DNS-over-QUIC

First experience with DoQ

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Intro

DNS-based products by AdGuard

- AdGuard DNS — public DNS resolver
- AdGuard Home — DNS server for personal use with content blocking capabilities
- AdGuard apps provide DNS filtering and encryption capabilities (DoH/DoT/DNSCrypt)
- Recently we’ve added DoQ support to all of them: https://adguard.com/en/blog/dns-over-quic.html

AdGuard DNS

- Public DNS resolver with the focus on content blocking
- The first beta was launched in the end of 2016
- Officially released in December, 2018
- Open-source
  https://github.com/AdguardTeam/AdGuardDNS
- Most of the clients are mobile devices

AdGuard DNS

Avg 100,000+ RPS

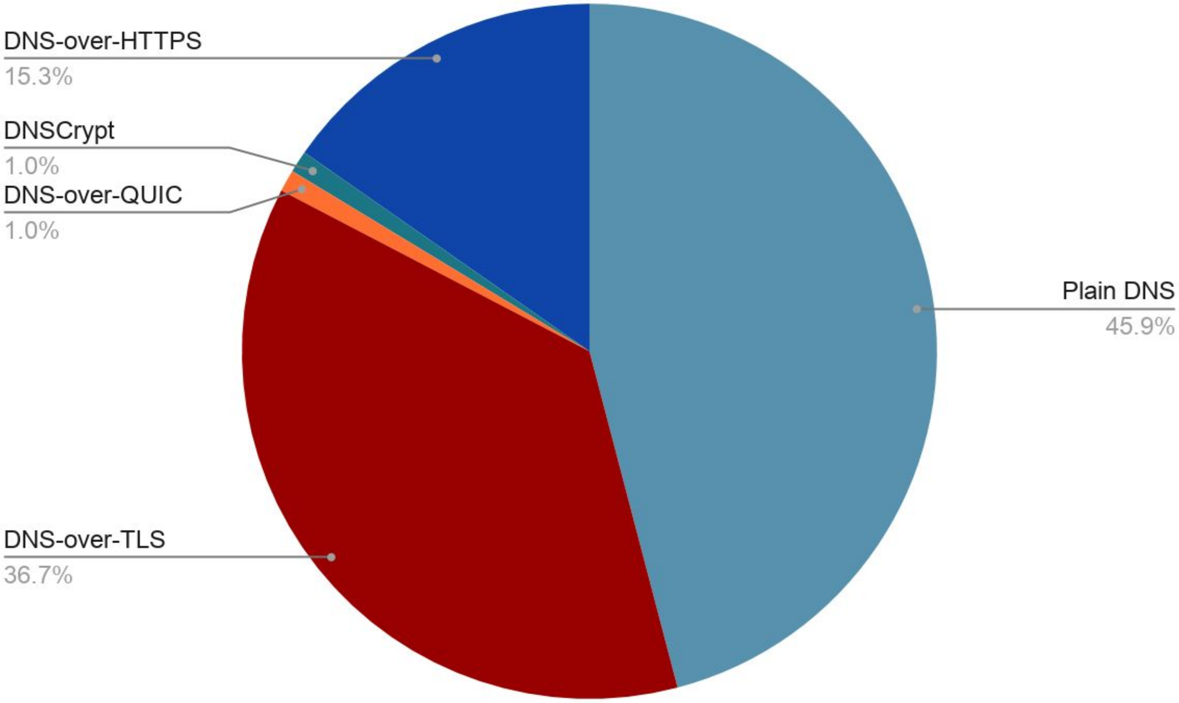
DNS: 46%

DoT: 37%

DoH: 15%

DNSCrypt: 1%

DoQ: 1%



DNS Encryption

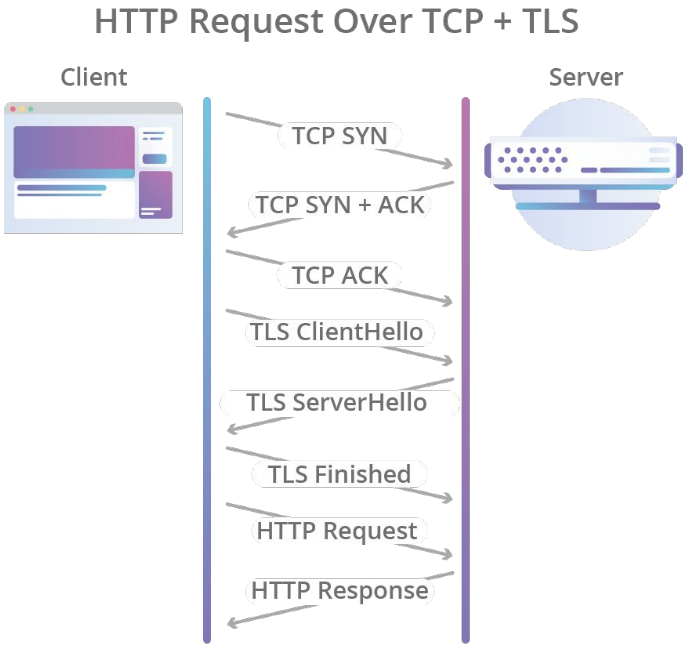
Different protocols pros and cons

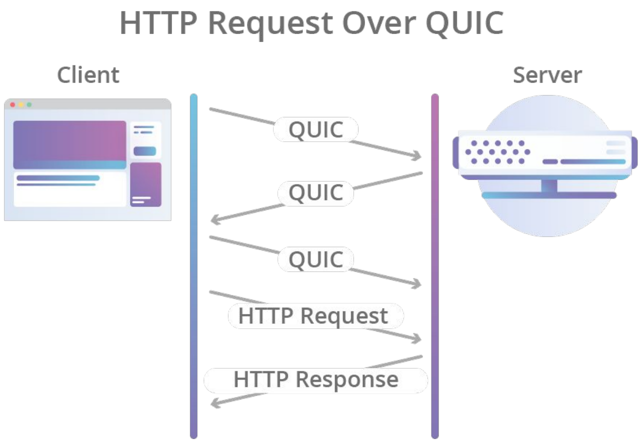
- Plain DNS - fast, no encryption
- DNSCrypt - fast, non-standard encryption
- DoT - slow, standard encryption
- DoH - slow but practical, standard encryption, more data points that can be potentially used for fingerprinting
- DoT/DoH bandwidth is x2.5 compared to DNS

