Multiple Virtual Storage (MVS)

Lesson 2: MVS Environnent Concepts

Lesson Objectives

- In this lesson, you will learn the following:
  - The manner in which data and commands are processed in general
  - The various MVS characteristics in detail

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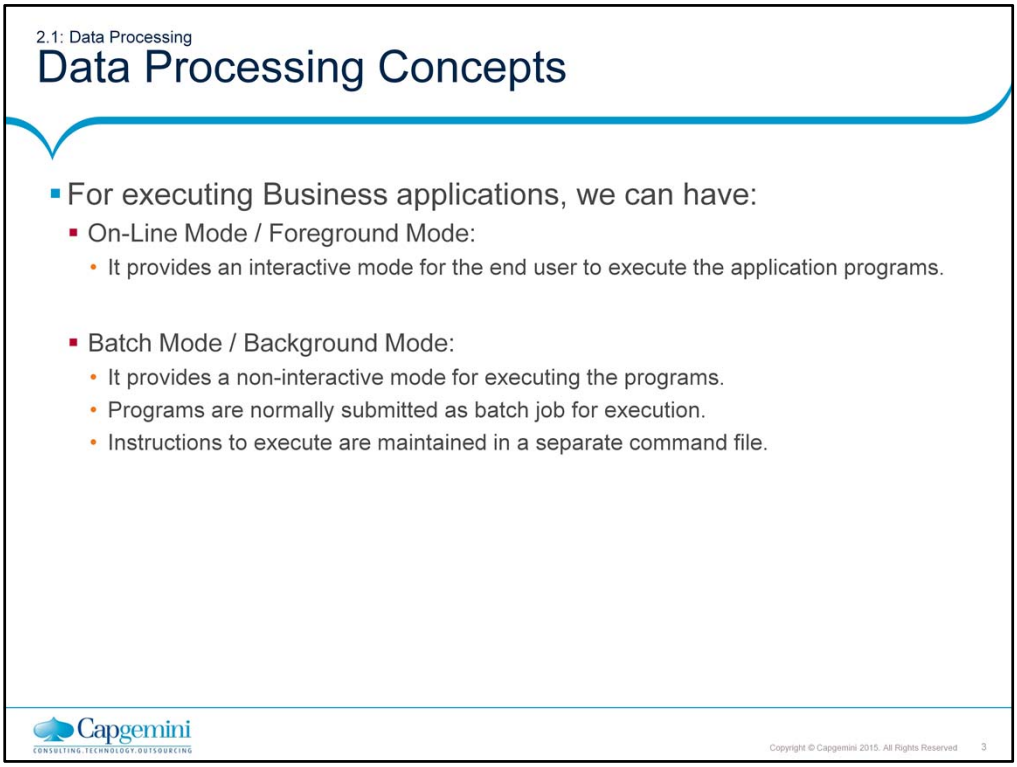
Note: We will be covering the basic characteristics of Mainframe OS in depth. Before that, let us check how data processing is done.



Data Processing:
Data Processing Concepts:
Online environment:
End user performs business functions. These application programs work interactively with End user. Execution is done in foreground mode, that is normally using the terminal devices for taking the input or displaying the output. Any transactions made are immediately updated in database to reflect the changes. It is typically used for transaction processing, queries, and master updates functions.

Batch Environment:
Some application programs are executed in background mode in which the business functions are periodically executed automatically. These functions are triggered by end user “as and when” required. The Operations department is responsible for monitoring the execution. A command file is created to execute these functions. This command file may consist of multiple programs / system utilities to execute the job. It is typically used for bulk transaction processing, report printing, periodic processing (for example: invoice generation, payroll calculation).

2.2: Command Processing

Command Processing Concepts

- Command Issue Mode:
  - How a user (programmer / end-user) interacts with the computer
  - For example: To edit a program, to execute a program:
    - On-line Mode: Using Terminal
    - Batch Mode: Using Punched Cards, JCL
- Command Execution Mode:
  - Foreground: Terminal is locked while the command is being executed.
  - Background: Terminal is free while the command is being executed.

