Chapter 8 roadmap

8.1 What is network security?
8.2 Principles of cryptography
8.3 Message integrity
8.4 Securing e-mail
8.5 Securing TCP connections: SSL
8.6 Network layer security: IPsec
8.7 Securing wireless LANs
8.8 Operational security: firewalls and IDS

SSL: Secure Sockets Layer

- Widely deployed security protocol
  - Supported by almost all browsers and web servers
  - https
  - Tens of billions $ spent per year over SSL
- Originally designed by Netscape in 1993
- Number of variations:
  - TLS: transport layer security, RFC 2246
- Provides
  - Confidentiality
  - Integrity
  - Authentication
- Original goals:
  - Had Web e-commerce transactions in mind
  - Encryption (especially credit-card numbers)
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  - Minimum hassle in doing business with new merchant
- Available to all TCP applications
  - Secure socket interface

SSL/TLS

SSL/TLS

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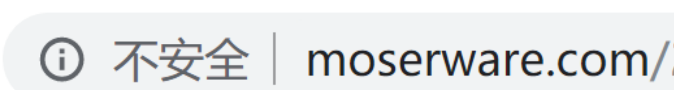
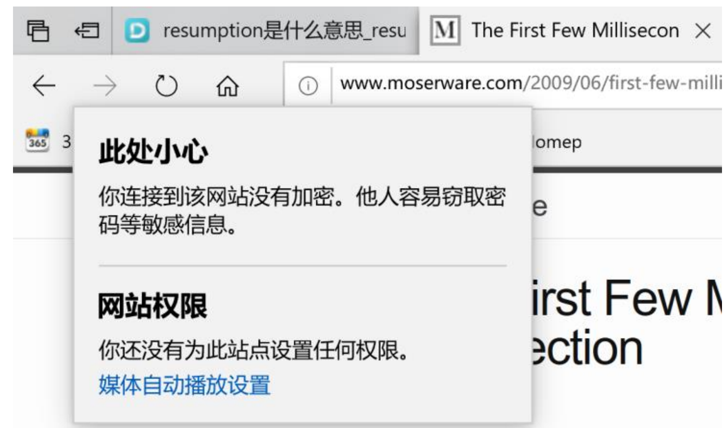


MS Edge:



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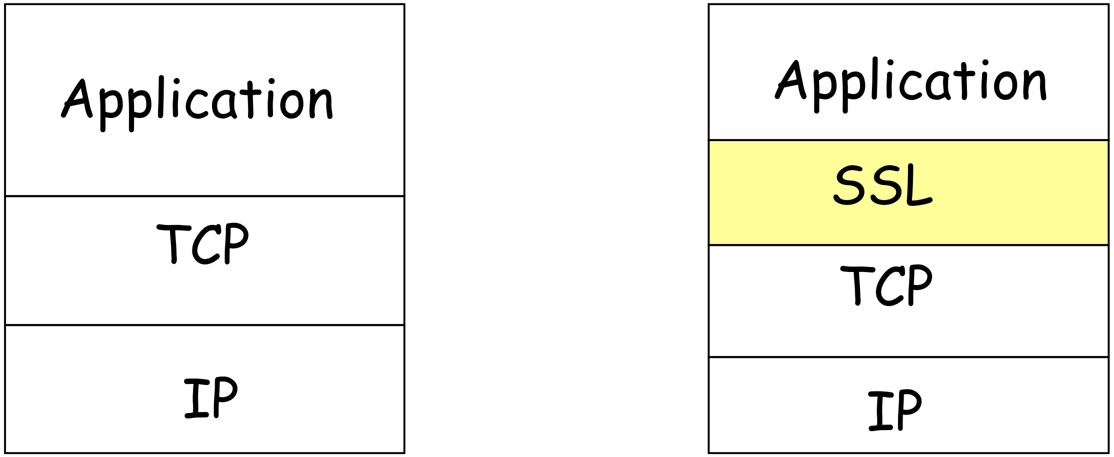
SSL and TCP/IP

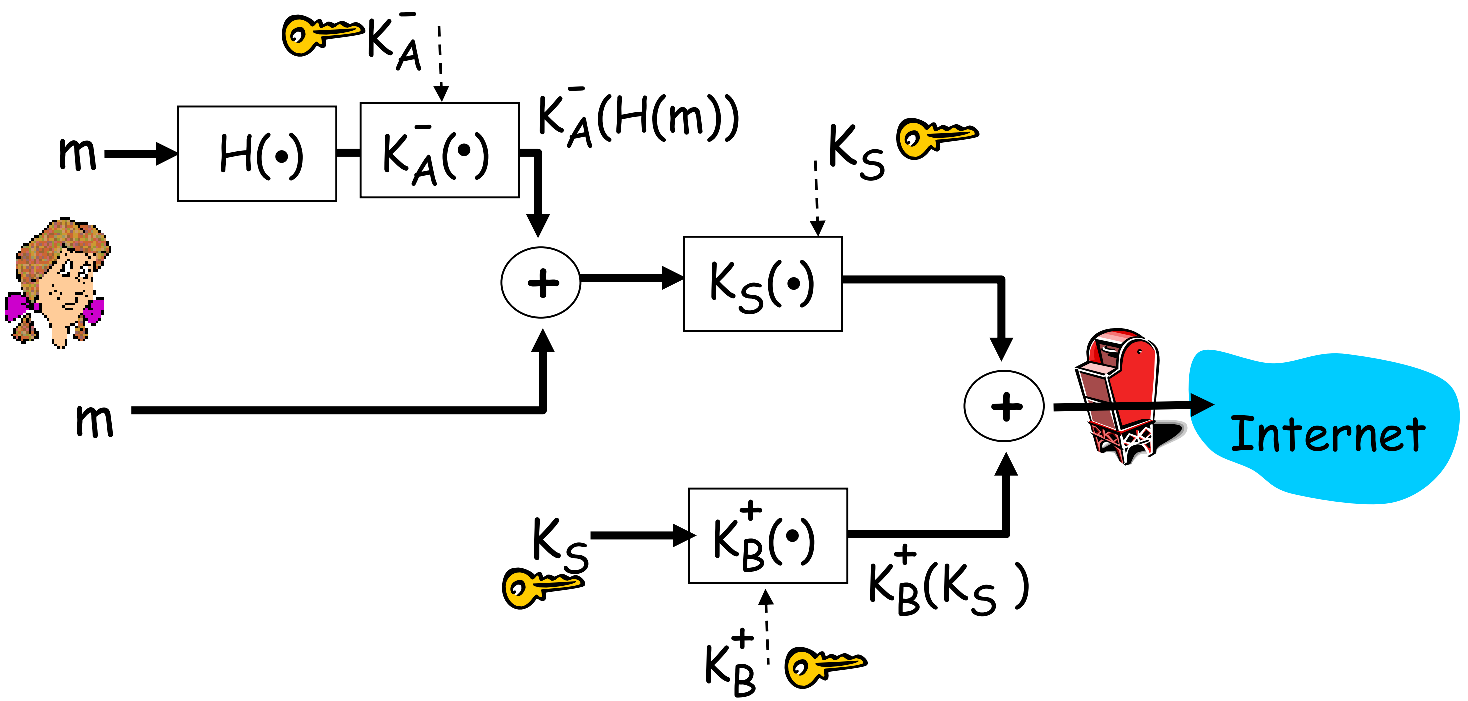


Normal Application

Application with SSL

- SSL provides application programming interface (API) to applications
- C and Java SSL libraries/classes readily available

Could do something like PGP:



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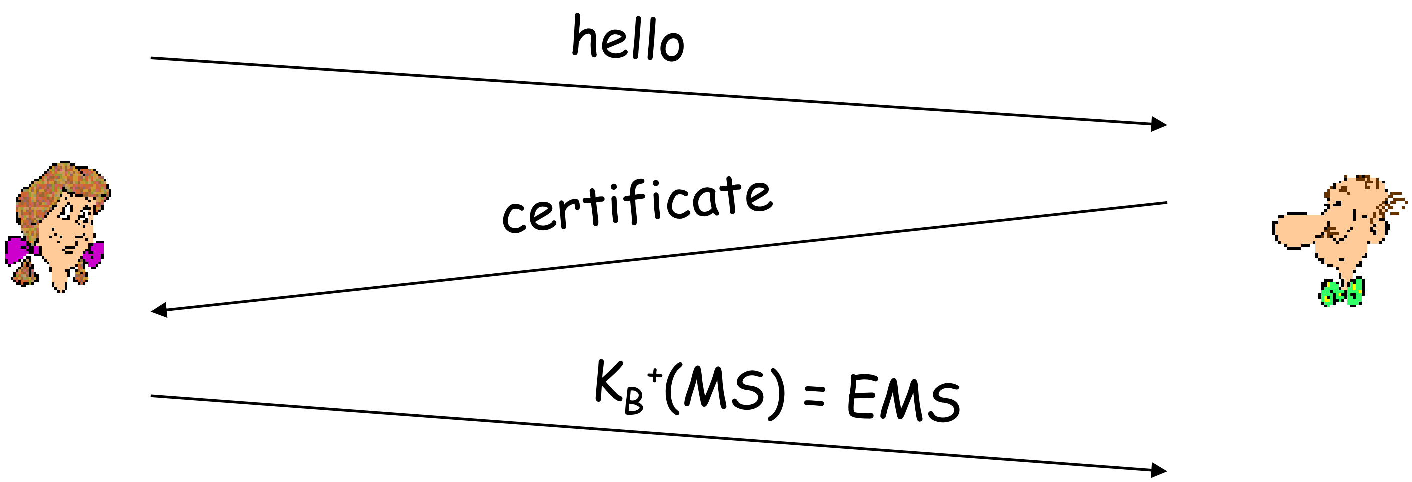

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  - Use different keys for message authentication code (MAC) and encryption
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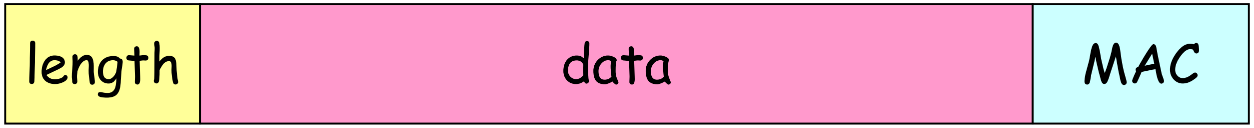

