L4S: Low Latency, Low Loss, Scalable Throughput Internet Service

draft-ietf-tsvwg-l4s-arch-02
draft-ietf-tsvwg-ecn-l4s-id-02
draft-ietf-tsvwg-aqm-dualq-coupled-04

Bob Briscoe, CableLabs
Koen De Schepper, Nokia Bell Labs
Marcelo Bagnulo, UC3M

IETF-101 Mar 2018

The authors were part-funded by the European Community under its Seventh Framework Programme through the Reducing Internet Transport Latency (RITE) project (ICT-317700). The views expressed here are solely those of the authors.
Recap

- **Motivation**
  - Extremely low queuing delay for all Internet traffic
  - already 1-2 orders better than state of the art
  - 500 μs vs 5-15 ms (fq-CoDel or PIE)

- **Architecture**
L4S Status Update (1/2)

- Landing page for code, specs, papers
  https://riteproject.eu/dctth/

- Source Code
  - Dual Queue Coupled AQM, DualPI2 for Linux [UPDATE in progress]
  - Data Centre TCP (DCTCP) for Linux (in the mainline kernel), FreeBSD patch, ns2 patch.
  - Accurate ECN TCP Feedback for Linux [testing needed]

- Implementations
  - DualQ Coupled AQM: in at least one chipset aimed at the data centre environment [availability TBA]
  - L4S Scalable congestion control: rmcat SCReAM
  - BBRevo, evolution of BBR with L4S support [NEW, see iccrg Fri]
  - Whole L4S system in ns3 [complete but evolving, first release Jun'18 timeframe]
L4S Status Update (2/2)

- IETF specs
  - Low Latency, Low Loss, Scalable Throughput (L4S) Internet Service: Architecture <draft-ietf-tsvwg-l4s-arch-02> [MINOR UPDATE]
  - A proposed new identifier for Low Latency, Low Loss, Scalable throughput (L4S) packets <draft-ietf-tsvwg-ecn-l4s-id-02> [MINOR UPDATE]
  - Dual-queue AQM: <draft-ietf-tsvwg-aqm-dualq-coupled-04> [2 UPDATES]
  - Interactions of L4S with Diffserv <draft-briscoe-tsvwg-l4s-diffserv-00> [NEW]
  - enabled by <RFC8311> [RFC published]
  - scalable TCP algorithms, e.g. Data Centre TCP (DCTCP) <RFC8257>, TCP Prague
  - Accurate ECN: <draft-ietf-tcpm-accurate-ecn-06> [UPDATED – WGLC pending review(s)]
  - ECN++ Adding ECN to TCP control packets: <draft-ietf-tcpm-generalized-ecn-02> [Supporting measurement paper published in IEEECommMag]
  - ECN support in trill <draft-ietf-trill-ecn-support-07>, motivated by L4S [4 updates, RFC Ed Q]
  - ECN in QUIC <draft-johansson-quic-ecn-03>, motivated by L4S [DES TEAM FORMED]

- 3GPP Proposal
  - ECN visibility to Radio Link Control (RLC) layer, motivated by L4S [Rejected for R15; Retry for R16]
DualQ Coupled AQMs for L4S
draft-ietf-tsvwg-aqm-dualq-coupled-04

- Two updates in this IETF cycle
- Overload handling
  - explained under security considerations
    (not just pseudocode in appendix A.2)
- Additional terminology for the control variables
- Un-deprecated WRR for inter-Q scheduler
- Added classifier flexibility, not only ECT(1):
  - addressing
  - protocols (e.g. DNS, LDAP, ARP)
  - or DSCP (see new draft – next slides)
Interactions between
Low Latency Low Loss Scalable throughput (L4S)
and Diffserv

draft-briscoe-tsvwg-l4s-diffserv-00

Bob Briscoe, CableLabs

IETF-101 Mar 2018
Why is DualQ Coupled AQM different?

- Diffserv controls bandwidth
  - controls queue latency by allocating bandwidth

- Coupled DualQ: semi-permeable membrane:
  - latency: delay of L queue isolated\(^1\) from C
  - bandwidth: behaves as 1 pool of capacity

- Can add bandwidth allocation to DualQ
  - but typically unnecessary

\(^1\): Lower latency is not at the expense of the C queue, C is for legacy
L4S-Diffserv: 4 types of interaction

1) None
   - typical

2) Codepoint mapping (next slide)
   - in absence of additional Diffserv queues

3) Operator configures bandwidth alloc'n around DualQ
   - no different from any AQM + Diffserv

