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INFO-6003

O/S & Application Security

Week 02

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Agenda

- Virtual Networks Revisited
- Virtualization & Security
- Operating Systems & History
- Need for O/S Security
- Access Control Concepts
- Lab Details

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Virtual Networks Revisited

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Virtual Networks

- Pay attention to how your virtual networks are set up
- It is important to know what level of network access your VMs have, especially when conducting network scans, etc.
- If you are testing Malware, ensure you are isolated from any production networks

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Virtual Networks

- If you require internet connectivity on your virtual machine and it doesn't exist, ensure you go through the basic troubleshooting steps
  - Check what type of virtual network connection you have and that NAT or Bridged is selected
  - Ensure that the virtual NIC is connected
  - Check your IPv4 settings
    - DHCP
    - Static

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Virtual Networks

- There may be times where the VM doesn't establish a connection after you have done troubleshooting
- You may have virtual networks set up incorrectly
- You can always start with a clean slate in VMWare Workstation by going to Edit -> Virtual Network Editor and clicking on the "Restore Default" button which is located on the bottom left of the menu

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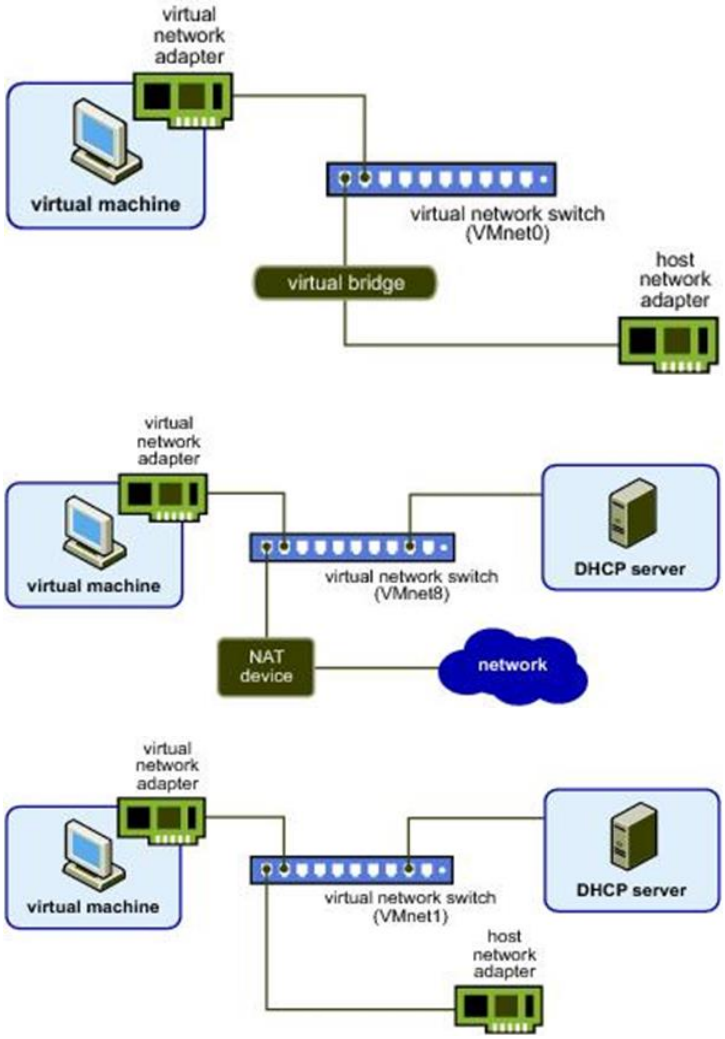
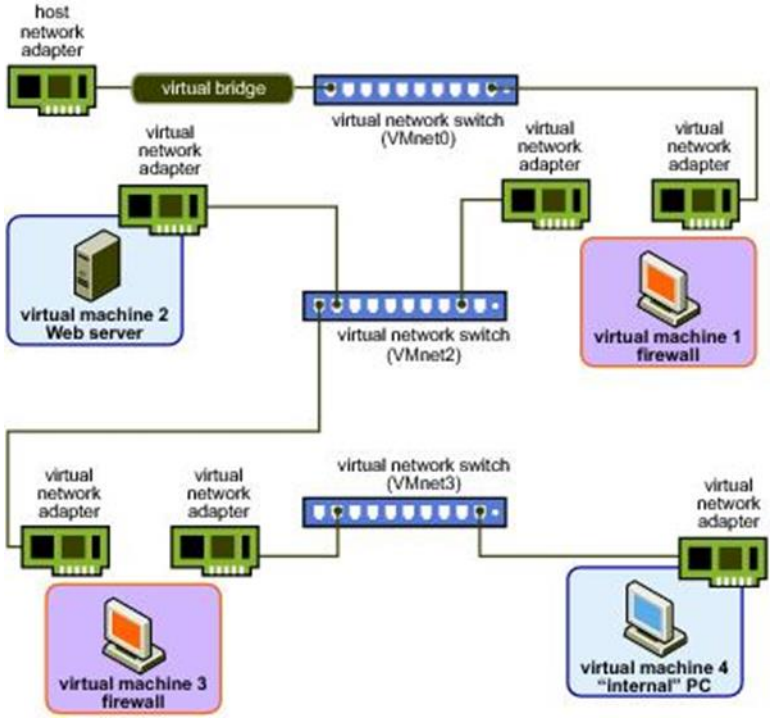
Virtual Switches

