CS & IT ENGINEERING

Operating System

Memory Management

Lecture - 5

By- Vishvadeep Gothi sir

Recap of Previous Lecture

Topic Performance of Paging

Topic TLB

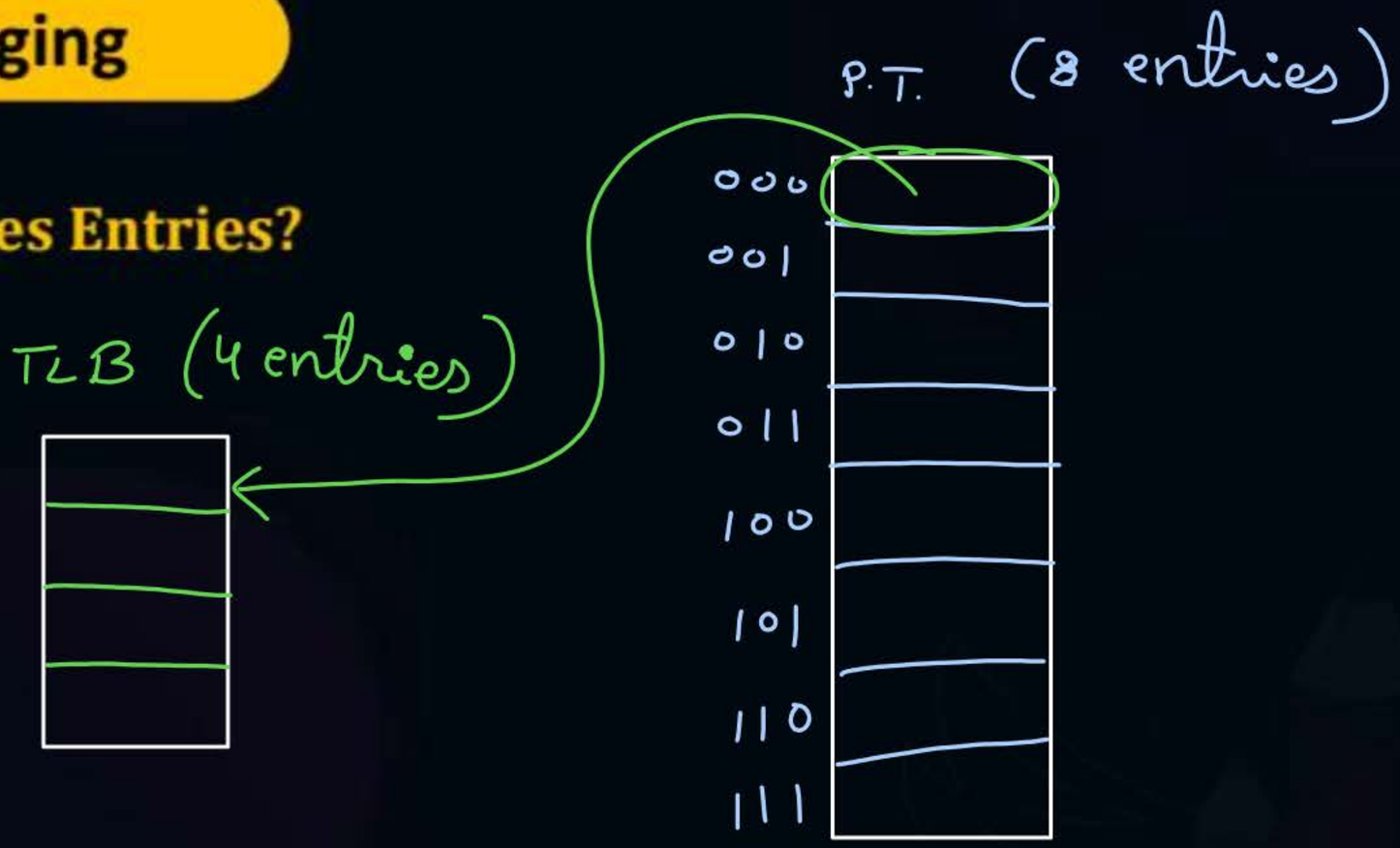
Topics to be Covered

Topic TLB Mapping

Topic Segmentation

Topic : Paging

How TLB Stores Entries?

