D1b – CINI4.0 Internal Survey: evaluation

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Introduction

In the CORNET research project CINI4.0[1] (www.cini40.eu), different emerging technologies are investigated. The investigation is among others based on the prior knowledge and the use cases for each technology the user committee provides. To provide an overview and to establish a baseline, a survey was performed among the members the user committee.

This survey is primarily based on questions that are aimed at the topics Time Sensitive Networking (TSN), Open Platform Communication Unified Architecture (OPC UA), Single Pair

[1] IGF 309 EN (01/08/2021-31/07/2023) – HBC.2020.2998

Ethernet (SPE) as well as for the topics Electro Magnetic Interference and Compatibility (EMI/EMC), Network Redundancy, Power over Ethernet (PoE), Power over Data Line (PoDL) and Advanced Physical Layer (APL).

The survey results are not only a reference for future events such as workshops, lectures and demonstrations, they also confirm once more the relevance of the project topics and the project approach.

The German members of the User Committee are: Endress+Hauser SE+Co. KG (Maulburg), Hilscher Gesellschaft für Systemautomation GmbH (Hattersheim am Main), Indu-Sol GmbH (Schmölin), Perinet Gmbh (Berlin), rt-solutions.de GmbH (Köln), ZVEI e.V (Frankfurt am Main), R. STAHL Schaltgeräte GmbH (Waldenburg), TOSIBOX Gmbh (Lemgo), ESR Pollmeier GmbH Servo-Antriebstechnik (Ober-Ramstadt), InnoRoute Gmbh (München), Lenze SE (Aerzen).

The Belgian members of the User Committee are: Phoenix Contact NV/SA (Zaventem), Prokorment VOF (Delft, The Netherlands), Bintz NV/SA (Zaventem), Prolink Engineering BV (Deinze), ArcelorMittal Belgium NV/SA (Zelzate/Gent), DSP Valley vzw (Leuven), Linkworx BVBA (Aalter), Volvo Cars Gent (Oostakker/Gent), iBA Benelux BVBA (Gent), VMA NV/SA (Sint-Martens-Latem), Agoria vzw (Brussel), Siemens NV/SA (Huizingen).

These companies are resident in Belgium or Germany and cover a broad spectrum both in the technological/industrial environment and in company size. The participants are active in various fields within their company.

The survey itself was filled out by 23 participants that answered the question “What type is your business?” with “Private Company” from 19 different companies. The companies can be technology providers and/or end users. The distribution is depicted in the table below:

Topic	Technology Provider	End User
OPC UA	10	7
TSN	5	8
SPE	6	4
EMI / EMC	5	4
Network Diagnostic	8	4
Network Redundancy	4	3
PoE	1	5

Table 1: Number of technology providers and end users of participating companies

Table 1 shows an overview of the number of technology providers and end users for every major technology in CINI4.0. It shows that the most technology providers are in the field of OPC UA followed by Tools for Network diagnostic and TSN. On the other hand, there are seven companies classified as end users for OPC UA and eight participants are end users of devices, which implement TSN.

Summary of the results

The summary focuses on data that are comparable and on possible conclusions. Besides that, some free answers were slightly modified to anonymize the answers. The results are depicted and summarized in the following paragraphs.

Topic	SPE	TSN	OPC UA	Network and Diagnostic	PoE, PoDL and APL	EMI & EMC	Network Rendundancy
Yes-selections	20	19	17	17	15	14	13

Table 2: Workshop demand

The survey results show a high demand for in-depth workshops and – as feedback from the UC sessions – training materials for every major topic. The results are summarized and ordered in the table. The highest demand is on the topics of SPE followed by TSN. After that, OPC UA and Network Diagnostic show the most demand. This is expected as most participants are at least using OPC UA "server" (or call it "driver") software in their applications. Although the topic Network Redundancy has the lowest number on Yes-selections, it has a substantial number of selections; this feels logical, because the investment mainly pays off when the cost of standstill is high or when interruptions (can) result in a lot of damage.

Topic	OPC UA	Network and Diagnostic	Network Redundancy	PoE, PoDL and APL	EMI/EMC	TSN	SPE
Results, formatted as: Freshman, Basic Understanding, Expert - selections	4, 12, 6	7, 10, 5	4, 14, 4	4, 17, 1	13, 5, 2	9, 12, 1	15, 4, 3

Table 3: Overview of previous experience with major topics of CINI4.0

In addition to the demand for workshops, the existing (at the start of the project) experience and knowledge with these topics was surveyed and the results are summarized in Table 3. If the participant was familiar with the topic, it was possible to estimate the complexity of the technologies. The topic which was the most known was OPC UA, where six participants estimated themselves as "Experts" and 12 as "Basic Understanding". Only four answered this question with "Freshman". On the other hand, 15 participants estimated themselves as "Freshman" on the topic Single Pair Ethernet. This result explains the high demand for workshops on this topic. The participants estimated themselves mostly as "Basic Understanding" for all other topics. For the topic TSN, nine participants estimated themselves as "Freshman" and 12 as "Basic Understanding". The complexity of TSN was mainly estimated as moderate to complex, which also explains the high demand for workshops.

The second to last question aims for specific results within the scope of the project CINI4.0. Most participants state that industrially relevant use cases are most important to them as a result. The second most selected answer was in-depth workshops as well as hands-on courses. This is followed by Migration paths for brownfields and a multivendor reference system/test

bed. Although these answers were mainly selected, all suggested topics have a significant number of selections, indicating that the planned project results are within the scope of expectation of the participants. This is also reflected in the fact that there are very few additional suggestions submitted as response to the last question.

Detailed results

The next pages provide in detail the answers to each question.

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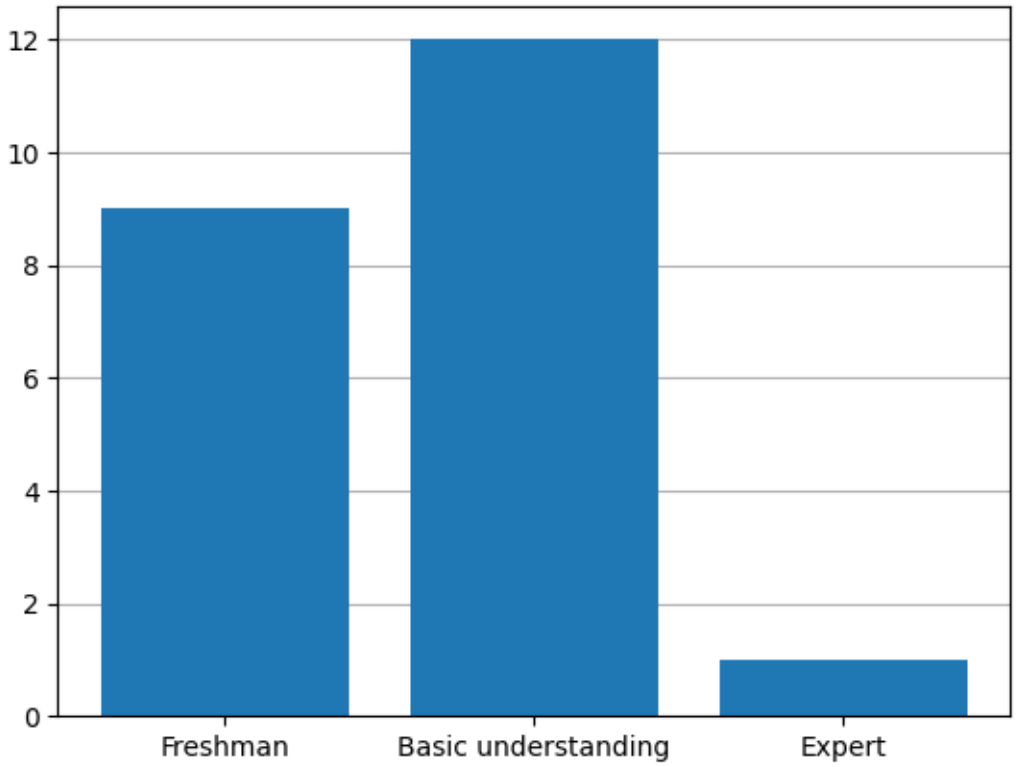
At present, I’m well acquainted with TSN?



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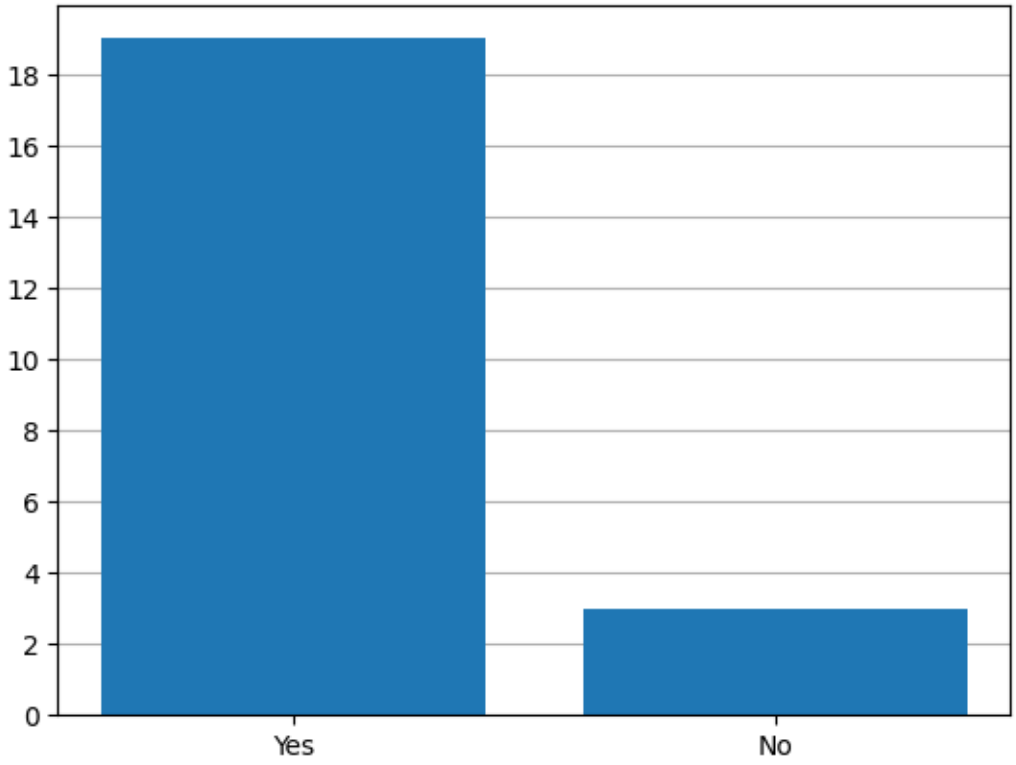
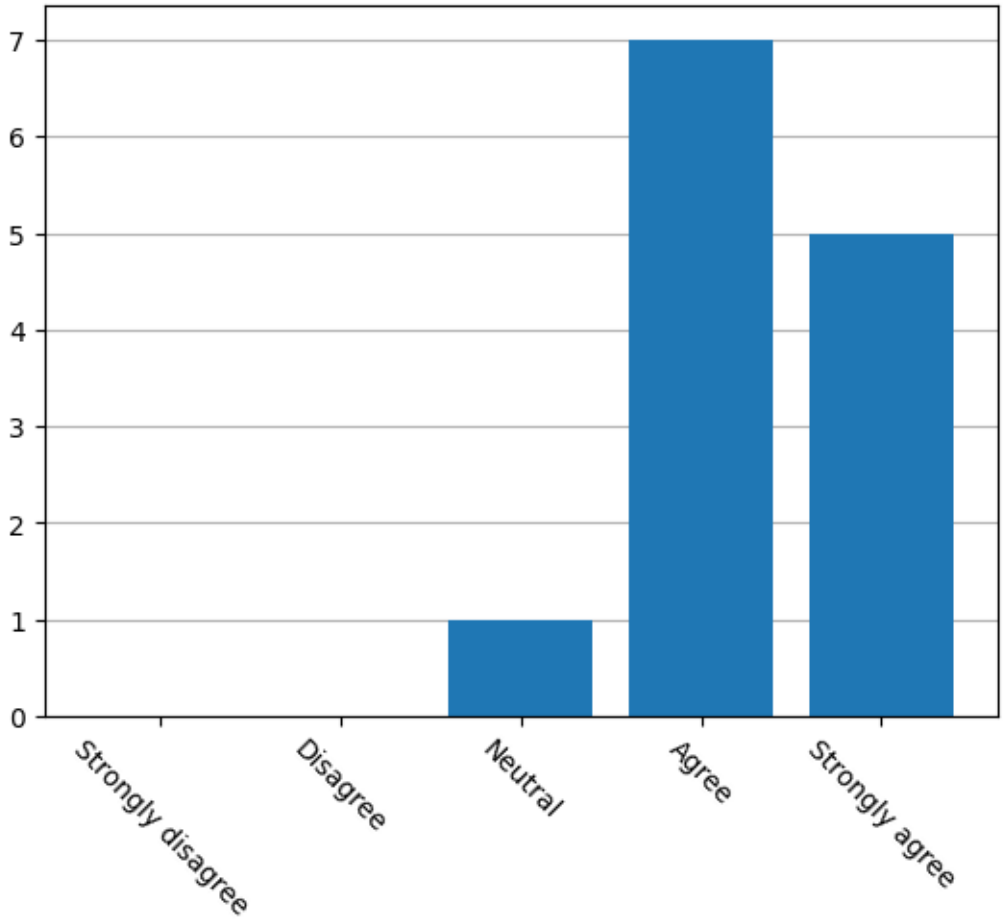


Do you have any concrete use-cases that require usage of TSN? Please specify briefly.

- TSN as replacement for PROFINET IRT applications.
  We see also a demand for TSN at Ethernet APL applications in the futur in the process automation, due to the bandwidth constraints of APL or Single Pair Ethernet.
- Replacement of proprietary real-time industrial Ethernet (mid-term)
- We have no specific use case at the moment, but we are willing to support other people/participants with the right TSN hardware for use in their use-case or POC
- Secure Communication via VPN over TSN
- Not at present, we focus on use cases that do not require "hard" real time, i.e. OT use cases, not AT applications
- PLC to PLC communication, As fieldbus replacement, flexible, self-configuring
- Diagnostics in IoT environment require data synchronization

What in your opinion is the most promising feature of TSN if it comes to the industrial scenarios? The list is not complete … [Time synchronization: IEEE 802.1AS: Timing and synchronization]



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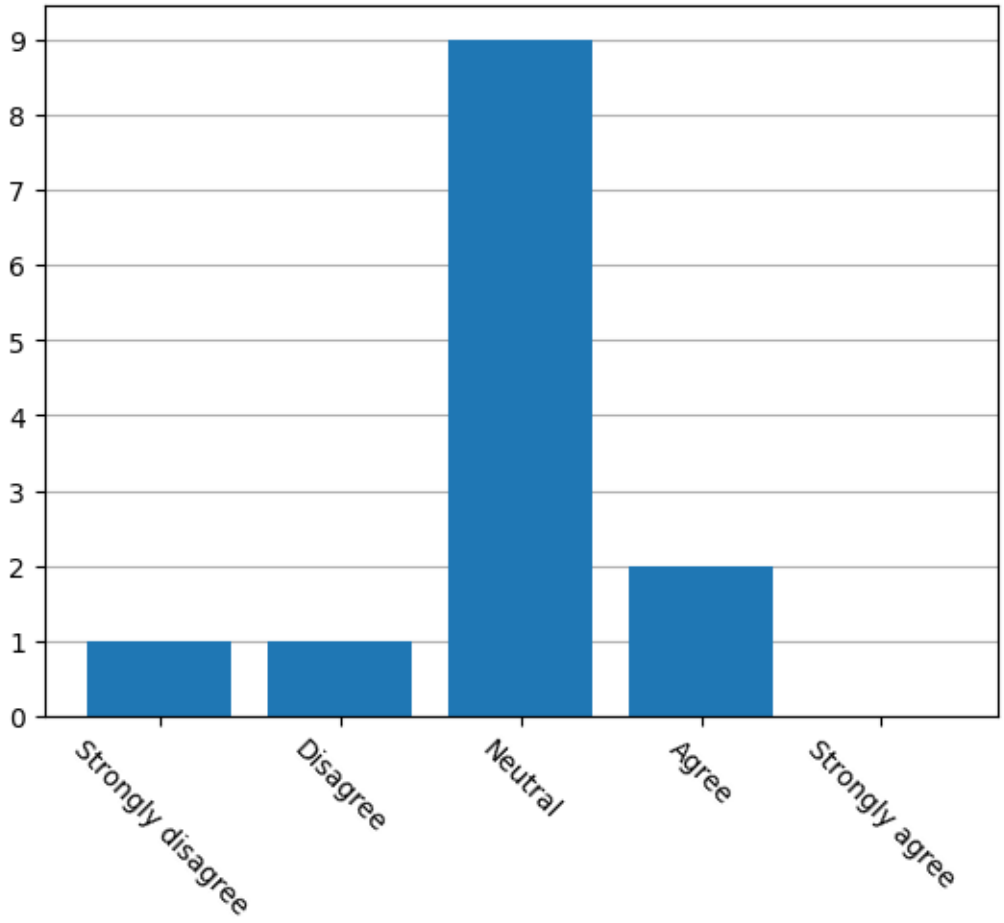

