The PROFINET way to TSN

Gunnar Leßmann

PHOENIX CONTACT

PROFIdag 2021

PI PROFIBUS • PROFINET

4 november Basiliek Veenendaal - www.PROFINET.nl

Vita

PHOENIX CONTACT

- 1998 Start with INTERBUS
- 2004 Responsible for PROFINET
- 2017 Responsible for TSN in PLCnext

PROFIBUS und PROFINET International

- WG-Lead: CB/PG6 - PNIO (Core-Specs und Guidelines)
- WG-Lead: CB/PG8 - Fieldbus Integration
- WG-Member: PN Marketing, Commitee-B, I4.0, SPE

OPC Foundation:

- WG Member: OPC UA FLC - TSN Expert Group
- WG Member: PROFINET for OPC UA

Gunnar Leßmann – PHOENIX CONTACT
glessmann@phoenixcontact.com

Contents

- Why TSN?
- What is TSN?
- What is today‘s solution?
- How can I use PROFINET over TSN?
- Which devices and topologies are possible?
- What advantages do I have of PROFINET over TSN?
- When will products be available?
- What's next for TSN?
- Summary

Why TSN?

- An Ethernet switch is like a roundabout at rush hour. If more vehicles enter than come out, traffic jams can happen. With Ethernet, packets are then discarded. Congestion loss can occur.
- Also, the time from departure to arrival can not be predicted with certain accuracy. Therefore, standard Ethernet today is not completely deterministic.
- This has led to specialized* solutions such as PROFINET IRT or EtherCAT.
- Time Sensitive Networking (TSN) describes a collection of IEEE standards that can significantly improve the real-time capability of standard Ethernet in future.

A switch can behave like a roundabout at rush hour

*Not using IEEE Standard Ethernet Hardware

What is TSN?

- The "**T**ime **S**ensitive **N**etworks" group in the IEEE is responsible for the worldwide standardization of Ethernet.
- TSN is not a single standard it is a "toolbox" of standards
- As a result, Ethernet is suitable for many industries and applications
- The support of TSN mechanisms requires new Ethernet chipsets and software in the devices.
- In future, every device with Ethernet interface is expected to support TSN standards
- The IEEE makes no statement about the profiling of the standards, this must be taken over by the user organizations.
- Thus, PROFINET defines its own TSN profile

#	IEEE	Content
1	802.1Qci	Streams & Config
2	802.1AS	Time&Cycle Sync
3	802.1Qbv	Scheduled Traffic
4	802.1Qbu	Frame Preemption
5	802.1CB	Seamless Redundancy

