Transport Layer Security

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Overview

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Literature

The lecture covers chapter 6 “Transport-level Security” in [1]. To make sure you have fully understood the chapter, you should solve problems 6.1, 6.2 and 6.3 in [1].

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Web Security Considerations

- The web is a client/server system.
- Easy to use, easy to develop and easy to setup.
- Complex software.
- Vulnerable to exploits.
- Easy to exploit users.

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Threats on the web

Web Security Considerations

	Threats	Consequences	Countermeasures
Integrity	•Modification of user data •Trojan horse browser •Modification of memory •Modification of message traffic in transit	•Loss of information •Compromise of machine •Vulnerabilty to all other threats	Cryptographic checksums
Confidentiality	•Eavesdropping on the net •Theft of info from server •Theft of data from client •Info about network configuration •Info about which client talks to server	•Loss of information •Loss of privacy	Encryption, Web proxies
Denial of Service	•Killing of user threads •Flooding machine with bogus requests •Filling up disk or memory •Isolating machine by DNS attacks	•Disruptive •Annoying •Prevent user from getting work done	Difficult to prevent
Authentication	•Impersonation of legitimate users •Data forgery	•Misrepresentation of user •Belief that false information is valid	Cryptographic techniques

Figure : A Comparison of Threats on the Web[1]

Security facilities in the TCP/IP protocol stack

Web Security Considerations

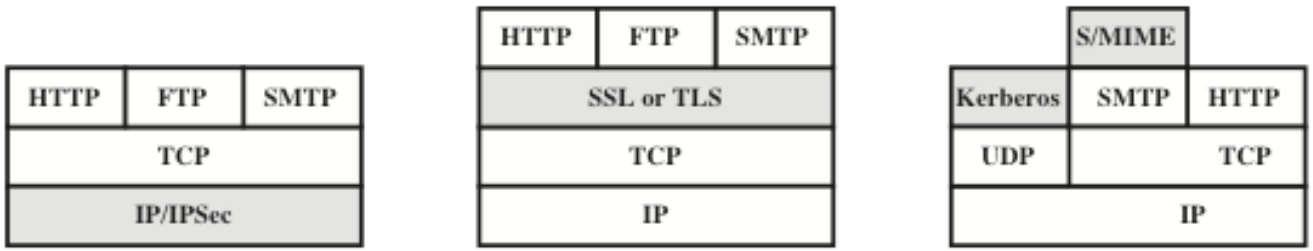

Figure : Relative location of security facilities in the TCP/IP protocol stack [1]

Overview

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Secure Socket Layer

SSL – Secure Socket Layer

- A widely used security service
- General purpose service implemented as a set of protocols relying on TCP.
- Part of underlying Protocol Suit
  - Transparent to applications.
- Embedded in specific packages, such as web browsers.

