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**Modern Operating Systems  
3rd Edition**

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# **Modern Operating Systems**

**by Andrew S. Tanenbaum, 3rd Edition**

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*LearningSystem*

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# **Chapter 1. WHAT IS AN OPERATING SYSTEM?**



## CHAPTER OUTLINE: KEY TERMS, PEOPLE, PLACES, CONCEPTS

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## **CHAPTER HIGHLIGHTS: KEY TERMS, PEOPLE, PLACES, CONCEPTS**

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### **Graphical user interface:**

In computing, a graphical user interface is a type of user interface that allows users to interact with electronic devices using images rather than text commands. GUIs can be used in computers, hand-held devices such as MP3 players, portable media players or gaming devices, household appliances and office equipment. A GUI represents the information and actions available to a user through graphical icons and visual indicators such as secondary notation, as opposed to text-based interfaces, typed command labels or text navigation.

### **Hypervisor:**

In computing, a hypervisor, is one of many hardware virtualization techniques allowing multiple operating systems, termed guests, to run concurrently on a host computer. It is so named because it is conceptually one level higher than a supervisory program. The hypervisor presents to the guest operating systems a virtual operating platform and manages the execution of the guest operating systems.

### **Interface:**

An interface in the Java programming language is an abstract type that is used to specify an interface (in the generic sense of the term) that classes must implement. Interfaces are declared using the keyword, and may only contain method signature and constant declarations (variable declarations that are declared to be both and ). An interface may never contain method definitions.

### **MINIX:**

MINIX is a Unix-like computer operating system based on a microkernel architecture created by Andrew S. Tanenbaum for educational purposes; MINIX also inspired the creation of the Linux kernel.

MINIX was first released in 1987, with its complete source code made available to universities for study in courses and research. It has been free and open source software since it was re-licensed under the BSD license in April 2000.

**Linux:**

Linux is a Unix-like computer operating system assembled under the model of free and open source software development and distribution. The defining component of Linux is the Linux kernel, an operating system kernel first released 5 October 1991 by Linus Torvalds.

Linux was originally developed as a free operating system for Intel x86-based personal computers.

**System call:**

In computing, a system call is how a program requests a service from an operating system's kernel. This may include hardware related services (e.g. accessing the hard disk), creating and executing new processes, and communicating with integral kernel services (like scheduling). System calls provide an essential interface between a process and the operating system.

**X Window System:**

The X window system is a computer software system and network protocol that provides a basis for graphical user interfaces (GUIs) and rich input device capability for networked computers. It creates a hardware abstraction layer where software is written to use a generalized set of commands, allowing for device independence and reuse of programs on any computer that implements X.

X originated at the Massachusetts Institute of Technology (MIT) in 1984. The current protocol version, X11, appeared in September 1987. The X.Org Foundation leads the X project, with the current reference implementation, X.Org Server, available as free and open source software under the MIT License and similar permissive licenses. Purpose and abilities

X is an architecture-independent system for remote graphical user interfaces and rich input device capabilities which allows many people to share the processing power of a time-sharing computer and to collaborate with each other through client applications running on remote computers.

**Multiplexing:**

In telecommunications and computer networks, multiplexing is a method by which multiple

analog message signals or digital data streams are combined into one signal over a shared medium. The aim is to share an expensive resource. For example, in telecommunications, several telephone calls may be carried using one wire.

### **Analytical Engine:**

The Analytical Engine was a proposed mechanical general-purpose computer designed by English mathematician Charles Babbage. It was first described in 1837 as the successor to Babbage's difference engine, a design for a mechanical calculator. The Analytical Engine incorporated an arithmetical unit, control flow in the form of conditional branching and loops, and integrated memory, making it the first Turing-complete design for a general-purpose computer.

### **FreeBSD:**

FreeBSD is a free Unix-like operating system descended from AT&T UNIX via BSD UNIX. Although for legal reasons FreeBSD cannot be called 'UNIX', as the direct descendant of BSD UNIX (many of whose original developers became FreeBSD developers), FreeBSD's internals and system APIs are UNIX-compliant. Thanks to its permissive licensing terms, much of FreeBSD's code base has become an integral part of other operating systems such as Apple's OS X that have subsequently been certified as UNIX-compliant and have formally received UNIX branding. With the exception of the proprietary OS X, FreeBSD is the most widely used BSD-derived operating system in terms of number of installed computers, and is the most widely used freely licensed, open-source BSD distribution, accounting for more than three-quarters of all installed systems running free, open-source BSD derivatives.

FreeBSD is a complete operating system.

### **Thinc:**

Thinc is a thin client protocol, currently at the research stage. Thinc is capable of playing full screen video and sound remotely which is notably a difficult problem for thin client protocols. There is a working vmware appliance available from the <http://www.ncl.cs.columbia.edu/research/thinc/download/> page which runs Debian Sid the appliance also works in Virtualbox.

### **Integrated circuit:**

An integrated circuit is an electronic circuit manufactured by the patterned diffusion of trace elements into the surface of a thin substrate of semiconductor material. Additional

materials are deposited and patterned to form interconnections between semiconductor devices.

Integrated circuits are used in virtually all electronic equipment today and have revolutionized the world of electronics.

### **Microcomputer:**

A microcomputer is a computer with a microprocessor as its central processing unit. It includes a microprocessor, memory, and input/output (I/O) facilities. Such computers are physically small compared to mainframes and minicomputers.

### **multiprogramming:**

Computer multiprogramming is the allocation of a computer system and its resources to more than one concurrent application, job or user ('program' in this nomenclature).

Initially, this technology was sought in order to optimize use of a computer system, since time and processing resources were often wasted when a single job waited for human interaction was developed as a feature of operating systems in the late 1950s and came into common use in mainframe computing in the mid- to late 1960s. This followed the development of hardware systems that possessed the requisite circuit logic and instruction sets to facilitate the transfer of control between the operating system and one or more independent applications, users or job streams.

### **POSIX:**

POSIX an acronym for 'Portable Operating System Interface', is a family of standards specified by the IEEE for maintaining compatibility between operating systems. POSIX defines the application programming interface (API), along with command line shells and utility interfaces, for software compatibility with variants of Unix and other operating systems.

#### **Name**

Originally, the name 'POSIX' referred to IEEE Std 1003.1-1988, released in 1988. The family of POSIX standards is formally designated as IEEE 1003 and the international standard name is ISO/IEC 9945.

**Disk operating system:**

Disk Operating System refers to an operating system software used in most computers that provides the abstraction and management of secondary storage devices and the information on them (e.g., file systems for organizing files of all sorts). Such software is referred to as a disk operating system when the storage devices it manages are made of rotating platters, such as floppy disks or hard disks.

In the early days of microcomputers, computer memory space was often limited, so the disk operating system was an extension of the operating system.

**Xenix:**

Xenix is a discontinued version of the Unix operating system, licensed by Microsoft from AT&T in the late 1970s. The Santa Cruz Operation (SCO) later acquired exclusive rights to the software, and eventually superseded it with SCO UNIX (now known as SCO OpenServer).

**History**

Xenix was Microsoft's version of Unix intended for use on microcomputers; because Microsoft was not able to license the 'UNIX' name itself, they gave it an original name.

**DAVID:**

DAVID (the Database for Annotation, Visualization and Integrated Discovery) is a free online bioinformatics resource developed by the Laboratory of Immunopathogenesis and Bioinformatics (LIB). All tools in the DAVID Bioinformatics Resources aim to provide functional interpretation of large lists of genes derived from genomic studies, e.g. microarray and proteomics studies. DAVID can be found at <http://david.niaid.nih.gov> or <http://david.abcc.ncifcrf.gov>

The DAVID Bioinformatics Resources consists of the DAVID Knowledgebase and five integrated, web-based functional annotation tool suites: the DAVID Gene Functional Classification Tool, the DAVID Functional Annotation Tool, the DAVID Gene ID Conversion Tool, the DAVID Gene Name Viewer and the DAVID NIAID Pathogen Genome Browser.

**distributed operating system:**

A distributed operating system is the logical aggregation of operating system software over a collection of independent, networked, communicating, and physically separate computational nodes. Individual nodes each hold a specific software subset of the global aggregate operating system. Each subset is a composite of two distinct service provisioners.

### **Network operating system:**

A networking operating system (NOS), also referred to as the Dialoguer, is the software that runs on a server and enables the server to manage data, users, groups, security, applications, and other networking functions. The network operating system is designed to allow shared file and printer access among multiple computers in a network, typically a local area network (LAN), a private network or to other networks. The most popular network operating systems are Microsoft Windows Server 2003, Microsoft Windows Server 2008, UNIX, Linux, Mac OS X, and Novell NetWare.

### **Unix:**

Unix (officially trademarked as UNIX is a multitasking, multi-user computer operating system originally developed in 1969 by a group of AT&T employees at Bell Labs, including Ken Thompson, Dennis Ritchie, Brian Kernighan, Douglas McIlroy, Michael Lesk and Joe Ossanna. The Unix operating system was first developed in assembly language, but by 1973 had been almost entirely recoded in C, greatly facilitating its further development and porting to other hardware. Today's Unix system evolution is split into various branches, developed over time by AT&T as well as various commercial vendors, universities (such as University of California, Berkeley's BSD), and non-profit organizations.

### **central processing unit:**

The central processing unit is the portion of a computer system that carries out the instructions of a computer program, to perform the basic arithmetical, logical, and input/output operations of the system. The central processing unit plays a role somewhat analogous to the brain in the computer. The term has been in use in the computer industry at least since the early 1960s.

### **Program counter:**

The program counter commonly called the instruction pointer (IP) in Intel x86 and Itanium microprocessors, and sometimes called the instruction address register (IAR) or just part of the instruction sequencer, is a processor register that indicates where a computer is in its program sequence.

In most processors, PC is incremented after fetching an instruction, and holds the memory address of ('points to') the next instruction that would be executed. (In a processor where the incrementation precedes the fetch, PC points to the current instruction being executed).

**Program status word:**

The Program status word is an IBM System/360 architecture and successors control register which performs the function of a Status register in other architectures, and more.

Although certain fields within the PSW may be tested or set by using non-privileged instructions, testing or setting the remaining fields may only be accomplished by using privileged instructions.

Contained within the PSW are certainly the zero (non-zero) and carry (borrow) flags and similar flags of other architectures' status registers, in this case encoded as a condition code with values from 0 to 15, representing the arithmetic sum of the four condition code bit values,  $2^3 + 2^2 + 2^1 + 2^0$ .

**Superscalar:**

A superscalar CPU architecture implements a form of parallelism called instruction level parallelism within a single processor. It therefore allows faster CPU throughput than would otherwise be possible at a given clock rate. A superscalar processor executes more than one instruction during a clock cycle by simultaneously dispatching multiple instructions to redundant functional units on the processor.

**Word:**

In computing, word is a term for the natural unit of data used by a particular processor design. A word is basically a fixed sized group of bits that are handled as a unit by the instruction set and/or hardware of the processor. The number of bits in a word (the word size, word width, or word length) is an important characteristic of a specific processor design or computer architecture.

**Mutual exclusion:**

Mutual exclusion, in computer science, refers to the problem of ensuring that no two processes or threads (henceforth referred to only as processes) can be in their critical

section at the same time. Here, a critical section refers to a period of time when the process accesses a shared resource, such as shared memory. The problem of mutual exclusion was first identified and solved by Edsger W. Dijkstra in his seminal 1965 paper titled: Solution of a problem in concurrent programming control.

### **memory hierarchy:**

The term memory hierarchy is used in computer architecture when discussing performance issues in computer architectural design, algorithm predictions, and the lower level programming constructs such as involving locality of reference. A 'memory hierarchy' in computer storage distinguishes each level in the 'hierarchy' by response time. Since response time, complexity, and capacity are related, the levels may also be distinguished by the controlling technology.

### **Random access:**

In computer science, random access is the ability to access an element at an arbitrary position in a sequence in equal time, independent of sequence size. The position is arbitrary in the sense that it is unpredictable, thus the use of the term 'random' in 'random access'. The opposite is sequential access, where a remote element takes longer time to access.

### **read-only memory:**

Read-only memory is a class of storage medium used in computers and other electronic devices. Data stored in read only memory cannot be modified, or can be modified only slowly or with difficulty, so it is mainly used to distribute firmware (software that is very closely tied to specific hardware, and unlikely to need frequent updates).

In its strictest sense, read only memory refers only to mask read only memory (the oldest type of solid state read only memory), which is fabricated with the desired data permanently stored in it, and thus can never be modified.

### **virtual memory:**

In computing, virtual memory is a memory management technique developed for multitasking kernels. This technique virtualizes a computer architecture's various forms of computer data storage (such as random-access memory and disk storage), allowing a program to be designed as though there is only one kind of memory, 'virtual' memory, which behaves like directly addressable read/write memory (RAM).



Most modern operating systems that support virtual memory also run each process in its own dedicated address space.

### **ConTeXt:**

ConTeXt is a general-purpose document processor. It is especially suited for structured documents, automated document production, very fine typography, and multi-lingual typesetting. It is based in part on the TeX typesetting system, and uses a document markup language for manuscript preparation.

### **Context switch:**

A context switch is the computing process of storing and restoring the state (context) of a CPU so that execution can be resumed from the same point at a later time. This enables multiple processes to share a single CPU. The context switch is an essential feature of a multitasking operating system. Context switches are usually computationally intensive and much of the design of operating systems is to optimize the use of context switches.

### **Memory management unit:**

A memory management unit sometimes called paged memory management unit is a computer hardware component responsible for handling accesses to memory requested by the CPU. Its functions include translation of virtual addresses to physical addresses (i.e., virtual memory management), memory protection, cache control, bus arbitration and in simpler computer architectures (especially 8-bit systems) bank switching.

### **How it works**

Modern Memory management units typically divide the virtual address space (the range of addresses used by the processor) into pages, each having a size which is a power of 2, usually a few kilobytes, but they may be much larger. The bottom  $n$  bits of the address (the offset within a page) are left unchanged.

### **direct memory access:**

Direct memory access is a feature of modern computers that allows certain hardware subsystems within the computer to access system memory independently of the central processing unit (CPU).

Without direct memory access, when the CPU is using programmed input/output, it is typically fully occupied for the entire duration of the read or write operation, and is thus unavailable to perform other work. With direct memory access, the CPU initiates the transfer, does other operations while the transfer is in progress, and receives an interrupt from the direct memory access controller when the operation is done.

**interrupt vector:**

An interrupt vector is the memory address of an interrupt handler, or an index into an array called an interrupt vector table that contains the memory addresses of interrupt handlers. When an interrupt is generated, the Operating System saves its execution state via a context switch, and begins execution of the interrupt handler at the interrupt vector.

**PCI Express:**

PCI Express officially abbreviated as PCIe, is a computer expansion bus standard designed to replace the older PCI, PCI-X, and AGP bus standards. PCIe has numerous improvements over the aforementioned bus standards, including higher maximum system bus throughput, lower I/O pin count and smaller physical footprint, better performance-scaling for bus devices, a more detailed error detection and reporting mechanism, and native hot-plug functionality. More recent revisions of the PCIe standard support hardware I/O virtualization.

**Plug and play:**

In computing, plug and play is a term used to describe the characteristic of a computer bus, or device specification, which facilitates the discovery of a hardware component in a system, without the need for physical device configuration, or user intervention in resolving resource conflicts.

Plug and play refers to both the boot-time assignment of device resources, and to hotplug systems such as USB and IEEE 1394 (FireWire). History of device configuration

In the beginnings of data processing technology, the hardware was just a collection of modules, and the functions of those modules had to be linked to accommodate different calculating operations.

**Multiprocessor:**

A multiprocessor is a tightly coupled computer system having two or more processing units (Multiple Processors) each sharing main memory and peripherals, in order to

simultaneously process programs.

Sometimes the term Multiprocessor is confused with the term Multiprocessing.

While Multiprocessing is a type of 'processing' in which two or more processors work together to 'process more than one program simultaneously', the term Multiprocessor is referred to the hardware architecture that allows multiprocessing.

### **Embedded operating system:**

An embedded operating system is an operating system for embedded computer systems. These operating systems are designed to be compact, efficient, and reliable, forsaking many functions that non-embedded computer operating systems provide, and which may not be used by the specialized applications they run. They are frequently also real-time operating systems, and the term RTOS is often used as a synonym for embedded operating system.

### **Real-time operating system:**

A real-time operating system is an operating system (OS) intended to serve real-time application requests.

A key characteristic of an Real time operating system is the level of its consistency concerning the amount of time it takes to accept and complete an application's task; the variability is jitter. A hard real-time operating system has less jitter than a soft real-time operating system.

### **Sensor node:**

A sensor node, is a node in a wireless sensor network that is capable of performing some processing, gathering sensory information and communicating with other connected nodes in the network. A mote is a node but a node cannot always be a mote.

### **History**

Although wireless sensor nodes have existed for decades and used for applications as diverse as earthquake measurements to warfare, the modern development of small sensor nodes dates back to the 1998 Smartdust project and the NASA Sensor Webs Project. One of the objectives of the Smartdust project was to create autonomous sensing and communication within a cubic millimeter of space.

## **Core Image:**

Core Image is a pixel-accurate, near-realtime, non-destructive image processing technology in Mac OS X. Implemented as part of the QuartzCore framework of Mac OS X 10.4 and later, Core Image provides a plugin-based architecture for applying filters and effects within the Quartz graphics rendering layer.

### **Overview**

Core Image abstracts the pixel-level manipulation process required when applying a filter to an image, making it simple for applications to implement image transformation capabilities without extensive coding. In a simple implementation, Core Image applies a single Image Filter to the pixel data of a given source to produce the transformed image.

## **Interpreter:**

In computer science, an interpreter normally means a computer program that executes, i.e. performs, instructions written in a programming language. An interpreter may be a program that either

- executes the source code directly
- translates source code into some efficient intermediate representation (code) and immediately executes this
- explicitly executes stored precompiled code made by a compiler which is part of the interpreter system

Early versions of the Lisp programming language and Dartmouth BASIC would be examples of type 1. Perl, Python, MATLAB, and Ruby are examples of type 2, while UCSD Pascal is type 3: Source programs are compiled ahead of time and stored as machine independent code, which is then linked at run-time and executed by an interpreter and/or compiler (for JIT systems). Some systems, such as Smalltalk, contemporary versions of BASIC, Java and others, may also combine 2 and 3.

## **Child process:**

A child process in computing is a process created by another process (the parent process).

A child process inherits most of its attributes, such as open files, from its parent. In UNIX, a child process is in fact created (using fork) as a copy of the parent.

## **Superuser:**

The superuser is a special user account used for system administration. Depending on

the operating system, the actual name of this account might be: root, administrator, admin or supervisor. In some cases the actual name is not significant, rather an authorization flag in the users profile determines if administrative functions can be performed.

### **FIFO:**

FIFO is an acronym for First In, First Out, an abstraction related to ways of organizing and manipulation of data relative to time and prioritization. This expression describes the principle of a queue processing technique or servicing conflicting demands by ordering process by first-come, first-served (FCFS) behaviour: where the persons leave the queue in the order they arrive, or waiting one's turn at a traffic control signal.

FCFS is also the jargon term for the FIFO operating system scheduling algorithm, which gives every process CPU time in the order they come.

### **Directory:**

Generally, a directory, as used in computing and telephony, refers to a repository or database of information which is heavily optimized for reading, under the assumption that data updates are very rare compared to data reads. Commonly, a directory supports search and browsing in addition to simple lookups.

A website which offer access to a categorized listing of other websites optimized for lookup, search, or browsing is a directory, a web directory.

### **PATH:**

PATH is an environment variable on Unix-like operating systems, DOS, OS/2, and Microsoft Windows, specifying a set of directories where executable programs are located. In general, each executing process or user session has its own PATH setting.

Unix and Unix-like

On POSIX and Unix-like operating systems, the variable is specified as a list of one or more directory names separated by colon (:) characters.

### **Working directory:**

In computing, the working directory of a process is a directory of a hierarchical file system,

if any, dynamically associated with each process. When the process refers to a file using a simple file name or relative path (as opposed to a file designated by a full path from a root directory), the reference is interpreted relative to the current working directory of the process. So for example a process with working directory `/rabbit-hats` that asks to create the file `foo.txt` will end up creating the file `/rabbit-hats/foo.txt`.

**Block:**

In computing (specifically data transmission and data storage), a block is a sequence of bytes or bits, having a nominal length (a block size). Data thus structured are said to be blocked. The process of putting data into blocks is called blocking.

**Chown:**

The `chown` command (abbreviation for change owner) is used on Unix-like systems to change the owner of a file. In most implementations, it can only be executed by the superuser, to prevent users simply changing ownership of files that aren't theirs to access them. Unprivileged (regular) users who wish to change the group of a file that they own may use `chgrp`.

**Data:**

In computer science, data ( *'de?t?-t?* or *'dæt?*) is information in a form suitable for use with a computer. Data is often distinguished from programs. A program is a sequence of instructions that detail a task for the computer to perform.

**data segment:**

A data segment is a portion of virtual address space of a program, which contains the global variables and static variables that are initialized by the programmer. This size of this segment is determined by the values placed there by the programmer before the program was compiled or assembled, and does not change at run-time.

The data segment is read-write, since the values of the variables can be altered at run-time.

**Exit:**

On many computer operating systems, a computer process terminates its execution by making an `exit` system call. More generally, an exit in a multithreading environment means that a thread of execution has stopped running. The operating system reclaims

resources (memory, files, etc).

### **mkdir:**

The mkdir (make directory) command in the Unix, DOS, OS/2, PHP, and Microsoft Windows operating systems is used to make a new directory. In DOS, OS/2 and Windows the command is often abbreviated to md.

#### Usage

Normal usage is as straightforward as follows:

Where name\_of\_directory is the name of the directory one wants to create.

### **rmdir:**

(or `rmdir`) is a command which will remove an empty directory on a Unix, DOS, OS/2 or Microsoft Windows operating system. In Unix, Linux, and MacOS, it is case sensitive, whereas DOS, OS/2 and Windows (95, 98, ME), you can type the characters in any combination of upper case and lower case letters, and `rd/rmdir` will recognize and remove that directory. Normal usage is straightforward where one types:

Where name\_of\_directory corresponds with the name of the directory one wishes to delete.

### **chmod:**

The command is a Unix command that lets a user tell the system how much (or little) access it should permit to a file. It changes the file system modes of files and directories. The modes include permissions and special modes.

### **Application programming interface:**

An application programming interface is a specification intended to be used as an interface by software components to communicate with each other. An API may include specifications for routines, data structures, object classes, and variables. An API specification can take many forms, including an International Standard such as POSIX or vendor documentation such as the Microsoft Windows API, or the libraries of a programming language, e.g. Standard Template Library in C++ or Java API.

An API differs from an application binary interface (ABI) in that the former is source code based while the latter is a binary interface.

### **Monolithic system:**

Monolithic system can have different meanings in the contexts of computer software and hardware.

In software

A software system is called 'monolithic' if it has a monolithic architecture, in which functionally distinguishable aspects (for example data input and output, data processing, error handling, and the user interface), are not architecturally separate components but are all interwoven.

Mainframe computers used a monolithic architecture with considerable success.

### **Layered system:**

In telecommunication, a layered system is a system in which components are grouped, i.e., layered, in a hierarchical arrangement, such that lower layers provide functions and services that support the functions and services of higher layers.

Note: Systems of ever-increasing complexity and capability can be built by adding or changing the layers to improve overall system capability while using the components that are still in place.

### **Microkernel:**

In computer science, a microkernel is the near-minimum amount of software that can provide the mechanisms needed to implement an operating system (OS). These mechanisms include low-level address space management, thread management, and inter-process communication (IPC). If the hardware provides multiple rings or CPU modes, the microkernel is the only software executing at the most privileged level (generally referred to as supervisor or kernel mode).

### **Virtual machine:**

A virtual machine is a 'completely isolated guest operating system installation within a normal host operating system'. Modern virtual machines are implemented with either



software emulation or hardware virtualization. In most cases, both are implemented together.

### **Exokernel:**

Exokernel is an operating system kernel developed by the MIT Parallel and Distributed Operating Systems group, and also a class of similar operating systems.

The idea behind exokernels is to force as few abstractions as possible on developers, enabling them to make as many decisions as possible about hardware abstractions. Exokernels are tiny, since functionality is limited to ensuring protection and multiplexing of resources, which are vastly simpler than conventional microkernels' implementation of message passing and monolithic kernels' implementation of abstractions.

### **Java virtual machine:**

A Java virtual machine is a virtual machine that can execute Java bytecode. It is the code execution component of the Java software platform. Sun Microsystems stated that there are over 5.5 billion JVM-enabled devices.

### **Paravirtualization:**

In computing, paravirtualization is a virtualization technique that presents a software interface to virtual machines that is similar but not identical to that of the underlying hardware.

The intent of the modified interface is to reduce the portion of the guest's execution time spent performing operations which are substantially more difficult to run in a virtual environment compared to a non-virtualized environment. The paravirtualization provides specially defined 'hooks' to allow the guest(s) and host to request and acknowledge these tasks, which would otherwise be executed in the virtual domain (where execution performance is worse).

### **Header file:**

In computer programming, header file is a file that allows programmers to separate certain elements of a program's source code into reusable files. Header files commonly contain forward declarations of classes, subroutines, variables, and other identifiers. Programmers who wish to declare standardized identifiers in more than one source file

can place such identifiers in a single header file, which other code can then include whenever the header contents are required.

### **Macro:**

A macro in computer science is a rule or pattern that specifies how a certain input sequence (often a sequence of characters) should be mapped to a replacement input sequence (also often a sequence of characters) according to a defined procedure. The mapping process that instantiates (transforms) a macro use into a specific sequence is known as macro expansion. A facility for writing macros may be provided as part of a software application or as a part of a programming language.

### **C preprocessor:**

The C preprocessor is the macro preprocessor for the C and C++ computer programming languages. The preprocessor provides the ability for the inclusion of header files, macro expansions, conditional compilation, and line control.

In many C implementations, it is a separate program invoked by the compiler as the first part of translation.

### **Object file:**

An object file is a file containing relocatable format machine code that is usually not directly executable. Object files are produced by an assembler, compiler, or other language translator, and used as input to the linker.

Additionally, object files may contain metadata such as information to resolve symbolic cross-references between different modules, relocation information, stack unwinding information, comments, program symbols, debugging or profiling information.