Toy: Sequence Numbers

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- Truncation attack:
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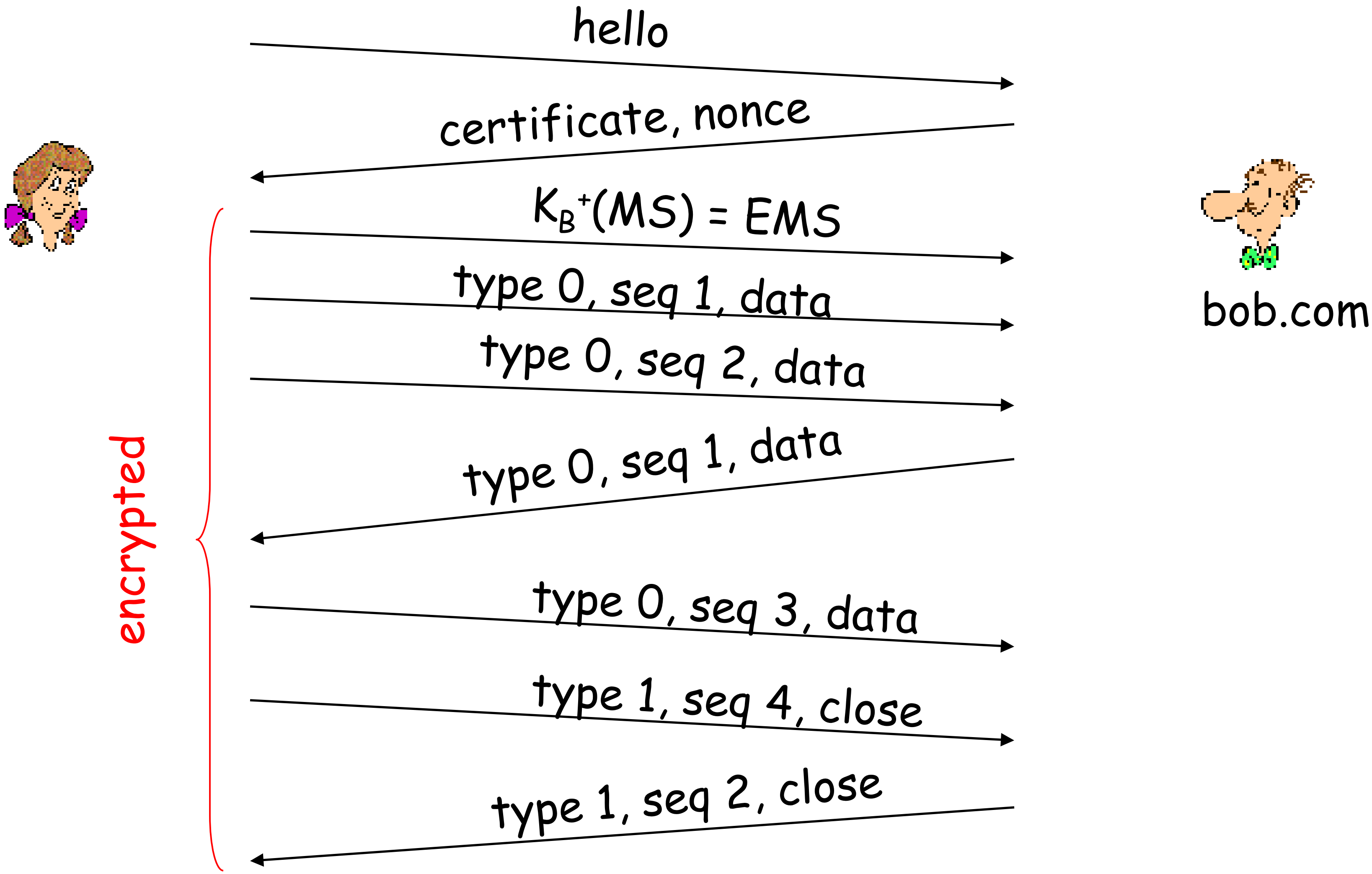
Toy SSL: summary



Toy SSL isn't complete

- How long are the fields?
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SSL Cipher Suite

- Cipher Suite
  - Public-key algorithm
  - Symmetric encryption algorithm
  - MAC algorithm
- SSL supports a variety of cipher suites
- Negotiation: client and server must agree on cipher suite
- Client offers choice; server picks one

Real SSL: Handshake (1)

Purpose

1. Server authentication
2. Negotiation: agree on crypto algorithms
3. Establish keys
4. Client authentication (optional)

Real SSL: Handshake (2)

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2. Server chooses algorithms from list; sends back: choice + certificate + server nonce
3. Client verifies certificate, extracts server's public key, generates pre_master_secret, encrypts with server's public key, sends to server
4. Client and server independently compute encryption and MAC keys from pre_master_secret and nonces
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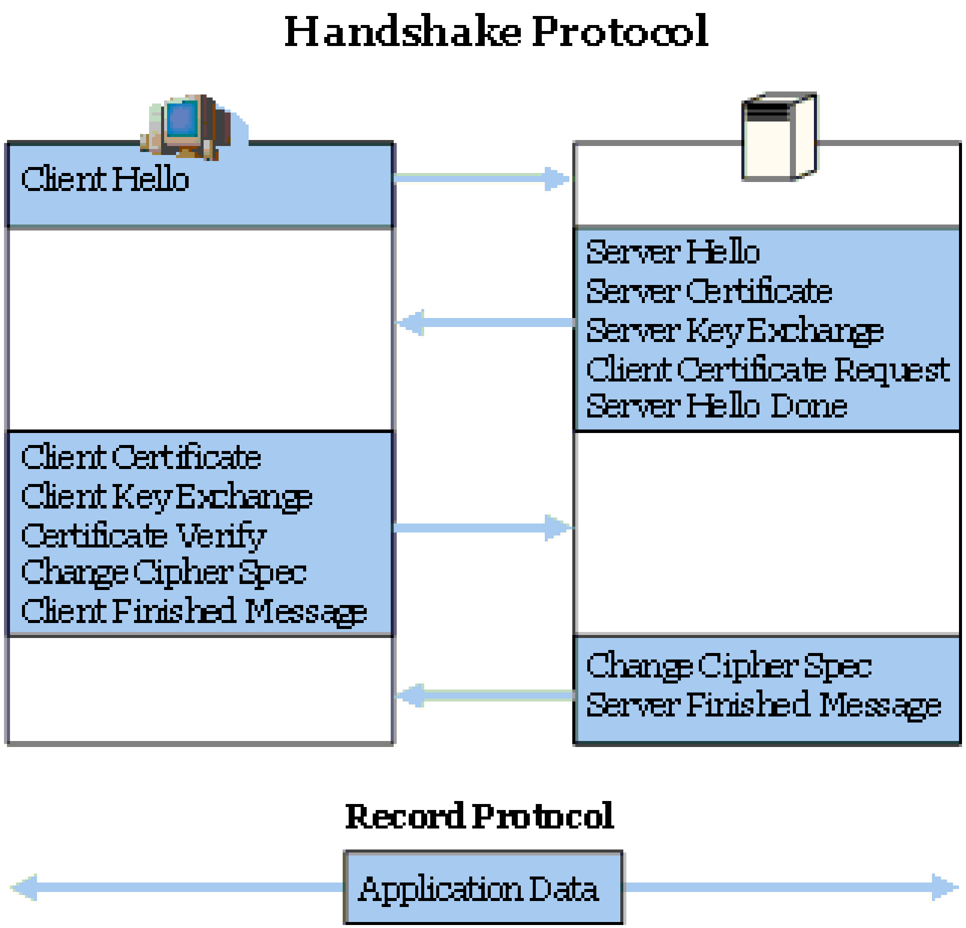
Real SSL: Handshaking (5)



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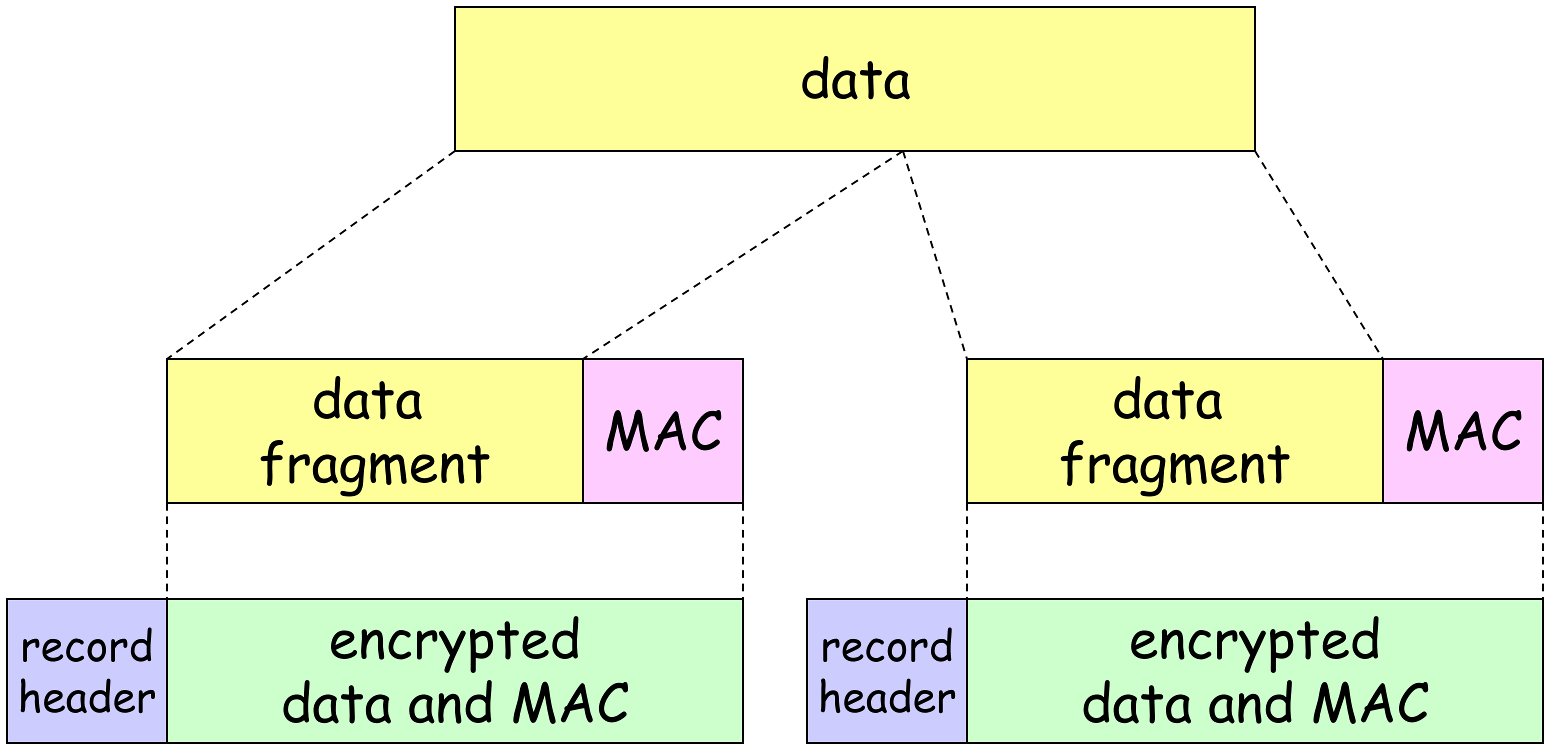

record header: content type; version; length

MAC: includes sequence number, MAC key M_x

Fragment: each SSL fragment 2^{14} bytes (~16 Kbytes)