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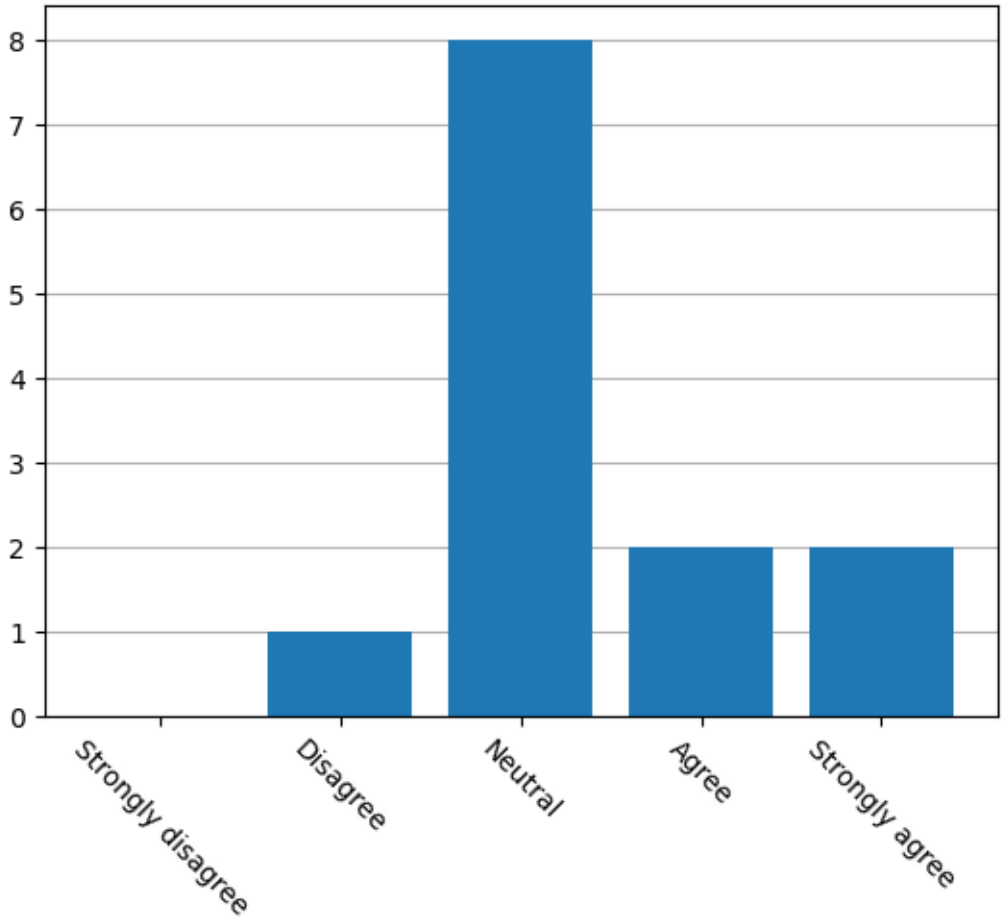

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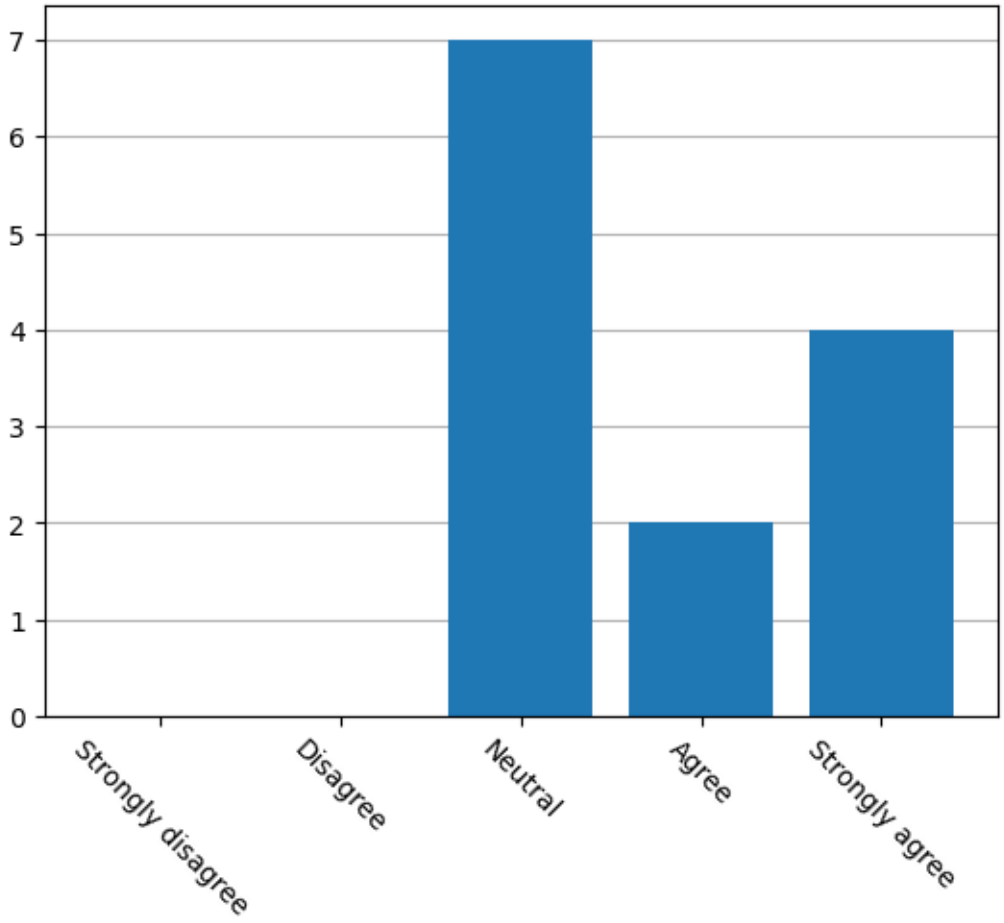

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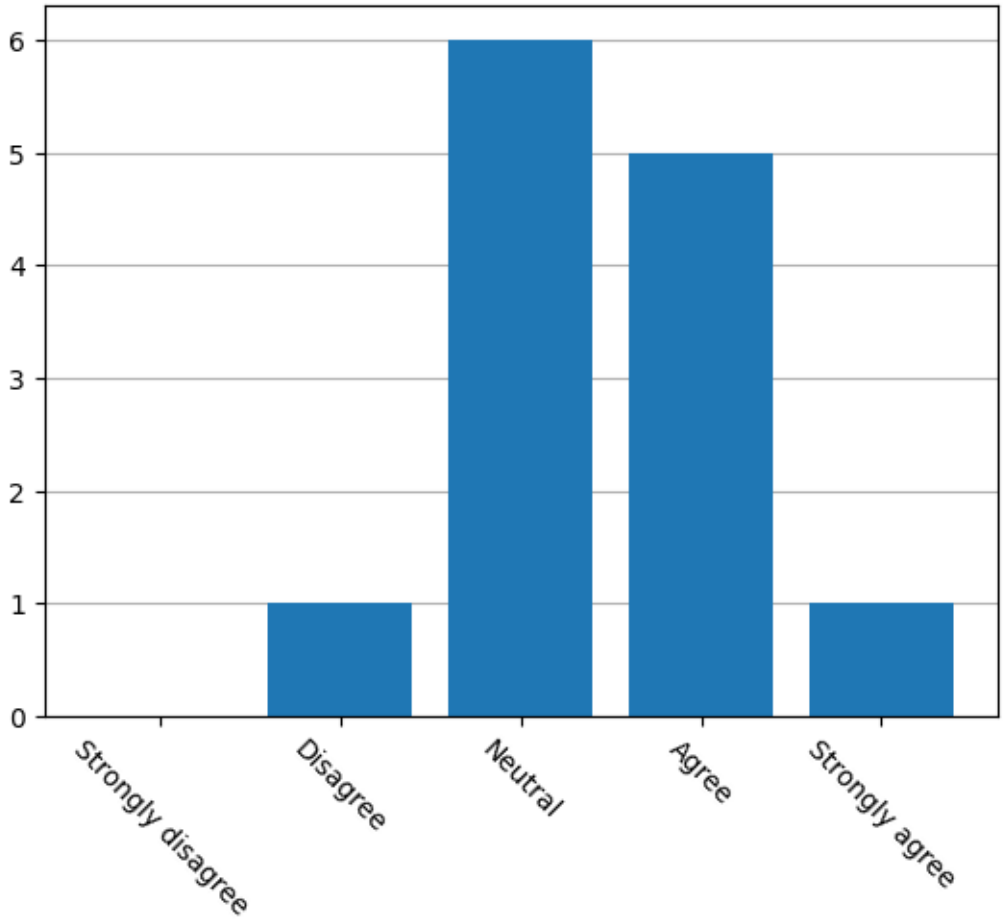

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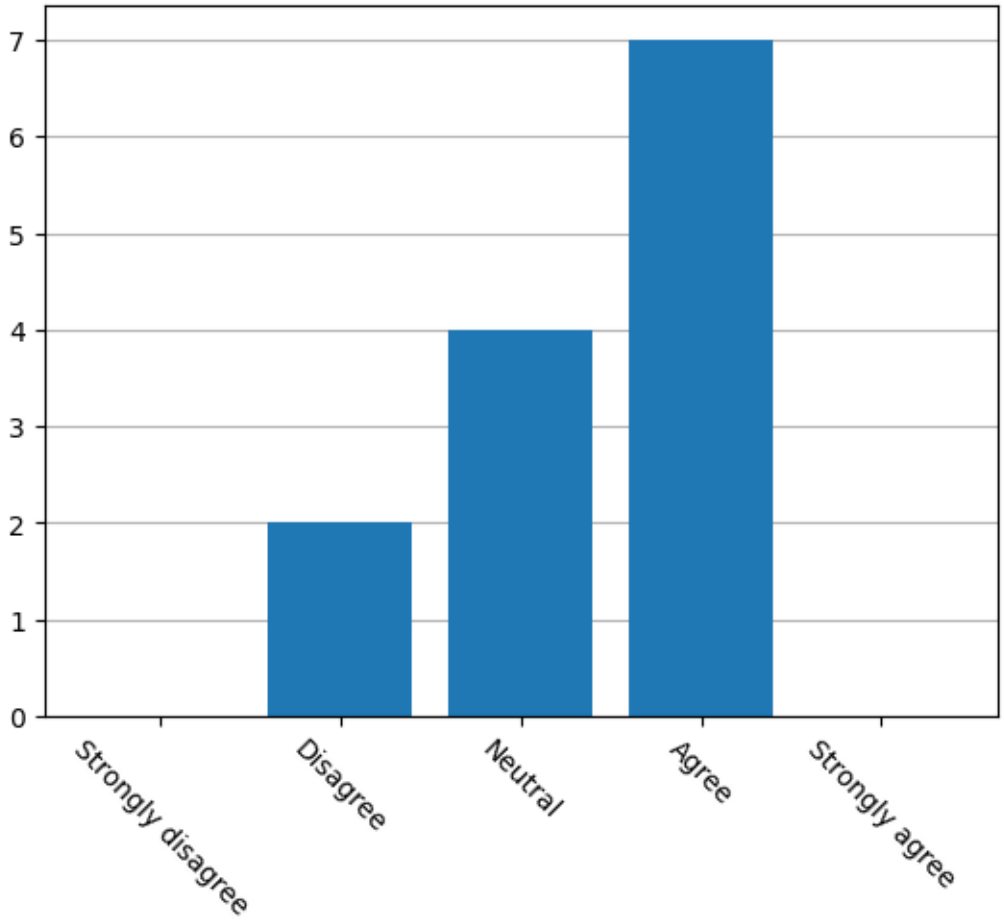

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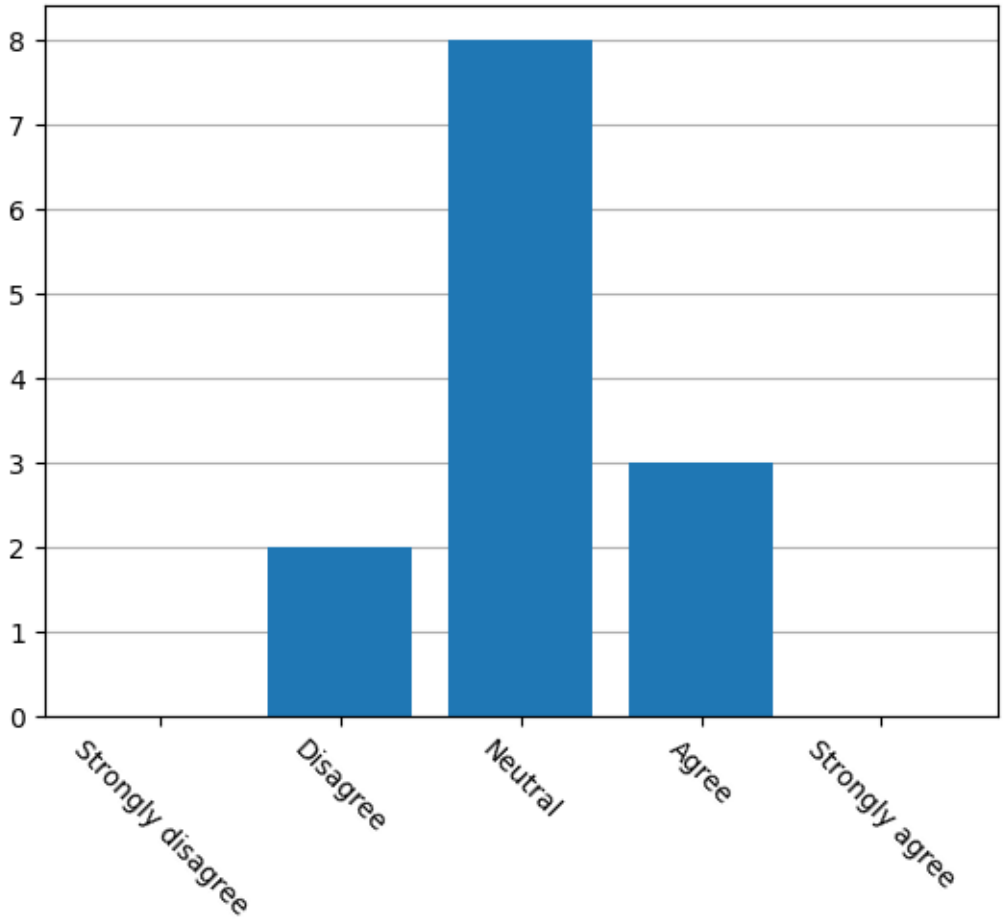

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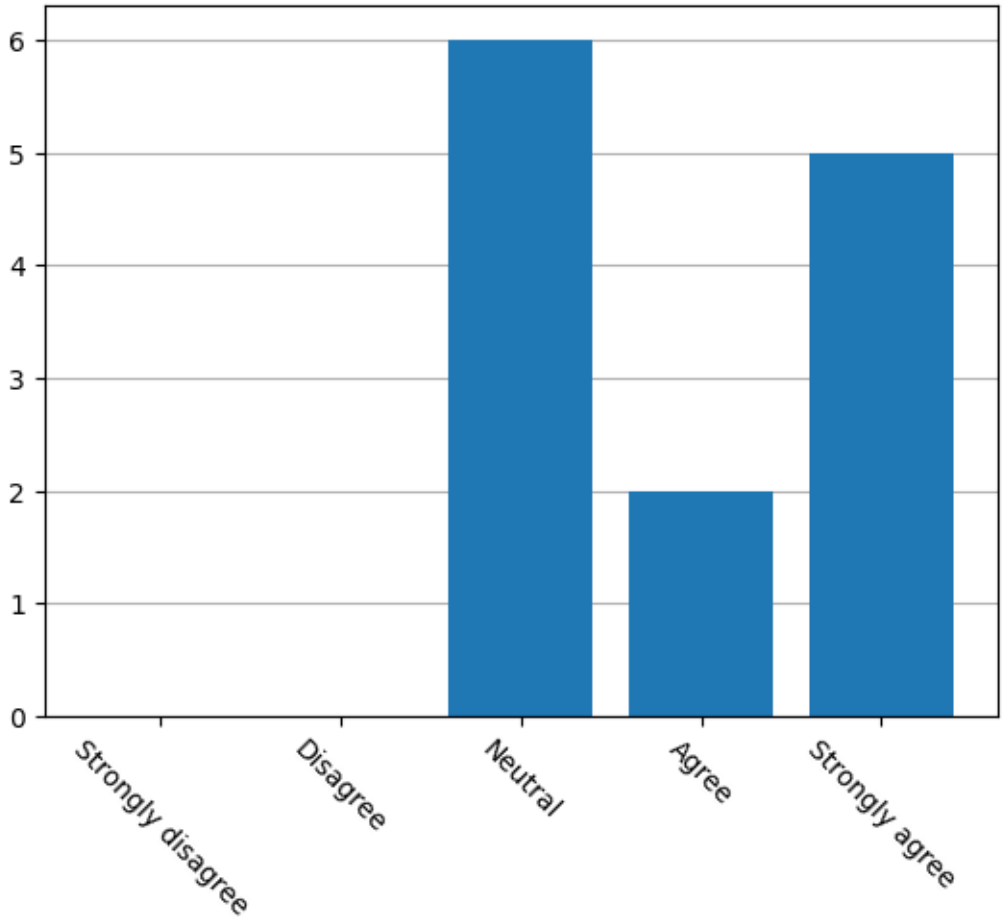

