CINI 4.0

Workshop ETFA 2022

Basic Ethernet Time Sensitive Networking

7/09/2022

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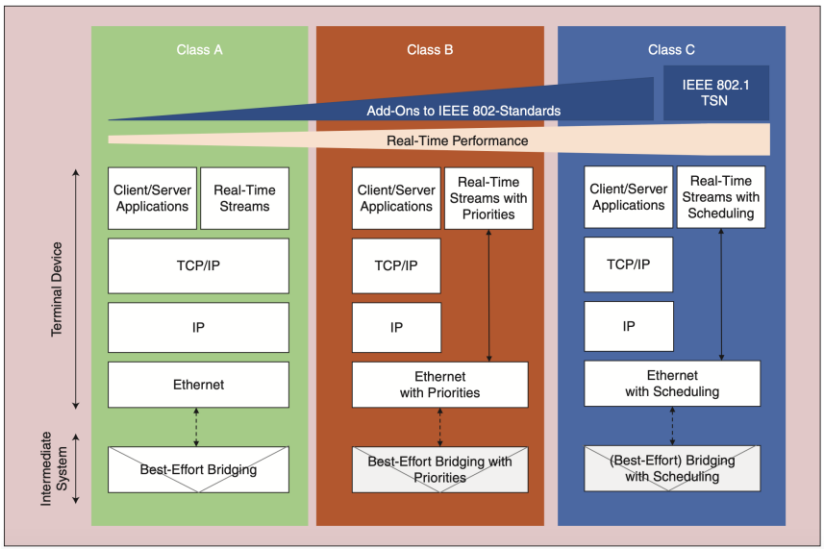
IGF 309 EN (01/08/2021-31/07/2023) – HBC.2020.2998

Industrial communication systems - QoS classes



Source: M. Wollschlaeger, T. Sauter and J. Jasperneite, "The Future of Industrial Communication: Automation Networks in the Era of the Internet of Things and Industry 4.0," in IEEE Industrial Electronics Magazine, vol. 11, no. 1, pp. 17-27, March 2017, doi: 10.1109/MIE.2017.2649104.

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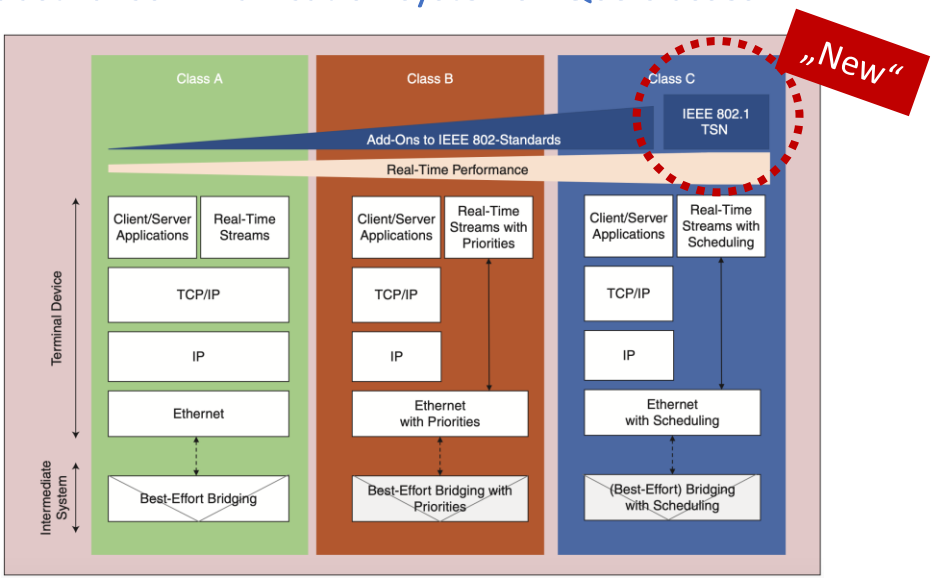
Industrial communication systems - QoS classes



