Protection and Security

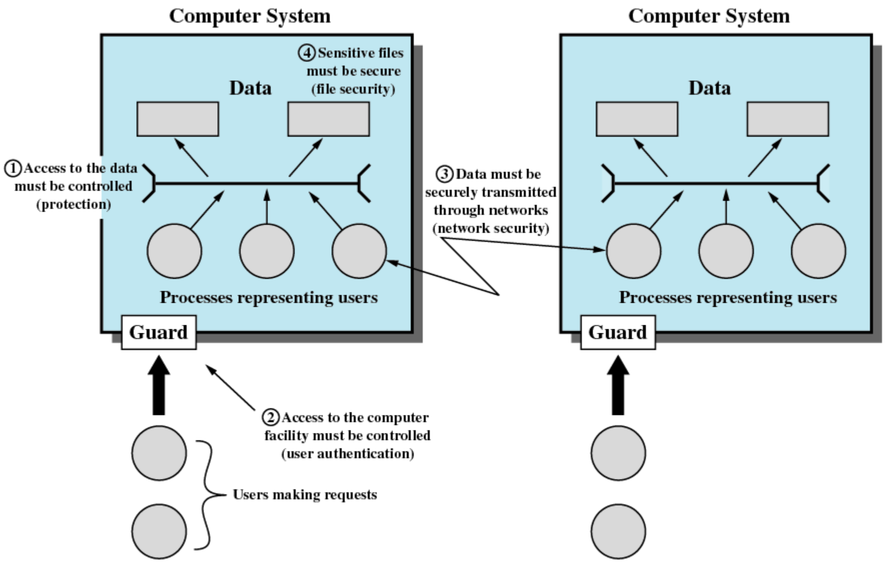
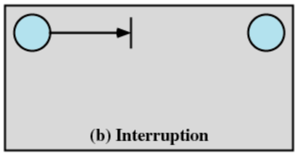

Computer System
Computer System
④Sensitive files must be secure (file security)
Data
Data
①Access to the data must be controlled (protection)
③Data must be securely transmitted through networks (network security)
Processes representing users
Processes representing users
Guard
Guard
②Access to the computer facility must be controlled (user authentication)
Users making requests

Figure 16.1 Scope of System Security [MAEK87]

Types of Threats

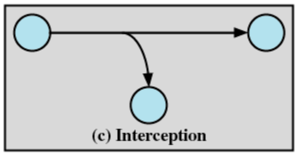
- Interruption
  - An asset of the system is destroyed
  - Attack on availability
  - Destruction of hardware
  - Cutting of a communication line
  - Disabling the file management system



(b) Interruption

Types of Threats

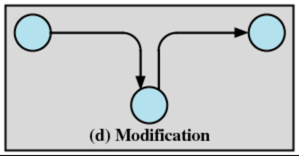
- Interception
  - An unauthorized party gains access to an asset
  - Attack on confidentiality
  - Wiretapping to capture data in a network
  - Illicit copying of files or programs



(c) Interception

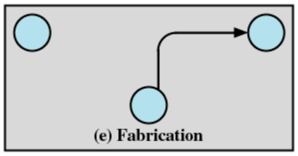
Types of Threats

- Modification
  - An unauthorized party not only gains access but tampers with an asset
  - Attack on integrity
  - Changing values in a data file
  - Altering a program so that it performs differently
  - Modifying the content of messages being transmitted in a network


(d) Modification

Types of Threats

- Fabrication
  - An unauthorized party inserts counterfeit objects into the system
  - Attack on authenticity
  - Insertion of spurious messages in a network
  - Addition of records to a file


(e) Fabrication

6

Computer System Assets

- Hardware
  - Threats include accidental and deliberate damage
- Software
  - Threats include deletion, alteration, damage
  - Backups of the most recent versions can maintain high availability

Computer System Assets

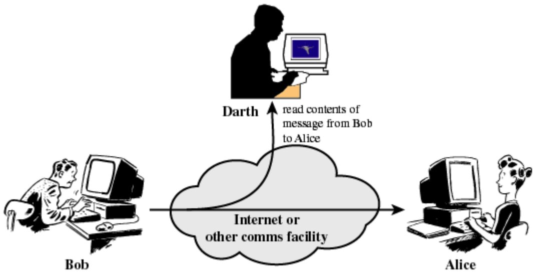
- Data
  - Involves files
  - Security concerns fro availability, secrecy, and integrity
  - Statistical analysis can lead to determination of individual information which threatens privacy

Computer System Assets

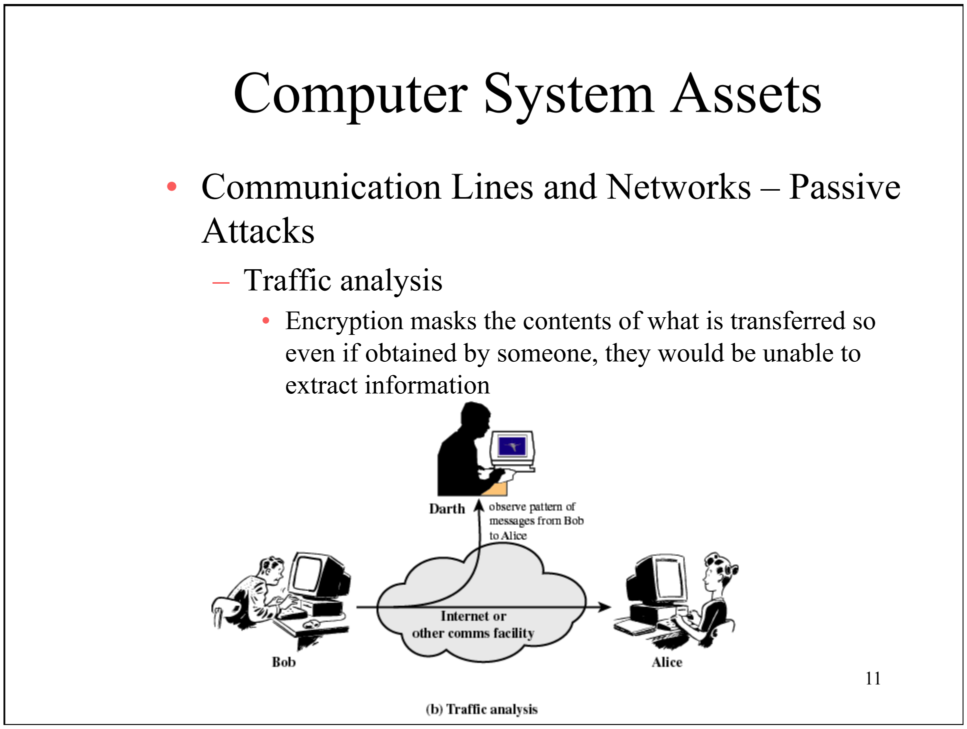
- Communication Lines and Networks – Passive Attacks
  - Learn or make use of information from the system but does not affect system resources
  - Traffic analysis
    - Encryption masks the contents of what is transferred so even if obtained by someone, they would be unable to extract information

Computer System Assets

- Communication Lines and Networks – Passive Attacks
  - Release of message contents for a telephone conversion, an electronic mail message, and a transferred file are subject to these threats


Darth
read contents of message from Bob to Alice
Internet or other comms facility
Bob
Alice

(a) Release of message contents



Computer System Assets

- Communication Lines and Networks – Passive Attacks
  - Traffic analysis
    - Encryption masks the contents of what is transferred so even if obtained by someone, they would be unable to extract information

Darth
observe pattern of messages from Bob to Alice
Internet or other comms facility
Bob
Alice