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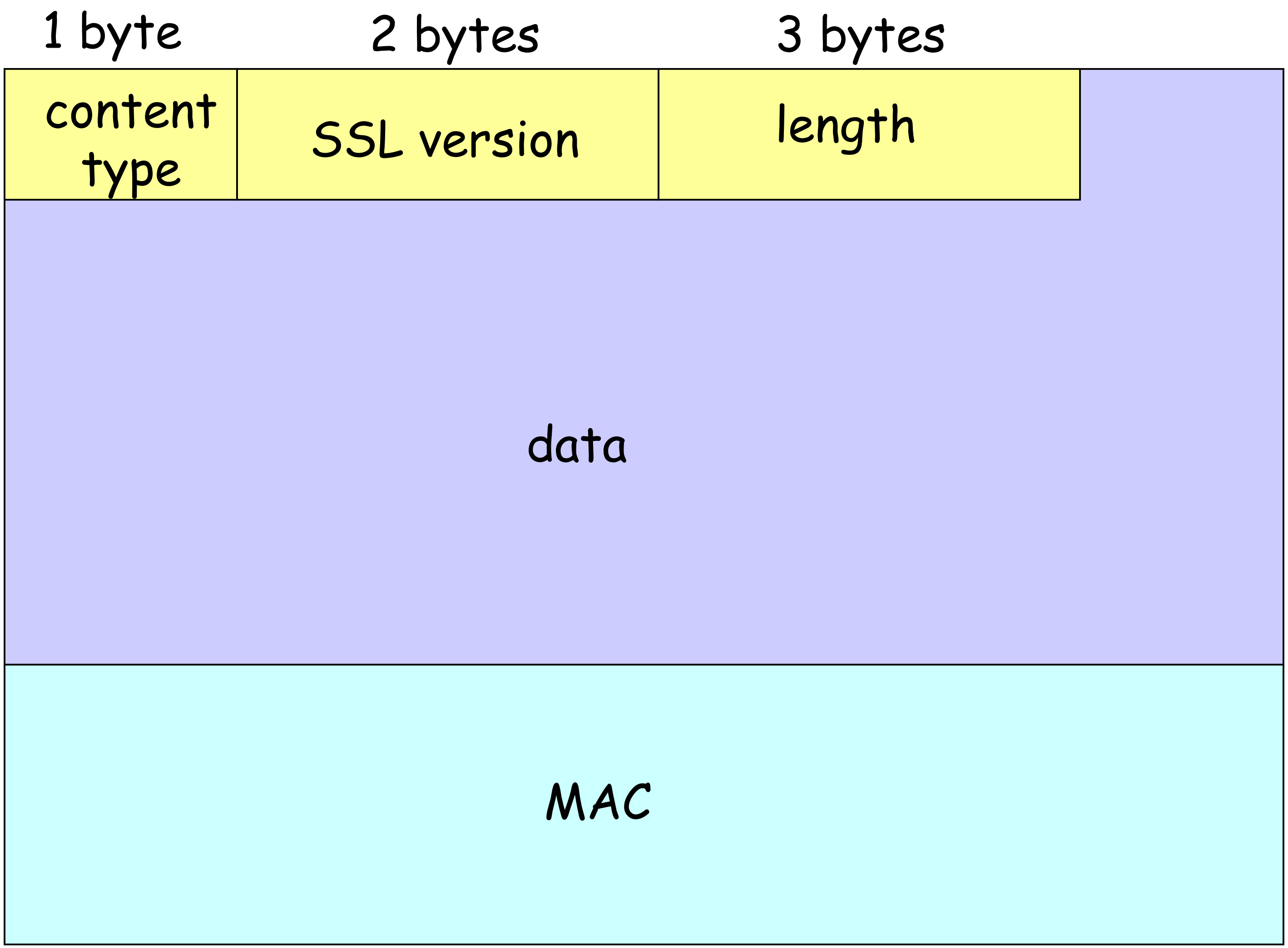
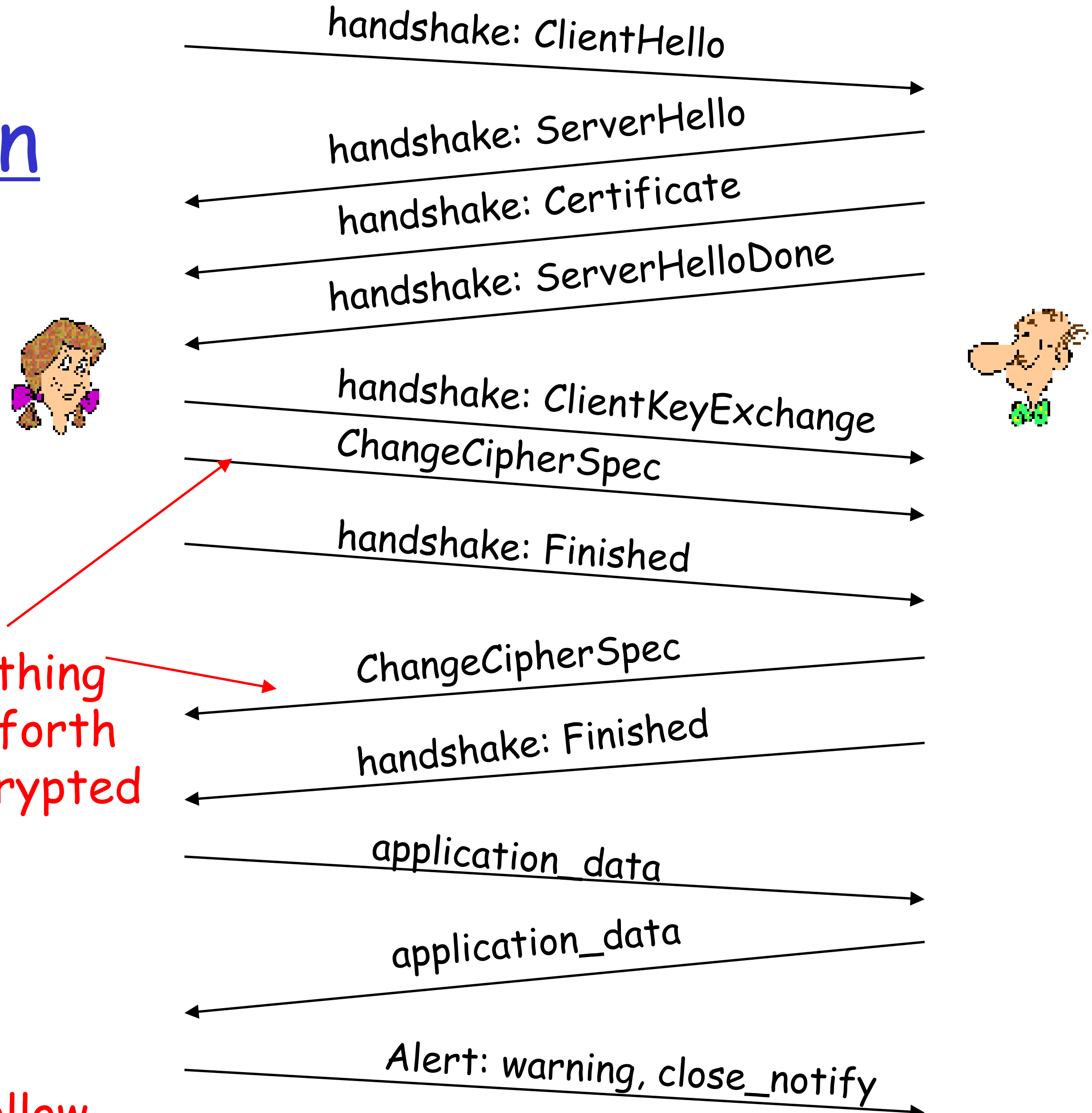


Data and MAC encrypted (symmetric algo)