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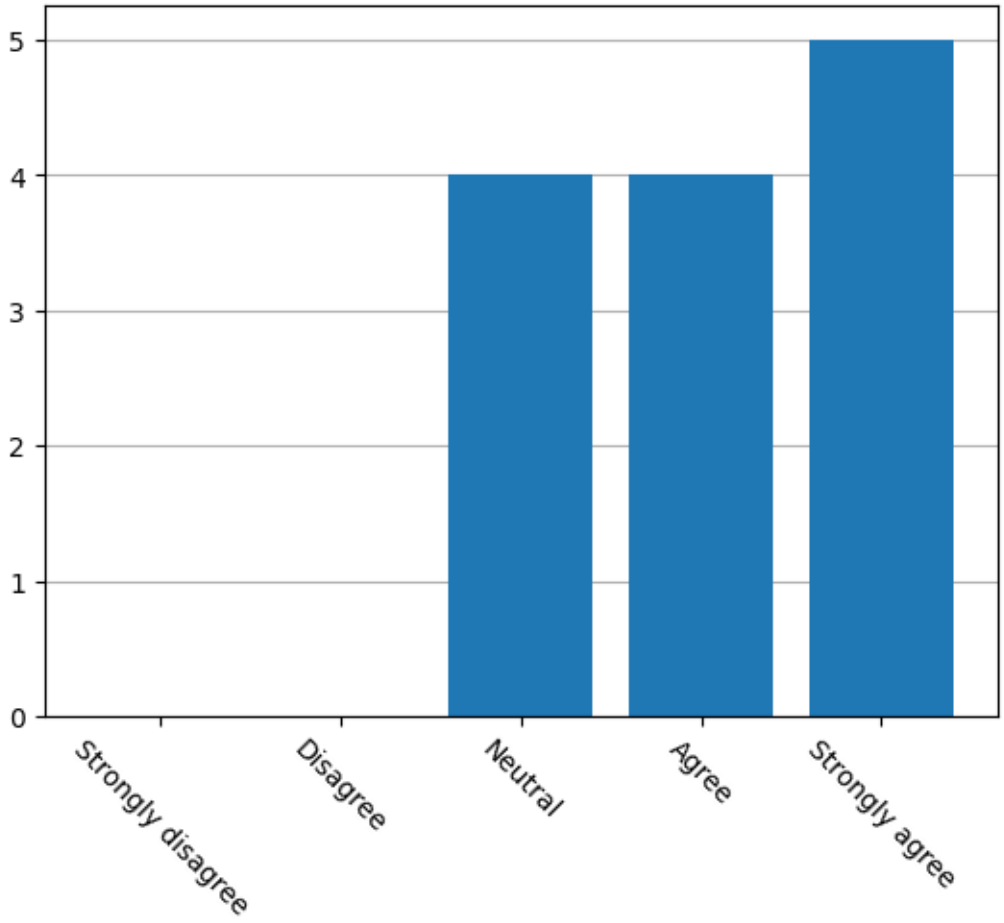
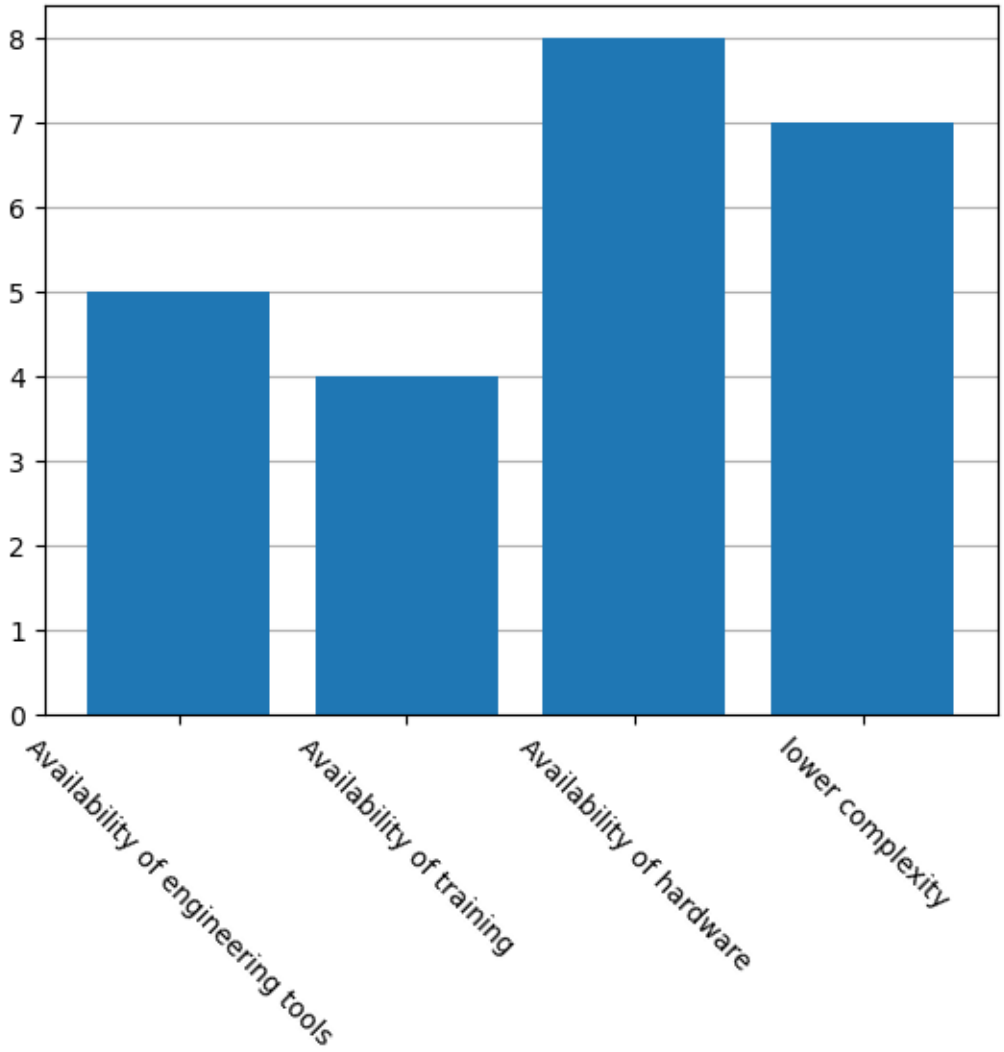


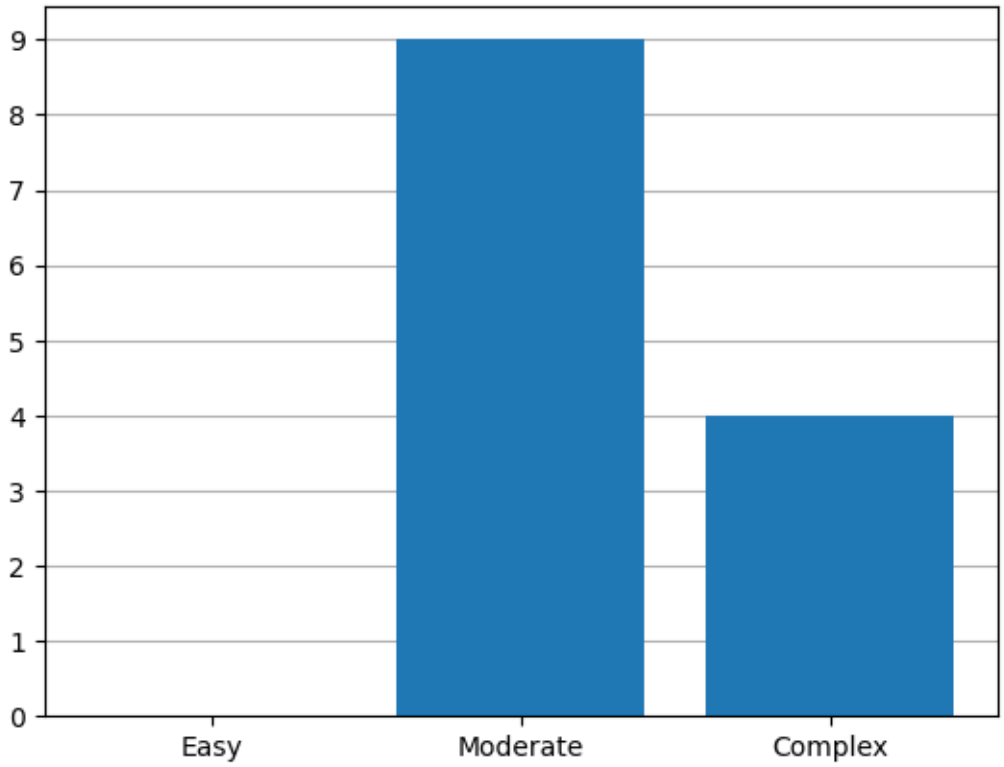
What in your opinion is the most critical aspect for increasing the acceptance of TSN in the industry?



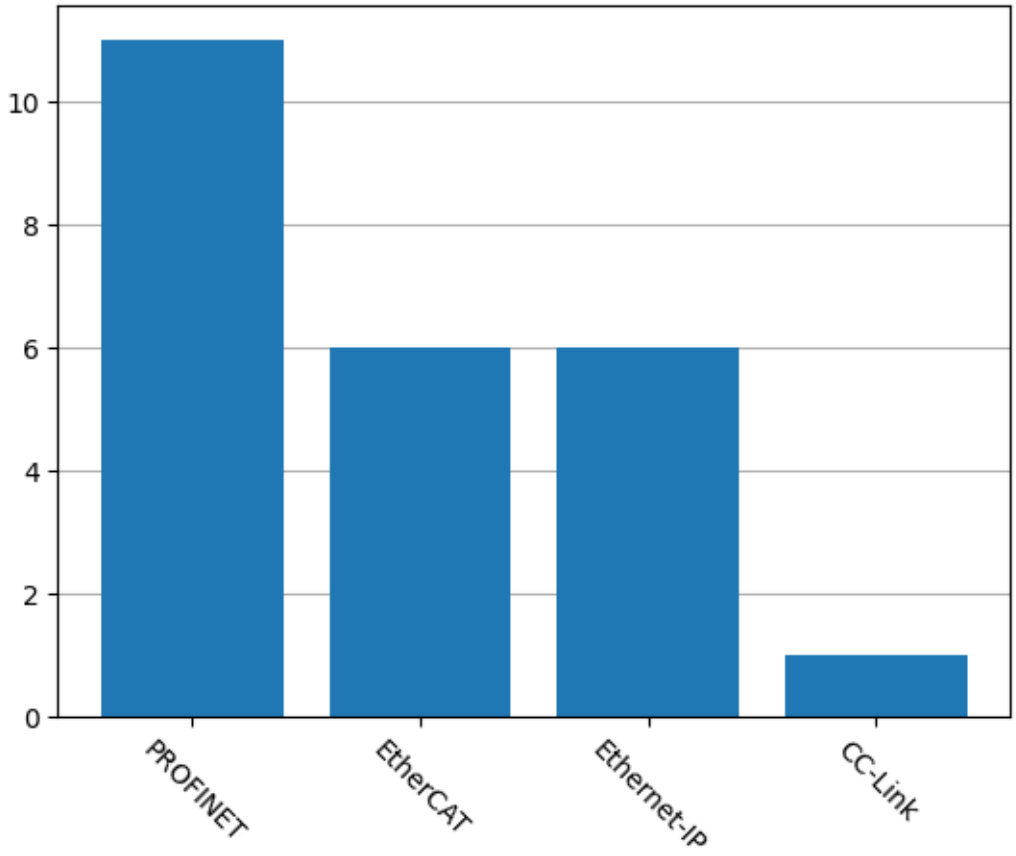
Is there any specific feature/requirement of TSN in which you are particularly interested in?

- For me is an independent engineering tool necessary and not a tool which is depending from one application. Because an application dependent tool do not fairly distribute bandwidth among the application but reserves too much for itself and therefore we waste too much bandwidth and have the end the same problems as before.
- Integration and use of CNC and Engineering Tools
- Mapping in capability models e.g. with the AAS.

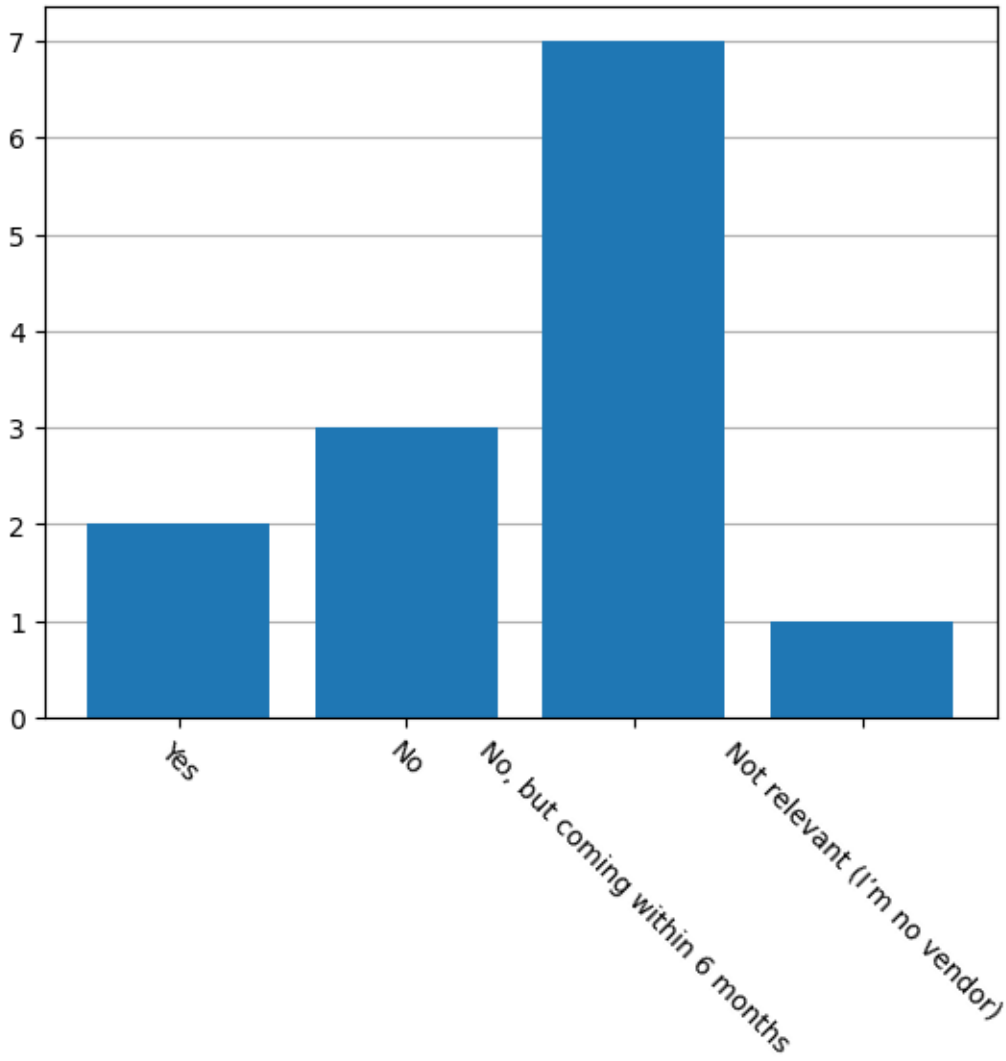
How do you estimate the complexity of TSN?



Do you plan to combine TSN with some other legacy protocols? If yes, which protocols are of interest for you?



