L4 SECURITY

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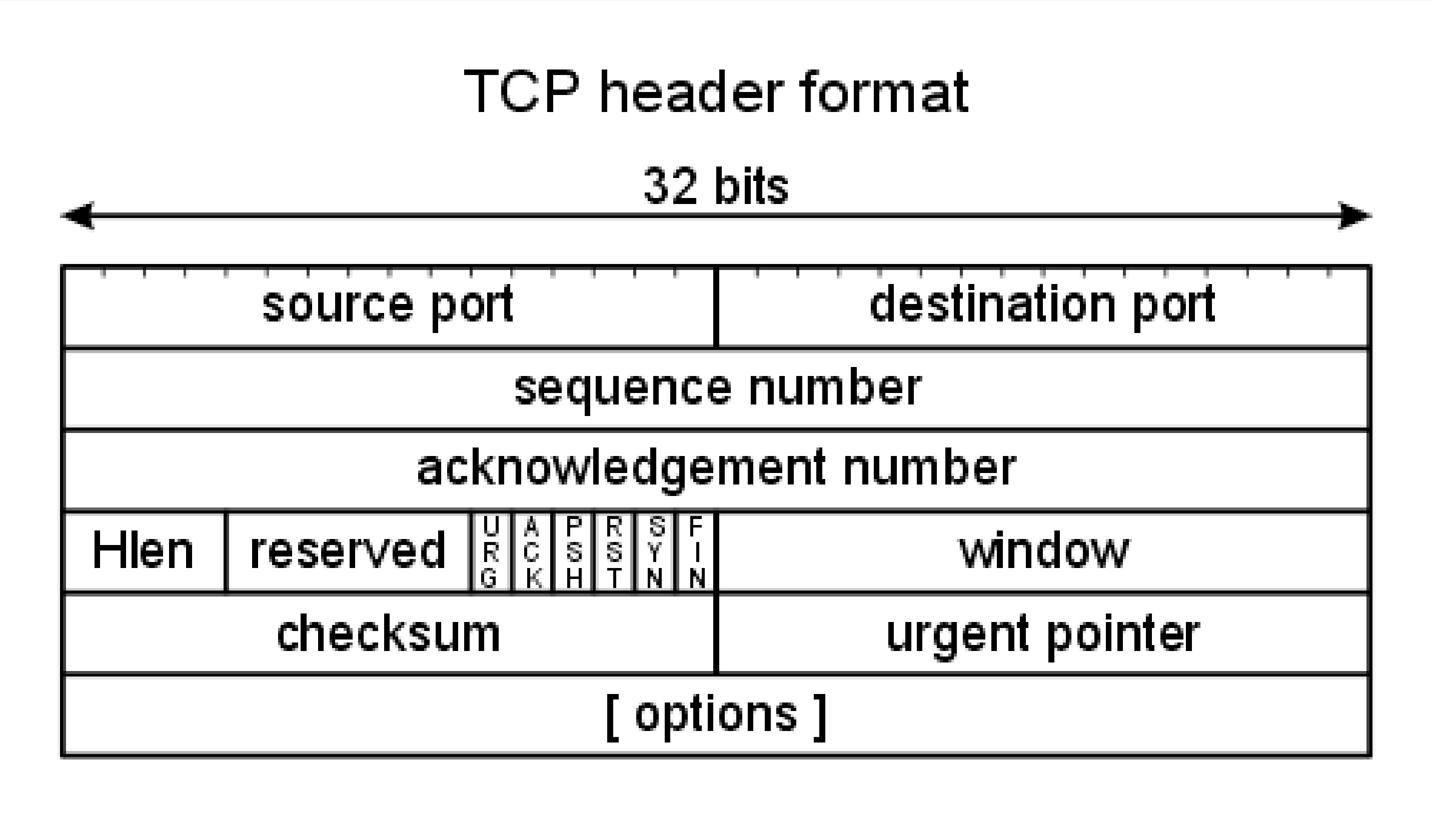
TCP PROTOCOL

- Layer 4 Protocol
- Multiplexing (ports)
- Reliable Delivery (ack/resend)
- Congestion control
- Units called *segments*

REVIEW

- Ethernet ***frame***
- IP ***packet***
- TCP ***segment***

TCP HEADER


TCP header format
32 bits
source port
destination port
sequence number
acknowledgement number
Hlen
reserved
URG
ACK
PSH
RST
SYN
FIN
window
checksum
urgent pointer
[options]

TCP HEADER FIELDS

- Source Port, Destination Port for multiplexing
- Sequence Number of the first data byte
- Acknowledgement Number of next expected seq. no.
- Hlen number of 32-byte words in the TCP header
- Window number of bytes willing to receive
- Checksum over the header and data

TCP FLAGS

- URG The URGENT POINTER field contains valid data
- ACK The acknowledgement number is valid
- PSH The receiver should pass this data to the application as soon as possible
- RST Reset the connection
- SYN Synchronize sequence numbers to initiate a connection.
- FIN Sender is finished sending data