Real Connection



Everything henceforth is encrypted

TCP Fin follow

Key derivation

- Client nonce, server nonce, and pre-master secret input into pseudo random-number generator.
  - Produces master secret
- Master secret and new nonces inputed into another random-number generator: “key block”
  - Because of resumption: TBD
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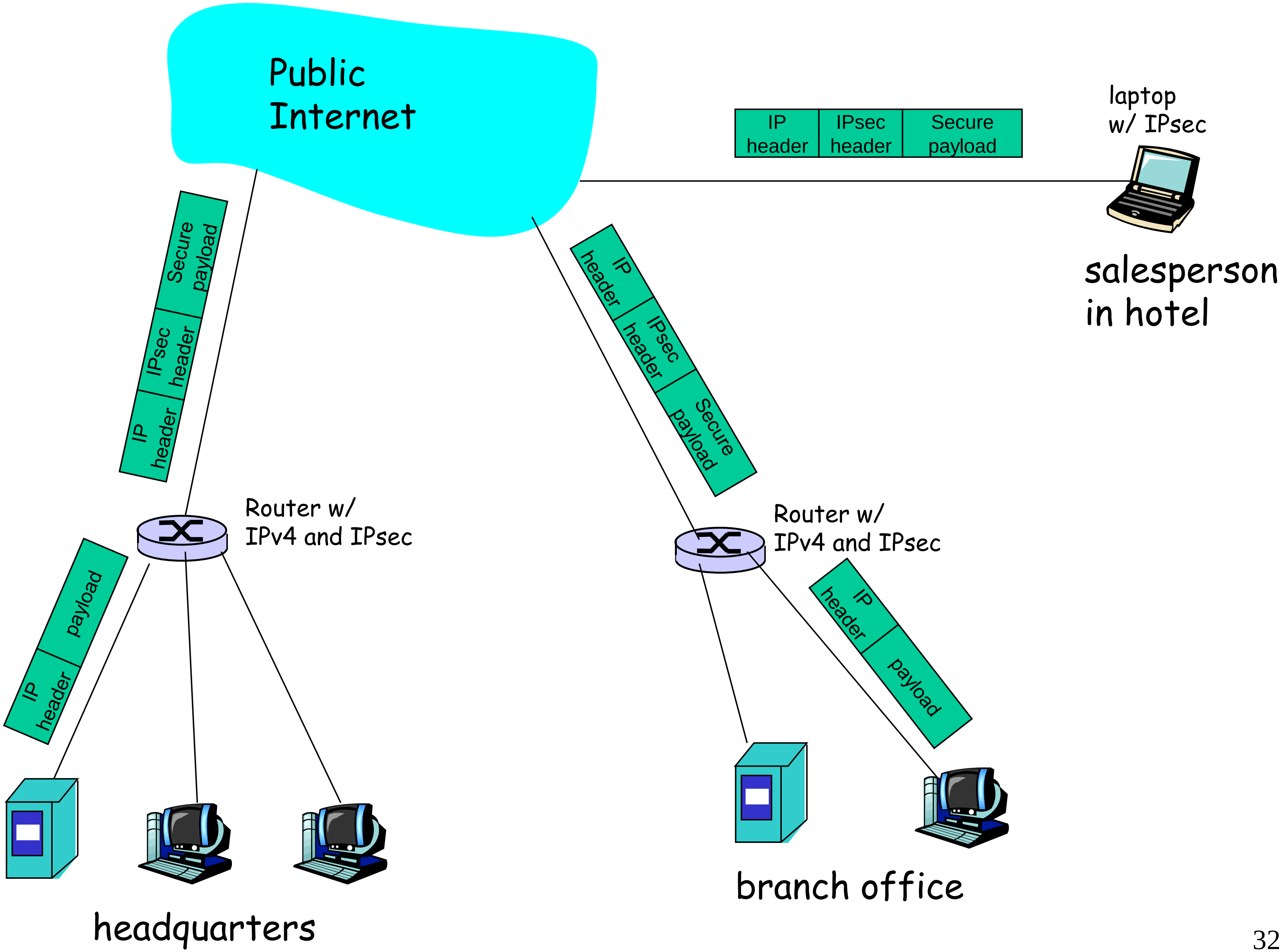
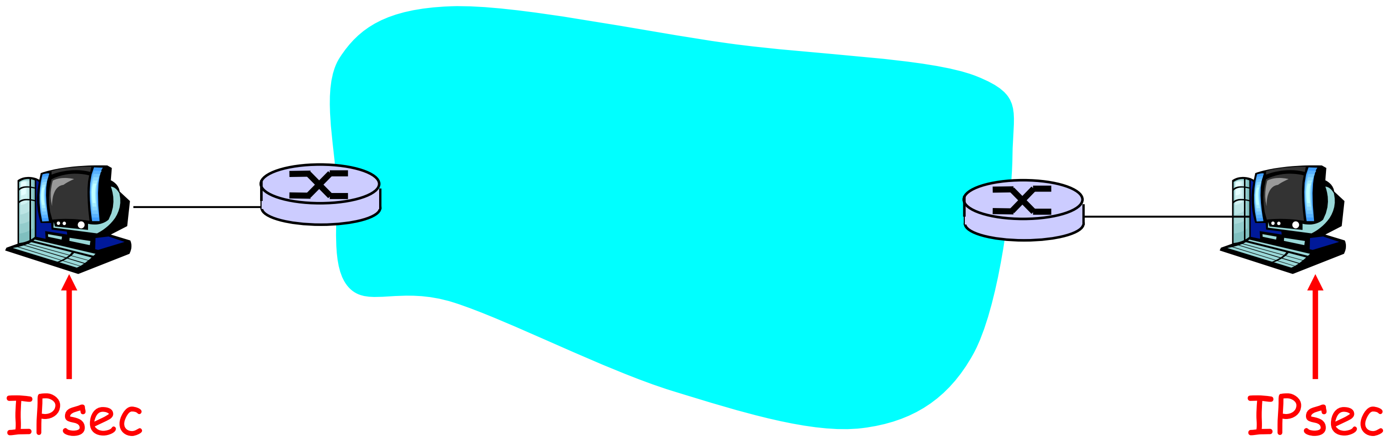


IPsec services

- Data integrity
- Origin authentication
- Replay attack prevention
- Confidentiality

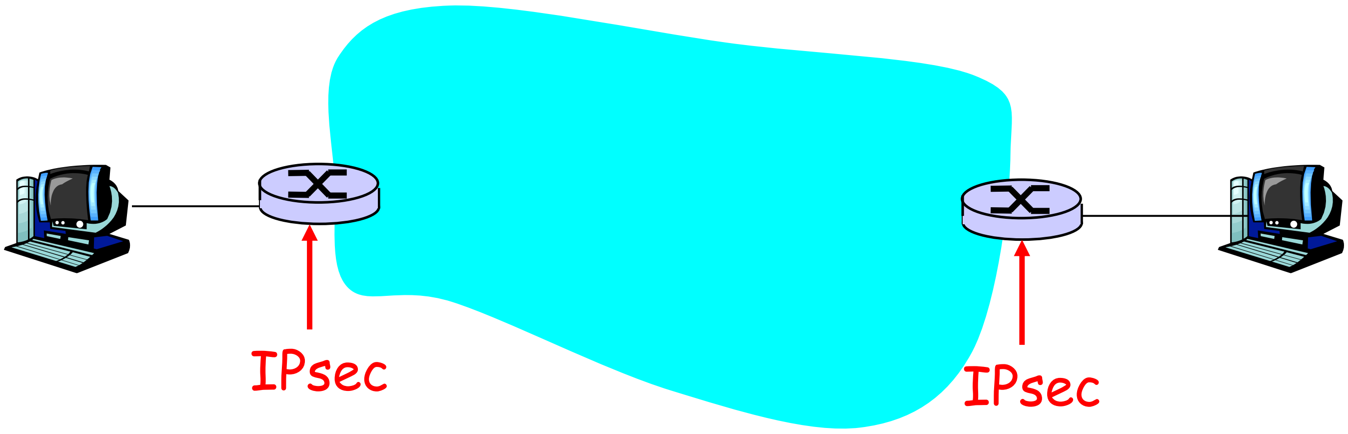
- Two protocols providing different service models:
  - AH
  - ESP

IPsec Transport Mode



- IPsec datagram emitted and received by end-system.
- Protects upper level protocols

IPsec - tunneling mode (1)



- End routers are IPsec aware. Hosts need not be.

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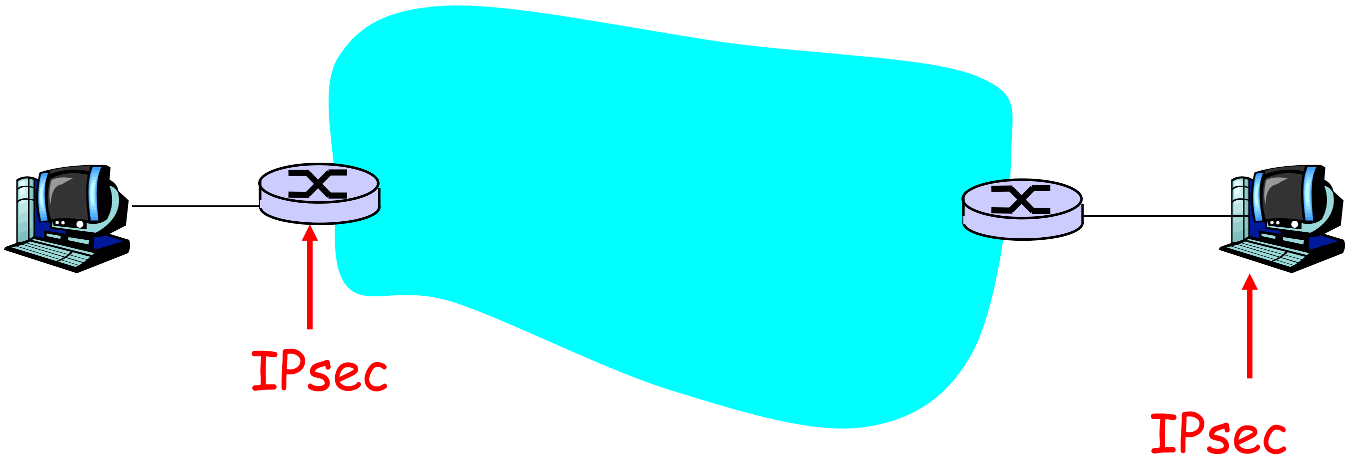

- Also tunneling mode.

Two protocols

- Authentication Header (AH) protocol
  - provides source authentication & data integrity but *not* confidentiality
- Encapsulation Security Protocol (ESP)
  - provides source authentication,data integrity, *and confidentiality*
  - more widely used than AH

Four combinations are possible!

Host mode with AH	Host mode with ESP
Tunnel mode with AH	Tunnel mode with ESP

Most common and most important

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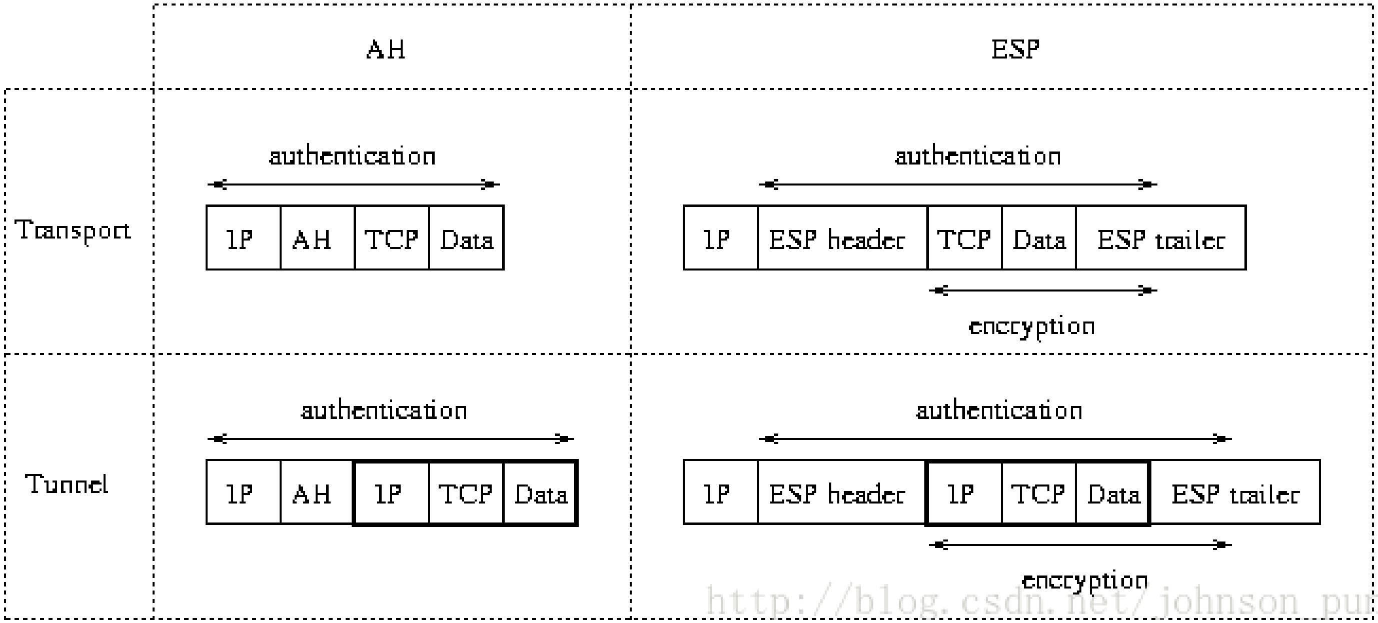

Network Security (summary)

Basic techniques......

