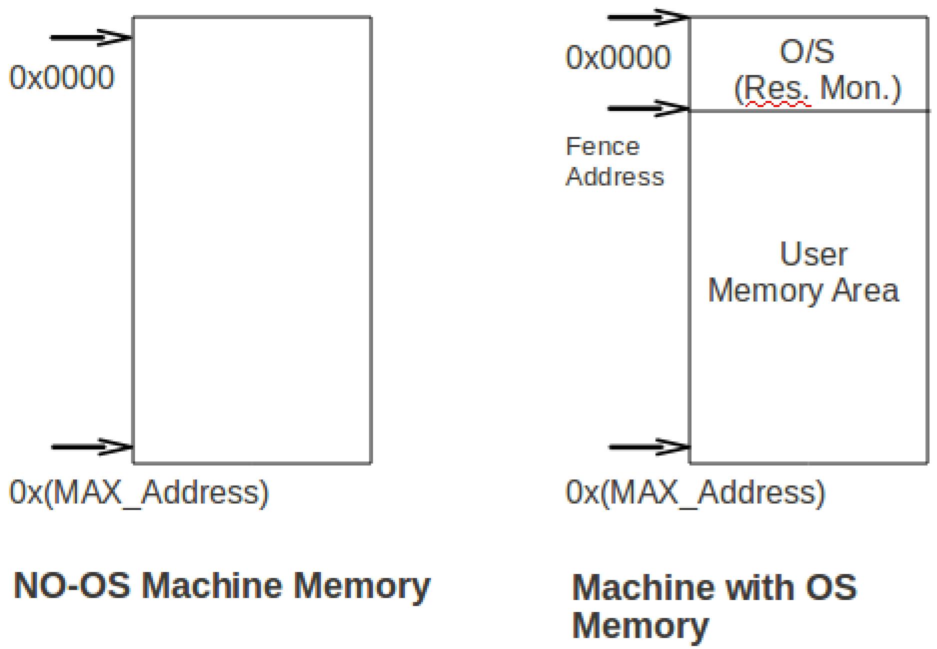
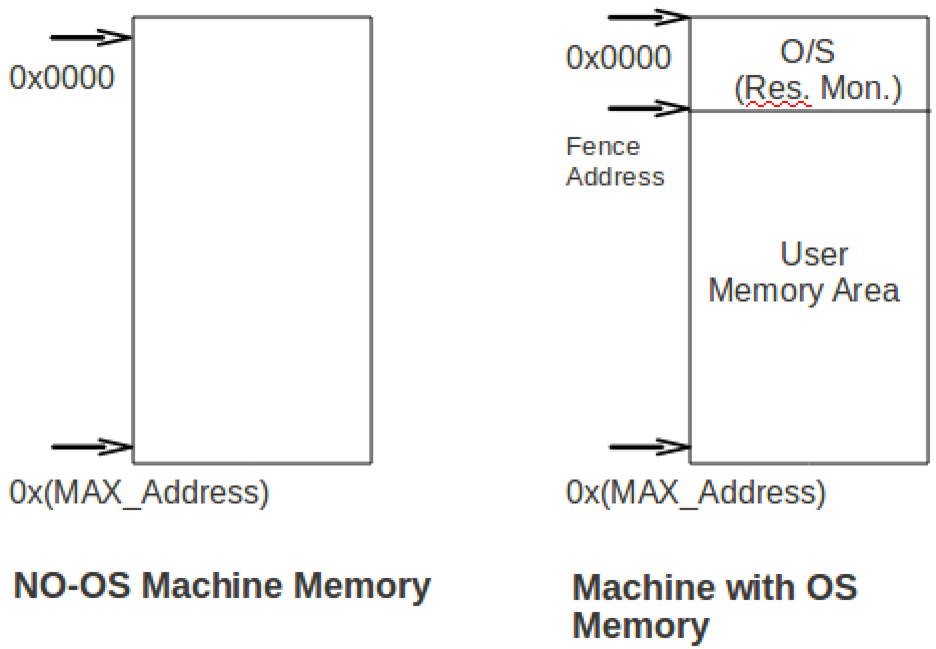
Memory Management (MFT)

3 November 2017
CS303
Autumn 2017

Memory Management



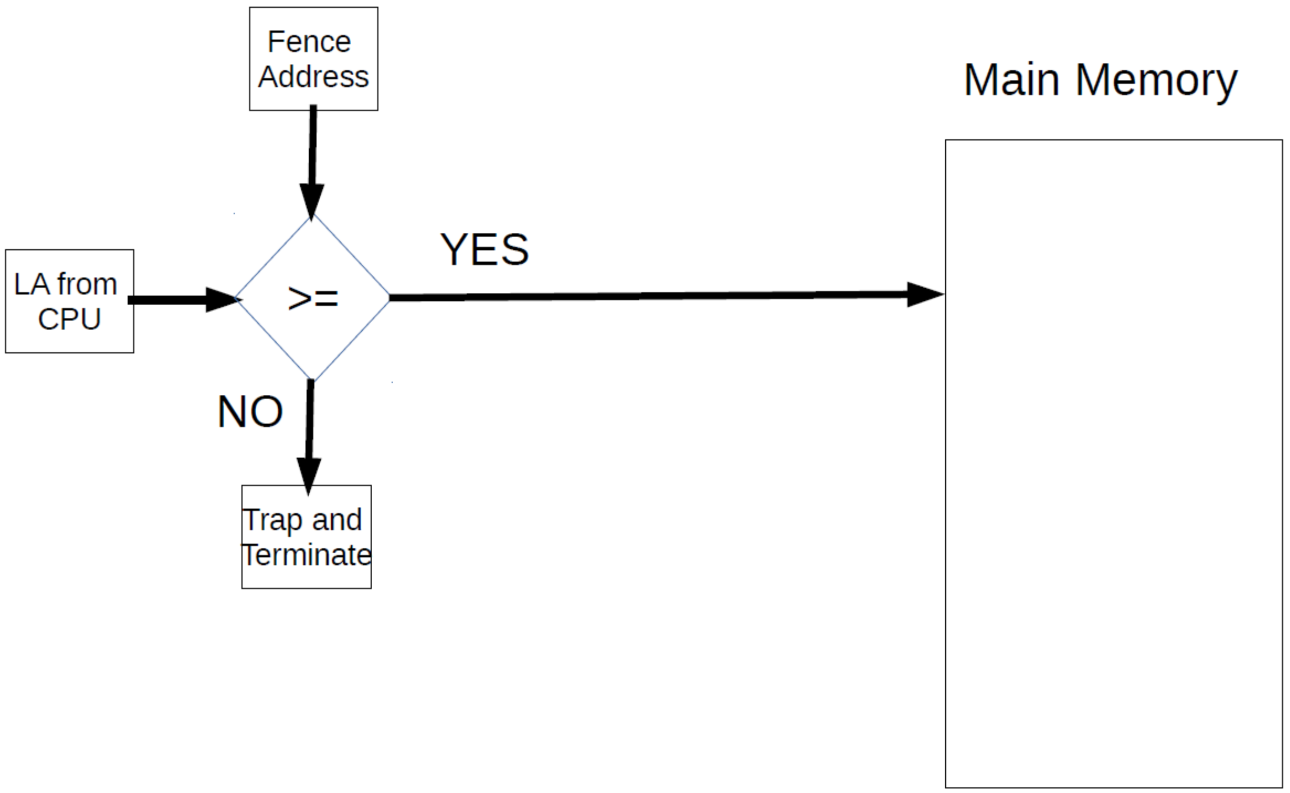
Memory Management



Fence Address (FA): stored in a register
Either Fixed in HW or Editable

1. On every address generated by CPU from a user process, it needs to be compared with the FA
    - this check can be implemented in
        - HW: hardware comparator 'Efficient'
        - SW: software instruction for comparing

Memory Management



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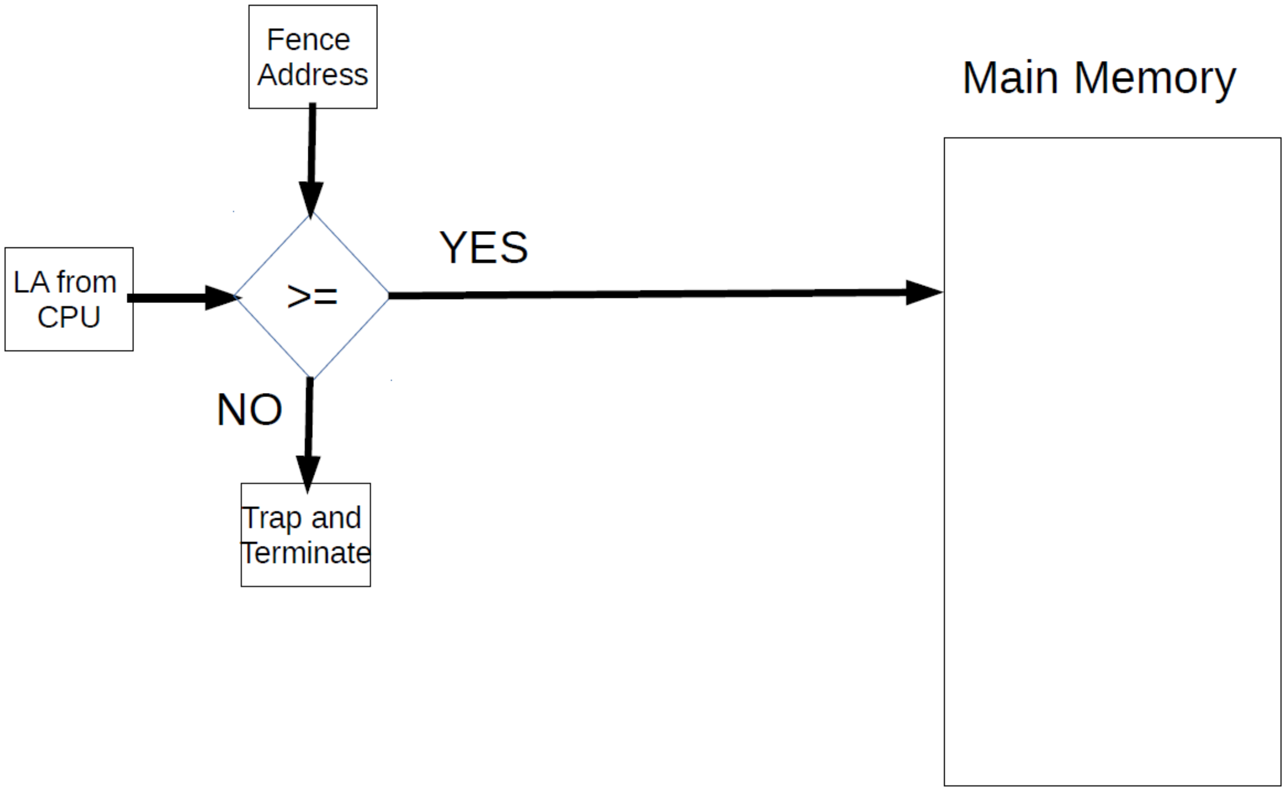
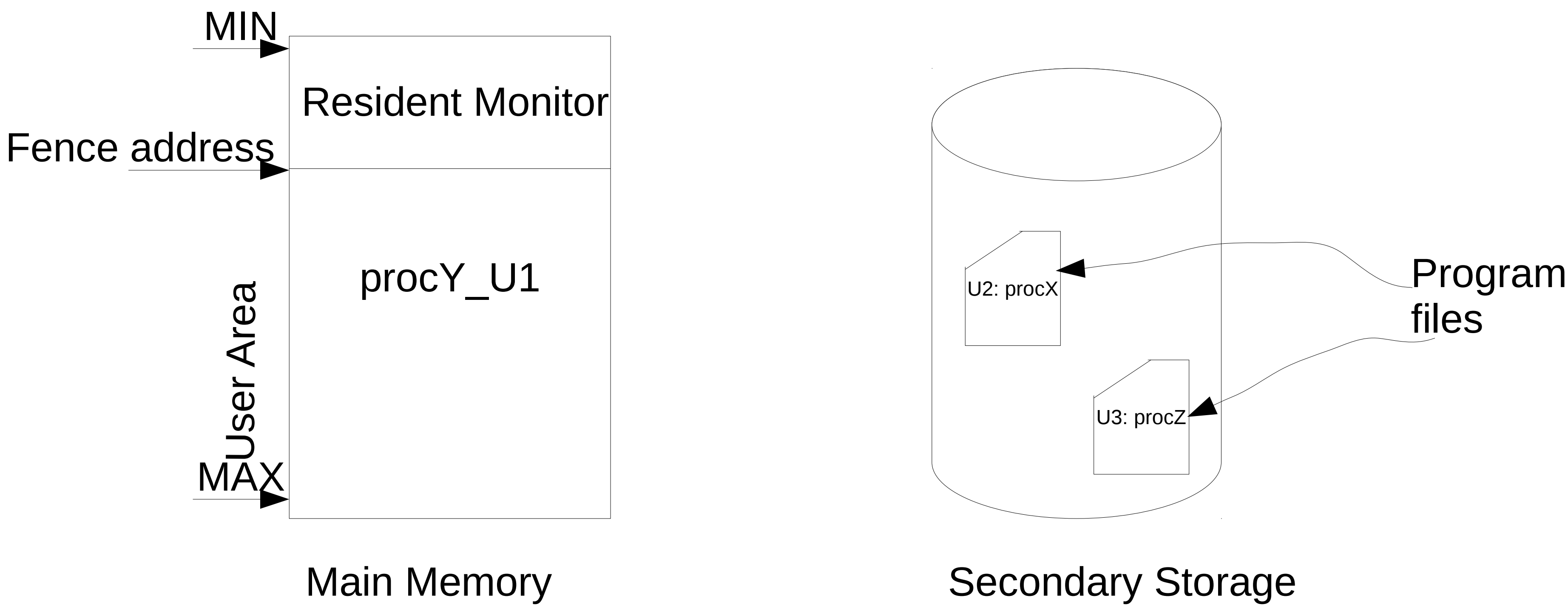
Memory Management