QUIC vs TCP+TLS

- Faster handshake
- Solves head-of-line blocking
- Connection migration

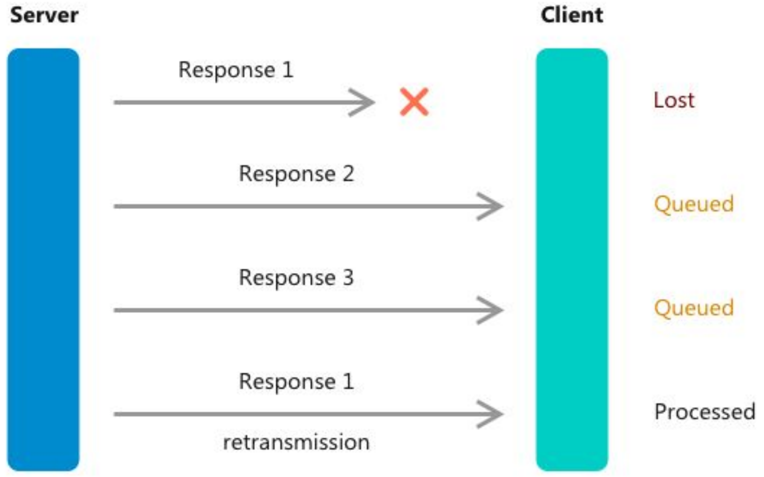
Faster Handshake



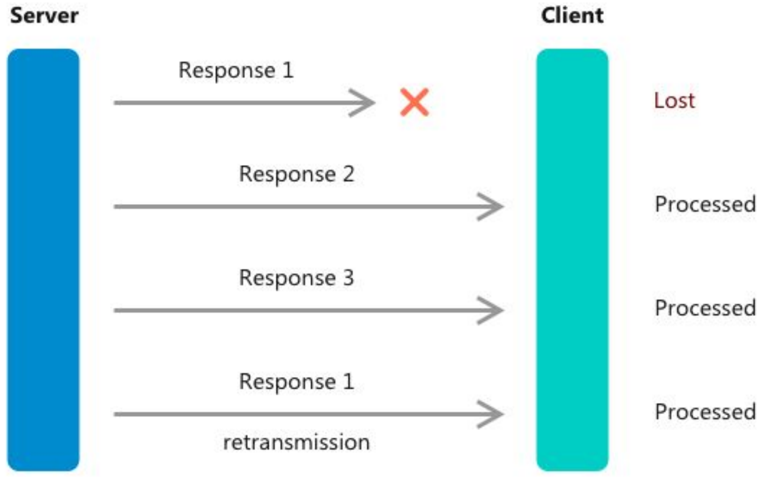


Images from https://blog.cloudflare.com/the-road-to-quic/

Head-Of-Line Blocking

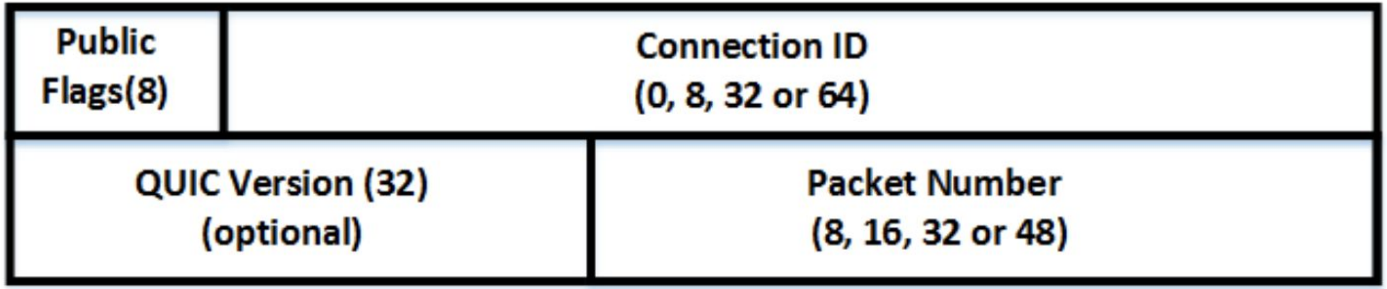


HTTP/2 head-of-line blocking: a single TCP packet loss will, all queries/responses have to wait



QUIC - every DNS query/response is a new QUIC stream

Connection Migration



Public Flags(8)	Connection ID (0, 8, 32 or 64)
QUIC Version (32) (optional)	Packet Number (8, 16, 32 or 48)

QUIC packet header

- Endpoints can use “Connection ID” to track connections
- This makes it possible to continue using the same connection when network change occur (i.e. Wi-Fi <-> Cellular)

