



FIT3031 INFORMATION & NETWORK SECURITY

COMMONWEALTH OF AUSTRALIA

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FIT3031: INFORMATION & NETWORK SECURITY

- Lecture 1:
- Introduction to Information and Network Security

Unit Structure: Lecture Topics

- ✓ **OSI security architecture**
 - **common security standards and protocols for network security applications**
 - **common information risks and requirements**
- operation of private key encryption techniques
- operation of public encryption techniques
- concepts and techniques for digital signatures, authentication and non-repudiation
- security threats of web servers, and their possible countermeasures
- Wireless Security Issues
- security threats of email systems and their possible countermeasures
- IP security
- intrusion detection techniques for security purpose
- risk of malicious software, virus and worm threats, and countermeasures
- firewall deployment and configuration to enhance protection of information assets
- network management protocol for security purpose

LN1: Outline

- **Security Concept**
- **OSI Security Architecture**
 - Security Attacks
 - Security Mechanisms
 - Security Services
- **Methods of Defense**
- **A model for Internetwork Security**
- **Internet standards and RFCs**

Background

- **Traditionally, before the widespread use of computers, security was provided by**
 - physical means – locked filing cabinets
 - administrative mechanisms – rigid hiring process
- **In recent times, especially in global networking environment, the security requirements have changed**
- **Ensuring security is a far more complicated issue today**
- **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**

Importance of Security

- **The Australian Institute of Criminology survey in 2016 revealed**

(http://aic.gov.au/media_library/publications/tandi_pdf/tandi526.pdf)

- The rapid growth of the internet is transforming how we engage and communicate. It also creates new opportunities for fraud and data theft.
- In a sample of more than 13 million emails identified as spam, more than 100,000 contained malicious attachments; nearly 1.4 million contained malicious web links that allows cybercriminals to remotely access them.
- The Australian economy relies on networked computer systems across all business sectors to facilitate service delivery and communication between government, the private sector and the general public
- About 91,927 small businesses reported a response to security breach in 2013
- these organizations suffered financial loss
 - \$890m
 - loss of productivity, customer confidence
- number of breaches rising

Importance of Security

- **The US Defense Department revealed that Pentagon recently suffered a massive cyber-attack** (<http://www.mobiledia.com/news/98487.html>)
 - In March 2011, hackers possibly working for a foreign government broke into a Pentagon contractor's computer system and stole 24,000 files.
- **Pentagon admitted similar attack in June 2007**
- **Massive hacking to Sony PlayStation Network in April, 2011**
- **Massive hacking to Sony Pictures Network in December, 2014**
 - It took forensic analyst few days to understand the complete extent of intrusion
- **There are serious concern about security and privacy of Facebook, Twitter, etc.**
- **Many more examples ...** (<http://www.cnet.com/topics/security/>)

Definitions

- **Computer Security or Information 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
 - > crucial in distributed system, networks and communication facilities
- **Internet Security**
 - measures to protect data during their transmission over a collection of interconnected networks
 - > Internetwork security

Definitions

- **No clear boundaries between these forms of security today**
- **For example, a virus introduced physically into a system may spread quickly over the Internet**

Security Focus

- Consists of measures to **deter, prevent, detect,** and **correct** security violations that involve the storage and transmission of information
- **Few Examples:**
 - **A** transmits a sensitive file to **B** that must be protected from disclosure. **C**, not authorized to read the file, monitors the transmission and captures the file during transmission
 - **D** intercepts a message during transmission, changes the content and transmits to **F** as if it originated from **E**.
 - A message is sent from a customer to a stockbroker with instructions of transactions. Subsequently, the investments lose value and the customer denies sending the message

Levels of Impact

- **can define 3 levels of impact from a security breach**
 - Low
 - Moderate
 - High

Computer Security Challenges

1. **not simple**
2. **must consider potential attacks**
3. **procedures used counter-intuitive**
4. **involve algorithms and secret info**
5. **must decide where to deploy mechanisms**
6. **battle of wits between attacker / admin**
7. **not perceived on benefit until fails**
8. **requires regular monitoring**
9. **too often an after-thought**
10. **regarded as impediment to using system**