### **Preprocessor:**

In computer science, a preprocessor is a program that processes its input data to produce output that is used as input to another program. The output is said to be a preprocessed form of the input data, which is often used by some subsequent programs like compilers. The amount and kind of processing done depends on the nature of the preprocessor; some preprocessors are only capable of performing relatively simple textual substitutions and macro expansions, while others have the power of full-fledged programming

languages.

**METRIC:**

METRIC is a computer model (Mapping EvapoTranspiration at high Resolution with Internalized Calibration) that uses Landsat satellite data to compute and map evapotranspiration (ET) developed by Richard Allen et.al. at the University of Idaho.

Climate Change is a world wide problem that affects every country on earth.



## **CHAPTER QUIZ: KEY TERMS, PEOPLE, PLACES, CONCEPTS**

---

1. In computing, a graphical user interface is a type of user interface that allows users to interact with electronic devices using images rather than text commands. GUIs can be used in computers, hand-held devices such as MP3 players, portable media players or gaming devices, household appliances and office equipment. A GUI represents the information and actions available to a user through graphical icons and visual indicators such as secondary notation, as opposed to text-based interfaces, typed command labels or text navigation.

a. Library Oriented Architecture

b. Graphical user interface

c. Open architecture

d. Presentation logic

2. In computing, a hypervisor, is one of many hardware virtualization techniques allowing multiple operating systems, termed guests, to run concurrently on a host computer. It is so named because it is conceptually one level higher than a supervisory program. The hypervisor presents to the guest operating systems a virtual operating platform and manages the execution of the guest operating systems.

a. Kestrel

b. Hypervisor

c. Linux Terminal Server Project

d. Liquid Computing

3. An interface in the Java programming language is an abstract type that is used to specify an interface (in the generic sense of the term) that classes must implement. Interfaces are declared using the keyword, and may only contain method signature and constant declarations (variable declarations that are declared to be both and ). An interface may never contain method definitions.

- a. Inversion of control
- b. Interface
- c. Omniscient Debugger
- d. Unified Expression Language

4. MINIX is a Unix-like computer operating system based on a microkernel architecture created by Andrew S. Tanenbaum for educational purposes; MINIX also inspired the creation of the Linux kernel.

MINIX was first released in 1987, with its complete source code made available to universities for study in courses and research. It has been free and open source software since it was re-licensed under the BSD license in April 2000.

- a. Rensselaer Polytechnic
- b. MINIX
- c. NGOMSL
- d. Notification system

5. Linux is a Unix-like computer operating system assembled under the model of free and open source software development and distribution. The defining component of Linux is the Linux kernel, an operating system kernel first released 5 October 1991 by Linus Torvalds.

Linux was originally developed as a free operating system for Intel x86-based personal computers.

a. BioLinux

b. Linux

c. BlackDog

d. Bodhi Linux

**ANSWER KEY**





## **ANSWER KEY**

1. b

2. b

3. b

4. b

5. b

---

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# Chapter 2. PROCESSES AND THREADS



## CHAPTER OUTLINE: KEY TERMS, PEOPLE, PLACES, CONCEPTS

---

- Multiprocessor
- multiprogramming
- Chown
- Daemon
- Exit
- Linux
- System call
- Process state
- Process control block
- Block
- interrupt vector
- Web server
- POSIX
- POSIX Threads
- Symbian
- user space

- scheduler activations
- Global variable
- CODE
- Race condition
- Directory
- critical section
- Mutual exclusion
- Sleep
- Priority inversion
- Action
- Wait
- Message passing
- Interface
- Turnaround time
- ConTeXt
- Context switch
- round-robin
- Queue
- lottery scheduling

- Fair-share scheduling





## **CHAPTER HIGHLIGHTS: KEY TERMS, PEOPLE, PLACES, CONCEPTS**

---

### **Multiprocessor:**

A multiprocessor is a tightly coupled computer system having two or more processing units (Multiple Processors) each sharing main memory and peripherals, in order to simultaneously process programs.

Sometimes the term Multiprocessor is confused with the term Multiprocessing.

While Multiprocessing is a type of 'processing' in which two or more processors work together to 'process more than one program simultaneously', the term Multiprocessor is referred to the hardware architecture that allows multiprocessing.

### **multiprogramming:**

Computer multiprogramming is the allocation of a computer system and its resources to more than one concurrent application, job or user ('program' in this nomenclature).

Initially, this technology was sought in order to optimize use of a computer system, since time and processing resources were often wasted when a single job waited for human interaction was developed as a feature of operating systems in the late 1950s and came into common use in mainframe computing in the mid- to late 1960s. This followed the development of hardware systems that possessed the requisite circuit logic and instruction sets to facilitate the transfer of control between the operating system and one or more independent applications, users or job streams.

### **Chown:**

The chown command (abbreviation for change owner) is used on Unix-like systems to change the owner of a file. In most implementations, it can only be executed by the superuser, to prevent users simply changing ownership of files that aren't theirs to access them. Unprivileged (regular) users who wish to change the group of a file that they own may use chgrp.

**Daemon:**

In Unix and other multitasking computer operating systems, a daemon ( 'de?m?n or 'di? m?n) is a computer program that runs as a background process, rather than being under the direct control of an interactive user. Typically daemon names end with the letter d: for example, syslogd is the daemon that implements the system logging facility and sshd is a daemon that services incoming SSH connections.

In a Unix environment, the parent process of a daemon is often, but not always, the init process.

**Exit:**

On many computer operating systems, a computer process terminates its execution by making an exit system call. More generally, an exit in a multithreading environment means that a thread of execution has stopped running. The operating system reclaims resources (memory, files, etc).

**Linux:**

Linux is a Unix-like computer operating system assembled under the model of free and open source software development and distribution. The defining component of Linux is the Linux kernel, an operating system kernel first released 5 October 1991 by Linus Torvalds.

Linux was originally developed as a free operating system for Intel x86-based personal computers.

**System call:**

In computing, a system call is how a program requests a service from an operating system's kernel. This may include hardware related services (e.g. accessing the hard disk), creating and executing new processes, and communicating with integral kernel services (like scheduling). System calls provide an essential interface between a process and the operating system.

**Process state:**

In a multitasking computer system, processes may occupy a variety of states. These

distinct states may not actually be recognized as such by the operating system kernel, however they are a useful abstraction for the understanding of processes.

### Primary process states

The following typical process states are possible on computer systems of all kinds.

### **Process control block:**

Process Control Block is a data structure in the operating system kernel containing the information needed to manage a particular process. The PCB is 'the manifestation of a process in an operating system'.

#### Included information

Implementations differ, but in general a PCB will include, directly or indirectly:

- The identifier of the process (a process identifier, or PID)
- Register values for the process including, notably, the program counter and stack pointer values for the process.
- The address space for the process
- Priority (in which higher priority process gets first preference.

### **Block:**

In computing (specifically data transmission and data storage), a block is a sequence of bytes or bits, having a nominal length (a block size). Data thus structured are said to be blocked. The process of putting data into blocks is called blocking.

### **interrupt vector:**

An interrupt vector is the memory address of an interrupt handler, or an index into an array called an interrupt vector table that contains the memory addresses of interrupt handlers. When an interrupt is generated, the Operating System saves its execution state via a context switch, and begins execution of the interrupt handler at the interrupt vector.

### **Web server:**

Web server can refer to either the hardware (the computer) or the software (the computer application) that helps to deliver Web content that can be accessed through the Internet.

The most common use of web servers is to host websites, but there are other uses such as gaming, data storage or running enterprise applications. Overview

The primary function of a web server is to deliver web pages on the request to clients using the Hypertext Transfer Protocol .

## **POSIX:**

POSIX an acronym for 'Portable Operating System Interface', is a family of standards specified by the IEEE for maintaining compatibility between operating systems. POSIX defines the application programming interface (API), along with command line shells and utility interfaces, for software compatibility with variants of Unix and other operating systems.

### **Name**

Originally, the name 'POSIX' referred to IEEE Std 1003.1-1988, released in 1988. The family of POSIX standards is formally designated as IEEE 1003 and the international standard name is ISO/IEC 9945.

## **POSIX Threads:**

POSIX Threads, usually referred to as Pthreads, is a POSIX standard for threads. The standard, POSIX.1c, Threads extensions (IEEE Std 1003.1c-1995), defines an API for creating and manipulating threads.

Implementations of the API are available on many Unix-like POSIX-conformant operating systems such as FreeBSD, NetBSD, OpenBSD, GNU/Linux, Mac OS X and Solaris.

## **Symbian:**

Symbian is a mobile operating system (OS) and computing platform designed for smartphones and currently maintained by Accenture. The Symbian platform is the successor to Symbian OS and Nokia Series 60; unlike Symbian OS, which needed an additional user interface system, Symbian includes a user interface component based on S60 5th Edition. The latest version, Symbiansq3, was officially released in Q4 2010, first used in the Nokia N8. In May 2011 an update, Symbian Anna, was officially announced, followed by Nokia Belle (previously Symbian Belle) in August 2011.

## **user space:**

A conventional computer operating system usually segregates virtual memory into kernel space and user space. Kernel space is strictly reserved for running the kernel, kernel

extensions, and most device drivers. In contrast, user space is the memory area where all user mode applications work and this memory can be swapped out when necessary.

### **scheduler activations:**

Scheduler Activations is a threading mechanism that, when implemented in an operating system's process scheduler, provides kernel-level thread functionality with user-level thread flexibility and performance. This mechanism uses a so-called 'N:M' strategy that maps some N number of application threads onto some M number of kernel entities, or 'virtual processors.' This is a compromise between kernel-level ('1:1') and user-level ('N:1') threading. In general, 'N:M' threading systems are more complex to implement than either kernel or user threads, because both changes to kernel and user-space code are required.

### **Global variable:**

In computer programming, a global variable is a variable that is accessible in every scope (unless shadowed). Interaction mechanisms with global variables are called global environment mechanisms. The global environment paradigm is contrasted with the local environment paradigm, where all variables are local with no shared memory (and therefore all interactions can be reconducted to message passing).

### **CODE:**

CODE (computationally oriented display environment) is a visual programming language and system for parallel programming, which lets users compose sequential programs into parallel programs.

### **Race condition:**

A race condition is unexpectedly and critically dependent on the sequence or timing of other events. The term originates with the idea of two signals racing each other to influence the output first.

Race conditions can occur in electronics systems, especially logic circuits, and in computer software, especially multithreaded or distributed programs.

### **Directory:**

Generally, a directory, as used in computing and telephony, refers to a repository or database of information which is heavily optimized for reading, under the assumption that

data updates are very rare compared to data reads. Commonly, a directory supports search and browsing in addition to simple lookups.

A website which offer access to a categorized listing of other websites optimized for lookup, search, or browsing is a directory, a web directory.

### **critical section:**

In concurrent programming a critical section is a piece of code that accesses a shared resource (data structure or device) that must not be concurrently accessed by more than one thread of execution. A critical section will usually terminate in fixed time, and a thread, task or process will have to wait a fixed time to enter it (aka bounded waiting). Some synchronization mechanism is required at the entry and exit of the critical section to ensure exclusive use, for example a semaphore.

### **Mutual exclusion:**

Mutual exclusion, in computer science, refers to the problem of ensuring that no two processes or threads (henceforth referred to only as processes) can be in their critical section at the same time. Here, a critical section refers to a period of time when the process accesses a shared resource, such as shared memory. The problem of mutual exclusion was first identified and solved by Edsger W. Dijkstra in his seminal 1965 paper titled: Solution of a problem in concurrent programming control.

### **Sleep:**

A computer program (process, task, or thread) may sleep, which places it into an inactive state for a period of time. Eventually the expiration of an interval timer, or the receipt of a signal or interrupt causes the program to resume execution.

### **Usage**

A typical sleep system call takes a time value as a parameter, specifying the minimum amount of time that the process is to sleep before resuming execution.

### **Priority inversion:**

In computer science, priority inversion is a problematic scenario in scheduling when a higher priority task is indirectly preempted by a lower priority task effectively 'inverting' the relative priorities of the two tasks.

This violates the priority model that high priority tasks can only be prevented from running by higher priority tasks and briefly by low priority tasks which will quickly complete their use of a resource shared by the high and low priority tasks. Example of a priority inversion

Consider there is a task L, with low priority.

### **Action:**

In the Unified Modeling Language, an action is a named element that is the fundamental unit of executable functionality. The execution of an action represents some transformation or processing in the modeled system. An action execution represents the run-time behavior of executing an action within a specific behavior execution.

### **Wait:**

In modern computer operating systems, a process may wait on another process to complete its execution. In most systems, a parent process can create an independently executing child process. The parent process may then issue a wait system call, which suspends the execution of the parent process while the child executes.

### **Message passing:**

Message passing in computer science is a form of communication used in parallel computing, object-oriented programming, and interprocess communication. In this model, processes or objects can send and receive messages (comprising zero or more bytes, complex data structures, or even segments of code) to other processes. By waiting for messages, processes can also synchronize.

### **Interface:**

An interface in the Java programming language is an abstract type that is used to specify an interface (in the generic sense of the term) that classes must implement. Interfaces are declared using the keyword, and may only contain method signature and constant declarations (variable declarations that are declared to be both and ). An interface may never contain method definitions.

### **Turnaround time:**

In Computing, Turnaround time is the total time taken between the submission of a program/process/thread/task(Linux) for execution and the return of the complete output to the customer/user. It may vary for various programming languages depending on the

developer of the software or the program.

Turnaround time is one of the metrics used to evaluate operating system scheduling algorithms.

### **ConTeXt:**

ConTeXt is a general-purpose document processor. It is especially suited for structured documents, automated document production, very fine typography, and multi-lingual typesetting. It is based in part on the TeX typesetting system, and uses a document markup language for manuscript preparation.

### **Context switch:**

A context switch is the computing process of storing and restoring the state (context) of a CPU so that execution can be resumed from the same point at a later time. This enables multiple processes to share a single CPU. The context switch is an essential feature of a multitasking operating system. Context switches are usually computationally intensive and much of the design of operating systems is to optimize the use of context switches.

### **round-robin:**

In computing, round-robin describes a method of choosing a resource for a task from a list of available ones, usually for the purposes of load balancing. Such may be distribution of incoming requests to a number of processors, worker threads or servers. As the basic algorithm, the scheduler selects a resource pointed to by a counter from a list, after which the counter is incremented and if the end is reached, returned to the beginning of the list.

### **Queue:**

In computer science, a queue ( ) is a particular kind of abstract data type or collection in which the entities in the collection are kept in order and the principal operations on the collection are the addition of entities to the rear terminal position and removal of entities from the front terminal position. This makes the queue a First-In-First-Out (FIFO) data structure. In a FIFO data structure, the first element added to the queue will be the first one to be removed.

### **lottery scheduling:**

Lottery Scheduling is a probabilistic scheduling algorithm for processes in an operating system. Processes are each assigned some number of lottery tickets, and the scheduler



draws a random ticket to select the next process. The distribution of tickets need not be uniform; granting a process more tickets provides it a relative higher chance of selection.

### **Fair-share scheduling:**

Fair-share scheduling is a scheduling strategy for computer operating systems in which the CPU usage is equally distributed among system users or groups, as opposed to equal distribution among processes.

For example, if four users (A,B,C,D) are concurrently executing one process each, the scheduler will logically divide the available CPU cycles such that each user gets 25% of the whole ( $100\% / 4 = 25\%$ ). If user B starts a second process, each user will still receive 25% of the total cycles, but each of user B's processes will now use 12.5%.

### **dining philosophers problem:**

In computer science, the dining philosophers problem is an example problem often used in concurrent algorithm design to illustrate synchronization issues and techniques for resolving them.

It was originally formulated in 1965 by Edsger Dijkstra as a student exam exercise, in terms of computers competing for access to tape drive peripherals. Soon after, Tony Hoare gave the problem its present formulation.



## **CHAPTER QUIZ: KEY TERMS, PEOPLE, PLACES, CONCEPTS**

---

1. A multiprocessor is a tightly coupled computer system having two or more processing units (Multiple Processors) each sharing main memory and peripherals, in order to simultaneously process programs.

Sometimes the term Multiprocessor is confused with the term Multiprocessing.

While Multiprocessing is a type of 'processing' in which two or more processors work together to 'process more than one program simultaneously', the term Multiprocessor is referred to the hardware architecture that allows multiprocessing.

- a. Multithreading
- b. Multiprocessor
- c. Parallel Element Processing Ensemble
- d. Parallel slowdown

2. Computer multiprogramming is the allocation of a computer system and its resources to more than one concurrent application, job or user ('program' in this nomenclature).

Initially, this technology was sought in order to optimize use of a computer system, since time and processing resources were often wasted when a single job waited for human interaction was developed as a feature of operating systems in the late 1950s and came into common use in mainframe computing in the mid- to late 1960s. This followed the development of hardware systems that possessed the requisite circuit logic and instruction sets to facilitate the transfer of control between the operating system and one or more independent applications, users or job streams.

- a. multiprogramming
- b. register renaming
- c. Rensselaer Polytechnic
- d. Parallel slowdown

3. The `chown` command (abbreviation for change owner) is used on Unix-like systems to change the owner of a file. In most implementations, it can only be executed by the superuser, to prevent users simply changing ownership of files that aren't theirs to access them. Unprivileged (regular) users who wish to change the group of a file that they own may use `chgrp`.

- a. Rensselaer Polytechnic
- b. Chown
- c. Rensselaer Polytechnic Institute
- d. Parallel slowdown

4. In Unix and other multitasking computer operating systems, a daemon ( 'de?m?n or 'di? m?n) is a computer program that runs as a background process, rather than being under the direct control of an interactive user. Typically daemon names end with the letter d: for example, `syslogd` is the daemon that implements the system logging facility and `sshd` is a daemon that services incoming SSH connections.

In a Unix environment, the parent process of a daemon is often, but not always, the `init` process.

- a. Data center

- b. Daemon
- c. Database server
- d. DHCPD

5. On many computer operating systems, a computer process terminates its execution by making an exit system call. More generally, an exit in a multithreading environment means that a thread of execution has stopped running. The operating system reclaims resources (memory, files, etc).

- a. Initng
- b. Exit
- c. Cedega
- d. CinePaint

**ANSWER KEY**



## **ANSWER KEY**

1. b

2. a

3. b

4. b

5. b

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# Chapter 3. MEMORY MANAGEMENT



## CHAPTER OUTLINE: KEY TERMS, PEOPLE, PLACES, CONCEPTS

---

- memory hierarchy
- virtual memory
- Symbian
- Bitmap
- Free list
- Memory management unit
- virtual address space
- Address space
- Frame
- page fault
- page table
- dirty bit
- translation lookaside buffer
- page replacement algorithm
- Linux
- SCSI

- | Locality of reference
- | Working set
- | I-Space
- | Data
- | Chown
- | copy-on-write
- | FIFO
- | position-independent code
- | CODE
- | Daemon
- | Interface
- | Distributed shared memory
- | Shared memory
- | Directory



## **CHAPTER HIGHLIGHTS: KEY TERMS, PEOPLE, PLACES, CONCEPTS**

---

### **memory hierarchy:**

The term memory hierarchy is used in computer architecture when discussing performance issues in computer architectural design, algorithm predictions, and the lower level programming constructs such as involving locality of reference. A 'memory hierarchy' in computer storage distinguishes each level in the 'hierarchy' by response time. Since response time, complexity, and capacity are related, the levels may also be distinguished by the controlling technology.

### **virtual memory:**

In computing, virtual memory is a memory management technique developed for multitasking kernels. This technique virtualizes a computer architecture's various forms of computer data storage (such as random-access memory and disk storage), allowing a program to be designed as though there is only one kind of memory, 'virtual' memory, which behaves like directly addressable read/write memory (RAM).

Most modern operating systems that support virtual memory also run each process in its own dedicated address space.

### **Symbian:**

Symbian is a mobile operating system (OS) and computing platform designed for smartphones and currently maintained by Accenture. The Symbian platform is the successor to Symbian OS and Nokia Series 60; unlike Symbian OS, which needed an additional user interface system, Symbian includes a user interface component based on S60 5th Edition. The latest version, Symbiansq3, was officially released in Q4 2010, first used in the Nokia N8. In May 2011 an update, Symbian Anna, was officially announced, followed by Nokia Belle (previously Symbian Belle) in August 2011.

### **Bitmap:**

In computer graphics, a bitmap is a type of memory organization or image file format used to store digital images. The term bitmap comes from the computer programming terminology, meaning just a map of bits, a spatially mapped array of bits. Now, along with pixmap, it commonly refers to the similar concept of a spatially mapped array of pixels.

**Free list:**

A free list is a data structure used in a scheme for dynamic memory allocation. It operates by connecting unallocated regions of memory together in a linked list, using the first word of each unallocated region as a pointer to the next. It's most suitable for allocating from a memory pool, where all objects have the same size.

**Memory management unit:**

A memory management unit sometimes called paged memory management unit is a computer hardware component responsible for handling accesses to memory requested by the CPU. Its functions include translation of virtual addresses to physical addresses (i.e., virtual memory management), memory protection, cache control, bus arbitration and in simpler computer architectures (especially 8-bit systems) bank switching.

**How it works**

Modern Memory management units typically divide the virtual address space (the range of addresses used by the processor) into pages, each having a size which is a power of 2, usually a few kilobytes, but they may be much larger. The bottom n bits of the address (the offset within a page) are left unchanged.

**virtual address space:**

In computing, virtual address space is a memory mapping mechanism available in modern operating systems such as OpenVMS, UNIX, Linux, and Windows NT. This is beneficial for different purposes, one is security through process isolation. An address generated by the process is called logical address (virtual address) and it is mapped to the virtual address space.

**Overview**

Virtual memory is easiest to comprehend if one thinks in terms of the virtual address space, and not the physical memory of the machine nor the size of its page file.

**Address space:**

In computing, an address space defines a range of discrete addresses, each of which may correspond to a network host, peripheral device, disk sector, a memory cell or other logical or physical entity.

**Overview**

Address spaces are created by combining enough uniquely identified qualifiers to make an address unambiguous (within a particular address space). For a person's physical address, the address space would be a combination of locations, such as a neighborhood, town, city, or country.

### **Frame:**

In computer networking and telecommunication, a frame is a digital data transmission unit or data packet that includes frame synchronization, i.e. a sequence of bits or symbols making it possible for the receiver to detect the beginning and end of the packet in the stream of symbols or bits. If a receiver is connected to the system in the middle of a frame transmission, it ignores the data until it detects a new frame synchronization sequence.

In computer networking, a frame is a data packet on the Layer 2 of the OSI model.

### **page fault:**

A page fault is a trap to the software raised by the hardware when a program accesses a page that is mapped in the virtual address space, but not loaded in physical memory. In the typical case the operating system tries to handle the page fault by making the required page accessible at a location in physical memory or kills the program in the case of an illegal access. The hardware that detects a page fault is the memory management unit in a processor.

### **page table:**

A page table is the data structure used by a virtual memory system in a computer operating system to store the mapping between virtual addresses and physical addresses. Virtual addresses are those unique to the accessing process. Physical addresses are those unique to the hardware, i.e., RAM.

### **Role of the page table**

In operating systems that use virtual memory, every process is given the impression that it is working with large, contiguous sections of memory.

### **dirty bit:**

The computer hardware concept of a Dirty Bit can be used when discussing the CPU cache or Page replacement algorithms of an operating system.



## Page Replacement

When speaking about page replacement, each page (frame) may have a modify bit associated with it in the hardware. The dirty bit for a page is set by the hardware whenever any word or byte in the page is written into, indicating that the page has been modified.

### **translation lookaside buffer:**

A translation lookaside buffer is a cache that memory management hardware uses to improve virtual address translation speed. All current desktop, notebook, and server processors use a translation lookaside buffer to map virtual and physical address spaces, and it is nearly always present in any hardware which utilizes virtual memory.

The translation lookaside buffer is typically implemented as content-addressable memory (CAM).

### **page replacement algorithm:**

In a computer operating system that uses paging for virtual memory management, page replacement algorithms decide which memory pages to page out (swap out, write to disk) when a page of memory needs to be allocated. Paging happens when a page fault occurs and a free page cannot be used to satisfy the allocation, either because there are none, or because the number of free pages is lower than some threshold.

When the page that was selected for replacement and paged out is referenced again it has to be paged in (read in from disk), and this involves waiting for I/O completion.

### **Linux:**

Linux is a Unix-like computer operating system assembled under the model of free and open source software development and distribution. The defining component of Linux is the Linux kernel, an operating system kernel first released 5 October 1991 by Linus Torvalds.

Linux was originally developed as a free operating system for Intel x86-based personal computers.

**SCSI:**

SCSI (SCSI -ee) is a set of standards for physically connecting and transferring data between computers and peripheral devices. The SCSI standards define commands, protocols, and electrical and optical interfaces. SCSI is most commonly used for hard disks and tape drives, but it can connect a wide range of other devices, including scanners and CD drives, although not all controllers can handle all devices.

**Locality of reference:**

In computer science, locality of reference, is the phenomenon of the same value or related storage locations being frequently accessed. There are two basic types of reference locality. Temporal locality refers to the reuse of specific data and/or resources within relatively small time durations.

**Working set:**

Working set is a concept in computer science which defines what memory a process requires in a given time interval.

**Definition**

Peter Denning (1968) defines 'the working set of information  $W(t, \tau)$  of a process at time  $t$  to be the collection of information referenced by the process during the process time interval  $(t - \tau, t)$ '. Typically the units of information in question are considered to be memory pages.

**I-Space:**

The Information Space, or I-Space was developed by Max Boisot as a conceptual framework relating the degree of structure of knowledge (i.e. its level of codification and abstraction) to its diffusibility as that knowledge develops.

This results in four different types of knowledge. •Public knowledge, such as textbooks and newspapers, which is codified and diffused. •Proprietary knowledge, such as patents and official secrets, which is codified but not diffused.

**Data:**

In computer science, data ( 'de?t?-t? or 'dæt?) is information in a form suitable for use

with a computer. Data is often distinguished from programs. A program is a sequence of instructions that detail a task for the computer to perform.

### **Chown:**

The chown command (abbreviation for change owner) is used on Unix-like systems to change the owner of a file. In most implementations, it can only be executed by the superuser, to prevent users simply changing ownership of files that aren't theirs to access them. Unprivileged (regular) users who wish to change the group of a file that they own may use chgrp.

### **copy-on-write:**

Copy-on-write is an optimization strategy used in computer programming. The fundamental idea is that if multiple callers ask for resources which are initially indistinguishable, they can all be given pointers to the same resource. This function can be maintained until a caller tries to modify its 'copy' of the resource, at which point a true private copy is created to prevent the changes becoming visible to everyone else.

