

# DetNet

## Bounded Latency-01

draft-finn-detnet-bounded-latency-01

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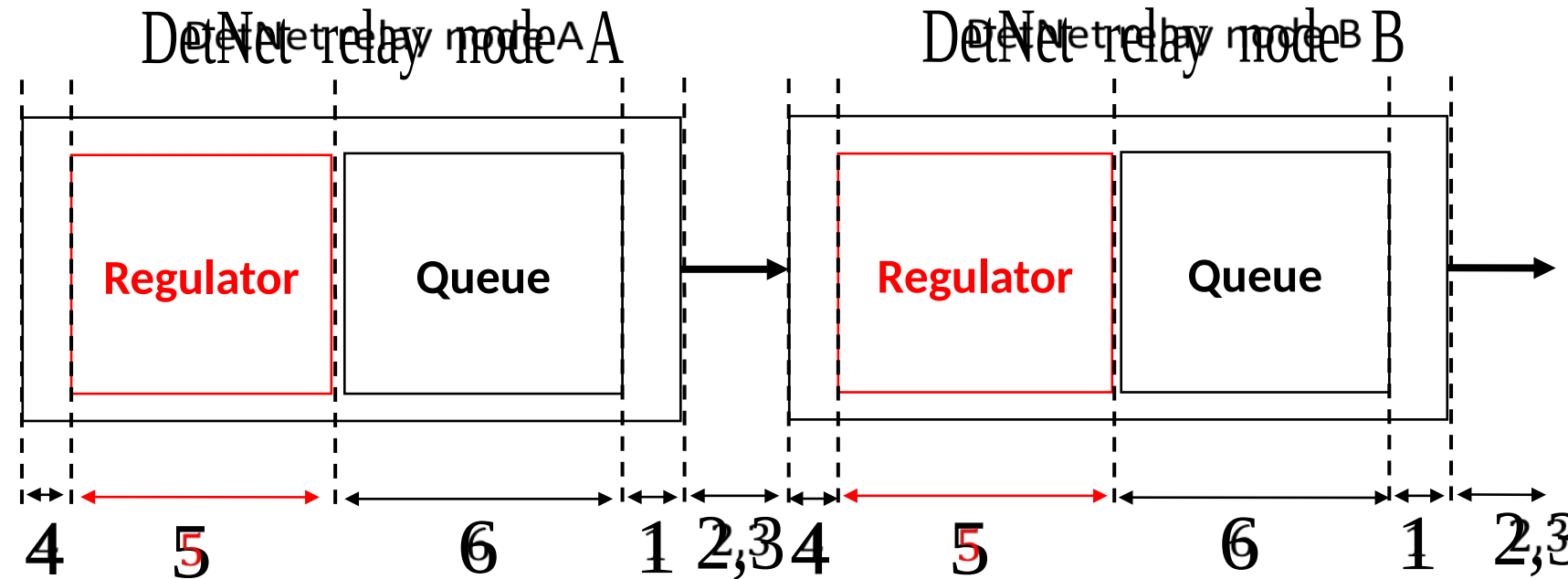
Montreal, 16<sup>th</sup> July, 2018

# A reminder to new attendees ...

- DetNet is about an **upper bound** on end-to-end latency – **not** low average latency.
- Bounded latency  $\Rightarrow$  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!