(b) Traffic analysis

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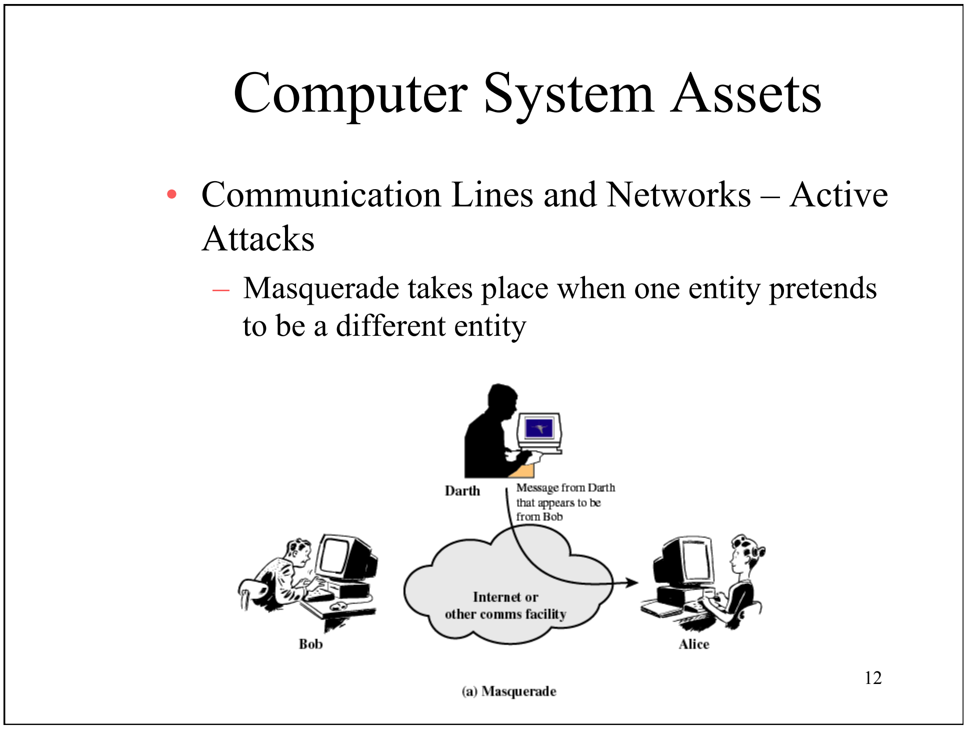


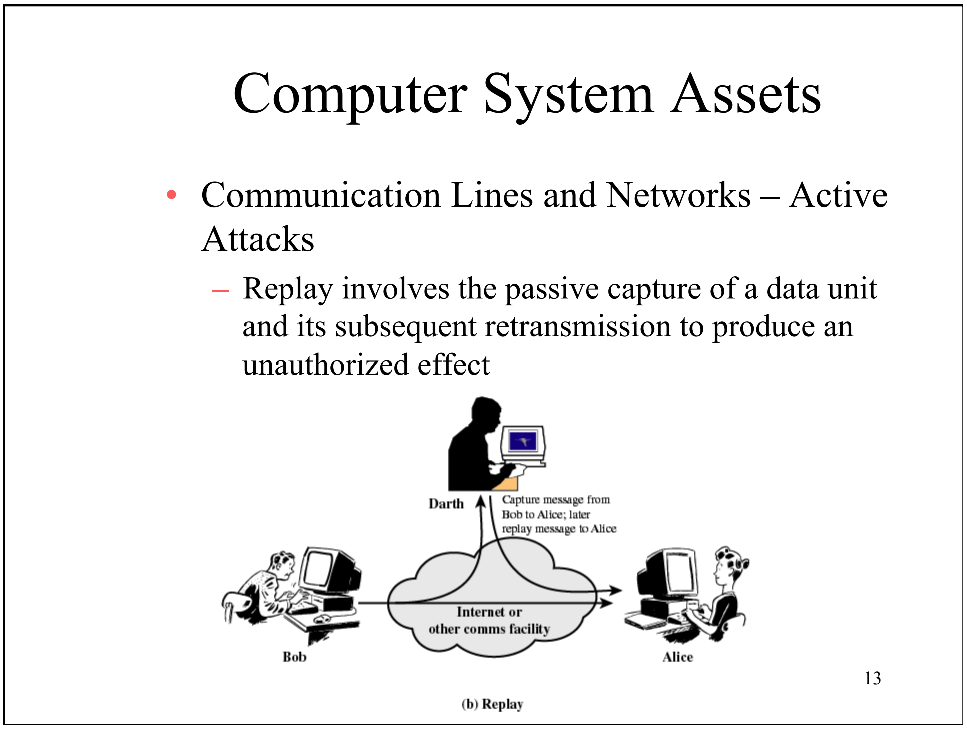
Computer System Assets

- Communication Lines and Networks – Active Attacks
  - Masquerade takes place when one entity pretends to be a different entity

Darth
Message from Darth that appears to be from Bob
Internet or other comms facility
Bob
Alice

(a) Masquerade

12



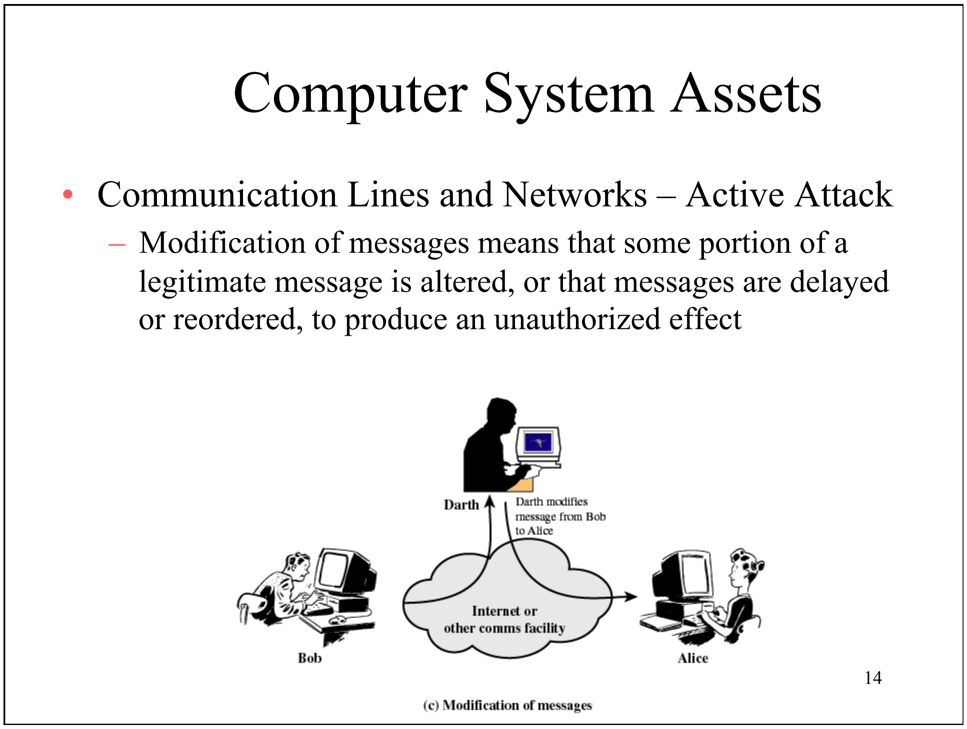
Computer System Assets

- Communication Lines and Networks – Active Attacks
  - Replay involves the passive capture of a data unit and its subsequent retransmission to produce an unauthorized effect

Darth
Capture message from Bob to Alice; later replay message to Alice
Internet or other comms facility
Bob
Alice

(b) Replay

13



Computer System Assets

- Communication Lines and Networks – Active Attack
  - Modification of messages means that some portion of a legitimate message is altered, or that messages are delayed or reordered, to produce an unauthorized effect

Darth
Darth modifies message from Bob to Alice
Internet or other comms facility
Bob
Alice

