



VORTEX



ABRIDGED INDUSTRIAL NETWORK SUPPORT REPORT

2020

PREFACE

Do the tasks and infrastructure of your network match one another?

Dear customers,
dear business partners,
dear interested readers,

Seldom before have so many innovations simultaneously arrived on the industrial automation market as in the last few years. The growing data volume and the increasing degree of networking in industrial networks are driving the technical advances. With the new V2.4 specification, for instance, PROFINET was standardised in mid-2019 for the gigabit range, among other things. In practice, "pure" PROFINET networks are found much less frequently than before. Often, several protocols communicate via the same infrastructure. Any other way is inconceivable, as three to four parallel networks would otherwise be needed, each with a very low utilisation rate. This trend, in turn, is the motor for developing marketable solutions for time-sensitive networking (TSN) so that real-time data transfer can be guaranteed despite higher network loads.

The current edition of the annual VORTEX report shows the high extent of demand for marketable solutions in these areas. Indu-Sol's measurement engineers were called out over 400 times in 2019 to metrologically evaluate communication in the machine/system networks of companies from a wide variety of industrial sectors. There are two very important results: Firstly, it stood out that unplanned interruptions to production were frequently caused by the simple network structure

or incorrectly selected components. Symptoms caused by this are, for example, discarded telegrams due to higher network loads (discards) or a delayed telegram arrival at the receiver (jitter) – see page 8/9. These observations from practice clearly show that it is becoming more important to plan and know utilisation rates in industrial networks, and to adapt the structure and the performance of the components accordingly – **Performance can be planned!**

Indu-Sol has over 18 years of experience in the planning and diagnostics of networks and industrial data communication. Several hundred service calls a year give us important information on how a permanently stable machine/system operation can be achieved even in the case of high networking. We would be glad to share our insights with you – Let's get going today!

With best wishes for an always sufficient bandwidth,
Your René Heidl



Director of Technology & Support
Indu-Sol GmbH

EXPERIENCE REPORT

The adventure of measurement – Much more than pressing buttons and checking diagrams

Before the measuring device is connected and the results can be checked on the display or laptop, the measurement engineers have often a lot of other things to do. Here are some impressions from service calls in 2019, during which we were grateful for advice from more experienced colleagues via digital communication channels.



NUMBER/LENGTH OF CALLS

Basic trust versus control: Are automation engineers "moonstruck"?

"Moonstruck" people get up in the middle of the night when the moon phase is changing. As they sleepwalk, they engage in regular activities or risky actions that would seem too dangerous during their waking hours. If you look at the development of the share of Indu-Sol's service calls where an interruption to operations related to the network necessitates an immediate check of communication quality (SOS missions), then it would be safe to assume that a proportion of the automation engineers are moonstruck too. Despite the network structures becoming more and more complex and the increasing data volume, machines and systems are still operating without network monitoring.

Automated monitoring of the data communication quality does not just ensure needs-oriented maintenance that reduces costs. It provides, above all, a valuable early-warning system when the quality of data communication starts to deteriorate. This means that operators can already introduce planned maintenance measures in good time without being surprised by sudden events. Blind trust in the reliability of the networks is not necessary, and the time saved by avoiding superfluous maintenance measures can be used more effectively. Thanks to the precise monitoring data, troubleshooting is no longer akin to "sleep-walking".

Time and again, the SOS missions also reveal the "ageing effects" of technology. In 2019, more than every second Indu-Sol SOS mission was aimed at a PROFIBUS network (which are often way more than a decade in use), whereas, only one in five applied to a PROFINET network.

DIAGRAM

SOS missions like phases of the moon, or what happens without network monitoring

The use of network monitoring systems meant that the proportion of SOS missions at regular Indu-Sol customers could be permanently reduced.



With new customers of Indu-Sol, the first call is increasingly an "SOS mission".

Year	2015	2016	2017	2018	2019
Indu-Sol trouble-shooting, total	399	349	312	239	185
Non-SOS missions	266	201	155	106	62
SOS missions	133	148	157	133	123
Proportion of SOS missions	33%	42%	50%	56%	66%



SOS mission = Call for metrological determination of the data communication quality in a fieldbus or network, which has become "immediately" necessary due to acute events and the associated serious impairment of the machine/system operation.

