Proposal for New Annex

“TrafficSpecification settings for bursty traffic with bounded latency”

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Abstract

- TrafficSpecification settings for bursty traffic with bounded latency in TSN networks are proposed.
  - to avoid disturbing other reserved traffic by temporal high network load
  - to avoid over-provisioning of bandwidth reservation

- In this presentation, the essence of the New Annex proposal for Std 802.1Q is provided.

Pre-draft text contribution:
https://www.ieee802.org/1/files/public/docs2020/new-maruhashi-TrafficSpecification-settings-for-bursty-traffic-1020-v02.pdf

Background

- Maintenance TG call (May 12th, 2020)
  - Introduced White Paper ”Mapping method of QoS requirements to TSpec for bursty traffic shaping” https://www.ieee802.org/1/files/public/docs2020/new-Maruhashi-Zein-Mapping-method-of-QoS-requirements-to-TSpec-for-bursty-traffic-shaping-0320-v00.pdf
  - Disposition: The proposed next steps are for the contributors to draft an informative annex from the content provided in the white paper. (omitted the rest)
- Maintenance TG call (Sept. 15th, 2020)
  - Introduced pre-draft informative annex “TrafficSpecification settings for bursty traffic with bounded latency”
  - Disposition:
    - Agreed (informally, none dissenting) to revise the pre-draft Annex based upon review comments and feedback and present the revision at a future TSN conference call.
    - Agreed (informally, none dissenting) to develop text for a draft PAR and CSD to be reviewed at a future TSN call.
- TSN TG call (Oct. 19th, 2020)
  - Explained the latest pre-draft annex and text proposal of draft PAR and CSD.

    https://www.ieee802.org/1/files/public/docs2020/new-nakano-TSpec-for-bursty-traffic-1020-v02.pdf

Outline of the New Annex

- Focuses on bursty traffic by time-sensitive application
  - “bursty” means the traffic comprises ”cluster of frames”
  - “time-sensitive” means the application requires ”bounded latency”
- This type of traffic is common in IoT applications.
  - e.g. real-time camera inspection system which is required to report within 500msec.
  - See Nendica Report: FFIoT
- TSpec settings for such traffic depend on latency information:
  - allowable worst-case latency that the application accepts (i.e. bounded latency)
  - latency that the network provides (i.e. accumulated latency)
- Introduces TSpec settings for such traffic to:
  - avoid disturbing other reserved traffic by temporal high network load
  - avoid over-provisioning of bandwidth reservation

Targeted Traffic Characteristic

- Parameters describing characteristic of traffic
  - Size of a ”cluster of frames” in bit/byte (*dataSize*)
  - Delivery time tolerance (upper bound of *deliveryTime*)
  - Minimum time between clusters
    - Note that clusters of frames occur sporadically, implying T1 ≠ T2
    - Assuming (Minimum time between clusters) > (Delivery time tolerance)