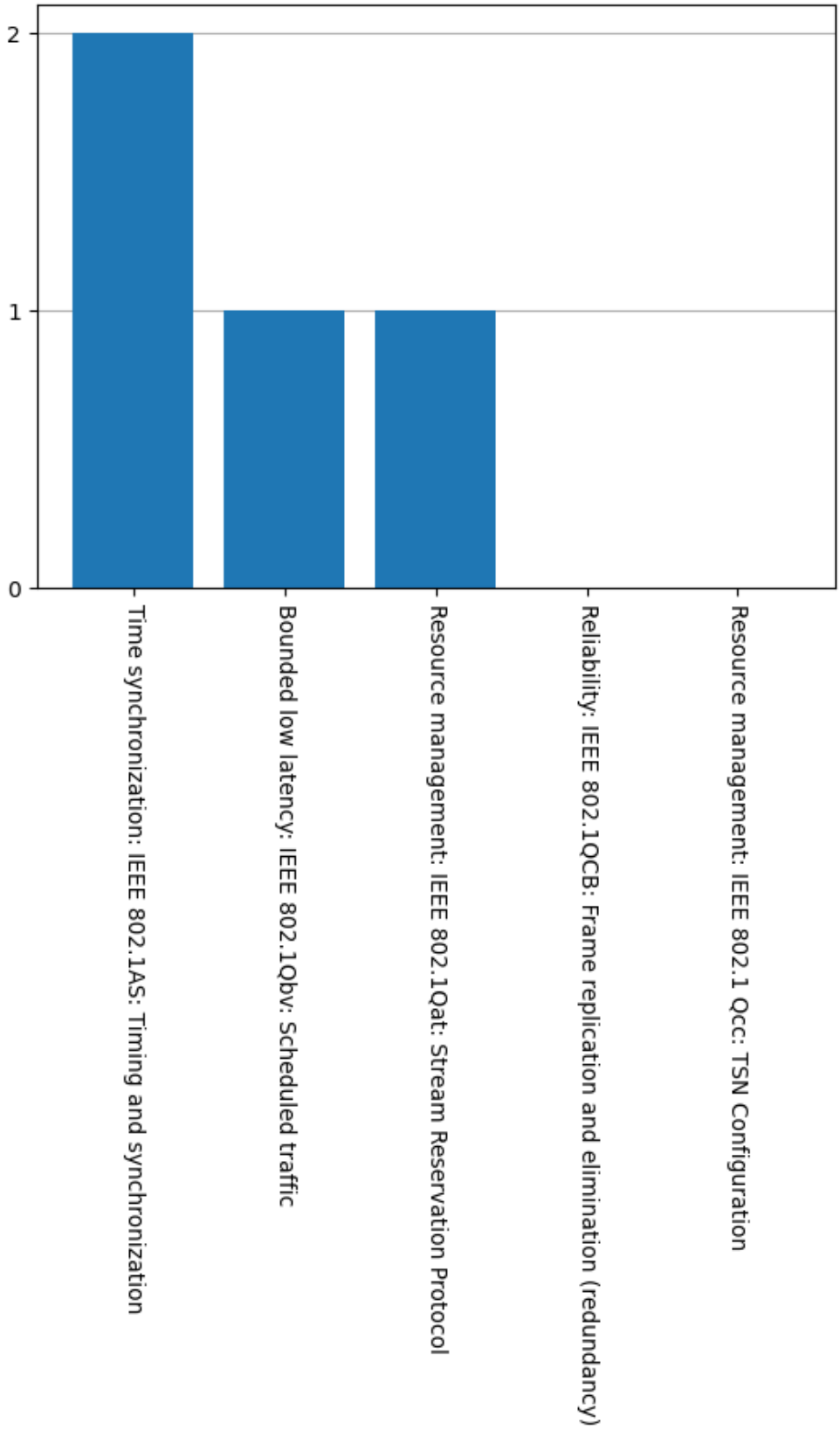
Do you already have your own TSN capable product(s)?



What type of product?

- Switch
- Switch

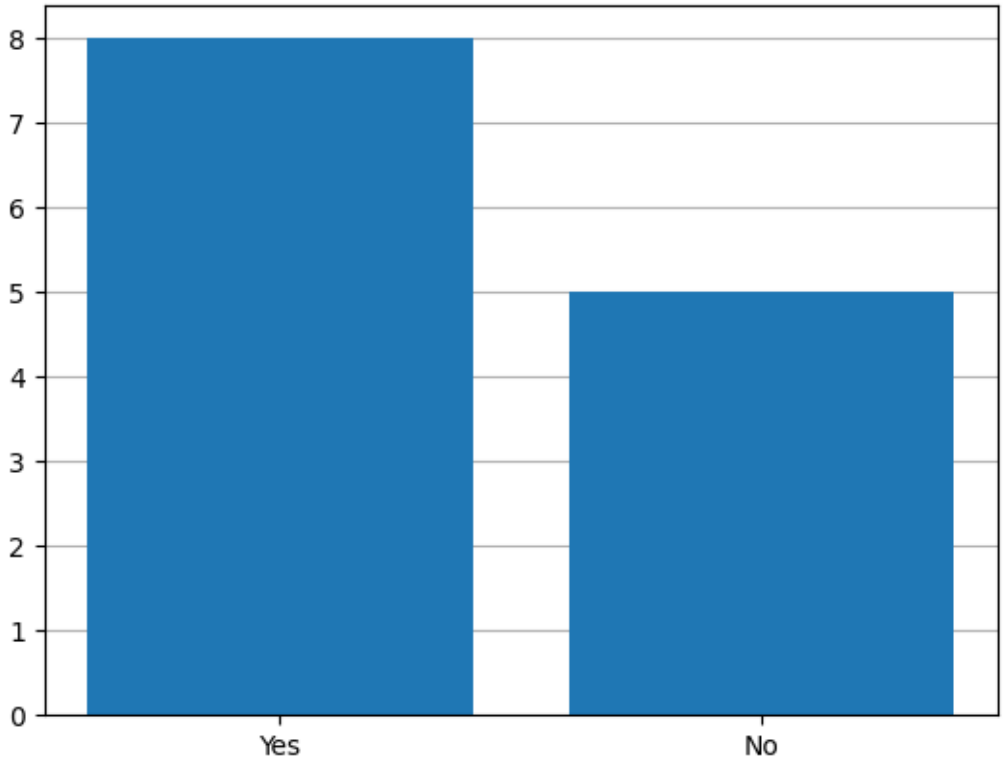
Which features of TSN does it cover?



Any other feature?

- EMC measurement, cable monitoring

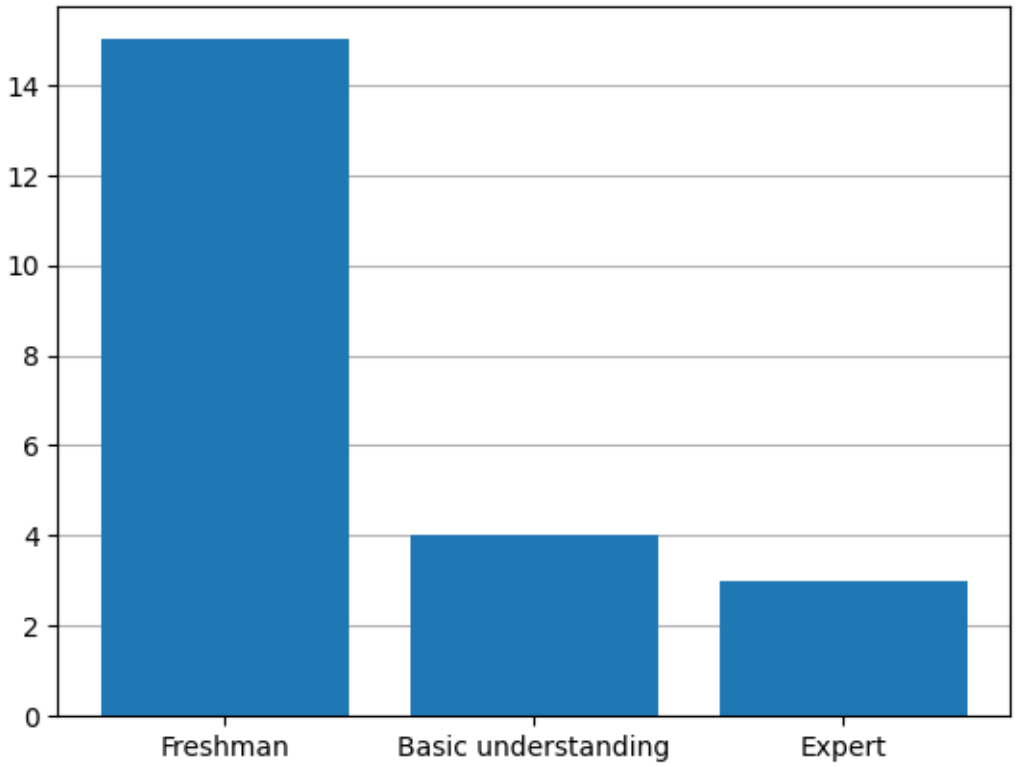
Do you plan to integrate TSN in your production automation in the future?



Please specify how do you plan to integrate TSN in your production automation in the future?

- different options, because we might support other companies during integration
- Will be provided as technology and software packet to our customers
- We strive to have our latest technologies also in our own production. TSN can, for example, be integrated into the stacker crane in the high-bay warehouse.
- We would use TSN to allow customers the option of more reliable and faster connections within their factory networks. Giving them the opportunity to increase the throughput and give them the opportunity to grow the network .
- new installations (green field) for safety aspects
- For our customers

At present, I'm well acquainted with SPE?



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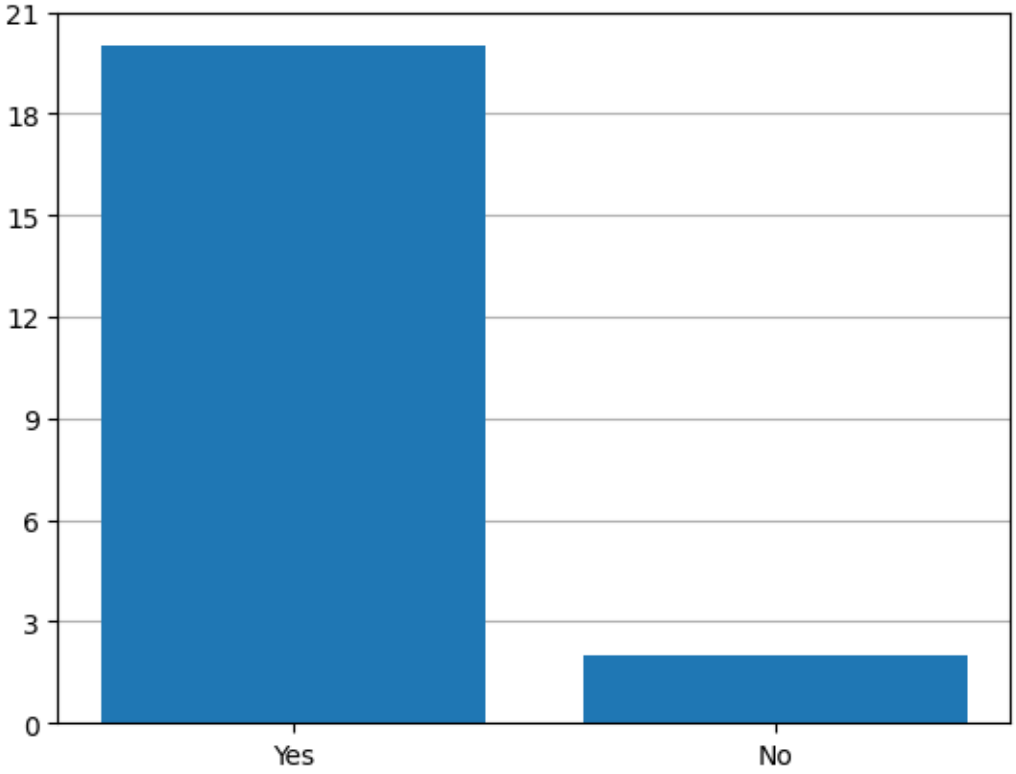


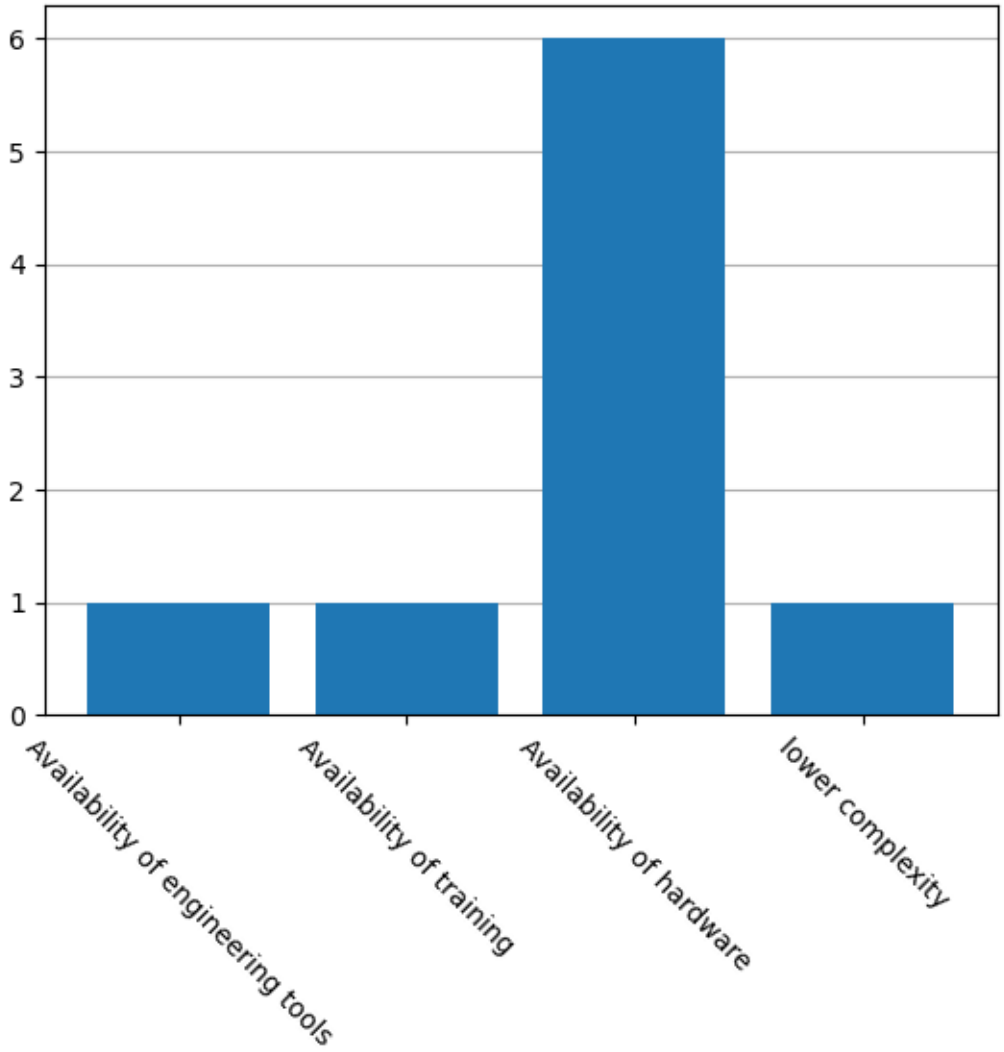
Do you have any concrete use-cases that require usage of SPE? Please specify briefly.

- Ethernet-APL - SPE for hazardous areas
- Honest, due to the bandwidth constraints I see not really a demand on SPE.
- SPE is a core technology that all our products are based upon, i.e. all of our use cases apply SPE
- for communication in field level

What in your opinion is the most promising feature of SPE if it comes to the industrial scenarios?

- Hazardous area application with Ethernet-APL and intrinsically safe Ethernet
- Combination of real-time and non-real-time traffic at one cable.
- Simple wiring, Speed vs. distance, scalability
- Replacement/ alternative for RS485, Ethernet to the sensor
- SPE allows inclusion of field-level devices such as sensors and actuators in OT-level IT networks and as such provides a transparency not present in current scenarios
- the longer distances possible without having to convert to FO.

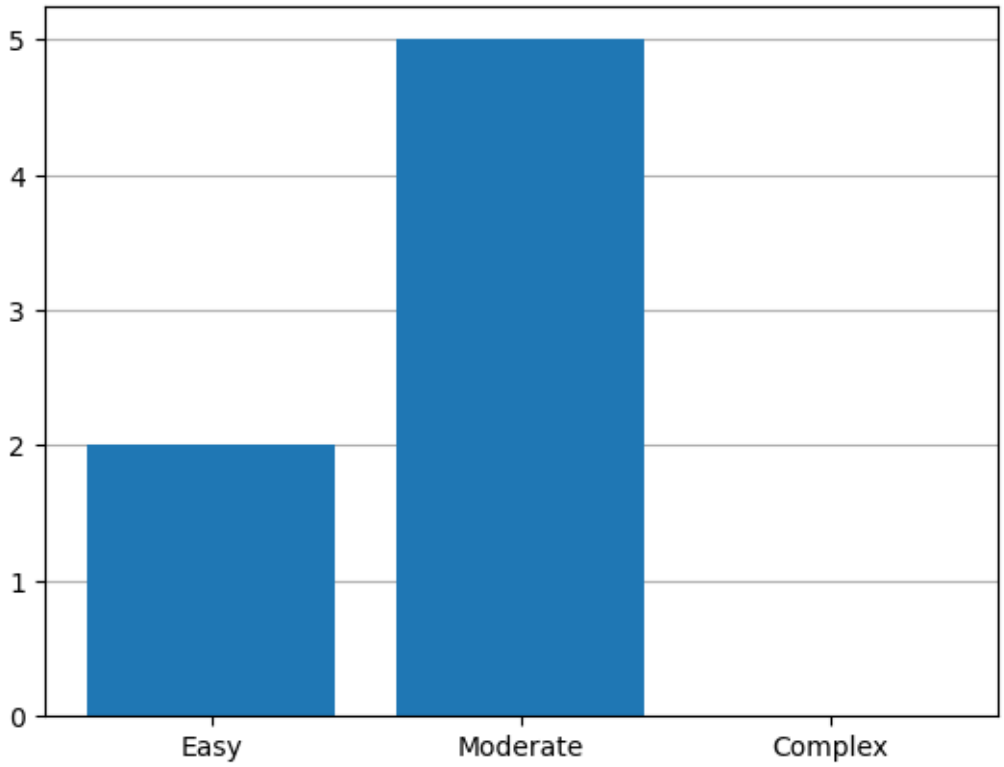
What in your opinion is the most critical aspect for increasing the acceptance of SPE in the industry?