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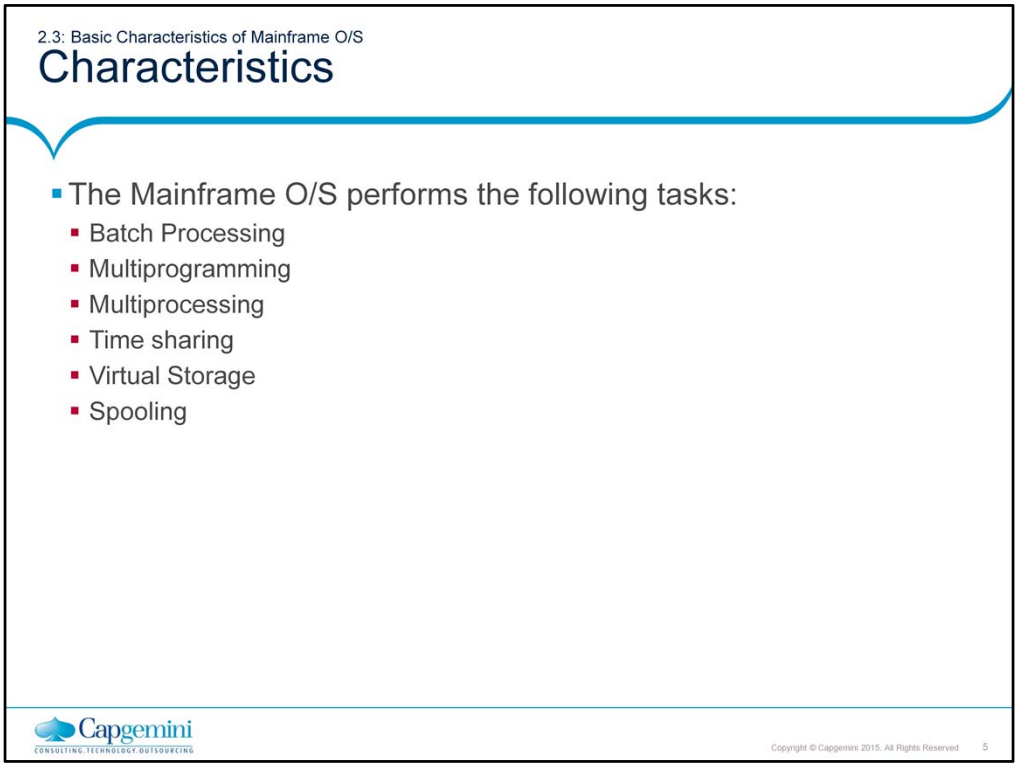
2.3: Basic Characteristics of Mainframe O/S
Characteristics
The Mainframe O/S performs the following tasks:
Batch Processing
Multiprogramming
Multiprocessing
Time sharing
Virtual Storage
Spooling
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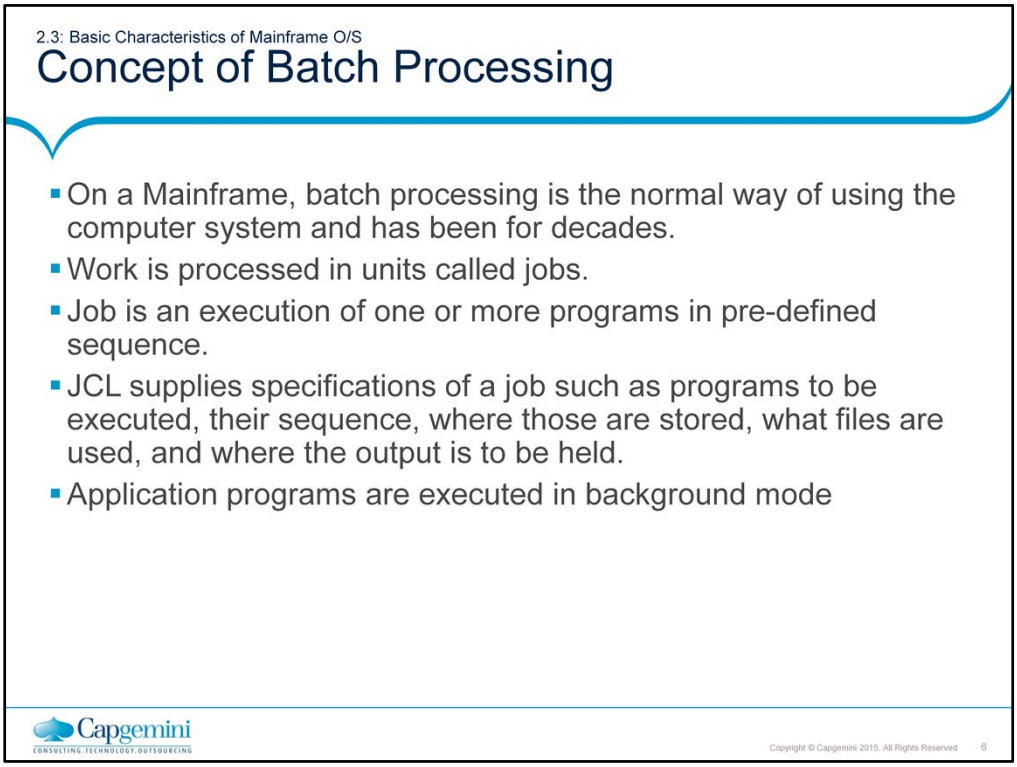


Batch Processing:
When batch processing is used, work is processed in units called “jobs”. A job may cause one or more programs to be executed in sequence. The system collectively processes batch jobs. The operating system is responsible for scheduling the jobs according to priority and the resources they require.

How are jobs executed in batch mode:

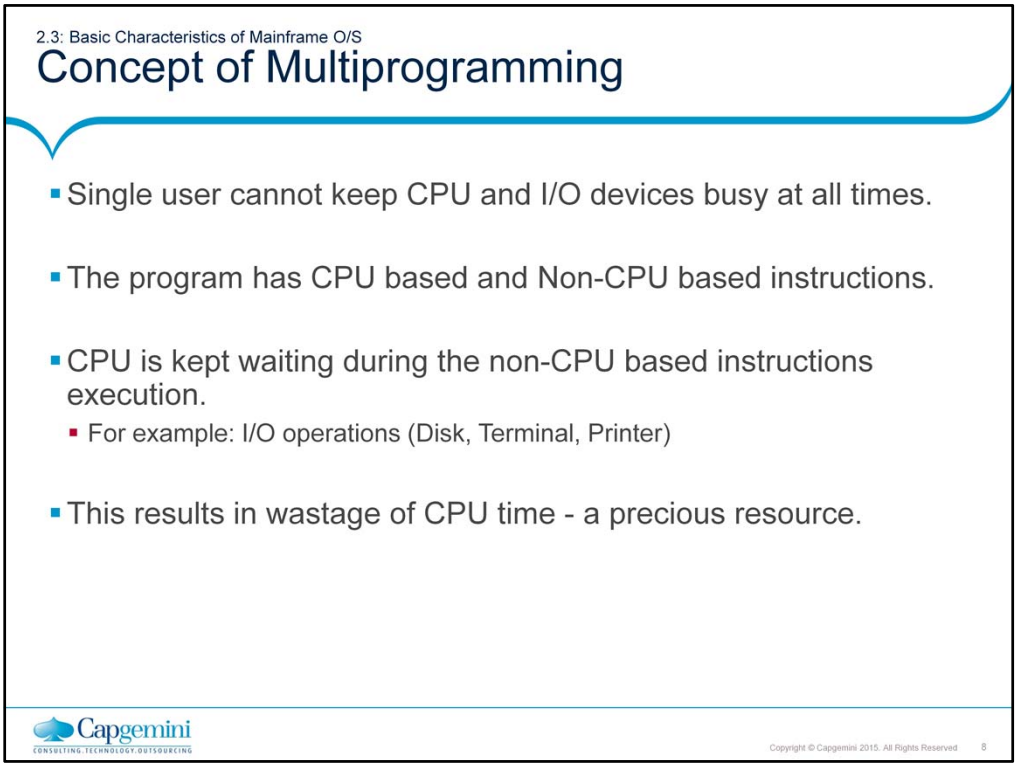
When a user submits a job to the system, that job is added to a list of other jobs, perhaps submitted by other users, that are waiting to be executed.
As the processor becomes available, the job scheduler of the O/S selects the next job to be executed from this list .
The job scheduler can make decisions about the order in which jobs should be executed.
Jobs with higher priority can be given preference over jobs with lower priority.