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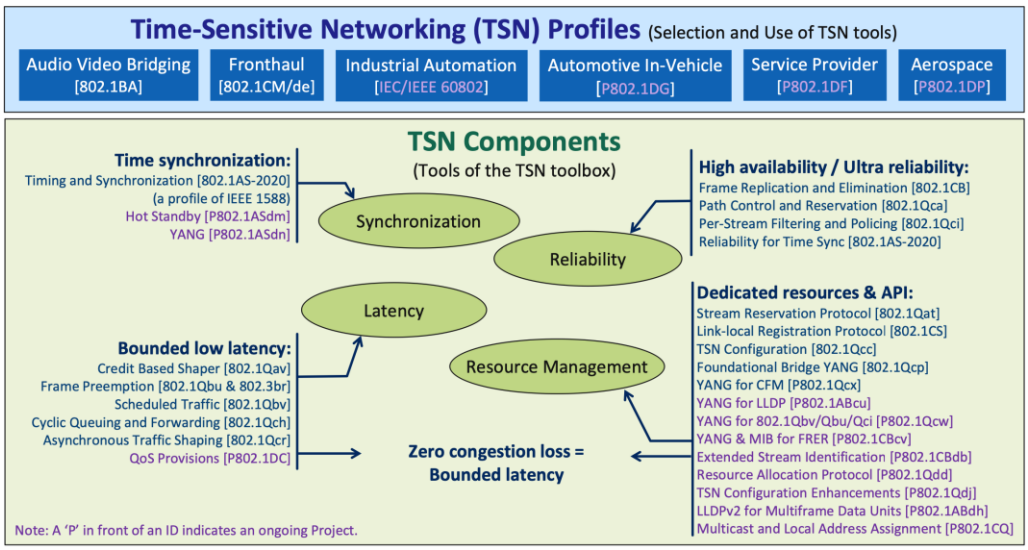
Time Sensitive Networking (TSN)



More on TSN standards and ongoing projects at: https://www.ieee802.org/1/tsn

February 3, 2021

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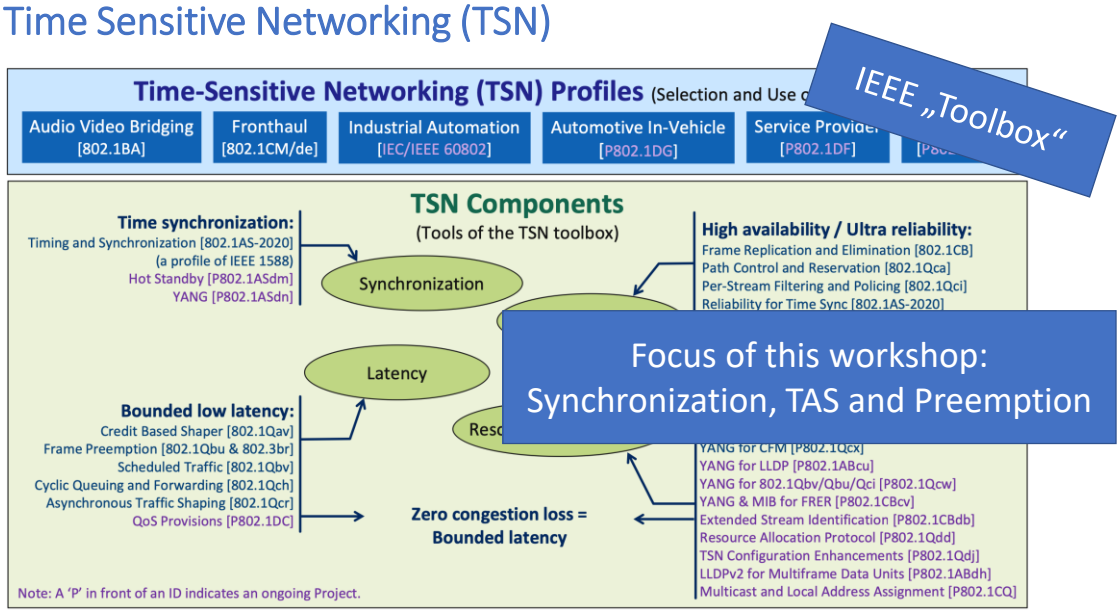
Time Sensitive Networking (TSN)



