CSE/EE 461 – Lecture 23

Network Security

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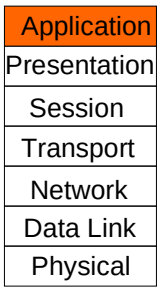
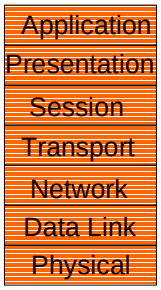
Last Time

- 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"?

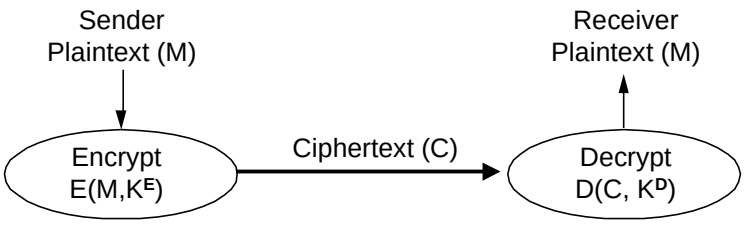
- Networks are fundamentally shared
  - Need means to protect messages sent by legitimate participants from others with access to the network
- Privacy: messages can't be eavesdropped
- Integrity: messages can't be tampered with
- Authenticity: messages were sent by the right party
- These are in addition 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

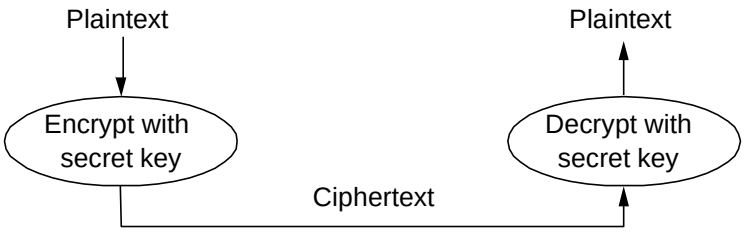
- Why is security difficult?
  - It's a negative goal: can you be sure there are no flaws?
  - Often assumptions turn out to be invalid, esp. randomness

Basic Encryption for Privacy



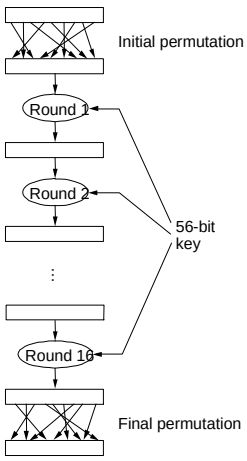
- Cryptographer chooses functions E, D and keys K^E, K^D
  - Mathematical basis
- Cryptanalyst try to "break" the system
  - Depends on what is known: E and D, M and C?

Secret Key Functions (DES, IDEA)

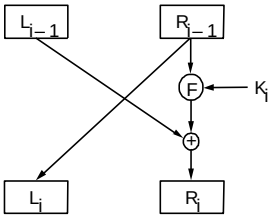


- Single key (symmetric) is shared between parties
  - Often chosen randomly, but must be communicated

Basics of DES

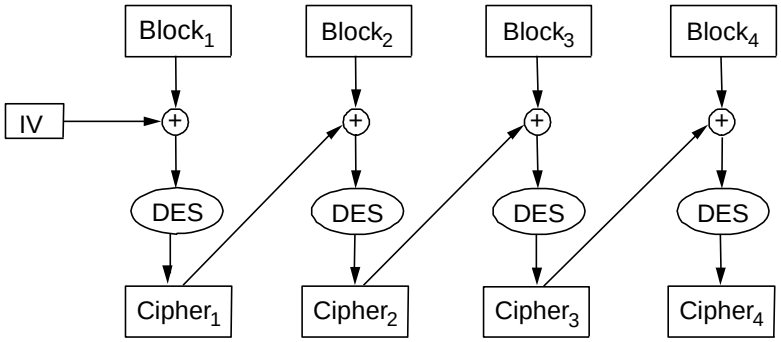


Each Round:



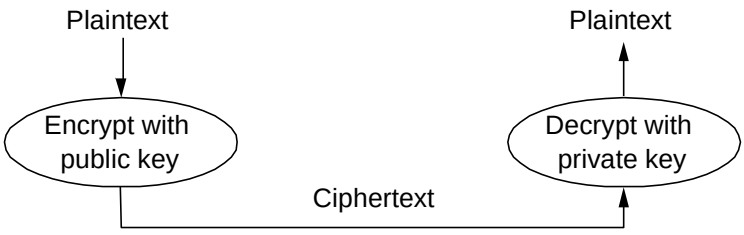
DES uses a 64 bit key (56 + 8)
Message encrypted 64 bits at a time
16 rounds in the encryption
Each round scrambles 64 bits

DES (cont.)



- Repeat process for larger messages with "chaining"

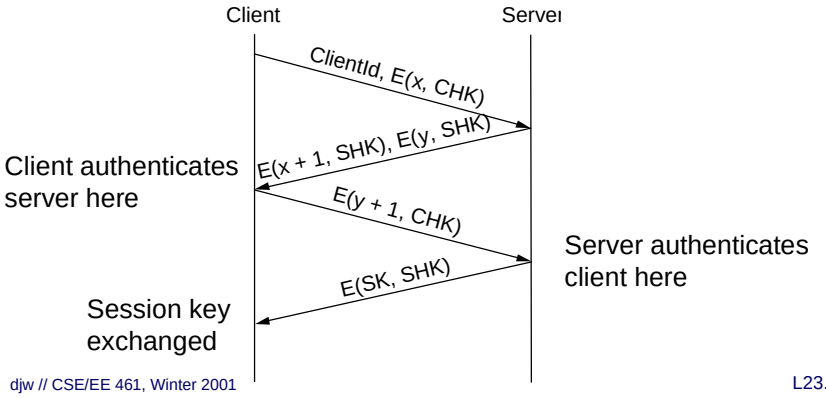
Public Key Functions (RSA)



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

Authentication Protocols

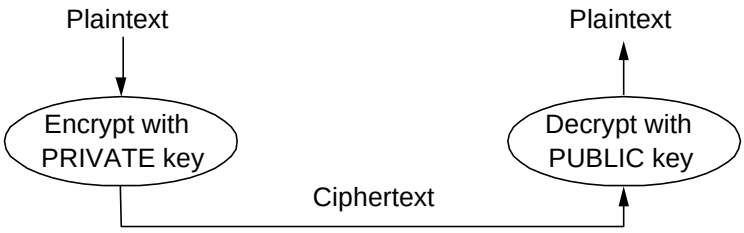
- Three-way handshake for mutual authentication
  - Client and server share secrets, e.g., login password



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



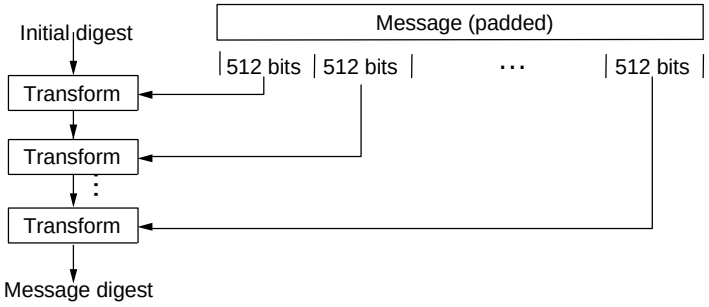
- Notice that we reversed the role of the keys (and the math just works out) so only one party can send the message but anyone can check it's authenticity

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