How are jobs executed in batch mode:

5. Priority of a job is specified in the JCL command file that supplies specifications of a job such as programs to be executed, their sequence, where those are stored, what files are used, where the output is to be held, and so on.
6. Once the execution is done, the output is held in the output queue or printed directly.

Example:

A large company would use batch processing to automate their payrolls where in it would find the list of employees, calculate their monthly salary (with tax deductions) and print the corresponding payslips. Batch processing is useful for this purpose since these procedures are repeated for every employee each month.



Multiprogramming:
While executing a program, some processing instructions – like reading data from disk – take much longer time than others.
As a result, most programs are idle, thus waiting a large percentage of the time for the completion of I/O operations. This also leads to wastage of CPU time.
So, how can we go about making efficient CPU utilization?

Multiprogramming means OS allows one or more programs to execute concurrently.

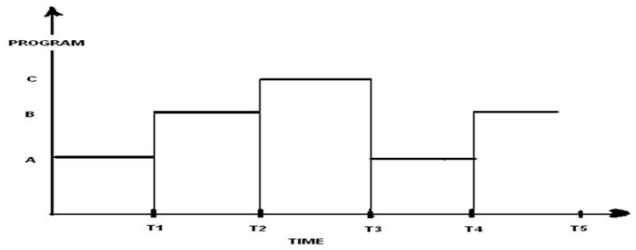
- Most programs spend most of their time waiting for I/O operations to complete.
- So while one program waits for an I/O operation, the CPU can execute instructions for another program.
- CPU executes only one program at any given moment of time.

Note: CPU performs concurrent execution of program and not simultaneous execution.

2.3: Basic Characteristics of Mainframe O/S

How does Multiprogramming Work?

- Multiple programs are kept “ready” for execution.
- CPU executes only one program at any given point in time.
  - If the currently executing program requires I/O, then it is put in a “wait” state. Another program is immediately taken for execution. On completion of I/O the program again becomes “ready” for execution.
  - This results in an illusion that multiple programs are being executed simultaneously, hence multiprogramming.



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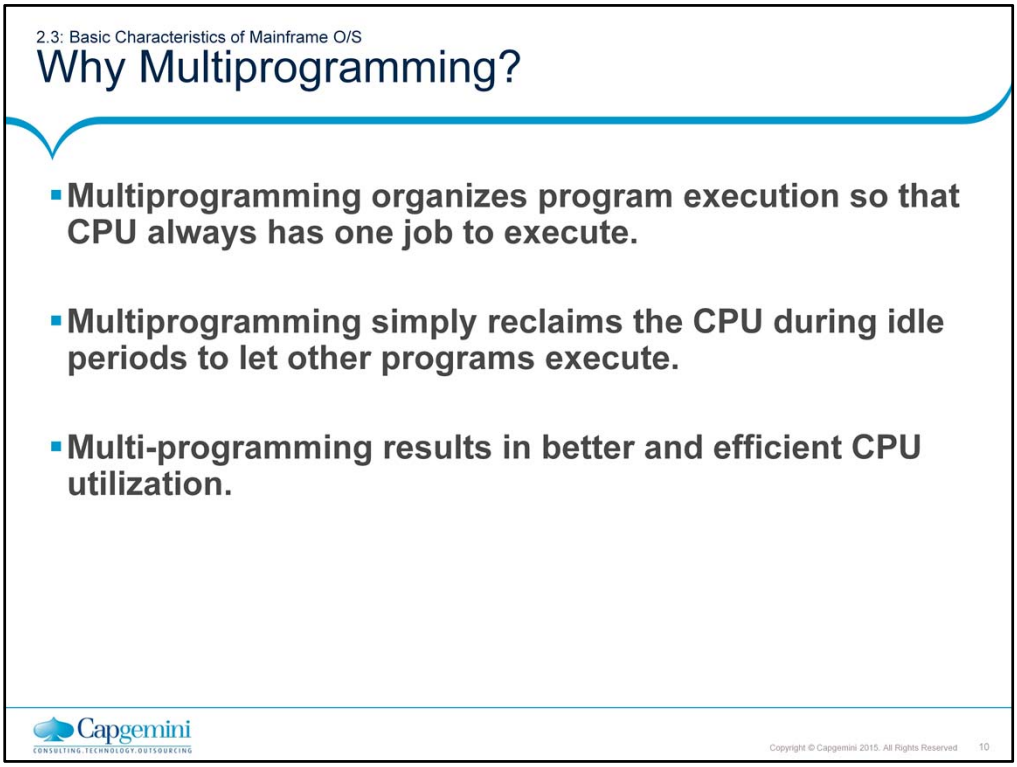
The above slide shows a diagrammatic representation of Multiprogramming. When one program goes for I/O, the O/S takes up second program for execution, and when that goes for I/O, then O/S starts executing another program.
Program doing I/O, goes in “wait” state. After I/O is over, it gets into “ready” state for execution.
The O/S keeps track of which programs are in “ready” state and which programs are in “wait” state.
Note: At any moment, the CPU is executing only one program. It is the concurrent execution of multiple programs.


2.3: Basic Characteristics of Mainframe O/S
Why Multiprogramming?
Multiprogramming organizes program execution so that CPU always has one job to execute.
Multiprogramming simply reclaims the CPU during idle periods to let other programs execute.
Multi-programming results in better and efficient CPU utilization.
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2.3: Basic Characteristics of Mainframe O/S

Multiprogramming Overheads

- Multiprogramming Overheads:
  - Program Queue Management
  - Program Status Management
  - Context Switching during Changeover
  - Multiple programs must be in main memory
  - Management of Common Resource Sharing (e.g. Printer)
  - It is critical to determine optimum level of Multiprogramming to maintain certain service level.

