DetNet

Bounded Latency-01

draft-finn-detnet-bounded-latency-01

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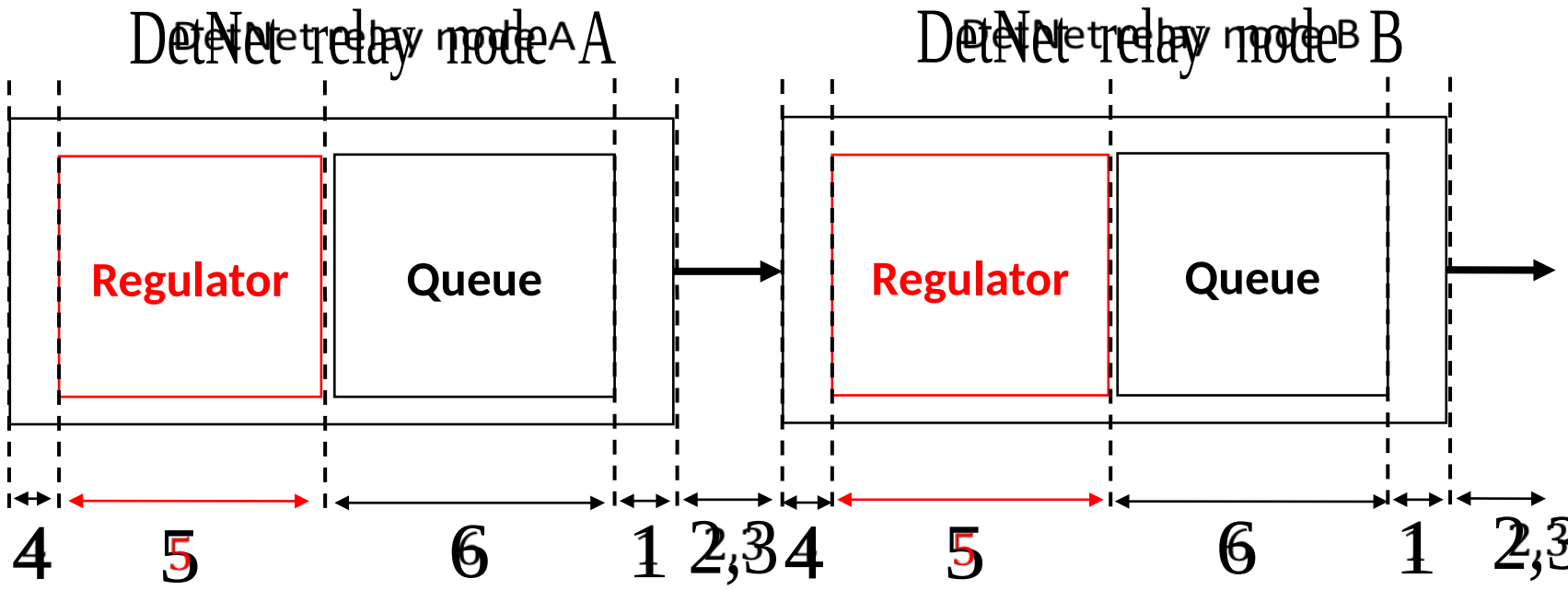
A reminder to new attendees …

- DetNet is about an **upper bound** on end-to-end latency – **not** low average latency.
- Bounded latency ⊔ the ability to compute exactly how many buffers are required to achieve zero congestion loss.
- **Feedback** that slows down flows to avoid congestion is **not an option** for the application space of interest to DetNet.
- Mathematically sound assurances can be given on latency and congestion loss.

