Network Security

Encrypting Network Communication

Radboud University Nijmegen, The Netherlands

Autumn 2014

Acknowledgement

Slides (in particular pictures) are based on lecture slides by Ruben Niederhagen (http://polycephaly.org)

A short recap

- Hostname resolution in the Internet uses DNS
- Two kinds of servers: authoritative and caching
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- Most powerful attack: sniffing DNS spoofing
- Countermeasures: Use crypto to protect DNS
  - DNSSEC (with various problems)
  - Alternative: DNSCurve

A longer recap

- So far in this lecture: various attacks (often MitM):
  - ARP spoofing
  - Routing attacks
  - DNS Attacks
- Conclusion: sniffing (and modifying) network traffic is not dark arts
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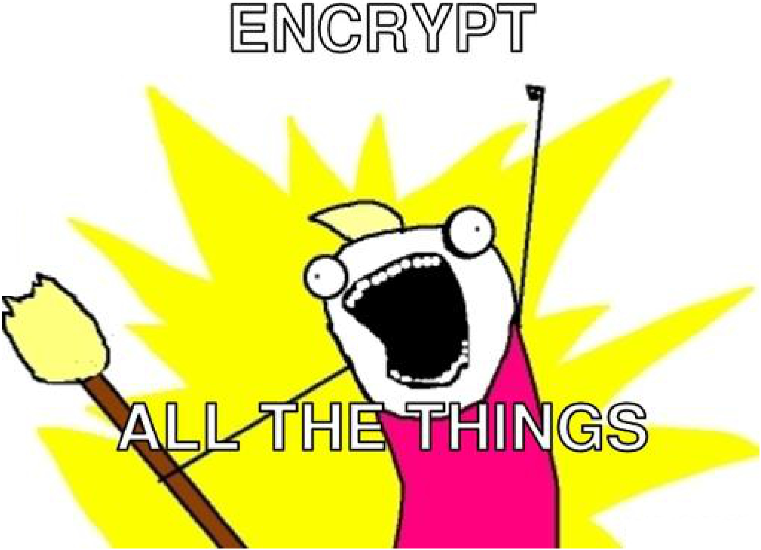
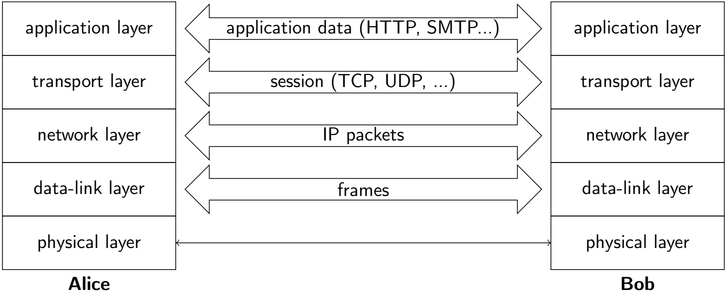
- It's doable for 2nd-year Bachelor students
- It's even easier for administrators of routers
- So far, relatively little on countermeasures… so, what now?


ENCRYPT
ALL THE THINGS

Cryptography in the TCP/IP stack



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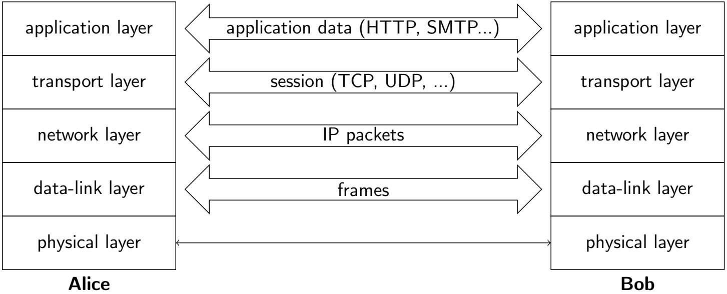
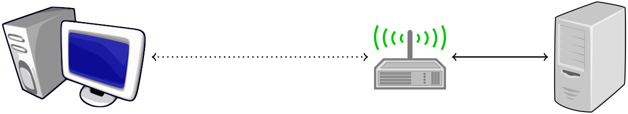


- Application-layer security (e.g., PGP, S/MIME, OTR)
- Transport-layer security (e.g., TLS/SSL)
- Network-layer security (e.g., IPsec)
- Link-layer security (e.g., WEP, WPA, WPA2)

Link-layer security



- Encrypt all network packets between network links, e.g., WPA2
- Point-to-point security between network interfaces
- “Encrypt to a MAC address”

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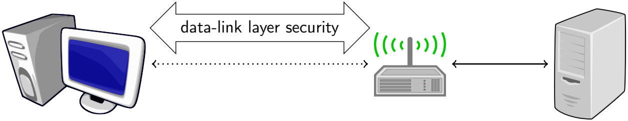

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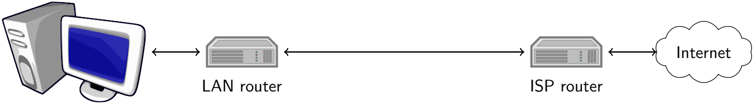

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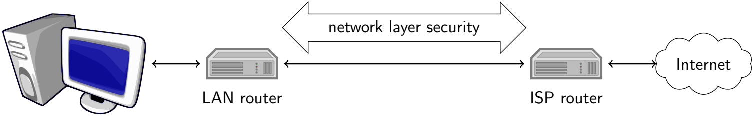

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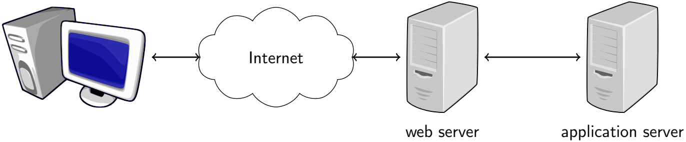

- Encrypt sessions and messages, e.g. TLS/SSL
- communication between web browser and server, or email clients and servers
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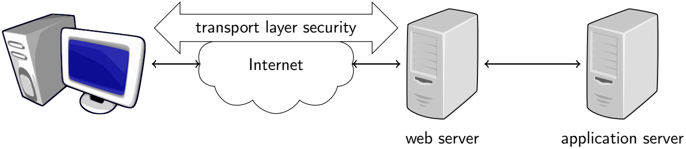

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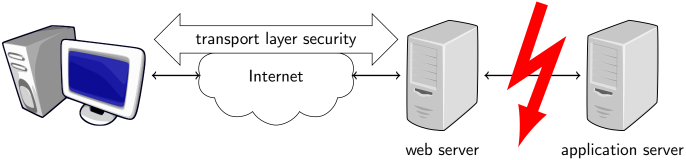

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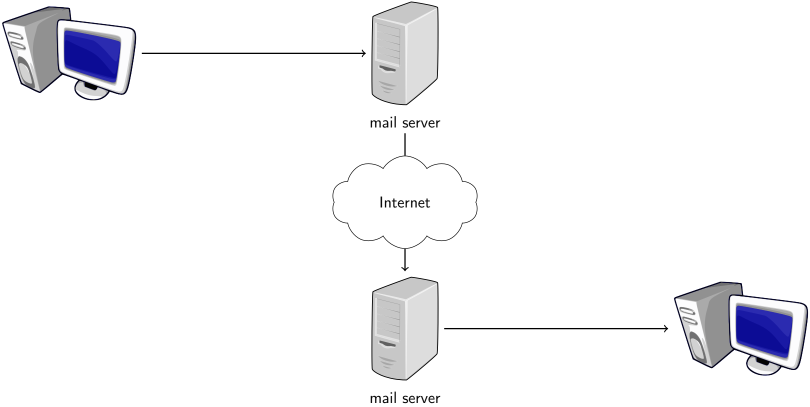

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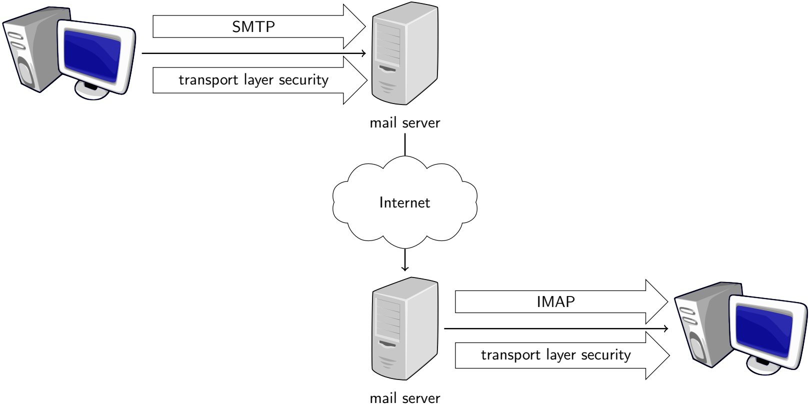

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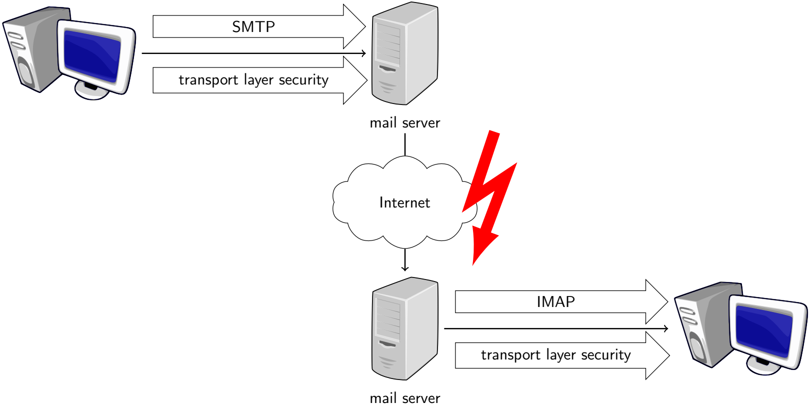

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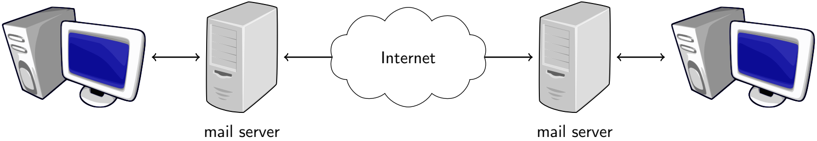

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- For email: entire link between two user mail clients is protected
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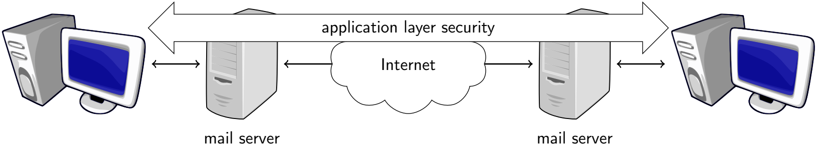

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- Transport-layer security needs applications to be modified to use secure transport layer
- Idea of network-layer security: No need to change applications (or user behavior)
- IPsec's promise: network security happening without you even noticing

IPsec – Modes of Operation

Transport mode:

- Only the payload of the IP packet is protected
- Data is protected from source to destination
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Tunnel mode:

- Entire IP packet is protected (i.e. IP header and data)
- Becomes the payload of a new IP packet
- May contain different source and destination addresses
- Can be used between hosts, gateways, or host-gateway

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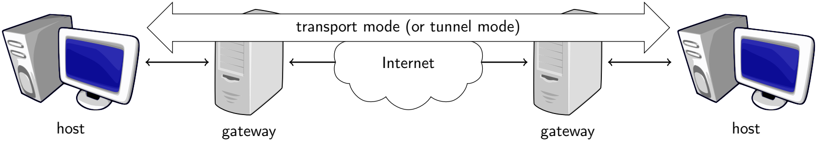

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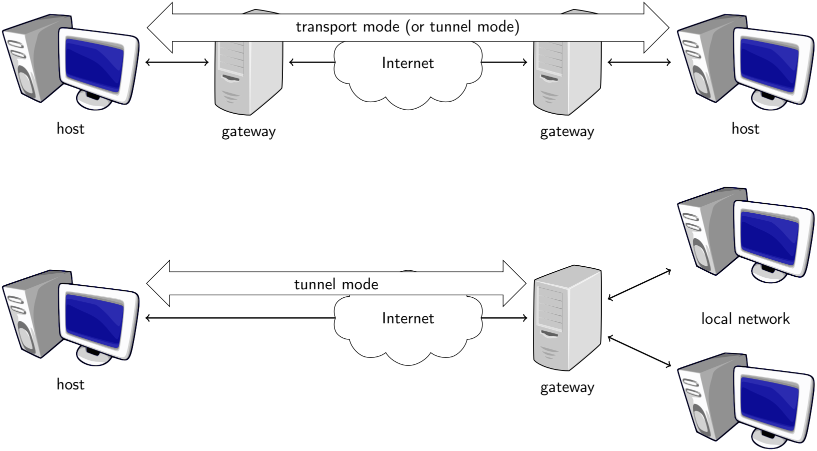

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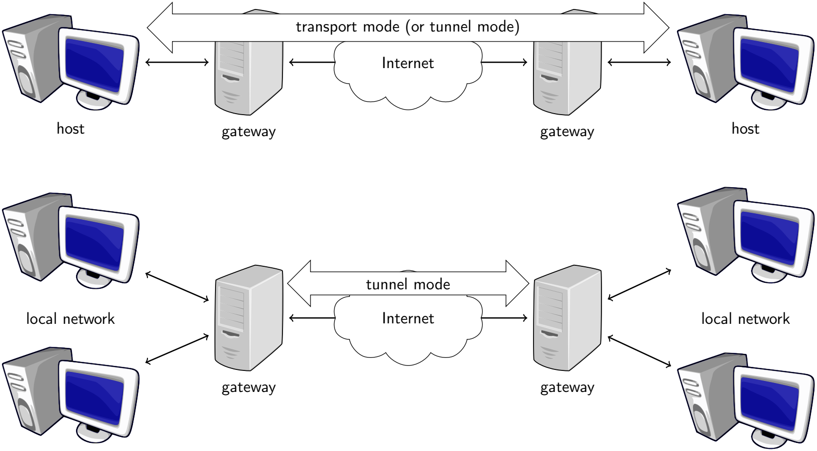

IPsec Protocols

- Authentication Header (AH)
- Encapsulating Security Payloads (ESP)
- Security Associations (SA)

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The Authentication Header provides

- data integrity,
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IP packet is expanded with an AH that contains items such as:

- next header — type of the header following this header,
- payload length — length of AH,
- Security Parameter Index (SPI) — identifies an SA,
- sequence number,
- authentication data — contains the MAC of the packet, also called Integrity Check Value (ICV).