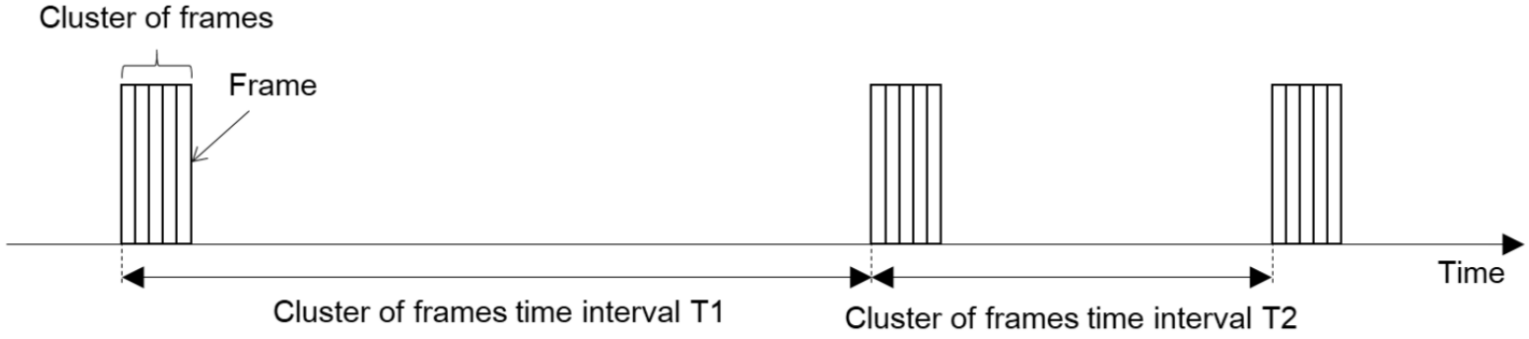

Figure Z-1— Example of bursty traffic pattern

Network Structure and Delivery Time

Mapped between elements in Figure Z-2 and Z-3

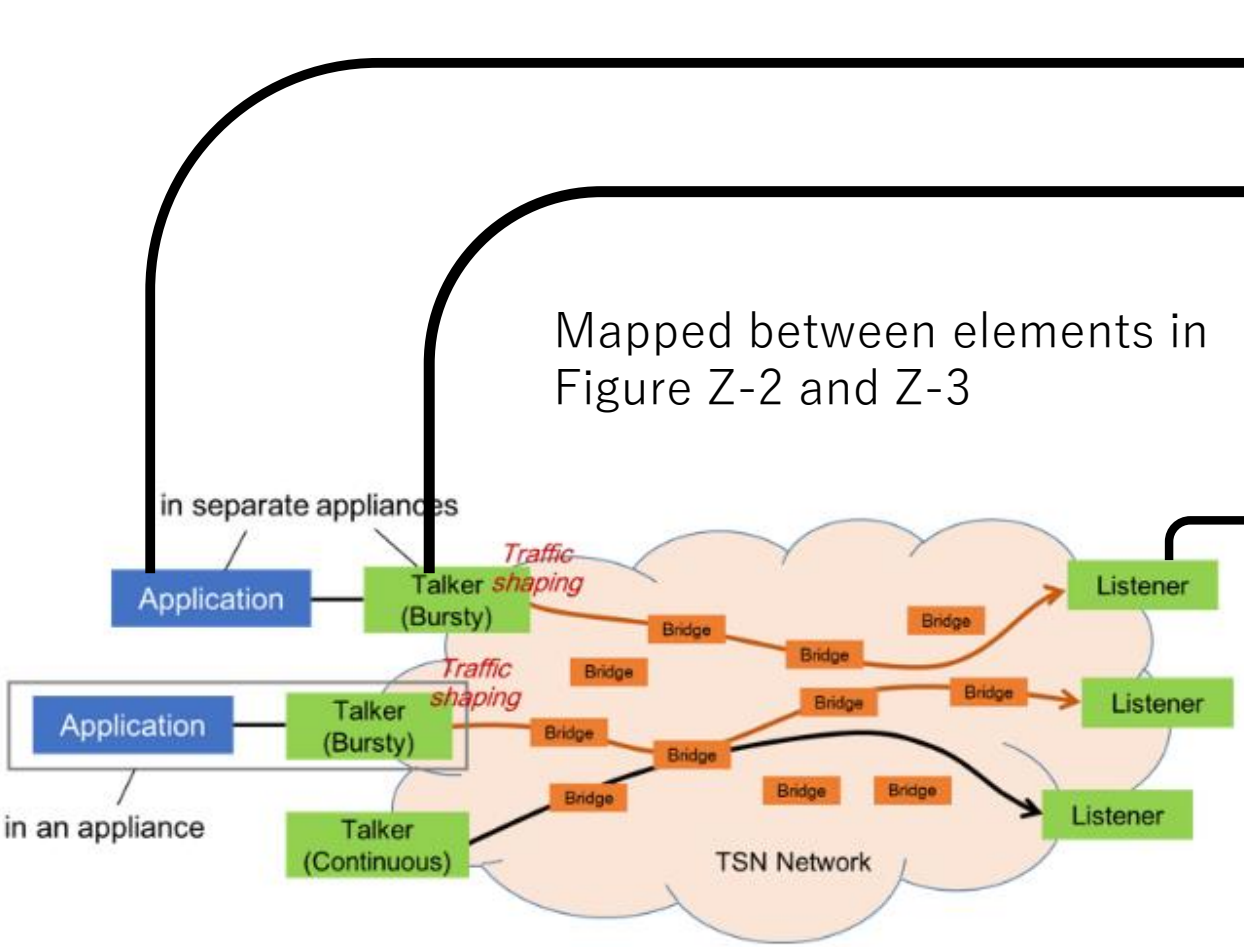

Figure Z-2 — An example of network structure under consideration

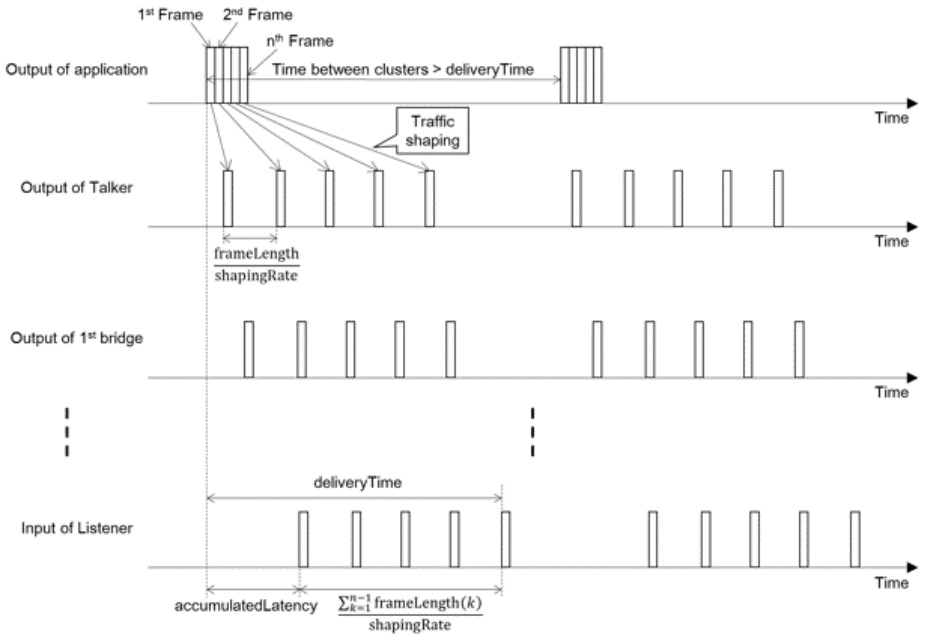

Figure Z-3— Frame propagation from Talker to Listener

Backup

Presentation slides at the TSN call on Oct. 19, 2020

https://www.ieee802.org/1/files/public/docs2020/new-nakano-TSpec-for-bursty-traffic-1020-v02.pdf

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Z.1 Feature of TSN network with Bursty Traffic

Z.1.1 Targeted Traffic Characteristic