4.3. Relay system model [updates]

1) Output delay
2) Link delay
3) Preemption delay
4) Processing delay
5) Regulation delay
6) Queuing delay



Interleaved Regulators

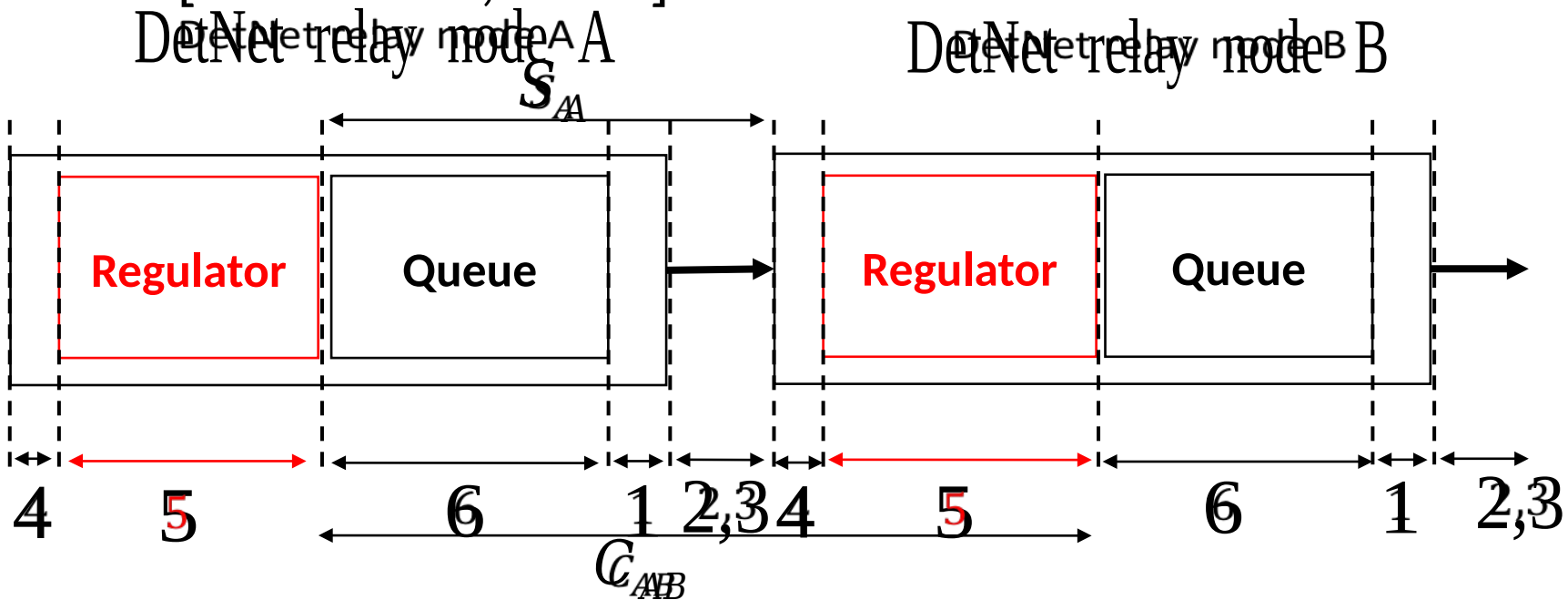
- **Interleaved regulator**: Called **Asynchronous Traffic Shaping** (P802.1Qcr) in the context of IEEE 802.1 TSN. An interleaved regulator reshapes individual flows, while doing **per-class queuing** and not per-flow queuing.

- Addition of interleaved regulator makes the calculation of end-to-end latency tractable; as in every node, each flow can be treated as a fresh one

Interleaved regulator is for free i.e. does not increase worst-case end-to-end latency!