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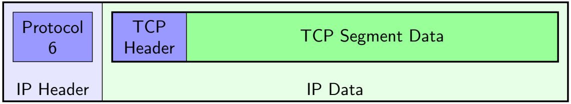

ICV (truncated HMAC) is computed over:

- immutable IP header fields (fields that do not change in transit), e.g., source address, IP header length,
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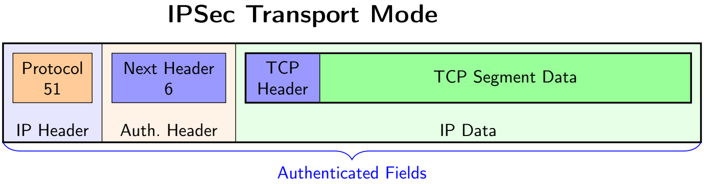

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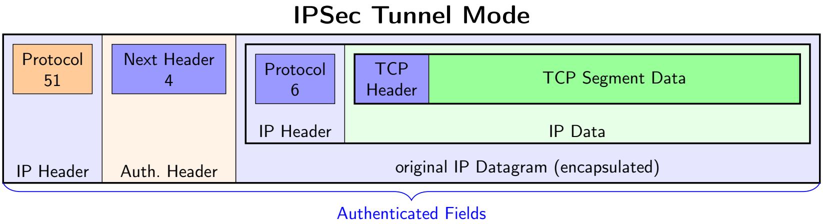

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IPsec – Authentication Header

Anti-replay protection prevents resending copies of authenticated packets.

- Uses sequence number field.
- For each new SA, sequence counter set to 0.
- Keep track of overflow (sequence number is 32 bits), negotiate new SA when counter reaches $2^{32} - 1$.
- Check whether counter is in window of fixed size.
- Right edge = highest sequence number so far received (with valid authentication).
- Mark numbers of received packets with valid authentication.
- Advance window if new sequence number falls to the right of window and packet authenticates.
- Discard packet if number falls to the left of window or packet does not authenticate.

IPsec – Encapsulating Security Payload (ESP)

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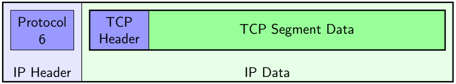
ESP adds an ESP header, encrypts the payload and adds an ESP trailer. An ESP packet contains:

- security parameter index (SPI),
- sequence number,
- payload data (encrypted),
- padding – to achieve data length a multiple of 32 bits (encrypted),
- padding length (encrypted),
- next header (encrypted),
- (optional) authentication data.

IPsec – Encapsulating Security Payload



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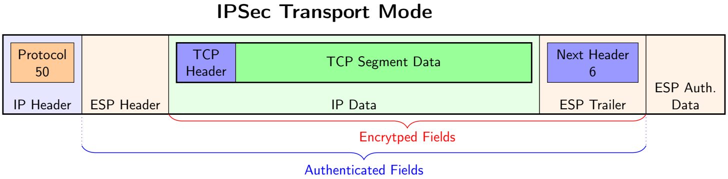

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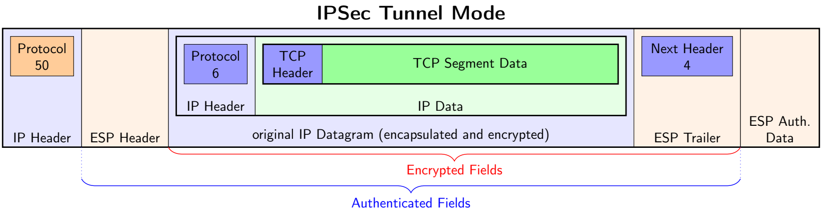

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SA parameters:

- sequence number, sequence number overflow
- anti-replay window
- AH information: authentication algorithm, key, key lifetime, etc.
- ESP information: encryption algorithm, key, key lifetime, etc.
- lifetime of the SA
- IPsec protocol mode (tunnel or transport)
- maximal packet size

IPsec - crypto algorithms

See RFC 4835

- Encryption: block ciphers in Cipher Block Chaining (CBC) mode
  Must have:
    - NULL encryption (RFC 2410)
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- These are symmetric algorithms, need a pre-shared secret key
- Different options for key-agreement protocols: PSK, Internet Key Exchange (IKE, IKE2), Kerberos (KINK), IPSECKEY DNS records

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- Most important problem: **It's complicated!**

IPsec problems

"The first two generations of these documents (principally RFCs 1825–1829, published in 1995, and 2401–2412, published in 1998) are really only intended to provide a guide for implementors and are notoriously complex, difficult to interpret and lacking in overall structure.

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The third and latest incarnation of the core IPsec standards were published as RFCs 4301–4309 in December 2005, and are somewhat more accessible.

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However, the new RFCs are still a long and complex set of documents, totalling over 300 pages."

—Paterson, 2006

Userspace VPN

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- Disadvantages:
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  - Need `iptables` rules to redirect traffic
- Generalize this idea: *user-space VPN*
- Software that authenticates users and tunnels traffic
- Examples: SSH, OpenVPN
- Question: How does the software get the traffic to tunnel (preferably without `iptables`)

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tyrion # ip l set dev tap3 up

arya # echo 1 > /proc/sys/net/ipv4/ip_forward
arya # ip tuntap add dev tap5 mode tap
arya # ip addr add dev tap5 10.0.5.2/24
arya # ip l set dev tap5 up

tyrion # ssh -o Tunnel=ethernet -w 3:5 arya
```

- Now try:

```
tyrion # ping 10.0.5.2
```

- You receive ARP packets through TAP
- The hosts are logically connected on the link layer
- They in the same broadcast domain

SSL/TLS

Secure Sockets Layer (SSL) and Transport Layer Security (TLS):

- TLS is a variant of SSLv3
- SSL originally designed for web environment by Netscape
- Design goals: security of web traffic, email, etc.
- Had to work well with HTTP
- Provides transparency for higher layers

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- Design goals: security of web traffic, email, etc.
- Had to work well with HTTP
- Provides transparency for higher layers

SSL/TLS provides a secure channel between server and client:

- Confidentiality
- Server (and client) authentication
- Message integrity

SSL/TLS

SSL/TLS runs on top of TCP:

- Transparent for application-layer protocols
- SSL/TLS connection acts like a secured TCP connection
- Most protocols running over TCP can be run over SSL/TLS instead
  e.g., HTTP → HTTPS, SMTP → SMTPS, ...

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- SSL/TLS connection acts like a secured TCP connection
- Most protocols running over TCP can be run over SSL/TLS instead
  e.g., HTTP → HTTPS, SMTP → SMTPS, . . .

Protocols in SSL/TLS:

- Handshake Protocol: initiate session,
  Authenticate server/client, establish keys
- Record Protocol: data transfer,
  Compute MAC for integrity, encrypt MAC and data
- Alert Protocol: alert the other side of exceptional conditions,
  e.g., errors and warnings.

SSL/TLS Handshake

- Client → Server: ClientHello
  - ClientRandom: random number,
  - Session ID (when resuming a session),
  - List of available CipherSuites:
    pk key exchange, pk auth, sym encryption, hash alg.

    Example: `TLS_ECDH_ECDSA_WITH_AES_128_CBC_SHA256`

ECDH	Elliptic curve Diffie Hellman key exchange.
ECDSA	Elliptic curve digital signature algorithm.
AES_128_CBC	AES with 128-bit key in CBC mode.
SHA256	SHA with 256-bit output for HMAC.

SSL/TLS Handshake (cont.)

- Server → Client: ServerHello
  - ServerRandom: random number,
  - Session ID: implementation specific, random number,
  - Chosen CipherSuite.
- Server → Client: Certificate
  - Server sends server certificate to client,
    client obtains server's public key and verifies certificate.
- Server → Client: ServerKeyExchange
  for DHE: P^a, random a,
  for ECDHE: $[a]P$, random a,
  for RSA: –
- Server → Client: ServerHelloDone
  - Message marks end of server messages.

SSL/TLS Handshake (cont.)

- Client → Server: ClientKeyExchange
  for DHE: P^b for a random b,
  for ECDHE: $[b]P$ for a random b,
  for RSA: random value encrypted with server's public key.
- Client → Server: ChangeCipherSpec
  - Notify that client switched to new CipherSuite.
- Client → Server: Finished
  - Encrypted Finished message containing hash over the previous handshake messages.

SSL/TLS Handshake (cont.)

- Client → Server: ClientKeyExchange
  for DHE: P^b for a random b,
  for ECDHE: $[b]P$ for a random b,
  for RSA: random value encrypted with server's public key.
- Client → Server: ChangeCipherSpec
  - Notify that client switched to new CipherSuite.
- Client → Server: Finished
  - Encrypted Finished message containing hash over the previous handshake messages.

- For DHE and ECDHE, client and server compute joint session key.

SSL/TLS Handshake (cont.)

- Server → Client: ChangeCipherSpec
  - Notify that client switched to new CipherSuite.
- Server → Client: Finished
  - Encrypted Finished message containing hash over the previous handshake messages.

SSL/TLS Handshake (cont.)

- Server → Client: ChangeCipherSpec
  - Notify that client switched to new CipherSuite.
- Server → Client: Finished
  - Encrypted Finished message containing hash over the previous handshake messages.

Interrupted session can be resumed:

- Server and client are supposed to store session ID and MasterSecret,
- client sends session ID in ClientHello,
- reduced protocol: Hello, ChangeCipherSpec and Finished messages,
- new keying data is exchanged,
- new session keys are derived.

SSL/TLS Record Protocol

Record protocol to exchange encrypted and authenticated data:

- Payload data is split into fragments
  which are protected and transmitted independently;
  when received, fragments are decrypted and verified independently.
- Each fragment is authenticated with a MAC which is appended;
  MAC is over a sequential number (anti-replay) and the content.
- Data fragment and MAC are encrypted.
- A record header is attached to the encrypted data,
  containing information necessary for interpreting the record
  such as type of data (e.g. Handshake or ApplicationData),
  length, and SSL version.
- (header || encrypted fragment and MAC) is sent.

Which SSL/TLS Cipher Suites to use?

TLS_ECDH_ECDSA_WITH_NULL_SHA
TLS_ECDH_RSA_WITH_AES_256_CBC_SHA384
TLS_SRP_SHA_WITH_AES_128_CBC_SHA
TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256
TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA
TLS_ECDHE_RSA_WITH_3DES_EDE_CBC_SHA
TLS_ECDH_ECDSA_WITH_AES_128_GCM_SHA256
TLS_ECDHE_PSK_WITH_AES_128_CBC_SHA
TLS_DHE_RSA_WITH_AES_128_GCM_SHA256
TLS_ECDHE_RSA_WITH_NULL_SHA
TLS_DHE_DSS_WITH_AES_256_GCM_SHA384
TLS_SRP_SHA_WITH_AES_256_CBC_SHA
TLS_ECDH_RSA_WITH_AES_128_CBC_SHA256
TLS_ECDHE_ECDSA_WITH_NULL_SHA
TLS_ECDH_ECDSA_WITH_AES_128_CBC_SHA
TLS_SRP_SHA_RSA_WITH_3DES_EDE_CBC_SHA
TLS_DHE_DSS_WITH_CAMELLIA_256_CBC_SHA
TLS_PSK_WITH_AES_128_CBC_SHA256
TLS_DH_anon_WITH_AES_128_CBC_SHA256
TLS_DH_anon_WITH_CAMELLIA_128_CBC_SHA256
TLS_ECDH_anon_WITH_3DES_EDE_CBC_SHA
TLS_DH_DSS_WITH_AES_128_GCM_SHA256
TLS_DH_anon_WITH_AES_256_CBC_SHA256
TLS_ECDH_RSA_WITH_NULL_SHA
TLS_SRP_SHA_RSA_WITH_AES_256_CBC_SHA
TLS_ECDHE_PSK_WITH_3DES_EDE_CBC_SHA
TLS_ECDHE_PSK_WITH_AES_256_CBC_SHA384
TLS_DHE_DSS_EXPORT1024_WITH_RC4_56_SHA
TLS_RSA_WITH_SEED_CBC_SHA
TLS_ECDH_ECDSA_WITH_AES_256_CBC_SHA384
TLS_DH_anon_WITH_CAMELLIA_128_CBC_SHA
TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA256
TLS_DH_anon_WITH_AES_128_GCM_SHA256
TLS_NTRU_NSS_WITH_AES_256_CBC_SHA
TLS_PSK_WITH_RC4_128_SHA
TLS_DHE_DSS_WITH_SEED_CBC_SHA
TLS_RSA_WITH_HC_128_CBC_SHA
TLS_RSA_PSK_WITH_NULL_SHA
TLS_DH_anon_WITH_CAMELLIA_256_CBC_SHA
TLS_ECDH_ECDSA_WITH_3DES_EDE_CBC_SHA
TLS_DHE_DSS_WITH_AES_256_CBC_SHA256
TLS_DHE_DSS_WITH_AES_128_CBC_SHA256
TLS_PSK_WITH_NULL_SHA256
TLS_NTRU_RSA_WITH_AES_128_CBC_SHA
TLS_DHE_PSK_WITH_AES_128_CBC_SHA256
TLS_DHE_DSS_WITH_CAMELLIA_256_CBC_SHA256
TLS_DH_DSS_WITH_CAMELLIA_128_CBC_SHA
TLS_RSA_EXPORT1024_WITH_RC4_56_MD5
TLS_DH_RSA_WITH_CAMELLIA_128_CBC_SHA256
TLS_DH_DSS_WITH_CAMELLIA_256_CBC_SHA
TLS_DHE_RSA_WITH_CAMELLIA_128_CBC_SHA
TLS_DH_DSS_WITH_AES_128_CBC_SHA25
TLS_PSK_WITH_NULL_SHA384
TLS_ECDHE_PSK_WITH_AES_256_CBC_SHA
TLS_KRB5_EXPORT_WITH_RC4_40_MD5
TLS_RSA_EXPORT1024_WITH_RC2_56_MD5
TLS_ECDH_RSA_WITH_AES_128_GCM_SHA256
TLS_RSA_WITH_CAMELLIA_128_CBC_SHA
TLS_RSA_WITH_AES_256_CBC_SHA
TLS_DHE_DSS_WITH_CAMELLIA_128_CBC_SHA256
TLS_DHE_PSK_WITH_RC4_128_SHA
TLS_DHE_RSA_WITH_AES_128_CBC_SHA
TLS_KRB5_EXPORT_WITH_DES_CBC_40_MD5
TLS_PSK_WITH_AES_256_CBC_SHA
TLS_DHE_PSK_WITH_NULL_SHA384
TLS_DHE_RSA_WITH_AES_256_GCM_SHA384
TLS_RSA_PSK_WITH_RC4_128_SHA
TLS_DHE_DSS_EXPORT_WITH_DES40_CBC_SHA
TLS_RSA_WITH_CAMELLIA_128_CBC_SHA256
TLS_RSA_WITH_NULL_SHA256
TLS_ECDH_RSA_WITH_AES_256_GCM_SHA384
SSL_FORTEZZA_KEA_WITH_RC4_128_SHA
SSL_CK_RC2_128_CBC_EXPORT40_WITH_MD5
TLS_RSA_WITH_AES_128_CBC_SHA
TLS_DH_anon_WITH_DES_CBC_SHA
TLS_DH_DSS_WITH_AES_128_CBC_SHA
TLS_PSK_WITH_AES_128_CBC_SHA
TLS_ECDH_anon_WITH_NULL_SHA
TLS_DHE_DSS_WITH_CAMELLIA_128_CBC_SHA
TLS_DH_anon_WITH_RC4_128_MD5
TLS_PSK_WITH_NULL_SHA
TLS_DH_RSA_WITH_AES_256_CBC_SHA256
TLS_DH_DSS_EXPORT_WITH_DES40_CBC_SHA
TLS_DH_RSA_WITH_AES_256_GCM_SHA384
TLS_DH_DSS_WITH_AES_256_CBC_SHA
TLS_RSA_WITH_RABBIT_CBC_SHA
TLS_KRB5_WITH_3DES_EDE_CBC_SHA
TLS_DHE_RSA_WITH_CAMELLIA_256_CBC_SHA256
TLS_RSA_WITH_RC4_128_MD5
TLS_NTRU_RSA_WITH_RC4_128_SHA
TLS_DHE_PSK_WITH_NULL_SHA
TLS_SRP_SHA_WITH_3DES_EDE_CBC_SHA
TLS_DH_RSA_WITH_CAMELLIA_128_CBC_SHA
TLS_RSA_EXPORT_WITH_RC4_40_MD5
TLS_DH_anon_EXPORT_WITH_DES40_CBC_SHA
TLS_DHE_DSS_EXPORT1024_WITH_DES_CBC_SHA
SSL_CK_DES_64_CBC_WITH_MD5
TLS_RSA_WITH_DES_CBC_SHA
TLS_DHE_DSS_WITH_DES_CBC_SHA
TLS_DHE_RSA_WITH_3DES_EDE_CBC_SHA
TLS_RSA_EXPORT1024_WITH_DES_CBC_SHA
TLS_RSA_WITH_RC4_128_SHA SSL_CK_RC4_128_EXPORT40_WITH_MD5
TLS_ECDHE_ECDSA_WITH_RC4_128_SHA
SSL_CK_DES_192_EDE3_CBC_WITH_MD5
TLS_DH_RSA_WITH_DES_CBC_SHA
TLS_DHE_RSA_WITH_AES_256_CBC_SHA256
SSL_CK_RC2_128_CBC_WITH_MD5
TLS_PSK_WITH_AES_256_CBC_SHA384
TLS_DH_DSS_WITH_3DES_EDE_CBC_SHA
TLS_DHE_RSA_EXPORT_WITH_DES40_CBC_SHA
TLS_RSA_EXPORT_WITH_DES40_CBC_SHA
SSL_FORTEZZA_KEA_WITH_NULL_SHA
TLS_DHE_PSK_WITH_NULL_SHA256
SSL_CK_IDEA_128_CBC_WITH_MD5
SSL_CK_RC4_64_WITH_MD5
TLS_KRB5_WITH_3DES_EDE_CBC_MD5
TLS_DHE_RSA_WITH_AES_128_CBC_SHA256
TLS_KRB5_WITH_RC4_128_MD5
TLS_NULL_WITH_NULL_NULL
TLS_DH_RSA_EXPORT_WITH_DES40_CBC_SHA
TLS_DH_DSS_WITH_DES_CBC_SHA
TLS_RSA_WITH_3DES_EDE_CBC_SHA
TLS_RSA_PSK_WITH_AES_256_CBC_SHA
TLS_KRB5_EXPORT_WITH_DES_CBC_40_SHA
TLS_RSA_EXPORT_WITH_RC2_CBC_40_MD5
TLS_ECDH_ECDSA_WITH_AES_256_CBC_SHA TLS_RSA_WITH_IDEA_CBC_SHA
TLS_KRB5_WITH_IDEA_CBC_MD5
TLS_DH_anon_WITH_3DES_EDE_CBC_SHA
TLS_DH_DSS_WITH_AES_256_GCM_SHA384
TLS_RSA_WITH_NULL_SHA
SSL_FORTEZZA_KEA_WITH_FORTEZZA_CBC_SHA
TLS_KRB5_EXPORT_WITH_RC2_CBC_40_SHA
TLS_RSA_WITH_NULL_MD5
TLS_DHE_DSS_WITH_3DES_EDE_CBC_SHA
TLS_DH_RSA_WITH_AES_128_GCM_SHA256
TLS_DH_RSA_WITH_3DES_EDE_CBC_SHA
TLS_KRB5_WITH_DES_CBC_MD5
SSL_RSA_FIPS_WITH_DES_CBC_SHA
TLS_DH_anon_EXPORT_WITH_RC4_40_MD5
TLS_KRB5_WITH_RC4_128_SHA
TLS_DH_RSA_WITH_AES_256_CBC_SHA
TLS_DHE_PSK_WITH_AES_128_CBC_SHA
TLS_KRB5_EXPORT_WITH_RC4_40_SHA
TLS_KRB5_WITH_IDEA_CBC_SHA
TLS_DHE_RSA_WITH_DES_CBC_SHA
TLS_DH_anon_WITH_CAMELLIA_256_CBC_SHA256
TLS_DHE_DSS_WITH_AES_128_GCM_SHA256
TLS_RSA_WITH_AES_256_CBC_SHA256
TLS_DH_RSA_WITH_AES_128_CBC_SHA
TLS_DH_anon_WITH_AES_128_CBC_SHA
TLS_KRB5_WITH_DES_CBC_SHA
TLS_RSA_PSK_WITH_3DES_EDE_CBC_SHA