OSI Security Architecture

- **ITU-T X.800 “Security Architecture for OSI”**
- **defines a systematic way of defining and providing security requirements**
- **provides a useful, if abstract, overview of concepts we will study**
- **A systematic approach is necessary to address the task(s)**
- **OSI security architecture provides a useful framework that defines such a systematic way**
 - To define the security requirements and
 - Adopt approaches to satisfy those requirements

OSI Security Architecture

- **OSI Security Architecture focuses on three aspects of information security :**
 - **security attacks**
 - **security mechanisms**
 - **security services**

Security Attacks

- **Any action that compromises the security of information owned by an organization**
 - **Vulnerability**: a weakness in a computer system that might be exploited to cause loss or harm
 - **Threat**: circumstances that have the potential to cause loss or harm
 - **Control**: a protective measure
- **Information security is about how to prevent attacks, or failing that, to detect attacks on information-based systems**
- **often *threat* & *attack* are used to mean the same thing**
- **Have a wide range of attacks**
- **Can focus on generic types of attacks**

Security Attacks - Taxonomy

- A security attack may attempt to do **one or more** of the following:
 - **Interruption**: an attack on availability
 - **Interception**: an attack on confidentiality
 - **Modification**: an attack on integrity
 - **Fabrication**: an attack on authenticity
- Two types of security attacks:
 - **Passive** Attacks
 - **Active** Attacks

Interruption

- Also known as *denial of services*.
- Information resources (hardware, software and data) are **deliberately made unavailable**, lost or unusable, usually through malicious destruction.
- e.g.: cutting a communication line, disabling a file management system, etc.

Interception

- Also known as *un-authorized access*.
- Difficult to trace as no traces of intrusion might be left.
- e.g: illegal eavesdropping or wiretapping or sniffing, illegal copying.

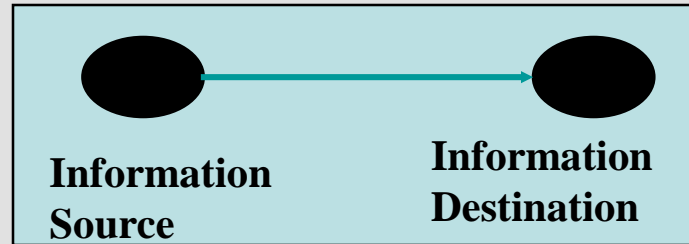
Modification

- Also known as ***tampering a resource.***
- Resources can be data, programs, hardware devices, etc.

Fabrication

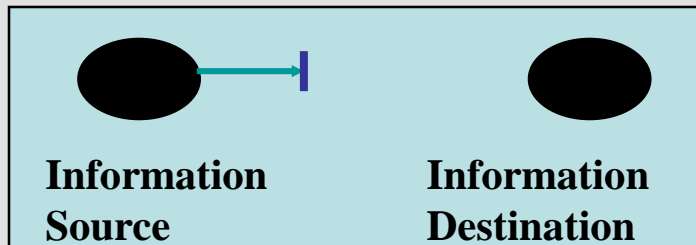
- Also known as **counterfeiting** (of objects such as data, programs, devices, etc).
- Allows to by-pass the authenticity checks.
- e.g.: insertion of spurious messages in a network, adding a record to a file, counterfeit bank notes, fake cheques,...
- **impersonation/masquerading**
 - to gain access to data, services etc..

