LE codepoint: preliminary results and ongoing work in the IETF

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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.
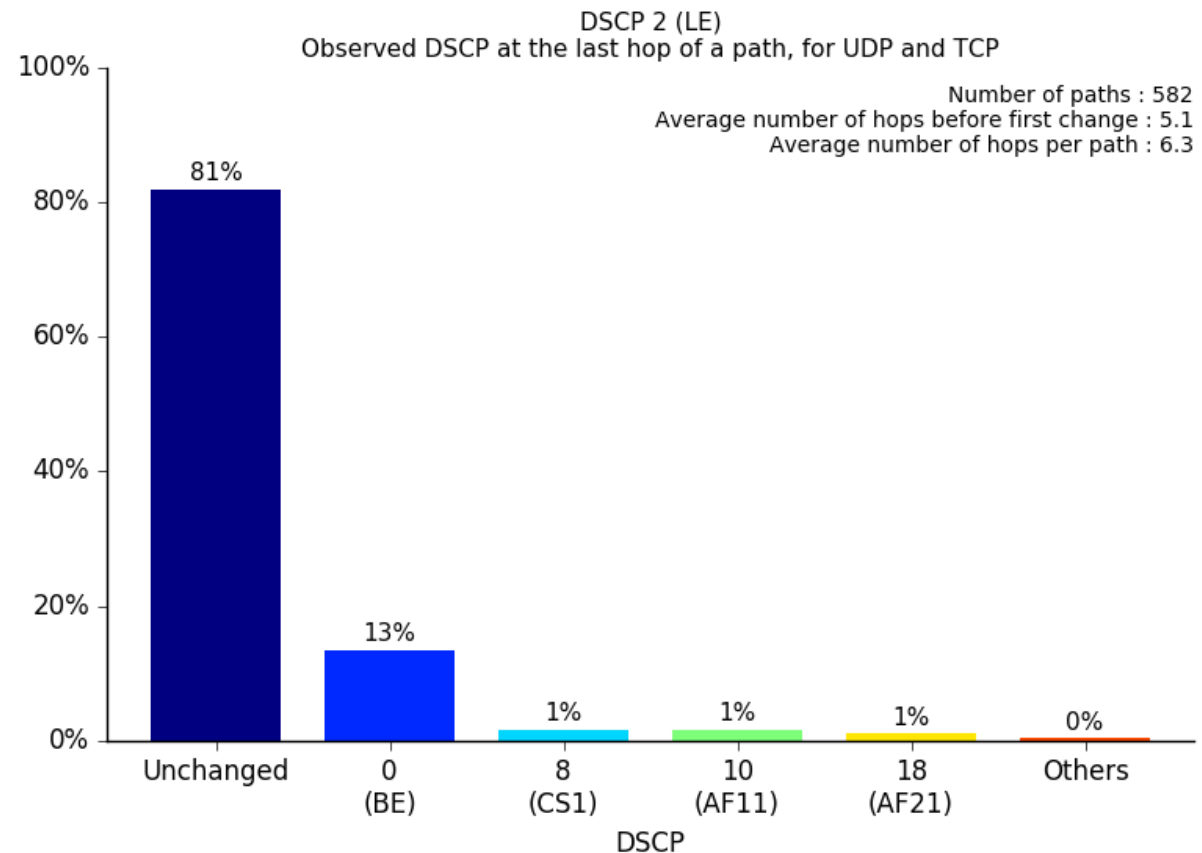
Preliminary results - PATHspider.net

- 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

DSCP 2 (LE)
Observed DSCP at the last hop of a path, for UDP and TCP

Number of paths : 582
Average number of hops before first change : 5.1
Average number of hops per path : 6.3

