Considerations for Assigning DSCPs

(Doomsday edition)
Ana Custura, Gorry Fairhurst, Raffaello Secchi

Updates in Current rev.

- draft-ietf-tsvwg-dscp-considerations-01

- Edits since last IETF:

  - We classified a new pathology (clear the 3 LSB of DSCP)

  - BC said: refer to RFC3086

  - RG said: comment on CS6 as management DSCP (supported both by measurements and operators)

  - RG said: clarify text from RFC 2474

  - RG said: useful clarifications around use of DSCP in mobile networks (GSMA IR 34 is not binding) and MPLS short-pipe

- Then paused to gather more understanding... see next slides

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Existing Registrations & Reserved DSCPs

- ToS Byte Precedence: CS DSCPs in RFC 2474

- AF DSCPs in RFC 2597

- EF, RFC 3246

- Voice Admit, RFC 5865

- LE, RFC 8622

- Experimental use: xxxx11

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Are They Used?

- AF11, AF21, CS3, EF used by webservers & some DNS servers

- AF11,12,13 observed in mobile networks

- ICMP traffic marked with DSCP CS6

- DNS likes CS1, CS4, AF11

- All measurement data - see Appendix!

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The Problem (i) - could they be used end-to-end?

- Internet core study shows some routers use former IP precedence bits (2015):

  - Clearing only 3 MSB of DSCPs: ToS Precedence Bleaching

- Supported by packet trace analysis (2018, 2019)

- Validated in edge networks (2021)

- **..all DSCPs < 8 have higher end-2-end traversal**

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The Problem (ii)
- could they be used end-to-end?

- AFx1 ToS Precedence Bleach to DSCP 2 - currently unusable - a lot of traffic aggregated to this

- DSCP 4: SSH clients set this code point for SSH traffic :-(

- DSCP 5: NQB *provisionally* allocated to this value.

- DSCP 6: same issue as DSCP 2

- DSCP 57,49,41,33,25,17,9 aggregate to LE (DSCP 1)

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What Next?

- If we accept there are currently only 8 possible semantics that can be carried end-to-end in the Internet:

  - Edge DSCPs that care have to share these semantics

  - E.g., could DSCP 5 not only be NQB, but an aggregate compatible with NQB.

- If not, then maybe decide if we encourage dual-assignments for edge/core:

  - a) choose one code point?

  - b) allow both for the same purpose in the Internet core (no strict requirement for re-marking)?

  - Risk making DSCPs in the same column unusable!

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Other Considerations

- Networks not re-marking DiffServ: operators pass all DSCPs transparently (valid) - we see this in measurements

- **Managed networks** using DiffServ: operators police DSCPs (allowed) - we see this in measurements

  - Operators need to keep up with new assignments, can choose to support them

  - *Encourage* operators to assign unknown DSCPs the default PHB, *not ToS precedence bleach*

  - *Discourage use of masks*.. re-marking from 45 to 5 in an NQB scenario should not include DSCPs 13, 21 etc.

- **Unmanaged networks** that re-mark in a way that introduces pathologies (problem):

  - Inconsistent re-marking

  - Leaking traffic marked with experimental DSCPs

  - ToS precedence bleaching

  - Bleaching of the 3 LSBs of DSCPs

- What does the WG want to say about this?

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Next Steps

- The current document is informational

- We will add above table and describe implications

- Can we make recommendations for future assignments?

- Make a new draft --- with your help!!!

    - Is it worthwhile organizing an operator survey

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Appendix

- Appendix contains measurement results taken between 2016-2022

DSCP Traversal Datasets

- Mobile Edge (Traceroute data for well-known DSCPs from 12 European mobile carriers, 2016):

    - ToS bleaching emerges a pathology

    - Most mobile networks remark to a single DSCP

    - AF11, 12, 13 are popular choices

- Core (Traceroute-like experiments for all 64 DSCPs to 500 web servers, from 8 vantage points, 2017):

