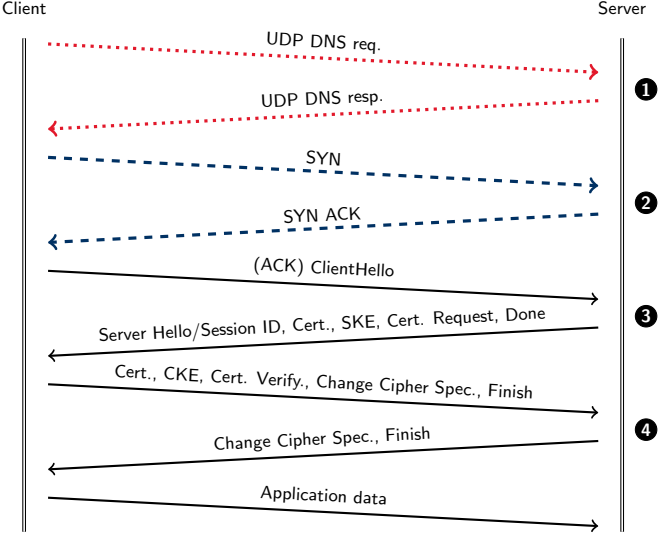


# TLS alternatives – faster and more secure

Tanja Lange  
Technische Universiteit Eindhoven

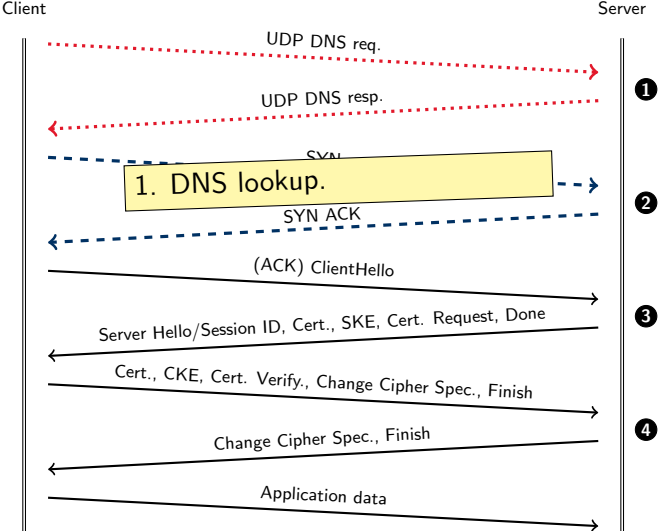
26 April 2015

# TLS: 4 roundtrips



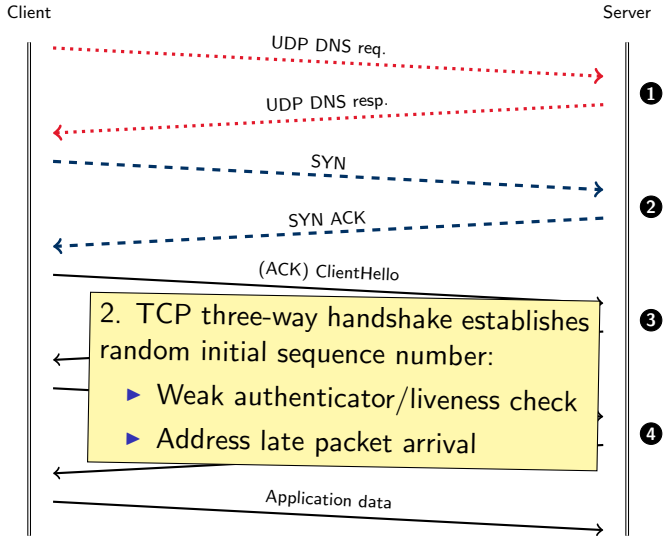
Slide credit: Mike Petullo.

# TLS: 4 roundtrips



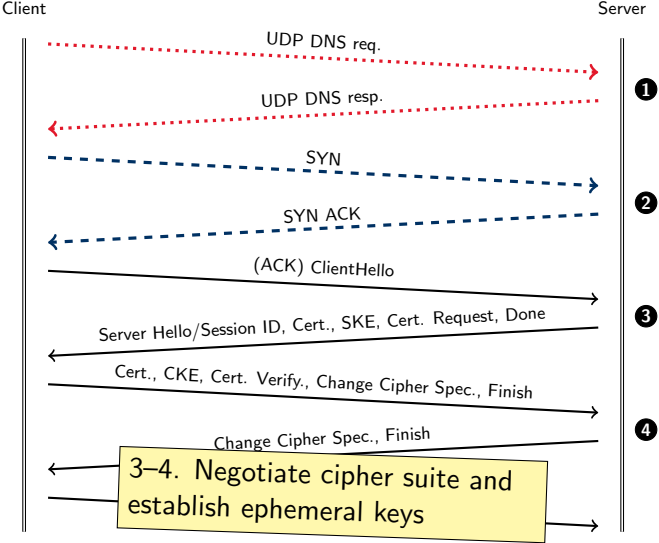
Slide credit: Mike Petullo.

# TLS: 4 roundtrips



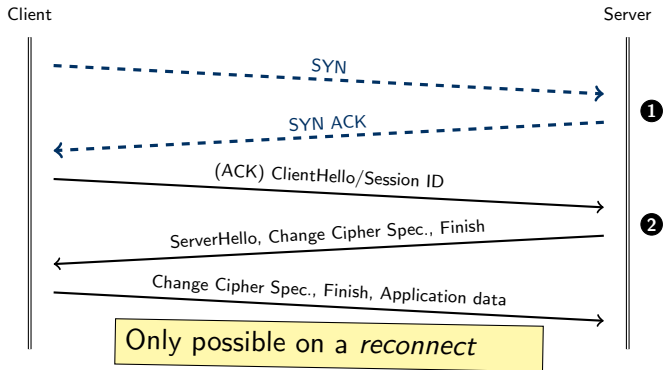
Slide credit: Mike Petullo.