1. Fence Address (FA): stored in a register
   Either Fixed in HW or Editable

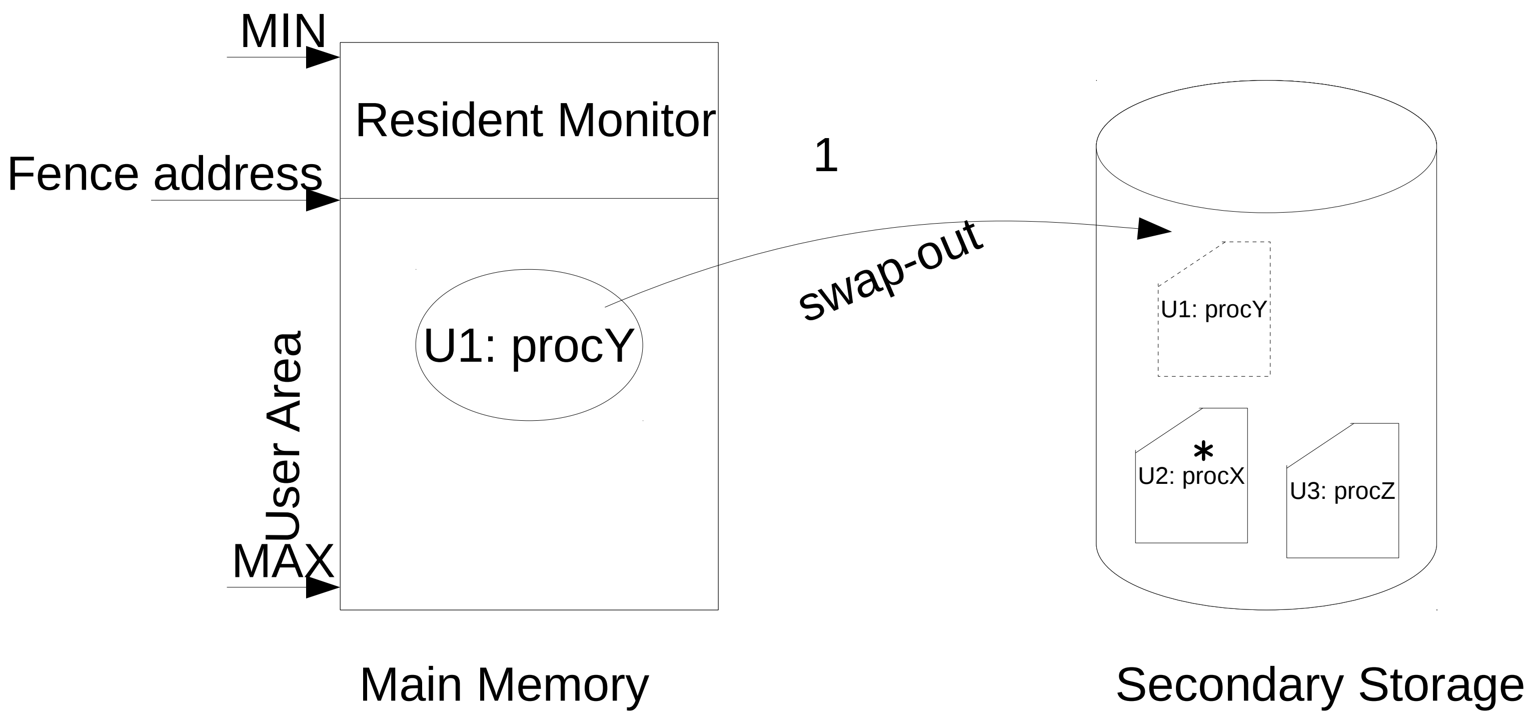
2. The checking requires a comparator, which could be implemented in:
   - HW: hardware comparator 'Efficient'
   - SW: software instruction for comparing

Simple Memory Model: Res. Montior + User Area



1. Single Process gets loaded into the MM from the SS/HD

Simple Memory Model: Res. Montior + Use Area

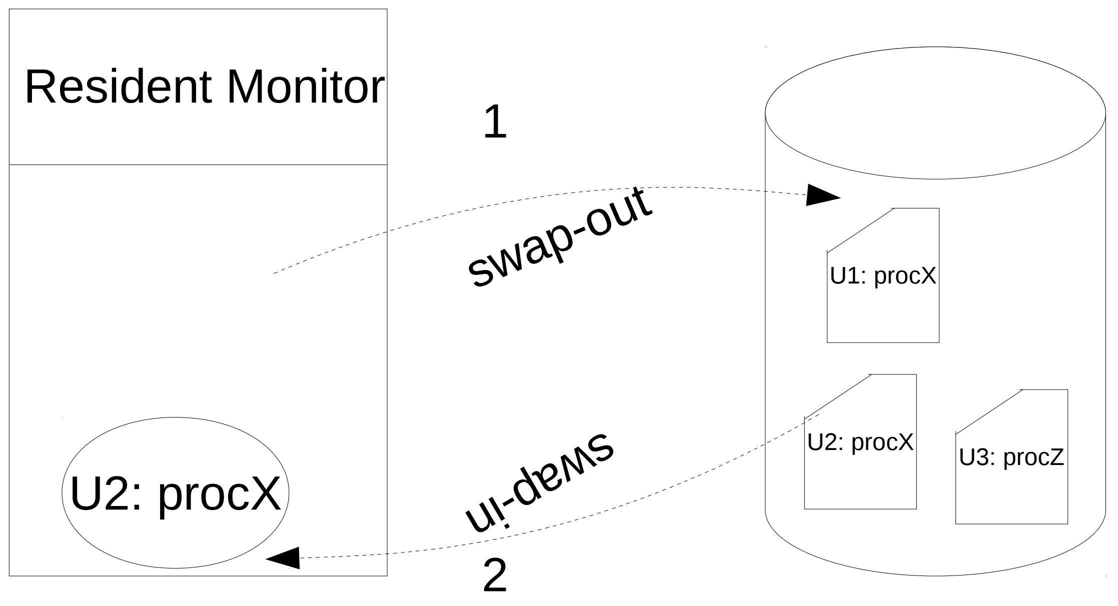


1. Single Process gets loaded into the MM from the SS/HD
2. When other process needs to run, first the current running process has to be moved-out onto the secondary storage

DRAWBACKS:

- The CPU would be idle during this IO operation, so inefficient
- Also, the degree of Multiprogramming is just 1.

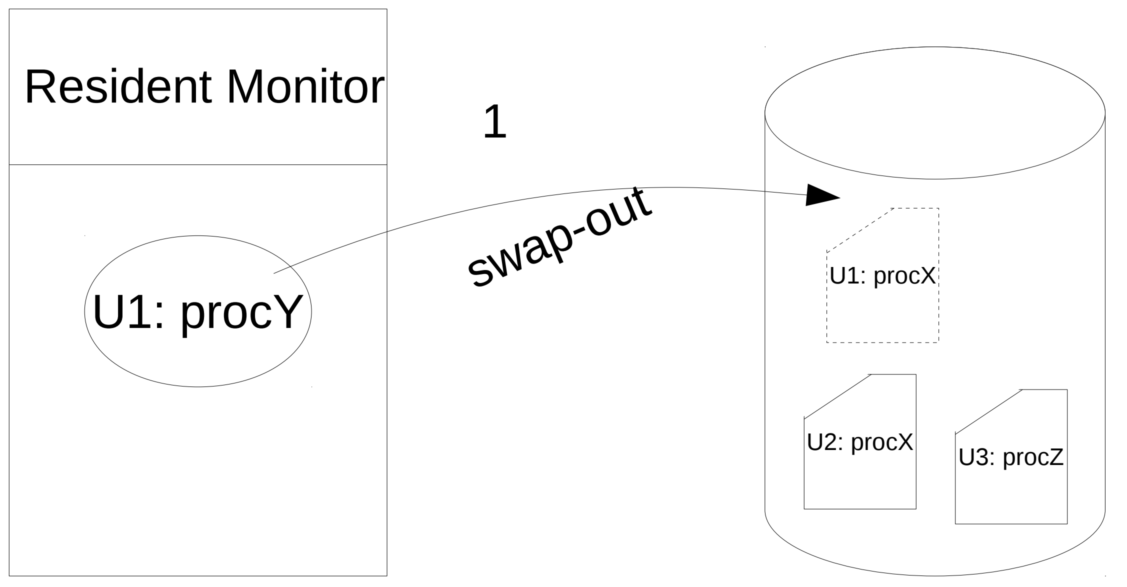
Multi-user System with OS



OBSERVE: It involves a kind of IO operation – as Secondary Storage is also a kind of IO device

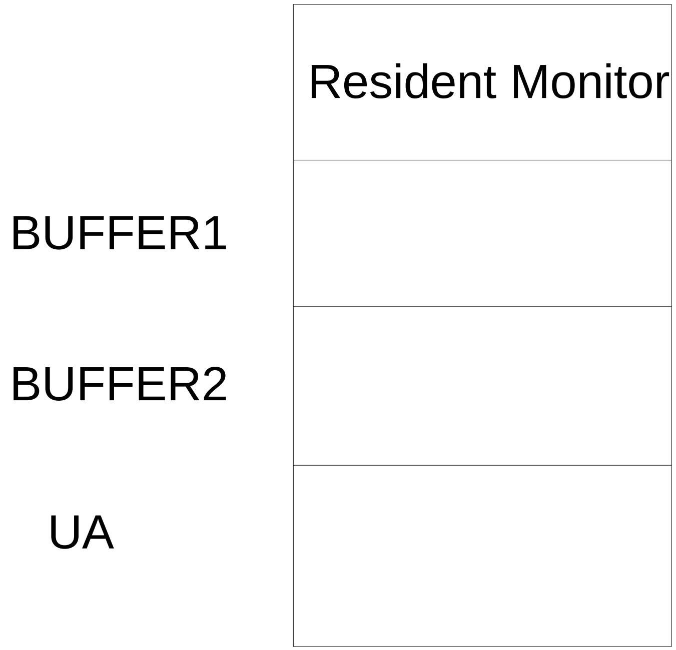
1. Sec. Storage is slower than MM access rate
2. The changes in var values etc. need to be changed in the SM as well

Multi-user System with OS



1. On demand, process is moved-out onto Sec. Storage
2. It involves IO operation
   - Sec. Storage is slower than MM access rate
3. The CPU would wait in this IO operation, so inefficient
4. Drawback back: Degree of Multiprogramming is just 1.

Partitioned Memory Model: Multiple Buffer Partitions + Active User Area



Paritions: Set of non-overlapping memory regions called partitions

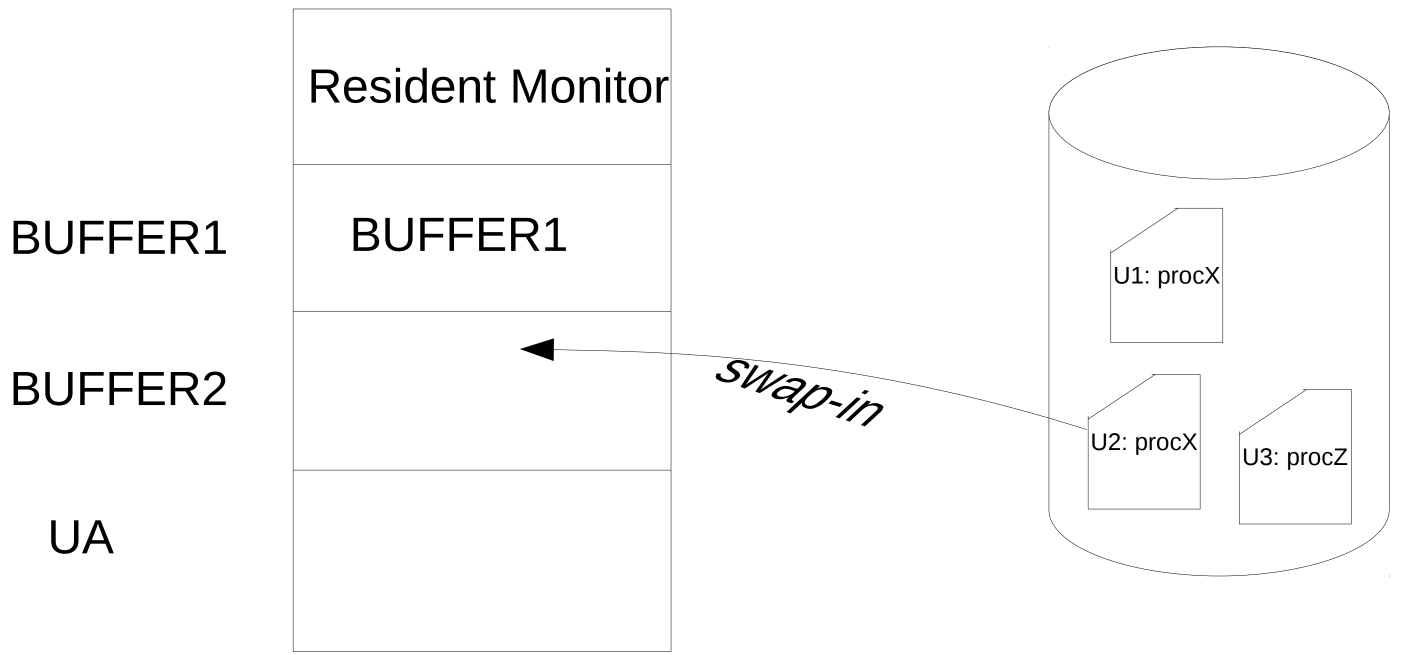
I .Partition the UA of MM into
BUFFER1, BUFFER2, ..., User Area

II. This makes possible for:

1. Swap-in new process from SM into BUFFER2
2. **Move the new process from BUFFER2 to UA**
3. **Move Active process from UA to BUFFER1**
4. Swap-out process from BUFFER1 onto SM