ECN FLAGS ADDED IN RFC 3168

<table>
<tr><td colspan="10">Source Post</td><td>Destination Post</td></tr>
<tr><td colspan="11">Sequence Number</td></tr>
<tr><td colspan="11">Acknowledgement Number</td></tr>
<tr><td>Header
Length</td><td>Reserv
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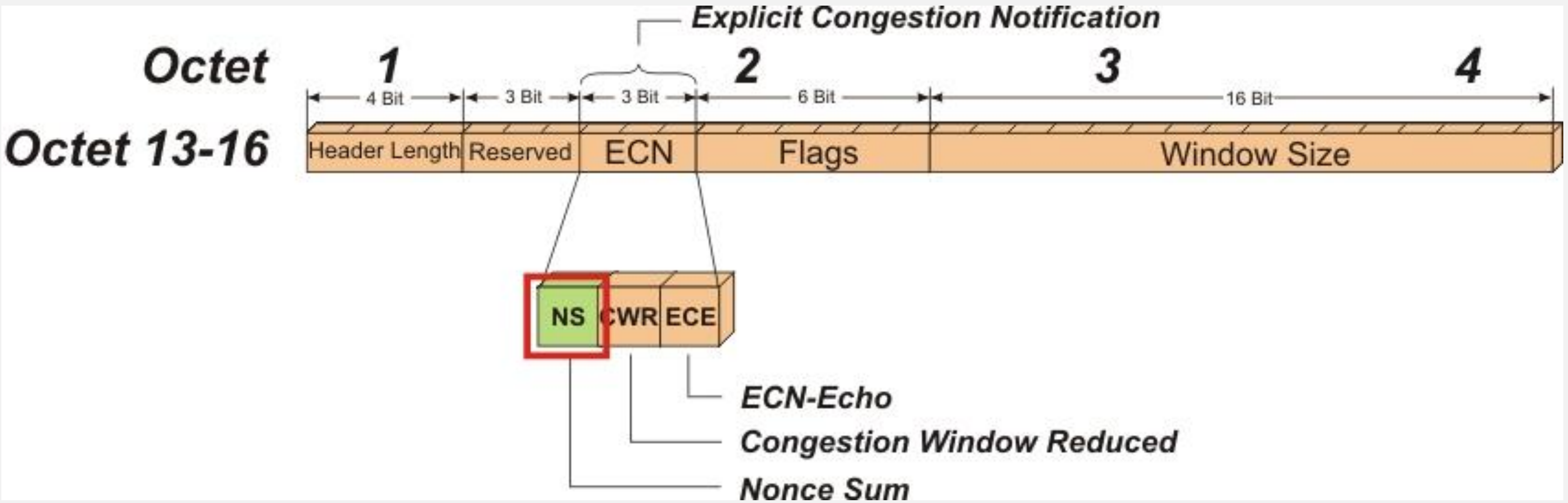
N</td><td></td></tr>
<tr><td colspan="10">TCP Checksum</td><td>Urgent Pointer</td></tr>
</table>

TCP FLAGS (CONT)

- CWR – Acknowledges that congestion notification received
- ECN – indicates congestion notification via IP layer
  - (NOTE! Requires ECN capable IP layer!)
  - Sent until CWR received
- Only used if negotiated using TCP options during handshake

OPTIONAL NS FLAG



ONE-BIT NONCE

- NS is a parity bit used to catch changes to a packet
- Because it's only one bit, a cheater can guess it 50% right
- But, over repeated trials (frequent congestion) will get caught

TCP OPTIONS

- Header can be "extended" with options
- Each option can have up to three fields:
  - Option Type (1 byte)
  - Option Length (1 byte)
  - Option data (variable)
- Examples include
  - Selective acknowledgement
  - ECN

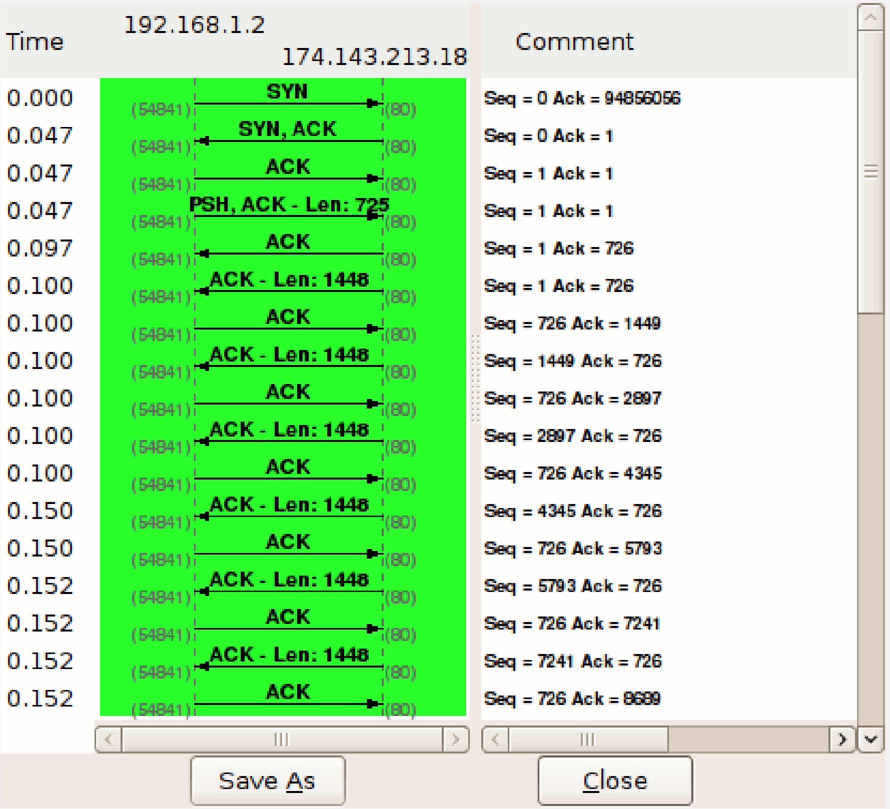
TCP SEQUENCE NUMBERS

- TCP header has a value for seq num and ack num every time
- SYN Sequence Number random between 0-4,294,967,295
- SYN Ack Num should be 0 (but any value should be ignored)
- SYN-ACK Seq Num also random
- SYN-ACK Ack Num is SYN Seq Num + 1
- (SYN-ACK) ACK Seq Num is SYN Seq Num + 1
- (SYN-ACK) ACK Ack Num is SYN-ACK Seq Num + 1

DATA SEQUENCE NUMBERS

- Technically, there is only one packet type in TCP
- Flags simply indicate how the values can be used
- Sequence number is set every time
- But only increased by the length of the data
- (or increased by +1 for SYN and FIN)
- Ack field indicates that the ACK number is valid