(c) Modification of messages

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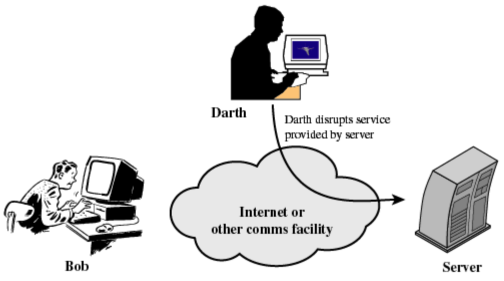
Computer System Assets

- Communication Lines and Networks – Active Attacks
  - Denial of service prevents or inhibits the normal use or management of communications facilities
    - Disable network or overload it with messages


Darth
Darth disrupts service provided by server
Internet or other comms facility
Bob
Server

(d) Denial of service

Protection

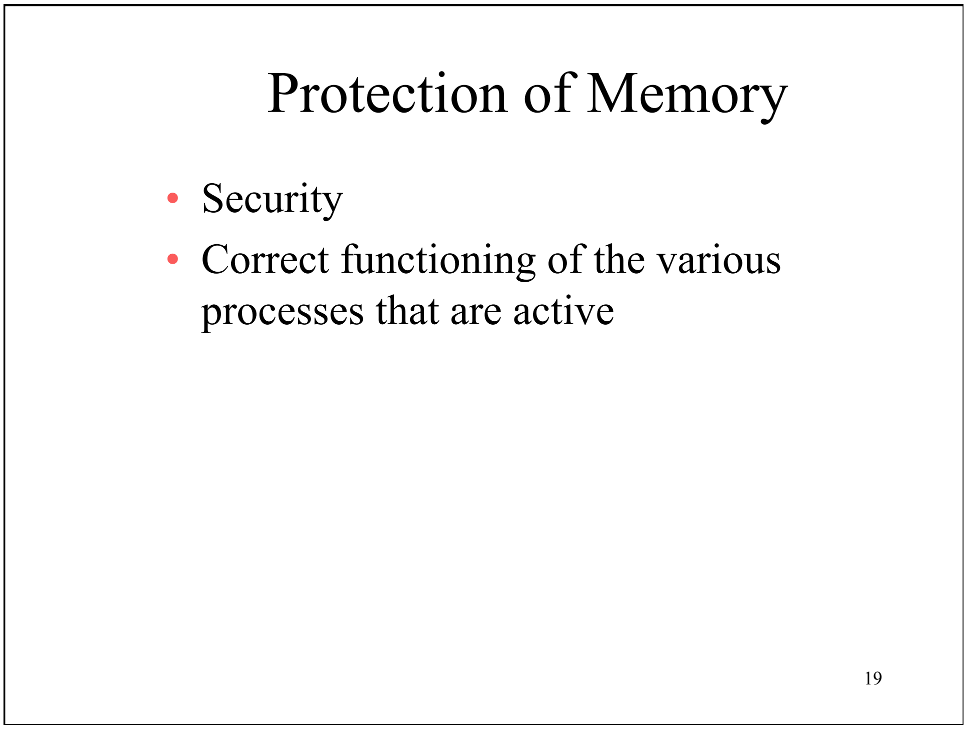
- No protection
  - Sensitive procedures are run at separate times
- Isolation
  - Each process operates separately from other processes with no sharing or communication

Protection

- Share all or share nothing
  - Owner of an object declares it public or private
- Share via access limitation
  - Operating system checks the permissibility of each access by a specific user to a specific object
  - Operating system acts as the guard

Protection

- Share via dynamic capabilities
  - Dynamic creation of sharing rights for objects
- Limit use of an object
  - Limit not just access to an object but also the use to which that object may be put
  - Example: a user may be able to derive statistical summaries but not to determine specific data values



Protection of Memory

- Security
- Correct functioning of the various processes that are active

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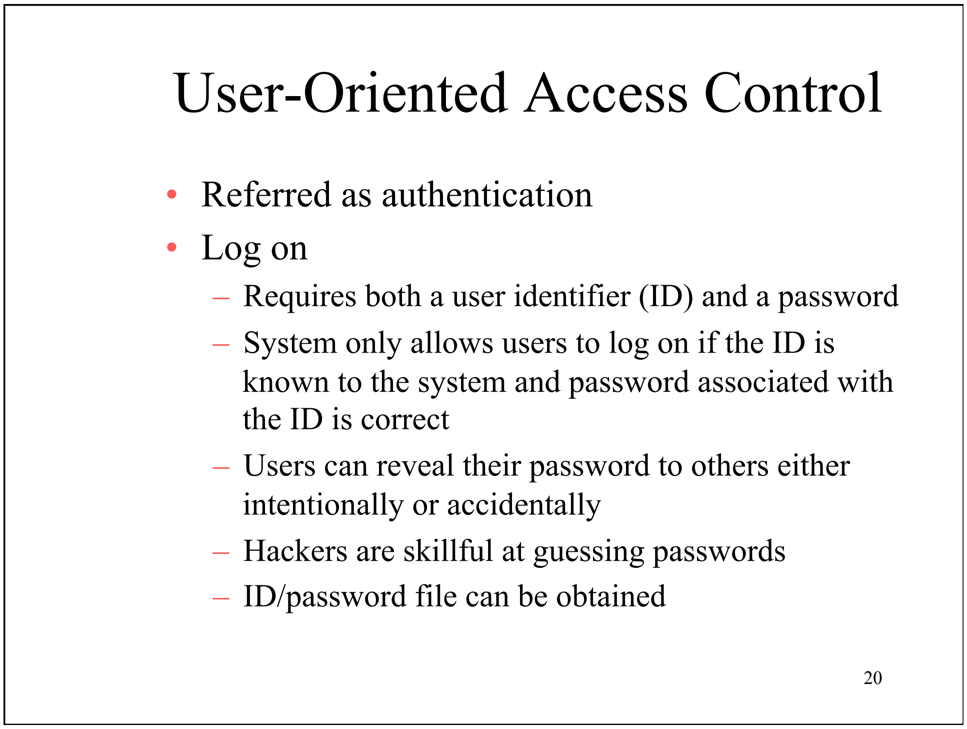

User-Oriented Access Control

- Referred as authentication
- Log on
  - Requires both a user identifier (ID) and a password
  - System only allows users to log on if the ID is known to the system and password associated with the ID is correct
  - Users can reveal their password to others either intentionally or accidentally
  - Hackers are skillful at guessing passwords
  - ID/password file can be obtained