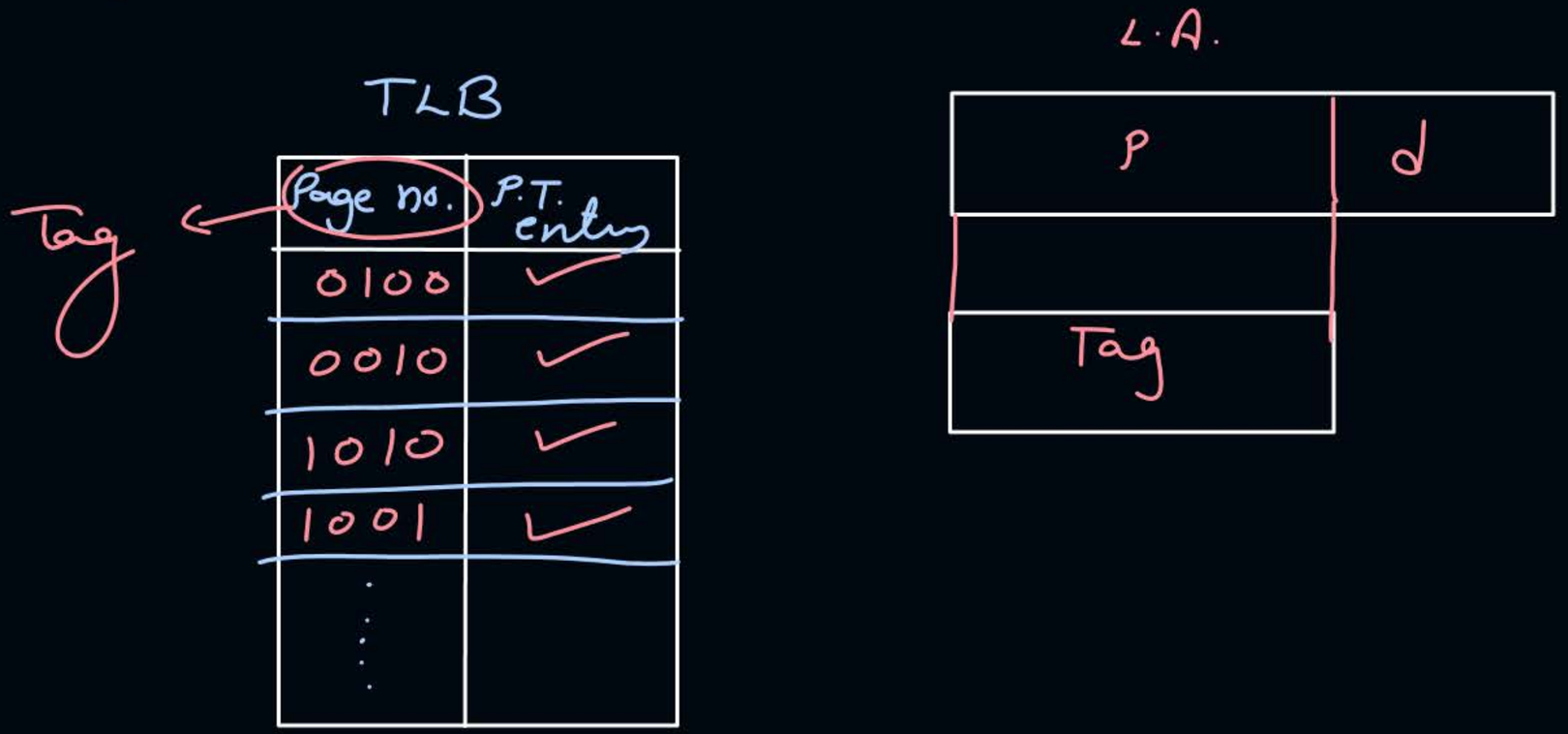


Topic : Paging-2

TLB Mapping → which P.T. entries is stored where in TLB

1. Fully Associative
2. Direct
3. Set-Associative

Fully associative mapping :-



Topic : Paging-2

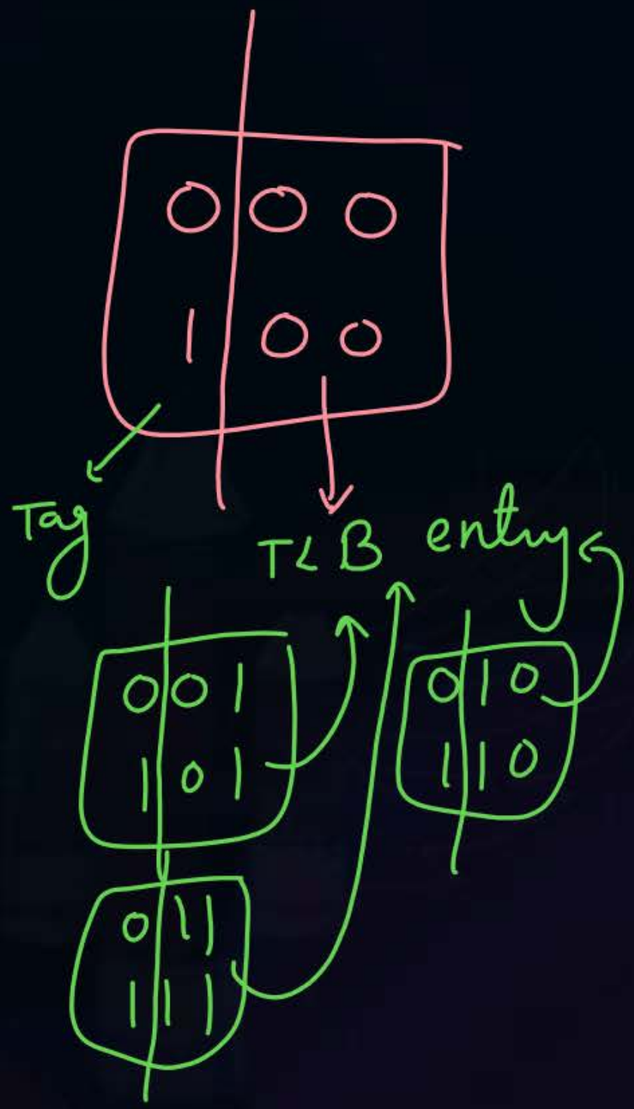
TLB Mapping: Direct

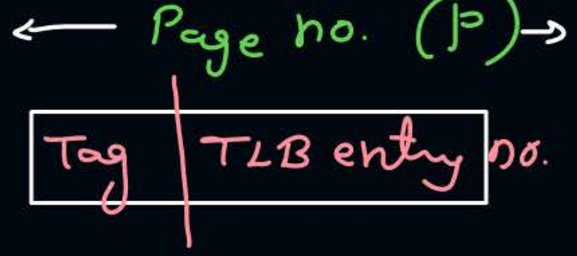
TLB (4 entries)

	Tag		
00	0	f10	0, 4
01			1, 5
10			2, 6
11			3, 7

P.T. (8 - entries)

000	
001	
010	
011	
100	
101	
110	
111	





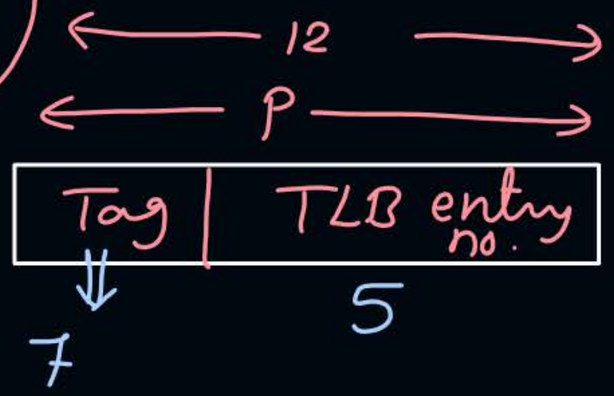
No. of bits in TLB entry no. $= \log_2$ (no. of entries in TLB)

Ex:- no. of pages $= 2^{12} \Rightarrow P = 12$ bits

TLB can store 32 entries $\rightarrow 2^5$

Direct mapping.

