What Is System Design?

By – Mohammad Imran

Introduction

System Design is the core concept behind the design of any distributed systems. System Design is defined as a process of creating an architecture for different components, interfaces, and modules of the system and providing corresponding data helpful in implementing such elements in systems.

Systems design is less concerned with coding and more about systems analysis, architectural patterns, API's, design patterns and gluing it all together.

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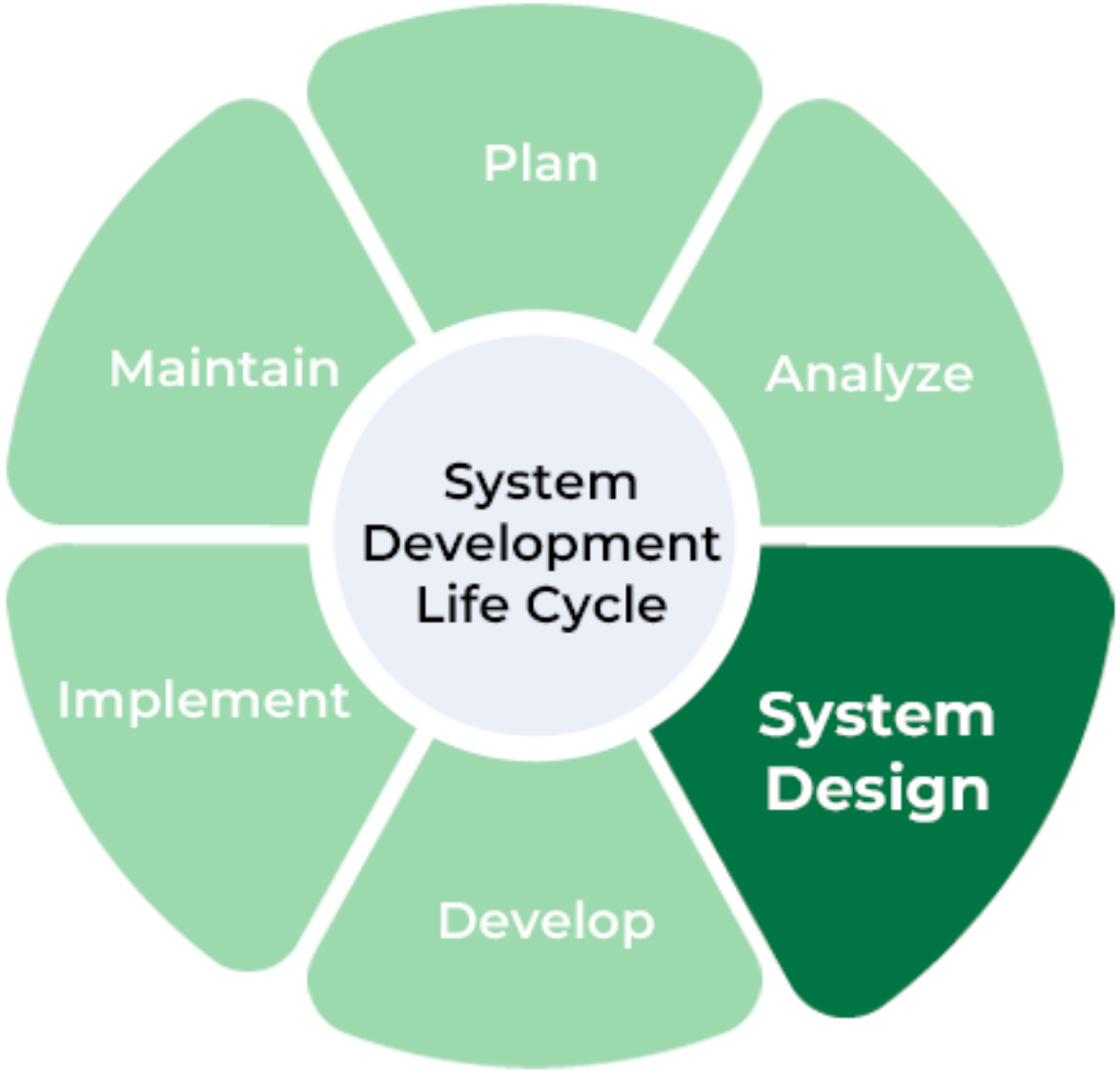
SDLC



