Survey

TSNWi-Fi Field Study

Determinism in wireless/wired industrial environments

fortiss

TSNWi-Fi Field Study –
Determinism in wireless/wired industrial environments

Author

Prof. Dr. Rute C. Sofia

fortiss GmbH,
Guerickestr. 25
80805 Munich
sofia@fortiss.org

Content

Abstract

Time Sensitive Networking (TSN) has already a proven role in Ethernet networks for Industry 4.0. TSN supports the strict delay and bandwidth requirements of critical applications in Industrial environments.

The next phase in industrial connectivity concerns a better mobility support, and automated configurability, as well as being able to handle large number of IoT devices. The need for simplification is driving the integration of wireless in industrial environments.

In this context, the most recent evolution of Wireless Fidelity (Wi-Fi) is „Wi-Fi 6", technically known as IEEE802.11ax. In contrast to prior Wi-Fi standards, Wi-Fi 6 has properties that can support precise time synchronisation and bounded latency.

This survey has been developed by fortiss and by Huawei Technologies in the context of the joint project TSNWIFI and is focused on exploring wireless deterministic capabilities. A key aspects is to understand the need to rely on wireless in an operational ground.

TSNWiFi was a project jointly developed by fortiss and Huawei Technologies in 2020

The survey is composed of 22 questions integrated into 3 groups: i) information on the entities, countries; advantages that the entities see in terms of TSN integration ii) interest in the integration of wireless in industrial environments and the need for deterministic guarantees.

The survey, developed via LimeSurvey, has been active between 04.10.2020 and 20.06.2021 included. The survey received a total of 35 answers, 18 of which were complete. Answers have been provided by entities in Germany (majority), Spain, Sweden, Greece.

Summary of results

TSN integration aspects

- 44.12 % consider TSN as highly relevant for the respective industries and 80 % expect to deploy TSN.
- In terms of TSN technologies to deploy, 81.25 % is planning for OPC UA FLC; 56.25 % for PROFINET over TSN; 43.75 % for Ethercat over TSN; 37.5 % for Ethernet/IP; 18.75 % mentioned in addition OPC UA skills over TSN; TSN over wireless; 5G as a bridge for IEEE TSN.
- Out of the 35 entities, 3 stated no interest in implementing TSN, 66.67 % of these presented no need; 33.33 % stated they were satisfied with competing solutions.
- In terms of field-level equipment numbers, the surveyed entities stated variable numbers, from an order of 10 to over thousands
- In terms of streams (control data flows) to be supported in parallel, entities stated again highly variable numbers, being the majority between 1-1000.
- 80 % of the entities expect to upgrade to a converged network; 15 % do not expect an upgrade; 5 % did not answer.
- 23.53 % consider A/V highly relevant to be integrated; 20.59 % less relevant; 11.76 % expressed average relevancy. Overall, A/V support is considered relevant.