Network Type	Switch Name	DHCP
Bridged	VMnet0	No
NAT	VMnet8	Yes
Host-only	VMnet1	Yes

- Can be viewed through the Virtual Network Editor
- By Default there are three network types
  - Bridged
  - NAT
  - Host-Only

Virtual Network Switches





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Virtualization & Security

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Virtualization & Security

- Security concerns include:
  - Guest OS isolation
    - Ensuring that programs executing within a guest OS may only access and use the resources allocated to it
  - Guest OS monitoring by the hypervisor
    - Which has privileged access to the programs and data in each guest OS
  - Virtualized environment security
    - Particularly image and snapshot management which attackers may attempt to view or modify

Virtualization & Security

- If the O/S running on physical hardware can be compromised, it will also be vulnerable when running in a virtualized environment
- Need to ensure that network traffic is isolated between guest Operating Systems if they do not need to communicate
- Ensure that the Hypervisor is secured as a compromised guest O/S may access the Hypervisor if such vulnerabilities exist
  - This is known as “VM Escape”

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Virtualization & Security

Organizations using virtualization should:

- **Carefully plan the security of the virtualized system**
- **Secure all elements of a full virtualization solution and maintain their security**
- **Ensure that the hypervisor is properly secured**
- **Restrict and protect administrator access to the virtualization solution**

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Hypervisor Security

- The Hypervisor should be:
  - Secured using a process similar to securing an operating system
  - Installed in an isolated environment
  - Configured so that it is updated automatically
  - Monitored for any signs of compromise
  - Accessed only by authorized administration

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Hypervisor Security

- May support both local and remote administration so must be configured appropriately
- Remote administration access should be considered and secured in the design of any network firewall and IDS capability in use
- Ideally administration traffic should use a separate network with very limited access provided from outside the organization

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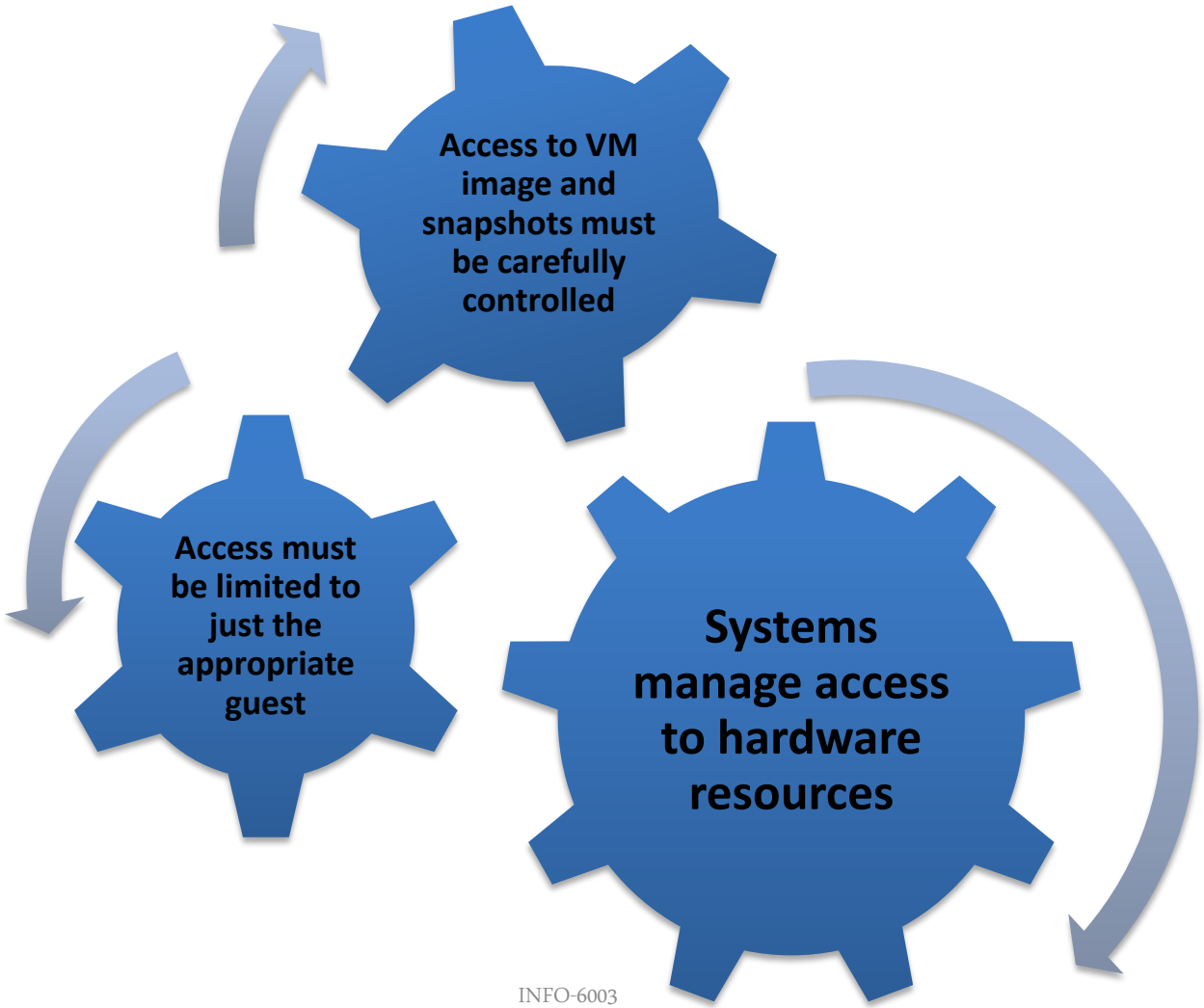
Virtualization Infrastructure Security



