TD N°1: Introduction to operating systems

Q1: What is the definition of a computer system and what are the three classes of computer system?

A computer system is a set of data acquisition and retrieval, processing and storage resources dedicated to information processing. It is divided into two parts: hardware (physical) and software (software).

There are three classes of computer system:

- Interactive system (operating system),
- Reactive system (real time),
- Transformational system (compiler).

Q2: What is a time-sharing operating system?

This is a system that shares CPU time between a set of processes running in parallel in an equitable manner.

Q3: Are the command interpreter and compilers part of the operating system?

Command interpreter is part of the operating system, but compilers are not part of the operating system.

Q4: Establish the correspondences between the terms and definitions presented in the table below:

Terms	Definitions
1- Multi-programming	A- Manages computer components
2- Operating system	B- Increases processor performance
3- Virtual machine	C- Test the computer's components
4- Time sharing	D- The processor is shared equally between users
5- BIOS (Basic Input Output System)	E- Allows you to share resources on a network
6- Distributed system	F- Allows you to hide the complexity of the hardware

Q5: An operating system is a set of programs that groups together a certain number of services needed to run the programs that a user can command. It is through its basic software component (or system kernel) that it manages all the operations designed to control and command the computer and its various peripherals. The second component consists of a set of utilities that are probably not needed to start the computer cold.

In what follows, we are interested in classifying the various system services according to which one they belong to. To do this, we ask you to fill in the following table by placing a cross in the appropriate box.

System service	System kernel	System utility
1. Managing hardware interruptions	■	□
2. Calculate the current date	■	□
3. Reading data from a USB flash drive	■	□
4. Sharing memory between processes	■	□
5. Detecting the existence of a virus	□	■

6. Checking a user's access permissions	■	□
7. Translating a program written in VB or C	□	■
8. Renaming a directory	■	□
9. Interpret user commands	□	■
10. Editing a text document	□	■
11. Archiving and restoring files	□	■
12. Compressing data in a file	□	■
13. Read current mouse position	■	□
14. Configuring a printer	□	■
15. Display a diagnosis of errors encountered during	■	□

Q7: Compare a single-tasking system and a multi-tasking system, specifying their qualities and defects according to the following criteria:

1. Complexity: Very complicated multitasking system compared with the single-tasking system.
2. Response time: Multitasking response time is much more efficient than single-tasking because of the parallelism of multitasking execution.
3. Execution time: Same execution time for both systems if the same processor is used.
4. System size: The size of the multitasking system (in GB) is much larger than the size of the single-tasking system (in MB).
5. Resource management: Multitasking provides better resource management than single-tasking.

Q8: What is the difference between user mode and kernel mode on a processor?

In user mode, the processor has no privileges to execute any instruction, whereas in system mode, the processor has full privileges to execute any instruction.

Q9: Which instructions should only be able to run in kernel mode?

System functions or system primitives.

Q10: What happens when a program executed in user mode receives an instruction from the processor that should only be executed in kernel mode?

There is a system call.

Exercise

This exercise concerns the historical development of operating systems and illustrates their performance (It is a simplified operating system).

Consider a computer whose peripherals are a card reader (1000 cards/minute) and a printer (1000 lines/minute). An "average job" is defined as follows:

- Read 300 cards.
- Use the processor for 1 minute,
- Print 500 lines.

It is assumed that all jobs submitted by users have characteristics identical to those of this average job. We define two measures of system performance:

- Average job throughput D: number of jobs completed in one hour.
- CPU efficiency R: fraction of the total time the CPU is in use during which it is performing useful work (other than managing peripherals).

A) First, assume that the peripherals are managed by the CPU. Calculate R and D according to the following operating assumptions:

- The system is operated in open door mode; the duration of a session is limited to 15 minutes. It is assumed that a user needs 4 minutes to correct his program in the light of the results, and make a new submission.

Solution

Time to read 1000 cards ⟶ 1 minute

Time to read 300 cards ⟶ x=?

$$x = \frac{300}{1000} = 0.3\ minute$$

Time to print 1000 lines ⟶ 1 minute

Time to print 500 lines ⟶ x=?

$$x = \frac{500}{1000} = 0.5\ minute$$

The time taken to make one pass is therefore:

$$\text{Time to read 300 cards} + \text{Processor time} + \text{Time to print 500 lines} = 0.3 + 1 + 0.5 = 1.8 \text{ minute}$$

As the user needs 4 minutes between two passes to correct, the number of passes for 15 minutes is at most n such that:

$$1.8 * n + 4 * (n - 1) \leq 15 \quad (1)$$

The value of n that satisfies this inequation (1) is $(n = 3)$.

As a result, the time for this session is :

$$1.8 * 3 + 4 * (3 - 1) = 13.4\ minutes$$

$$R = \frac{Number\ of\ jobs}{Time\ for\ These\ jobs} = \frac{3}{15} = 0.2 = 20\%$$

3 jobs ⟶ 15 minutes

x jobs ⟶ 60 minutes

$$D = x = \frac{3 * 60}{15} = 12\ jobs/heure$$

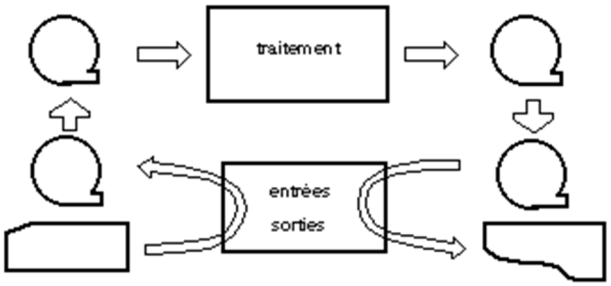
- The system is operated with a job sequencing monitor.

When the system is operated with a job sequencing monitor, the passage time is the same, but there is no waiting between two passages. It follows that:

$$D = \frac{60}{1.8} = 33\ jobs/heure$$

$$R = \frac{Number\ of\ jobs}{Time\ for\ These\ jobs(one\ hour)} = \frac{33}{60} = 0.55 = 55\%$$

B) It is now assumed that the peripherals are managed by a separate computer, which creates an input magnetic tape from the cards and lists the contents of an output magnetic tape on a printer. The computer is fed by the input magnetic tape and produces the output tape; the time taken to read and write the tapes is neglected. The time taken to transfer the tapes from one computer to another is 5 minutes in each direction; it is assumed that one tape contains a batch of 50 jobs (see figure below).



It is assumed that the rate at which jobs are submitted is sufficient to keep the computer running full time. Calculate the values of R and D.

Maximum throughput is limited to 60 jobs per hour by the processing unit.

The maximum card input rate is 60 / 0.3 = 200 jobs per hour.

The maximum print rate is 60 / 0.5 = 120 jobs per hour.

Hence D = 60, and R = 60 / 60 = 1.0 = 100%.