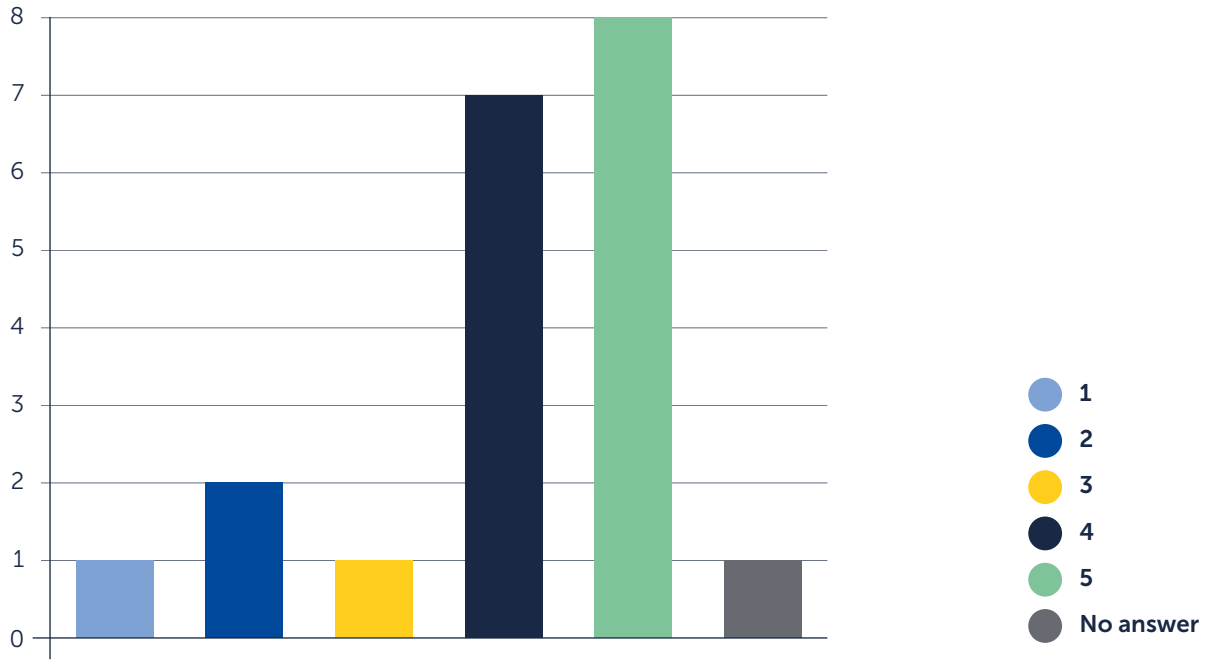
Wireless/TSN integration aspects

- 50 % consider wireless integration during the next 5 years highly relevant.
- 50 % are already relying on Wi-Fi at a field-level operational level.
- Out of these 52.94 % the key reasons to rely on wireless concern reduction in operational costs; more flexibility in terms of operating robotics/AGVs and easier planning/dimensioning; possibility to use wireless in harsh environments with onboard and offshore systems.
- Out of the entities that are not yet relying on wireless, 55.56 % is not interested in deploying while the other 44.44 % have no interest in deploying wireless. The key aspect for the lack of interest relates with the fact that Wi-Fi is not yet an accepted medium in automation. Comments relate with the possibility to see Wi-Fi integrated in components (together with industrial Ethernet). A second aspect concerned reliability and availability. A third concerned dependency on network operators, and the lack of industrial equipment that could rely on Wi-Fi. Finally, aspects such as power supply, latency, number of channels, connection security, eavesdropping security, manipulation, interference immunity (EMC).
- Use-cases mentioned to apply wireless concern:
  - Cognitive wireless factory.
  - Scalable production.
  - Interpolating decentralized embedded axis controller.
  - Replacement of several fieldbus-based systems with Ethernet/TSN in the mid-term.
  - Replacement of slip ring applications / (assembly) rail systems.
  - Real-time monitoring of physical as docks and fast decision making when critical parameters are sensing.
  - Monitoring of fire alarms (currently done through Modbus TCP).
  - Critical systems inside aircrafts.
  - Large vessels, offshore structures.
  - Handheld battery powered measuring tools.
  - Supervising automatically guided vehicles (e.g., avoiding accidents).
  - Support for mobile devices.
- Regarding the proposed TSN traffic profiles (rf. to question 14), 94.44 % believes that the proposed profiles are enough.