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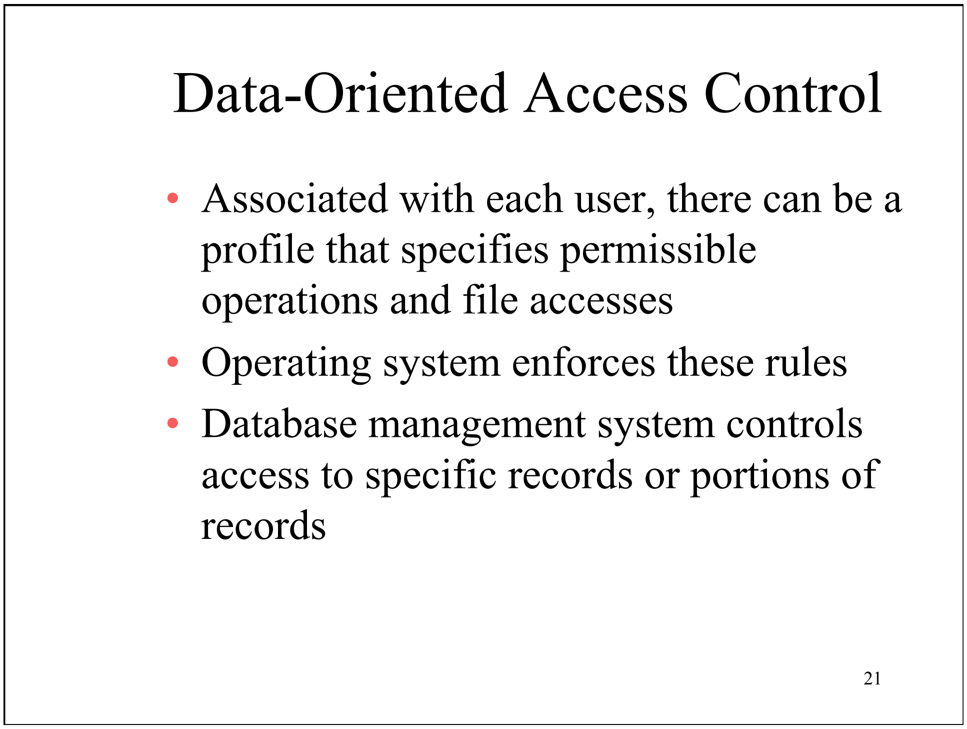
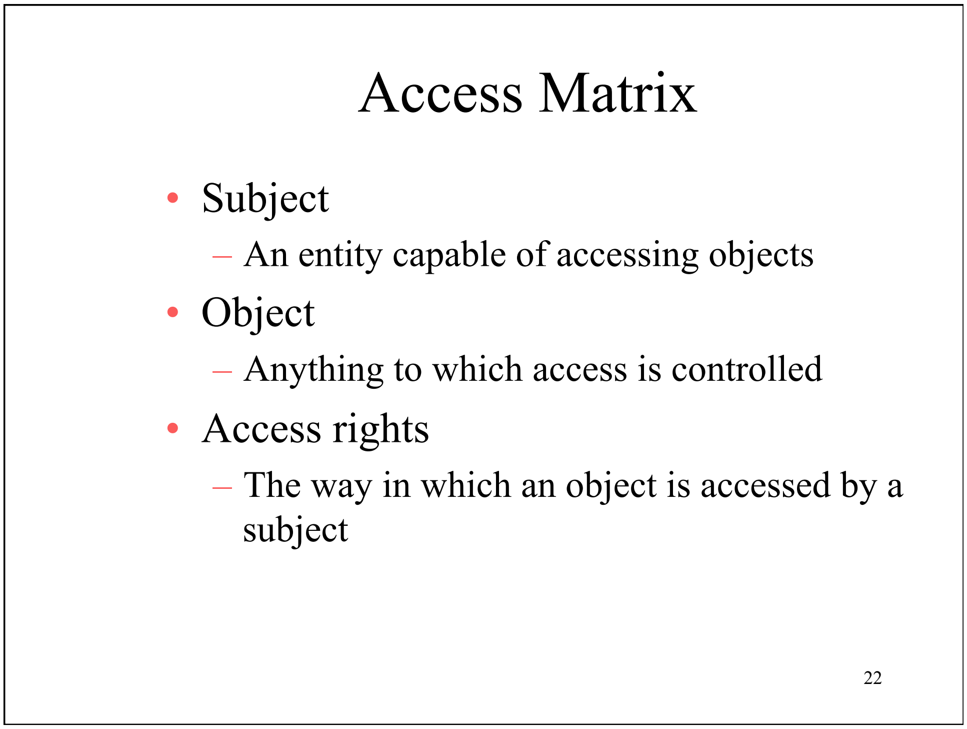


Data-Oriented Access Control

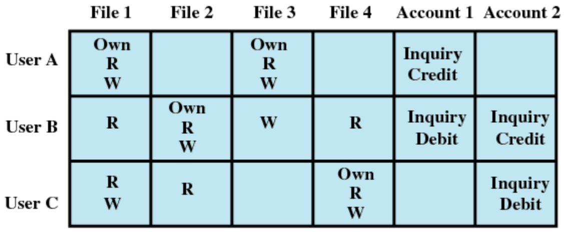
- Associated with each user, there can be a profile that specifies permissible operations and file accesses
- Operating system enforces these rules
- Database management system controls access to specific records or portions of records



Access Matrix

- Subject
  - An entity capable of accessing objects
- Object
  - Anything to which access is controlled
- Access rights
  - The way in which an object is accessed by a subject

Access Matrix



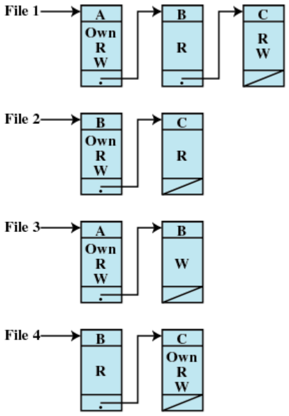
	File 1	File 2	File 3	File 4	Account 1	Account 2
User A	Own R W		Own R W		Inquiry Credit	
User B	R	Own R W	W	R	Inquiry Debit	Inquiry Credit
User C	R W	R		Own R W		Inquiry Debit

(a) Access matrix

Access Control List

- Matrix decomposed by columns
- For each object, an access control list gives users and their permitted access rights

Access Control List

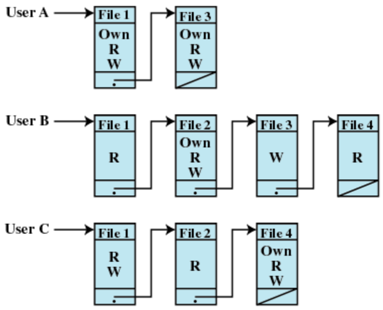


(b) Access control lists for files of part (a)

Capability Tickets

- Decomposition of access matrix by rows
- Specifies authorized objects and operations for a user

Capability Tickets



(c) Capability lists for files of part (a)

Intrusion Techniques

- Objective of intruder is the gain access to the system or to increase the range of privileges accessible on a system
- Protected information that an intruder acquires is a password

Techniques for Learning Passwords

- Try default password used with standard accounts shipped with system
- Exhaustively try all short passwords
- Try words in dictionary or a list of likely passwords
- Collect information about users and use these items as passwords

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Techniques for Learning Passwords

- Try users' phone numbers, social security numbers, and room numbers
- Try all legitimate license plate numbers for this state
- Use a Trojan horse to bypass restrictions on access
- Tap the line between a remote user and the host system

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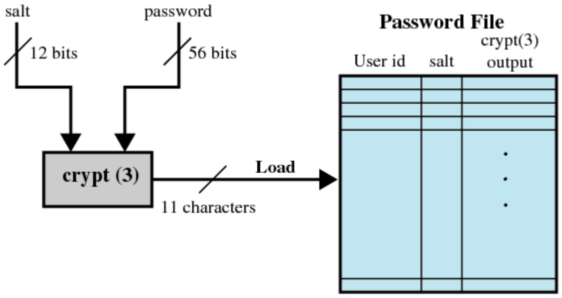
ID Provides Security

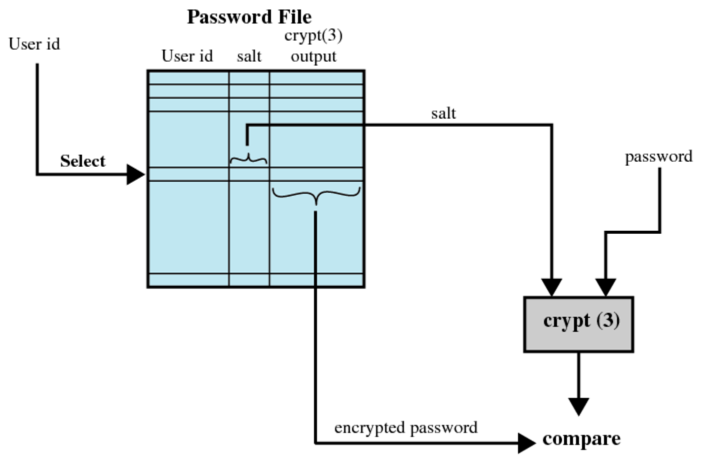
- Determines whether the user is authorized to gain access to a system
- Determines the privileges accorded to the user
  - Superuser enables file access protected by the operating system
  - Guest or anonymous accounts have more limited privileges than others
- ID is used for discretionary access control
  - A user may grant permission to files to others by ID