WIRESHARK TRACE



TCP SHUTDOWN

SECURITY

- Obviously, TCP is not designed with security in mind
  - No confidentiality!
  - No authentication!
  - No integrity (checksum is not cryptographic)
- No secure availability either!
  - End any connection with RST

SSLV2

- SSL = Secure Sockets Layer
- SSLv1 was never published
- SSLv2 was published 11/29/1994, last updated 2/9/1995

SSL RECORD LAYER

- All data encapsulated in a “Record”
  - Header
  - Data
- Header includes record length, and some meta information
- Data portion includes
  - Mac data
  - Actual data
  - Padding data

SSLV2 RECORD MAC

- MAC-DATA = HASH[SECRET, ACTUAL-DATA, PADDING-DATA, SEQUENCE-NUMBER]
- Sequence is 32bit number, starts at 0 and increments
- SECRET is the CLIENT-WRITE-KEY for the client.
- SECRET is the SERVER-WRITE-KEY for the server
- CLIENT-READ-KEY = SERVER-WRITE-KEY

SSLV2 HANDSHAKE

- client-hello C -> S: challenge, cipher_specs
- server-hello S -> C: connection-id,server_certificate,cipher_specs
- client-master-key C -> S: {master_key}server_public_key
- client-finish C -> S: {connection-id}client_write_key
- server-verify S -> C: {challenge}server_write_key
- server-finish S -> C: {new_session_id}server_write_key

KEY DERIVATION

- KEY-MATERIAL-0 = MD5[MASTER-KEY, "0", CHALLENGE, CONNECTION-ID]
- KEY-MATERIAL-1 = MD5[MASTER-KEY, "1", CHALLENGE, CONNECTION-ID]
- CLIENT-READ-KEY = KEY-MATERIAL-0[0-15]
- CLIENT-WRITE-KEY = KEY-MATERIAL-1[0-15]

SSLV2 SESSION RECOVERY

- client-hello C -> S: challenge, session_id, cipher_specs
- server-hello S -> C: connection-id, session_id_hit
- client-finish C -> S: {connection-id}client_write_key
- server-verify S -> C: {challenge}server_write_key
- server-finish S -> C: {session_id}server_write_key

CLIENT AUTH

- Server may request client cert
- Send a challenge to authenticate

BULK DATA TRANSMISSION

- Use write key to create data
  - C = {P}write-key
- Use same write key to MAC data
  - MAC = Hash(write-key, C, Padding, Sequence)

SSLV3

- Netscape Memo March 1996
- “Layered Protocol” (e.g., record layer, message layer)
- “Stateful”

“SSL takes messages to be transmitted, fragments the data into manageable blocks, optionally compresses the data, applies a MAC, encrypts, and transmits the result. Received data is decrypted, verified, decompressed, and reassembled, then delivered to higher level clients”

SSLV3 STATE

- Session identifier – arbitrary bytes
- Peer certificate – (may be null)
- Compression method
- Cipher spec – specifics bulk data, MAC, hash size, etc
- Master secret - 48-byte secret shared
- Is resumable

SSLV3 CONNECTION STATE

- There can be multiple connections within the same session
- Server and client random
- Client write key
- Client write MAC secret
- Server write key
- Server write MAC secret
- IV's and sequence numbers

