

Operating System

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Introduction

Objectives

- Why do we need Operating Systems?
- What is an OS?
- What does an OS do?
- Classification of Operating Systems
- Disambiguation of some concepts
- Why virtualization?

Reference

- Chapter 1,2 of **Operating System Concepts**

Why do we need OSes?



- What does a computer can do?
- What language does it “speak”?
- What does a computer have?
- Can we “use” the computer and its resources directly?

Quiz

Quiz

Select the best description of what a pure computer can do?

- A. Do calculation, string manipulation and communicate with other devices
- B. Provide graphical interface for users
- C. Provide applications for users
- D. Provide applications and an Internet connection

Quiz

Select the code that a pure computer can do

- A. `a=a+b`
- B. `0110010110`
- C. `c.open();`
- D. `add AX, BX`

Quiz

Select the language a pure computer can understand

- A. Binary code (0110010110)
- B. C
- C. C++
- D. Assembly

Quiz

Select the best description of resources a **pure** computer may have

- A. CPU, RAM, Disks
- B. CPU, RAM and anything that can connect to the computer, such as CD, network card, ...
- C. CPU, RAM, Disk, printer
- D. CPU, RAM, Disk, printer, monitor

Quiz

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- C. CPU, RAM, Disk, printer
- D. CPU, RAM, Disk, printer, monitor

Quiz

Can we use a **pure** computer and its resources directly?

- A. Yes, only some system programmers can
- B. Any normal user can
- C. Normal software developers can
- D. Computer providers can

➡ Why do we need an OS?

Operating System definition



Operating System definition

Can you
drive a bus?



Operating System definition

Can you
drive a bus?



Have you ever gone by bus?

Operating System definition

Can you
drive a bus?



Have you ever gone by bus?
How did you go?

Operating System definition

Can you
drive a bus?



Have you ever gone by bus?

How did you go?

Who helped you to go?

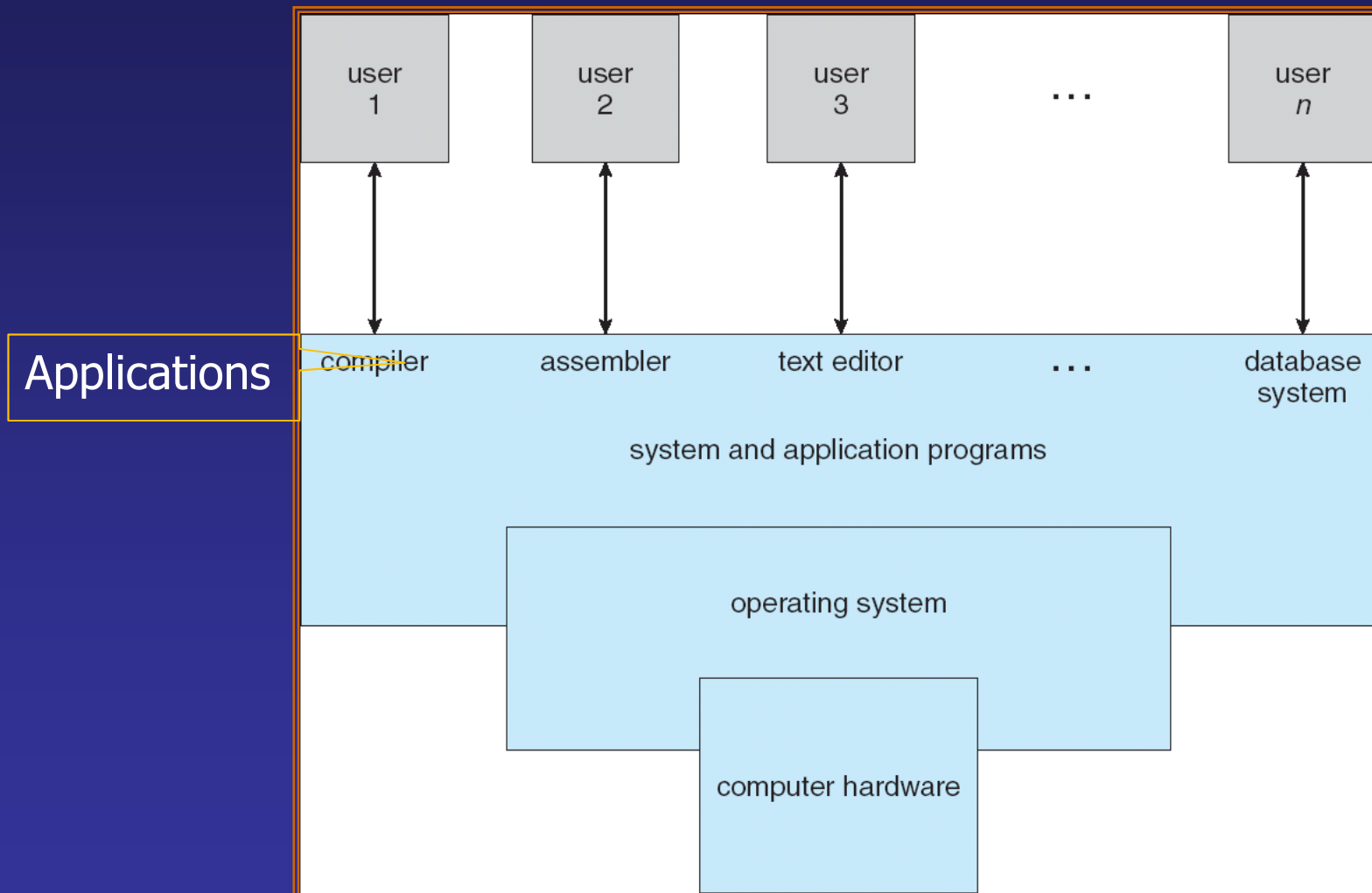
What is an Operating System?

- A **program** that acts as an **intermediary** between a user of a computer and the computer hardware (**only for computer**).
- Operating system goals:
 - Execute user programs and make solving user problems easier.
 - Make the computer system convenient to use.
 - Use the computer hardware (resources) in an efficient manner.
 - Provide interfaces for programmers

Important concepts

- Software ~ Hardware
- Application ~ a set program
- Program ~ 1 file on disk/storage
- Process ~ a running program