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SSLv3

SSL – Secure Socket Layer

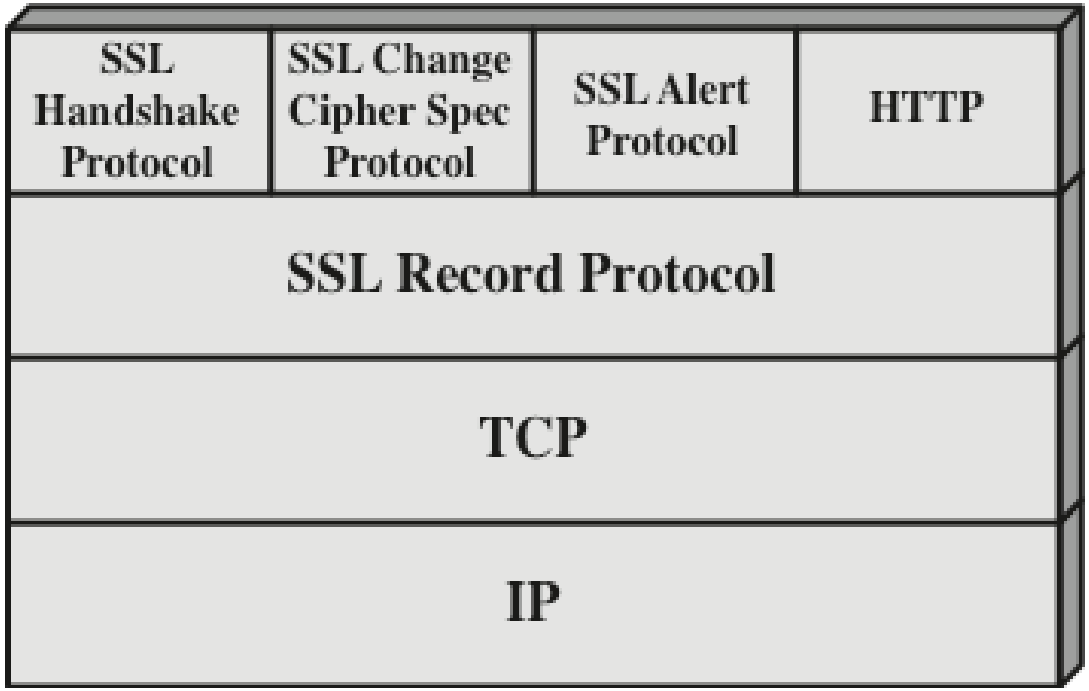

Figure : SSL protocol stack[1]

SSL Session

SSL – Secure Socket Layer

Session

- An association between a client and a server.
- Created by the handshake protocol.
- Defines a set of cryptographic security parameters.
- Shared amongst several connections.
- Avoids expensive negotiations.

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SSL Connection

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SSL Record Protocol

SSL – Secure Socket Layer

Services

- Confidentiality
- Message Integrity

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SSL Record Protocol II

SSL – Secure Socket Layer

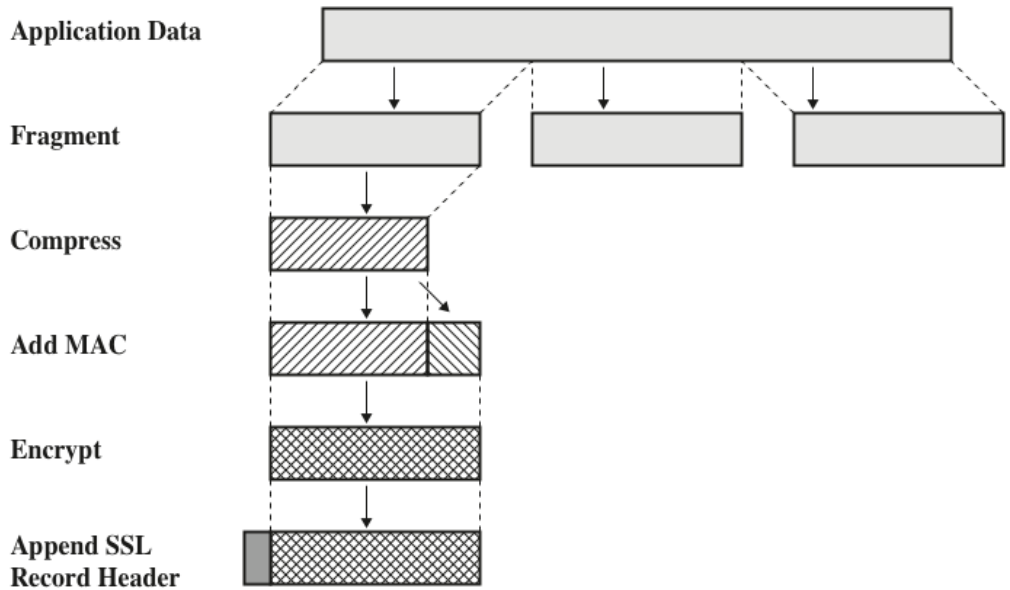

Figure : SSL Record protocol[1]

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SSLv3 MAC

SSL – Secure Socket Layer

```
hash(MAC_write_secret || pad_2 ||
hash(MAC_write_secret || pad1 || seq_num ||
SSL_Compressed.type || SSLCompressed.length ||
SSLCompressed.fragment))
```

Supported algorithms

SSL – Secure Socket Layer

Block Cipher		Stream Cipher	
Algorithm	Key size	Algorithm	Key Size
AES	128,256	RC-40	40
IDEA	128	RC-128	128
RC2-40	40		
DES-40	40		
DES	56		
3DES	168		
Fortezza	80		

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Change Cipher Spec Protocol

SSL – Secure Socket Layer

- Used for changing the pending state to current state.
- Contains a single byte with the value 1.

