Security

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Cryptography

- Why Cryptography
- Symmetric Encryption
  - Key exchange
- Public-Key Cryptography
  - Key exchange
  - Certification

Why Cryptography

- General Security Goal

  - Confidentiality
  - Message Integrity
  - End-point Authentication
  - Operational security

Potentially Threats

- Eaves dropping
- Modification, insertions, deletion
- Masquerade
- Playback
- Man-in-a-middle-attack
- DDoS (ie. SYN-flooding)

Cryptography - general

- To send messages over a network,
  which is unable to understand for a third part
- General technique:
  - Plain text
  - Encode (algorithm + key)
  - Cipher text (send over the network)
  - Decode (algorithm + key)
  - Plain text

Cryptography - coding

- Old days simple letter transformation
  e.g. **c** for an **a** and **d** for a **b** and so on
  i.e. ape -> crg
- To day
  - Symmetric key
  - Public-private keys

How to break encryption

- Force brute
  - Try combinations
    - Ciphertext-only attack – try all
    - Known-plaintext Attack – know few word in text
    - Chosen-plaintext Attack – know one full text

Cryptography - Symmetric

- Using the same key to encode and decode
- Which goal are fulfilled ?
  - Confidentiality
  - Authentication
  - Integrity
  - Operational security

-Confidentiality – yes
- Authentication - yes
- Integrity - yes
- Operational security - no

Cryptography - Symmetric

- Implementations:
  - DES (Data Encryption Standard) most known
    (round 4 min)
    today modified to triple DES
    key length 64bit (3*64 bit)
  - Other IDEA, RC5
    to day even 128 bit (round 149 trillion year)

Cryptography - Symmetric

- Key exchange:
  - Problem to exchange the key
    - we can not send it with a mail
    - then it would not be secret any longer
  - Using a Key Distribution Center (KDC)
    - I have an agreement with the KDC
      and with this an secret key.
    - So have all I communicate with.

Cryptography - Symmetric

- Windows use Symmetric key in an implementation called Kerberos:
  - All like KDC but you get grant (a key) to a resource for a certain time (all called a ticket)

Cryptography Asymmetric

- Using the different keys to encode and decode
- You always have a pair of keys
  a public key and a private key

- If you encode with a public key – you must
  decode with a private key

- If you encode with a private key – you must
  decode with a public key

Cryptography Asymmetric

Which goal are fulfilled from A to B (B public Key)?

- Confidentiality
- Authentication
- Integrity
- Operational security

-Confidentiality – yes
-Authentication - no
- Integrity - no
- Operational security - no

Cryptography Asymmetric

Which goal are fulfilled from A to B (A private Key)?

- Confidentiality
- Authentication
- Integrity
- Operational security

-Confidentiality – no
- Authentication - yes
- Integrity - yes
- Operational Security - no

Cryptography Asymmetric

Can we fulfilled both

- Confidentiality and
- Authentication
- Integrity

?

YES – encode with A private key and then with B public key i.e. twice

Cryptography Asymmetric

- Implementations:
  - RSA – most known
    key length recommended 1024bit (2048bit)
  - (512 bit brute force approx. 5 month)

Cryptography Asymmetric

- Key exchange:
  - Problem to exchange the key
    - public key are public to everyone
    - But do we believe the sender of the key
  - Using Certification
    - I believe in some Certification Authorities
      e.g. VeriSign, Thrust, (in DK TDC)
    - get the public key from one of those trusted third part companies.

Cryptography Asymmetric

- To fulfilled the goal you must encode 2 times (A private and B public)
- A more easy way is to create a Message Digest (MD) a sort of a checksum
- And this ‘checksum’ are encoded with A’s private key (Digital Signature). Then the whole message + the MD are encoded with B’s public key

Cryptography Asymmetric

- For authentication :
  - Message Authentication Code (MAC)
    - Both sides – shared secret (s)
    - Send m + H(m+s)
    - Check m+s hached == H(m+s)
  - Fill with Nonsens

Cryptography Mixed

- Using asymmetric keys to exchange a symmetric key
- Then use this symmetric key for rest of this session.

This increase the speed of encryption and decryption.

