CSE/EE 461 – Lecture 23

Network Security

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Last Time

• Naming

• Focus
  – How do we name hosts etc.?

• Topics
  – Domain Name System (DNS)
  – Email/URLs
This Time

- Network security

Focus
- How do we secure distributed systems?

Topics
- Privacy, integrity, authenticity
- Cryptography

What do we mean by “Security”?

- Networks are fundamentally shared
  - Need means to protect messages sent by legitimate participants from others with access to the network

- Privacy: messages can’t be eavesdropped
- Integrity: messages can’t be tampered with
- Authenticity: messages were sent by the right party

- These are in addition to the need to protect networked systems from intrusions and compromise by attackers
Approaches at 10,000 ft

- Physical security
  - Tackle the problem of sharing directly
- “Security through obscurity”
  - Hope no-one will find out what you’re doing!
- Throw math at the problem
  - Cryptography

Why is security difficult?
- It's a negative goal: can you be sure there are no flaws?
- Often assumptions turn out to be invalid, esp. randomness

Basic Encryption for Privacy

- Cryptographer chooses functions E, D and keys KE, KP
  - Mathematical basis
- Cryptanalyst try to “break” the system
  - Depends on what is known: E and D, M and C?
Secret Key Functions (DES, IDEA)

- Single key (symmetric) is shared between parties
  - Often chosen randomly, but must be communicated

Basics of DES

DES uses a 64 bit key (56 + 8)
Message encrypted 64 bits at a time
16 rounds in the encryption
Each round scrambles 64 bits
**DES (cont.)**

Repeat process for larger messages with “chaining”

- Block₁
- Block₂
- Block₃
- Block₄

**IV**

DES

Cipher₁

DES

Cipher₂

DES

Cipher₃

DES

Cipher₄

**Public Key Functions (RSA)**

- Public and private key related mathematically
  - Public key can be published; private is a secret
Authentication Protocols

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

![Diagram of three-way handshake]

Authenticity and Integrity

- Sometimes we care about knowing messages authentic, but don’t care about privacy.
- If only sender and receiver knew the keys we would be done … but that’s often not the case
  - A pair of keys for each pair of communicating parties?
- In public key (RSA) systems the “encryption” key is potentially known by everyone
  - anyone could have sent us a confidential message by encrypting with our public key
RSA Digital Signature

- Notice that we reversed the role of the keys (and the math just works out) so only one party can send the message but anyone can check it’s authenticity.

A Faster “RSA Signature”

- Encryption can be expensive, e.g., RSA 1Kbps.
- To speed up, let’s sign just the checksum instead!
  - Check that the encrypted bit is a signature of the checksum.
- Problem: Easy to alter data without altering checksum.
- Answer: Cryptographically strong “checksums” called message digests where it’s computationally difficult to choose data with a given checksum.
  - But they still run much more quickly than encryption.
  - MD5 (128 bits) is the most common example.
Message Digests (MD5, SHA)

- Act as a cryptographic checksum or hash
  - Typically small compared to message (MD5 128 bits)
  - "One-way": infeasible to find two messages with same digest

Cryptography in Protocols

- These techniques can be applied at different levels:
  - IP packets (IPSEC)
  - Web transfers or other transports (SSL/TLS, Secure HTTP)
  - Email (PGP)

- Next time ..
Key Concepts

• Privacy, integrity, and authenticity
• Cryptographic mechanisms are used to support these properties: private key, public key and digests