UNIX Password Scheme



(a) Loading a new password

UNIX Password Scheme



(b) Verifying a password

Password Selection Strategies

- Computer generated passwords
  - Users have difficulty remembering them
  - Need to write it down
  - Have history of poor acceptance

Password Selection Strategies

- Reactive password checking strategy
  - System periodically runs its own password cracker to find guessable passwords
  - System cancels passwords that are guessed and notifies user
  - Consumes resources to do this
  - Hacker can use this on their own machine with a copy of the password file

Password Selection Strategies

- Proactive password checker
  - The system checks at the time of selection if the password is allowable
  - With guidance from the system users can select memorable passwords that are difficult to guess

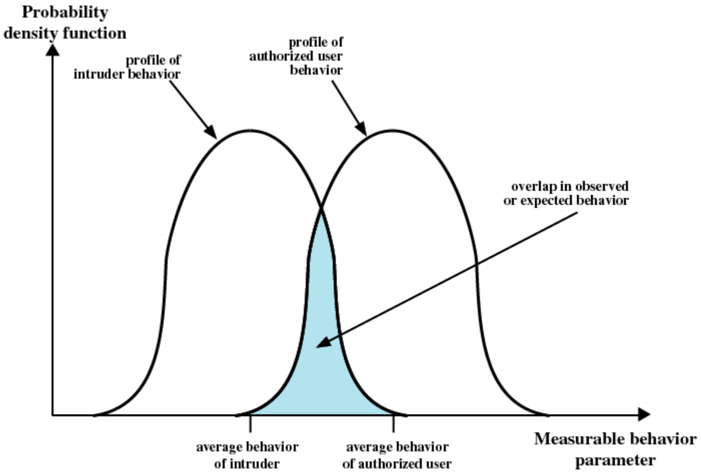
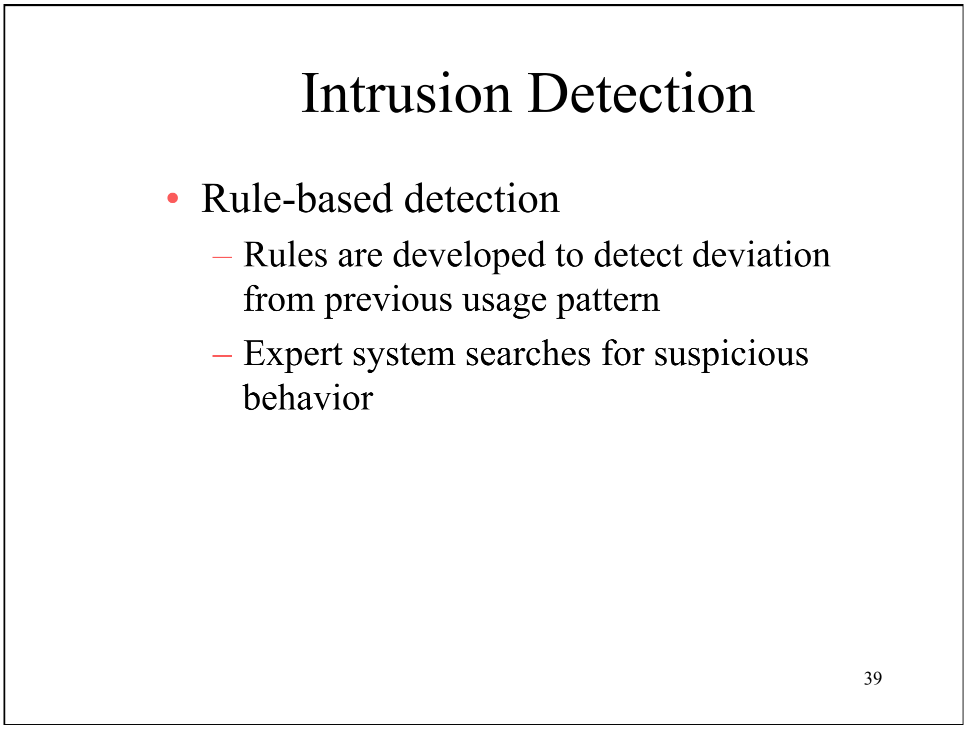


Figure 16.7 Profiles of Behavior of Intruders and Authorized Users

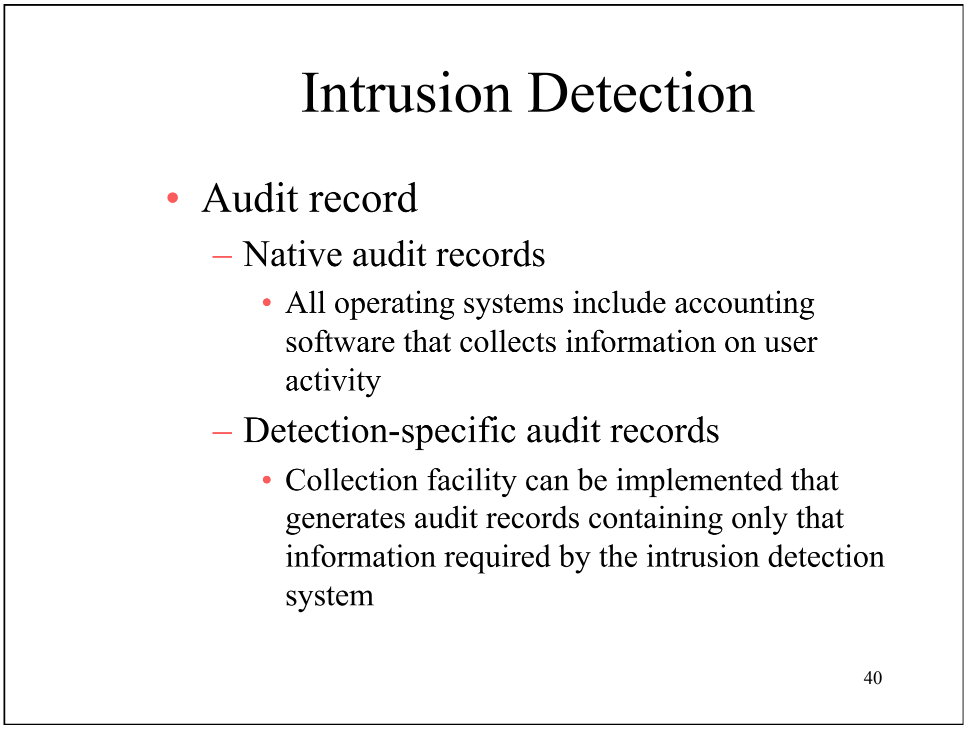
Intrusion Detection

- Assume the behavior of the intruder differs from the legitimate user
- Statistical anomaly detection
  - Collect data related to the behavior of legitimate users over a period of time
  - Statistical tests are used to determine if the behavior is not legitimate behavior



Intrusion Detection

- Rule-based detection
  - Rules are developed to detect deviation from previous usage pattern
  - Expert system searches for suspicious behavior



Intrusion Detection

- Audit record
  - Native audit records
    - All operating systems include accounting software that collects information on user activity
  - Detection-specific audit records
    - Collection facility can be implemented that generates audit records containing only that information required by the intrusion detection system

Malicious Programs

- Those that need a host program
  - Fragments of programs that cannot exist independently of some application program, utility, or system program
- Independent
  - Self-contained programs that can be scheduled and run by the operating system