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Virtualization Infrastructure Security

- Virtualized systems manage access to:
  - Hardware resources such as disk storage and network interfaces
  - This access must be limited to just the appropriate guest OSs that use any resource
  - The configuration of network interfaces and use of an internal virtual network may present issues for organizations that wish to monitor all network traffic between systems

Virtualization Infrastructure Security

- Hosted virtualized systems, as typically used on client systems, pose some additional security concerns
- These result from the presence of the host OS under, and other host applications beside, the hypervisor and its guest OSs
- Hence there are yet more layers to secure. Further, the users of such systems often have full access to configure the hypervisor, and to any VM images and snapshots

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Virtualization Infrastructure Security

- It is possible to design a host system and virtualization solution that is more protected from access and modification by the users
- This approach may be used to support well-secured guest OS images used to provide access to enterprise networks and data, and to support central administration and update of these images
- Cloud Providers often use an API to allow clients access to virtual machine hypervisors which allow for an automated approach to configuring new VMs

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Operating Systems & History

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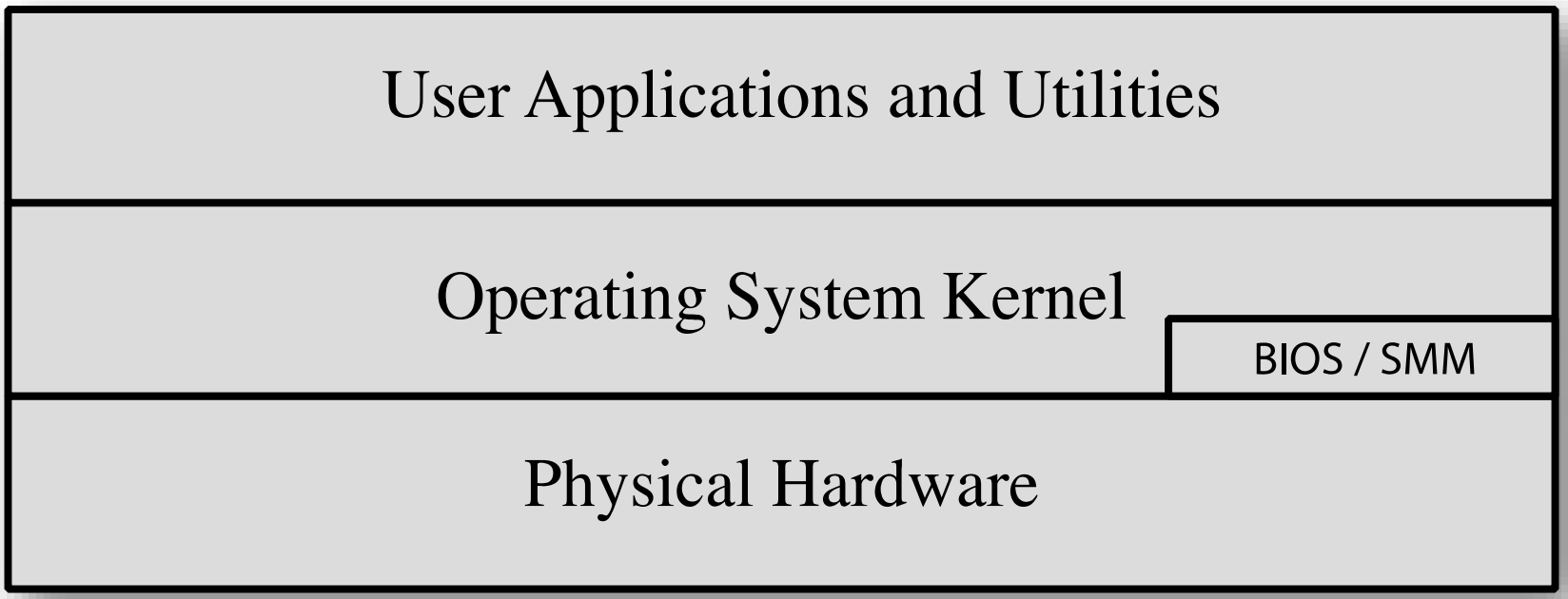
Operating Systems

- An Operating System is a resource manager
- We view a system as having a number of layers, with the physical hardware at the bottom; the base operating system above including:
  - Privileged kernel code
  - APIs, and services
  - User applications and utilities in the top layer

Operating Systems



- Each of these layers is vulnerable to attack so they all need to be secured appropriately

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Operating Systems - BIOS

- Basic Input / Output System (BIOS)
- Manages data flow between the O/S and attached devices such as the keyboard, etc.
- It is external to the O/S and typically not visible by the O/S
- Manages the computer upon boot up
- Supports low-level hardware control
- Generally designed for a specific Motherboard model

