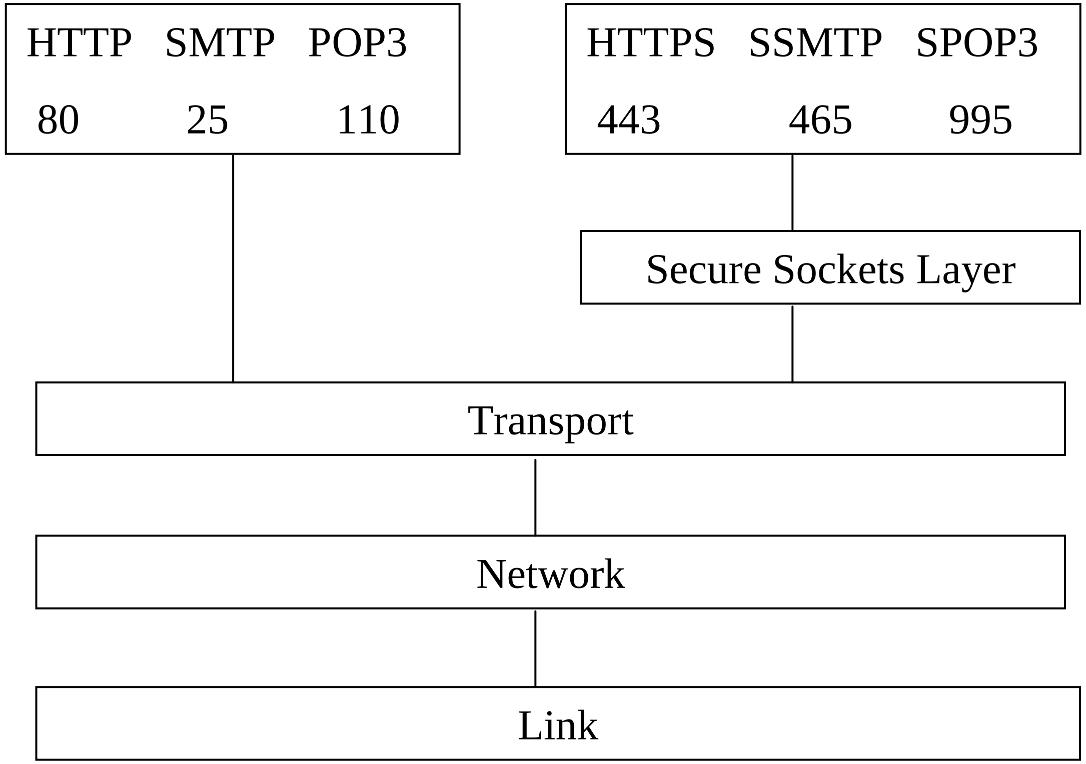
Transport-Level Security

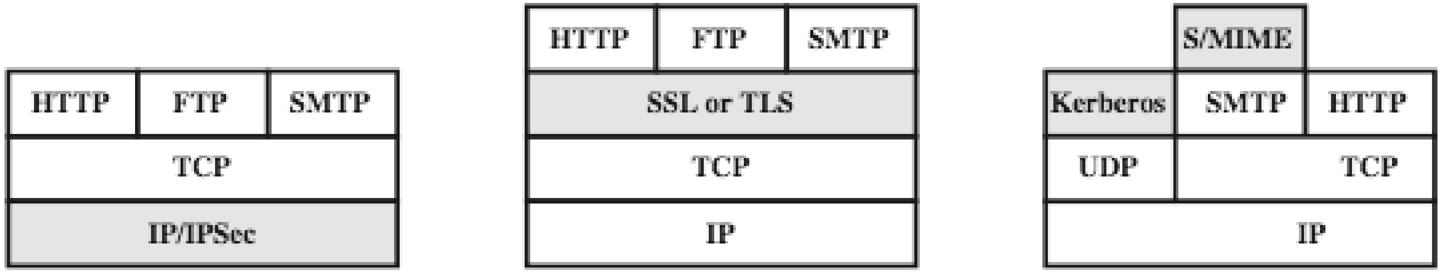
Web Security

- Web now widely used by business, government, individuals
- but Internet & Web are vulnerable
- have a variety of threats
  - integrity
  - confidentiality
  - denial of service
  - authentication
- need added security mechanisms