Security Attacks - Taxonomy

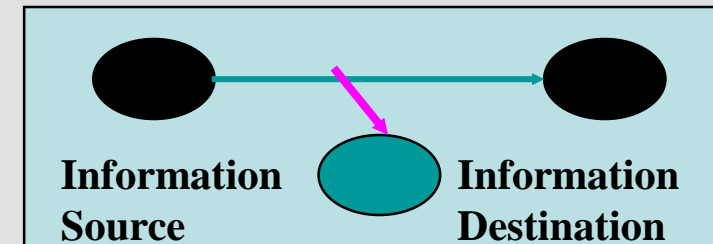


Source and Destination - can be what is supposed to be and what you get

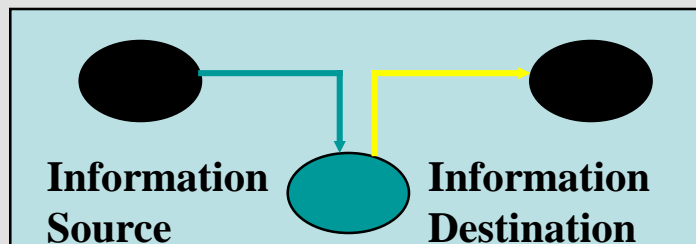
Normal



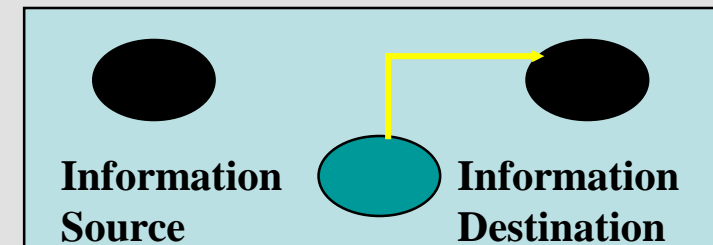
Interruption



Interception



Modification

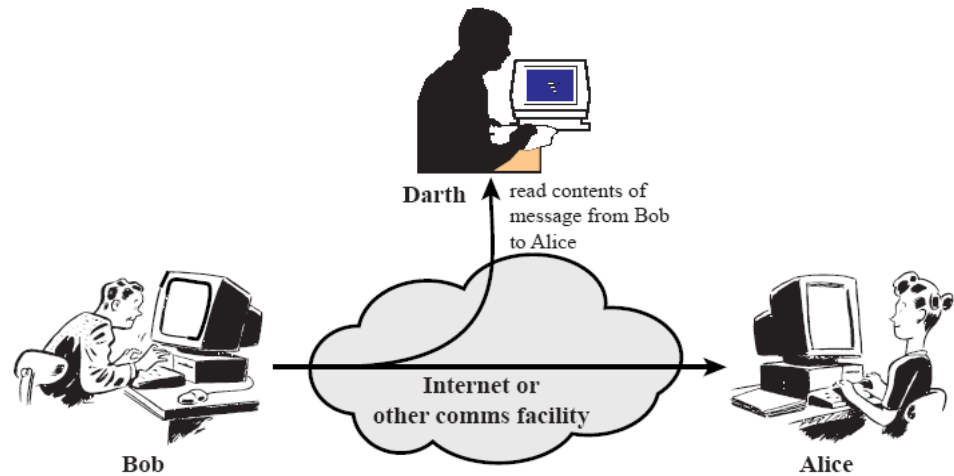


Fabrication

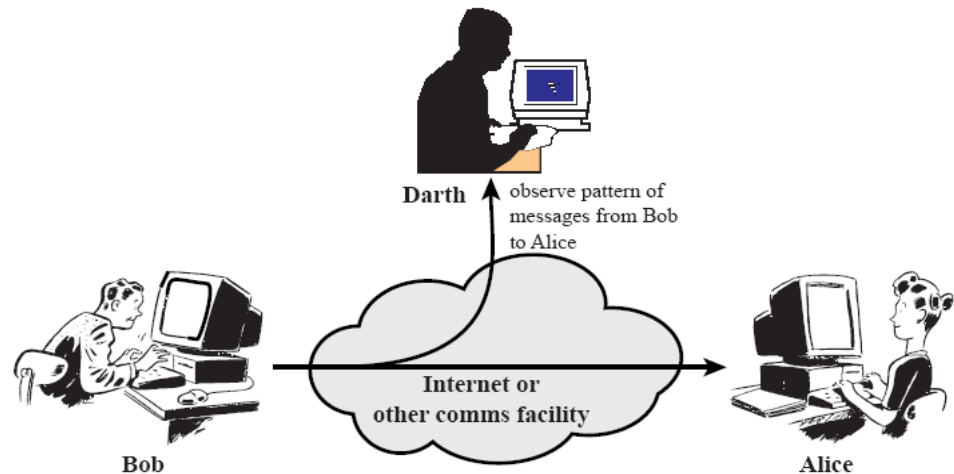
Passive Attacks

- **Nature:** eavesdropping on, or monitoring of, transmission of information between the communicating parties
- **Goal:** to capture information during transmission
- **Two types of Passive attack:**
 - **Release of message content**
 - capture and read the content
 - **Traffic analysis:**
 - can't read the information, but observe the pattern
 - determine the location and identity of communicating parties
 - observe frequency and length of communication

Passive Attacks...