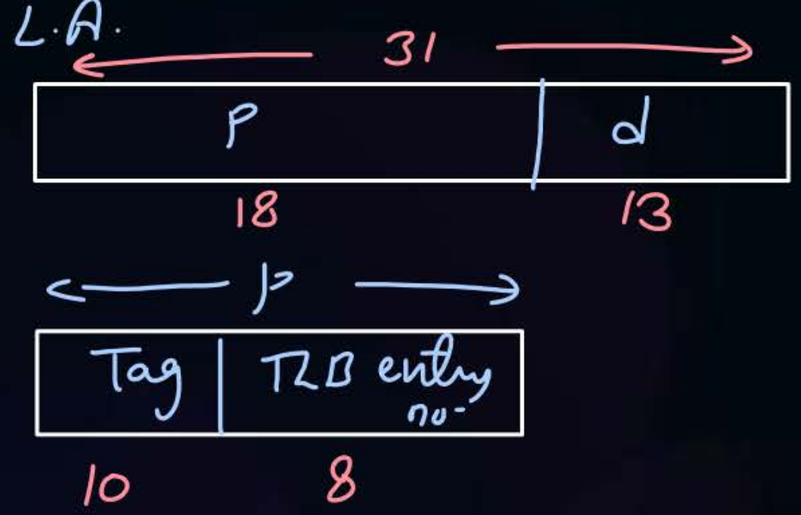
Tag = 7 bits



Topic : Question

2^{13} B

#Q. A computer system implements a 31- bit ~~virtual~~ logical address, page size of 8 kilobytes, and a 256-entry translation look-aside buffer (TLB) organized as direct mapped. The minimum length of the TLB tag in bits is _____?



no. of entries in TLB = 256 = 2^8

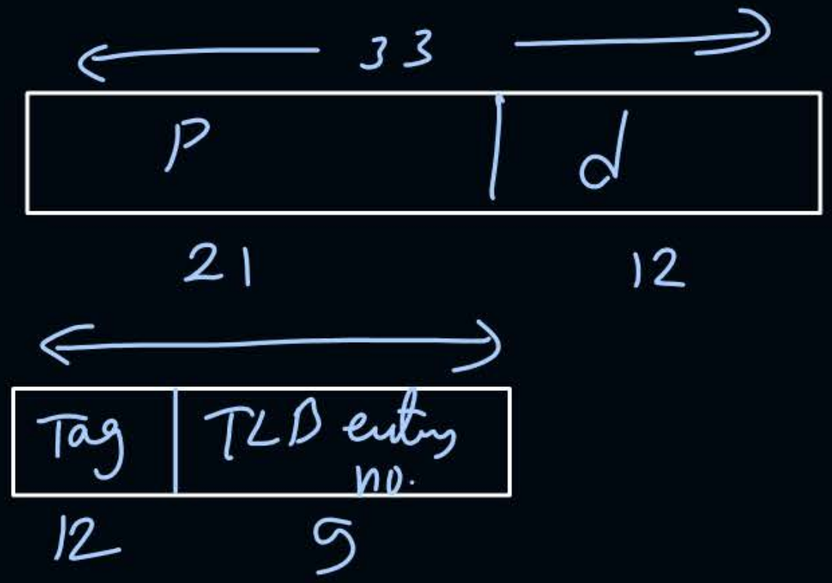
entry no. = $\log_2 256$ = 8 bits

#Q.) L.A.S. = 8GB = 2^{33} B ⇒ LA = 33 bits

Direct mapped TLB has 512 entries → 2^9

Page = 4KBytes = 2^{12} B

Tag = 12 bits



ex:- TLB Size = 64 bytes

1 P.T. entry = 2 bytes

no. of entries in TLB = $\frac{64B}{2B}$

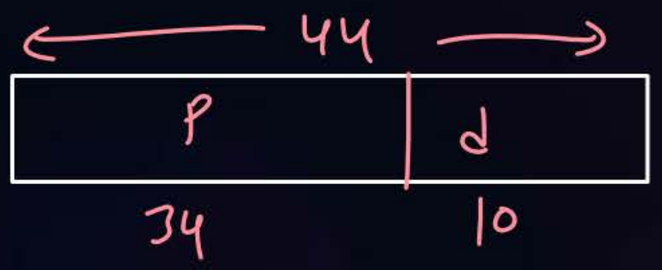
= 32

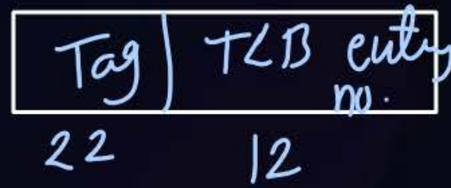
Topic : Question

2^{10}

#Q. A computer system implements a 44- bit virtual address, page size of (1) kilobytes, and a 16KB look-aside buffer (TLB) organized as direct mapped. Each page table entry is of 4bytes. The minimum length of the TLB tag in bits is 22 ?