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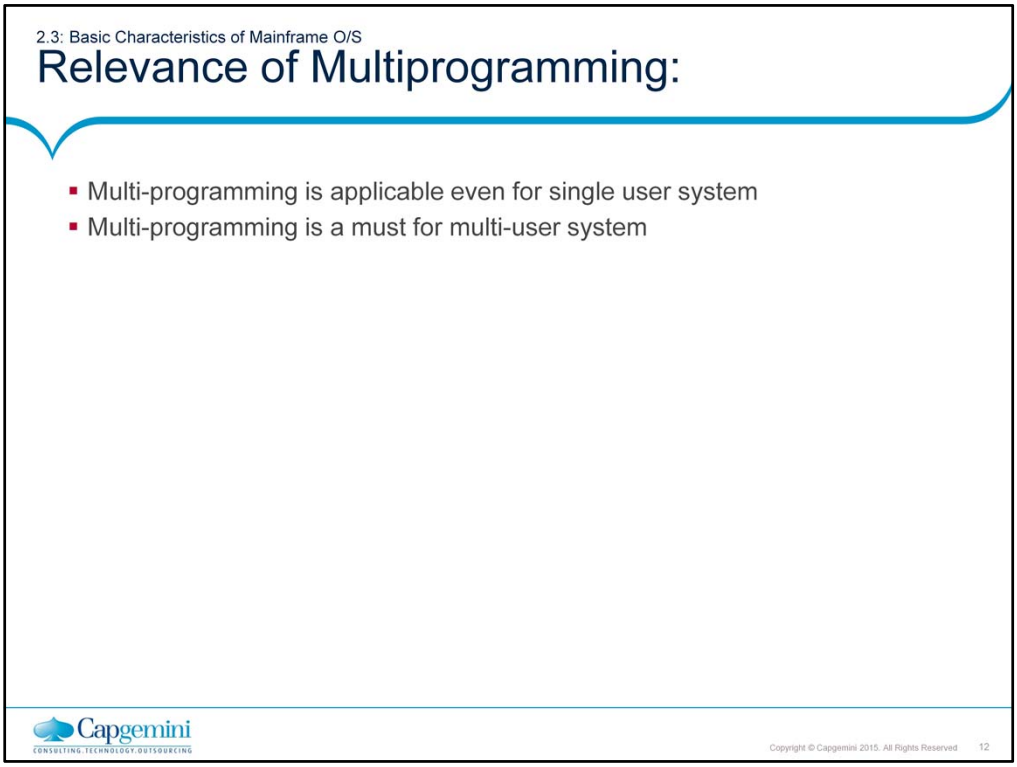
2.3: Basic Characteristics of Mainframe O/S
Relevance of Multiprogramming:
Multi-programming is applicable even for single user system
Multi-programming is a must for multi-user system
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2.4: Multiprocessing

Concept of Multiprocessing

- There are multiple CPUs (processors) in one machine.
- During Multiprocessing, these CPUs work together under a single operating system.
- Each CPU executes a separate program.
- O/S assigns programs to each CPU.
- Essentially CPU is treated as an allocable device!!!!!

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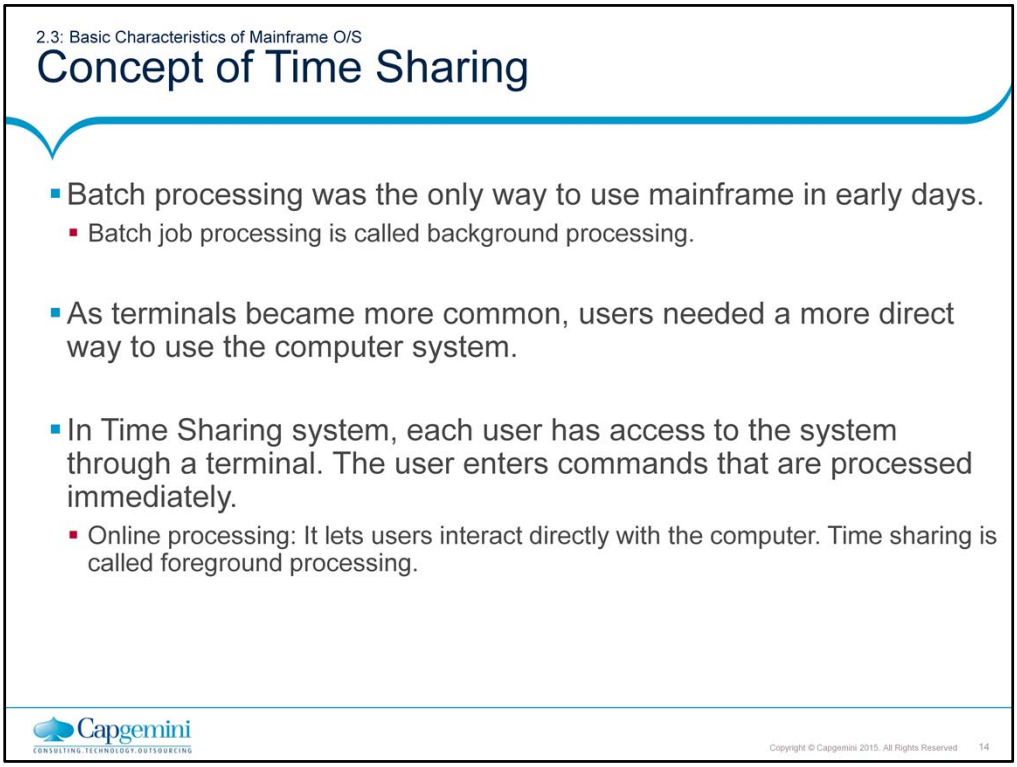
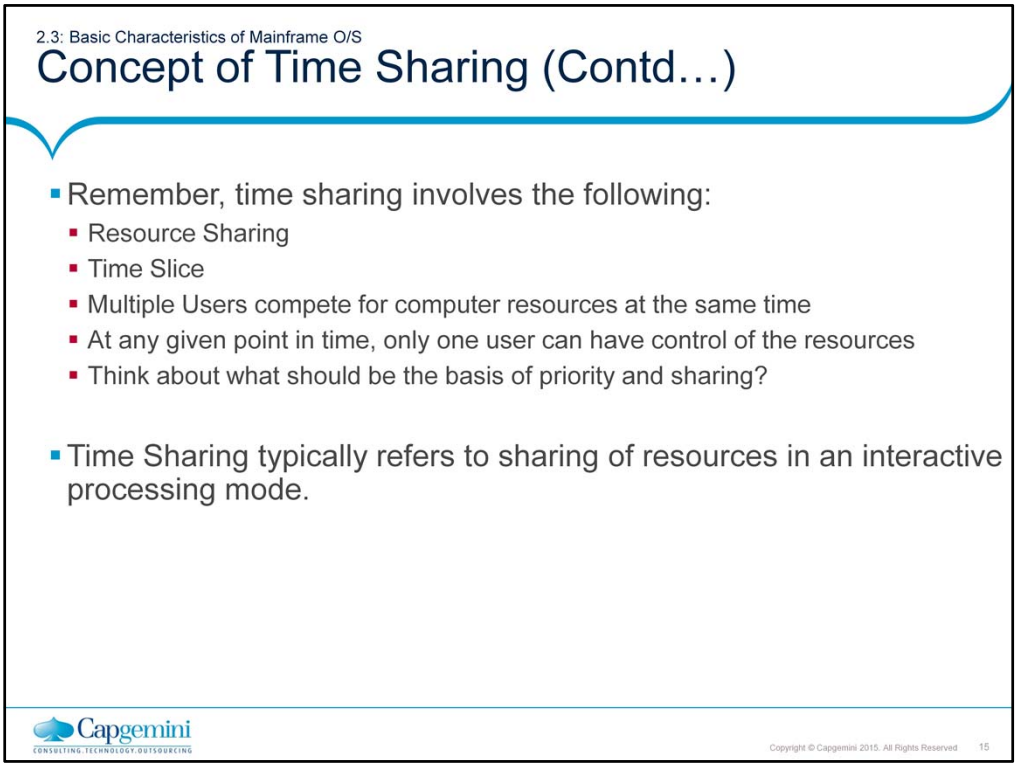