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 DCSP 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
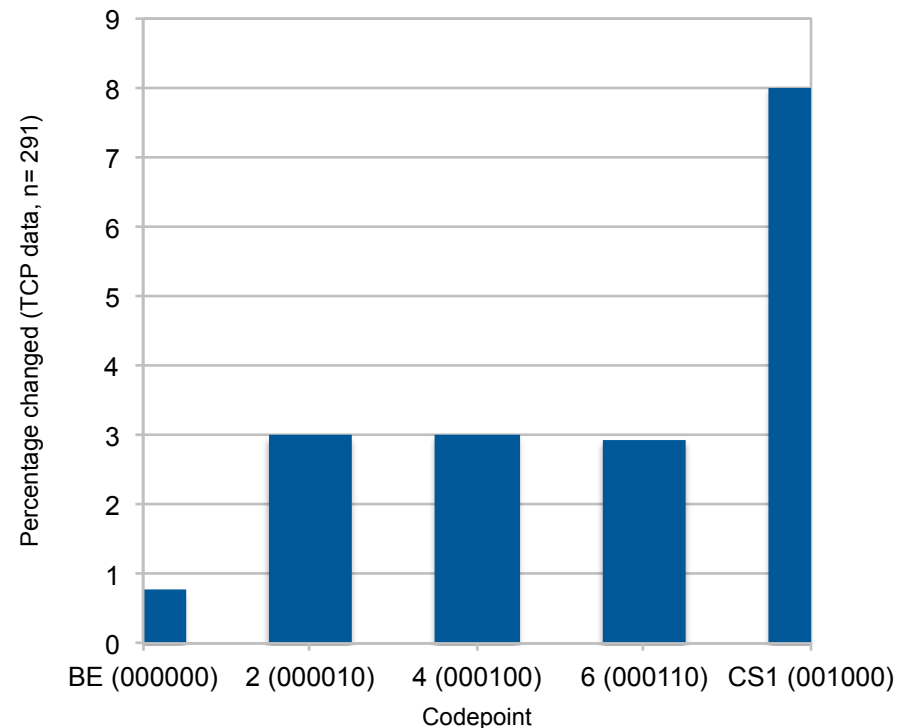
Problems with routers using ToS Semantics

