Advanced Topics in Distributed Systems

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Security Introduction

Based on Ch1, Cryptography and Network Security 4th Ed

Outline

- Attacks, services and mechanisms
- Security attacks
- Security services
- Security mechanisms
- A model for network security, and network access security

Background

- Information Security requirements have changed in recent times
- traditionally provided by *physical* and *administrative* mechanisms
- computer use requires automated tools to protect files and other stored information
- use of networks and communications links requires measures to protect data during transmission

Definitions

- **Computer Security** - generic name for the collection of tools designed to protect data and to thwart hackers
- **Network Security** - measures to protect data during their transmission
- **Internet Security** - measures to protect data during their transmission over a collection of interconnected networks

Possible Security Violations

- A transmits a file to B. C (not authorized to read the file) monitors transmissions and captures a copy
- D transmits a message to computer E, instructing E to update an authorization file. User F intercepts the message, alters its contents to add or delete entries and forward to E which accepts the message as being from D
- User F constructs its own message and transmits to E as if coming from D
- Denying sending a message

Services, Mechanisms, Attacks

- Need systematic way to define security requirements
- Consider three aspects of information security:
  - ***security attack***
    - ➢action that compromises the security of information owned by an organization
  - ***security mechanism***
    - ➢Designed to detect, prevent, or recover from a security attack
  - ***security service***
    - ➢Enhances the security of data processing systems and information transfers of an organization
- Consider in reverse order

Security Service

- enhances the security of the data processing systems and the information transfers of an organization
- intended to counter *security attacks*
- make use of one or more *security mechanisms* to provide the service
- replicate functions normally associated with physical documents
  - e.g., have signatures, dates; need protection from disclosure, tampering, or destruction; be notarized or witnessed; be recorded or licensed (problems with electronic documents)

Security Mechanism

- a mechanism that is designed to detect, prevent, or recover from a security attack
- no single mechanism that will support all functions required
- however one particular element underlies many of the security mechanisms in use: ***cryptographic techniques***

Security Attack

- Any action that compromises the security of information owned by an organization
- information security is about how to prevent attacks, or *failing that*, to detect attacks on information-based systems
- have a wide range of attacks
- can focus of generic types of attacks
- note: often *threat* & *attack* mean same

OSI Security Architecture

- ITU-T (International Telecommunication Union, Telecommunication Standardization Sector) **X.800** *Security Architecture for OSI*
- defines a systematic way of defining and providing security requirements

Security Service

- X.800 defines it as: *a service provided by a protocol layer of communicating open systems, which ensures adequate security of the systems or of data transfers*
- RFC 2828 defines it as: *a processing or communication service provided by a system to give a specific kind of protection to system resources*
- X.800 defines it in 5 major categories

Security Services (X.800) 1/7

- **Authentication** - assurance that the communicating entity is the one claimed
- **Access Control** - prevention of the unauthorized use of a resource
- **Data Confidentiality** –protection of data from unauthorized disclosure
- **Data Integrity** - assurance that data received are exactly as sent by an authorized entity
- **Nonrepudiation** - protection against denial by one of the parties in a communication
- What about **Availability**?

Security Services (X.800) 2/7

- **Authentication** - *assurance that the communicating entity is the one claimed*
  - ➢Peer Entity Authentication
    - ✓Confidence in the identities of entities connected (corroboration of identity of peer entity in an association)
    - ✓Used at establishment of connection, and during data transfer phase
  - ➢Data-Origin Authentication
    - ✓Source of received data is as claimed

Security Services (X.800) 3/7

- **Access Control** - *prevention of the unauthorized use of a resource*
  - ➢Who can have access to a resource?
  - ➢Under what conditions?
  - ➢If you are granted access, what are you allowed to do?

