Evaulation for EDF&TQF on Referenced Topology

EDF: draft-peng-detnet-deadline-based-forwarding-12
TQF: draft-peng-detnet-packet-timeslot-mechanism-09

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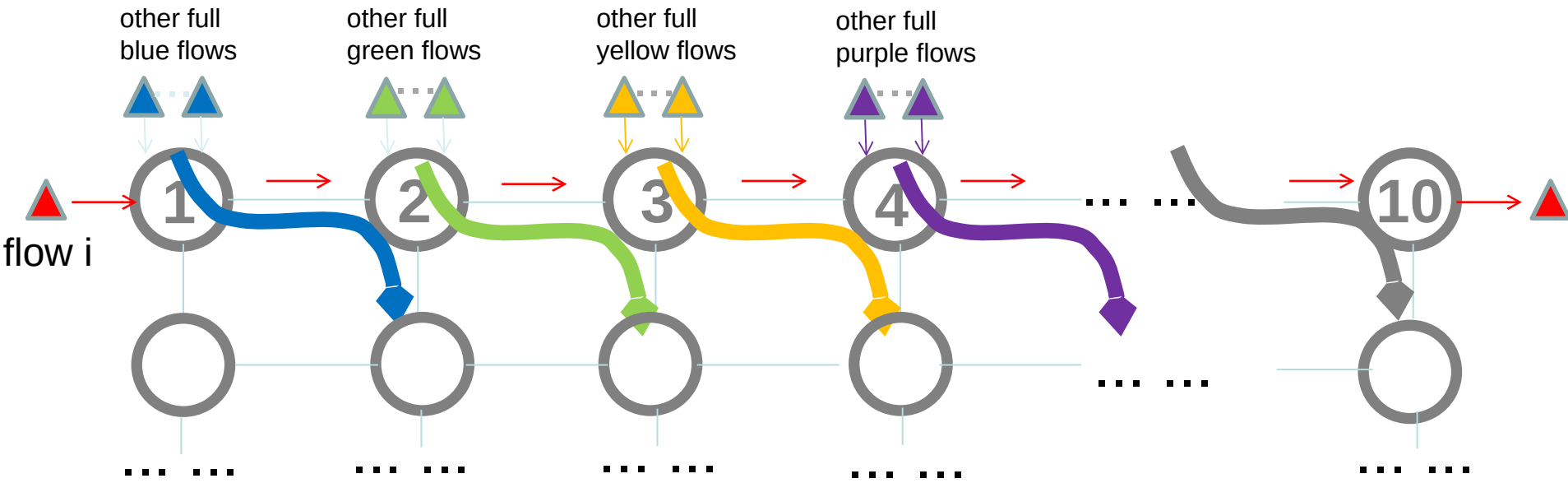
Main Works and Updates of EDF & TQF

- The authors have initiated discussions in 6man WG maillist for the data plane encoding topic (https://mailarchive.ietf.org/arch/msg/ipv6/nmJg8TCJoBaMeo5_jmgkpXUP2cU/). No feedback received yet.

- The related data plane encoding proposals (draft-pb-6man-deterministic-crh-01 & draft-p-6man-deterministic-eh-01) have been requestd presentation in 6man WG during IETF-121. Waiting for more comments.

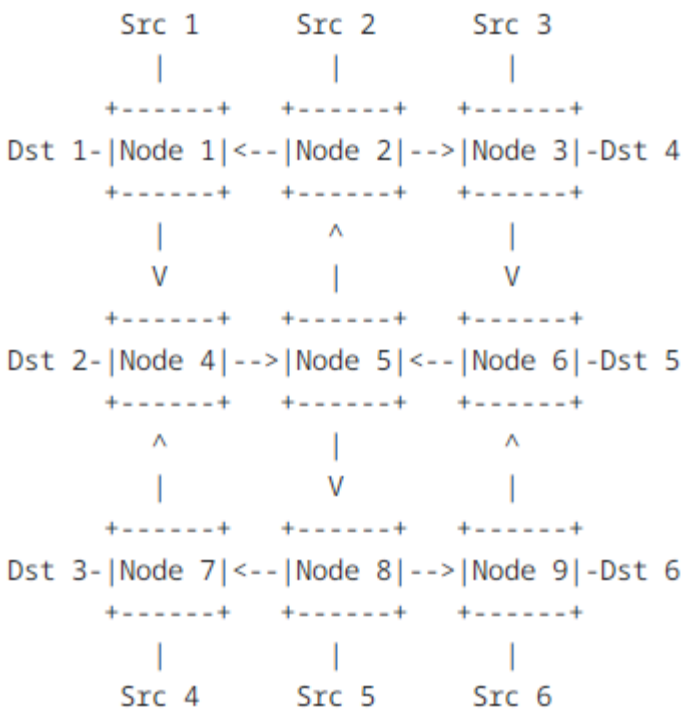
- Main updates in the new version.
  - On the basis of the heavyweight loading topology evaluated in the last version, the new version further evaluated the performance metrics of another lightweight loading topology (i.e., Grid Referrence Topology defind in draft-taxonomy).
    - Heavyweight loading means that every hop is a bottleneck link, while lightweight loading is not.
    - Will provide evaluation of the recently discussed Ring-Mesh Referrence Topology in the next version.