- Parameters describing characteristic of traffic
  - Size of a ”cluster of frames” in bit/byte (*dataSize*)
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    - Note that clusters of frames occur sporadically, implying T1 ≠ T2
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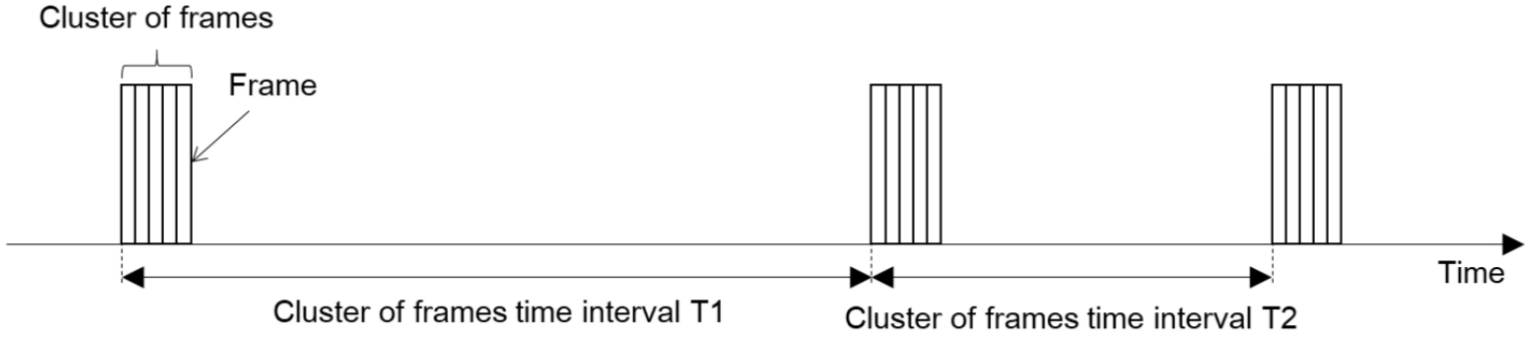

Figure Z-1— Example of bursty traffic pattern

Z.1 Feature of TSN network with Bursty Traffic

Z.1.2 Network Structure

- Talker is assumed to be equipped with
  - transmission selection algorithm
    - credit-based shaper
      and/or
    - ATS
  - enough buffer memory
- Bridges and Listeners are assumed to support resource (bandwidth) reservation function.