### **FIFO:**

FIFO is an acronym for First In, First Out, an abstraction related to ways of organizing and manipulation of data relative to time and prioritization. This expression describes the principle of a queue processing technique or servicing conflicting demands by ordering process by first-come, first-served (FCFS) behaviour: where the persons leave the queue in the order they arrive, or waiting one's turn at a traffic control signal.

FCFS is also the jargon term for the FIFO operating system scheduling algorithm, which gives every process CPU time in the order they come.

### **position-independent code:**

In computing, position-independent code or position-independent executable (PIE) is a body of machine code that, being placed somewhere in the primary memory, executes properly regardless of its absolute address. position independent code is commonly used for shared libraries, so that the same library code can be loaded in a location in each program address space where it will not overlap any other uses of memory (for example, other shared libraries). position independent code was also used on older computer systems lacking an MMU, so that the operating system could keep applications away from each other even within the single address space of an MMU-less system.

**CODE:**

CODE (computationally oriented display environment) is a visual programming language and system for parallel programming, which lets users compose sequential programs into parallel programs.

**Daemon:**

In Unix and other multitasking computer operating systems, a daemon ( 'de?m?n or 'di? m?n) is a computer program that runs as a background process, rather than being under the direct control of an interactive user. Typically daemon names end with the letter d: for example, syslogd is the daemon that implements the system logging facility and sshd is a daemon that services incoming SSH connections.

In a Unix environment, the parent process of a daemon is often, but not always, the init process.

**Interface:**

An interface in the Java programming language is an abstract type that is used to specify an interface (in the generic sense of the term) that classes must implement. Interfaces are declared using the keyword, and may only contain method signature and constant declarations (variable declarations that are declared to be both and ). An interface may never contain method definitions.

**Distributed shared memory:**

Distributed Shared Memory in Computer Architecture is a form of memory architecture where the (physically separate) memories can be addressed as one (logically shared) address space. Here, the term shared does not mean that there is a single centralized memory but shared essentially means that the address space is shared (same physical address on two processors refers to the same location in memory). Alternatively in computer science it is known as (DGAS), a concept that refers to a wide class of software and hardware implementations, in which each node of a cluster has access to shared memory in addition to each node's non-shared private memory.

**Shared memory:**

In computing, shared memory is memory that may be simultaneously accessed by multiple programs with an intent to provide communication among them or avoid redundant copies. Shared memory is an efficient means of passing data between

programs. Depending on context, programs may run on a single processor or on multiple separate processors.

### **Directory:**

Generally, a directory, as used in computing and telephony, refers to a repository or database of information which is heavily optimized for reading, under the assumption that data updates are very rare compared to data reads. Commonly, a directory supports search and browsing in addition to simple lookups.

A website which offer access to a categorized listing of other websites optimized for lookup, search, or browsing is a directory, a web directory.

### **call gate:**

A call gate is a mechanism in Intel's x86 architecture for changing the privilege level of the CPU when it executes a predefined function call using a CALL FAR instruction.

### **Overview**

Call gates are intended to allow less privileged code to call code with a higher privilege level. This type of mechanism is essential in modern operating systems that employ memory protection since it allows user applications to use kernel functions and system calls in a way that can be controlled by the operating system.



## CHAPTER QUIZ: KEY TERMS, PEOPLE, PLACES, CONCEPTS

---

1. The term memory hierarchy is used in computer architecture when discussing performance issues in computer architectural design, algorithm predictions, and the lower level programming constructs such as involving locality of reference. A 'memory hierarchy' in computer storage distinguishes each level in the 'hierarchy' by response time. Since response time, complexity, and capacity are related, the levels may also be distinguished by the controlling technology.

- a. Rensselaer Polytechnic
- b. memory hierarchy
- c. Franklin Institute
- d. Virginia State

2. In computing, virtual memory is a memory management technique developed for multitasking kernels. This technique virtualizes a computer architecture's various forms of computer data storage (such as random-access memory and disk storage), allowing a program to be designed as though there is only one kind of memory, 'virtual' memory, which behaves like directly addressable read/write memory (RAM).

Most modern operating systems that support virtual memory also run each process in its own dedicated address space.

- a. Demand paging
- b. virtual memory

c. page table

d. virtual address space

3. Symbian is a mobile operating system (OS) and computing platform designed for smartphones and currently maintained by Accenture. The Symbian platform is the successor to Symbian OS and Nokia Series 60; unlike Symbian OS, which needed an additional user interface system, Symbian includes a user interface component based on S60 5th Edition. The latest version, Symbiansq3, was officially released in Q4 2010, first used in the Nokia N8. In May 2011 an update, Symbian Anna, was officially announced, followed by Nokia Belle (previously Symbian Belle) in August 2011.

a. Rensselaer Polytechnic

b. Symbian

c. page table

d. virtual address space

4. In computer graphics, a bitmap is a type of memory organization or image file format used to store digital images. The term bitmap comes from the computer programming terminology, meaning just a map of bits, a spatially mapped array of bits. Now, along with pixmap, it commonly refers to the similar concept of a spatially mapped array of pixels.

a. Rensselaer Polytechnic

b. Memory management unit

c. page table

d. Bitmap



5. A free list is a data structure used in a scheme for dynamic memory allocation. It operates by connecting unallocated regions of memory together in a linked list, using the first word of each unallocated region as a pointer to the next. It's most suitable for allocating from a memory pool, where all objects have the same size.

- a. paging
- b. Free list
- c. memory segmentation
- d. pointer swizzling

**ANSWER KEY**



## **ANSWER KEY**

1. b

2. b

3. b

4. d

5. b

---

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**Chapter 4. FILE SYSTEMS**



## CHAPTER OUTLINE: KEY TERMS, PEOPLE, PLACES, CONCEPTS

---

- FIFO
- False sharing
- Block
- Directory
- Linux
- Sequential access
- Random access
- System call
- File attribute
- Chown
- PATH
- Working directory
- boot sector
- Hard link
- Master boot record
- symbolic link

- Layout
- linked list
- File Allocation Table
- Symbian
- virtual file system





## **CHAPTER HIGHLIGHTS: KEY TERMS, PEOPLE, PLACES, CONCEPTS**

---

### **FIFO:**

FIFO is an acronym for First In, First Out, an abstraction related to ways of organizing and manipulation of data relative to time and prioritization. This expression describes the principle of a queue processing technique or servicing conflicting demands by ordering process by first-come, first-served (FCFS) behaviour: where the persons leave the queue in the order they arrive, or waiting one's turn at a traffic control signal.

FCFS is also the jargon term for the FIFO operating system scheduling algorithm, which gives every process CPU time in the order they come.

### **False sharing:**

In computer science, false sharing is a performance degrading usage pattern that can arise in systems with distributed, coherent caches at the size of the smallest resource block managed by the caching mechanism. When a system participant attempts to periodically access data that will never be altered by another party, but that data shares a cache block with data that is altered, the caching protocol may force the first participant to reload the whole unit despite a lack of logical necessity. The caching system is unaware of activity within this block and forces the first participant to bear the caching system overhead required by true shared access of a resource.

### **Block:**

In computing (specifically data transmission and data storage), a block is a sequence of bytes or bits, having a nominal length (a block size). Data thus structured are said to be blocked. The process of putting data into blocks is called blocking.

### **Directory:**

Generally, a directory, as used in computing and telephony, refers to a repository or database of information which is heavily optimized for reading, under the assumption that data updates are very rare compared to data reads. Commonly, a directory supports search and browsing in addition to simple lookups.

A website which offer access to a categorized listing of other websites optimized for lookup, search, or browsing is a directory, a web directory.

### **Linux:**

Linux is a Unix-like computer operating system assembled under the model of free and open source software development and distribution. The defining component of Linux is the Linux kernel, an operating system kernel first released 5 October 1991 by Linus Torvalds.

Linux was originally developed as a free operating system for Intel x86-based personal computers.

### **Sequential access:**

In computer science, sequential access means that a group of elements (e.g. data in a memory array or a disk file or on magnetic tape data storage) is accessed in a predetermined, ordered sequence. Sequential access is sometimes the only way of accessing the data, for example if it is on a tape. It may also be the access method of choice, for example if we simply want to process a sequence of data elements in order.

### **Random access:**

In computer science, random access is the ability to access an element at an arbitrary position in a sequence in equal time, independent of sequence size. The position is arbitrary in the sense that it is unpredictable, thus the use of the term 'random' in 'random access'. The opposite is sequential access, where a remote element takes longer time to access.

### **System call:**

In computing, a system call is how a program requests a service from an operating system's kernel. This may include hardware related services (e.g. accessing the hard disk), creating and executing new processes, and communicating with integral kernel services (like scheduling). System calls provide an essential interface between a process and the operating system.

### **File attribute:**

A file attribute is metadata that describes or is associated with a computer file. For

example, an operating system often keeps track of the date a file was created and last modified, as well as the file's size and extension (and what application to open it with). File permissions are also kept track of.

### **Chown:**

The `chown` command (abbreviation for change owner) is used on Unix-like systems to change the owner of a file. In most implementations, it can only be executed by the superuser, to prevent users simply changing ownership of files that aren't theirs to access them. Unprivileged (regular) users who wish to change the group of a file that they own may use `chgrp`.

### **PATH:**

`PATH` is an environment variable on Unix-like operating systems, DOS, OS/2, and Microsoft Windows, specifying a set of directories where executable programs are located. In general, each executing process or user session has its own `PATH` setting.

### **Unix and Unix-like**

On POSIX and Unix-like operating systems, the variable is specified as a list of one or more directory names separated by colon (:) characters.

### **Working directory:**

In computing, the working directory of a process is a directory of a hierarchical file system, if any, dynamically associated with each process. When the process refers to a file using a simple file name or relative path (as opposed to a file designated by a full path from a root directory), the reference is interpreted relative to the current working directory of the process. So for example a process with working directory `/rabbit-hats` that asks to create the file `foo.txt` will end up creating the file `/rabbit-hats/foo.txt`.

### **boot sector:**

A boot sector is a region of a hard disk, floppy disk, optical disc, or other data storage device that contains machine code to be loaded into random-access memory (RAM) by a computer system's built-in firmware. The purpose of a boot sector is to allow the boot process of a computer to load a program (usually, but not necessarily, an operating system) stored on the same storage device. The location and size of the boot sector is specified by the design of the computing platform.

### **Hard link:**

In computing, a hard link is a directory entry that associates a name with a file on a file system. (A directory is itself a special kind of file that contains a list of such entries). The term is used in file systems which allow multiple hard links to be created for the same file.

### **Master boot record:**

A master boot record is a type of boot sector, a data sector at the beginning of many types of computer mass storage. It is most common on disk drives large enough to be partitioned, hence it is not usually present on floppy disks or small thumbdrives.

The master boot record was popularized by the IBM Personal Computer.

### **symbolic link:**

In computing, a symbolic link is a special type of file that contains a reference to another file or directory in the form of an absolute or relative path and that affects pathname resolution. Symbolic links were already present by 1978 in mini-computer operating systems from DEC and Data General's RDOS. Today they are supported by the POSIX operating-system standard, most Unix-like operating systems such as FreeBSD, GNU/Linux, and Mac OS X, and also Windows operating systems such as Windows Vista, Windows 7 and to some degree in Windows 2000 and Windows XP in the form of Shortcut files.

Symbolic links operate transparently for most operations: programs which read or write to files named by a symbolic link will behave as if operating directly on the target file.

### **Layout:**

In computing, layout is the process of calculating the position of objects in space subject to various constraints. This functionality can be part of an application or packaged as a reusable component or library.

Web browser engines are sometimes called layout engines.

### **linked list:**

In computer science, a linked list is a data structure consisting of a group of nodes which

together represent a sequence. Under the simplest form, each node is composed of a datum and a reference (in other words, a link) to the next node in the sequence; more complex variants add additional links. This structure allows for efficient insertion or removal of elements from any position in the sequence.

### **File Allocation Table:**

File Allocation Table is the name of a computer file system architecture and a family of industry standard file systems utilizing it.

The FAT file system is technically relatively simple yet robust. It offers reasonably good performance even in light-weight implementations and is therefore widely adopted and supported by virtually all existing operating systems for personal computers.

### **Symbian:**

Symbian is a mobile operating system (OS) and computing platform designed for smartphones and currently maintained by Accenture. The Symbian platform is the successor to Symbian OS and Nokia Series 60; unlike Symbian OS, which needed an additional user interface system, Symbian includes a user interface component based on S60 5th Edition. The latest version, Symbiansq3, was officially released in Q4 2010, first used in the Nokia N8. In May 2011 an update, Symbian Anna, was officially announced, followed by Nokia Belle (previously Symbian Belle) in August 2011.

### **virtual file system:**

A virtual file system or virtual filesystem switch is an abstraction layer on top of a more concrete file system. The purpose of a virtual file system is to allow client applications to access different types of concrete file systems in a uniform way. A virtual file system can, for example, be used to access local and network storage devices transparently without the client application noticing the difference.

### **Disk quota:**

A disk quota is a limit set by a system administrator that restricts certain aspects of file system usage on modern operating systems. The function of using disk quotas is to allocate limited disk space in a reasonable way.

#### **Types of quotas**

There are two basic types of disk quotas.



## CHAPTER QUIZ: KEY TERMS, PEOPLE, PLACES, CONCEPTS

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1. FIFO is an acronym for First In, First Out, an abstraction related to ways of organizing and manipulation of data relative to time and prioritization. This expression describes the principle of a queue processing technique or servicing conflicting demands by ordering process by first-come, first-served (FCFS) behaviour: where the persons leave the queue in the order they arrive, or waiting one's turn at a traffic control signal.

FCFS is also the jargon term for the FIFO operating system scheduling algorithm, which gives every process CPU time in the order they come.

- a. LIFO
- b. FIFO
- c. Top-nodes algorithm
- d. Weighted round robin

2. In computer science, false sharing is a performance degrading usage pattern that can arise in systems with distributed, coherent caches at the size of the smallest resource block managed by the caching mechanism. When a system participant attempts to periodically access data that will never be altered by another party, but that data shares a cache block with data that is altered, the caching protocol may force the first participant to reload the whole unit despite a lack of logical necessity. The caching system is unaware of activity within this block and forces the first participant to bear the caching system overhead required by true shared access of a resource.

- a. False sharing
- b. Scheduling



c. Top-nodes algorithm

d. Weighted round robin

3. In computing (specifically data transmission and data storage), a block is a sequence of bytes or bits, having a nominal length (a block size). Data thus structured are said to be blocked. The process of putting data into blocks is called blocking.

a. Werner Buchholz

b. Block

c. Field specification

d. Frame

4. Generally, a directory, as used in computing and telephony, refers to a repository or database of information which is heavily optimized for reading, under the assumption that data updates are very rare compared to data reads. Commonly, a directory supports search and browsing in addition to simple lookups.

A website which offer access to a categorized listing of other websites optimized for lookup, search, or browsing is a directory, a web directory.

a. Mobile database

b. Directory

c. Composite data type

d. Decimal data type

5. Linux is a Unix-like computer operating system assembled under the model of free and open source software development and distribution. The defining component of Linux is the Linux kernel, an operating system kernel first released 5 October 1991 by Linus Torvalds.

Linux was originally developed as a free operating system for Intel x86-based personal computers.

a. BioLinux

b. Linux

c. BlackDog

d. Bodhi Linux

**ANSWER KEY**



## **ANSWER KEY**

1. b

2. a

3. b

4. b

5. b

---

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**Chapter 5. INPUT/OUTPUT**



## CHAPTER OUTLINE: KEY TERMS, PEOPLE, PLACES, CONCEPTS

---

- Block
- CODE
- direct memory access
- cycle stealing
- interrupt vector
- Linux
- System call
- Symbian
- Interrupt handler
- Wait
- Device driver
- Circular buffer
- Daemon
- Directory
- serial ATA
- Seeks



- Logical block addressing
- volume table of contents
- Disk formatting
- hardware abstraction
- abstraction layer
- High-level architecture
- Master boot record
- shortest seek first
- Elevator algorithm
- stable storage
- Watchdog timer
- Terminal
- escape character
- X Window System
- Xlib
- X window manager
- Graphical user interface
- Interface
- VRAM

• Hungarian notation

• Notation

• Graphics device interface

• Bitmap

• Thin client



## **CHAPTER HIGHLIGHTS: KEY TERMS, PEOPLE, PLACES, CONCEPTS**

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### **Block:**

In computing (specifically data transmission and data storage), a block is a sequence of bytes or bits, having a nominal length (a block size). Data thus structured are said to be blocked. The process of putting data into blocks is called blocking.

### **CODE:**

CODE (computationally oriented display environment) is a visual programming language and system for parallel programming, which lets users compose sequential programs into parallel programs.

### **direct memory access:**

Direct memory access is a feature of modern computers that allows certain hardware subsystems within the computer to access system memory independently of the central processing unit (CPU).

Without direct memory access, when the CPU is using programmed input/output, it is typically fully occupied for the entire duration of the read or write operation, and is thus unavailable to perform other work. With direct memory access, the CPU initiates the transfer, does other operations while the transfer is in progress, and receives an interrupt from the direct memory access controller when the operation is done.

### **cycle stealing:**

Cycle stealing is used to describe the 'stealing' of a single CPU cycle, for example, to allow a DMA controller to perform a DMA operation. This is opposed to block operation where a DMA controller would request a bus, hold it for a complete transaction (typically 16-32 bytes but could last much longer) before releasing to a CPU.

Cycle stealing generally occurs when the entire DMA transfer of data is finished, the DMA controller interrupts the CPU. Modern architecture

This term is less common in modern computer architecture (say above 66-100 MHz), where the various external buses and controllers generally run at different rates, and CPU internal operations are no longer closely coupled to I/O bus operations. Examples in actual computer systems

Cycle stealing has been the cause of major performance degradation on machine such as the Sinclair QL, where, for economy reasons, the video RAM was not dual access.

### **interrupt vector:**

An interrupt vector is the memory address of an interrupt handler, or an index into an array called an interrupt vector table that contains the memory addresses of interrupt handlers. When an interrupt is generated, the Operating System saves its execution state via a context switch, and begins execution of the interrupt handler at the interrupt vector.

### **Linux:**

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Linux was originally developed as a free operating system for Intel x86-based personal computers.

### **System call:**

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followed by Nokia Belle (previously Symbian Belle) in August 2011.

**Interrupt handler:**

An interrupt handler, is a callback subroutine in microcontroller firmware, operating system or device driver whose execution is triggered by the reception of an interrupt. Interrupt handlers have a multitude of functions, which vary based on the reason the interrupt was generated and the speed at which the interrupt handler completes its task.

An interrupt handler is a low-level counterpart of event handlers.

**Wait:**

In modern computer operating systems, a process may wait on another process to complete its execution. In most systems, a parent process can create an independently executing child process. The parent process may then issue a wait system call, which suspends the execution of the parent process while the child executes.

**Device driver:**

In computing, a device driver is a computer program allowing higher-level computer programs to interact with a hardware device.

A driver typically communicates with the device through the computer bus or communications subsystem to which the hardware connects. When a calling program invokes a routine in the driver, the driver issues commands to the device.

**Circular buffer:**

A circular buffer, cyclic buffer or ring buffer is a data structure that uses a single, fixed-size buffer as if it were connected end-to-end. This structure lends itself easily to buffering data streams.

Uses

An example that could possibly use an overwriting circular buffer is with multimedia.

**Daemon:**

In Unix and other multitasking computer operating systems, a daemon ( 'de?m?n or 'di? m?n) is a computer program that runs as a background process, rather than being under the direct control of an interactive user. Typically daemon names end with the letter d: for example, syslogd is the daemon that implements the system logging facility and sshd is a daemon that services incoming SSH connections.

In a Unix environment, the parent process of a daemon is often, but not always, the init process.

### **Directory:**

Generally, a directory, as used in computing and telephony, refers to a repository or database of information which is heavily optimized for reading, under the assumption that data updates are very rare compared to data reads. Commonly, a directory supports search and browsing in addition to simple lookups.

A website which offer access to a categorized listing of other websites optimized for lookup, search, or browsing is a directory, a web directory.

### **serial ATA:**

Serial ATA is a computer bus interface for connecting host bus adapters to mass storage devices such as hard disk drives and optical drives. Serial ATA was designed to replace the older parallel ATA (PATA) standard (often called by the old name IDE), offering several advantages over the older interface: reduced cable size and cost (7 conductors instead of 40), native hot swapping, faster data transfer through higher signalling rates, and more efficient transfer through an (optional) I/O queuing protocol.

SATA host-adapters and devices communicate via a high-speed serial cable over two pairs of conductors.

### **Seeks:**

Seeks is an open source project licensed under the Affero General Public License version 3 (AGPLv3). It exists to create an alternative search engine to the current commercially available market leading search engines which is driven by user concerns rather than corporate interests. The original manifesto was created by Emmanuel Benazera and Sylvio Drouin and published in October 2006. Since then, the project has been under

active development and stable releases of the engine are available for public use in addition to various distributions of the source code for adventurous users.

### **Logical block addressing:**

Logical block addressing is a common scheme used for specifying the location of blocks of data stored on computer storage devices, generally secondary storage systems such as hard disks.

Logical block addressing is a particularly simple linear addressing scheme; blocks are located by an integer index, with the first block being Logical block addressing 0, the second Logical block addressing 1, and so on.

IDE standard included 22-bit Logical block addressing as an option, which was further extended to 28-bit with the release of ATA-1 (1994) and to 48-bit with the release of ATA-6 (2003).

### **volume table of contents:**

In the IBM mainframe storage architecture, Volume Table Of Contents, is a data structure, that provides a way of locating the data sets that reside on a particular disk volume. It can reside within the first 64K tracks on the volume, and lists the names of each data set on the volume as well as size, location, and permissions. Additionally, it contains an entry for every area of contiguous free space on the volume.

### **Disk formatting:**

Disk formatting is the process of preparing a hard disk drive or flexible disk medium for data storage. In some cases, the formatting operation may also create one or more new file systems. The formatting process that performs basic medium preparation is often referred to as 'low-level formatting.' The term 'high-level formatting' most often refers to the process of generating a new file system.

### **hardware abstraction:**

Hardware abstractions are sets of routines in software that emulate some platform-specific details, giving programs direct access to the hardware resources.

They often allow programmers to write device-independent, high performance



applications by providing standard Operating System (OS) calls to hardware. The process of abstracting pieces of hardware is often done from the perspective of a CPU. Each type of CPU has a specific instruction set architecture or ISA. The ISA represents the primitive operations of the machine that are available for use by assembly programmers and compiler writers.

### **abstraction layer:**

An abstraction layer is a way of hiding the implementation details of a particular set of functionality. Software models that use layers of abstraction include the OSI 7-layer model for computer network protocols, the OpenGL graphics drawing library, and the byte stream input/output (I/O) model originated by Unix and adopted by MSDOS, Linux, and most other modern operating systems.

In the Unix operating system, most types of input and output operations are considered to be streams of bytes being read from a device or being written to a device.

### **High-level architecture:**

A high-level architecture (HLA) is a general purpose architecture for distributed computer simulation systems. Using HLA, computer simulations can interact (that is, to communicate data, and to synchronize actions) with other computer simulations regardless of the computing platforms. The interaction between simulations is managed by a Run-Time Infrastructure (RTI).

### **Master boot record:**

A master boot record is a type of boot sector, a data sector at the beginning of many types of computer mass storage. It is most common on disk drives large enough to be partitioned, hence it is not usually present on floppy disks or small thumbdrives.

The master boot record was popularized by the IBM Personal Computer.

### **shortest seek first:**

Shortest seek first is a secondary storage scheduling algorithm to determine the motion of the disk's arm and head in servicing read and write requests.

Description

This is a direct improvement upon a first-come first-served (FIFO) algorithm. The drive maintains an incoming buffer of requests, and tied with each request is a cylinder number of the request.

### **Elevator algorithm:**

The elevator algorithm is a disk scheduling algorithm to determine the motion of the disk's arm and head in servicing read and write requests.

From an implementation perspective, the drive maintains a buffer of pending read/write requests, along with the associated cylinder number of the request. Lower cylinder numbers indicate that the cylinder is closest to the spindle, and higher numbers indicate the cylinder is further away.

### **stable storage:**

Stable storage is a classification of computer data storage technology that guarantees atomicity for any given write operation and allows software to be written that is robust against some hardware and power failures. To be considered atomic, upon reading back a just written-to portion of the disk, the storage subsystem must return either the write data or the data that was on that portion of the disk before the write operation.

Most computer disk drives are not considered stable storage because they do not guarantee atomic write; an error could be returned upon subsequent read of the disk where it was just written to in lieu of either the new or prior data.

### **Watchdog timer:**

A watchdog timer (timer) is a computer hardware or software timer that triggers a system reset or other corrective action if the main program, due to some fault condition, such as a hang, neglects to regularly service the watchdog (writing a 'service pulse' to it, also referred to as 'kicking the dog', 'petting the dog', 'feeding the watchdog' or 'waking the watchdog'). The intention is to bring the system back from the unresponsive state into normal operation.

Watchdog timers can be more complex, attempting to save debug information onto a persistent medium; i.e. information useful for debugging the problem that caused the fault.

### **Terminal:**

Terminal (also referred to as Terminal.app) is a terminal emulator included in Apple's OS X operating system. It originated in OS X's predecessors, NeXTSTEP and OPENSTEP, and allows the user to interact with the computer through a command line interface. It provides an environment for Unix shells, which, among other things, allow the OS X user to visually interact with the system core.

### **escape character:**

In computing and telecommunication, an escape character is a character which invokes an alternative interpretation on subsequent characters in a character sequence. An escape character is a particular case of metacharacters. Generally, the judgement of whether something is

produces a syntax error, whereas:

produces the intended output.

### **X Window System:**

The X window system is a computer software system and network protocol that provides a basis for graphical user interfaces (GUIs) and rich input device capability for networked computers. It creates a hardware abstraction layer where software is written to use a generalized set of commands, allowing for device independence and reuse of programs on any computer that implements X.

X originated at the Massachusetts Institute of Technology (MIT) in 1984. The current protocol version, X11, appeared in September 1987. The X.Org Foundation leads the X project, with the current reference implementation, X.Org Server, available as free and open source software under the MIT License and similar permissive licenses. Purpose and abilities

X is an architecture-independent system for remote graphical user interfaces and rich input device capabilities which allows many people to share the processing power of a time-sharing computer and to collaborate with each other through client applications running on remote computers.