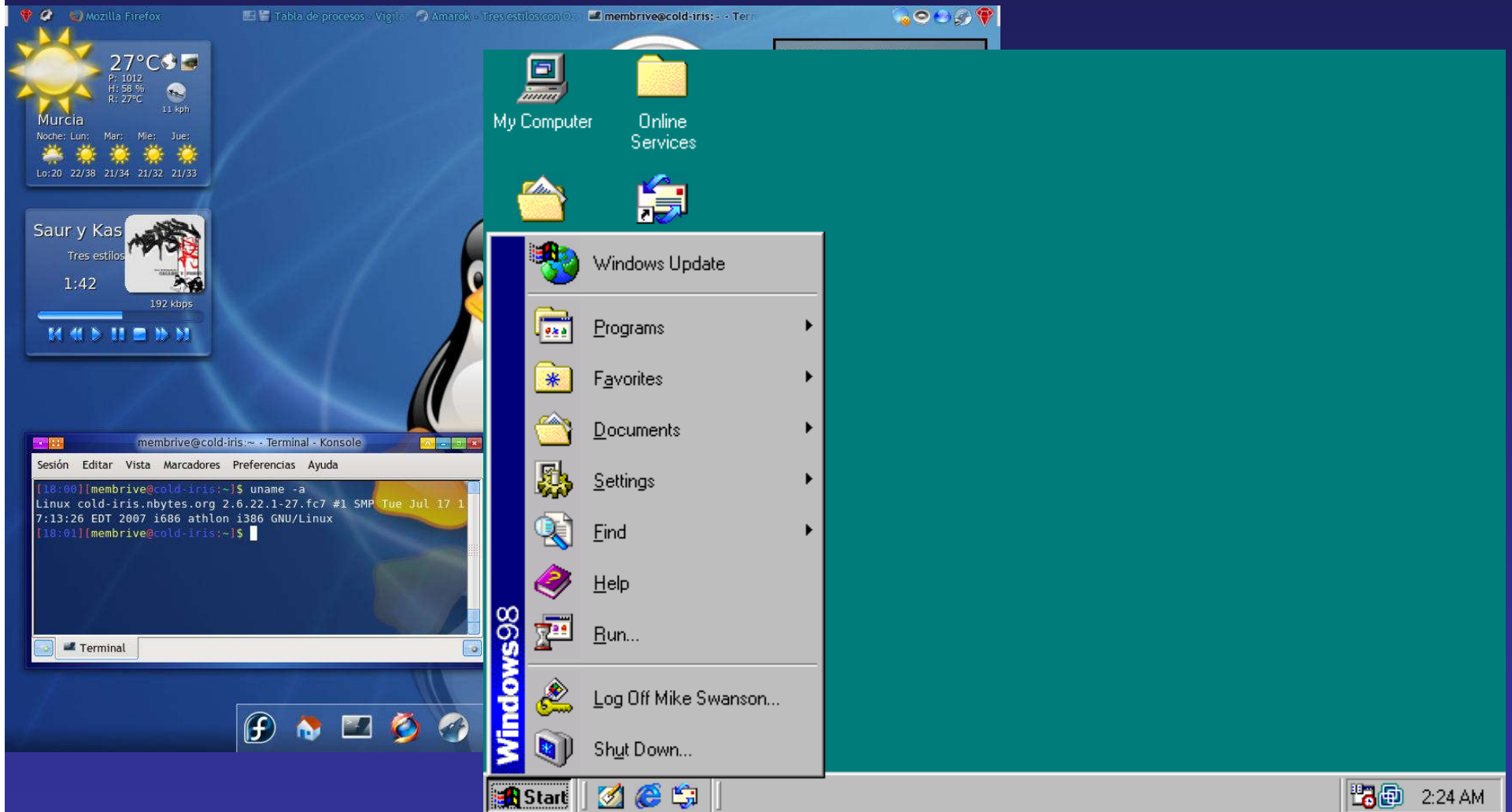
Position of an Operating System



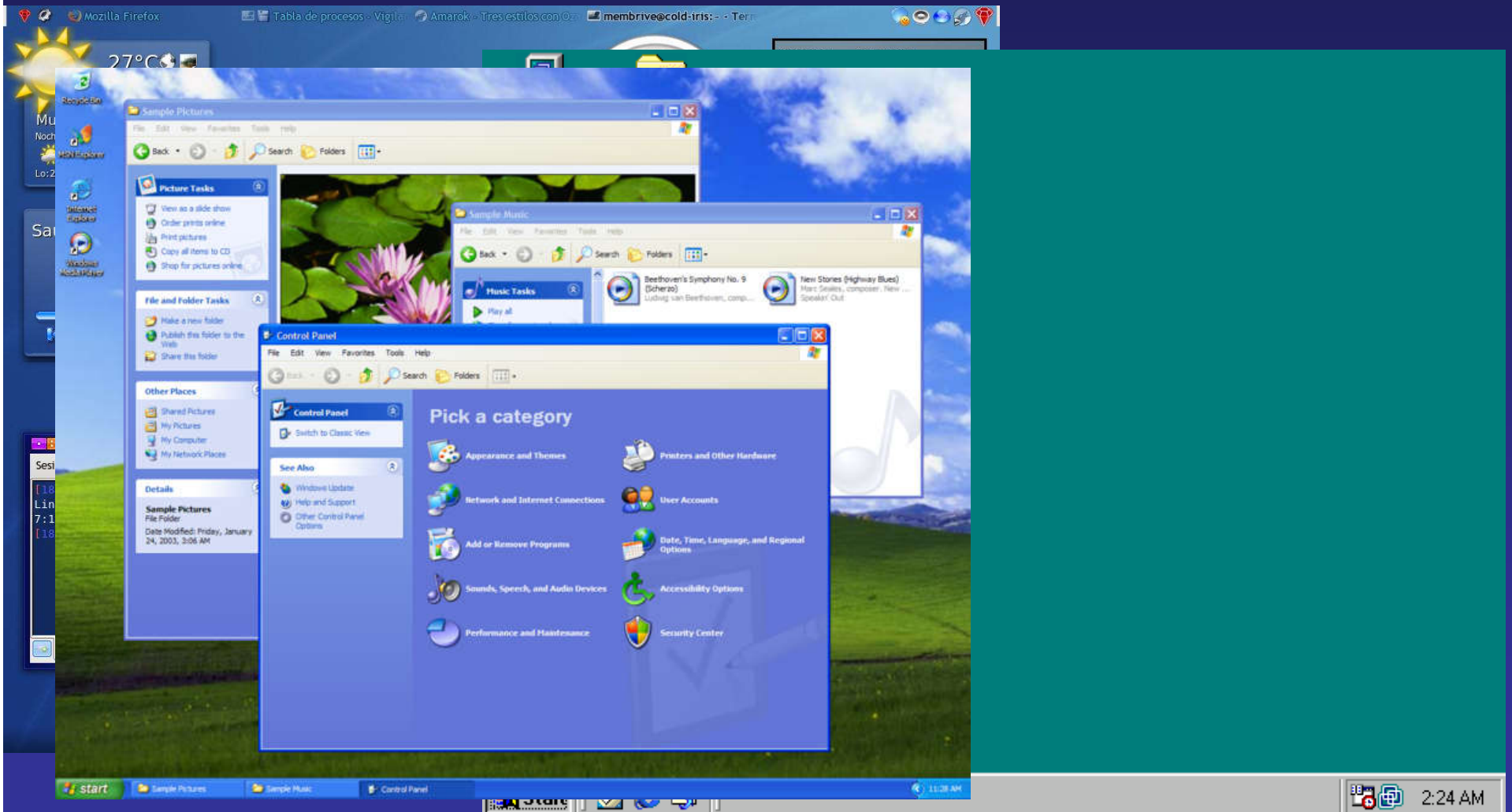
Typical Operating Systems



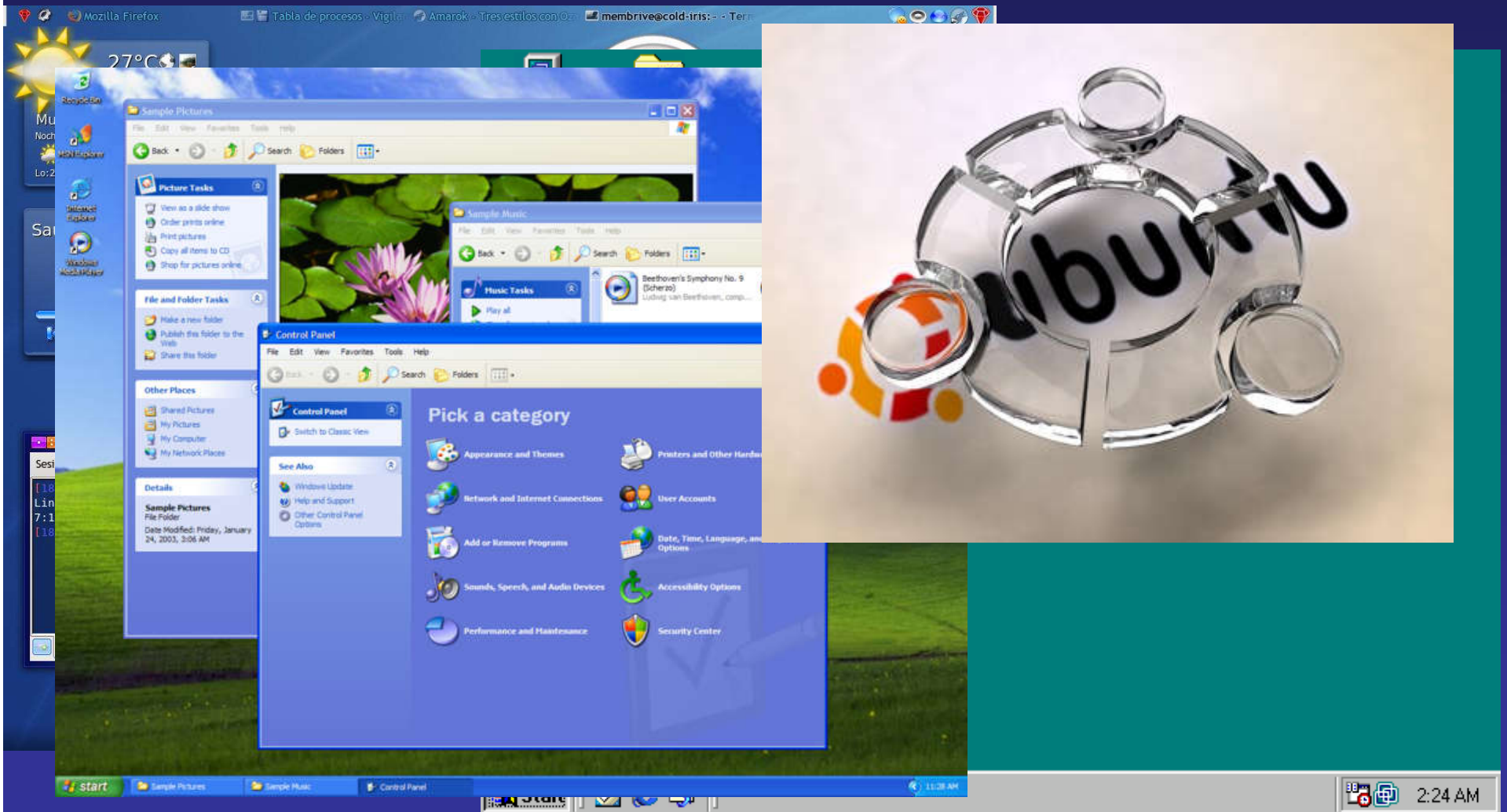
Typical Operating Systems



Typical Operating Systems



Typical Operating Systems



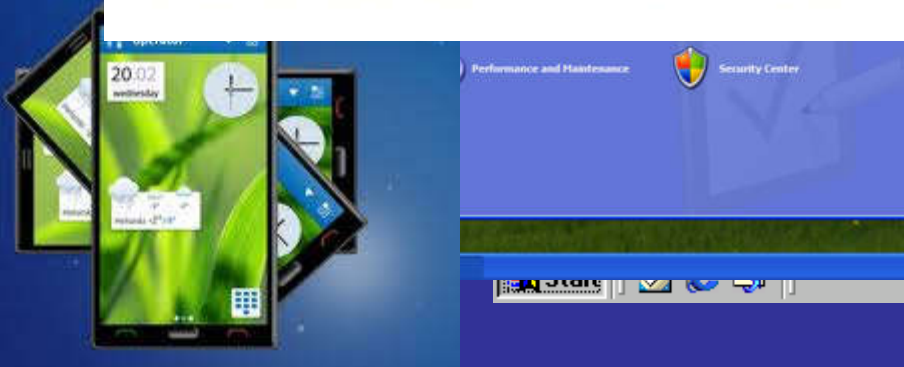
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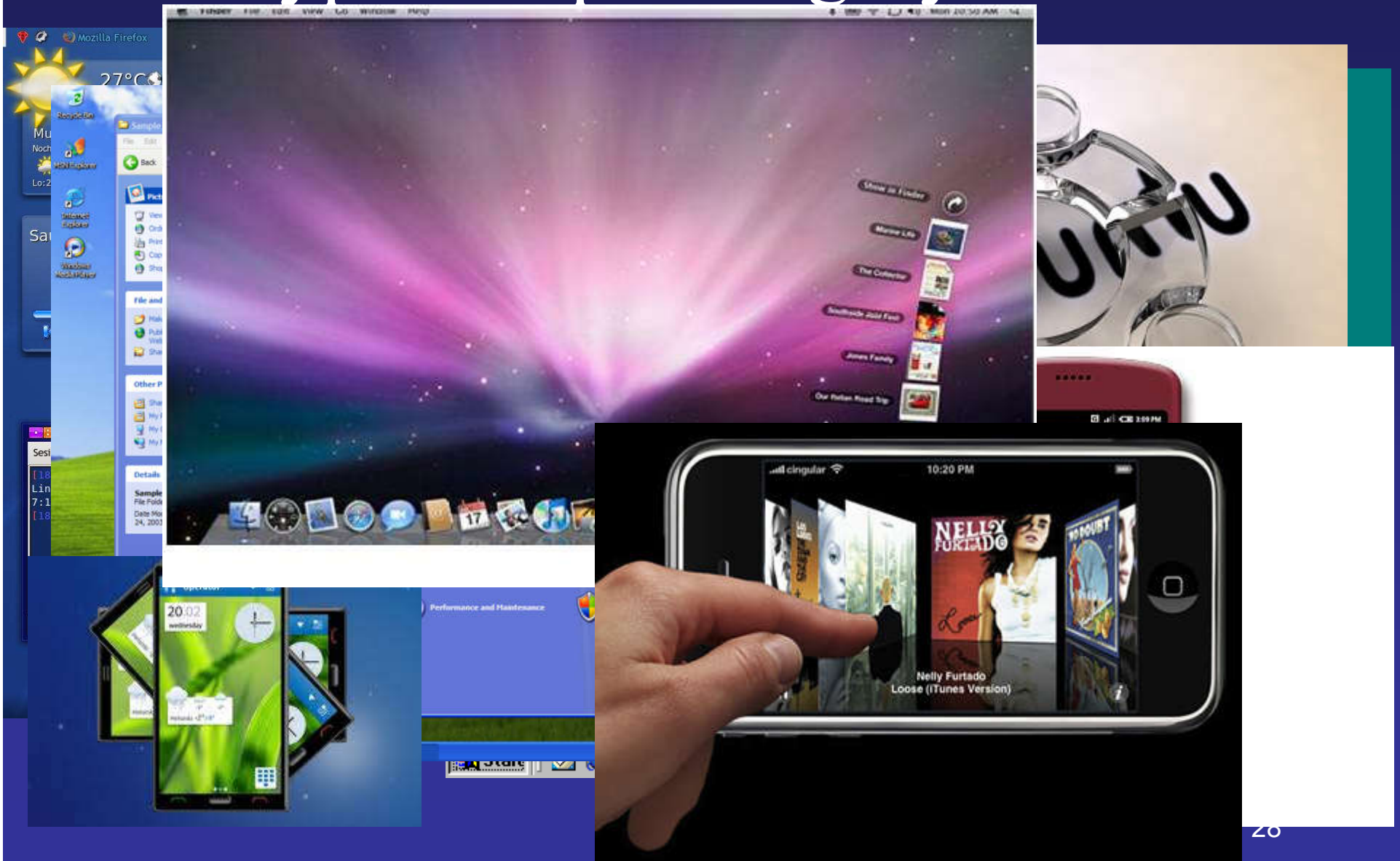
Typical Operating Systems



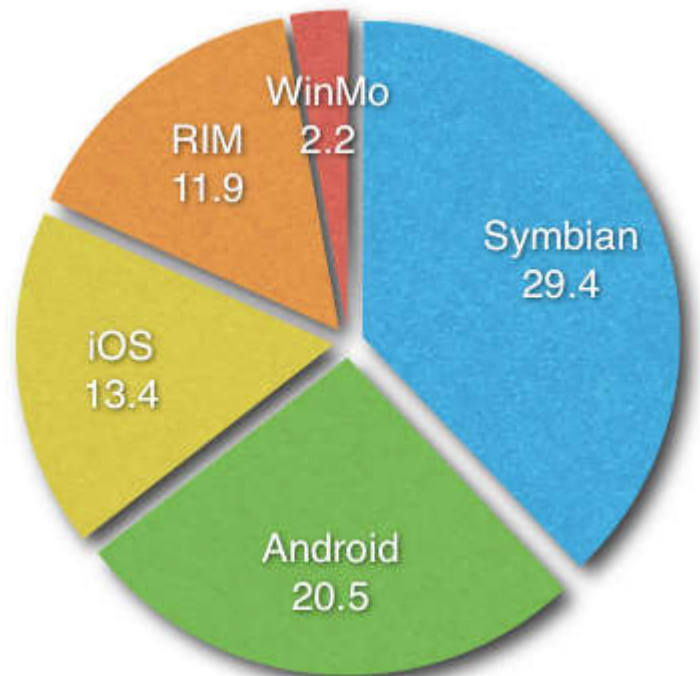
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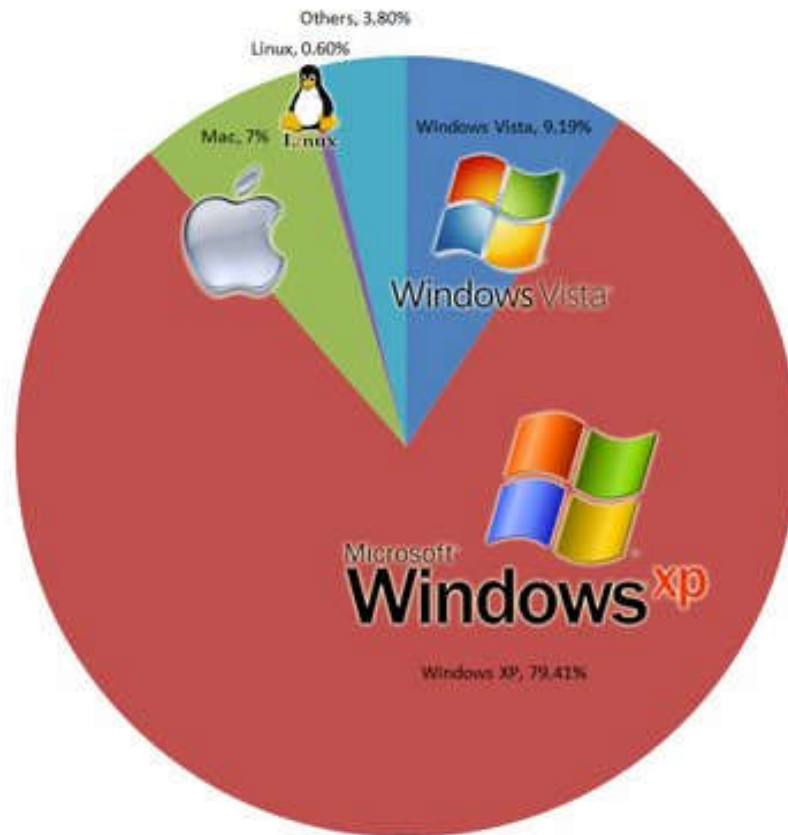
Typical Operating Systems



Typical Operating Systems



Typical Operating Systems



Quiz

What is **incorrect** about the **main purposes** of Operating Systems

- A. resource allocator (manages all resources for requests/applications)
- B. control program (controls execution of programs to prevent errors and improper use of the computer)
- C. database management (database management system)
- D. provide system calls (API) for programming

List of operating systems

- http://en.wikipedia.org/wiki/List_of_operating_systems
- http://en.wikipedia.org/wiki/List_of_Linux_distributions
- http://en.wikipedia.org/wiki/Mobile_operating_system

Quiz

Which is NOT true about an application?

- A. Does a certain task/purpose
- B. Database Management System (DBMS) is an example
- C. Manages IO operations, such as disk IO operations
- D. May consist of several files on storage devices

Main tasks of an OS

- Process Management
- Memory Management (RAM)
- Storage Management
 - File/directory
 - Disks
- Protection and Security
- Networking
- Main tasks are usually implemented in **kernel** (core)

OS classification

- Batch processing
 - very early OS's
- Uniprogramming
 - less powerful (weak) machines
- Multiprogramming (powerful machines)
 - Timesharing/multitasking
 - Multi-user system
- Parallel processing (PC-cluster) (highly computational application)
 - search engines, e.g., google, yahoo,..

OS classification (cont'd)

- Embedded (embedded into devices to do a specific task)
 - the task has limited (few) functions
 - usually is made as a firmware (NOT as software)
 - Calculator, game players, digital camera, mp3 player, ...
- Special-purpose systems
 - designed to perform a specific task
 - Factory's control system
 - GPS receiver

OS classification (cont'd)

- Real-time systems
 - Do a task with a **time constraint** (produce output when the input comes before it is too late)
 - NASA's control system
 - missile defense systems
 - earth-quake detection systems
 - robot control systems
 - Boeing automatic flying systems
- **Boundaries** among OS types are not clear
 - one OS can have characteristics of many types

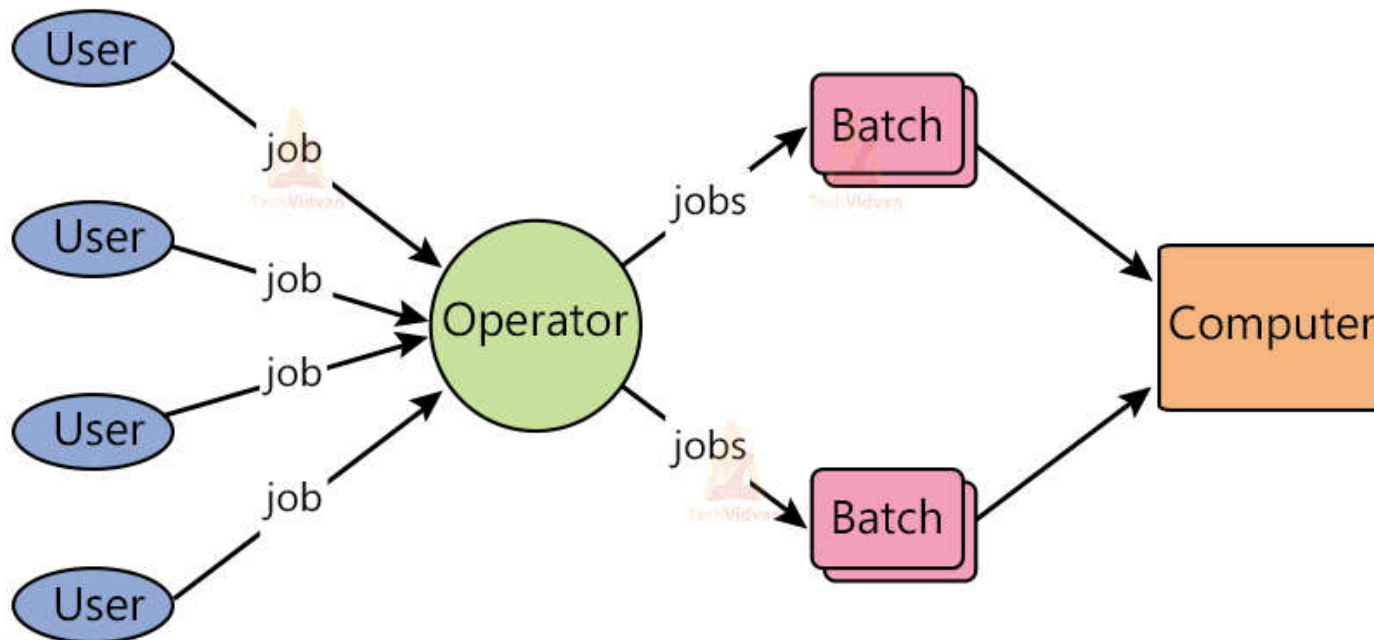
IBM/360

IBM 360 Computer



IBM System 360, Model 30, Memory size: up to 64K bytes, 1965
(3 times faster processor and memory access speed than the 1050)