Time sharing:
Time sharing is a logical extension in which CPU switches jobs so frequently that users can interact with each job while it is running, thus creating interactive computing.
In timesharing:

Response time should be < 1 second.
Each user has at least one program executing in memory ⇨process
If several jobs ready to run at the same time ⇨ CPU scheduling
If processes don't fit in memory, then swapping moves them in and out to run.
Virtual memory allows execution of processes not completely in memory.

On-line communication between the user and the system is provided. When the operating system finishes the execution of one command, it seeks the next "control statement" not from a card reader, but rather from the user's keyboard.
This involves the CPU allocating individual time slices to a number of users on the computer system. As the number of users increase, the response time for each terminal declines. The speed of the CPU compared to that of the VDU and terminal is so much faster that it gives the user the impression that s/he is the sole user of the system.

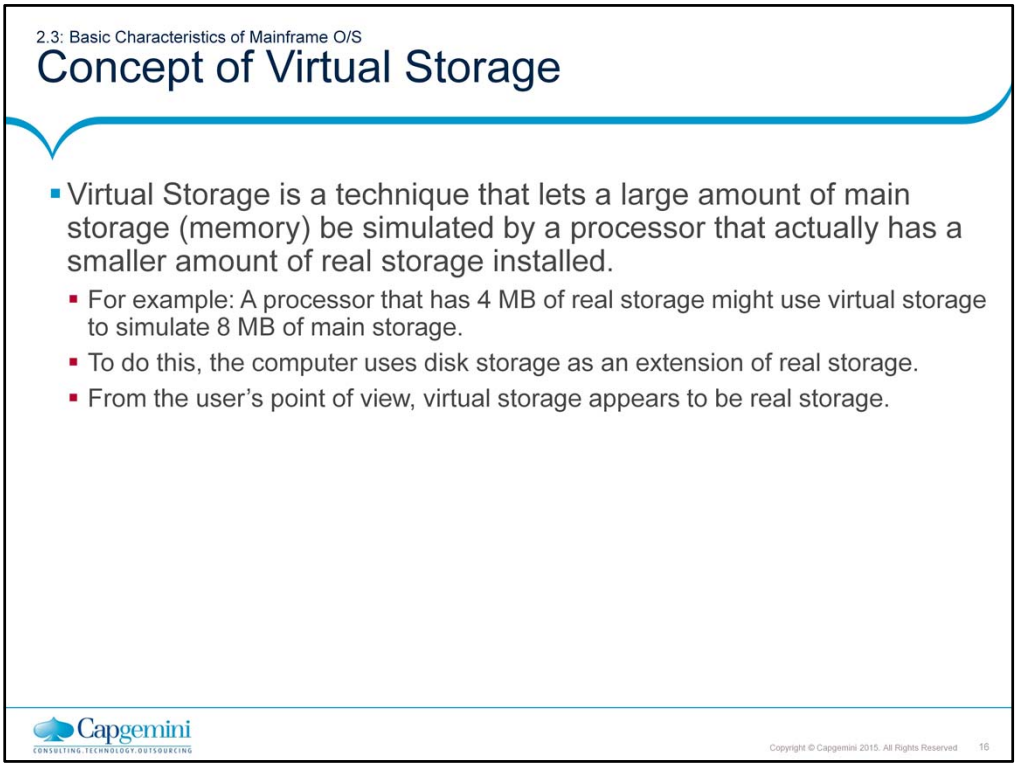


Time Sharing:
Time Slice:
Each user is given control of resources for a pre-defined period, that is a time slice. The control is passed on to the next in the queue user at the end of time slice (even if first user's work is incomplete). If the user requires I/O before the time slice is over, then the control is handed over to the next user (since CPU cannot do anything until I/O is complete).
One can decide on the time sharing priority based on usage of one or more algorithm:

1. First come first served?
2. Priority based?
3. Whosoever can grab it - Law of Jungle?
4. Equal - Democratically?
5. Need based?