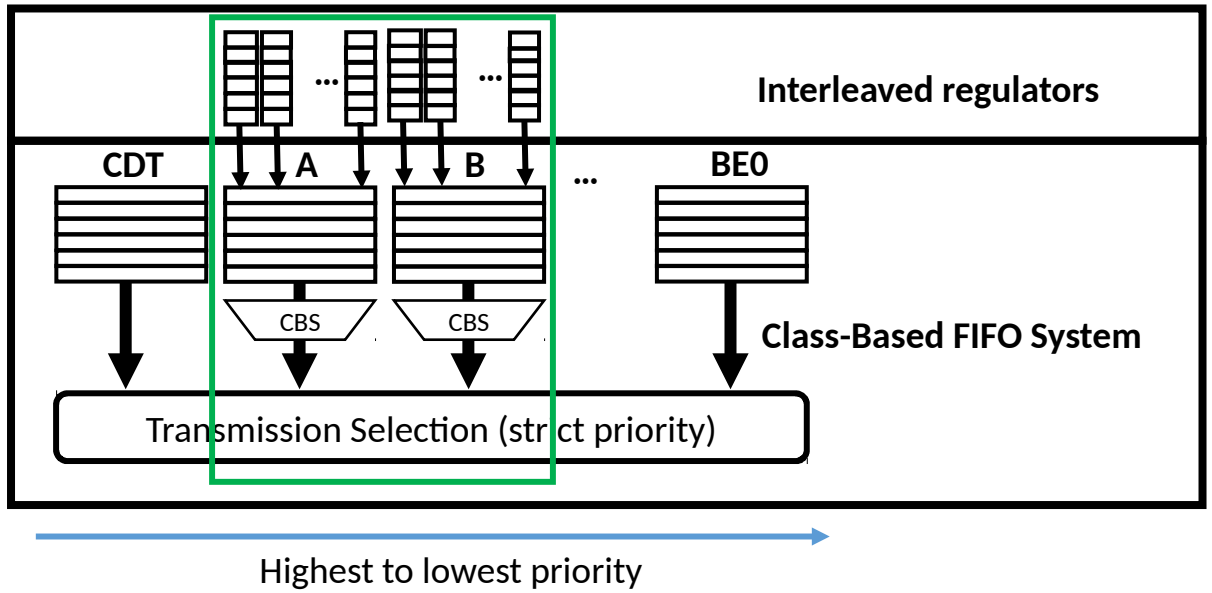
- Define:
  - $C_{AB} = \sup\{(6_A + 1_A + 2_A + 3_A) + (4_B + 5_B)\}$
  - $S_A = \sup\{6_A + 1_A + 2_A + 3_A\}$
- Directly From [Le boudec, 2018]:

$$C_{AB} = S_A$$



7.3. TSN with ATS- Queuing Model [added] (1)

- Two level of queuing:
  - Interleaved regulators
  - Class-Based FIFO System
- Contention occurs only at the output port
- Input ports and switching fabrics are modeled as variable delays with known bounds
- We focus on classes A and B which queues are using CBS and ATS
- All classes are non-preemptive



Ref: [Mohammadpour, Stai, Mohiuddin, Le boudec, 2018]

7.3. TSN with ATS- Queuing Model [added] (2)

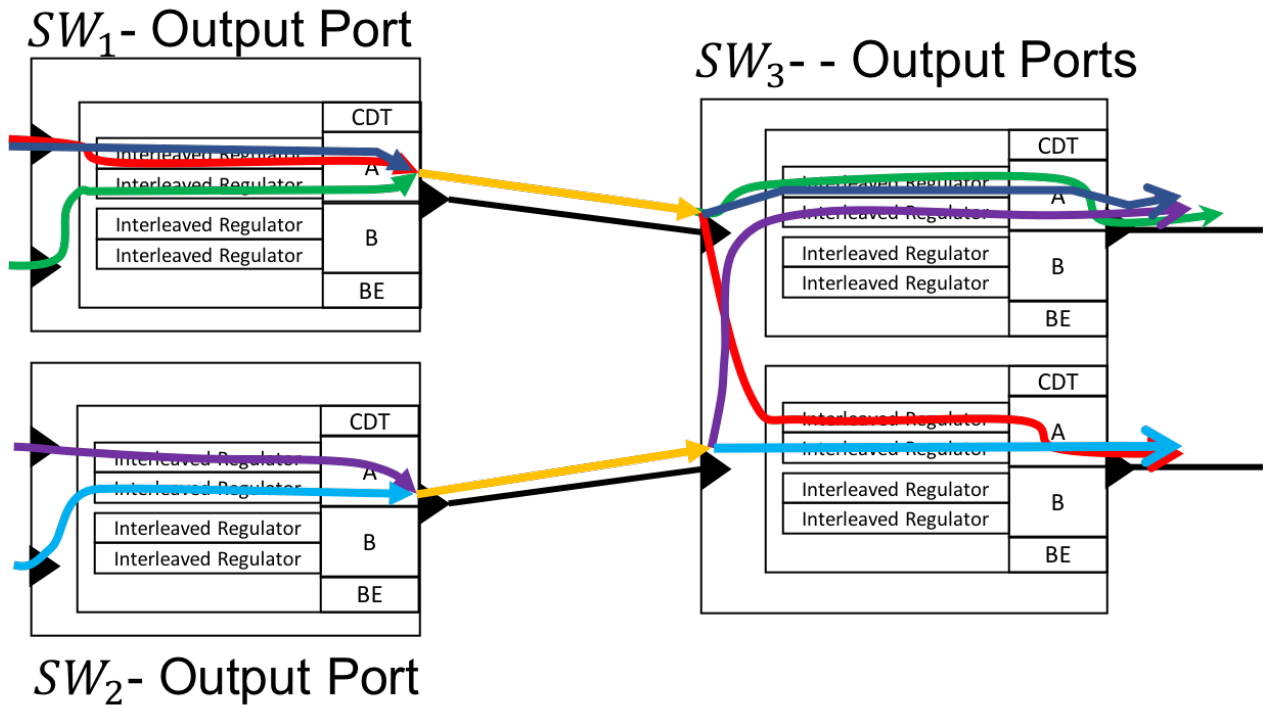
Queuing policy: *two flows share the same interleave regulator queue, if:*