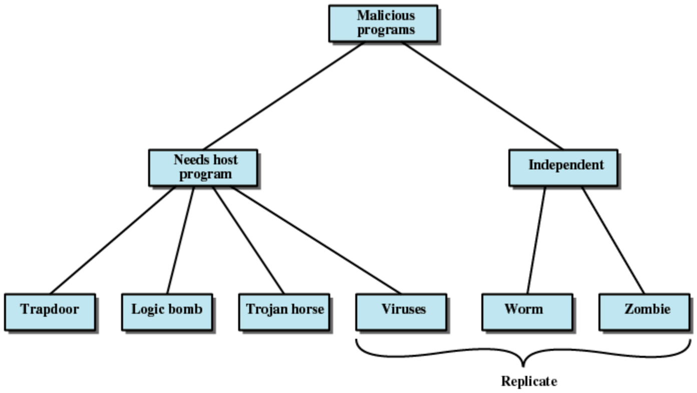
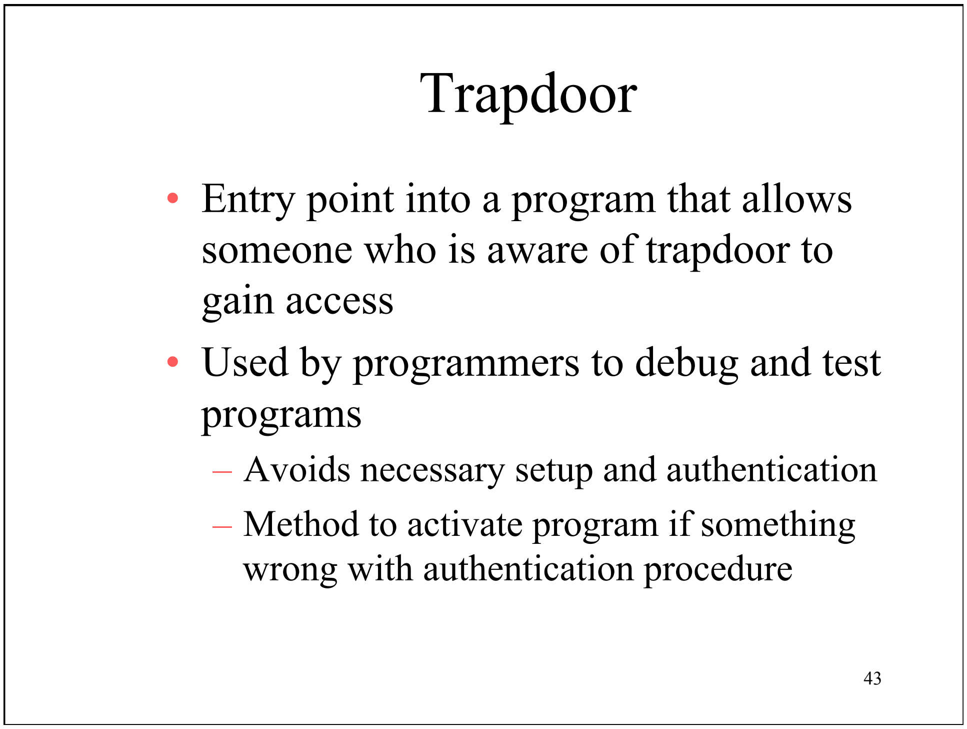
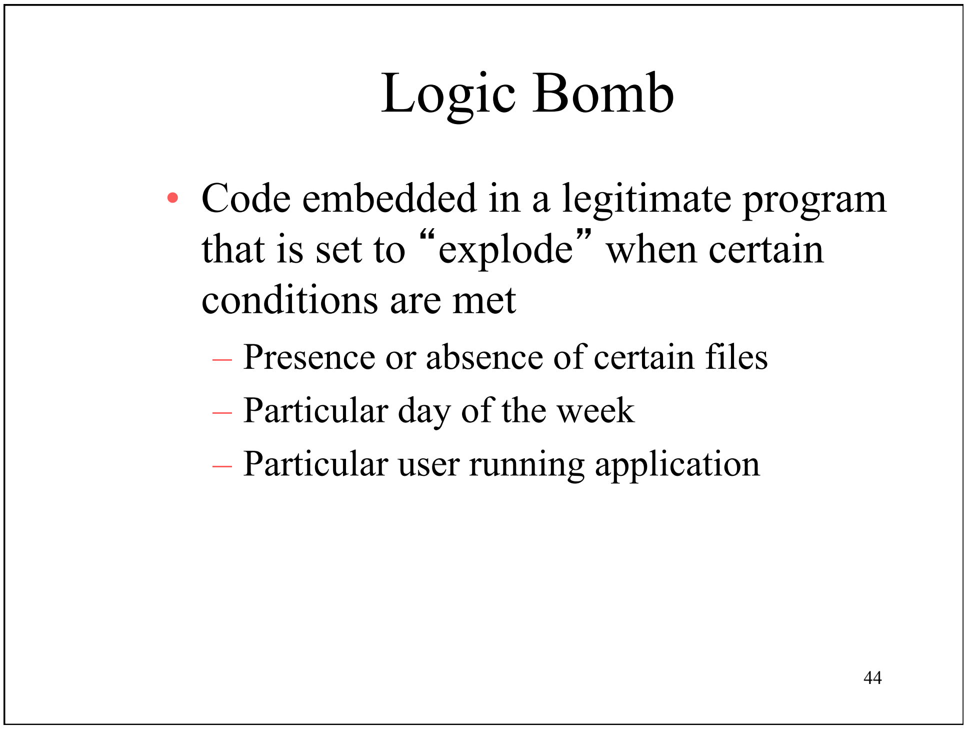


Figure 16.8 Taxonomy of Malicious Programs



Trapdoor

- Entry point into a program that allows someone who is aware of trapdoor to gain access
- Used by programmers to debug and test programs
  - Avoids necessary setup and authentication
  - Method to activate program if something wrong with authentication procedure



Logic Bomb

- Code embedded in a legitimate program that is set to “explode” when certain conditions are met
  - Presence or absence of certain files
  - Particular day of the week
  - Particular user running application

Trojan Horse

- Useful program that contains hidden code that when invoked performs some unwanted or harmful function
- Can be used to accomplish functions indirectly that an unauthorized user could not accomplish directly
  - User may set file permission so everyone has access

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Virus

- Program that can "infect" other programs by modifying them
  - Modification includes copy of virus program
  - The infected program can infect other programs

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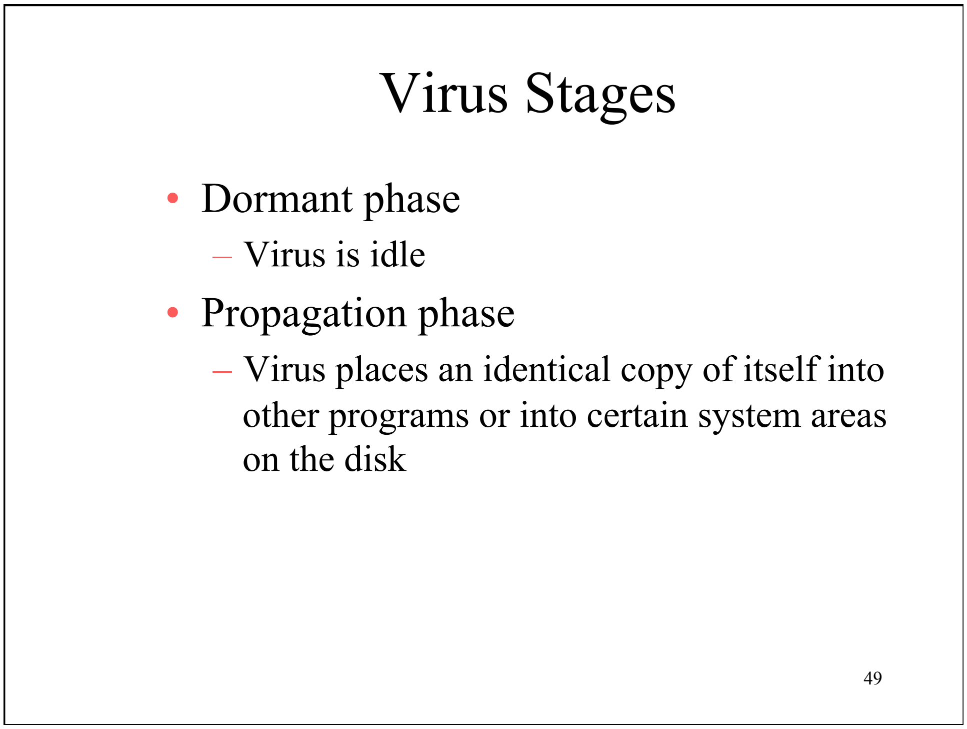
Worms