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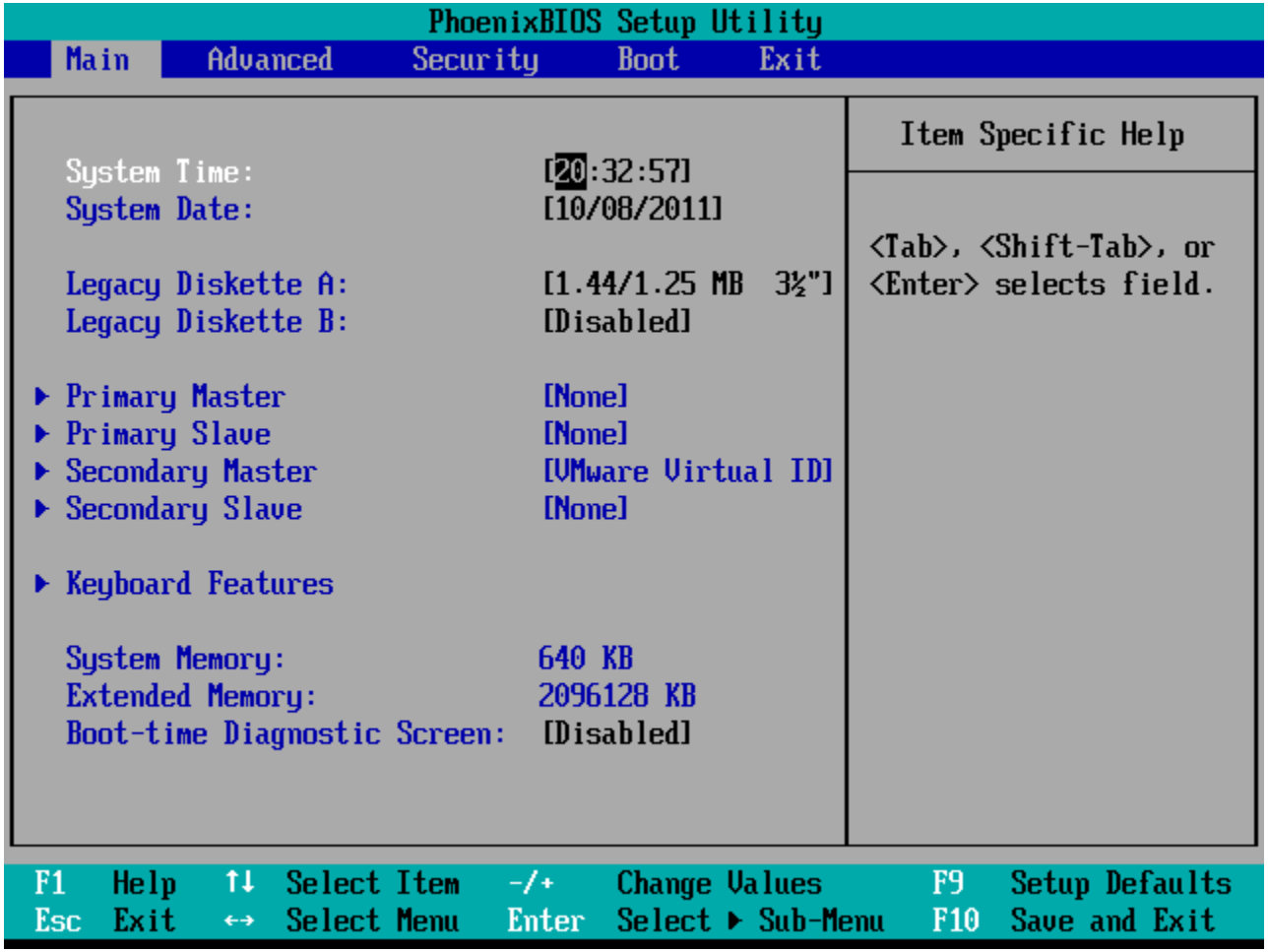
Operating Systems - BIOS

- Historically the BIOS was stored on a ROM chip
- Newer systems store BIOS on flash memory which allows for updates / bug fixes
- This led to security problems where attackers could infect the BIOS chip with Malware such as Viruses and Rootkits
- In the last few years, BIOS has been replaced with the Unified Extensible Firmware Interface (UEFI)

Example of BIOS Screen



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Operating Systems - UEFI

- Replaced BIOS as the interface between an operating system and the firmware in a computer
- Allows for remote access to troubleshoot computer systems without the O/S
- Provides a more intuitive graphical interface than BIOS
- Caused some firmware issues with certain laptop manufacturers in the past
- Microsoft introduced secure boot with UEFI starting with Windows 8

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Example of UEFI Screen

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Operating System History

- Originally, computer systems did not necessarily require an operating systems
  - Mainframe computers
- Operating systems can have many different interfaces
- Older Operating Systems used a Command Line Interface (CLI)
- Newer Operating Systems have incorporated a Graphical User Interface (GUI)

Operating System History

- Development of Operating systems had an early start in the 1950's
- In the late 1960's, MIT, AT&T Bell labs, GE started developing various operating systems (Unics, Multics) which eventually led to the development of the UNIX O/S
- UNIX became quite popular

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Operating System History

- The 1970's saw more development of Operating Systems including various versions of the Disk Operating System (DOS)
- Microsoft's version of DOS (MS-DOS) came out in the early 1980's
- MS-DOS quickly became a popular Operating System as it was included with early IBM Personal Computers (PCs)

