Kleptography in Authentication Protocols: Why is it Still Possible?

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Network Steganography

- hiding the existence of information
- covert sender (CS) and covert receiver (CR) practise secret communication by hiding messages in overt communication of an established system
- multiple scenarios are conceivable (see *Possibilities for Covert Sender and Receiver Positioning*)

Kleptography

- value from a black box cryptographic device or software is assumed to be random
- in reality, it contains encrypted content when the device is compromised and serves as CS

TLS 1.3

- widely used protocol to secure network connections
- handshake uses random nonce in all versions (see *TLS 1.3 Handshake*)
- opens path to kleptography attacks
- known for 25 years (Young & Yung 1997)
- attack and possible cure presented 16 years ago (Golebiewski et al. 2006)
- practical attack presented 4 years ago (Janovsky et al. 2018)
- TLS still not rectified

Possible Reasons

1. not widely deployed
2. unclear how to exploit
3. unclear how to cure
4. steganographic bandwidth too small

⇒ 1–3 do not apply to TLS

TLS Handshake Covert Channel Bandwidth Estimation

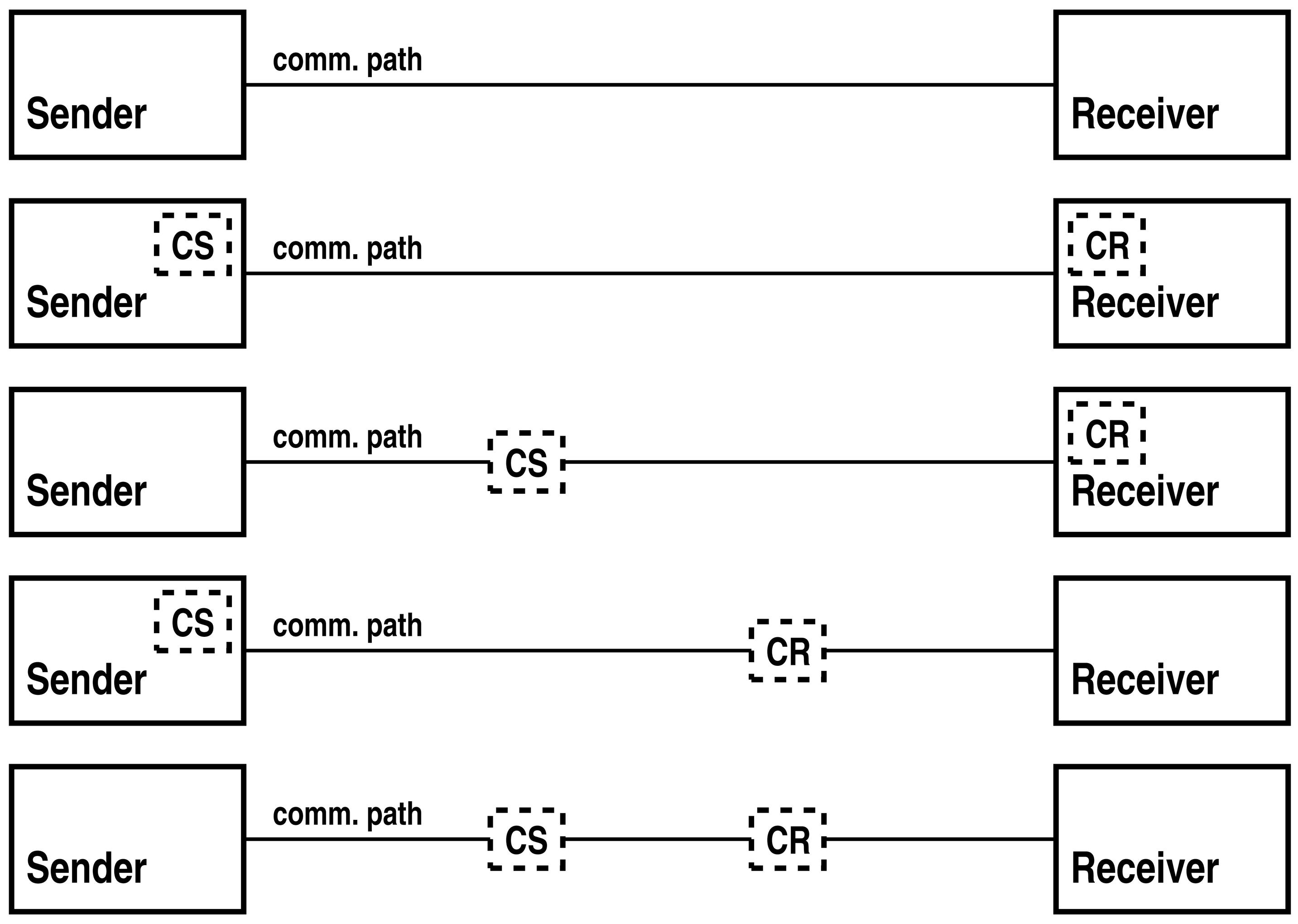
- 32 byte nonce
- hourly handshake and 10 servers