**Xlib:**

Xlib is an X Window System protocol client library written in the C programming language. It contains functions for interacting with an X server. These functions allow programmers to write programs without knowing the details of the protocol.

**X window manager:**

An X window manager is a window manager which runs on top of the X Window System, a windowing system mainly used on Unix-like systems.

Unlike the Mac OS (Apple Macintosh) and Microsoft Windows platforms (excepting Microsoft Windows explorer.exe shell replacements) which have historically provided a vendor-controlled, fixed set of ways to control how windows and panes display on a screen, and how the user may interact with them, window management for the X Window System was deliberately kept separate from the software providing the graphical display. The user can choose between various third-party window managers, which differ from one another in several ways, including:

- customizability of appearance and functionality:
- textual menus used to start programs and/or change options
- docks and other graphical ways to start programs
- multiple desktops and virtual desktops (desktops larger than the physical monitor size), and pagers to switch between them
- consumption of memory and other system resources
- degree of integration with a desktop environment, which provides a more complete interface to the operating system, and provides a range of integrated utilities and applications.

How X window managers work

When a window manager is running, some kinds of interaction between the X server and its clients are redirected through the window manager.

**Graphical user interface:**

In computing, a graphical user interface is a type of user interface that allows users to interact with electronic devices using images rather than text commands. GUIs can be used in computers, hand-held devices such as MP3 players, portable media players or gaming devices, household appliances and office equipment. A GUI represents the information and actions available to a user through graphical icons and visual indicators such as secondary notation, as opposed to text-based interfaces, typed command labels or text navigation.

**Interface:**

An interface in the Java programming language is an abstract type that is used to specify an interface (in the generic sense of the term) that classes must implement. Interfaces are

declared using the keyword, and may only contain method signature and constant declarations (variable declarations that are declared to be both and ). An interface may never contain method definitions.

### **VRAM:**

VRAM, is a dual-ported variant of dynamic RAM (DRAM), which was once commonly used to store the framebuffer in some graphics adapters.

It was invented by F. Dill, D. Ling and R. Matick at IBM Research in 1980, with a patent issued in 1985 (US Patent 4,541,075). The first commercial use of VRAM was in a high-resolution graphics adapter introduced in 1986 by IBM for the PC/RT system, which set a new standard for graphics displays. Prior to the development of VRAM, dual-ported memory was quite expensive, limiting higher resolution bitmapped graphics to high-end workstations.

### **Hungarian notation:**

Hungarian notation is an identifier naming convention in computer programming, in which the name of a variable or function indicates its type or intended use. There are two types of Hungarian notation: Systems Hungarian notation and Applications Hungarian notation.

Hungarian notation was designed to be language-independent, and found its first major use with the BCPL programming language.

### **Notation:**

The term notation can refer to:

Written communication •Phonographic writing systems, by definition, use symbols to represent components of auditory language, i.e. speech, which in turn refers to things or ideas. The two main kinds of phonographic notational system are the alphabet and syllabary. Some written languages are more consistent in their correlation of written symbol or grapheme and sound or phoneme, and are therefore considered to have better phonemic orthography. •Ideographic writing, by definition, refers to things or ideas independently of their pronunciation in any language.

### **Graphics device Interface:**

A graphics device interface is a subsystem that most operating systems use for representing graphical objects and transmitting them to output devices such as monitors and printers. In most cases, the graphics device interface is only able to draw 2D graphics and simple 3D graphics, in order to make use of more advanced graphics and keep performance, an API such as DirectX or OpenGL needs to be installed.

In Microsoft Windows, the GDI functionality resides in gdi.exe on 16-bit Windows, and gdi32.dll on 32-bit Windows.

### **Bitmap:**

In computer graphics, a bitmap is a type of memory organization or image file format used to store digital images. The term bitmap comes from the computer programming terminology, meaning just a map of bits, a spatially mapped array of bits. Now, along with pixmap, it commonly refers to the similar concept of a spatially mapped array of pixels.

### **Thin client:**

A thin client is a computer or a computer program which depends heavily on some other computer (its server) to fulfill its traditional computational roles. This stands in contrast to the traditional fat client, a computer designed to take on these roles by itself. The exact roles assumed by the server may vary, from providing data persistence (for example, for diskless nodes) to actual information processing on the client's behalf.

### **central processing unit:**

The central processing unit is the portion of a computer system that carries out the instructions of a computer program, to perform the basic arithmetical, logical, and input/output operations of the system. The central processing unit plays a role somewhat analogous to the brain in the computer. The term has been in use in the computer industry at least since the early 1960s.



## CHAPTER QUIZ: KEY TERMS, PEOPLE, PLACES, CONCEPTS

---

1. In computing (specifically data transmission and data storage), a block is a sequence of bytes or bits, having a nominal length (a block size). Data thus structured are said to be blocked. The process of putting data into blocks is called blocking.

- a. Werner Buchholz
- b. Block
- c. Field specification
- d. Frame

2. CODE (computationally oriented display environment) is a visual programming language and system for parallel programming, which lets users compose sequential programs into parallel programs.

- a. Fabrik
- b. CODE
- c. Lava
- d. Lily

3. Direct memory access is a feature of modern computers that allows certain hardware subsystems within the computer to access system memory independently of the central processing unit (CPU).



Without direct memory access, when the CPU is using programmed input/output, it is typically fully occupied for the entire duration of the read or write operation, and is thus unavailable to perform other work. With direct memory access, the CPU initiates the transfer, does other operations while the transfer is in progress, and receives an interrupt from the direct memory access controller when the operation is done.

a. Rensselaer Polytechnic

b. Kyma

c. direct memory access

d. Lily

4. Cycle stealing is used to describe the 'stealing' of a single CPU cycle, for example, to allow a DMA controller to perform a DMA operation. This is opposed to block operation where a DMA controller would request a bus, hold it for a complete transaction (typically 16-32 bytes but could last much longer) before releasing to a CPU.

Cycle stealing generally occurs when the entire DMA transfer of data is finished, the DMA controller interrupts the CPU. Modern architecture

This term is less common in modern computer architecture (say above 66-100 MHz), where the various external buses and controllers generally run at different rates, and CPU internal operations are no longer closely coupled to I/O bus operations. Examples in actual computer systems

Cycle stealing has been the cause of major performance degradation on machine such as the Sinclair QL, where, for economy reasons, the video RAM was not dual access.

a. Vampire tap

b. MISD

c. cycle stealing

d. Rensselaer Polytechnic

5. An interrupt vector is the memory address of an interrupt handler, or an index into an array called an interrupt vector table that contains the memory addresses of interrupt handlers. When an interrupt is generated, the Operating System saves its execution state via a context switch, and begins execution of the interrupt handler at the interrupt vector.

a. Unparser

b. interrupt vector

c. Rensselaer Polytechnic Institute

d. Notification system

**ANSWER KEY**



## **ANSWER KEY**

1. b

2. b

3. c

4. c

5. b

---

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# Chapter 6. DEADLOCKS



## CHAPTER OUTLINE: KEY TERMS, PEOPLE, PLACES, CONCEPTS

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- Linux
- System call
- Ostrich algorithm
- Preemption
- Mutual exclusion
- Wait
- Two-phase locking





## **CHAPTER HIGHLIGHTS: KEY TERMS, PEOPLE, PLACES, CONCEPTS**

---

### **Linux:**

Linux is a Unix-like computer operating system assembled under the model of free and open source software development and distribution. The defining component of Linux is the Linux kernel, an operating system kernel first released 5 October 1991 by Linus Torvalds.

Linux was originally developed as a free operating system for Intel x86-based personal computers.

### **System call:**

In computing, a system call is how a program requests a service from an operating system's kernel. This may include hardware related services (e.g. accessing the hard disk), creating and executing new processes, and communicating with integral kernel services (like scheduling). System calls provide an essential interface between a process and the operating system.

### **Ostrich algorithm:**

In computer science, the ostrich algorithm is a strategy of ignoring potential problems on the basis that they may be exceedingly rare - 'to stick your head in the sand and pretend that there is no problem'. This assumes that it is more cost-effective to allow the problem to occur than to attempt its prevention.

This approach may be used in dealing with deadlocks in concurrent programming if deadlocks are believed to be very rare, and if the cost of detection or prevention is high.

### **Preemption:**

In computing, preemption (more correctly pre-emption) is the act of temporarily interrupting a task being carried out by a computer system, without requiring its cooperation, and with the intention of resuming the task at a later time. Such a change is known as a context switch. It is normally carried out by a privileged task or part of the

system known as a preemptive scheduler, which has the power to preempt, or interrupt, and later resume, other tasks in the system.

### **Mutual exclusion:**

Mutual exclusion, in computer science, refers to the problem of ensuring that no two processes or threads (henceforth referred to only as processes) can be in their critical section at the same time. Here, a critical section refers to a period of time when the process accesses a shared resource, such as shared memory. The problem of mutual exclusion was first identified and solved by Edsger W. Dijkstra in his seminal 1965 paper titled: Solution of a problem in concurrent programming control.

### **Wait:**

In modern computer operating systems, a process may wait on another process to complete its execution. In most systems, a parent process can create an independently executing child process. The parent process may then issue a wait system call, which suspends the execution of the parent process while the child executes.

### **Two-phase locking:**

In databases and transaction processing, two-phase locking is a concurrency control method that guarantees serializability. It is also the name of the resulting set of database transaction schedules (histories). The protocol utilizes locks, applied by a transaction to data, which may block (interpreted as signals to stop) other transactions from accessing the same data during the transaction's life.

### **Chown:**

The chown command (abbreviation for change owner) is used on Unix-like systems to change the owner of a file. In most implementations, it can only be executed by the superuser, to prevent users simply changing ownership of files that aren't theirs to access them. Unprivileged (regular) users who wish to change the group of a file that they own may use chgrp.



## **CHAPTER QUIZ: KEY TERMS, PEOPLE, PLACES, CONCEPTS**

---

1. Linux is a Unix-like computer operating system assembled under the model of free and open source software development and distribution. The defining component of Linux is the Linux kernel, an operating system kernel first released 5 October 1991 by Linus Torvalds.

Linux was originally developed as a free operating system for Intel x86-based personal computers.

a. BioLinux

b. Linux

c. BlackDog

d. Bodhi Linux

2. In computing, a system call is how a program requests a service from an operating system's kernel. This may include hardware related services (e.g. accessing the hard disk), creating and executing new processes, and communicating with integral kernel services (like scheduling). System calls provide an essential interface between a process and the operating system.

a. SystemVerilog DPI

b. System call

c. Telephony Server Application Programming Interface

d. Transport Layer Interface

3. In computer science, the ostrich algorithm is a strategy of ignoring potential problems on the basis that they may be exceedingly rare - 'to stick your head in the sand and pretend that there is no problem'. This assumes that it is more cost-effective to allow the problem to occur than to attempt its prevention.

This approach may be used in dealing with deadlocks in concurrent programming if deadlocks are believed to be very rare, and if the cost of detection or prevention is high.

a. Rensselaer Polytechnic

b. TAO

c. Ostrich algorithm

d. Transport Layer Interface

4. In computing, preemption (more correctly pre-emption) is the act of temporarily interrupting a task being carried out by a computer system, without requiring its cooperation, and with the intention of resuming the task at a later time. Such a change is known as a context switch. It is normally carried out by a privileged task or part of the system known as a preemptive scheduler, which has the power to preempt, or interrupt, and later resume, other tasks in the system.

a. Process

b. Preemption

c. Restricted shell

d. Segmentation fault

5. Mutual exclusion, in computer science, refers to the problem of ensuring that no two processes or threads (henceforth referred to only as processes) can be in their critical section at the same time. Here, a critical section refers to a period of time when the process accesses a shared resource, such as shared memory. The problem of mutual exclusion was first identified and solved by Edsger W. Dijkstra in his seminal 1965 paper titled: Solution of a problem in concurrent programming control.

a. Non-lock concurrency control

b. Mutual exclusion

c. Semaphore

d. Serializability

**ANSWER KEY**





## **ANSWER KEY**

1. b

2. b

3. c

4. b

5. b

---

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**Chapter 7. MULTIMEDIA OPERATING SYSTEMS**



## CHAPTER OUTLINE: KEY TERMS, PEOPLE, PLACES, CONCEPTS

---

• | Asymmetric digital subscriber line

• | Service

• | admission control

• | Frame

• | pixel

• | Quantization

• | CODE

• | JPEG

• | Macroblock

• | Linux

• | Chown

• | System call

• | Data



## **CHAPTER HIGHLIGHTS: KEY TERMS, PEOPLE, PLACES, CONCEPTS**

---

### **Asymmetric digital subscriber line:**

Asymmetric digital subscriber line is a type of digital subscriber line technology, a data communications technology that enables faster data transmission over copper telephone lines than a conventional voiceband modem can provide. It does this by utilizing frequencies that are not used by a voice telephone call. A splitter, or DSL filter, allows a single telephone connection to be used for both Asymmetric digital subscriber line service and voice calls at the same time.

### **Service:**

In the context of enterprise architecture, service-orientation and service-oriented architecture, the term service refers to a set of related software functionalities that can be reused for different purposes, together with the policies that should control its usage.

OASIS defines service as 'a mechanism to enable access to one or more capabilities, where the access is provided using a prescribed interface and is exercised consistent with constraints and policies as specified by the service description.' Service engineering

An enterprise architecture team will develop the organization's service model first by defining the top level business functions. Once the business functions are defined, they are further sectioned into services that represent the processes and activities needed to manage the assets of the organization in their various states.

### **admission control:**

Admission Control is a validation process in communication systems where a check is performed before a connection is established to see if current resources are sufficient for the proposed connection.

Admission control systems •Public switched telephone network•IEEE 1394•Audio Video Bridging using Stream Reservation Protocol•IP networks using Integrated services•Asynchronous Transfer Mode.

### **Frame:**

In computer networking and telecommunication, a frame is a digital data transmission unit or data packet that includes frame synchronization, i.e. a sequence of bits or symbols making it possible for the receiver to detect the beginning and end of the packet in the stream of symbols or bits. If a receiver is connected to the system in the middle of a frame transmission, it ignores the data until it detects a new frame synchronization sequence.

In computer networking, a frame is a data packet on the Layer 2 of the OSI model.

### **pixel:**

In digital imaging, a pixel, (picture element) is a single point in a raster image, or the smallest addressable screen element in a display device; it is the smallest unit of picture that can be represented or controlled.

Each pixel has its own address. The address of a pixel corresponds to its coordinates.

### **Quantization:**

Quantization, in mathematics and digital signal processing, is the process of mapping a large set of input values to a smaller set - such as rounding values to some unit of precision. A device or algorithmic function that performs quantization is called a quantizer. The error introduced by quantization is referred to as quantization error or round-off error.

### **CODE:**

CODE (computationally oriented display environment) is a visual programming language and system for parallel programming, which lets users compose sequential programs into parallel programs.

### **JPEG:**

In computing, JPEG ( [pronounced as jay-peg] is a commonly used method of lossy compression for digital photography (image). The degree of compression can be adjusted, allowing a selectable tradeoff between storage size and image quality. JPEG typically achieves 10:1 compression with little perceptible loss in image quality.

### **Macroblock:**



Macroblock is an image compression component and technique based on discrete cosine transform used on still images and video frames. Macroblocks are usually composed of two or more blocks of pixels. In the JPEG standard macroblocks are called MCU blocks.

**Linux:**

Linux is a Unix-like computer operating system assembled under the model of free and open source software development and distribution. The defining component of Linux is the Linux kernel, an operating system kernel first released 5 October 1991 by Linus Torvalds.

Linux was originally developed as a free operating system for Intel x86-based personal computers.

**Chown:**

The chown command (abbreviation for change owner) is used on Unix-like systems to change the owner of a file. In most implementations, it can only be executed by the superuser, to prevent users simply changing ownership of files that aren't theirs to access them. Unprivileged (regular) users who wish to change the group of a file that they own may use chgrp.

**System call:**

In computing, a system call is how a program requests a service from an operating system's kernel. This may include hardware related services (e.g. accessing the hard disk), creating and executing new processes, and communicating with integral kernel services (like scheduling). System calls provide an essential interface between a process and the operating system.

**Data:**

In computer science, data ( 'de?t?-t? or 'dæt?) is information in a form suitable for use with a computer. Data is often distinguished from programs. A program is a sequence of instructions that detail a task for the computer to perform.

**Block:**

In computing (specifically data transmission and data storage), a block is a sequence of bytes or bits, having a nominal length (a block size). Data thus structured are said to be

blocked. The process of putting data into blocks is called blocking.



## CHAPTER QUIZ: KEY TERMS, PEOPLE, PLACES, CONCEPTS

---

1. Asymmetric digital subscriber line is a type of digital subscriber line technology, a data communications technology that enables faster data transmission over copper telephone lines than a conventional voiceband modem can provide. It does this by utilizing frequencies that are not used by a voice telephone call. A splitter, or DSL filter, allows a single telephone connection to be used for both Asymmetric digital subscriber line service and voice calls at the same time.

- a. Rensselaer Polytechnic
- b. Rensselaer Polytechnic Institute
- c. Asymmetric digital subscriber line
- d. Virginia State

2. In the context of enterprise architecture, service-orientation and service-oriented architecture, the term service refers to a set of related software functionalities that can be reused for different purposes, together with the policies that should control its usage.

OASIS defines service as 'a mechanism to enable access to one or more capabilities, where the access is provided using a prescribed interface and is exercised consistent with constraints and policies as specified by the service description.' Service engineering

An enterprise architecture team will develop the organization's service model first by defining the top level business functions. Once the business functions are defined, they are further sectioned into services that represent the processes and activities needed to manage the assets of the organization in their various states.

- a. Service Abstraction

b. Service

c. Service Component Architecture

d. Service discovery

3. Admission Control is a validation process in communication systems where a check is performed before a connection is established to see if current resources are sufficient for the proposed connection.

Admission control systems •Public switched telephone network•IEEE 1394•Audio Video Bridging using Stream Reservation Protocol•IP networks using Integrated services•Asynchronous Transfer Mode.

a. admission control

b. Rensselaer Polytechnic

c. Rensselaer Polytechnic Institute

d. Service discovery

4. In computer networking and telecommunication, a frame is a digital data transmission unit or data packet that includes frame synchronization, i.e. a sequence of bits or symbols making it possible for the receiver to detect the beginning and end of the packet in the stream of symbols or bits. If a receiver is connected to the system in the middle of a frame transmission, it ignores the data until it detects a new frame synchronization sequence.

In computer networking, a frame is a data packet on the Layer 2 of the OSI model.

a. Gibibit

b. Frame

c. Kibibit

d. Kibibyte

5. In digital imaging, a pixel, (picture element) is a single point in a raster image, or the smallest addressable screen element in a display device; it is the smallest unit of picture that can be represented or controlled.

Each pixel has its own address. The address of a pixel corresponds to its coordinates.

a. dot pitch

b. color depth

c. Rensselaer Polytechnic

d. pixel

**ANSWER KEY**





## **ANSWER KEY**

1. c

2. b

3. a

4. b

5. d

---

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**Chapter 8. MULTIPLE PROCESSOR SYSTEMS**



## CHAPTER OUTLINE: KEY TERMS, PEOPLE, PLACES, CONCEPTS

---

- Tightly Coupled Systems
- Datagram
- Multiprocessor
- Omega network
- System on a chip
- Chown
- Linux
- Multiprocessor scheduling
- two-level scheduling
- Gang scheduling
- Grid
- packet switching
- circuit switching
- Interface
- Communication software
- Network processor

- | Active message
- | Remote procedure call
- | Distributed shared memory
- | Shared memory
- | False sharing
- | sequential consistency
- | Load balancing
- | Hypervisor
- | Virtual machine
- | Basic block
- | Binary translation
- | Block
- | Application programming interface
- | Microkernel
- | Paravirtualization
- | Virtual machine interface
- | Memory virtualization
- | page table
- | Domain

- Virtual appliance
- Middleware
- Local area network
- Vampire tap
- wide area network
- exponential backoff
- Network service
- Service
- Datagram service
- IP address
- Transmission Control Protocol
- domain name
- Domain Name System
- Hyperlink
- Uniform resource locator
- Directory
- Location transparency
- location independence
- System call

- Common Object Request Broker Architecture

- Object request broker

- Object-based

- Tuple space

- Jini





## **CHAPTER HIGHLIGHTS: KEY TERMS, PEOPLE, PLACES, CONCEPTS**

---

### **Tightly Coupled Systems:**

Tightly Coupled Systems are systems in which CPUs are connected together in such a way that they share some or all of the system's memory and I/O resources. They are also called multiprocessor systems.

### **Datagram:**

A datagram is a basic transfer unit associated with a packet-switched network in which the delivery, arrival time, and order of arrival are not guaranteed by the network service.

Each datagram has two components, a header and a data payload. The header contains all the information sufficient for routing from the originating equipment to the destination without relying on prior exchanges between the equipment and the network.

### **Multiprocessor:**

A multiprocessor is a tightly coupled computer system having two or more processing units (Multiple Processors) each sharing main memory and peripherals, in order to simultaneously process programs.

Sometimes the term Multiprocessor is confused with the term Multiprocessing.

While Multiprocessing is a type of 'processing' in which two or more processors work together to 'process more than one program simultaneously', the term Multiprocessor is referred to the hardware architecture that allows multiprocessing.

### **Omega network:**

An Omega network is a network configuration often used in parallel computing architectures. It is an indirect topology that relies on the perfect shuffle interconnection algorithm.

Connection Architecture

An 8x8 Omega network is a multistage interconnection network, meaning that processing elements (PEs) are connected using multiple stages of switches.

### **System on a chip:**

A system on a chip is an integrated circuit (IC) that integrates all components of a computer or other electronic system into a single chip. It may contain digital, analog, mixed-signal, and often radio-frequency functions--all on a single chip substrate. A typical application is in the area of embedded systems.

### **Chown:**

The chown command (abbreviation for change owner) is used on Unix-like systems to change the owner of a file. In most implementations, it can only be executed by the superuser, to prevent users simply changing ownership of files that aren't theirs to access them. Unprivileged (regular) users who wish to change the group of a file that they own may use chgrp.

### **Linux:**

Linux is a Unix-like computer operating system assembled under the model of free and open source software development and distribution. The defining component of Linux is the Linux kernel, an operating system kernel first released 5 October 1991 by Linus Torvalds.

Linux was originally developed as a free operating system for Intel x86-based personal computers.

### **Multiprocessor scheduling:**

In computer science, multiprocessor scheduling is an NP-hard optimization problem. The problem statement is: 'Given a set  $J$  of jobs where job  $j_i$  has length  $l_i$  and a number of processors  $m_i$ , what is the minimum possible time required to schedule all jobs in  $J$  on  $m$  processors such that none overlap?' The applications of this problem are numerous, but are, as suggested by the name of the problem, most strongly associated with the scheduling of computational tasks in a multiprocessor environment. The multiprocessor scheduling problem is a generalization of the optimization version of the number partitioning problem, which considers the case of partitioning a set of numbers (jobs) into two equal sets (processors)..

**two-level scheduling:**

Two-level scheduling is a computer science term to describe a method to more efficiently perform process scheduling that involves swapped out processes.

Consider this problem: A system contains 50 running processes all with equal priority. However, the system's memory can only hold 10 processes in memory simultaneously.

**Gang scheduling:**

In computer science, gang scheduling is a scheduling algorithm for parallel systems that schedules related threads or processes to run simultaneously on different processors. Usually these will be threads all belonging to the same process, but they may also be from different processes, for example when the processes have a producer-consumer relationship, or when they all come from the same MPI program.

Gang scheduling is used so that if two or more threads or processes communicate with each other, they will all be ready to communicate at the same time.

**Grid:**

In the context of a spatial index, a grid (a.k.a. 'mesh', also 'global grid' if it covers the entire surface of the globe) is a regular tessellation of a manifold or 2-D surface that divides it into a series of contiguous cells, which can then be assigned unique identifiers and used for spatial indexing purposes. A wide variety of such grids have been proposed or are currently in use, including grids based on 'square' or 'rectangular' cells, triangular grids or meshes, hexagonal grids, grids based on diamond-shaped cells, and possibly more.

**packet switching:**

Packet switching is a digital networking communications method that groups all transmitted data - regardless of content, type, or structure - into suitably sized blocks, called packets. Packet switching features delivery of variable-bit-rate data streams (sequences of packets) over a shared network. When traversing network adapters, switches, routers and other network nodes, packets are buffered and queued, resulting in variable delay and throughput depending on the traffic load in the network.

**circuit switching:**

Circuit switching is a methodology of implementing a telecommunications network in which two network nodes establish a dedicated communications channel (circuit) through the network before the nodes may communicate. The circuit guarantees the full bandwidth of the channel and remains connected for the duration of the communication session. The circuit functions as if the nodes were physically connected as with an electrical circuit.

**Interface:**

An interface in the Java programming language is an abstract type that is used to specify an interface (in the generic sense of the term) that classes must implement. Interfaces are declared using the keyword, and may only contain method signature and constant declarations (variable declarations that are declared to be both and ). An interface may never contain method definitions.

**Communication software:**

Communication software is used to provide remote access to systems and exchange files and messages in text, audio and/or video formats between different computers or users. This includes terminal emulators, file transfer programs, chat and instant messaging programs, as well as similar functionality integrated within MUDs. The term is also applied to software operating a bulletin board system but seldom to that operating a computer network or Stored Program Control exchange.

**Network processor:**

A network processor is an integrated circuit which has a feature set specifically targeted at the networking application domain.

Network processors are typically software programmable devices and would have generic characteristics similar to general purpose central processing units that are commonly used in many different types of equipment and products. History of development

In modern telecommunications networks, information (voice, video, data) is now transferred as packet data (termed packet switching) rather than previously in older telecommunications networks as analog signals such as in the public switched telephone network (PSTN) or analog TVRadio networks.

**Active message:**

An Active message is a messaging object capable of performing processing on its own.

This contrasts with traditional computer-based messaging systems in which messages are passive entities with no processing power.

### **Distributed Memory Programming**

Active messages are communications primitive for exploiting the full performance and flexibility of modern computer interconnects.

### **Remote procedure call:**

In computer science, a remote procedure call is an inter-process communication that allows a computer program to cause a subroutine or procedure to execute in another address space (commonly on another computer on a shared network) without the programmer explicitly coding the details for this remote interaction. That is, the programmer writes essentially the same code whether the subroutine is local to the executing program, or remote. When the software in question uses object-oriented principles, RPC is called remote invocation or remote method invocation.

