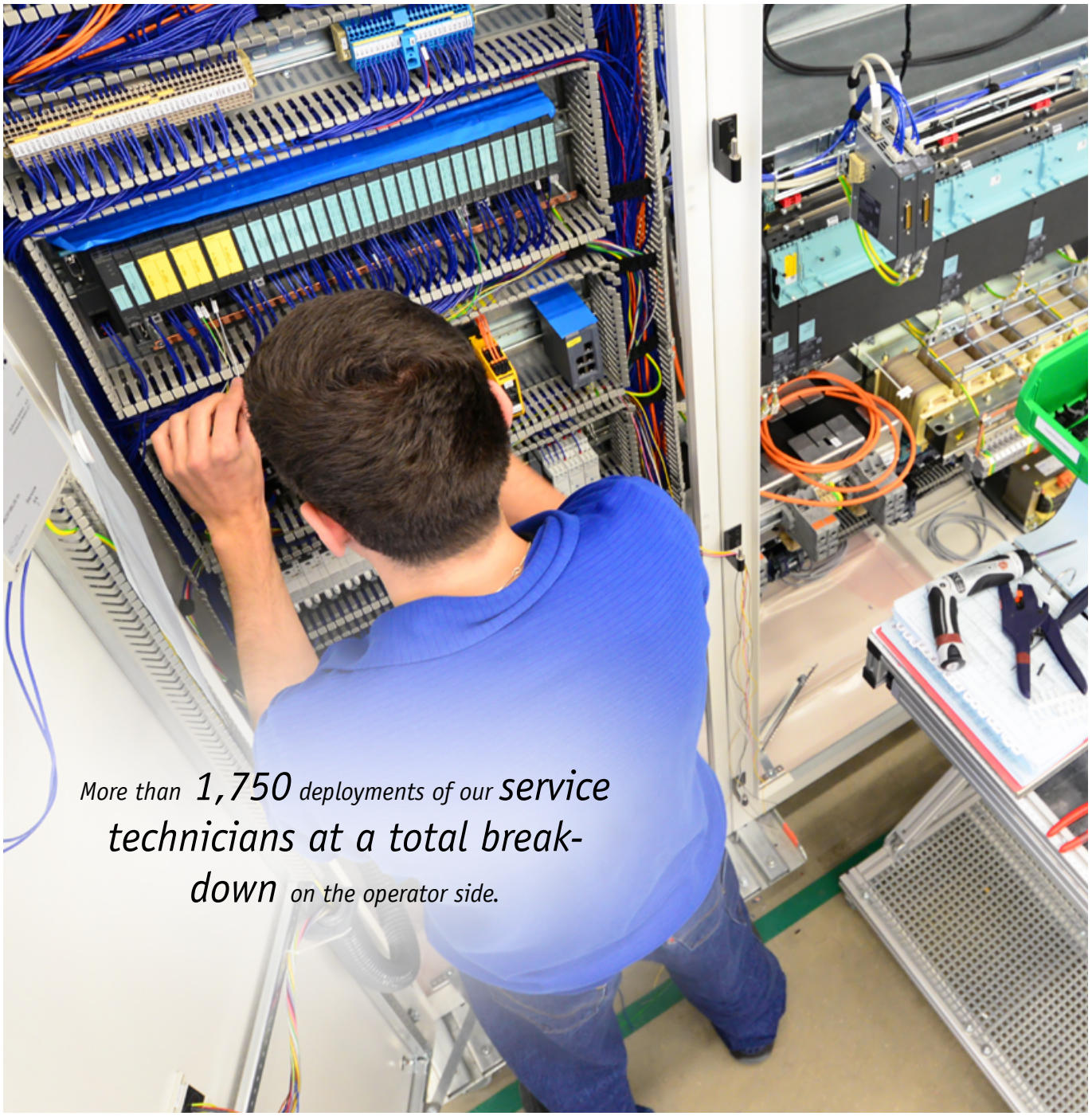
Maintenance and management strategy at the shopfloor level

Our team of 40 network specialists offers industrial companies throughout Europe the daily support needed to appropriately and purposefully meet every type of challenge that can arise from the operation of machine networks.

No matter which maintenance strategy you pursue in your company:

We advise, plan, prepare projects and manage for you the decisive measures that increase overall system effectiveness significantly, stabilize production processes and open up access to previously unattainable potential savings.

In future, the digitalization know-how in our condition monitoring systems will not only extend to the network itself, but also to the machines and production processes connected to it.



Condition Monitoring System

automate the maintenance activities

We extend the CMMS* to include multi-sensors (SIEDS*) and an OT security device (D*bridge) and create the basis so that installers and operators receive equal access to the data streams below the PLC.

The result will be that in future, many routine tasks (such as inspections and similar) can be automated and worked through in a structured way. A valuable contribution with which we will help industry to deal with the shortage of skilled maintenance workers.

Make your maintenance strategy more successful and make your machine networks real value drivers in the company, which will pay directly into the operating result.

Planning productive OT networks

Network planning is one of the unique competencies of InduSol, which enable customers to increase strategic network improvements at any time and achieve significant improvements when it comes to availability and performance.

