Deadline based Forwarding

draft-peng-detnet-deadline-based-forwarding-18

Shaofu Peng ZTE
Zongpeng Du China Mobile
Kashinath Basu Oxford Brookes University
Zuopin Cheng New H3C
Dong Yang Beijing Jiaotong University
Chang Liu China Unicom

IETF-124 Nov 2025

Main Updates (17 -> 18)

- No significant changes.
  - update-1:

    For section “Relationship Between Service Burst Interval and Delay Level”, clarified that when a flow with small SBI (such as 10 us) apply large delay level (such as 100 us), it will not cause burst accumulation over time, due to not increasing the output packet interval.

  - update-2:

    For section “Compatibility with Legacy Device”, clarified that an interoperability solution between EDF and SP is to treat the SP domain as a single hop between EDF nodes, and the SP domain with limited hops provide low jitter transmission..

Processed Comments

- A concern raised by Janos in the last IETF 123 meeting, about the category conflict between EDF and C-SCORE. A corresponding clarification has been sent in the maillist. (repeated as below)
  - EDF apply the category list defined in the draft-taxonomy-04, while C-SCORE apply another list that better reflects the derivation procedure but differs from the order of the list in the draft-taxonomy-04.
  - Suggest that all solutions apply the same category list defined in the document later.

Actions

- According to Chairs' instructions, we checked the category, and sent the implementation status to the mailist.
  - **Category**

    6.1. **Right-bounded category** **<--- EDF in-time**
    6.2. Flow level periodic bounded category
    6.3. Class level periodic bounded category
    6.4. Flow level non-periodic bounded category
    6.5. **Class level non-periodic bounded category** **<--- EDF on-time**
    6.6. Flow level rate based unbounded category
    6.7. Flow level Rate based left-bounded category

  - **Implementations**
    – EDF has been implemented in ZTE Corporation's router ZXR10 M6000-SE V6, with the developed ASIC module.
    – Interoperability test between EDF and SP in the laboratory. SP domain has limited hops to provide low jitter transmission. EDF enabled on the ingress node, high concurrency aggregation nodes and egress node. The the end-to-end latency is met, and jitter is within 30us.

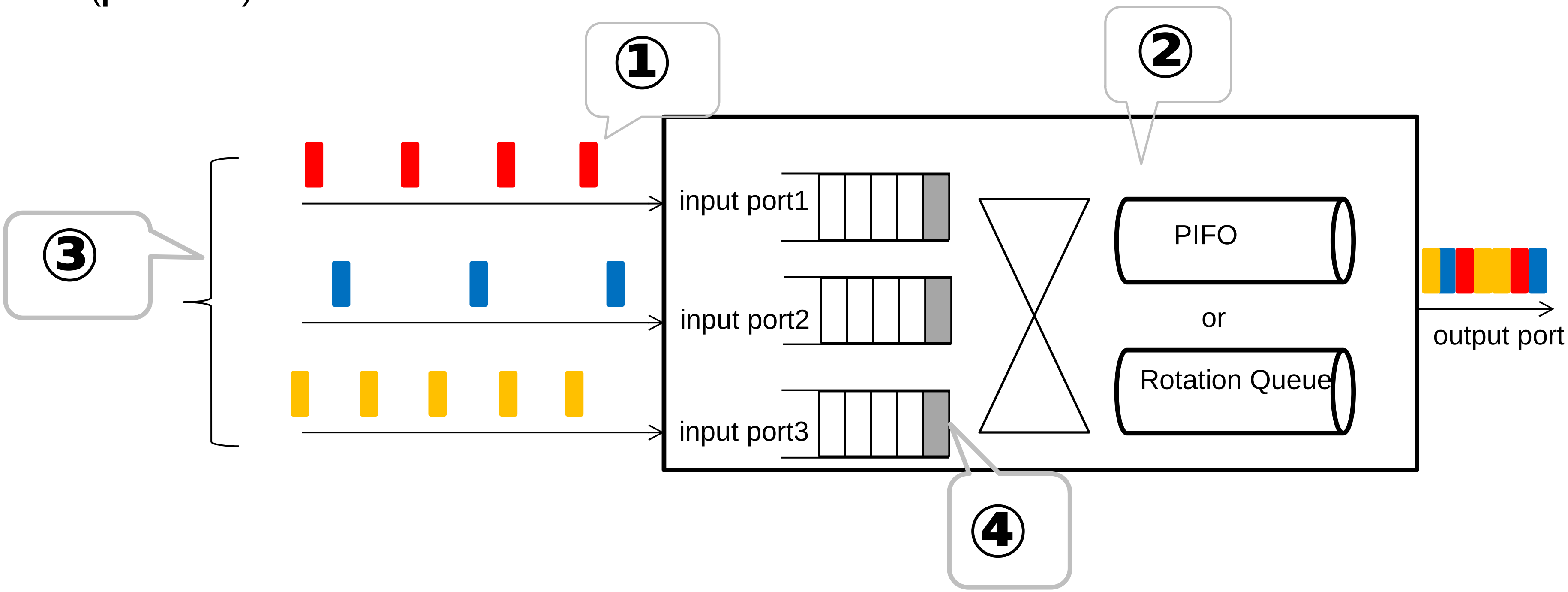
EDF Solution Overview

Target: Based on the quantified delay level resources in the network, different flows are assigned different delay levels to ensure scheduling before their deadline.