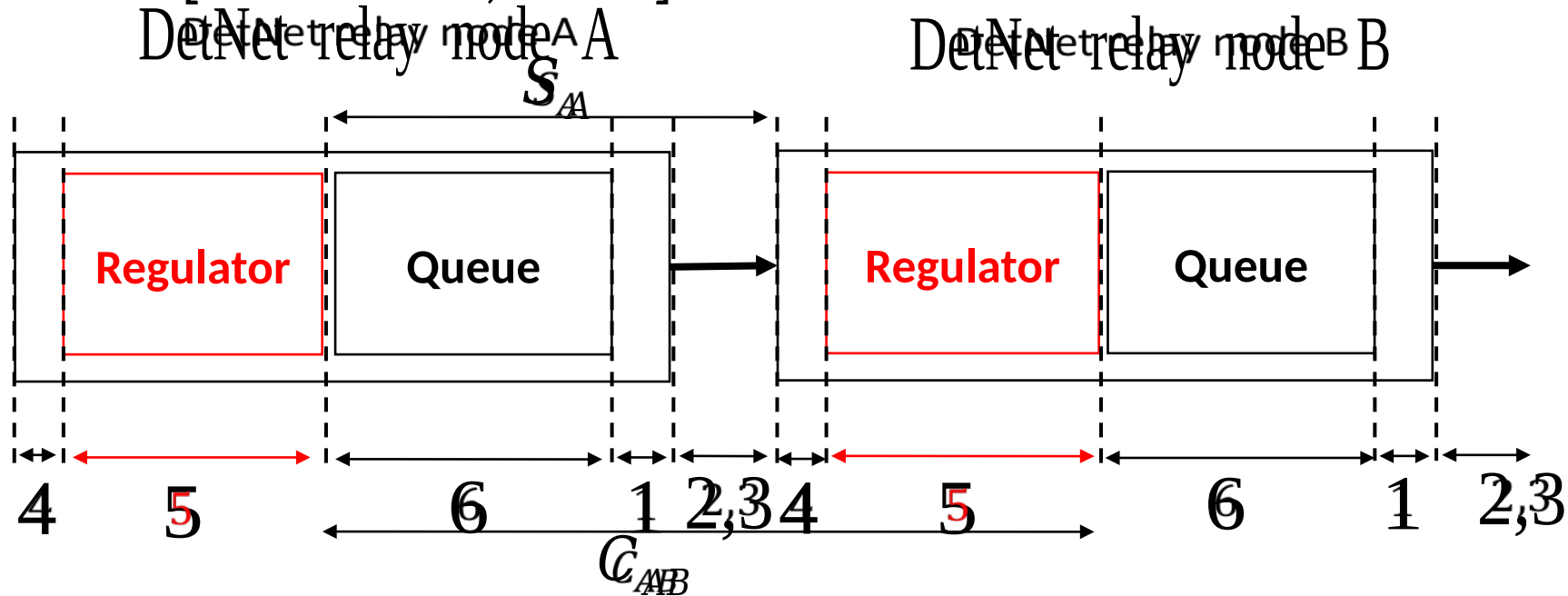
- Define:

- $C_{AB} = \sup\{(6_A + 1_A + 2_A + 3_A) + (4_B + 5_B)\}$
- $S_A = \sup\{6_A + 1_A + 2_A + 3_A\}$

- Directly From [Le boudec, 2018]:

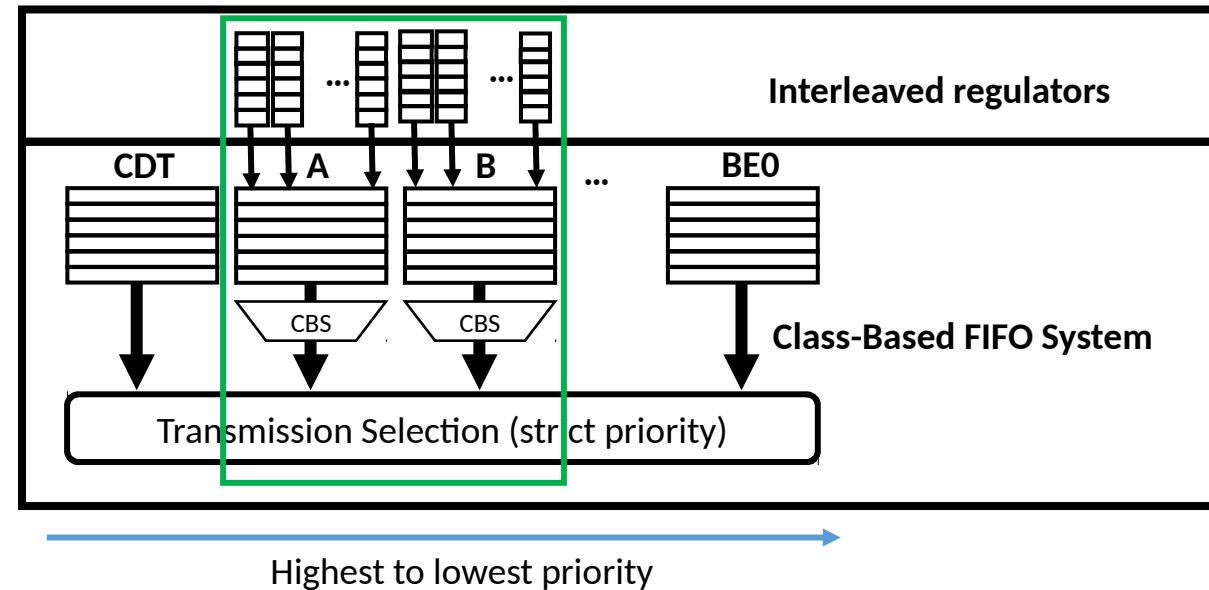
$$C_{AB} \equiv S_A$$

- Directly From [Le boudec, 2018]:



# 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



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

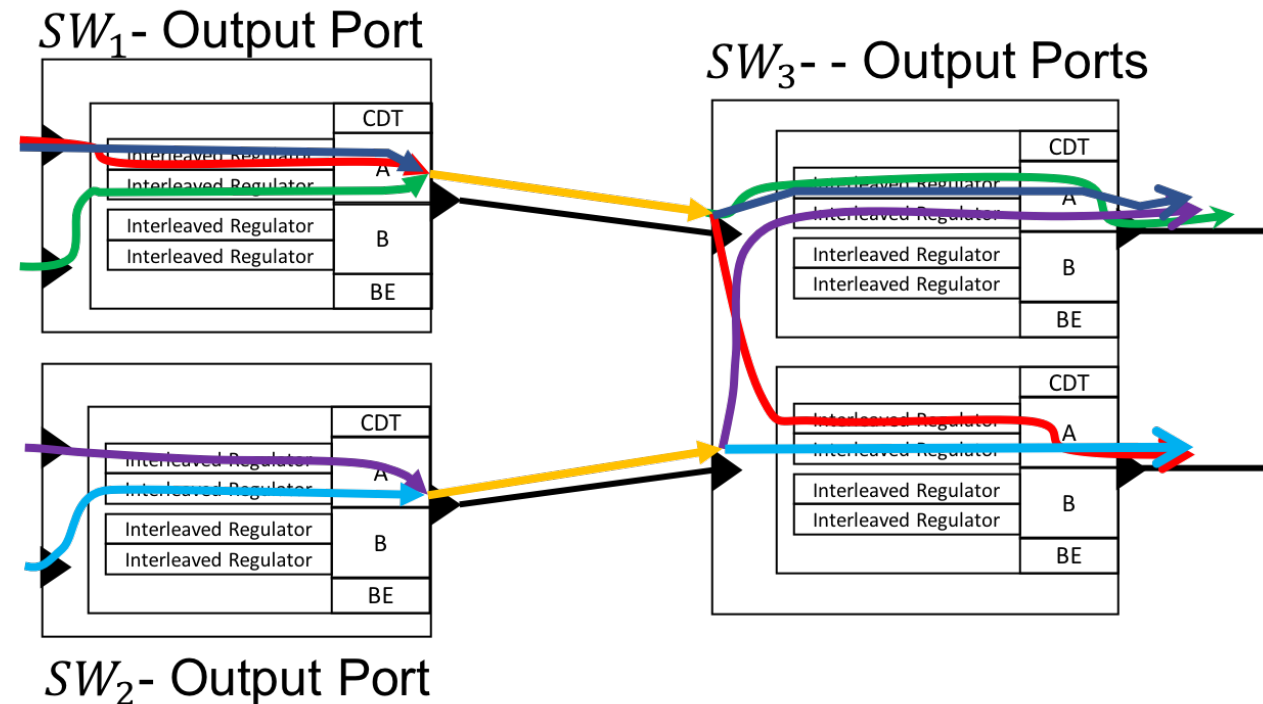
**Queuing policy:** two flows share the same interleave regulator queue, if:

- 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)

