CSE/EE 461 – Lecture 24

Network Security II

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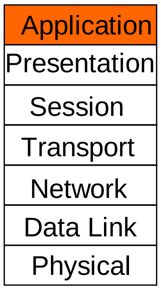
Last Time

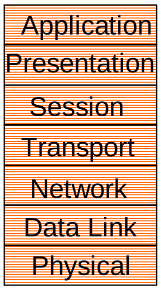
- Network security
- Focus
  - How do we secure distributed systems?
- Topics
  - Basic properties: privacy, authenticity
  - Cryptography



Application
Presentation
Session
Transport
Network
Data Link
Physical

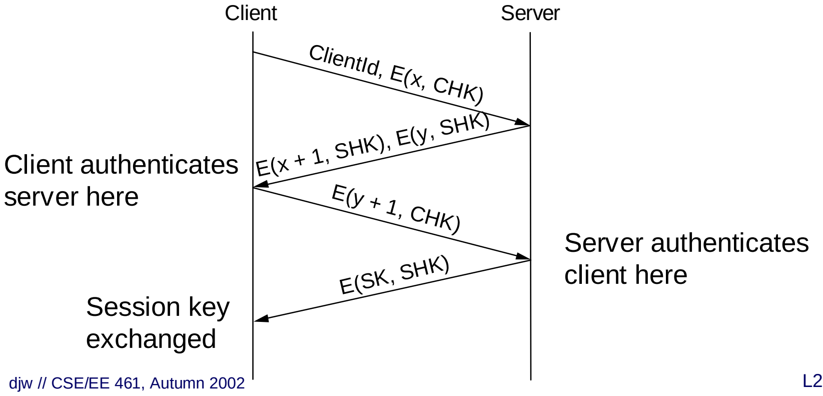
This Time

- Network security
- Focus
  - How do we secure distributed systems?
- Topics
  - Building systems w/ crypto
  - Firewalls

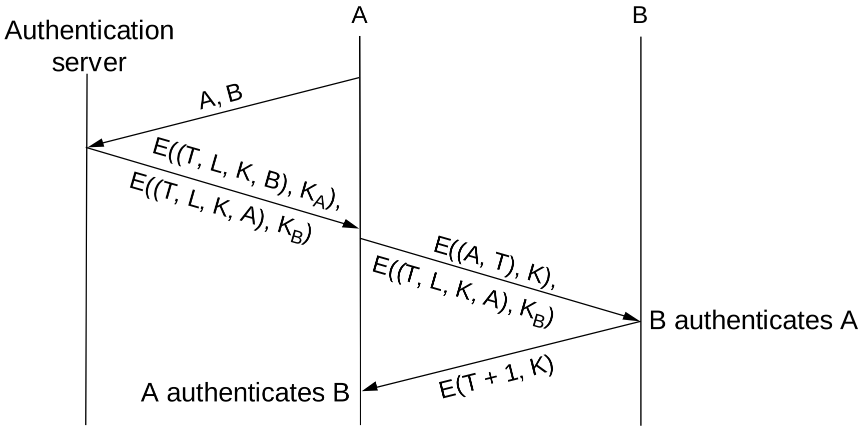


Authentication Protocols

- Three-way handshake for mutual authentication
  - Client and server share secrets, e.g., login password



Via Trusted Third Party (Kerberos)



Authentication server

A

B

A, B

$E((T, L, K, B), K_A)$,

$E((T, L, K, A), K_B)$

$E((A, T), K)$,

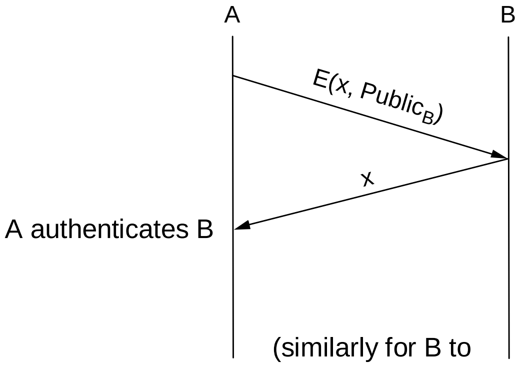
$E((T, L, K, A), K_B)$

B authenticates A

$E(T + 1, K)$

A authenticates B

Public Key Authentication



A

B

$E(x, Public_B)$

x

A authenticates B

(similarly for B to authenticate A)