Usually the combination of 2 and 4 is used, that is all are equal but some are more equal!!!!!

Priority:
Each user / function is assigned a priority level.
The higher priority users are serviced first in a round robin fashion.
Only if the higher priority users are in "wait" state for I/O completion, then the users in lower priority are serviced.


2.3: Basic Characteristics of Mainframe O/S
Concept of Virtual Storage
Virtual Storage is a technique that lets a large amount of main storage (memory) be simulated by a processor that actually has a smaller amount of real storage installed.
For example: A processor that has 4 MB of real storage might use virtual storage to simulate 8 MB of main storage.
To do this, the computer uses disk storage as an extension of real storage.
From the user's point of view, virtual storage appears to be real storage.
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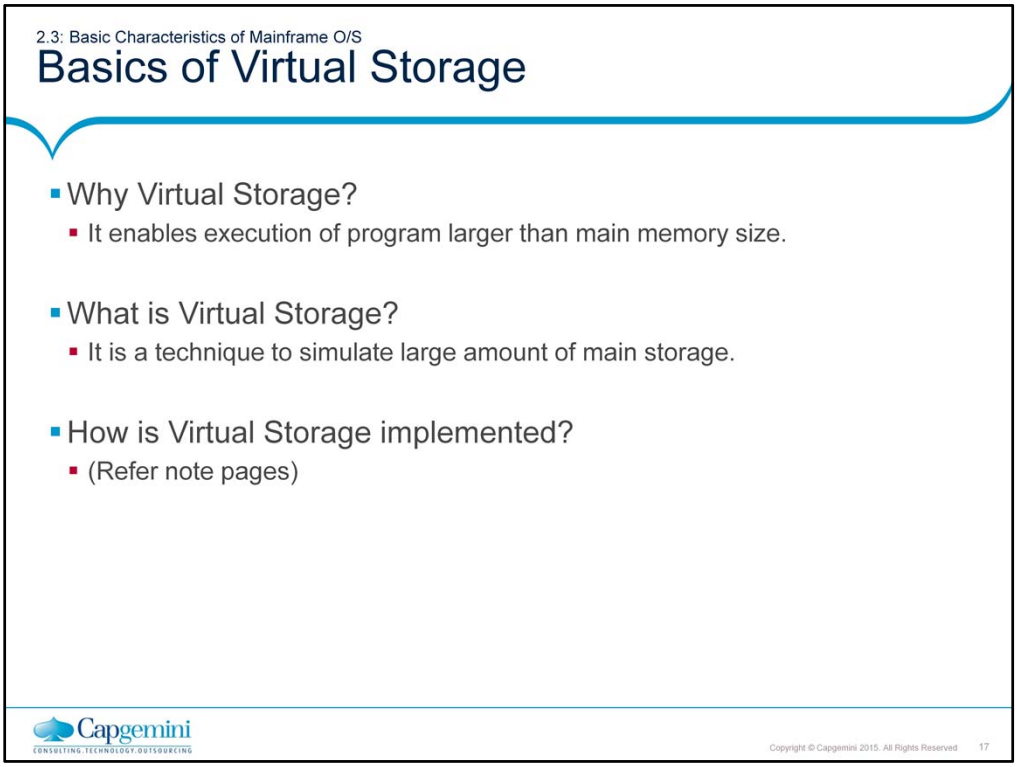
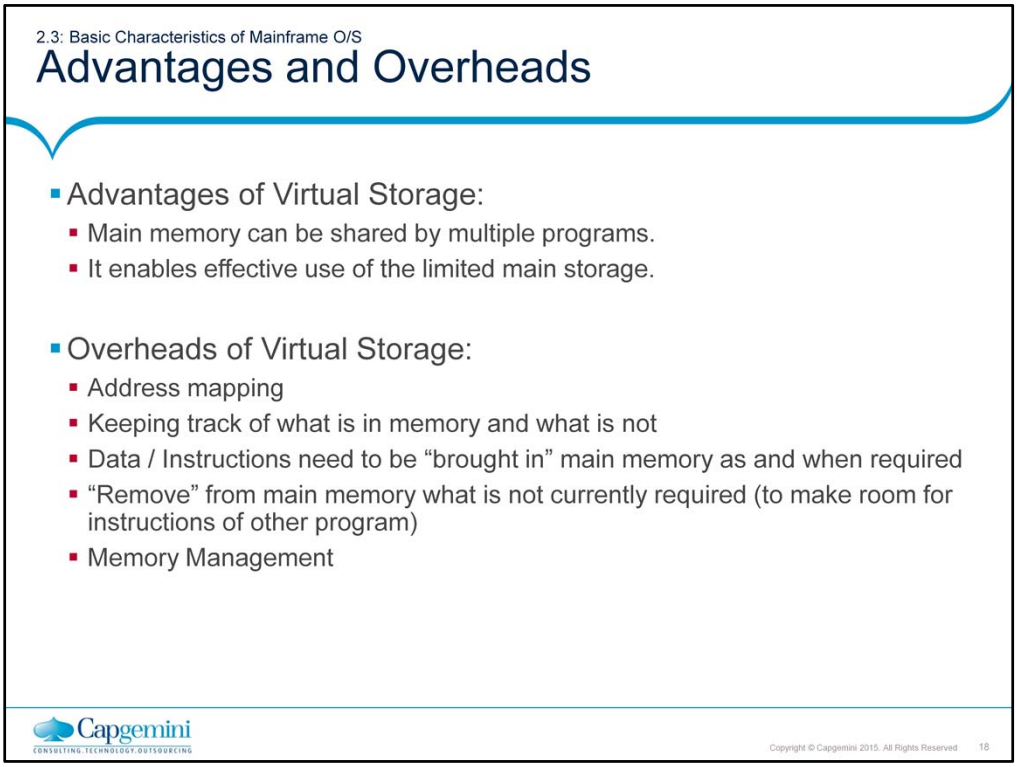