Where SSL Fits



Web Traffic Security Approaches



(a) Network Level

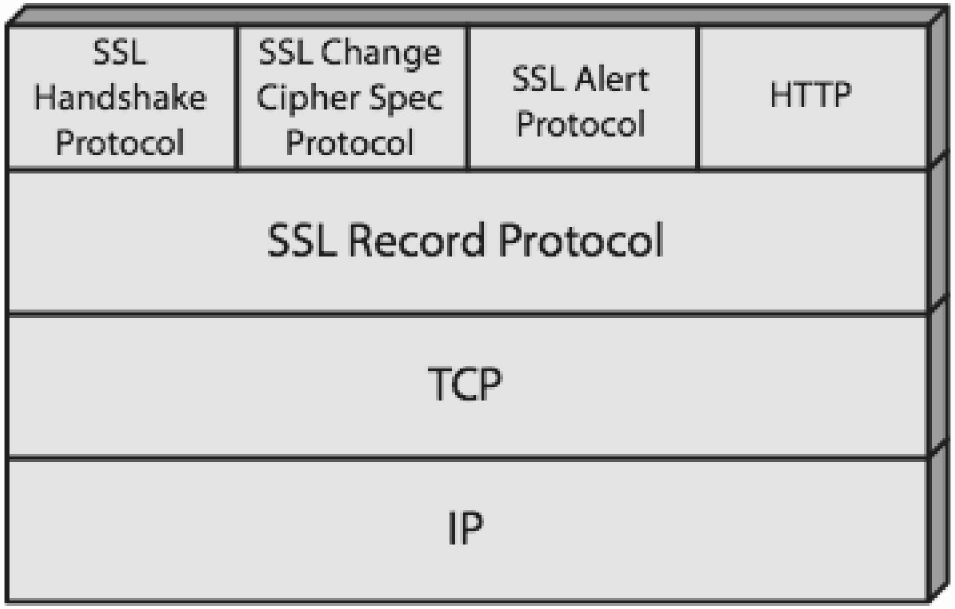
(b) Transport Level

(c) Application Level

SSL (Secure Socket Layer)

- transport layer security service
- originally developed by Netscape
- version 3 designed with public input
- subsequently became Internet standard known as TLS (Transport Layer Security)
- uses TCP to provide a reliable end-to-end service
- SSL has two layers of protocols