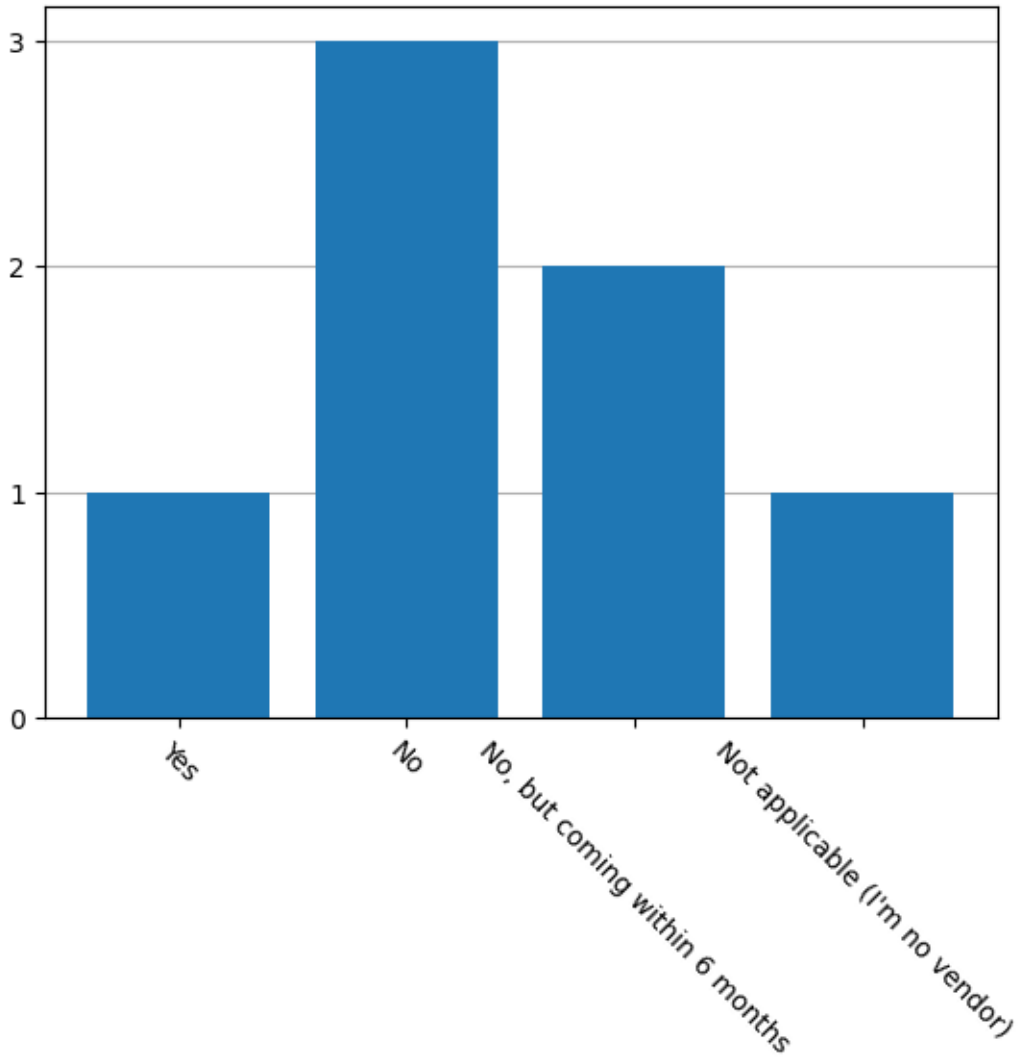
Is there any specific feature/requirement of SPE in which you are particularly interested in?

- Max distance, based on used cable and other factors. What are the limitations?

How do you estimate the complexity of SPE?



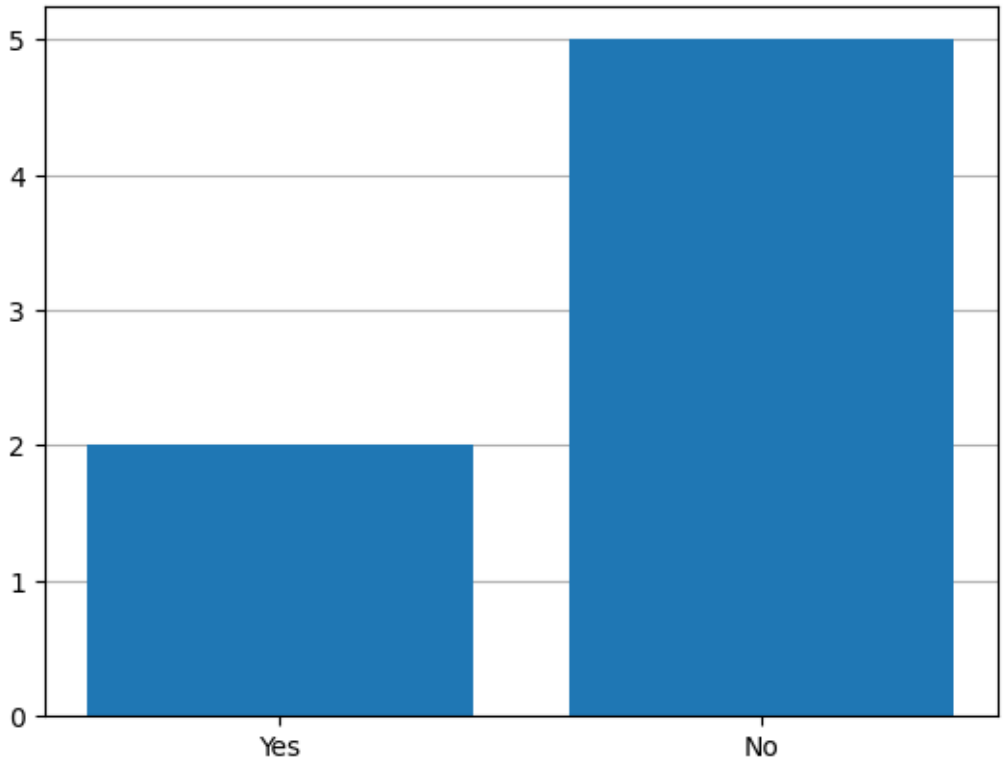
Do you already have your own SPE capable product(s)?



What type of product? (E.g. switch, PLC, connector, cables, …)

- Switch, Sensor, Actuator, Media converter, Connector, Cable, smart adapter for sensors & actuators

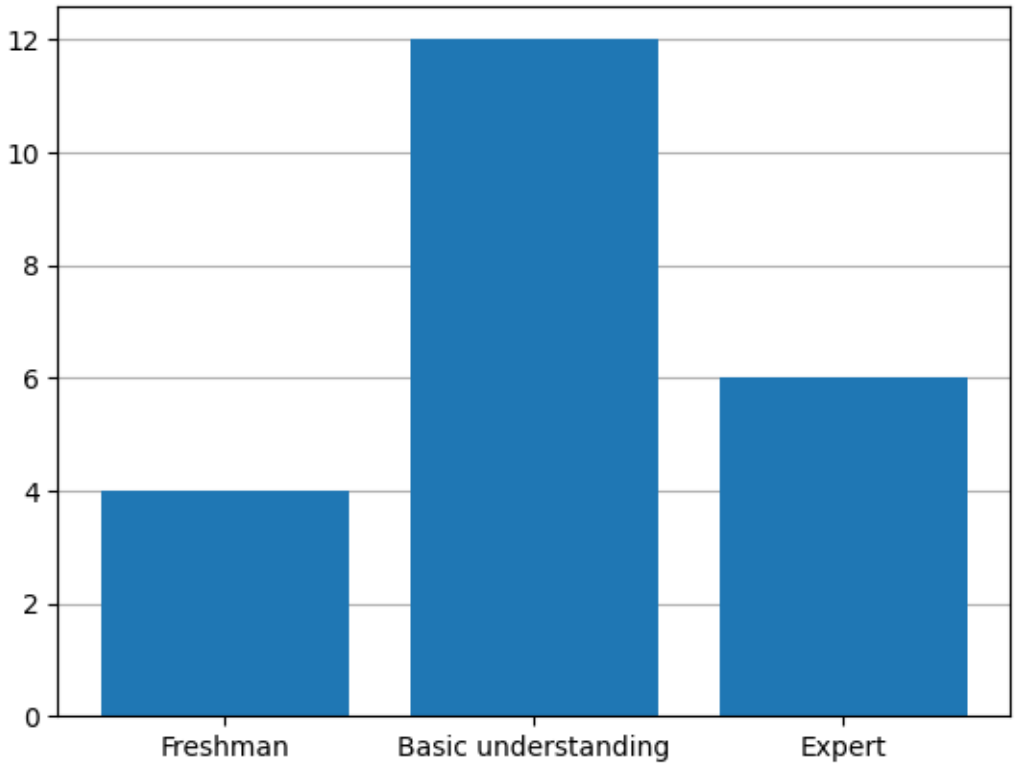
Do you plan to integrate SPE in your production automation in the future?



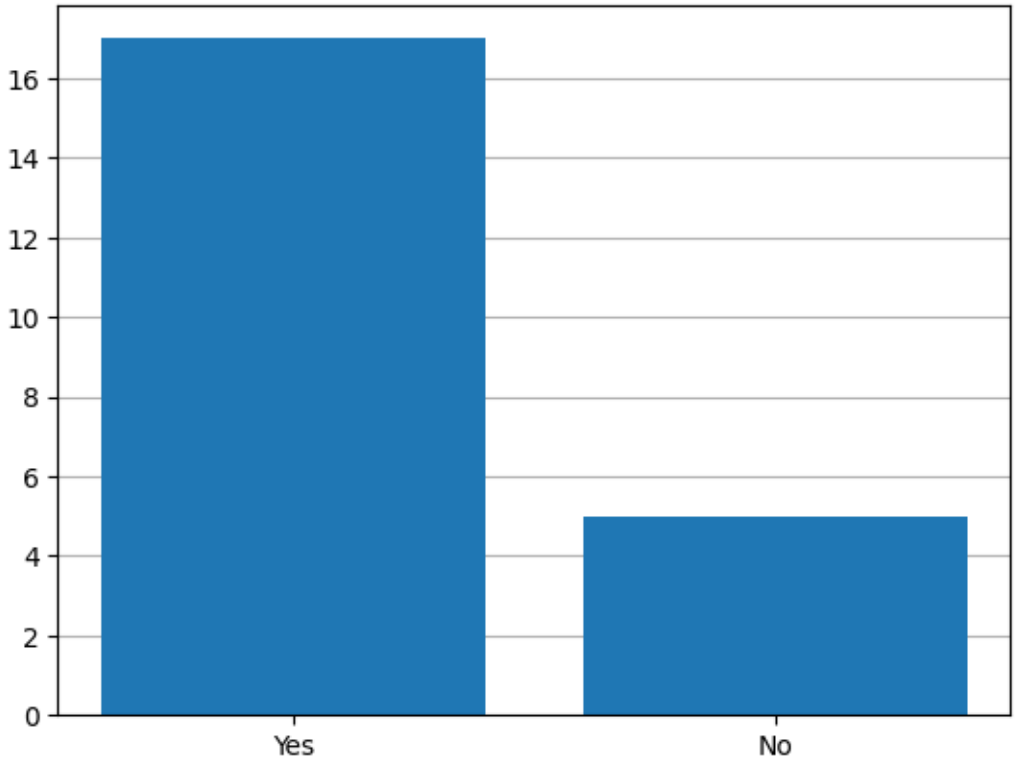
Please specify how do you plan to integrate SPE in your production automation in the future?

- We have integrated our own products into our in-house EoL-testers, etc.
- We would give the customers more options for covering larger distances within a factory. FO is a fragile medium and damages easily, SPE would mitigate that for distances up to 1 KM. The customer wouldn't need a media converter then and would have an easier time installing the cables and the hardware.

At present, I'm well acquainted with OPC UA?



Could you (your collaborators, customers and business contacts) use a general - but fairly detailed - workshop / course on OPC UA?



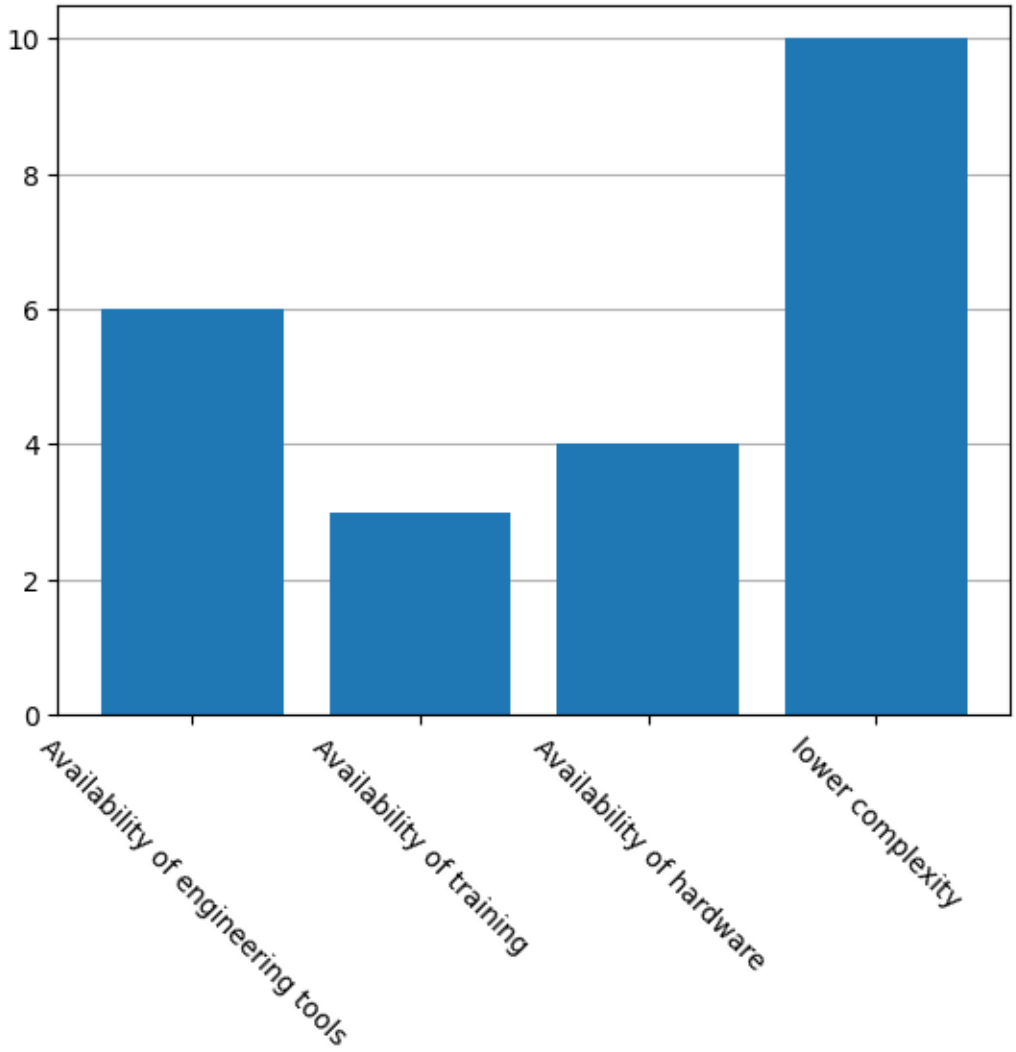
Do you have any concrete use-cases that require usage of OPC UA? Please specify briefly.

- Yes, we mainly use OPCUA in our IIoT gateways and data analytic tools as standard communication protocol.
- YES. Many customers use OPC UA to collect and share data.
- Remoter I/O for data transmission into cloud; NAMUR NOA and MTP
- Our network monitoring software has to share information about the network status with upper Scada applications and for that we use OPC-UA.
- OPC/UA as unified data layer, we are already using OPC for specific projects
- Increase knowledge
- machine interfaces
- SCADA, Mainly OPC UA HDA
- We have several customers that use OPC UA technology to connect ERP systems to a factory SCADA system. Or to exchange data between PLC's from different manufacturers using different protocols.
- required' is not the correct word, but where it can be use. Use case: quality lab with robot and measurement equipment.
- Device diagnostics, control

What in your opinion is the most promising feature of OPC UA if it comes to the industrial scenarios?

- It will be a standard protocol that easily can exchange data between servers and clients. On top it will be a secured protocol.
- Ease of integration compared to OPC DA. Added OPC UA HDA also can be useful.
- Open protocol, not influenced by single vendors
- standardized information exchange
- Widely accepted standard
- Broad support by different manufacturers
- unified communication across different vendors
- flexible information modelling
- Self Description, semantic, Client server principle
- HDA, Pub/Sub model
- Manufacturer-independent and operating system-independent data exchange.
- Object oriented modeling, method execution
- Pub-Sub
- Easy to embedded server in industrial devices

What in your opinion is the most critical aspect for increasing the acceptance of OPC UA in the industry?



