

# Latency Guarantee with Stateless Fair Queuing (C-SCORE)

draft-joung-detnet-stateless-fair-queuing-08

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# Overview (1/2)



- Revised three times after IETF 124 (Currently v.08)
- Added sections on v.06

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# Overview (2/2)

- Revisions on v.07 and 08
  - Minimize the duplicative parts with ITU-T standards
  - Added references
  - Added a section

## 9. Relationships to ITU-T Standards

- It is currently a complete document. No need to read references.

# Header formats (1/2)

- IPv6 Hop-by-Hop (HbH) Options Header
  - a specific type of Extension Header designed for information that must be examined and processed by all the transit nodes along a packet's delivery path.

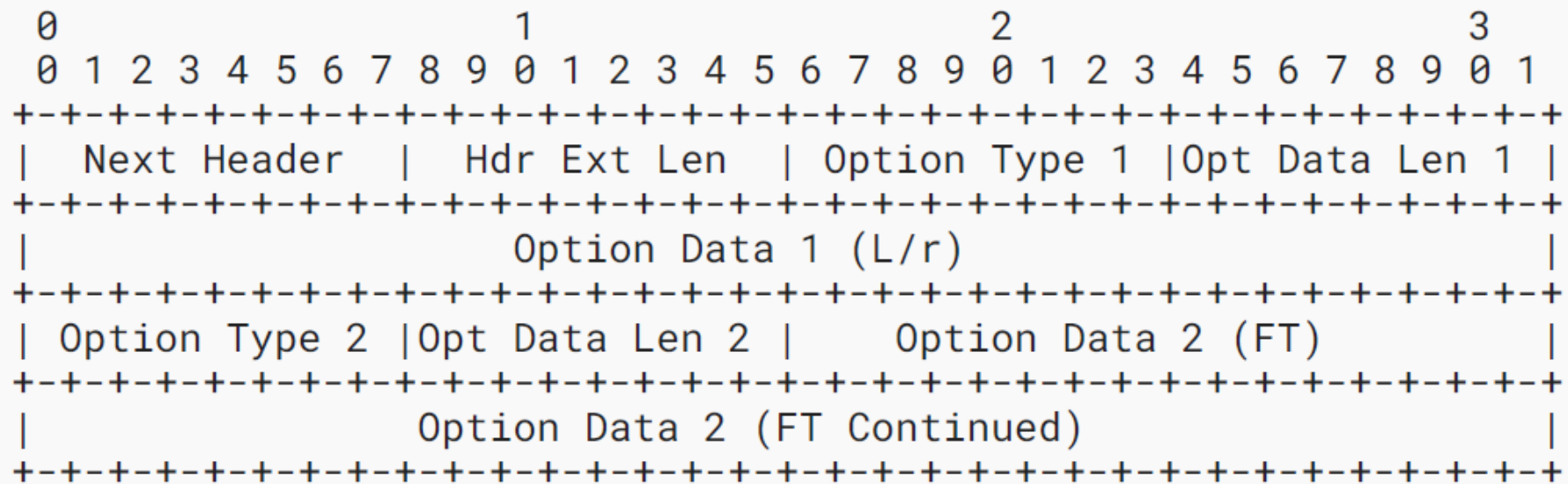


Figure 1: IPv6 HbH Options Header example for two metadata for C-SCORE

# Header formats (2/2)

- MPLS Post-Stack MNA (MPLS Network Action)
  - With Post-Stack MNA sub-stack, the DetNet-specific information is carried after the label stack.