Looking Back at Heavyweight Loading Case



- The observed flow (red) is competed by other full flows on each hop, e.g, blue full flows on hop-1-2, another green full flows on hop-2-3, etc.
- The competed flows may arrive simultaneously at **multiple incoming ports**, with the **same starting time** when measuring their respective residence time.
- **Every hop is a bottleneck link**, and every hop reaches the worst-case latency. A solution's bounded E2E latency simply equals to the sum of (worst-case latency of each hop).

Lightweight Loading Case: Grid RT

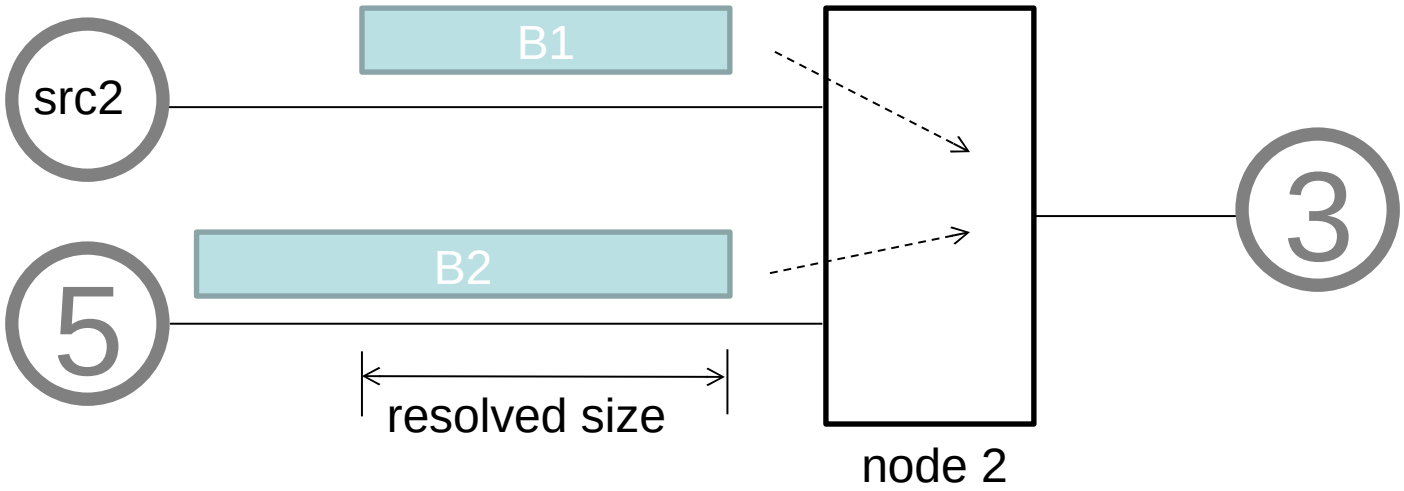


- Audio flow
  1 packet (1*2000 bits) per SBI
  SBI = 1.25 ms
  arrival rate = 1.6 Mbps
  expect E2E latency: 5 ms
- Vedio flow
  30 packets (30*12000 bits) per SBI
  SBI = 33 ms
  arrival rate = 11 Mbps
  expect E2E latency: 10 ms
- CC flow
  1 packet (1*2400 bits) per SBI
  SBI = 5 ms
  arrival rate = 0.48 Mbps
  expect E2E latency: 5 ms

- Flows to Dst1, 6 are Audio flows, to Dst 3, 4 are Vedio flows, to Dst 2, 5 are CC flows.
- On each node, the competed flows arrive at a small number (2 or 3) of incoming ports.
- Only link 2->3 and link 8->7 are **bottleneck link**s, both carry **10 audio, 60 vedio, 10 CC flows**.
- The longest path contain **7 hops**, e.g, Src2-2-3-6-5-8-7-Dst3.