(a) Release of message contents



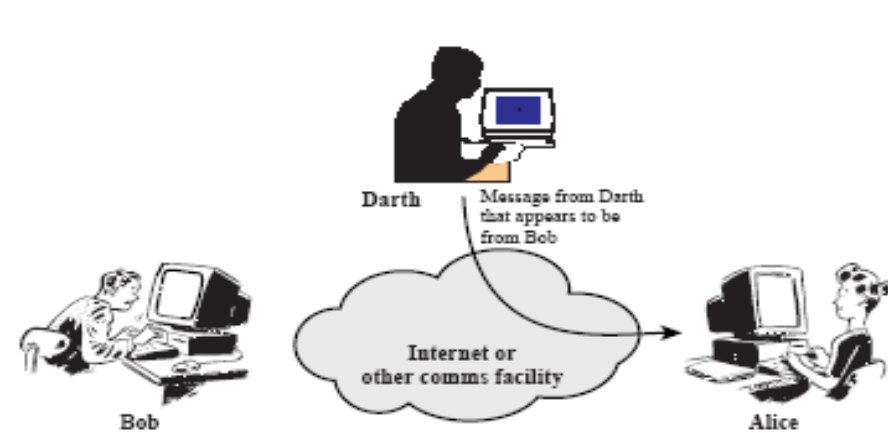
(b) Traffic analysis



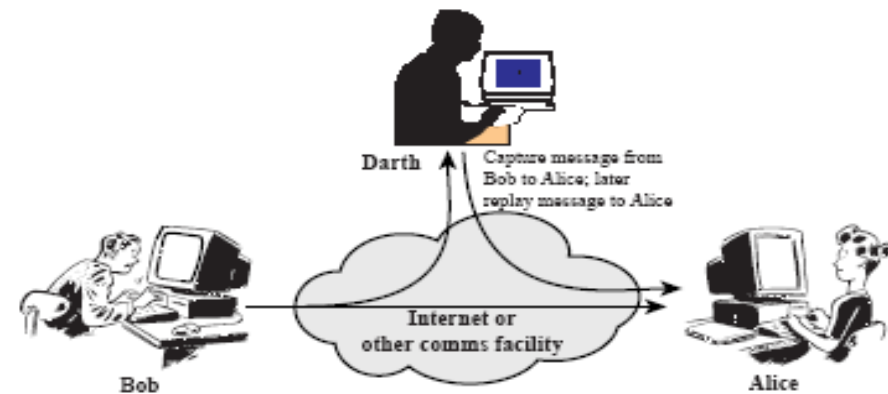
Active Attacks

- **Modifies a data stream or creates a false data streams**
- **Four types of active attacks:**
 - **Masquerade**: one entity pretends to be a different entity
 - > authentication sequences are captured and replayed
 - > an entity can gain extra privileges
 - **Replay**: passive capture of data and subsequent retransmission
 - **Modification of Message**: messages can be altered, delayed or reordered to produce unauthorized effect
 - **Denial of Service**: prevents normal use or management of communication facilities
 - > usually have a specific target
 - > disruption of services of an entire network or suppression of all messages directed to a particular destination