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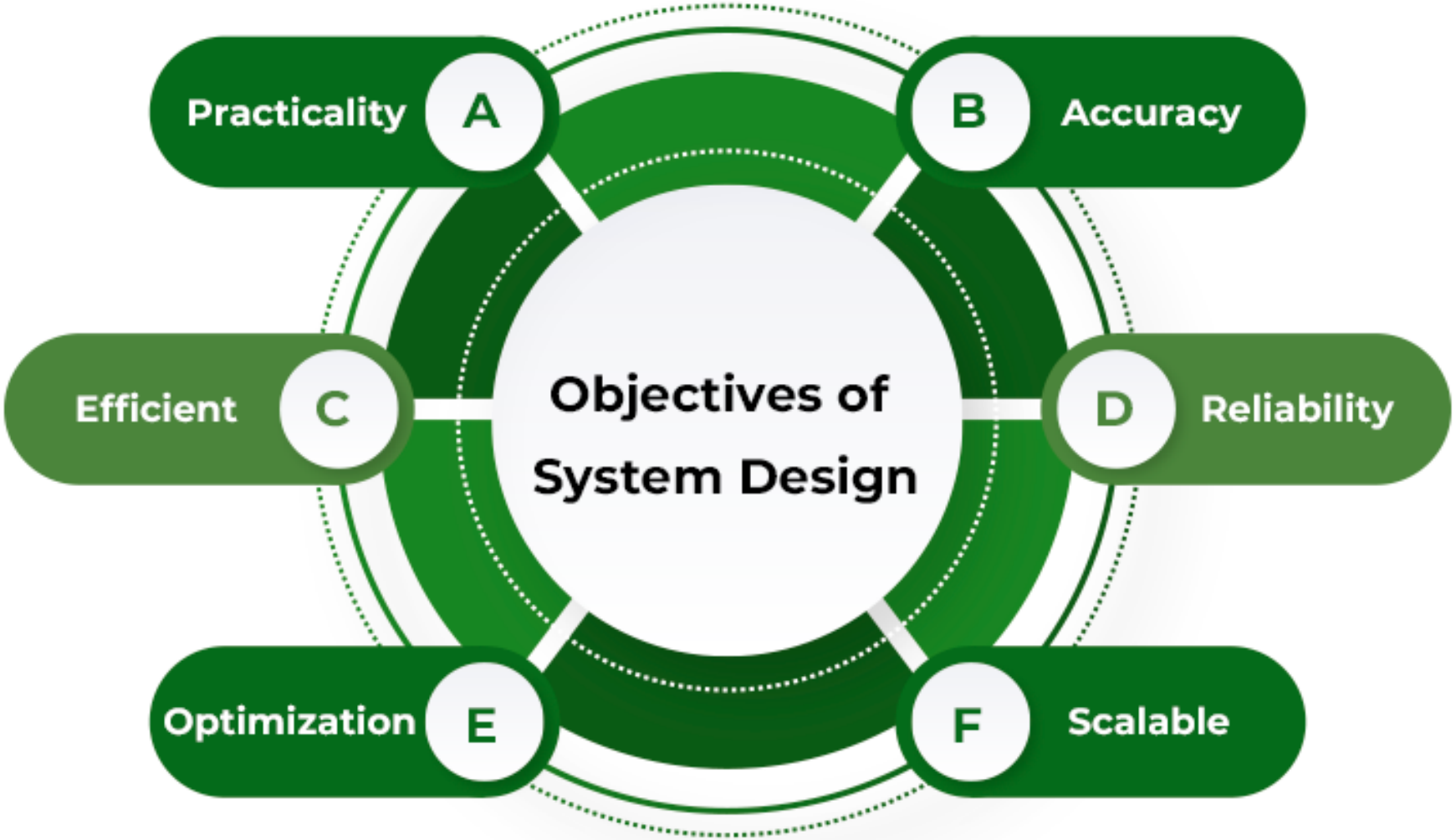
System Design