SSL_CK_RC4_128_WITH_MD5
TLS_RSA_PSK_WITH_AES_128_GCM_SHA256
TLS_PSK_WITH_3DES_EDE_CBC_SHA
TLS_KRB5_EXPORT_WITH_RC2_CBC_40_MD5
TLS_DH_anon_WITH_AES_256_CBC_SHA
TLS_DHE_DSS_WITH_RC4_128_SHA
SSL_RSA_FIPS_WITH_3DES_EDE_CBC_SHA
TLS_RSA_WITH_AES_128_CBC_SHA256
TLS_ECDHE_RSA_WITH_RC4_128_SHA
TLS_RSA_WITH_CAMELLIA_256_CBC_SHA
TLS_RSA_PSK_WITH_AES_256_GCM_SHA384
TLS_DHE_DSS_WITH_AES_128_CBC_SHA
TLS_RSA_PSK_WITH_AES_128_CBC_SHA256
TLS_RSA_WITH_HC_128_CBC_MD5
TLS_DH_DSS_WITH_AES_256_CBC_SHA256
TLS_SRP_SHA_RSA_WITH_AES_128_CBC_SHA
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TLS_NTRU_RSA_WITH_3DES_EDE_CBC_SHA
TLS_DHE_RSA_WITH_SEED_CBC_SHA
TLS_NTRU_NSS_WITH_3DES_EDE_CBC_SHA
TLS_DHE_PSK_WITH_AES_128_GCM_SHA256
TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA256
TLS_SRP_SHA_DSS_WITH_3DES_EDE_CBC_SHA
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TLS_DHE_RSA_WITH_CAMELLIA_128_CBC_SHA256
TLS_SRP_SHA_DSS_WITH_AES_256_CBC_SHA
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TLS_PSK_WITH_AES_256_GCM_SHA384
TLS_RSA_WITH_CAMELLIA_256_CBC_SHA256
TLS_ECDH_ECDSA_WITH_AES_256_GCM_SHA384
TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA
TLS_SRP_SHA_DSS_WITH_AES_128_CBC_SHA
TLS_ECDH_RSA_WITH_3DES_EDE_CBC_SHA
TLS_ECDH_anon_WITH_AES_128_CBC_SHA
TLS_ECDH_anon_WITH_AES_256_CBC_SHA
TLS_DHE_PSK_WITH_AES_256_CBC_SHA384
TLS_ECDHE_PSK_WITH_NULL_SHA256
TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256

Which SSL/TLS Cipher Suites to use?

NULL and EXPORT

- NULL obviously provides no protection
- EXPORT ciphers are very low-security
- US export laws used to forbid strong crypto
- Strong crypto was considered a weapon
- EXPORT ciphers are a leftover from that time

Which SSL/TLS Cipher Suites to use?

TLS_ECDH_ECDSA_WITH_NULL_SHA

TLS_ECDH_RSA_WITH_AES_256_CBC_SHA384

TLS_SRP_SHA_WITH_AES_128_CBC_SHA

TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256

TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA

TLS_ECDHE_RSA_WITH_3DES_EDE_CBC_SHA

TLS_ECDHE_PSK_WITH_AES_128_CBC_SHA

TLS_ECDH_ECDSA_WITH_AES_128_GCM_SHA256

TLS_DHE_RSA_WITH_AES_128_GCM_SHA256

TLS_ECDHE_RSA_WITH_NULL_SHA

TLS_DHE_DSS_WITH_AES_256_GCM_SHA384

TLS_SRP_SHA_WITH_AES_256_CBC_SHA

TLS_ECDH_RSA_WITH_AES_128_CBC_SHA256

TLS_ECDHE_ECDSA_WITH_NULL_SHA

TLS_ECDH_ECDSA_WITH_AES_128_CBC_SHA

TLS_SRP_SHA_RSA_WITH_3DES_EDE_CBC_SHA

TLS_DHE_DSS_WITH_CAMELLIA_256_CBC_SHA

TLS_PSK_WITH_AES_128_CBC_SHA256

TLS_DH_anon_WITH_AES_128_CBC_SHA256

TLS_ECDH_anon_WITH_3DES_EDE_CBC_SHA

TLS_DH_anon_WITH_CAMELLIA_128_CBC_SHA256

TLS_DH_DSS_WITH_AES_128_GCM_SHA256

TLS_DH_anon_WITH_AES_256_CBC_SHA256

TLS_ECDH_RSA_WITH_NULL_SHA

TLS_SRP_SHA_RSA_WITH_AES_256_CBC_SHA

TLS_ECDHE_PSK_WITH_3DES_EDE_CBC_SHA

TLS_ECDHE_PSK_WITH_AES_256_CBC_SHA384

TLS_DHE_DSS_EXPORT1024_WITH_RC4_56_SHA

TLS_RSA_WITH_SEED_CBC_SHA

TLS_ECDH_ECDSA_WITH_AES_256_CBC_SHA384

TLS_DH_anon_WITH_CAMELLIA_128_CBC_SHA

TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA256

TLS_DH_anon_WITH_AES_128_GCM_SHA256

TLS_NTRU_NSS_WITH_AES_256_CBC_SHA

TLS_PSK_WITH_RC4_128_SHA

TLS_DHE_DSS_WITH_SEED_CBC_SHA

TLS_RSA_WITH_HC_128_CBC_SHA

TLS_RSA_PSK_WITH_NULL_SHA

TLS_DH_anon_WITH_CAMELLIA_256_CBC_SHA

TLS_ECDH_ECDSA_WITH_3DES_EDE_CBC_SHA

TLS_DHE_DSS_WITH_AES_256_CBC_SHA256

TLS_DHE_DSS_WITH_AES_128_CBC_SHA256

TLS_PSK_WITH_NULL_SHA256

TLS_NTRU_RSA_WITH_AES_128_CBC_SHA

TLS_DHE_PSK_WITH_AES_128_CBC_SHA256

TLS_DHE_DSS_WITH_CAMELLIA_256_CBC_SHA256

TLS_DH_DSS_WITH_CAMELLIA_128_CBC_SHA

TLS_RSA_EXPORT1024_WITH_RC4_56_MD5

TLS_DH_RSA_WITH_CAMELLIA_128_CBC_SHA256

TLS_DH_DSS_WITH_CAMELLIA_256_CBC_SHA

TLS_DHE_RSA_WITH_CAMELLIA_128_CBC_SHA

TLS_DH_DSS_WITH_AES_128_CBC_SHA25

TLS_PSK_WITH_NULL_SHA384

TLS_ECDHE_PSK_WITH_AES_256_CBC_SHA

TLS_RSA_EXPORT1024_WITH_RC2_56_MD5

TLS_KRB5_EXPORT_WITH_RC4_40_MD5

TLS_ECDH_RSA_WITH_AES_128_GCM_SHA256

TLS_RSA_WITH_CAMELLIA_128_CBC_SHA

TLS_RSA_WITH_AES_256_CBC_SHA

TLS_DHE_DSS_WITH_CAMELLIA_128_CBC_SHA256

TLS_DHE_PSK_WITH_RC4_128_SHA

TLS_DHE_RSA_WITH_AES_128_CBC_SHA

TLS_KRB5_EXPORT_WITH_DES_CBC_40_MD5

TLS_PSK_WITH_AES_256_CBC_SHA

TLS_DHE_RSA_WITH_AES_256_GCM_SHA384

TLS_DHE_PSK_WITH_NULL_SHA384

TLS_RSA_PSK_WITH_RC4_128_SHA

TLS_RSA_WITH_CAMELLIA_128_CBC_SHA256

TLS_DHE_DSS_EXPORT_WITH_DES40_CBC_SHA

TLS_RSA_WITH_NULL_SHA256

TLS_ECDH_RSA_WITH_AES_256_GCM_SHA384

SSL_FORTEZZA_KEA_WITH_RC4_128_SHA

SSL_CK_RC2_128_CBC_EXPORT40_WITH_MD5

TLS_RSA_WITH_AES_128_CBC_SHA

TLS_DH_anon_WITH_DES_CBC_SHA

TLS_DH_DSS_WITH_AES_128_CBC_SHA

TLS_PSK_WITH_AES_128_CBC_SHA

TLS_ECDH_anon_WITH_NULL_SHA

TLS_DHE_DSS_WITH_CAMELLIA_128_CBC_SHA

TLS_DH_anon_WITH_RC4_128_MD5

TLS_PSK_WITH_NULL_SHA

TLS_DH_RSA_WITH_AES_256_CBC_SHA256

TLS_DH_RSA_WITH_AES_256_GCM_SHA384

TLS_DH_DSS_EXPORT_WITH_DES40_CBC_SHA

TLS_DH_DSS_WITH_AES_256_CBC_SHA

TLS_RSA_WITH_RABBIT_CBC_SHA

TLS_KRB5_WITH_3DES_EDE_CBC_SHA

TLS_DHE_RSA_WITH_CAMELLIA_256_CBC_SHA256

TLS_RSA_WITH_RC4_128_MD5

TLS_NTRU_RSA_WITH_RC4_128_SHA

TLS_DHE_PSK_WITH_NULL_SHA

TLS_SRP_SHA_WITH_3DES_EDE_CBC_SHA

TLS_RSA_EXPORT_WITH_RC4_40_MD5

TLS_DH_RSA_WITH_CAMELLIA_128_CBC_SHA

TLS_DH_anon_EXPORT_WITH_DES40_CBC_SHA

TLS_DHE_DSS_EXPORT1024_WITH_DES_CBC_SHA

SSL_CK_DES_64_CBC_WITH_MD5

TLS_RSA_WITH_DES_CBC_SHA

TLS_DHE_DSS_WITH_DES_CBC_SHA

TLS_DHE_RSA_WITH_3DES_EDE_CBC_SHA

TLS_RSA_EXPORT1024_WITH_DES_CBC_SHA

TLS_RSA_WITH_RC4_128_SHA

SSL_CK_RC4_128_EXPORT40_WITH_MD5

TLS_ECDHE_ECDSA_WITH_RC4_128_SHA

SSL_CK_DES_192_EDE3_CBC_WITH_MD5

TLS_DH_RSA_WITH_DES_CBC_SHA

TLS_DHE_RSA_WITH_AES_256_CBC_SHA256

SSL_CK_RC2_128_CBC_WITH_MD5

TLS_PSK_WITH_AES_256_CBC_SHA384

TLS_DH_DSS_WITH_3DES_EDE_CBC_SHA

TLS_DHE_RSA_EXPORT_WITH_DES40_CBC_SHA

TLS_RSA_EXPORT_WITH_DES40_CBC_SHA

SSL_FORTEZZA_KEA_WITH_NULL_SHA

TLS_DHE_PSK_WITH_NULL_SHA256

SSL_CK_IDEA_128_CBC_WITH_MD5

SSL_CK_RC4_64_WITH_MD5

TLS_KRB5_WITH_3DES_EDE_CBC_MD5

TLS_DHE_RSA_WITH_AES_128_CBC_SHA256

TLS_KRB5_WITH_RC4_128_MD5

TLS_NULL_WITH_NULL_NULL

TLS_DH_RSA_EXPORT_WITH_DES40_CBC_SHA

TLS_DH_DSS_WITH_DES_CBC_SHA

TLS_RSA_WITH_3DES_EDE_CBC_SHA

TLS_RSA_PSK_WITH_AES_256_CBC_SHA

TLS_KRB5_EXPORT_WITH_DES_CBC_40_SHA

TLS_RSA_EXPORT_WITH_RC2_CBC_40_MD5

TLS_ECDH_ECDSA_WITH_AES_256_CBC_SHA

TLS_RSA_WITH_IDEA_CBC_SHA

TLS_KRB5_WITH_IDEA_CBC_MD5

TLS_DH_anon_WITH_3DES_EDE_CBC_SHA

TLS_DH_DSS_WITH_AES_256_GCM_SHA384

TLS_RSA_WITH_NULL_SHA

SSL_FORTEZZA_KEA_WITH_FORTEZZA_CBC_SHA

TLS_KRB5_EXPORT_WITH_RC2_CBC_40_SHA

TLS_RSA_WITH_NULL_MD5

TLS_DHE_DSS_WITH_3DES_EDE_CBC_SHA

TLS_DH_RSA_WITH_AES_128_GCM_SHA256

TLS_DH_RSA_WITH_3DES_EDE_CBC_SHA

SSL_RSA_FIPS_WITH_DES_CBC_SHA

TLS_KRB5_WITH_DES_CBC_MD5

TLS_DH_anon_EXPORT_WITH_RC4_40_MD5

TLS_KRB5_WITH_RC4_128_SHA

TLS_DH_RSA_WITH_AES_256_CBC_SHA

TLS_DHE_PSK_WITH_AES_128_CBC_SHA

TLS_KRB5_EXPORT_WITH_RC4_40_SHA

TLS_KRB5_WITH_IDEA_CBC_SHA

TLS_DHE_DSS_WITH_AES_128_GCM_SHA256

TLS_DHE_RSA_WITH_DES_CBC_SHA

TLS_DH_anon_WITH_CAMELLIA_256_CBC_SHA256

TLS_RSA_WITH_AES_256_CBC_SHA256

TLS_DH_RSA_WITH_AES_128_CBC_SHA

TLS_DH_anon_WITH_AES_128_CBC_SHA

TLS_KRB5_WITH_DES_CBC_SHA

TLS_RSA_PSK_WITH_3DES_EDE_CBC_SHA

SSL_CK_RC4_128_WITH_MD5

TLS_RSA_PSK_WITH_AES_128_GCM_SHA256

TLS_PSK_WITH_3DES_EDE_CBC_SHA

TLS_KRB5_EXPORT_WITH_RC2_CBC_40_MD5

TLS_DH_anon_WITH_AES_256_CBC_SHA

TLS_DHE_DSS_WITH_RC4_128_SHA

SSL_RSA_FIPS_WITH_3DES_EDE_CBC_SHA

TLS_RSA_WITH_AES_128_CBC_SHA256

TLS_ECDHE_RSA_WITH_RC4_128_SHA

TLS_RSA_WITH_CAMELLIA_256_CBC_SHA

TLS_RSA_PSK_WITH_AES_256_GCM_SHA384

TLS_RSA_PSK_WITH_AES_128_CBC_SHA256

TLS_DHE_DSS_WITH_AES_128_CBC_SHA

TLS_RSA_WITH_HC_128_CBC_MD5

TLS_DH_DSS_WITH_AES_256_CBC_SHA256

TLS_SRP_SHA_RSA_WITH_AES_128_CBC_SHA

TLS_NTRU_NSS_WITH_AES_128_CBC_SHA

TLS_NTRU_NSS_WITH_RC4_128_SHA

TLS_PSK_WITH_AES_128_GCM_SHA256

TLS_DHE_RSA_WITH_CAMELLIA_256_CBC_SHA

TLS_DHE_DSS_WITH_AES_256_CBC_SHA

TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384

TLS_NTRU_RSA_WITH_3DES_EDE_CBC_SHA

TLS_DHE_RSA_WITH_SEED_CBC_SHA

TLS_NTRU_NSS_WITH_3DES_EDE_CBC_SHA

TLS_DHE_PSK_WITH_AES_128_GCM_SHA256

TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA256

TLS_SRP_SHA_DSS_WITH_3DES_EDE_CBC_SHA

TLS_DH_RSA_WITH_AES_128_CBC_SHA256

TLS_DH_RSA_WITH_CAMELLIA_256_CBC_SHA

TLS_ECDH_ECDSA_WITH_RC4_128_SHA

TLS_RSA_PSK_WITH_NULL_SHA256

TLS_RSA_PSK_WITH_AES_128_CBC_SHA

TLS_DH_DSS_WITH_SEED_CBC_SHA

TLS_ECDHE_PSK_WITH_AES_128_CBC_SHA256

TLS_RSA_PSK_WITH_AES_256_CBC_SHA384

TLS_DHE_RSA_WITH_AES_256_CBC_SHA

TLS_DHE_PSK_WITH_3DES_EDE_CBC_SHA

TLS_RSA_WITH_AES_256_GCM_SHA384

TLS_ECDH_anon_WITH_RC4_128_SHA

TLS_ECDH_RSA_WITH_RC4_128_SHA

TLS_DHE_RSA_WITH_CAMELLIA_128_CBC_SHA256

TLS_SRP_SHA_DSS_WITH_AES_256_CBC_SHA

TLS_DHE_PSK_WITH_AES_256_CBC_SHA

TLS_RSA_WITH_AES_128_GCM_SHA256

TLS_ECDH_ECDSA_WITH_AES_128_CBC_SHA256

TLS_RSA_PSK_WITH_NULL_SHA384

TLS_DH_DSS_WITH_CAMELLIA_256_CBC_SHA256

TLS_ECDHE_ECDSA_WITH_3DES_EDE_CBC_SHA

TLS_ECDHE_PSK_WITH_RC4_128_SHA

TLS_RSA_EXPORT1024_WITH_RC4_56_SHA

TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA384

TLS_NTRU_RSA_WITH_AES_256_CBC_SHA

TLS_DH_DSS_WITH_CAMELLIA_128_CBC_SHA256

TLS_DH_anon_WITH_AES_256_GCM_SHA384

TLS_DHE_PSK_WITH_AES_256_GCM_SHA384

TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA384

TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384

TLS_DH_RSA_WITH_SEED_CBC_SHA

TLS_DH_RSA_WITH_CAMELLIA_256_CBC_SHA256

TLS_ECDH_RSA_WITH_AES_128_CBC_SHA

TLS_ECDHE_PSK_WITH_NULL_SHA384

TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA

TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA

TLS_DH_ANON_WITH_SEED_CBC_SHA

TLS_ECDHE_PSK_WITH_NULL_SHA

TLS_ECDH_RSA_WITH_AES_256_CBC_SHA

TLS_PSK_WITH_AES_256_GCM_SHA384

TLS_RSA_WITH_CAMELLIA_256_CBC_SHA256

TLS_ECDH_ECDSA_WITH_AES_256_GCM_SHA384

TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA

TLS_SRP_SHA_DSS_WITH_AES_128_CBC_SHA

TLS_ECDH_RSA_WITH_3DES_EDE_CBC_SHA

TLS_ECDH_anon_WITH_AES_128_CBC_SHA

TLS_ECDH_anon_WITH_AES_256_CBC_SHA

TLS_DHE_PSK_WITH_AES_256_CBC_SHA384

TLS_ECDHE_PSK_WITH_NULL_SHA256

TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256

Which SSL/TLS Cipher Suites to use?

TLS_ECDH_RSA_WITH_AES_256_CBC_SHA384
TLS_SRP_SHA_WITH_AES_128_CBC_SHA
TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256
TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA
TLS_ECDHE_RSA_WITH_3DES_EDE_CBC_SHA
TLS_ECDHE_PSK_WITH_AES_128_CBC_SHA
TLS_ECDH_ECDSA_WITH_AES_128_GCM_SHA256
TLS_DHE_RSA_WITH_AES_128_GCM_SHA256
TLS_DHE_DSS_WITH_AES_256_GCM_SHA384
TLS_SRP_SHA_WITH_AES_256_CBC_SHA
TLS_ECDH_RSA_WITH_AES_128_CBC_SHA256
TLS_ECDH_ECDSA_WITH_AES_128_CBC_SHA
TLS_DHE_DSS_WITH_CAMELLIA_256_CBC_SHA
TLS_SRP_SHA_RSA_WITH_3DES_EDE_CBC_SHA
TLS_PSK_WITH_AES_128_CBC_SHA256
TLS_DH_anon_WITH_AES_128_CBC_SHA256
TLS_DH_anon_WITH_CAMELLIA_128_CBC_SHA256
TLS_ECDH_anon_WITH_3DES_EDE_CBC_SHA
TLS_DH_DSS_WITH_AES_128_GCM_SHA256
TLS_DH_anon_WITH_AES_256_CBC_SHA256
TLS_SRP_SHA_RSA_WITH_AES_256_CBC_SHA
TLS_ECDHE_PSK_WITH_3DES_EDE_CBC_SHA
TLS_ECDHE_PSK_WITH_AES_256_CBC_SHA384
TLS_RSA_WITH_SEED_CBC_SHA
TLS_ECDH_ECDSA_WITH_AES_256_CBC_SHA384
TLS_DH_anon_WITH_CAMELLIA_128_CBC_SHA
TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA256
TLS_DH_anon_WITH_AES_128_GCM_SHA256
TLS_NTRU_NSS_WITH_AES_256_CBC_SHA
TLS_PSK_WITH_RC4_128_SHA
TLS_DHE_DSS_WITH_SEED_CBC_SHA
TLS_RSA_WITH_HC_128_CBC_SHA
TLS_DH_anon_WITH_CAMELLIA_256_CBC_SHA
TLS_ECDH_ECDSA_WITH_3DES_EDE_CBC_SHA
TLS_DHE_DSS_WITH_AES_256_CBC_SHA256
TLS_DHE_DSS_WITH_AES_128_CBC_SHA256
TLS_NTRU_RSA_WITH_AES_128_CBC_SHA
TLS_DHE_PSK_WITH_AES_128_CBC_SHA256
TLS_DHE_DSS_WITH_CAMELLIA_256_CBC_SHA256
TLS_DH_DSS_WITH_CAMELLIA_128_CBC_SHA
TLS_DH_RSA_WITH_CAMELLIA_128_CBC_SHA256
TLS_DH_DSS_WITH_CAMELLIA_256_CBC_SHA
TLS_DHE_RSA_WITH_CAMELLIA_128_CBC_SHA
TLS_DH_DSS_WITH_AES_128_CBC_SHA25
TLS_ECDHE_PSK_WITH_AES_256_CBC_SHA
TLS_ECDH_RSA_WITH_AES_128_GCM_SHA256
TLS_RSA_WITH_CAMELLIA_128_CBC_SHA
TLS_RSA_WITH_AES_256_CBC_SHA
TLS_DHE_DSS_WITH_CAMELLIA_128_CBC_SHA256
TLS_DHE_PSK_WITH_RC4_128_SHA
TLS_DHE_RSA_WITH_AES_128_CBC_SHA
TLS_PSK_WITH_AES_256_CBC_SHA
TLS_DHE_RSA_WITH_AES_256_GCM_SHA384
TLS_RSA_PSK_WITH_RC4_128_SHA
TLS_RSA_WITH_CAMELLIA_128_CBC_SHA256
TLS_ECDH_RSA_WITH_AES_256_GCM_SHA384
SSL_FORTEZZA_KEA_WITH_RC4_128_SHA
TLS_RSA_WITH_AES_128_CBC_SHA
TLS_DH_anon_WITH_DES_CBC_SHA
TLS_DH_DSS_WITH_AES_128_CBC_SHA
TLS_PSK_WITH_AES_128_CBC_SHA
TLS_DHE_DSS_WITH_CAMELLIA_128_CBC_SHA
TLS_DH_anon_WITH_RC4_128_MD5
TLS_DH_RSA_WITH_AES_256_CBC_SHA256
TLS_DH_RSA_WITH_AES_256_GCM_SHA384
TLS_DH_DSS_WITH_AES_256_CBC_SHA
TLS_RSA_WITH_RABBIT_CBC_SHA
TLS_KRB5_WITH_3DES_EDE_CBC_SHA
TLS_DHE_RSA_WITH_CAMELLIA_256_CBC_SHA256
TLS_RSA_WITH_RC4_128_MD5
TLS_NTRU_RSA_WITH_RC4_128_SHA
TLS_SRP_SHA_WITH_3DES_EDE_CBC_SHA
TLS_DH_RSA_WITH_CAMELLIA_128_CBC_SHA
SSL_CK_DES_64_CBC_WITH_MD5
TLS_RSA_WITH_DES_CBC_SHA
TLS_DHE_DSS_WITH_DES_CBC_SHA
TLS_DHE_RSA_WITH_3DES_EDE_CBC_SHA
TLS_RSA_WITH_RC4_128_SHA
TLS_ECDHE_ECDSA_WITH_RC4_128_SHA
SSL_CK_DES_192_EDE3_CBC_WITH_MD5
TLS_DH_RSA_WITH_DES_CBC_SHA
TLS_DHE_RSA_WITH_AES_256_CBC_SHA256
SSL_CK_RC2_128_CBC_WITH_MD5
TLS_PSK_WITH_AES_256_CBC_SHA384
TLS_DH_DSS_WITH_3DES_EDE_CBC_SHA
SSL_CK_IDEA_128_CBC_WITH_MD5
SSL_CK_RC4_64_WITH_MD5
TLS_KRB5_WITH_3DES_EDE_CBC_MD5
TLS_DHE_RSA_WITH_AES_128_CBC_SHA256
TLS_KRB5_WITH_RC4_128_MD5
TLS_DH_DSS_WITH_DES_CBC_SHA
TLS_RSA_WITH_3DES_EDE_CBC_SHA
TLS_RSA_PSK_WITH_AES_256_CBC_SHA
TLS_ECDH_ECDSA_WITH_AES_256_CBC_SHA
TLS_RSA_WITH_IDEA_CBC_SHA
TLS_KRB5_WITH_IDEA_CBC_MD5
TLS_DH_anon_WITH_3DES_EDE_CBC_SHA
TLS_DH_DSS_WITH_AES_256_GCM_SHA384
SSL_FORTEZZA_KEA_WITH_FORTEZZA_CBC_SHA
TLS_DHE_DSS_WITH_3DES_EDE_CBC_SHA
TLS_DH_RSA_WITH_AES_128_GCM_SHA256
TLS_DH_RSA_WITH_3DES_EDE_CBC_SHA
SSL_RSA_FIPS_WITH_DES_CBC_SHA
TLS_KRB5_WITH_DES_CBC_MD5
TLS_KRB5_WITH_RC4_128_SHA
TLS_DH_RSA_WITH_AES_256_CBC_SHA
TLS_DHE_PSK_WITH_AES_128_CBC_SHA
TLS_KRB5_WITH_IDEA_CBC_SHA
TLS_DHE_RSA_WITH_DES_CBC_SHA
TLS_DH_anon_WITH_CAMELLIA_256_CBC_SHA256
TLS_DHE_DSS_WITH_AES_128_GCM_SHA256
TLS_RSA_WITH_AES_256_CBC_SHA256
TLS_DH_RSA_WITH_AES_128_CBC_SHA
TLS_DH_anon_WITH_AES_128_CBC_SHA
TLS_KRB5_WITH_DES_CBC_SHA
TLS_RSA_PSK_WITH_3DES_EDE_CBC_SHA
SSL_CK_RC4_128_WITH_MD5
TLS_RSA_PSK_WITH_AES_128_GCM_SHA256
TLS_PSK_WITH_3DES_EDE_CBC_SHA
TLS_DH_anon_WITH_AES_256_CBC_SHA
TLS_DHE_DSS_WITH_RC4_128_SHA
SSL_RSA_FIPS_WITH_3DES_EDE_CBC_SHA
TLS_RSA_WITH_AES_128_CBC_SHA256
TLS_RSA_WITH_CAMELLIA_256_CBC_SHA
TLS_ECDHE_RSA_WITH_RC4_128_SHA
TLS_RSA_PSK_WITH_AES_256_GCM_SHA384
TLS_RSA_PSK_WITH_AES_128_CBC_SHA256
TLS_DHE_DSS_WITH_AES_128_CBC_SHA
TLS_RSA_WITH_HC_128_CBC_MD5
TLS_DH_DSS_WITH_AES_256_CBC_SHA256
TLS_SRP_SHA_RSA_WITH_AES_128_CBC_SHA
TLS_NTRU_NSS_WITH_AES_128_CBC_SHA
TLS_NTRU_NSS_WITH_RC4_128_SHA
TLS_PSK_WITH_AES_128_GCM_SHA256
TLS_DHE_RSA_WITH_CAMELLIA_256_CBC_SHA
TLS_DHE_DSS_WITH_AES_256_CBC_SHA
TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384
TLS_NTRU_RSA_WITH_3DES_EDE_CBC_SHA
TLS_DHE_RSA_WITH_SEED_CBC_SHA
TLS_NTRU_NSS_WITH_3DES_EDE_CBC_SHA
TLS_DHE_PSK_WITH_AES_128_GCM_SHA256
TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA256
TLS_SRP_SHA_DSS_WITH_3DES_EDE_CBC_SHA
TLS_DH_RSA_WITH_AES_128_CBC_SHA256
TLS_DH_RSA_WITH_CAMELLIA_256_CBC_SHA
TLS_ECDH_ECDSA_WITH_RC4_128_SHA
TLS_RSA_PSK_WITH_AES_128_CBC_SHA
TLS_DH_DSS_WITH_SEED_CBC_SHA
TLS_ECDHE_PSK_WITH_AES_128_CBC_SHA256
TLS_RSA_PSK_WITH_AES_256_CBC_SHA384
TLS_DHE_RSA_WITH_AES_256_CBC_SHA
TLS_DHE_PSK_WITH_3DES_EDE_CBC_SHA
TLS_RSA_WITH_AES_256_GCM_SHA384
TLS_ECDH_anon_WITH_RC4_128_SHA
TLS_ECDH_RSA_WITH_RC4_128_SHA
TLS_DHE_RSA_WITH_CAMELLIA_128_CBC_SHA256
TLS_SRP_SHA_DSS_WITH_AES_256_CBC_SHA
TLS_DHE_PSK_WITH_AES_256_CBC_SHA
TLS_RSA_WITH_AES_128_GCM_SHA256
TLS_ECDH_ECDSA_WITH_AES_128_CBC_SHA256
TLS_DH_DSS_WITH_CAMELLIA_256_CBC_SHA256
TLS_ECDHE_ECDSA_WITH_3DES_EDE_CBC_SHA
TLS_ECDHE_PSK_WITH_RC4_128_SHA
TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA384
TLS_NTRU_RSA_WITH_AES_256_CBC_SHA
TLS_DH_DSS_WITH_CAMELLIA_128_CBC_SHA256
TLS_DH_anon_WITH_AES_256_GCM_SHA384
TLS_DHE_PSK_WITH_AES_256_GCM_SHA384
TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA384
TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384
TLS_DH_RSA_WITH_SEED_CBC_SHA
TLS_DH_RSA_WITH_CAMELLIA_256_CBC_SHA256
TLS_ECDH_RSA_WITH_AES_128_CBC_SHA
TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA
TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA
TLS_DH_ANON_WITH_SEED_CBC_SHA
TLS_ECDH_RSA_WITH_AES_256_CBC_SHA
TLS_PSK_WITH_AES_256_GCM_SHA384
TLS_RSA_WITH_CAMELLIA_256_CBC_SHA256
TLS_ECDH_ECDSA_WITH_AES_256_GCM_SHA384
TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA
TLS_SRP_SHA_DSS_WITH_AES_128_CBC_SHA
TLS_ECDH_RSA_WITH_3DES_EDE_CBC_SHA
TLS_ECDH_anon_WITH_AES_128_CBC_SHA
TLS_ECDH_anon_WITH_AES_256_CBC_SHA
TLS_DHE_PSK_WITH_AES_256_CBC_SHA384
TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256

Which SSL/TLS Cipher Suites to use?

DES

- Data Encryption Standard from 1976
- Extremely low-security 56-bit key
- Some sort of fix: 3DES (112-bit or 168-bit key)
- Main problem with 3DES: it's slow

Which SSL/TLS Cipher Suites to use?

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MD5

- Hash algorithm by Rivest from 1992
- Collision-resistance totally broken
- Also more advanced attacks (chosen-prefix collision attack)
- Weaknesses used to create a rogue CA certificate in 2008
- Weaknesses used against Windows update in Flame malware

Which SSL/TLS Cipher Suites to use?

TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256
TLS_SRP_SHA_WITH_AES_128_CBC_SHA
TLS_ECDH_RSA_WITH_AES_256_CBC_SHA384
TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA
TLS_ECDHE_RSA_WITH_3DES_EDE_CBC_SHA
TLS_ECDH_ECDSA_WITH_AES_128_GCM_SHA256
TLS_ECDHE_PSK_WITH_AES_128_CBC_SHA
TLS_DHE_RSA_WITH_AES_128_GCM_SHA256
TLS_DHE_DSS_WITH_AES_256_GCM_SHA384
TLS_SRP_SHA_WITH_AES_256_CBC_SHA
TLS_ECDH_RSA_WITH_AES_128_CBC_SHA256
TLS_ECDH_ECDSA_WITH_AES_128_CBC_SHA
TLS_DHE_DSS_WITH_CAMELLIA_256_CBC_SHA
TLS_SRP_SHA_RSA_WITH_3DES_EDE_CBC_SHA
TLS_PSK_WITH_AES_128_CBC_SHA256
TLS_DH_anon_WITH_AES_128_CBC_SHA256
TLS_DH_anon_WITH_CAMELLIA_128_CBC_SHA256
TLS_ECDH_anon_WITH_3DES_EDE_CBC_SHA
TLS_DH_DSS_WITH_AES_128_GCM_SHA256
TLS_DH_anon_WITH_AES_256_CBC_SHA256
TLS_ECDHE_PSK_WITH_AES_256_CBC_SHA384
TLS_ECDHE_PSK_WITH_3DES_EDE_CBC_SHA
TLS_SRP_SHA_RSA_WITH_AES_256_CBC_SHA
TLS_RSA_WITH_SEED_CBC_SHA
TLS_ECDH_ECDSA_WITH_AES_256_CBC_SHA384
TLS_DH_anon_WITH_CAMELLIA_128_CBC_SHA
TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA256
TLS_DH_anon_WITH_AES_128_GCM_SHA256
TLS_NTRU_NSS_WITH_AES_256_CBC_SHA
TLS_PSK_WITH_RC4_128_SHA
TLS_DHE_DSS_WITH_SEED_CBC_SHA
TLS_RSA_WITH_HC_128_CBC_SHA
TLS_DH_anon_WITH_CAMELLIA_256_CBC_SHA
TLS_ECDH_ECDSA_WITH_3DES_EDE_CBC_SHA
TLS_DHE_DSS_WITH_AES_256_CBC_SHA256
TLS_DHE_DSS_WITH_AES_128_CBC_SHA256
TLS_NTRU_RSA_WITH_AES_128_CBC_SHA
TLS_DHE_PSK_WITH_AES_128_CBC_SHA256
TLS_DHE_DSS_WITH_CAMELLIA_256_CBC_SHA256
TLS_DH_DSS_WITH_CAMELLIA_128_CBC_SHA
TLS_DH_RSA_WITH_CAMELLIA_128_CBC_SHA256
TLS_DH_DSS_WITH_CAMELLIA_256_CBC_SHA
TLS_DHE_RSA_WITH_CAMELLIA_128_CBC_SHA
TLS_DH_DSS_WITH_AES_128_CBC_SHA25
TLS_ECDHE_PSK_WITH_AES_256_CBC_SHA
TLS_ECDH_RSA_WITH_AES_128_GCM_SHA256
TLS_RSA_WITH_CAMELLIA_128_CBC_SHA
TLS_DHE_DSS_WITH_CAMELLIA_128_CBC_SHA256
TLS_RSA_WITH_AES_256_CBC_SHA
TLS_DHE_RSA_WITH_AES_128_CBC_SHA
TLS_DHE_PSK_WITH_RC4_128_SHA
TLS_PSK_WITH_AES_256_CBC_SHA
TLS_DHE_RSA_WITH_AES_256_GCM_SHA384
TLS_RSA_WITH_CAMELLIA_128_CBC_SHA256
TLS_RSA_PSK_WITH_RC4_128_SHA
TLS_ECDH_RSA_WITH_AES_256_GCM_SHA384
SSL_FORTEZZA_KEA_WITH_RC4_128_SHA
TLS_RSA_WITH_AES_128_CBC_SHA
TLS_DH_anon_WITH_DES_CBC_SHA
TLS_DH_DSS_WITH_AES_128_CBC_SHA
TLS_PSK_WITH_AES_128_CBC_SHA
TLS_DHE_DSS_WITH_CAMELLIA_128_CBC_SHA
TLS_DH_anon_WITH_RC4_128_MD5
TLS_DH_RSA_WITH_AES_256_CBC_SHA256
TLS_DH_RSA_WITH_AES_256_GCM_SHA384
TLS_DH_DSS_WITH_AES_256_CBC_SHA
TLS_RSA_WITH_RABBIT_CBC_SHA
TLS_DHE_RSA_WITH_CAMELLIA_256_CBC_SHA256
TLS_KRB5_WITH_3DES_EDE_CBC_SHA
TLS_RSA_WITH_RC4_128_MD5
TLS_NTRU_RSA_WITH_RC4_128_SHA
TLS_SRP_SHA_WITH_3DES_EDE_CBC_SHA
TLS_DH_RSA_WITH_CAMELLIA_128_CBC_SHA
SSL_CK_DES_64_CBC_WITH_MD5
TLS_RSA_WITH_DES_CBC_SHA
TLS_DHE_DSS_WITH_DES_CBC_SHA