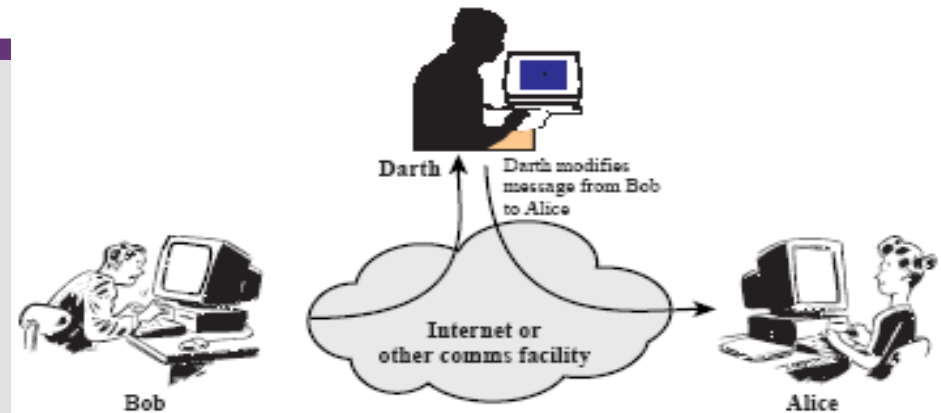
Active Attacks



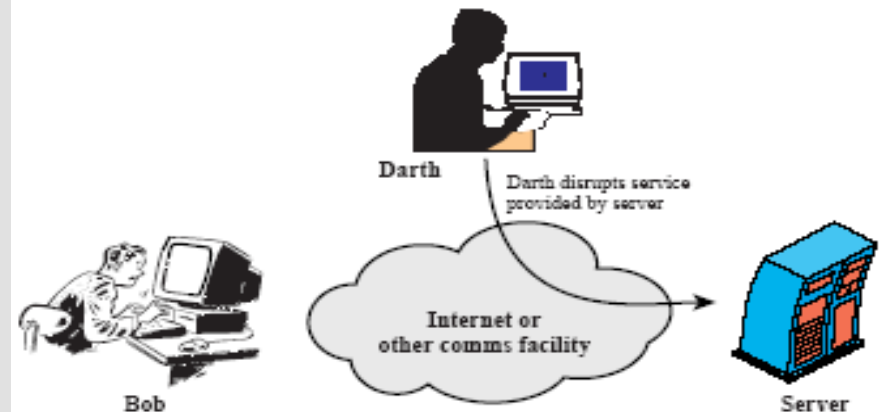
(a) Masquerade



(b) Replay



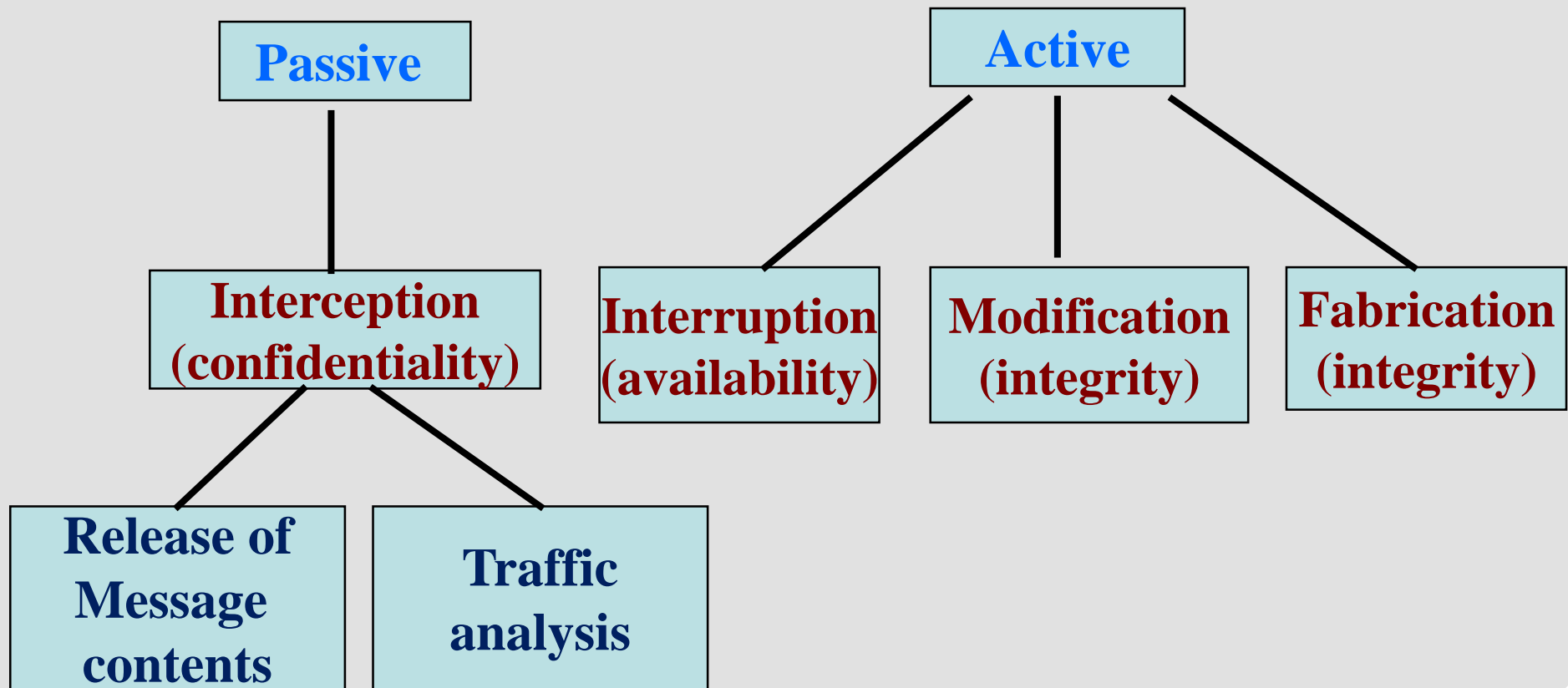
(c) Modification of messages



(d) Denial of service



Attacks



Security Services

- **Enhance 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

Security Services (X.800)

- **X.800 (OSI Security Architecture) definition:**
 - *a service provided by a protocol layer of communicating open systems, which ensures adequate security of the **systems** or of **data** transfers*
 - *Security services are implemented by security mechanism*
- **X.800 defines security services into 6 major categories:**
 - **Confidentiality**
 - **Integrity**
 - **Authentication**
 - **Non-repudiation**
 - **Access control**
 - **Availability**

Security Services (X.800) ...

- **Data Confidentiality** – protection of data from unauthorized disclosure
- **Data Integrity** - assurance that data received is as sent by an authorized entity
- **Authentication:** assures that the communication is authentic