- cryptography (symmetric and public)
- message integrity
- end-point authentication

.... used in many different security scenarios

- secure email
- secure transport (SSL)
- IP sec
- 802.11

Operational Security: firewalls and IDS

Chapter 8 roadmap

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  - https
  - Tens of billions $ spent per year over SSL
- Originally designed by Netscape in 1993
- Number of variations:
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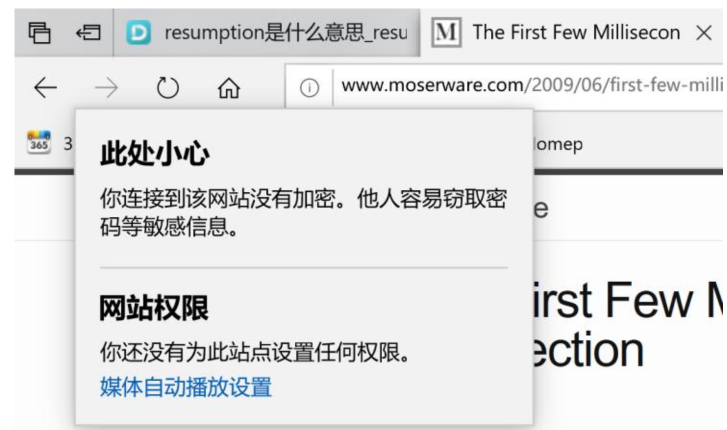
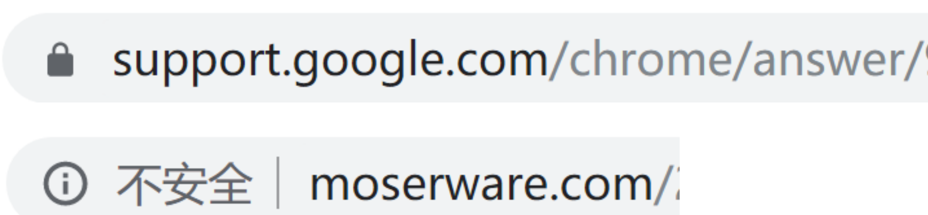


Chrome:



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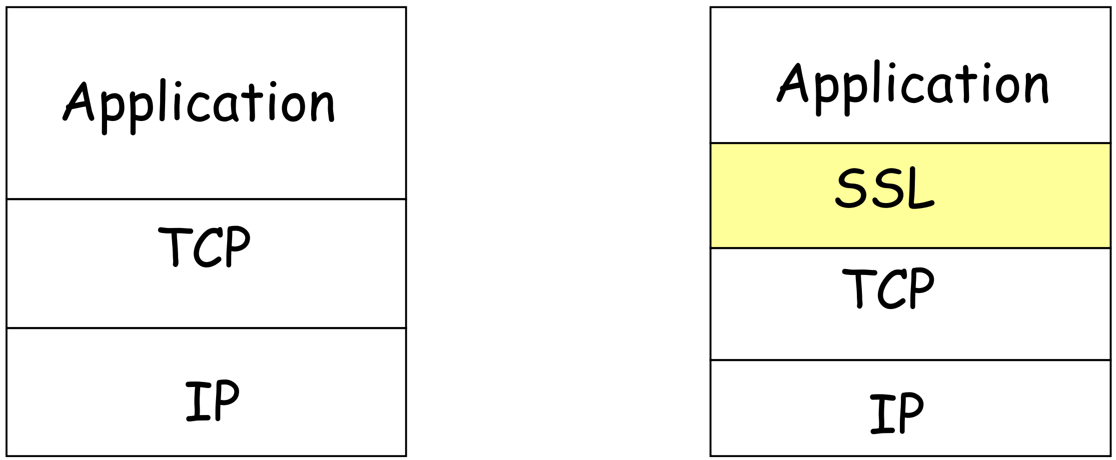

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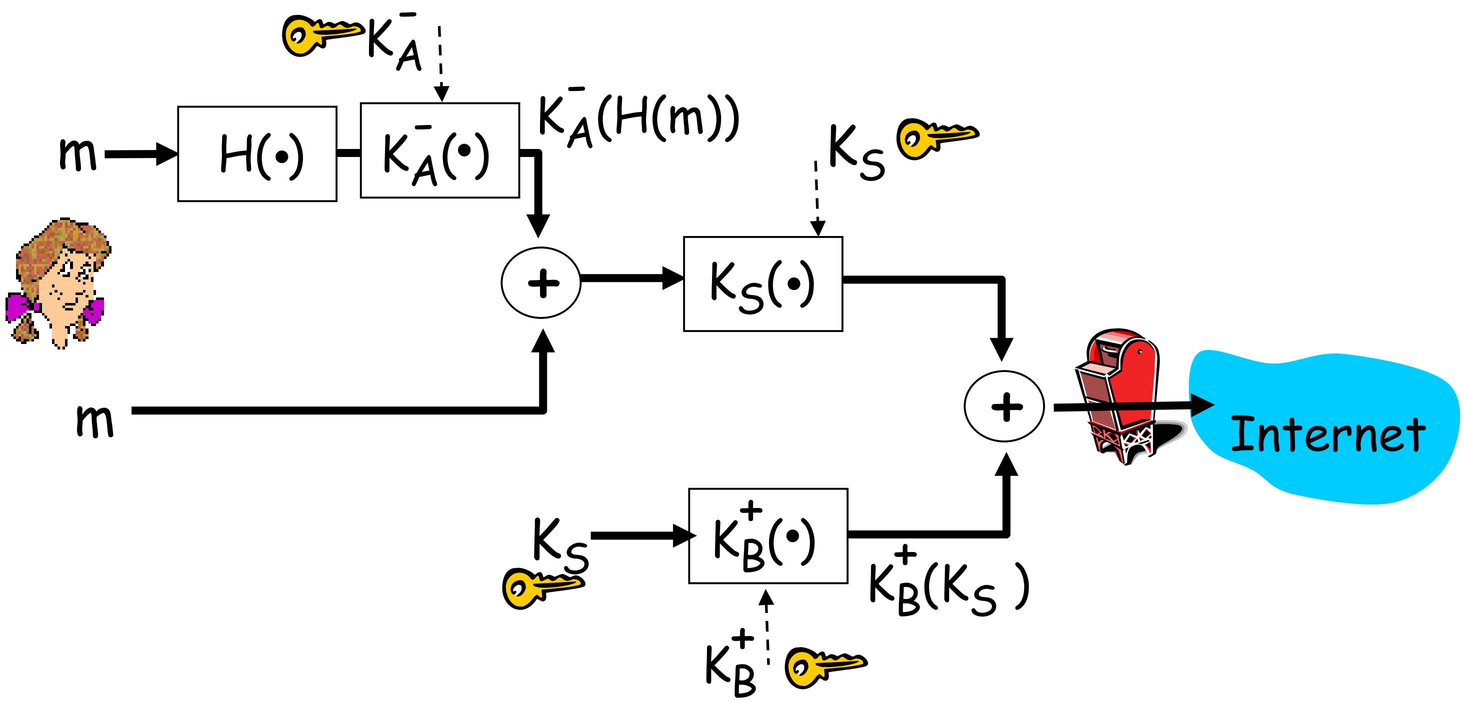

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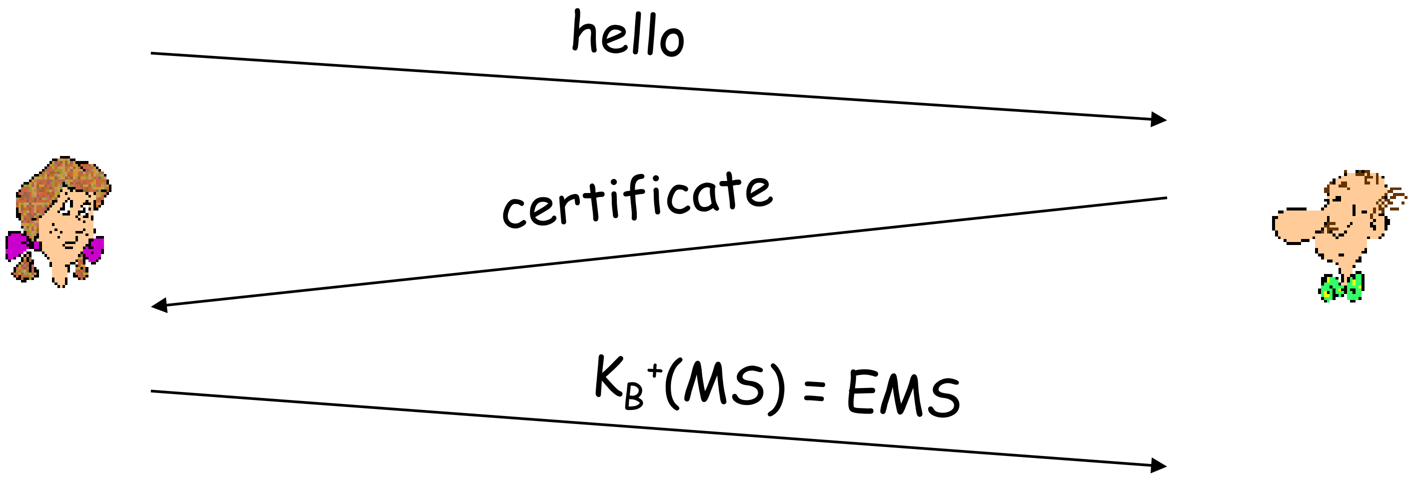