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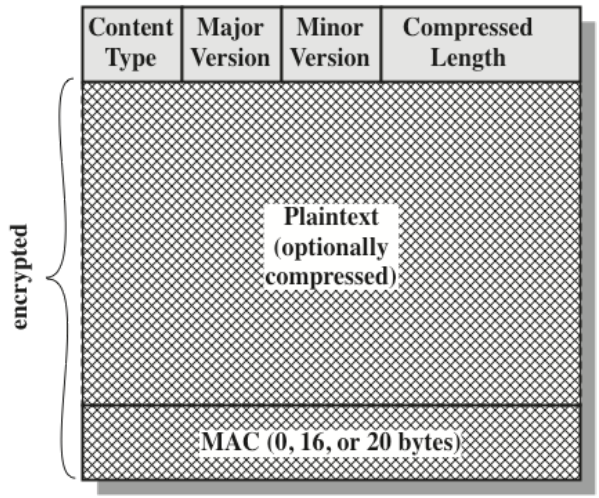
Alert Protocol

SSL – Secure Socket Layer

- Used to send alerts to the peer.
- Message is encrypted and optionally compressed.
- Two bytes – Severity and Alert



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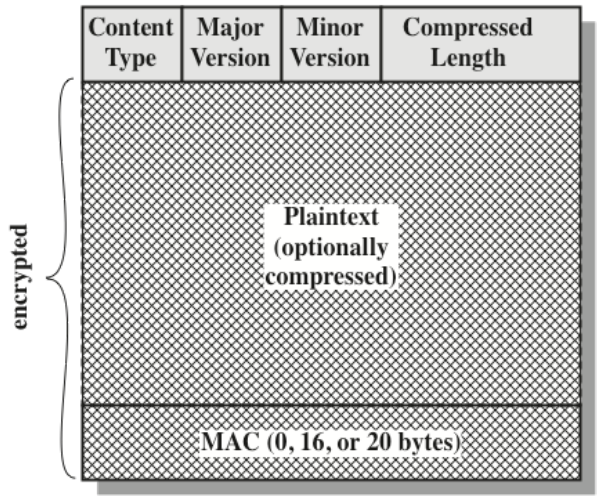

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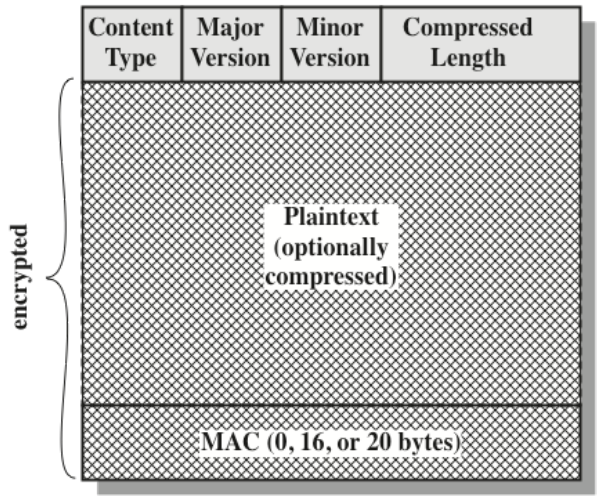

