# Generic TSN end-to-end guideline

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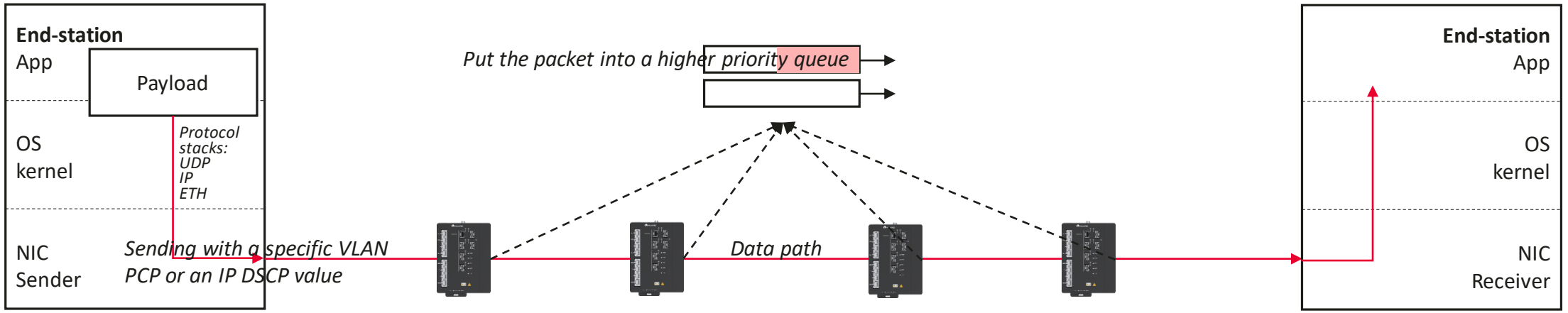
# Previous contribution

- July Plenary.
  - > https://www.ieee802.org/1/files/public/docs2024/new-chen-generic-tsn-e2e-guide-0724-v01.pdf
  - > Problem: Although significant progress has been made in TSN technique and standardization by IEEE 802.1 TSN TG, there is no generic guide on how to apply TSN to time-sensitive applications. Together with the various understandings and misunderstandings of TSN in the industry have, to a certain extent, constrained / slowed down the practical use of TSN.
  - > Suggestion: **An informative generic TSN end-to-end guideline** can be helpful for stakeholders deploying TSN systems. The guideline could contain multiple examples, each based on a selected TSN feature set, describing the fundamental factors that need to be considered to achieve deterministic connectivity.




*A basic option is to use Strict Priority (802.1Q 8.6.8.1)*

# Discussions and follow-up

- Concern 1: We work on Profile standards for certain application areas, a generic one may not be needed.
  - > Response: **The proposed generic TSN end-to-end guideline is not a profile.**
  - > Distinctions:

| A Profile | The proposed guideline |
| --- | --- |
| > Select features, options, configurations, defaults, protocols, and procedures of bridges, end stations, and LANs for networks of a particular domain. | > Give informative examples that provide deterministic connectivity based on selected feature sets.<br>- Strict Priority only.<br>- SP + CBS/ATS.<br>- SP with time synchronization.<br>- SP + EST with time synchronization.<br>- … |
| > Specify conformance classes. | > It is NOT the intention to compare different feature selection sets, but maintaining objective and focusing on the goal of providing end-to-end deterministic connectivity. |
| > Can be used to develop conformance test. | > Informative. |

# Discussions and follow-up

- Concern 2: A generic guideline seems not to be a IEEE 802.1 standardization task.
  > Response: **IEEE can also develop other types of documents, e.g., a Recommended practice or a Guide.**
  > http://standards.ieee.org/wp-content/uploads/import/documents/other/ieee_sa_toolkit.pdf

**PROJECT AUTHORIZATION REQUEST (PAR)**

The first step is to determine what type of document should be developed. It can be one of the three types of IEEE standards documents:

- **Standards:** Documents with mandatory requirements.
- **Recommended practices:** Documents in which procedures and positions preferred by IEEE are presented.
- **Guides:** Documents in which alternative approaches to good practice are suggested but no clear-cut recommendations are made.

These levels of requirements are often shown by the use of particular "standards verbs," i.e., "shall" for requirements, "should" for recommendations, and "may" for guidelines. (more information can be found in the IEEE SA Standards Board Operations Manual and the IEEE SA Standards Style Manual) Figuring out what level of requirement is needed helps determine what kind of document should be developed.