Questions

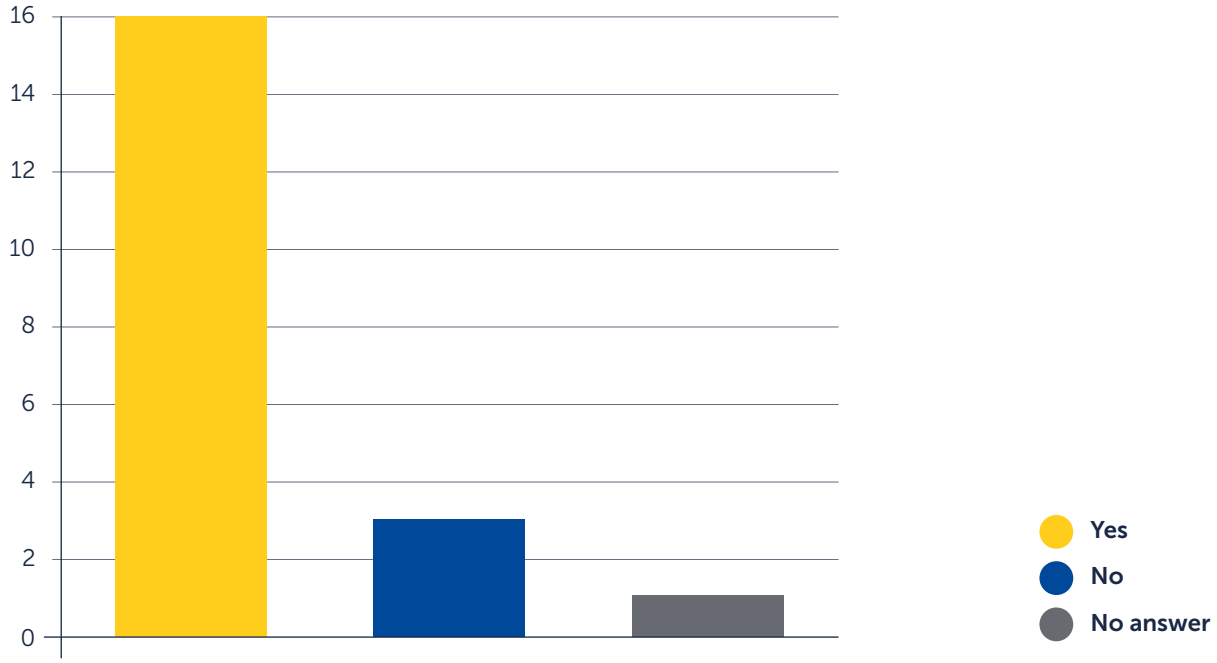
1 How Relevant do you think TSN is for your industry (1, less relevant; 5 highly relevant)

TSN is seen as relevant by most of the inquiries.



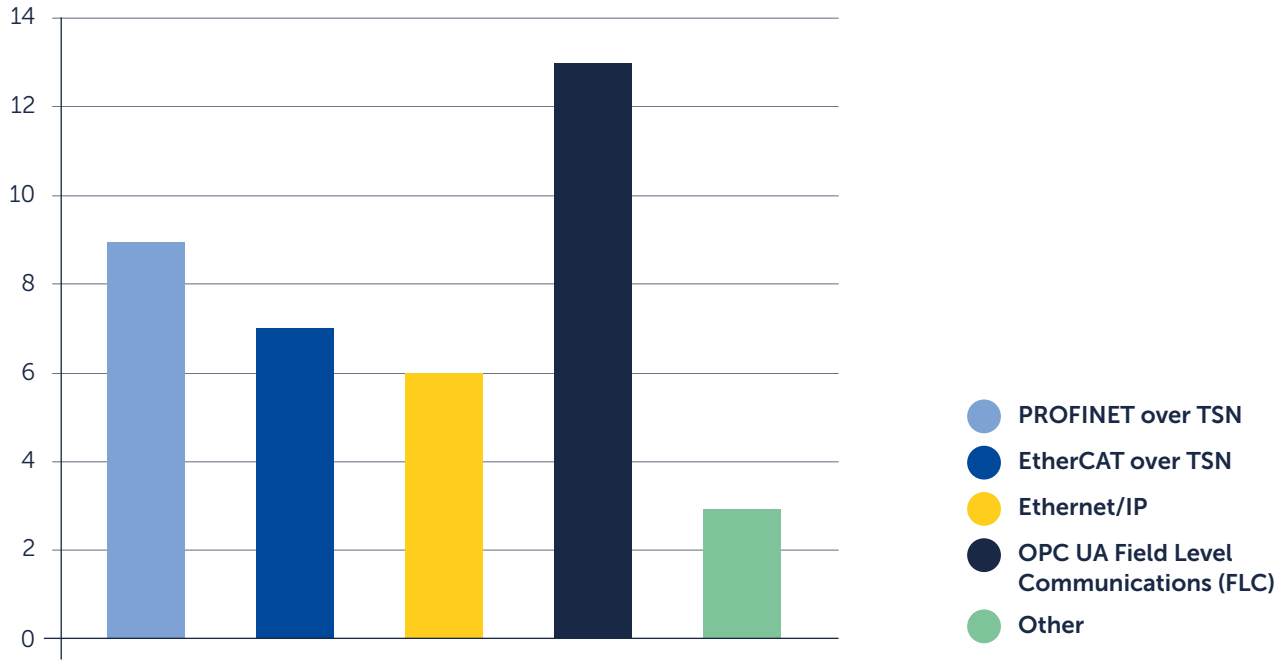
2 Does your company have plans to deploy TSN?

