Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

17th July 2019
Privacy Enhancing Technologies Symposium
Stockholm, Schweden

A QUIC Look at Web Tracking

Erik Sy, Christian Burkert, Hannes Federrath, Matthias Fischer

Motivation

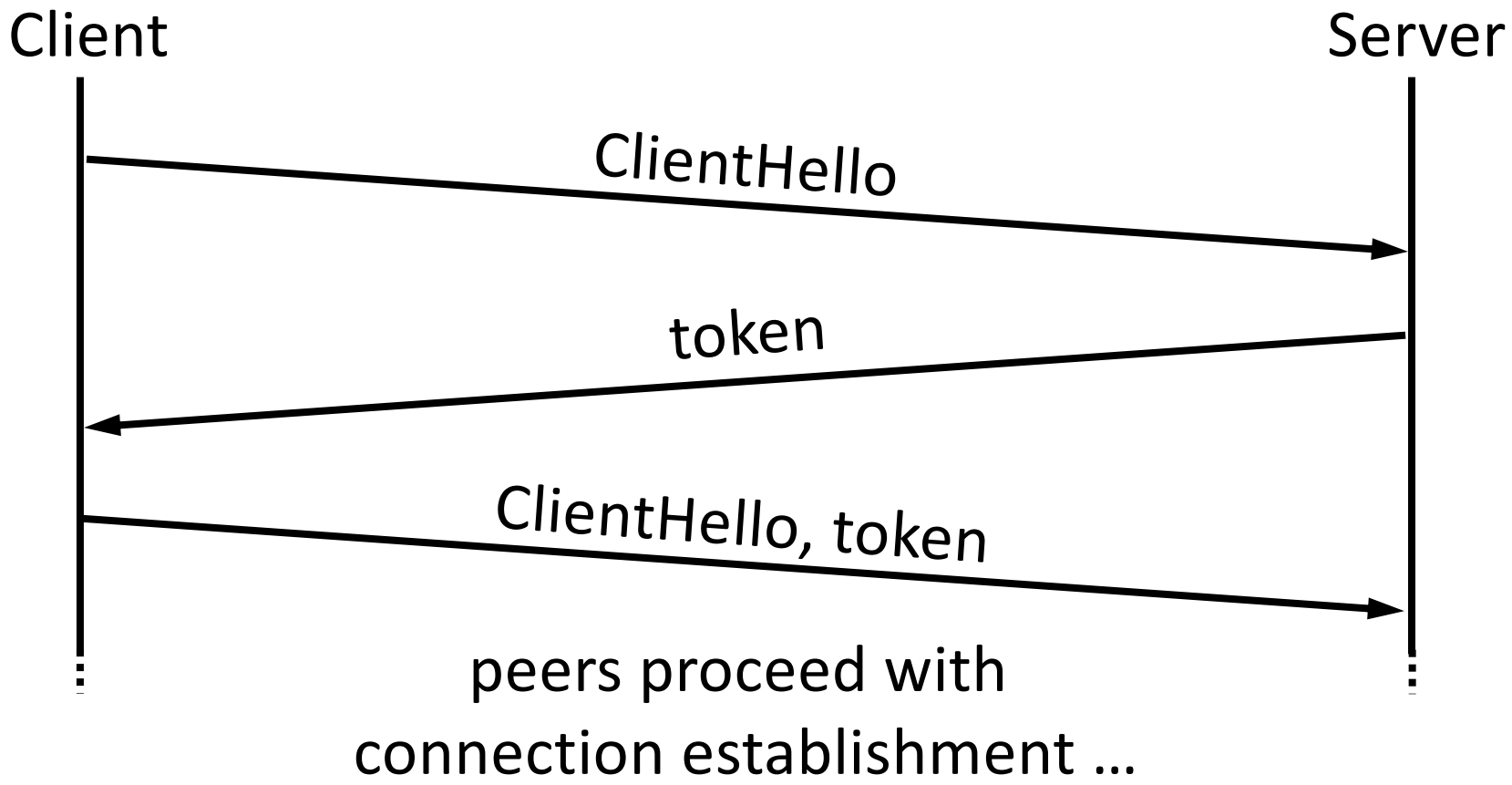
Transport protocols should not allow distinguishing Alice and Bob as the sender of a message.

Introduction to the QUIC Transport Protocol

- QUIC is going to replace TLS over TCP in HTTP/3
- Improves problems of TLS over TCP
  - Protocol Entrenchment
  - Implementation Entrenchment
  - Handshake Delay
  - Head-of-line Blocking
  - Mobility
- Google's QUIC protocol is already widely deployed on the Internet
  - Accounts for 7% of global Internet traffic
  - Supported by Google Chrome (approx. 60% browser market share)

