DNS-over-QUIC (DoQ)

draft-ietf-dprive-dnsoquic

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DNS-over-QUIC

- Why are we standardizing ANOTHER protocol for encrypted DNS?
- Where are we with the IETF standards process?
- Where are we with implementation and deployment?
  - Next steps?

QUIC - Background

- QUIC and HTTP/3 developed by Google as experiment in 2012
- Development moved to IETF in 2015, standardized in 2021
- Deployed by browsers and CDNs (7.6% websites)

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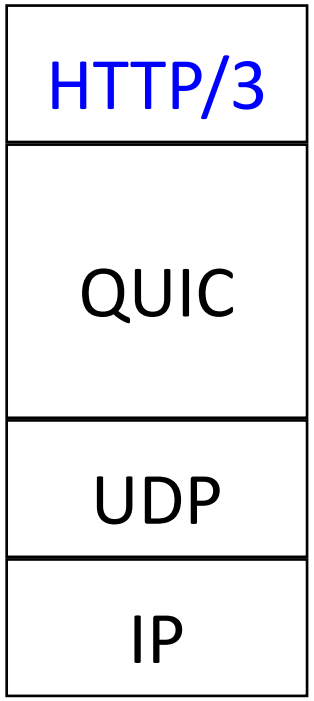
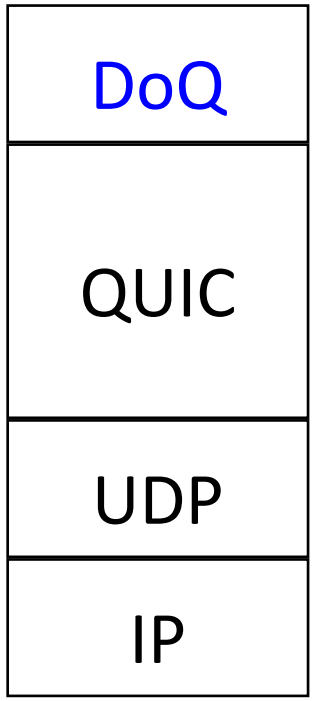
- Deployed by browsers and CDNs (7.6% websites)
- **Key QUIC characteristics**
  - TLS 1.3 secured transport that runs over UDP
  - Reduced latency in handshake (0-RTT)
  - Stream based - no head of line blocking
  - Improved error detection and loss recovery compared to TCP
  - Connection migration (IP address can change)
- HTTP/3 runs over QUIC



DoQ - Background

- Early realisation that DoQ would be a good fit for encrypted DNS
  - Low latency
  - UDP but with QUIC benefits and
    - Source address validation
    - Path MTU does not limit size of messages
- But… QUIC WG decided QUIC v1 would only support HTTP/3



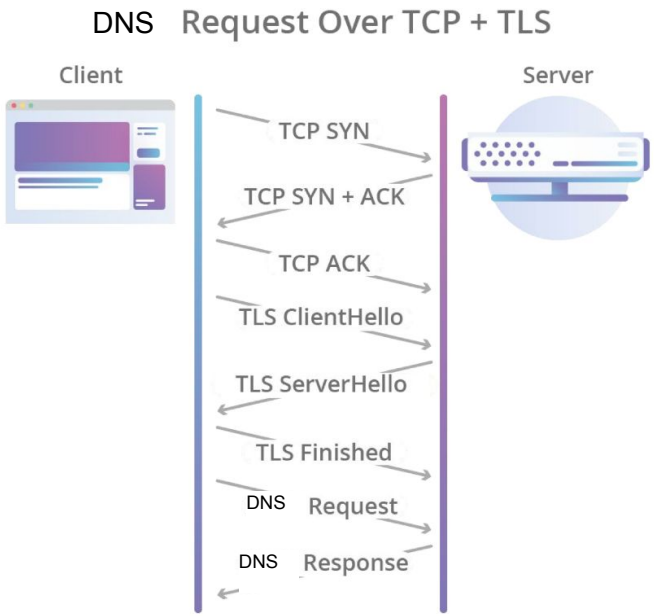
DoQ - Background

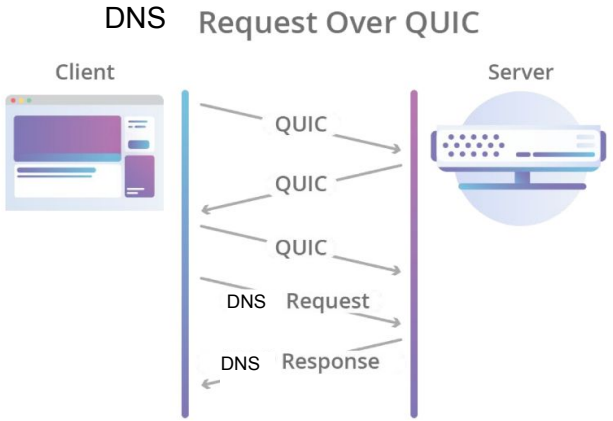
- **April 2017** - First Draft in QUIC WG
- **December 2018** - Adguard DoQ service launched

- **Apr 2020** - Draft adopted in DPRIVE WG (stub to rec ONLY)
- **2021** - Re-scoped to include XFR and rec to auth, mapping updated and port 853 requested (more later)
- **Oct-Dec 2021 -** Working group last call
- **January 2022** - IETF Last Call (RFC later this year?)