TLS_DHE_RSA_WITH_3DES_EDE_CBC_SHA
TLS_RSA_WITH_RC4_128_SHA
TLS_ECDHE_ECDSA_WITH_RC4_128_SHA
SSL_CK_DES_192_EDE3_CBC_WITH_MD5
TLS_DH_RSA_WITH_DES_CBC_SHA
TLS_DHE_RSA_WITH_AES_256_CBC_SHA256
SSL_CK_RC2_128_CBC_WITH_MD5
TLS_PSK_WITH_AES_256_CBC_SHA384
TLS_DH_DSS_WITH_3DES_EDE_CBC_SHA
SSL_CK_IDEA_128_CBC_WITH_MD5
SSL_CK_RC4_64_WITH_MD5
TLS_KRB5_WITH_3DES_EDE_CBC_MD5
TLS_DHE_RSA_WITH_AES_128_CBC_SHA256
TLS_KRB5_WITH_RC4_128_MD5
TLS_DH_DSS_WITH_DES_CBC_SHA
TLS_RSA_WITH_3DES_EDE_CBC_SHA
TLS_RSA_PSK_WITH_AES_256_CBC_SHA
TLS_ECDH_ECDSA_WITH_AES_256_CBC_SHA
TLS_RSA_WITH_IDEA_CBC_SHA
TLS_KRB5_WITH_IDEA_CBC_MD5
TLS_DH_anon_WITH_3DES_EDE_CBC_SHA
TLS_DH_DSS_WITH_AES_256_GCM_SHA384
SSL_FORTEZZA_KEA_WITH_FORTEZZA_CBC_SHA
TLS_DHE_DSS_WITH_3DES_EDE_CBC_SHA
TLS_DH_RSA_WITH_AES_128_GCM_SHA256
TLS_DH_RSA_WITH_3DES_EDE_CBC_SHA
SSL_RSA_FIPS_WITH_DES_CBC_SHA
TLS_KRB5_WITH_DES_CBC_MD5
TLS_KRB5_WITH_RC4_128_SHA
TLS_DH_RSA_WITH_AES_256_CBC_SHA
TLS_DHE_PSK_WITH_AES_128_CBC_SHA
TLS_KRB5_WITH_IDEA_CBC_SHA
TLS_DHE_RSA_WITH_DES_CBC_SHA
TLS_DHE_DSS_WITH_AES_128_GCM_SHA256
TLS_DH_anon_WITH_CAMELLIA_256_CBC_SHA256
TLS_RSA_WITH_AES_256_CBC_SHA256
TLS_DH_RSA_WITH_AES_128_CBC_SHA
TLS_DH_anon_WITH_AES_128_CBC_SHA
TLS_KRB5_WITH_DES_CBC_SHA
TLS_RSA_PSK_WITH_3DES_EDE_CBC_SHA
SSL_CK_RC4_128_WITH_MD5
TLS_RSA_PSK_WITH_AES_128_GCM_SHA256
TLS_PSK_WITH_3DES_EDE_CBC_SHA
TLS_DH_anon_WITH_AES_256_CBC_SHA
TLS_DHE_DSS_WITH_RC4_128_SHA
TLS_RSA_WITH_AES_128_CBC_SHA256
SSL_RSA_FIPS_WITH_3DES_EDE_CBC_SHA
TLS_ECDHE_RSA_WITH_RC4_128_SHA
TLS_RSA_WITH_CAMELLIA_256_CBC_SHA
TLS_RSA_PSK_WITH_AES_256_GCM_SHA384
TLS_RSA_PSK_WITH_AES_128_CBC_SHA256
TLS_DHE_DSS_WITH_AES_128_CBC_SHA
TLS_DH_DSS_WITH_AES_256_CBC_SHA256
TLS_RSA_WITH_HC_128_CBC_MD5
TLS_SRP_SHA_RSA_WITH_AES_128_CBC_SHA
TLS_NTRU_NSS_WITH_AES_128_CBC_SHA
TLS_NTRU_NSS_WITH_RC4_128_SHA
TLS_PSK_WITH_AES_128_GCM_SHA256
TLS_DHE_RSA_WITH_CAMELLIA_256_CBC_SHA
TLS_DHE_DSS_WITH_AES_256_CBC_SHA
TLS_DHE_RSA_WITH_SEED_CBC_SHA
TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384
TLS_NTRU_RSA_WITH_3DES_EDE_CBC_SHA
TLS_NTRU_NSS_WITH_3DES_EDE_CBC_SHA
TLS_DHE_PSK_WITH_AES_128_GCM_SHA256
TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA256
TLS_SRP_SHA_DSS_WITH_3DES_EDE_CBC_SHA
TLS_DH_RSA_WITH_AES_128_CBC_SHA256
TLS_DH_RSA_WITH_CAMELLIA_256_CBC_SHA
TLS_ECDH_ECDSA_WITH_RC4_128_SHA
TLS_RSA_PSK_WITH_AES_128_CBC_SHA
TLS_DH_DSS_WITH_SEED_CBC_SHA
TLS_ECDHE_PSK_WITH_AES_128_CBC_SHA256
TLS_RSA_PSK_WITH_AES_256_CBC_SHA384
TLS_DHE_RSA_WITH_AES_256_CBC_SHA
TLS_DHE_PSK_WITH_3DES_EDE_CBC_SHA
TLS_RSA_WITH_AES_256_GCM_SHA384
TLS_ECDH_anon_WITH_RC4_128_SHA
TLS_ECDH_RSA_WITH_RC4_128_SHA
TLS_DHE_RSA_WITH_CAMELLIA_128_CBC_SHA256
TLS_SRP_SHA_DSS_WITH_AES_256_CBC_SHA
TLS_DHE_PSK_WITH_AES_256_CBC_SHA
TLS_RSA_WITH_AES_128_GCM_SHA256
TLS_ECDH_ECDSA_WITH_AES_128_CBC_SHA256
TLS_DH_DSS_WITH_CAMELLIA_256_CBC_SHA256
TLS_ECDHE_ECDSA_WITH_3DES_EDE_CBC_SHA
TLS_ECDHE_PSK_WITH_RC4_128_SHA
TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA384
TLS_NTRU_RSA_WITH_AES_256_CBC_SHA
TLS_DH_DSS_WITH_CAMELLIA_128_CBC_SHA256
TLS_DH_anon_WITH_AES_256_GCM_SHA384
TLS_DHE_PSK_WITH_AES_256_GCM_SHA384
TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA384
TLS_DH_RSA_WITH_SEED_CBC_SHA
TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384
TLS_DH_RSA_WITH_CAMELLIA_256_CBC_SHA256
TLS_ECDH_RSA_WITH_AES_128_CBC_SHA
TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA
TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA
TLS_DH_ANON_WITH_SEED_CBC_SHA
TLS_ECDH_RSA_WITH_AES_256_CBC_SHA
TLS_PSK_WITH_AES_256_GCM_SHA384
TLS_RSA_WITH_CAMELLIA_256_CBC_SHA256
TLS_ECDH_ECDSA_WITH_AES_256_GCM_SHA384
TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA
TLS_ECDH_RSA_WITH_3DES_EDE_CBC_SHA
TLS_SRP_SHA_DSS_WITH_AES_128_CBC_SHA
TLS_ECDH_anon_WITH_AES_128_CBC_SHA
TLS_ECDH_anon_WITH_AES_256_CBC_SHA
TLS_DHE_PSK_WITH_AES_256_CBC_SHA384
TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256

Which SSL/TLS Cipher Suites to use?

TLS_ECDH_RSA_WITH_AES_256_CBC_SHA384
TLS_SRP_SHA_WITH_AES_128_CBC_SHA
TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256
TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA
TLS_ECDHE_PSK_WITH_AES_128_CBC_SHA
TLS_ECDH_ECDSA_WITH_AES_128_GCM_SHA256
TLS_DHE_RSA_WITH_AES_128_GCM_SHA256
TLS_DHE_DSS_WITH_AES_256_GCM_SHA384
TLS_SRP_SHA_WITH_AES_256_CBC_SHA
TLS_ECDH_RSA_WITH_AES_128_CBC_SHA256
TLS_ECDH_ECDSA_WITH_AES_128_CBC_SHA
TLS_DHE_DSS_WITH_CAMELLIA_256_CBC_SHA
TLS_PSK_WITH_AES_128_CBC_SHA256
TLS_DH_anon_WITH_AES_128_CBC_SHA256
TLS_DH_anon_WITH_CAMELLIA_128_CBC_SHA256
TLS_DH_DSS_WITH_AES_128_GCM_SHA256
TLS_DH_anon_WITH_AES_256_CBC_SHA256
TLS_SRP_SHA_RSA_WITH_AES_256_CBC_SHA
TLS_ECDHE_PSK_WITH_AES_256_CBC_SHA384
TLS_RSA_WITH_SEED_CBC_SHA
TLS_ECDH_ECDSA_WITH_AES_256_CBC_SHA384
TLS_DH_anon_WITH_CAMELLIA_128_CBC_SHA
TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA256
TLS_DH_anon_WITH_AES_128_GCM_SHA256
TLS_NTRU_NSS_WITH_AES_256_CBC_SHA
TLS_PSK_WITH_RC4_128_SHA
TLS_DHE_DSS_WITH_SEED_CBC_SHA
TLS_RSA_WITH_HC_128_CBC_SHA
TLS_DH_anon_WITH_CAMELLIA_256_CBC_SHA
TLS_DHE_DSS_WITH_AES_256_CBC_SHA256
TLS_DHE_DSS_WITH_AES_128_CBC_SHA256
TLS_NTRU_RSA_WITH_AES_128_CBC_SHA
TLS_DHE_PSK_WITH_AES_128_CBC_SHA256
TLS_DHE_DSS_WITH_CAMELLIA_256_CBC_SHA256
TLS_DH_DSS_WITH_CAMELLIA_128_CBC_SHA
TLS_DH_RSA_WITH_CAMELLIA_128_CBC_SHA256
TLS_DH_DSS_WITH_CAMELLIA_256_CBC_SHA
TLS_DHE_RSA_WITH_CAMELLIA_128_CBC_SHA
TLS_DH_DSS_WITH_AES_128_CBC_SHA25
TLS_ECDHE_PSK_WITH_AES_256_CBC_SHA
TLS_ECDH_RSA_WITH_AES_128_GCM_SHA256
TLS_RSA_WITH_CAMELLIA_128_CBC_SHA
TLS_RSA_WITH_AES_256_CBC_SHA
TLS_DHE_DSS_WITH_CAMELLIA_128_CBC_SHA256
TLS_DHE_PSK_WITH_RC4_128_SHA
TLS_DHE_RSA_WITH_AES_128_CBC_SHA
TLS_PSK_WITH_AES_256_CBC_SHA
TLS_DHE_RSA_WITH_AES_256_GCM_SHA384
TLS_RSA_PSK_WITH_RC4_128_SHA
TLS_RSA_WITH_CAMELLIA_128_CBC_SHA256
TLS_ECDH_RSA_WITH_AES_256_GCM_SHA384
SSL_FORTEZZA_KEA_WITH_RC4_128_SHA
TLS_RSA_WITH_AES_128_CBC_SHA
TLS_DH_DSS_WITH_AES_128_CBC_SHA
TLS_PSK_WITH_AES_128_CBC_SHA
TLS_DHE_DSS_WITH_CAMELLIA_128_CBC_SHA
TLS_DH_RSA_WITH_AES_256_CBC_SHA256
TLS_DH_RSA_WITH_AES_256_GCM_SHA384
TLS_DH_DSS_WITH_AES_256_CBC_SHA
TLS_RSA_WITH_RABBIT_CBC_SHA
TLS_DHE_RSA_WITH_CAMELLIA_256_CBC_SHA256
TLS_NTRU_RSA_WITH_RC4_128_SHA
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TLS_RSA_PSK_WITH_AES_256_CBC_SHA
TLS_ECDH_ECDSA_WITH_AES_256_CBC_SHA
TLS_RSA_WITH_IDEA_CBC_SHA
TLS_DH_DSS_WITH_AES_256_GCM_SHA384
SSL_FORTEZZA_KEA_WITH_FORTEZZA_CBC_SHA
TLS_DH_RSA_WITH_AES_128_GCM_SHA256
TLS_KRB5_WITH_RC4_128_SHA
TLS_DH_RSA_WITH_AES_256_CBC_SHA
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Which SSL/TLS Cipher Suites to use?

RC4

- Stream cipher by Rivest from 1987
- Multiple attacks, also against its use in TLS (AlFardan, Bernstein, Paterson, Poettering, Schuldt, 2013).
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- Timing channel exploited by "Lucky 13" attack (AlFardan and Paterson, 2013)

Which SSL/TLS Cipher Suites to use?

TLS_ECDH_RSA_WITH_AES_256_CBC_SHA384

TLS_SRP_SHA_WITH_AES_128_CBC_SHA

TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256

TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA

TLS_ECDHE_PSK_WITH_AES_128_CBC_SHA

TLS_ECDH_ECDSA_WITH_AES_128_GCM_SHA256

TLS_DHE_RSA_WITH_AES_128_GCM_SHA256

TLS_DHE_DSS_WITH_AES_256_GCM_SHA384

TLS_SRP_SHA_WITH_AES_256_CBC_SHA

TLS_ECDH_RSA_WITH_AES_128_CBC_SHA256

TLS_ECDH_ECDSA_WITH_AES_128_CBC_SHA

TLS_DHE_DSS_WITH_CAMELLIA_256_CBC_SHA

TLS_PSK_WITH_AES_128_CBC_SHA256

TLS_DH_anon_WITH_AES_128_CBC_SHA256

TLS_DH_anon_WITH_CAMELLIA_128_CBC_SHA256

TLS_DH_DSS_WITH_AES_128_GCM_SHA256

TLS_DH_anon_WITH_AES_256_CBC_SHA256

TLS_SRP_SHA_RSA_WITH_AES_256_CBC_SHA

TLS_ECDHE_PSK_WITH_AES_256_CBC_SHA384

TLS_RSA_WITH_SEED_CBC_SHA

TLS_ECDH_ECDSA_WITH_AES_256_CBC_SHA384

TLS_DH_anon_WITH_CAMELLIA_128_CBC_SHA

TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA256

TLS_DH_anon_WITH_AES_128_GCM_SHA256

TLS_NTRU_NSS_WITH_AES_256_CBC_SHA

TLS_PSK_WITH_RC4_128_SHA

TLS_DHE_DSS_WITH_SEED_CBC_SHA

TLS_RSA_WITH_HC_128_CBC_SHA

TLS_DH_anon_WITH_CAMELLIA_256_CBC_SHA

TLS_DHE_DSS_WITH_AES_256_CBC_SHA256

TLS_DHE_DSS_WITH_AES_128_CBC_SHA256

TLS_NTRU_RSA_WITH_AES_128_CBC_SHA

TLS_DHE_PSK_WITH_AES_128_CBC_SHA256

TLS_DHE_DSS_WITH_CAMELLIA_256_CBC_SHA256

TLS_DH_DSS_WITH_CAMELLIA_128_CBC_SHA

TLS_DH_RSA_WITH_CAMELLIA_128_CBC_SHA256

TLS_DH_DSS_WITH_CAMELLIA_256_CBC_SHA

TLS_DHE_RSA_WITH_CAMELLIA_128_CBC_SHA

TLS_DH_DSS_WITH_AES_128_CBC_SHA25

TLS_ECDHE_PSK_WITH_AES_256_CBC_SHA

TLS_ECDH_RSA_WITH_AES_128_GCM_SHA256

TLS_RSA_WITH_CAMELLIA_128_CBC_SHA

TLS_RSA_WITH_AES_256_CBC_SHA

TLS_DHE_DSS_WITH_CAMELLIA_128_CBC_SHA256

TLS_DHE_PSK_WITH_RC4_128_SHA

TLS_DHE_RSA_WITH_AES_128_CBC_SHA

TLS_PSK_WITH_AES_256_CBC_SHA

TLS_DHE_RSA_WITH_AES_256_GCM_SHA384

TLS_RSA_PSK_WITH_RC4_128_SHA

TLS_RSA_WITH_CAMELLIA_128_CBC_SHA256

TLS_ECDH_RSA_WITH_AES_256_GCM_SHA384

SSL_FORTEZZA_KEA_WITH_RC4_128_SHA

TLS_RSA_WITH_AES_128_CBC_SHA

TLS_DH_DSS_WITH_AES_128_CBC_SHA

TLS_PSK_WITH_AES_128_CBC_SHA

TLS_DHE_DSS_WITH_CAMELLIA_128_CBC_SHA

TLS_DH_RSA_WITH_AES_256_CBC_SHA256

TLS_DH_RSA_WITH_AES_256_GCM_SHA384

TLS_DH_DSS_WITH_AES_256_CBC_SHA

TLS_RSA_WITH_RABBIT_CBC_SHA

TLS_DHE_RSA_WITH_CAMELLIA_256_CBC_SHA256

TLS_NTRU_RSA_WITH_RC4_128_SHA

TLS_DH_RSA_WITH_CAMELLIA_128_CBC_SHA

TLS_RSA_WITH_RC4_128_SHA

TLS_ECDHE_ECDSA_WITH_RC4_128_SHA

TLS_DHE_RSA_WITH_AES_256_CBC_SHA256

TLS_PSK_WITH_AES_256_CBC_SHA384

TLS_DHE_RSA_WITH_AES_128_CBC_SHA256

TLS_RSA_PSK_WITH_AES_256_CBC_SHA

TLS_ECDH_ECDSA_WITH_AES_256_CBC_SHA

TLS_RSA_WITH_IDEA_CBC_SHA

TLS_DH_DSS_WITH_AES_256_GCM_SHA384

SSL_FORTEZZA_KEA_WITH_FORTEZZA_CBC_SHA

TLS_DH_RSA_WITH_AES_128_GCM_SHA256

TLS_KRB5_WITH_RC4_128_SHA

TLS_DH_RSA_WITH_AES_256_CBC_SHA

TLS_DHE_PSK_WITH_AES_128_CBC_SHA

TLS_KRB5_WITH_IDEA_CBC_SHA

TLS_DH_anon_WITH_CAMELLIA_256_CBC_SHA256

TLS_DHE_DSS_WITH_AES_128_GCM_SHA256

TLS_RSA_WITH_AES_256_CBC_SHA256

TLS_DH_RSA_WITH_AES_128_CBC_SHA

TLS_DH_anon_WITH_AES_128_CBC_SHA

TLS_RSA_PSK_WITH_AES_128_GCM_SHA256