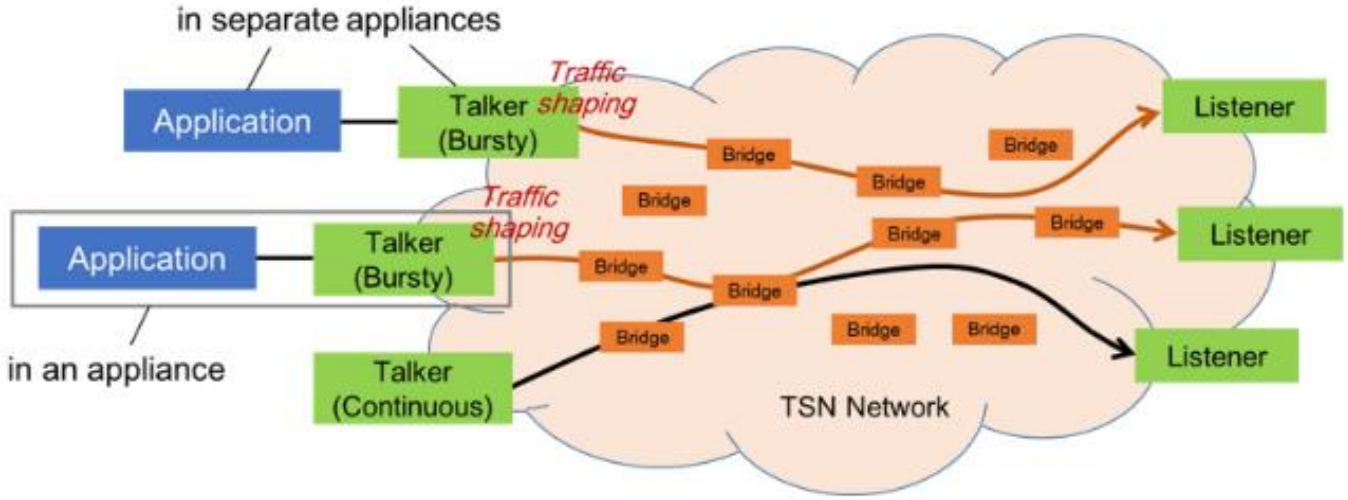

Figure Z-2 — An example of network structure under consideration

Z.2 Overall Frame Transmission Delay

Z.2.1 Delivery Time

- This clause provides definition and calculation of *dataSize* and *deliveryTime*

$$dataSize = \sum_{k=1}^{n} frameLength(k)$$

$$deliveryTime = accumlatedLatency + \frac{\sum_{k=1}^{n-1} frameLength(k)}{shapingRate}$$