Objectives



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System Design

Objectives

- ✓ **Practicality**: We need a system that should be targetting the set of audiences(users) corresponding to which they are designing.
- ✓ **Accuracy**: Above system design should be designed in such a way it fulfills nearly all requirements around which it is designed be it functional o non-functional requirements.
- ✓ **Completeness**: System design should meet all user requirements
- ✓ **Efficient**: The system design should be such that it should not overuse surpassing the cost of resources nor under use as it will by now we know will result in low thorough put (output) and less response time(latency).

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System Design

Objectives

- ✓ **Reliability**: The system designed should be in proximity to a failure-free environment for a certain period of time.
- ✓ **Optimization**: Time and space are just likely what we do for code chunks for individual components to work in a system.
- ✓ **Scalable (Flexibility)**: System design should be adaptable with time as per different user needs of customers which we know will keep on changing on time.

Note: System Design also helps us to achieve fault tolerance which is ability of a software to continue working where even its 1 or 2 component fails.

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Operating System

Introduction

An operating system is a type of software without which you cannot operate or run a computer. It acts as an intermediary or translation system between computer hardware and application programs installed on the computer. In other words, you cannot directly use computer programs with computer hardware without having a medium to establish a connection between them.

Ex: Windows 10, Macintosh (Mac), Unix, Linux, Android etc.

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Computer System

Structure

A Computer System consists of:

- ✓ Users (People who are using the computer)
- ✓ Application Programs (Compilers, Databases, Games, Video player, Browsers, etc.)
- ✓ System Programs (Shells, Editors, Compilers, etc.)
- ✓ Operating System (A special program which acts as an interface between user and hardware)
- ✓ Hardware (CPU, Disks, Memory, etc.)

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Operating System

Major Function

An operating system is a type of software without which you cannot operate or run a computer. It acts as an intermediary or translation system between computer hardware and application programs installed on the computer. In other words, you cannot directly use computer programs with computer hardware without having a medium to establish a connection between them.

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Operating System

Major Function

- ✓ Process Management
- ✓ Process Synchronization
- ✓ Memory Management
- ✓ CPU Scheduling
- ✓ File Management
- ✓ Security

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A Program does nothing unless its instructions are executed by a CPU. A program in execution is called a process. In order to accomplish its task, process needs the computer resources.

There may exist more than one process in the system which may require the same resource at the same time. Therefore, the operating system has to manage all the processes and the resources in a convenient and efficient way.

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Process Management

The operating system is responsible for the following activities in connection with Process Management.

- ✓ Scheduling processes and threads on the CPUs.
- ✓ Creating and deleting both user and system processes.
- ✓ Suspending and resuming processes.
- ✓ Providing mechanisms for process synchronization.
- ✓ Providing mechanisms for process communication.

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Process Management

Attribute of Process

A process is a running program. When we construct a C or C++ program, for example, the compiler generates binary code. For both raw and binary codes are programs. When we run the binary code, it turns into a process. A procedure is divided into four sections:

Text: The existing actions are reflected by the value of the text.

Stack: Program Local variables, functional parameters, return addresses, and other transient data are stored in the Counter Stack.

Storage: The global variables are stored in data.

Heap: Space that is dynamically allocated and processed during runtime.

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Process Control Block

Introduction

Process Control Block is a block in the operating system to regulate a process (PCB).

A Process Control Block (PCB) is a data structure that is used by an Operating System to manage and regulate how processes are carried out. In operating systems, managing the process and scheduling them properly play the most significant role in the efficient usage of memory and other system resources. In the process control block, all the details regarding the process corresponding to it like its current status, its program counter, its memory use, its open files, and details about CPU scheduling are stored.