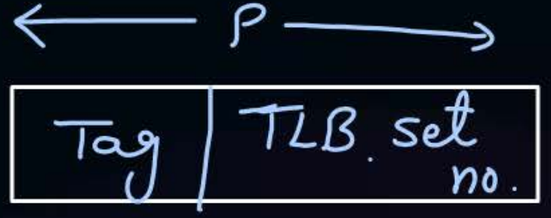
Soln no. of entries in TLB = $\frac{16kB}{4B} = 4k = 2^{12}$



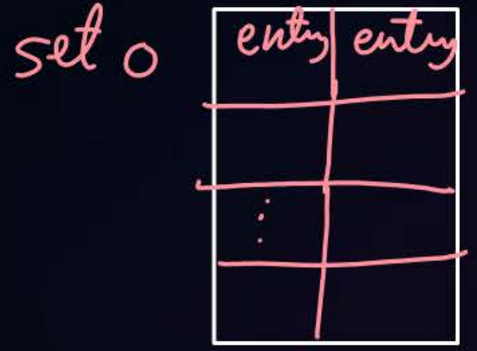


Topic : Paging-2

TLB Mapping: Set Associative



2-way set associative TLB



$$\text{no. of bits in TLB set no.} = \log_2 (\text{no. of sets in TLB})$$

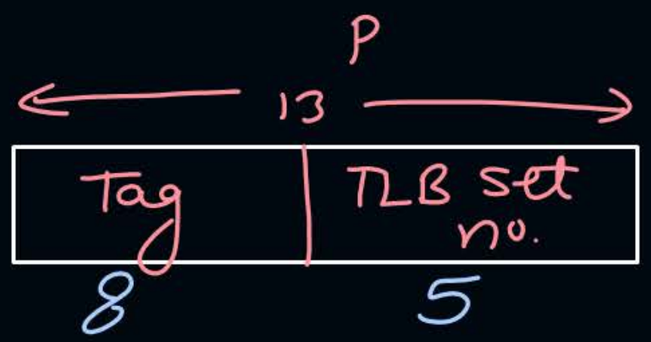
$$\text{no. of sets in TLB} = \frac{\text{no. of entries in TLB}}{\text{associativity}}$$

ex:-

TLB ⇒ 64 entries

2-way set associative

P ⇒ 13 bits



no. of sets in TLB = $\frac{64}{2}$

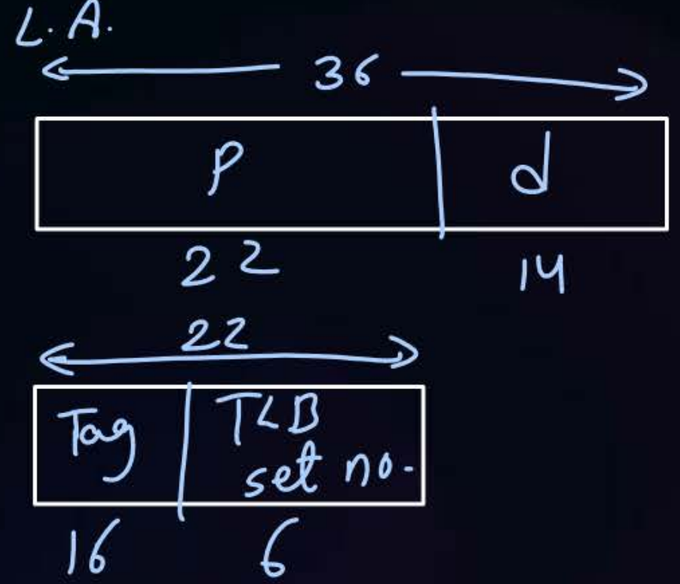
= 32

= 2^5 ⇒ TLB set no = 5 bits

Topic : Question

2^{14}

#Q. A Computer system implements a 36-bit virtual address, page size of 16 Kbytes and a 256 – entry translation look-aside buffer (TLB) organized into 64 sets each having four ways. Assume that the TLB tag does not store any process id. The minimum length of the TLb tag in bits is _____.



