Introduction

Security: Objectives

- Defense against non-authorized activities (adversaries)
  - Initiated by someone "from inside"
  - Initiated by someone "from outside"
- Types of illegal activities:
  - Access to information
  - Information modification
  - Resource usage
    - CPU, memory, printer, network, etc.
  - Denial of Service (DoS)
  - Vandalism
    - Interference with the normal system behavior without any benefit for the attacker

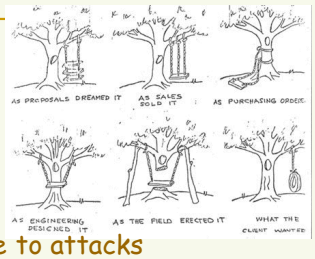
Security in computing systems: Complex problems

- Computers can do a lot of damage in a short time frame
  - They manage an always growing amount of data/information
  - They process and communicate very fast
- The number of weakness is always growing
  - Systems are getting more complex with time
  - Time-to-market is each time shorter
- Networks allow:
  - Anonymous (?) attacks from anywhere
  - Automatic propagation of cyberplagues
  - The existence and exploitation of hostile hosts and applications
- In general users are not careful
  - Because they are not aware of the problems and solutions
  - Because they take risks

Security: Pragmatic approach

- There will never be a 100% protection
  - Cost-efficiency balance
- Security is expensive
  - Dedicated technology, skilled people
  - Use only the minimum required
- Protection, value e punishment
  - Good protection for the most frequent attacks
  - Less interference with daily work than the damage caused by attackers
  - Police and courts for tracking and prosecuting attackers
    - It is critical to avoid the notion of total impunity

Security: Lexicon



- Vulnerability
  - A system weakness that makes it sensible to attacks
  - Design / development / installation
- Attack
  - A set of steps that lead to the execution of illegal activities
    - Usually exploiting vulnerabilities
- Risks / threats
  - Damage resulting from an attack
- Defense
  - Set of policies and mechanisms aiming at
    - Reducing the amount of vulnerabilities
    - Detect as fast as possible actual and past attacks
    - Reduce the risks of systems

Security: Risks

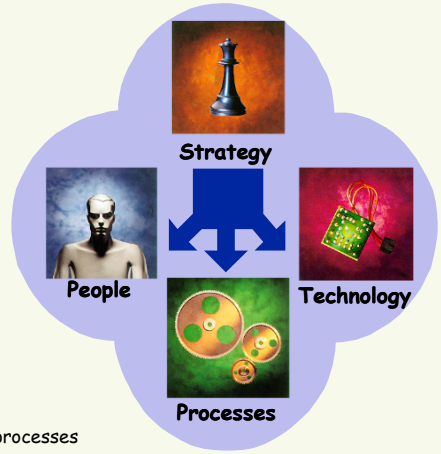
- Information, time and money
  - Destruction or tampering of information
- Confidentiality
  - Non-authorized access to information
- Privacy
  - Non-authorized gathering of personal information
  - Data warehousing on personal information
- Resource availability
  - Disruption of computing systems / networks
- Impersonation
  - Of people / of services
  - Non-authorized exploitation of personal accounts / profiles

Security:
Main vulnerability sources

- Applications with bugs or hostile
  - Morris Worm 1988
    - *Buffer overflows* + discovery of weak passwords
  - root kits
- People
  - Ignorant or careless
    - telnet vs. ssh, IMAPS vs. IMAP
    - Problems? I'm sufficiently protected with my anti-virus/IDS
  - Hostile
- Defective administration
  - Systems get more complex as they evolve
  - Default configuration seldom are the most secure ones
  - Security restrictions vs. flexible operation
- Communications over uncontrolled/unknown network links

Security:
Dimensions to consider

- Training
- Awareness
- Organization of security



- Vulnerability scanning
- Firewalls
- Authentication
- Access Control
- Auditing
- Cryptography
- Digital signatures
- Certification authorities
- Certification hierarchies
- Etc.

- Security policies
- Security administration processes
- Continues evolution of auditing and follow-up processes

Security: Policies

- Define the power of each and every subject
  - Least privilege principle
  - *Hardening*
- Define security procedures
  - How does what in which circumstances
- Define the minimum security requirements of a domain
  - Security levels
  - Required authorization
    - And related minimum authentication requirements
    - Strong/weak, single/multi-factor, remote/face-to-face
- Define defense strategies and fight back tactics
  - Defensive architecture
  - Monitoring of critical activities or attack signs
  - Reaction against attacks or other abnormal scenarios
- Define the universe of legal and illegal activities
  - All that is not forbidden is allowed
  - All that is not allowed is forbidden

Security: Mechanisms

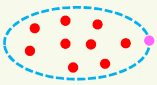
- Mechanisms implement policies
  - Policies define, at an higher level, what needs to be done
  - Mechanisms are used to deploy policies
- Generic security mechanisms
  - Confinement (sandboxing)
  - Authentication
  - Access control
  - Privileged execution
  - Filtering
  - Logging
  - Inspection
  - Auditing
  - Crypto algorithms
  - Crypto protocols

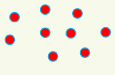
Security:
Security level offered by a computer

- Depends on:
  - Available security policies
  - Correctness and effectiveness of their specification / implementation
- Evaluation criteria:
  - NCSC Trusted Computer System Evaluation Criteria (TCSEC, Orange Book)
    - Classes: **D**, ***C*** (1, 2), **B** (1, 2, 3) e ***A*** (1)
    - D: insecure (minimum protection level)
    - A1: most secure
      - Very demanding and expensive protection policies
      - Formal validation of specification
      - Highly supervised implementation
  - EC Information Technology Security Evaluation Criteria (ITSEC)
    - Levels: **E1** to **E6**
      - Formal specification level
      - Correctness of implementation