IEEE TSN „Toolbox “

In-Car

Profile A

Profile B

PROFINET

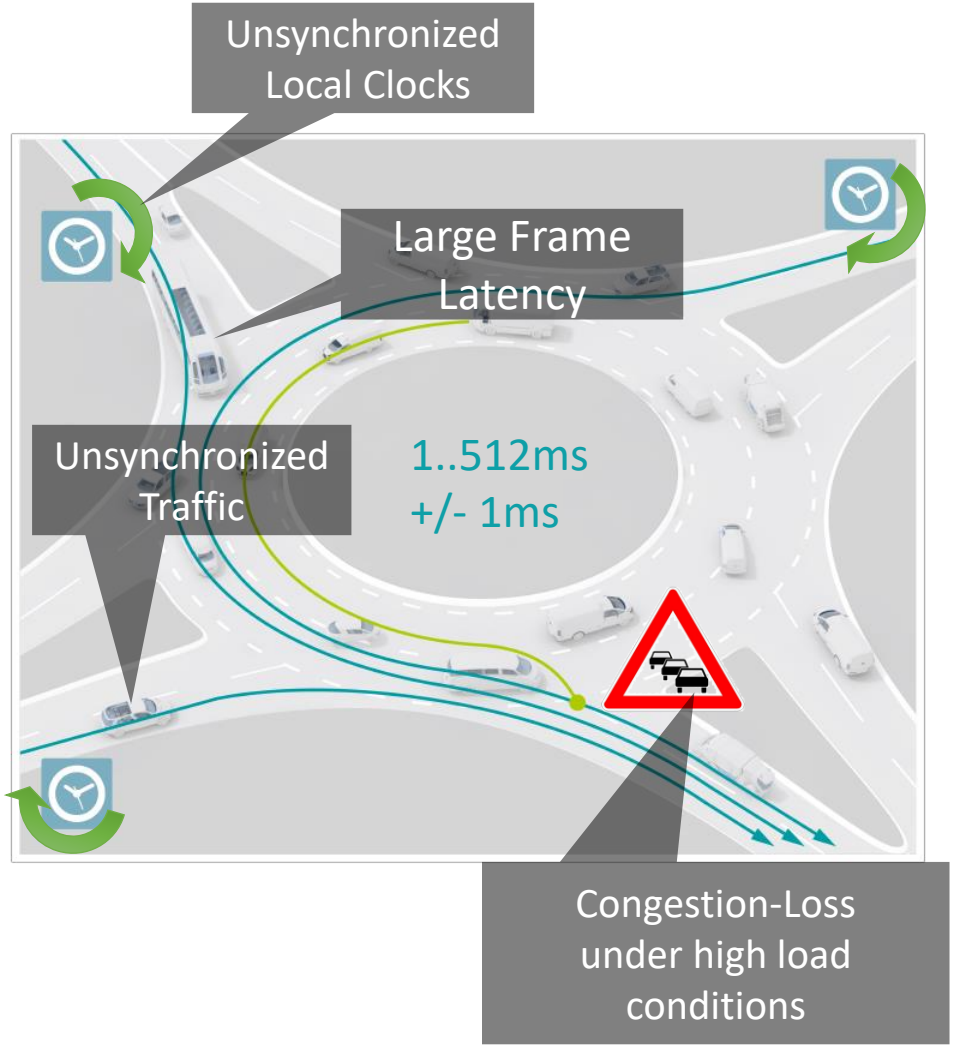
Manufacturing

Profile C

Energy Automation

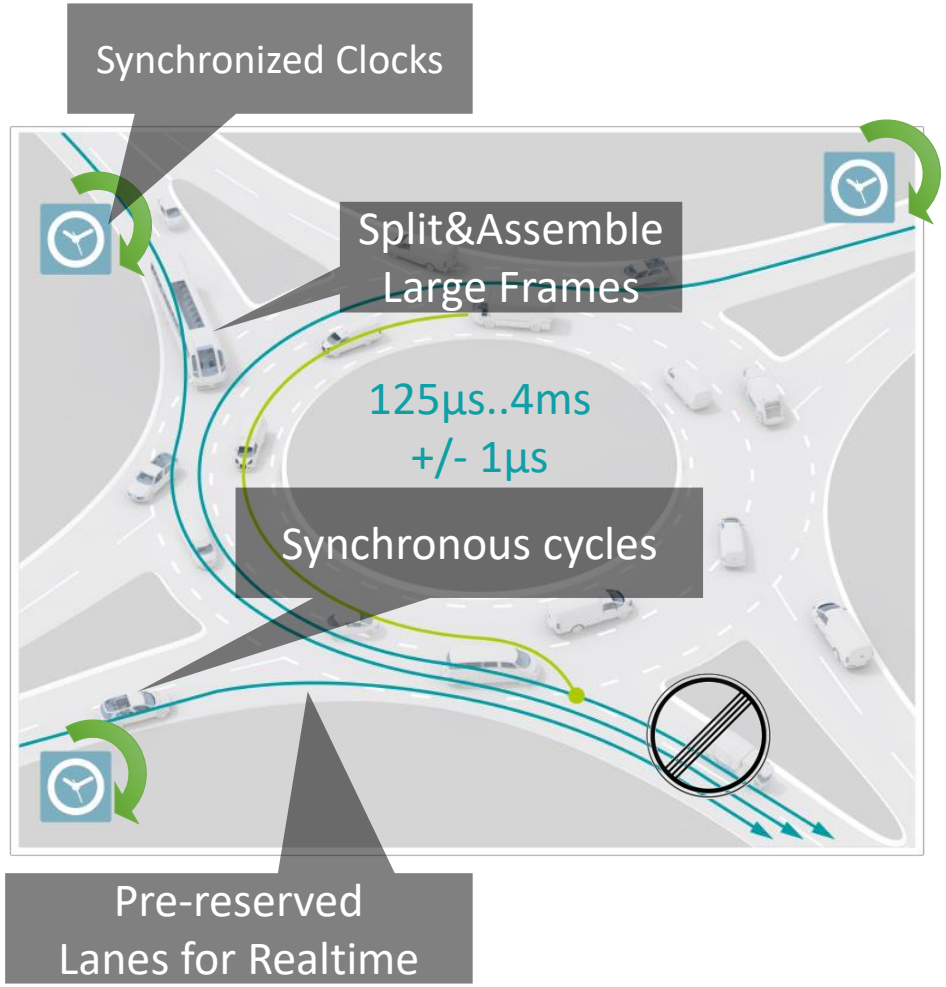
What is today's solution?