    - 80% end2end traversal rate for DSCPs<7

    - 55% end2end traversal rate for DSCPs >7

    - **ToS precedence bleaching on up to 20% of paths**

    - Some paths remark to AF11

RIPE Atlas traceroutes

- 10,000 RIPE Atlas probes, many in edge networks

- Sender DSCP set to 0, 42, 45, 2, 5,

- TCP traceroute to port 8080 at UoA server, June 2021
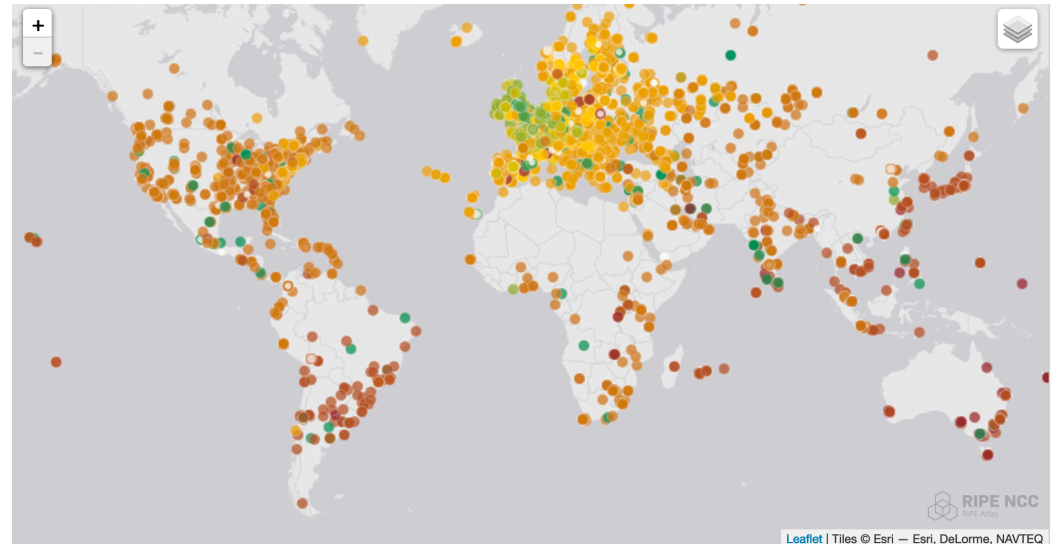
- DSCP 45 has a 20% traversal rate; DSCP 5 has a 25% traversal rate

- Bleaching to DSCP 0 happens in the first AS on up to 40% of paths

- **ToS bleaching still happening**

CAIDA Passive Traces

- Traffic recorded during 1 hour in January at Equinox DC in NY

- OC192 backbone link (9953 Mbps) of a Tier 1 ISP between NY and Sao Paulo

- Traffic is bidirectional and anonymised preserving prefixes

- We looked at DSCP markings

	2018	**2019**
IPv4 Packets	9,568,663,465	7,937,877,712
IPv6 Packets	316,007,533	234,393,206
TCP/UDP split	79 / 19 (2% other traffic)	73 / 24 (3% other traffic)

CAIDA Passive Traces

	2018 - Dir A	2018 - Dir B	2019 - Dir A	2019 - Dir B
All packets Per direction and year	BE: 91% 42, 44, 46: < 0.01% 2: 7% 6: 0.5% 4: 0.3% 5: 0.1%	BE: 79% 42: < 0.01% 2: 15% 5: 3.8% 4: 0.4% 6: 0.1%	BE: 78% 42: < 0.01% 2: 19% 4: 0.2% 5: 0.2% 6: 0.3%	BE: 81% 42: < 0.01% 2: 13% 5: 4.9% 4: 0.3% 6: 0.1%
	2018 - IPv4	**2018 - IPv6**	**2019 - IPv4**	**2019 - IPv6**
All packets Per protocol	BE: 82% 42, 44, 46: <=0.01% 2: 13% 5: 3% 4: 0.4% 6: 0.2%	BE: 90% 42, 44, 46: <0.01% 2: 7% 5: 0.03% 4: < 0.01% 6: < 0.01%	BE: 79% 42, 44, 46: <0.01% 2: 14% 5: 3.6% 4: 0.2% 6: 0.2%	BE: 94% 42, 44, 46: <0.01% 2: 4% 4: < 0.01% 5: < 0.01% 6: < 0.01%

- Traffic w/DSCP 2 accounts for ~4-19%, present across direction, year and IP version split.

- Other DSCPs (4, 5, 6) seen less, with the exception of DSCP 5 in Dir

- DSCP 2 results from ToS bleaching of AF11, AF21, AF31 and AF41

DSCPs set by applications
(CAIDA dataset 2018)

- ICMP - DSCP 48 - 19.1%

- SSH - DSCP 4 - 31.5%;

- DNS - DSCP 5 - 8.1%;

- SIP - DSCP 5, 14%

Honorable mentions:

  - TCP, ports 8001 and 8880 - DSCP 1 - 65% and 45% respectively

  - TCP, port 9050 (Tor SOCKS port) - DSCP 2 - 49.9%;

  - TCP and UDP, port 8999: DSCP 5 - 16%; (what is this??)

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Server Reply Datasets - PATHSpider
DSCPs set by DNS servers/server edge

- DNS request to authoritative NSes for Alexa top 1M domains

- Replies from 15% servers with non-0 DSCP (v4 and v6)

- Popular code points are 8 (CS1), 32 (CS4), 10 (AF11), 14 (AF13), 6 (ToS Bleach of EF)

DSCP	Percentage
CS1	71%
CS4	6%
AF11	4.9%
AF13	3.22%
ToS Bleach EF	3%
1	1.9%
AF31	1.8%
AF21	1.7%

Server Reply Datasets - PATHSpider
DSCPs set by HTTP servers/server edge

- HTTP request to Alexa top 1M domains (over 400k IP addresses)

- Replies from 52762 (12.7%) servers with non-0 DSCP (v4)

- Popular code points are AF11, AF21, AF31 and CS3

- Of these, 1222 servers reply with DSCP 5

DSCP	Percentage
AF11	63.3
AF21	18.2
CS3	4.45
6 (ToS bl of EF)	2.45
5	2.31
AF31	1.96
1	1.63
CS6	1.47