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Attribute of Process

Process ID

When a process is created, a unique id is assigned to the process which is used for unique identification of the process in the system.

Program Counter

A program counter stores the address of the last instruction of the process on which the process was suspended. The CPU uses this address when the execution of this process is resumed.

Process State

The Process, from its creation to the completion, goes through various states which are new, ready, running and waiting. We will discuss about them later in detail.

Priority

Every process has its own priority. The process with the highest priority among the processes gets the CPU first. This is also stored on the process control block.

General Purpose Registers

Every process has its own set of registers which are used to hold the data which is generated during the execution of the process.

List of Open Files

During the Execution, Every process uses some files which need to be present in the main memory. OS also maintains a list of open files in the PCB.

List of Open Devices

OS also maintain the list of all open devices which are used during the execution of the process.

Process State

The process, from its creation to completion, passes through various states.

The names of the states are not standardized although the process may be in one of the following states during execution.

Process State

The states of a process are as follows:

New

A program which is going to be picked up by the OS into the main memory is called a new process.

Ready

Whenever a process is created, it directly enters in the ready state, in which, it waits for the CPU to be assigned. The OS picks the new processes from the secondary memory and put all of them in the main memory.

Process State

The states of a process are as follows:

Running

One of the processes from the ready state will be chosen by the OS depending upon the scheduling algorithm. Hence, if we have only one CPU in our system, the number of running processes for a particular time will always be one. If we have n processors in the system then we can have n processes running simultaneously.

Process State

The states of a process are as follows:

Block or Wait

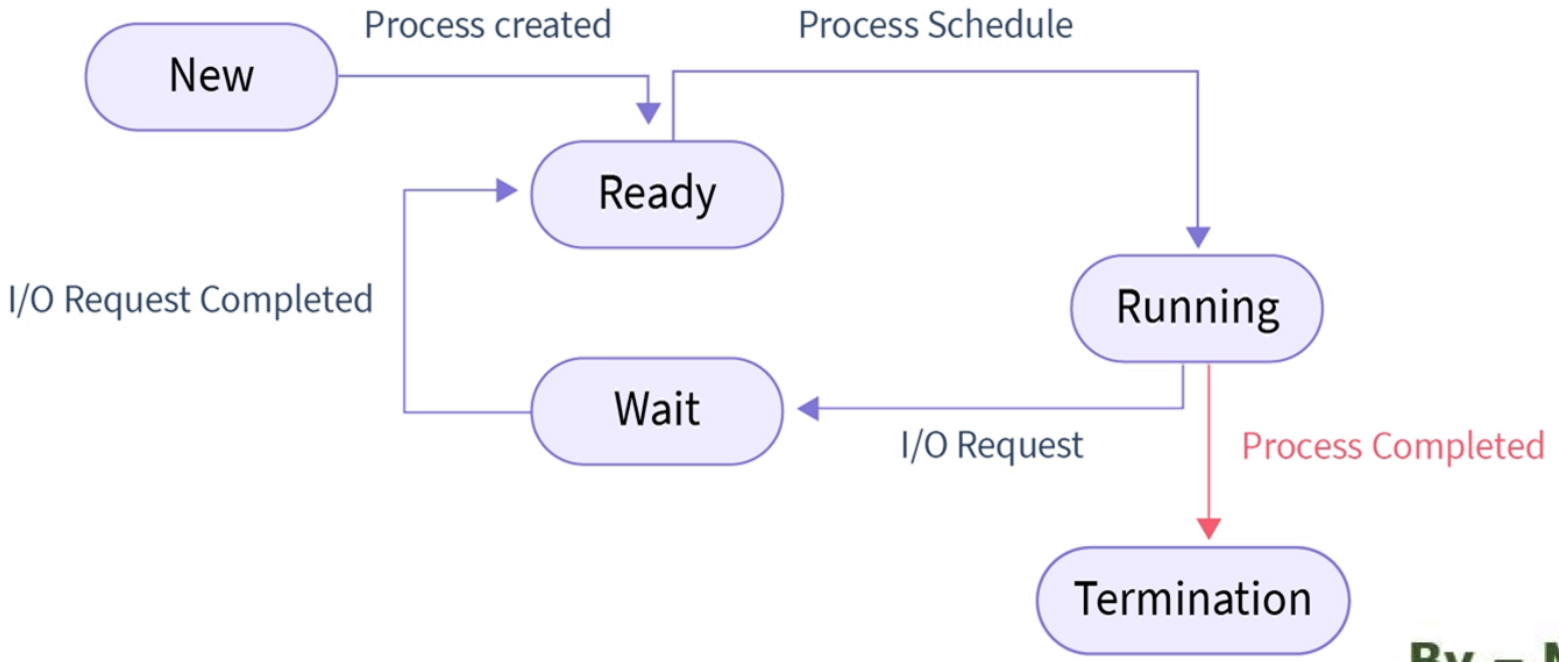
From the Running state, a process can make the transition to the block or wait state depending upon the scheduling algorithm or the intrinsic behavior of the process.