DISTRIBUTION OF CALLS

Ethernet in automation: Added value through the correct switches

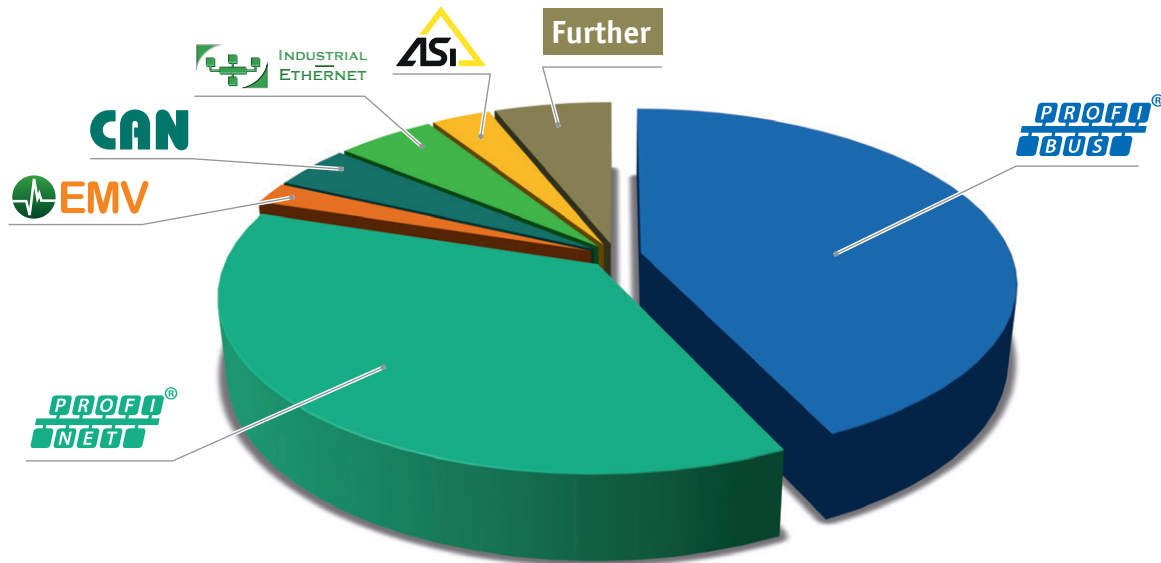
More bandwidth, flexible topologies, continuous communication beyond network boundaries: Because of the advantages that Ethernet-based communication offers compared to classic fieldbuses, these technologies are becoming more established in industrial automation. In 2018, Industrial Ethernet (without PROFINET, which is considered separately) first appeared to any appreciable extent on the list of network types, in which Indu-Sol measurement engineers evaluated the communication in a customer order. By 2019 it had already made it to 3rd place (see right page) – and the tendency is upwards.








The core elements in the Ethernet-based communication are the switches. The higher the utilisation of a network, the more important it is to keep an eye on the utilisation of the bandwidth so that bottlenecks can be diagnosed in good time. The port statistics are the evidence for this – as long as managed switches are installed that provide such statistics.

The more complex network structures become, the more important it is to have an infrastructure where diagnostics are possible. This aspect is becoming more important, especially in the area of remote maintenance. If maintenance work is necessary at distant locations, the unavoidable question is which expert to send: A network technician? An electrician? Or perhaps a mechanic? Basing your decision on a glance at the diagnostics data in the web interface or the switches can save vital time and of course money – especially in the case of the sporadic, non-reproducible events that are typical for Ethernet networks.

DIAGRAM

Reasons for customers to request service calls by Indu-Sol



	2015	2016	2017	2018	2019
	55 %	49 %	45 %	43 %	43 %
	28 %	32 %	36 %	38 %	37 %
	0,07 %	0,2 %	0,3 %	4 %	5 %
	2 %	4 %	4 %	4 %	4 %
	5 %	6 %	7 %	4 %	2 %
	5 %	5 %	5 %	3 %	3 %
	5 %	4 %	3 %	4 %	6 %

