SSL/TLS & 3D Secure

BİL 448/548

Internet Security Protocols

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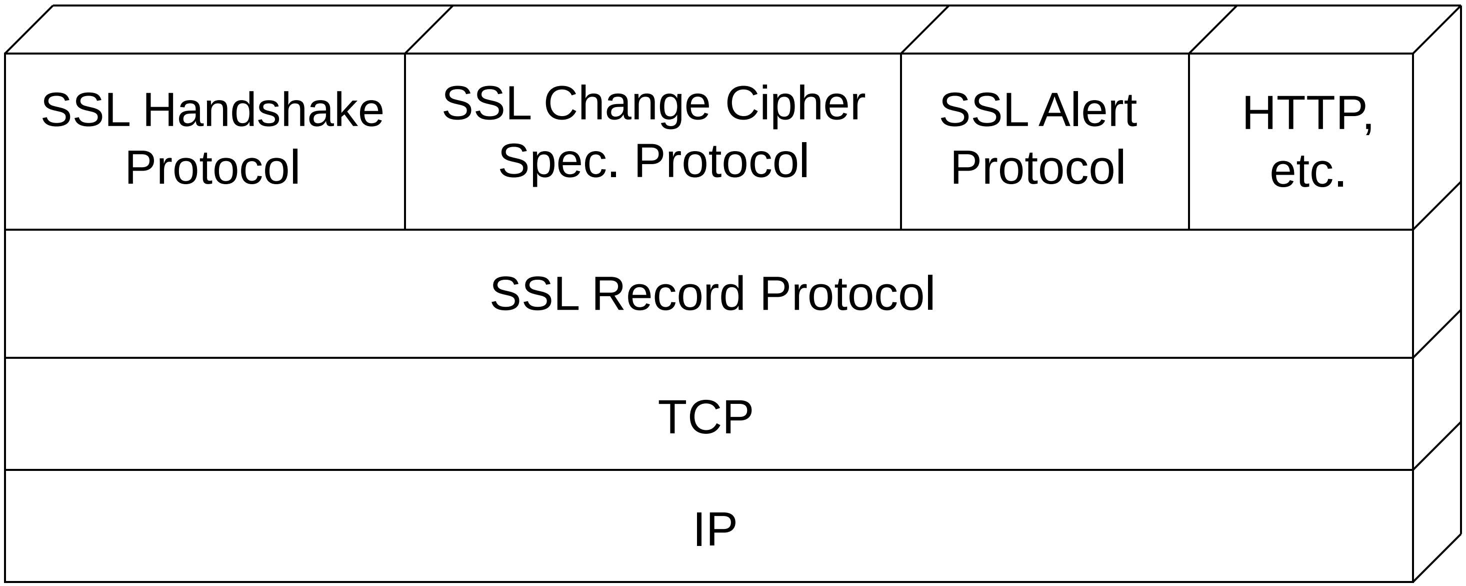
Brief History of SSL/TLS