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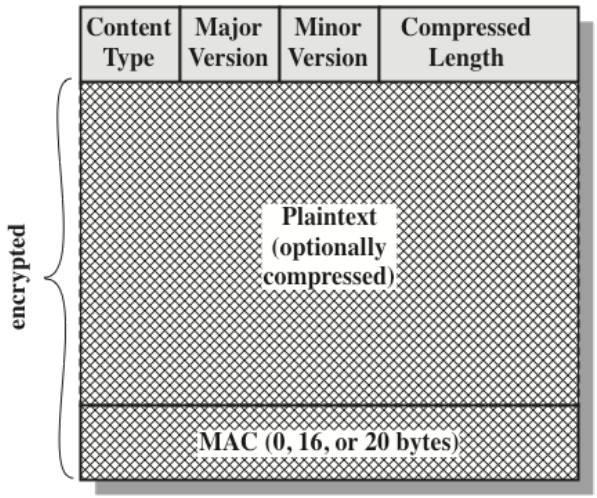
Alert Protocol II

SSL – Secure Socket Layer

- Severity
  - Warning – Session is still running.
  - Fatal – Session is closed.
- Alert
  - Type of alert



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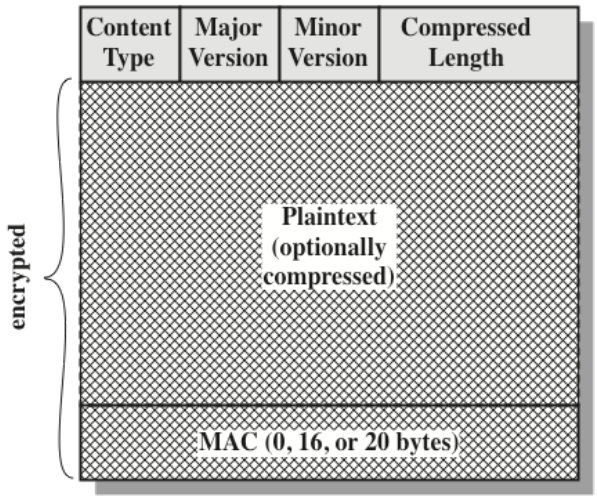

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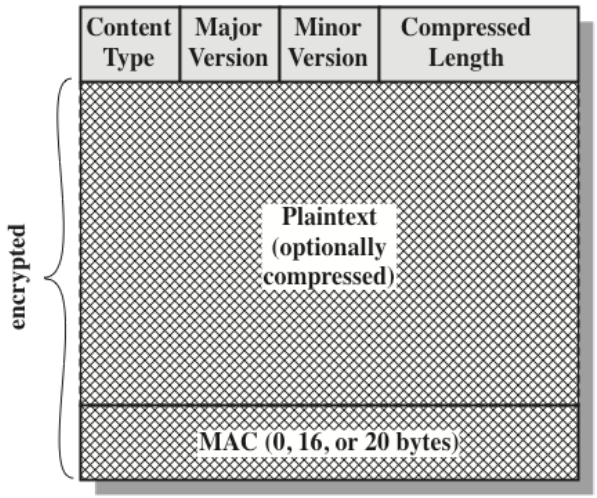

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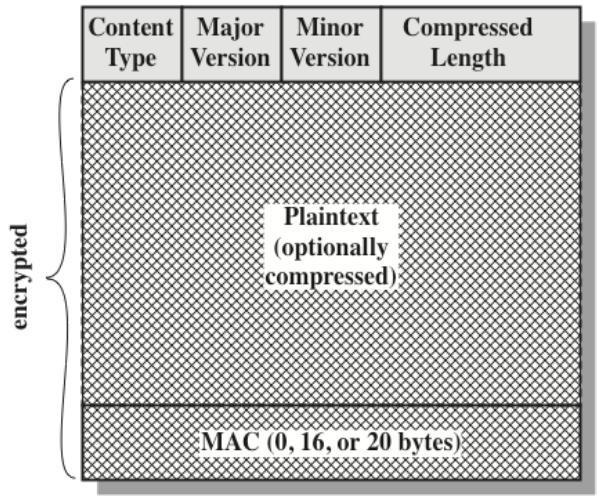