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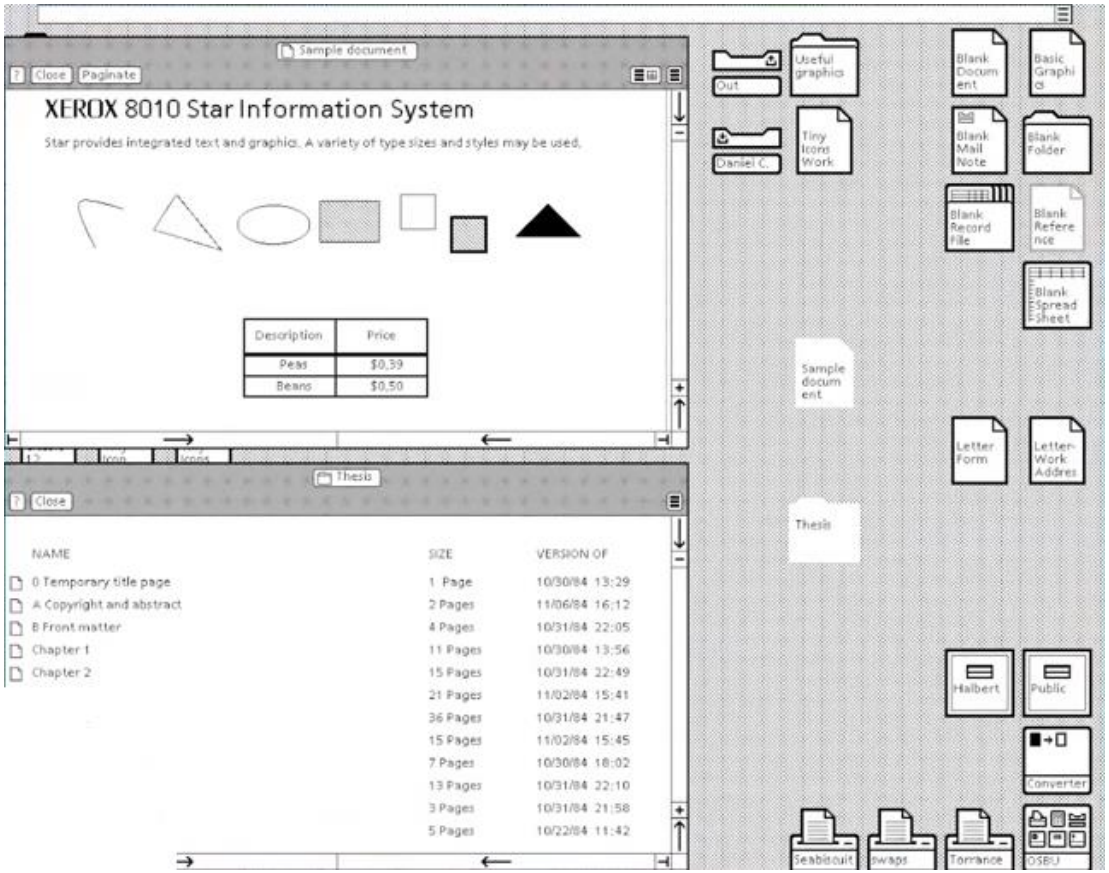
Operating System History

- The 1980's saw the development of smaller Personal Computers
- In 1981 Xerox created the Xerox Star Operating System
- This was a pioneer of the Graphical User Interface
- Brochures for this O/S boasted the ability to create documents with words and pictures