- There are many communication standards on Ethernet such as MODBUS/TCP or Ethernet/IP. PROFINET RT also works with today's IEEE standard Ethernet technology.
- PROFINET RT is market leading in many controllers, switches, bus-terminals and I/Os. 100MBit/s is primarily used in the devices.
- The bandwidth, real-time capability and speed of PROFINET RT are not sufficient for automation applications that require extended requirements such as cycle times < 1ms or isochronous applications like Motion Control.
- In addition, more and more communication is taking place between the automation devices and IT in order to enable data analytics and more. This communication can exceed the bandwidth of 100MBit and must not affect real-time communication through "congestion loss".
- With PROFINET RT, the network load is predicted by planning rules not by system-> See PI Planning-Guidlines

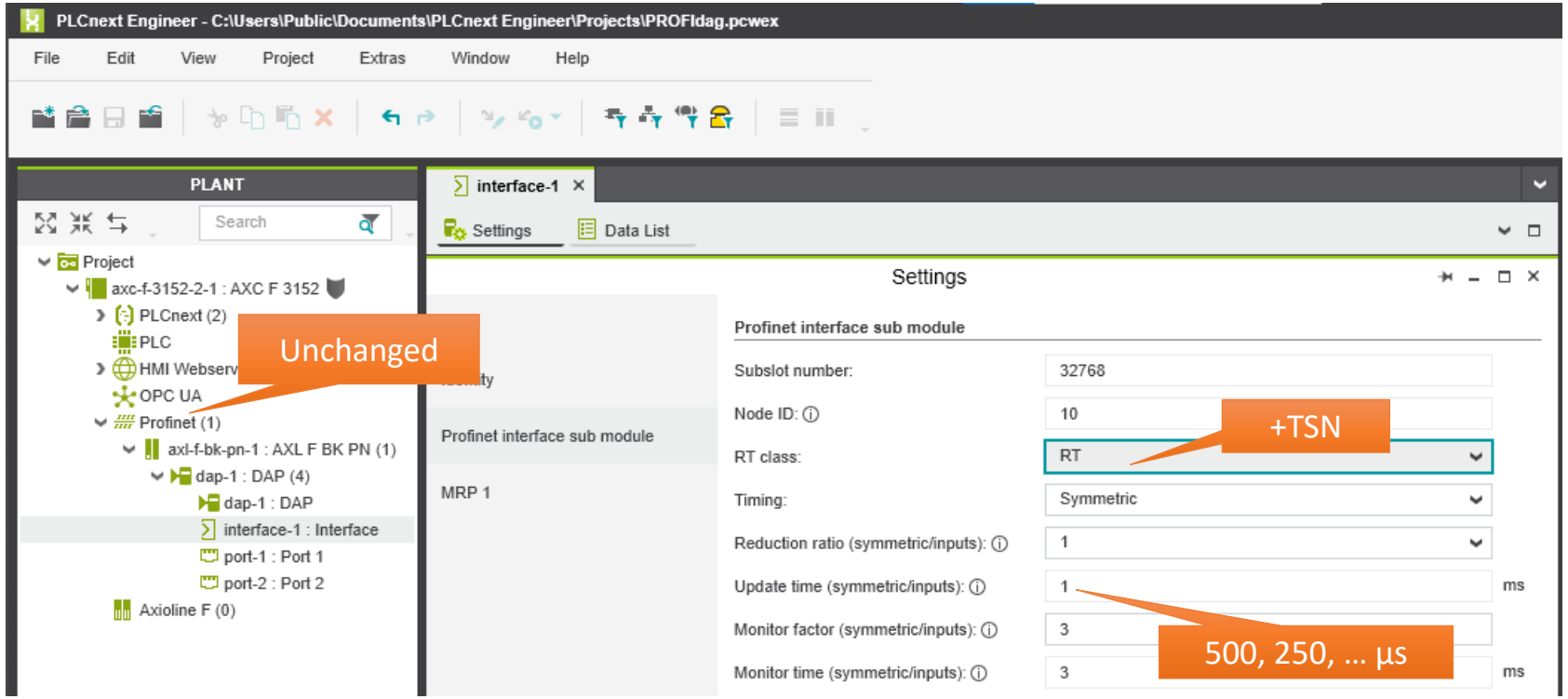


What is PROFINET over TSN?

- Since version 2.4, PROFINET is also specified for use with TSN standards.
- The user view remains unchanged. Customers can take advantage of the new possibilities of TSN without having to familiarize their self with a new system.
