Course Work 1

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26/4/2023

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Platform and Operating Systems

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Introduction

The OS (Operating System) is a crucial part of a computer-based device, since it provides a platform for downloading and running applications as well as managing hardware resources. Therefore, understanding this topic is integral for computer science and cybersecurity students. All functions required by cybersecurity depend on the understanding of OS concepts. Furthermore, different OS platforms have different versions which provide different services for the hardware and software management to reflect the required computer-based functionality.

The main purpose of this document is to illustrate an in-depth understanding of various concepts of operating systems as well as how it interacts with the computer's hardware. Additionally, this report will prove the students' understanding of different offered services regarding the process control, file, and memory management, as well as supplementing with a small snippet of code illustrating the process control block. This

report will also explain and illustrate how these services affect different OS platforms, such as Windows, Unix/Linux, as well as Mac OS.

The reader will have a thorough understanding of OS ideas, services offered by various platforms, and their effect on the performance of computer-based systems at the end of this report. The reader will also learn the benefits and drawbacks of each platform for each service, making it simpler to select the optimal platform for a given set of requirements.

OS Concepts

OS (Operating System) are the main backbone of computer systems; it provides a layer of software that interacts with the user's hardware components and allows users to install and run applications as well as manage the system's resources. However, there are main concepts of an operating system which include:

Definition and types of OS:

An operating system is a component that controls the hardware and software resources of a computer, offers a user interface, and executes programs. Real-time, network, mobile, and embedded operating systems are only a few of the numerous varieties. Every OS type has distinctive characteristics and capabilities that are tailored to particular use cases and requirements.

Functions of the OS:

An operating system includes functions like process management, file management, memory management, and input/output (I/O). Furthermore, Process management includes creating, terminating, and scheduling of installed processes. File management deals with the manipulation and organization factors of files and directories. Memory management involves the deallocation and allocation of memory regarding the processes, lastly the I/O management, which means input output, handles the communication line between hardware peripherals and the operating system.

Structure of OS:

Foundationally, an operating systems structure consists of 4 main components, which are:
the user interface, device drivers, system libraries, and finally the kernel, which is the most important part of the operating system as it is its core, managing system resources as well as providing low-level services. The device drivers allow the OS to communicate with peripheral components, while the system libraries manage the high-level functions that are utilized by the installed applications. Finally, the user interface, which is put in place in order to allow the user to interact with OS in a more user-friendly way using a graphical interface.

Process management:

This concept is crucial to an operating system as it involves the creation and termination as well as scheduling of a process. The OS must have the ability to either terminate or execute multiple processes at the same time while ensuring that they don't interfere. The PCB, which is the process control block, is a data structure utilized by the operating system in order to store information about each running process such as the resources used, the state, and the priority.

File management:

File management is another crucial function of an operating system, since it involves the organization and manipulation of files and directories. The OS must ensure that the files are stored and secured while also allowing authorized users to access and modify their files.

Memory Management:

Memory management includes the management, allocation, and deallocation of the memory to processes, the OS handles the part which distributes the memory to each process according to the requirement of each process and prevent them from accessing memory that doesn't belong to them. Memory management techniques involve paging, segmentation, and virtual memory.

Process Control

Process control is a function in which an operating system manages the execution and termination of processes within the computer system. It is a crucial component of an operating system as it utilizes and efficiently uses the hardware resources to ensure that the different processes do not cause any malfunctions and don't interfere with each other.

There are various ways in which an operating system approaches process control, for example, windows use a system that is priority-based which assigns a certain priority value to each process based on the set importance. Priority decides which process gets to be executed. On the other hand, Unix/Linux uses a more shared approach, where all processes share the CPU at the same time in a looping manner.

PCB, a data structure that contains all the information about the running processes, such as the memory requirements, the state, and the priority. A normal PCB would also normally contain the process ID, the pointers to memory segments as well as the CPU registers. Here is an example code of a simple PCB I constructed written in C (See figure 1.1)

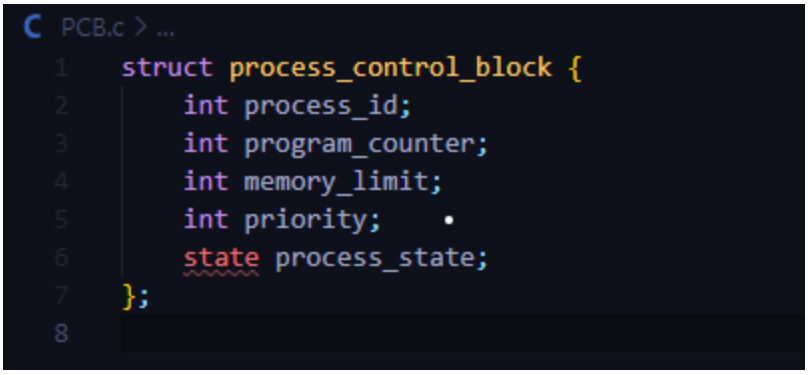

Figure: 1.1

Process control is a crucial component of an operating system, and different platforms implement it differently. A crucial data structure that enables the operating system to efficiently manage and monitor the execution of processes is the process control block.

File Management

File Management means the method of storing, retrieving, and organizing files that are on a computer system. In includes managing the location of the field on the storage device, as well as keeping track of the files metadata. But most importantly, it is crucial since it allows users to access, create, and edit files as fast as possible.

However, Operating systems use multiple approaches to this topic, Windows uses a tree like system, which is hierarchical, where the file are organized in a structure following the branches of a tree but inverted, with the root directory at the very top/ root of the upside-down tree. Linux on the other hand uses a tree-structured approach, where the root is at the very bottom of the tree and the files branch from it.