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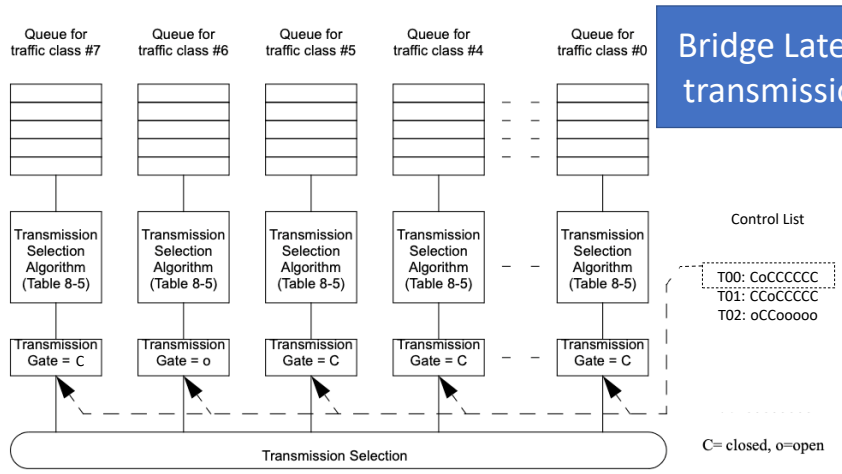
TSN – Latency



Bridge Latencies caused be ongoing transmissions of best effort frames

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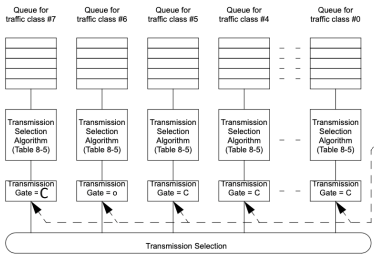
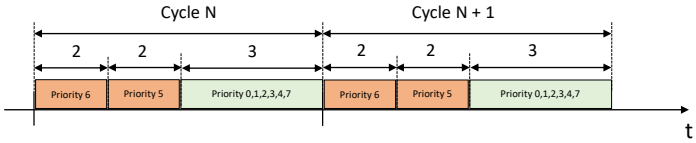
TSN – Latency – Time Aware Shaping (TAS)



Control List

T00: CoCCCCCC 2ms
T01: CCoCCCCC → 2ms
T02: oCCooooo 3ms

Lower latency by queue masking



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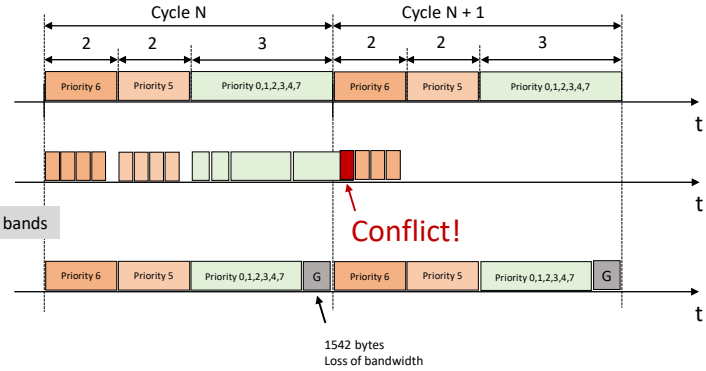
TSN – Latency – Guard Bands



- Guard-Band in the size of the maximum frame size
  - Pros: deterministic forwarding of time critical frames
  - cons: not optimal usage of available bandwidth

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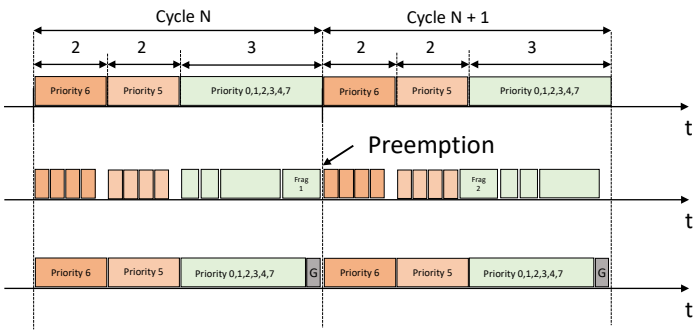
TSN – Latency – Preemption



- Frame pre-emption describe a mechanism which allows to prioritise certain frame while sending or forwarding
- Fragmentation of preemptable frames is possible to make the guard band small as the size of one fragment