 - communicating entities are who they claim to be
 - have both peer-entity & data origin authentication
- **Access Control** - prevention of the unauthorized use of a resource
- **Non-Repudiation** - protection against denial by one of the parties in a communication
 - Receiver can prove that sender has sent the message
 - Sender can proof the receiver has received the message
- **Availability** – resource accessible/usable
 - May be subject to Denial of Service or virus attack

Security Mechanism

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

Security Mechanism (X.800)

- **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
- ***specific security mechanisms are protocol layer specific, whilst the pervasive security mechanisms are not***

Security Mechanism (X.800)...

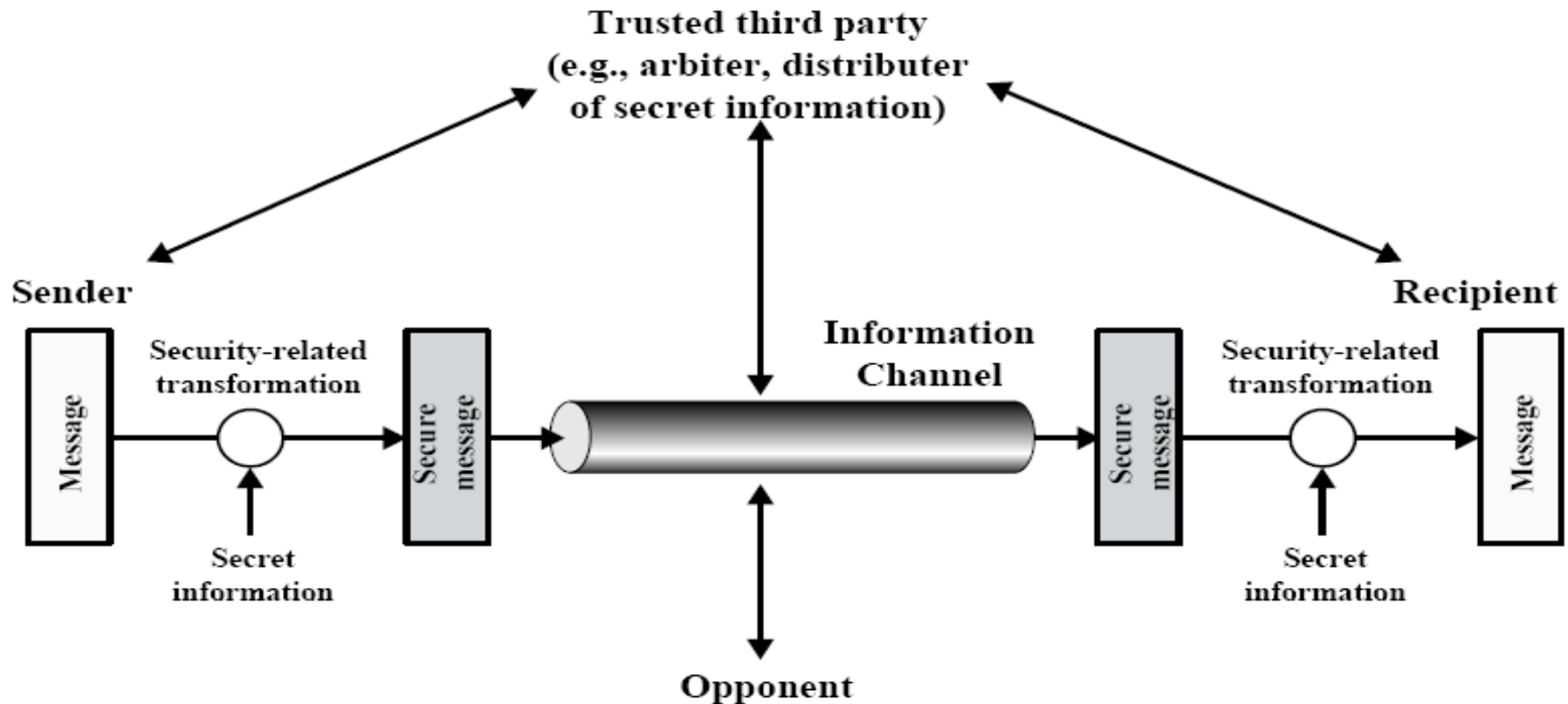
- **Security services are implemented by one or more security mechanism**
- **security mechanisms are invoked at appropriate layers and in appropriate combinations**
- **See the Table 1.4 for relationship between different security service and mechanism**