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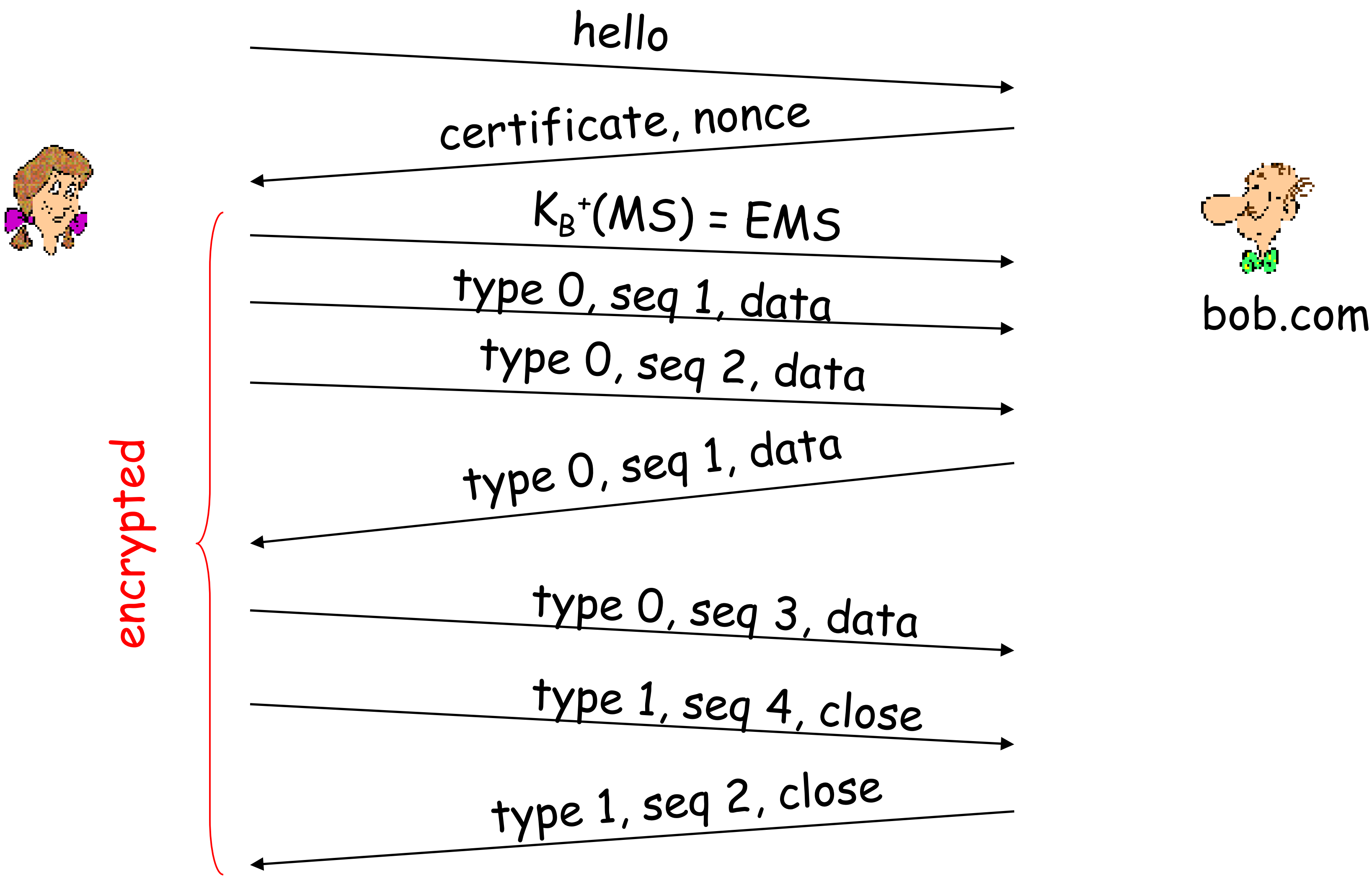

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Public key encryption

- RSA

SSL Cipher Suite

- Cipher Suite
  - Public-key algorithm
  - Symmetric encryption algorithm
  - MAC algorithm
- SSL supports a variety of cipher suites
- Negotiation: client and server must agree on cipher suite
- Client offers choice; server picks one

Real SSL: Handshake (1)

Purpose

1. Server authentication
2. Negotiation: agree on crypto algorithms
3. Establish keys
4. Client authentication (optional)

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Real SSL: Handshaking (3)

Last 2 steps protect handshake from tampering

- Client typically offers range of algorithms, some strong, some weak
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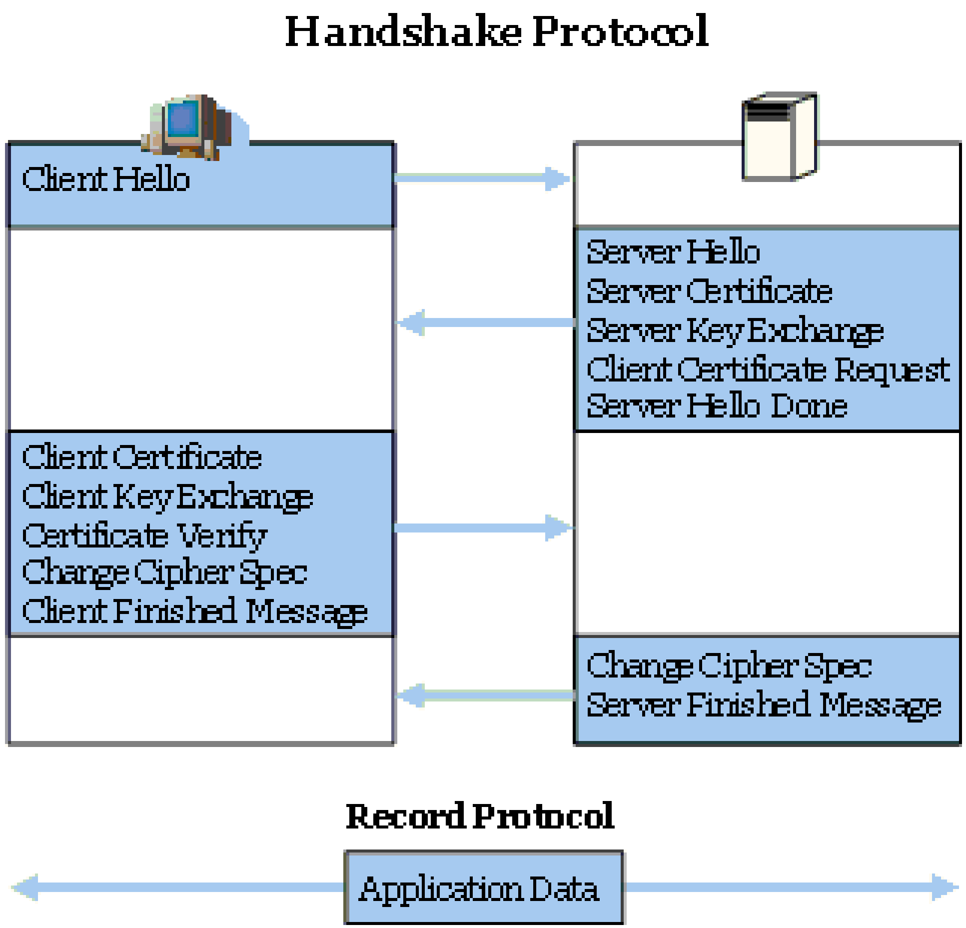
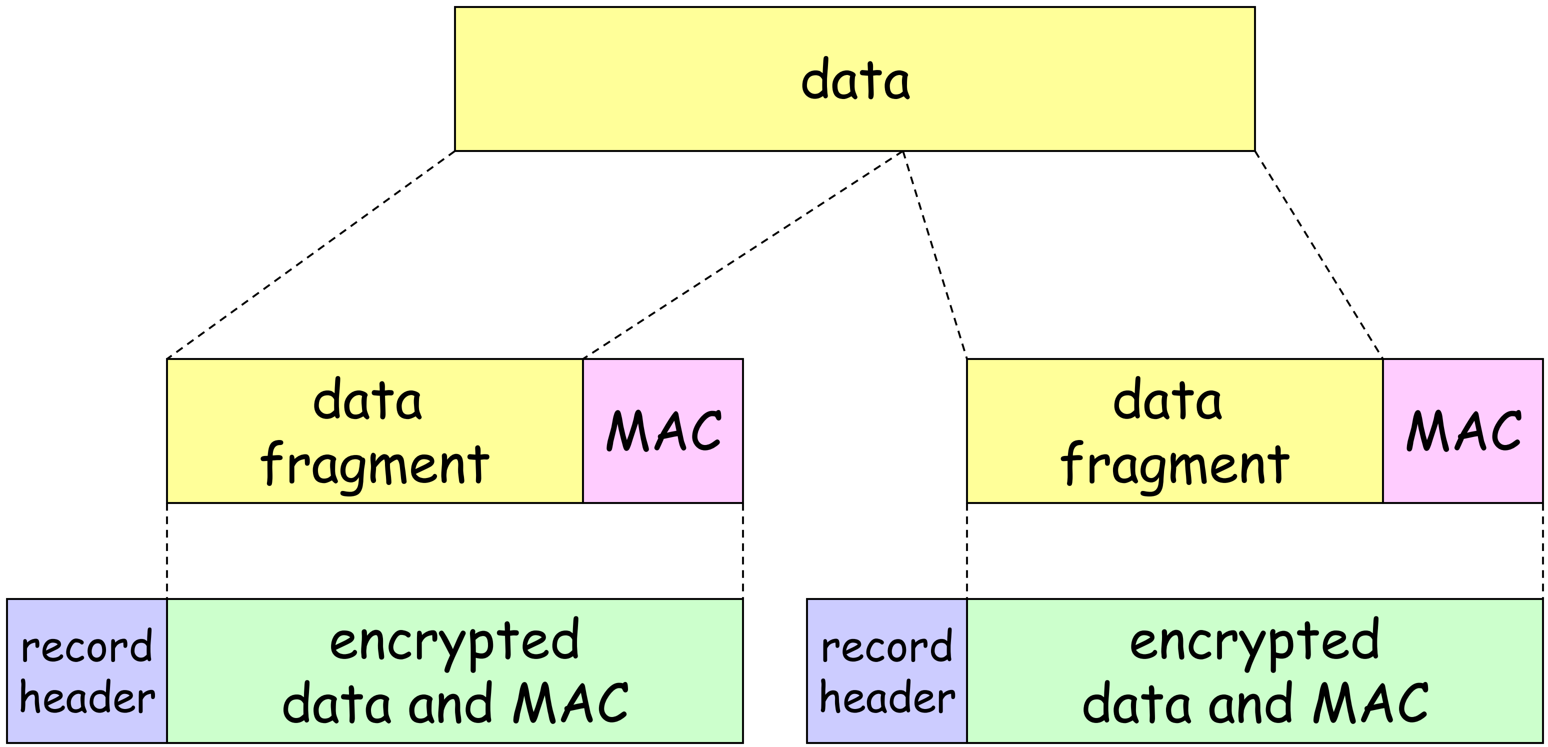