accumulatedLatency needs to be calculated in advance

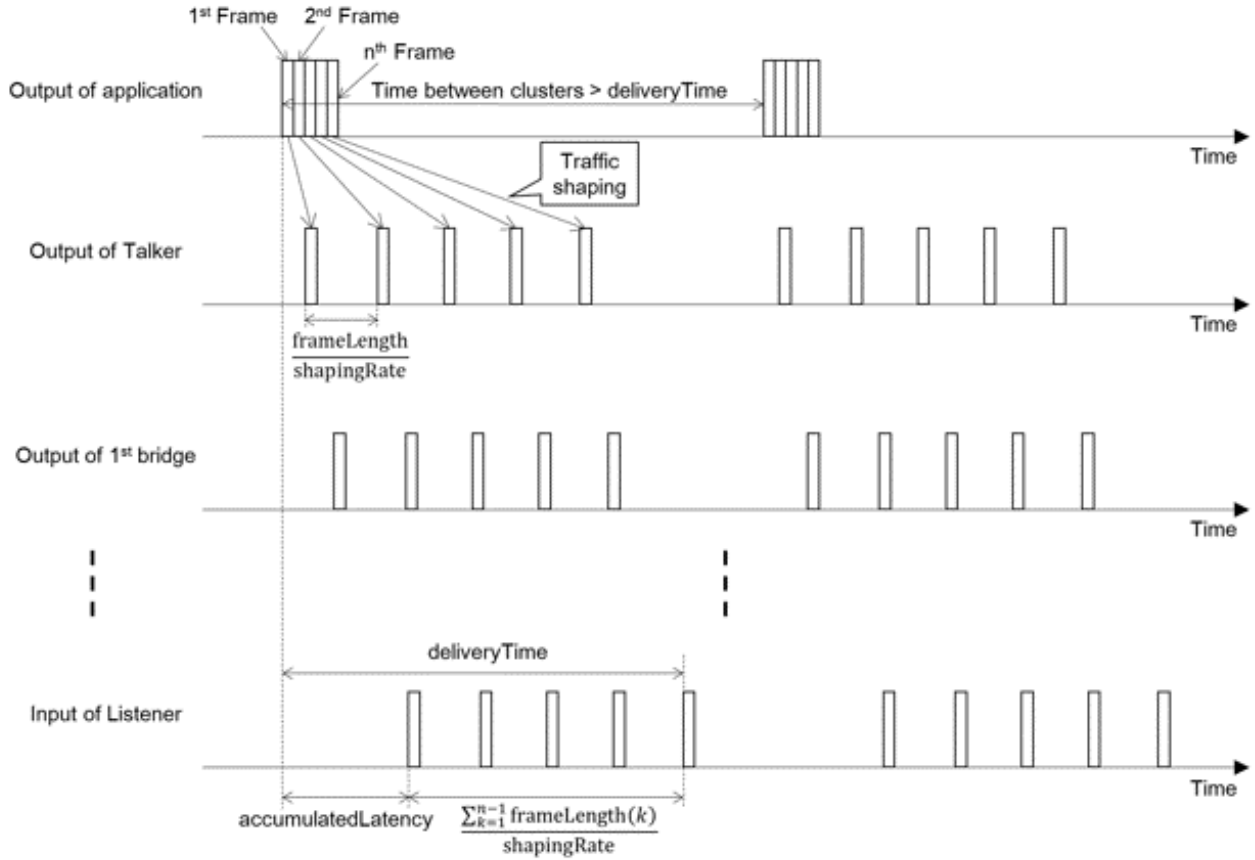

Figure Z-3— Frame propagation from Talker to Listener

Z.1 Feature of TSN network with Bursty Traffic

Network structure and Delivery Time

Mapped between elements in Figure Z-2 and Z-3

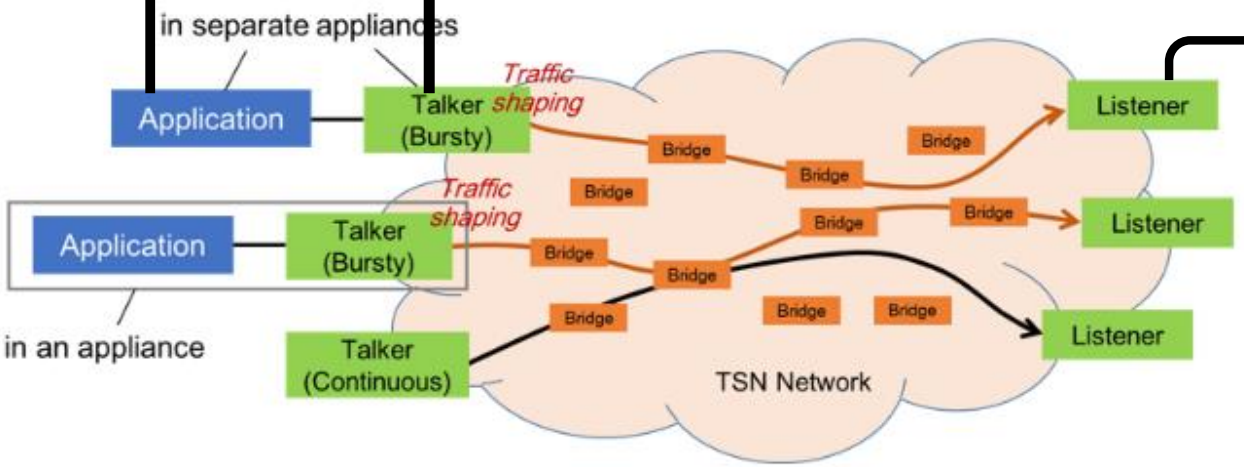

Figure Z-2 — An example of network structure under consideration

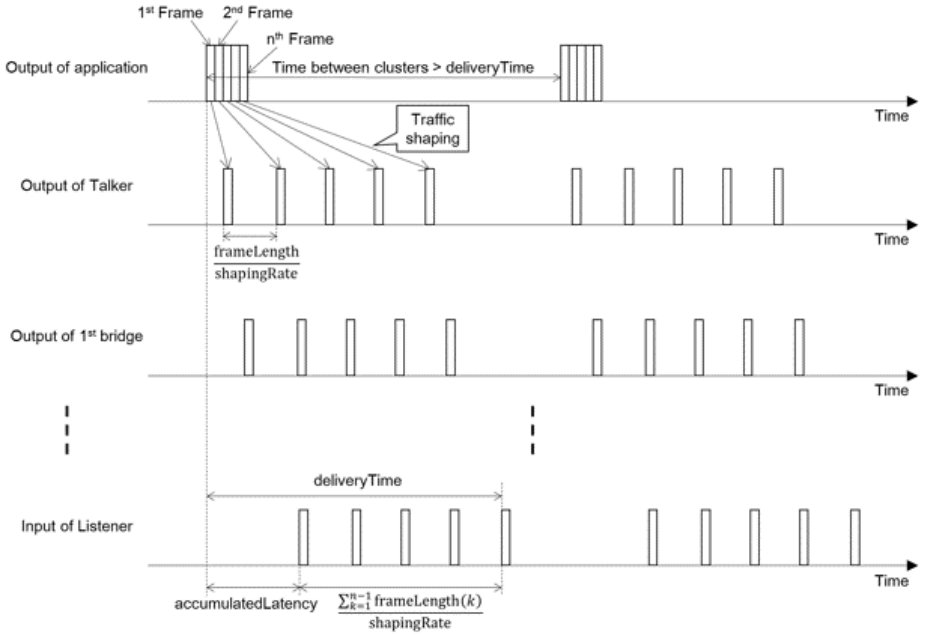

Figure Z-3— Frame propagation from Talker to Listener

Z.2.2 Accumulated Latency acquisition

Z.2.2.1 Fully distributed model

- Currently UNI does not have functionality to obtain the value of *accumulatedLatency* in advance of reservation.
  - *accumulatedLatency* is obtained from AccumulatedLatency group in Status group as a result of successful reservation (IEEE Std 802.1Qcc-2018, Clause 46.2.5.2)
    - The word “element” refers to a single item of information used for TSN configuration. The word “group” refers to a collection of related elements. Groups are organized hierarchically,” (IEEE Std 802.1Qcc-2018, Clause 46.2)
  - Therefore, two steps are required at least to:
    1. Make a reservation with tentative higher accumulatedLatency
    2. Redo the reservation with more suitable accumulatedLatency
       - Note that the second reservation can fails.

Z.2.2.2 Fully centralized model and centralized network/distributed user model

- CNC obtains all information from the network directly.
- Therefore CNC can compute *accumulatedLatency* by itself.

  - For example, the CNC reads the bridge delay (12.32.1) and propagation delay (12.32.2) from each bridge in order to compute *accumulatedLatency* (-see Annex U, Clause U2, step 5, IEEE Std 802.1Qcc-2018).

Z.3 Recommended TSpec Settings

- *requiredMinimumShapingRate* is intended to
  - shape the bursty traffic with bounded latency
  - ensure the requirement for the delivery time is met
  - minimize over-provisioning of bandwidth reservation

$$requiredMinimumShapingRate = \frac{\sum_{k=1}^{n-1} frameLength(k)}{targetLatency}$$

$$= \frac{dataSize - frameLength(n)}{targetLatency}$$

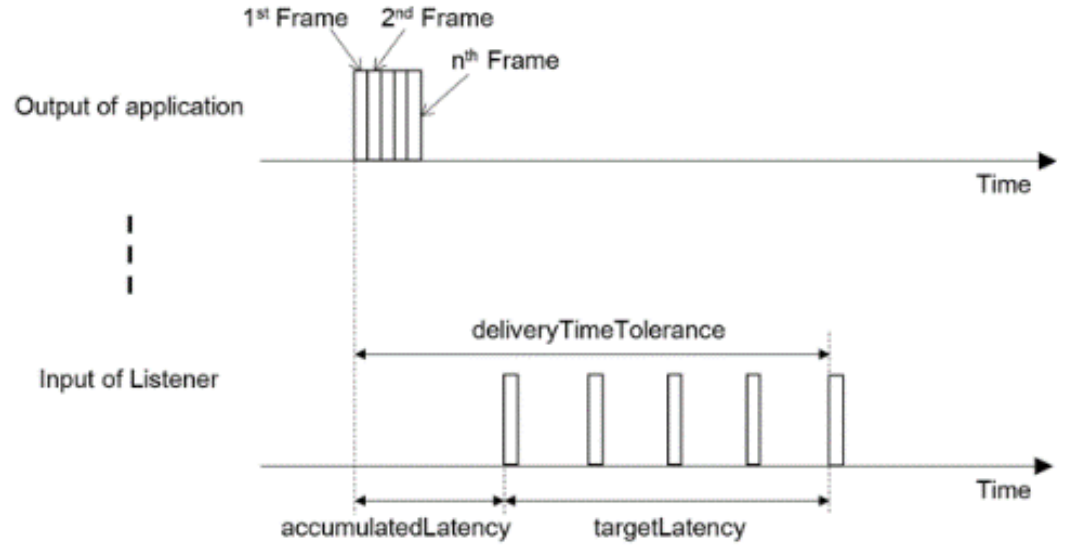

Figure Z-4— Frame propagation within delivery time tolerance while minimizing over-provision of bandwidth reservation