- Use network connections to spread form system to system
- Electronic mail facility
  - A worm mails a copy of itself to other systems
- Remote execution capability
  - A worm executes a copy of itself on another system
- Remote log-in capability
  - A worm logs on to a remote system as a user and then uses commands to copy itself from one system to the other

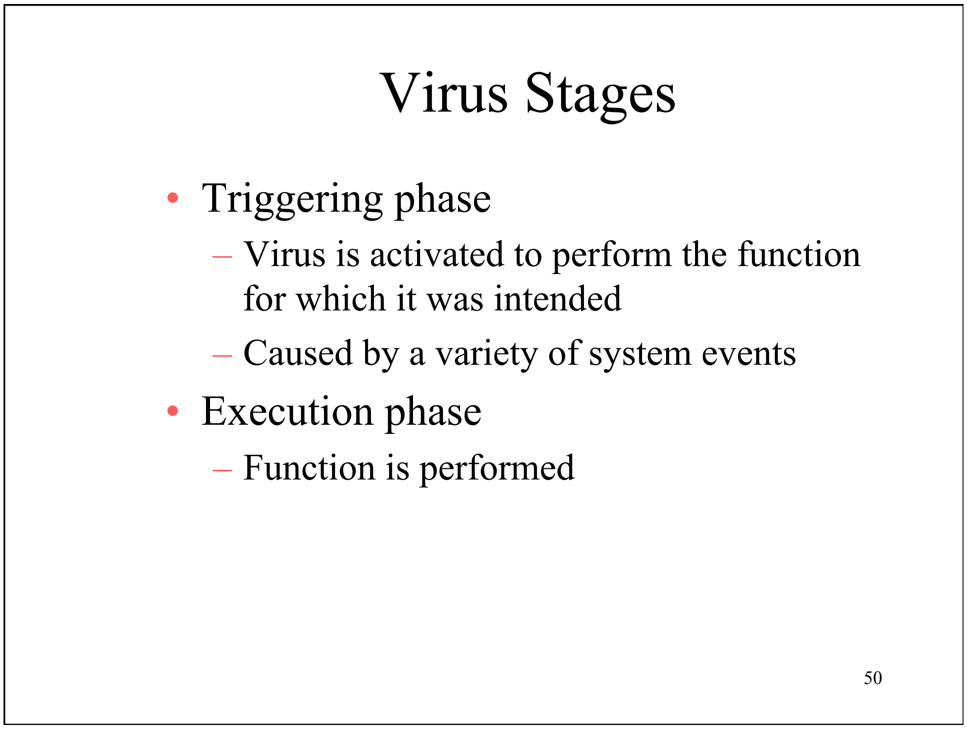
Zombie

- Program that secretly takes over another Internet-attached computer
- It uses that computer to launch attacks that are difficult to trace to the zombie' s creator



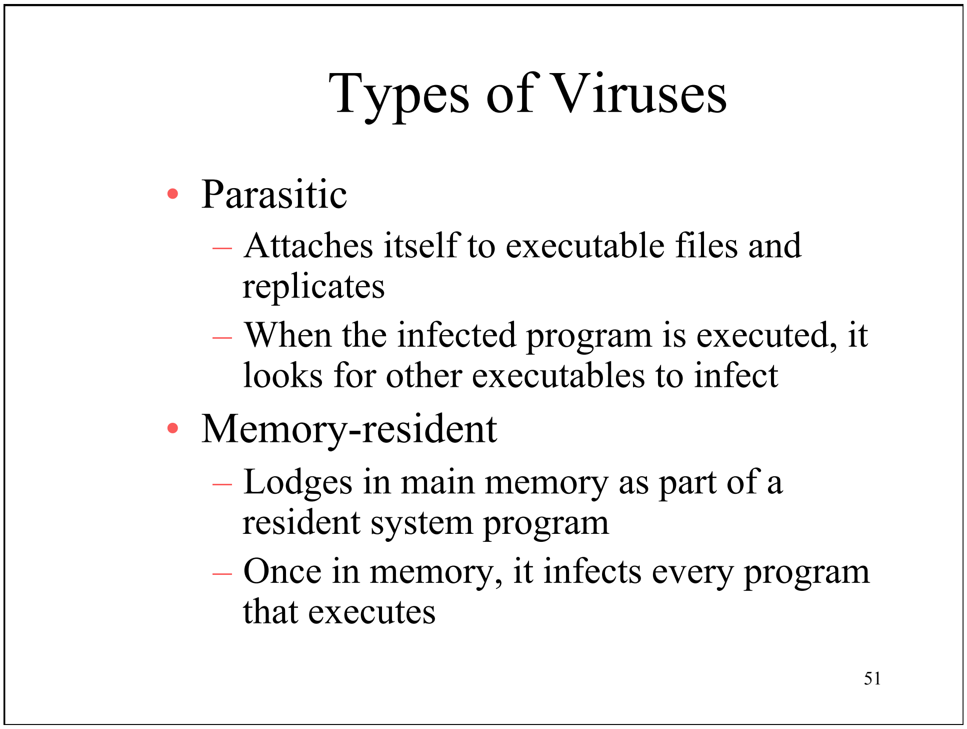
Virus Stages

- Dormant phase
  - Virus is idle
- Propagation phase
  - Virus places an identical copy of itself into other programs or into certain system areas on the disk



Virus Stages

- Triggering phase
  - Virus is activated to perform the function for which it was intended
  - Caused by a variety of system events
- Execution phase
  - Function is performed



Types of Viruses

- Parasitic
  - Attaches itself to executable files and replicates
  - When the infected program is executed, it looks for other executables to infect
- Memory-resident
  - Lodges in main memory as part of a resident system program
  - Once in memory, it infects every program that executes

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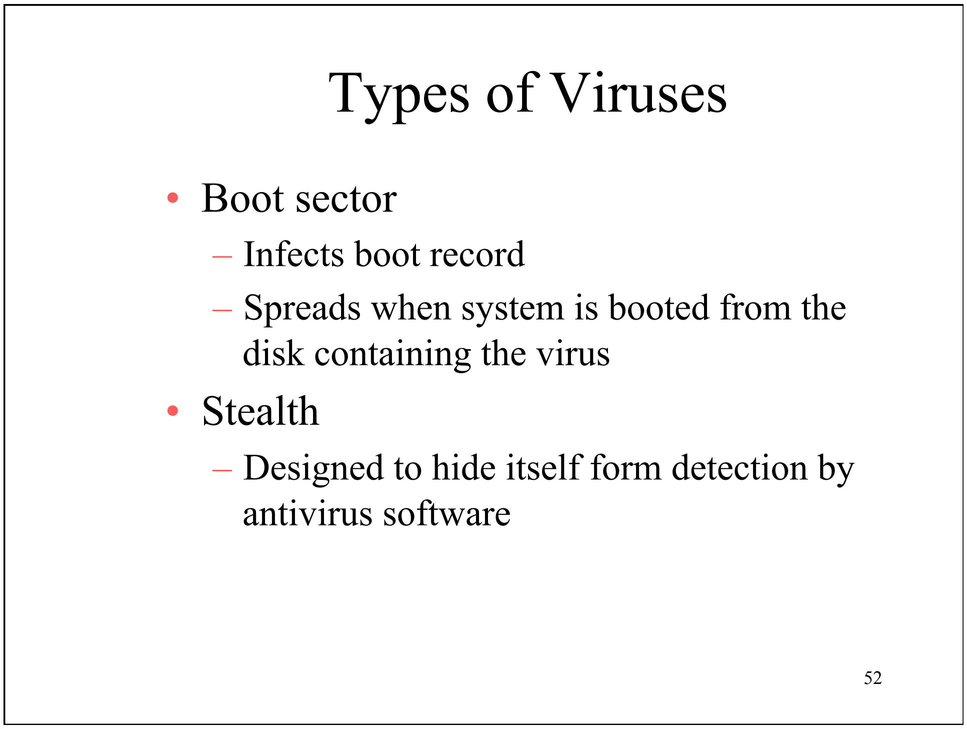