Most of the participants have expressed interest in deploying TSN.



3 If yes, please select the technologies being considered

The majority is considering deploying OPC UA FLC. PROFINET over TSN is the follow-up key selection. In third place comes Ethernet/IP. In terms of "Others", the surveyed entities mentioned: OPC UA skills over TSN; TSN over wireless; implement 5G as a bridge to IEEE TSN.



4 How many field-level devices does your industrial environment integrate?

The numbers provided vary, being most answers focused on 1 to 1000 field-level devices. 1 entity stated an environment with up to hundred thousand devices.

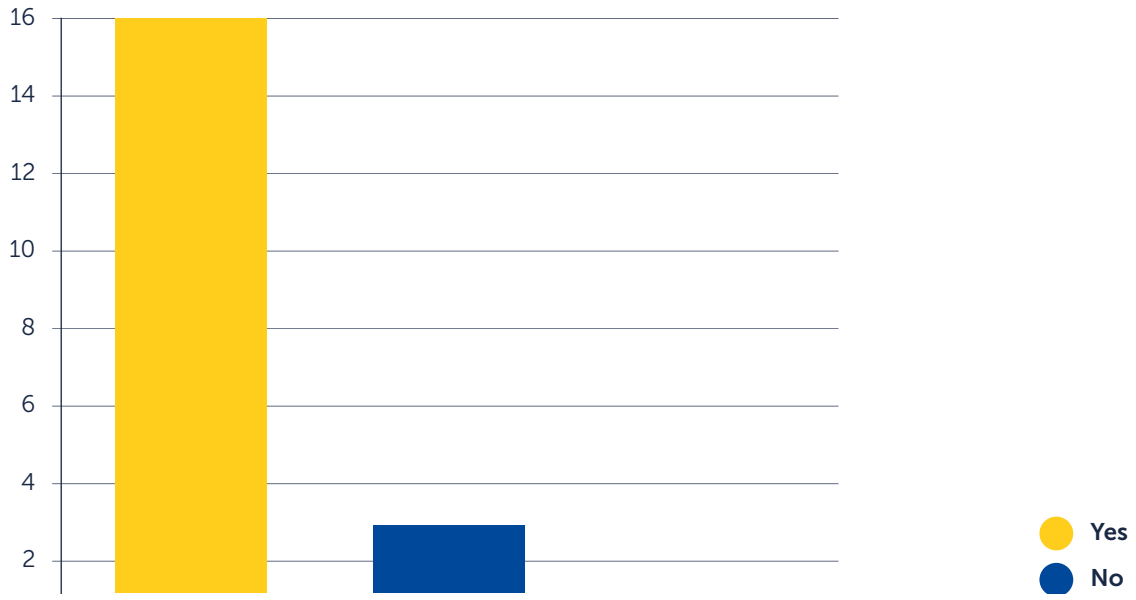
5 How many streams (i.e., control data flows) do you think should be supported in parallel?