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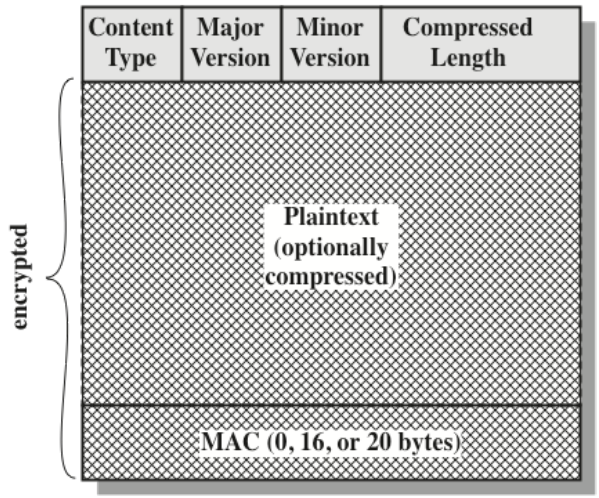

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SSL Handshake protocol

SSL – Secure Socket Layer

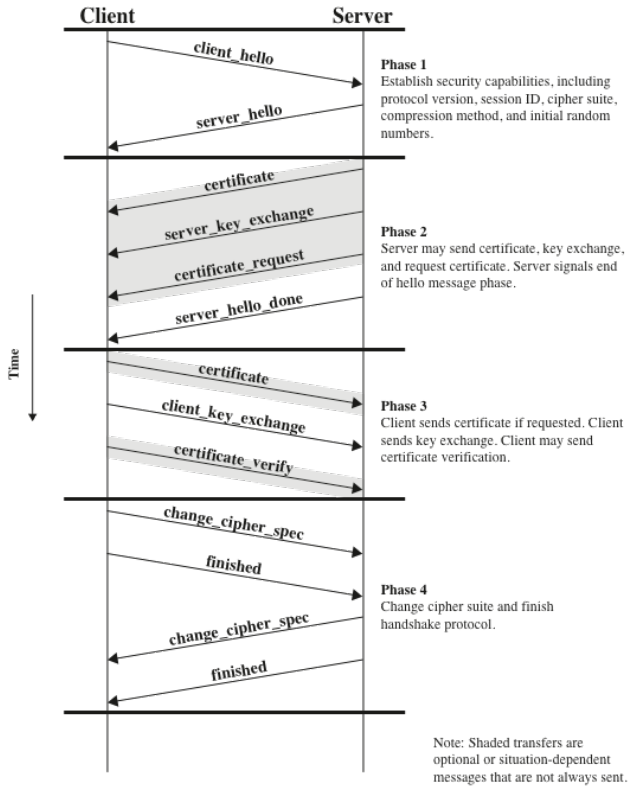

Figure : Handshake Protocol Action[1]

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Generating Cryptographic Parameters

SSL – Secure Socket Layer

```
master_secret = MD5(pre_master_secret || SHA('A' ||
pre_master_secret || ClientHello.random ||
ServerHello.random))||
MD5(pre_master_secret || SHA('BB' ||
pre_master_secret || ClientHello.random ||
ServerHello.random))||
MD5(pre_master_secret || SHA('CCC' ||
pre_master_secret || ClientHello.random ||
ServerHello.random))
```

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Generating key block

SSL – Secure Socket Layer

```
Key_block =
MD5(master_secret || SHA('A' || master_secret ||
ServerHello.random || ClientHello.random)) ||
MD5(master_secret || SHA('BB' || master_secret ||
ServerHello.random || ClientHello.random)) ||
MD5(master_secret || SHA('CCC' || master_secret ||
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Transport Layer Security

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TLS MAC

TLS – Transport Layer Security

