LE codepoint: preliminary results and ongoing work in the IETF
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Gorry Fairhurst
Ana Custura
Andre Venne
Tom Jones (edgetrace)
(University of Aberdeen, UK)
Which DSCP for LE?

- RFC 3662 designates CS1 for ‘low priority’ data
- RFC 4594 talks about using CS1 (DSCP 8) for LE
- Proposed LE PHB: 000010 (DSCP 2)
  - draft-ietf-tsvwg-le-phb-01

- Measurements over 2 campaigns using PATHscope and PATHspider from the core to webservers.
Preliminary results - PATHspider.net

- Entire Alexa Top 1 million website list resolved and IP addresses A/B tested for DSCP 0 & 2
  - Tested 4.2 Million unique paths
  - 3-way handshake completed for both DSCPs for 99.998% of paths
  - 7200 failures attributed to packet loss when testing

- Similar results for DSCP 46 (EF) (99.97% of paths)

- Setting a DSCP did not blackhole packets

(Details at end of slides)
PATHscope Measurements

- Tool created packets with increasing TTL
- Captured ICMP type 11 messages
- Measurements from 3 Digital Ocean vantage points to 300 targets randomly chosen from Alexa Top 1 Million list, using both TCP & UDP
Preservation of DSCP 2 (000010)
Results for 582 unique paths

- DSCP traverses 81% of paths unchanged
- 19% remarked, but 13% remarked to 0 (BE)
- No difference between TCP & UDP
Pathologies

%age routers changing DSCP

- DSCPs 1 to 7 had lowest modification rate, changed for <3% of routers; (unaffected by routers modifying upper 3 bits)

- A DSCP that sets the upper 3 bits is modified by a router using RFC791 ToS Semantics

- CS1 (DSCP 8) changed by 5% more routers than DCSP 2
Problems with routers using ToS Semantics

• In a study of 524 routers, 88 (16.79 %) bleached the upper three bits of the DS field:

\[10, 16, 26, 34 \text{ (AFx1)} \land 000111 = 2\]
\[12, 18, 28, 26 \text{ (AFx2)}, 44 \text{ (Voice Admit)} \land 000111 = 4\]
\[14, 22, 30, 38 \text{ (AFx3)}, 46 \text{ (EF)} \land 000111 = 6\]

• AFx1, etc can be remarked as LE, resulting in priority inversion

• CS1 priority already ambiguous using ToS Semantics
Next steps: Edgetrace

- We need to find out about DSCPs in the Edge
- We made an easy to install go command line tool
- This tests DSCP values from your current location
- Please download at trace.erg.abdn.ac.uk
Conclusion
– Is DSCP2 good for LE?

• DSCP 2 has good survivability
  • Good compatibility with 802.11 (can be updated)
  • Not affected by pathologies resulting from ToS semantics

• Routers/Hosts still using ToS semantics problematic
  • Routers can cause priority inversion for higher DSCPs
  • ToS applications (Portable OpenSSH sets DSCPs 2 & 4)

• DSCP 2 is better than CS1
  • CS1 was more often remarked
  • CS1 was more prone to priority inversion
Questions & Answers

Please use *Edgetrace* to measure edge networks – try it and help us understand more of what really works

![Map of observed DSCP at end of path](trace.erg.abdn.ac.uk)
Extra slides - for info
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PATHspider Tool (EU MAMI Project)

- Tool to perform path transparency measurements
- Entire Alexa Top 1 million website list resolved to IP address
- IP addresses tested for A/E connectivity

https://pathspider.net/
PATHspider Measurements

- Tested for A/B connectivity using DSCP 2
- A connection is considered successful if the TCP 3-way handshake completed for both DSCP 0 and DSCP 2
- In total, over 4.2 million paths tested

https://pathspider.net/
Other known usage (backwards compatibility)

- SSH code base still uses ToS semantics:
  - `#define IPTOS_LOWDELAY      0x10`
  - `#define IPTOS_THROUGHPUT    0x08`
  - `if (options->ip_qos_interactive == -1)`
    - `options->ip_qos_interactive = IPTOS_LOWDELAY;`
  - `if (options->ip_qos_bulk == -1)`
    - `options->ip_qos_bulk = IPTOS_THROUGHPUT;`

- Current DSCP used interactive and bulk data SSH sessions are 2 (000010) and 4 (000110).
  - This could also result in priority inversion
  - Portable OpenSSH bug number 1856: [https://bugzilla.mindrot.org/show_bug.cgi?id=1856](https://bugzilla.mindrot.org/show_bug.cgi?id=1856)
  - Bug recommending replacing ToS options for SSH interactive sessions and SCP with AF21 and AF11
Edge trace

• An easy to install that tests which DSCPs are usable from your current location
Edgetrace Software Stack

- **Client**
  - go command line tool
  - runs everywhere™
- **Server**
  - nginx front end
  - go server
Edgetrace Operation

- Client requests session token from server
- Adds to Token:
  - Send DSCP
  - OS
- Sends
  - 10 datagrams per DSCP send
  - Paced 5 packets per second
### DSCPs tested by edgetrace

<table>
<thead>
<tr>
<th></th>
<th>CS0</th>
<th>AF11</th>
<th>AF31</th>
</tr>
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<tbody>
<tr>
<td>CS1</td>
<td></td>
<td>AF12</td>
<td>AF32</td>
</tr>
<tr>
<td>CS2</td>
<td></td>
<td>AF13</td>
<td>AF33</td>
</tr>
<tr>
<td>CS3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CS4</td>
<td></td>
<td>AF21</td>
<td>AF41</td>
</tr>
<tr>
<td>CS5</td>
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<td>AF22</td>
<td>AF42</td>
</tr>
<tr>
<td>CS6</td>
<td></td>
<td>AF23</td>
<td>AF43</td>
</tr>
</tbody>
</table>

DF
EF
(LBE)
JSON blob returned from the request to the edgetrace server

```json
{
  "host":"139.133.204.55",
  "time":"20170321090918",
  "token":"475fc335577904615f3f2299e40c8c84763279fe",
  "dscp":0,
  "description":"ERG TestRun",
  "os":"darwin"
}
```