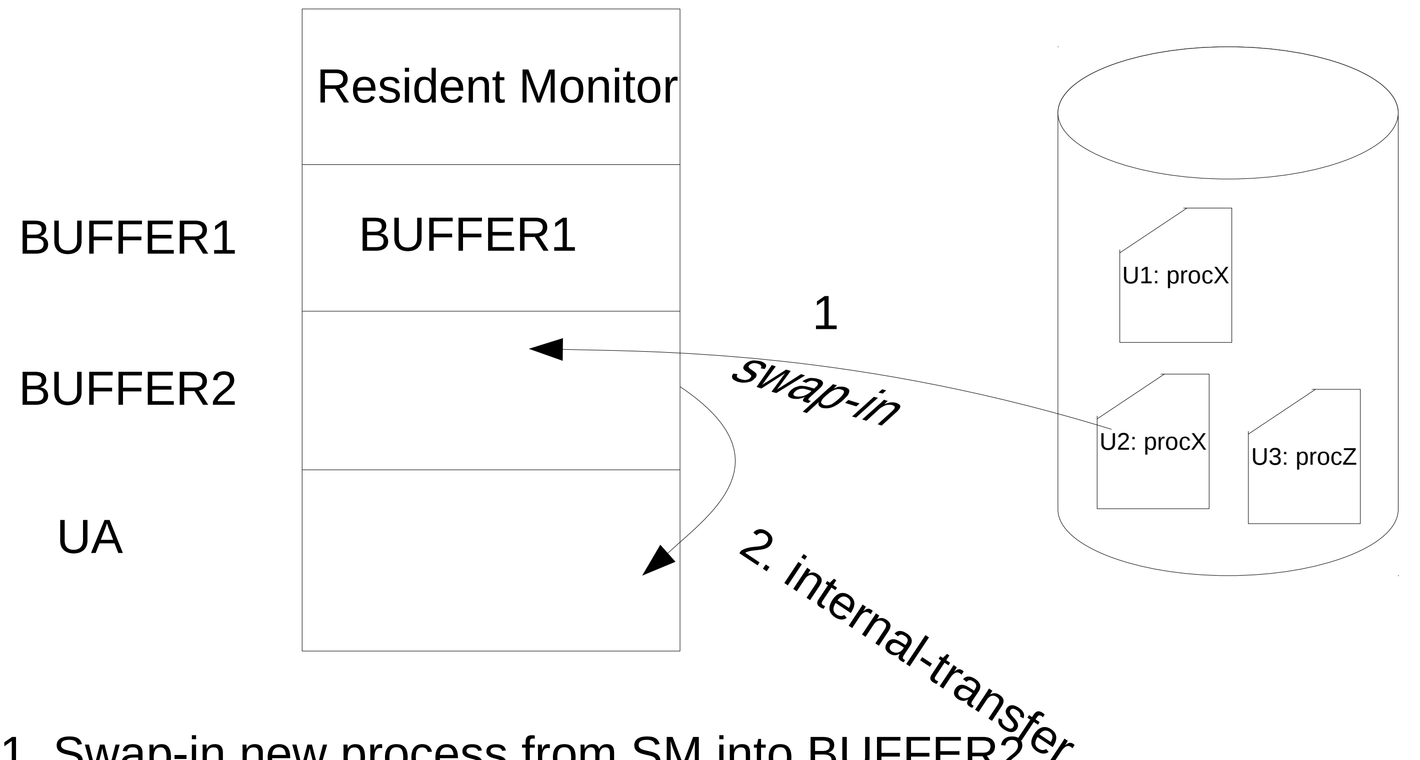
III. Multiple progs can be loaded into buffers simultaneously

Partitioned Memory Model: Multiple Buffer Partitions + Active User Area



1. Swap-in new process from SM into BUFFER2

Partitioned Memory Model: Multiple Buffer Partitions + Active User Area



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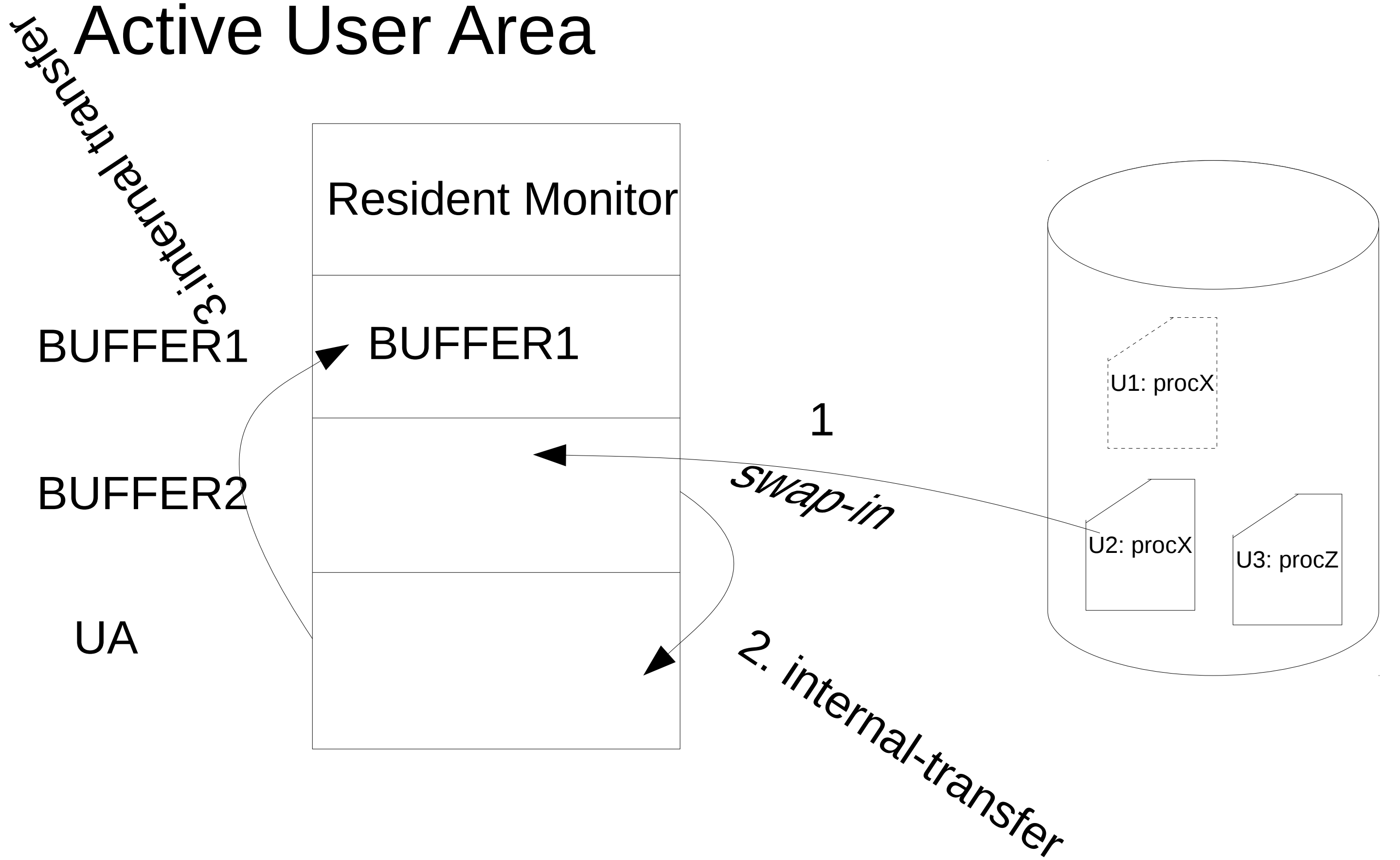

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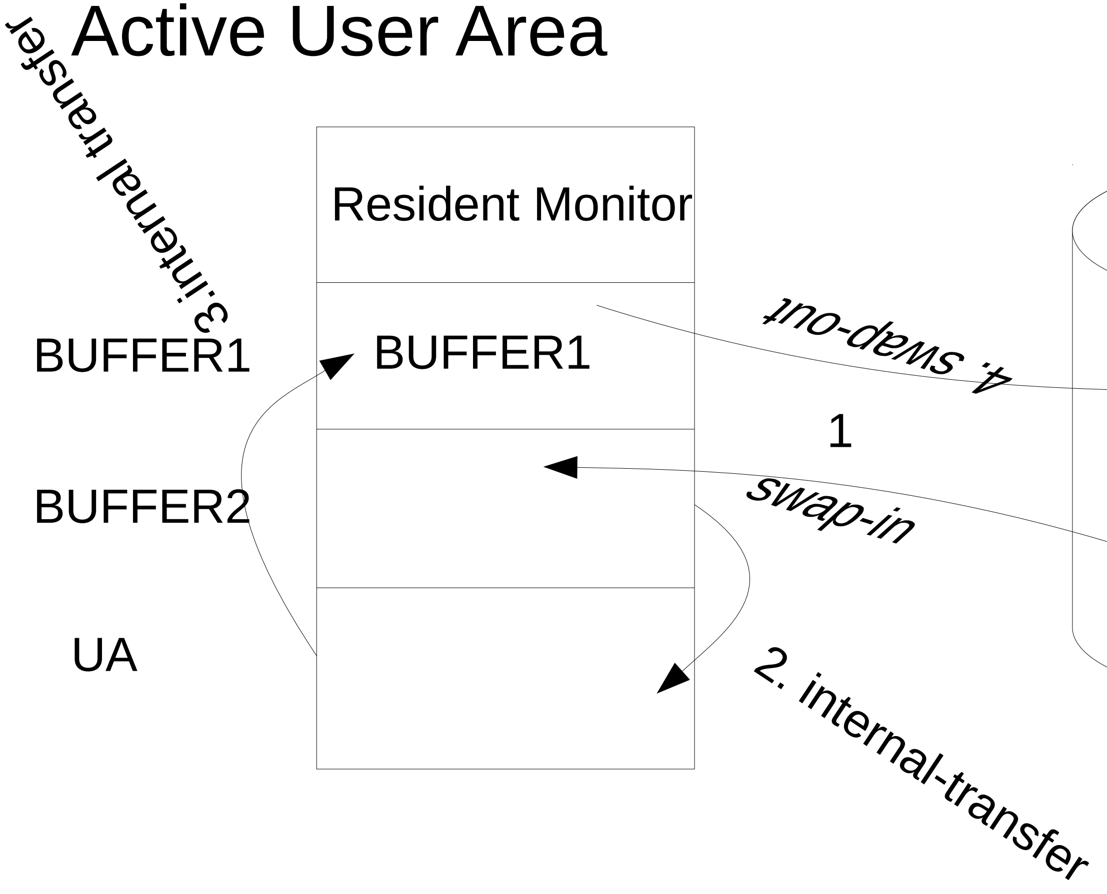