Relationship between Security Services & Mechanisms

Table 1.4 Relationship Between Security Services and Mechanisms

Service	Mechanism							
	Enciph- erment	Digital signature	Access control	Data integrity	Authenti- cation exchange	Traffic padding	Routing control	Notari- zation
Peer entity authentication	Y	Y			Y			
Data origin authentication	Y	Y						
Access control			Y					
Confidentiality	Y						Y	
Traffic flow confidentiality	Y					Y	Y	
Data integrity	Y	Y		Y				
Non-repudiation		Y		Y				Y
Availability				Y	Y			

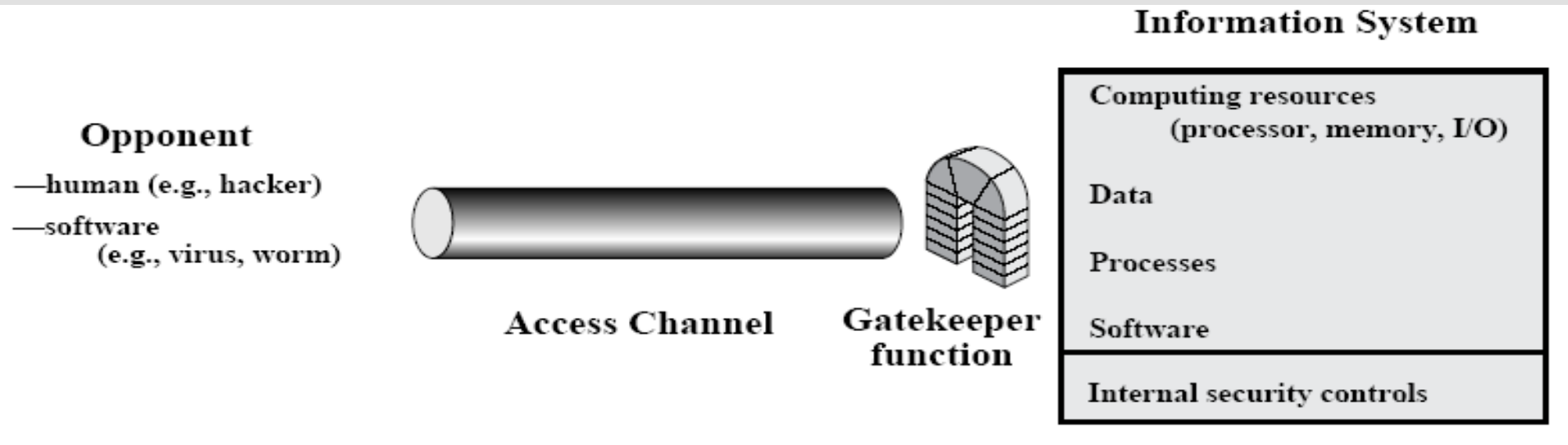
Model for Network Security



Model for Network Security...