- PROFINET TSN can be integrated into every new device and switch if chipsets and software support TSN standards.
- The devices can also be used for RT and other Standard Ethernet systems like MODBUS/TCP or Ethernet/IP as TSN Standards are downwards compatible.
- PROFINET TSN is specified for 10MBit to 10Gbit/s and thus can also be used to improve new applications like APL/SPE.
- Today's PROFINET RT devices can be connected to a TSN network without loss of function -> investment protection and migration path
- It is guaranteed that PROFINET and other IoT data do not influence each other. Check of planning rules is integrated in the system.



How can I use PROFINET over TSN?

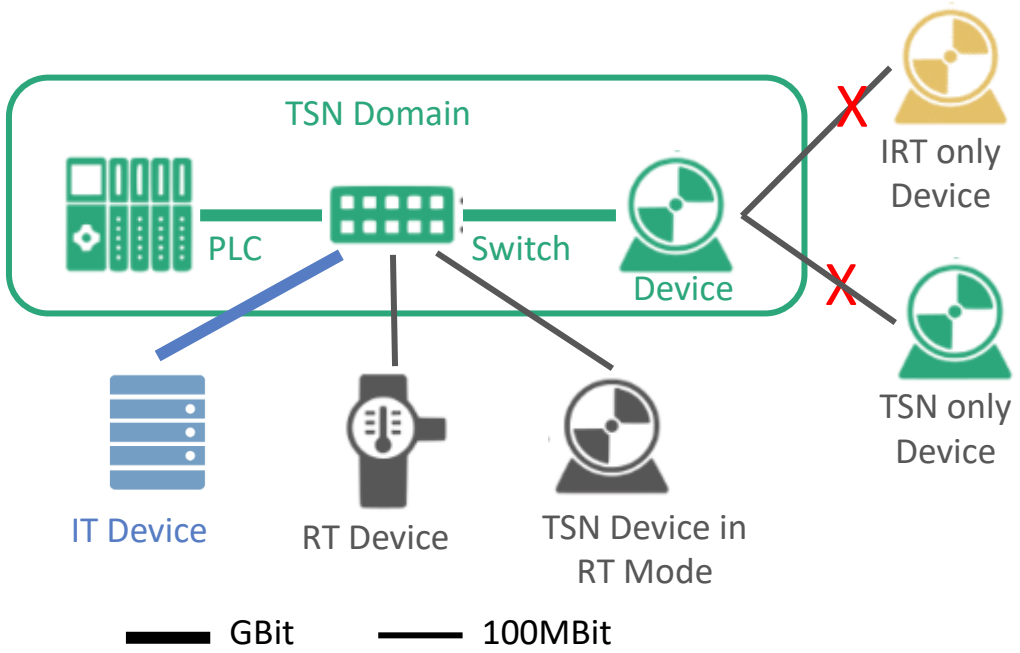


Example PROFINET Engineering Tool

- The Profinet configuration of the devices remains unchanged. The necessary TSN planning is carried out on the controller
- For devices with TSN capability, TSN can be selected as an additional RT class
- Depending on the performance of the controller, smaller cycle times than 1ms are then possible.
- The installed network topology can be changed without the need to adapt the PLC engineering -> Plug&Produce

Which devices and topologies are possible?

