

Question 1:

	Cache action	what request on the bus	who response	writeback required?	State of cache 1`	State of cache 2	State of cache 3
P1: Read X	Miss	Place read request on bus.	Memory.	No.	Shared	-	-
P2: Write X	Miss	Place write miss on bus.	Cache 1.	No.	Invalid	Exclusive	-
P2: Read X	Hit	No request on bus	-	No.?	Invalid	Exclusive	-
P3: Write X	Miss	P3 put request on bus asking for exclusive access	Cache 1, 2	No.	Invalid	Invalid	Exclusive
P1: Write X	Miss	P1 put request on bus asking for exclusive access	Cache 2, 3	No.	Exclusive	Invalid	Invalid
P1: Read Y	Miss	Place read request on bus	Memory.	Yes. Write X back to memory	Share(Y)	Invalid	Invalid
P2: Read X	Miss	Place read request on bus	Memory.	No.	Share(Y)	Shared(X)	Invalid

Question 2:

	Message sent on the network	State of directory	State of cache 1`	State of cache 2	State of cache 3
P1: Read X	Read miss. Cache 1 send address to home dir. Local node == Home node, so no interprocessor messages. Home memory return data to cache 1.	1 0 0	Shared	-	-
P2: Write X	Cache 2 send write miss to home node/P1 (msg 1). Home node/P1 send invalidation to Cache 1 (msg 2). Cache ack to home node/P1 (msg 3). Home node/P1 send exclusive permission to P2 (msg 4).	0 1 0	Invalid	Exclusive	-
P2: Read X	Read hit.	0 1 0	Invalid	Exclusive	-
P3: Write X	Cache 3 send write miss. to home node/P1 (msg 5). Home node/P1 send write miss msg to cache 2 (msg 6). Do not send invalidation to Cache 1, as it's not in the sharer's list. Cache 2 ack (msg 7). Home node/P1 send exclusive permission to P3 (msg 8).	0 0 1	Invalid	Invalid	Exclusive
P1: Write X	Cache 1 send write miss to home node/P1. Not a interprocessor msg. Home node/P1 send invalidate to cache 3 (msg 9). Cache 3 ack (msg 10). Home node/P1 send exclusive permission to P1. Not a interprocessor msg.	1 0 0	Exclusive	invalid	Invalid
P1: Read Y	Cache 1 send read miss to home node/P1. No a interprocessor msg. P1 writeback X to memory (Not a interprocessor msg) Home node /P1 get data from memory and put it to cache 1.	1 0 0 (for Y) 0 0 0 (for X)	Shared(Y)	Invalid	Invalid
P2: Read X	Cache 2 send read miss to home node/P1 (msg 11) Home node/P1 get data from memory, and send data to cache 2 (msg 12).	1 0 0 (for Y) 0 1 0 (for X)	Shared(Y)	shared(X)	Invalid

Question 3:

1) There are four possible values of the output: -4, 8, 0, -12 (each results correspond to the 2 columns in the following table)

Thread 1	Thread 2	Thread 1	Thread 2	Thread 1	Thread 2	Thread 1	Thread 2
B = 8		B = 8		B = 8			if (A > 0)
A = 4		A = 4		A = 4		B = 8	
A = A - B			if (A > 0)		if (A > 0)		else B = 16
print A		A = A - B			A = 8	A = 4	
	if (A > 0)		A = 8	A = A - B		A = A - B	
	A = 8	print A		print A		print A	
	else B = 16		else B = 16		else B = 16		

2) When the code is protected by lock, it can not be interleaved by other thread. So there are two possibility of executing the two thread. One is execute T1 first, then T2. The other is T2 first, then T1. But both case get same result, i.e. the output of 'print A' is -4.