### **Distributed shared memory:**

Distributed Shared Memory in Computer Architecture is a form of memory architecture where the (physically separate) memories can be addressed as one (logically shared) address space. Here, the term shared does not mean that there is a single centralized memory but shared essentially means that the address space is shared (same physical address on two processors refers to the same location in memory). Alternatively in computer science it is known as (DGAS), a concept that refers to a wide class of software and hardware implementations, in which each node of a cluster has access to shared memory in addition to each node's non-shared private memory.

### **Shared memory:**

In computing, shared memory is memory that may be simultaneously accessed by multiple programs with an intent to provide communication among them or avoid redundant copies. Shared memory is an efficient means of passing data between programs. Depending on context, programs may run on a single processor or on multiple separate processors.

### **False sharing:**

In computer science, false sharing is a performance degrading usage pattern that can arise in systems with distributed, coherent caches at the size of the smallest resource block managed by the caching mechanism. When a system participant attempts to periodically access data that will never be altered by another party, but that data shares a

cache block with data that is altered, the caching protocol may force the first participant to reload the whole unit despite a lack of logical necessity. The caching system is unaware of activity within this block and forces the first participant to bear the caching system overhead required by true shared access of a resource.

### **sequential consistency:**

Sequential consistency is one of the consistency models used in the domain of concurrent programming (e.g. in distributed shared memory, distributed transactions, etc).. It was first defined as the property that requires that '... the result of any execution is the same as if the operations of all the processors were executed in some sequential order, and the operations of each individual processor appear in this sequence in the order specified by its program.'

The system provides sequential consistency if every node of the system sees the (write) operations on the same memory part (page, virtual object, cell, etc). in the same order, although the order may be different from the order as defined by real time (as observed by hypothetical external observator or global clock) of issuing the operations.

### **Load balancing:**

Load balancing is a computer networking methodology to distribute workload across multiple computers or a computer cluster, network links, central processing units, disk drives, or other resources, to achieve optimal resource utilization, maximize throughput, minimize response time, and avoid overload. Using multiple components with load balancing, instead of a single component, may increase reliability through redundancy. The load balancing service is usually provided by dedicated software or hardware, such as a multilayer switch or a Domain Name System server.

### **Hypervisor:**

In computing, a hypervisor, is one of many hardware virtualization techniques allowing multiple operating systems, termed guests, to run concurrently on a host computer. It is so named because it is conceptually one level higher than a supervisory program. The hypervisor presents to the guest operating systems a virtual operating platform and manages the execution of the guest operating systems.

### **Virtual machine:**

A virtual machine is a 'completely isolated guest operating system installation within a normal host operating system'. Modern virtual machines are implemented with either

software emulation or hardware virtualization. In most cases, both are implemented together.

### **Basic block:**

In computing, a basic block is a portion of the code within a program with certain desirable properties that make it highly amenable to analysis. Compilers usually decompose programs into their basic blocks as a first step in the analysis process. Basic blocks form the vertices or nodes in a control flow graph.

### **Binary translation:**

In computing, binary translation is the emulation of one instruction set by another through translation of code. Sequences of instructions are translated from the source to the target instruction set. In some cases such as instruction set simulation, the target instruction set may be the same as the source instruction set, providing testing and debugging features such as instruction trace, conditional breakpoints and hot spot detection.

### **Block:**

In computing (specifically data transmission and data storage), a block is a sequence of bytes or bits, having a nominal length (a block size). Data thus structured are said to be blocked. The process of putting data into blocks is called blocking.

### **Application programming interface:**

An application programming interface is a specification intended to be used as an interface by software components to communicate with each other. An API may include specifications for routines, data structures, object classes, and variables. An API specification can take many forms, including an International Standard such as POSIX or vendor documentation such as the Microsoft Windows API, or the libraries of a programming language, e.g. Standard Template Library in C++ or Java API.

An API differs from an application binary interface (ABI) in that the former is source code based while the latter is a binary interface.

### **Microkernel:**

In computer science, a microkernel is the near-minimum amount of software that can provide the mechanisms needed to implement an operating system (OS). These mechanisms include low-level address space management, thread management, and

inter-process communication (IPC). If the hardware provides multiple rings or CPU modes, the microkernel is the only software executing at the most privileged level (generally referred to as supervisor or kernel mode).

### **Paravirtualization:**

In computing, paravirtualization is a virtualization technique that presents a software interface to virtual machines that is similar but not identical to that of the underlying hardware.

The intent of the modified interface is to reduce the portion of the guest's execution time spent performing operations which are substantially more difficult to run in a virtual environment compared to a non-virtualized environment. The paravirtualization provides specially defined 'hooks' to allow the guest(s) and host to request and acknowledge these tasks, which would otherwise be executed in the virtual domain (where execution performance is worse).

### **Virtual machine interface:**

Virtual machine interface may refer to a communication protocol for running parallel programs on a distributed memory system.

Virtual Machine Interface is also the name given by VMware to the proposed open standard protocol that guest operating systems can use to communicate with the hypervisor of a virtual machine. An implementation of this standard was merged in the main Linux kernel version 2.6.21. A number of popular GNU/Linux distributions now ship with VMI support enabled by default.

### **Memory virtualization:**

In computer science, memory virtualization decouples volatile random access memory (RAM) resources from individual systems in the data center, and then aggregates those resources into a virtualized memory pool available to any computer in the cluster. The memory pool is accessed by the operating system or applications running on top of the operating system. The distributed memory pool can then be utilized as a high-speed cache, a messaging layer, or a large, shared memory resource for a CPU or a GPU application.

### **page table:**



A page table is the data structure used by a virtual memory system in a computer operating system to store the mapping between virtual addresses and physical addresses. Virtual addresses are those unique to the accessing process. Physical addresses are those unique to the hardware, i.e., RAM.

#### Role of the page table

In operating systems that use virtual memory, every process is given the impression that it is working with large, contiguous sections of memory.

#### **Domain:**

A domain is a field of study that defines a set of common requirements, terminology, and functionality for any software program constructed to solve a problem in the area of computer programming, known as domain engineering.

#### **Virtual appliance:**

A virtual appliance is a virtual machine image designed to run on a virtualization platform (e.g., VirtualBox, Xen, VMware Workstation, Parallels Workstation).

Virtual appliances are a subset of the broader class of software appliances. Installation of a software appliance on a virtual machine creates a virtual appliance.

#### **Middleware:**

Middleware in the context of distributed applications is software that provides services beyond those provided by the operating system to enable the various components of a distributed system to communicate and manage data. Middleware supports and simplifies complex distributed applications. It includes web servers, application servers, messaging and similar tools that support application development and delivery.

#### **Local area network:**

A local area network is a computer network that interconnects computers in a limited area such as a home, school, computer laboratory, or office building using network media. The defining characteristics of Local area networks, in contrast to wide area networks (WANs), include their usually higher data-transfer rates, smaller geographic area, and lack of a need for leased telecommunication lines.

ARCNET, Token Ring and other technology standards have been used in the past, but Ethernet over twisted pair cabling, and Wi-Fi are the two most common technologies currently used to build Local area networks.

### **Vampire tap:**

A vampire tap is a device for physically connecting a station (e.g. a computer or printer) to a network that uses 10BASE5 cabling. This device clamps onto and 'bites' into the cable (hence the vampire name), forcing a spike through a hole drilled through the outer shielding to contact the inner conductor while other spikes bite into the outer conductor. From the vampire tap, a short cable called an AUI (Attachment Unit Interface) is connected directly from the tap to the network card in the PC. Vampire taps allow new connections to be made on a given physical cable while the cable is in use.

### **wide area network:**

A Wide Area Network is a telecommunication network that covers a broad area (i.e., any network that links across metropolitan, regional, or national boundaries). Business and government entities utilize wide area networks to relay data among employees, clients, buyers, and suppliers from various geographical locations. In essence this mode of telecommunication allows a business to effectively carry out its daily function regardless of location.

### **exponential backoff:**

Exponential backoff is an algorithm that uses feedback to multiplicatively decrease the rate of some process, in order to gradually find an acceptable rate.

Binary exponential backoff / truncated exponential backoff

In a variety of computer networks, binary exponential backoff or truncated binary exponential backoff refers to an algorithm used to space out repeated retransmissions of the same block of data, often as part of network congestion avoidance.

Examples are the retransmission of frames in carrier sense multiple access with collision avoidance (CSMA/CA) and carrier sense multiple access with collision detection (CSMA/CD) networks, where this algorithm is part of the channel access method used to send data on these network.

### **Network service:**

A network service is a service hosted on a computer network. Network services provide

some functionality for members or users of the network. Services are usually based on a defined service protocol.

**Service:**

In the context of enterprise architecture, service-orientation and service-oriented architecture, the term service refers to a set of related software functionalities that can be reused for different purposes, together with the policies that should control its usage.

OASIS defines service as 'a mechanism to enable access to one or more capabilities, where the access is provided using a prescribed interface and is exercised consistent with constraints and policies as specified by the service description.' Service engineering

An enterprise architecture team will develop the organization's service model first by defining the top level business functions. Once the business functions are defined, they are further sectioned into services that represent the processes and activities needed to manage the assets of the organization in their various states.

**Datagram service:**

Datagram service is a service provided by IP at the Internet layer. It is a connectionless, best effort, unreliable, message delivery service. Many higher level protocols including TCP (a connection-oriented service) depend on IP's Datagram service, laying additional functionality on top.

**IP address:**

An Internet Protocol address (IP address) is a numerical label assigned to each device (e.g., computer, printer) participating in a computer network that uses the Internet Protocol for communication. An IP address serves two principal functions: host or network interface identification and location addressing. Its role has been characterized as follows: 'A name indicates what we seek.

**Transmission Control Protocol:**

The Transmission Control Protocol is one of the core protocols of the Internet Protocol Suite. Transmission Control Protocol is one of the two original components of the suite, complementing the Internet Protocol (IP), and therefore the entire suite is commonly referred to as Transmission Control Protocol/IP. Transmission Control Protocol provides reliable, ordered delivery of a stream of bytes from a program on one computer to another program on another computer. Transmission Control Protocol is the protocol that major

Internet applications such as the World Wide Web, email, remote administration and file transfer rely on.

**domain name:**

A domain name is an identification string that defines a realm of administrative autonomy, authority, or control on the Internet. Domain names are formed by the rules and procedures of the Domain Name System (DNS).

Domain names are used in various networking contexts and application-specific naming and addressing purposes.

**Domain Name System:**

The Domain Name System is a hierarchical distributed naming system for computers, services, or any resource connected to the Internet or a private network. It associates various information with domain names assigned to each of the participating entities. A Domain Name Service resolves queries for these names into IP addresses for the purpose of locating computer services and devices worldwide.

**Hyperlink:**

In computing, a hyperlink is a reference to data that the reader can directly follow, or that is followed automatically. A hyperlink points to a whole document or to a specific element within a document. Hypertext is text with hyperlinks.

**Uniform resource locator:**

In computing, a uniform resource locator is a specific character string that constitutes a reference to an Internet resource.

A Uniform resource locator is technically a type of uniform resource identifier (URI) but in many technical documents and verbal discussions Uniform resource locator is often used as a synonym for URI. History

The Uniform Resource Locator was created in 1994 by Tim Berners-Lee and the URI working group of the Internet Engineering Task Force (IETF) as an outcome of collaboration started at the IETF Living Documents 'Birds of a Feather' session in 1992. The format combines the pre-existing system of domain names (created in 1985) with file

path syntax, where forward slashes are used to separate folder and file names. Conventions already existed where server names could be prepended to complete file paths, preceded by a double-slash (//).

### **Directory:**

Generally, a directory, as used in computing and telephony, refers to a repository or database of information which is heavily optimized for reading, under the assumption that data updates are very rare compared to data reads. Commonly, a directory supports search and browsing in addition to simple lookups.

A website which offer access to a categorized listing of other websites optimized for lookup, search, or browsing is a directory, a web directory.

### **Location transparency:**

In computer networks location transparency describes names used to identify network resources independent of both the user's location and the resource location.

A distributed system will need to employ a networked scheme for naming resources.

In other words it is an idea that the resources can be accessed by a user from anywhere on the network without knowing where the resource is located.

### **location independence:**

Location independence is a growing trend among technology and knowledge workers that has been popularized by blogs such as [LocationIndependent.com](http://LocationIndependent.com), Thrilling Heroics, Fluent in 3 months, Virtual Business Lifestyle and Workshifting. A location independent professional--or digital nomad--often adopts Timothy Ferriss' principles of lifestyle design and utilizes new technology to design a lifestyle that allows them to live and work wherever they want--be it from home, the internet cafe, on the beach, or even from the other side of the world.

Location independent professionals frequently work as freelance writers, photographers, affiliate marketers, web designers, web developers, graphic designers, programmers and often other working holiday jobs such as teaching English (TESOL or TEFL).

## **System call:**

In computing, a system call is how a program requests a service from an operating system's kernel. This may include hardware related services (e.g. accessing the hard disk), creating and executing new processes, and communicating with integral kernel services (like scheduling). System calls provide an essential interface between a process and the operating system.

## **Common Object Request Broker Architecture:**

The Common Object Request Broker Architecture is a standard defined by the Object Management Group (OMG) that enables software components written in multiple computer languages and running on multiple computers to work together (i.e., it supports multiple platforms).

### **Overview**

CORBA enables separate pieces of software written in different languages and running on different computers to work with each other like a single application or set of services. More specifically, CORBA is a mechanism in software for normalizing the method-call semantics between application objects residing either in the same address space (application) or remote address space (same host, or remote host on a network).

### **Object request broker:**

In distributed computing, an object request broker is a piece of middleware software that allows programmers to make program calls from one computer to another via a network. Object request brokers promote interoperability of distributed object systems because they enable users to build systems by piecing together objects from different vendors, so that they communicate with each other via the Object request broker.

Object request brokers handle the transformation of in-process data structures to and from the byte sequence, which is transmitted over the network. This is called marshalling or serialization.

### **Object-based:**

In general, object-based indicates that something such as a theory, language, or model is based on the concept of object.

In computer science, the term object-based has two different senses:•A somehow limited version of object-oriented programming, where one or more of the following restrictions applies: (a) There is no implicit inheritance, (b) there is no polymorphism, (c) only a very reduced subset of the available values are objects (typically the GUI components).•Prototype-based systems (that is, those based on 'prototype' objects that are not instances of any class).

Visual Basic is an example of a language that is object-based in the first sense of the term, and JavaScript is an example of the second.

### **Tuple space:**

A tuple space is an implementation of the associative memory paradigm for parallel/distributed computing. It provides a repository of tuples that can be accessed concurrently. As an illustrative example, consider that there are a group of processors that produce pieces of data and a group of processors that use the data.

### **Jini:**

Jini, is a network architecture for the construction of distributed systems in the form of modular co-operating services.

Originally developed by Sun, Jini was released under an open source license (Apache license). Responsibility for Jini has been transferred to Apache under the project name 'River'.

### **Lookup:**

In computing, lookup usually refers to searching a data structure for an item that satisfies some specified property. (Note that in grammatical usage, lookup is the noun form describing the verb form to look up). For example, variable lookup performed by a (scripting) language interpreter, virtual machine or other similar engine usually consists of performing certain actions to dynamically find correspondence between variable identifier and actual variable internal representation, usually involving symbol table lookup.





## **CHAPTER QUIZ: KEY TERMS, PEOPLE, PLACES, CONCEPTS**

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1. Tightly Coupled Systems are systems in which CPUs are connected together in such a way that they share some or all of the system's memory and I/O resources. They are also called multiprocessor systems.

- a. Tightly Coupled Systems
- b. Rensselaer Polytechnic
- c. Rensselaer Polytechnic Institute
- d. Franklin Institute

2. A datagram is a basic transfer unit associated with a packet-switched network in which the delivery, arrival time, and order of arrival are not guaranteed by the network service.

Each datagram has two components, a header and a data payload. The header contains all the information sufficient for routing from the originating equipment to the destination without relying on prior exchanges between the equipment and the network.

- a. Field specification
- b. Datagram
- c. Gibibit
- d. Gibibyte

3. A multiprocessor is a tightly coupled computer system having two or more processing units (Multiple Processors) each sharing main memory and peripherals, in order to simultaneously process programs.

Sometimes the term Multiprocessor is confused with the term Multiprocessing.

While Multiprocessing is a type of 'processing' in which two or more processors work together to 'process more than one program simultaneously', the term Multiprocessor is referred to the hardware architecture that allows multiprocessing.

- a. Multithreading
- b. Multiprocessor
- c. Parallel Element Processing Ensemble
- d. Parallel slowdown

4. An Omega network is a network configuration often used in parallel computing architectures. It is an indirect topology that relies on the perfect shuffle interconnection algorithm.

Connection Architecture

An 8x8 Omega network is a multistage interconnection network, meaning that processing elements (PEs) are connected using multiple stages of switches.

- a. Rensselaer Polytechnic
- b. Omega network
- c. Point
- d. Radial line

5. A system on a chip is an integrated circuit (IC) that integrates all components of a computer or other electronic system into a single chip. It may contain digital, analog, mixed-signal, and often radio-frequency functions--all on a single chip substrate. A typical application is in the area of embedded systems.

a. Rensselaer Polytechnic

b. System on a chip

c. Byte orientation

d. Canonicalization

**ANSWER KEY**



## **ANSWER KEY**

1. a

2. b

3. b

4. b

5. b

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**Chapter 9. SECURITY**





## CHAPTER OUTLINE: KEY TERMS, PEOPLE, PLACES, CONCEPTS

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- Data
- protection mechanism
- Data integrity
- Data loss
- Ciphertext
- Public-key cryptography
- Cryptographic hash function
- One-way function
- Hash function
- Block
- Certificate
- Authority
- Domain
- Linux
- System call
- Chown

- access control list
- Tagged architecture
- Trusted computing base
- Discretionary access control
- Mandatory access control
- multilevel security
- STAR
- covert channel
- IP address
- Notation
- Unix
- one-time password
- CHAIN
- hash chain
- Challenge-response authentication
- Wavelet
- Logic bomb
- CODE
- Code review

- Login spoofing
- Buffer overflow
- Overflow
- Shellcode
- Integer overflow
- Code injection
- malware
- Privilege escalation
- botnet
- chmod
- dropper
- Executable
- boot sector
- Device driver
- Macro
- Macro virus
- source code
- Source code virus
- Daemon

- spyware
- Drive-by download
- ActiveX
- adware
- Browser hijacking
- Action
- Rootkit
- FIFO
- Intrusion detection system
- Personal firewall
- Stateful firewall
- Code signing
- Exit
- Applet
- mobile code
- Java virtual machine
- reference monitor



## **CHAPTER HIGHLIGHTS: KEY TERMS, PEOPLE, PLACES, CONCEPTS**

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### **Data:**

In computer science, data ( 'de?t?-t? or 'dæt?) is information in a form suitable for use with a computer. Data is often distinguished from programs. A program is a sequence of instructions that detail a task for the computer to perform.

### **protection mechanism:**

In computer science, protection mechanisms are built into a computer architecture to support the enforcement of security policies. A simple definition of a security policy is 'to set who may use what information in a computer system'.

The access matrix model, first introduced in 1971, is a generalized description of operating system protection mechanisms.

### **Data integrity:**

Data Integrity in its broadest meaning refers to the trustworthiness of information over its entire life cycle. In more analytic terms, it is 'the representational faithfulness of information to the true state of the object that the information represents, where representational faithfulness is composed of four essential qualities or core attributes: completeness, currency/timeliness, accuracy/correctness and validity/authorization.' The concept of business rules is already widely used nowadays and is subdivided into six categories which include data rules. Data is further subdivided Data Integrity Rules, data sourcing rules, data extraction rules, data transformation rules and data deployment rules.

### **Data loss:**

Data loss is an error condition in information systems in which information is destroyed by failures or neglect in storage, transmission, or processing. Information systems implement backup and disaster recovery equipment and processes to prevent data loss or restore lost data.

Data loss is distinguished from data unavailability, such as may arise from a network

outage.

### **Ciphertext:**

In cryptography, ciphertext is the result of encryption performed on plaintext using an algorithm, called a cipher. Ciphertext is also known as encrypted or encoded information because it contains a form of the original plaintext that is unreadable by a human or computer without the proper cipher to decrypt it. Decryption, the inverse of encryption, is the process of turning ciphertext into readable plaintext.

### **Public-key cryptography:**

Public-key cryptography refers to a cryptographic system requiring two separate keys, one to lock or encrypt the plaintext, and one to unlock or decrypt the ciphertext. Neither key will do both functions. One of these keys is published or public and the other is kept private.

### **Cryptographic hash function:**

A cryptographic hash function is a hash function, that is, an algorithm that takes an arbitrary block of data and returns a fixed-size bit string, the (cryptographic) hash value, such that an (accidental or intentional) change to the data will (with very high probability) change the hash value. The data to be encoded is often called the 'message,' and the hash value is sometimes called the message digest or simply digest.

The ideal cryptographic hash function has four main or significant properties:•it is easy to compute the hash value for any given message•it is infeasible to generate a message that has a given hash•it is infeasible to modify a message without changing the hash•it is infeasible to find two different messages with the same hash

Cryptographic hash functions have many information security applications, notably in digital signatures, message authentication codes (MACs), and other forms of authentication.

### **One-way function:**

In computer science, a one-way function is a function that is easy to compute on every input, but hard to invert given the image of a random input. Here 'easy' and 'hard' are to be understood in the sense of computational complexity theory, specifically the theory of polynomial time problems. Not being one-to-one is not considered sufficient of a function

for it to be called one-way .

### **Hash function:**

A hash function is any algorithm or subroutine that maps large data sets of variable length, called keys, to smaller data sets of a fixed length. For example, a person's name, having a variable length, could be hashed to a single integer. The values returned by a hash function are called hash values, hash codes, hash sums, checksums or simply hashes.

### **Block:**

In computing (specifically data transmission and data storage), a block is a sequence of bytes or bits, having a nominal length (a block size). Data thus structured are said to be blocked. The process of putting data into blocks is called blocking.

### **Certificate:**

In computational complexity theory, a certificate (also called a witness) is a string that certifies the answer to a computation, or certifies the membership of some string in a language. A certificate is often thought of as a solution path within a verification process, which is used to check whether a problem gives the answer 'Yes' or 'No'.

In the decision tree model of computation, certificate complexity is the minimum number of the  $n$  input variables of a decision tree that need to be assigned a value in order to definitely establish the value of the Boolean function  $f$ .

### **Authority:**

Authority in management is the formal or legitimate authority specified in a charter that gives a project manager the authority to act in the name of the sponsoring executive or on behalf on the organization.

There are different types of authority:

- Positional authority: refers to the project manager's authority enforced through the project charter.
- Coercive authority (also referred as penalty authority): refers to motivating staff by punishment and is predicated on fear of losing status, positions, bonuses or jobs.
- Expert authority: is earned if the team respects one's skills as a project manager or subject-matter expert.
- Referent authority: refers to the ability to influence others through charisma, personality, and charm.
- Reward authority:



refers to positive reinforcement and the ability to award something of value..

**Domain:**

A domain is a field of study that defines a set of common requirements, terminology, and functionality for any software program constructed to solve a problem in the area of computer programming, known as domain engineering.

**Linux:**

Linux is a Unix-like computer operating system assembled under the model of free and open source software development and distribution. The defining component of Linux is the Linux kernel, an operating system kernel first released 5 October 1991 by Linus Torvalds.

Linux was originally developed as a free operating system for Intel x86-based personal computers.

**System call:**

In computing, a system call is how a program requests a service from an operating system's kernel. This may include hardware related services (e.g. accessing the hard disk), creating and executing new processes, and communicating with integral kernel services (like scheduling). System calls provide an essential interface between a process and the operating system.

**Chown:**

The chown command (abbreviation for change owner) is used on Unix-like systems to change the owner of a file. In most implementations, it can only be executed by the superuser, to prevent users simply changing ownership of files that aren't theirs to access them. Unprivileged (regular) users who wish to change the group of a file that they own may use chgrp.

**access control list:**

An access control list with respect to a computer file system, is a list of permissions attached to an object. An access control list specifies which users or system processes are granted access to objects, as well as what operations are allowed on given objects. Each entry in a typical access control list specifies a subject and an operation.

**Tagged architecture:**

In computer science, a tagged architecture is a particular type of computer architecture where every word of memory constitutes a tagged union, being divided into a number of bits of data, and a tag section that describes the type of the data: how it is to be interpreted, and, if it is a reference, the type of the object that it points to.

Two notable series of tagged architectures were the Lisp machines, which had tagged pointer support at the hardware and opcode level, and the Burroughs large systems which had a data-driven tagged and descriptor-based architecture.

**Trusted computing base:**

The trusted computing base of a computer system is the set of all hardware, firmware, and/or software components that are critical to its security, in the sense that bugs or vulnerabilities occurring inside the Trusted computing base might jeopardize the security properties of the entire system. By contrast, parts of a computer system outside the Trusted computing base must not be able to misbehave in a way that would leak any more privileges than are granted to them in accordance to the security policy.

The careful design and implementation of a system's trusted computing base is paramount to its overall security.

**Discretionary access control:**

In computer security, discretionary access control is a type of access control defined by the Trusted Computer System Evaluation Criteria 'as a means of restricting access to objects based on the identity of subjects and/or groups to which they belong. The controls are discretionary in the sense that a subject with a certain access permission is capable of passing that permission (perhaps indirectly) on to any other subject (unless restrained by mandatory access control)'.

Discretionary access control is commonly discussed in contrast to mandatory access control (MAC, sometimes termed non-discretionary access control).

**Mandatory access control:**

In computer security, mandatory access control refers to a type of access control by

which the operating system constrains the ability of a subject or initiator to access or generally perform some sort of operation on an object or target. In practice, a subject is usually a process or thread; objects are constructs such as files, directories, TCPUDP ports, shared memory segments, etc. Subjects and objects each have a set of security attributes.

### **multilevel security:**

Multilevel security is the application of a computer system to process information with different sensitivities (i.e., at different security levels), permit simultaneous access by users with different security clearances and needs-to-know, and prevent users from obtaining access to information for which they lack authorization. This is a paraphrase of the Committee on National Security Systems (CNSSI) 4009 glossary definition for Multi-Level Security. Note that the UCDMO (the US government lead for cross-domain and multi-level secure systems) created a Cross Domain Multi-Level category on its baseline of accredited systems, which is synonymous with multi-level security.