Operating System History

- Screen shot of the Xerox Star O/S

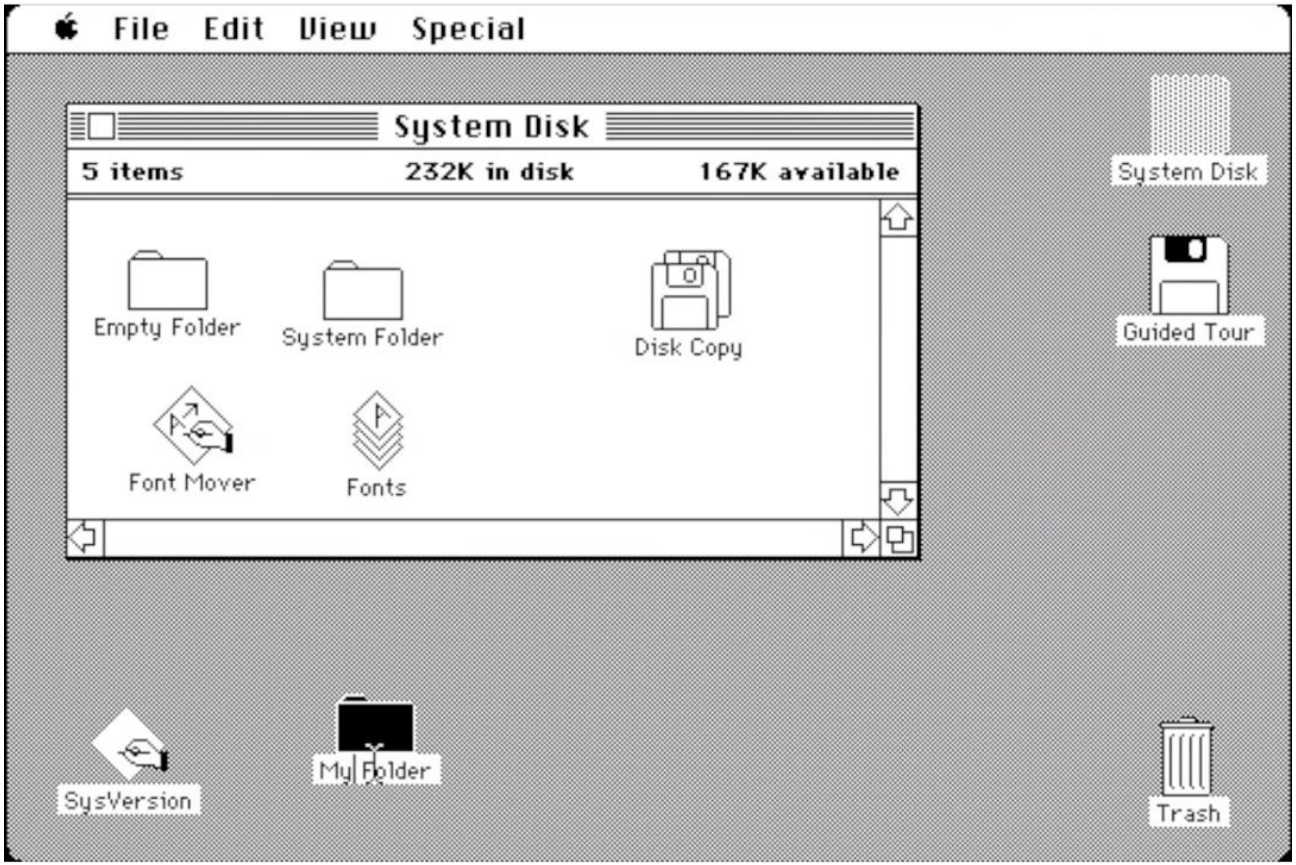


Operating System History

- The 1980's then brought us other Graphical User Interface Operating Systems
- 1983 saw the launch of Apple's Lisa O/S which was too expensive for most users and the machine itself eventually became a commercial failure
- 1984 saw the release of Mac OS 1.0 which displayed many similarities to the Xerox Star Operating System

Operating System History

- Screen shot of Mac OS 1.0

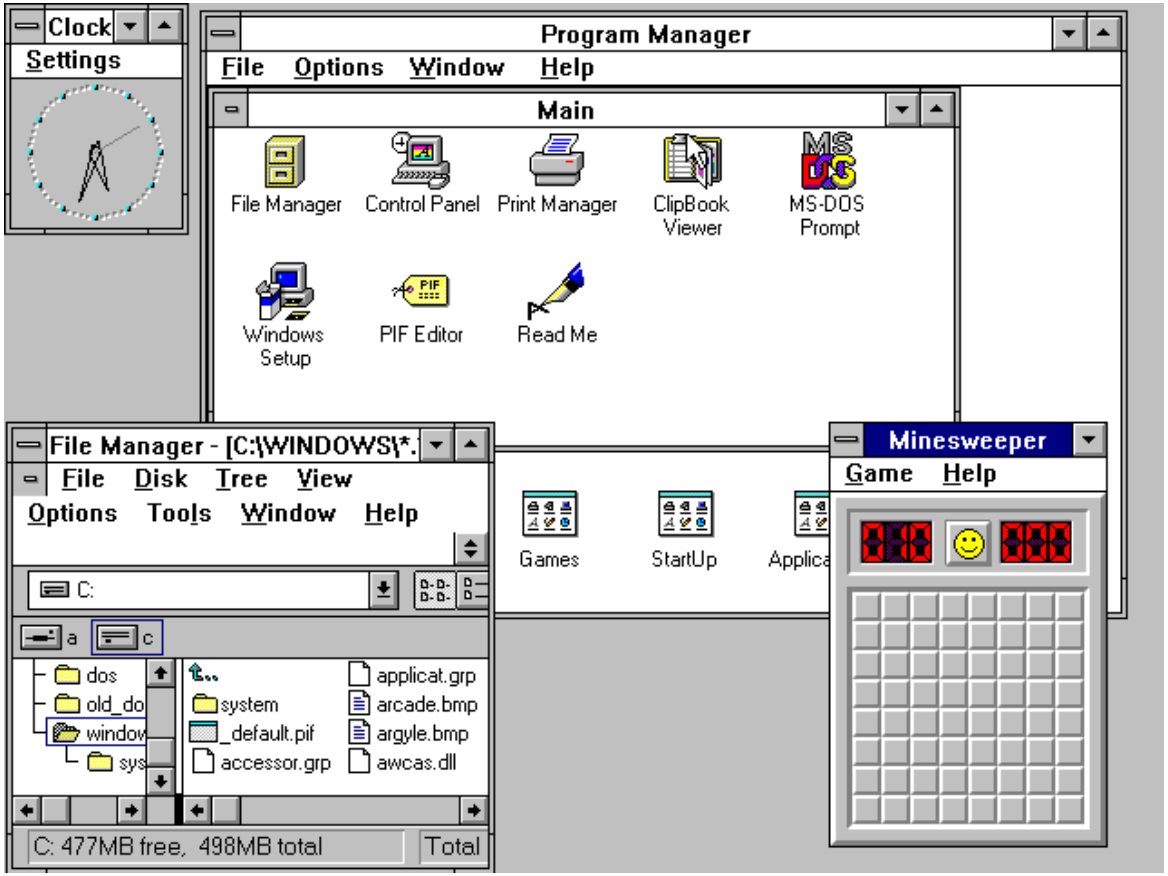


Operating System History

- The 1980's also brought us the first versions of Microsoft's Windows O/S, starting with Windows 1.0
- These Operating Systems all included what was at the time, a modern approach to the O/S interface
- Microsoft would go on to deliver further versions of Windows in the 1990's
  - Windows 3.1x
  - Windows 95
  - Windows 98