Z.3 Recommended TSpec Settings

Z.3.1 Settings for MSRP TSpec

According to IEEE Std 802.1Q-2018

$$MaxFrameSize = \min\left(\text{floor}\left(\frac{dataSize}{targetLatency} \times classMeasurementInterval\right), Maximum\ SDU\ Size\right) \quad (Z-5)$$

$$MaxIntervalFrames = \text{ceil}\left(\frac{1}{MaxFrameSize} \times \frac{dataSize}{targetLatency} \times classMeasurementInterval\right) \quad (Z-6)$$

According to IEEE Std 802.1Qcc-2018

$$MaxFrameSize = \min\left(\text{floor}\left(\frac{dataSize}{targetLatency} \times Interval\right), Maximum\ SDU\ Size\right) \quad (Z-7)$$

$$MaxFramesPerInterval = \text{ceil}\left(\frac{1}{MaxFrameSize} \times \frac{dataSize}{targetLatency} \times Interval\right) \quad (Z-8)$$

Z.3 Recommended TSpec Settings

Z.3.2 Settings for Token Bucket TSpec

- According to P802.1Qcr, parameters for ATS are
  - *CommittedBurstSize*
    - shoud be *CommittedBurstSize* ≧ (any frame sizes in the cluster)
  - *CommittedInformationRate*

$$CommittedBurstSize = Maximum\ SDU\ Size \qquad (Z-9)$$

$$CommittedInformationRate = \frac{dataSize}{targetLatency} \qquad (Z-10)$$

References

- White paper
  - https://www.ieee802.org/1/files/public/docs2020/new-Maruhashi-Zein-Mapping-method-of-QoS-requirements-to-TSpec-for-bursty-traffic-shaping-0320-v00.pdf
- IEEE 802 Nendica Report: Flexible Factory IoT
  - https://mentor.ieee.org/802.1/dcn/20/1-20-0026-00-ICne-ieee-802-nendica-report-flexible-factory-iot-use-cases-and-communication-requirements-for-wired-and-wireless-bridged-networks.pdf

Text proposal for main parts of PAR and CSD

Note: black text is common text copied from previous 1Q amendment, while the red text is specific for this PAR.

Main Part of PAR

- 2.1 – Project Title

Standard for Local and metropolitan area networks--Bridges and Bridged Networks
Amendment: TrafficSpecification settings for bursty traffic with bounded latency

- 4.2 and 4.3 Project dates

4.2 Expected Date of submission of draft to the IEEE-SA for Initial Sponsor Ballot:
01/2022*

- 4.3 Projected Completion Date for Submittal to RevCom

11/2022*

* To be discussed with TSN TG

Main Part of PAR –cont'd

- 5.2A – Standard scope

This standard specifies Bridges that interconnect individual LANs, each supporting the IEEE 802 MAC Service using a different or identical media access control method, to provide Bridged Networks and VLANs.

- 5.2B – Project scope

This project adds an informative annex to clarify the definition and use of TrafficSpecification (TSpec) for bursty traffic generated by time-sensitive application and gives recommendations for TSpec settings at stream bandwidth reservation. It also adds citation to this annex in the main body of the standard where necessary.

Main Part of PAR –cont'd

- 5.3 – Project contingency

5.3 Is the completion of this standard dependent upon the completion of another standard:

No.

- 5.4 – Project purpose

Bridges, as specified by this standard, allow the compatible interconnection of information technology equipment attached to separate individual LANs.

Main Part of PAR –cont'd

- 5.5 – Project need

Industrial networks serve traffic with a variety of characteristics including bursty traffic generated from IoT devices, which requires to be conveyed across available bandwidth links with tolerable latency. Shaping is needed in order to mitigate the impact of a temporarily high network load caused by this bursty traffic when it shares the same port with other traffic and avoiding over-provisioning of bandwidth reservation, while ensuring its delivery within its delivery time tolerance. It is therefore necessary to clarify the definition and use of TSpec for this specific characteristic of traffic and to give recommendation for its setting in the applicable shaper.

- 5.6 Stakeholders for the Standard:

Developers, providers, and users of networking services and equipment for streaming of time-sensitive data. This includes software developers, networking integrated circuit developers, bridge and network interface controller vendors, and users.

