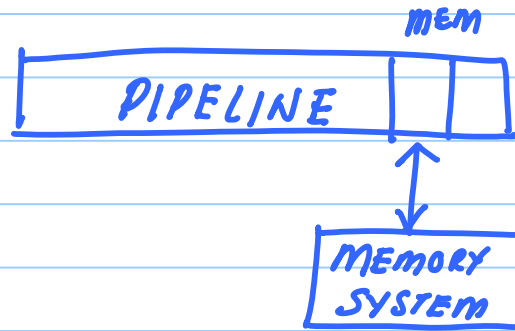


Oct 22nd

Note Title

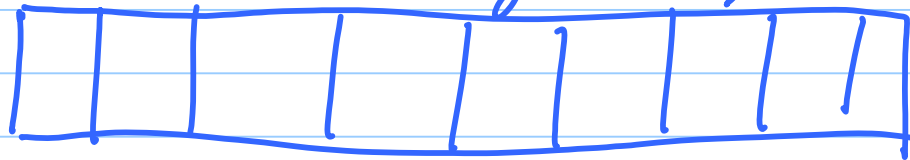
22-10-2011

Caches



Memory System: Simplest Form.

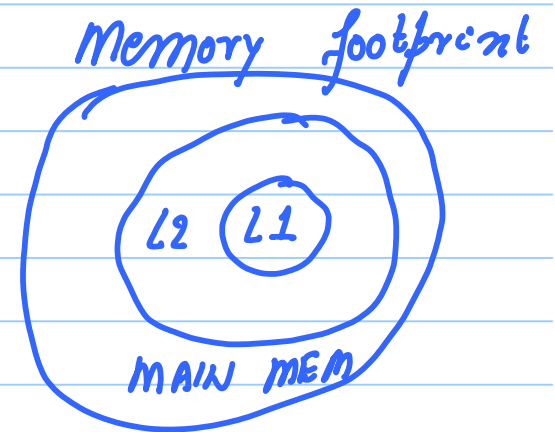
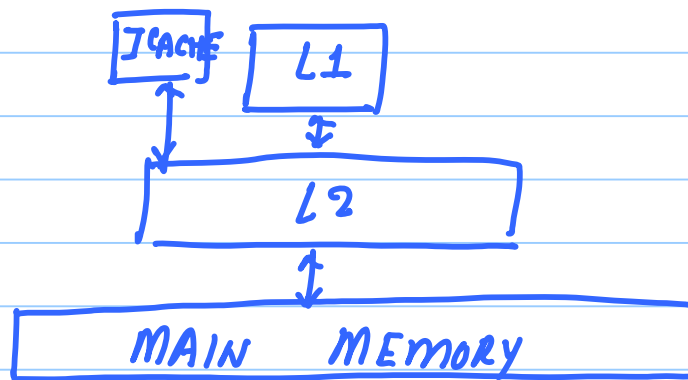
One large array



Larger the memory structure \rightarrow more is the access time

What is typically done :

Hierarchy of memory structures.

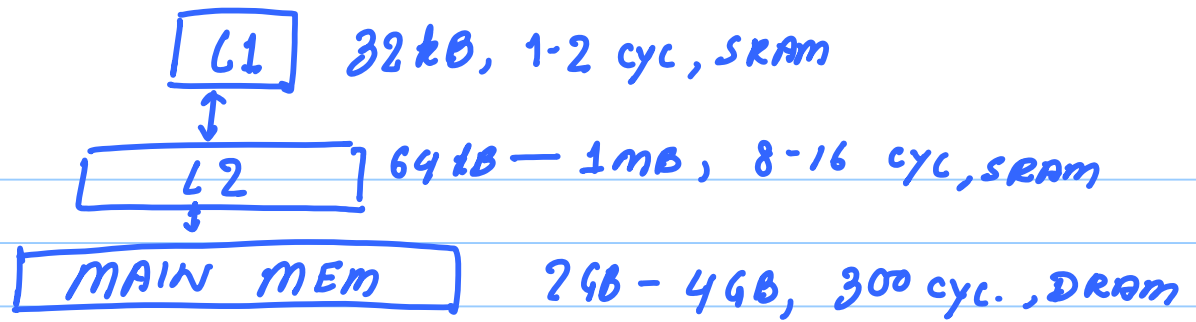


Advantage of hierarchical memory system

Programs exhibit temporal & spatial locality

temporal locality
→ tend to reuse recently used data frequently

spatial locality →
If I have touched mem. address A ⇒
Probability of touching nearby addresses (A) is high.



temporal & spatial locality will ensure that most of the accesses hit in L1

Scenario 1 (NO HIERARCHY)

Avg. Mem access time
300 cyc.