Virtual Storage:
Basics of Virtual Storage:
Why Virtual Storage?
It is required to enable execution of programs which are larger than the main memory size.
What is Virtual Storage?
It is a technique to simulate large amount of main storage.
In reality, main storage is much less.
For example: Real main storage is 16MB but virtual storage is 2GB.
How is Virtual Storage implemented?
Program executable code is generated assuming virtual storage size.
At any given moment, only part of the program is loaded in main memory, that is only the current program instruction and the data it accesses needs to be in real storage (memory). Other instructions and data can be placed temporarily on disk and recalled into main storage when needed.
Address translation mechanism is used to map virtual address to actual address.
Operating systems with virtual storage, transfer the instructions and data between real storage and disk, as and when they are needed.
It is feasible because only the instruction currently being executed and the corresponding data need to be in the main storage.

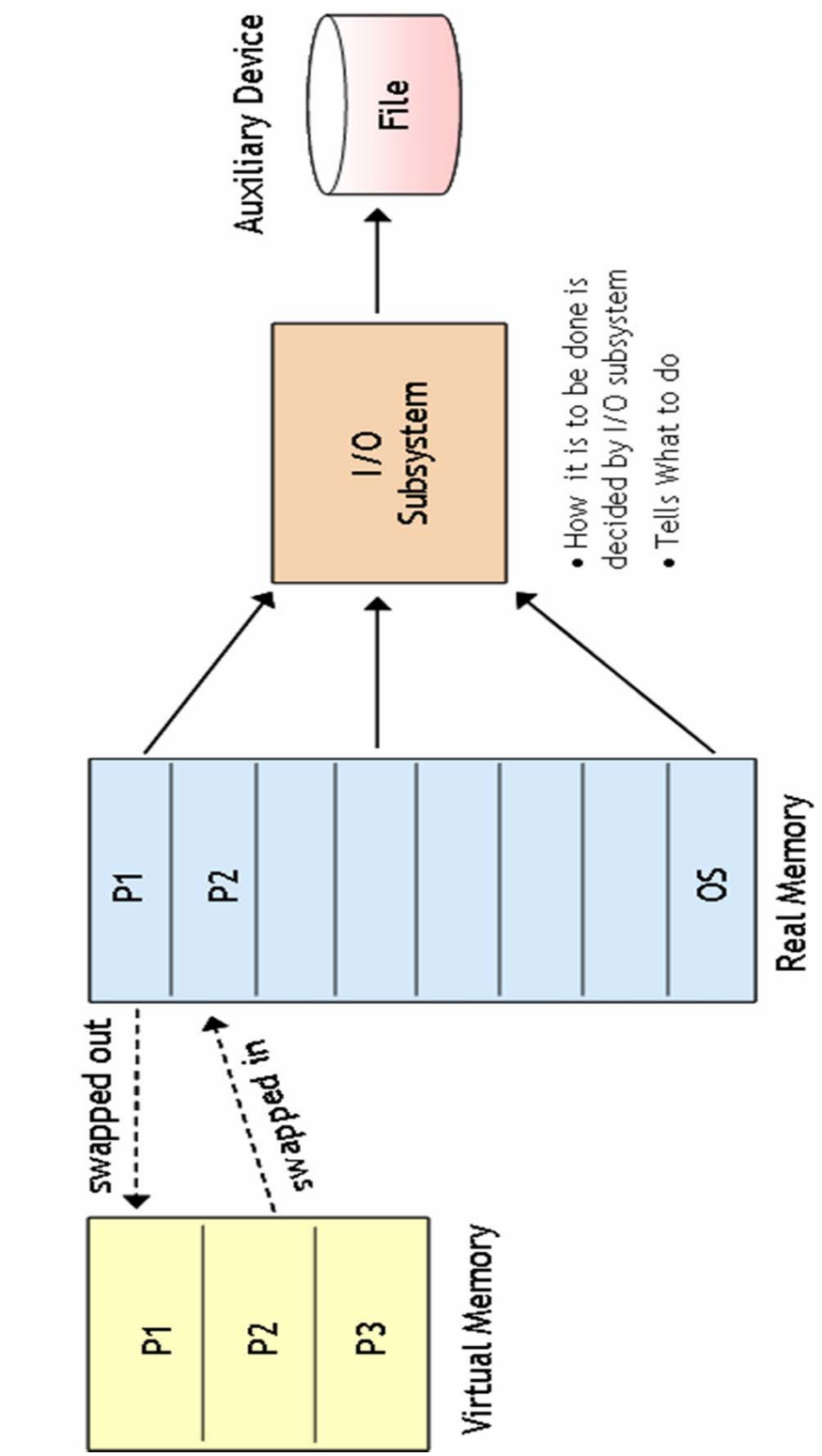


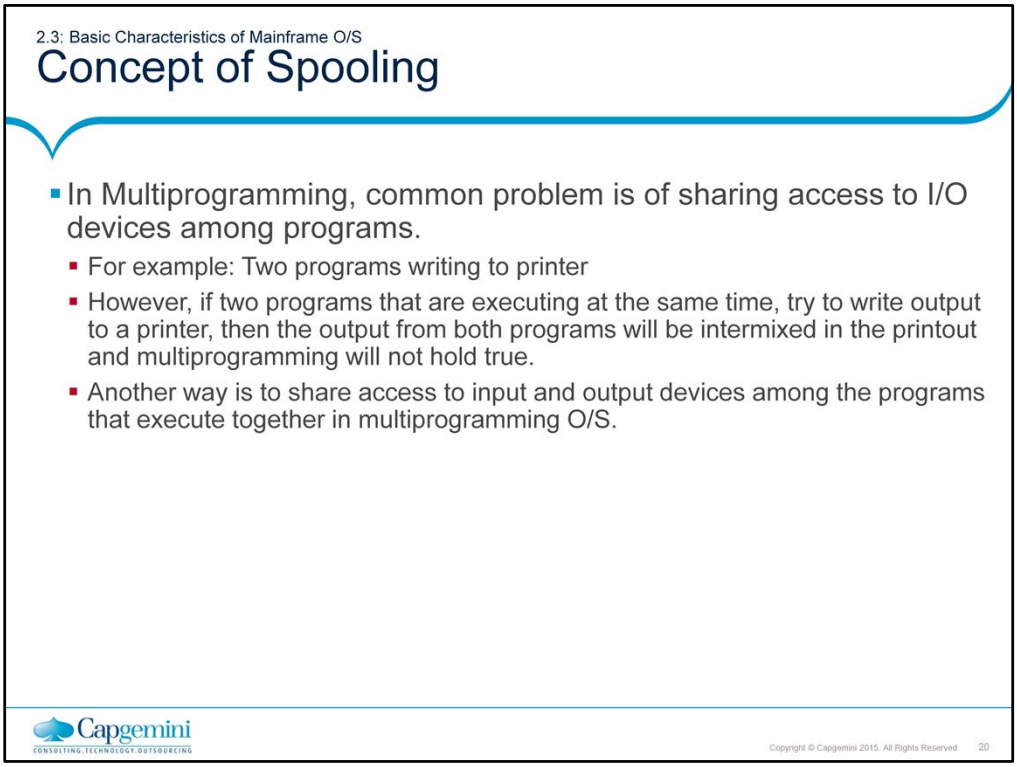
Virtual Storage:
Advantages and Overheads:
Memory Management:
Problem: Anything that is to be executed must be in memory (Memory limitation).
Solution: (1) Place task in real memory; (2) Place task in virtual memory

Real Memory implementation:
- Code and data are in real memory.
- Size of code and data is limited by size of installed memory
- Good performance, low overhead
- Possible wastage of memory

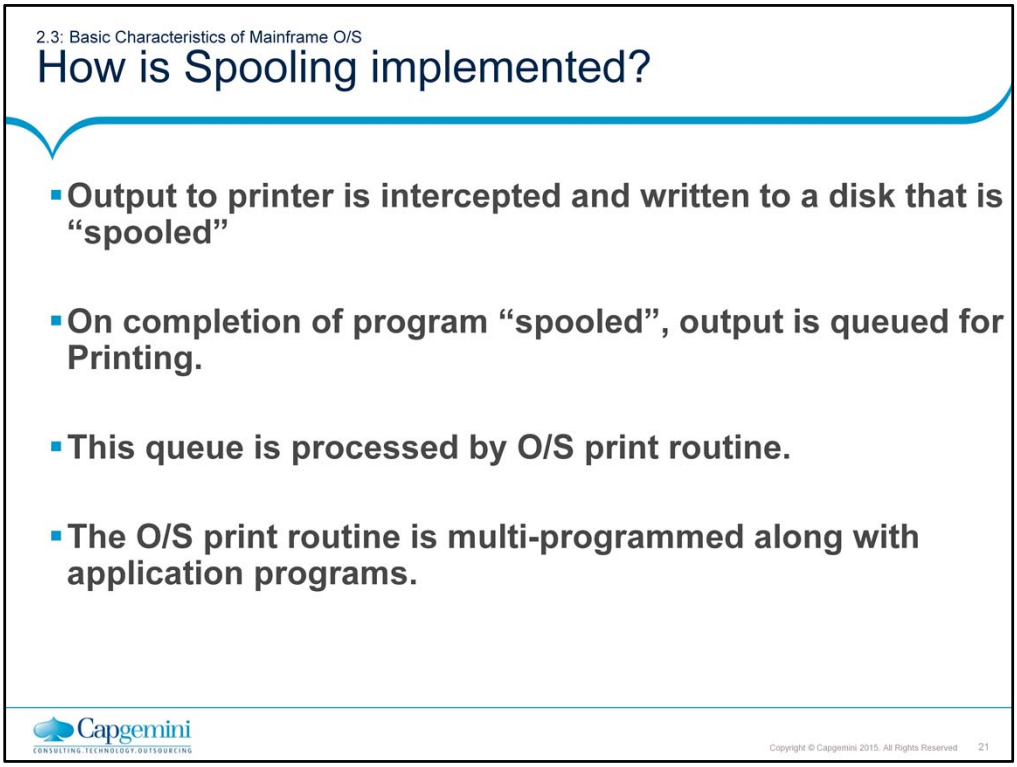
Virtual Memory implementation:
- Based on assumption for a task, not all code and data is needed in real memory at all times.
- It is implemented on a combination of real plus auxiliary storage.
- Operating system takes responsibility of bringing rest part of tasks in real memory when required.