Secure connections examples

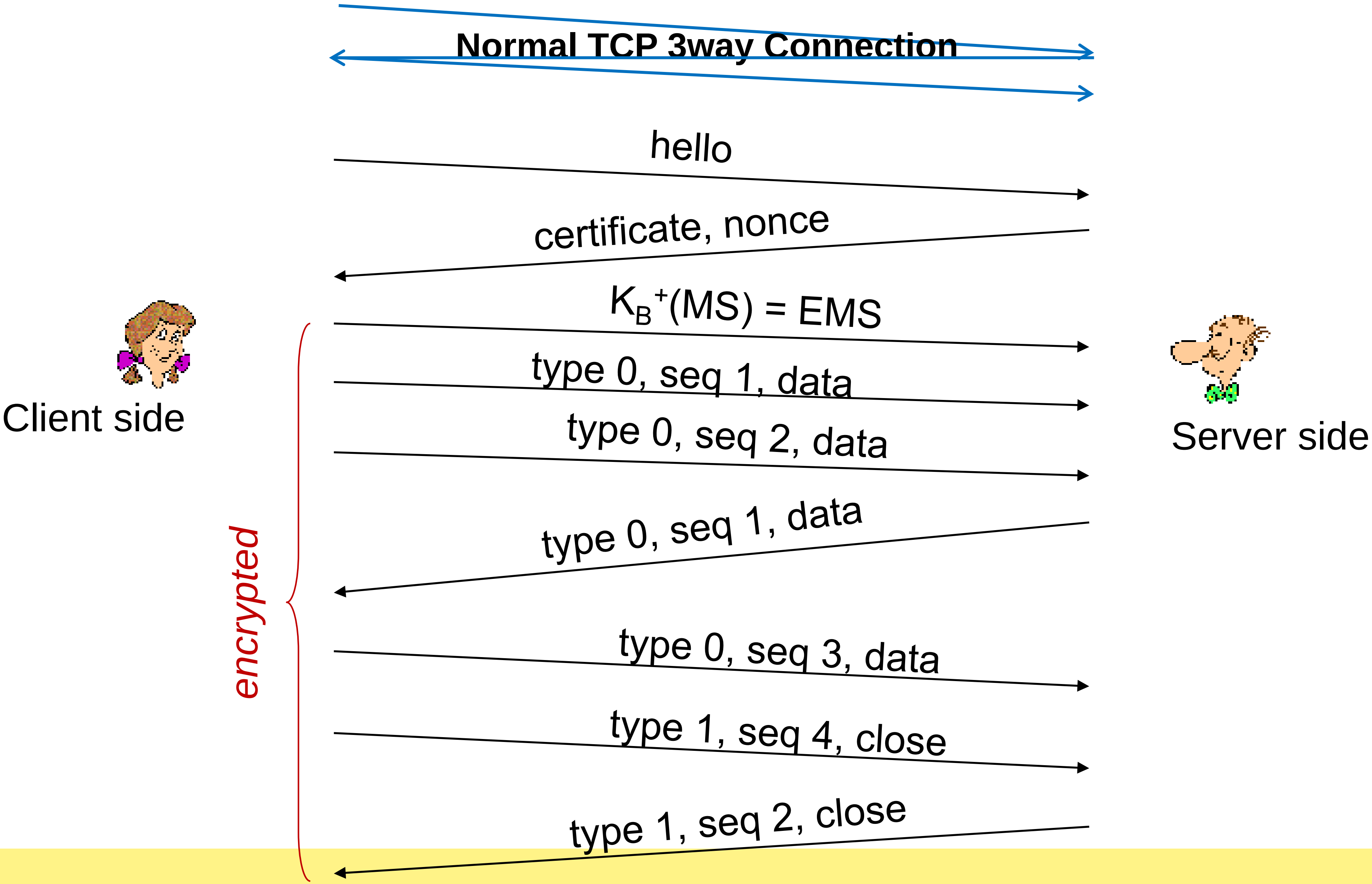
Application Layer	Email – Pretty Good Privacy
Transport Layer	Secure Socket Layer
Network Layer	Ipsec (VPN)
DataLink Layer	Wifi – WEP (not part of curriculum)
Physical Layer	N/A

Secure Transport layer - Secure Socket Layer (SSL)

- SSL support Confidential (HTTP**S** is based on SSL)
- SSL ***can*** *support Integrity*

- Four keys (part of EMS – Encrypted Master Secret):
  - K_c = encryption key for data sent from client to server
  - M_c = MAC key for data sent from client to server
  - K_s = encryption key for data sent from server to client
  - M_s = MAC key for data sent from server to client

Secure Transport layer - Secure Socket Layer (SSL)


Normal TCP 3way Connection
hello
certificate, nonce
$K_B^+(MS) = EMS$
type 0, seq 1, data
type 0, seq 2, data
type 0, seq 1, data
type 0, seq 3, data
type 1, seq 4, close
type 1, seq 2, close
encrypted
Client side
Server side