When a process waits for a certain resource to be assigned or for the input from the user then the OS move this process to the block or wait state and assigns the CPU to the other processes.

Process State

Completed or Terminated

When a process finishes its execution, it comes in the termination state. All the context of the process (Process Control Block) will also be deleted the process will be terminated by the Operating system.



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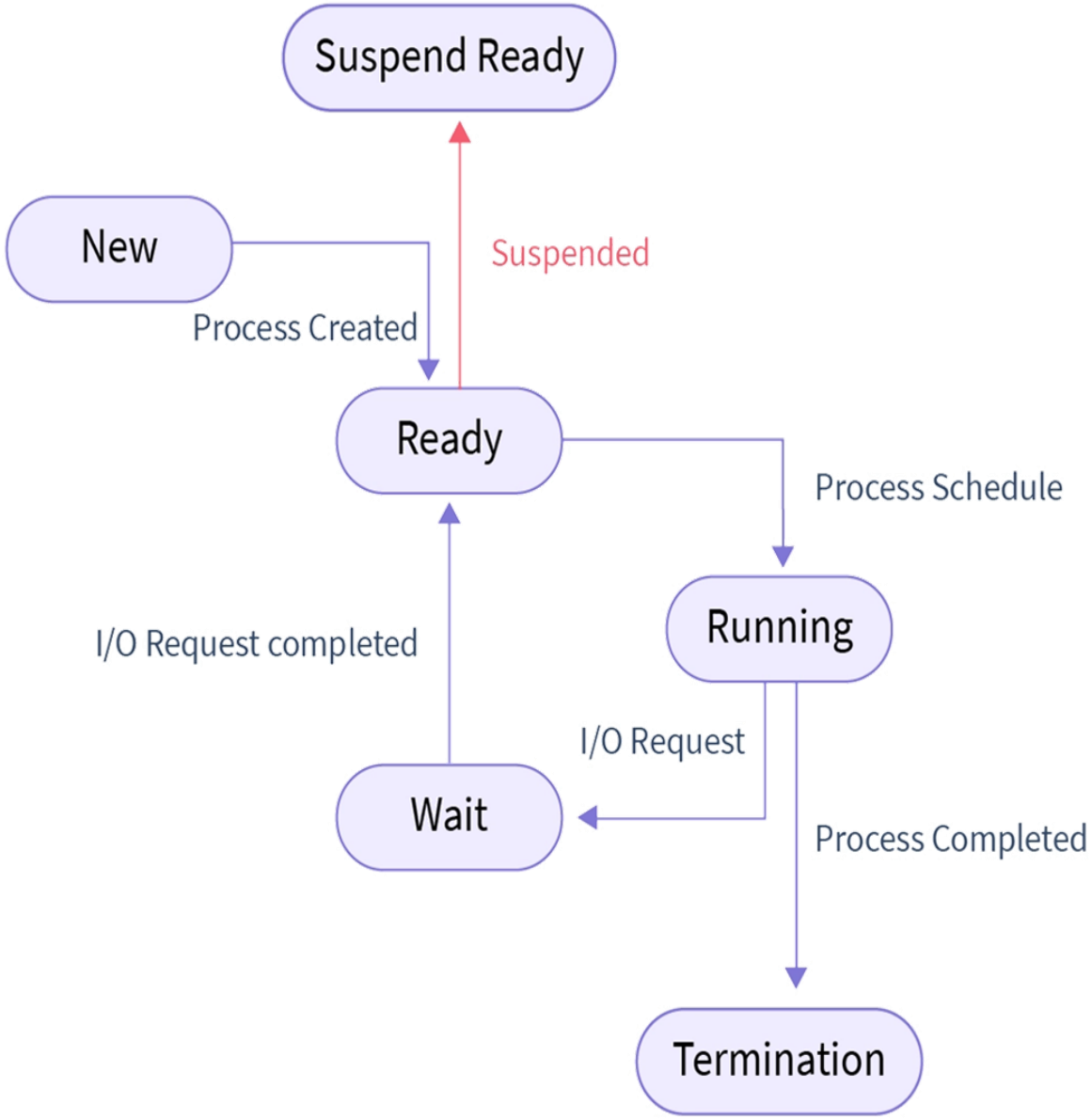
Process State