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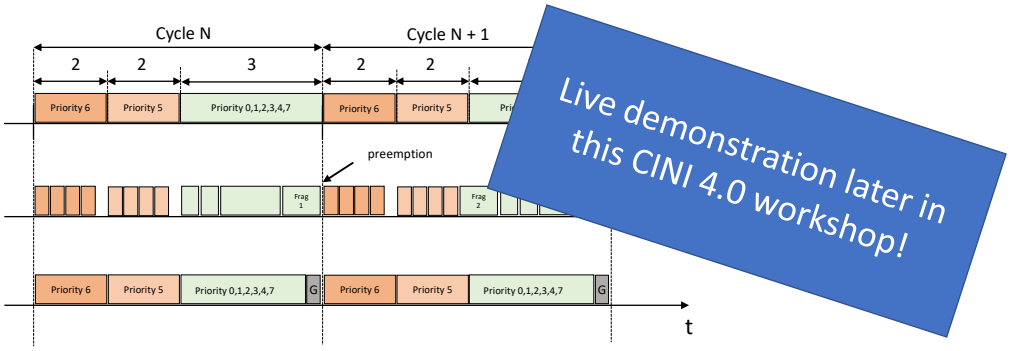
TSN – Latency – Preemption



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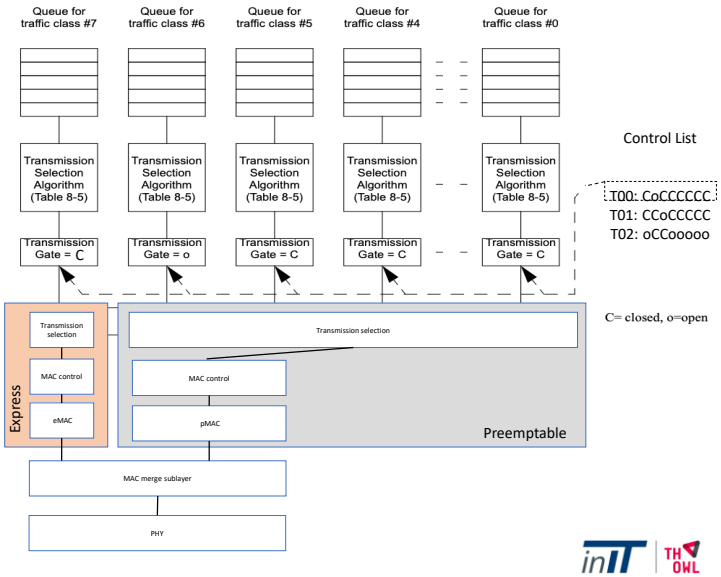

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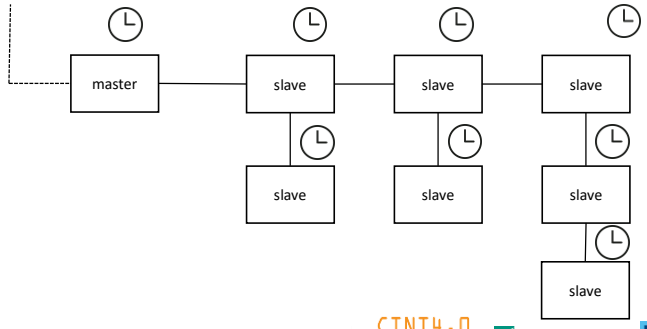
TSN – clock synchronisation

- IEEE 802.1AS-2020
- Function range:
  - Clock synchronisation between diverse TSN devices
  - Data exchange happens at the 2nd layer
  - Best Master Selection Algorithm (BMCA) chooses the Grandmaster inside the synchronisation domain
  - Measurements of bridge and line delay
  - Sending sync frames to adjust the clock drift at the slaves



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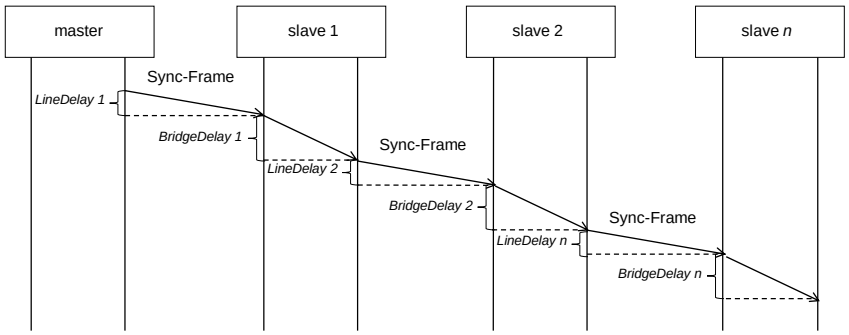
TSN – clock synchronisation



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Thank you very much!

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