Batch processing



Special purpose – Embedded Systems



Special purpose – Embedded Systems



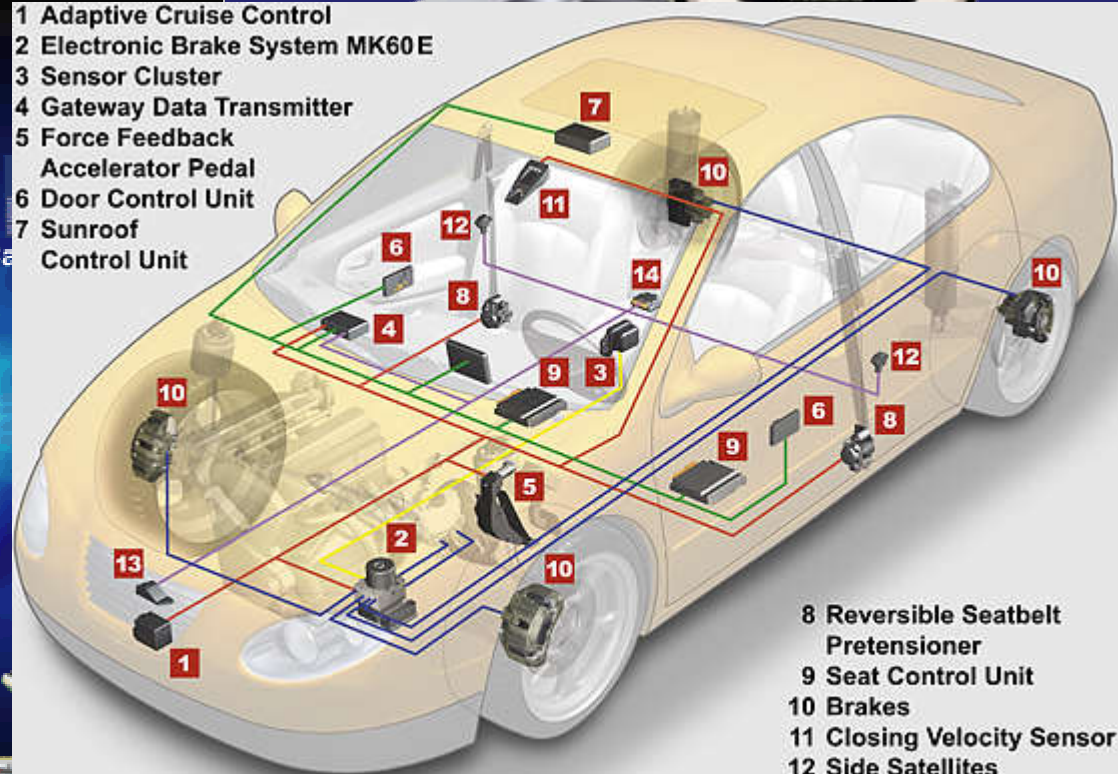
Special purpose – Embedded Systems



Special purpose – Embedded Systems



- 1 Adaptive Cruise Control
- 2 Electronic Brake System MK60E
- 3 Sensor Cluster
- 4 Gateway Data Transmitter
- 5 Force Feedback Accelerator Pedal
- 6 Door Control Unit
- 7 Sunroof Control Unit



- 8 Reversible Seatbelt Pretensioner
- 9 Seat Control Unit
- 10 Brakes
- 11 Closing Velocity Sensor
- 12 Side Satellites
- 13 Upfront Sensor
- 14 Airbag Control Unit

Real-time Systems



Real-time Systems

REAL-Time Trend Graphs

Show the effect of diet, exercise, medication and lifestyle on glucose levels

REAL-Time Alarms

Protect patients by warning of low and high glucose levels

Wireless Transmitter

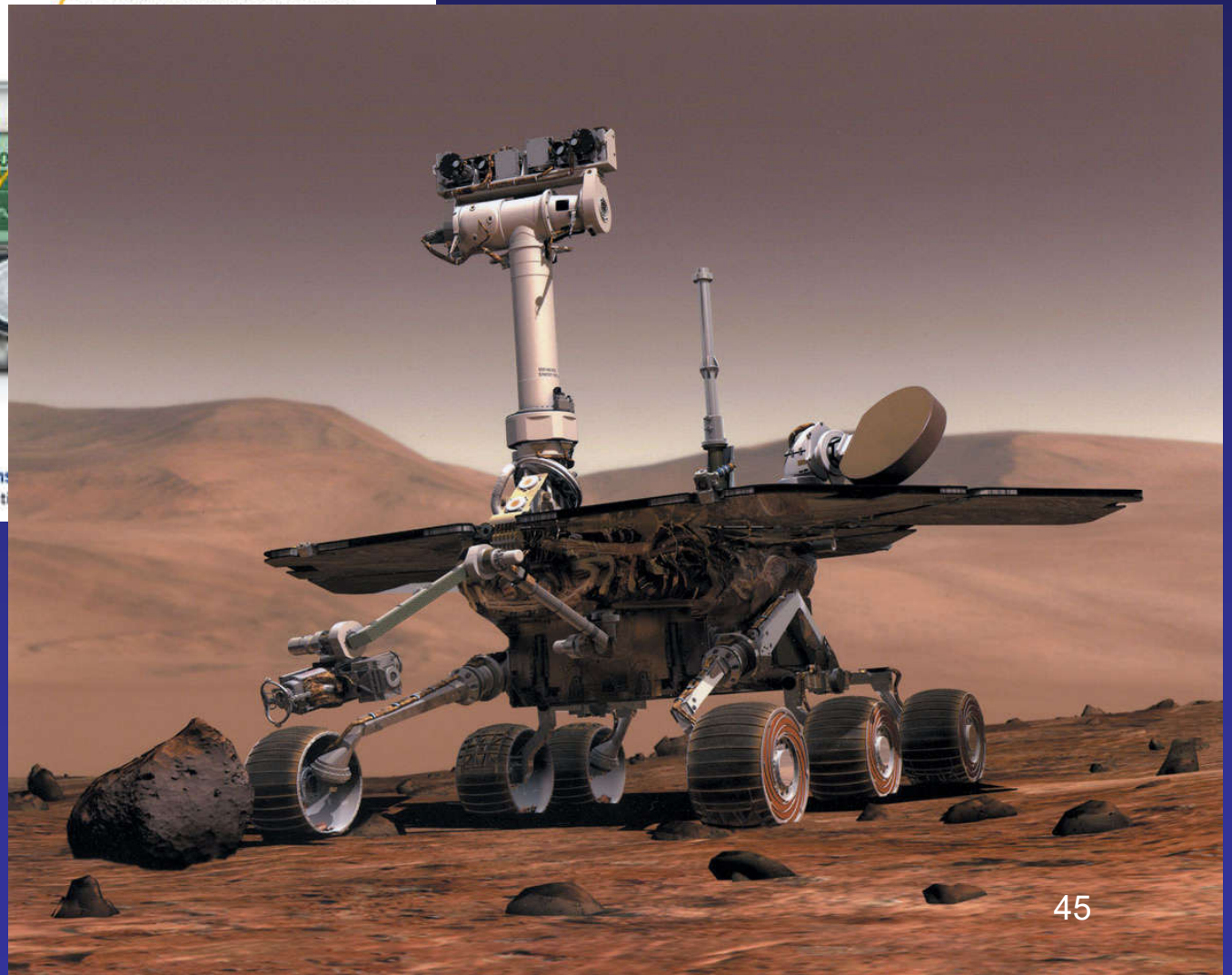
Small, discreet, and waterproof

Glucose Sensor

Up to 3-day continuous monitoring

REAL-Time Readings

- Help patients take action sooner



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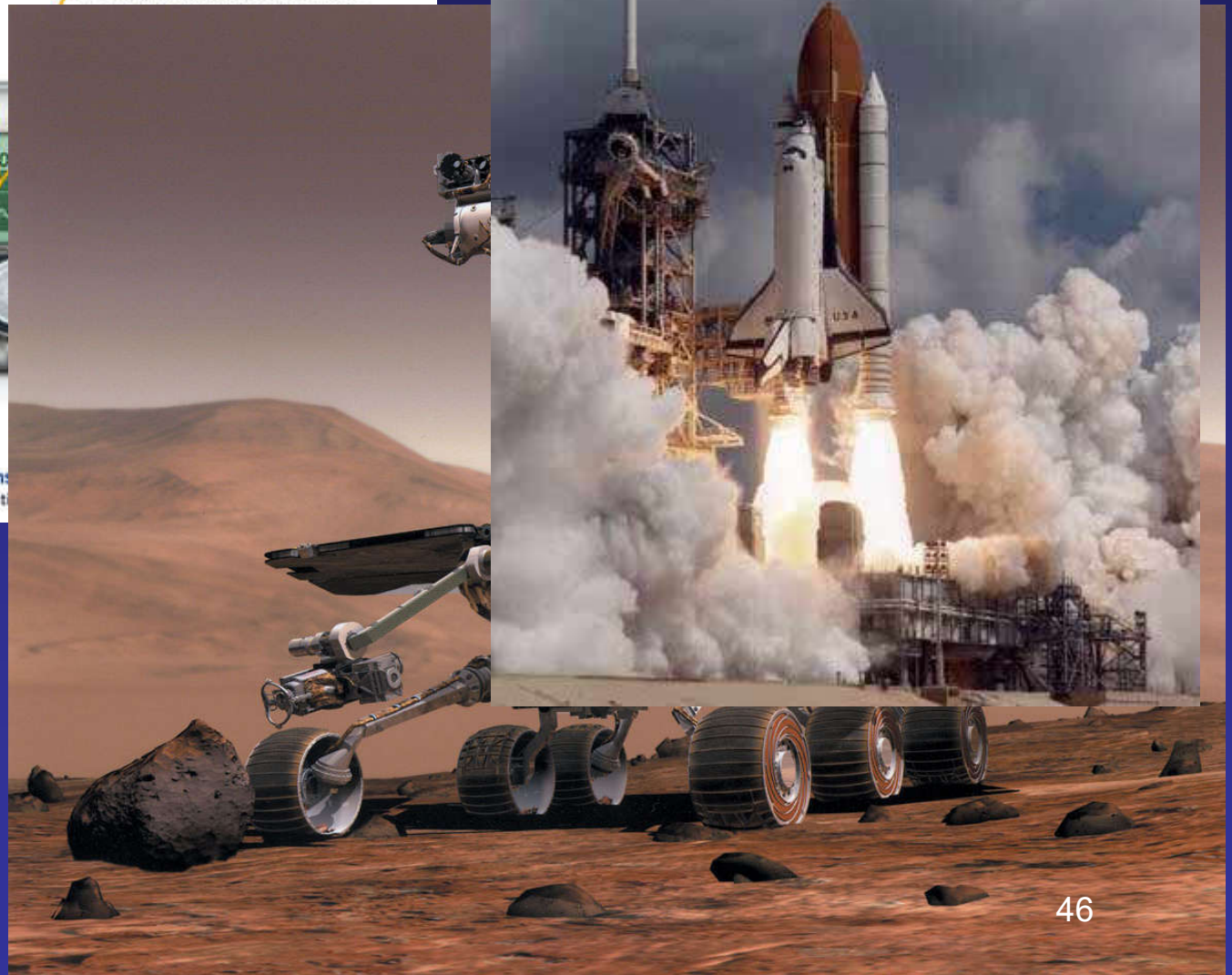


Wireless Transmitter
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REAL-Time Readings

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Real-time Systems

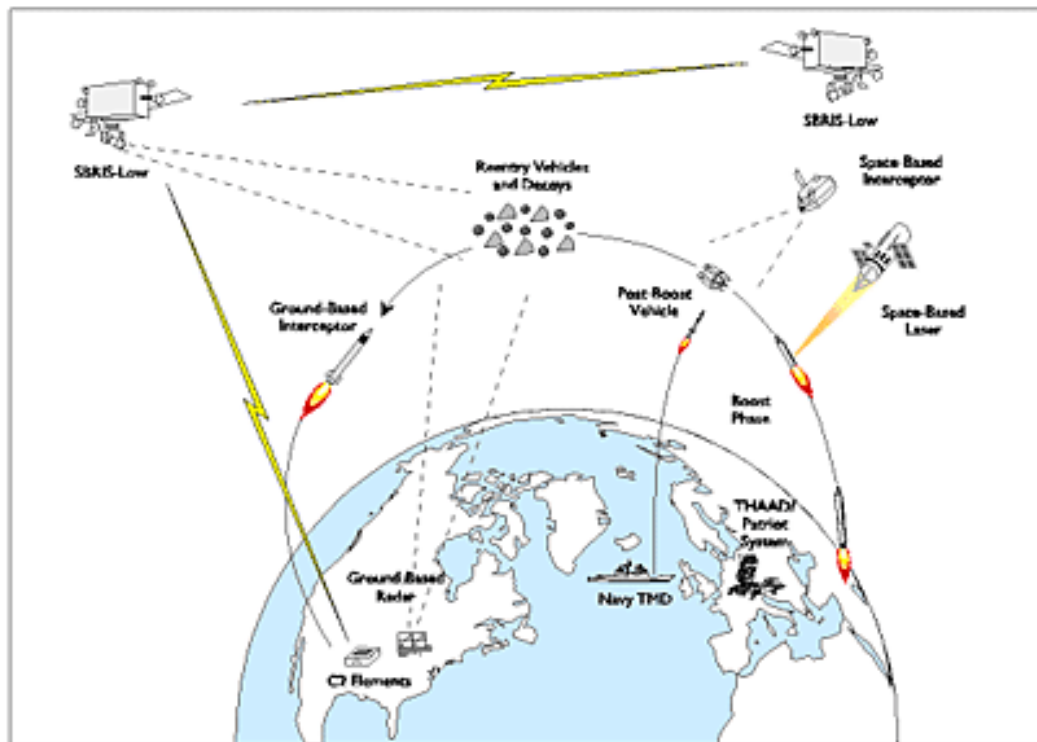
REAL-Time Trend Graphs

Show the effect of diet, exercise, medication and lifestyle on glucose levels

REAL-Time Readings

- Help patients take action sooner

Basic Missile Defense Elements



Terminal Phase

- Atmosphere Slows Decoys
- Warheads Can Maneuver
- Hard to Avoid Lethal Effects

Mid-Course Phase

- Above Earth's Atmosphere
- Must Discriminate Between Weapons and Decoys

Boost Phase

- Threat Most Vulnerable
- Get Many RVs With One Shot

Source: *Defending America: A Plan to Meet the Urgent Missile Threat*, The Heritage Foundation, 1999.



