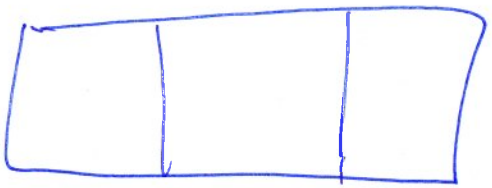
Logical vs virtual address.

Direct-mapped cache

Virtual address is the main-memory address of the MM cell being requested by the cpu.

Consists of three fields: tag, line, and word.



the number of bits in the main-memory address

Cache: 8 lines
4 words/line

MM: 128 words
1 B/word/cell

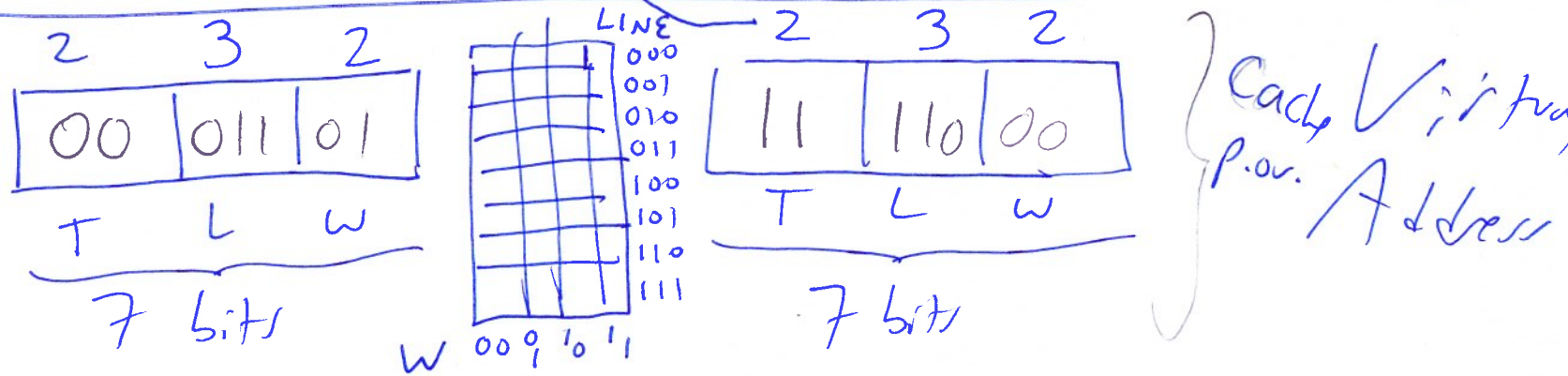
① $\log_2 128 = 7$ -bit MM address.

② $MM = 2^7 \frac{w}{MM} \div 2^5 \frac{w}{cache} = 2^2 \frac{caches}{MM}$ ie MM = $2^2 = 4$ times bigger than cache

Consider MM cells:

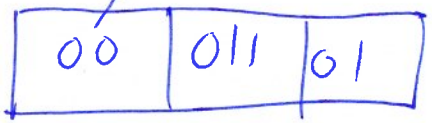
cell 13	cell 120
0001101	1111000
Cache: line 3, word 1	Cache: line 6, word 0

} CPU/MM P.O.V.



								line
~~mm Evict 0~~ 0	32	1	33	2	34	3	35	000
64	96	65	97	66	98	67	99	
4	36	5	37	6	38	7	39	001
68	100	69	101	70	102	71	103	
8	40	9	41	10	42	11	43	010
72	104	73	105	74	106	75	107	
12	44	(13)	45	14	46	15	47	011
76	108	77	109	78	110	79	111	
16	48	17	49	18	(50)	19	51	100
80	112	81	113	82	114	83	115	
20	52	21	53	22	54	23	55	101
84	116	85	117	86	118	87	119	
24	56	25	57	26	58	27	59	110
88	(120)	89	121	90	122	91	123	
28	60	29	61	30	62	31	63	111
92	124	93	125	94	126	95	127	
word		00	01	10	11			