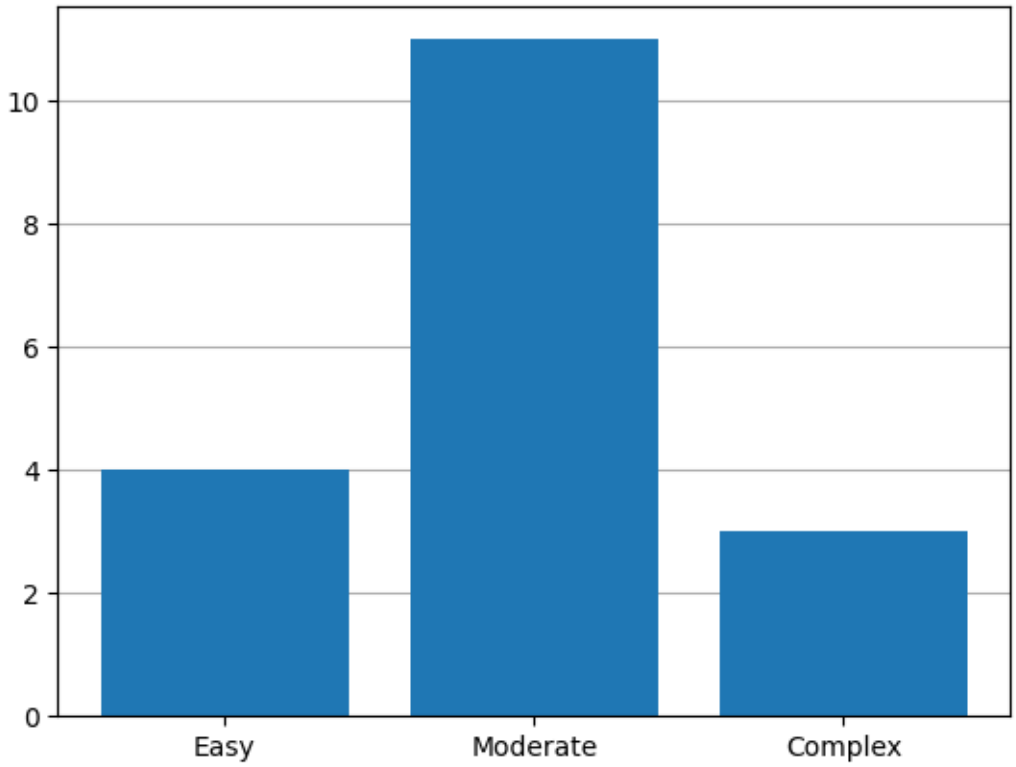
- I think it is fairly accepted by now
- 1. Standardizing profile usage
  In OPC UA there are different profiles like "nano ...", "micro ..." facets, see https://profiles.opcfoundation.org/category/42 e.g.
  For better interoperability (e. g. matching server and client capabilities) it is important to standardize usage (e. g. using only "nano ..." or "micro ..." for cost sensitive use cases.
  2. Separation of domain semantics
  Clear separation of domain specific semantics from the OPC UA information model by mapping of IDTA submodels (including semantics from Eclass, IEC CDD) and profiles like the CANopen drive profile CiA 402 (IEC 61800-7- 201/-301) to OPC UA is needed. Focus from OPC UA companion specs with embedded semantics to such mappings is strongly advised.

- Everything is present to make the implementation

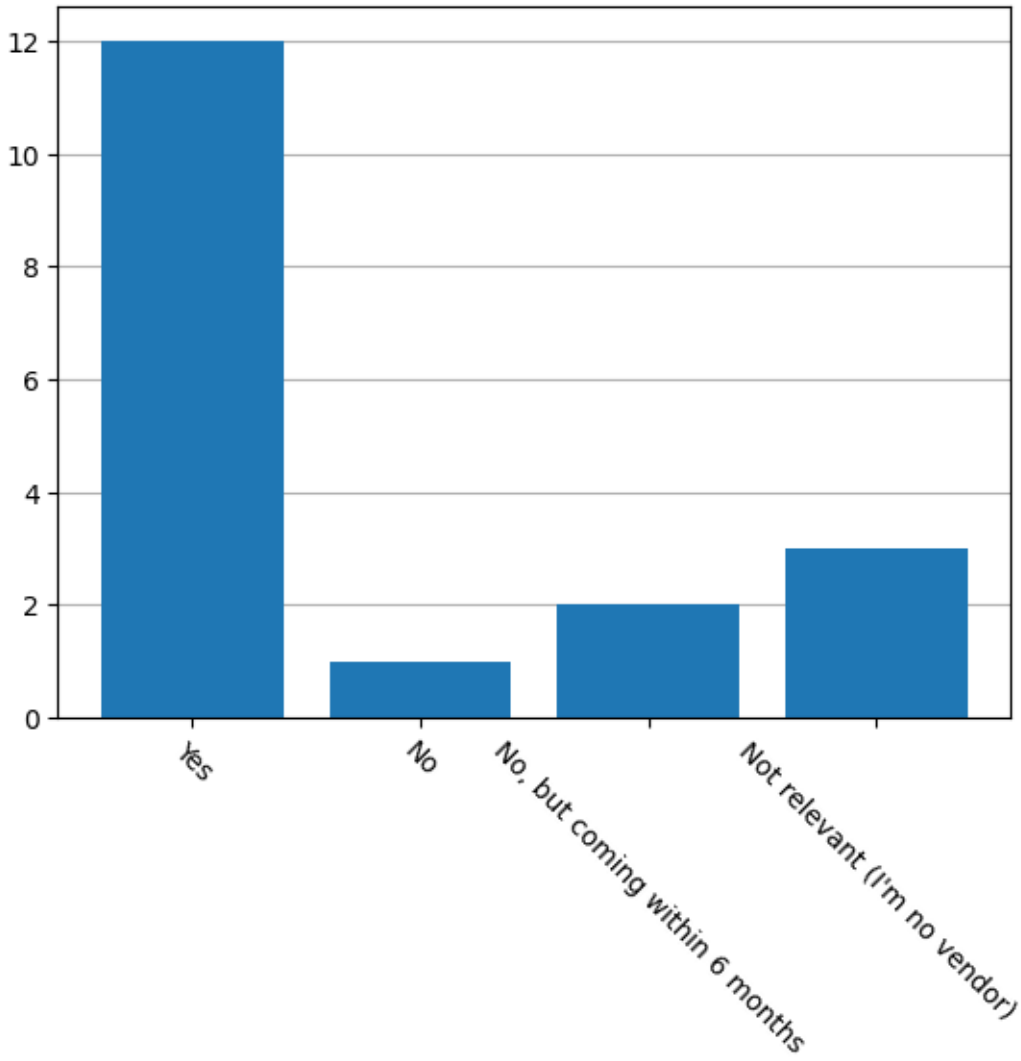
Is there any specific feature/requirement of OPC UA in which you are particularly interested in?

- NOA PA-DIM
- Interaction with the AAS
- all... :-) it's the base of our software platform

How do you estimate the complexity of OPC UA?



Do you already have your own OPC UA capable product(s)?



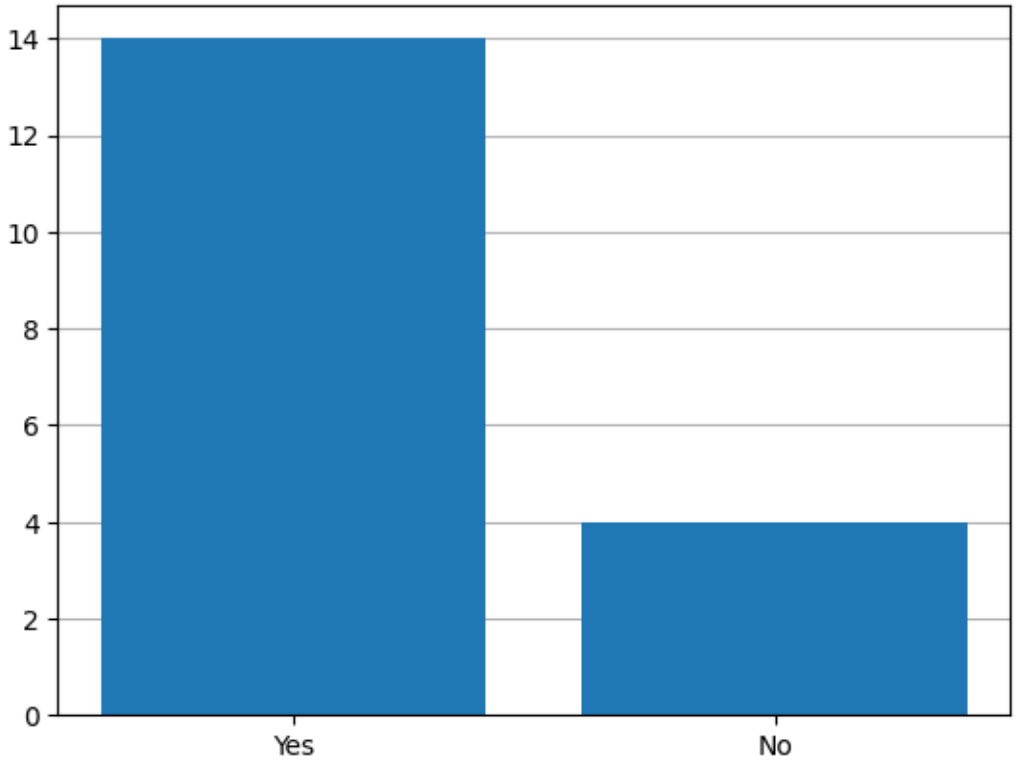
What type of product? (E.g. client/server software, engineering software, …)

- IIoT gateway's, PLC's, data analytic tools
- Both client and server for OPC UA, OPC UA HDA data connection to our Historian is under development.
- Remote I/O with OPC UA Server
- network monitoring hard- and software
- By default, our PLC Next controller has an OPC/UA server embedded and available.
- OPC Servers, OPC UA Pub Sub
- servers, clients, engineering software, ..
- Clients, Our PLCnext is capable of using OPC UA
- Engineering Software that includes OPC UA drivers,
  Hardware devices that include a OPC UA server and client
- MES
- Simatic Net, S7-1500, Scada systems, Panels,...

Which features of OPC UA does it cover?

- OPC UA client, OPC UA server, OPC UA HDA Server
- OPC UA Server for diagnostics; basic NOA PA-DIM support
- information exchange
- Data Access (maybe also other features, I need help from my colleagues to confirm)
- Represent aspects of devices, Communication between devices
- we are just able to send data via OPC UA from the PLC program to for example another vendor independent product.
- OPC UA A&E specifications
- Dynamic modeling (without coding) ; listen to monitored item changes, execute methods, ...

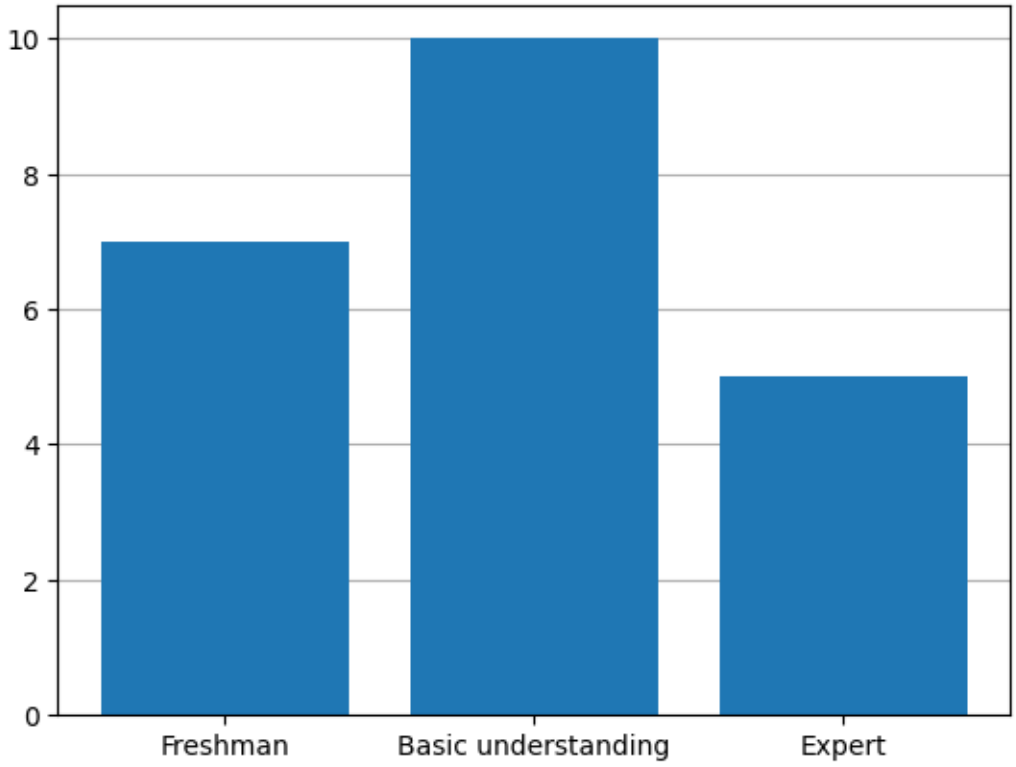
Do you plan to integrate OPC UA in your production automation in the future?



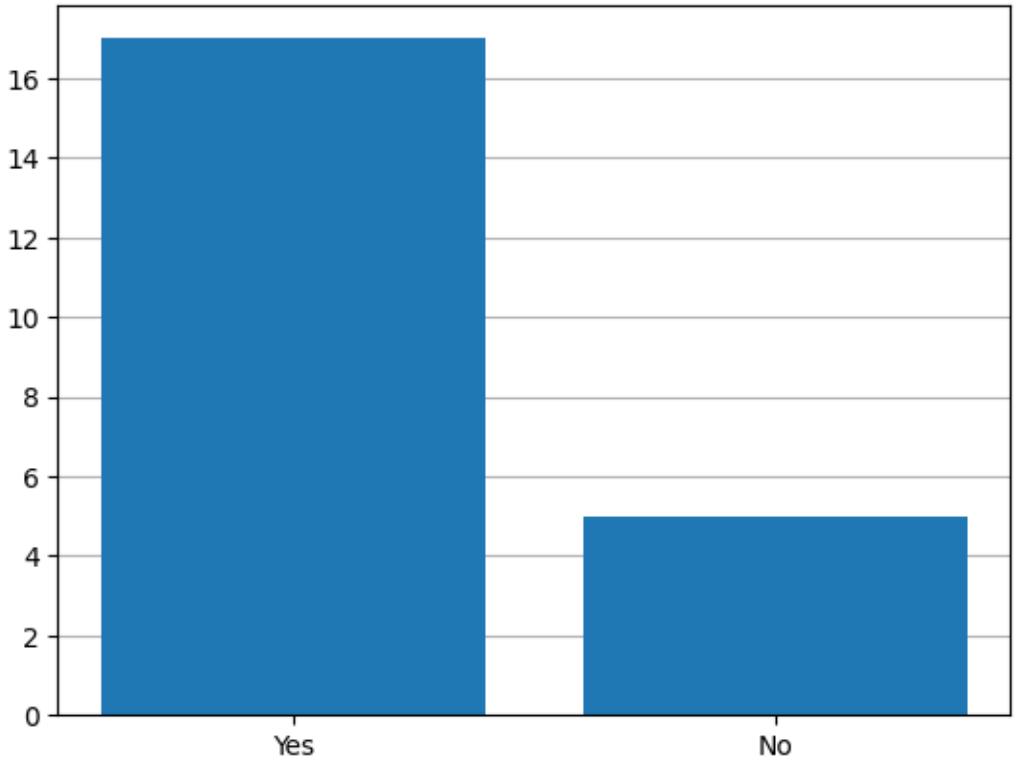
Please specify how do you plan to integrate OPC UA in your production automation in the future?

- We are a sales company, we don't integrate ourselves.
- OPC UA HDA will be useable to extract data from the ibaHD-server Historian.
- Standardizing communication if preconditions 1, 2 (see 2 pages before) are met
- not specified at this moment
- different options, support for asset owners or system integrators
- As products for our customers.
- an OPC UA CS to show as example of our possibilities in the own production ...
- We are already using OPC UA in several running projects.
- SCADA comm.
- It's already integrated.
- Is an important part for machine to machine communication and for vertical integration in a Network
- Unable to answer
- Communication PLC/Scada/MES
- no info at the moment

At present, I'm well acquainted with network diagnostics and planning (tools)?