Real-time Systems

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Show the effect of diet, exercise, medication and lifestyle on glucose levels

REAL-Time Readings

- Help patients take action sooner

Basic Missile Defense Elements



Terminal Phase

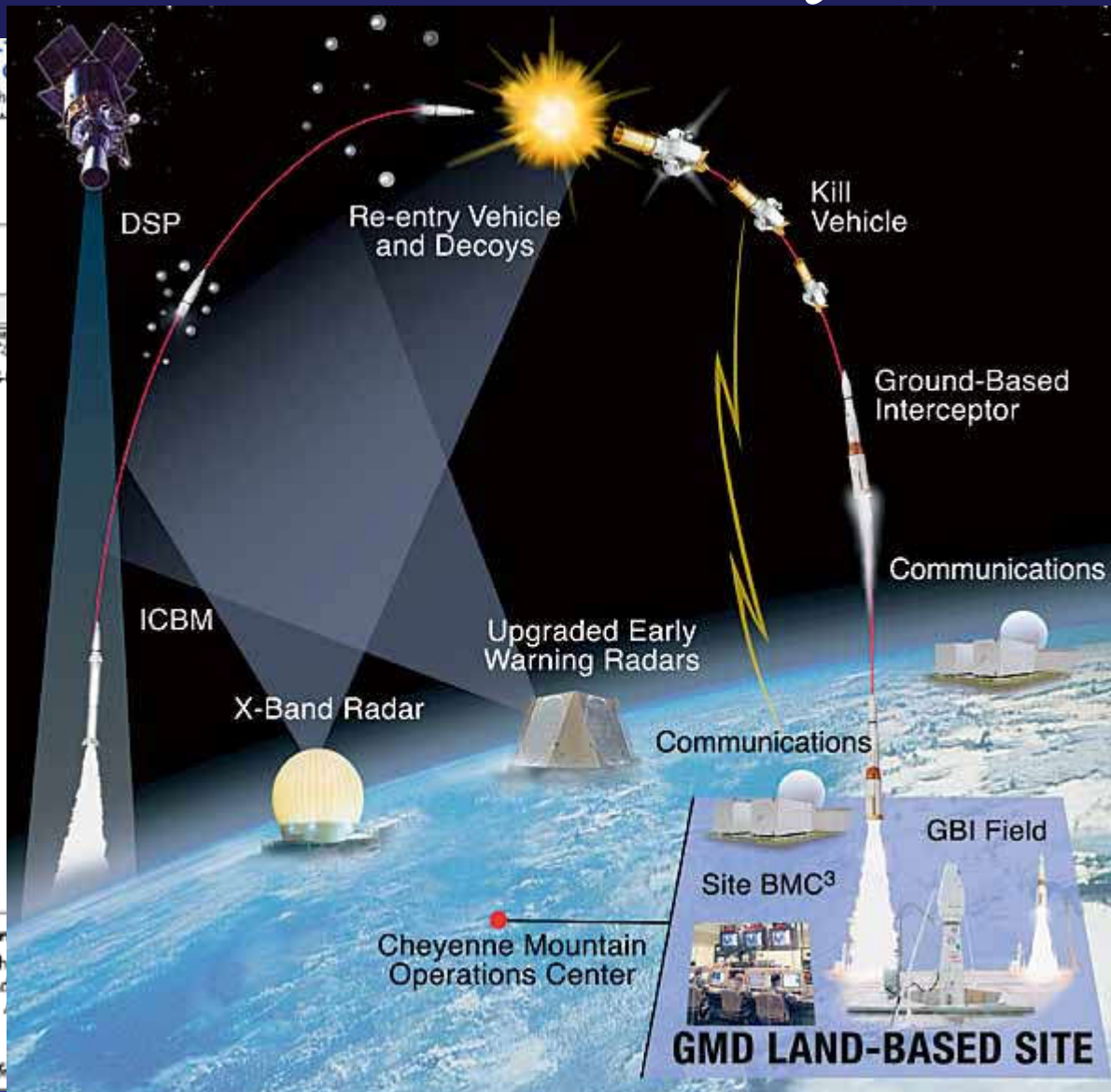
- Atmosphere Slows Decoys
- Warheads Can Maneuver
- Hard to Avoid Lethal Effects

- Abort
- Must
- and

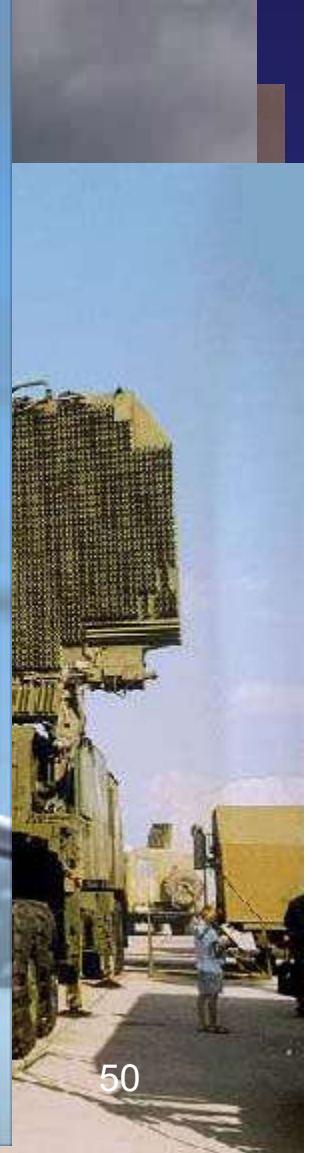
Source: *Defending America: A Plan to Meet the Urgent*



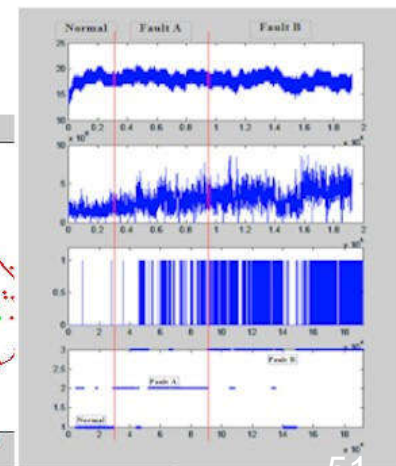
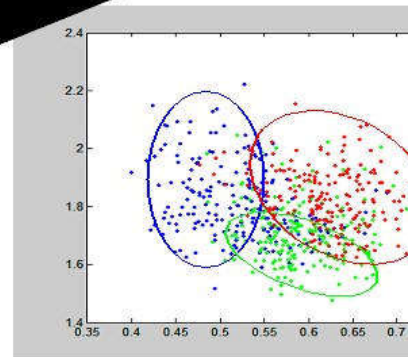
Real-time Systems



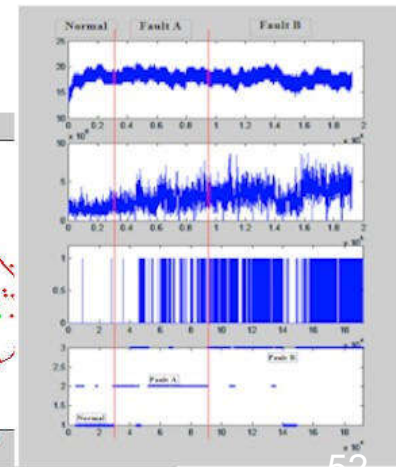
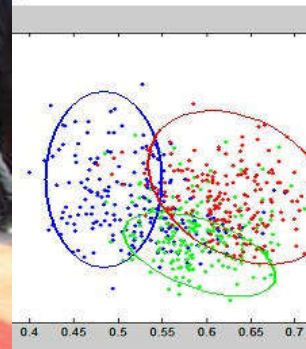
Real-time Systems



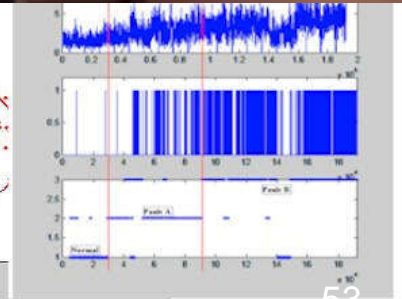
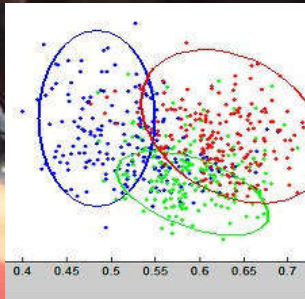
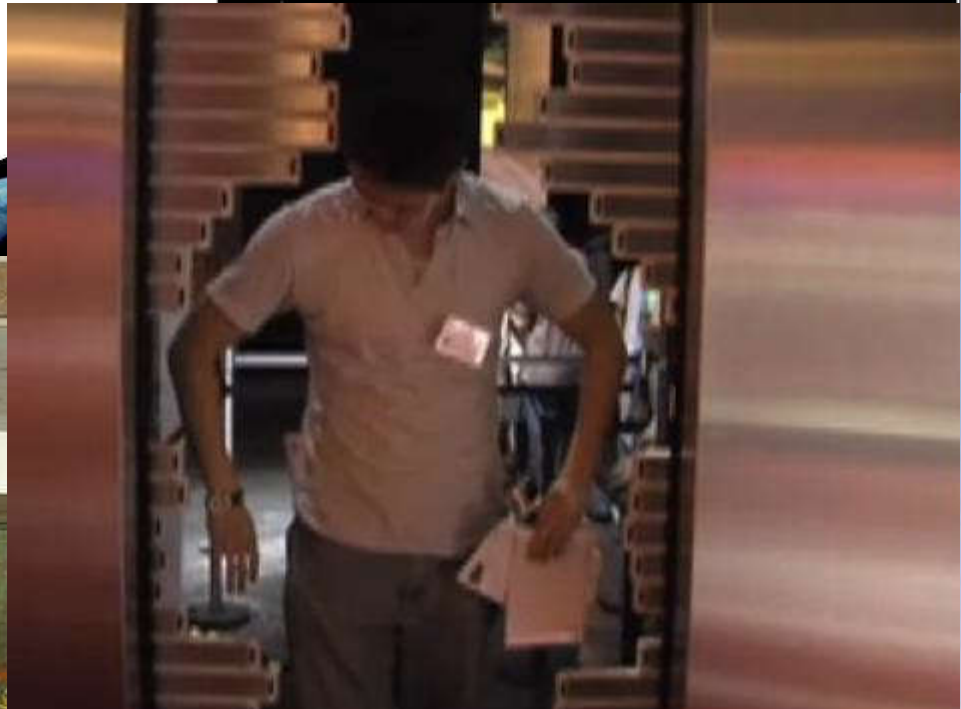
Real-time Systems



Real-time Systems



Real-time Systems



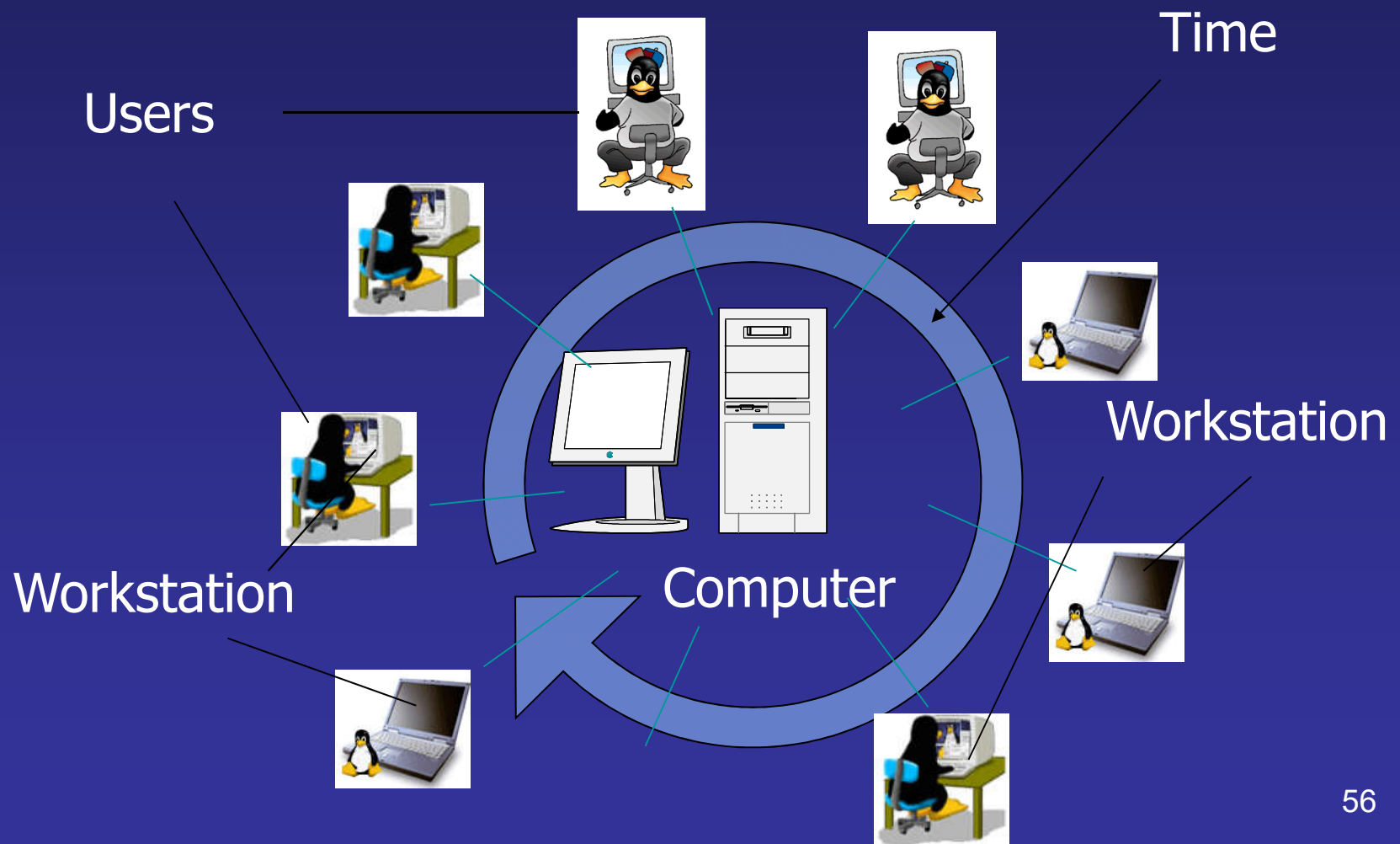
OS classification (cont'd)

- you're a perfect real-time system when
 - drive a car
 - play a game
 - play sports
 - ...

Why multiprogramming?

- **Multiprogramming** needed for efficiency
 - Single user cannot keep CPU and I/O devices busy at all times
 - Multiprogramming organizes jobs (code and data) so CPU always has one to execute
 - A subset of total jobs in system is kept in memory
- **Timesharing (multitasking)** is logical extension in which CPU switches jobs so frequently that users can interact with each job while it is running, creating **interactive** computing
 - Each user has at least one program executing in memory
⇒ **process**
 - If several jobs ready to run at the same time ⇒ **CPU scheduling**

Timesharing system



Quiz

What is the **correct** class of Windows XP?

- A. Uniprogramming
- B. Multiprogramming
- C. Embedded
- D. Special-purpose

Quiz

What is correct about a program?

- A. A process
- B. A compiled application (in machine code)
- C. A part of Operating Systems
- D. A library

Quiz

What is correct about a process?