ERROR SOURCES

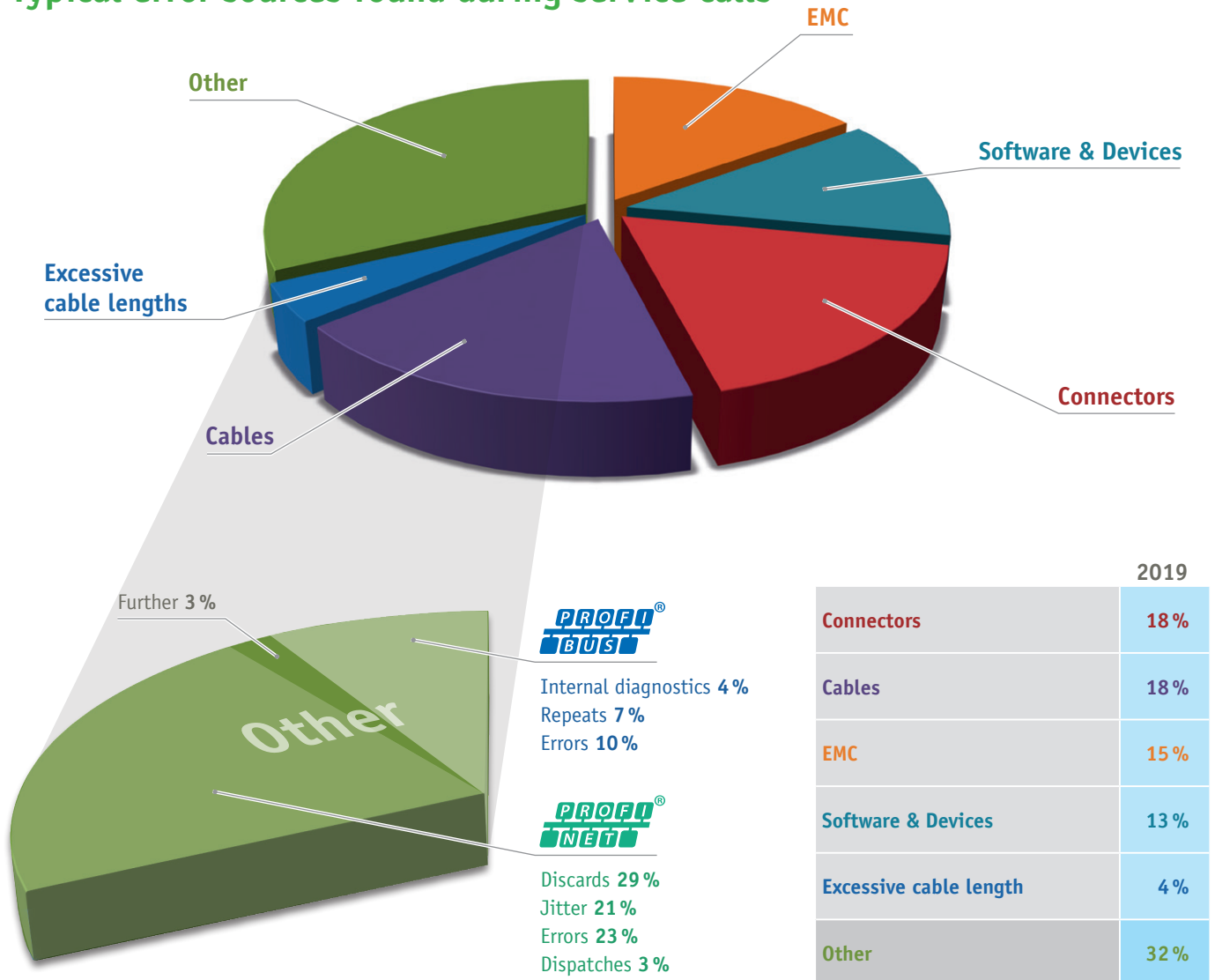
The domino effect of the network structure: Discards and jitter

The infrastructure of industrial networks has been continuously developed in order to guarantee the high data throughputs and shorter reaction times required by high performing automation processes. While PROFIBUS still functioned with one wire pair up to a maximum of 12 mbps, PROFINET increased the highest possible data throughput to 100 mbps with simultaneous transmission and reception (two wire pairs). Four wire pairs were then already required for the changeover to gigabit. Even such supposedly banal components as cables therefore significantly influence network performance. This continues into the switches. If these components are not selected according to performance requirements (data throughput, storage capacities, ...), data communication and hence machine/system function can be impaired. By looking more closely at the "Other" category in the adjacent overview, you can see the way in which this could happen. The main causes here are jitter (late telegram arrival) and discards (telegrams that are discarded because of overloaded switches). Although these are logical parameters, they are influenced by the hardware's performance capability (switches) and the network structure. The latter made up a noteworthy proportion in the "Other" category for the first time in 2019, with a 6% share.

On the following double-page you will find more detailed explanations and a classification of the phenomenon in the context of network structures.

