KARNAVATI UNIVERSITY

Operating Systems

Course Code: **71203002004**

Segmentation Techniques

by -

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Segmentation

- Segmentation divides a program into variable-sized parts called segments (like functions, arrays, or modules).
- It matches the user's view of memory instead of the computer's physical memory, making management and protection easier.

Key Points

- **Variable size** – Segments can be of different lengths as needed.
- **Logical division** – Segments represent useful parts like code, data, or stack.
- **Two-part address** – A logical address has:
  - **Segment number (s):** which segment
  - **Offset (d):** location inside that segment

  Formula: **Logical Address = ⟨s, d⟩**
- **Protection & sharing** – Segments can have permissions (read/write/execute) and can be shared.
- **No internal fragmentation** – Because segment sizes are flexible.
- **External fragmentation** – May occur if free memory is scattered.

Types of Segmentation in OS

Virtual Memory Segmentation

- A process is divided into segments.
- Segmentation may happen during program execution (run time) or not.

Simple Segmentation

- A process is divided into segments.
- All segments are loaded into memory at run time (not always in a continuous block).

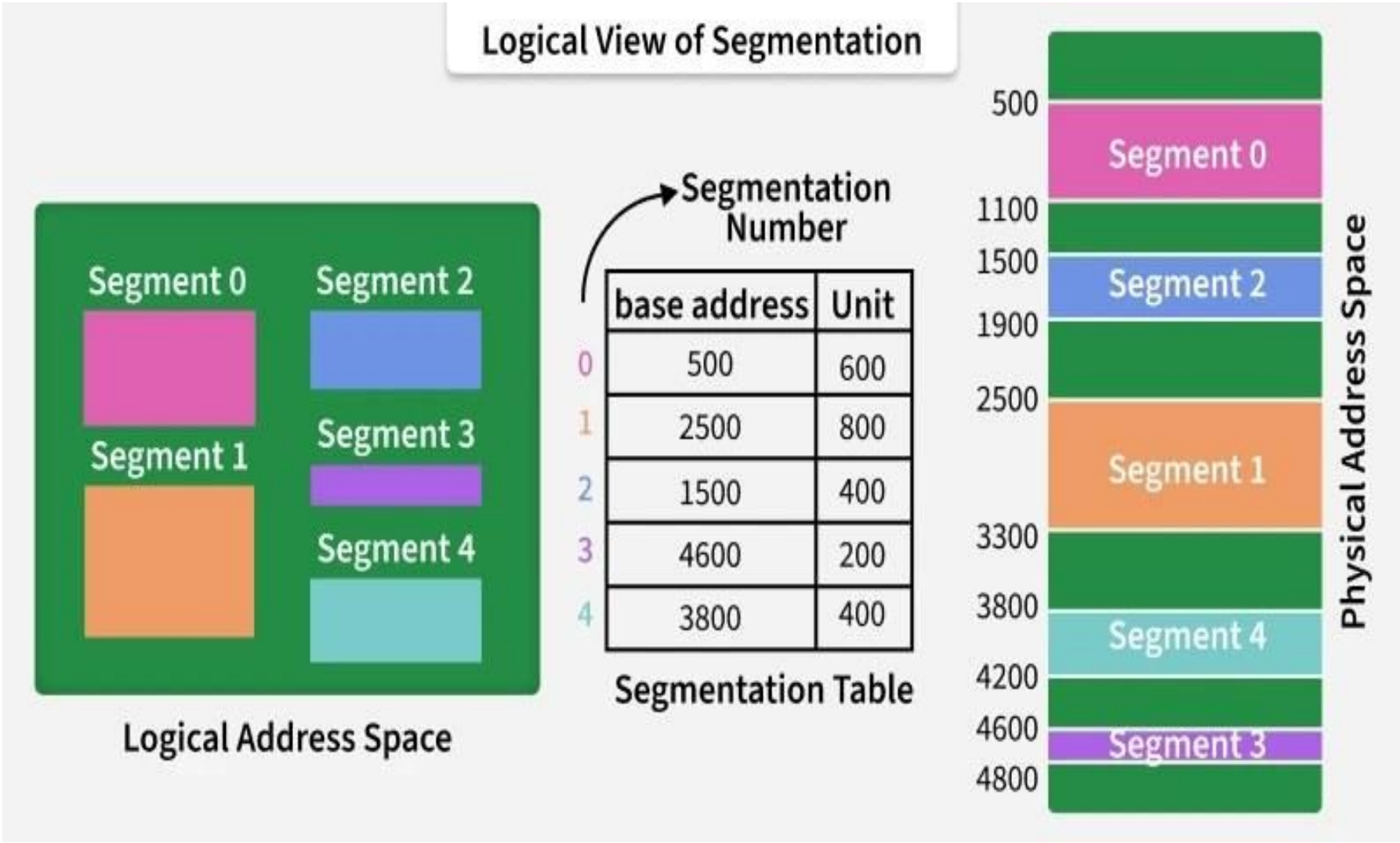
Segment Table

- A Segment Table converts a logical address ⟨segment number, offset⟩ into a physical address.
- It helps the CPU find where each segment is stored in memory.

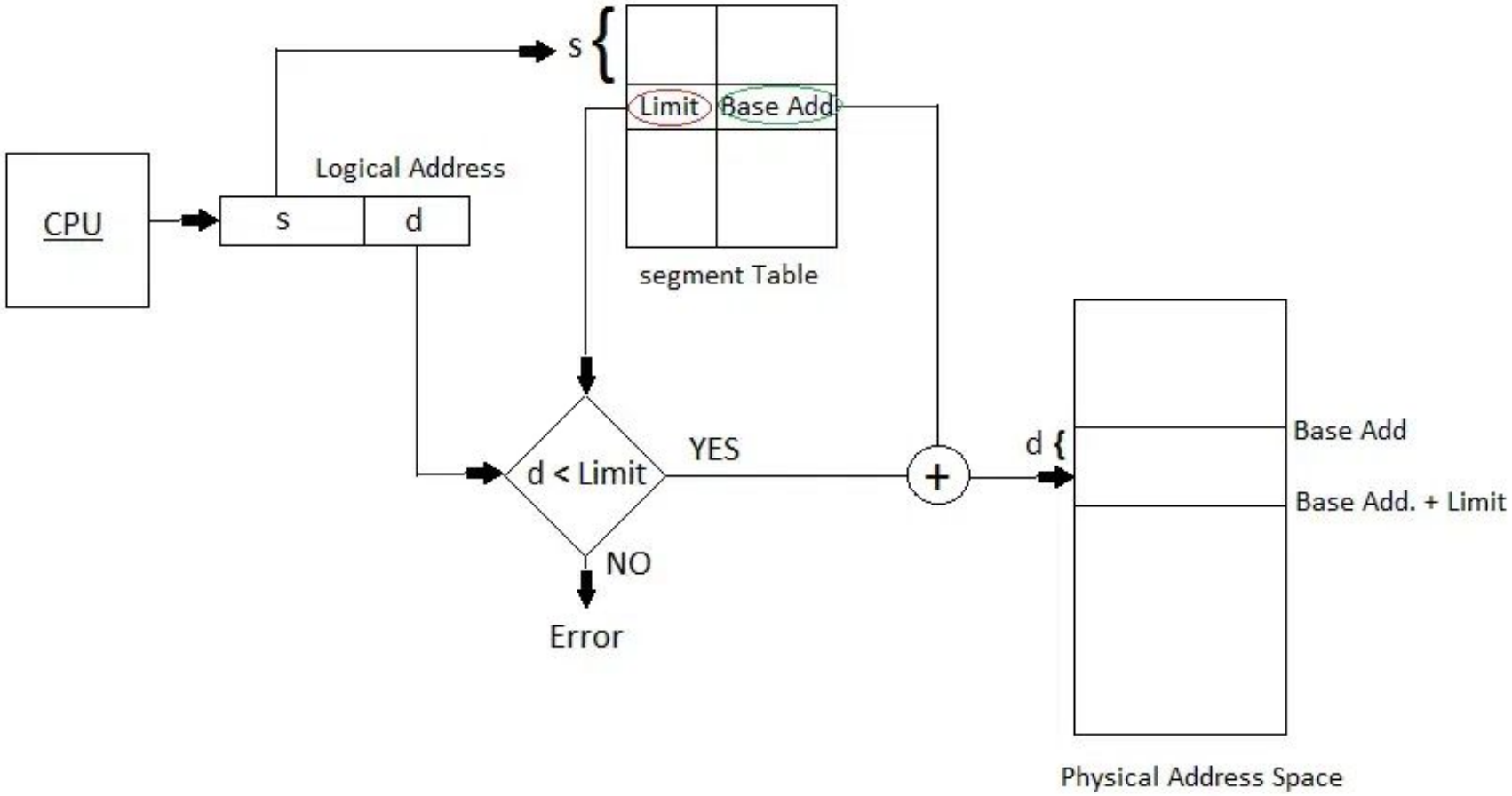
Each entry in the Segment Table has:

1. **Base Address** – Starting physical address of the segment in memory.
2. **Segment Limit** – Length (size) of the segment, to check if the offset is valid.