SSL Architecture



SSL Handshake Protocol

SSL Change Cipher Spec Protocol

SSL Alert Protocol

HTTP

SSL Record Protocol

TCP

IP

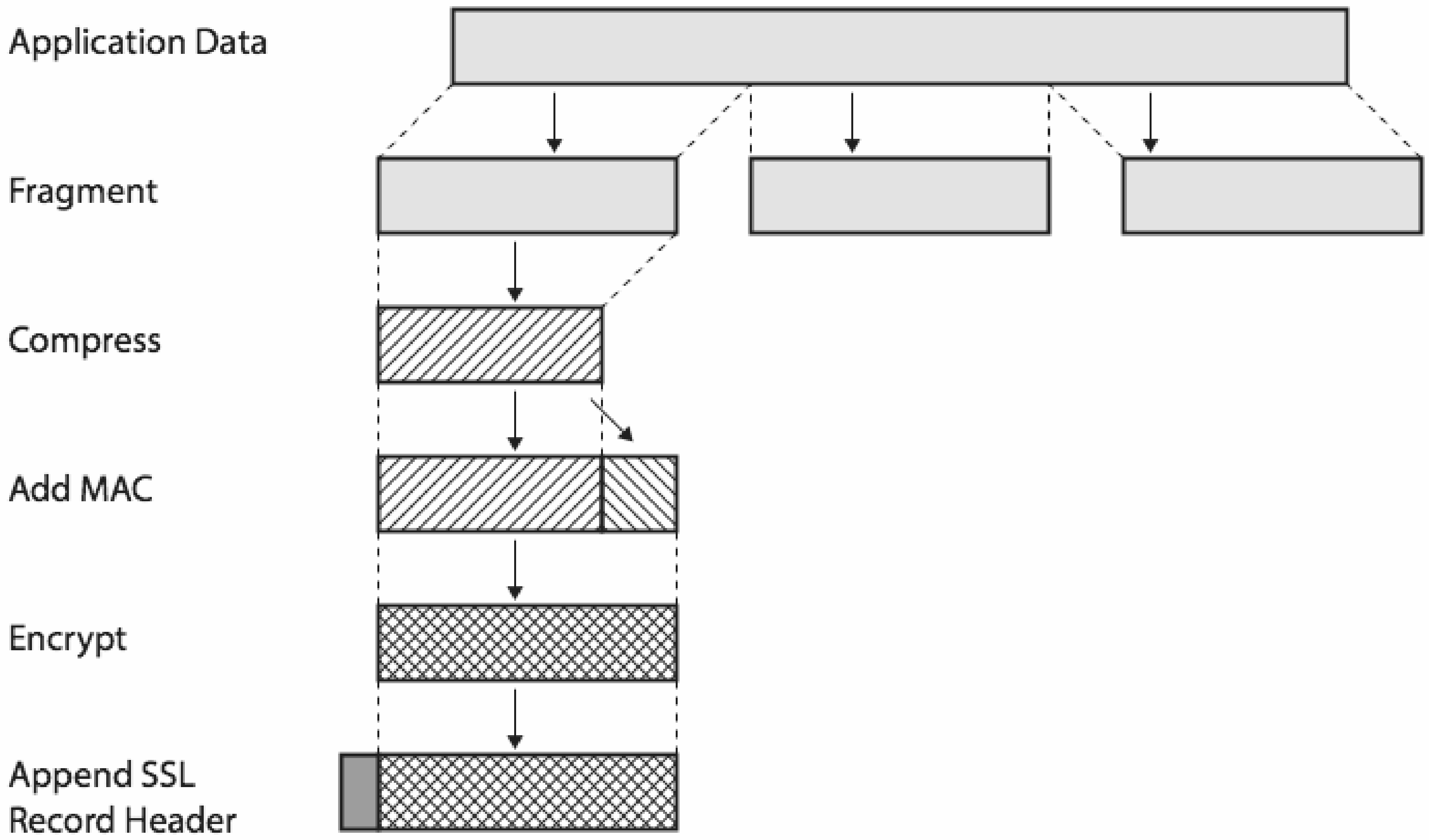
SSL Architecture

- **SSL connection**
  - a transient, peer-to-peer, communications link
  - associated with 1 SSL session
- **SSL session**
  - an association between client & server
  - created by the Handshake Protocol
  - define a set of cryptographic parameters
  - may be shared by multiple SSL connections

SSL Record Protocol Services

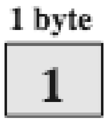
- **confidentiality**
  - using symmetric encryption with a shared secret key defined by Handshake Protocol
  - AES, IDEA, RC2-40, DES-40, DES, 3DES, Fortezza, RC4-40, RC4-128
  - message is compressed before encryption
- **message integrity**
  - using a MAC with shared secret key
  - similar to HMAC but with different padding

SSL Record Protocol Operation



SSL Change Cipher Spec Protocol

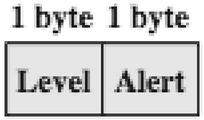
- one of 3 SSL specific protocols which use the SSL Record protocol
- a single message
- causes pending state to become current
- hence updating the cipher suite in use



(a) Change Cipher Spec Protocol

SSL Alert Protocol

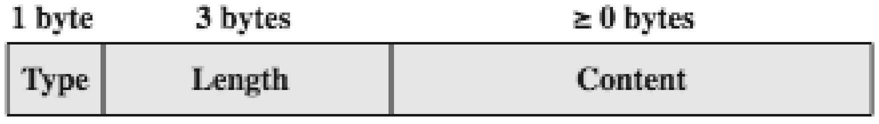
- conveys SSL-related alerts to peer entity
- severity
    - warning or fatal
- specific alert
    - fatal: unexpected message, bad record mac, decompression failure, handshake failure, illegal parameter
    - warning: close notify, no certificate, bad certificate, unsupported certificate, certificate revoked, certificate expired, certificate unknown
- compressed & encrypted like all SSL data