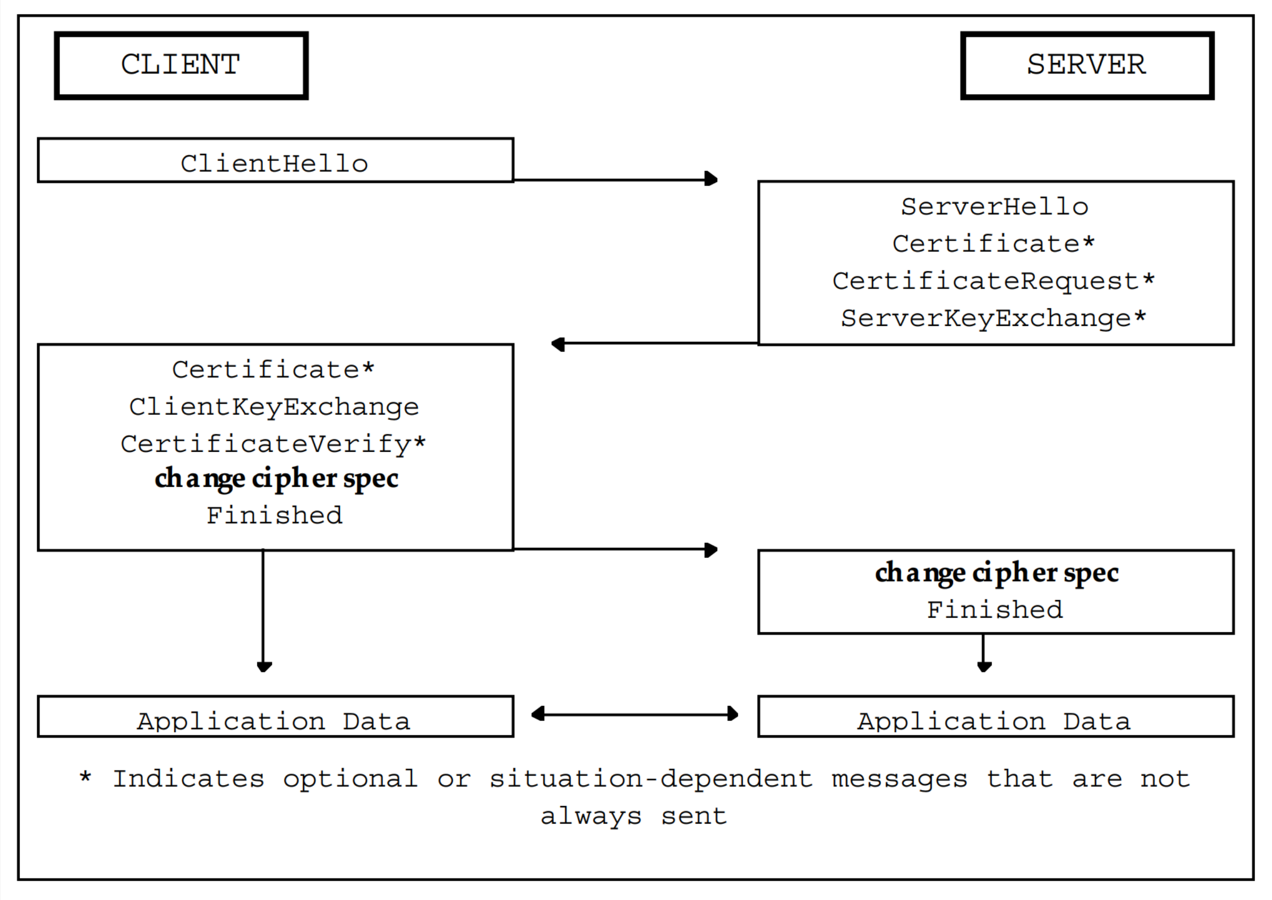
RECORD LAYER

- Fragmentation
  - The record layer fragments information blocks into SSLPlaintext records of 2^{14} bytes or less
- Record layer now includes:
  - Version
  - Higher SSL type
- Supports compression

NEW MAC

- hash(MAC_write_secret + pad_2 + hash (MAC_write_secret + pad_1 + seq_num + length + content));
- pad_1 - 0x36 repeated 48x for MD5 this or 40x for SHA.
- pad_2 - 0x5c repeated the same number of times.
- hash – chosen by cipher suite

HANDSHAKE CHANGES



SSLV3 HANDSHAKE CHANGES

- Certs can now be a chain (before, only 1!)
- Many key exchange options including DH
- Hash of all handshake messages at the end
  - md5_hash MD5(master_secret + pad2 + MD5(handshake_messages + Sender + master_secret + pad1));
  - sha_hash SHA(master_secret + pad2 + SHA(handshake_messages + Sender + master_secret + pad1));

MASTER SECRET

- Derived from pre-master secret
- Pre-master secret computed directly from DH
- Or, can exchange pre-master secret encrypted with pub key
- 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));

DERIVING SECRETS

- 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 + ServerHello.random ClientHello.random))

  + [...];

KEYS FROM KEY BLOCK

- client_write_MAC_secret[CipherSpec.hash_size]
- server_write_MAC_secret[CipherSpec.hash_size]
- client_write_key[CipherSpec.key_material]
- server_write_key[CipherSpec.key_material]
- client_write_IV[CipherSpec.IV_size]
- server_write_IV[CipherSpec.IV_size]

TLS 1.0

- Very similar to SSLv3
- Different key derivation and MAC
- Not compatible

TLS 1.0 HMAC

- Standardized HMAC, RFC 2104
- H(K XOR opad, H(K XOR ipad, text))
- Ipad: the byte 0x36 repeated B times
- Opad: the byte 0x5C repeated B times
- B: block size of H (64 bytes for SHA-1)
- K: Key

TLS 1.0 MAC

- HMAC_hash(MAC_write_secret, seq_num + TLSCompressed.type +TLSCompressed.version + TLSCompressed.length + TLSCompressed.fragment));

TLS 1.0 DATA EXPANSION

- P_hash(secret, seed) = HMAC_hash(secret, A(1) + seed) +

  HMAC_hash(secret, A(2) + seed) +

  HMAC_hash(secret, A(3) + seed) + ...
- A() is defined as:
- A(0) = seed
- A(i) = HMAC_hash(secret, A(i-1))

TLS 1.0 PRF

- Pseudo Random Function
- PRF(secret, label, seed) = P_MD5(S1, label + seed) XOR
  P_SHA-1(S2, label + seed);
- S1 = first half of secret
- S2 = second half of secret

TLS 1.0 KEY BLOCK

- key_block = PRF(SecurityParameters.master_secret, "key expansion", SecurityParameters.server_random + SecurityParameters.client_random);
- Session keys derived from key_block similar to SSLv3

TLS 1.0 FINISHED MSG

- verify_data = PRF(master_secret, finished_label, MD5(handshake_messages) + SHA-1(handshake_messages)) [0..11];

TLS 1.0 BULK DATA TRANSFER

- The record layer encapsulates a bulk data fragment
- struct {

    ContentTypetype;

    ProtocolVersionversion;

    uint16 length;

    opaque fragment[TLSPlaintext.length];

  } TLSPlaintext;
- (Opaque just means raw bytes)

FRAGMENT TYPES

```
select (CipherSpec.cipher_type) {
        case stream: GenericStreamCipher;
        case block: GenericBlockCipher;
} fragment;
```

STREAM TYPE

```
stream-ciphered struct {
        opaque content[TLSCompressed.length];
        opaque MAC[CipherSpec.hash_size];
} GenericStreamCipher;
```

CBC BLOCK CIPHER

```
block-ciphered struct {
        opaque content[TLSCompressed.length];
        opaque MAC[CipherSpec.hash_size];
        uint8 padding[GenericBlockCipher.padding_length];
        uint8 padding_length;
} GenericBlockCipher;
```

CHANGE FROM SSLV3

- The contents of "padding" not specified in SSLV3
- In TLS 1.0, specified as:

"Each uint8 in the padding data vector must be filled with the padding length value."

TO CLARIFY

- Sample 10 legal padding bytes in SSLV3:
  - 0xAA 0xBB 0xCC 0xDD 0xEE 0xFF 0x00 0x11 0x22 0x33 0xA
  - (NOTE:0xA=10=Length)
- Only 10 legal padding bytes in TLS 1.0:
  - 0xA 0xA0xA0xA0xA0xA0xA0xA0xA0xA0xA
  - (NOTE:last0xA is still length!)