The numbers provided are quite variable. There are a few entities stating ten thousand and more, while the majority provided numbers between 1 and thousands.

6 Are you considering upgrading to a converged network?

i.e., an infrastructure which can carry a combination of operational control traffic (before, only supported by fieldbuses) and other types of traffic, such as audio/video or generic IP-based traffic?

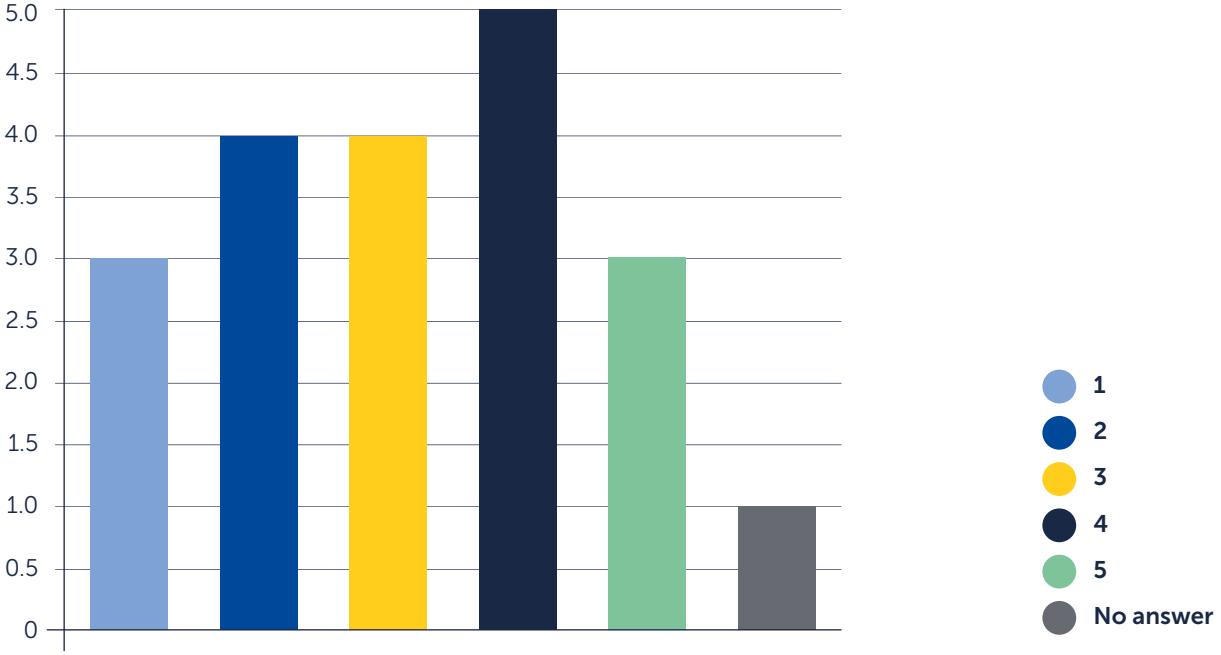
The majority is considering an upgrade to a converged network.