What does DoQ look like?

- Set up a connection with a QUIC handshake (TLS 1.3)
- Use ALPN ‘doq’





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

What does DoQ look like?

- Exchange of messages on streams (ids are 4, 8,12)
- One stream is used for one DNS query/response (then closed)
- There are 2^{64} stream IDs - that's a lot of messages on one connection
  - MessageID is ALWAYS 0

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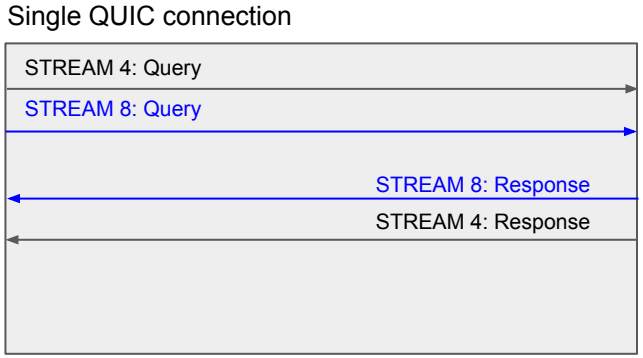
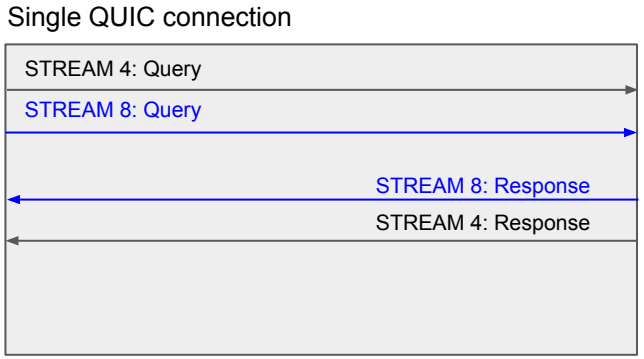
  - MessageID is ALWAYS 0
- Original mapping
  - JUST DNS message
  - Immediate close at both ends

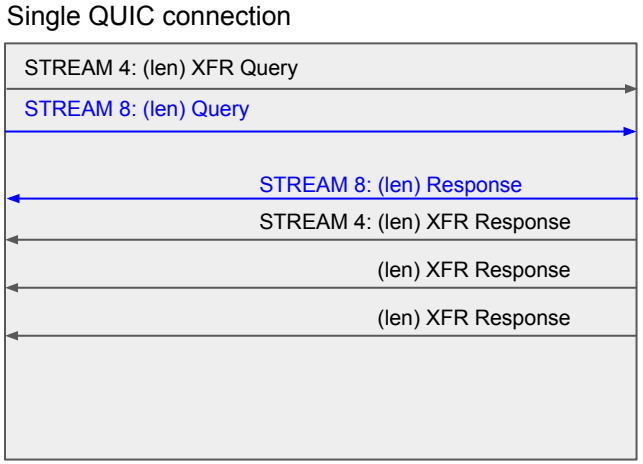


But.. if we want to do XFR…

- **Original mapping**



- **Current mapping**
  - Prepend with length field (like TCP)
  - Server can send multiple responses



DoQ is a general purpose protocol

- AdGuard claim **good performance** (particularly in mobile networks)
- With the more flexible mapping **XFR is now possible** (RFC for XFR-over-TLS last year)
- **Lots of interest in using DoQ for recursive to authoritative**
  - Lighter weight than DoT and DoH, better latency
  - Protocol is maturing

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- Originally port 784 was used for experiments but WG proposed to use port 853 (assigned to DNS-over-DTLS in 2016). IANA process but…. now agreed.
  - TCP port 853: DNS-over-TLS
  - **UDP port 853: DNS over DTLS or QUIC**

DoQ Implementations (open source)

Implementation	Language	Notes
CoreDNS	Go	AdGuard use as DoQ server
AdGuard DNS Proxy	Go	Simple proxy or server supporting DoQ (used in ADGuard Home)
dnslookup	Go	Command line utility wrapper for Adguard DNS proxy
AdGuard C++ DNS libs	C++	AdGuard use in mobile app
Quicdoc	C	Simple DoQ impl based on Picoquic
aioquic	Python	QUIC implementation includes example DoQ client/server
Flamethrower	C++	DNS performance utility with experimental DoQ

- Starting to hear interest in recursive to auth experiments

DoQ open issues

- Padding
  - Multiple studies show padding is needed or ML can derive the encrypted queries
  - Discussion: Require implementation of the Experimental RFC 8467
  - This will be a new IETF Last Call to approve a Down Reference for RFC 8467 to be Normative
- Security Considerations
  - Does community see missing considerations for recursive to auth?
    - Note that authentication model for rec to auth are still a WIP
    - Privacy vs Security is a tricky trade-off for DoQ

- Lacking formal performance measurements (particularly for rec to auth traffic patterns)

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Please review the specification!

Backup slides

DoQ vs DoT vs DoH3?