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

    10, 16, 26, 34 (AFx1) & 000111 = 2
    12, 18, 28, 26 (AFx2), 44 (Voice Admit) & 000111 = 4
    14, 22, 30, 38 (AFx3), 46 (EF) & 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
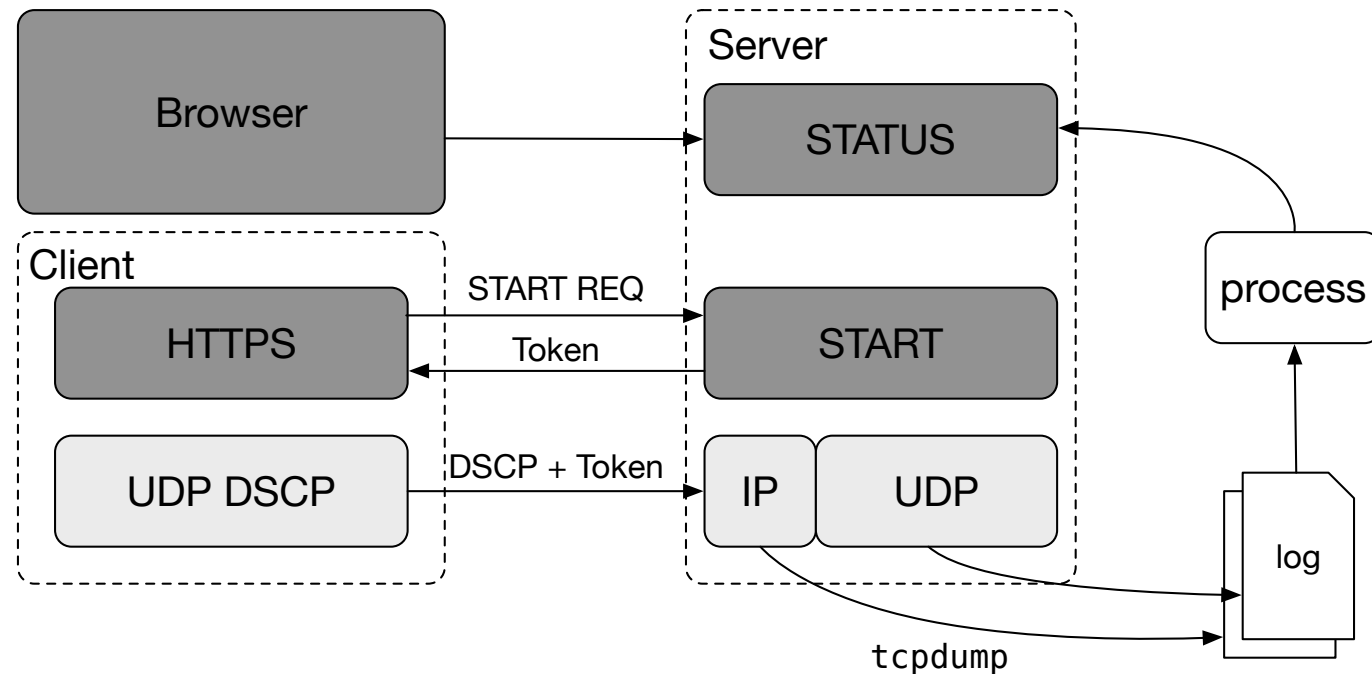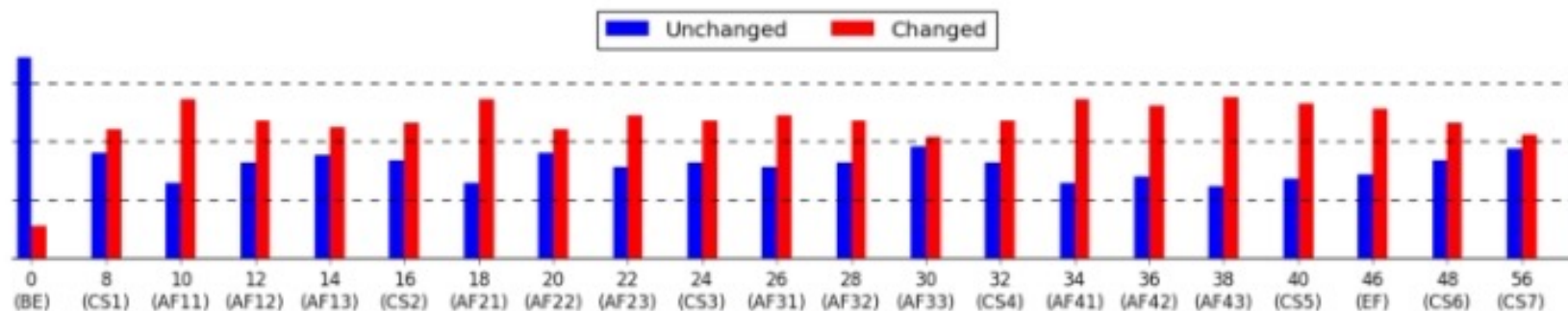
Conclusion
– Is DSCP2 good for LE?

- **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

Observed DSCP at end of path

Legend: Unchanged, Changed

DSCP values:
0 (BE), 8 (CS1), 10 (AF11), 12 (AF12), 14 (AF13), 16 (CS2), 18 (AF21), 20 (AF22), 22 (AF23), 24 (CS3), 26 (AF31), 28 (AF32), 30 (AF33), 32 (CS4), 34 (AF41), 36 (AF42), 38 (AF43), 40 (CS5), 46 (EF), 48 (CS6), 56 (CS7)