### **STAR:**

STAR Reading, STAR Early Literacy and STAR Math are standardized, computer-adaptive assessments created by Renaissance Learning, Inc., for use in K-12 education. Each is a 'Tier 2' assessment of a skill (reading practice, math practice, and early literacy, respectively) that can be used any number of times due to item-bank technology. These assessments fall somewhere between progress monitoring tools ('Tier 1') and high-stakes tests.

### **covert channel:**

In computer security, a covert channel is a type of computer security attack that creates a capability to transfer information objects between processes that are not supposed to be allowed to communicate by the computer security policy. The term, originated in 1973 by Lampson is defined as '(channels) not intended for information transfer at all, such as the service program's effect on system load.' to distinguish it from Legitimate channels that are subjected to access controls by COMPUSEC.

### **Characteristics**

A covert channel is so called because it is hidden from the access control mechanisms of ultra-high-assurance secure operating systems since it does not use the legitimate data transfer mechanisms of the computer system such as read and write, and therefore cannot be detected or controlled by the hardware based security mechanisms that underlie ultra-high-assurance secure operating systems. Covert channels are exceedingly hard to install in real systems, and can often be detected by monitoring system performance; in addition, they suffer from a low signal-to-noise ratio and low data rates

(on the order of a few bits per second).

**IP address:**

An Internet Protocol address (IP address) is a numerical label assigned to each device (e.g., computer, printer) participating in a computer network that uses the Internet Protocol for communication. An IP address serves two principal functions: host or network interface identification and location addressing. Its role has been characterized as follows: 'A name indicates what we seek.

**Notation:**

The term notation can refer to:

Written communication •Phonographic writing systems, by definition, use symbols to represent components of auditory language, i.e. speech, which in turn refers to things or ideas. The two main kinds of phonographic notational system are the alphabet and syllabary. Some written languages are more consistent in their correlation of written symbol or grapheme and sound or phoneme, and are therefore considered to have better phonemic orthography. •Ideographic writing, by definition, refers to things or ideas independently of their pronunciation in any language.

**Unix:**

Unix (officially trademarked as UNIX is a multitasking, multi-user computer operating system originally developed in 1969 by a group of AT&T employees at Bell Labs, including Ken Thompson, Dennis Ritchie, Brian Kernighan, Douglas McIlroy, Michael Lesk and Joe Ossanna. The Unix operating system was first developed in assembly language, but by 1973 had been almost entirely recoded in C, greatly facilitating its further development and porting to other hardware. Today's Unix system evolution is split into various branches, developed over time by AT&T as well as various commercial vendors, universities (such as University of California, Berkeley's BSD), and non-profit organizations.

**one-time password:**

A one-time password is a password that is valid for only one login session or transaction. one time passwords avoid a number of shortcomings that are associated with traditional (static) passwords. The most important shortcoming that is addressed by one time passwords is that, in contrast to static passwords, they are not vulnerable to replay attacks.

**CHAIN:**

The CECED Convergence Working Group has defined a new platform, called CHAIN (Ceced Home Appliances Interoperating Network), which defines a protocol for interconnecting different home appliances in a single multibrand system.

It allows for control and automation of all basic appliance-related services in a home: e.g., remote control of appliance operation, energy or load management, remote diagnostics and automatic maintenance support to appliances, downloading and updating of data, programs and services (possibly from the Internet).

**hash chain:**

A hash chain is the successive application of a cryptographic hash function to a piece of data. In computer security, a hash chain is a method to produce many one-time keys from a single key or password. For non-repudiation a hash function can be applied successively to additional pieces of data in order to record the chronology of data's existence.

**Challenge-response authentication:**

In computer security, challenge-response authentication is a family of protocols in which one party presents a question ('challenge') and another party must provide a valid answer ('response') to be authenticated.

The simplest example of a challenge-response protocol is password authentication, where the challenge is asking for the password and the valid response is the correct password.

Clearly an adversary that can eavesdrop on a password authentication can then authenticate itself in the same way.

**Wavelet:**

A wavelet is a wave-like oscillation with an amplitude that starts out at zero, increases, and then decreases back to zero. It can typically be visualized as a 'brief oscillation' like one might see recorded by a seismograph or heart monitor. Generally, wavelets are purposefully crafted to have specific properties that make them useful for signal processing.

**Logic bomb:**

A logic bomb is a piece of code intentionally inserted into a software system that will set off a malicious function when specified conditions are met. For example, a programmer may hide a piece of code that starts deleting files (such as a salary database trigger), should they ever be terminated from the company.

Software that is inherently malicious, such as viruses and worms, often contain logic bombs that execute a certain payload at a pre-defined time or when some other condition is met.

**CODE:**

CODE (computationally oriented display environment) is a visual programming language and system for parallel programming, which lets users compose sequential programs into parallel programs.

**Code review:**

Code review is systematic examination (often as peer review) of computer source code. It is intended to find and fix mistakes overlooked in the initial development phase, improving both the overall quality of software and the developers' skills. Reviews are done in various forms such as pair programming, informal walkthroughs, and formal inspections.

**Login spoofing:**

Login spoofings are techniques used to steal a user's password. The user is presented with an ordinary looking login prompt for username and password, which is actually a malicious program, usually called a Trojan horse under the control of the attacker. When the username and password are entered, this information is logged or in some way passed along to the attacker, breaching security.

**Buffer overflow:**

In computer security and programming, a buffer overflow, is an anomaly where a program, while writing data to a buffer, overruns the buffer's boundary and overwrites adjacent memory. This is a special case of violation of memory safety.

Buffer overflows can be triggered by inputs that are designed to execute code, or alter the

way the program operates.

### **Overflow:**

OVERFLOW - the OVERset grid FLOW solver - is a software package for simulating fluid flow around solid bodies using computational fluid dynamics (CFD). It is a compressible 3-D flow solver that solves the time-dependent, Reynolds-averaged, Navier-Stokes equations using multiple overset structured grids.

### **History**

OVERFLOW was developed as part of a collaborative effort between NASA's Johnson Space Center in Houston, Texas and NASA Ames Research Center (ARC) in Moffett Field, California.

### **Shellcode:**

In computer security, a shellcode is a small piece of code used as the payload in the exploitation of a software vulnerability. It is called 'shellcode' because it typically starts a command shell from which the attacker can control the compromised machine. Shellcode is commonly written in machine code, but any piece of code that performs a similar task can be called shellcode.

### **Integer overflow:**

In computer programming, an integer overflow occurs when an arithmetic operation attempts to create a numeric value that is too large to be represented within the available storage space. For instance, adding 1 to the largest value that can be represented constitutes an integer overflow. The most common result in these cases is for the least significant representable bits of the result to be stored (the result is said to wrap).

### **Code injection:**

Code injection is the exploitation of a computer bug that is caused by processing invalid data. Code injection can be used by an attacker to introduce (or 'inject') code into a computer program to change the course of execution. The results of a code injection attack can be disastrous.

### **malware:**

Malware is software designed to disrupt computer operation, gather sensitive information, or gain unauthorized access to computer systems. While it is sometimes software, it can also appear in the form of script or code. Malware is a general term used to describe any

kind of software or code specifically designed to exploit a computer, or the data it contains, without consent.

### **Privilege escalation:**

Privilege escalation is the act of exploiting a bug, design flaw or configuration oversight in an operating system or software application to gain elevated access to resources that are normally protected from an application or user. The result is that an application with more privileges than intended by the application developer or system administrator can perform unauthorized actions.

### **Background**

Most computer systems are designed for use with multiple users.

### **botnet:**

A botnet is a collection of compromised computers, each of which is known as a 'bot', connected to the Internet. When a computer is compromised by an attacker, there is often code within the malware that commands it to become part of a botnet. The 'botmaster' or 'bot herder' controls these compromised computers via standards-based network protocols such as IRC and http.

### **chmod:**

The command is a Unix command that lets a user tell the system how much (or little) access it should permit to a file. It changes the file system modes of files and directories. The modes include permissions and special modes.

### **dropper:**

A dropper is a program (malware component) that has been designed to 'install' some sort of malware (virus, backdoor, etc). to a target system. The malware code can be contained within the dropper in such a way as to avoid detection by virus scanners or the dropper may download the malware to the target machine once activated (two stage).

### **Executable:**

In computing, an executable file causes a computer 'to perform indicated tasks according to encoded instructions,' as opposed to a data file that must be parsed by a program to be meaningful. These instructions are traditionally machine code instructions for a physical CPU. However, in a more general sense, a file containing instructions (such as bytecode) for a software interpreter may also be considered executable; even a scripting language



source file may therefore be considered executable in this sense. The exact interpretation depends upon the use; while the term often refers only to machine code files, in the context of protection against computer viruses all files which cause potentially hazardous instruction execution, including scripts, are conveniently lumped together.

**boot sector:**

A boot sector is a region of a hard disk, floppy disk, optical disc, or other data storage device that contains machine code to be loaded into random-access memory (RAM) by a computer system's built-in firmware. The purpose of a boot sector is to allow the boot process of a computer to load a program (usually, but not necessarily, an operating system) stored on the same storage device. The location and size of the boot sector is specified by the design of the computing platform.

**Device driver:**

In computing, a device driver is a computer program allowing higher-level computer programs to interact with a hardware device.

A driver typically communicates with the device through the computer bus or communications subsystem to which the hardware connects. When a calling program invokes a routine in the driver, the driver issues commands to the device.

**Macro:**

A macro in computer science is a rule or pattern that specifies how a certain input sequence (often a sequence of characters) should be mapped to a replacement input sequence (also often a sequence of characters) according to a defined procedure. The mapping process that instantiates (transforms) a macro use into a specific sequence is known as macro expansion. A facility for writing macros may be provided as part of a software application or as a part of a programming language.

**Macro virus:**

In computing terminology, a macro virus is a virus that is written in a macro language: that is to say, a language built into a software application such as a word processor. Since some applications (notably, but not exclusively, the parts of Microsoft Office) allow macro programs to be embedded in documents, so that the programs may be run automatically when the document is opened, this provides a distinct mechanism by which viruses can be spread. This is why it may be dangerous to open unexpected attachments in e-mails.

**source code:**

In computer science, source code is any collection of computer instructions (possibly with comments) written using some human-readable computer language, usually as text. The source code of a programming language is specially designed to facilitate the work of computer programmers, who specify the actions to be performed by a computer mostly by writing source code. The source code is automatically translated at some point to machine code that the computer can directly read and execute.

**Source code virus:**

Source code viruses are a subset of computer viruses that make modifications to source code located on an infected machine. A source file can be overwritten such that it includes a call to some malicious code. By targeting a generic programming language, such as C, source code viruses can be very portable.

**Daemon:**

In Unix and other multitasking computer operating systems, a daemon ( 'de?m?n or 'di? m?n) is a computer program that runs as a background process, rather than being under the direct control of an interactive user. Typically daemon names end with the letter d: for example, syslogd is the daemon that implements the system logging facility and sshd is a daemon that services incoming SSH connections.

In a Unix environment, the parent process of a daemon is often, but not always, the init process.

**spyware:**

Spyware is a type of malware (malicious software) installed on computers that collects information about users without their knowledge. The presence of spyware is typically hidden from the user and can be difficult to detect. Spyware is often secretly installed on a user's personal computer without their knowledge.

**Drive-by download:**

Drive-by download means two things, each concerning the unintended download of computer software from the Internet:

- Downloads which a person authorized but without understanding the consequences (e.g. downloads which install an unknown or counterfeit executable program, ActiveX

component, or Java applet).•Any download that happens without a person's knowledge, often spyware, a computer virus or malware.

Drive-by downloads may happen when visiting a website, viewing an e-mail message or by clicking on a deceptive pop-up window: by clicking on the window in the mistaken belief that, for instance, an error report from the computer' operating system itself is being acknowledged, or that an innocuous advertisement pop-up is being dismissed. In such cases, the 'supplier' may claim that the person 'consented' to the download although actually unaware of having started an unwanted or malicious software download. Websites that exploit the Windows Metafile vulnerability (eliminated by a Windows update of 5 January 2006) may provide examples of drive-by downloads of this sort.

### **ActiveX:**

ActiveX is a framework for defining reusable software components in a programming language-independent way. Software applications can then be composed from one or more of these components in order to provide their functionality.

It was introduced in 1996 by Microsoft as a development of its Component Object Model (COM) and Object Linking and Embedding (OLE) technologies and is commonly used in its Windows operating system, although the technology itself is not tied to it.

### **adware:**

Adware, is any software package which automatically renders advertisements. These advertisements can be in the form of a pop-up. They may also be in the user interface of the software or on a screen presented to the user during the installation process.

### **Browser hijacking:**

Browser hijacking is the modification of a web browser's settings by malware. The term 'hijacking' is used as the changes are performed without the user's permission. Some browser hijacking can be easily reversed, while other instances may be difficult to reverse.

### **Action:**

In the Unified Modeling Language, an action is a named element that is the fundamental unit of executable functionality. The execution of an action represents some transformation or processing in the modeled system. An action execution represents the run-time behavior of executing an action within a specific behavior execution.

**Rootkit:**

A rootkit is software that implements stealth capabilities that are designed to hide the existence of certain processes or programs. While some uses of the technology may be beneficial, the most notable usage is by malware seeking to avoid detection by antivirus software. The term rootkit is derived from a concatenation of 'root' (the traditional name of the privileged account on Unix operating systems) and the word 'kit' (which refers to the software components that implement the tool).

**FIFO:**

FIFO is an acronym for First In, First Out, an abstraction related to ways of organizing and manipulation of data relative to time and prioritization. This expression describes the principle of a queue processing technique or servicing conflicting demands by ordering process by first-come, first-served (FCFS) behaviour: where the persons leave the queue in the order they arrive, or waiting one's turn at a traffic control signal.

FCFS is also the jargon term for the FIFO operating system scheduling algorithm, which gives every process CPU time in the order they come.

**Intrusion detection system:**

An intrusion detection system is a device or software application that monitors network or system activities for malicious activities or policy violations and produces reports to a Management Station. Some systems may attempt to stop an intrusion attempt but this is neither required nor expected of a monitoring system. Intrusion detection and prevention systems (IDPS) are primarily focused on identifying possible incidents, logging information about them, and reporting attempts.

**Personal firewall:**

A personal firewall is an application which controls network traffic to and from a computer, permitting or denying communications based on a security policy. Typically it works as an application layer firewall.

A personal firewall differs from a conventional firewall in terms of scale.

**Stateful firewall:**

In computing, a stateful firewall (any firewall that performs stateful packet inspection (SPI) or stateful inspection) is a firewall that keeps track of the state of network connections (such as TCP streams, UDP communication) traveling across it. The firewall is programmed to distinguish legitimate packets for different types of connections. Only packets matching a known active connection will be allowed by the firewall; others will be rejected.

### **Code signing:**

Code signing is the process of digitally signing executables and scripts to confirm the software author and guarantee that the code has not been altered or corrupted since it was signed by use of a cryptographic hash.

Code signing can provide several valuable features. The most common use of code signing is to provide security when deploying; in some programming languages, it can also be used to help prevent namespace conflicts.

### **Exit:**

On many computer operating systems, a computer process terminates its execution by making an exit system call. More generally, an exit in a multithreading environment means that a thread of execution has stopped running. The operating system reclaims resources (memory, files, etc).

### **Applet:**

In computing, an applet is any small application that performs one specific task that runs within the scope of a larger program, often as a plug-in. An applet typically also refers to Java applets, i.e., programs written in the Java programming language that are included in a web page. The word Applet was first used in 1990 in PC Magazine.

### **mobile code:**

In computer science, mobile code is software transferred between systems, e.g. transferred across a network or via a USB flash drive, and executed on a local system without explicit installation or execution by the recipient. Examples of mobile code include scripts (JavaScript, VBScript), Java applets, ActiveX controls, Flash animations, Shockwave movies (and Xtras), and macros embedded within Microsoft Office documents.

Mobile code can also download and execute in the client workstation via email.

### **Java virtual machine:**

A Java virtual machine is a virtual machine that can execute Java bytecode. It is the code execution component of the Java software platform. Sun Microsystems stated that there are over 5.5 billion JVM-enabled devices.

### **reference monitor:**

In operating systems architecture a reference monitor concept defines a set of design requirements on a reference validation mechanism, which enforces an access control policy over subjects' (e.g., processes and users) ability to perform operations (e.g., read and write) on objects (e.g., files and sockets) on a system. The properties of a reference monitor are:

- The reference validation mechanism must always be invoked (complete mediation). Without this property, it is possible for an attacker to bypass the mechanism and violate the security policy.
- The reference validation mechanism must be tamperproof (tamperproof).

### **Virtual machine:**

A virtual machine is a 'completely isolated guest operating system installation within a normal host operating system'. Modern virtual machines are implemented with either software emulation or hardware virtualization. In most cases, both are implemented together.



## CHAPTER QUIZ: KEY TERMS, PEOPLE, PLACES, CONCEPTS

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1. In computer science, data ( 'de?t?-t? or 'dæt?) is information in a form suitable for use with a computer. Data is often distinguished from programs. A program is a sequence of instructions that detail a task for the computer to perform.

a. Synthetic data

b. Data

c. 18-bit

d. Binary code

2. In computer science, protection mechanisms are built into a computer architecture to support the enforcement of security policies. A simple definition of a security policy is 'to set who may use what information in a computer system'.

The access matrix model, first introduced in 1971, is a generalized description of operating system protection mechanisms.

a. Trusted computing base

b. same origin policy

c. protection mechanism

d. Binary code



3. Data Integrity in its broadest meaning refers to the trustworthiness of information over its entire life cycle. In more analytic terms, it is 'the representational faithfulness of information to the true state of the object that the information represents, where representational faithfulness is composed of four essential qualities or core attributes: completeness, currency/timeliness, accuracy/correctness and validity/authorization.' The concept of business rules is already widely used nowadays and is subdivided into six categories which include data rules. Data is further subdivided Data Integrity Rules, data sourcing rules, data extraction rules, data transformation rules and data deployment rules.

a. Distributed transaction

b. Data integrity

c. Durability

d. Memory semantics

4. Data loss is an error condition in information systems in which information is destroyed by failures or neglect in storage, transmission, or processing. Information systems implement backup and disaster recovery equipment and processes to prevent data loss or restore lost data.

Data loss is distinguished from data unavailability, such as may arise from a network outage.

a. Random access

b. Data loss

c. Use Case Diagram

d. User

5. In cryptography, ciphertext is the result of encryption performed on plaintext using an algorithm, called a cipher. Ciphertext is also known as encrypted or encoded information because it contains a form of the original plaintext that is unreadable by a human or computer without the proper cipher to decrypt it. Decryption, the inverse of encryption, is the process of turning ciphertext into readable plaintext.

a. cryptosystem

b. Ciphertext

c. security association

d. Rensselaer Polytechnic

**ANSWER KEY**



## **ANSWER KEY**

1. b

2. c

3. b

4. b

5. b

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**Chapter 10. CASE STUDY 1: LINUX**



## CHAPTER OUTLINE: KEY TERMS, PEOPLE, PLACES, CONCEPTS

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- Linux
- Unix
- Compiler
- POSIX
- Interface
- Graphical user interface
- MINIX
- X Window System
- System call
- shell script
- Header file
- FIFO
- Linux kernel
- Child process
- Chown
- Daemon



- Parent process
- Process identifier
- Identifier
- Process group
- Exit
- sigaction
- copy-on-write
- Master boot record
- Block
- Data
- data segment
- Memory-mapped file
- Mmap
- Frame
- Address space
- page replacement algorithm
- Swap
- Virtual machine
- Swappiness

• Transmission Control Protocol

• User Datagram Protocol

• Datagram

• Asymmetric digital subscriber line

• ioctl

• line discipline

• Elevator algorithm

• Working directory

• Directory

• PATH

• mkdir

• rmdir

• Data structure

• Journaling block device

• EEPROM

• setuid

• Superuser



## **CHAPTER HIGHLIGHTS: KEY TERMS, PEOPLE, PLACES, CONCEPTS**

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### **Linux:**

Linux is a Unix-like computer operating system assembled under the model of free and open source software development and distribution. The defining component of Linux is the Linux kernel, an operating system kernel first released 5 October 1991 by Linus Torvalds.

Linux was originally developed as a free operating system for Intel x86-based personal computers.

### **Unix:**

Unix (officially trademarked as UNIX is a multitasking, multi-user computer operating system originally developed in 1969 by a group of AT&T employees at Bell Labs, including Ken Thompson, Dennis Ritchie, Brian Kernighan, Douglas McIlroy, Michael Lesk and Joe Ossanna. The Unix operating system was first developed in assembly language, but by 1973 had been almost entirely recoded in C, greatly facilitating its further development and porting to other hardware. Today's Unix system evolution is split into various branches, developed over time by AT&T as well as various commercial vendors, universities (such as University of California, Berkeley's BSD), and non-profit organizations.

### **Compiler:**

A compiler is a computer program that transforms source code written in a programming language (the source language) into another computer language (the target language, often having a binary form known as object code). The most common reason for wanting to transform source code is to create an executable program.

The name 'compiler' is primarily used for programs that translate source code from a high-level programming language to a lower level language (e.g., assembly language or machine code).

## **POSIX:**

POSIX an acronym for 'Portable Operating System Interface', is a family of standards specified by the IEEE for maintaining compatibility between operating systems. POSIX defines the application programming interface (API), along with command line shells and utility interfaces, for software compatibility with variants of Unix and other operating systems.

### **Name**

Originally, the name 'POSIX' referred to IEEE Std 1003.1-1988, released in 1988. The family of POSIX standards is formally designated as IEEE 1003 and the international standard name is ISO/IEC 9945.

## **Interface:**

An interface in the Java programming language is an abstract type that is used to specify an interface (in the generic sense of the term) that classes must implement. Interfaces are declared using the keyword, and may only contain method signature and constant declarations (variable declarations that are declared to be both and ). An interface may never contain method definitions.

## **Graphical user interface:**

In computing, a graphical user interface is a type of user interface that allows users to interact with electronic devices using images rather than text commands. GUIs can be used in computers, hand-held devices such as MP3 players, portable media players or gaming devices, household appliances and office equipment. A GUI represents the information and actions available to a user through graphical icons and visual indicators such as secondary notation, as opposed to text-based interfaces, typed command labels or text navigation.

## **MINIX:**

MINIX is a Unix-like computer operating system based on a microkernel architecture created by Andrew S. Tanenbaum for educational purposes; MINIX also inspired the creation of the Linux kernel.

MINIX was first released in 1987, with its complete source code made available to universities for study in courses and research. It has been free and open source software since it was re-licensed under the BSD license in April 2000.

## **X Window System:**

The X window system is a computer software system and network protocol that provides a basis for graphical user interfaces (GUIs) and rich input device capability for networked computers. It creates a hardware abstraction layer where software is written to use a generalized set of commands, allowing for device independence and reuse of programs on any computer that implements X.

X originated at the Massachusetts Institute of Technology (MIT) in 1984. The current protocol version, X11, appeared in September 1987. The X.Org Foundation leads the X project, with the current reference implementation, X.Org Server, available as free and open source software under the MIT License and similar permissive licenses. Purpose and abilities

X is an architecture-independent system for remote graphical user interfaces and rich input device capabilities which allows many people to share the processing power of a time-sharing computer and to collaborate with each other through client applications running on remote computers.

## **System call:**

In computing, a system call is how a program requests a service from an operating system's kernel. This may include hardware related services (e.g. accessing the hard disk), creating and executing new processes, and communicating with integral kernel services (like scheduling). System calls provide an essential interface between a process and the operating system.

## **shell script:**

A shell script is a script written for the shell, or command line interpreter, of an operating system. The shell is often considered a simple domain-specific programming language. Typical operations performed by shell scripts include file manipulation, program execution, and printing text.

## **Header file:**

In computer programming, header file is a file that allows programmers to separate certain elements of a program's source code into reusable files. Header files commonly contain forward declarations of classes, subroutines, variables, and other identifiers. Programmers who wish to declare standardized identifiers in more than one source file can place such identifiers in a single header file, which other code can then include whenever the header contents are required.

**FIFO:**

FIFO is an acronym for First In, First Out, an abstraction related to ways of organizing and manipulation of data relative to time and prioritization. This expression describes the principle of a queue processing technique or servicing conflicting demands by ordering process by first-come, first-served (FCFS) behaviour: where the persons leave the queue in the order they arrive, or waiting one's turn at a traffic control signal.

FCFS is also the jargon term for the FIFO operating system scheduling algorithm, which gives every process CPU time in the order they come.

**Linux kernel:**

The Linux kernel is the operating system kernel used by the Linux family of Unix-like operating systems. It is one of the most prominent examples of free and open source software.

The Linux kernel is released under the GNU General Public License version 2 (GPLv2) (plus some firmware images with various non-free licenses), and is developed by contributors worldwide.

**Child process:**

A child process in computing is a process created by another process (the parent process).

A child process inherits most of its attributes, such as open files, from its parent. In UNIX, a child process is in fact created (using fork) as a copy of the parent.

**Chown:**

The chown command (abbreviation for change owner) is used on Unix-like systems to change the owner of a file. In most implementations, it can only be executed by the superuser, to prevent users simply changing ownership of files that aren't theirs to access them. Unprivileged (regular) users who wish to change the group of a file that they own may use chgrp.

**Daemon:**

In Unix and other multitasking computer operating systems, a daemon ( 'de?m?n or 'di? m?n) is a computer program that runs as a background process, rather than being under the direct control of an interactive user. Typically daemon names end with the letter d: for example, syslogd is the daemon that implements the system logging facility and sshd is a daemon that services incoming SSH connections.

In a Unix environment, the parent process of a daemon is often, but not always, the init process.

**Parent process:**

In computing, a parent process is a process that has created one or more child processes.

Unix

In the operating system Unix, every process except process 0 (the swapper) is created when another process executes the fork system call. The process that invoked fork is the parent process and the newly-created process is the child process.

**Process identifier:**

In computing, the process identifier is a number used by most operating system kernels (such as that of UNIX, Mac OS X or Microsoft Windows) to (temporarily) uniquely identify a process. This number may be used as a parameter in various function calls allowing processes to be manipulated, such as adjusting the process's priority or killing it altogether.

In Unix-like operating systems, new processes are created by the system call.

**Identifier:**

An identifier is a name that identifies (that is, labels the identity of) either a unique object or a unique class of objects, where the 'object' or class may be an idea, physical [countable] object , or physical [noncountable] substance . The abbreviation ID often refers to identity, identification (the process of identifying), or an identifier (that is, an instance of identification). An identifier may be a word, number, letter, symbol, or any combination of those.