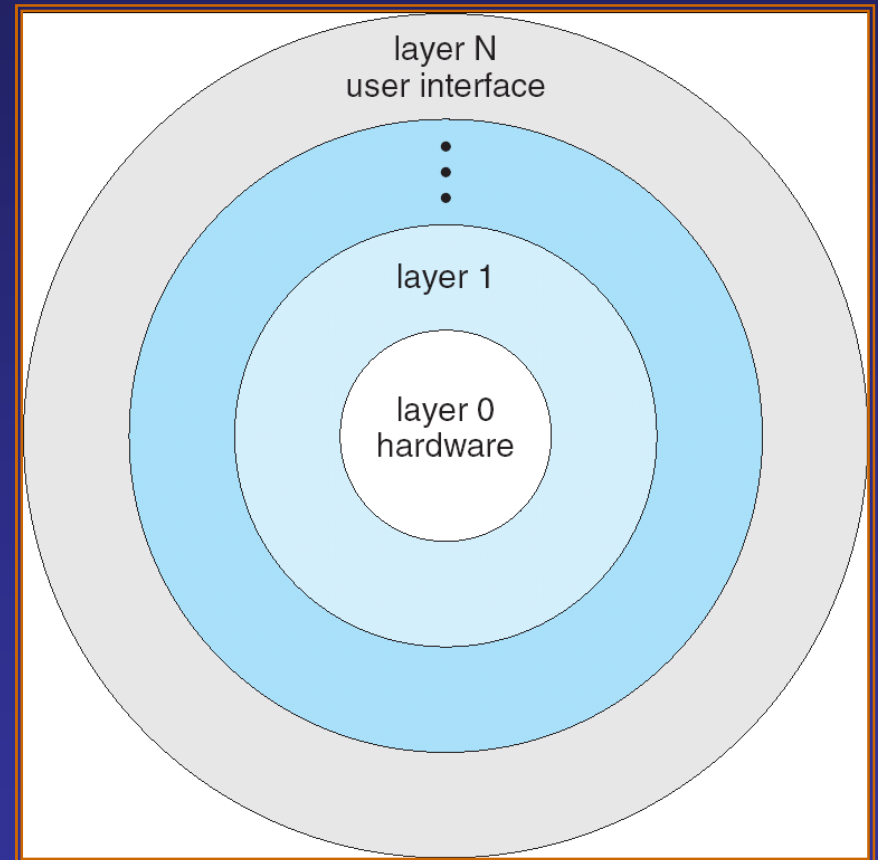
- A. A file on disk
- B. An application
- C. A program running on the system
- D. A library

Operating System Structure

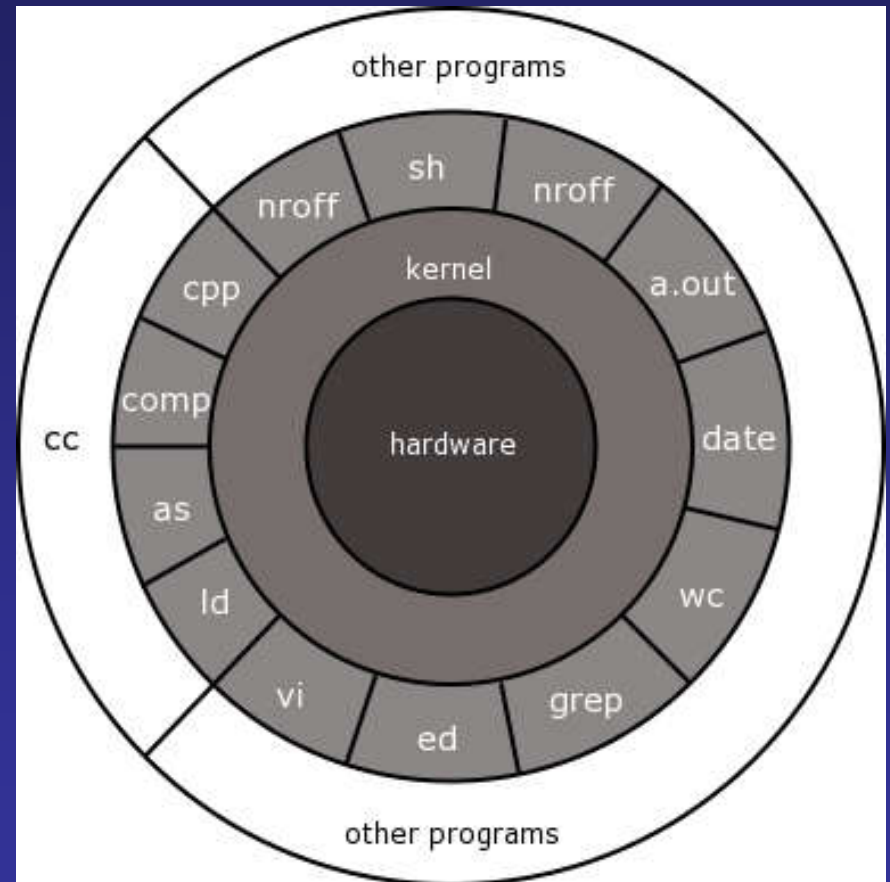
OS structure

Layered approach

- OS is divided into several levels
- A higher level can only access/use its direct lower level
 - level 3 can access level 2
 - level 4 cannot access level 2
- Why? Motivation?



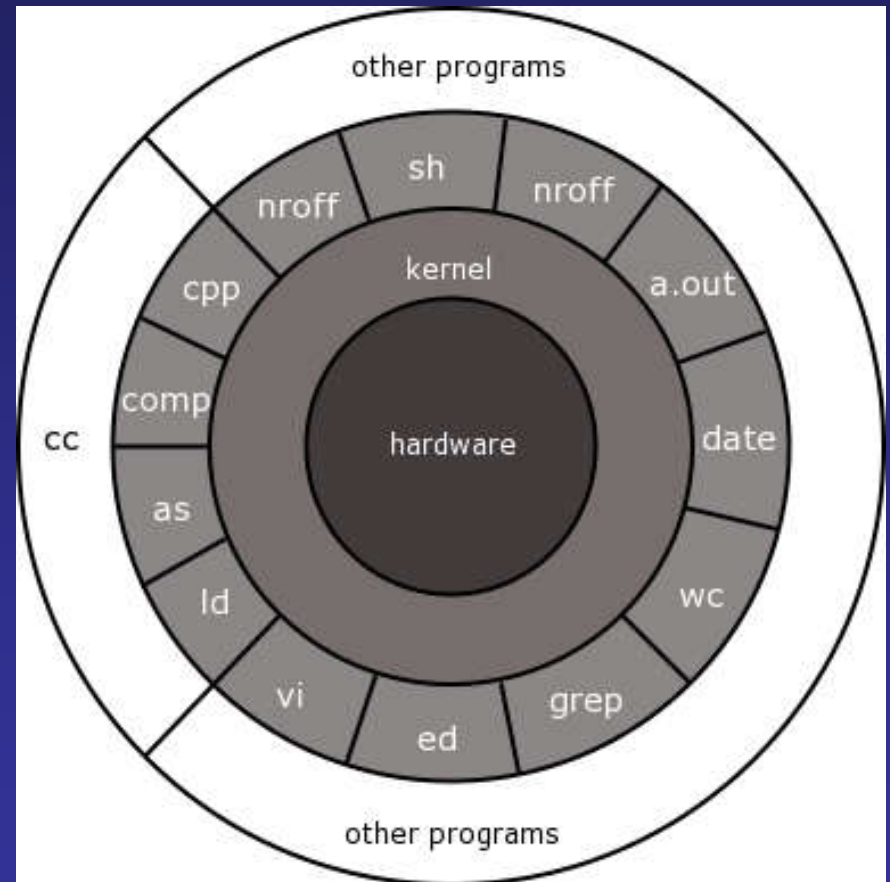
Layered approach example



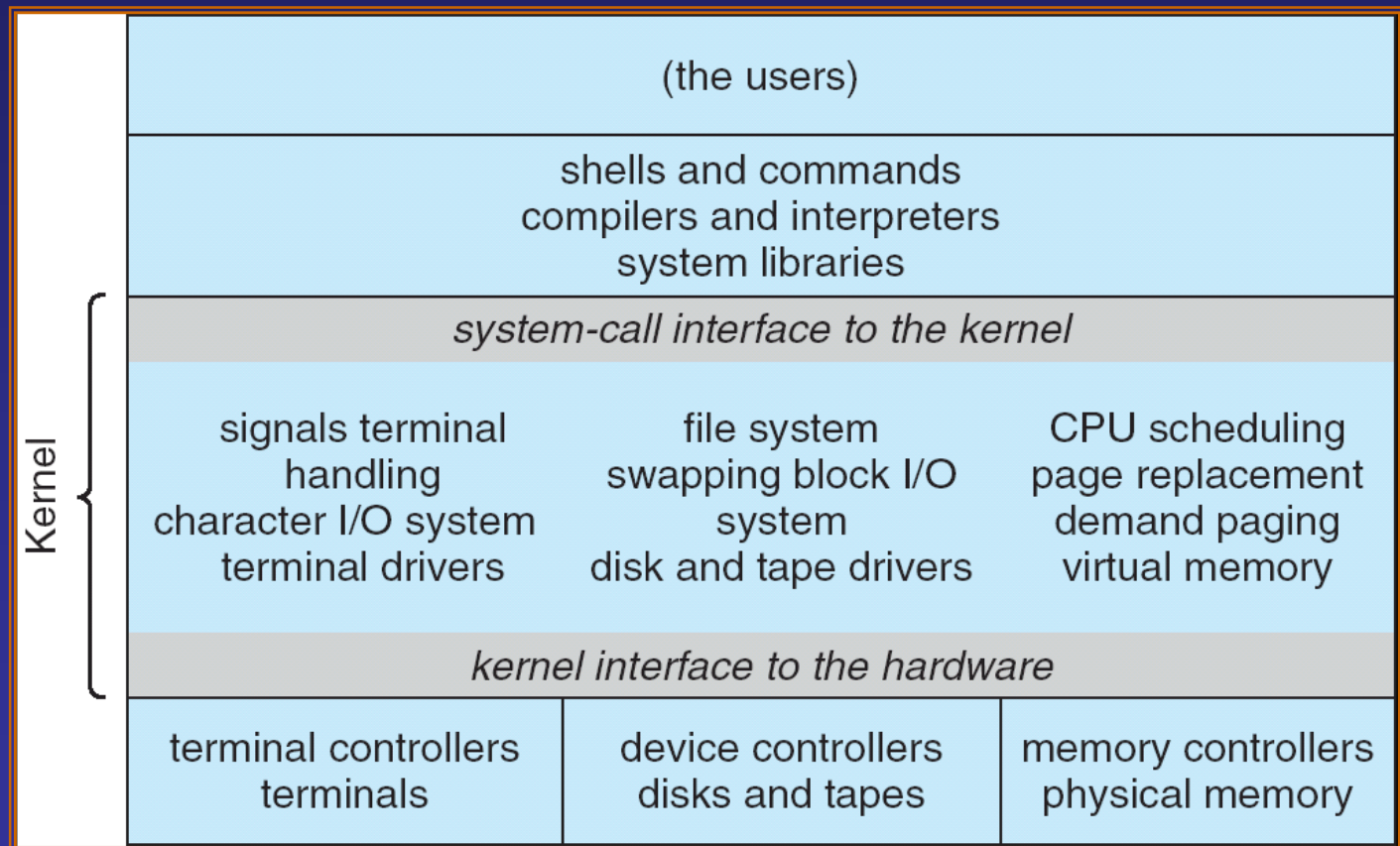
Layered approach example

- UNIX, LINUX
- How many levels are there?

- A. 1
- B. 2
- C. 3
- D. 4



UNIX another view



UNIX another view

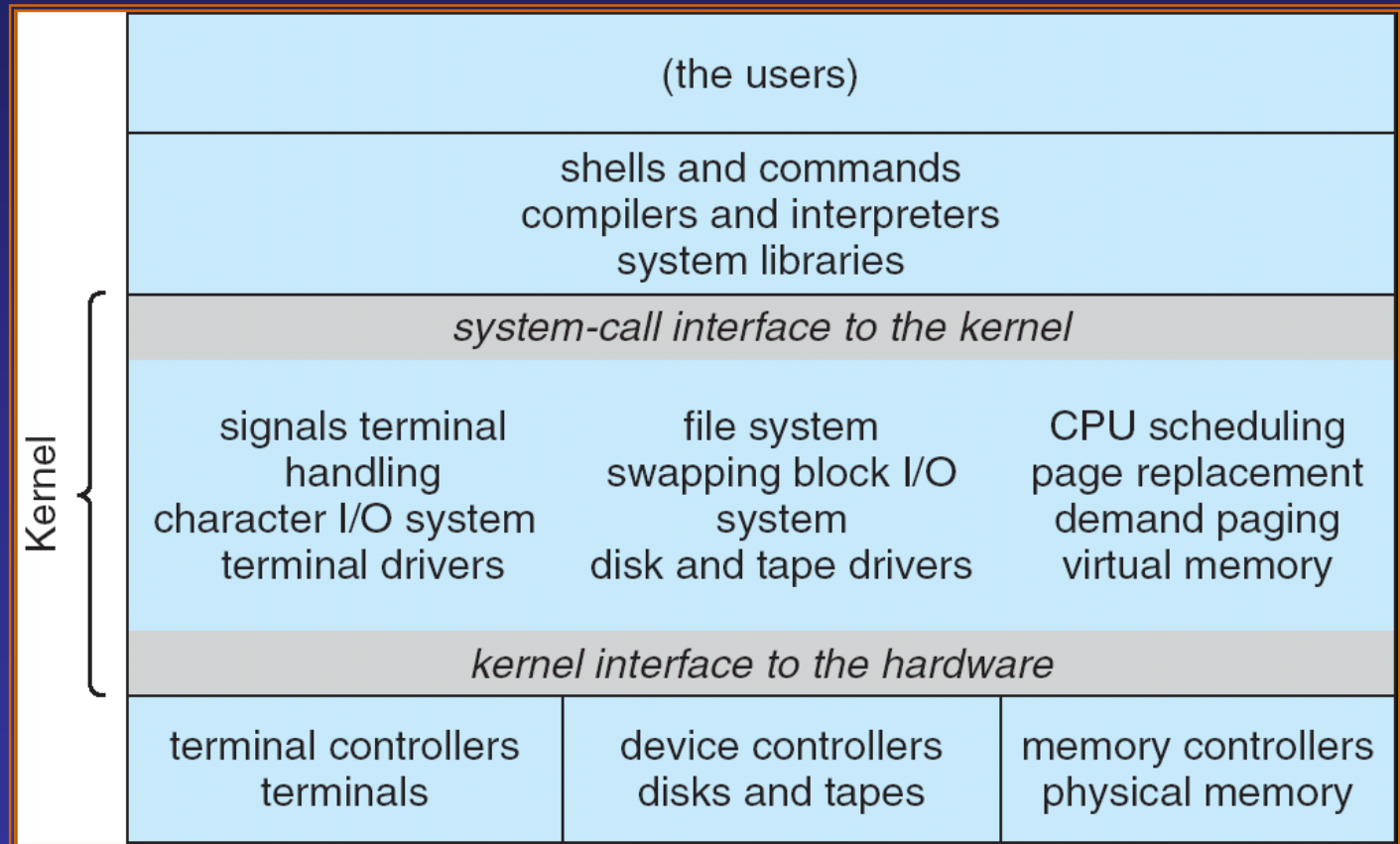
- How many levels are there?