7 How relevant is Audio/video in your operational environment?

(1 less relevant; 5 highly relevant)

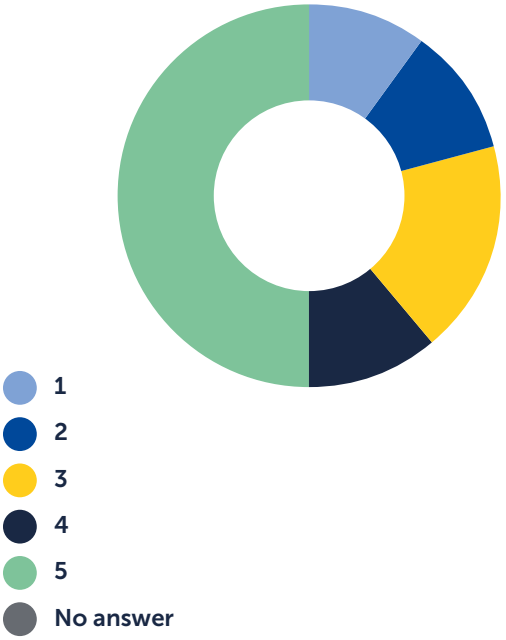
The answers to this question vary, showing that A/V is considered by the majority to be relevant in the respective operational environment.



8 How relevant do you think wireless will be in the next 5 years, for your operations?

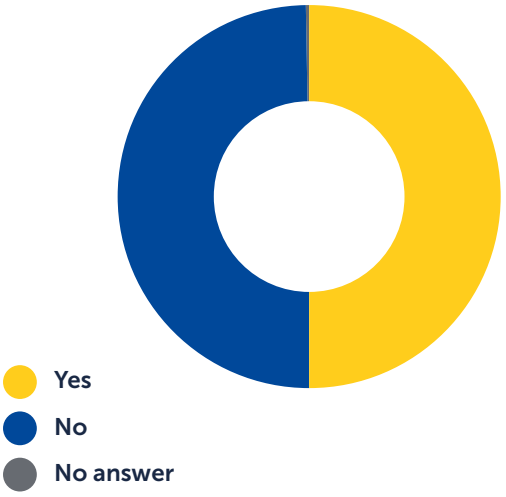
(1 less relevant; 5 highly relevant)

The majority believes wireless is highly relevant to be deployed within 5 years.



9 Do you already use wireless to support operations in a field-level?

Wireless is already being deployed by 50 % of the entities (out of 18 answers).



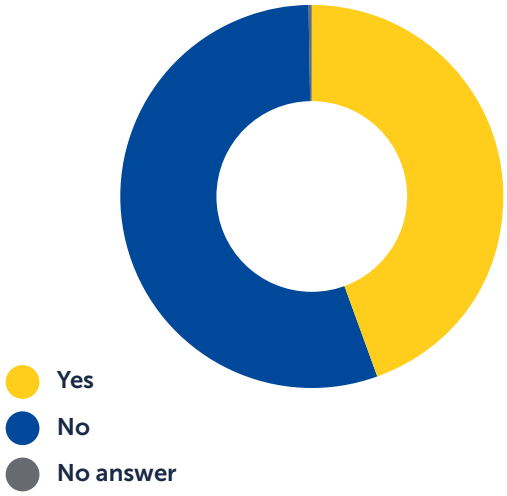
10 If yes, can you please explain the reason to use wireless?

The key reason to apply wireless relates with cost reduction and easier planning and dimensioning. Additional reasons mentioned were:

- Inability to use wires
- High power, high voltage, and chemical scenarios.
- Broad space (ports mainly) and need of disperse sensing.
- Harsh environment within onboard and offshore systems

11 If not, are you interested in deploying wireless?

This answer received an equal percentage for yes and no. The number of answers was reduced (9).



12 If you are not interested in deploying wireless, can you please explain the issues you, see?

The key aspect for the lack of interest relates with the fact that Wi-Fi is not yet an accepted medium in automation. Comments relate with the possibility to see Wi-Fi integrated in components (together with industrial Ethernet). A second aspect concerned reliability and availability. A third concerned dependency on network operators, and the lack of industrial equipment that could rely on Wi-Fi.

Finally, aspects such as power supply, latency, number of channels, connection security, eavesdropping security, manipulation, interference immunity (EMC).