**Process group:**

In POSIX-conformant operating systems, a process group denotes a collection of one or more processes. Process groups are used to control the distribution of signals. A signal directed to a process group is delivered individually to all of the processes that are members of the group.

**Exit:**

On many computer operating systems, a computer process terminates its execution by making an exit system call. More generally, an exit in a multithreading environment means that a thread of execution has stopped running. The operating system reclaims resources (memory, files, etc).

**sigaction:**

In computing, is a function API defined by POSIX to give the programmer access to what should be a program's behavior when receiving specific OS signals.

**General**

In Unix-like operating systems, one means of inter-process communication is through signals. When an executing unit (process or thread) receives a signal from the OS, it should react in some way defined by the datasheet and the conventional meaning of this signal (ie. by dumping its data, stopping execution, synchronizing something.)...

**copy-on-write:**

Copy-on-write is an optimization strategy used in computer programming. The fundamental idea is that if multiple callers ask for resources which are initially indistinguishable, they can all be given pointers to the same resource. This function can be maintained until a caller tries to modify its 'copy' of the resource, at which point a true private copy is created to prevent the changes becoming visible to everyone else.

**Master boot record:**

A master boot record is a type of boot sector, a data sector at the beginning of many types of computer mass storage. It is most common on disk drives large enough to be partitioned, hence it is not usually present on floppy disks or small thumbdrives.

The master boot record was popularized by the IBM Personal Computer.

**Block:**

In computing (specifically data transmission and data storage), a block is a sequence of bytes or bits, having a nominal length (a block size). Data thus structured are said to be blocked. The process of putting data into blocks is called blocking.

**Data:**

In computer science, data ( 'de?t?-t? or 'dæt?) is information in a form suitable for use with a computer. Data is often distinguished from programs. A program is a sequence of instructions that detail a task for the computer to perform.

**data segment:**

A data segment is a portion of virtual address space of a program, which contains the global variables and static variables that are initialized by the programmer. This size of this segment is determined by the values placed there by the programmer before the program was compiled or assembled, and does not change at run-time.

The data segment is read-write, since the values of the variables can be altered at run-time.

**Memory-mapped file:**

A memory-mapped file is a segment of virtual memory which has been assigned a direct byte-for-byte correlation with some portion of a file or file-like resource. This resource is typically a file that is physically present on-disk, but can also be a device, shared memory object, or other resource that the operating system can reference through a file descriptor. Once present, this correlation between the file and the memory space permits applications to treat the mapped portion as if it were primary memory.

**Mmap:**

In computing, is a POSIX-compliant Unix system call that maps files or devices into memory. It is a method of memory-mapped file I/O. It naturally implements demand paging, because initially file contents are not entirely read from disk and do not use physical RAM at all. The actual reads from disk are performed in 'lazy' manner, after a specific location is accessed.

**Frame:**

In computer networking and telecommunication, a frame is a digital data transmission unit or data packet that includes frame synchronization, i.e. a sequence of bits or symbols making it possible for the receiver to detect the beginning and end of the packet in the stream of symbols or bits. If a receiver is connected to the system in the middle of a frame transmission, it ignores the data until it detects a new frame synchronization sequence.

In computer networking, a frame is a data packet on the Layer 2 of the OSI model.

### **Address space:**

In computing, an address space defines a range of discrete addresses, each of which may correspond to a network host, peripheral device, disk sector, a memory cell or other logical or physical entity.

#### **Overview**

Address spaces are created by combining enough uniquely identified qualifiers to make an address unambiguous (within a particular address space). For a person's physical address, the address space would be a combination of locations, such as a neighborhood, town, city, or country.

### **page replacement algorithm:**

In a computer operating system that uses paging for virtual memory management, page replacement algorithms decide which memory pages to page out (swap out, write to disk) when a page of memory needs to be allocated. Paging happens when a page fault occurs and a free page cannot be used to satisfy the allocation, either because there are none, or because the number of free pages is lower than some threshold.

When the page that was selected for replacement and paged out is referenced again it has to be paged in (read in from disk), and this involves waiting for I/O completion.

### **Swap:**

In computer programming, the act of swapping two variables refers to mutually exchanging the values of the variables. Usually, this is done with the data in memory. For example, in a program, two variables may be defined thus (in pseudocode):

To swap them one might do

(In many programming languages where the swap function is built-in; in C++, overloads are provided allowing `std::swap` to swap some large structures in  $O(1)$  time).

### **Virtual machine:**

A virtual machine is a 'completely isolated guest operating system installation within a normal host operating system'. Modern virtual machines are implemented with either software emulation or hardware virtualization. In most cases, both are implemented together.

### **Swappiness:**

Swappiness is a property for the Linux kernel that changes the balance between swapping out runtime memory, as opposed to dropping pages from the system page cache. Swappiness can be set to values between 0 and 100 inclusive. A low value means the kernel will try to avoid swapping as much as possible where a higher value instead will make the kernel aggressively try to use swap space.

### **Transmission Control Protocol:**

The Transmission Control Protocol is one of the core protocols of the Internet Protocol Suite. Transmission Control Protocol is one of the two original components of the suite, complementing the Internet Protocol (IP), and therefore the entire suite is commonly referred to as Transmission Control Protocol/IP. Transmission Control Protocol provides reliable, ordered delivery of a stream of bytes from a program on one computer to another program on another computer. Transmission Control Protocol is the protocol that major Internet applications such as the World Wide Web, email, remote administration and file transfer rely on.

### **User Datagram Protocol:**

The User Datagram Protocol is one of the core members of the Internet Protocol Suite, the set of network protocols used for the Internet. With User Datagram Protocol, computer applications can send messages, in this case referred to as Destination port number. This field identifies the receiver's port and is required. Similar to source port number, if the client is the destination host then the port number will likely be an ephemeral port number and if the destination host is the server then the port number will likely be a well-known port number. Length A field that specifies the length in bytes of the entire datagram: header and data.

**Datagram:**

A datagram is a basic transfer unit associated with a packet-switched network in which the delivery, arrival time, and order of arrival are not guaranteed by the network service.

Each datagram has two components, a header and a data payload. The header contains all the information sufficient for routing from the originating equipment to the destination without relying on prior exchanges between the equipment and the network.

**Asymmetric digital subscriber line:**

Asymmetric digital subscriber line is a type of digital subscriber line technology, a data communications technology that enables faster data transmission over copper telephone lines than a conventional voiceband modem can provide. It does this by utilizing frequencies that are not used by a voice telephone call. A splitter, or DSL filter, allows a single telephone connection to be used for both Asymmetric digital subscriber line service and voice calls at the same time.

**ioctl:**

In computing, (an abbreviation of input/output control) is a system call for device-specific input/output operations and other operations which cannot be expressed by regular system calls. It takes a parameter specifying a request code; the effect of a call depends completely on the request code. Request codes are often device-specific.

**line discipline:**

A line discipline is a layer in the terminal subsystem in some Unix-like systems. The terminal subsystem consists of three layers: the upper layer to provide the character device interface, the lower hardware driver to communicate with the hardware or pseudo terminal, and the middle line discipline to specify a policy for the driver.

The line discipline glues the low level device driver code with the high level generic interface routines (such as `read(2)`, `write(2)` and `ioctl(2)`), and is responsible for implementing the semantics associated with the device.

**Elevator algorithm:**

The elevator algorithm is a disk scheduling algorithm to determine the motion of the disk's

arm and head in servicing read and write requests.

From an implementation perspective, the drive maintains a buffer of pending read/write requests, along with the associated cylinder number of the request. Lower cylinder numbers indicate that the cylinder is closest to the spindle, and higher numbers indicate the cylinder is further away.

### **Working directory:**

In computing, the working directory of a process is a directory of a hierarchical file system, if any, dynamically associated with each process. When the process refers to a file using a simple file name or relative path (as opposed to a file designated by a full path from a root directory), the reference is interpreted relative to the current working directory of the process. So for example a process with working directory `/rabbit-hats` that asks to create the file `foo.txt` will end up creating the file `/rabbit-hats/foo.txt`.

### **Directory:**

Generally, a directory, as used in computing and telephony, refers to a repository or database of information which is heavily optimized for reading, under the assumption that data updates are very rare compared to data reads. Commonly, a directory supports search and browsing in addition to simple lookups.

A website which offer access to a categorized listing of other websites optimized for lookup, search, or browsing is a directory, a web directory.

### **PATH:**

PATH is an environment variable on Unix-like operating systems, DOS, OS/2, and Microsoft Windows, specifying a set of directories where executable programs are located. In general, each executing process or user session has its own PATH setting.

### **Unix and Unix-like**

On POSIX and Unix-like operating systems, the variable is specified as a list of one or more directory names separated by colon (:) characters.

**mkdir:**

The mkdir (make directory) command in the Unix, DOS, OS/2, PHP, and Microsoft Windows operating systems is used to make a new directory. In DOS, OS/2 and Windows the command is often abbreviated to md.

**Usage**

Normal usage is as straightforward as follows:

Where name\_of\_directory is the name of the directory one wants to create.

**rmdir:**

(or ) is a command which will remove an empty directory on a Unix, DOS, OS/2 or Microsoft Windows operating system. In Unix, Linux, and MacOS, it is case sensitive, whereas DOS, OS/2 and Windows (95, 98, ME), you can type the characters in any combination of upper case and lower case letters, and rd/rmdir will recognize and remove that directory. Normal usage is straightforward where one types:

Where name\_of\_directory corresponds with the name of the directory one wishes to delete.

**Data structure:**

In computer science, a data structure is a particular way of storing and organizing data in a computer so that it can be used efficiently.

Different kinds of data structures are suited to different kinds of applications, and some are highly specialized to specific tasks. For example, B-trees are particularly well-suited for implementation of databases, while compiler implementations usually use hash tables to look up identifiers.

**Journaling block device:**

Journaling block device is a generic block device journaling layer in the Linux kernel written by Stephen C. Tweedie from Red Hat.

**Overview**

The Journaling Block Device provides a filesystem-independent interface for filesystem journaling. ext3, ext4 and OCFS2 are known to use Journaling block device. ext4 uses a fork of Journaling block device called Journaling block device2.

## **EEPROM:**

EEPROM stands for Electrically Erasable Programmable Read-Only Memory and is a type of non-volatile memory used in computers and other electronic devices to store small amounts of data that must be saved when power is removed, e.g., calibration tables or device configuration.

When larger amounts of static data are to be stored (such as in USB flash drives) a specific type of EEPROM such as flash memory is more economical than traditional EEPROM devices. EEPROMs are realized as arrays of floating-gate transistors.

## **setuid:**

setuid and setgid (short for 'set user ID upon execution' and 'set group ID upon execution', respectively) are Unix access rights flags that allow users to run an executable with the permissions of the executable's owner or group. They are often used to allow users on a computer system to run programs with temporarily elevated privileges in order to perform a specific task. While the assumed user id or group id privileges provided are not always elevated, at a minimum they are specific.

## **Superuser:**

The superuser is a special user account used for system administration. Depending on the operating system, the actual name of this account might be: root, administrator, admin or supervisor. In some cases the actual name is not significant, rather an authorization flag in the users profile determines if administrative functions can be performed.

## **chmod:**

The command is a Unix command that lets a user tell the system how much (or little) access it should permit to a file. It changes the file system modes of files and directories. The modes include permissions and special modes.





## CHAPTER QUIZ: KEY TERMS, PEOPLE, PLACES, CONCEPTS

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1. Linux is a Unix-like computer operating system assembled under the model of free and open source software development and distribution. The defining component of Linux is the Linux kernel, an operating system kernel first released 5 October 1991 by Linus Torvalds.

Linux was originally developed as a free operating system for Intel x86-based personal computers.

a. BioLinux

b. Linux

c. BlackDog

d. Bodhi Linux

2. Unix (officially trademarked as UNIX is a multitasking, multi-user computer operating system originally developed in 1969 by a group of AT&T employees at Bell Labs, including Ken Thompson, Dennis Ritchie, Brian Kernighan, Douglas McIlroy, Michael Lesk and Joe Ossanna. The Unix operating system was first developed in assembly language, but by 1973 had been almost entirely recoded in C, greatly facilitating its further development and porting to other hardware. Today's Unix system evolution is split into various branches, developed over time by AT&T as well as various commercial vendors, universities (such as University of California, Berkeley's BSD), and non-profit organizations.

a. Elle

b. Unix

c. Universe

d. Unix billennium

3. A compiler is a computer program that transforms source code written in a programming language (the source language) into another computer language (the target language, often having a binary form known as object code). The most common reason for wanting to transform source code is to create an executable program.

The name 'compiler' is primarily used for programs that translate source code from a high-level programming language to a lower level language (e.g., assembly language or machine code).

a. Compiler Description Language

b. Compiler

c. Control flow graph

d. Control table

4. POSIX an acronym for 'Portable Operating System Interface', is a family of standards specified by the IEEE for maintaining compatibility between operating systems. POSIX defines the application programming interface (API), along with command line shells and utility interfaces, for software compatibility with variants of Unix and other operating systems.

Name

Originally, the name 'POSIX' referred to IEEE Std 1003.1-1988, released in 1988. The family of POSIX standards is formally designated as IEEE 1003 and the international standard name is ISO/IEC 9945.

- a. PSGL
- b. POSIX
- c. Record Management System
- d. SCSI Pass Through Interface

5. An interface in the Java programming language is an abstract type that is used to specify an interface (in the generic sense of the term) that classes must implement. Interfaces are declared using the keyword, and may only contain method signature and constant declarations (variable declarations that are declared to be both and ). An interface may never contain method definitions.

- a. Inversion of control
- b. Interface
- c. Omniscient Debugger
- d. Unified Expression Language

**ANSWER KEY**



## **ANSWER KEY**

1. b

2. b

3. b

4. b

5. b

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**Chapter 11. CASE STUDY 2: WINDOWS VISTA**





## CHAPTER OUTLINE: KEY TERMS, PEOPLE, PLACES, CONCEPTS

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- Microcomputer
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- Object Manager
- Unicode
- Namespace
- Windows on Windows
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- reference monitor
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• | Multiprocessor

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• | NTFS

• | FIFO

• | Sparse

• | sparse file

• | Data stream

• | Access token



## **CHAPTER HIGHLIGHTS: KEY TERMS, PEOPLE, PLACES, CONCEPTS**

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### **Microcomputer:**

A microcomputer is a computer with a microprocessor as its central processing unit. It includes a microprocessor, memory, and input/output (I/O) facilities. Such computers are physically small compared to mainframes and minicomputers.

### **Chown:**

The chown command (abbreviation for change owner) is used on Unix-like systems to change the owner of a file. In most implementations, it can only be executed by the superuser, to prevent users simply changing ownership of files that aren't theirs to access them. Unprivileged (regular) users who wish to change the group of a file that they own may use chgrp.

### **Local Procedure Call:**

The Local Procedure Call is an internal, undocumented inter-process communication facility provided by the Microsoft Windows NT kernel for lightweight IPC between processes on the same computer. As of Windows Vista, LPC has been rewritten as Advanced Local Procedure Call in order to provide a high-speed scalable communication mechanism required to efficiently implement User-Mode Driver Framework, whose user-mode parts require an efficient communication channel with UMDF's components in the executive.

The (A)LPC interface is part of Windows NT's undocumented Native API, and as such is not available to applications for direct use.

### **security descriptor:**

Security descriptors are data structures of security information for securable Windows objects, that is objects that can be identified by a unique name. Security descriptors can be associated with any named objects, including files, folders, shares, registry keys, processes, threads, named pipes, services, job objects and other resources.

Security descriptors contain discretionary access control lists (DACL's) that contain access control entries (ACEs) that grant and deny access to trustees such as users or groups.

### **Object Manager:**

Object Manager (internally called Ob) is a subsystem implemented as part of the Windows Executive which manages Windows resources. Each resource, which are surfaced as logical objects, resides in a namespace for categorization. Resources can be physical devices, files or folders on volumes, Registry entries or even running processes.

### **Unicode:**

Unicode is a computing industry standard for the consistent encoding, representation and handling of text expressed in most of the world's writing systems. Developed in conjunction with the Universal Character Set standard and published in book form as The Unicode Standard, the latest version of Unicode consists of a repertoire of more than 110,000 characters covering 100 scripts, a set of code charts for visual reference, an encoding methodology and set of standard character encodings, an enumeration of character properties such as upper and lower case, a set of reference data computer files, and a number of related items, such as character properties, rules for normalization, decomposition, collation, rendering, and bidirectional display order . As of 2012, the most recent version is Unicode 6.1.

### **Namespace:**

A namespace (sometimes also called a name scope) is an abstract container or environment created to hold a logical grouping of unique identifiers or symbols (i.e., names). An identifier defined in a namespace is associated only with that namespace. The same identifier can be independently defined in multiple namespaces.

### **Windows on Windows:**

In computing, Windows on Windows - commonly referred to by its acronym Windows on Windows or WoW - is a software component of 32-bit versions of the Microsoft Windows NT family of operating systems that provides limited support for running legacy Win16 applications - applications written for Windows 3.x. Alternatively 'Windows on Windows' may also refer to support for running 32-bit applications on 64-bit versions of Windows - known as Windows on Windows64.

### **Background**

Many Win16 applications can run without changes on 32-bit editions of Windows,

complete with the limitations of such applications compared with applications written for Win32. The operating system thunks 16-bit APIs to their underlying 32-bit equivalents in order to provide support for 16-bit pointers, memory models and address space. 32-bit Windows shortens long filenames into 8.3 filenames to allow their use by legacy applications.

### **Linux:**

Linux is a Unix-like computer operating system assembled under the model of free and open source software development and distribution. The defining component of Linux is the Linux kernel, an operating system kernel first released 5 October 1991 by Linus Torvalds.

Linux was originally developed as a free operating system for Intel x86-based personal computers.

### **Mmap:**

In computing, is a POSIX-compliant Unix system call that maps files or devices into memory. It is a method of memory-mapped file I/O. It naturally implements demand paging, because initially file contents are not entirely read from disk and do not use physical RAM at all. The actual reads from disk are performed in 'lazy' manner, after a specific location is accessed.

### **System call:**

In computing, a system call is how a program requests a service from an operating system's kernel. This may include hardware related services (e.g. accessing the hard disk), creating and executing new processes, and communicating with integral kernel services (like scheduling). System calls provide an essential interface between a process and the operating system.

### **Digital rights:**

The term digital rights describes the permissions of individuals legitimately to perform actions involving the use of a computer, any electronic device, or a communications network. The term is particularly related to the protection and realization of existing rights, such as the right to privacy or freedom of expression , in the context of new digital technologies, especially the Internet.

Human rights and the Internet



A number of human rights have been identified as relevant with regard to the Internet.

### **Service:**

In the context of enterprise architecture, service-orientation and service-oriented architecture, the term service refers to a set of related software functionalities that can be reused for different purposes, together with the policies that should control its usage.

OASIS defines service as 'a mechanism to enable access to one or more capabilities, where the access is provided using a prescribed interface and is exercised consistent with constraints and policies as specified by the service description.' Service engineering

An enterprise architecture team will develop the organization's service model first by defining the top level business functions. Once the business functions are defined, they are further sectioned into services that represent the processes and activities needed to manage the assets of the organization in their various states.

### **volume table of contents:**

In the IBM mainframe storage architecture, Volume Table Of Contents, is a data structure, that provides a way of locating the data sets that reside on a particular disk volume. It can reside within the first 64K tracks on the volume, and lists the names of each data set on the volume as well as size, location, and permissions. Additionally, it contains an entry for every area of contiguous free space on the volume.

### **Blue Screen of Death:**

The Blue Screen of Death known officially as a Stop Error or a bug check, is the error screen displayed by the Microsoft Windows family of operating systems upon encountering a critical error, of a non-recoverable nature, that causes the system to crash. The color of the screen generated by the error. In Unix-based operating systems, a similar term is kernel panic.

### **Plug and play:**

In computing, plug and play is a term used to describe the characteristic of a computer bus, or device specification, which facilitates the discovery of a hardware component in a system, without the need for physical device configuration, or user intervention in resolving resource conflicts.

Plug and play refers to both the boot-time assignment of device resources, and to hotplug systems such as USB and IEEE 1394 (FireWire). History of device configuration

In the beginnings of data processing technology, the hardware was just a collection of modules, and the functions of those modules had to be linked to accommodate different calculating operations.

#### **reference monitor:**

In operating systems architecture a reference monitor concept defines a set of design requirements on a reference validation mechanism, which enforces an access control policy over subjects' (e.g., processes and users) ability to perform operations (e.g., read and write) on objects (e.g., files and sockets) on a system. The properties of a reference monitor are:

- The reference validation mechanism must always be invoked (complete mediation). Without this property, it is possible for an attacker to bypass the mechanism and violate the security policy.
- The reference validation mechanism must be tamperproof (tamperproof).

#### **Device driver:**

In computing, a device driver is a computer program allowing higher-level computer programs to interact with a hardware device.

A driver typically communicates with the device through the computer bus or communications subsystem to which the hardware connects. When a calling program invokes a routine in the driver, the driver issues commands to the device.

#### **filter driver:**

A filter driver is a Microsoft Windows driver that adds value to peripheral devices or supports a specialized device in the personal computer. It is a driver/program/module that is inserted into the existing driver stack to perform some specific function. A filter driver should not affect the normal working of the existing driver stack in any major way.

#### **class driver:**

In computing, a class driver is a type of hardware device driver that can operate a large

number of different devices of a broadly similar type.

Class drivers are very often used with USB based devices, which share the essential USB protocol in common, and devices with similar functionality can easily adopt common protocols.

As another example, instead of having a separate driver for every kind of class driver-ROM device, a class driver can operate a wide variety of class driver-ROMs from different manufacturers.

### **ActiveX:**

ActiveX is a framework for defining reusable software components in a programming language-independent way. Software applications can then be composed from one or more of these components in order to provide their functionality.

It was introduced in 1996 by Microsoft as a development of its Component Object Model (COM) and Object Linking and Embedding (OLE) technologies and is commonly used in its Windows operating system, although the technology itself is not tied to it.

### **DLL Hell:**

In computing, DLL Hell is a term for the complications that arise when working with dynamic link libraries (DLLs) used with Microsoft Windows operating systems, particularly legacy 16-bit editions which all run in a single memory space. While the phrase is Windows-specific and a derivation of the general cross-platform phrase 'dependency hell', the rhyme 'DLL hell' makes its use popular for discussing a general Windows-related dependency hell case.

DLL Hell can manifest itself in many different ways; typically applications do not launch or work correctly.

### **Svchost.exe:**

In the Windows NT family of operating systems, svchost.exe is a system process which hosts multiple Windows services. Its executable image, %SystemRoot%\System32\Svchost.exe or %SystemRoot%\SysWOW64\Svchost.exe (for 32-bit services running on 64-bit systems) runs in multiple instances, each hosting one or

more services. It is essential in the implementation of so-called shared service processes, where a number of services can share a process in order to reduce resource consumption.

**Block:**

In computing (specifically data transmission and data storage), a block is a sequence of bytes or bits, having a nominal length (a block size). Data thus structured are said to be blocked. The process of putting data into blocks is called blocking.

**Data:**

In computer science, data ( 'de?t?-t? or 'dæt?) is information in a form suitable for use with a computer. Data is often distinguished from programs. A program is a sequence of instructions that detail a task for the computer to perform.

**transactional memory:**

Transactional memory attempts to simplify parallel programming by allowing a group of load and store instructions to execute in an atomic way. It is a concurrency control mechanism analogous to database transactions for controlling access to shared memory in concurrent computing.

Hardware vs. software transactional implementations

Hardware transactional memory systems may comprise modifications in processors, cache and bus protocol to support transactions.

**ConTeXt:**

ConTeXt is a general-purpose document processor. It is especially suited for structured documents, automated document production, very fine typography, and multi-lingual typesetting. It is based in part on the TeX typesetting system, and uses a document markup language for manuscript preparation.

**Data structure:**

In computer science, a data structure is a particular way of storing and organizing data in a computer so that it can be used efficiently.

Different kinds of data structures are suited to different kinds of applications, and some

are highly specialized to specific tasks. For example, B-trees are particularly well-suited for implementation of databases, while compiler implementations usually use hash tables to look up identifiers.

### **MailSlot:**

A MailSlot is a type of interprocess communication that allows communication between processes both locally and over a network. The use of MailSlots is generally simpler than named pipes or sockets, but they are more limited.

#### **Features**

MailSlots function as a server-client interface.

### **critical section:**

In concurrent programming a critical section is a piece of code that accesses a shared resource (data structure or device) that must not be concurrently accessed by more than one thread of execution. A critical section will usually terminate in fixed time, and a thread, task or process will have to wait a fixed time to enter it (aka bounded waiting). Some synchronization mechanism is required at the entry and exit of the critical section to ensure exclusive use, for example a semaphore.

### **IDEAL:**

iDEAL is an Internet payment method in the Netherlands, based on online banking. Introduced in 2005, this payment method allows customers to buy securely on the Internet using direct online transfers from their bank account. iDEAL processed 4,5 million transfers in 2006, 15 million transfers in 2007, 28 million transfers in 2008, 45.4 million in 2009 and 68.8 million in 2010. iDEAL is owned by the Dutch organization Currence, which also owns PIN and Chipknip.

### **Priority inversion:**

In computer science, priority inversion is a problematic scenario in scheduling when a higher priority task is indirectly preempted by a lower priority task effectively 'inverting' the relative priorities of the two tasks.

This violates the priority model that high priority tasks can only be prevented from running by higher priority tasks and briefly by low priority tasks which will quickly complete their use of a resource shared by the high and low priority tasks. Example of a priority inversion

Consider there is a task L, with low priority.

### **Bank switching:**

Bank switching is a technique to increase the amount of usable memory beyond the amount directly addressable by the processor. It can be used to configure a system differently at different times; for example, a ROM required to start a system from diskette could be switched out when no longer needed.

Bank switching originated in minicomputer systems.

### **copy-on-write:**

Copy-on-write is an optimization strategy used in computer programming. The fundamental idea is that if multiple callers ask for resources which are initially indistinguishable, they can all be given pointers to the same resource. This function can be maintained until a caller tries to modify its 'copy' of the resource, at which point a true private copy is created to prevent the changes becoming visible to everyone else.

### **translation lookaside buffer:**

A translation lookaside buffer is a cache that memory management hardware uses to improve virtual address translation speed. All current desktop, notebook, and server processors use a translation lookaside buffer to map virtual and physical address spaces, and it is nearly always present in any hardware which utilizes virtual memory.

The translation lookaside buffer is typically implemented as content-addressable memory (CAM).