A. 1

B. 2

C. 3

D. 4



Microkernel

- Keep minimum/essential functions in kernel
- Others are built as libraries/applications
- Examples
 - Mach, Tru64 UNIX, QNX
 - [http://en.wikipedia.org/wiki/Mach \(kernel\)](http://en.wikipedia.org/wiki/Mach_(kernel))

Module approach

- Considered as most effective approach
 - Inherits OOP paradigm
 - Sun Solaris is an example
 - [http://en.wikipedia.org/wiki/Solaris \(operating system\)](http://en.wikipedia.org/wiki/Solaris_(operating_system))

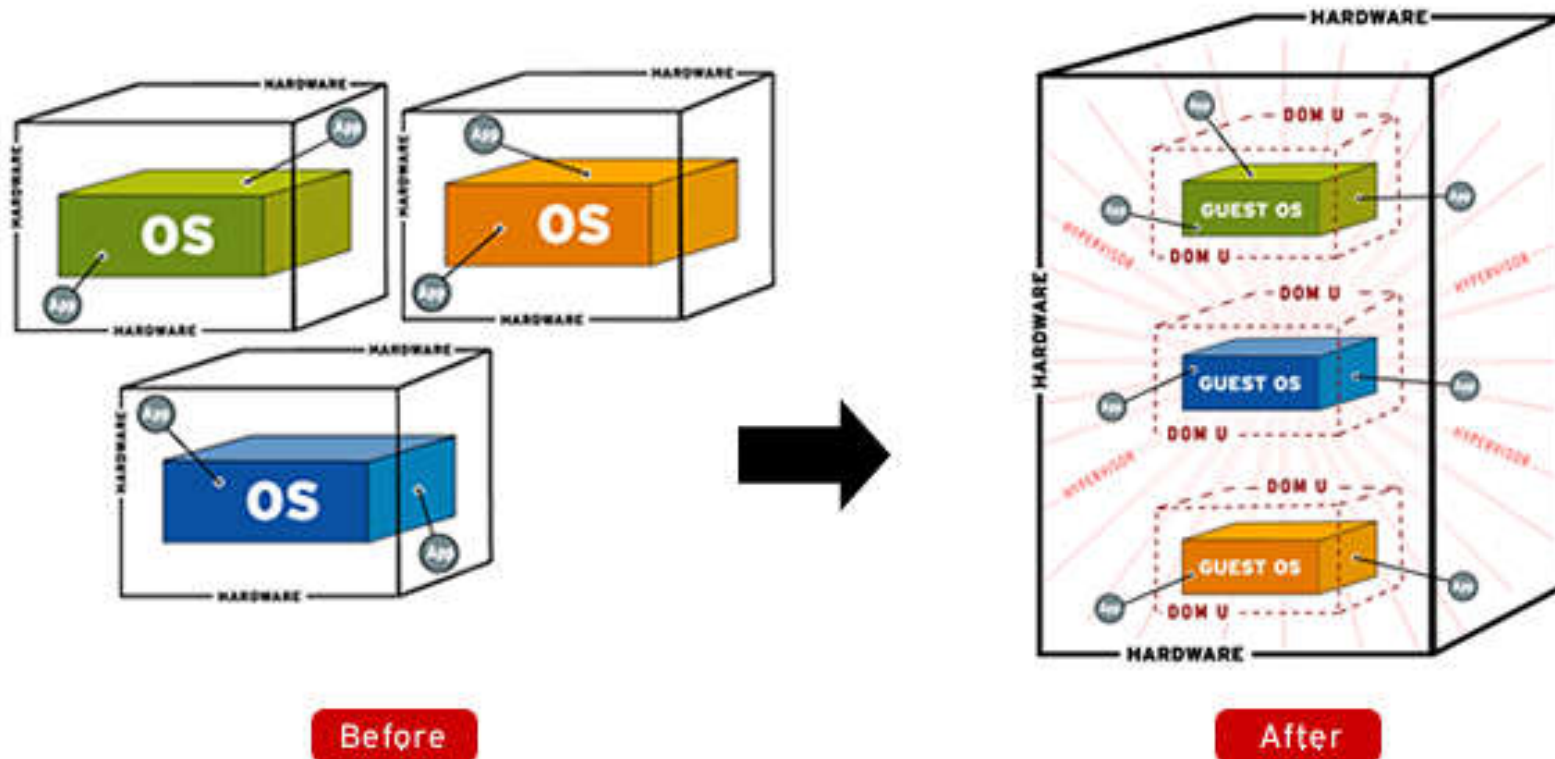
Virtual Machine

Virtual machine

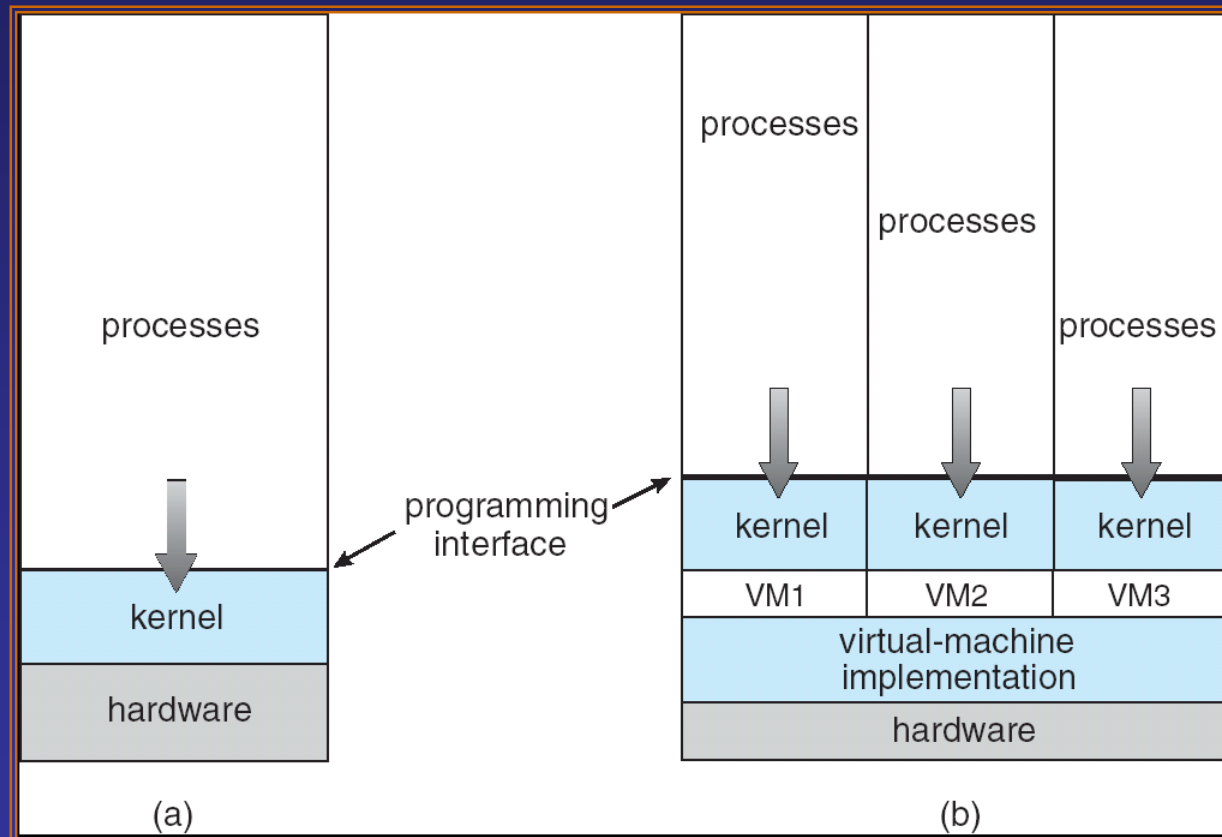
- A concept refers to the abstraction of computer resources

Virtual machine

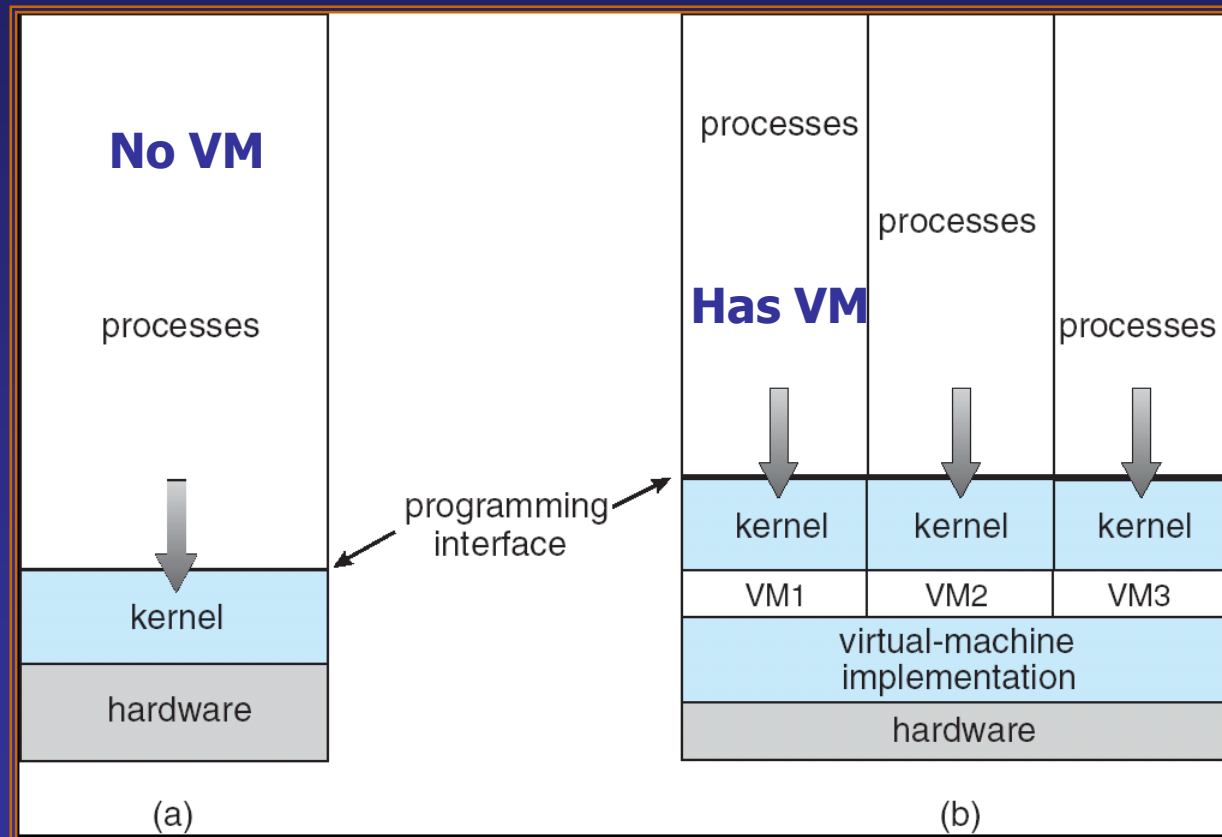
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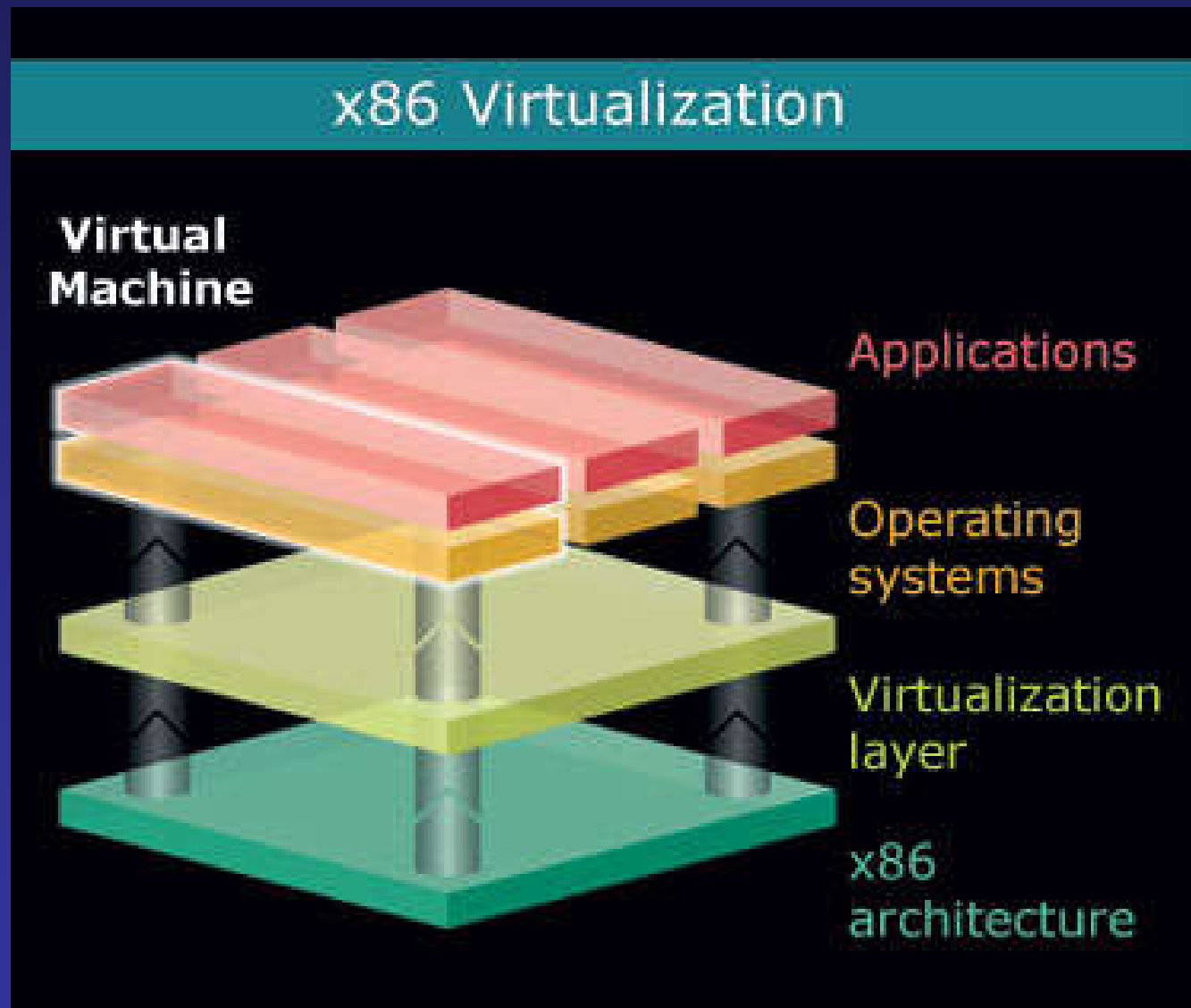
Virtual machine