Tracking via Source-Address Token

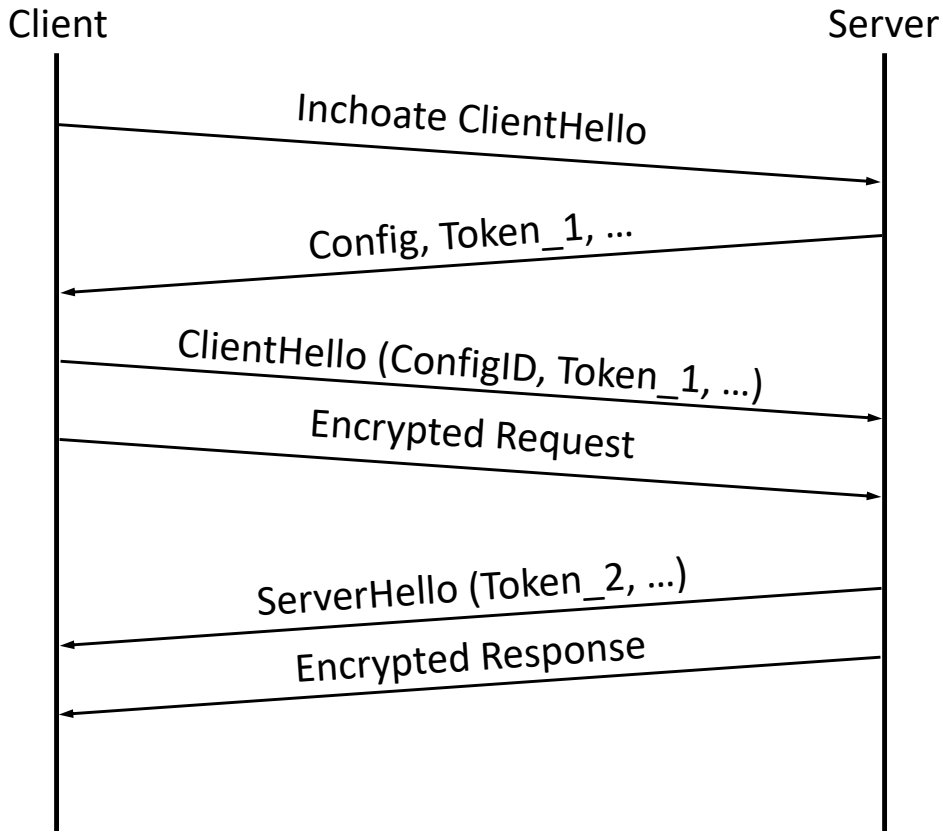
- Source-address token speed up the validation of the client's IP address in subsequent connections between the same peers



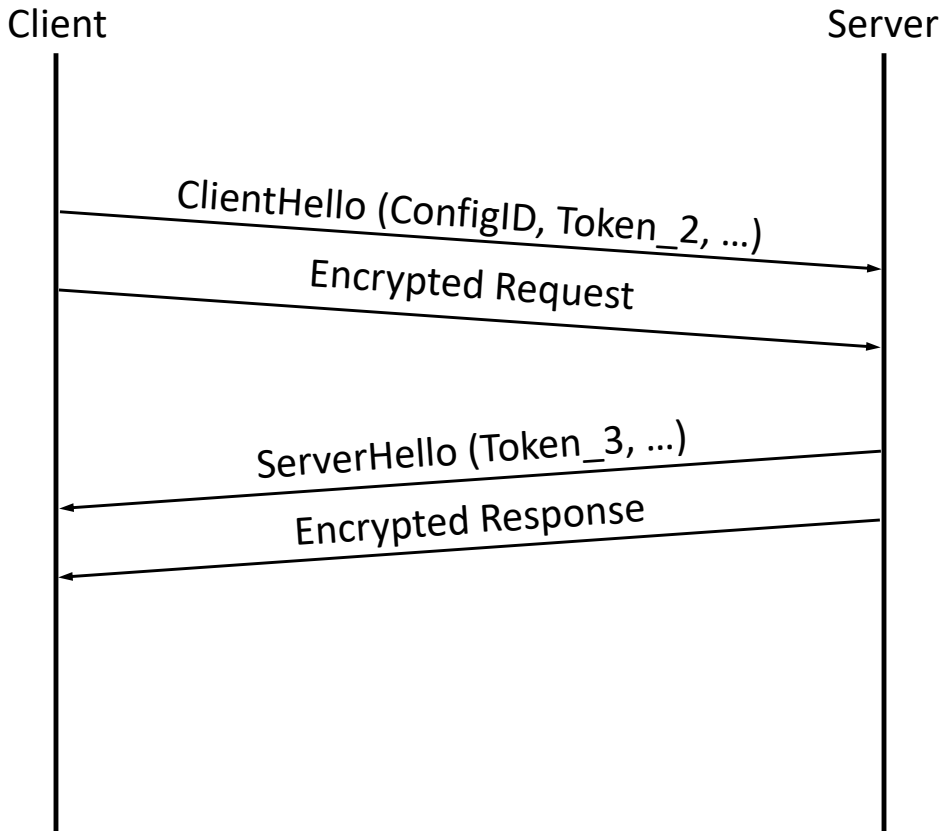
Tracking via QUIC's Server Config

- QUIC's server config contains a public key used to bootstrap the cryptographic connection establishment
- Client reuses server config across different connections
- Tracking feasible if server distributes unique server configs/ server config identifiers to its clients