Policing on Vedio Flow

- Vedio flow (a little elephant, i.e., 30 back-to-back packets in a single burst) in Grid RT is a good example for observing the trade-off between bursts, latency, and service scale.
- See link-2-3 below, which is expected to carry **10 audio, 60 vedio, 10 CC flows**, in which, 10 CC + 10 audio + 20 vedio from the incoming port connected to src-2, 40 vedio from incoming port connected to node-5.



  - B1 is composed by 10 CC + 10 audio + 20 vedio, with the size 7244000 bits. B2 is composed by 40 vedio, with the size 14400000 bits. Both B1 and B2 are **eligible** arrivals !
  - The resolved size is 7244000 bits, introducing a maximum queuing delay of **7.244 ms** just for a single hop. This is independent of any queueing solutions.
  - **Trade-off**: reduce the resolved size (e.g.,by policing of flow, or reducing the admited flows).
  - **Policing** function is common for all solutions, see DetNet architecture (section 3.2.).

Evaluation for EDF

- 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.
- For simplicity, a unified delay resource pool is configured on each link, with slightly increasing the loading and assuming that the number of each type of flows on each link reaches 60.
- A possible delay level resource table: (note: vedio flow has been shaped)

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	

Note: a more smaller bounded latency for each hop can be calculated based on the **acutual number** (less than allowed number) of admited flows on that hop.

- **Bounded latency per-hop**

  If the **allowed number** of admited flows is not exceeded, the bounded latency per-hop is the delay level, such as 200 us for CC, 700 us for Audio, and 1100 us for Vedio, respectively.

- **E2E bounded latency**

  Bounded latency per-hop * hop-count.
  E.g., for the vedio flow of path Src2-2-3-6-5-8-7-Dst3, it is 7*1100 us.

- **E2E bounded jitter**

  The path jitter is 0 with the help of delay deviation (E).
  However, the E2E jitter (if including the transmission to destination APP site) is detemined by the transmission amount (60 flows of specific type in this example) at the last hop that faced to the destination site that may not enable **latency compensation** function.
  It is 144 us for CC, 120 us for Audio, 720 us for Vedio.

Evaluation for TQF

- The OPL (Orchestration Period Length) 5 ms and timeslot length 100 us are choosed based on the service burst interval and maximum packet size of the flows.
  - An OP contains one round CC burst, 4 round Audio burst, 5 Round Vedio burst.
- A possible timeslot resource table:
  - Principle: ensuring that the offset between the incoming timeslot and the reserved outgoing timeslot is less than the per-hop latency bound of each type of flow , e.g., 700us for audio and CC flows, 1400us for vedio flows.

Timeslot	**Burst Resource**	**Allowed Admited Flows**
#0~#9	100 Kbits	for 60 CC/Audio/Vedio (round-1). For example, 40 CC + 2 Audio in #0, 20 CC + 26 Audio in #1, 26 Audio + 4 Vedio in #2, etc.
#10~#20	1000 Kbits	for 60 Audio/Vedio (round-2)
#21~#30	1000 Kbits	for 60 Audio/Vedio (round-3)
#31~#40	1000 Kbits	for 60 Audio/Vedio (round-4)
#41~#49	1000 Kbits	for 60 Vedio (round-5)

Note: different hop may have different table.

- **Bounded latency per-hop**

  The bounded latency per-hop is carefully controlled, equal to the **offset** between the incoming timeslot and outgoing timeslot.
  In the above table, assuming that the first round of all flows arrive concurrently (a bad flow interleaving), Vedio packets will experience larger offset (1 ms) than CC/Audio packets (500 us). However, different hops may have different flow interleaving and corresponding offsets.

- **E2E bounded latency**

  The sum of bounded latency per-hop.
  E.g., for the vedio flow of path Src2-2-3-6-5-8-7-Dst3, it is 7*1000 us if each hop get the same offset 1 ms.

- **E2E bounded jitter**

  The path jitter is 2 timeslot, or 0 with the help of time deviation (E).
  However, the E2E jitter (if including the transmission to destination APP site) is detemined by the transmission amount (60 flows of specific type in this example) at the last hop that faced to the destination and may not apply timeslot based scheduling. It is 144 us for CC, 120 us for Audio, 720 us for Vedio.

Next step

- The authors believe both EDF and TQF categories are the right direction for DetNet EDP and the content is basically mature, would like to request WG adoption.
- Any questions/comments ?

Thank you!