TLS_DH_anon_WITH_AES_256_CBC_SHA

TLS_DHE_DSS_WITH_RC4_128_SHA

TLS_RSA_WITH_AES_128_CBC_SHA256

TLS_ECDHE_RSA_WITH_RC4_128_SHA

TLS_RSA_WITH_CAMELLIA_256_CBC_SHA

TLS_RSA_PSK_WITH_AES_256_GCM_SHA384

TLS_RSA_PSK_WITH_AES_128_CBC_SHA256

TLS_DHE_DSS_WITH_AES_128_CBC_SHA

TLS_DH_DSS_WITH_AES_256_CBC_SHA256

TLS_SRP_SHA_RSA_WITH_AES_128_CBC_SHA

TLS_NTRU_NSS_WITH_AES_128_CBC_SHA

TLS_NTRU_NSS_WITH_RC4_128_SHA

TLS_PSK_WITH_AES_128_GCM_SHA256

TLS_DHE_RSA_WITH_CAMELLIA_256_CBC_SHA

TLS_DHE_DSS_WITH_AES_256_CBC_SHA

TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384

TLS_DHE_RSA_WITH_SEED_CBC_SHA

TLS_DHE_PSK_WITH_AES_128_GCM_SHA256

TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA256

TLS_DH_RSA_WITH_AES_128_CBC_SHA256

TLS_DH_RSA_WITH_CAMELLIA_256_CBC_SHA

TLS_ECDH_ECDSA_WITH_RC4_128_SHA

TLS_RSA_PSK_WITH_AES_128_CBC_SHA

TLS_DH_DSS_WITH_SEED_CBC_SHA

TLS_ECDHE_PSK_WITH_AES_128_CBC_SHA256

TLS_RSA_PSK_WITH_AES_256_CBC_SHA384

TLS_DHE_RSA_WITH_AES_256_CBC_SHA

TLS_RSA_WITH_AES_256_GCM_SHA384

TLS_ECDH_anon_WITH_RC4_128_SHA

TLS_ECDH_RSA_WITH_RC4_128_SHA

TLS_DHE_RSA_WITH_CAMELLIA_128_CBC_SHA256

TLS_SRP_SHA_DSS_WITH_AES_256_CBC_SHA

TLS_DHE_PSK_WITH_AES_256_CBC_SHA

TLS_RSA_WITH_AES_128_GCM_SHA256

TLS_ECDH_ECDSA_WITH_AES_128_CBC_SHA256

TLS_DH_DSS_WITH_CAMELLIA_256_CBC_SHA256

TLS_ECDHE_PSK_WITH_RC4_128_SHA

TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA384

TLS_NTRU_RSA_WITH_AES_256_CBC_SHA

TLS_DH_DSS_WITH_CAMELLIA_128_CBC_SHA256

TLS_DH_anon_WITH_AES_256_GCM_SHA384

TLS_DHE_PSK_WITH_AES_256_GCM_SHA384

TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA384

TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384

TLS_DH_RSA_WITH_SEED_CBC_SHA

TLS_DH_RSA_WITH_CAMELLIA_256_CBC_SHA256

TLS_ECDH_RSA_WITH_AES_128_CBC_SHA

TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA

TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA

TLS_DH_ANON_WITH_SEED_CBC_SHA

TLS_ECDH_RSA_WITH_AES_256_CBC_SHA

TLS_PSK_WITH_AES_256_GCM_SHA384

TLS_RSA_WITH_CAMELLIA_256_CBC_SHA256

TLS_ECDH_ECDSA_WITH_AES_256_GCM_SHA384

TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA

TLS_SRP_SHA_DSS_WITH_AES_128_CBC_SHA

TLS_ECDH_anon_WITH_AES_128_CBC_SHA

TLS_ECDH_anon_WITH_AES_256_CBC_SHA

TLS_DHE_PSK_WITH_AES_256_CBC_SHA384

TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256

Which SSL/TLS Cipher Suites to use?

TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256

TLS_ECDH_ECDSA_WITH_AES_128_GCM_SHA256

TLS_DHE_RSA_WITH_AES_128_GCM_SHA256

TLS_DHE_DSS_WITH_AES_256_GCM_SHA384

TLS_DH_DSS_WITH_AES_128_GCM_SHA256

TLS_DH_anon_WITH_AES_128_GCM_SHA256

TLS_ECDH_RSA_WITH_AES_128_GCM_SHA256

TLS_DHE_RSA_WITH_AES_256_GCM_SHA384

TLS_ECDH_RSA_WITH_AES_256_GCM_SHA384

TLS_DH_RSA_WITH_AES_256_GCM_SHA384

TLS_DH_DSS_WITH_AES_256_GCM_SHA384

TLS_DH_RSA_WITH_AES_128_GCM_SHA256

TLS_DHE_DSS_WITH_AES_128_GCM_SHA256

TLS_RSA_PSK_WITH_AES_128_GCM_SHA256

TLS_RSA_PSK_WITH_AES_256_GCM_SHA384

TLS_PSK_WITH_AES_128_GCM_SHA256

TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384

TLS_DHE_PSK_WITH_AES_128_GCM_SHA256

TLS_RSA_WITH_AES_256_GCM_SHA384

TLS_RSA_WITH_AES_128_GCM_SHA256

TLS_DH_anon_WITH_AES_256_GCM_SHA384

TLS_DHE_PSK_WITH_AES_256_GCM_SHA384

TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384

TLS_PSK_WITH_AES_256_GCM_SHA384

TLS_ECDH_ECDSA_WITH_AES_256_GCM_SHA384

TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256

Which SSL/TLS Cipher Suites to use?

anonymous

- “anonymous” ciphers don’t use certificates
- Susceptible to a MitM attack

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anonymous

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PSK

- Pre-shared keys (PSK) only practical in special environments
- Advantage: faster crypto
- Can be easier in small closed environments
- Doesn’t scale for the Internet

Which SSL/TLS Cipher Suites to use?

TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256

TLS_ECDH_ECDSA_WITH_AES_128_GCM_SHA256

TLS_DHE_RSA_WITH_AES_128_GCM_SHA256

TLS_DHE_DSS_WITH_AES_256_GCM_SHA384

TLS_DH_DSS_WITH_AES_128_GCM_SHA256

TLS_DH_anon_WITH_AES_128_GCM_SHA256

TLS_ECDH_RSA_WITH_AES_128_GCM_SHA256

TLS_DHE_RSA_WITH_AES_256_GCM_SHA384

TLS_ECDH_RSA_WITH_AES_256_GCM_SHA384

TLS_DH_RSA_WITH_AES_256_GCM_SHA384

TLS_DH_DSS_WITH_AES_256_GCM_SHA384

TLS_DH_RSA_WITH_AES_128_GCM_SHA256

TLS_DHE_DSS_WITH_AES_128_GCM_SHA256

TLS_RSA_PSK_WITH_AES_128_GCM_SHA256

TLS_RSA_PSK_WITH_AES_256_GCM_SHA384

TLS_PSK_WITH_AES_128_GCM_SHA256

TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384

TLS_DHE_PSK_WITH_AES_128_GCM_SHA256

TLS_RSA_WITH_AES_256_GCM_SHA384

TLS_RSA_WITH_AES_128_GCM_SHA256

TLS_DH_anon_WITH_AES_256_GCM_SHA384

TLS_DHE_PSK_WITH_AES_256_GCM_SHA384

TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384

TLS_PSK_WITH_AES_256_GCM_SHA384

TLS_ECDH_ECDSA_WITH_AES_256_GCM_SHA384

TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256

Which SSL/TLS Cipher Suites to use?

TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256

TLS_ECDH_ECDSA_WITH_AES_128_GCM_SHA256

TLS_DHE_RSA_WITH_AES_128_GCM_SHA256

TLS_DHE_DSS_WITH_AES_256_GCM_SHA384

TLS_DH_DSS_WITH_AES_128_GCM_SHA256

TLS_ECDH_RSA_WITH_AES_128_GCM_SHA256

TLS_DHE_RSA_WITH_AES_256_GCM_SHA384

TLS_ECDH_RSA_WITH_AES_256_GCM_SHA384

TLS_DH_RSA_WITH_AES_256_GCM_SHA384

TLS_DH_DSS_WITH_AES_256_GCM_SHA384

TLS_DH_RSA_WITH_AES_128_GCM_SHA256

TLS_DHE_DSS_WITH_AES_128_GCM_SHA256

TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384

TLS_RSA_WITH_AES_256_GCM_SHA384

TLS_RSA_WITH_AES_128_GCM_SHA256

TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384

TLS_ECDH_ECDSA_WITH_AES_256_GCM_SHA384

TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256

Which SSL/TLS Cipher Suites to use?

Use ephemeral key exchange!

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- Problem: key gets compromised, read all old messages

Which SSL/TLS Cipher Suites to use?

Use ephemeral key exchange!

- Can encrypt with long-term public key
- Problem: key gets compromised, read all old messages
- Better: use long-term public key for authentication
- Agree on new (*ephemeral*) encryption key for each session
- This is known as *perfect forward secrecy*
- Use ciphers containing `DHE` or `ECDHE`

Which SSL/TLS Cipher Suites to use?

TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256

TLS_ECDH_ECDSA_WITH_AES_128_GCM_SHA256

TLS_DHE_RSA_WITH_AES_128_GCM_SHA256

TLS_DHE_DSS_WITH_AES_256_GCM_SHA384

TLS_DH_DSS_WITH_AES_128_GCM_SHA256

TLS_ECDH_RSA_WITH_AES_128_GCM_SHA256

TLS_DHE_RSA_WITH_AES_256_GCM_SHA384

TLS_ECDH_RSA_WITH_AES_256_GCM_SHA384

TLS_DH_RSA_WITH_AES_256_GCM_SHA384

TLS_DH_DSS_WITH_AES_256_GCM_SHA384

TLS_DH_RSA_WITH_AES_128_GCM_SHA256

TLS_DHE_DSS_WITH_AES_128_GCM_SHA256

TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384

TLS_RSA_WITH_AES_256_GCM_SHA384

TLS_RSA_WITH_AES_128_GCM_SHA256

TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384

TLS_ECDH_ECDSA_WITH_AES_256_GCM_SHA384

TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256

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TLS_DHE_DSS_WITH_AES_256_GCM_SHA384

TLS_DHE_RSA_WITH_AES_256_GCM_SHA384

TLS_DHE_DSS_WITH_AES_128_GCM_SHA256

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TLS_DHE_DSS_WITH_AES_128_GCM_SHA256

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TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384

TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256

Which SSL/TLS Cipher Suites to use?

DSS and ECDSA

- DSS and ECDSA need random value for each signature
- Small biases in randomness are disastrous
- Attacker can compute signing key from various messages with few known “random” bits
- Bad ECDSA randomness allowed Sony PS3 crack

Which SSL/TLS Cipher Suites to use?

TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256

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TLS_DHE_DSS_WITH_AES_256_GCM_SHA384

TLS_DHE_RSA_WITH_AES_256_GCM_SHA384

TLS_DHE_DSS_WITH_AES_128_GCM_SHA256

TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384

TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384

TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256

Which SSL/TLS Cipher Suites to use?

AES-GCM

- AES-GCM only available since TLS 1.2
- Consists of AES in counter mode and GHASH
- GHASH is designed for hardware implementation
- Intel built AES and GHASH hardware support into their recent CPUs
- Terribly hard to implement fast and securely in software
- Matter of time until we see timing attacks?

What now?

A reasonable selection of algorithms

- AES-GCM is quite good for many CPUs
- AES-CBC is not so terrible (after implementation fixes)
- DSS and ECDSA is maybe (hopefully!) not that much of a problem
- Client-side selection of algorithms is a tradeoff:
  - I really only want `ECDHE`, `RSA`, `AES-GCM`, `SHA2`
  - I also want to connect to at least a few web sites
- Good test: `https://howsmyssl.com`

What now?

Better algorithms in the future?

- Biggest problem: no fully satisfactory symmetric authenticated encryption
- Current IETF draft by Langley: ChaCha20 and Poly1305 for TLS: https://tools.ietf.org/html/draft-agl-tls-chacha20poly1305-01
- ChaCha20 is a state-of-the art stream cipher
- Poly1305 is a state-of-the art authenticator
- Both designed by Bernstein
- Both very efficient in software

Who do you trust?

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- DigiNotar compromised in 2011: >300,000 Iranian Gmail users compromised

SSLstrip

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- Possible for an active attacker to “avoid” HTTPS
- Idea: rewrite links from HTTPS to HTTP
- Requires that client does not enforce HTTPS
- More details:
  - Erik’s lecture on Web Security
  - http://www.thoughtcrime.org/software/sslstrip/

OpenSSL Heartbleed Bug

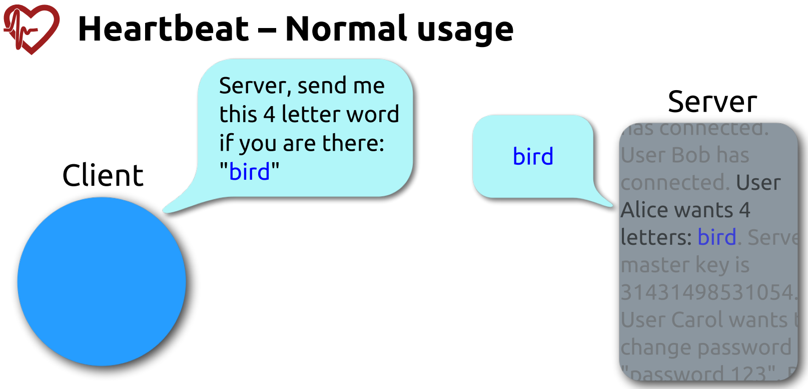
Bug in the implementation of the Heartbeat Extension (RFC 6520):