QUIC's Connection Establishment



a) Initial Handshake



b) Subsequent Handshake

Opportunities and Limitations of Tracking via QUIC

- Independent of common tracking approaches like IP addresses, HTTP cookies and browser fingerprinting

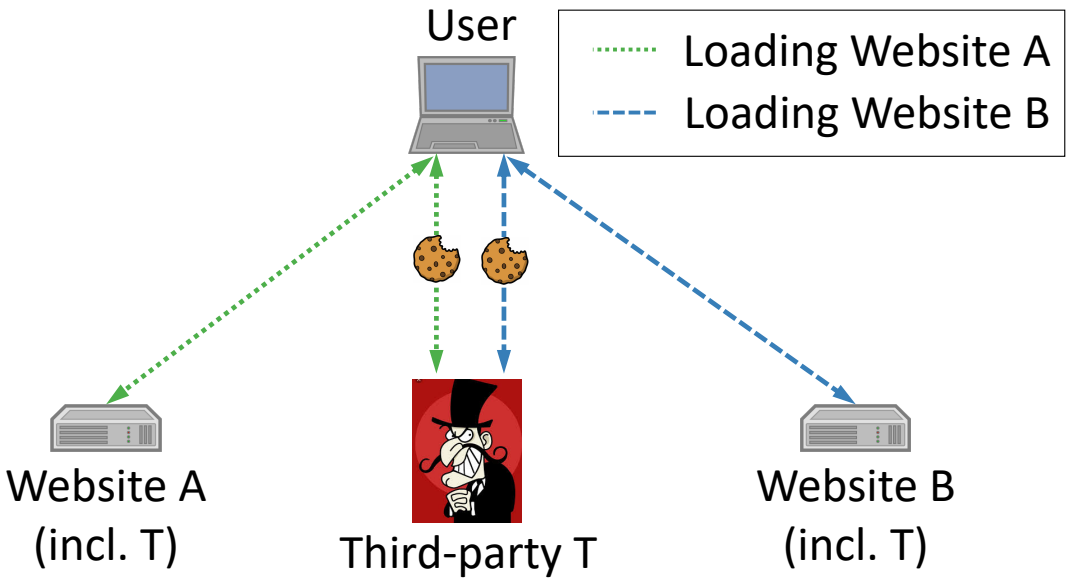
- Opportunities compared to browser fingerprinting
  - Client cannot detect tracking via QUIC
  - Lower consumption of bandwidth and computational resources
  - Faster unique identification of a user
    - Relevant in the context of real-time bidding

- Limitations
  - Browser restarts terminate a tracking period
  - QUIC configuration of a browser
    - Lifetime of token and server configs
    - Feasibility of third-party tracking

Experiments to Test Browsers' Default QUIC Configuration

- Measurement of QUIC's Token lifetime within popular browsers
  - Maximum delay between two website visits for which the browser still attempts to establish the new connection with a cached Token

- Investigating the feasibility of third-party tracking via QUIC by comparing Tokens observed in both connections with T



Summary on the Browser's Default QUIC Configuration

Browser	Lifetime of Token and Server Config	Third-party Tracking
Chrome	unrestricted*	viable
Opera	unrestricted*	viable
Chromium	unrestricted*	viable
Chrome (mobile)	unrestricted*	viable

* evaluated for at least 11 days

Countermeasures

- Connection establishments based on public key cryptography require mechanisms to assure that public keys are not unique per user
- Browser vendors should align tracking via QUIC with HTTP cookie policies
  - Preventing a bypass of HTTP cookie policies
- Limiting the lifetime of cached QUIC data to achieve an effective privacy protection
- Disabling third-party tracking via QUIC by limiting the reuse of third-party QUIC state only for revisits to the same first party

Disclosure

Responses from Google

- “The 'cookie-like' mechanisms in QUIC are largely equivalent to the cookie handling in HTTP and thus do not substantially change the privacy posture of the browser.”
  - Only true, if tracking via HTTP cookies is unrestricted.

- “Blink (and hence the named browsers) implement TTL checking and additionally enforce a maximum TTL lifetime of one week.”
  - Browsers aim to restrict feasible tracking periods to seven days.

Future Work

- Privacy-friendly validation Token approving only a previously established connection between peers
  - Concept can be similar to “Privacy Pass: Bypassing Internet Challenges Anonymously” (PETS 2018)

- Design of a mechanism to detect servers issuing large numbers of public keys per epoch
  - Concept can be comination of Certificate Transparency logs and Online Certificate Status Protocol (OCSP)
  - Can be applied to Encrypted Server Name Indication (ESNI) for TLS 1.3

Conclusion

- QUIC combines great features with new privacy risks
- Tracking via QUIC is stealthy, fast and allows a unique user identification by third-party trackers
- Presented tracking mechanisms affect a huge user base and effective mitigations by browser vendors are not in sight

Thank you

Questions and Answers

E-mail: PETS@erik-sy.de

Slides: https://erik-sy.de/pets2019