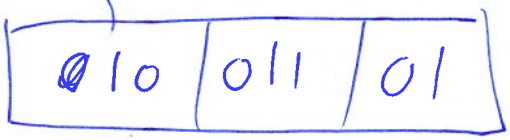
13: tag 0 means it's the first cell that gets mapped here



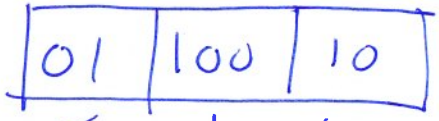
(2) (3) (2)

120:

77:



tag 2 means it's the third cell that gets mapped here



Cell 50

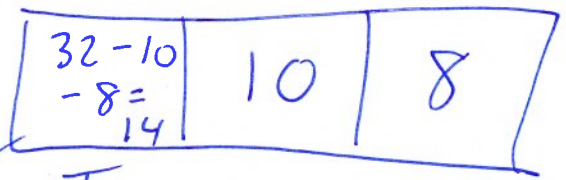
therefore 88 in binary is

10 110 00

Cache: 1024 lines
256 words/line
$\Big\}\ 2^{10}\frac{L}{\text{cache}} \times 2^{8}\frac{w}{L} = 2^{18}\frac{\text{word}}{\text{cache}}$

MM: 32 bit address
1 Byte/word
1 Byte/cell

V.A. makeup?



32 bits

How many bits make the tag, line, and word of the virtual address?

is it really 14?
That means there must be 2^{14} ~~competitors~~ competing blocks for every line. ∴ MM must be 2^{14} times bigger than cache.

Check: $2^{32}\frac{\text{words}}{M} \div 2^{18}\frac{\text{words}}{\text{cache}} = 2^{14}\frac{\text{cache}}{\text{memory}}$ ✓

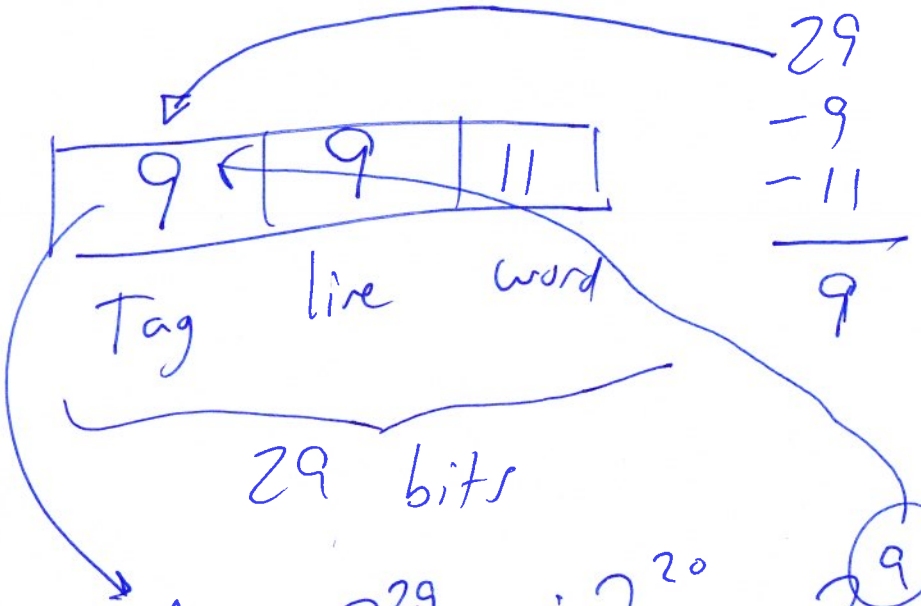
Same question:

Cache: 512 lines
2048 words/line
$\left.\begin{matrix}\\ \\ \end{matrix}\right\} 2^{\frac{L}{C}} \times 2^{\frac{W}{C}} = 2^{\frac{W}{C}}$

MM: one gigabyte
2 Bytes/word
1 Byte/cell
$\left.\begin{matrix}\\ \\ \end{matrix}\right\} 2^{29}$ Words

~~Cache~~ mem

What is the size of the tag? the line? the word? in the virtual address



$MM = 2^{\frac{29}{m}W} \div 2^{\frac{20}{C}W} = 2^{\frac{9}{m}C}$