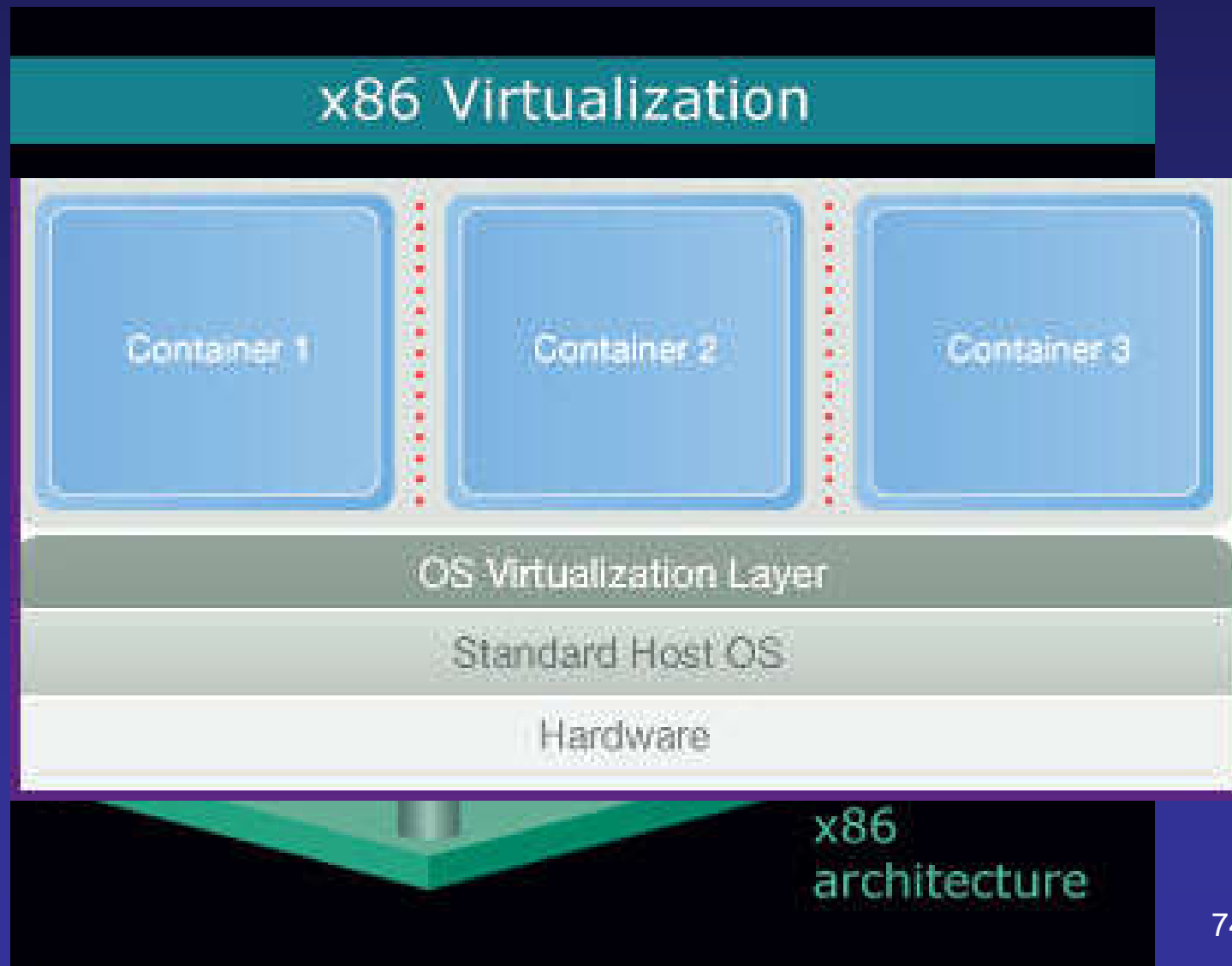
Virtual machine



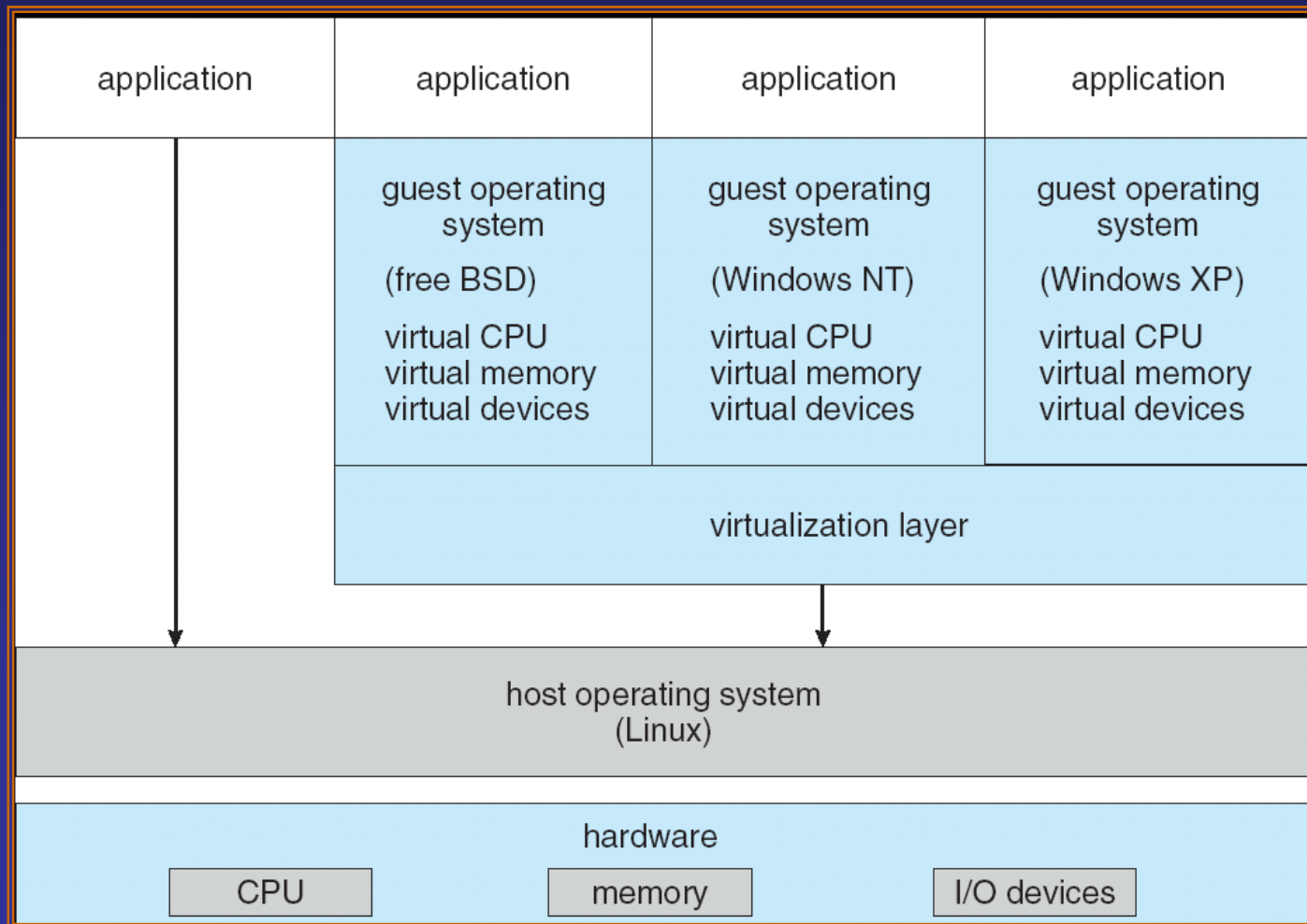
Virtual machine



Virtual machine

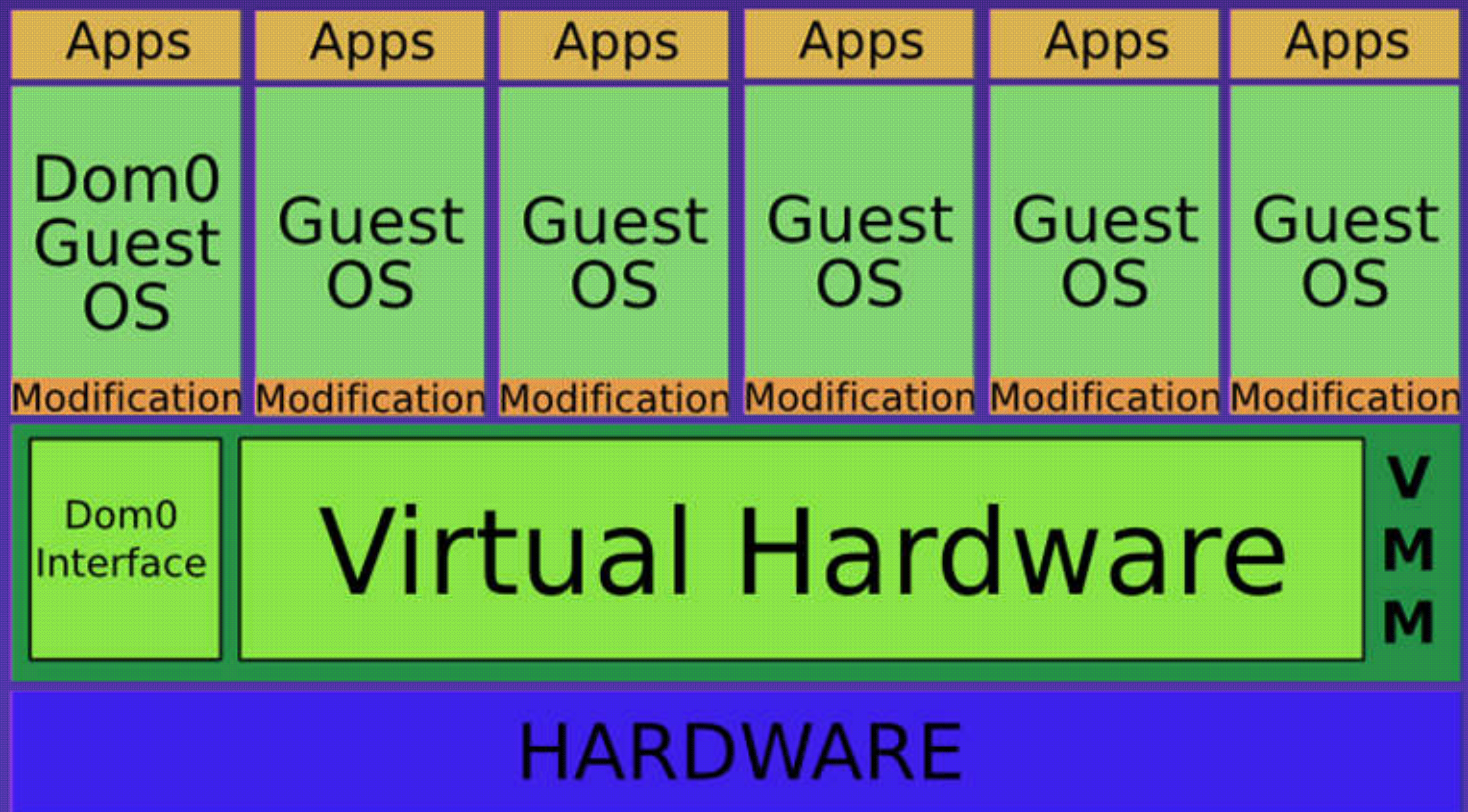


Virtual machine - VMWare

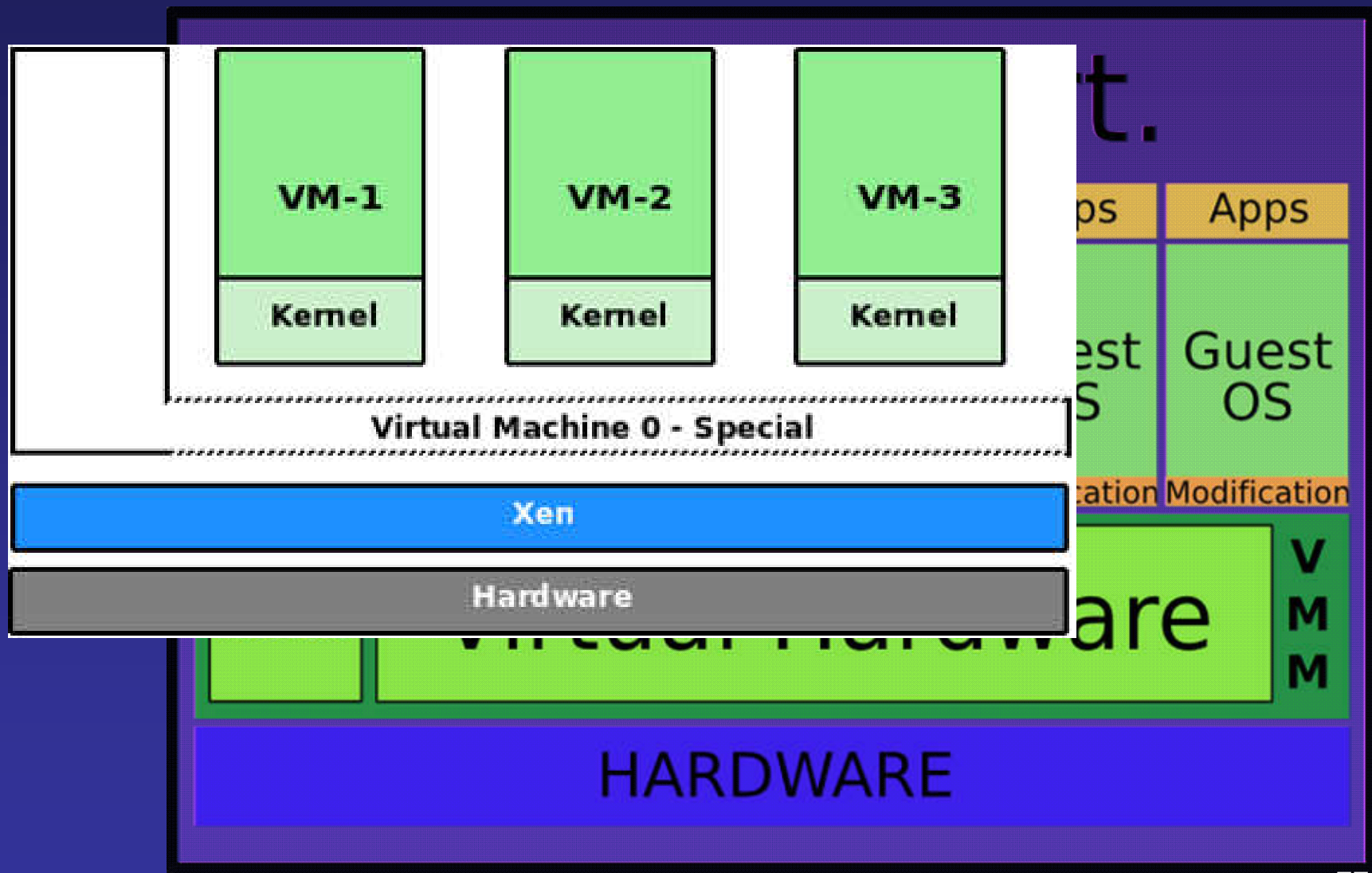


Virtual machine

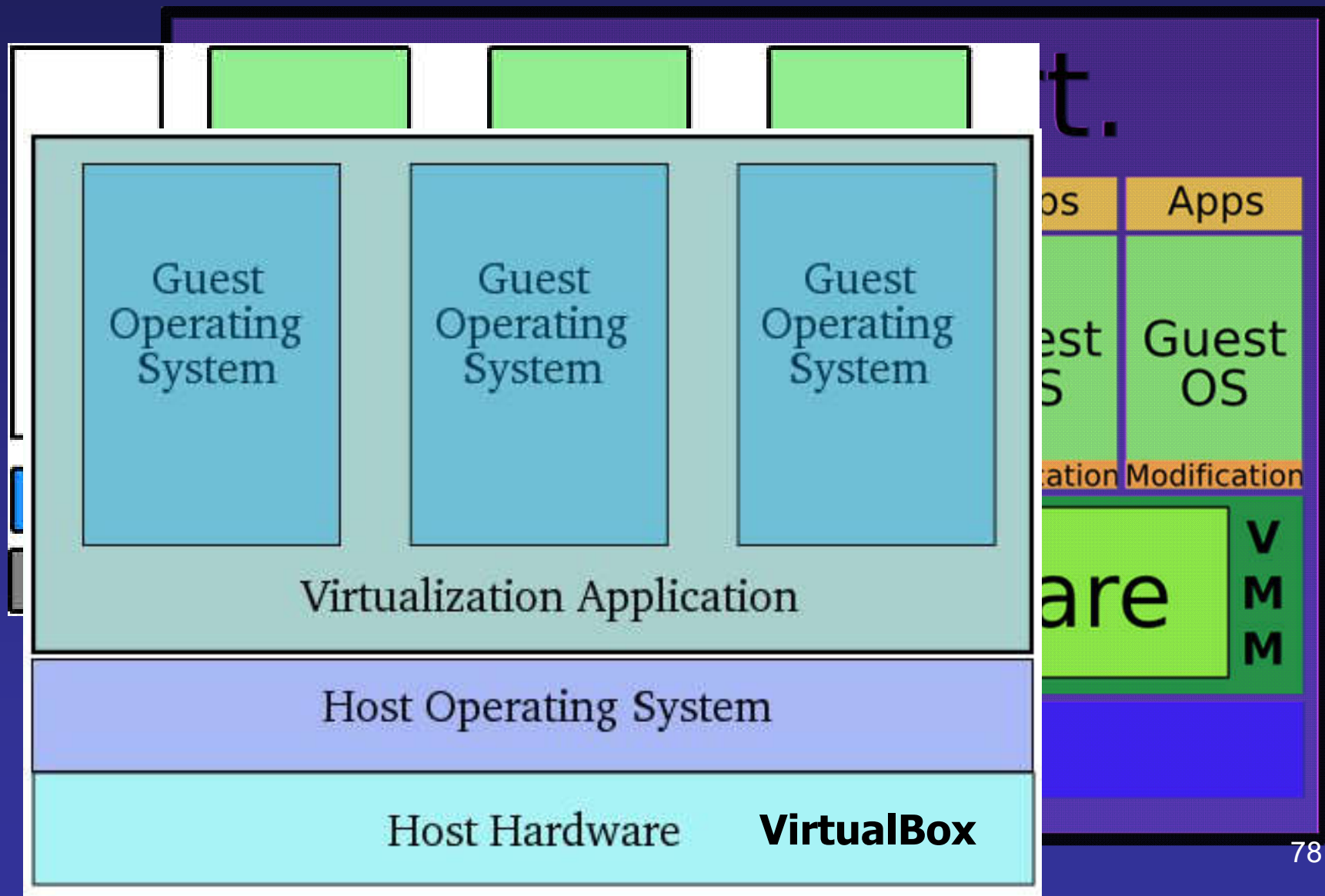
Xen Paravirt.