Operating System History

- Screen shot of Windows 3.11



Operating System History

- Screen shot of Windows 95

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Linux Operating Systems

- In 1991, Linus Torvalds created the Linux Kernel
- Linux is considered a Unix-like Operating System
- There are many different versions/distributions of Linux (referred to as Distros)
- The underlying source code was made to be used, modified, and distributed by respective licenses (free for the most part)

Linux Operating Systems

- Major distributions of Linux include:
  - Ubuntu
  - Debian
  - Fedora
  - Linux Mint
  - openSUSE
  - FreeBSD
- Linux O/S is used by PCs, Servers, supercomputers, embedded devices, and Mobile devices

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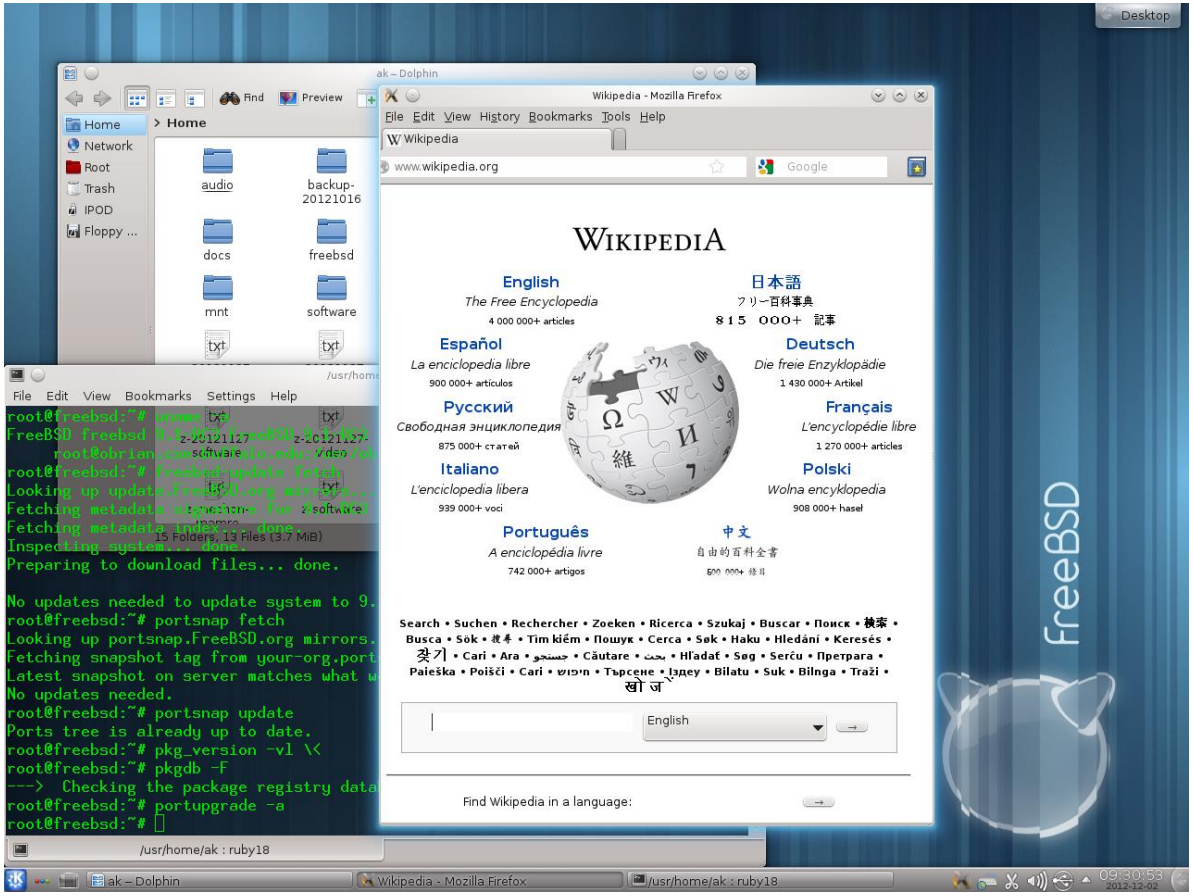
Linux Operating Systems

- The Android mobile O/S is based on the Linux Kernel
- Just like any other Operating System, Linux O/S needs to be secured
- Patches and upgrades apply to all Operating Systems
- Modern Desktop Linux distributions include a GUI
- Server versions of Linux typically only allow for the CLI which is similar to a version of Windows Server Core

Linux Operating Systems

- Screen shot of FreeBSD 9.1



Need for O/S Security

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O/S Security

- No computer system can be made 100% secure
- Security is the process of taking steps to limit exposure to potentially malicious users
  - Close off avenues of attack
- Security is a trade off between ease of use by authorized users and potential exposure to attackers

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O/S Security

- Security can also be compromised by regular authorized users
- Employees may do something by mistake without trying to be malicious and cause security problems
- Access should follow the principle of least privilege and always be monitored