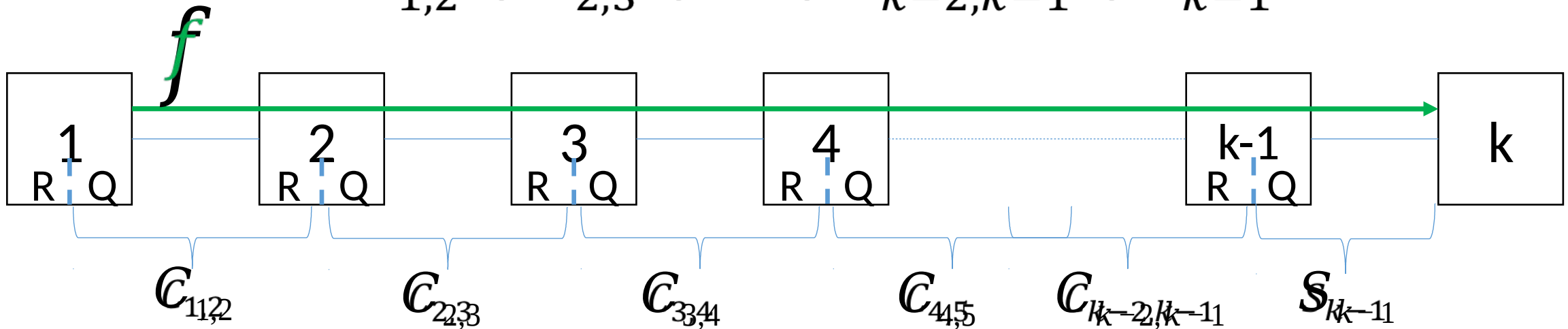
+ Leaky Bucket (LB)



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

End-to-end delay bound for flow  $f$ :

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



R: Regulator

Q: Queue



# Suboptimality of per-node E2E delay calculation

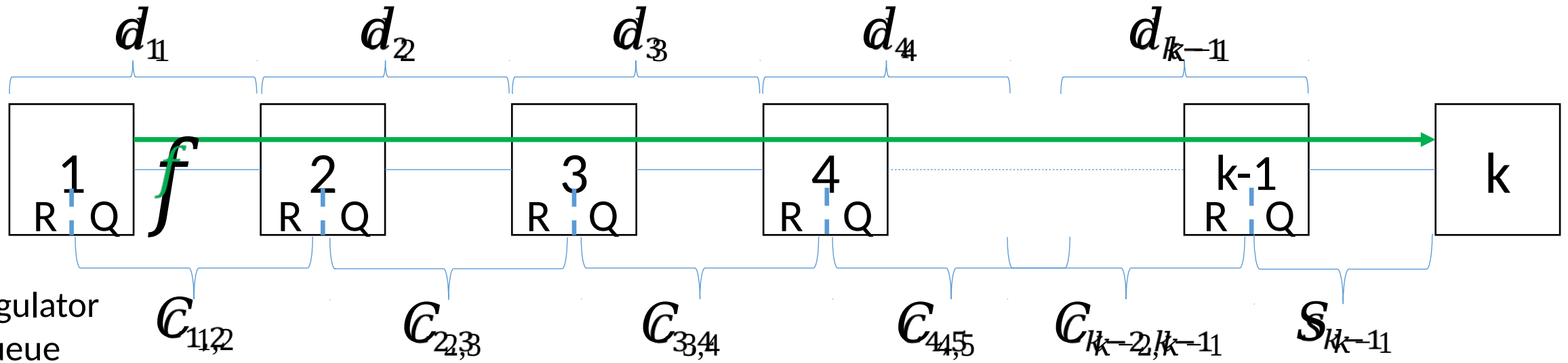
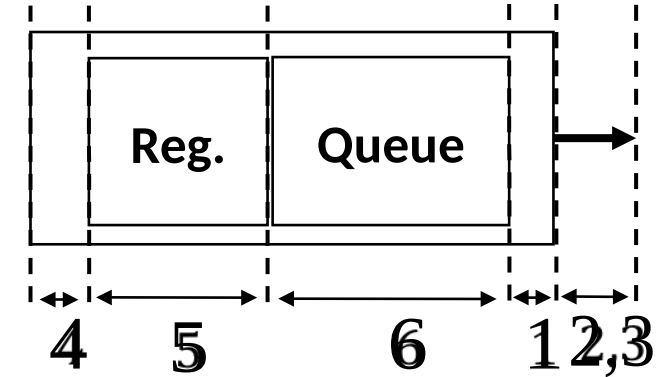
- Define node delay bound:

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

- Then:

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

- Then:



R: Regulator  
Q: Queue

# 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