SCENARIO 2 (HIERARCHY)

90% → L1 (1)

9% → L2 (10)

1% → mm (300)

Avg. Access time =

$$\begin{aligned} & 0.9 \times 1 + 0.09 \times 10 \\ & \quad + 0.01 \times 300 \\ & \approx 0.9 + 0.9 + 3 \\ & \quad = \underline{4.8} \end{aligned}$$

Cache:

Which bytes are stored?

How are they accessed?

Optimize:

Store the most frequently used bytes.
(minimize miss rate)

Searching should be very fast.

Simplification:

Create blocks.

For example,

create $\left[\begin{array}{l} \text{blocks} \\ \text{lines} \end{array} \right]$ of 32 bytes

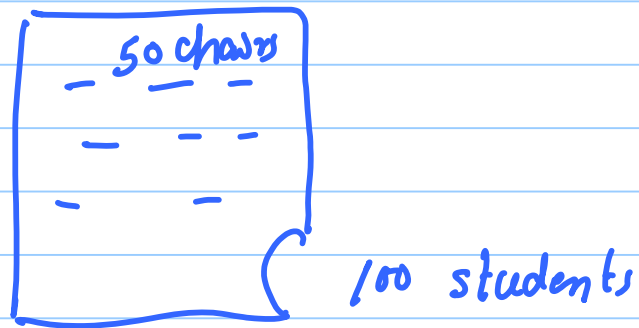
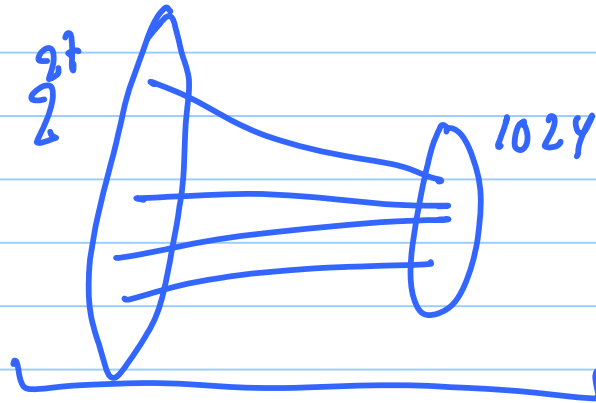


$$32 = 2^5$$

27
(block number)

offset within the block

32 kB cache: 1024 blocks.



Every student \rightarrow unique integer:

$$\underline{i} \% 50 \rightarrow \text{seat}$$

$$j \% 50 \rightarrow$$

Search for student:

1) Take the roll no. i

$$2) k = i \% 50$$

3) Search seat k

4) See if the person matches.

Direct mapped
Scheme
(DM)

✓ less contention.

✓ Searching is very easy
X space usage not optimal

Fully Associative (FA) Scheme

Any student can sit anywhere.