Message Integrity Protocols

- Sometimes we don’t care about privacy but do care about integrity / authenticity
- Digital signatures (RSA)
  - Sign message with private key (encrypt); others verify with public key (decrypt)
- MD5 with RSA
  - Send signed digest of message along with message
- Keyed MD5
  - Send digest of message plus shared secret along with message
- Last two methods increase performance

Key Distribution

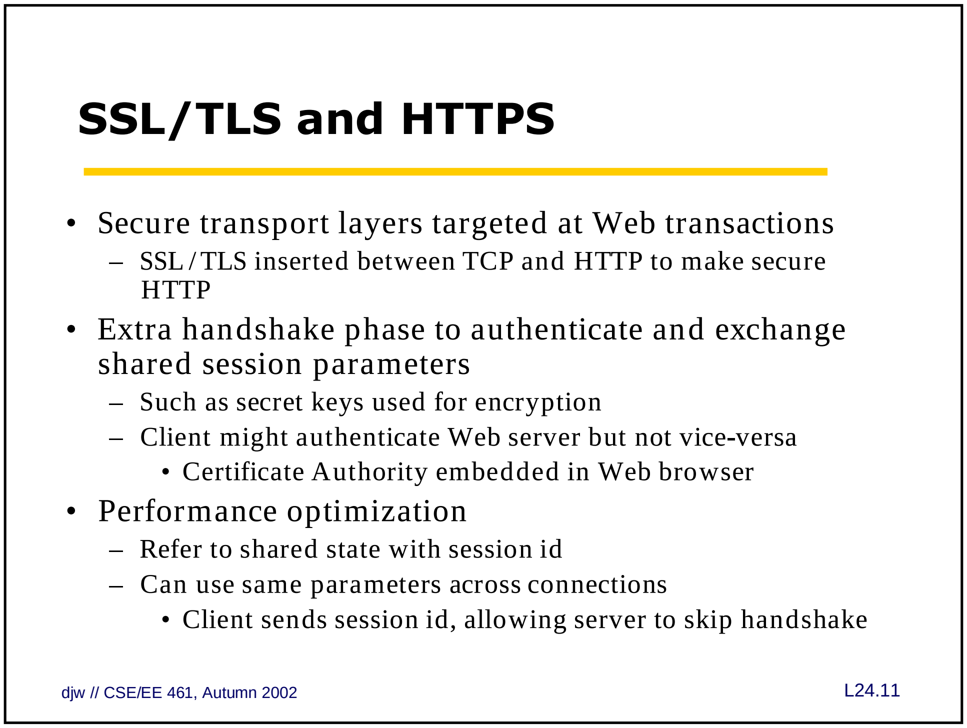
- Public key systems depend on the distribution of keys!
  - Public Key Infrastructures (PKIs), e.g., Verisign
  - An Achilles heel?
- Certificates (X.509)
  - Distribute keys by trusted certification authority (CA)
    - “I swear X’s public key is Y”, signed by CA
  - Still requires bootstrapping …
  - Also allows us to can build chains of trust
    - e.g., public keys for a domain name so that “.edu” (root) certifies “washington.edu”s key, they certify “cs…”’s key …
  - Certificate Revocation Lists needed to “undo” associations!

Example Systems

- Pretty Good Privacy (PGP)
  - For authentic and confidential email
- Secure Sockets (SSL) and Secure HTTP (HTTPS)
  - For secure Web transactions
- IP Security (IPSEC)
  - Framework for encrypting / authenticating IP packets