13 Could you please elaborate on a use-case where you see a need for wireless/wired TSN support?

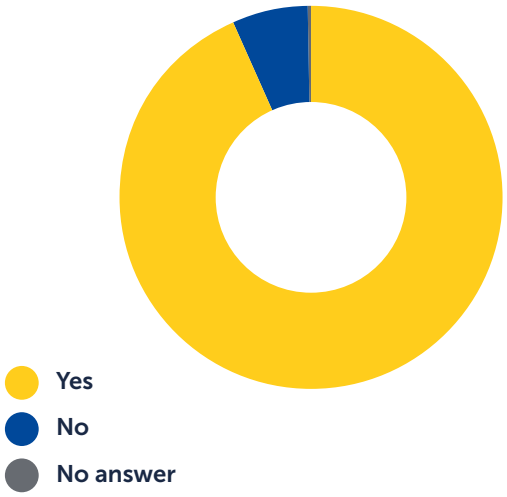
Use-cases mentioned to apply wireless concern:

- Cognitive wireless factory.
- Scalable production.
- Interpolating decentralized embedded axis controller.
- Replacement of several fieldbus-based systems with Ethernet/TSN in the mid-term.
- Replacement of slip ring applications / (assembly) rail systems.
- Real-time monitoring of physical as docks and fast decision making when critical parameters are sensing.
- Monitoring of fire alarms (currently done through Modbus TCP).
- Critical systems inside aircrafts.
- Large vessels, offshore structures.
- Handheld battery powered measuring tools.
- Supervising automatically guided vehicles (e.g., avoiding accidents).
- Support for mobile devices.

14 **Traffic Profiles: To adequately provide TSN support in wired/wireless environments, our field study considers the following traffic profiles. These are based on the most recent directives of the IIC and OPC FLC. From the perspective of your operational environment, do you think these profiles are enough?**

- Network control, e.g., time synchronisation (PTP), network redundancy (e.g., MSTP) Isochronous control (data exchange synchronously, usually common deadline, lowest latency, time-triggered traffic)
- Cyclic control e.g., high performance motion, fast I/O applications (guaranteed deadline, low latency)
- Event-based control/alarms
- Configuration and Diagnostics
- Audio/Video User defined, e.g., traffic with a higher priority than Best Effort
- Best Effort, i.e., traffic with no timing or delivery guarantees

Regarding the proposed TSN traffic profiles (rf. to question 14), the majority believes that the proposed profiles are enough.



List of Acronyms

TSN	Time Sensitive Networking
IIC	Industrial Internet Consortium
OPC FLC	OPC Field Level Communications
OPC	Open Platform Communications
IEEE	Institute of Electrical and Electronics Engineers
A/V	Audio/Video
TCP	Transmission Control Protocol
IP	Internet Protocol
Wi-Fi	Wireless Fidelity
I/O	Input/Output
PTP	Precision Time Protocol

Imprint

Publisher
fortiss
www.fortiss.org

Author
Prof. Dr. Rute C. Sofia

Layout
Sonja Taut

ISSN Online
2700-2977

Picture Credits
Title: adobe stock © sdecoret
Page 4: adobe stock © Nadya_C
Page 12: fortissGmbH ©Kathrin Kahle

1. Edition, January 2022

fortiss is the Free State of Bavaria research institute for software-intensive systems based in Munich. The institute's scientists work on research, development and transfer projects together with universities and technology companies in Bavaria and other parts of Germany, as well as across Europe. The research activities focus on state-of-the-art methods, techniques and tools used in software development and systems & service engineering and their application with cognitive cyber-physical systems such as the Internet of Things (IoT).

fortiss is legally structured as a non-profit limited liability company (GmbH). The shareholders are the Free State of Bavaria (majority shareholder) and the Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V.

fortiss GmbH
Guerickestraße 25
80805 München
Deutschland
www.fortiss.org
Tel.: +49 89 3603522 0
E-Mail: info@fortiss.org

fortiss