IIT KHARAGPUR

NPTEL ONLINE
CERTIFICATION COURSES

CLOUD COMPUTING

CLOUD SECURITY I

PROF. SOUMYA K. GHOSH

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

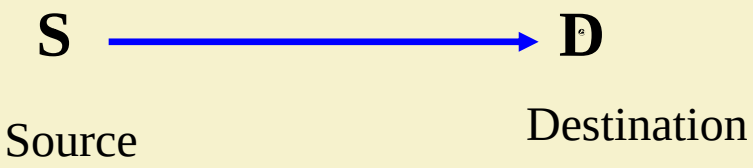
IIT KHARAGPUR

Security - Basic Components

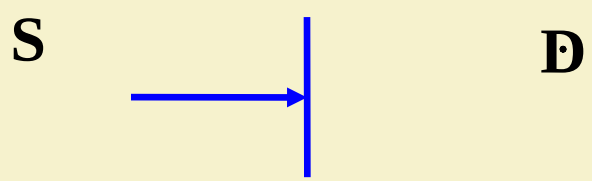
- Confidentiality
  - Keeping data and resources hidden
- Integrity
  - Data integrity (integrity)
  - Origin integrity (authentication)
- Availability
  - Enabling access to data and resources

Security Attacks

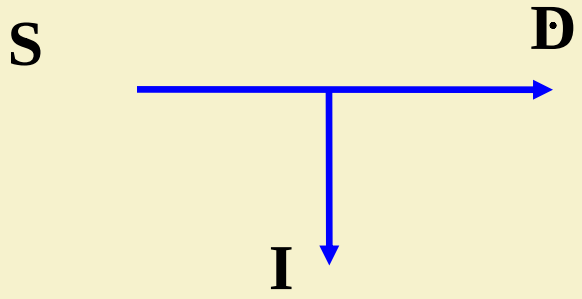
- Any action that compromises the security of information.
- Four types of attack:
  1. Interruption
  2. Interception
  3. Modification
  4. Fabrication
- Basic model:



Security Attacks (contd.)



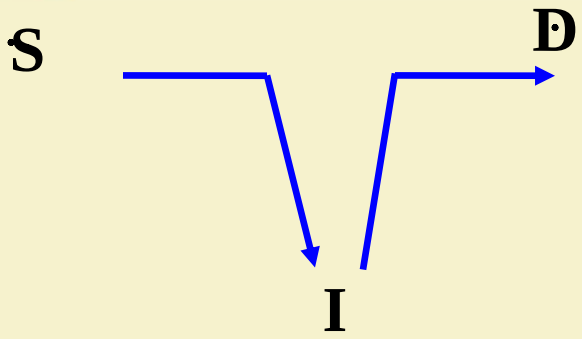
- Interruption:
  - Attack on availability



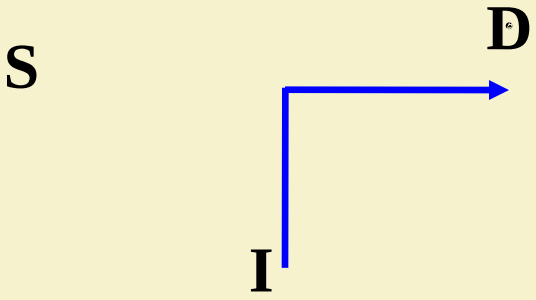
- Interception:
  - Attack on confidentiality

Security Attacks

- Modification:
  - Attack on integrity



- Fabrication:
  - Attack on authenticity



Classes of Threats

- Disclosure
  - Snooping
- Deception
  - Modification, spoofing, repudiation of origin, denial of receipt
- Disruption
  - Modification
- Usurpation
  - Modification, spoofing, delay, denial of service

Policies and Mechanisms

- Policy says what is, and is not, allowed
  - This defines "security" for the site/system/*etc*.
- Mechanisms enforce policies
- Composition of policies
  - If policies conflict, discrepancies may create security vulnerabilities

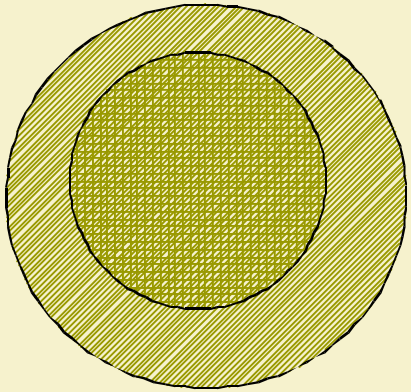
Goals of Security

- Prevention
  - Prevent attackers from violating security policy
- Detection
  - Detect attackers' violation of security policy
- Recovery
  - Stop attack, assess and repair damage
  - Continue to function correctly even if attack succeeds