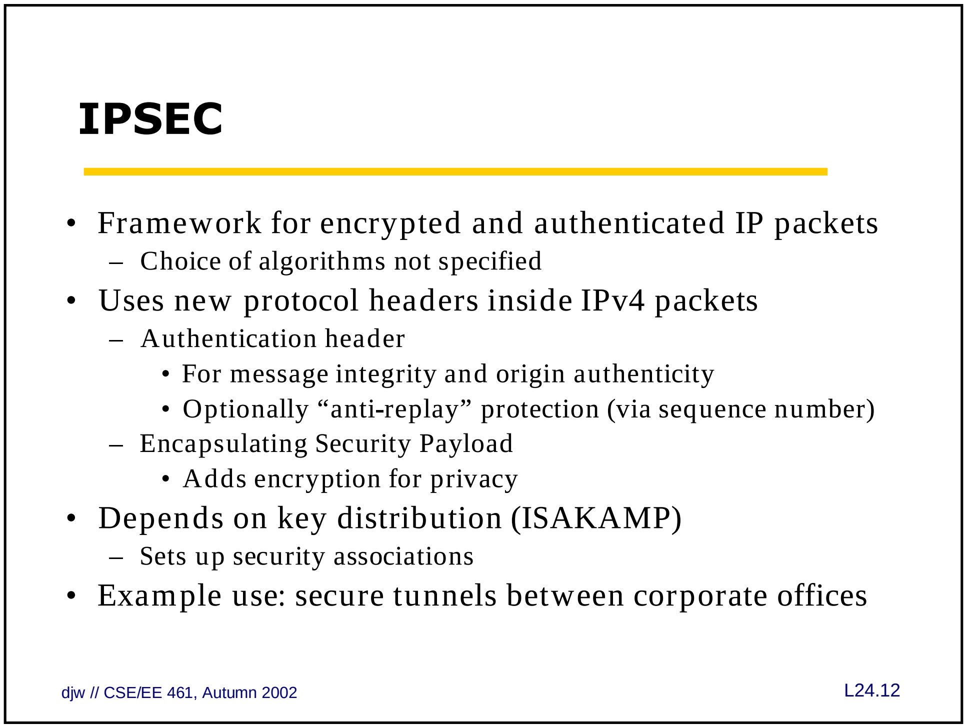
PGP

- Application level system
- Based on public keys and a “grass roots” Web of trust
- Sign messages for integrity / authenticity
  - Encrypt with private key of sender
- Encrypt messages for privacy
  - Could just use public key of receiver …
  - But encrypt message with secret key, and secret key with public key of receiver to boost performance



SSL/TLS and HTTPS

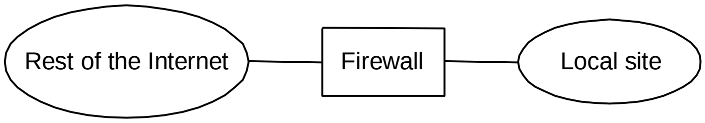
- Secure transport layers targeted at Web transactions
  - SSL/TLS inserted between TCP and HTTP to make secure HTTP
- Extra handshake phase to authenticate and exchange shared session parameters
  - Such as secret keys used for encryption
  - Client might authenticate Web server but not vice-versa
    - Certificate Authority embedded in Web browser
- Performance optimization
  - Refer to shared state with session id
  - Can use same parameters across connections
    - Client sends session id, allowing server to skip handshake



IPSEC

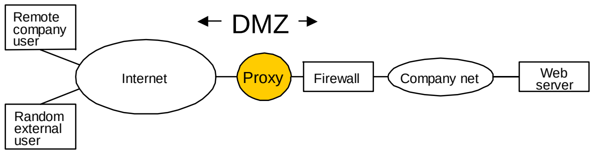
- Framework for encrypted and authenticated IP packets
  - Choice of algorithms not specified
- Uses new protocol headers inside IPv4 packets
  - Authentication header
    - For message integrity and origin authenticity
    - Optionally “anti-replay” protection (via sequence number)
  - Encapsulating Security Payload
    - Adds encryption for privacy
- Depends on key distribution (ISAKAMP)
  - Sets up security associations
- Example use: secure tunnels between corporate offices

Filter-based Firewalls



- Sit between site and rest of Internet, filter packets
  - Enforce site policy in a manageable way
  - e.g. pass (*,*, 128.7.6.5, 80), then drop (*, *, *, 80)
  - Rules may be added dynamically to pass new connections
- Sometimes called a “level 4” switch
  - Acts like a router (accepts and forwards packets)
  - But looks at information up to TCP port numbers (layer 4)

Proxy-Based Firewalls



- Problem: Filter ruleset can be complex/insufficient
  - Adequate filtering may require application knowledge
- Run proxies for Web, mail, etc. just outside firewall
  - In the “de-militarized zone” DMZ
  - External requests go to proxies, only proxies connect inside
    - External user may or may not know this is happening
  - Proxies filter based on application semantics