Windows utilizes the New Technology File System (NTFS) or the File Allocation Table (FAT) for file management, Although, Linux uses Unix File System (UFS) or in some cases the Extended File System (EXT). The choice of the technique used all depends on the efficiency of file access, the maximum file size the OS can handle, as well as the security of such file, all depending on the case.

A file is represented by a file control block (FCB). This FCB contains metadata about the file, including the file's name, type, location, size, date of creation/modification/access, and access permissions. Every file has an FCB, which the operating system creates, maintains, and uses to control file operations like opening, reading, writing, and terminating.

Memory management

All operating systems have a critical function that they cannot function without, which is memory management. Memory management handles the allocation and deallocation of memory resources to the different processes. It is crucial that this function runs as smoothly and efficiently as possible.

There are multiple ways in which operating systems approached memory management.

Windows Memory Management

Windows, utilizes a virtual memory system which allows the OS to allocate more memory than the hardware capabilities, this can happen due to the use of page files, which windows places on the hard disk, and when the process requires more memory than available, the OS switches some of the data from the memory to the page file in order to allow new data to enter the memory.

Unix/Linux Memory Management

Linux also utilizes a virtual memory system, although, it has a variant approach to managing memory, Unix uses a paging system that efficiently divides the memory into smaller fixed-size pages, and when a process requires more memory than currently available, the OS swaps some of the data located in the memory to the created page. In addition to that, Linux/Unix has the feature to move entire processes from and out of the memory to the disk, this feature is called “Swapping”.

In terms of performance, Unix is the winner, as its paging system is a much more efficient paging system. However, during the previous years windows has developed their paging system and became comparable to Linux.

Overall, memory management is a vital component of any operating system and is essential to making sure the system operates faultlessly. An operating system's overall performance and efficiency can be significantly impacted by the method of memory management it employs.

Comparison of OS services in Different Platforms

An operating system's capacity to manage various services, including process control, file management, and memory management, determines how effective and efficient it is. In this section, we'll contrast the various OS features offered by the four most popular operating systems: Windows, Unix/Linux, Android, and Mac OS.

Process Control

Process control is one of the most essential services in an operating system the manages the termination or execution of a process. As mentioned before, Windows and Linux utilize different approaches to handle process control. Android and Mac OS on the other hand, use a familiar approach close to that of Linux/Unix, however they do contain some differences.

Android uses a Linux kernel, which in turn enables the same multi-level scheduler, in addition to that, Android uses a unique process control method called Intents, which in foundation allows all applications to contact and communicate with each other. Process control in Mac OS is handled using a hybrid strategy that combines elements of both Windows and Unix/Linux.

File Management

Another essential operating system function is file management, which includes creating, opening, closing, reading, writing, and deleting files. When it comes to file management, Windows and Unix/Linux take different approaches. File management in Windows is handled by the File Allocation Table (FAT) or New Technology File System (NTFS). while File management in Linux is structured like an upright tree with the

Unix/Linux file systems are used by Android and Mac OS. But Android makes use of a special file system called YAFFS (Yet Another Flash File System), which is designed specifically for NAND flash memory found in mobile devices. The Hierarchical File System Plus (HFS+) file system, which is an expansion of the Hierarchical File System (HFS) is used by Mac OS

Memory Management

Operating systems need to manage the allocation and deallocation of memory resources as part of their memory management function. Memory management is done differently in Windows and Unix/Linux. While Unix/Linux combines paging and segmentation techniques, Windows divides memory into fixed-size pages using a paging technique.

Similar memory management strategies are used by Android and Mac OS and Unix/Linux, but there are some differences. The Linux kernel, which powers Android, uses the same memory management strategies as Unix/Linux. However, Android also makes use of a special garbage collection mechanism to release memory used by unused programs. The operating system of Mac OS, on the other hand, makes use of a method known as virtual memory that enables it to access more memory than is available.

Advantages and Disadvantages

Every platform has benefits and drawbacks. Windows' single scheduler gives it an advantage in process management, but its file management is less efficient than Unix/Linux's. While Unix/Linux excels at managing files and memory, its process control may not be as effective as Windows'. Android's distinctive Intents process control mechanism works well with mobile devices but may not be appropriate for desktop computers. even though Mac OS combines the best aspects of Windows and Unix/Linux, its app compatibility may be limited.

Summary Comparison Table

To better understand the differences between the OS services provided by the different platforms, we have created the following summary comparison table (See table 1.1)

Service	**Windows**	**Unix/Linux**	**Android**	**Mac OS**
Process Control	Single	Multi-level	Multi-level	Hybrid
Scheduler	Scheduler	Scheduler	Scheduler	
File Management	FAT/NTFS	Hierarchical	Hierarchical	HFS+/HFS

Table 1.1

Conclusion

In conclusion, the purpose of this report was to explain the fundamental ideas behind operating systems and how they are used in computer science and cyber security. The main functions of process control, file management, and memory management were covered in the report, along with how they are implemented in various operating systems such as Windows, Unix/Linux, Android, and Mac OS.

To quickly summarize the various strategies employed in the various operating systems, a comparison table was made. Based on the comparison, it was determined that each platform has pros and cons, with some being more effective than others for providing services. For instance, while Unix/Linux is well-known for it being open-source and advanced, Windows is renowned for its superb graphical user interface and user-friendliness.

In computer science and cyber security, it is essential to comprehend the ideas behind and the ways in which operating systems work. The differences in how various operating systems handle process control, file management, and memory management highlight how crucial it is to select the appropriate platform for a given task.

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Note: Some aspects of this report may have been assisted by AI language models.