- Advantage: Code and data size are independent of the real memory.

Virtual Storage:





Spooling:
SPOOL is an acronym for simultaneous peripheral operations on-line.
Spooling refers to putting jobs in a buffer, a special area in memory or on a disk, where a device can access them whenever it is ready.
The most common spooling application is print spooling.
Spooling also lets you place a number of print jobs on a queue instead of waiting for each one to finish before specifying the next one.



Spooling:
Spooling is used to provide shared access to printer devices.
Spooling manages printer output for applications by intercepting it and instead directing it to a disk device. When the program is finished, the O/S collects its spooled print output. and directs it to the printer.
In a multiprogramming environment, each program's spooled output is stored separately on disk so that it can be separately printed.
Since disk devices are much faster than printers, programs that produce spooled print output can execute faster than programs that access printers directly.

Summary

- In this lesson, you have learnt:
  - The basics of command processing using:
    - the batch mode
    - the online processing mode
  - Batch processing is the oldest form of processing data. For example: punch card.
  - The mainframe characteristics like time sharing, multiprogramming, spooling, and virtual storage that form the basic for the MVS O/S

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Review Question

- Question 1: Virtual Storage simulates ___ memory.
  - real
  - virtual
  - disk

- Question 2: Spooling is same as buffering.
  - True / False
- Question 3: In multiprogramming, the ___ is reclaimed during the idle cycles.
  - CPU
  - memory
  - output

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