If the offset > segment limit → memory error (segmentation fault).


Logical View of Segmentation
Segment 0
Segment 2
Segment 1
Segment 3
Segment 4
Logical Address Space
Segmentation Number
base address
Unit
0
500
600
1
2500
800
2
1500
400
3
4600
200
4
3800
400
Segmentation Table
500
Segment 0
1100
1500
Segment 2
1900
2500
Segment 1
3300
3800
Segment 4
4200
4600
Segment 3
4800
Physical Address Space

Translation of Logical Address → Physical Address in Segmentation



Advantages and Disadvantages of Segmentation

Advantages	Disadvantages
Reduced Internal Fragmentation – Segments are sized as per program needs, so less wasted space.	**External Fragmentation** – Free memory gets scattered, causing waste.
Smaller Segment Table – Needs less space compared to page tables.	**Overhead** – Extra memory and management needed for segment tables.
Better CPU Utilization – Entire modules are loaded at once, improving performance.	**Slower Access** – Two lookups (segment table + memory) increase access time.

Advantages and Disadvantages of Segmentation

Advantages	Disadvantages
Closer to User's View – Programs divided into logical modules (like code, data, stack).	**Complexity** – Managing variable-sized segments is harder than paging.
User-Controlled Size – Segment size defined by user, unlike fixed-size paging.	**Segmentation Faults** – Errors occur if accessing memory outside a segment.
Security & Separation – Segments help isolate sensitive data and operations.	–

Segmentation With Paging

It combines **Segmentation** (logical division of a program) and **Paging** (fixed-size memory blocks) to use the best of both.

How It Works:

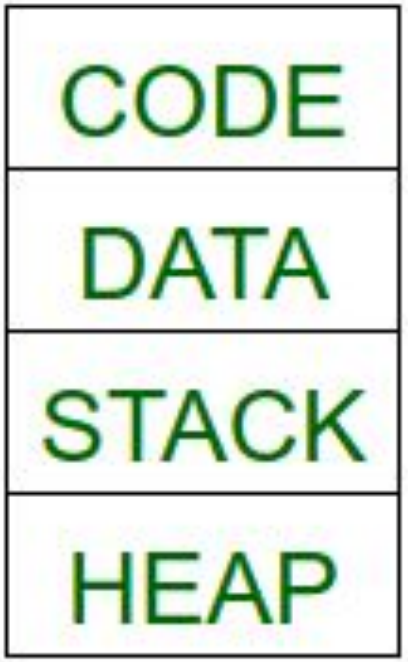
A process is divided into segments (Code, Data, Stack, Heap).

Each segment is further divided into fixed-size pages.

Each segment has its own page table.

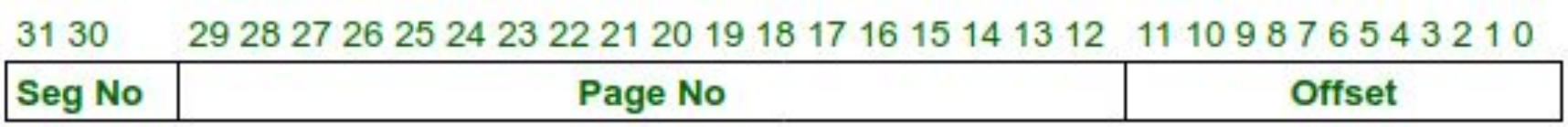
A Segment Table stores:

- Base address of the segment's page table.
- Limit (size of segment).



