The Profinet TSN profile for easy network configuration

How Plug&Produce works even with TSN

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-Member: PN Marketing, Commitee-B, I4.0, SPE

OPC Foundation:

- WG Member: OPC UA FLC - TSN Expert Group

- WG Member: PROFINET for OPC UA

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Time Sensitive Networks

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.

*Not using IEEE Standard Ethernet Hardware

Realtime Traffic

Best Effort Traffic

Congestion loss!

A switch can behave like a roundabout at rush hour

What is TSN?

- The "**T**ime **S**ensitive **N**etworks" group in the IEEE is responsible for the worldwide standardization of Ethernet.

- TSN is <u>not a single standard</u> it is a <u>"toolbox" of standards available since 2018</u>

- 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.

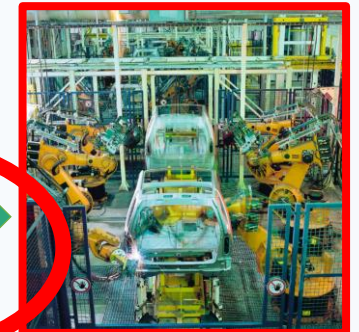- Thus, PROFINET defines its own TSN profile

#	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 "

Profile A

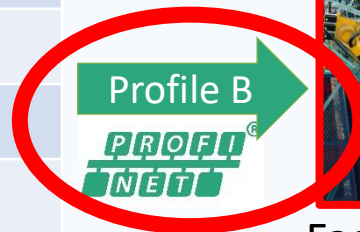In-Car

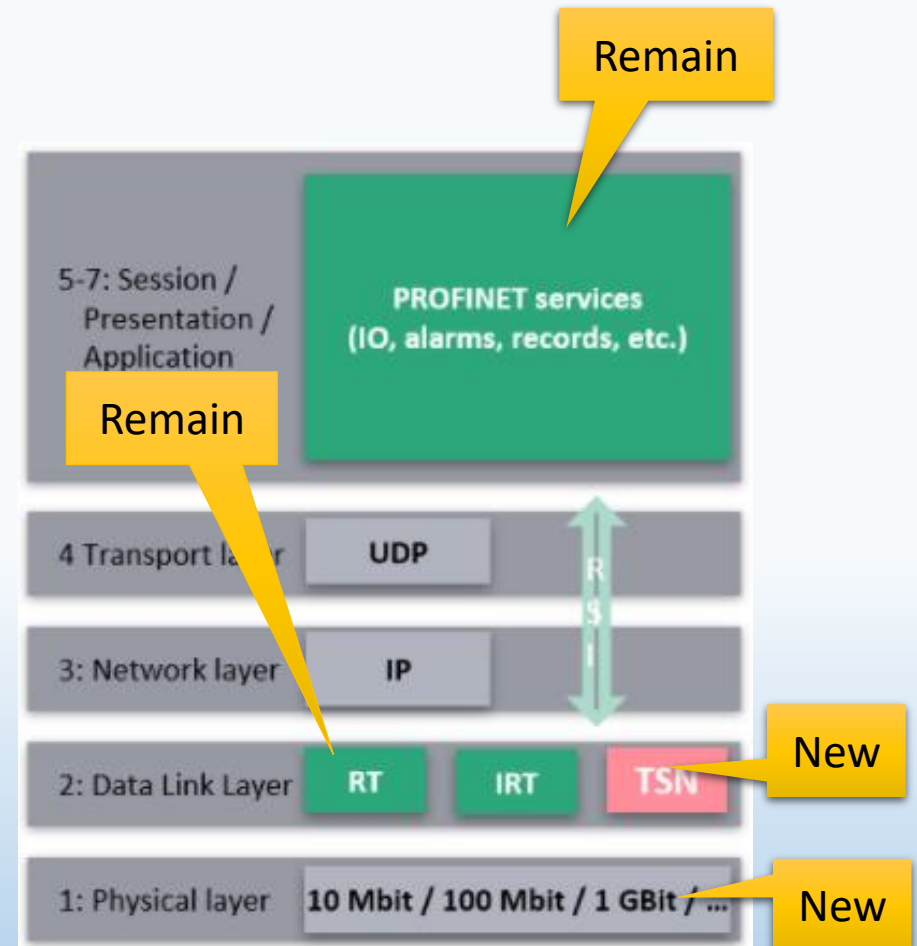Profile B

PROFI NET

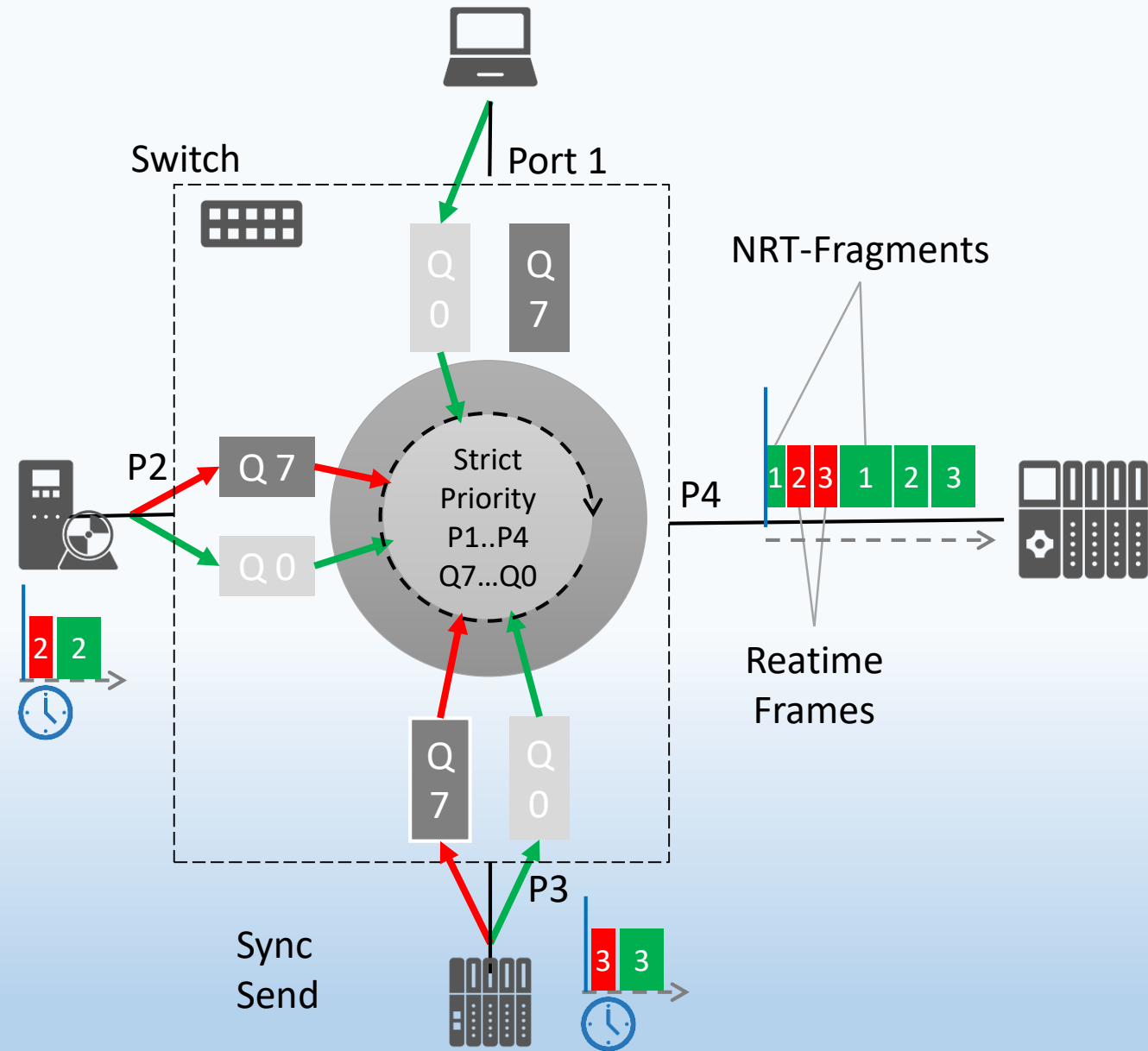Factory Automation

Profile C

Professional AV

What is Profinet over TSN?

- Since version 2.4, PROFINET is also specified for use with TSN standards.

- The <u>user view and look&feel is unchanged</u>. Customers can take advantage of the new possibilities of TSN without having to familiarize their self with a new system or handling.