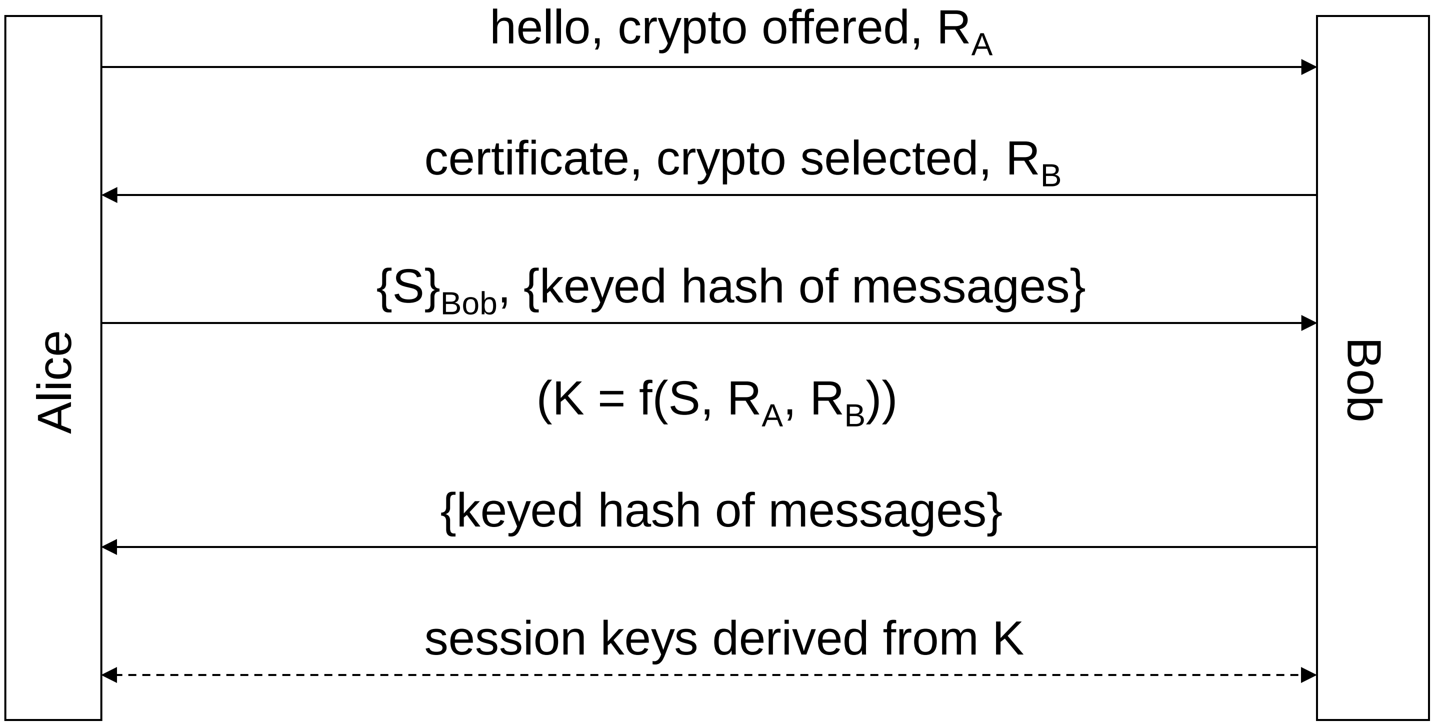
- SSLv2
  - Released in 1995 with Netscape 1.1
  - Key generation algorithm kept secret
  - Reverse engineered & broken by Wagner & Goldberg
- SSLv3
  - Fixed and improved, released in 1996
  - Public design process
- TLS: IETF’s version; the current standard
  - Latest: v1.2 (RFC 5246, August 2008)
- DTLS (Datagram TLS): TLS over UDP

SSL Architecture



- Record Protocol: Message encryption/authentication
- Handshake P.: Identity authentication & key exchange
- Alert P.: Error notification (cryptographic or otherwise)
- Change Cipher P.: Activate the pending crypto suite