Detailed plots

Windows   MAC   Linux   BSD

trace.erg.abdn.ac.uk

Extra slides - for info

Acknowledgemetns

# 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/
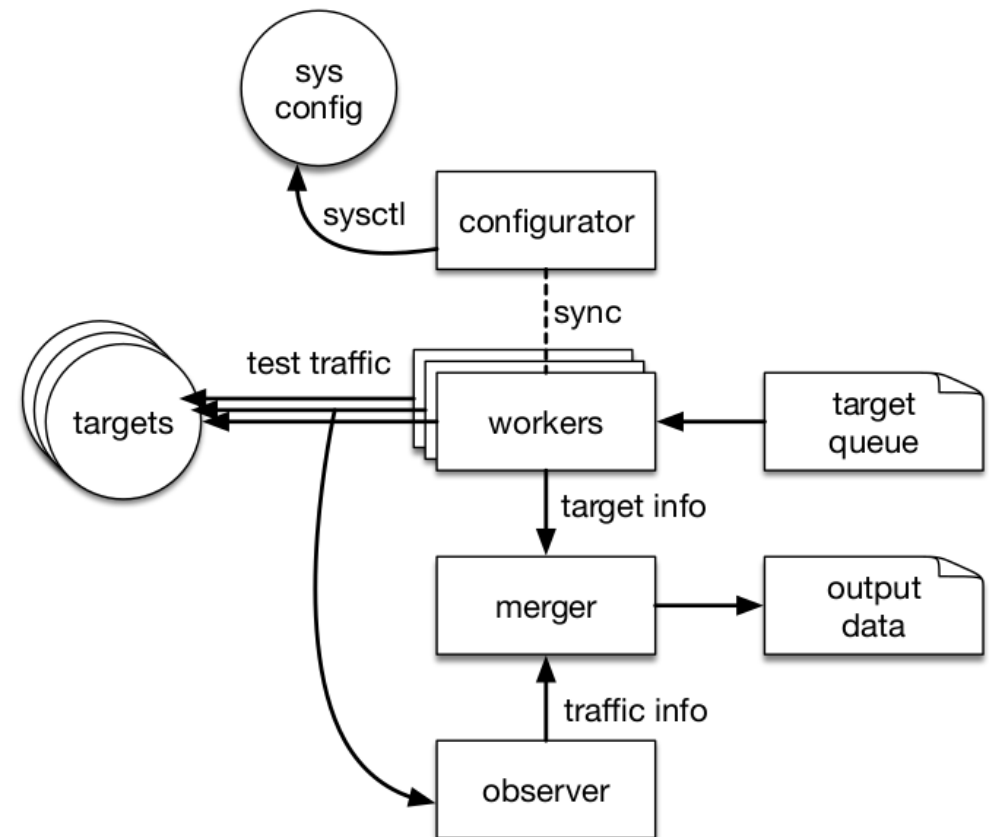
PATHspider Measurements

- 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/
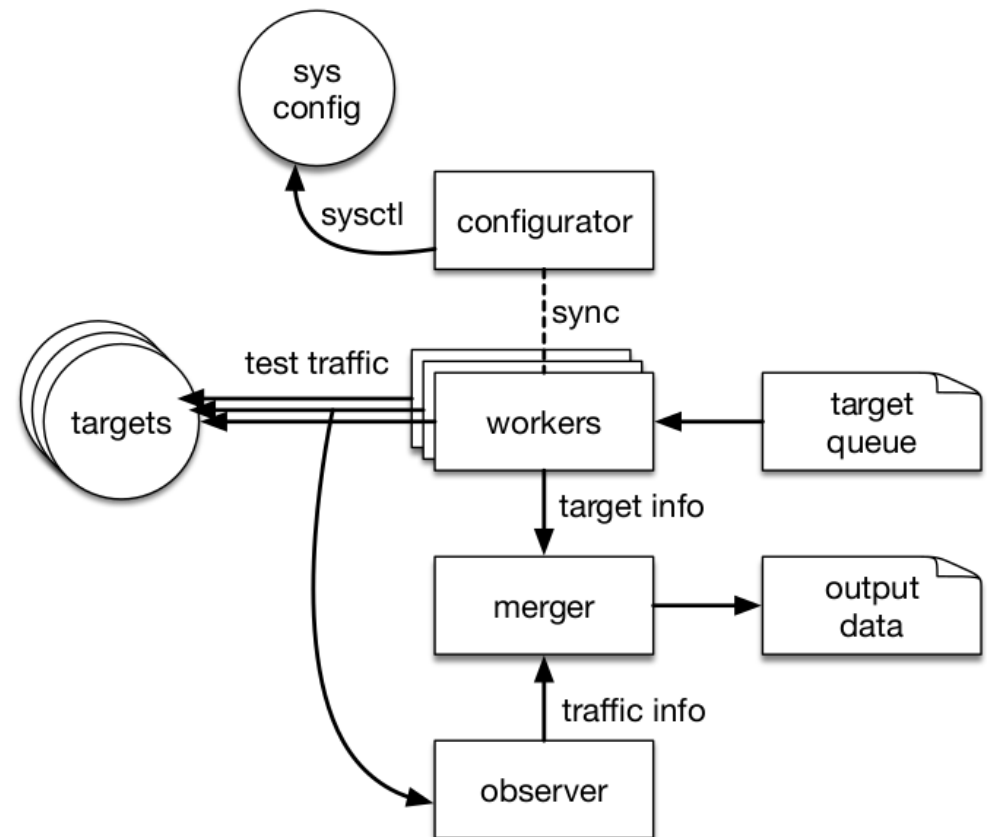
Other known usage (backwards compatibility)