- 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 OPC UA Pub/Sub, 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 <u>PROFINET RT devices can be connected to a TSN network without loss of function</u> -> 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.
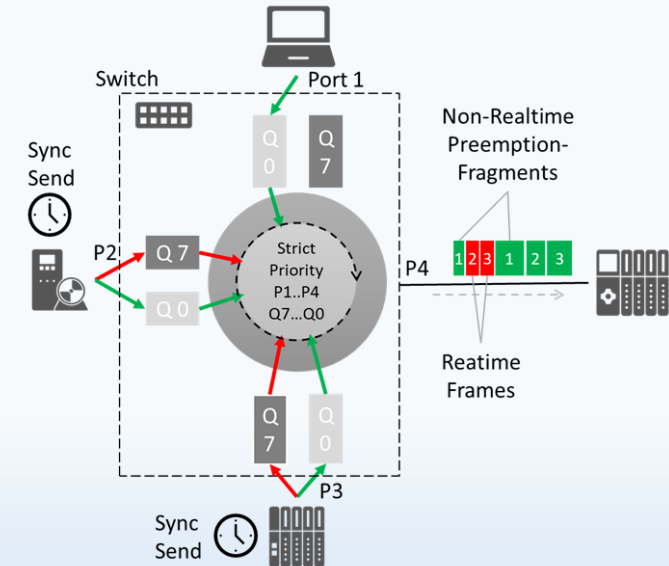

Remain

Remain

5-7: Session / Presentation / Application — PROFINET services (IO, alarms, records, etc.)

4 Transport layer — UDP

3: Network layer — IP

2: Data Link Layer — RT   IRT   TSN

New

1: Physical layer — 10 Mbit / 100 Mbit / 1 GBit / ...

New

How does is work?

- Clock synchronization with 802.1AS

- Synchronized sending of frames

- Frame-Storage in switch Qs

- Strict priority scheduling

- Preemption of large NRT frames

- Configured Switch-Buffers to avoid overload of NRT to RT traffic.

