Extension Headers for QoS - discussion

6MAN / DetNet WG, IETF119 Brisbane, v1.0

draft-eckert-6man-qos-exthdr-discuss-00

Toerless Eckert, Futurewei USA (tte@cs.fau.de) (Editor)
Jinoo Joung (jjoung@smu.ac.kr)
Shaofu Peng (peng.shaofu@zte.com.cn)
Xuesong Geng (gengxuesong@huawei.com)
Goals with 6MAN perspective

Admin: Work towards an actual draft-ietf-6man-qos-exthdr draft

... Currently several open technical IPv6 EH questions
... Is there enough support to do the real draft work.
... Provide summary of the use-cases (specs have likely multiple hundreds of pages in other drafts)

Technical: Single (set of) common EH to support multiple different QoS schemes

Promote instead of roadblock innovation in IPv6!

Break through core problem: Each single QoS scheme will fail to argue for new header alone (proof: 25 years IETF history)

Do not have arbitrary/enough EH code points

Do not want open-ended packet parsing if more QoS schemes show up

Differentiated by new “Method” code point in header

Define Standards / Experimental / Information(External) allocation – and extensibility

Each (set of) QoS Methods to use this header would be new doc, referring/complying to qos-exthdr RFC

Common qos-exthdr RFC defines

Common processing, payload (“metadata) encoding & information model requirements
Goals with DetNet perspective

... Research/advanced HW development background: Programmable QoS
  PIFO (Push In First Out) queues. Packets enqueued/dequeued with desired time of departure
  First scaleable PIFO algorithms for ASCI/FPGA shown recently/'24.
  FPE (e.g.: P4) can calculate this time for many queuing algorithms.
  Also several simpler methods for existing / easy HW (e.g.: cyclic queuing based)
... Multiple “large-scale DetNet” QoS mechanism proposals
  Not using per-flow QoS, but per-packet QoS (eliminates state management, per-packet flexibility)
    Requires additional in-packet metadata (which else is bound to per-flow state in routers)
... Difficult IETF /DetNet selection process. Each method has different Pro/Cons
... Chicken and Egg problem: Absence of easy-to-use EH makes deployment experimentation difficult.
  Absence of experimentation makes standardization difficult
... Common header / ease of getting “Method” codepoint would allow experimentation
  And DetNet problem could reduce to labelling (standard / experimental / informational) the methods.

“Congestion Control” based traffic / use-cases may (hopefully) also chime in.
Possible proposal – HbH header

<table>
<thead>
<tr>
<th>Next Header</th>
<th>Hdr Ext Len</th>
<th>V</th>
<th>Rsvd</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method Parameters (64 bits)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Method: New registry, each Method value defines syntax/semantic of Method parameters
  - Sub-Range 1: IETF standard Methods
  - Sub-Range 2: IETF all (std, exp, inf), non-IETF (expert review, spec required)
  - Sub-Range 3: local experiment
  - Sub-Range 4: network wide configured

- Fixed size for all Methods to minimize HW-packet-parser-cost to skip unknown Methods at linerate
  TBD: will 64 bits suffice for „all“ interesting/future Methods – collect likely Methods
  - Rather waste some bits than make it harder to deploy!

- V=0. Support extensibility of Methods with V=1, only after 5 years of initial allocation of Method.
Possible proposal – Further details

• Also “Destination Option” header
  • Same format, separate Method registry.
  • See DetNet example

• Specification requirements / guidelines
  • For all spec types: Standard, Experimental, Information, external):
    • Format / Semantic of Method Parameters
    • Packet processing when Method parameter encountered
      • Limitations such as “limited to per-hop packet scheduling”
    • Permissible semantic of Method parameters
      • To address e.g. Privacy concerns upfront
    • Further details from draft-ietf-6man-hbh-processing
    • Use of additional metadata fields, e.g.: per-flow behavior with IPv6 flow-label, parameter fields in IPv6 SID/Addresses (RFC6554, RFC8754)
Examples - DetNet – see draft for summary of functionality

DetNet Destination Option Header for PREOF and timed playout

```
+-----------------------------------------------+
| Reserved | P | End-to-End Timestamp |
+-----------------------------------------------+
```

HbH Method for per-hop bounded latency with C-SCORE Method (guaranteed latency stateless WFQ)

```
+-----------------------------------------------+
| Reserved | Service Rate (16 bit) | Finish Time (usec) |
+-----------------------------------------------+
```

HbH Method for per-hop bounded latency and jitter with TCQF Method (cyclic queuing with explicit cycle Identifier)

```
+-----------------------------------------------+
| Reserved | Prio | Cycle |
| Reserved |
+-----------------------------------------------+
```

HbH Method for per-hop bounded latency and relaxed Jitter with TQF Method (orchestration period scale cyclic queuing and slip tracking)

```
+-----------------------------------------------+
| Reserved | Timeslot |
| Reserved | Deviation (#slot slips) |
+-----------------------------------------------+
```

HbH Method for per-hop bounded latency with minimum jitter with gLBF Method (UBS calculus with Damper)

```
+-----------------------------------------------+
| Reserved | PPrio | Prio |
| Damper Time (usec) |
+-----------------------------------------------+
```
Examples – Mechanisms for “AQM” with Congestion Controlled Traffic

• HbH Method for per-hop stateless weighted fair queuing – draft-stoica-diffserv-dps (2000)

```
+----------------------------------------+
| Reserved                               |
+----------------------------------------|
+----------------------------------------+
| Flow rate (bits/sec)                   |
+----------------------------------------+
```

• Possible other per-packet metadata that was considered for enhanced CC
  • In research paper or IETF discussions (but AFAIK never made it into drafts)

• More than 1 ECN bit to indicate level of congestion (e.g. LIVE research paper ca. 2010)
• More than 1/2 bit to indicate type of congestion control (as required today when ECN is used to distinguish L4S from non-L4S traffic.
• More than 1 bit to indicate degree of “Pre Congestion” (PCN vs. ECN – currently impossible to distinguish with 2 ECN bits).
• Parameters to help “Upspeeding” – aka: maximum free bandwidth on slowest congestion point along path.
From 6MAN discussions (Thanks TimC / Tom Herbert)

- Authentication metadata (Tim Chown -> draft-herbert-fast)
  - Crypto authentication like FAST should be separate HbH extension header from HbH QoS:
    - QoS HbH header must be acted on on every hop (for e.g.: per-hop latency)
    - FAST type authentication would only be acted upon on domain ingress router
      (no need to support on every hop)
  - FAST style cryptographic authentication not necessary in single-domain when e.g.: 802.1X is used.
    - Likely in industrial DetNet deployments.

- Accounting/Billing metadata e.g.: draft-cc-v6ops-wlcg-flow-label-marking in EH instead of flow-label
  - Strong rejection from INTAREA / TSVWG chairs/ADs in 2013 for similar (broader) proposal
  - draft-eckert-intarea-flow-metadata-framework, draft-choukir-tsvwg-flow-metadata-encoding
  - Argument: Applications cannot be trusted to send unencrypted privacy critical metadata such as “Application Type” or “User related” metadata into the network. Network can/must always be considered untrustworthy.
  - Author did not believe arguments back in 2013, but will not try to have the same fight again.
    - Best to try to go with encrypted metadata with FAST for any such potentially privacy sensitive metadata
      - Need experiments with hardware forwarding plane feasible crypto operation.
Questions?

• Please contact us when you are interested in this!