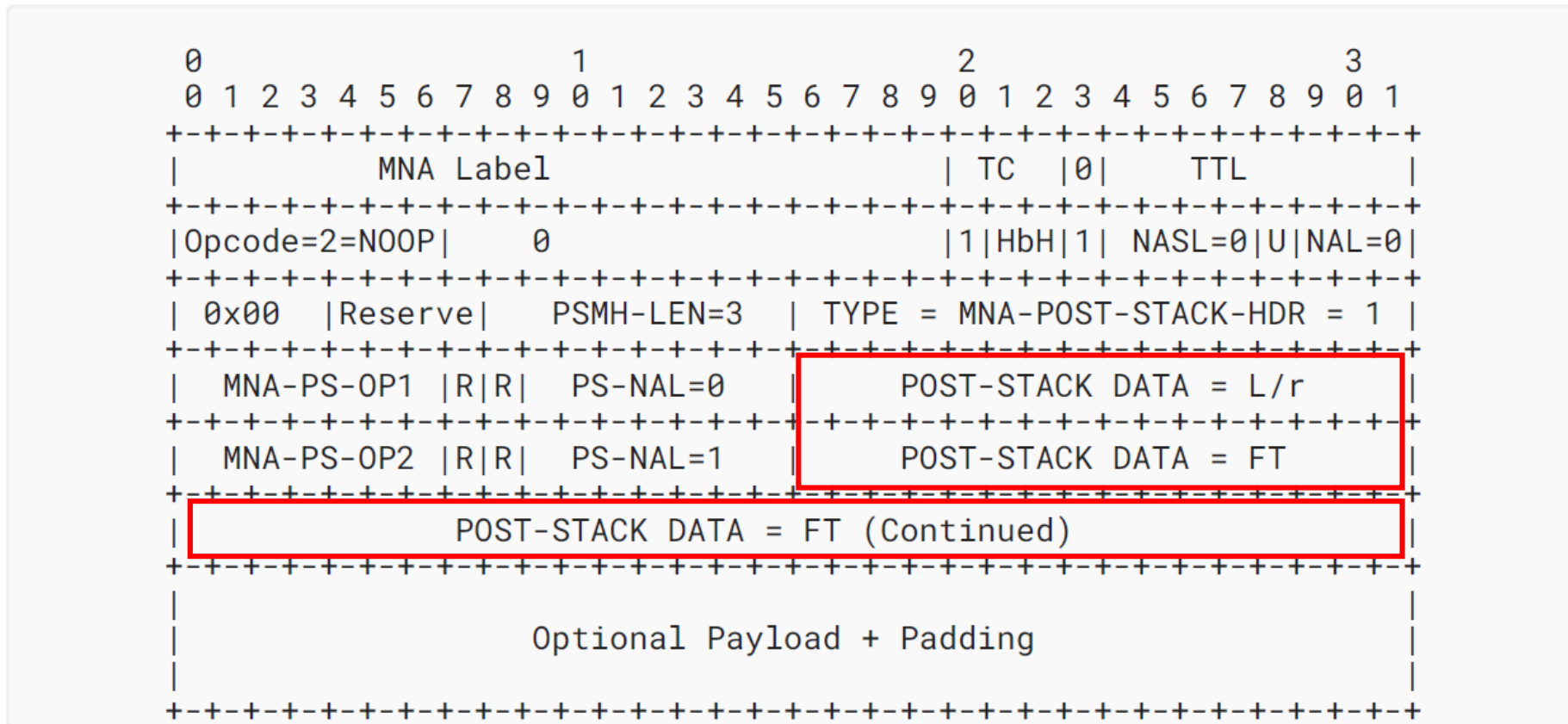


Figure 2: Post Stack MNA Sub-Stack example with two PSNAs for two metadata for C-SCORE

# Admission control process (1/2)

- Default process (Request for service rate)
- 4) Core nodes check if the requested service rate  $r$  is within the aggregate bandwidth threshold of the outgoing interface.
  - 5) Each core node adds its per-hop max latency value  $(L/r + L_h/R_h)$  to a field in the PATH message. This allows the egress node to calculate the E2E latency bound.
  - 6) The egress node receives the PATH message. If the E2E latency bound meets the application's requirement, it generates a RESV message.