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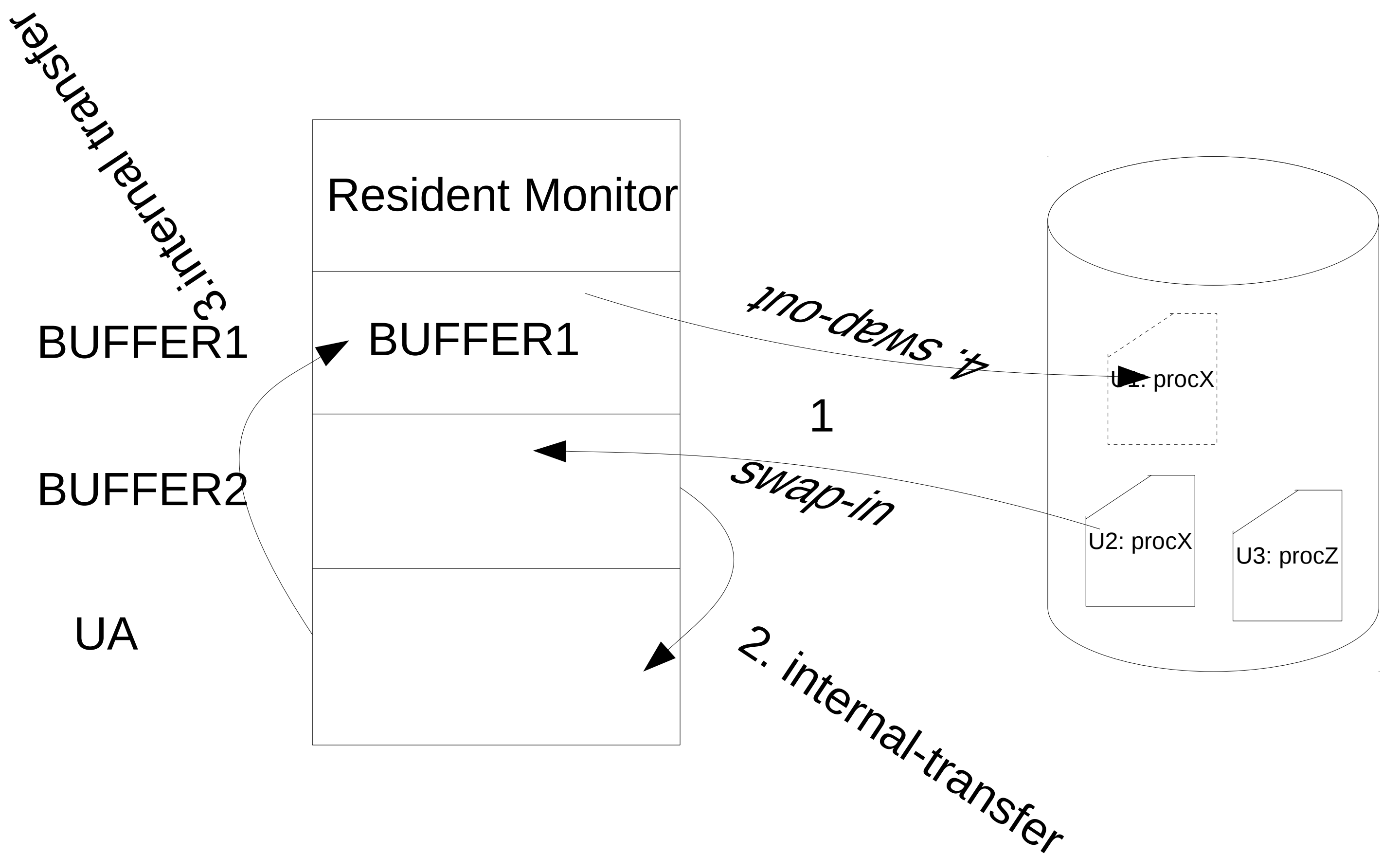
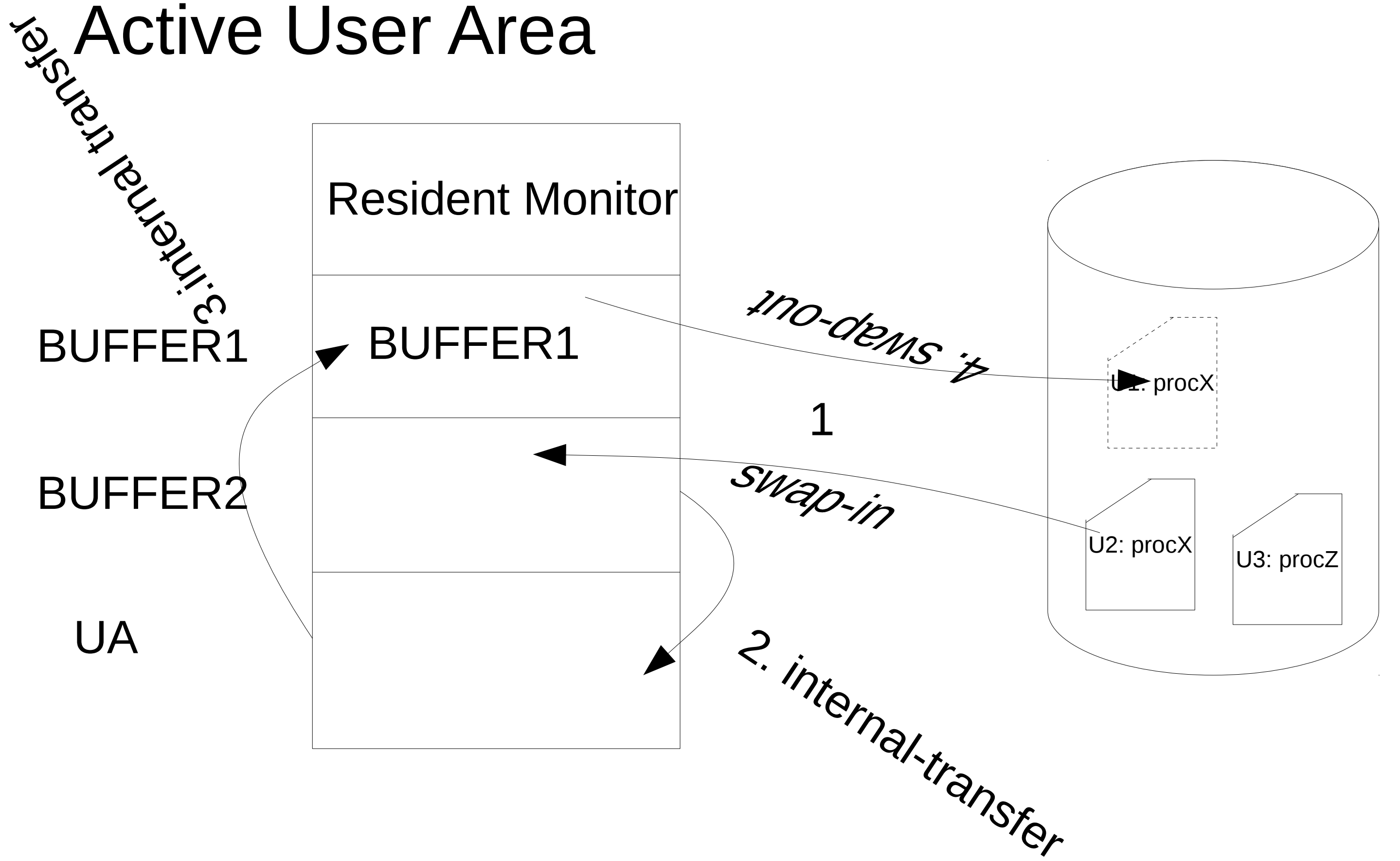
Multi-partitioned Memory Model



3. Multiple progs can be loaded into buffers simultaneously
  - degree of multiprogramming increases

Partitioned Memory Model: Multiple Buffer Partitions + Active User Area



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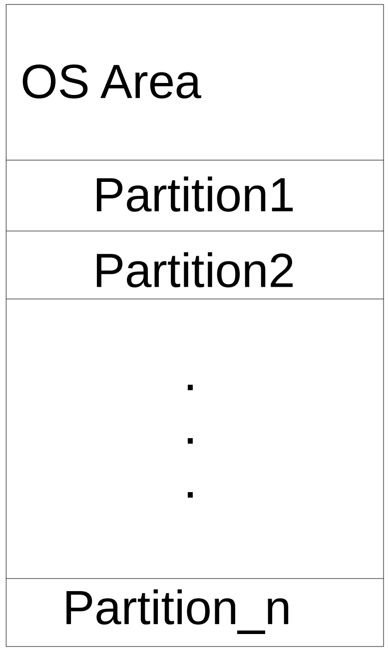
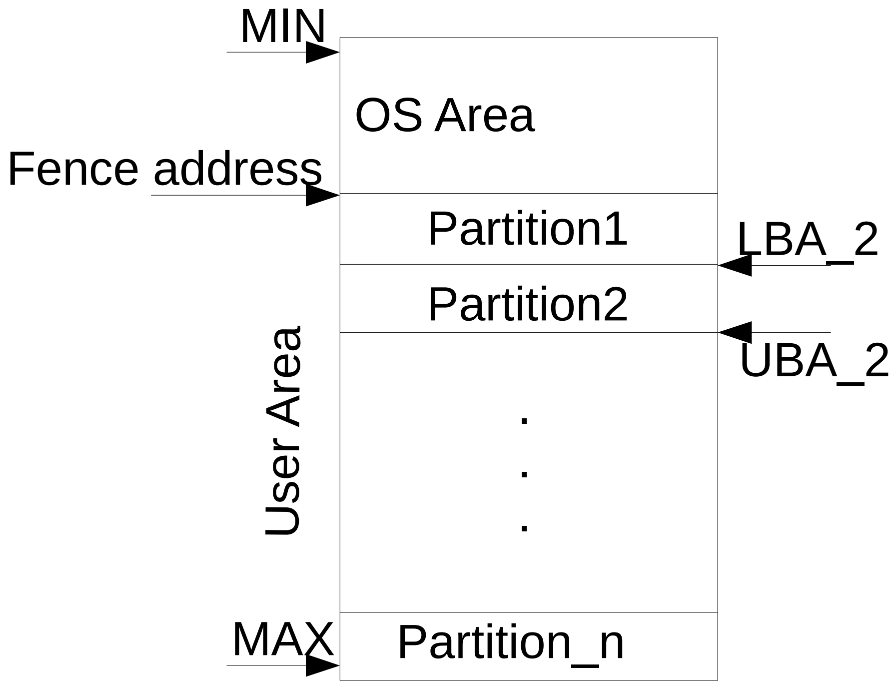
Multi-Partitioned Memory Model: Fixed number of fixed sized paritions



1 .Every partition is characterised by:
Base Address
Size/Limit

2. Process when loaded gets mapped to one partition

Multi-Partitioned Memory Model: Fixed number of paritions



1. In such multi-partitioned model, memory protection is more complex
   - need to make sure one process in a partition can not access address belonging to another partition

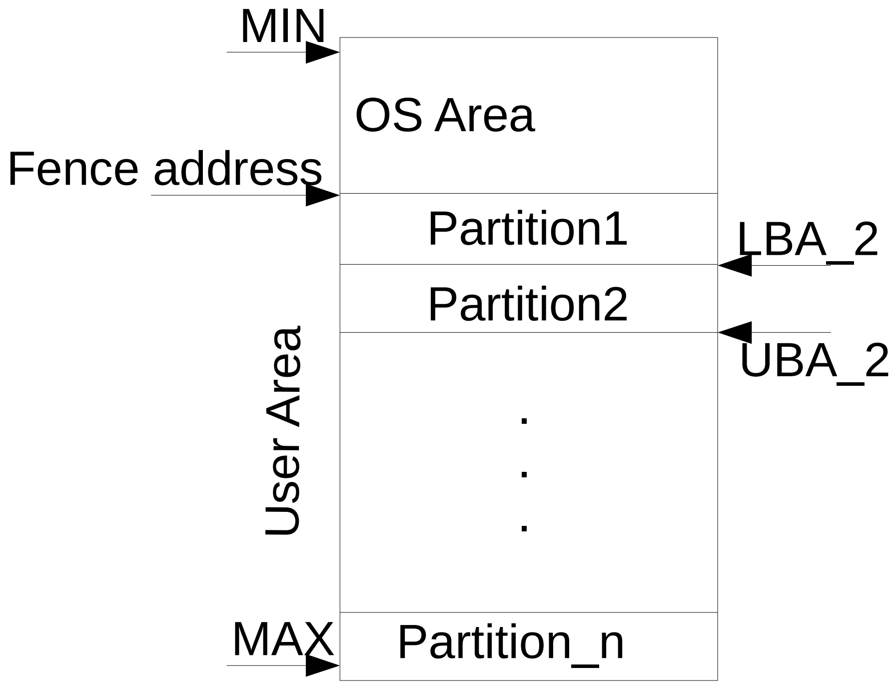
2. Each partition is identified by a contiguous memory addresses between two address bounds;
   - Lower Bound Address/Register (LBA)
   - Upper Bound Address/Register (UBA)

If size of partition is S_p, then
UBR_p = LBR_p + S_p

3. So every address from a process (belonging to a partition) shall respect these bounds for that partition.

4. LBA is stored in Base Register; while UBA is stored in Limit Register

Multi-Partitioned Memory Model: Fixed number of paritions



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If size of partition is S_p, then
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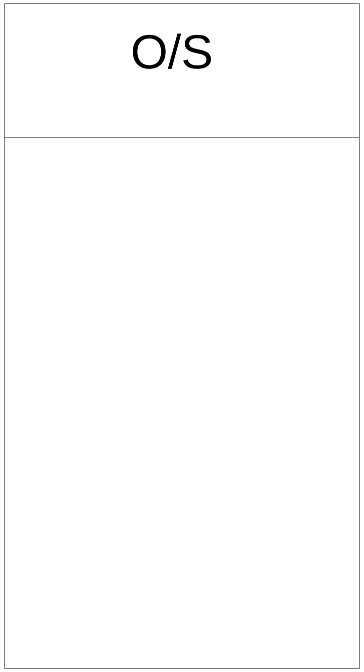
4. Every address shall be greater than o