⇒ >60 kbit/day, non-negligible

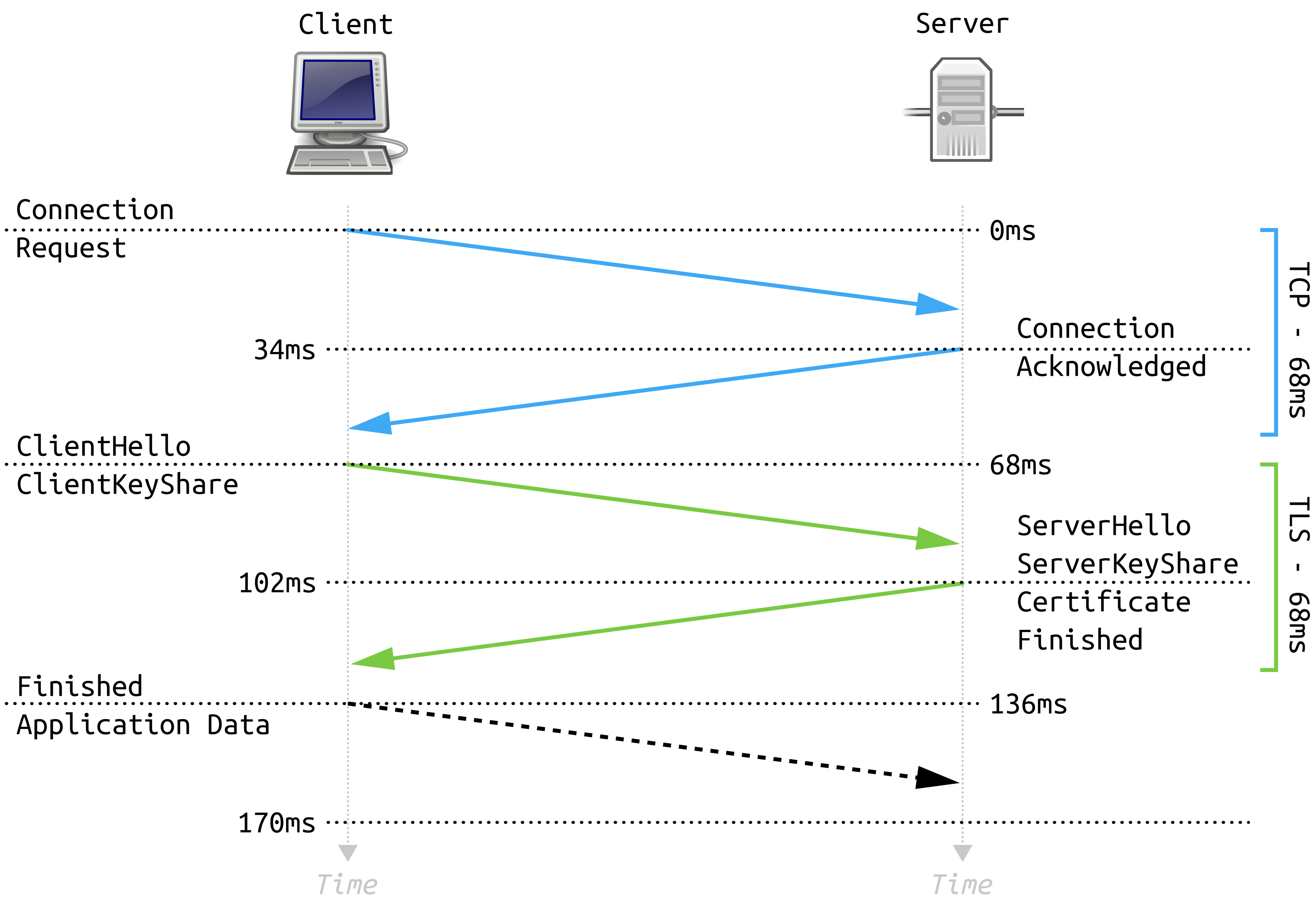
Conclusions

- TLS should be secured against attack
- OCRA and HTTP/1.1 digest access authentication protocols possibly affected

Possibilities for Covert Sender and Receiver Positioning



TLS 1.3 Handshake



ClientHello

```
struct {
   ProtocolVersion legacy_version = 0x0303;
   Random random;
   opaque legacy_session_id<0..32>;
   CipherSuite cipher_suites<2..2^16-2>;
   opaque legacy_compression_methods<1..2^8-1>;
   Extension extensions<8..2^16-1>;
} ClientHello;
```

ServerHello

```
struct {
   ProtocolVersion legacy_version = 0x0303;
   Random random;
   opaque legacy_session_id_echo<0..32>;
   CipherSuite cipher_suite;
   uint8 legacy_compression_method = 0;
   Extension extensions<6..2^16-1>;
} ServerHello;
```

References

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