```
hash(MAC_write_secret ⊕ pad2 ||
hash((MAC_write_secret ⊕ pad1) || seq_num ||
TLSCompressed.type || TLSCompressed.version ||
TLSCompressed.length || TLSCompressed.fragment)
)
```

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TLS Key generation

TLS – Transport Layer Security

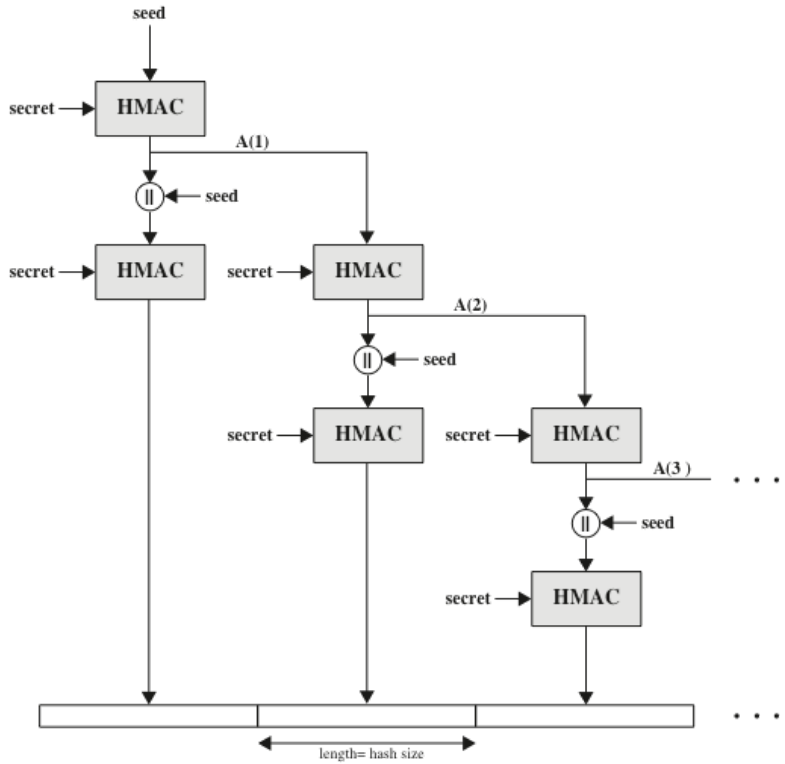

Figure : TLS key generation[1]

Overview

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HTTP over SSL/TLS

HTTPS

- HTTPS uses either SSL or TLS
- Following elements are encrypted.
  - URL of the requested document
  - Contents of the document
  - Contents of browser forms
  - Cookies
  - Content of HTTP header

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SSH

- A protocol used for secure remote communications.
- Designed to be simple and inexpensive.
- Initially meant to replace TELNET and other remote login schemes.
- Provides file transfers, tunneling et cetera.
- Server / Client
- Consists of three protocols

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Protocol Stack

SSH

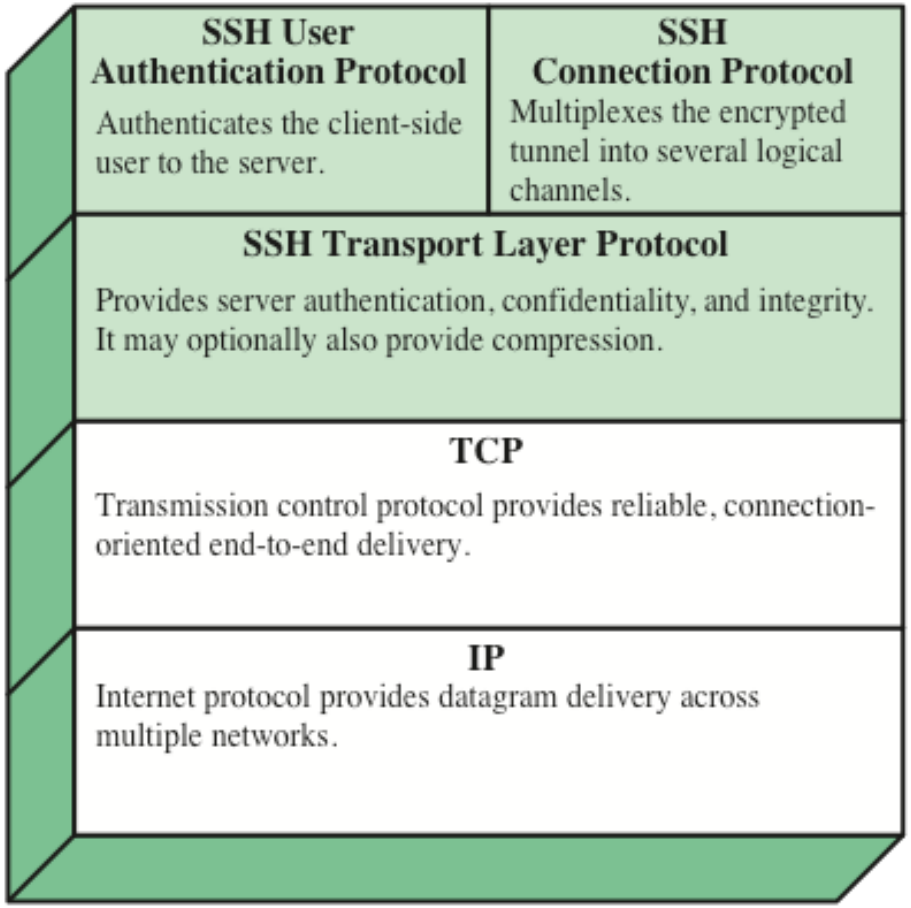

Figure : SSH Protocol Stack [1]

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Transport Layer Protocol
SSH

- Directly above transport layer.
- Based on the server possessing a public/private key pair.
- Can have multiple host keys using different asymmetric encryption schemes.
- Multiple hosts may share the same key.
- The server host key is used during key exchange to authenticate the host.
- Client must possess the servers public key before a secure connection can be set up.