SSL Record Protocol



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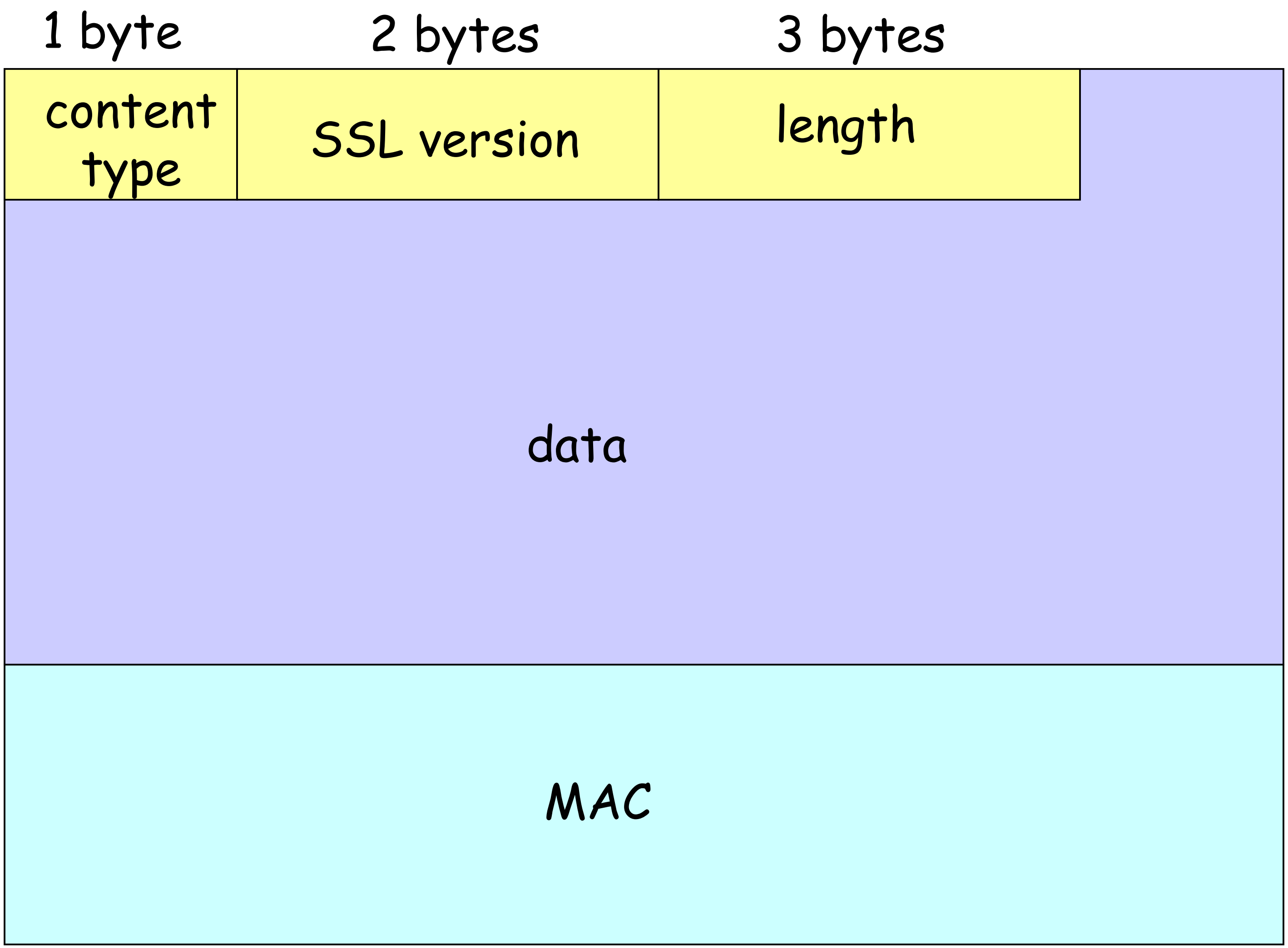
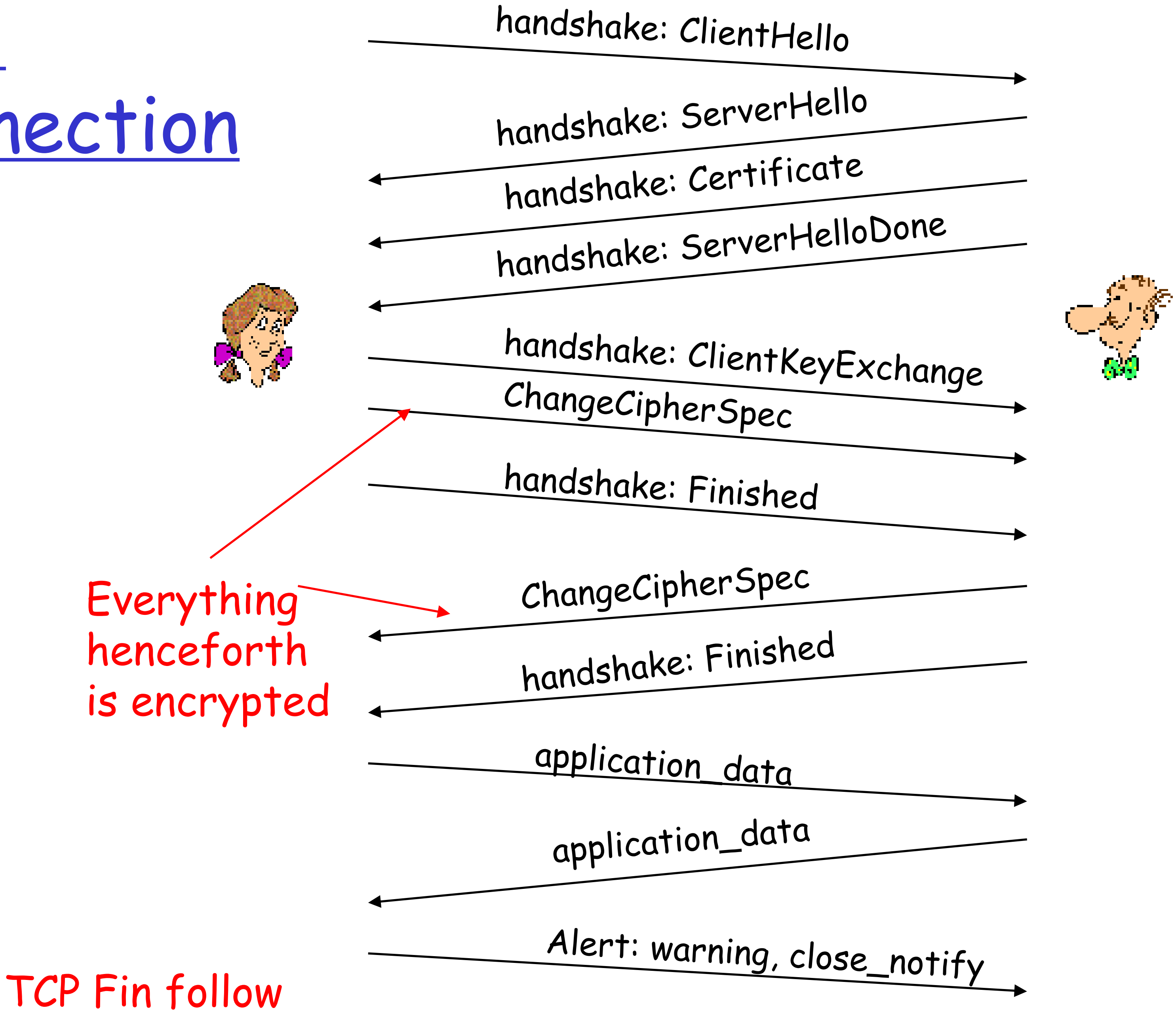


Data and MAC encrypted (symmetric algo)

Real Connection



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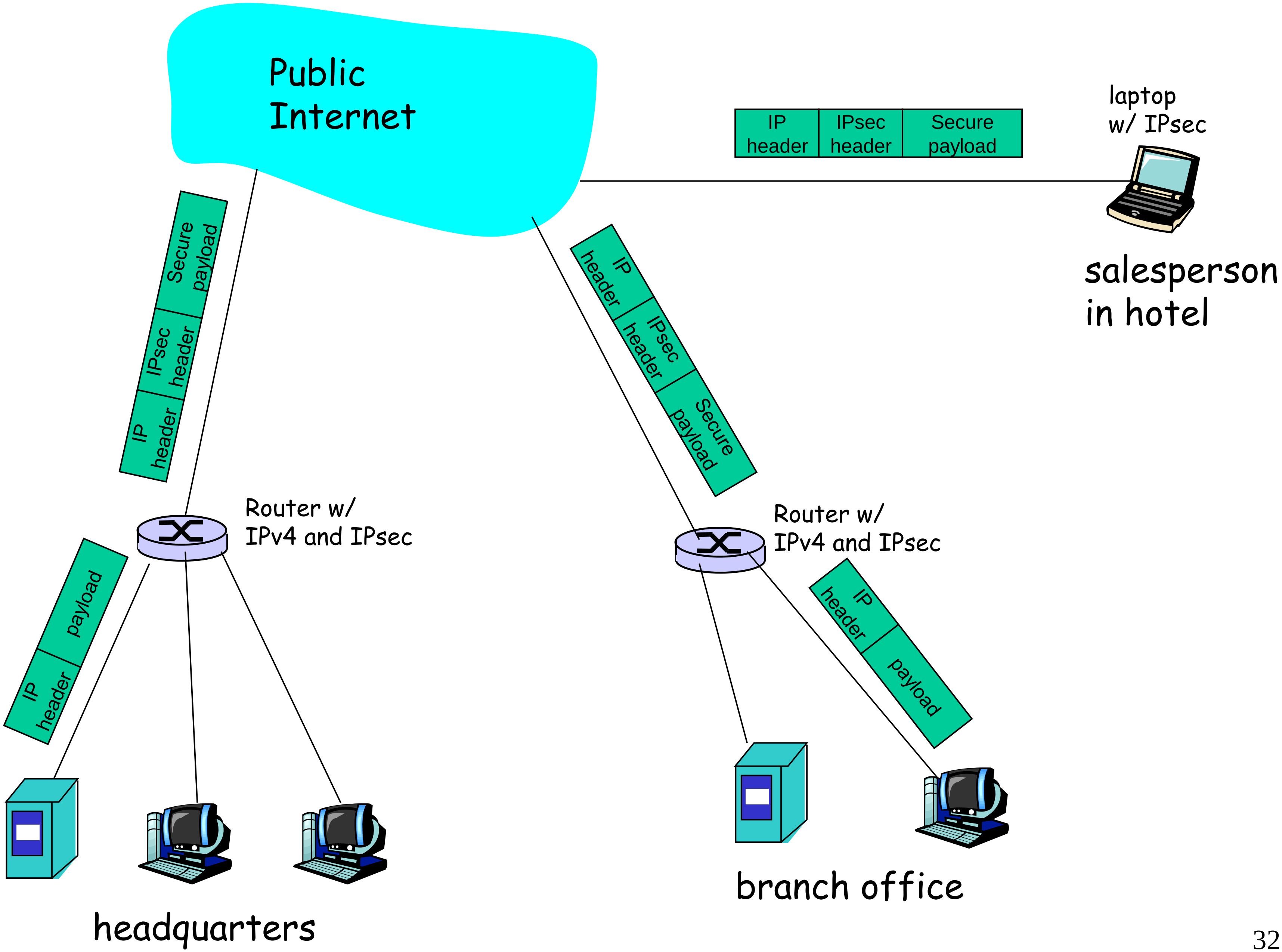