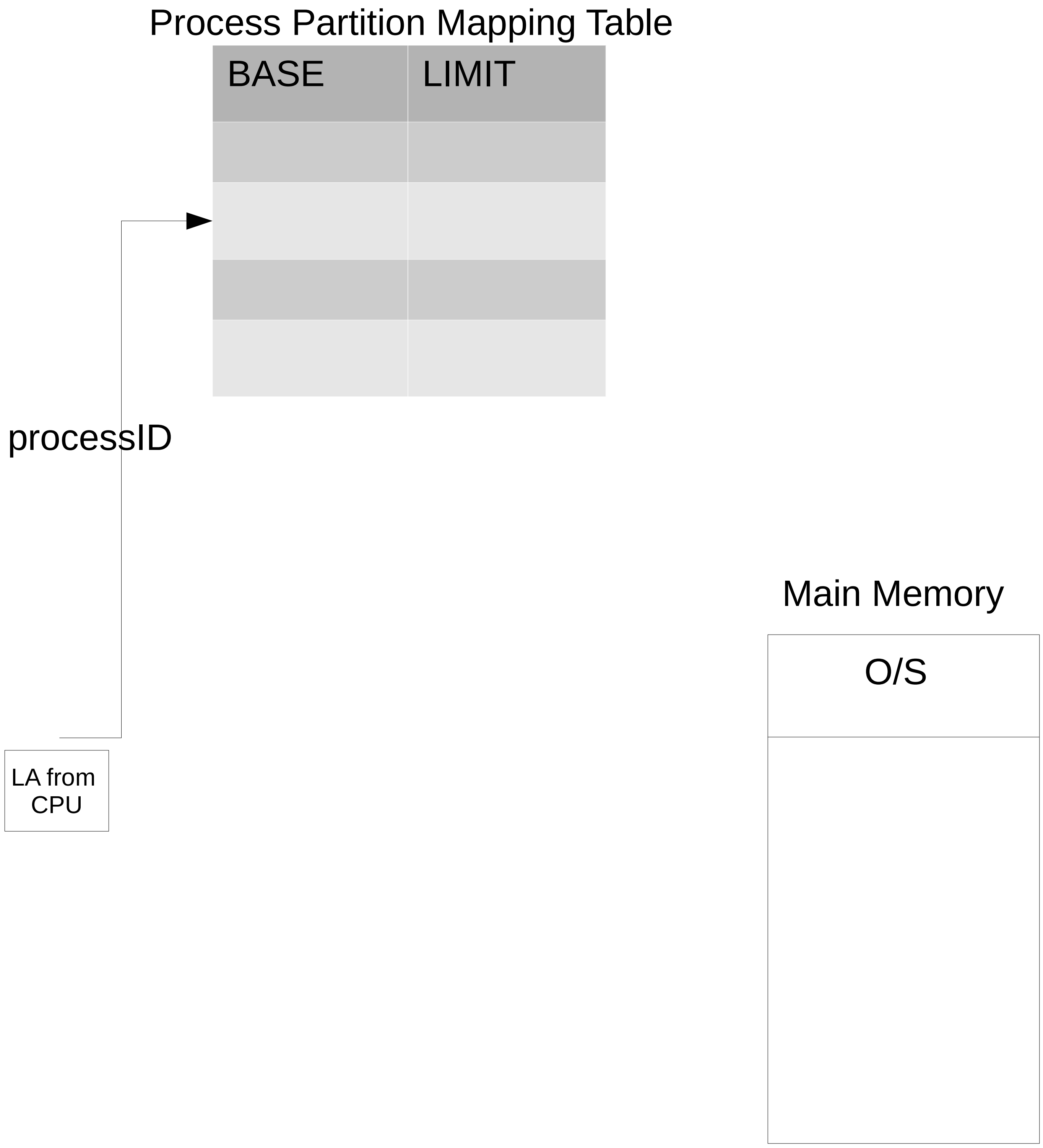
Process Partition Mapping Table

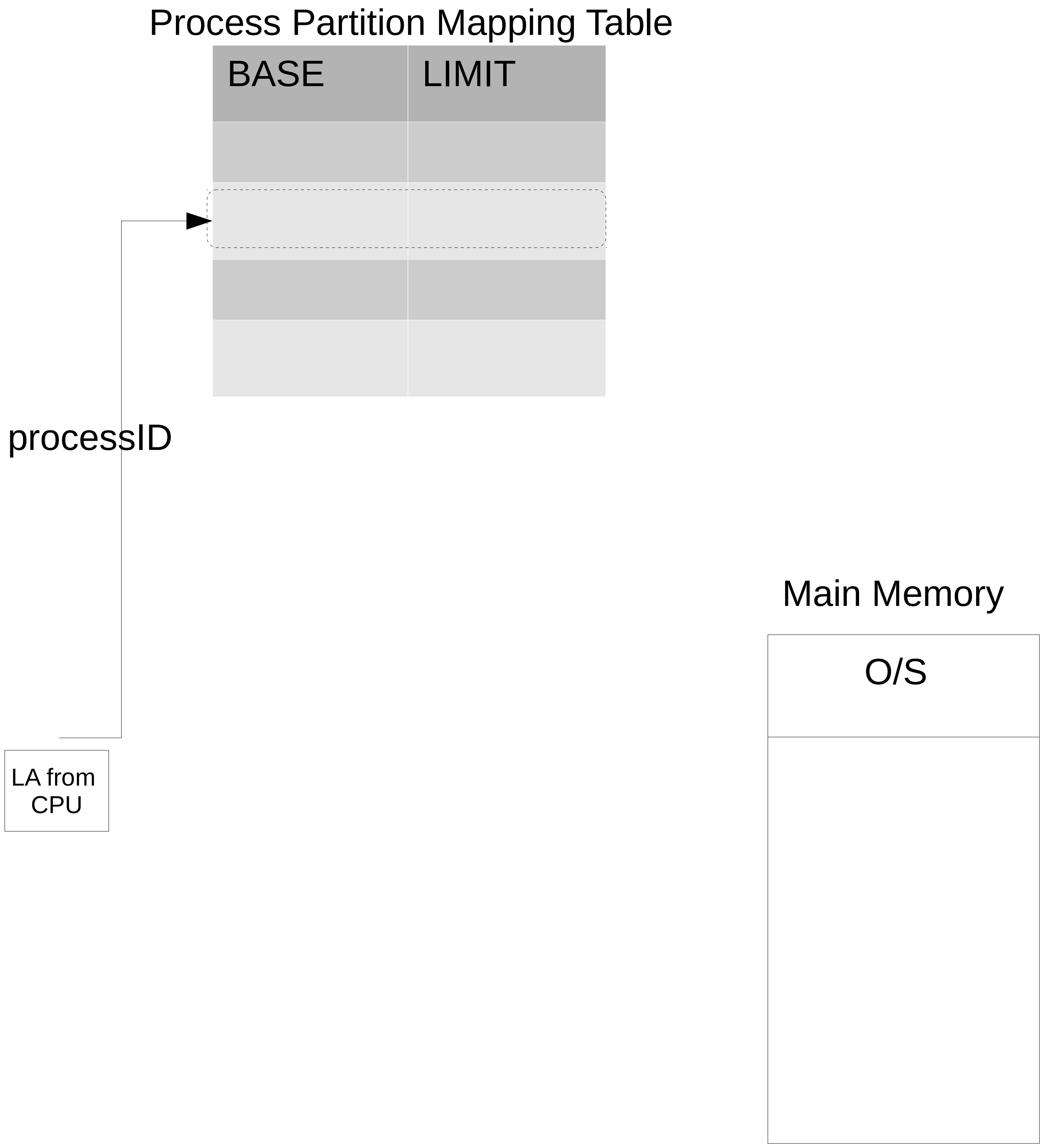
BASE	LIMIT

Main Memory



LA from CPU


Process Partition Mapping Table
BASE
LIMIT
processID
LA from CPU
Main Memory
O/S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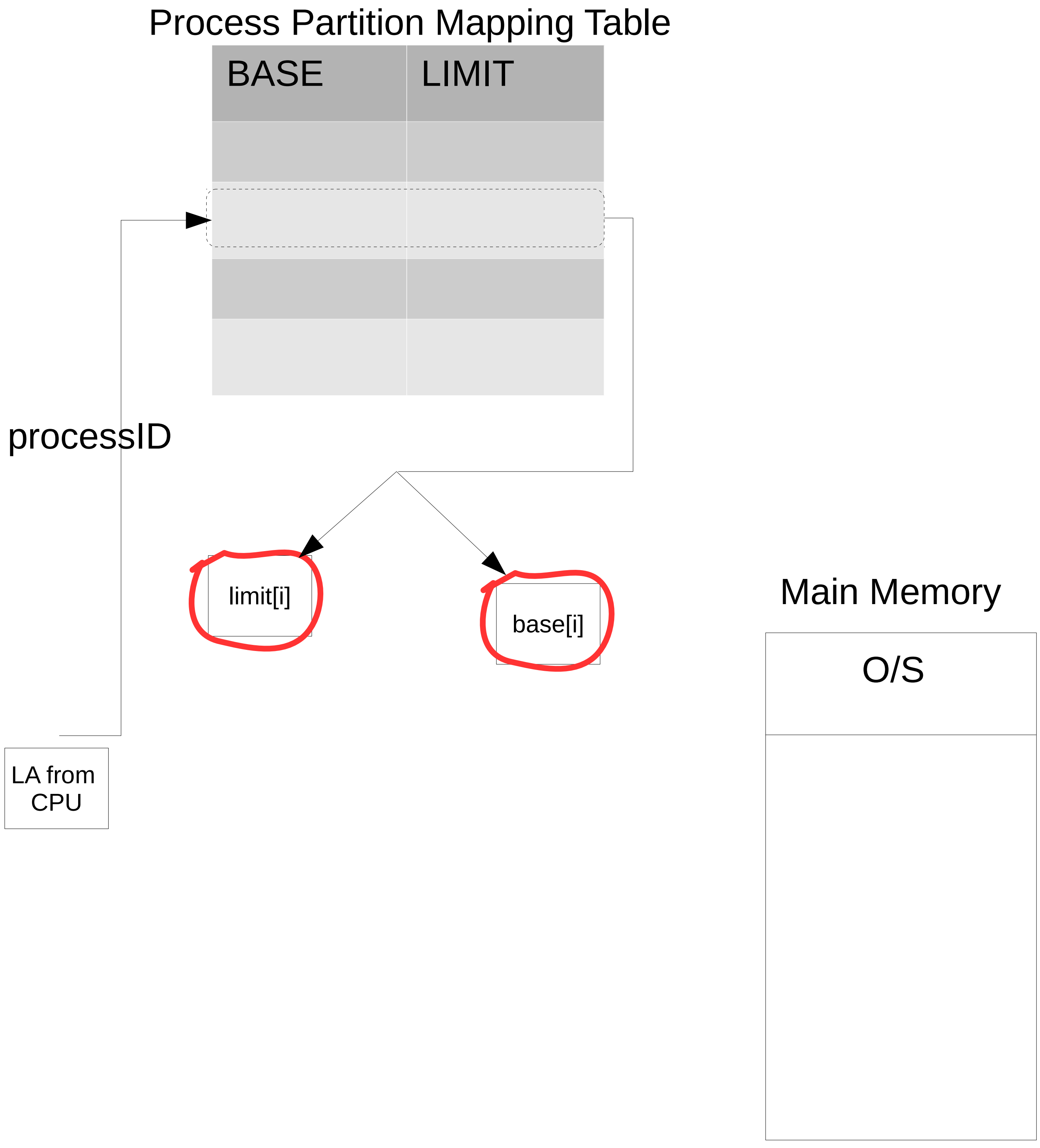
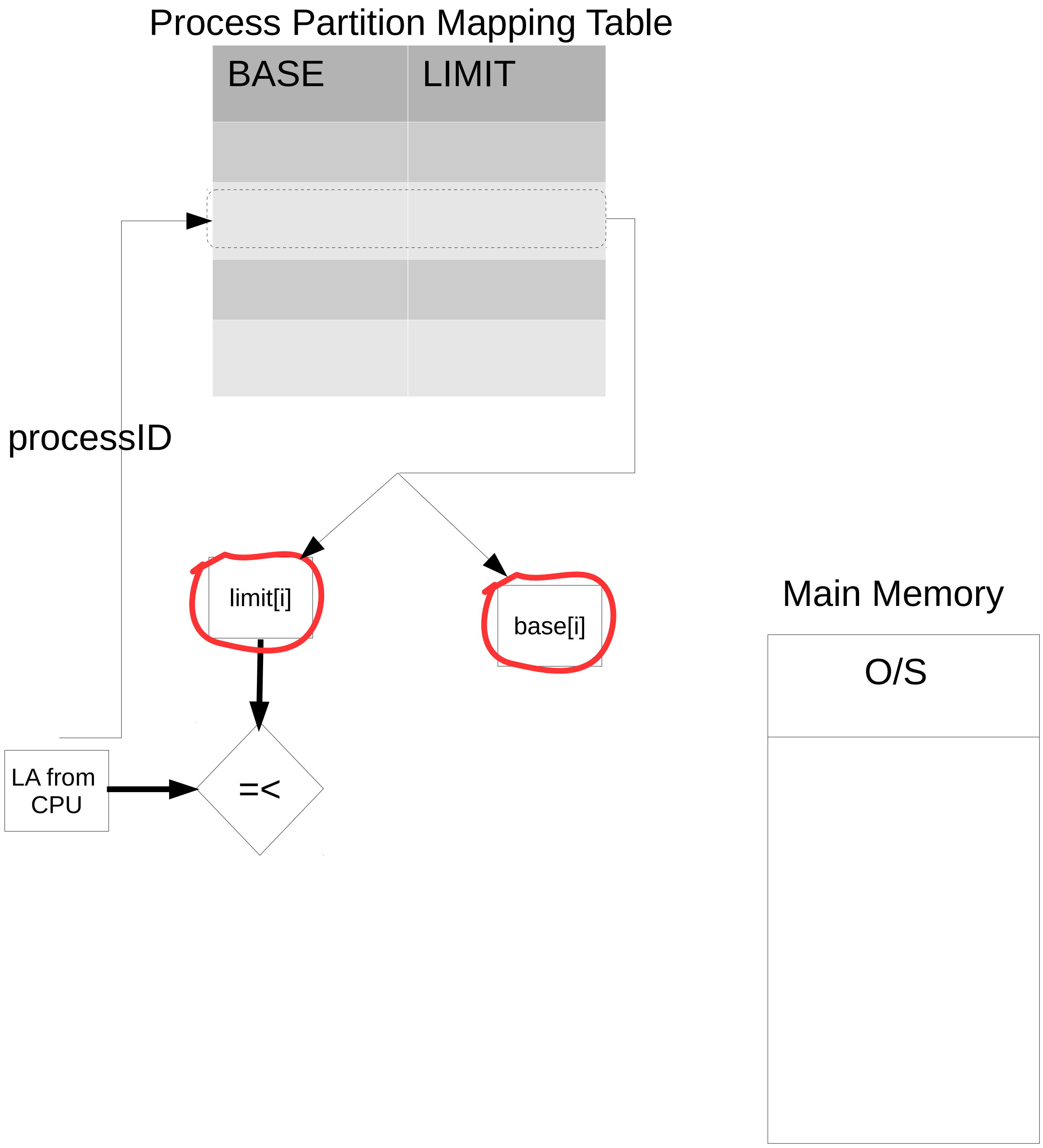
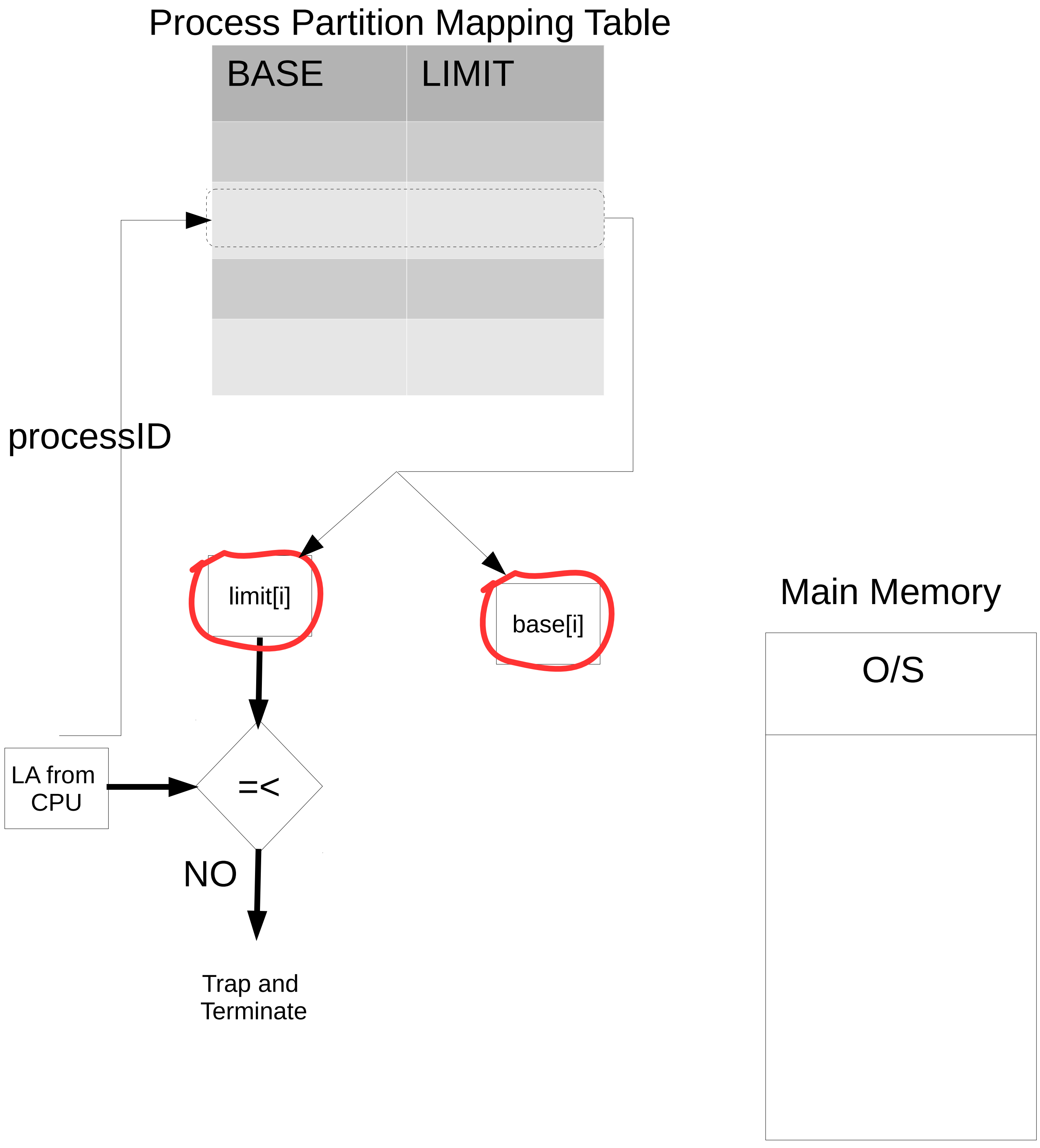
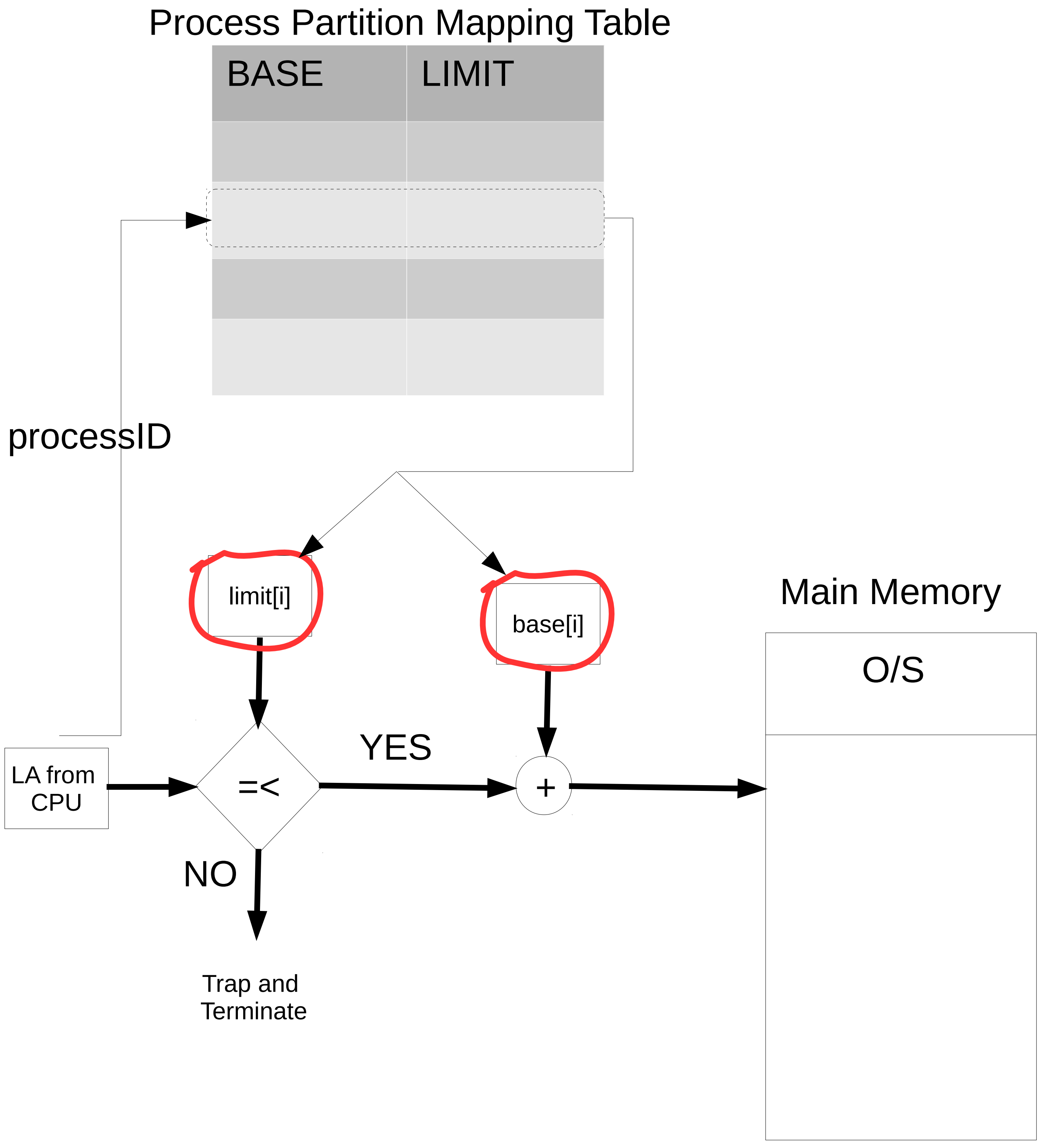