Address Translation Steps

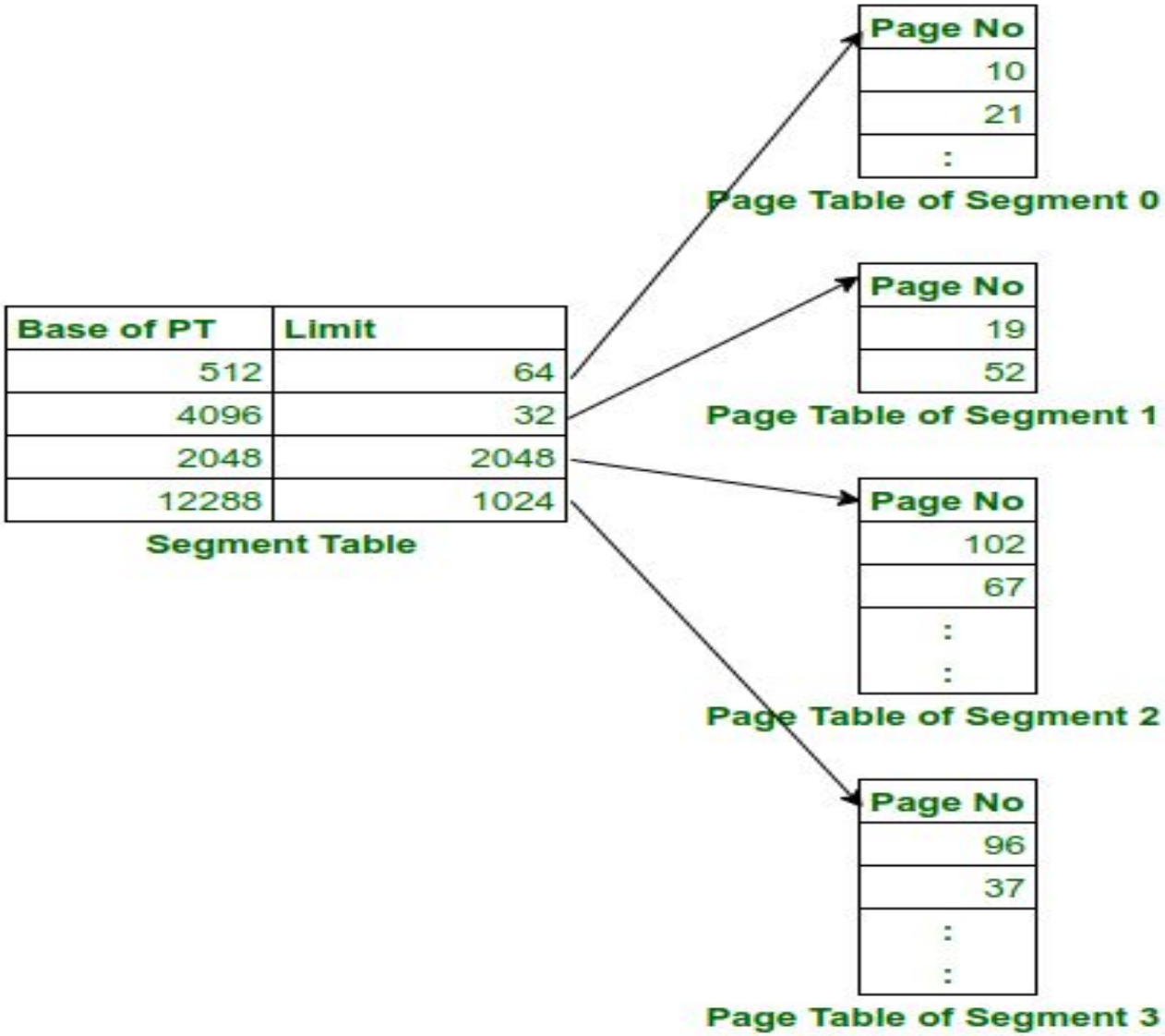
The CPU logical address is divided into: Segment Number, Page Number, Offset