(b) Alert Protocol

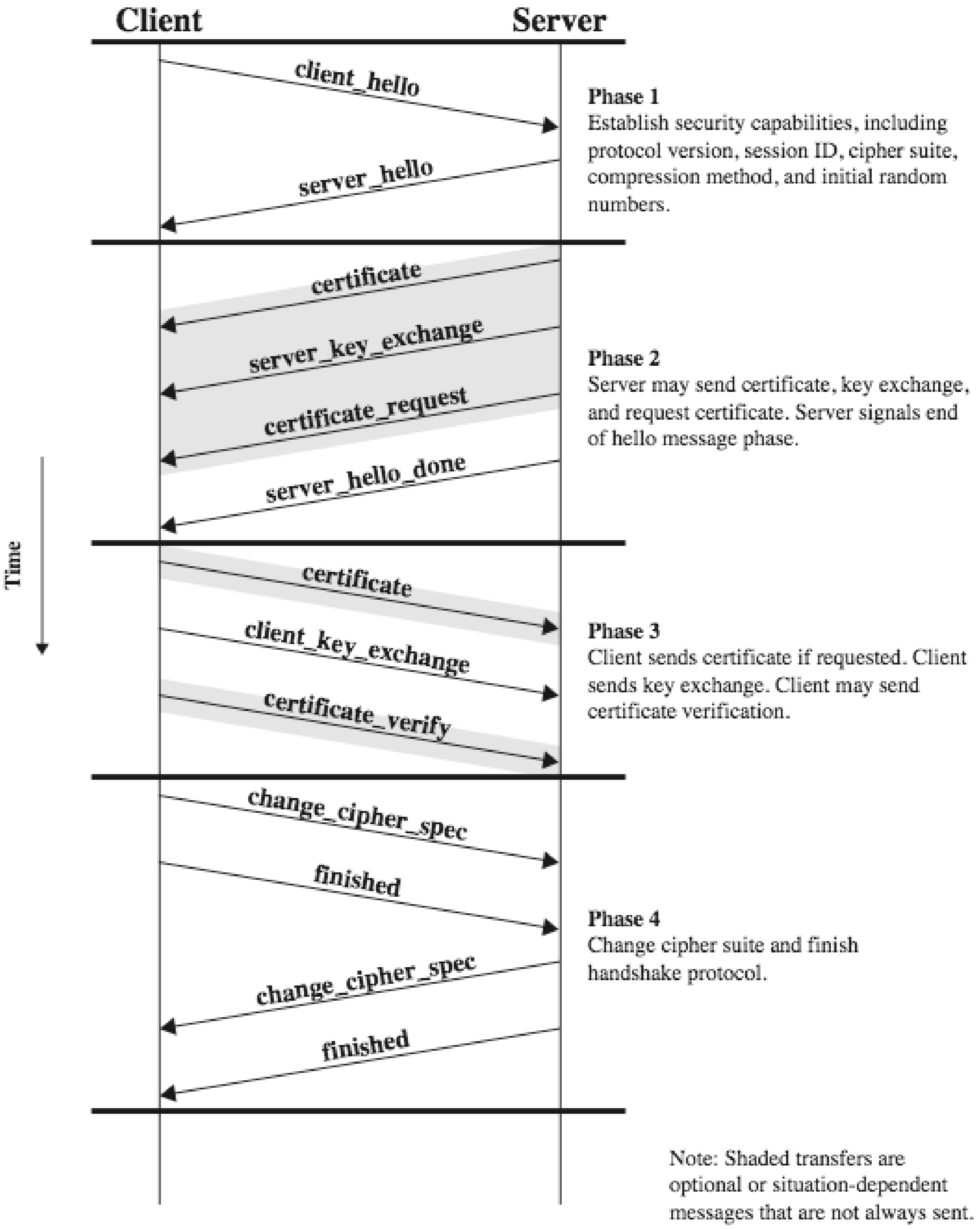
SSL Handshake Protocol

- allows server & client to:
  - authenticate each other
  - to negotiate encryption & MAC algorithms
  - to negotiate cryptographic keys to be used
- comprises a series of messages in phases
  1. Establish Security Capabilities
  2. Server Authentication and Key Exchange
  3. Client Authentication and Key Exchange
  4. Finish



(c) Handshake Protocol

SSL Handshake Protocol



Phase 1
Establish security capabilities, including protocol version, session ID, cipher suite, compression method, and initial random numbers.

Phase 2
Server may send certificate, key exchange, and request certificate. Server signals end of hello message phase.

Phase 3
Client sends certificate if requested. Client sends key exchange. Client may send certificate verification.

Phase 4
Change cipher suite and finish handshake protocol.

Note: Shaded transfers are optional or situation-dependent messages that are not always sent.

Cryptographic Computations

- master secret creation
  - a one-time 48-byte value
  - generated using secure key exchange (RSA / Diffie-Hellman) and then hashing info
- generation of cryptographic parameters
  - client write MAC secret, a server write MAC secret, a client write key, a server write key, a client write IV, and a server write IV
  - generated by hashing master secret

TLS (Transport Layer Security)

- IETF standard RFC 2246 similar to SSLv3
- with minor differences
  - in record format version number
  - uses HMAC for MAC
  - a pseudo-random function expands secrets
    - based on HMAC using SHA-1 or MD5
  - has additional alert codes
  - some changes in supported ciphers
  - changes in certificate types & negotiations
  - changes in crypto computations & padding