Process Partition Mapping Table
BASE
LIMIT
processID
limit[i]
base[i]
Main Memory
O/S
LA from
CPU

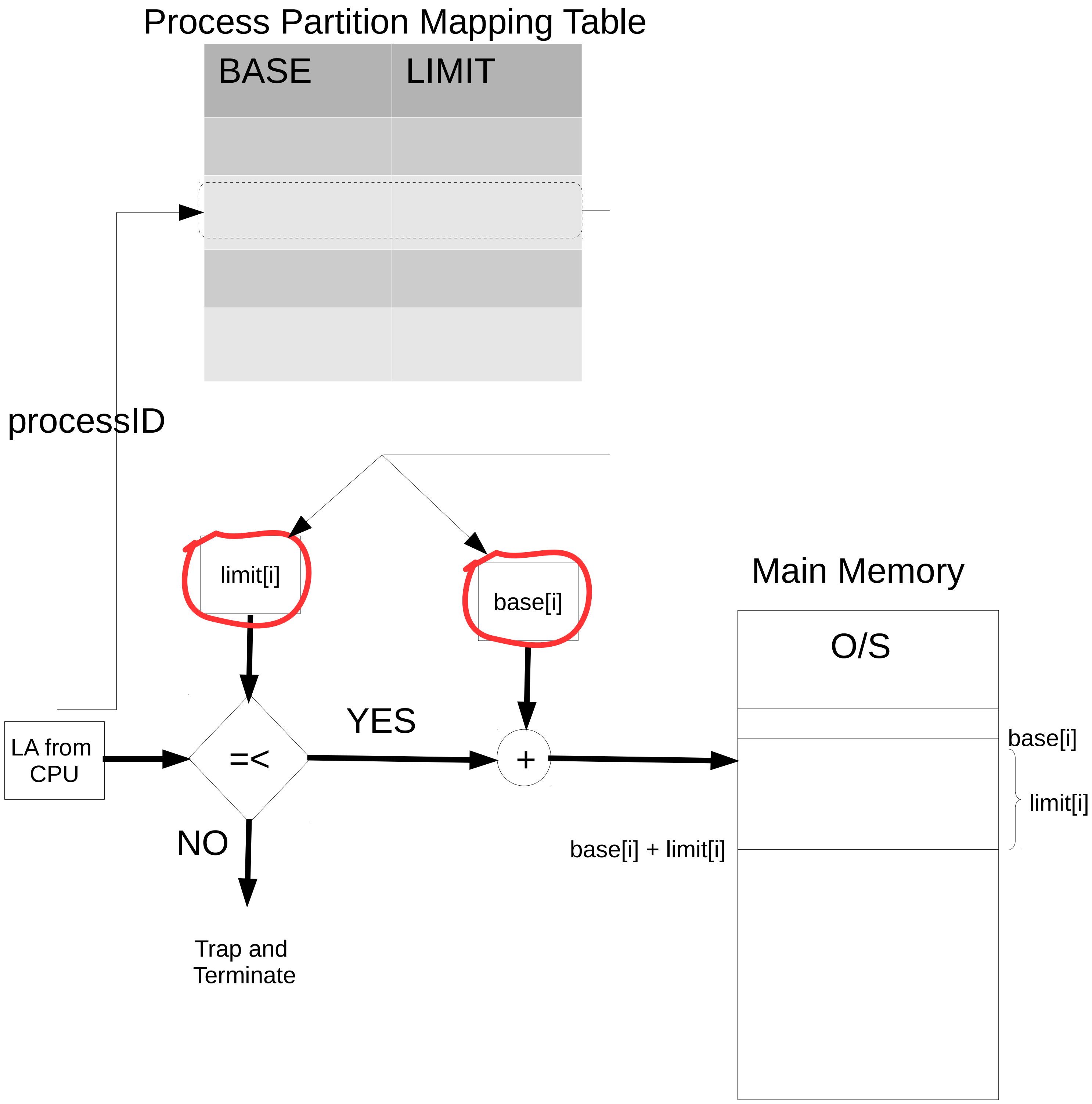


Process Partition Mapping Table
BASE
LIMIT
processID
limit[i]
base[i]
LA from CPU
=<
Main Memory
O/S



Process Partition Mapping Table
BASE
LIMIT
processID
limit[i]
base[i]
LA from CPU
=<
NO
Trap and Terminate
Main Memory
O/S


Process Partition Mapping Table
BASE
LIMIT
processID
limit[i]
base[i]
Main Memory
O/S
LA from CPU
=<
YES
+
NO
Trap and Terminate



Process Partition Mapping Table
BASE
LIMIT
processID
limit[i]
base[i]
Main Memory
O/S
LA from CPU
=<
YES
+
NO
Trap and Terminate
base[i]
limit[i]
base[i] + limit[i]

Fragmentation in MM

- Memory fragmentation: breaking of memory into non-contiguous blocks that often lead to non-utilisation or wastage of memory
- In this Multi-partition with fixed number processes or fixed-sized paritions: (also called as Multiprogramming with Fixed number of Tasks (MFT))
  - the size of each partition is fixed
  - Partitions could be of different sizes
  - With MFT we have fragmentation
    - Fragmentation: The inability in using memory even though it is empty!
  - Partition gets allocated to a process
    - Several algorithms exist for process-to-partition mapping
    - Different algorithms have different trade-offs particularly w.r.t fragementation perspective
    - Ofcourse, we need to have an associated data/record
      - Start address
      - Size
      - Allocation status

Partition allocation algorithms

- Two kinds:
  - First-fit algorithm
  - Best-fit algorithm
- First-fit algorithm:

  - Finds the first available partition with the size greater than or equal to the process memory needs

- Best-fit algorithm:

  - Finds the nearest sized partition meeting the process memory size of a process.

Fragmentation types

- Two type
  - Internal memory fragmentation
    - ILLUSTRATE
  - External memory fragmentation
    - ILLUSTRATE
- Best-fit minimises Int. mem. Frag
  - But complexity is high in comparison to FF

Fragmentation in MM

- Memory fragmentation: breaking of memory into non-contiguous blocks that often lead to non-utilisation or wastage of memory
- In this Multi-partition with fixed number of processes:
  - the size of each partition is fixed
  - Partitions could be of different sizes
  - With MFT we have fragmentation
  - Partition gets allocated to a process
    - This record is maintained in Partition Allocation Table

Memory Management

6 November 2018
CS303
Autumn 2018

Memory Mgmt./Multiprogramming With Fixed Number of Tasks (MFT)

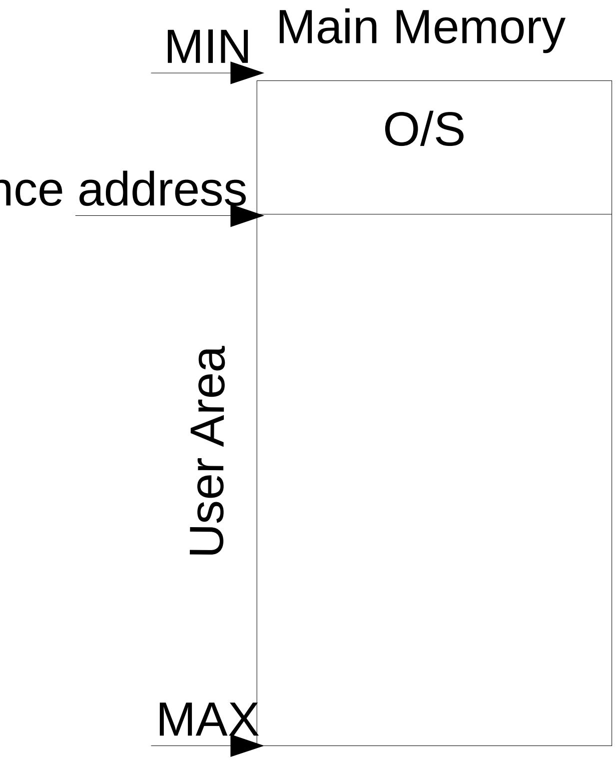
- Features of MFT:
    - MM organised into fixed number of partitions
        - Each of fixed size
        - Each partition is defined by lower limit and upper limit
            - LBA/LBR
            - UBA/UBR
            - Size = UBA – LBA
            -
    - Each partition gets allocated to a process via algorithms such as
        - First-fit: Less complexity but higher memory fragmentation
        - Best-fit: Increased complexity but decreases fragmentation
- Drawbacks of MFT:
    - As partition number and size are fixed, the max. degree of multiprogramming possible is defined by this number
    - Fragmentation is inevitable since partitions are fixed in advance
        - Fragmentation types: Internal fragmentation and External fragmentation