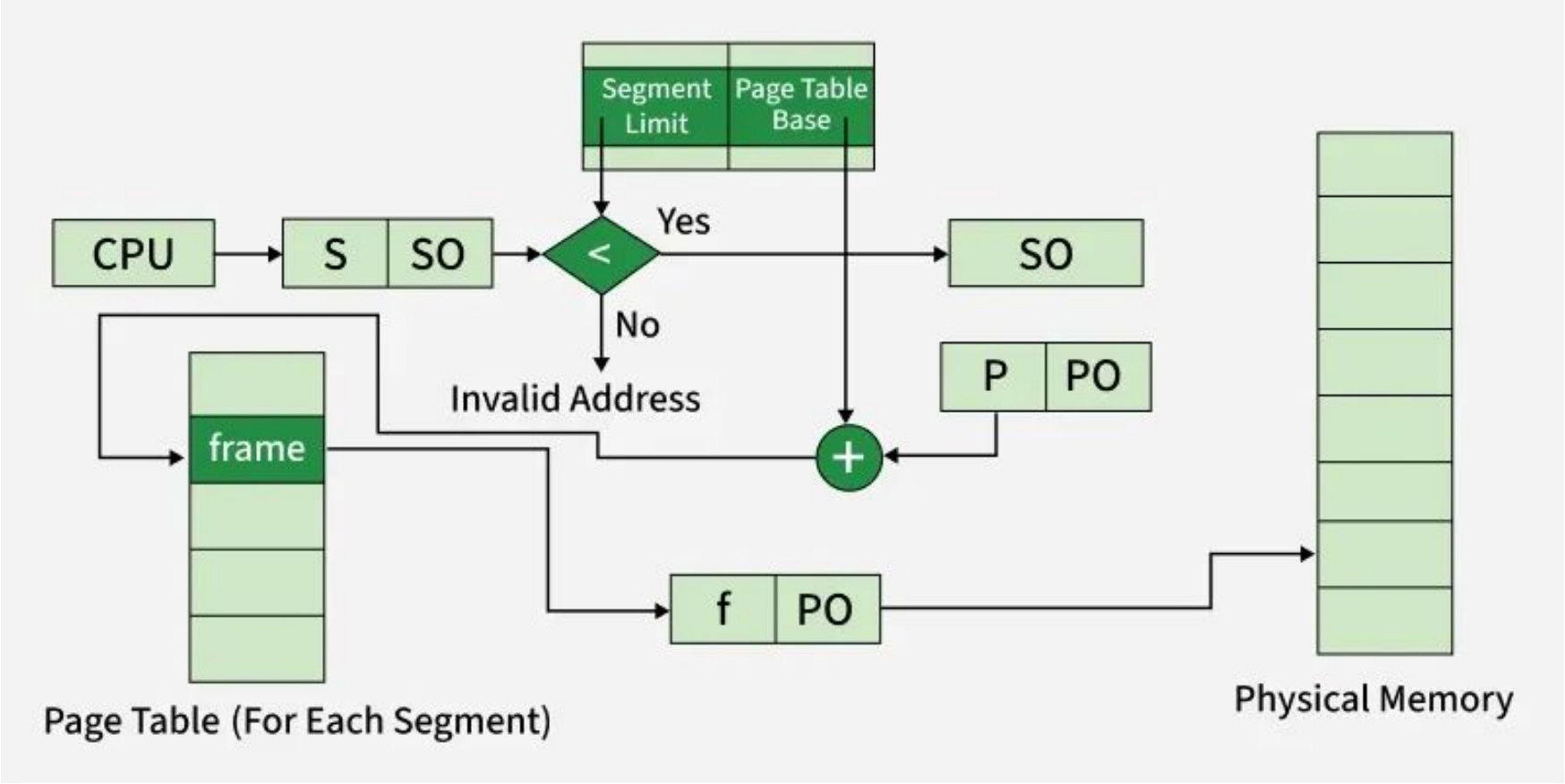
Address Translation Steps

MMU (Memory Management Unit):

1. Looks up the Segment Table using Segment Number.
2. Finds the base of the page table for that segment.
3. Uses Page Number to locate the Frame in memory.
4. Adds the Offset → gives the Physical Address.


Base of PT
Limit
512
64
4096
32
2048
2048
12288
1024
Segment Table
Page No
10
21
:
Page Table of Segment 0
Page No
19
52
Page Table of Segment 1
Page No
102
67
:
:
Page Table of Segment 2
Page No
96
37
:
:
Page Table of Segment 3

Segmented paging



Advantages of Segmented Paging

1. Page table size is smaller since pages exist only for segment data.
2. Provides programmer's logical view (segments) along with paging benefits.
3. External fragmentation reduced compared to pure segmentation.

Disadvantages of Segmented Paging

- Internal fragmentation still occurs within pages.
- Needs extra hardware for implementation.
- Slower translation due to multiple lookups (segment + page).
- Some external fragmentation can still occur (because of variable segment and page table sizes).

DISCUSSION & REVISION

1. In segmentation, what does the logical address consist of?
2. Which type of fragmentation occurs in segmentation?
3. What table is used in segmentation to map logical to physical addresses?
4. In paging, memory is divided into fixed-size blocks called?
5. Which hybrid technique combines segmentation and paging?

REFERENCES

- https://www.geeksforgeeks.org/operating-systems/segmentation-in-operating-system/
- https://www.geeksforgeeks.org/operating-systems/segmentation-with-paging/