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Servers public key trust level

SSH

Local database

- Client stores the public key in a local database.
- Associates the public key based on host name.
- Problems?

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Servers public key trust level II

SSH

Using a CA

- Use a trusted CA.
- host name to key association.
- Only need to store and trust the CA public key.
- Problems?

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Servers public key trust level II

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Packet Exchange

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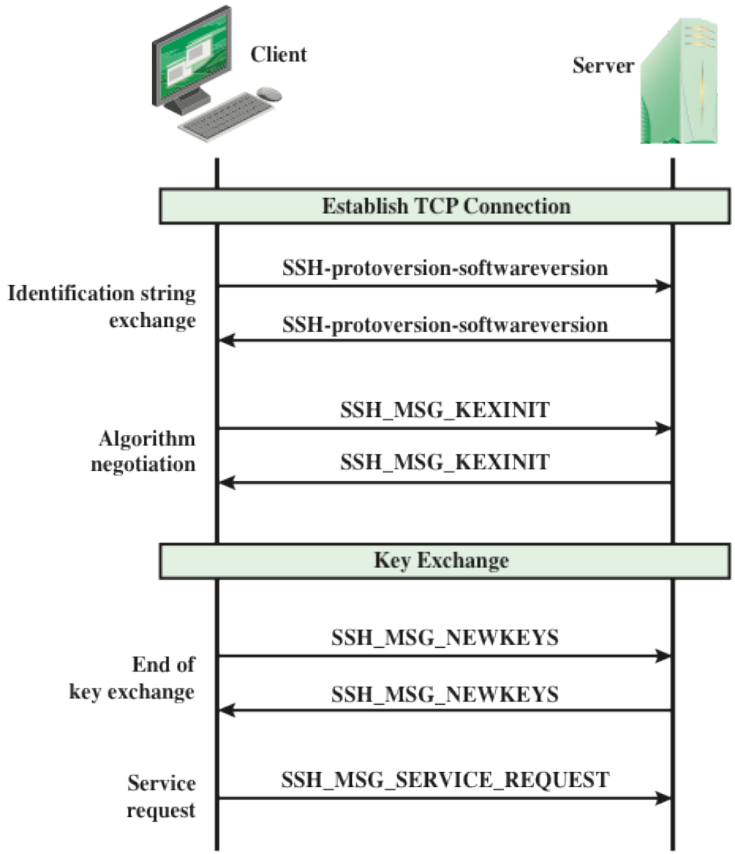

Figure : SSH Transport Layer Packet Exchange[1]

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User Authentication Protocol

SSH

- Used to authenticate the client to the server.
- Three authentication methods
  - Public key
  - Password
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Connection Protocol
SSH

Channel mechanism

- Communication using SSH are supported using separate channels.
- Server or Client can open a channel.
- For each channel, each side associates a unique channel number.
- Channels are flow controlled using a window mechanism
- A channel progresses through the steps: Opening, data transfer, closing.

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Connection Protocol
SSH

Channel mechanism

- Communication using SSH are supported using separate channels.