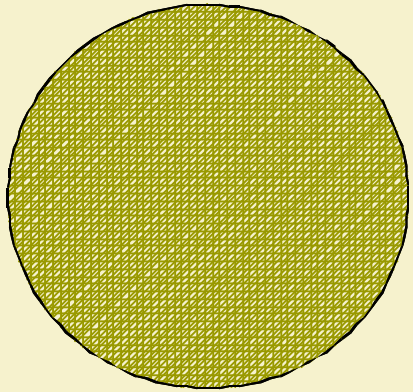
Trust and Assumptions

- Underlie all aspects of security
- Policies
  - Unambiguously partition system states
  - Correctly capture security requirements
- Mechanisms
  - Assumed to enforce policy
  - Support mechanisms work correctly

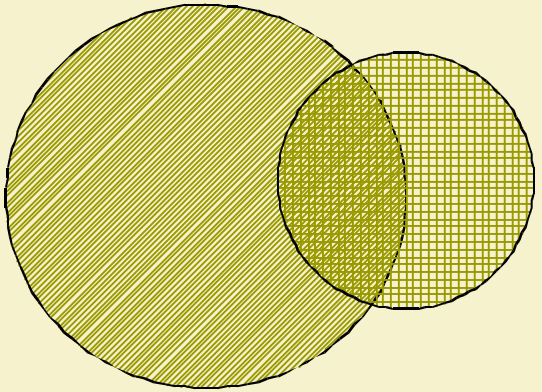
Types of Mechanisms



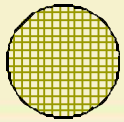
secure



precise



broad



set of reachable states

set of secure states

Assurance

- Specification
  - Requirements analysis
  - Statement of desired functionality
- Design
  - How system will meet specification
- Implementation
  - Programs/systems that carry out design