# TLS: 4 roundtrips



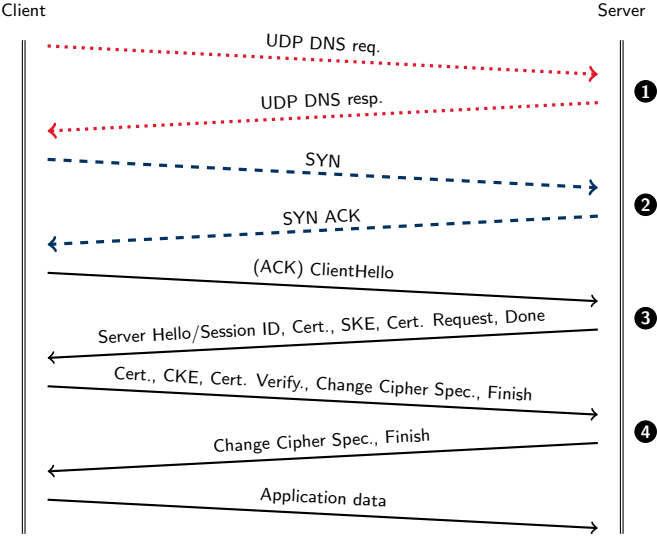
Slide credit: Mike Petullo.

# TLS (abbreviated): 2 roundtrips



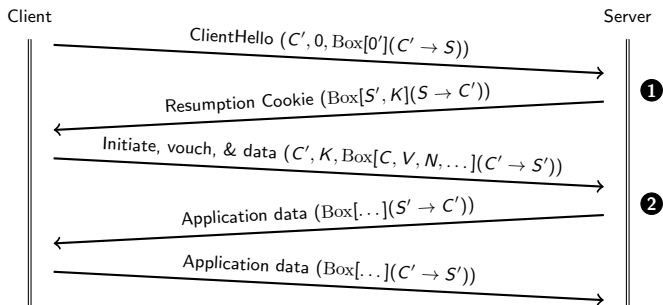
Slide credit: Mike Petullo.

# TLS: 4 roundtrips



Slide credit: Mike Petullo.

# CurveCP: Usable security for the Internet, DJB, 2010



$c', C'$ : client's short-term private & public key

$s, S$ : server's long-term private & public key

$s', S'$ : server's short-term private & public key

$\text{Box}[m](C' \rightarrow S)$ : encrypt  $m$  using DH key obtained from  $c'$  and  $S$

$K = \text{Box}[C', s'](t)$ : encrypt  $m$  under minute key  $t$ .

If no long-term  $C$ : skip  $V$ , else  $V = \text{Box}[C'](C \rightarrow S)$ .



# MinimaLT: Minimal Latency Tunneling, CCS'13

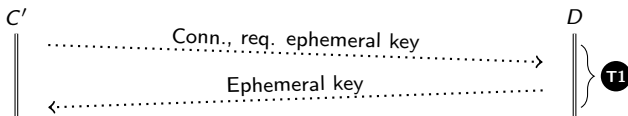
(Petullo, Zhang, Solworth, Bernstein, Lange  
implementation for linux and ethos involves more UIC students.)

## MinimaLT objects

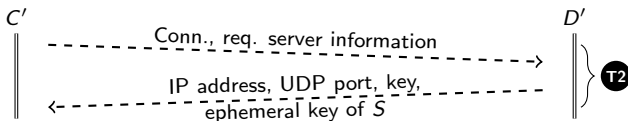
- ▶ **Public keys:** identify client users and servers
- ▶ **Ephemeral keys:** time-based and cryptographically protect identifying traffic
- ▶ **Tunnels:** an encrypted channel between two hosts which multiplexes connections
- ▶ **Connections:** user-authenticated two-way communication within a tunnel
- ▶ **Directory and name service:** resolve hostnames to IP addresses and keys

# MinimalLT roundtrips

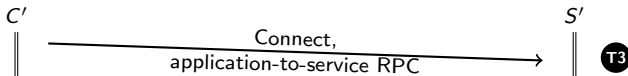
Obtaining  $D$ 's ephemeral key (only at boot time):



DNS-like lookup (only if tunnel does not yet exist):



Connection establishment:



Plus: Lots of cool crypto in rekeying, proof-of-work puzzles, resumption at different IP address.

# QUIC: Quick UDP Internet Connections

Design Document and Specification Rationale, Roskind

QUIC Crypto, Langley, Chang

- ▶ 0 RTT achieved similar to current 0 RTT proposals:
  - ▶ Client tries previous (stored) server key.
  - ▶ If key still active, get 0 RTT. Else data in first packet (or prior to ACK) is lost.
  - ▶ Server can reply with fresh key (1 RTT, 2 RTT worst case).
- ▶ Con: Less radical change than MinimaLT.
- ▶ Con: Favors long key validity, so bad for forward secrecy.
- ▶ Pro: Actually in use for Chrome – Google connections.  
Chromium Blog: [Results so far are positive, with the data showing that QUIC provides a real performance improvement over TCP](#)
- ▶ Less cool stuff on rekeying.