DIAGRAM

Typical error sources found during service calls



FORECAST

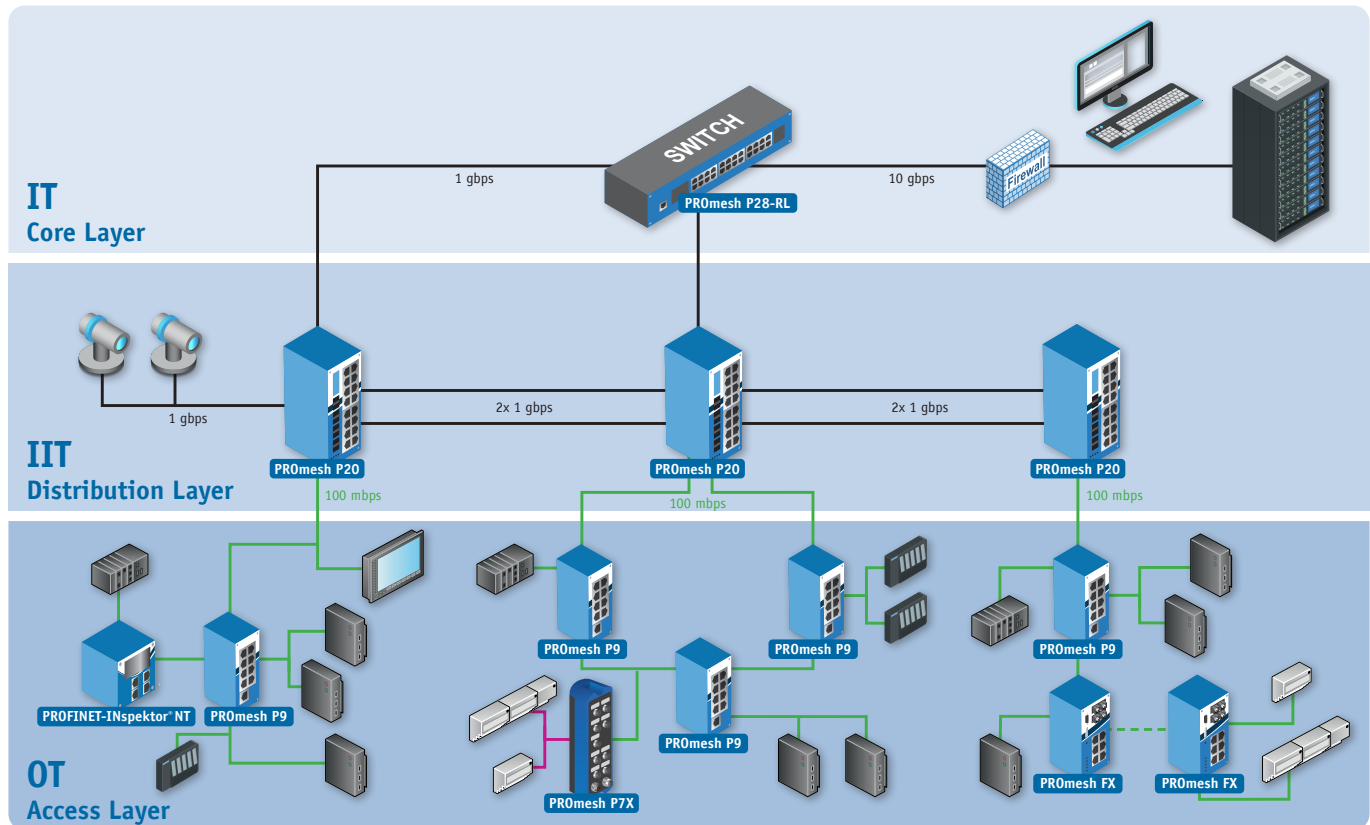
Networking challenge: Everything gigabit? Separated networks? Neither!

When the Indu-Sol measurement engineers are called in by a customer to investigate logical inconsistencies in PROFINET/Industrial Ethernet communication, two typical scenarios present themselves: Either the networks are equipped with gigabit-capable high-end components although the determined actual network load $< 1\%$; or, unmanaged switches with low data transmission capacities are installed, which cannot keep up with the prevailing network loads and provide no diagnostic data. Usually there is therefore extreme over- or under-dimensioning. As with today's society, a happy medium no longer seems to be present.

Careful planning of the network infrastructure guarantees the required performance and availability, and on top of everything else, ensures that the costs for equipment remain proportionate to needs. Access layer switches (up to 100 mbps) are generally sufficient for machine and system control (Operational Technology/OT), as long as no other data traffic is in this network section. Production-related data that is not directly required for process control can be processed at an intermediate level – i.e. Industrial IT (IIT). Distribution layer switches are usually required here, which guarantee gigabit transmission rates and enable secure data transfer between the levels through firewalls/routing. At the IT-level, core layer switches guarantee highly redundant forwarding and the highest data transmission rates. The optimal network structure and which performance profile the components have to fulfil must, however, be decided individually for the respective applications.

SAMPLE CONFIGURATION

As powerful as necessary: Needs-based selection of network infrastructure components according to purpose



PROFINET offers the advantage of being able to transmit acyclic non-PROFINET data with the same infrastructure as PROFINET data. However, numerous measurements in practice reveal that this increases the network load, which leads to discarded telegrams (discards) or a long delay during transmission of time-critical tele-

grams (jitter). This hurdle can be surmounted in some applications by creating an intermediate level underneath the IT-level, in which this acyclic data traffic flows, relieving the machine/system level (Operational Technology/OT) – this is called Industrial IT (IIT).



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