# Discussions and follow-up

- Concern 3: Who will be working on it?
  - > Response: **Having something generic may attract contributors from a broad variety of markets**.
  - > Any application requiring deterministic communication in a LAN/MAN network should be able to use TSN, regardless of whether there is a profile standard or not

| Markets with a finished/ongoing TSN Profile |
| --- |
| > Audio Video Bridging Systems. |
| > Fronthaul. |
| > Industrial Automation. |
| > Automotive In-Vehicle Ethernet. |
| > Aerospace Onboard Ethernet. |

| Others |
| --- |
| > In-vessel network. |
| > In-equipment network. |
| > In-robot network. |
| > Campus network. |
| > Data center network. |
| > … |

# Proposal

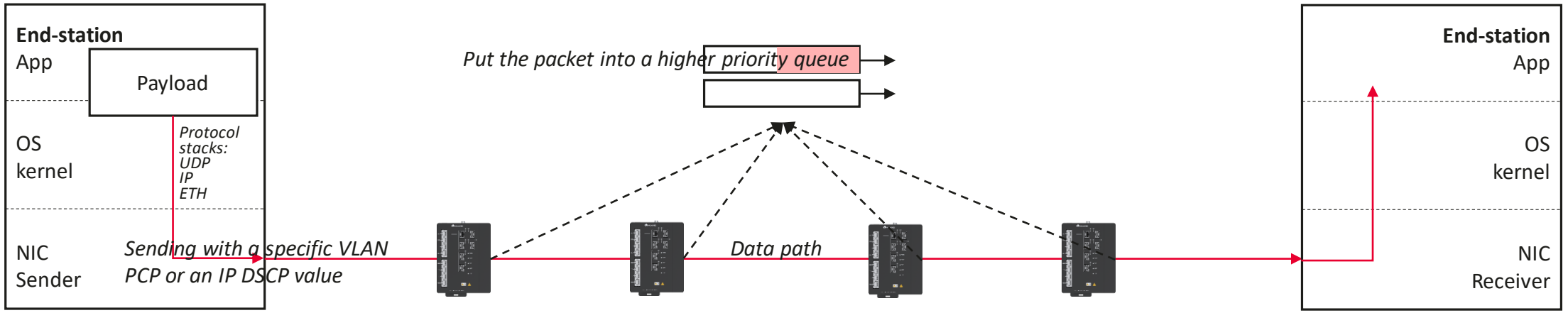
- **Scope of proposed Guide**: This guide specifies a generic TSN guideline providing baseline examples for deploying a TSN system, from the sender end-station through the network to the receiver end-station. An example should consider fundamental factors, including the usage of transmission selection schemes, the collaboration between end-stations and bridges, and ways to check whether the deterministic requirements are met.

- **Need for the Project**: The IEEE 802.1 TSN TG is chartered to provide deterministic connectivity through IEEE 802 networks and many features, protocols and procedures have been specified and standardized. There is little guide given in published IEEE 802.1 Standards, Recommended practices, Guides or ongoing projects for using these features, protocols and procedures for deterministic connectivity, or it is often specific and may not be broadly applicable.

Thank you.

# An example, based on Strict Priority only

- Content: The fundamental factors that need to be considered.
  - > The usage of transmission selection schemes. -> Strict Priority
  - > The collaboration between end-stations and bridges. -> A value in the frame header to identify time-sensitive traffic.
  - > The way to check if the deterministic requirements are to be met. -> Simplified math. The bound can be loose, but must be right.




*A basic option is to use Strict Priority (802.1Q 8.6.8.1)*

# An example - more specifically

- 1, make sure the bridge supports and enables Strict Priority.
  > Explain Strict Priority, what else might it be called, and in which part of a bridge document might the descriptions of such behavior be found.
- 2, choose a way for packet identification.
  > Option 1: VLAN PCP. Use UDP* to develop the network communication part for the time-sensitive application. Make sure a VLAN tag is added to the Ethernet frame header and the Priority Code Point is set to 5 (or 4, or …). Make sure the bridge supports VLAN and trusts the PCP value.

  > Option 2: IP DSCP. …
- 3, check the numbers.
  > Option 1: check the reference table.

| Case | Bandwidth | Scale | Traffic pattern | Latency requirement |
|---|---|---|---|---|
| 1 | No less than 1Gbps. | 100 flow @ 10 hop | cyclic, no more than 200Byte per 1ms | No less than 500us |
| 2 | No less than 1Gbps. | 1000 flow @ 100 hop | cyclic, no more than 200Byte per 4ms | No less than 4ms |
| 3 | … | … | … | … |

*The math is hidden with a generous engineering margin. The bandwidth of Ethernet makes it possible.*

  > Option 2: do the math. This example provides a way to calculate a right latency upper bound. This example may or may not provide more ways to calculate tighter latency upper bound.
    - On a per-hop addition basis.
    - Consider the link delay as fixed/based on length, the store-and-forward delay based on max-packet-length, the queuing delay based on the lower priority max-packet-length block, and all other delays within the bridge (processing and regulation delay) as fixed/based on tests.
    - Consider all other high priority packets come right before you.



*Yet IEEE 802 does not specify a EtherType that encapsulate APP layer headers and payloads directly after the Ethernet frameheader, does it?

# More examples

- If time synchronization is a selected feature, add…
  - > NIC-network-NIC and System-NIC synchronization.
  - > The use of system time for applications.
  - > Notes on synchronization accuracy.

- If enhancements for scheduled traffic is a selected feature, add…
  - > Configuration scheme: End-to-end ‘express’ tunnel or ‘bus mode’, or schedule calculated by any algorithm, or CQF/ECQF.
  - > Sending time (baseTime, cycleTime, offset) control on the sender side (time synchronization, real-time system, task scheduling, and scheduled-traffic-like function on the NIC…) and its alignment with the network.
  - > Notes on dealing with deviations.

- If CBS or ATS is a selected feature, add…

- …