- 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
  - 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
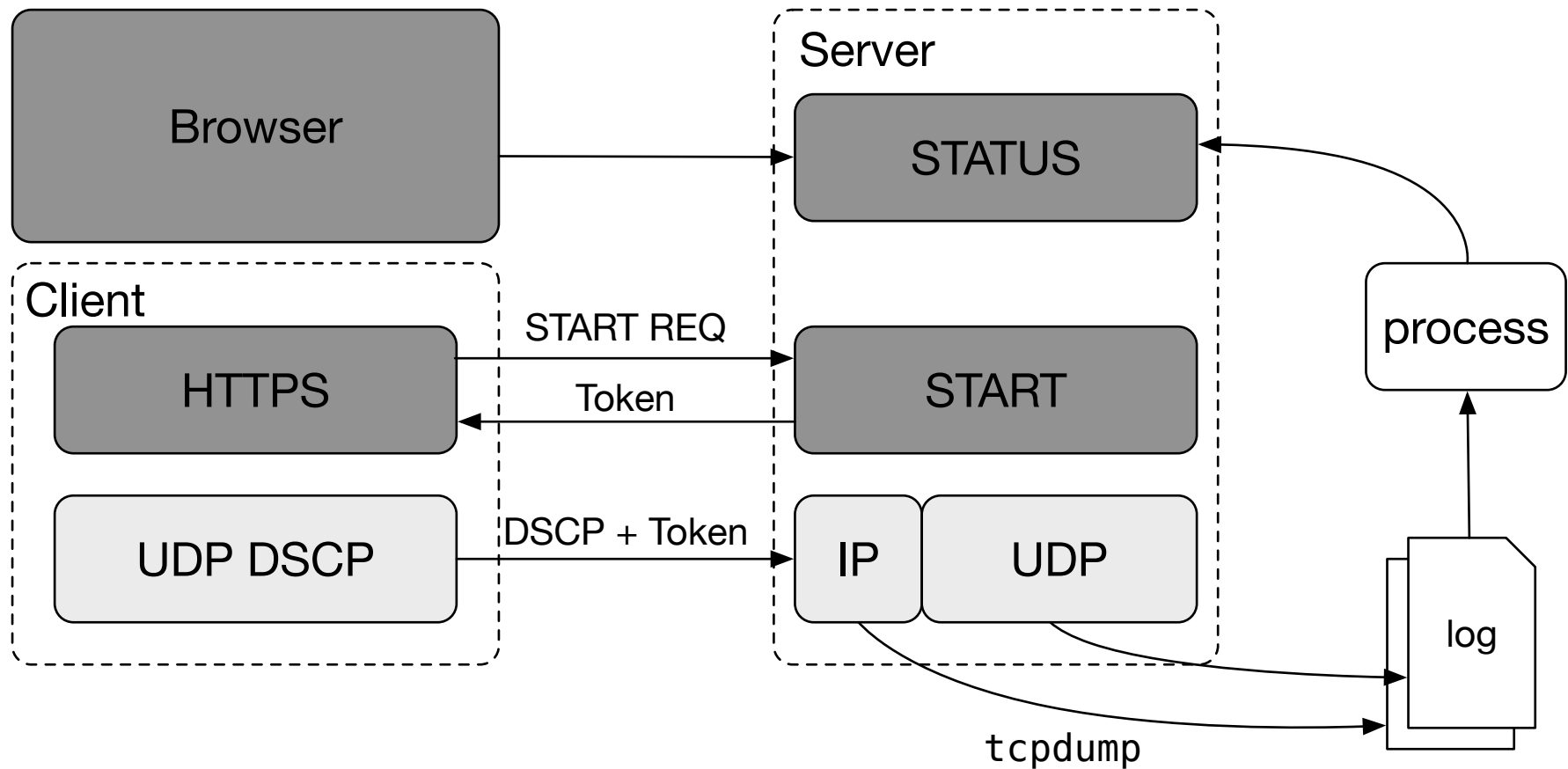
Edgetrace Software Stack