Main Part of CSD - 1.1.1 Managed objects

Describe the plan for developing a definition of managed objects. The plan shall specify one of the following:

a) The definitions will be part of this project.

b) The definitions will be part of a different project and provide the plan for that project or anticipated future project.

c) The definitions will not be developed and explain why such definitions are not needed.

This project will use method c). The definitions will not be developed, since this amendment will only add informative information to the standard.

Main Part of CSD - Coexistence

A WG proposing a wireless project shall demonstrate coexistence through the preparation of a Coexistence Assurance (CA) document unless it is not applicable.

a) Will the WG create a CA document as part of the WG balloting process as described in Clause 13? (yes/no)

b) If not, explain why the CA document is not applicable.

This project will use method b). This project is not a wireless project.

Main Part of CSD - Broad market potential

Each proposed IEEE 802 LMSC standard shall have broad market potential. At a minimum, address the following areas:

a) Broad sets of applicability.

b) Multiple vendors and numerous users.

The proposed amendment enhances bridges functionality allowing systems to further provision for broad variety services, applications requiring the transmission of bursty traffic that needs to be delivered within certain time tolerance and shared with other traffics.

TSN has been applicable for many applications including industrial automation and other applications. This amendment further extends the application of TSN to include IoT devices broadening TSN applications and use.

Furthermore, the proposed amendment enable efficient utilization of legacy network in support of increased traffic in industrial applications.

This proposal supports network with IoT devices that are deployed in factories, warehouses, hospitals, market places, stadiums and etc.

Multiple vendors and users of industrial automation, professional audio-video, automotive, and other systems require complete and comprehensive management of TSN features in bridged LAN networks through common interfaces.

Main Part of CSD - Compatibility

Each proposed IEEE 802 LMSC standard should be in conformance with IEEE Std 802, IEEE 802.1AC, and IEEE 802.1Q. If any variances in conformance emerge, they shall be thoroughly disclosed and reviewed with IEEE 802.1 WG prior to submitting a PAR to the Sponsor.

a) Will the proposed standard comply with IEEE Std 802, IEEE Std 802.1AC and IEEE Std 802.1Q?

b) If the answer to a) is no, supply the response from the IEEE 802.1 WG.

The review and response is not required if the proposed standard is an amendment or revision to an existing standard for which it has been previously determined that compliance with the above IEEE 802 standards is not possible. In this case, the CSD statement shall state that this is the case.

As an amendment to 802.1Q, the proposed standard shall comply with IEEE Std 802, IEEE Std 802.1AC and IEEE 802.1Q.

Main Part of CSD - Distinct Identity

Each proposed IEEE 802 LMSC standard shall provide evidence of a distinct identity. Identify standards and standards projects with similar scopes and for each one describe why the proposed project is substantially different.

This amendment differs from existing IEEE Std 802.1 in that it addresses shaping in order to mitigate the impact of a temporarily high network load caused by bursty traffic that needs to be delivered within certain time tolerance when it shares the same port with other traffic.

Main Part of CSD - Technical Feasibility

Each proposed IEEE 802 LMSC standard shall provide evidence that the project is technically feasible within the time frame of the project. At a minimum, address the following items to demonstrate technical feasibility:

a) Demonstrated system feasibility.

The proposed amendment clarifies the definition of TSpec parameters and gives recommendation for its setting for traffic with a specific characteristic.

b) Proven similar technology via testing, modeling, simulation, etc.

This project is to clarify use of TSpec and based on mature virtual LAN bridging and transmit selection and scheduling.

Main Part of CSD - Economic Feasibility

Each proposed IEEE 802 LMSC standard shall provide evidence of economic feasibility. Demonstrate, as far as can reasonably be estimated, the economic feasibility of the proposed project for its intended applications. Among the areas that may be addressed in the cost for performance analysis are the following:

a) Balanced costs (infrastructure versus attached stations).
b) Known cost factors.
c) Consideration of installation costs.
d) Consideration of operational costs (e.g., energy consumption).
e) Other areas, as appropriate.

The well-established balance between infrastructure and attached stations will not be changed by this enhancement.

The cost factors, including installation and operational factors, are well known from similar technologies and proportional to the benefits gained.

The proposed amendment does not require additional hardware cost as it adds clarification to the definition and use of TSpec parameters for traffic with a specific characteristic, i.e. bursty traffic generated by time-sensitive application, and gives recommendations for its settings at stream bandwidth reservation in existing equipment.