We consider the whole network and generally achieve the required goal with up to 40% lower production costs.

Training offers for all aspects of industrial networks

As a long-standing specialist for industrial networks and an official PI training center, we are extremely familiar with the optimization of automation networks.

Based on our experiences and extensive expertise, we offer you practice oriented further training courses for EtherNet/IP, PROFINET, PROFIBUS & Co.

Benefit from our know-how and become an expert!

Consulting for OT and IIT networks and integrations

Our experts are already undertaking the field level network management for several of our most renowned customers. Working closely with the maintenance on site – via remote – together we are already developing the forward-looking network management of tomorrow today.

Installers and operators benefit equally from our advisory expertise, which we contribute during the strategy and planning phase.

Our planning expertise sets itself apart through:

- clear structures in the network without weak points and unnecessary redundancies
- optimisation of the maximum network load, the overall performance and making sure that the hardest real-time requirements are met
- security and continuity through segmentation
- We plan greenfield and brownfield projects to be <|digital ready|> so that the OT can deliver the data for optimising the production processes in the IT.
- independent device selection

**CMMS = Condition Monitoring Management Systems*
**SIEDS = smart industrial environment digitalization sensor*

The benefits for your business

In order for these comprehensive and integrative processes and services to succeed, advice and network planning that bring together the interests of the installers involved as well as those of the operator are needed in the strategy phase. The result is more benefits, availability and performance for significantly lower costs (generally approx. 40%), with a clearly defined network for the installation phase.

This saves valuable time and costs for the commissioning of the system. We offer this integrative advisory and planning service for all brownfield and greenfield projects.



SOS Network Service –
always there when it's really urgent

In **2022,** our network experts were called out to approx. **150 SOS deployments** on site (in industry).

The reasons for these are generally massive faults in the production process or total breakdowns, which are caused by a reactive maintenance strategy, which exceed the client's resources and know-how.

We have used the events of recent years as an opportunity – to review how the quality of machine networks and the opportunities for operating proactive condition monitoring have developed.

» 2.3 billion of lost profits due to reactive maintenance. 90% could have been avoided.

Five numbers really surprised us:

1. More than **1,750 deployments** of our technicians at a total breakdown on the operator side.
2. **2.3 working days** average until stable running of the plant/system is restored.
3. Indirect maintenance costs of **$5,000-25,000/hour ,** due to (material loss, lost profits, cleaning and disposal costs, etc.)
4. The industrial customers who called out our technicians to SOS deployments during this period incurred more than **2.9 billion** in lost profits due to total breakdowns.
5. Many companies use these severe experiences as an opportunity and set up a forward-looking maintenance regime. But what is truly astonishing is that approx. **62%** of the companies continue to opt for reactive maintenance and call us out to SOS deployments again.

And another surprising number:

The reasons for more than **90%** of these downtime costs could have been identified in good time and prevented with proactive **condition monitoring** and **predictive maintenance**.

Digitalization and OT/IT integration are changing everything

Due to the increasing digitalisation of the field level, sweeping changes result within the classic job descriptions. New task profiles result.

Apart from production planning and control, this also severely affects maintenance. Due to the integration of OT and IT in particular, new specialists are sought who know their way around the needs of both spheres. Nevertheless, the classic maintenance must continue to ensure the availability of the plants and systems in a structured way and with maximum security.

The classic OT organization not only meets its limits with regard to content but above all in terms of personnel. The new objective is to automate the core process and constantly recurring maintenance tasks economically and efficiently.

The three network services described in the following, in combination with our system know-how at the system condition monitoring management level and forward-looking maintenance offer a massive economic contribution.



PowerUp Service –
we determine how the network in your plant is doing

Our service technicians carry out extensive examinations of the plant condition on the network level, record the plant condition as part of an inspection and assess the network quality. You then decide what happens next. We are there at your side whenever it's necessary.



Network CareUp Service – we support you with your network management when support is necessary

This service is a supplementary configuration stage to the PowerUp service. Then, based on the analysis of the results, our network experts work with the client to develop an offer with supporting maintenance offers, e.g. in the form of regular updates, etc.



Network SmartUp Service – provision of network monitoring of the defined plants/systems

» We develop the optimisation measures and draw up the timetables for the implementation.
On request, we provide advice and support for the measures through to the final implementation.
» Creation of a catalogue of measures for the defined networks in the event of technical problems
» Testing & adjustment of the threshold values for the alarm management for Indu-Sol hardware and software of the defined networks
» Database maintenance by Indu-Sol
» Software of the defined networks



Network EmpowerUp Service – Provision of network monitoring + protection measures for network-related plants

» *The content of all services is based on the SmartUp service*
\+ Database maintenance by Indu-Sol software of the defined networks
\+ Implementation of the planned measures to secure plant availability



Network ManageUp Service – Provision of network support + network management of network-related plants

» *The content of all services is based on the SmartUp service*
\+ Implementation of the planned measures to secure plant availability
\+ Spare parts stocking
\+ 24/7 availability and on-call

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Certified according to DIN EN ISO 9001:2015

PROFINET/EtherNet-IP - The Movie | Technology Made Easy

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or use the QR code directly

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