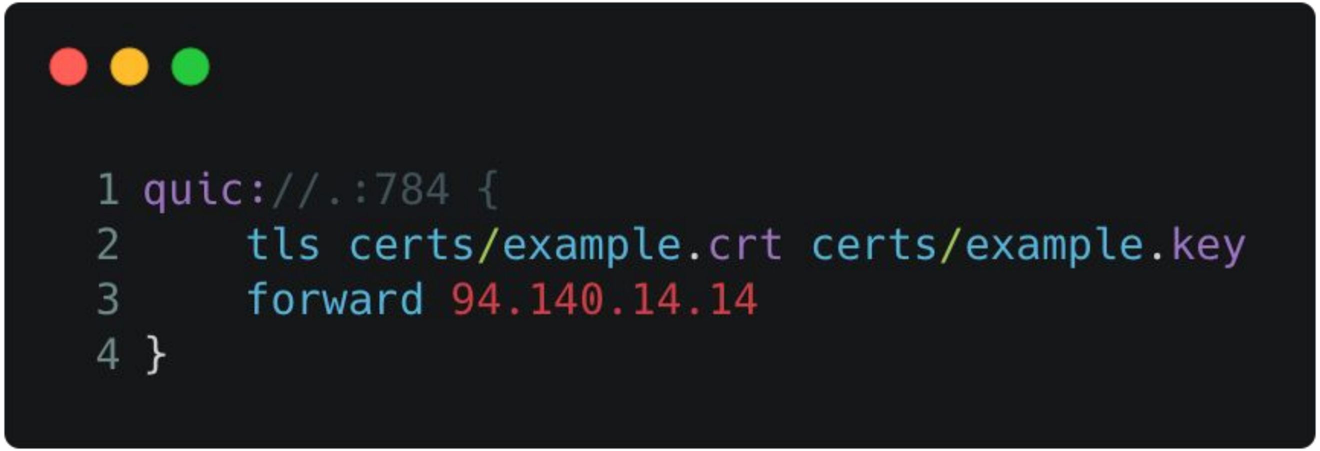
DoQ vs DNS-over-HTTP/3

- Both DoQ and DoH3 use QUIC as an underlying transport
- HTTP/3 adds HTTP on top of it
- HTTP adds almost zero value
- It adds more data-points that can be used for fingerprinting clients

  Examples:
  - HTTP headers order
  - TLS properties
  - ETag tracking

DoQ Server-Side Implementations

- CoreDNS fork: https://github.com/AdguardTeam/coredns

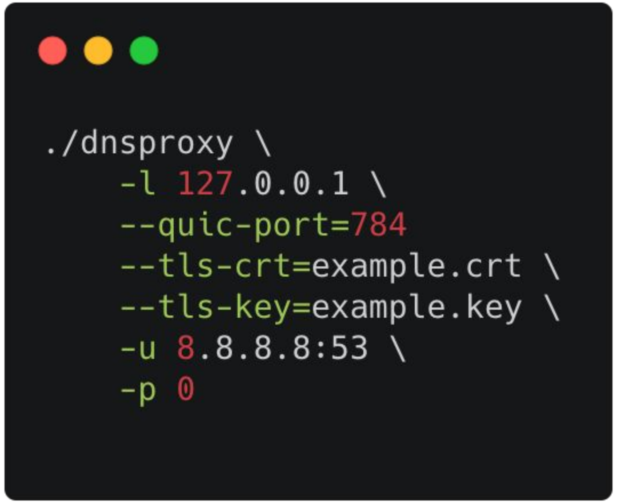


```
quic://.:784 {
    tls certs/example.crt certs/example.key
    forward 94.140.14.14
}
```