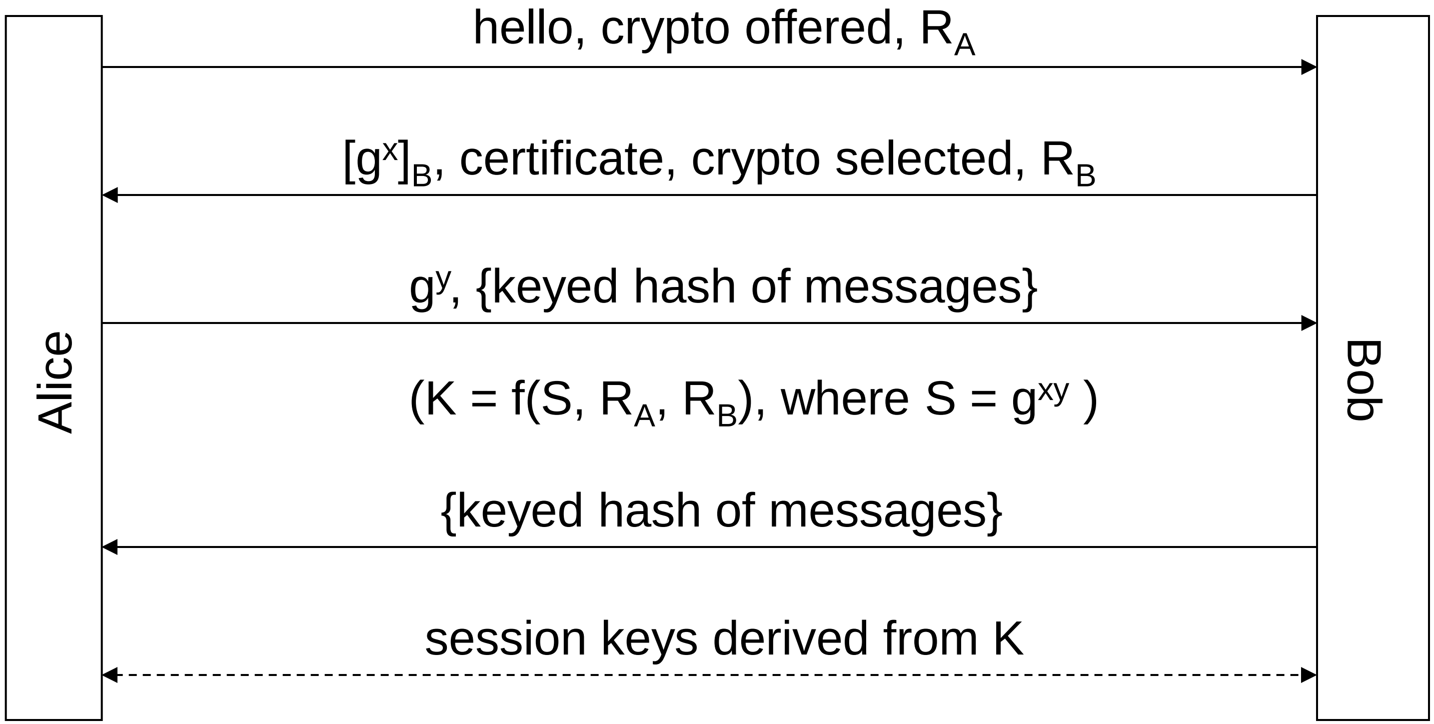
Basic SSL/TLS Handshake Protocol



SSL/TLS Handshake Protocol

- Client authentication:
  - Bob can optionally send “cert. req.” in msg 2.
  - Then, Alice will send her certificate in msg 3 as well as her signature on all messages so far.
- DH is supported too (fixed, ephemeral, or anon.)
- DH is gaining popularity (ECDH, in particular) over RSA key transport. Especially after Snowden.
- IETF is to drop RSA key transport from TLS 1.3. http://www.theinquirer.net/inquirer/news/2343117/ietf-drops-rsa-key-transport-from-ssl