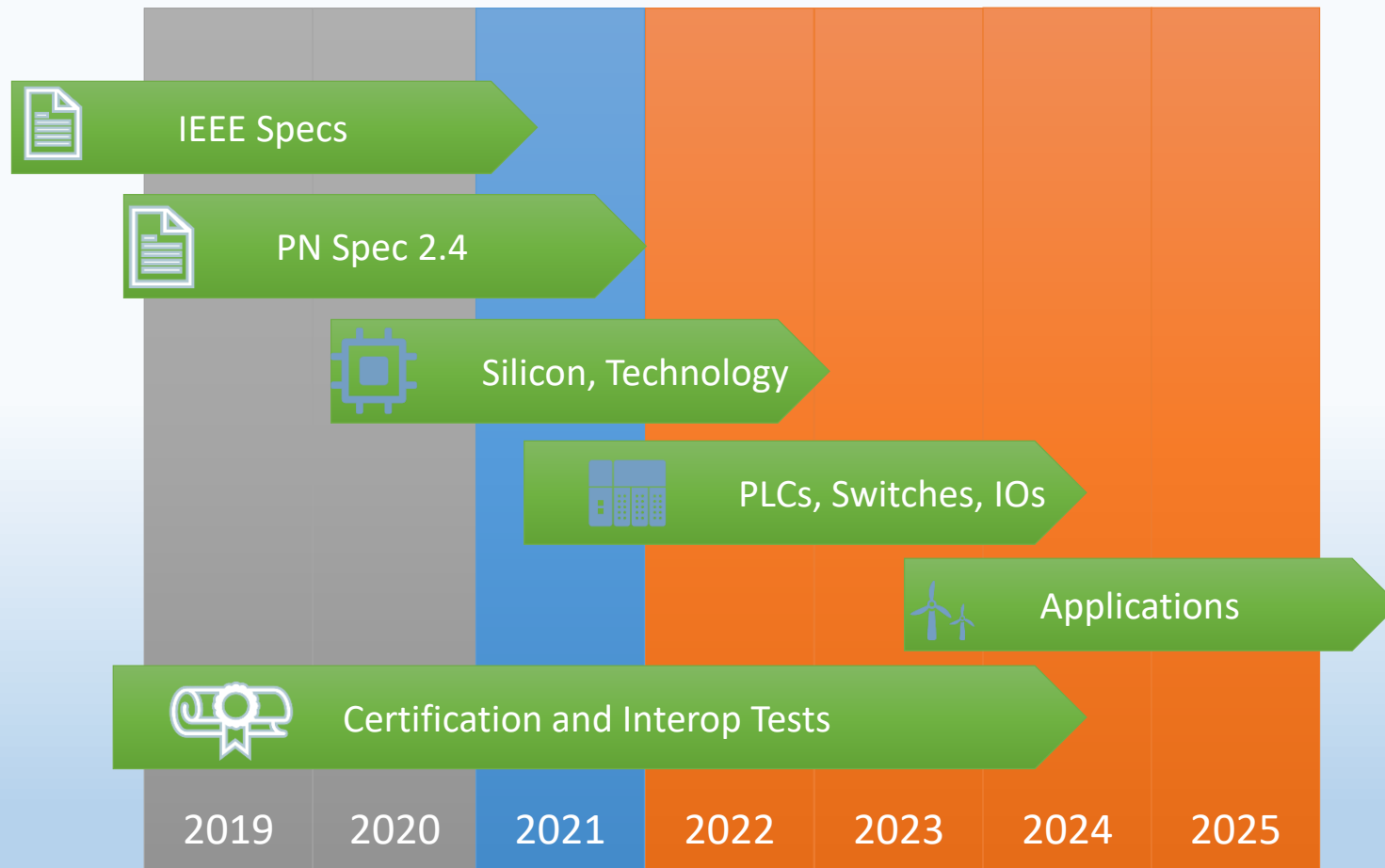**Industrial Ethernet**

The PROFINET way to TSN

Advantages?

- Switches do not need to be synchronized*

- No complex frame scheduling

- Devices can be plugged and pulled during runtime

- Device position can be changed during runtime

- Low latency due to preemption (1μs@1GBit/s per hop)

- No waste of bandwidth

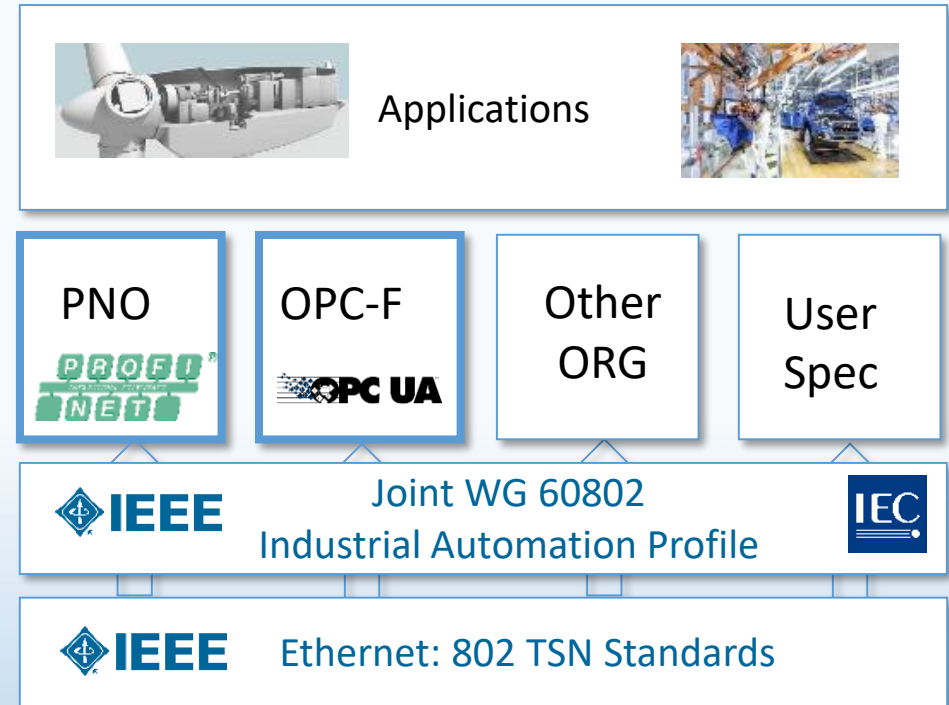*Only transparent for PTP sync frames.

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/

Applications

| PNO | OPC-F | Other ORG | User Spec |

◈ IEEE — Joint WG 60802 Industrial Automation Profile — IEC

◈ IEEE — Ethernet: 802 TSN Standards

L1: 10MBit … 10GBit, SPE, APL

Summary

- The usage of IEEE TSN standards continues the Profinet success story for the next decades.

- Profint 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.

Thank you – Questions?

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