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O/S Security

- Servers must expose parts of the operating system, the services and applications they run to valid users
- Servers must allow access to valid users and run tasks on behalf of the valid users
- Securing the server requires limiting the exposure of the system to malicious users without making the system unusable

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O/S Security

- All software has bugs (for a variety of reasons)
- Development time lines rush products out to meet market demands
  - Reach market before competitors
- Software is often tested for functionality not security
  - The bad attitude of “software security can be fixed after if problems arise”
- One cannot possibly think of all the ways that a program could be misused

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O/S Security

- Keeping on top of Security patches and updates is essential to minimizing risk
- There are many open source and commercial tools available to perform what is referred to as “Patch Management”
- Many large organizations will also go through a testing phase before releasing patches onto the production environment

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O/S Security

- Software patches or updates can also be released to smaller groups in a production environment to see how it affects the users
- This is also known as the Canary method
- It basically uses some users as test subjects prior to releasing the updates to the rest of the user group

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Access Control Concepts

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AAA

- Authentication
  - Verifying the credentials of users and system entities
    - Who are they?
- Authorization
  - Granting rights and permissions to users and system entities
    - What should they be able to do?
- Accounting / Auditing
  - Keeping track of what users and system entities have been doing
  - Used to make sure access controls are working, to ensure compliance, etc.
    - What have they done?

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O/S Security

- OS security is based on the concept of subjects, objects and access controls
- **Subjects**
  - Subjects are mostly users, but may be better thought of as anything trying to access an object
- **Objects**
  - Objects are the system components to which subjects (users) are granted or denied access
- **Access Controls / Rights**
  - Access controls determine how subjects can interact with objects

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Subjects & Objects

- Subjects are any entity that is capable of accessing an object
  - Users, computers, services and processes
- Objects are anything to which access is controlled
  - Files, hardware, memory etc

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Subject Classification

- Subjects can generally be classified into 3 categories
  - Owner (User)
    - Often the creator of resource
      - A file is a common resource
  - Group
    - Collection of users
      - Used to control access to an object
  - World (Others, Everyone)
    - Access granted to any other users
      - Not the owner or a member of a group
      - Usually with limited access such as read only

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Access Controls / Rights

- Access Controls may include:
  - Read, Write, Execute
  - Delete
  - Create
  - Search
  - Modify
- Each operating system will have different permissions which are used to control access to objects

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Access Control

- In general there are 3 types of access controls
  - Discretionary - DACL or DAC
  - Mandatory - MACL or DAC
  - Role Based - RBACL or RBAC

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DACL

- DACL – Discretionary ACL
  - Most common type of ACL
  - The ACL is set at the discretion of the user that creates the object (the owner)
  - Controls access of the requestor based on their authorization
  - Users who have DAC over an object can often assign other users access to the resource

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MACL

- MACL – Mandatory ACL
  - The ACL is set by the system
  - Uses security labels and clearances to control access to system resources
  - Users that create objects cannot change the MACLs created by the system
  - Provides more security than a DACL
  - Require administrators to have detailed knowledge of the exact operation of the controls
  - Not user friendly

MACL

- MACL - Mandatory ACL Continued
  - Some Linux systems such as SUSE & RedHat have partial MACLs that apply to some essential services but allow DACLs for most user applications
  - Windows does not support MACLs
    - Windows uses System ACLs (SACL)

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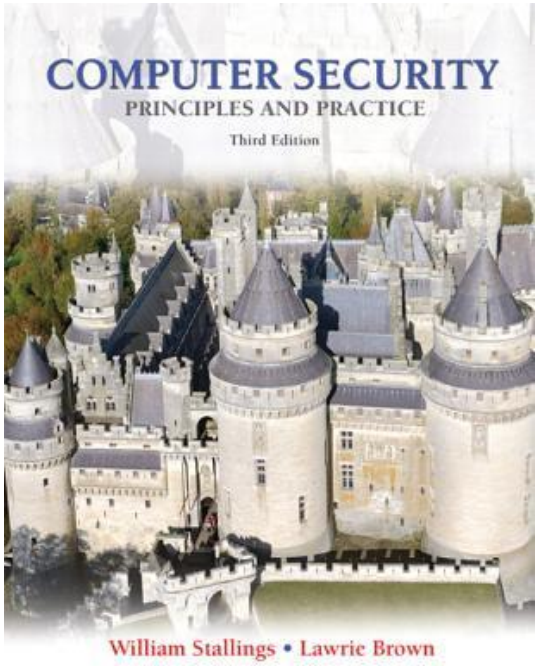
RBAC

- RBAC - Role Based Access Control
  - Used to assign permissions based on the subject's job duties
  - Assign permissions to the role and then assign users (subjects) as members of the role via groups
  - As users are assigned new job duties they can be made members of the group and their individual user permissions don't have to be changed
  - Easier to manage for temporary job duties during vacations, etc.

Homework

- Read Chapter 4 for detailed information on Access Control
  - 4.1 – Access Control Principles
  - 4.2 – Subjects, Objects, and Access Rights
  - 4.3 – Discretionary Access Control
  - 4.5 – Role-Based Access Control
  - 4.6 – Attribute-Based Access Control



Lab 01 – Basic Setup

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Lab 01 Details

- Setup lab environments in VMWare Workstation
- Configure network interfaces
- Change computer names