- This model requires us to :
 - **design** a suitable algorithm for the security-related 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

Model for Network **Access** Security



Model for Network **Access** Security...

- **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**

Security Management

- **OSI Security Architecture defines three areas of security management**
 - **System security management:** concerned with the management of security aspects of the overall distributed computing environment
 - **Security service management:** concerned with the management of particular security services
 - **Security mechanism management:** concerned with the management of particular security mechanisms

Internet Standards & RFCs

- **The Internet society**
 - Internet Architecture Board (IAB)
 - Internet Engineering Task Force (IETF)
 - Internet Engineering Steering Group (IESG)
- **Standards development and publications of the internet society is done by these 3 organizations of the internet society.**

Internet RFC Publication Process

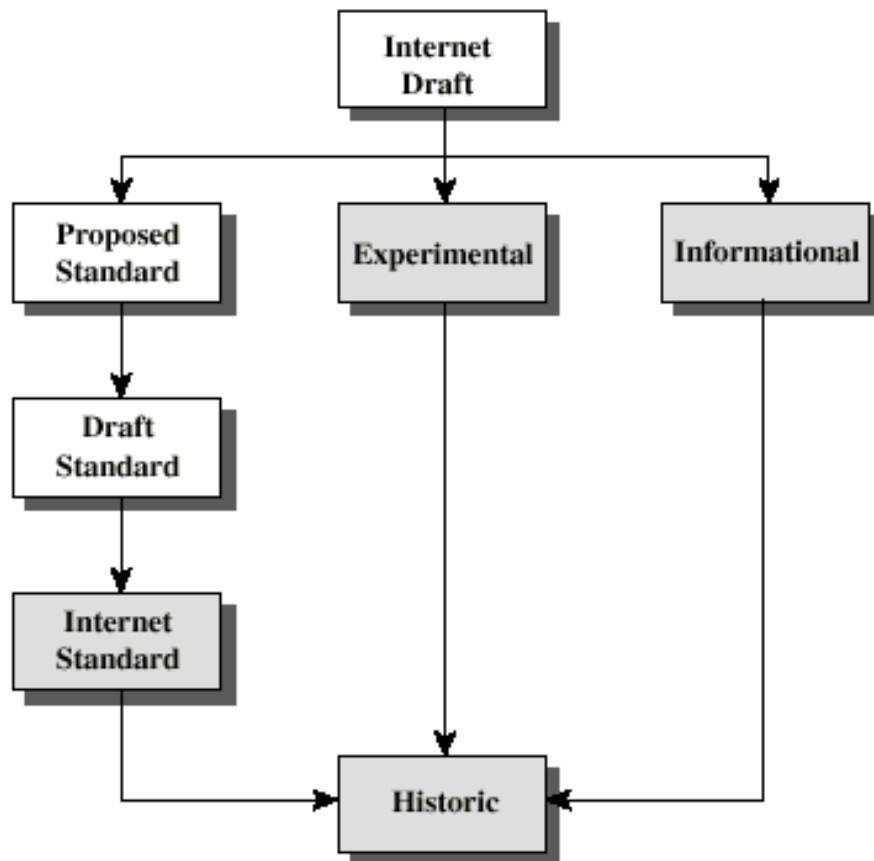


Figure 1.5 Internet RFC Publication Process

- The **Internet Engineering Steering Group (IESG)** is a body composed of the **Internet Engineering Task Force (IETF)** chair and area directors.
- The **IESG** is responsible for the technical management of IETF activities and the Internet standards process.

Further Reading

- **Study Guide 1**
- **Chapter 1 of the textbook: *Network Security Essentials- Application & Standards*” by William Stallings 5th Edition, Prentice Hall, 2013**
- **Acknowledgement: part of the materials presented in the slides was developed with the help of Instructor’s Manual and other resources made available by the author of the textbook.**