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

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Edgetrace Operation

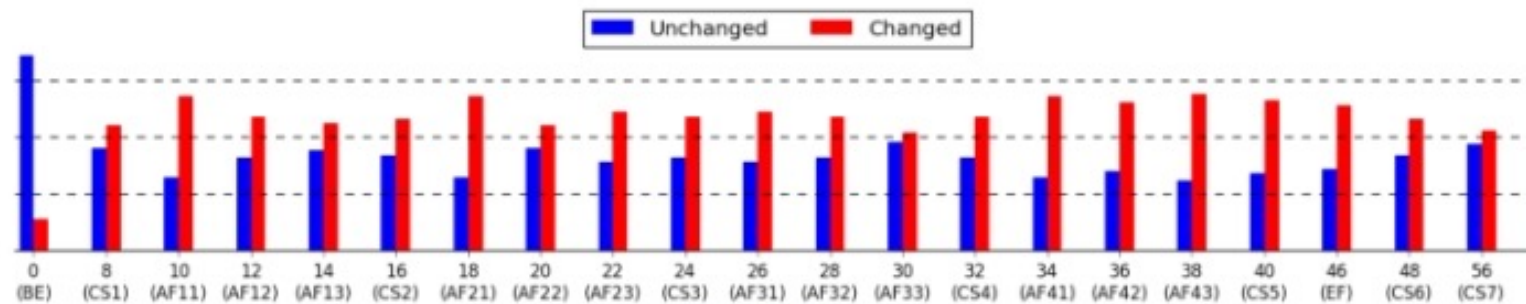- Client requests session token from server
- Adds to Token:
  - Send DSCP
  - OS
- Sends
  - 10 datagrams per DSCP send
  - Paced 5 packets per second

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Observed DSCP at end of path

■ Unchanged ■ Changed

| 0 (BE) | 8 (CS1) | 10 (AF11) | 12 (AF12) | 14 (AF13) | 16 (CS2) | 18 (AF21) | 20 (AF22) | 22 (AF23) | 24 (CS3) | 26 (AF31) | 28 (AF32) | 30 (AF33) | 32 (CS4) | 34 (AF41) | 36 (AF42) | 38 (AF43) | 40 (CS5) | 46 (EF) | 48 (CS6) | 56 (CS7) |

[Detailed plots](#)

Windows	MAC	Linux	BSD
Binary1	Binary1	Binary1	Binary1
Binary2	Binary2	Binary2	Binary2
Binary3	Binary3	Binary3	Binary3

Free icon credits

DSCPs tested by edgetrace

DF
EF
（LBE）

CS0	AF11	AF31
CS1	AF12	AF32
CS2	AF13	AF33
CS3		
CS4	AF21	AF41
CS5	AF22	AF42
CS6	AF23	AF43

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JSON blob returned from the request to the edgetrace server

```
{

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

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