Network Security in Practice (cont.)

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Practices of Network Security

- Access control: firewalls
- Attacks and counter measures
  - mapping, sniffing, spoofing, cross-site scripting, DOS attack
- Security protocol case studies
  - Application-layer PGP: secure email
  - Transport-layer SSL: secure sockets
  - Network-layer IPsec: secure networking
  - Anonymity networks

Secure Email: Confidentiality

Alice wants to send confidential e-mail, m, to Bob.

- encrypts message with Bob’s public key, all problems solved?

Secure Email: Confidentiality

Alice:
- generates symmetric key, $K_S$
- encrypts message with $K_S$
- encrypts $K_S$ with Bob’s public key
- sends both $K_S(m)$ and $K_B(K_S)$ to Bob

Bob:
- uses his private key to decrypt and recover $K_S$
- uses $K_S$ to decrypt $K_S(m)$ to recover $m$
Secure Email: Sender Authentication and Message Integrity

- Sender authentication and message integrity:
  - generates a digital signature of the message digest using his/her private key
- Put everything together
  - uses one-time session key and the receiver’s public key to encrypt a digitally signed message
  - supports confidentiality, sender authentication, and message integrity
  - PGP (pretty good privacy) for Internet email

Secure Sockets Layer (SSL)/Transport Layer Security (TLS)

- SSL/TLS: transport layer security service to any TCP-based applications
  - used for remote terminal access (SSH).
  - used between Web browsers, servers for e-commerce (https).
  - used between IMAP clients and servers.
- Security services:
  - CA-certified public keys.
  - data confidentiality by encryption using a symmetric session key, key encrypted with server’s public key.
  - source authentication & data integrity by signed message digests.

Network Layer Security Protocol IPsec

- Two goals that secure socket layer cannot accomplish
  - secure everything (not just TCP traffic) on Internet
  - enable segmented protection – protect a segment of the Internet path (e.g., public Internet but not internal company network)
- Like before:
  - data confidentiality by encryption using a symmetric session key
  - source authentication & data integrity by signed message digests
- Done in a way that is compatible with basic IP
  - IPsec packet is recognized as a supported protocol in IP
  - routers who don’t support it can ignore it ⇒ allow incremental deployment with incremental benefits

More on IPsec

- Transport mode (only host-to-host protection):
  - IP header | IPsec header | Payload is data (TCP/UDP)
- Tunnel mode (allow segmented protection):
  - IP header | IPsec header | Payload is a full IP packet
- Tunnel mode allows intermediate segment of secure conn between two routers.
  - (Virtual Private Network) VPN:
    - IBM US - Internet - IBM India
- A rare example of success on enhancing the Internet!


**Tor Anonymity Network**

- Standard encryption mechanisms protect the content of communication, but not the identities of the comm. parties
- **Tor**, The Onion Router, anonymity network
  - "Tor directs Internet traffic through a free, worldwide, volunteer network consisting of more than four thousand relays to conceal a user's location or usage from anyone conducting network surveillance or traffic analysis." --Wikipedia
  - "Edward Snowden used the Tor Network to send information about PRISM to the Washington Post and The Guardian in June 2013." --Wikipedia

**Tor Anonymity Network**

- NSA and GHCQ are interested in it
  - Compromise the source
  - Quotes from Guardian: But the documents [NSA leaks] suggest that the fundamental security of the Tor service remains intact. One top-secret presentation, titled 'Tor Stinks', states: "We will never be able to de-anonymize all Tor users all the time." It continues: "With manual analysis we can de-anonymize a very small fraction of Tor users," and says the agency has had "no success de-anonymizing a user in response" to a specific request.

**Network Security (summary)**

Basic techniques......
- cryptography (symmetric and public)
- authentication
- message integrity
- key distribution

.... network security in practice
- firewall
- attacks and countermeasures
- secure application (PGP for email)
- secure transport (SSL/TLS)
- secure network (IPsec)
- Tor anonymity network

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