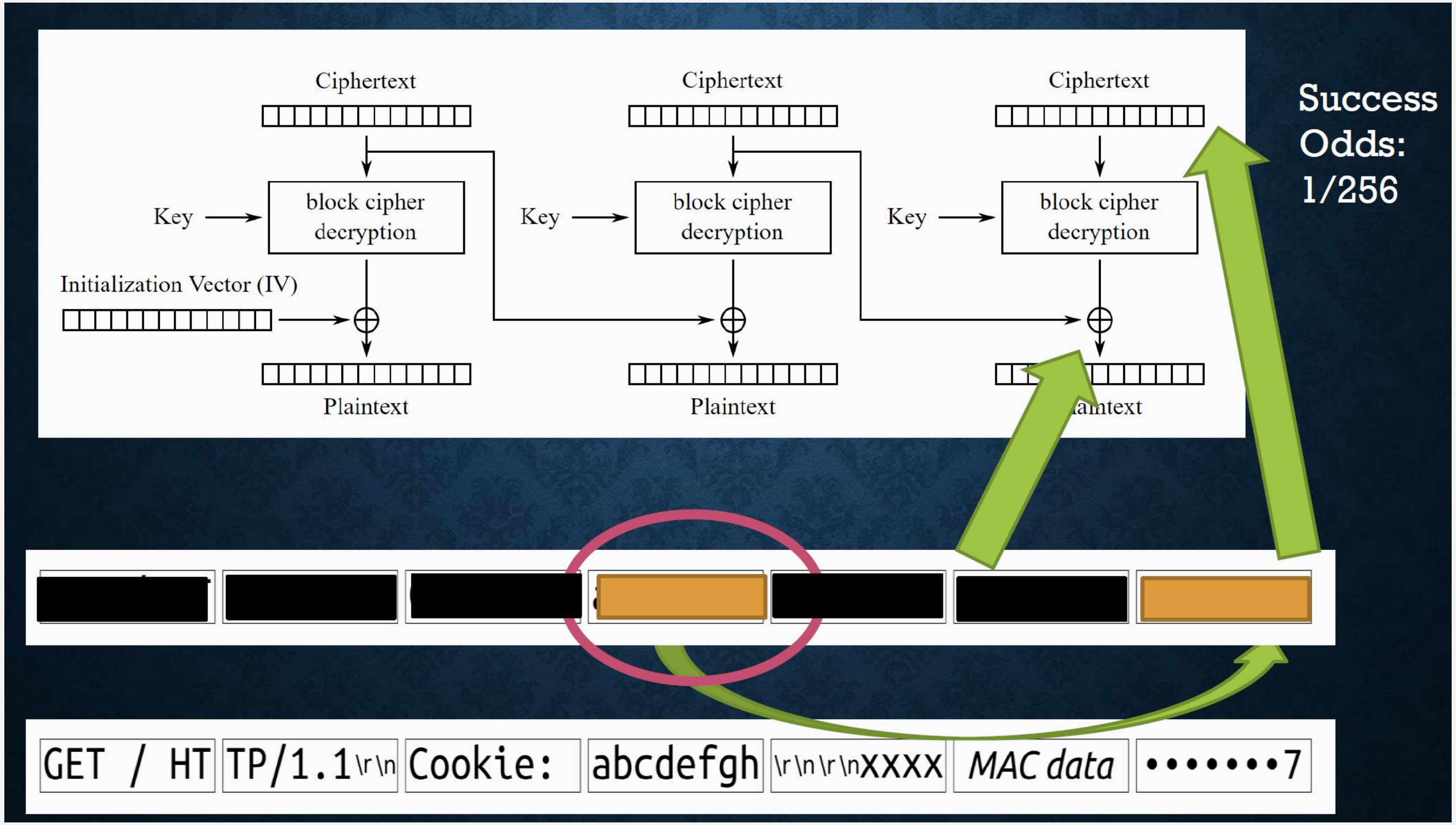
NOTE: AUTH THEN ENCRYPT

- Both SSLv3 and TLS 1.0 chose to auth then encrypt
- Look at the data structure: The MAC is included in the plaintext
- ALSO NOTE: DID NOT INCLUDE THE PADDING!!!!

SSLV3 POODLE ATTACK

- SSLV3's lack of a padding specification resulted in an attack
- You could use a "paddingoracle" attack to decrypt bytes
- Approximately, 256 messages would reveal one byte

PADDING ORACLE ATTACK



GET THE NEXT BYTE

GET /a H	TTP/1.1\r	\nCookie:	abcdefg	h\r\n\r\nxxx	*MAC data*	•••••••7

ATTACKING TLS 1.0

- POODLE would use an MITM to force a downgrade to SSLv3
- OR ,some TLS1.0 versions DIDN'T CHECK the PADDING!