no. of sets = 64 = 2^6 ⇒ set no. = 6 bits

Topic : Paging

Paging suffers from internal fragmentation

Assume a process 9 kbytes

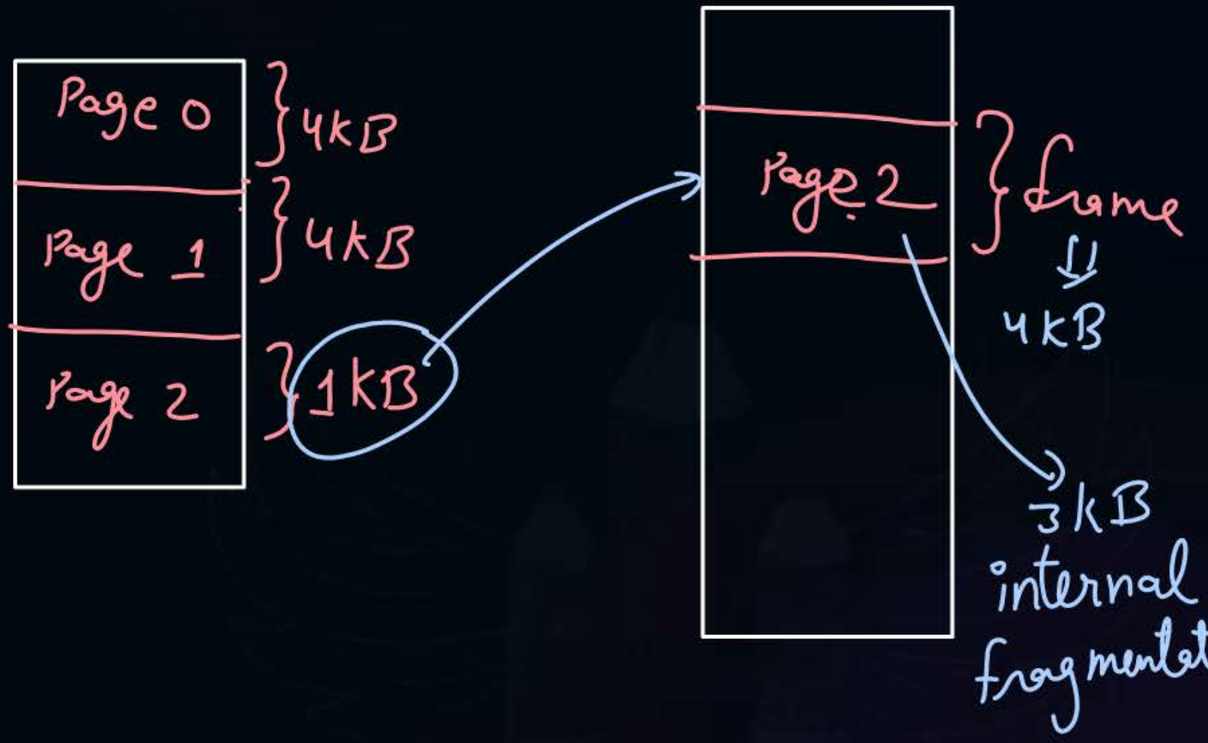
Page size = 4 kbytes

⇓

if Page size = 2kbytes

⇓

internal fragmentat^{n} ⇒ 1kB



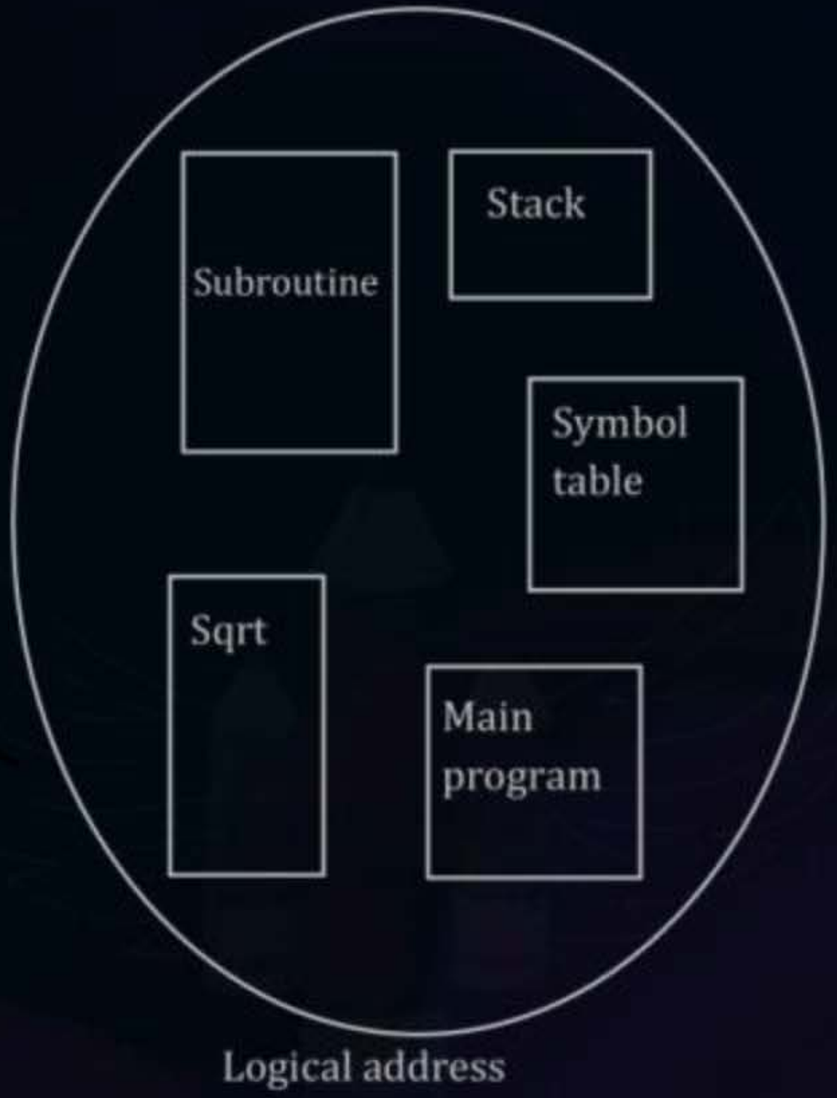
Reducing page size can reduce internal fragmentation.