Multiprog. With Variable Number of Tasks(MVT)

- Features of MVT:
  - Partitions get created of size demanded by processes
    - Having the size as required
    - Each partition is defined by lower limit and upper limit
      - LBA/LBR
      - UBA/UBR
      - Size = UBA – LBA
  - Internal fragmentation is eradicated completely, as partitions get created of the required size

- Drawbacks of MFT:
  - External fragmentation is possible

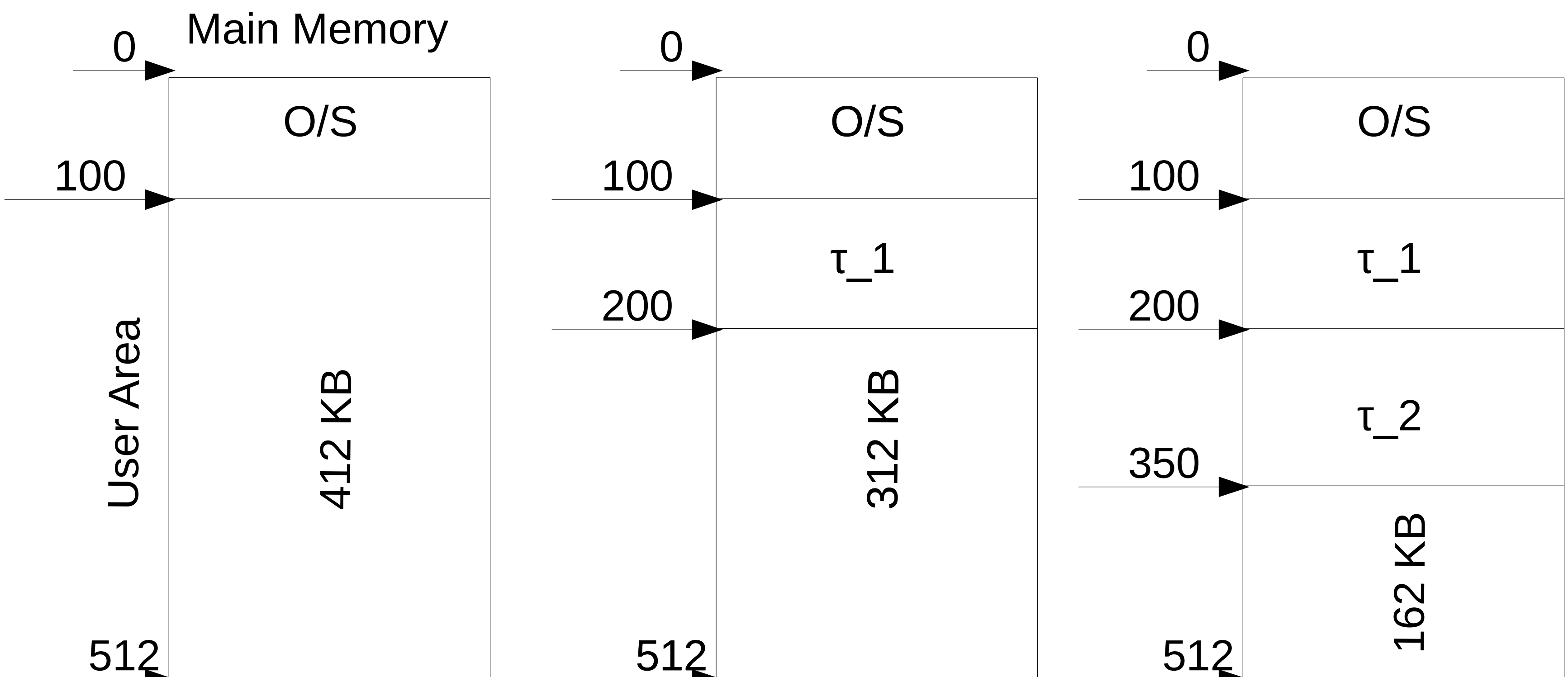
MVT Illustration: Ext. Fragmentation



ProcessID	SIZE (KB)	CPU Burst
τ_1	100	10
τ_2	150	6
τ_3	40	25
τ_4	90	10
τ_5	60	16
τ_6	110	10

- All processes arriving simultaneously at t_0
- Consider a FCFS

MVT Illustration: Ext. Frag (..cont)



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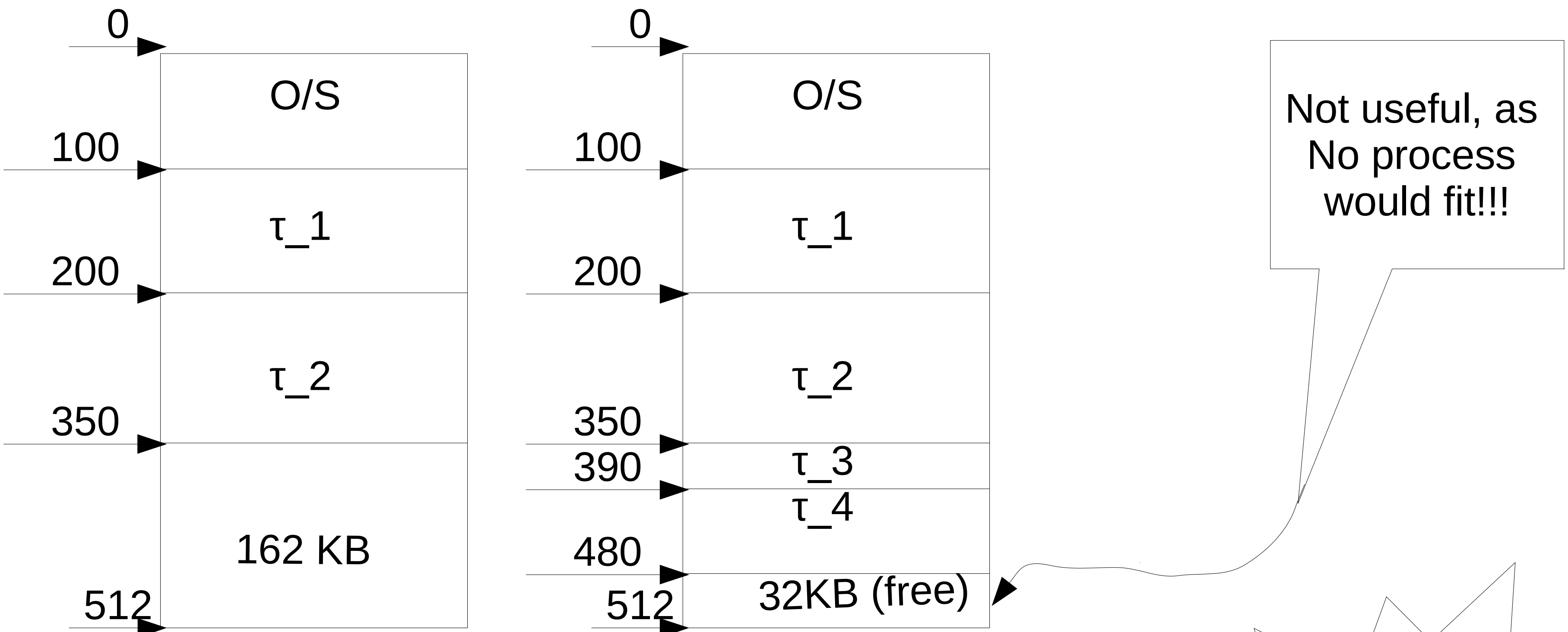

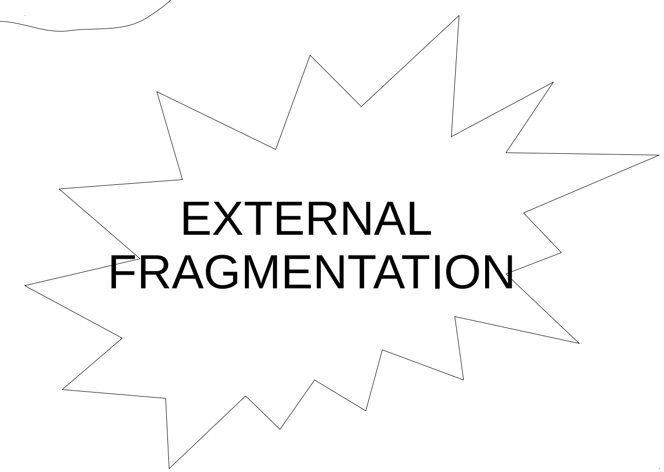

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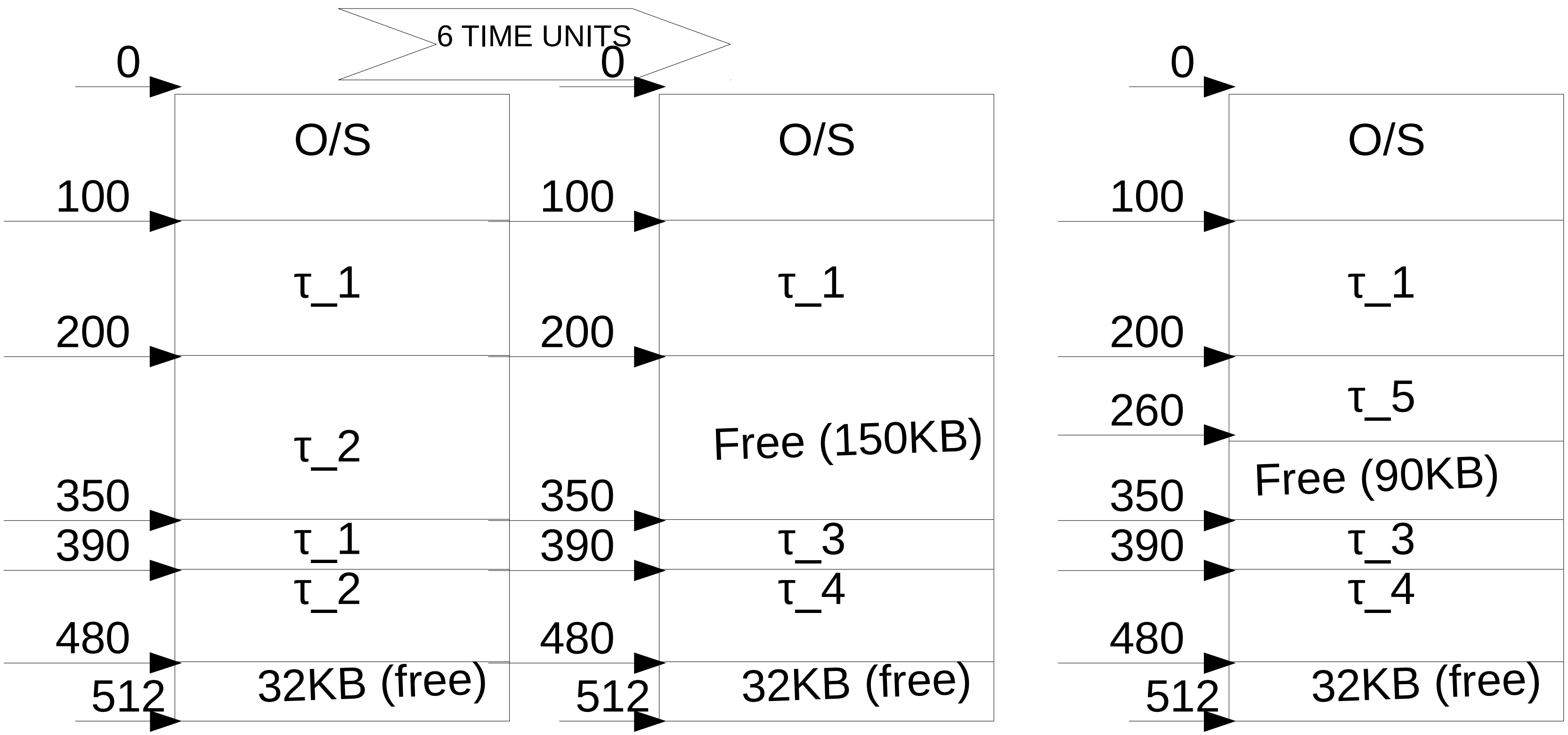
MVT Illustration: Ext. Frag (..cont)



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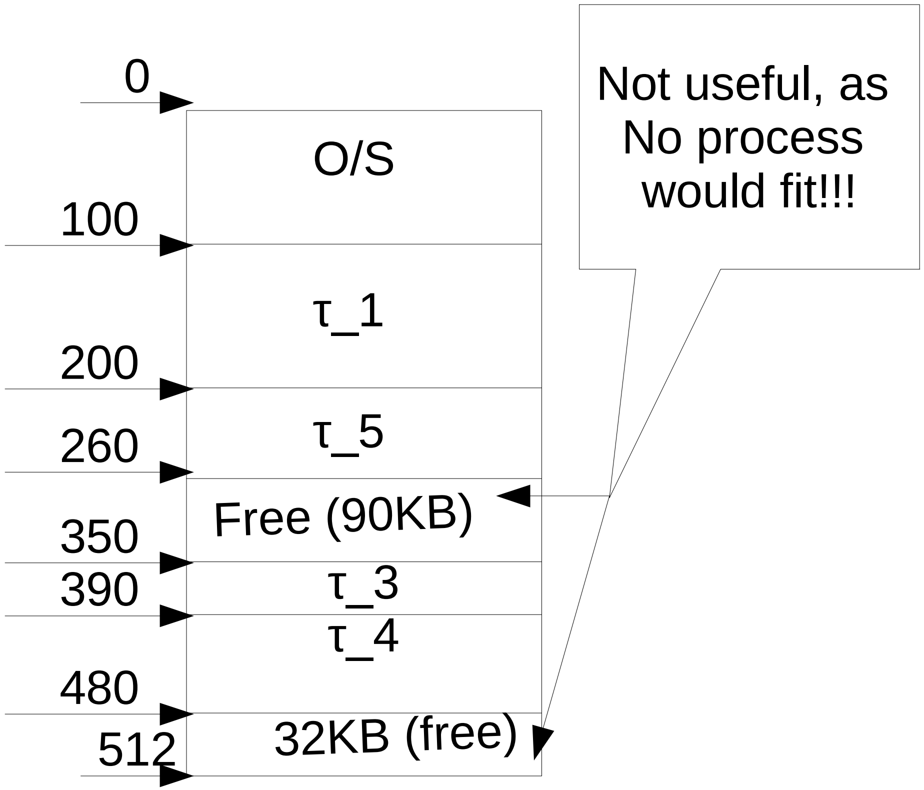