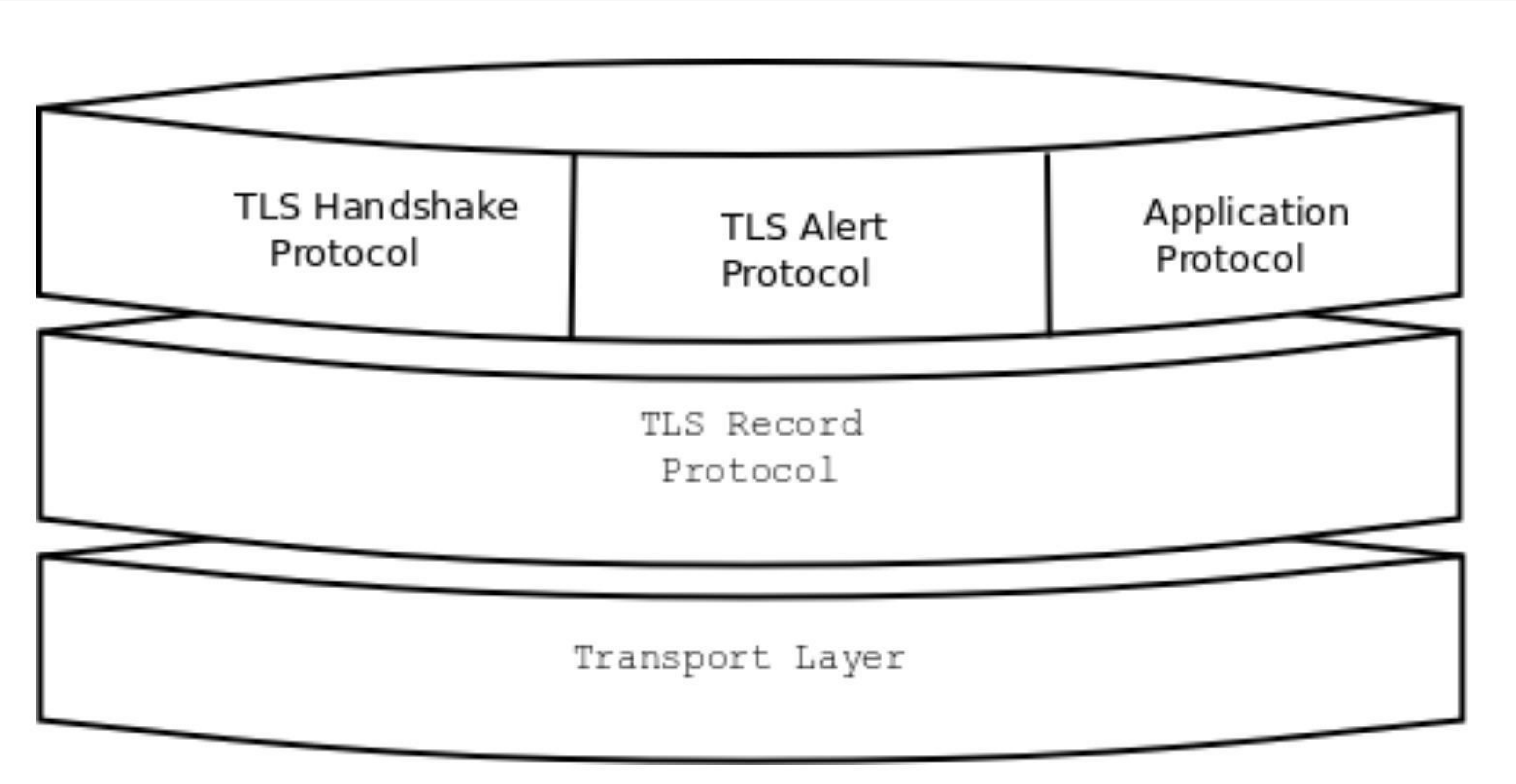
TLS 1.1

- Attempted to fix various problems with TLS 1.0
- CBC IV's (explicit v implicit)
  - Now included in record
  - Prior to1.1, IV was last ciphertext block of previous record
- Padding errors now just return error "bad_record_mac"
- •Sometimes called the forgotten middle child

TLS 1.2

- PRF replaced MD5/SHA1 with cipher suite specific function
- Signatures explicitly identify hashing algorithm
- Support for authenticated encryption
- Changes to resist known attacks against previous versions

TLS 1.2 REVIEW



CONNECTION STATE CONTAINS:

- Connection end –"client" or "server"
- PRFalgorithm
- Bulk encryption algorithm
- MACalgorithm
- Compressionalgorithm
- Master secret
- Client random
- Server random

CONNECTION STATE CONTAINS:

- Compression state
- Cipherstate
- MAC key
- Sequence number

CONNECTION STATE SECURITY PARAMETERS

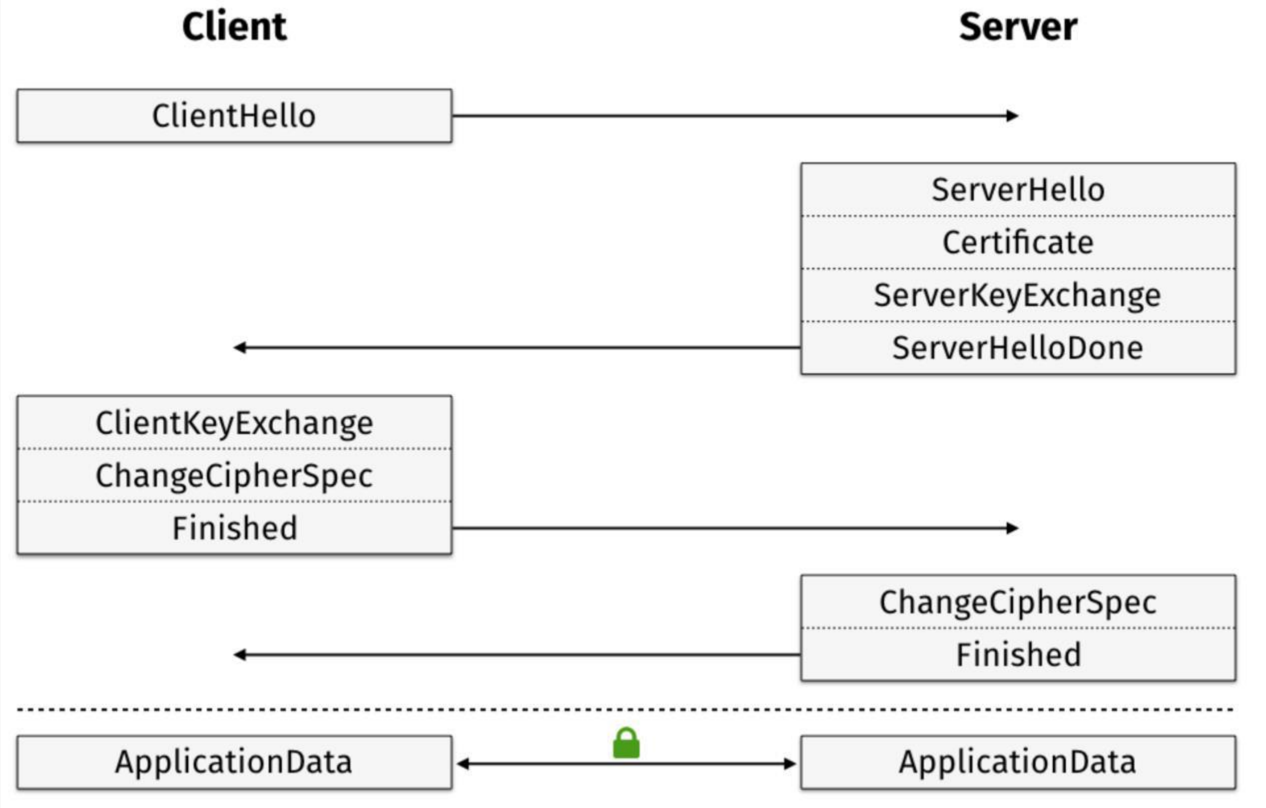
```
struct {
    ConnectionEnd          entity;
    PRFAlgorithm           prf_algorithm;
    BulkCipherAlgorithm    bulk_cipher_algorithm;
    CipherType             cipher_type;
    uint8                  enc_key_length;
    uint8                  block_length;
    uint8                  fixed_iv_length;
    uint8                  record_iv_length;
    MACAlgorithm           mac_algorithm;
    uint8                  mac_length;
    uint8                  mac_key_length;
    CompressionMethod      compression_algorithm;
    opaque                 master_secret[48];
    opaque                 client_random[32];
    opaque                 server_random[32];
} SecurityParameters;
```