Homework :-

If page size is reduced or increased, then what impact it causes on page table size?

Topic : Segmentation

- Divide Process in logically related partitions (Segments) Segments are scattered in physical memory



Topic : Segmentation

Process

seg.no.

Segment table

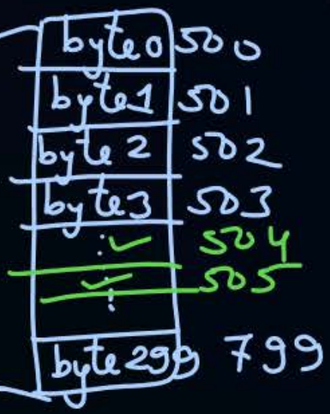
0	2000	500
1	500	300
2	5000	900

base

limit

size of each segment

Memory



Topic : Segmentation

- Size of segment can vary, so along with base, keep limit information also
- Limit defines max number of bytes within the segment

CPU generates logical add.

segment no.

offset (byte no. of the segment)

offset is calculated based on largest allowed segment size.

Ex:- CPU wants L.A. ⇒ s = 1
byte = 5

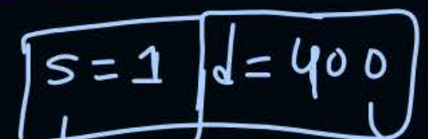
search in seg. table ⇒ Base add. = 500

500 + 5 = 505

⇓

Physical add.

CPU generates L.A. =



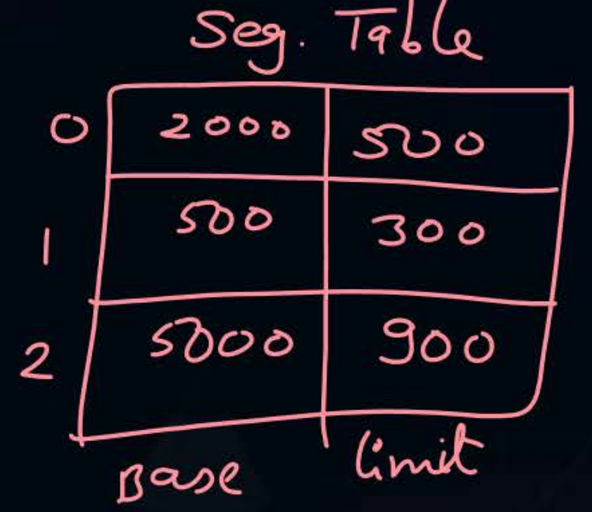
→ 900

seg. Table = base = 500

[NAT]