- Going to the same output port, and
- Having the same class, and
- Coming from the same input port.

Regulation: *Types of Regulation:*

+ Length Rate Quotient (LRQ)

+ Leaky Bucket (LB)

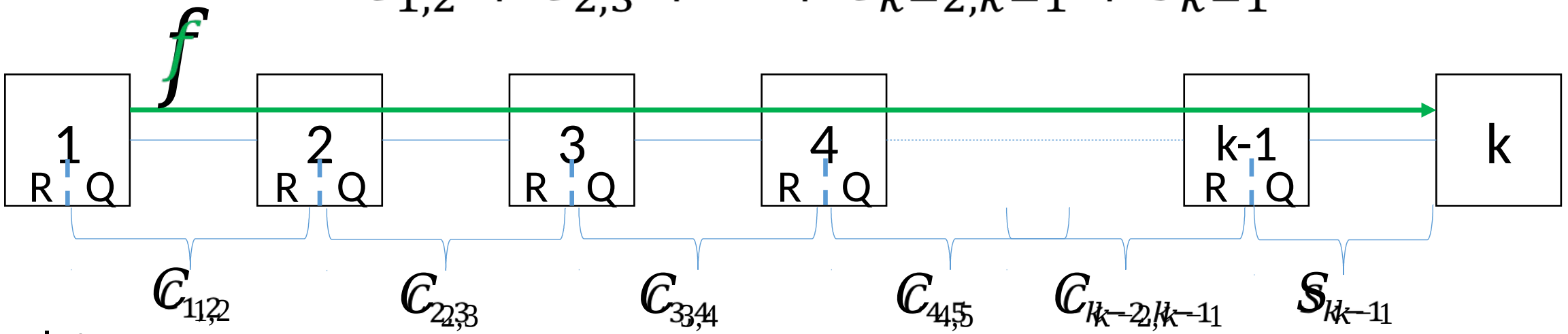


Ref: [Mohammadpour, Stai, Mohiuddin, Le boudec, 2018]

5.1. Examples of Computations- TSN with ATS [added]

End-to-end delay bound for flow f:

$$D = C_{1,2} + C_{2,3} + \cdots + C_{k-2,k-1} + S_{k-1}$$



R: Regulator

Q: Queue

Ref: [Mohammadpour, Stai, Mohiuddin, Le boudec, 2018]