Types of Viruses

- Boot sector
  - Infects boot record
  - Spreads when system is booted from the disk containing the virus
- Stealth
  - Designed to hide itself form detection by antivirus software

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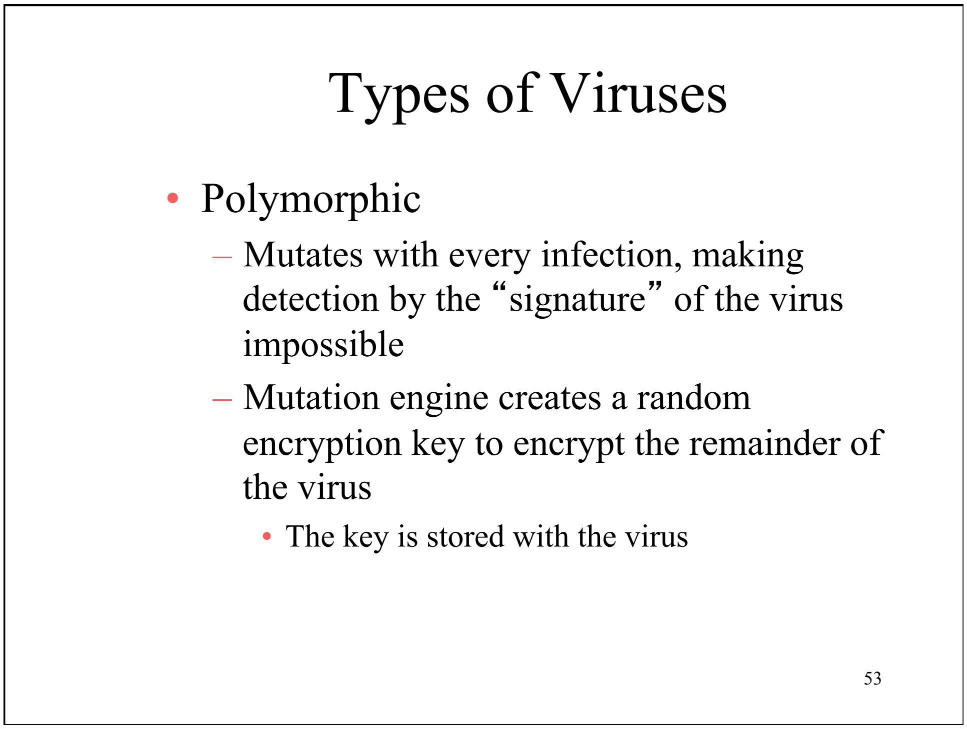
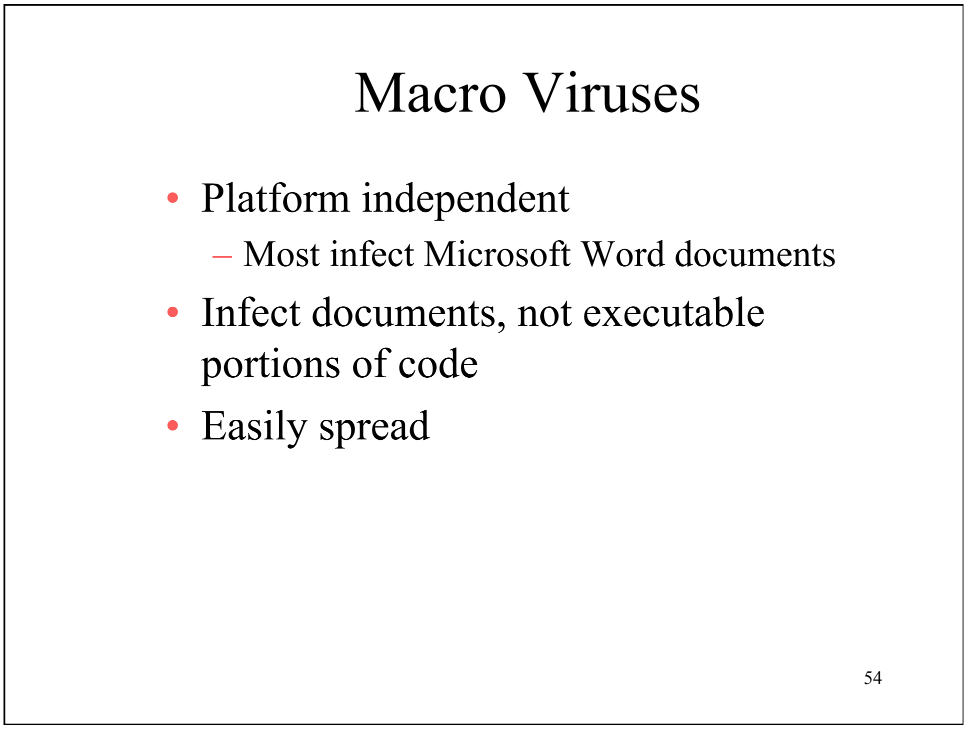


Types of Viruses

- Polymorphic
  - Mutates with every infection, making detection by the “signature” of the virus impossible
  - Mutation engine creates a random encryption key to encrypt the remainder of the virus
    - The key is stored with the virus



Macro Viruses

- Platform independent
  - Most infect Microsoft Word documents
- Infect documents, not executable portions of code
- Easily spread

Macro Viruses

- A macro is an executable program embedded in a word processing document or other type of file
- Autoexecuting macros in Word
  - Autoexecute
    - Executes when Word is started
  - Automacro
    - Executes when defined event occurs such as opening or closing a document
  - Command macro
    - Executed when user invokes a command (e.g., File Save)

Antivirus Approaches

- Detection
- Identification
- Removal

Generic Decryption

- CPU emulator
  - Instructions in an executable file are interpreted by the emulator rather than the processor
- Virus signature scanner
  - Scan target code looking for known virus signatures
- Emulation control module
  - Controls the execution of the target code

Digital Immune System

- Developed by IBM
- Motivation has been the rising threat of Internet-based virus propagation
  - Integrated mail systems
  - Mobile-program system

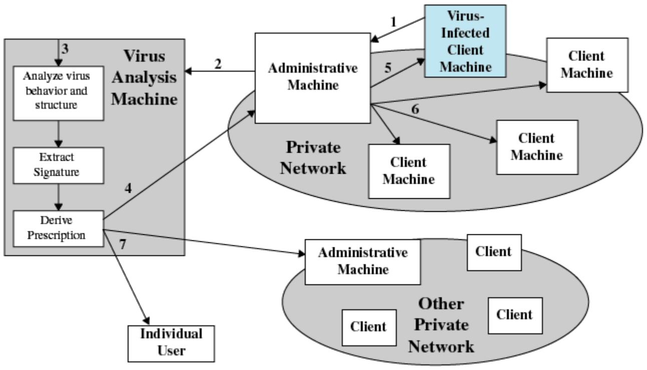


Figure 16.9 Digital Immune System

E-mail Virus

- Activated when recipient opens the e-mail attachment
- Activated by opening an e-mail that contains the virus
- Uses Visual Basic scripting language
- Propagates itself to all of the e-mail addresses known to the infected host