① Packet's deadline = arrival time (A) + planned residence time (D) + latency deviation (E).
② Packet inserted into the the sorted queue (or approximate sorted queue) based on its deadline.
③ All eligible arrivals must meet the schedulability conditions.

for PIFO: $C * t \geq \sum_{i=1}^{N} A_i (t - \mathrm{d}_i) + M$ for RPQ: $C * t \geq A_1 (t - d_1) + \sum_{i=2}^{N} A_i (t + \mathrm{AT} - \mathrm{d}_i) + M$

④ When actual arrivals violates eligible arrival, take re-shaping or latency compensation (**preferred**).



Evaluation on Grid RT

- The delay levels are choosed based on the per-hop latency bound of each type of flow , e.g., 700us for audio and CC flows, 1400us for vedio flows, to meet 5 ms or 10 ms E2E latency along the path with 7 hops.
- A possible delay level resource table: (note: video flow has been regulated on the ingress node)

Delay Level	Burst Resource	Bandwidth Resource	Allowed Admited Flows
100 us	40 Kbits	10 Mbps	Reserved for urgent flows
200 us	144 Kbits	30 Mbps	60 CC flows
300~600 us	0	0	
700 us	120 Kbits	96 Mbps	60 Audio flows
800~1000 us	0	0	
1100 us	720 Kbits	660 Mbps	60 Vedio flows
		total utilization: 796 Mbps	

- E2E bounded delay = Bounded latency per-hop * hop-count. E.g., for the video flow of path Src2-2-3-6-5-8-7-Dst3, it is 7*1100 us.
- E2E bounded jitter is 0 with the help of latency deviation (E) and on-time mode.

Evaluation on Ring-mesh RT

- In the ring network (1 Gbps), on each hop, there are two bursts competing for the outgoing interface. Their sizes are 1 flow-set and 6 flow-sets, respectively. The designed delay level resource table:

Delay Level	Burst Resource	Bandwidth Resource	Allowed Admited Flows
225 us	1223.6 Kbits	725 Mbps	CC/Audio/Video of 7 flow-sets

- In the core network (10 Gbps), on the bottleneck link, there are 12 bursts competing for the outgoing interface. Their sizes are 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 30, and 30 flow-sets respectively. The designed delay level resource table:

Delay Level	Burst Resource	Bandwidth Resource	Allowed Admited Flows
400 us	6356 Kbits	1860 Mbps	CC/Audio of 70 flow-sets
700 us	5880 Kbits	5390 Mbps	Video of 70 flow-sets

- E2E bounded delay for CC/Audio is 4.75 ms (225*14 + 400*4), for Video is 5.95 ms (225*14 + 700*4).
- E2E bounded jitter is 0 with the help of latency deviation (E) and on-time mode.

Functional Characteristics Analysis

Taxonomy with Functional Characteristics (draft-taxonomy-04, section 5)	**Functional Characteristics of EDF mechanism**
5.1 Periodicity • If a solution has a set of consecutive time slots that is repeated periodically, • and the time slots are assigned to packets based on a predefined rule. then the solution is periodic.	**It is non-periodic:** • The scheduling power of EDF is measured over an arbitrarily long non repetitive time duration.
5.2. Traffic Granularity • Flow level: Each packet is controlled based on its specific flow. • Flow aggregate level: Flows are grouped by shared characteristics like TSpec, RSpec, or routing path. • Class level: Flows are further grouped by similar RSpec, regardless of specific path or TSpec.	**It is class level:** • Flows can be grouped by similar delay levels provided in the network. • Packets will be provided EDF service based on the delay level, without checking flow identification.
5.3. Time Bounds • **Bounded: A packet's transmission completion is allowed after a minimum time bound and before a maximum time bound.** • **Left-bounded: A packet's transmission completion is allowed after a minimum time bound.** • **Right-bounded: A packet's transmission completion is allowed before a maximum time bound.**	**It is at least right-bounded:** • **Deadline, by definition, is the maximum time bound. So EDF with in-time mode is right-bounded.** • **While EDF with on-time mode, due to further limiting the minimum time bound, is bounded.**

History of Comments and Responses

[Q1] There has been a lot of previous work on this topic, it would be good to understand what is novel in this document. (from gengxuesong, IETF115)
[Q2] What have you contributed here which is not in the 1986 reference publication you quoted, ... in your case it is highly simplified without sufficient proof. I think the calculation is invalid...... (from gengxuesong, IETF117)
[A] This document proposes a core stateless EDF mechanism to better adapt to the Diffserv architecture, and also aims to quantify delay level resources and provide a foundation for path computation. The appendix provides proof. The latest version supplements the research result of the academic community.

[Q3] What preparations should be made before the deadline: such as: bandwidth guarantee, path planning, etc......(from chengzuopin, https://mailarchive.ietf.org/arch/msg/detnet/HLaJZx5bhJYCUGgqwj68Paek7jI/)
[A] Add section for path computation and resource reservation.

[Q4] A question for clarification on the admission criteria (or the schedulability condition) of the Deadline based forwarding... ... (from Jinoo, https://mailarchive.ietf.org/arch/msg/detnet/4VaZEQ1nmisd-SsHGIEnQf-hgKE/)
[A] consensus reached on the understanding of schedulability conditions, and a summary of in-time/on-time has been added as suggested by Jinoo.

Other issues in interim meetings have been clarified, see https://notes.ietf.org/notes-ietf-interim-2023-detnet-02-detnet, https://mailarchive.ietf.org/arch/msg/detnet/UbXwJ8rOOEROYXL__OyQQmg1-mg/

Next step

- WG adoption ?
- Any questions/comments ?

Thank you!