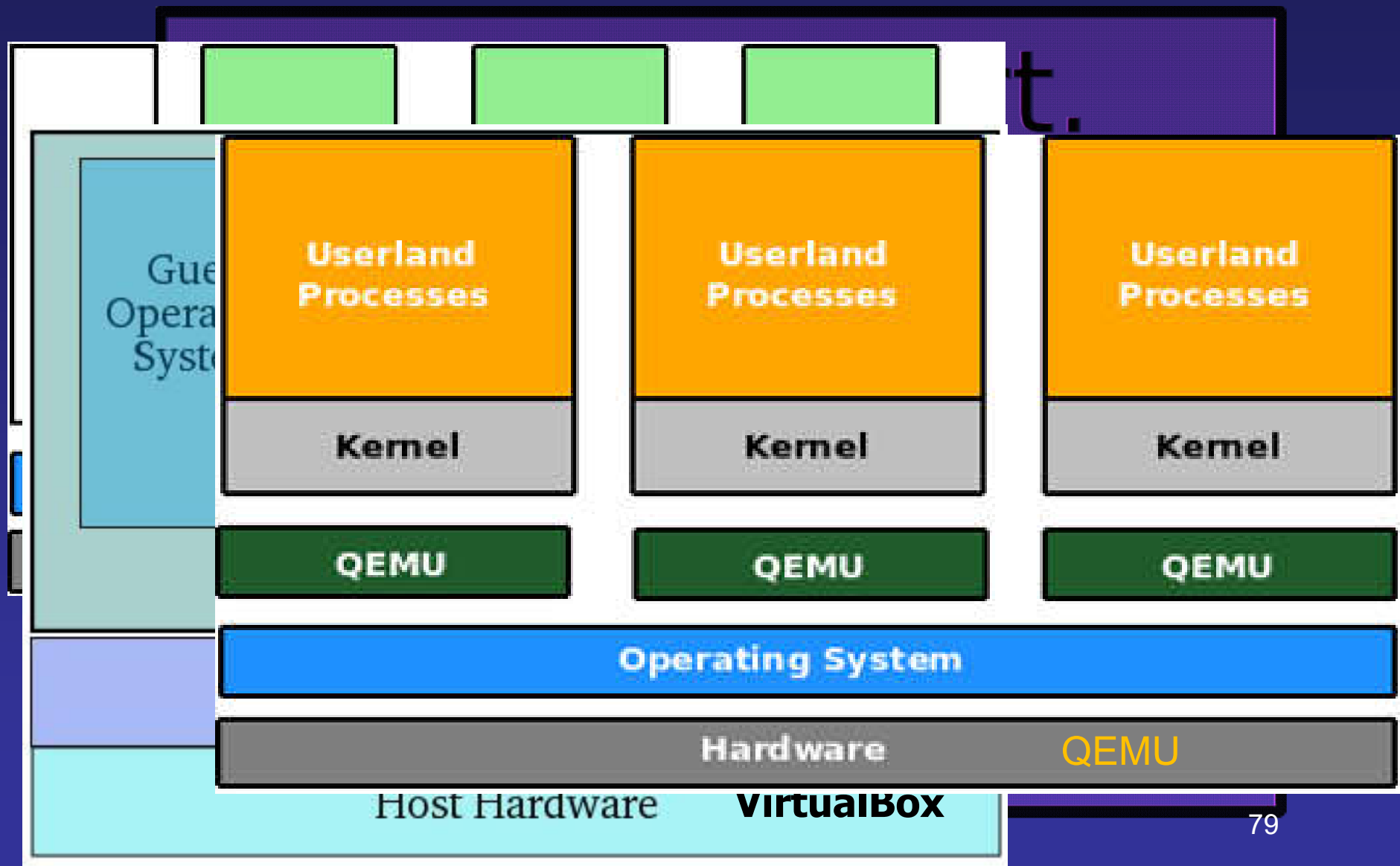
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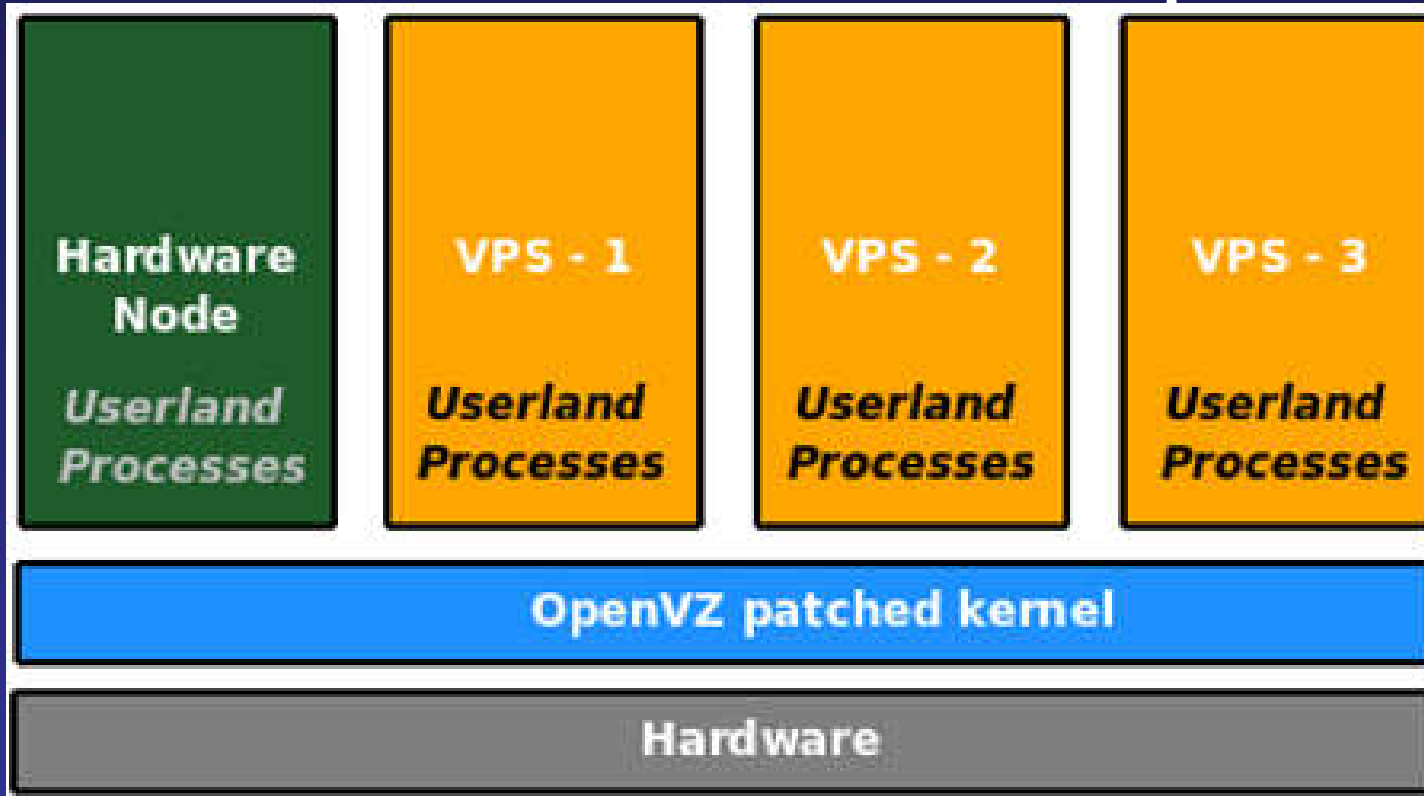
Virtual machine



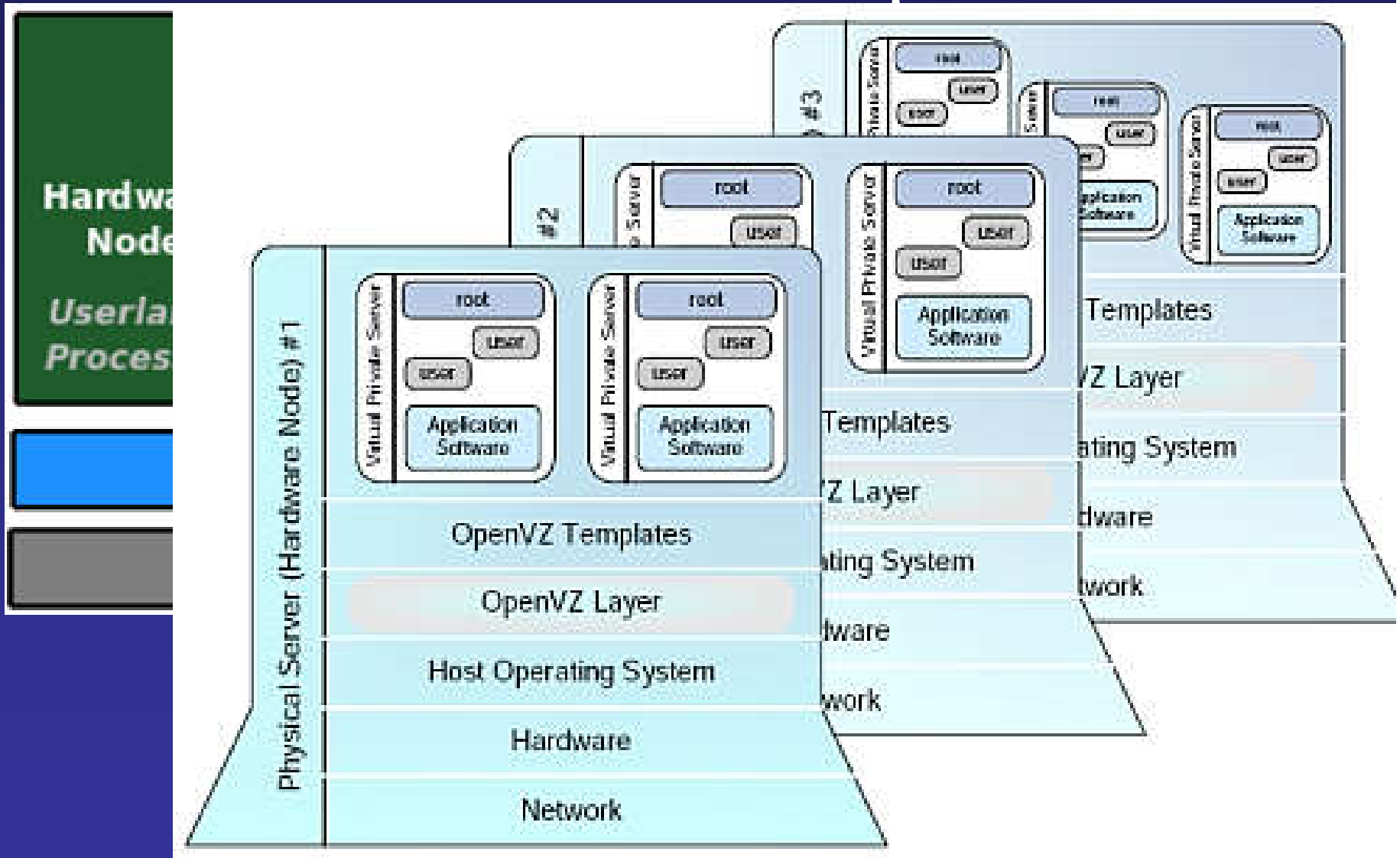
Virtual machine



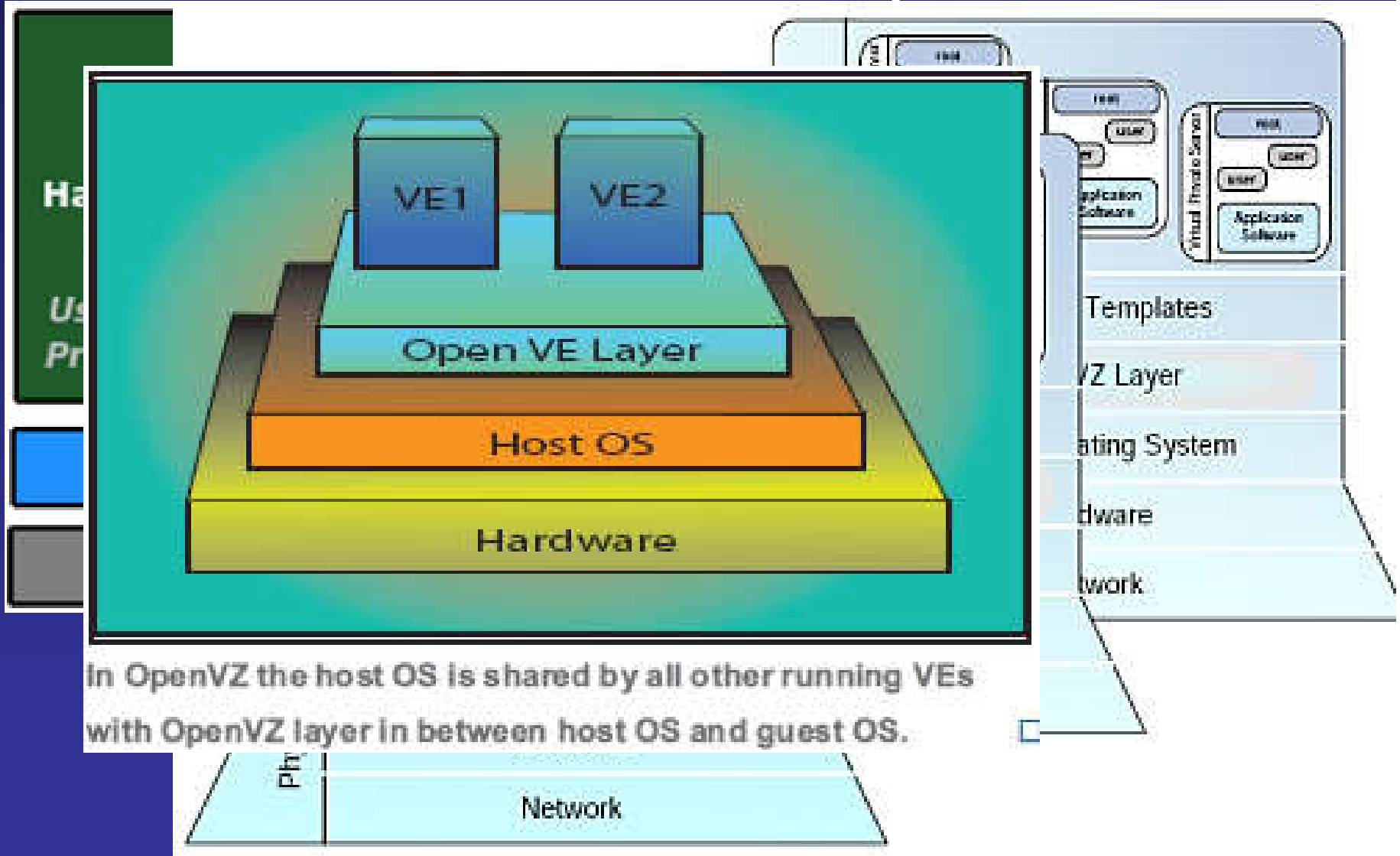
Virtual machine - OpenVZ



Virtual machine - OpenVZ



Virtual machine - OpenVZ



Quiz

Which is **NOT** the main purposes of Virtual machines?

- A. Creates more processes
- B. Utilizes RAM, CPU more effectively
- C. Allows multiple independent Operating Systems to run on the same machine
- D. Allows multiple independent Operating Systems to run with separated resources (e.g. IP address, Ports, Domain names, ...)



Windows is shutting down...



Windows is shutting down...

Any question?