DH SSL/TLS Handshake Protocol



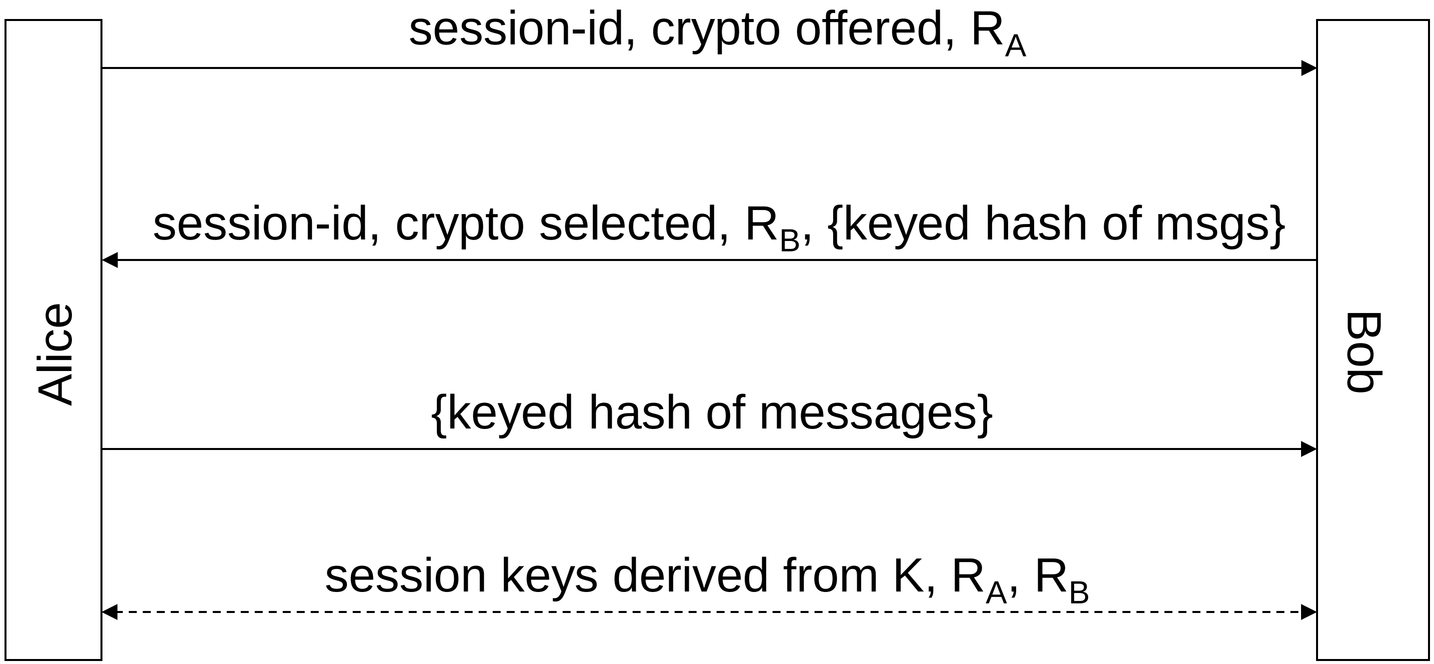
DH in SSL/TLS

- Main advantage: PFS
  https://www.imperialviolet.org/2011/11/22/forwardsecret.html
- Disadvantage: More costly
  - RSA key transport: One exponentiation per side
  - Ephemeral DH: Three exponentiations per side
- But, with new ECC algorithms (e.g., EC25519), the overhead has become almost negligible.
  https://www.imperialviolet.org/2013/05/10/fastercurve25519.html

SSL Session vs. Connection

- “Sessions” are relatively long-lived.
- Multiple “connections” (TCP) can be supported under the same SSL session.
- To start a connection, Alice can send an existing session ID.
- If Bob doesn’t remember the session ID Alice sent, he responds with a different value.

Session Resumption ("Connection")



Key Computation

- "pre-master secret": S
- "master secret": $K = f(S, R_A, R_B)$
- For each connection, 6 keys are generated from K and the nonces.
  (3 keys for each direction: encryption, auth., IV)
- Implicit IVs are abandoned in TLS 1.1 and later: http://crypto.stackexchange.com/questions/2641/why-do-new-versions-of-tls-use-an-explicit-iv-for-cbc-suites

Negotiating Crypto Suites

- *Crypto suite*: A complete package specifying the crypto to be used. (encryption algorithm, key length, integrity algorithm, etc.)
- 30+ predefined standard cipher suites.
- 256 values reserved for private use.
- Selection:
  - v2: Alice proposes a set of suites; Bob returns a subset of them; Alice selects one.
    (which doesn’t make much sense)
  - v3: Alice proposes a set of suites; Bob selects one.

The Trust Model

- PKI: Oligarchy model with X.509 certificates
- Browsers come configured with a set of trusted root CAs (VeriSign, AT&T, Entrust/Nortel, etc.) Additions to the root CA list by user is possible.
- Typically, only the server is authenticated. Client authentication is optional.
- Certificate revocation: Two alternative protocols:
  - CRL
  - OCSP

Secure Electronic Transaction (SET)

- Application-layer e-commerce protocol
- Developed by Visa & MasterCard consortium, 1996
- Provides security, authentication, order transaction, payment authorization, etc.
- Both the merchant & customer are authenticated by X.509 certificates

SET

- Problems of e-commerce over SSL/TLS:
  - malicious merchants (stealing credit card numbers)
  - malicious customers (using stolen credit card no.s)
- SET solution:
  - Bank (B) acts as an intermediary between the customer (C) & the merchant (M)
  - M forwards C's info. to B, encrypted with B's key
  - B does:
    - authenticate C's public key signature
    - decrypt the transaction info. (amount, card number, etc.)
    - issue payment authorization & send it to M

SET & 3D-Secure

- SET problem: All users are required to have public keys & “wallets”.
  - difficult to deploy & expensive
  - not convenient (user access from a single terminal)
- 3D-Secure solution:
  - No wallets are required.
  - B authenticates C by password (or, SMS-OTP).
  - M directs C to B, to which password is SSL-encrypted. (Problem: Malicious merchants can do m.i.t.m. attack, directing C to a fake page it controls.)
  - Officially launched in 2003, supported by Visa & MC.