Security Services (X.800) 4/7

- **Data Confidentiality** *–protection of data from unauthorized disclosure*
  - ➢Connection Confidentiality
    - ✓All user data is protected
  - ➢Connectionless Confidentiality
    - ✓All user data in a single data block is protected
  - ➢Selective-Field Confidentiality
    - ➢Specific fields are protected
  - ➢Traffic-flow Confidentiality
    - ✓Protecting traffic flow from analysis

Security Services (X.800) 5/7

- **Data Integrity** - *assurance that data received are exactly as sent by an authorized entity (no modification, insertion, deletion, or replay)*
  - ➢Connection Integrity with Recovery
  - ➢Connection Integrity without Recovery
  - ➢Selective-field Connection Integrity
  - ➢Connectionless Integrity
  - ➢Selective-Field Connectionless Integrity

Security Services (X.800) 6/7

- **Nonrepudiation** - *protection against denial by one of the parties in a communication*
  - ➢Nonrepudiation, Origin
  - ➢Nonrepudiation, Receiver

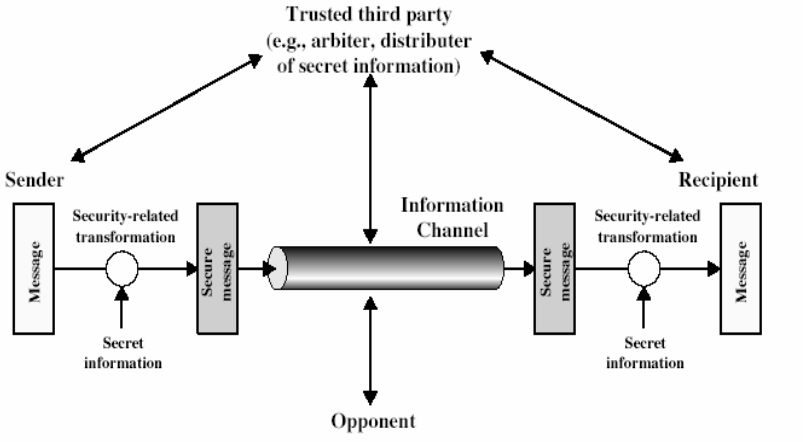
Security Mechanisms (X.800) 7/7

- specific security mechanisms:
  - – encipherment, digital signatures, access controls, data integrity, authentication exchange, traffic padding, routing control, notarization
- pervasive security mechanisms:
  - – trusted functionality, security labels, event detection, security audit trails, security recovery
- Others not included here?

Classify Security Attacks as

- **passive attacks** - *eavesdropping on, or monitoring of, transmissions to:*
  - obtain message contents, or
  - monitor traffic flows
  - Difficult to detect since no alteration of data
- **active attacks** – *modification of data stream, or creation of a false stream*
  - masquerade of one entity as some other
  - replay previous messages
  - modify messages in transit
  - denial of service

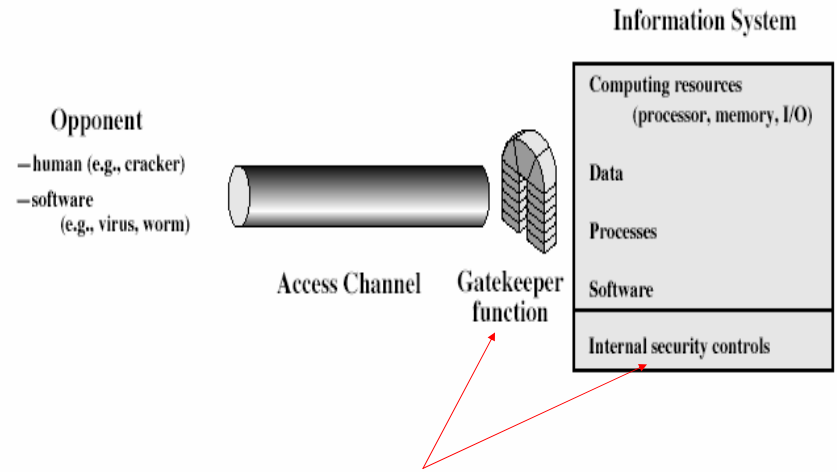
Model for Network Security 1/2



Model for Network Security 2/2

- using this model requires us to:
  - design a suitable algorithm for the security transformation
  - generate the secret information (keys) used by the algorithm
  - develop methods to distribute and share the secret information
  - specify a protocol enabling the principals to use the transformation and secret information for a security service

Network Access Security Model 1/2



Network Access Security Model 2/2

- using this model requires us to:
  - select appropriate gatekeeper functions to identify users
  - implement security controls to ensure only authorised users access designated information or resources
- trusted computer systems can be used to implement this model

Further Reading

- RFC 2828 (Informational), *Internet Security Glossary*, available at http://www.ietf.org