Sample CoreDNS configuration

DoQ Server-Side Implementations

- dnsproxy: https://github.com/AdguardTeam/dnsproxy

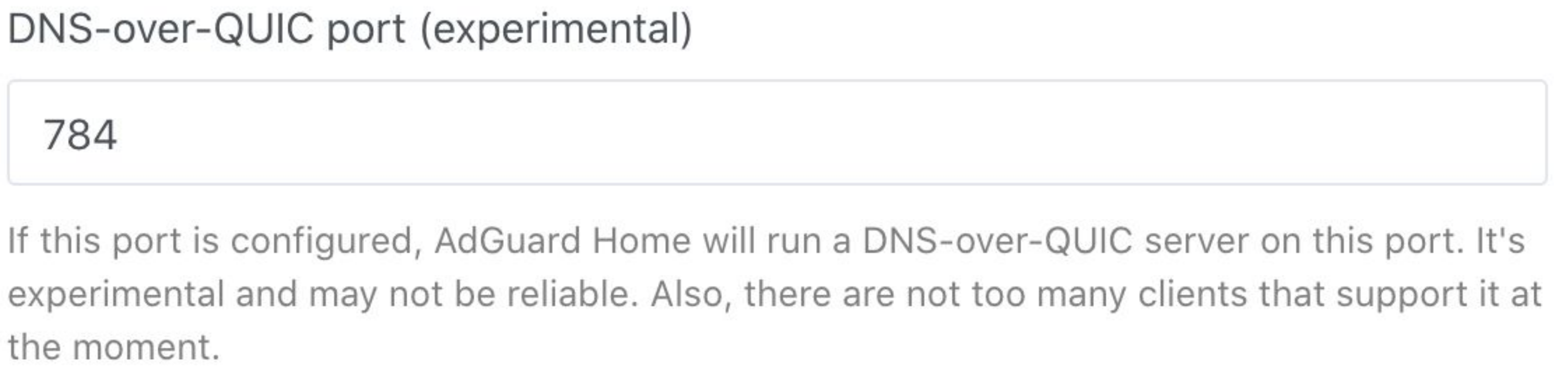


```
./dnsproxy \
    -l 127.0.0.1 \
    --quic-port=784
    --tls-crt=example.crt \
    --tls-key=example.key \
    -u 8.8.8.8:53 \
    -p 0
```

Running dnsproxy as a DoQ server forwarding queries to 8.8.8.8

DoQ Server-Side Implementations

- AdGuard Home: https://github.com/AdguardTeam/AdGuardHome



DNS-over-QUIC port (experimental)

784

If this port is configured, AdGuard Home will run a DNS-over-QUIC server on this port. It's experimental and may not be reliable. Also, there are not too many clients that support it at the moment.

DoQ Client-Side Implementations

- dnsproxy (written in Golang, can be used as a library): https://github.com/AdguardTeam/dnsproxy
- AdGuard Home (written in Golang, uses dnsproxy internally): https://github.com/AdguardTeam/AdGuardHome
- DnsLibs (library, written in C++): https://github.com/AdguardTeam/DnsLibs
- dnslookup (simple nslookup-like util, supports DoQ/DoH/DoT/DNSCrypt): https://github.com/ameshkov/dnslookup

QUIC Implementations

- Golang: **quic-go**
  https://github.com/lucas-clemente/quic-go
  Does not support connection migration yet.

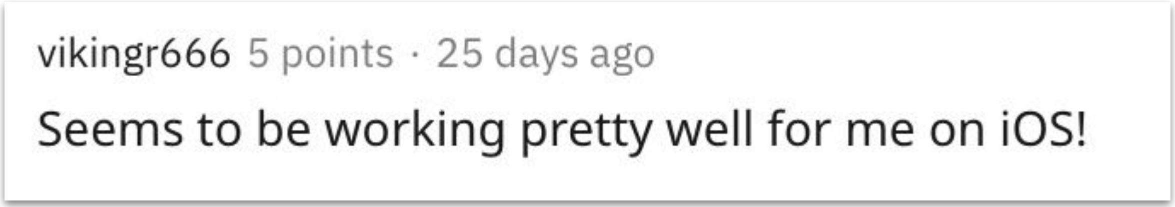
- C++: **ngtcp2**
  https://github.com/ngtcp2/ngtcp2

Current issues

- Connection migration is not supported by AdGuard DNS:
    - Not yet implemented in **quic-go**
    - We use ECMP to balance load between servers in the same location which is not compatible with connection migration
- QUIC and DoQ are still drafts:
    - They’re not likely to change much, though

Feedback

- Users' feedback ranges from very positive to neutral



vikingr666 5 points · 25 days ago

Seems to be working pretty well for me on iOS!

- We're yet to get the precise numbers, but for now it seems that:
    - The share of networks where DoQ is blocked, is quite small
    - It does provide advantage over DoH in cellular data networks, as expected

Thank you!

Questions?

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