Suspended Ready

So whenever the main memory is full, the process which is in a ready state is swapped out from main memory to secondary memory. The process is in a ready state when goes through the transition of moving from main memory to secondary memory, the state of that process is changed to Suspend Ready state.



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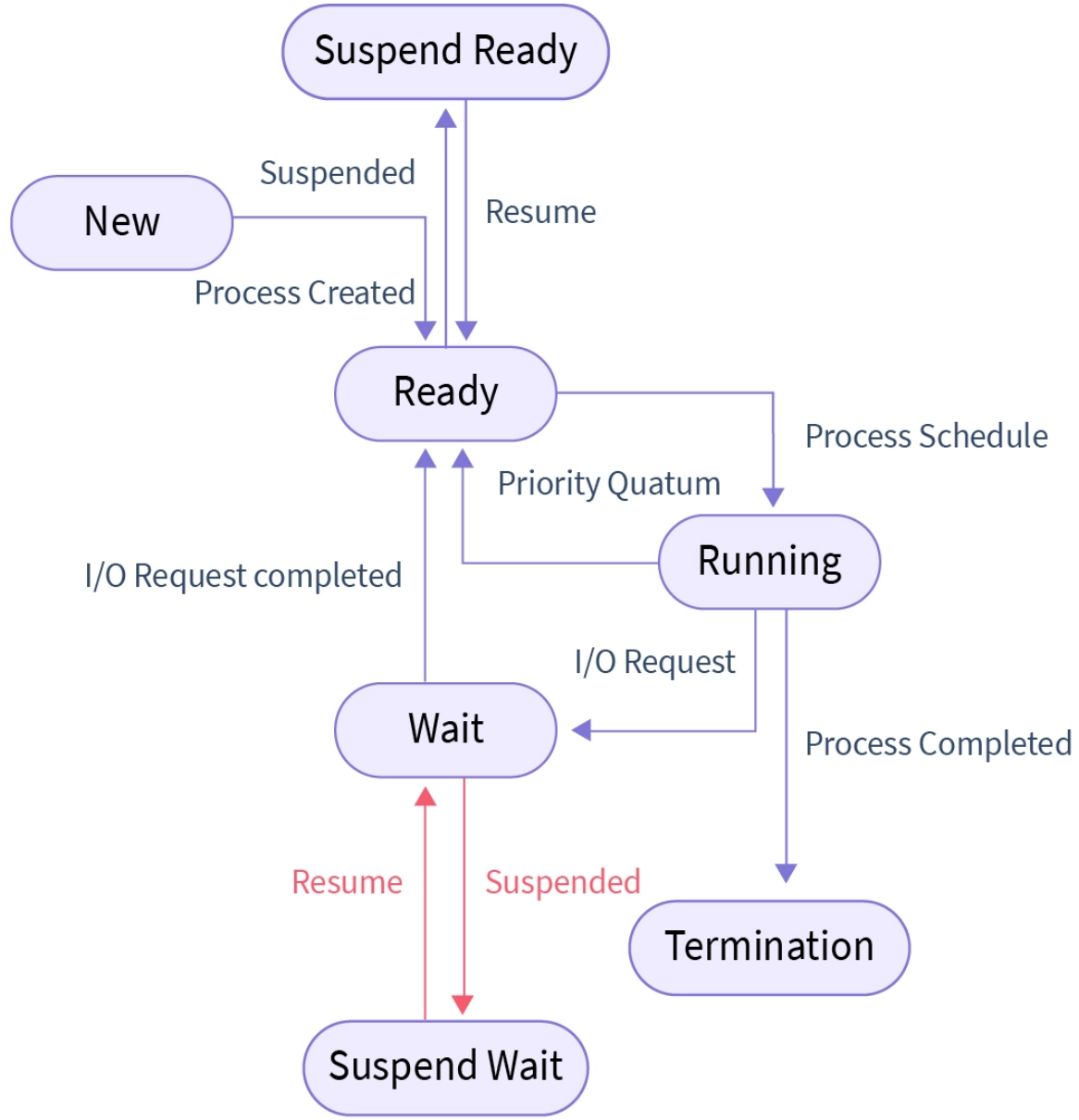
Process State