```
   struct {
  HeartbeatMessageType type;
  uint16 payload_length;
  opaque payload[HeartbeatMessage.payload_length];
  opaque padding[padding_length];
} HeartbeatMessage;

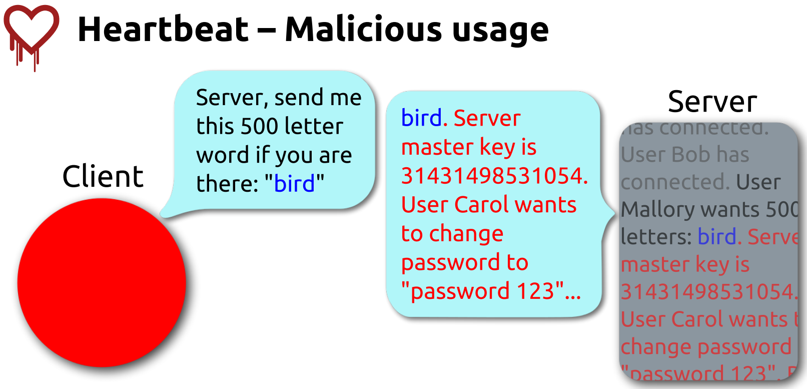
[...]
When a HeartbeatRequest message is received [...],
the receiver MUST send a corresponding HeartbeatResponse
message carrying an exact copy of the payload of the received
HeartbeatRequest.
```

OpenSSL failed to check actual length of payload data.

OpenSSL Heartbleed Bug


Heartbeat – Normal usage
Client
Server, send me this 4 letter word if you are there: "bird"
bird
Server
has connected. User Bob has connected. User Alice wants 4 letters: bird. Serve master key is 31431498531054. User Carol wants t change password "password 123". P

OpenSSL Heartbleed Bug



Heartbeat – Malicious usage

Client

Server, send me this 500 letter word if you are there: "bird"

bird. Server master key is 31431498531054. User Carol wants to change password to "password 123"...

Server

has connected. User Bob has connected. User Mallory wants 500 letters: bird. Serve master key is 31431498531054. User Carol wants t change password "password 123". P

How much web traffic is encrypted?

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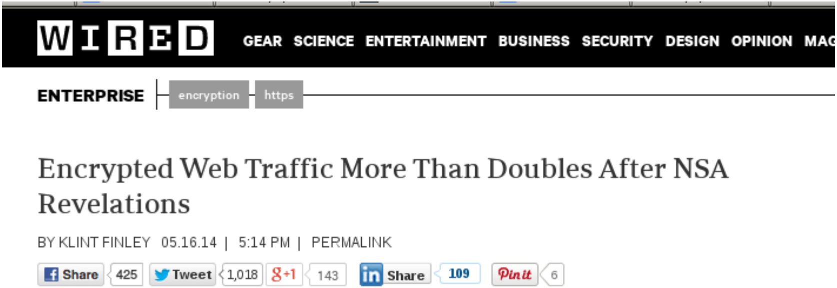

WIRED
GEAR SCIENCE ENTERTAINMENT BUSINESS SECURITY DESIGN OPINION MAG
ENTERPRISE
encryption
https

Encrypted Web Traffic More Than Doubles After NSA Revelations

BY KLINT FINLEY 05.16.14 | 5:14 PM | PERMALINK

How much web traffic is encrypted?

From the article:

“Early last year–before the Snowden revelations–encrypted traffic accounted for 2.29 percent of all peak hour traffic in North America, according to Sandvine’s report. Now, it spans 3.8 percent. But that’s a small jump compared to other parts of the world. In Europe, encrypted traffic went from 1.47 percent to 6.10 percent, and in Latin America, it increased from 1.8 percent to 10.37 percent.”

—Klint Finley on wired.com, May 16, 2014.