- Server or Client can open a channel.
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SSH Connection Protocol

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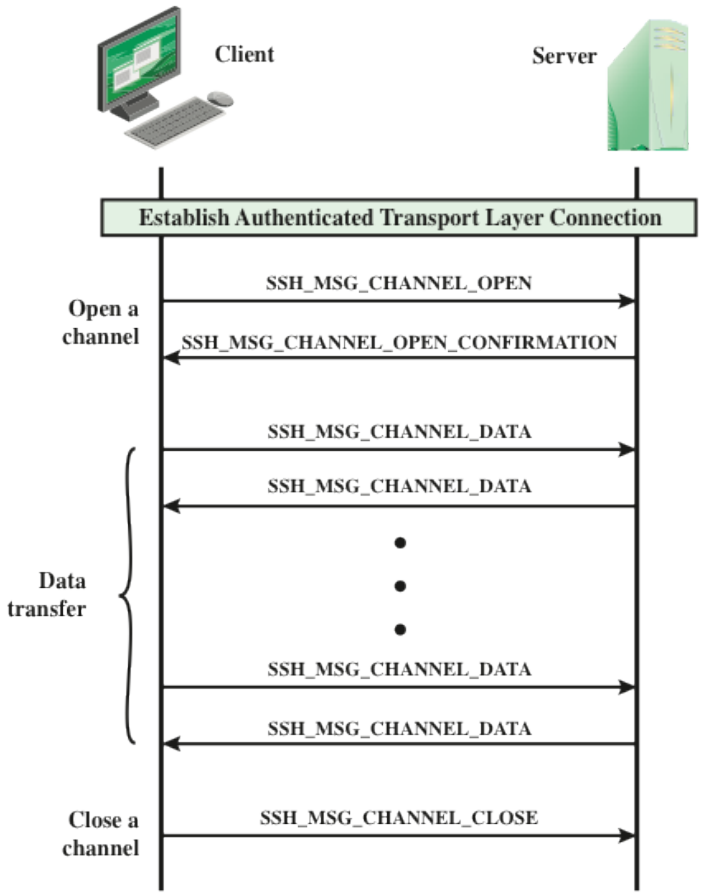

Figure : SSH Connection Protocol[1]

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Channel Types
SSH

Four channel types used in SSH Connection Protocols

- Session – Remote execution of a program, such as shell, file transfer, et cetera.
- X11 – X window system
- forwarded-tcpip – Remote port forwarding
- direct-tcpip – Local port forwarding

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Port Forwarding
SSH

Converts any insecure TCP connection into a secure SSH connection.

Local forwarding

- Allows the client to redirect traffic through an SSH connection.
- Listen on a local port and forwards all traffic through an SSH tunnel

Remote forwarding

Client acts on the servers behalf

Dynamic forwarding

SSH acts as a SOCKS-proxy.

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Overview

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References

[1] William Stallings. *Network security essentials : applications and standards*. 5th ed. International Edition. Pearson Education, 2013. ISBN: 978-0-273-79336-6.

[2] T. Dierks and E. Rescorla. *The Transport Layer Security (TLS) Protocol Version 1.2*. RFC 5246 (Proposed Standard). Updated by RFCs 5746, 5878, 6176. Internet Engineering Task Force, Aug. 2008. URL: `http://www.ietf.org/rfc/rfc5246.txt`.

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