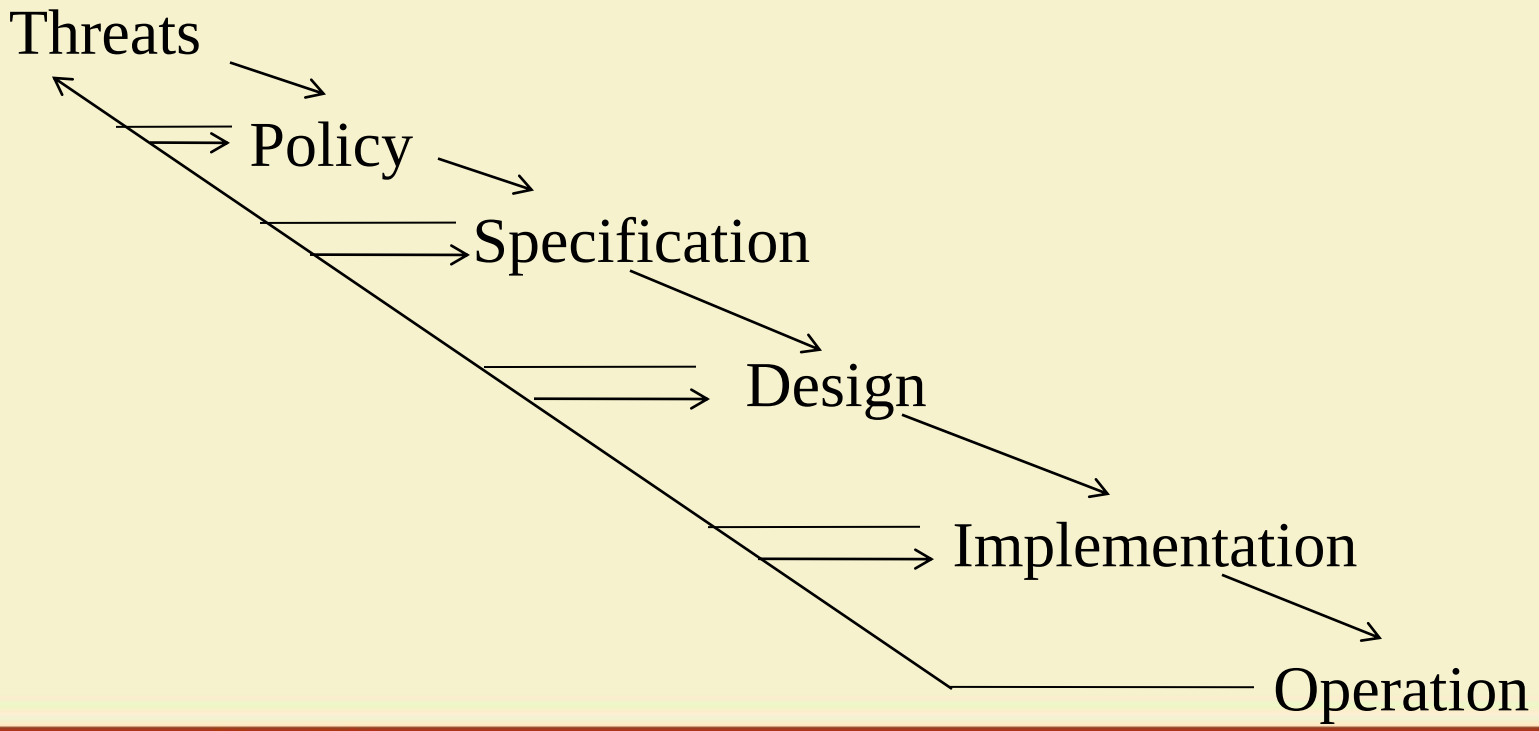
Operational Issues

- Cost-Benefit Analysis
  - Is it cheaper to prevent or recover?
- Risk Analysis
  - Should we protect something?
  - How much should we protect this thing?
- Laws and Customs
  - Are desired security measures illegal?
  - Will people do them?

Human Issues

- Organizational Problems
  - Power and responsibility
  - Financial benefits
- People problems
  - Outsiders and insiders
  - Social engineering

Tying Together



Passive and Active Attacks

- Passive attacks
  - Obtain information that is being transmitted (eavesdropping).
  - Two types:
    - Release of message contents:- It may be desirable to prevent the opponent from learning the contents of the transmission.
    - Traffic analysis:- The opponent can determine the location and identity of communicating hosts, and observe the frequency and length of messages being exchanged.
  - Very difficult to detect.

- Active attacks
  - Involve some modification of the data stream or the creation of a false stream.
  - Four categories:
    - Masquerade:- One entity pretends to be a different entity.
    - Replay:- Passive capture of a data unit and its subsequent retransmission to produce an unauthorized effect.
    - Modification:- Some portion of a legitimate message is altered.
    - Denial of service:- Prevents the normal use of communication facilities.

Security Services

- Confidentiality (privacy)
- Authentication (who created or sent the data)
- Integrity (has not been altered)
- Non-repudiation (the order is final)
- Access control (prevent misuse of resources)
- Availability (permanence, non-erasure)
  - Denial of Service Attacks
  - Virus that deletes files

Role of Security

- A security infrastructure provides:
  - Confidentiality – protection against loss of privacy
  - Integrity – protection against data alteration/ corruption
  - Availability – protection against denial of service
  - Authentication – identification of legitimate users
  - Authorization – determination of whether or not an operation is allowed by a certain user
  - Non-repudiation – ability to trace what happened, & prevent denial of actions
  - Safety – protection against tampering, damage & theft

Types of Attack

- Social engineering/phishing
- Physical break-ins, theft, and curb shopping
- Password attacks
- Buffer overflows
- Command injection
- Denial of service
- Exploitation of faulty application logic
- Snooping
- Packet manipulation or fabrication
- Backdoors

Network Security…

- Network security works like this:
  - Determine network security policy
  - Implement network security policy
  - Reconnaissance
  - Vulnerability scanning
  - Penetration testing
  - Post-attack investigation