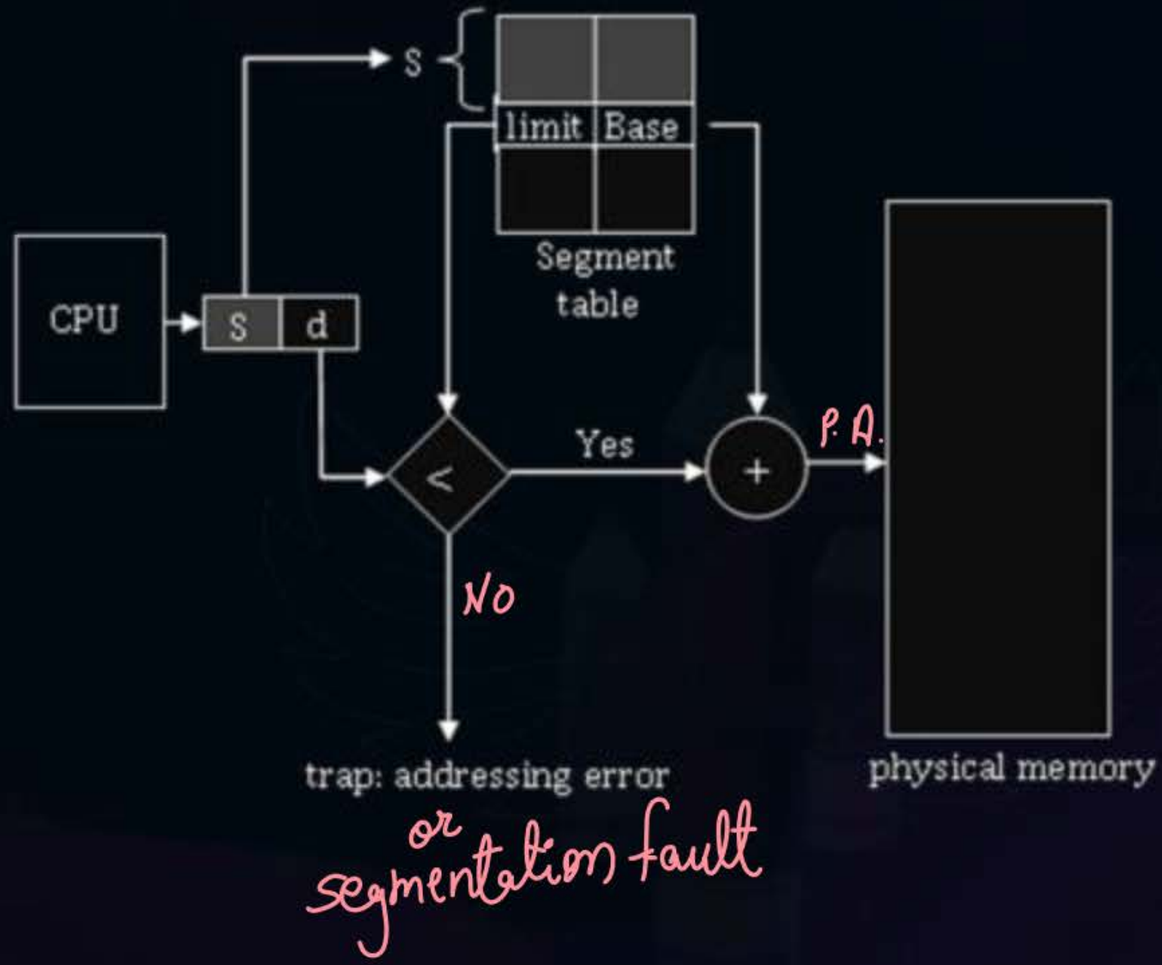
#Q. Find physical address for the following requests?

S	d	Physical Address
2	856	5000 + 856 = 5856
1	256	500 + 256 = 756
0	480	2000 + 480 = 2480
2	952	seg. fault



Topic : Segmentation

Segmentation



Topic : Segmentation

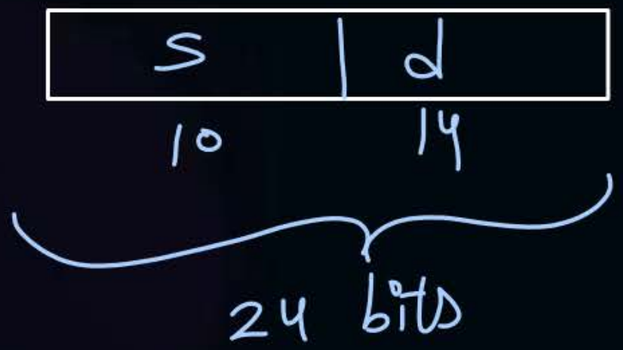
- Size of segment can vary, so along with base, keep limit information also
- Limit defines max number of words within the segment

[NAT]

#Q. Maximum segment size = 16KB $= 2^{14}$B $\Rightarrow$ d = 14 bits

Number of segments in process = 2^{10} $\Rightarrow$ s = 10 bits

Logical address = 24 bits ??



Topic : Segmentation

- Segmentation suffers from external fragmentation

2 mins Summary

Topic TLB Mapping

Topic Segmentation

Happy Learning

THANK - YOU