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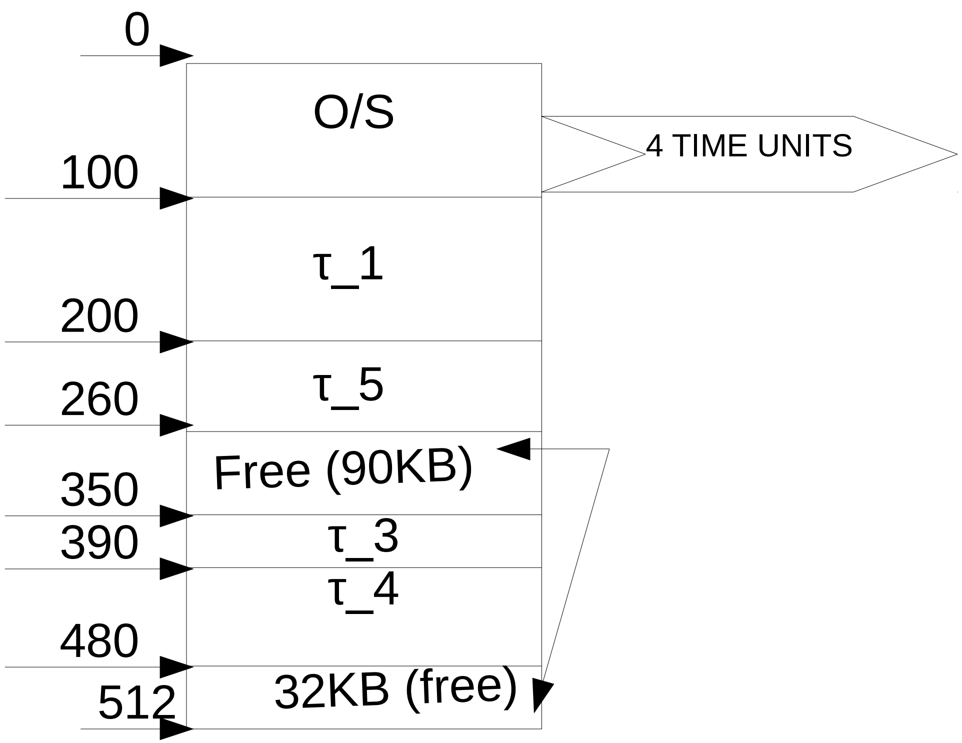

Memory replacement can help?

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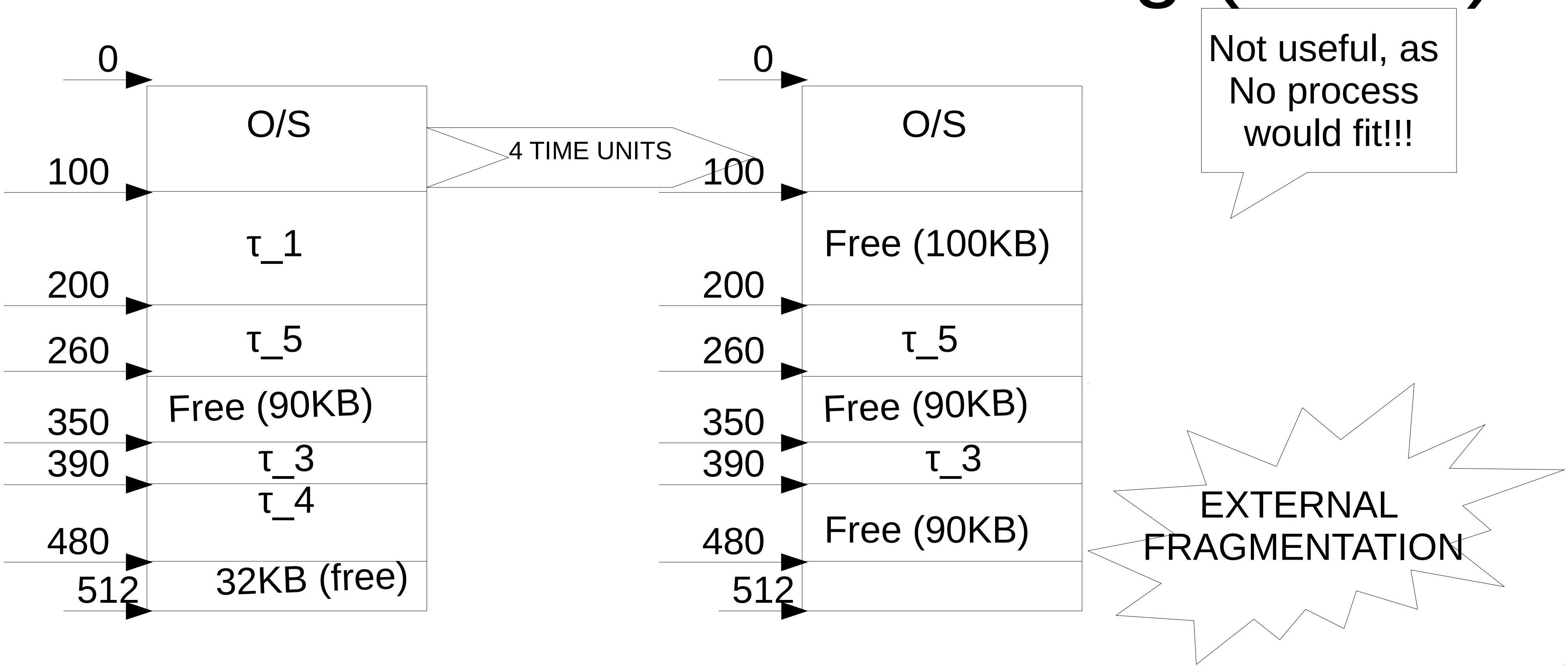

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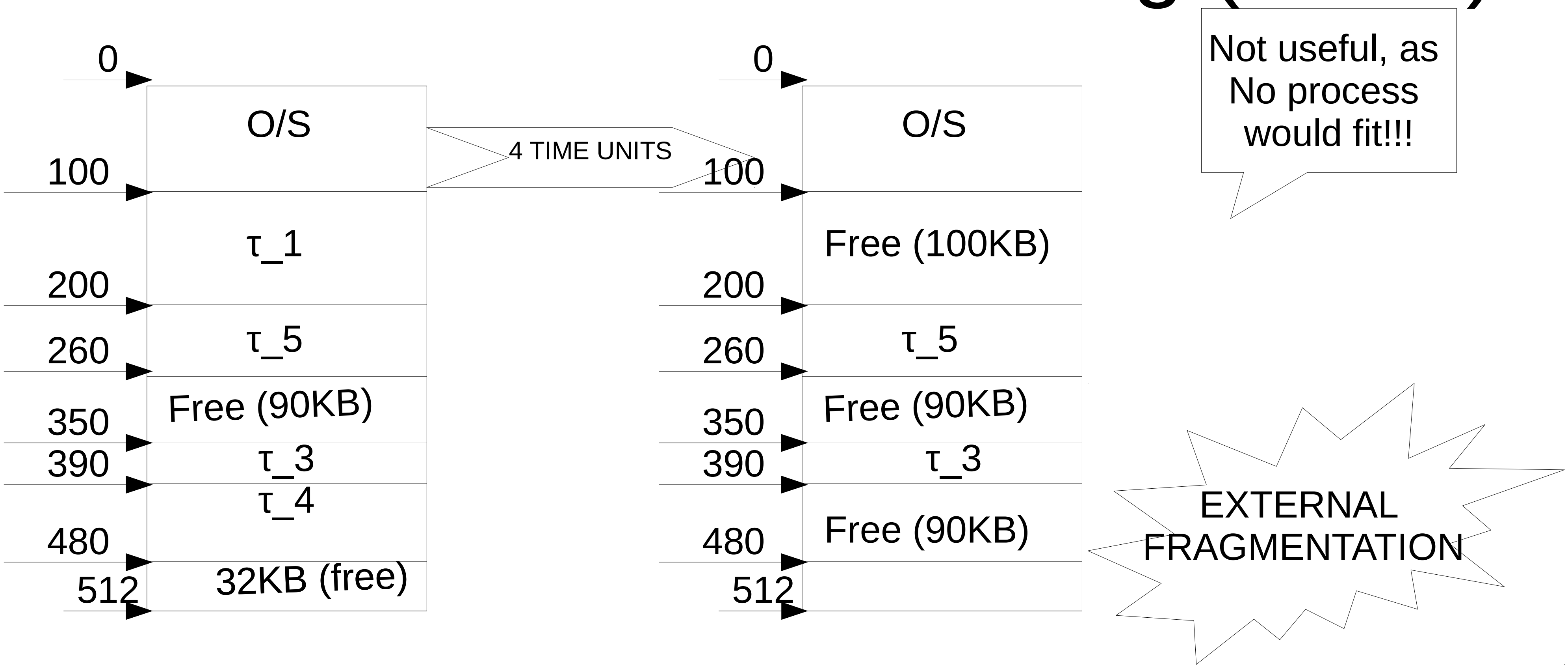

Though free space is available
As it is not contiguous,
Cannot be allocated to req.
processes!!!!

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τ_1	100	10
τ_2	150	6
τ_3	40	25
τ_4	90	10
τ_5	60	16
[illegible]	[illegible]	[illegible]

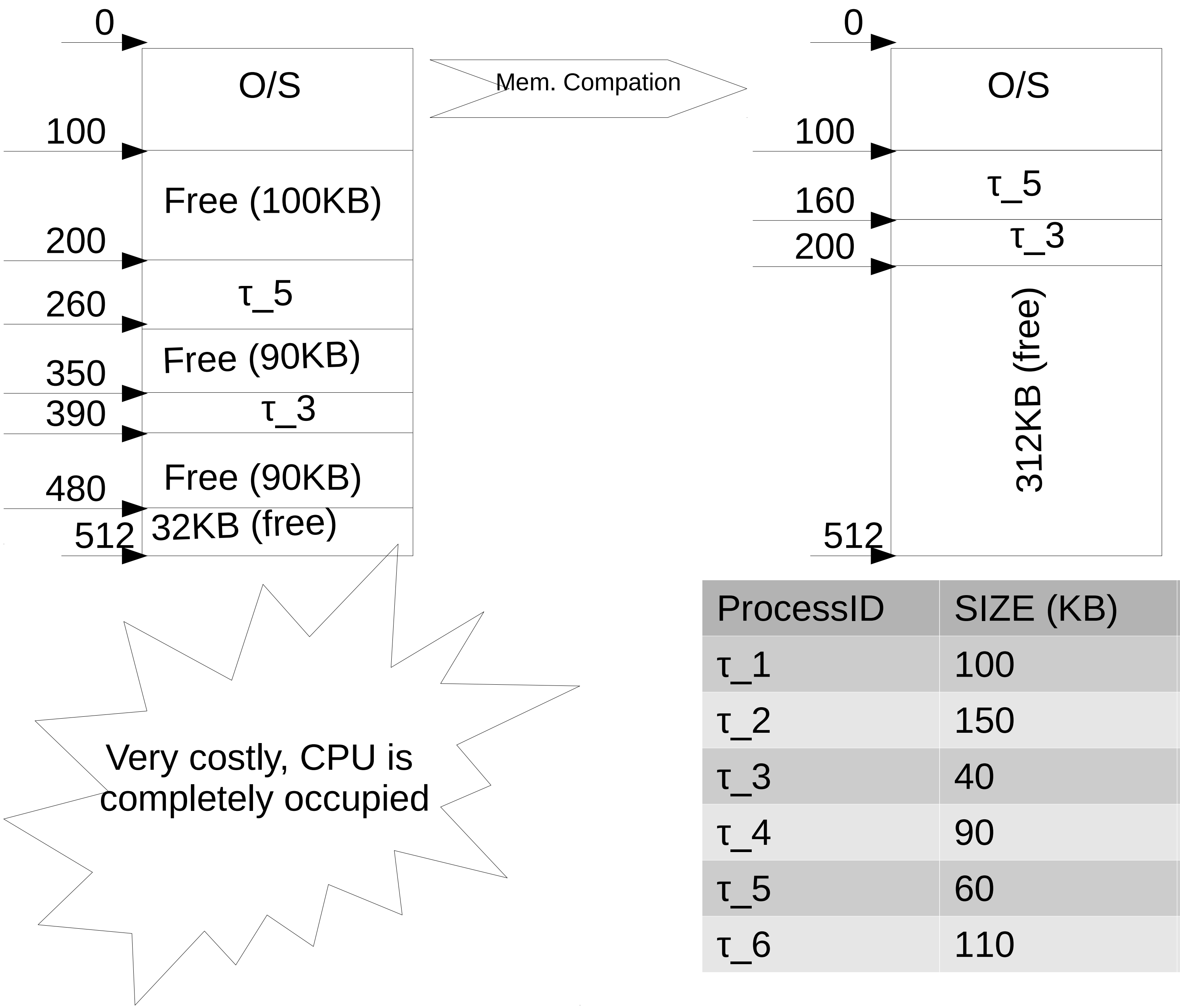
Memory Replacement

- If free space is available of required size but is in a discontiguous fashion
  - It cannot be allocated
  - Move all the free areas together, by reallocating the allocated partitions
  - Called **Memory Compaction**
    - **Lets move the free areas together to create a larger free area that is contiguous**

Memory Compaction

- Memory Compaction algorithm and data str.
  - Keeps track of free areas getting available
  - Keeps track of occupied partitions
  - When advantageous, partition replacement is done
  - A partition table records all this info, which is processed by the algorithm to do the compaction

MVT Illustration: Compaction



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