Suspended Wait

Whenever the process that is in waiting for state or block state in main memory gets to swap out to secondary memory due to main memory being completely full, the process state is changed to Suspend wait or Suspend blocked state.



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Conclusion

- ✓ The program under execution is called process.
- ✓ Process goes through different states throughout the life cycle which are called process states.
- ✓ New, Ready, Running, Waiting or Block, Terminated or Completed, Suspend ready, and Suspend wait or blocked are different states in which process might go during the life cycle.
- ✓ The state of the process is stored in Process Control Block (PCB).

Process Control Block

PCB

Process Control Block is a data structure that contains information of the process related to it. The process control block is also known as a task control block, entry of the process table, etc.

It is very important for process management as the data structuring for processes is done in terms of the PCB. It also defines the current state of the operating system.

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Process Control Block

Structure

The process control stores many data items that are needed for efficient process management. Some of these data items are explained with the help of the given diagram –

- **Process State**
- **Process Number**
- **Program Counter**
- **Registers**
- **Memory Units**
- **List of Open Files**
- **CPU Scheduling Information**
- **Memory Management Information**
- **I/O Status Information**
- **Account Information**

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Process Control Block

Structure

Process State

This specifies the process state i.e. new, ready, running, waiting or terminated.

Process Number

This shows the number of the particular process.

Program Counter

This contains the address of the next instruction that needs to be executed in the process.

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Process Control Block

Structure

Registers

This specifies the registers that are used by the process. They may include **accumulators**, index registers, stack pointers, **general purpose registers** etc.

List of Open Files

These are the different files that are associated with the process.

Process Control Block

Structure

CPU Scheduling Information

The process priority, pointers to scheduling queues etc. is the **CPU scheduling** information that is contained in the PCB. This may also include any other scheduling parameters.

Memory Management Information

The memory management information includes the page tables or the segment tables depending on the memory system used. It also contains the value of the base registers, limit registers etc.

Process Control Block

Structure

I/O Status Information

This information includes the list of **I/O devices** used by the process, the list of files etc.

Accounting information

The time limits, account numbers, amount of **CPU** used, process numbers etc. are all a part of the PCB accounting information.

QUIZ

By – Mohammad Imran

Quiz - 1

The process of understanding and specifying in detail what the information system should accomplish is called systems _____.

a) Design
b) Specification
c) Analysis
d) Administration

ANSWER

c

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Quiz - 2

The most important role of a systems analyst in business is _____.

a) Technical Understanding of Information System

b) Specification

c) Analysis

d) Administration

ANSWER

c

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