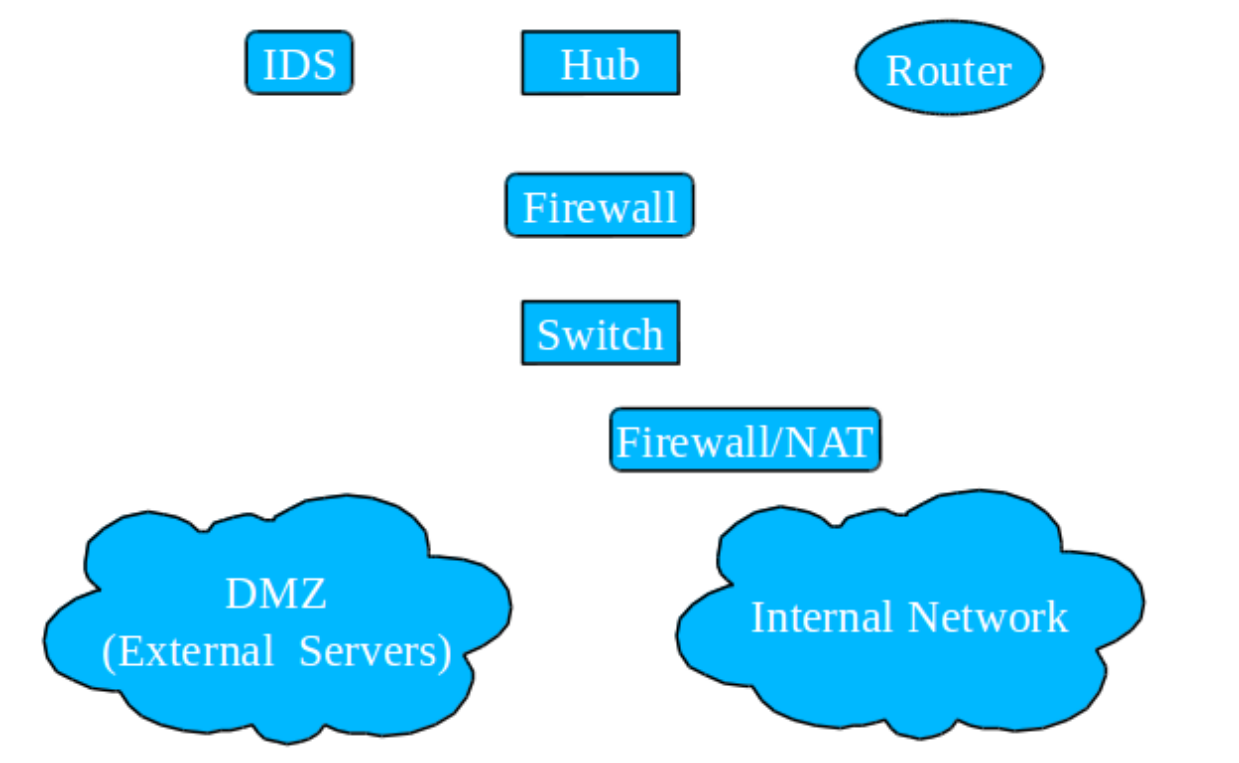
Step 1: Determine Security Policy

- A security policy is a full security roadmap
  - Usage policy for networks, servers, etc.
  - User training about password sharing, password strength, social engineering, privacy, etc.
  - Privacy policy for all maintained data
  - A schedule for updates, audits, etc.
- The network design should reflect this policy
  - The placement/protection of database/file servers
  - The location of demilitarized zones (DMZs)
  - The placement and rules of firewalls
  - The deployment of intrusion detection systems (IDSs)

Step 2: Implement Security Policy

- Implementing a security policy includes:
  - Installing and configuring firewalls
    - *iptables* is a common free firewall configuration for Linux
    - Rules for incoming packets should be created
      - These rules should drop packets by default
    - Rules for outgoing packets *may* be created
      - This depends on your security policy
  - Installing and configuring IDSes
    - *snort* is a free and upgradeable IDS for several platforms
    - Most IDSs send alerts to log files regularly
    - Serious events can trigger paging, E-Mail, telephone

Step 2: Implement Security Policy



Step 2: Implement Security Policy

- Firewall
  - Applies filtering rules to packets passing through it
  - Comes in three major types:
    - Packet filter – Filters by destination IP, port or protocol
    - Stateful – Records information about ongoing TCP sessions, and ensures out-of-session packets are discarded
    - Application proxy – Acts as a proxy for a specific application, and scans all layers for malicious data
- Intrusion Detection System (IDS)
  - Scans the incoming messages, and creates alerts when suspected scans/attacks are in progress
- Honeypot/honeynet (e.g. honeyd)
  - Simulates a decoy host (or network) with services

Step 3: Reconnaissance

- First, we learn about the network
  - IP addresses of hosts on the network
  - Identify key servers with critical data
  - Services running on those hosts/servers
  - Vulnerabilities on those services
- Two forms: passive and active
  - Passive reconnaissance is undetectable
  - Active reconnaissance is often detectable by IDS

Step 4: Vulnerability Scanning

- We now have a list of hosts and services
  - We can now target these services for attacks
- Many scanners will detect vulnerabilities (e.g. nessus)
  - These scanners produce a risk report
- Other scanners will allow you to exploit them (e.g. metasploit)
  - These scanners find ways in, and allow you to choose the payload to use (e.g. obtain a root shell, download a package)
  - The payload is the code that runs once inside
- The best scanners are updateable
  - For new vulnerabilities, install/write new plug-ins
  - e.g. Nessus Attack Scripting Language (NASL)

Step 5: Penetration Testing

- We have identified vulnerabilities
  - Now, we can exploit them to gain access
  - Using frameworks (e.g. metasploit), this is as simple as selecting a payload to execute
  - Otherwise, we manufacture an exploit
- We may also have to try to find new vulnerabilities
  - This involves writing code or testing functions accepting user input

Step 6: Post-Attack Investigation

- Forensics of Attacks
- This process is heavily guided by laws
  - Also, this is normally done by a third party
- Retain chain of evidence
  - The evidence in this case is the data on the host
  - The log files of the compromised host hold the footsteps and fingerprints of the attacker
  - Every minute with that host must be accounted for
  - For legal reasons, you should examine a low-level copy of the disk and not modify the original

Thank You!