4) Operator configures bandwidth alloc'n within DualQ

Assured b/w for demanding app, e.g. VR

Low latency for L₁-L₃
More b/w per flow for L₁ than L₃
(like Diffserv Assured Forwarding)
Mapping Diffserv Service Classes [RFC4594] to L4S
(if operator solely offers Latency & Classic queues)

<table>
<thead>
<tr>
<th>Service Class Name</th>
<th>DSCP Name</th>
<th>DSCP Value</th>
<th>App example</th>
<th>AQM</th>
<th>LLD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network Control</td>
<td>CS7</td>
<td>111000</td>
<td>(Resv'd for) Network routing</td>
<td>Y &amp; N</td>
<td>L if ECT1</td>
</tr>
<tr>
<td>Network Control</td>
<td>CS6</td>
<td>110000</td>
<td>Internetwork routing</td>
<td>Y &amp; N</td>
<td>L if ECT1</td>
</tr>
<tr>
<td>OAM</td>
<td>CS2</td>
<td>010000</td>
<td>Ops, admin, mgmt &amp; provis'ng</td>
<td>Y &amp; N</td>
<td>L if ECT1</td>
</tr>
<tr>
<td>Signalling</td>
<td>CS5</td>
<td>101000</td>
<td>IP telephony signalling</td>
<td>N</td>
<td>L</td>
</tr>
<tr>
<td>Telephony</td>
<td>EF</td>
<td>101110</td>
<td>IP telephony bearer</td>
<td>N</td>
<td>L</td>
</tr>
<tr>
<td>Voice Admit^1</td>
<td></td>
<td>101100</td>
<td>Admission-control'd IP telephony</td>
<td>N</td>
<td>L</td>
</tr>
<tr>
<td>Real-Time Interactive</td>
<td>CS4</td>
<td>100000</td>
<td>Video conf &amp; interactive gaming</td>
<td>N</td>
<td>L if ECT1</td>
</tr>
<tr>
<td>MM Conferencing</td>
<td>AF4x; x=1,2,3</td>
<td>100{01,10,11}0</td>
<td>H.323/V2 video conf. (adaptive)</td>
<td>Y</td>
<td>L if ECT1</td>
</tr>
<tr>
<td>Broadcast Video</td>
<td>CS3</td>
<td>011000</td>
<td>Broadcast TV &amp; live events</td>
<td>N</td>
<td>L if ECT1</td>
</tr>
<tr>
<td>Multimedia Streaming</td>
<td>AF3x; x=1,2,3</td>
<td>011{01,10,11}0</td>
<td>Streamed video &amp; audio</td>
<td>Y</td>
<td>L if ECT1</td>
</tr>
<tr>
<td>Low Latency Data</td>
<td>AF2x; x=1,2,3</td>
<td>010{01,10,11}0</td>
<td>Client-server transactions, Web</td>
<td>Y</td>
<td>L if ECT1</td>
</tr>
<tr>
<td>High Throughput Data</td>
<td>AF1x; x=1,2,3</td>
<td>001{01,10,11}0</td>
<td>Store and forward applications</td>
<td>Y</td>
<td>L if ECT1</td>
</tr>
<tr>
<td>Standard</td>
<td>DF (CS0)</td>
<td>000000</td>
<td>Undifferentiated applications</td>
<td>Y</td>
<td>L if ECT1</td>
</tr>
<tr>
<td>Low Priority Data</td>
<td>LE^3</td>
<td>000001^3</td>
<td>Any flow with no b/w assurance</td>
<td>Y</td>
<td>L if ECT1</td>
</tr>
</tbody>
</table>

- “L if ECT1” is not classified into L 'cos of its DSCP
- Need to consider NTP (advice in RFC4594 n/a for LLD)
- RFC5865 gives Voice Admit priority over EF
- To take advantage of scalable congestion control
- Less Effort [draft-ietf-tsvwg-le-phb] update to RFC4594
- Flows using LE SHOULD also use LE congestion ctrl
Status & Next Steps

- **AQM: aqm-dualq-coupled**: continual improvement
  - feedback from implementers (all offlist)
  - evaluation over other specific links besides DSL (DOCSIS, LTE/5G, DC) using ns3, Linux and prototype h/w implementations

- **Architecture & Identifier**: in holding pattern
  - l4s-arch, ecn-l4s-id

Next:
- **TCP Prague**: Pulling parts together
- **aqm-dualq-coupled**: more on policing / queue protection

- Review of relationship with Diffserv
- **draft-briscoe-tsvwg-l4s-diffserv** adoption?
  - loosely coupled to rest of L4S process?
Q&A