### **page fault:**

A page fault is a trap to the software raised by the hardware when a program accesses a page that is mapped in the virtual address space, but not loaded in physical memory. In the typical case the operating system tries to handle the page fault by making the required page accessible at a location in physical memory or kills the program in the case of an illegal access. The hardware that detects a page fault is the memory management unit in a processor.

**Frame:**

In computer networking and telecommunication, a frame is a digital data transmission unit or data packet that includes frame synchronization, i.e. a sequence of bits or symbols making it possible for the receiver to detect the beginning and end of the packet in the stream of symbols or bits. If a receiver is connected to the system in the middle of a frame transmission, it ignores the data until it detects a new frame synchronization sequence.

In computer networking, a frame is a data packet on the Layer 2 of the OSI model.

**Balance:**

Balance is a simple but powerful generic TCP proxy with round robin load balancing and failover mechanisms. Its behaviour can be controlled at runtime using a simple command line syntax.

Balance successfully runs at least on Linux(386), Linux(Itanium), FreeBSD, BSD/OS, Solaris, Cygwin, Mac-OS X, HP-UX and many more.

**Multiprocessor:**

A multiprocessor is a tightly coupled computer system having two or more processing units (Multiple Processors) each sharing main memory and peripherals, in order to simultaneously process programs.

Sometimes the term Multiprocessor is confused with the term Multiprocessing.

While Multiprocessing is a type of 'processing' in which two or more processors work together to 'process more than one program simultaneously', the term Multiprocessor is referred to the hardware architecture that allows multiprocessing.

**Shared memory:**

In computing, shared memory is memory that may be simultaneously accessed by multiple programs with an intent to provide communication among them or avoid redundant copies. Shared memory is an efficient means of passing data between programs. Depending on context, programs may run on a single processor or on multiple separate processors.

**ioctl:**

In computing, (an abbreviation of input/output control) is a system call for device-specific input/output operations and other operations which cannot be expressed by regular system calls. It takes a parameter specifying a request code; the effect of a call depends completely on the request code. Request codes are often device-specific.

**False sharing:**

In computer science, false sharing is a performance degrading usage pattern that can arise in systems with distributed, coherent caches at the size of the smallest resource block managed by the caching mechanism. When a system participant attempts to periodically access data that will never be altered by another party, but that data shares a cache block with data that is altered, the caching protocol may force the first participant to reload the whole unit despite a lack of logical necessity. The caching system is unaware of activity within this block and forces the first participant to bear the caching system overhead required by true shared access of a resource.

**NTFS:**

NTFS is a proprietary file system developed by Microsoft Corporation for its Windows line of operating systems, beginning with Windows NT 3.1 and Windows 2000, including Windows XP, Windows Server 2003, and all their successors to date.

NTFS supersedes the FAT file system as the preferred file system for Microsoft's Windows operating systems. NTFS has several improvements over FAT and HPFS (High Performance File System), such as improved support for metadata, and the use of advanced data structures to improve performance, reliability, and disk space utilization, plus additional extensions, such as security access control lists (ACL) and file system journaling.

**FIFO:**

FIFO is an acronym for First In, First Out, an abstraction related to ways of organizing and manipulation of data relative to time and prioritization. This expression describes the principle of a queue processing technique or servicing conflicting demands by ordering process by first-come, first-served (FCFS) behaviour: where the persons leave the queue in the order they arrive, or waiting one's turn at a traffic control signal.

FCFS is also the jargon term for the FIFO operating system scheduling algorithm, which



gives every process CPU time in the order they come.

**Sparse:**

In computer science, Sparse is a tool designed to find possible coding faults in the Linux kernel. This static analysis tool differed from other such tools in that it was initially designed to flag constructs that were only likely to be of interest to kernel developers, e.g. mixing pointers to user address space and pointers to kernel address space.

Sparse contains built-in checks for known problematic and a set of annotations designed to convey semantic information about types, such as what address space pointers point to, or what locks a function acquires or releases.

**sparse file:**

In computer science, a sparse file is a type of computer file that attempts to use file system space more efficiently when blocks allocated to the file are mostly empty. This is achieved by writing brief information (metadata) representing the empty blocks to disk instead of the actual 'empty' space which makes up the block, using less disk space. The full block size is written to disk as the actual size only when the block contains 'real' (non-empty) data.

**Data stream:**

In telecommunications and computing, a data stream is a sequence of digitally encoded coherent signals (packets of data or data packets) used to transmit or receive information that is in the process of being transmitted.

In electronics and computer architecture, a data flow determines for which time which data item is scheduled to enter or leave which port of a systolic array, a Reconfigurable Data Path Array or similar pipe network, or other processing unit or block (cf. main article).

**Access token:**

In Microsoft Windows operating systems, an access token contains the security information for a login session and identifies the user, the user's groups, and the user's privileges.

## Overview

An access token is an object encapsulating the security descriptor of a process. Attached to a process, a security descriptor identifies the owner of the object (in this case, the process) and ACLs that specify access rights allowed or denied to the owner of the object.

### **Identifier:**

An identifier is a name that identifies (that is, labels the identity of) either a unique object or a unique class of objects, where the 'object' or class may be an idea, physical [countable] object, or physical [noncountable] substance. The abbreviation ID often refers to identity, identification (the process of identifying), or an identifier (that is, an instance of identification). An identifier may be a word, number, letter, symbol, or any combination of those.



## CHAPTER QUIZ: KEY TERMS, PEOPLE, PLACES, CONCEPTS

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1. A microcomputer is a computer with a microprocessor as its central processing unit. It includes a microprocessor, memory, and input/output (I/O) facilities. Such computers are physically small compared to mainframes and minicomputers.

- a. Rensselaer Polytechnic
- b. BDII
- c. BluOnyx
- d. Microcomputer

2. The chown command (abbreviation for change owner) is used on Unix-like systems to change the owner of a file. In most implementations, it can only be executed by the superuser, to prevent users simply changing ownership of files that aren't theirs to access them. Unprivileged (regular) users who wish to change the group of a file that they own may use chgrp.

- a. Rensselaer Polytechnic
- b. Rack unit
- c. Chown
- d. Reading

3. The Local Procedure Call is an internal, undocumented inter-process communication

facility provided by the Microsoft Windows NT kernel for lightweight IPC between processes on the same computer. As of Windows Vista, LPC has been rewritten as Advanced Local Procedure Call in order to provide a high-speed scalable communication mechanism required to efficiently implement User-Mode Driver Framework, whose user-mode parts require an efficient communication channel with UMDF's components in the executive.

The (A)LPC interface is part of Windows NT's undocumented Native API, and as such is not available to applications for direct use.

a. MailSlot

b. Local Procedure Call

c. SIMPL

d. Message queue

4. Security descriptors are data structures of security information for securable Windows objects, that is objects that can be identified by a unique name. Security descriptors can be associated with any named objects, including files, folders, shares, registry keys, processes, threads, named pipes, services, job objects and other resources.

Security descriptors contain discretionary access control lists (DACL's) that contain access control entries (ACEs) that grant and deny access to trustees such as users or groups.

a. Rensselaer Polytechnic

b. Semi-s-cobordism

c. security descriptor

d. Sheaf

5. Object Manager (internally called Ob) is a subsystem implemented as part of the Windows Executive which manages Windows resources. Each resource, which are surfaced as logical objects, resides in a namespace for categorization. Resources can be physical devices, files or folders on volumes, Registry entries or even running processes.

a. Object Manager

b. Opaque data type

c. Opaque pointer

d. Option type

**ANSWER KEY**





## **ANSWER KEY**

1. d

2. c

3. b

4. c

5. a

---

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**Chapter 12. CASE STUDY 3: SYMBIAN OS**



## CHAPTER OUTLINE: KEY TERMS, PEOPLE, PLACES, CONCEPTS

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• Symbian

• Linux

• System call

• Microkernel

• Device driver



## **CHAPTER HIGHLIGHTS: KEY TERMS, PEOPLE, PLACES, CONCEPTS**

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### **Symbian:**

Symbian is a mobile operating system (OS) and computing platform designed for smartphones and currently maintained by Accenture. The Symbian platform is the successor to Symbian OS and Nokia Series 60; unlike Symbian OS, which needed an additional user interface system, Symbian includes a user interface component based on S60 5th Edition. The latest version, Symbiansq3, was officially released in Q4 2010, first used in the Nokia N8. In May 2011 an update, Symbian Anna, was officially announced, followed by Nokia Belle (previously Symbian Belle) in August 2011.

### **Linux:**

Linux is a Unix-like computer operating system assembled under the model of free and open source software development and distribution. The defining component of Linux is the Linux kernel, an operating system kernel first released 5 October 1991 by Linus Torvalds.

Linux was originally developed as a free operating system for Intel x86-based personal computers.

### **System call:**

In computing, a system call is how a program requests a service from an operating system's kernel. This may include hardware related services (e.g. accessing the hard disk), creating and executing new processes, and communicating with integral kernel services (like scheduling). System calls provide an essential interface between a process and the operating system.

### **Microkernel:**

In computer science, a microkernel is the near-minimum amount of software that can provide the mechanisms needed to implement an operating system (OS). These mechanisms include low-level address space management, thread management, and inter-process communication (IPC). If the hardware provides multiple rings or CPU modes, the microkernel is the only software executing at the most privileged level (generally referred to as supervisor or kernel mode).

**Device driver:**

In computing, a device driver is a computer program allowing higher-level computer programs to interact with a hardware device.

A driver typically communicates with the device through the computer bus or communications subsystem to which the hardware connects. When a calling program invokes a routine in the driver, the driver issues commands to the device.

**removable media:**

In computer storage, removable media refers to storage media which are designed to be removed from the computer without powering the computer off.

Some types of removable media are designed to be read by removable readers and drives. Examples include:

- Optical discs (Blu-ray discs, DVDs, CDs)
- Memory cards (CompactFlash card, Secure Digital card, Memory Stick)
- Floppy disks / Zip disks
- Magnetic tapes
- Paper data storage (punched cards, punched tapes)

Some removable media readers and drives are integrated into computers, others are themselves removable.





## **CHAPTER QUIZ: KEY TERMS, PEOPLE, PLACES, CONCEPTS**

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1. Symbian is a mobile operating system (OS) and computing platform designed for smartphones and currently maintained by Accenture. The Symbian platform is the successor to Symbian OS and Nokia Series 60; unlike Symbian OS, which needed an additional user interface system, Symbian includes a user interface component based on S60 5th Edition. The latest version, Symbiansq3, was officially released in Q4 2010, first used in the Nokia N8. In May 2011 an update, Symbian Anna, was officially announced, followed by Nokia Belle (previously Symbian Belle) in August 2011.

- a. Rensselaer Polytechnic
- b. Rensselaer Polytechnic Institute
- c. Franklin Institute
- d. Symbian

2. Linux is a Unix-like computer operating system assembled under the model of free and open source software development and distribution. The defining component of Linux is the Linux kernel, an operating system kernel first released 5 October 1991 by Linus Torvalds.

Linux was originally developed as a free operating system for Intel x86-based personal computers.

- a. BioLinux
- b. Linux

c. BlackDog

d. Bodhi Linux

3. In computing, a system call is how a program requests a service from an operating system's kernel. This may include hardware related services (e.g. accessing the hard disk), creating and executing new processes, and communicating with integral kernel services (like scheduling). System calls provide an essential interface between a process and the operating system.

a. SystemVerilog DPI

b. System call

c. Telephony Server Application Programming Interface

d. Transport Layer Interface

4. In computer science, a microkernel is the near-minimum amount of software that can provide the mechanisms needed to implement an operating system (OS). These mechanisms include low-level address space management, thread management, and inter-process communication (IPC). If the hardware provides multiple rings or CPU modes, the microkernel is the only software executing at the most privileged level (generally referred to as supervisor or kernel mode).

a. Mode setting

b. Microkernel

c. Process

d. Process management

5. In computing, a device driver is a computer program allowing higher-level computer programs to interact with a hardware device.

A driver typically communicates with the device through the computer bus or communications subsystem to which the hardware connects. When a calling program invokes a routine in the driver, the driver issues commands to the device.

a. Device independent

b. Device driver

c. Feature complete

d. Fileset

**ANSWER KEY**



## **ANSWER KEY**

1. d

2. b

3. b

4. b

5. b

---

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**Chapter 13. OPERATING SYSTEM DESIGN**





## CHAPTER OUTLINE: KEY TERMS, PEOPLE, PLACES, CONCEPTS

---

- Linux
- Interface
- System call
- Data
- Chown
- Layered system
- Exokernel
- Microkernel
- late binding
- Indirection
- reusability
- CheckKing
- Chief programmer team
- Programmer
- second-system effect
- No Silver Bullet

- Address space

- Spaces

- Embedded operating system

- Embedded system



## **CHAPTER HIGHLIGHTS: KEY TERMS, PEOPLE, PLACES, CONCEPTS**

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### **Linux:**

Linux is a Unix-like computer operating system assembled under the model of free and open source software development and distribution. The defining component of Linux is the Linux kernel, an operating system kernel first released 5 October 1991 by Linus Torvalds.

Linux was originally developed as a free operating system for Intel x86-based personal computers.

### **Interface:**

An interface in the Java programming language is an abstract type that is used to specify an interface (in the generic sense of the term) that classes must implement. Interfaces are declared using the keyword, and may only contain method signature and constant declarations (variable declarations that are declared to be both and ). An interface may never contain method definitions.

### **System call:**

In computing, a system call is how a program requests a service from an operating system's kernel. This may include hardware related services (e.g. accessing the hard disk), creating and executing new processes, and communicating with integral kernel services (like scheduling). System calls provide an essential interface between a process and the operating system.

### **Data:**

In computer science, data ( 'de?t?-t? or 'dæt?) is information in a form suitable for use with a computer. Data is often distinguished from programs. A program is a sequence of instructions that detail a task for the computer to perform.

### **Chown:**

The chown command (abbreviation for change owner) is used on Unix-like systems to

change the owner of a file. In most implementations, it can only be executed by the superuser, to prevent users simply changing ownership of files that aren't theirs to access them. Unprivileged (regular) users who wish to change the group of a file that they own may use `chgrp`.

### **Layered system:**

In telecommunication, a layered system is a system in which components are grouped, i.e., layered, in a hierarchical arrangement, such that lower layers provide functions and services that support the functions and services of higher layers.

Note: Systems of ever-increasing complexity and capability can be built by adding or changing the layers to improve overall system capability while using the components that are still in place.

### **Exokernel:**

Exokernel is an operating system kernel developed by the MIT Parallel and Distributed Operating Systems group, and also a class of similar operating systems.

The idea behind exokernels is to force as few abstractions as possible on developers, enabling them to make as many decisions as possible about hardware abstractions. Exokernels are tiny, since functionality is limited to ensuring protection and multiplexing of resources, which are vastly simpler than conventional microkernels' implementation of message passing and monolithic kernels' implementation of abstractions.

### **Microkernel:**

In computer science, a microkernel is the near-minimum amount of software that can provide the mechanisms needed to implement an operating system (OS). These mechanisms include low-level address space management, thread management, and inter-process communication (IPC). If the hardware provides multiple rings or CPU modes, the microkernel is the only software executing at the most privileged level (generally referred to as supervisor or kernel mode).

### **late binding:**

Late binding is a computer programming mechanism in which the method being called upon an object is looked up by name at runtime. This is informally known as duck typing

or name binding.

Late binding is often confused with dynamic dispatch, but there are significant differences.

### **Indirection:**

In computer programming, indirection is the ability to reference something using a name, reference, or container instead of the value itself. The most common form of indirection is the act of manipulating a value through its memory address. For example, accessing a variable through the use of a pointer.

### **reusability:**

In computer science and software engineering, reusability is the likelihood a segment of source code that can be used again to add new functionalities with slight or no modification. Reusable modules and classes reduce implementation time, increase the likelihood that prior testing and use has eliminated bugs and localizes code modifications when a change in implementation is required.

Subroutines or functions are the simplest form of reuse.

### **CheckKing:**

checkKing QA is a web application developed by Optimyth Software intended for monitoring the quality of software development process and its results, for organizations that want to control software quality before it is put into production.

The tool complies with the ISO/IEC 9126 standard.

The automated analysis include measures obtained from the software development process (activity, requirements, defects and changes) and analyzable software elements: project documentation, source code, test scripts, build scripts.

### **Chief programmer team:**

A chief programmer team is a programming team which is organised around a chief programmer who is an expert programmer. The other team members have other,

specialised roles, such as librarian, which support the chief programmer in his primary task of designing and coding the software.

The concept is similar to that of a surgical team in which a surgeon who performs the operation is supported by medical staff such as an anaesthetist and nurses.

### **Programmer:**

A programmer, computer programmer is a person who writes computer software. The term computer programmer can refer to a specialist in one area of computer programming or to a generalist who writes code for many kinds of software. One who practices or professes a formal approach to programming may also be known as a programmer analyst.

### **second-system effect:**

The second-system effect refers to the tendency of small, elegant, and successful systems to have elephantine, feature-laden monstrosities as their successors. The term was first used by Fred Brooks in his classic The Mythical Man-Month. It described the jump from a set of simple operating systems on the IBM 700/7000 series to OS/360 on the 360 series.

### **No Silver Bullet:**

'No Silver Bullet -- Essence and Accidents of Software Engineering' is a widely discussed paper on software engineering written by Fred Brooks in 1986. Brooks argues that 'there is no single development, in either technology or management technique, which by itself promises even one order of magnitude [tenfold] improvement within a decade in productivity, in reliability, in simplicity.' He also states that 'we cannot expect ever to see two-fold gains every two years' in software development, like there is in hardware development.

Brooks makes a distinction between accidental complexity and essential complexity, and asserts that most of what software engineers now do is devoted to the essential, so shrinking all the accidental activities to zero will not give an order-of-magnitude improvement. Brooks advocates addressing the essential parts of the software process.

### **Address space:**

In computing, an address space defines a range of discrete addresses, each of which may correspond to a network host, peripheral device, disk sector, a memory cell or other logical or physical entity.

## Overview

Address spaces are created by combining enough uniquely identified qualifiers to make an address unambiguous (within a particular address space). For a person's physical address, the address space would be a combination of locations, such as a neighborhood, town, city, or country.

## **Spaces:**

Spaces was a virtual desktop feature of Mac OS X, introduced in version 10.5 'Leopard'. It was announced by Steve Jobs during the opening keynote at the Worldwide Developers Conference on August 7, 2006. As of Mac OS X 10.7 'Lion', it has been supplanted by Mission Control.

## Overview

Spaces enables users to create multiple virtual desktops suited to the unique needs or work habits of the user.

## **Embedded operating system:**

An embedded operating system is an operating system for embedded computer systems. These operating systems are designed to be compact, efficient, and reliable, forsaking many functions that non-embedded computer operating systems provide, and which may not be used by the specialized applications they run. They are frequently also real-time operating systems, and the term RTOS is often used as a synonym for embedded operating system.

## **Embedded system:**

An embedded system is a computer system designed for specific control functions within a larger system, often with real-time computing constraints. It is embedded as part of a complete device often including hardware and mechanical parts. By contrast, a general-purpose computer, such as a personal computer (PC), is designed to be flexible and to meet a wide range of end-user needs.

## **Sensor node:**

A sensor node, is a node in a wireless sensor network that is capable of performing some



processing, gathering sensory information and communicating with other connected nodes in the network. A mote is a node but a node cannot always be a mote.

## History

Although wireless sensor nodes have existed for decades and used for applications as diverse as earthquake measurements to warfare, the modern development of small sensor nodes dates back to the 1998 Smartdust project and the NASA Sensor Webs Project. One of the objectives of the Smartdust project was to create autonomous sensing and communication within a cubic millimeter of space.



## CHAPTER QUIZ: KEY TERMS, PEOPLE, PLACES, CONCEPTS

---

1. Linux is a Unix-like computer operating system assembled under the model of free and open source software development and distribution. The defining component of Linux is the Linux kernel, an operating system kernel first released 5 October 1991 by Linus Torvalds.

Linux was originally developed as a free operating system for Intel x86-based personal computers.

a. BioLinux

b. Linux

c. BlackDog

d. Bodhi Linux

2. An interface in the Java programming language is an abstract type that is used to specify an interface (in the generic sense of the term) that classes must implement. Interfaces are declared using the keyword, and may only contain method signature and constant declarations (variable declarations that are declared to be both and ). An interface may never contain method definitions.

a. Inversion of control

b. Interface

c. Omniscient Debugger

d. Unified Expression Language

3. In computing, a system call is how a program requests a service from an operating system's kernel. This may include hardware related services (e.g. accessing the hard disk), creating and executing new processes, and communicating with integral kernel services (like scheduling). System calls provide an essential interface between a process and the operating system.

a. SystemVerilog DPI

b. System call

c. Telephony Server Application Programming Interface

d. Transport Layer Interface

4. In computer science, data ( 'deɪt?-t? or 'dæt?) is information in a form suitable for use with a computer. Data is often distinguished from programs. A program is a sequence of instructions that detail a task for the computer to perform.

a. Synthetic data

b. Data

c. 18-bit

d. Binary code

5. The chown command (abbreviation for change owner) is used on Unix-like systems to change the owner of a file. In most implementations, it can only be executed by the

superuser, to prevent users simply changing ownership of files that aren't theirs to access them. Unprivileged (regular) users who wish to change the group of a file that they own may use `chgrp`.

- a. `Chown`
- b. 12-bit
- c. 18-bit
- d. Binary code

**ANSWER KEY**



## **ANSWER KEY**

1. b

2. b

3. b

4. b

5. a

---

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**Chapter 14. READING LIST AND BIBLIOGRAPHY**



## CHAPTER OUTLINE: KEY TERMS, PEOPLE, PLACES, CONCEPTS

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- Domain
- NTFS
- Multiprocessor
- journaling file system
- MINIX



## **CHAPTER HIGHLIGHTS: KEY TERMS, PEOPLE, PLACES, CONCEPTS**

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### **Domain:**

A domain is a field of study that defines a set of common requirements, terminology, and functionality for any software program constructed to solve a problem in the area of computer programming, known as domain engineering.

### **NTFS:**

NTFS is a proprietary file system developed by Microsoft Corporation for its Windows line of operating systems, beginning with Windows NT 3.1 and Windows 2000, including Windows XP, Windows Server 2003, and all their successors to date.

NTFS supersedes the FAT file system as the preferred file system for Microsoft's Windows operating systems. NTFS has several improvements over FAT and HPFS (High Performance File System), such as improved support for metadata, and the use of advanced data structures to improve performance, reliability, and disk space utilization, plus additional extensions, such as security access control lists (ACL) and file system journaling.

### **Multiprocessor:**

A multiprocessor is a tightly coupled computer system having two or more processing units (Multiple Processors) each sharing main memory and peripherals, in order to simultaneously process programs.

Sometimes the term Multiprocessor is confused with the term Multiprocessing.

While Multiprocessing is a type of 'processing' in which two or more processors work together to 'process more than one program simultaneously', the term Multiprocessor is referred to the hardware architecture that allows multiprocessing.

### **journaling file system:**

A journaling file system is a file system that keeps track of the changes that will be made

in a journal (usually a circular log in a dedicated area of the file system) before committing them to the main file system. In the event of a system crash or power failure, such file systems are quicker to bring back online and less likely to become corrupted.

## **Rationale**

Updating file systems to reflect changes to files and directories usually requires many separate write operations.

## **MINIX:**

MINIX is a Unix-like computer operating system based on a microkernel architecture created by Andrew S. Tanenbaum for educational purposes; MINIX also inspired the creation of the Linux kernel.

MINIX was first released in 1987, with its complete source code made available to universities for study in courses and research. It has been free and open source software since it was re-licensed under the BSD license in April 2000.

## **Symbian:**

Symbian is a mobile operating system (OS) and computing platform designed for smartphones and currently maintained by Accenture. The Symbian platform is the successor to Symbian OS and Nokia Series 60; unlike Symbian OS, which needed an additional user interface system, Symbian includes a user interface component based on S60 5th Edition. The latest version, Symbiansq3, was officially released in Q4 2010, first used in the Nokia N8. In May 2011 an update, Symbian Anna, was officially announced, followed by Nokia Belle (previously Symbian Belle) in August 2011.



## **CHAPTER QUIZ: KEY TERMS, PEOPLE, PLACES, CONCEPTS**

---

1. A domain is a field of study that defines a set of common requirements, terminology, and functionality for any software program constructed to solve a problem in the area of computer programming, known as domain engineering.

- a. GRASP
- b. Domain
- c. Presentation logic
- d. Rule of least power

2. NTFS is a proprietary file system developed by Microsoft Corporation for its Windows line of operating systems, beginning with Windows NT 3.1 and Windows 2000, including Windows XP, Windows Server 2003, and all their successors to date.

NTFS supersedes the FAT file system as the preferred file system for Microsoft's Windows operating systems. NTFS has several improvements over FAT and HPFS (High Performance File System), such as improved support for metadata, and the use of advanced data structures to improve performance, reliability, and disk space utilization, plus additional extensions, such as security access control lists (ACL) and file system journaling.

- a. Rensselaer Polytechnic
- b. Layer
- c. Presentation logic



d. NTFS

3. A multiprocessor is a tightly coupled computer system having two or more processing units (Multiple Processors) each sharing main memory and peripherals, in order to simultaneously process programs.

Sometimes the term Multiprocessor is confused with the term Multiprocessing.

While Multiprocessing is a type of 'processing' in which two or more processors work together to 'process more than one program simultaneously', the term Multiprocessor is referred to the hardware architecture that allows multiprocessing.

a. Multithreading

b. Multiprocessor

c. Parallel Element Processing Ensemble

d. Parallel slowdown

4. A journaling file system is a file system that keeps track of the changes that will be made in a journal (usually a circular log in a dedicated area of the file system) before committing them to the main file system. In the event of a system crash or power failure, such file systems are quicker to bring back online and less likely to become corrupted.

Rationale

Updating file systems to reflect changes to files and directories usually requires many separate write operations.

a. symbolic link

b. journaling file system

c. shadow paging

d. temporary file

5. MINIX is a Unix-like computer operating system based on a microkernel architecture created by Andrew S. Tanenbaum for educational purposes; MINIX also inspired the creation of the Linux kernel.

MINIX was first released in 1987, with its complete source code made available to universities for study in courses and research. It has been free and open source software since it was re-licensed under the BSD license in April 2000.

a. Rensselaer Polytechnic

b. home directory

c. shadow paging

d. MINIX

**ANSWER KEY**



## **ANSWER KEY**

1. b

2. d

3. b

4. b

5. d

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