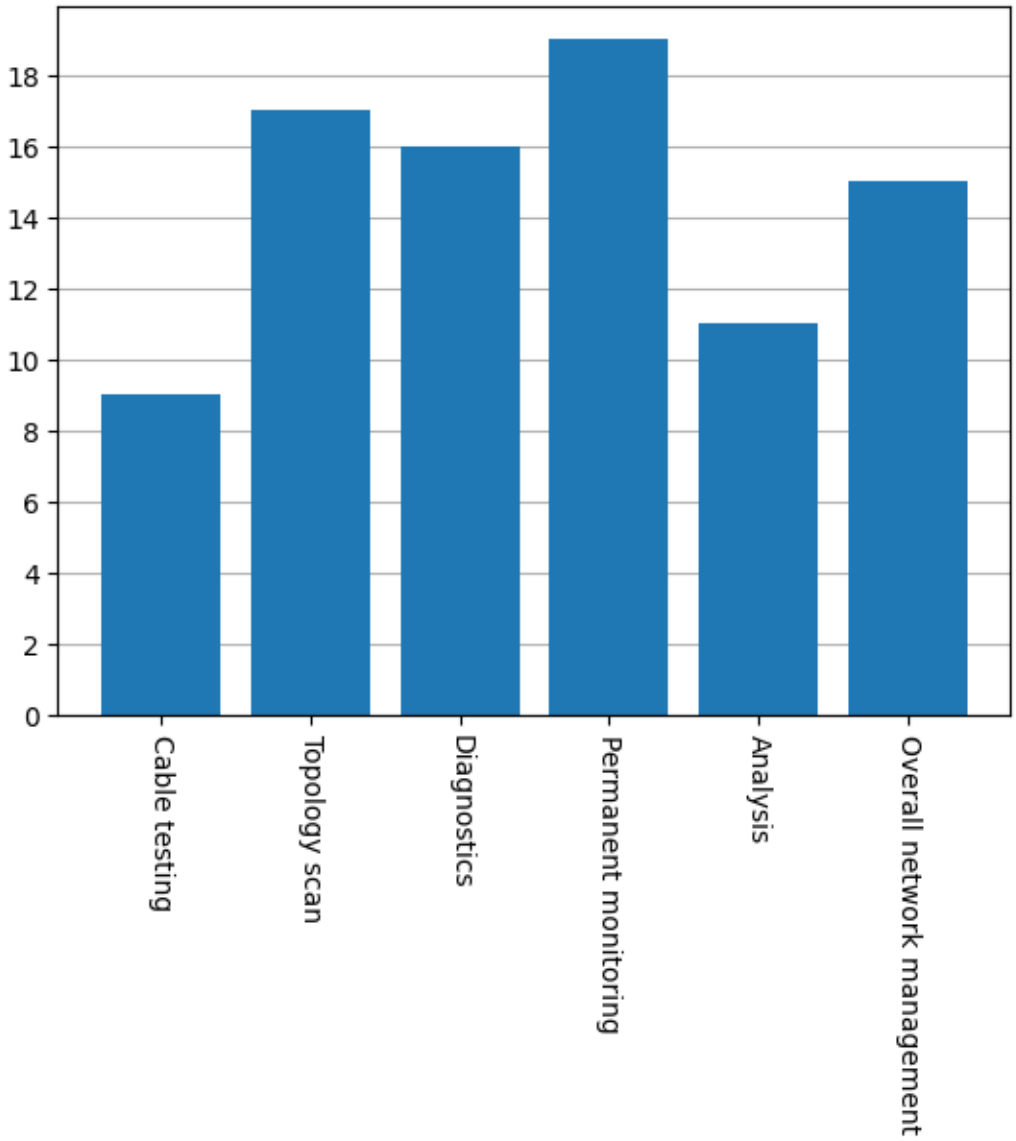
Could you (your collaborators, customers and business contacts) use a general - but fairly detailed - workshop / course on network diagnostics and planning (tools)?



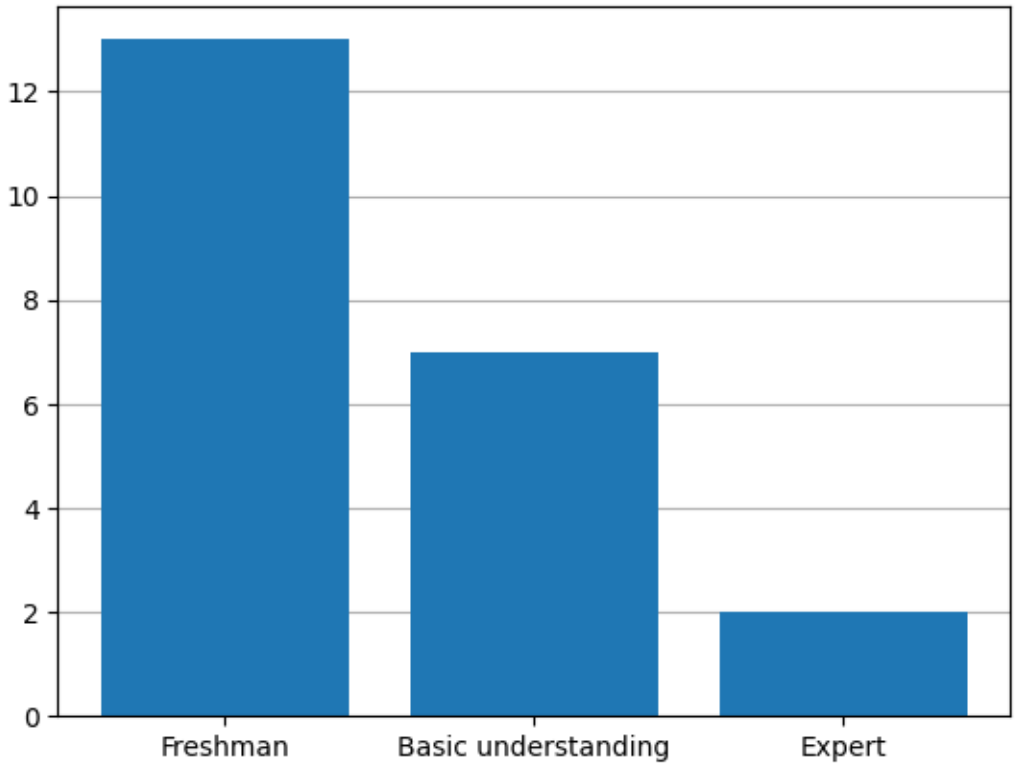
Do you have any concrete use-cases that require usage of network diagnostics and planning (tools)? Please specify briefly.

- Yes, we represent Procentec. So we offer specific solutions in that field. Many customers ask us for a diagnostic solution.
- Yes. Customers often expect us to provide them input about how their networks should look like for integrating our tools.
- Ethernet-APL Services
- Our customers have a lot for preventive network maintenance and to increase the network availability.
- for commissioning and troubleshooting in the field of our Solution
- Constant monitoring of multiple PN networks
- We have our own products as network planning tool

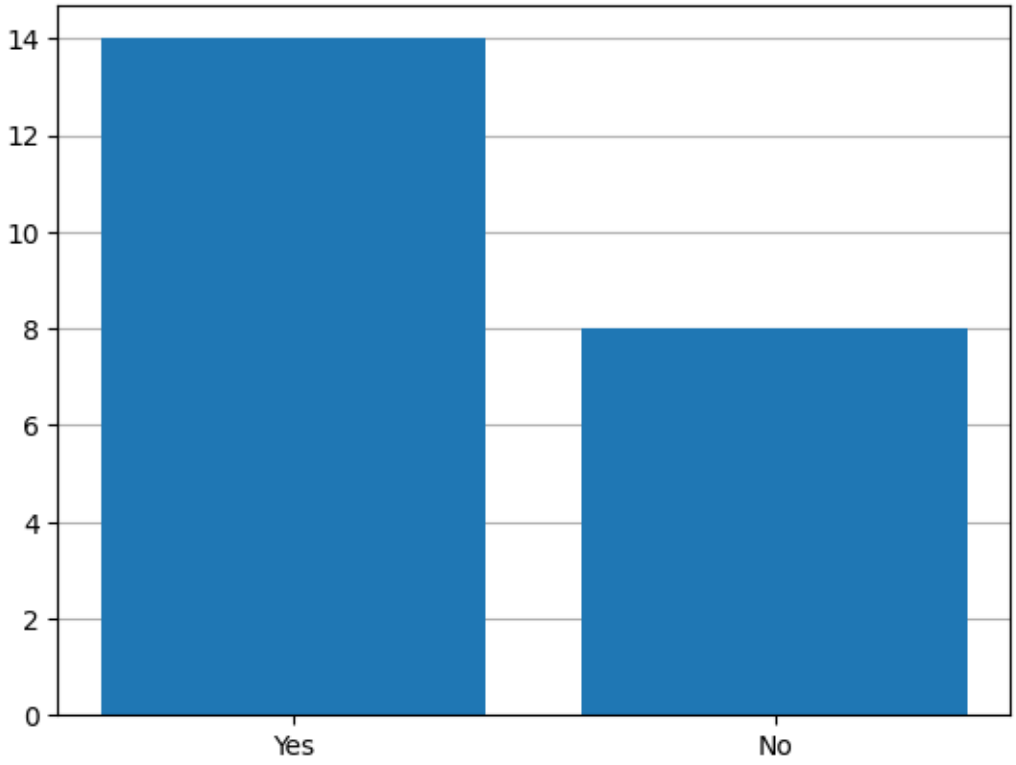
Your interests for network diagnostics and planning (tools) are in …



At present, I'm well acquainted with network related EMI/EMC?



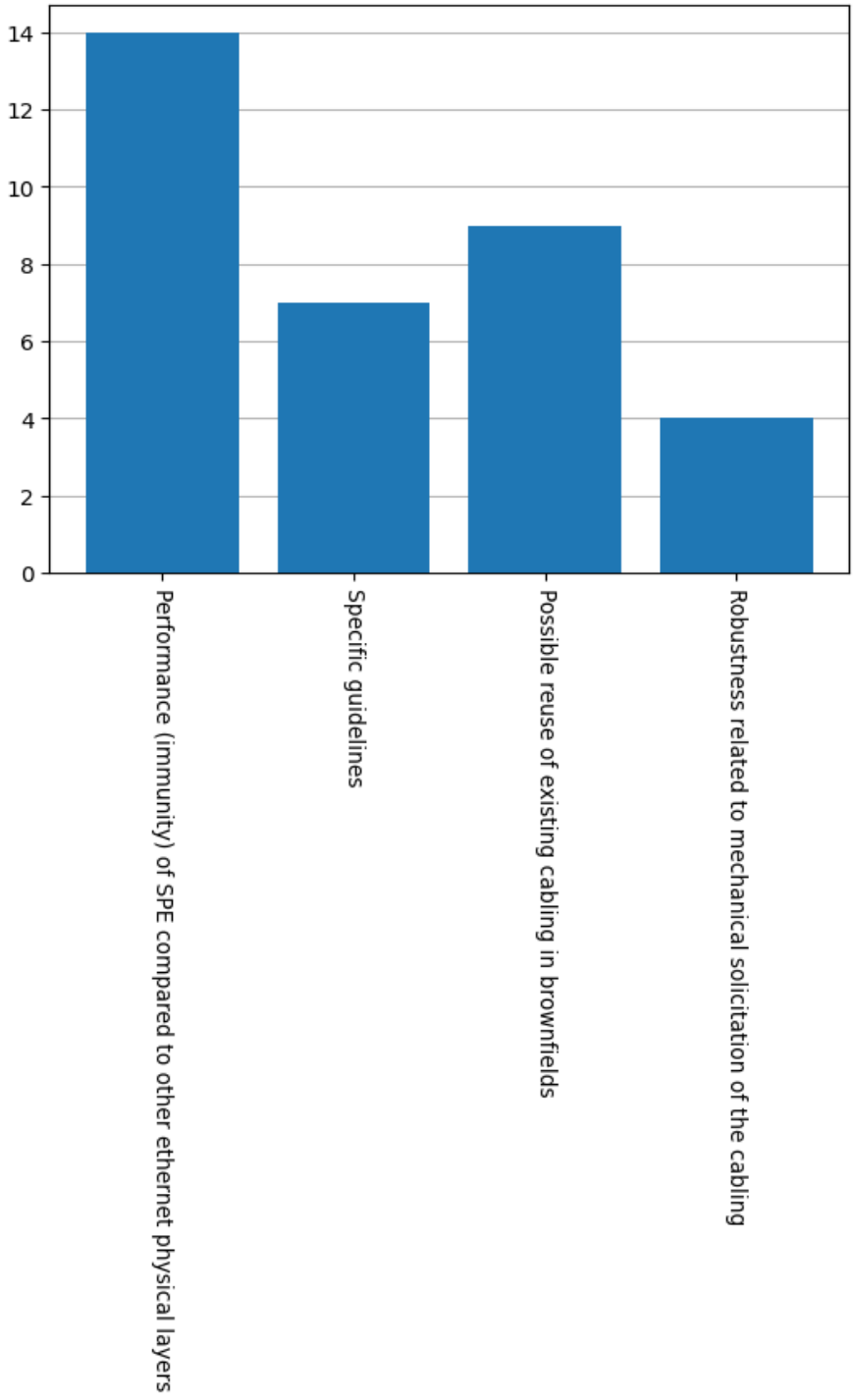
Could you (your collaborators, customers and business contacts) use a general - but fairly detailed - workshop / course on network related EMI/EMC?



Do you have any concrete use-cases that require usage of network diagnostics and planning (tools)? Please specify briefly..1

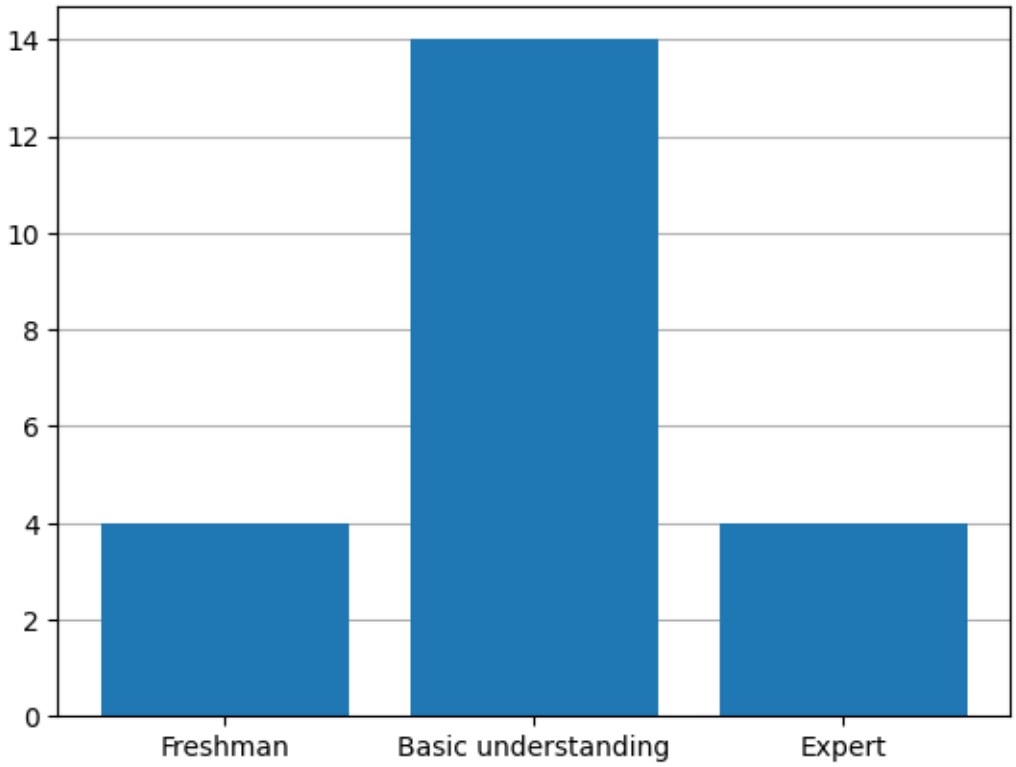
- Ethernet-Remote I/O and Ethernet-APL
- Each customer which goes the way from homogeneous to heterogeneous networks, goes also the way from unmanaged to managed Ethernet and for that it needs this tools.
- based on our products

Your interests for EMI/EMC related to SPE are in …

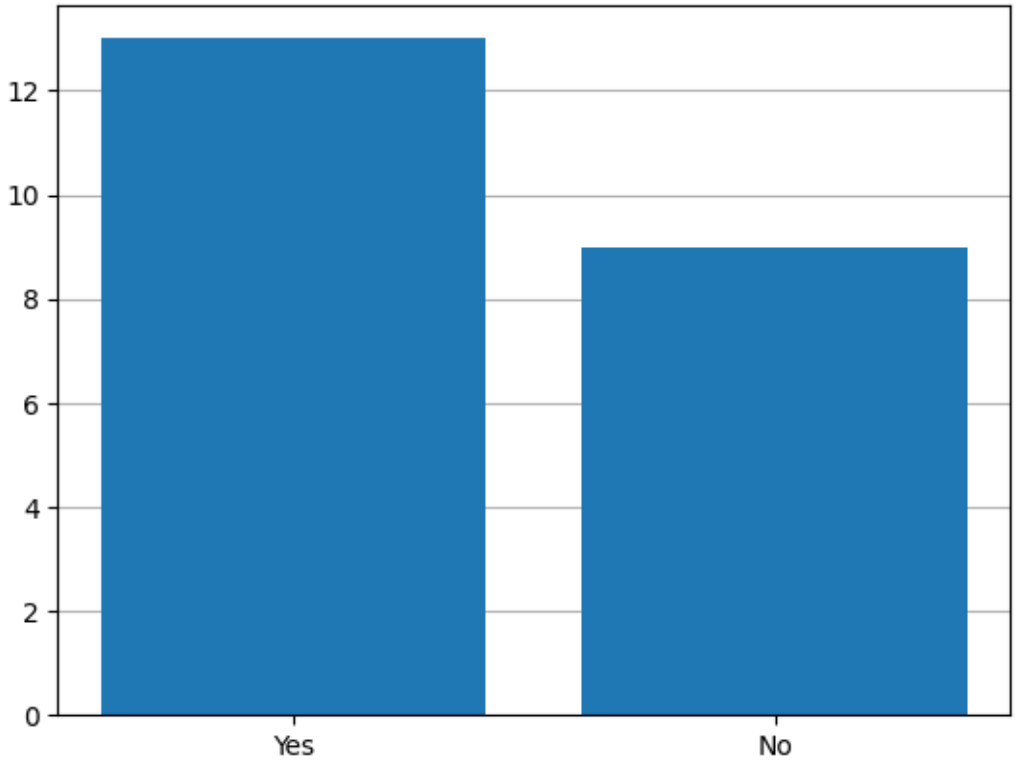


- Nothing specifically SPE related but EMI/EMC in general

At present, I'm well acquainted with network redundancy?