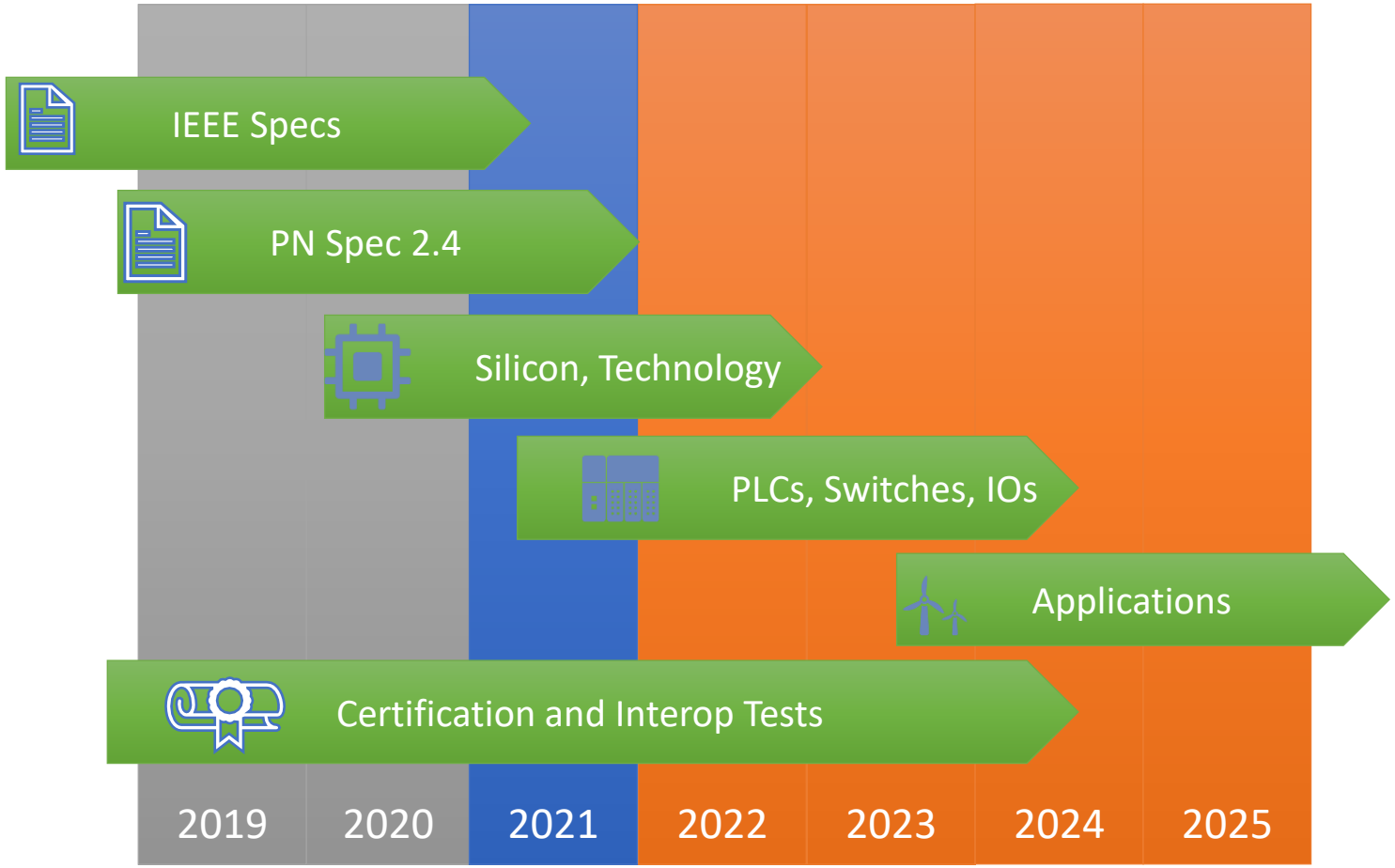
- All devices in a so-called TSN domain can use TSN features. The domain is configured during set-up of the devices.
- On free ports of a TSN domain, existing Profinet RT devices and IT devices can be used without restriction.
- Devices that support TSN and RT can be used inside and outside of a TSN domain -> One product for RT and TSN
- TSN-only devices are only allowed in a TSN domain
- IRT Devices can not be used on boundary ports with IRT functionality
- The capabilities of the devices are documented in the GSDML file.
- Be preferred bandwidth in the TSN domain is 1GBit/s



What advantages do I have of PROFINET over TSN?