x lot of fighting

x searching is hard

✓ optimal usage of space

Set Associative (SA) Scheme

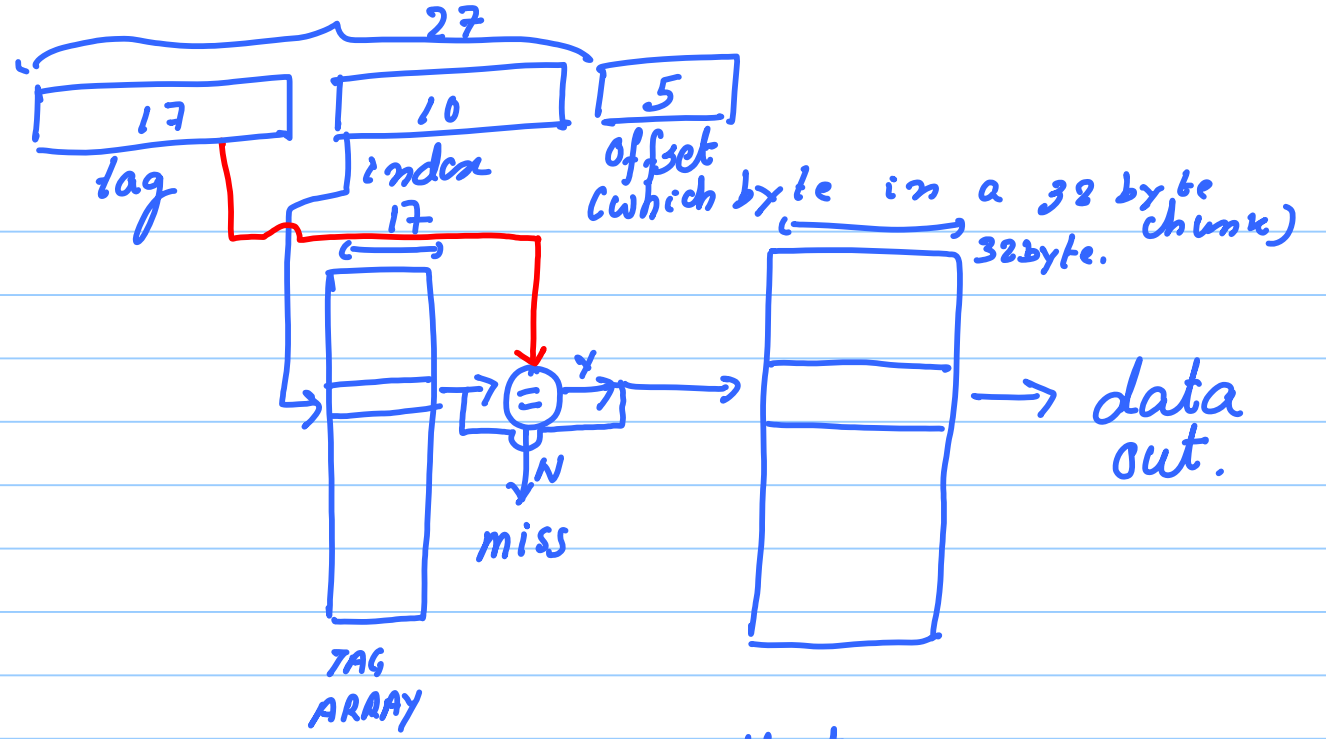
roll no. $\rightarrow i$
 $k = (i \% 25) \times 2$
or

hash-func-1

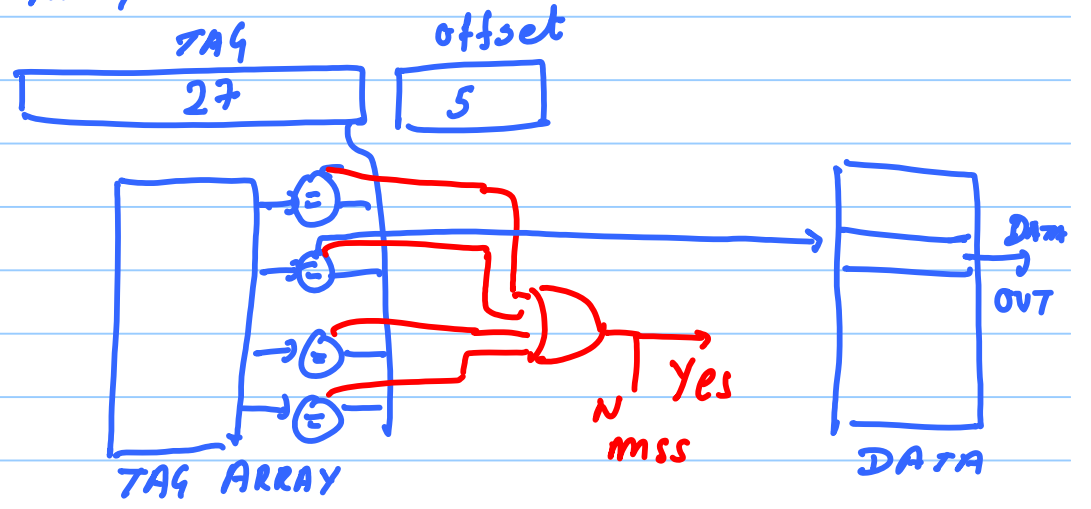
$(i \% 25) \times 2 + 1$

hash-func-2

DM



EA



k-way set Associative

SA
4-way