DERIVED VALUES

```
The record layer will use the security parameters to generate the
following six items (some of which are not required by all ciphers,
and are thus empty):

   client write MAC key
   server write MAC key
   client write encryption key
   server write encryption key
   client write IV
   server write IV
```

TLS 1.2 HANDSHAKE



CLIENT HELLO

```
struct {
    ProtocolVersion client_version;
    Random random;
    SessionID session_id;
    CipherSuite cipher_suites<2..2^16-2>;
    CompressionMethod compression_methods<1..2^8-1>;
    select (extensions_present) {
        case false:
            struct {};
        case true:
            Extension extensions<0..2^16-1>;
    };
} ClientHello;
```

CLIENT HELLO EXAMPLE

```
Handshake Protocol: Client Hello
    Handshake Type: Client Hello (1)
    Length: 199
    Version: TLS 1.2 (0x0303)
  Random
      GMT Unix Time: Jan 20, 2017 16:26:14.000000000 Eastern Standard Time
      Random Bytes: 2ccacc6176e4b62418b67e3a36cc5b87f8de3ef7696ff56c...
    Session ID Length: 0
    Cipher Suites Length: 56
  Cipher Suites (28 suites)
      Cipher Suite: TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384 (0xc02c)
      Cipher Suite: TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256 (0xc02b)
      Cipher Suite: TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384 (0xc030)
      Cipher Suite: TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256 (0xc02f)
      Cipher Suite: TLS_DHE_RSA_WITH_AES_256_GCM_SHA384 (0x009f)
      Cipher Suite: TLS_DHE_RSA_WITH_AES_128_GCM_SHA256 (0x009e)
      Cipher Suite: TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA384 (0xc024)
      Cipher Suite: TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA256 (0xc023)
      Cipher Suite: TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA384 (0xc028)
      Cipher Suite: TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA256 (0xc027)
      Cipher Suite: TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA (0xc00a)
      Cipher Suite: TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA (0xc009)
      Cipher Suite: TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA (0xc014)
      Cipher Suite: TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA (0xc013)
      Cipher Suite: TLS_DHE_RSA_WITH_AES_256_CBC_SHA (0x0039)
      Cipher Suite: TLS_DHE_RSA_WITH_AES_128_CBC_SHA (0x0033)
      Cipher Suite: TLS_RSA_WITH_AES_256_GCM_SHA384 (0x009d)
      Cipher Suite: TLS_RSA_WITH_AES_128_GCM_SHA256 (0x009c)
      Cipher Suite: TLS_RSA_WITH_AES_256_CBC_SHA256 (0x003d)
      Cipher Suite: TLS_RSA_WITH_AES_128_CBC_SHA256 (0x003c)
      Cipher Suite: TLS_RSA_WITH_AES_256_CBC_SHA (0x0035)
```

TLS 1.2 EXTENSIONS EXAMPLE

```
    Cipher Suite: TLS_RSA_WITH_AES_128_CBC_SHA256 (0x003c)
    Cipher Suite: TLS_RSA_WITH_AES_256_CBC_SHA (0x0035)
    Cipher Suite: TLS_RSA_WITH_AES_128_CBC_SHA (0x002f)
    Cipher Suite: TLS_RSA_WITH_3DES_EDE_CBC_SHA (0x000a)
    Cipher Suite: TLS_DHE_DSS_WITH_AES_256_CBC_SHA256 (0x006a)
    Cipher Suite: TLS_DHE_DSS_WITH_AES_128_CBC_SHA256 (0x0040)
    Cipher Suite: TLS_DHE_DSS_WITH_AES_256_CBC_SHA (0x0038)
    Cipher Suite: TLS_DHE_DSS_WITH_AES_128_CBC_SHA (0x0032)
    Cipher Suite: TLS_DHE_DSS_WITH_3DES_EDE_CBC_SHA (0x0013)
  Compression Methods Length: 1
> Compression Methods (1 method)
  Extensions Length: 102
v Extension: server_name
    Type: server_name (0x0000)
    Length: 16
  v Server Name Indication extension
      Server Name list length: 14
      Server Name Type: host_name (0)
      Server Name length: 11
      Server Name: example.com
> Extension: status_request
> Extension: elliptic_curves
> Extension: ec_point_formats
> Extension: signature_algorithms
> Extension: SessionTicket TLS
```

SERVER HELLO

```
struct {
    ProtocolVersion server_version;
    Random random;
    SessionID session_id;
    CipherSuite cipher_suite;
    CompressionMethod compression_method;
    select (extensions_present) {
        case false:
            struct {};
        case true:
            Extension extensions<0..2^16-1>;
    };
} ServerHello;
```