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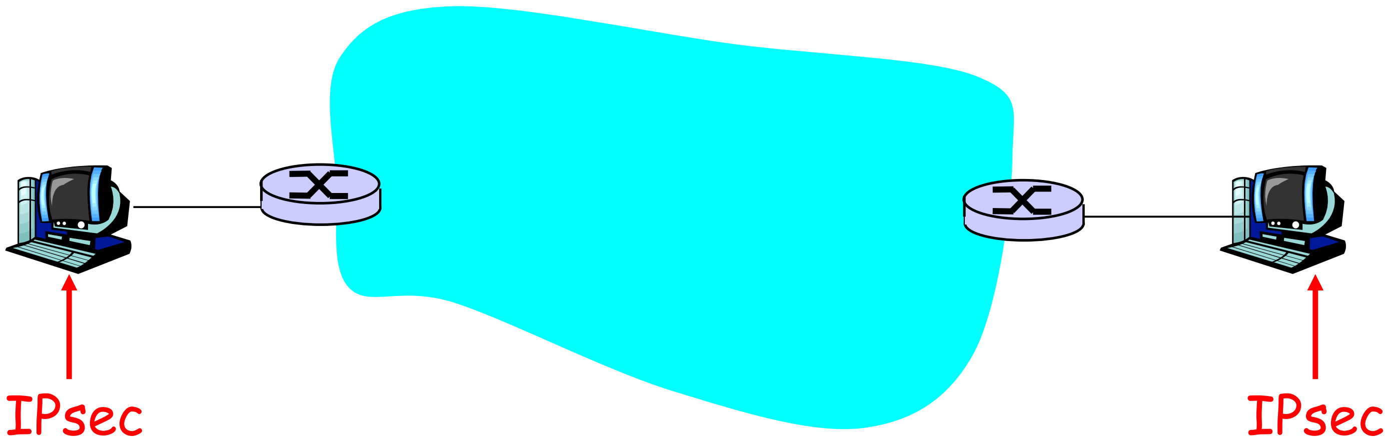

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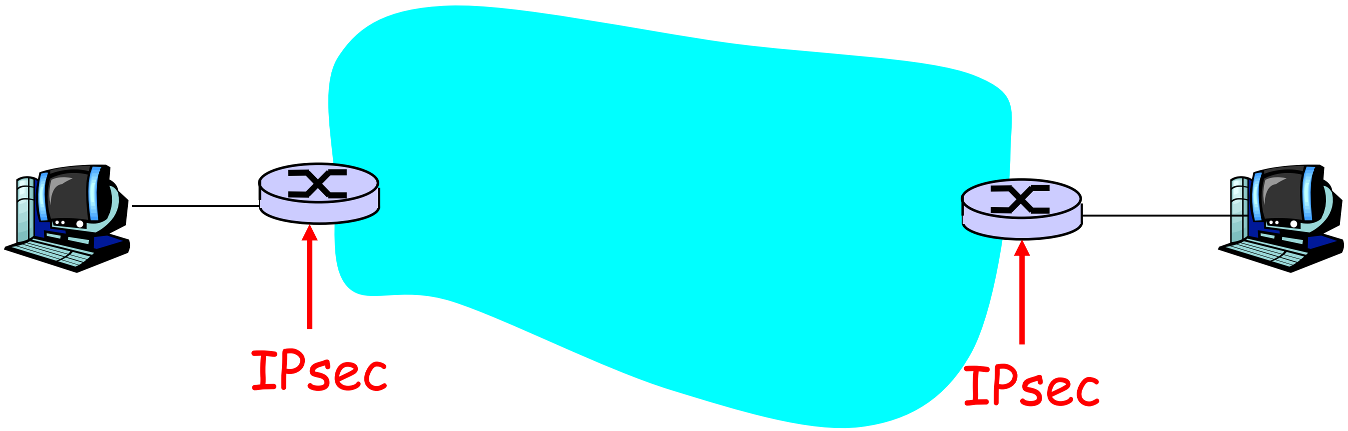
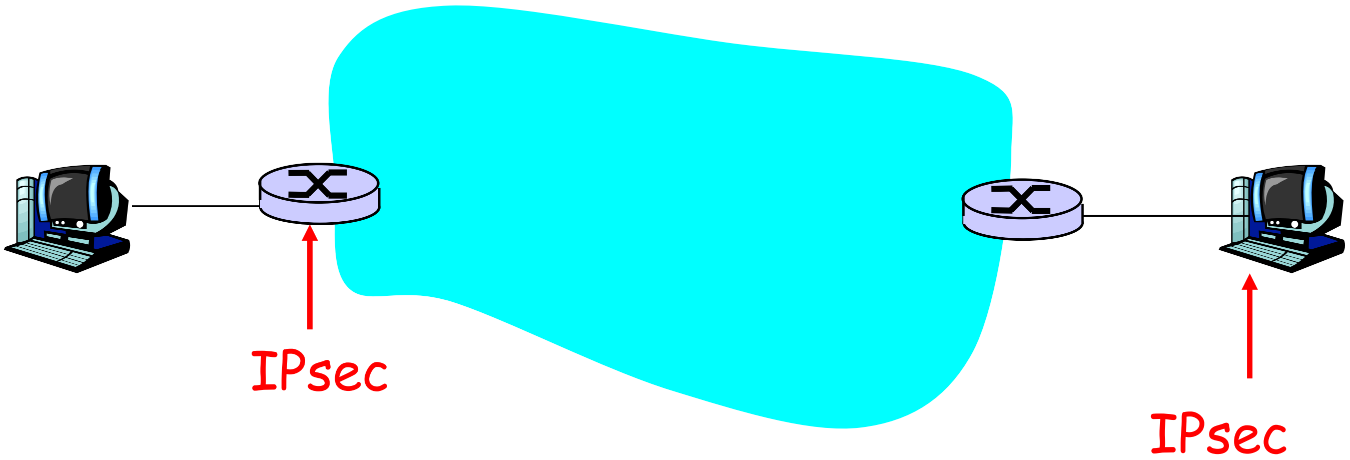


- End routers are IPsec aware. Hosts need not be.

IPsec - tunneling mode (2)



- Also tunneling mode.

Two protocols

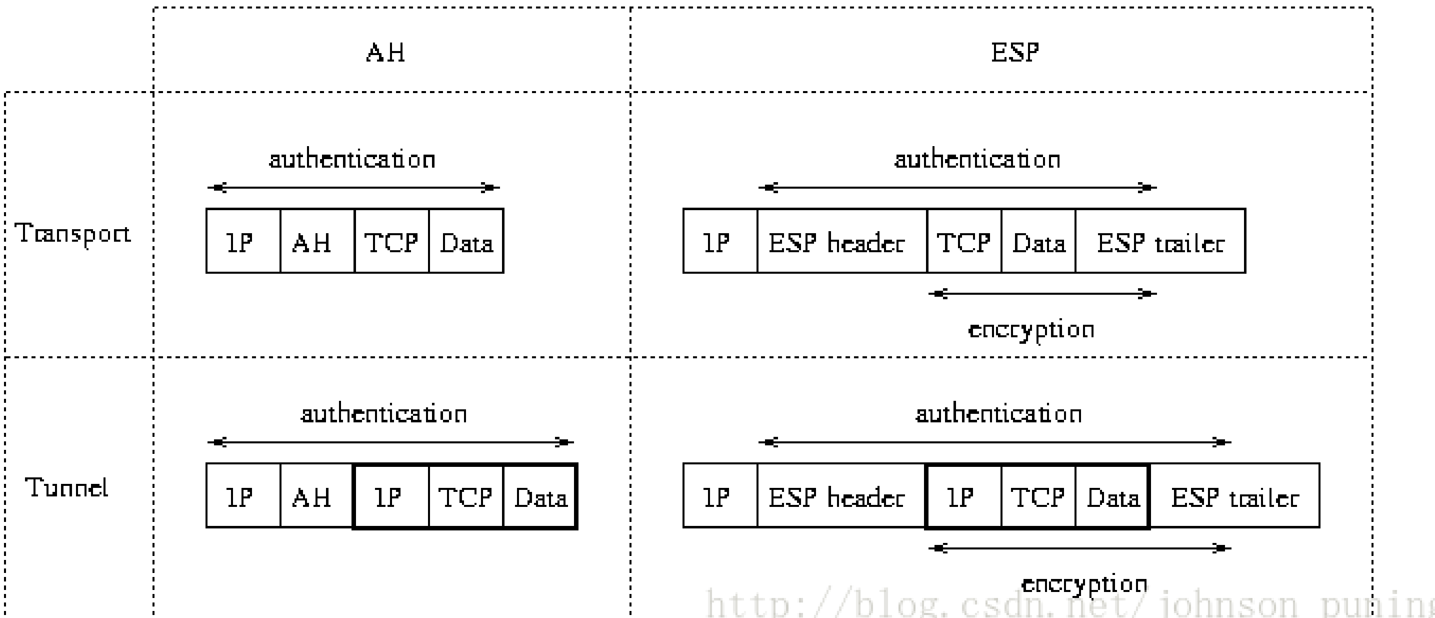
- Authentication Header (AH) protocol
  - provides source authentication & data integrity but *not* confidentiality
- Encapsulation Security Protocol (ESP)
  - provides source authentication,data integrity, *and confidentiality*
  - more widely used than *AH*

Four combinations are possible!

Host mode with AH	Host mode with ESP
Tunnel mode with AH	Tunnel mode with ESP

Most common and most important

Four combinations are possible!



Network Security (summary)

Basic techniques……

- cryptography (symmetric and public)
- message integrity
- end-point authentication

…. used in many different security scenarios

- secure email
- secure transport (SSL)
- IP sec
- 802.11

Operational Security: firewalls and IDS