Security:
Policies for distributed systems

- Must encompass several hosts and networks
  - Security Domains
    - Definition of the set of hosts and networks of the domain
    - Definition of the set of accepted/authorized users
    - Definition of the set of accepted/not accepted activities
  - Security gateways
    - Definition of the set of allowed in-out interactions
- Perimeter defense vs. Defense in depth





Security:

Attacks to distributed systems

- Attacks to hosts
  - Stealing
  - Intrusion
  - Impersonation (of users)
  - Denial of service
- Attacks to networks
  - Packet inspection
  - Packet tampering / injection
  - Traffic interception
  - Traffic replaying
  - Host impersonation
  - Denial of service (jamming, flooding, deception, etc.)
- Other
  - Covert channels

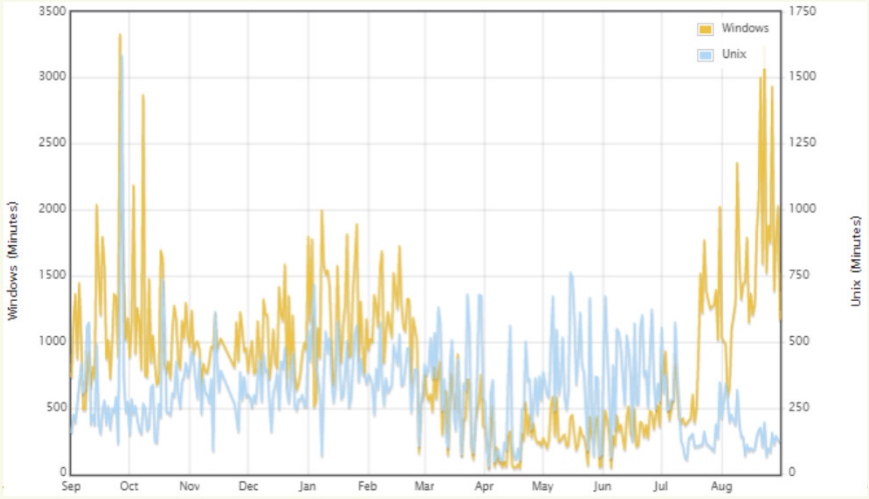
"On the Internet, nobody knows you're a dog."

Attack models

- Target-specific attacks
  - Conceived for a particular host / network
  - Idealized and conducted in real-time by specialists
- Generic, autonomous attacks
  - Conceived for exploiting well-known, common vulnerabilities
  - Coded for many scenarios and targets
  - Mean survivability time
    - Time between two consecutive automatic attacks
    - There are "network sensors" that help to compute it

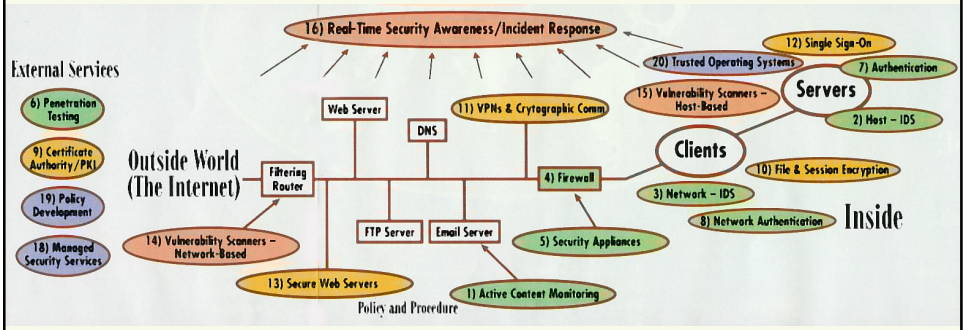
Mean survival time

(http://isc.sans.org/survivaltime.html)



Security:

Mechanisms for distributed systems (1/5)



Security:
Mechanisms for distributed systems (2/5)

- Trusted Operating Systems
  - Security levels, certification
  - Secure execution environments for servers
  - Sandboxing / virtual machines
- Authentication
  - Local
  - Remote (network authentication)
  - Single Sign-On
- Firewalls & Security Appliances
  - Traffic control between networks
  - Monitoring (traffic load, etc.)

Security:
Mechanisms for distributed systems (3/5)

- Certification Authorities / PKI
  - Management of public key certificates
- Encryption of files and sessions
  - Privacy / confidentiality of network data
  - Privacy / confidentiality of long-term stored data
- Secure communications / VPNs
  - Secure channels over insecure, public networks
  - Secure extension of organizational networks

Security:
Mechanisms for distributed systems (4/5)

- Content monitoring
  - Detection of virus, worms or other cyberplagues
- Intrusion detection
  - Detention of forbidden / abnormal activities
  - Host-based / Network-Based
- Vulnerability scanners
  - Scanning for problem fixing or exploitation
  - Network-based / Host-based
- Penetration testing
  - Vulnerability assessment
  - Demo penetration attempts
  - Testing of installed security mechanisms
  - Assessment of badly implemented security policies

Security:
Mechanisms for distributed systems (5/5)

- Security administration
  - Development of security policies
  - Distributed enforcement of policies
  - Co-administration / outsourcing of security services
- Real-Time Security Awareness / Incident Response
  - Capacity to detect and react correctly to security incidents in real-time
  - Means for a rapid and effective incident reaction