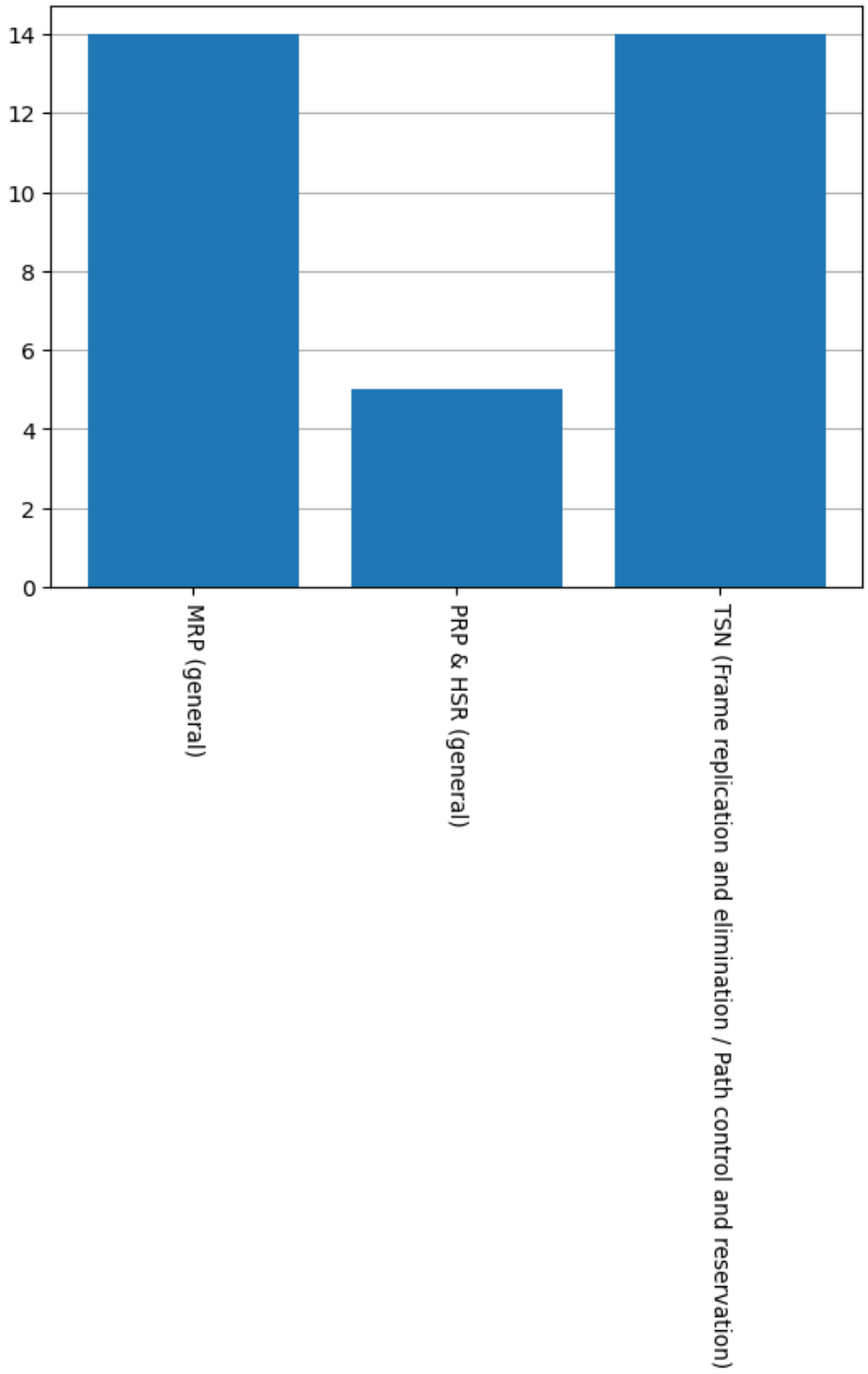
Could you (your collaborators, customers and business contacts) use a general - but fairly detailed - workshop / course on network redundancy?



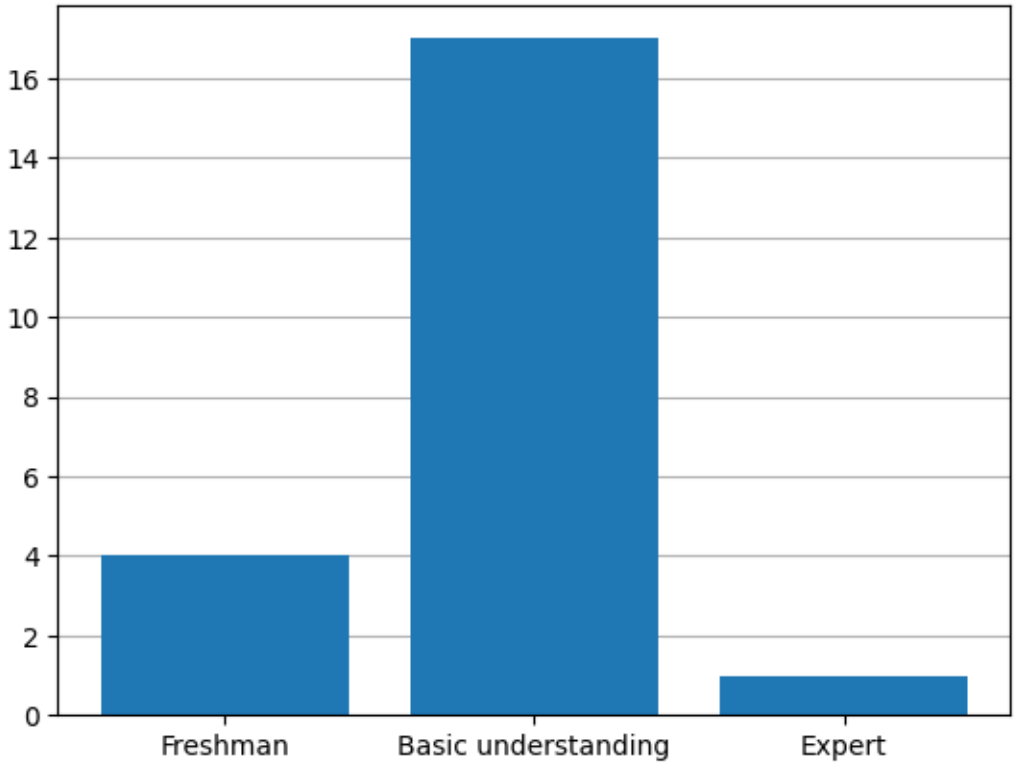
Do you have any concrete use-cases that require usage of network redundancy? Please specify briefly.

- Next to none
- Remote I/Os
- seamless network redundancy is required
- not at present
- no
- Yes, in all industrial networks
- no concrete use-cases

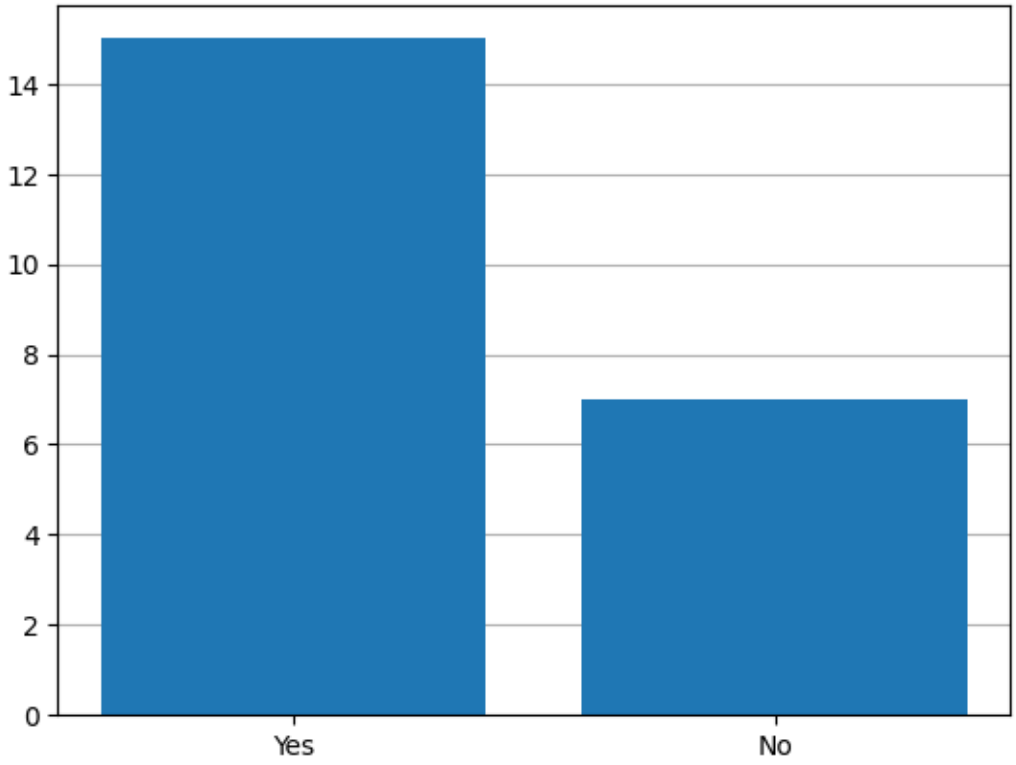
Your interests for network redundancy are in …



At present, I'm well acquainted with Power over Ethernet (PoE), Power over Data Line (PoDL) and/or Advanced Physical Layer (APL)?



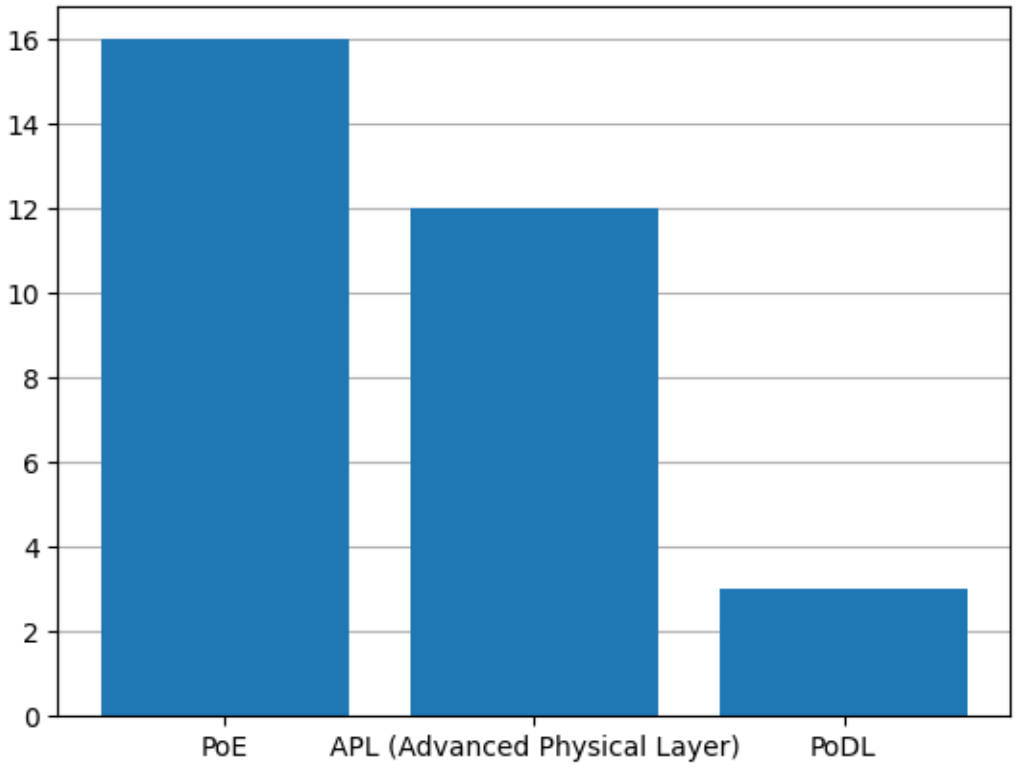
Could you (your collaborators, customers and business contacts) use a general - but fairly detailed - workshop / course on PoE, PoDL and/or APL?



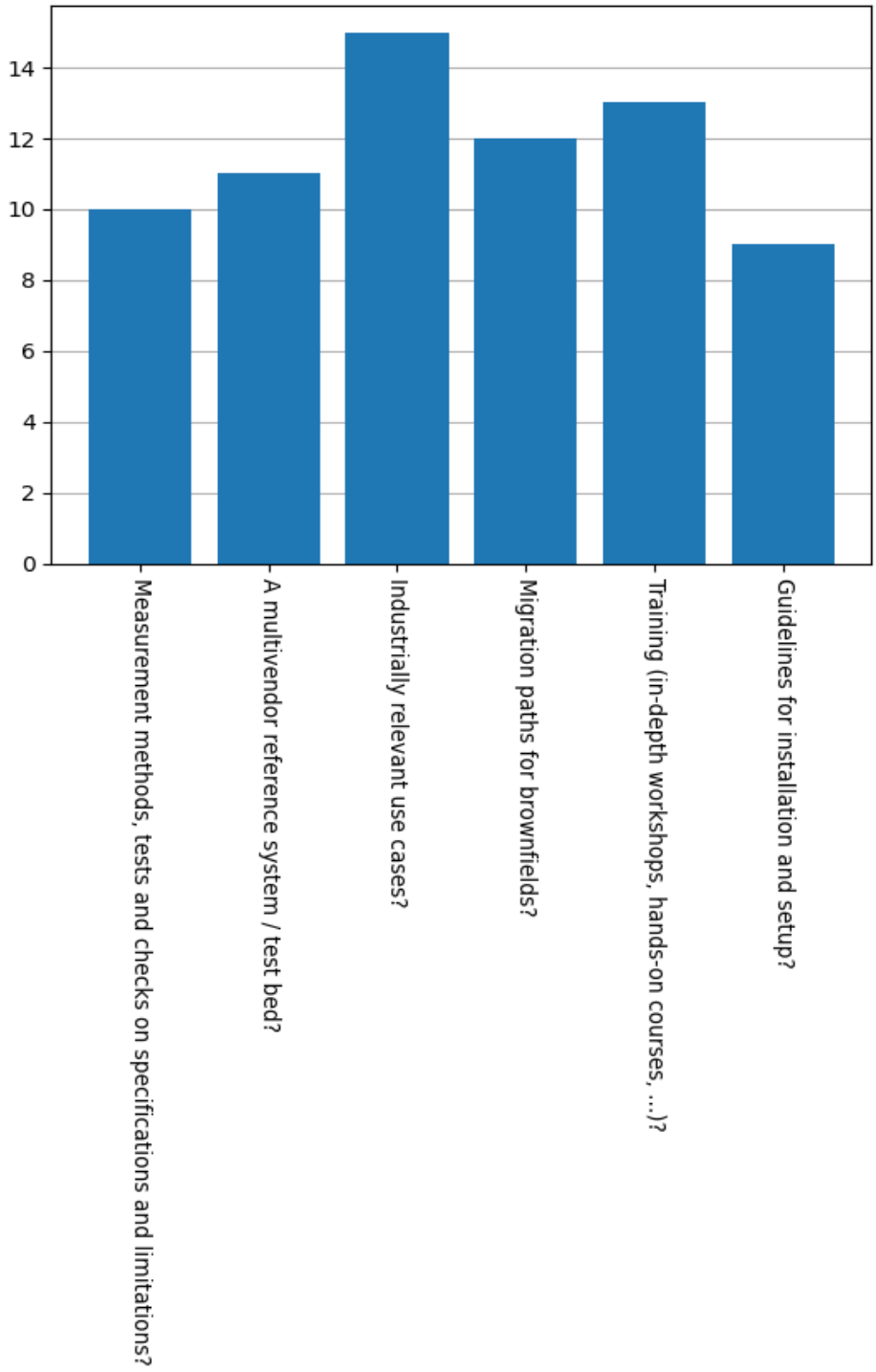
Do you have any concrete use-cases that require usage of PoE, PoDL and/or APL? Please specify briefly.

- In connection to our VMS ibaCapture, many network devices (cameras, switches) use PoE.
- Ethernet-APL Field Switches
- Often network cameras need PoE.
- Yes, POE switches from Scalance

Your interests are in …



To help you implement new technologies, we plan to provide you with different project “outputs”; are these important for you, your colleagues, your customers, your company?



Is there anything else that we did not cover in this survey but you would like us to know?

- 1. Importance of standards for domain-specific semantics
  2. Open educational resources (OER) that can be widely reused (Information independent from vendors and user groups)
- Hybrid SPE