# Admission control process (2/2)

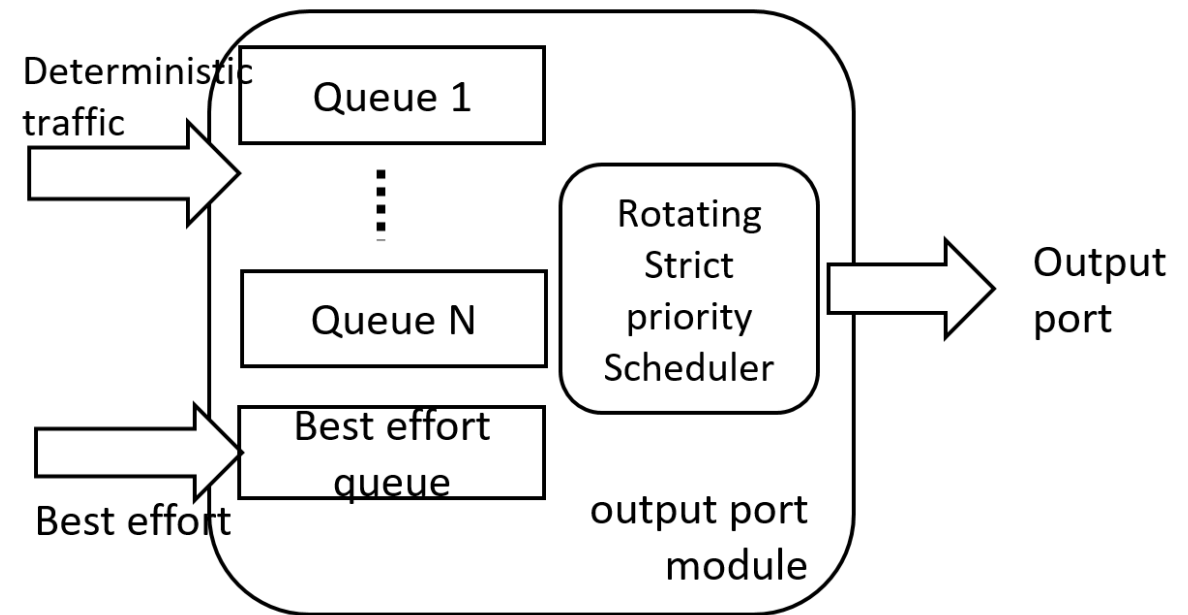
- Alternative process (Rate selection capable)
- 2) The entrance node sends a PATH message with a **Desired Rate ( $r_{\text{desired}}$ )** and a **Minimum Acceptable Rate ( $r_{\text{min}}$ )**, along with T-Spec and R-Spec.
  - 3) Each core node on the path calculates its residual capacity ( $r_{\text{avail}}$ ). This is the total capacity of the link minus the sum of the service rates ( $r$ ) of all already admitted flows.
  - 4) As the PATH message moves hop-by-hop, it maintains a field called **Path-Available-Rate ( $r_{\text{path}}$ )**. At each hop  $h$ , the router performs:  $r_{\text{path}} = \min(r_{\text{path}}, r_{\text{avail}_h})$ , while the subscript  $h$  denotes the node.
  - 5) By the time the PATH message reaches the egress,  $r_{\text{path}}$  represents the maximum service rate the entire end-to-end path can support at that specific moment.
  - 6) The optimal rate is not always the highest possible rate. The egress node can select the optimal rate, which can be less than  $r_{\text{path}}$ .
  - 7) Once the optimal **service rate ( $r = r_{\text{opt}}$ )** is determined, the egress sends the RESV message back to the entrance node, carrying the  $r_{\text{opt}}$  value.

# Approximate C-SCORE

- Strict Priority scheduler rotates priority at a fixed time. A single queue is served in a FIFO manner. The server services the packets in a work conserving manner.
- If the queue  $k$ ,  $0 \leq k \leq N-1$ , is the highest priority queue at time  $t$ , then the queue  $(k+N-1) \pmod N$  has the lowest priority at  $t$ .
- An arriving packet  $p$  is assigned to queue  $i$  if its finish time falls within the slot interval  $(T_{i-1}, T_i]$ .

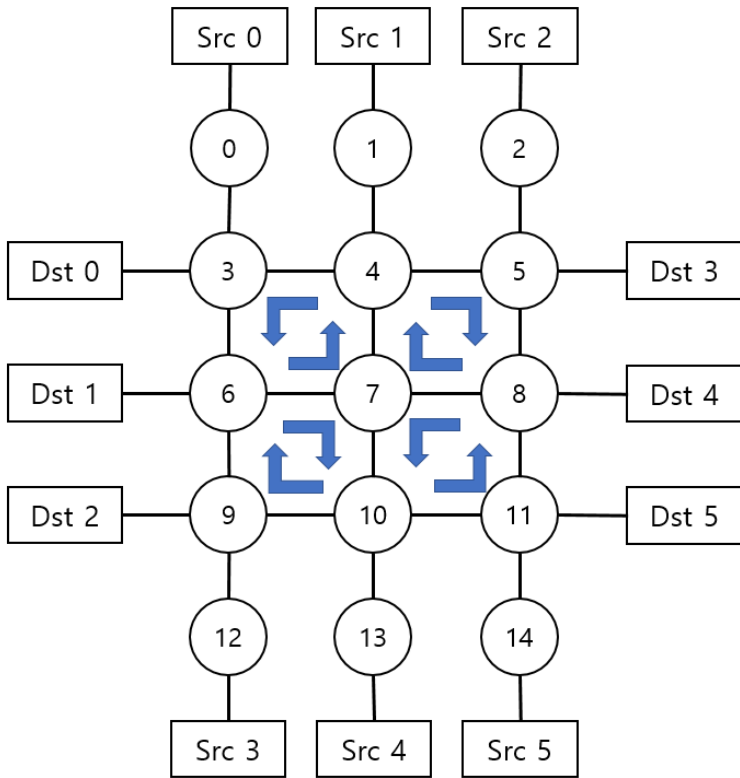
**Theorem 3.** The E2E latency with the proposed schedulers is **upper bounded** by  $B/r + \sum_{h=0}^H \{(n_{f,h} + 1)S_h + L_h^{max}/R_h\} + \sum_{h=0}^{H-1} \delta_h(p)$ , where  $B$  and  $r$  are the maximum burst size and the service rate of the flow under observation.