- ✓Advanced real-time capabilities
- ✓Bandwidths from 10MBit to 10GBit
- ✓Guaranteed transmission of real-time data even under high IT loads in the same network
- ✓PI as established and mature user organization for controller and device manufacturers
- ✓Unchanged Look&Feel
- ✓Plug&Produce like PROFINET RT

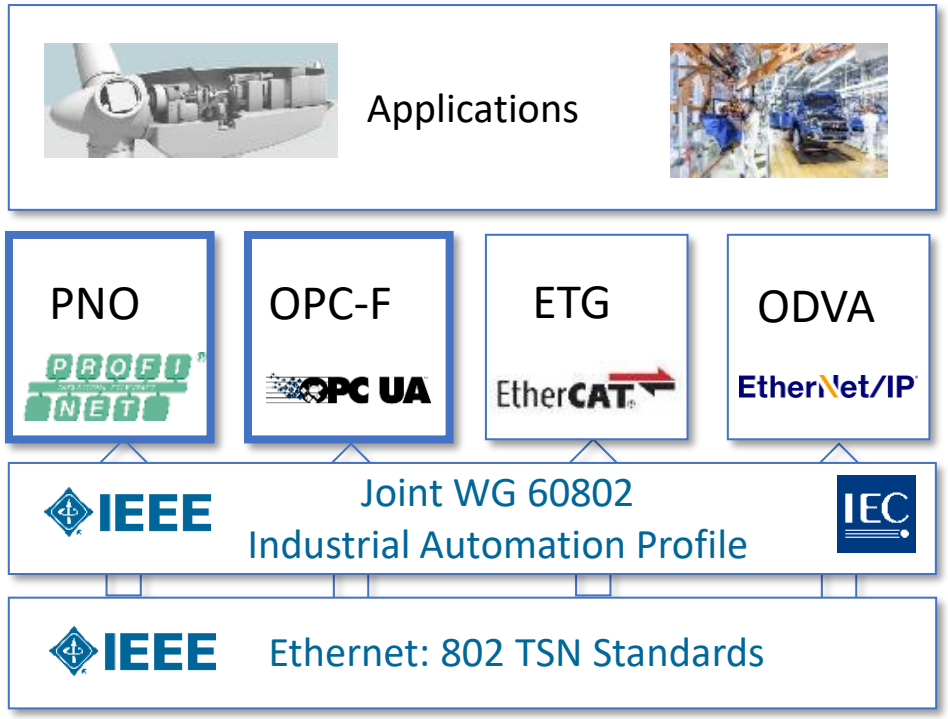
When will products be available?



- TSN is a future technology that requires new chipsets and stacks and thus new developments in all devices involved.
- Availability depends on the respective technology, product and PLC provider
- In parallel work is already being done on the development of a certification system for Profinet with TSN

What's next for TSN?

- TSN standards are related to data link layer (2)
- As IEEE does not do any profiling, each user organization can select different TSN standards for their ecosystem.
- To harmonize this, a joint task force of IEEE and IEC has been set up – 60802. Release is expected for 2023
- IEC/IEEE 60802 targets the converged network, which enables the concurrent support of PROFINET, OPC UA, EtherCAT, vendorspecific and TCP/IP traffic on the same wire
- Profinet will follow IEC/IEEE 60802 to enable the converged network with OPC UA and TSN
- See: https://1.ieee802.org/tsn/iec-ieee-60802/



L1: 10MBit … 10GBit, SPE, APL

Summary

- The usage of IEEE TSN standards continues the PI success story for the next decades.
- PROFINET over TSN enables additional applications that RT, IRT and even other standards cannot fulfil.
- Existing PROFINET RT devices can be used in combination with TSN for seamless migration
- Look and Feel is not changing. The PROFINET Plug&Produce concept remain.

The PROFINET way to TSN

Thank you! Questions?