SERVER CERT/KEY EXCHANGE

```
struct {
    ASN.1Cert certificate_list<0..2^24-1>;
} Certificate;
```

```
struct {
    select (KeyExchangeAlgorithm) {
        case dh_anon:
            ServerDHParams params;
        case dhe_dss:
        case dhe_rsa:
            ServerDHParams params;
            digitally-signed struct {
                opaque client_random[32];
                opaque server_random[32];
                ServerDHParams params;
            } signed_params;
        case rsa:
        case dh_dss:
        case dh_rsa:
            struct {} ;
           /* message is omitted for rsa, dh_dss, and dh_rsa */
        /* may be extended, e.g., for ECDH -- see [TLSECC] */
    };
} ServerKeyExchange;
```

```
struct {
    opaque dh_p<1..2^16-1>;
    opaque dh_g<1..2^16-1>;
    opaque dh_Ys<1..2^16-1>;
} ServerDHParams;     /* Ephemeral DH parameters */
```

CLIENT KEY EXCHANGE

```
struct {
    ProtocolVersion client_version;
    opaque random[46];
} PreMasterSecret;
```

```
struct {
    select (KeyExchangeAlgorithm) {
        case rsa:
            EncryptedPreMasterSecret;
        case dhe_dss:
        case dhe_rsa:
        case dh_dss:
        case dh_rsa:
        case dh_anon:
            ClientDiffieHellmanPublic;
    } exchange_keys;
} ClientKeyExchange;
```

FINISHED

```
struct {
    opaque verify_data[verify_data_length];
} Finished;

verify_data
   PRF(master_secret, finished_label, Hash(handshake_messages))
      [0..verify_data_length-1];
```

verify_data_lengthcanbespecifiedbytheciphersuite, otherwise, is 12.

PRF

- In the base RFC, always uses SHA-256
- Newcipher suites must define their PRF function
- SHOULDuseSHA-256

DATA EXPANSION

```
P_hash(secret, seed) = HMAC_hash(secret, A(1) + seed) +
                       HMAC_hash(secret, A(2) + seed) +
                       HMAC_hash(secret, A(3) + seed) + ...
```

```
A() is defined as:

   A(0) = seed
   A(i) = HMAC_hash(secret, A(i-1))
```

PRF DEFINITION

```
TLS's PRF is created by applying P_hash to the secret as:

   PRF(secret, label, seed) = P_<hash>(secret, label + seed)

The label is an ASCII string.  It should be included in the exact
form it is given without a length byte or trailing null character.
For example, the label "slithy toves" would be processed by hashing
the following bytes:

   73 6C 69 74 68 79 20 74 6F 76 65 73
```

COMPUTING MASTER SECRET

```
master_secret = PRF(pre_master_secret, "master secret",
                    ClientHello.random + ServerHello.random)
                    [0..47];
```

COMPUTING KEYS

```
key_block = PRF(SecurityParameters.master_secret,
                "key expansion",
                SecurityParameters.server_random +
                SecurityParameters.client_random);
```

```
client_write_MAC_key[SecurityParameters.mac_key_length]
server_write_MAC_key[SecurityParameters.mac_key_length]
client_write_key[SecurityParameters.enc_key_length]
server_write_key[SecurityParameters.enc_key_length]
client_write_IV[SecurityParameters.fixed_iv_length]
server_write_IV[SecurityParameters.fixed_iv_length]
```

CHANGE CIPHER SUITE

- Single Byte. Indicates next message will be encrypted

```
TLSv1.2 Record Layer: Change Cipher Spec Protocol: Change Cipher Spec
    Content Type: Change Cipher Spec (20)
    Version: TLS 1.2 (0x0303)
    Length: 1
    Change Cipher Spec Message
```

RECORD LAYER TYPES

```
struct {
    ContentType type;
    ProtocolVersion version;
    uint16 length;
    select (SecurityParameters.cipher_type) {
        case stream: GenericStreamCipher;
        case block:  GenericBlockCipher;
        case aead:   GenericAEADCipher;
    } fragment;
} TLSCiphertext;
```

STREAM/BLOCK DEFS

```
stream-ciphered struct {
    opaque content[TLSCompressed.length];
    opaque MAC[SecurityParameters.mac_length];
} GenericStreamCipher;
```

```
struct {
    opaque IV[SecurityParameters.record_iv_length];
    block-ciphered struct {
        opaque content[TLSCompressed.length];
        opaque MAC[SecurityParameters.mac_length];
        uint8 padding[GenericBlockCipher.padding_length];
        uint8 padding_length;
    };
} GenericBlockCipher;
```

NEW: AEAD TYPE

```
struct {
   opaque nonce_explicit[SecurityParameters.record_iv_length];
   aead-ciphered struct {
       opaque content[TLSCompressed.length];
   };
} GenericAEADCipher;
```

AEAD

- Authenticated Encryption with Additional Data
- Plaintext is simultaneously encrypted and integrity protected.
- Default TLS 1.2 algorithms: CCM and GCM
- No MAC key

```
AEADEncrypted = AEAD-Encrypt(write_key, nonce, plaintext,
                             additional_data)
```

```
additional_data = seq_num + TLSCompressed.type +
                  TLSCompressed.version + TLSCompressed.length;
```

TLS 1.2 ATTACKS

- ROBOT
  - Return Of Bleichenbacher's Oracle Threat
- Applies primarily to RSA encryption (not signatures)
- The RSA encryption in TLS 1.2 uses PKCS 1.5 padding
- Known padding oracle attack
- •Countermeasures built in to TLS 1.2, rather than disabling
- •Countermeasures are complicated, and many are vulnerable

TLS 1.3

- Algorithms are ALL authenticated encryption
- Handshake messages after the ServerHelloare now encrypted
- Key derivation based off Extract-and-Expand Key Derivation Function (HKDF)
- Compression, custom DHE groups, and DSA removed
- RSA signature padding now uses PSS

TLS 1.3 HANDSHAKE