$n_{f,h} = \left\lceil \frac{L_f}{rS_h} \right\rceil$ .  $\sum_{h=0}^{H-1} \delta_h(p)$  is the E2E propagation delay.  $S_h$  is the slot length at node  $h$ .



# Simulation of approximate C-SCORE: Reference Topology 1

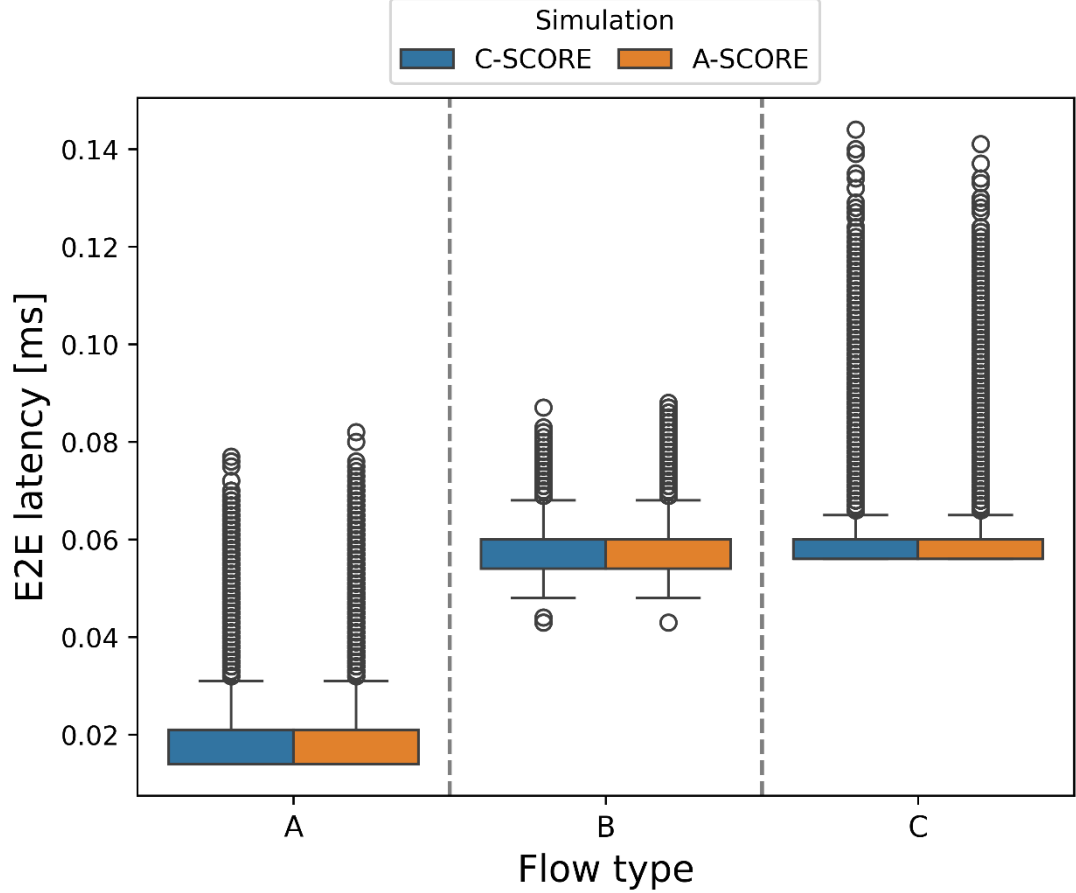
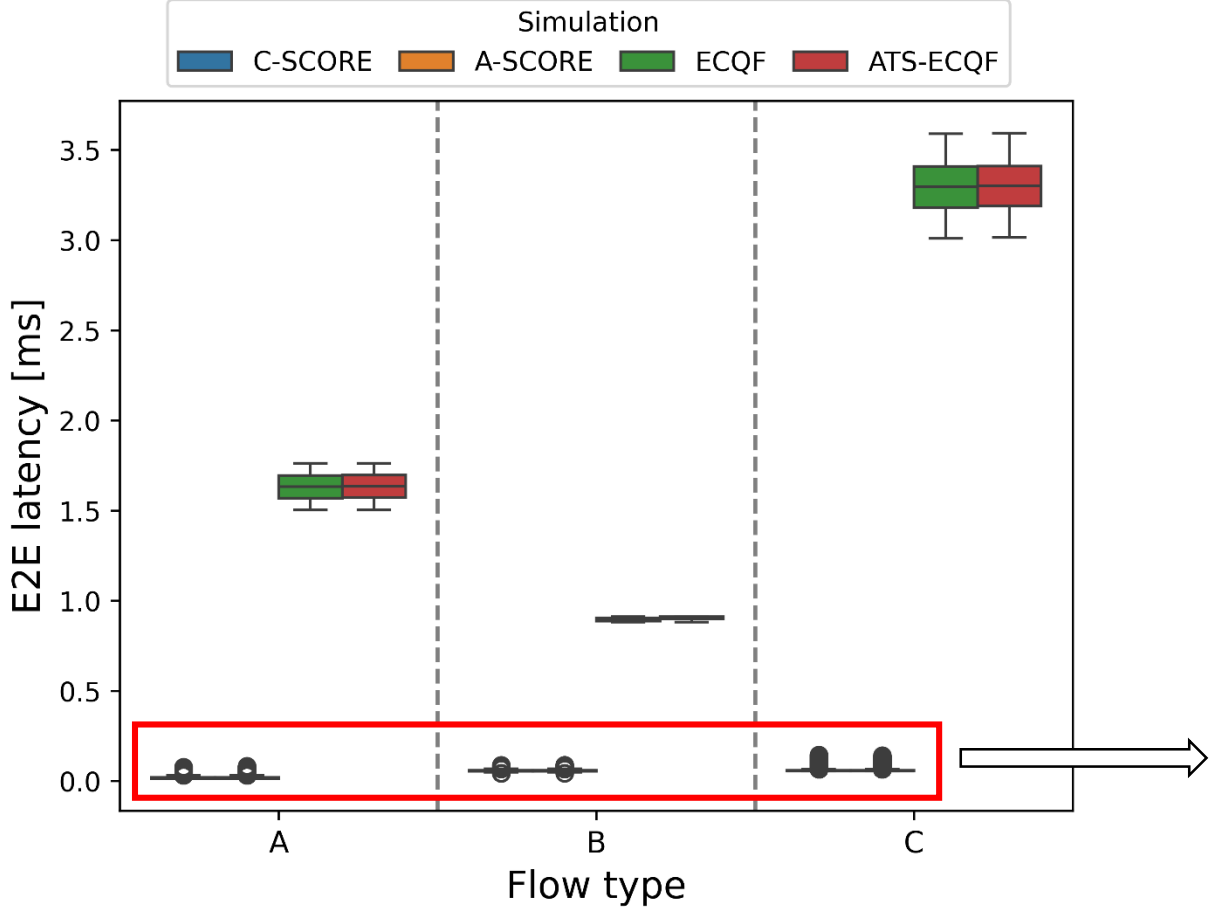
- Links with 1Gbps capacity
- A source generates flows of 2 A-type, 2 B-type, 4 C-type.
- Utilization 31.2% (A higher utilization makes ECQF's slot length too long.)



Characteristic	Flow type		
	A	B	C
Maximum burst size	2Kbit	360Kbit	8Kbit
Maximum packet length	2Kbit	6Kbit	8Kbit
Arrival rate	8Mbps	11.64Mbps	16Mbps
Service rate	8Mbps	48Mbps	16Mbps
Burst period	250us	33ms	500us
Inter arrival time	250us	125us	500us
Deadline	10ms	2ms	10ms
Destination	Dst 0,5	Dst 2,3	Dst 1,4

# Simulation of approximate C-SCORE: Result

- ECQF: slot lengths 125, 250, 500 us
- A-SCORE (Approximate C-SCORE): slot length 125us
- **A-SCORE and C-SCORE perform almost identically.**



# Future plan

- Any duplicative parts will be removed.
- Only a couple of sentences, regarding the philosophy of the stateless fair queuing, will remain in 6.1 Framework.
- Readers would need to READ the ITU-T standards for a complete understanding of the technology.

# Thank you

- Please take a look at

<https://datatracker.ietf.org/doc/draft-joung-detnet-stateless-fair-queuing/>