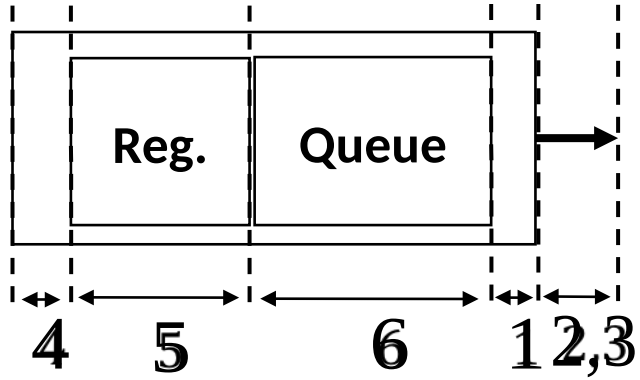
Suboptimality of per-node E2E delay calculation

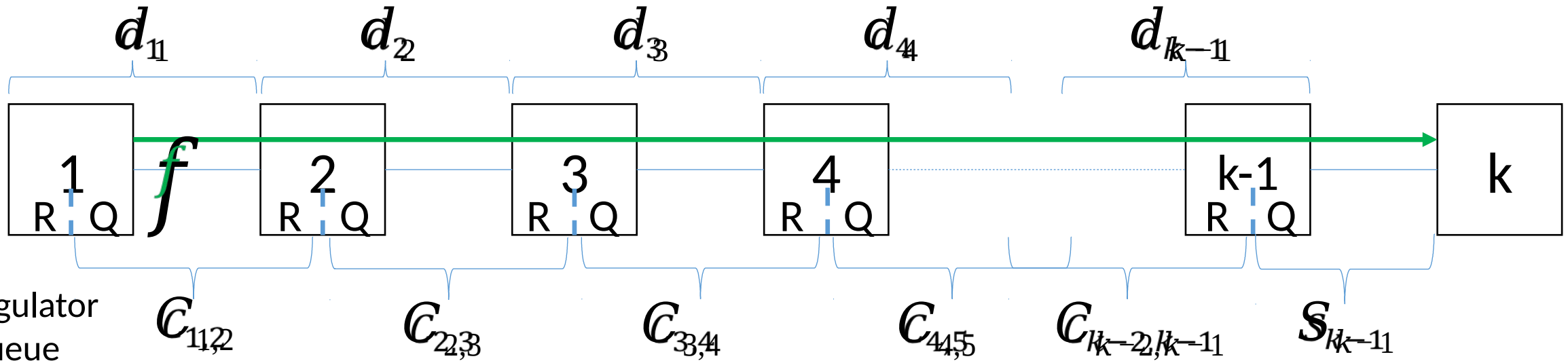
- Define node delay bound:

$$d_i = \sup\{4_i + 5_i + 6_i + 1_i + 2_i + 3_i\}$$

- Then:

$$\text{Latency Bound (previous slide)} \ll \sum_{i=1}^{k-1} d_i$$





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Q: Queue

Ref: [Mohammadpour, Stai, Mohiuddin, Le boudec, 2018]

References

[1] J.-Y. Le Boudec, “A Theory of Traffic Regulators for Deterministic Networks with Application to Interleaved Regulators,” *arXiv:1801.08477 [cs]*, Jan. 2018. [Online]. Available: http://arxiv.org/abs/1801.08477/, (Accessed:09/02/2018).

[2] E. Mohammadpour, E. Stai, M. Mohiuddin, and J.-Y. Le Boudec, “ End-to-end Latency and Backlog Bounds in Time-Sensitive Networking with Credit Based Shapers and Asynchronous Traffic Shaping,” arXiv:1804.10608 [cs.NI], 2018. [Online]. Available: https: //arxiv.org/abs/1804.10608/

A New IEEE 802.1 TSN Project

- A Project Authorization Request (PAR) has been approved for IEEE P802.1DC Quality of Service Provision by Network Systems
- P802.1DC scope:

  This standard specifies procedures and managed objects for Quality of Service (QoS) features specified in IEEE Std 802.1Q, such as per-stream filtering and policing, queuing, transmission selection, flow control and preemption, in a network system which is not a bridge.

- The intention is that a host, router, label switch, firewall appliance, or any other system can call out the specifications in IEEE Std 802.1DC in order to obtain TSN Quality of Service features.

Thank you