

CSE 520 Computer Architecture II
Term: Spring 2026
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Problem Set 4

Posted April. 23rd, 2026

<http://ascslab.org/courses/cse520/index.html>

General guidelines: Always state your assumptions and clearly explain your answers.

Advanced Concepts

Explain in a sentence or two the concepts below:

1. *Temporal Locality in Caching*
2. *Spatial Locality in Caching*
3. *Direct-Mapped Cache*
4. *Fully Associative Cache*
5. *Compulsory Miss*
6. *Conflict Miss*
7. *Write through*
8. *Write back*
9. *No write allocate*
10. *Write allocate*
11. *False Sharing in Caching*
12. *Snoopy Cache Coherence*
13. *Directory Cache Coherence*
14. *Network Topology*
15. *NoC Routing*
16. *NoC Flow Control*

17. Router microarchitecture

18. NoC Link Architecture

19. Network Interface

Cache Coherence

A four-processor shared-memory system implements the MESI protocol for the cache coherence.

M: Modified, the cacheline is present only in the current cache and it is dirty.

E: Exclusive, the cacheline is present only in the current cache and it is clean.

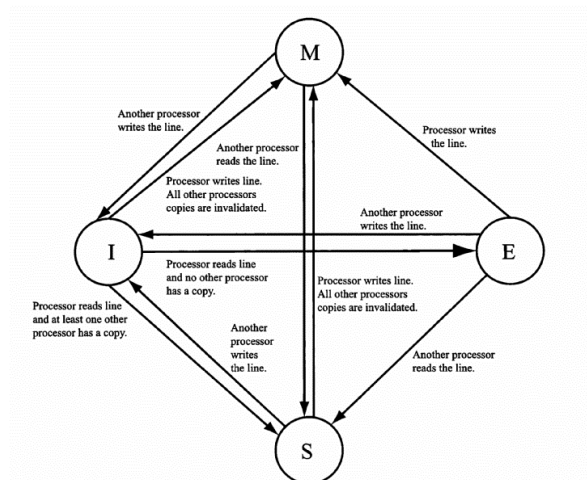
S: Shared, indicates that this cacheline may be stored in other caches of the system and it is clean.

I: Invalid, indicates that this cacheline is invalid (unused).

For the following sequence of memory references, show the state of the line containing the variable **A** in each processor's cache after each reference is resolved. Each processors start out with the line containing **A** invalid in their cache.

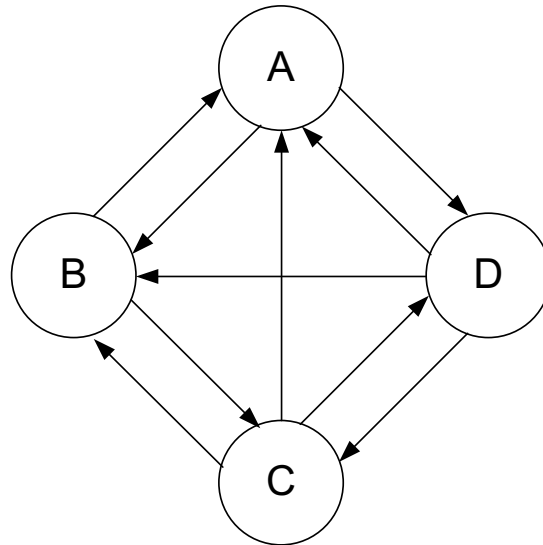
	State of P0's cache	State of P1's cache	State of P2's cache	State of P3's cache
P0 reads A				
P1 reads A				
P2 reads A				
P3 writes A				
P0 reads A				

MESI cache coherence protocol



Interconnect Network

We have the following network topology with 4 network nodes and 10 links.



Note that each link is unidirectional, and only one link exists between A and C (only a link from C to A (not from A to C), and only from D to B between B and D). Each link can transfer 1 flit per cycle and there is only one virtual channel per link. For all parts, 180-degree turns are not allowed.

a) *Fill in the following table of the properties of this network.*

Diameter	
Average Distance	
Bisection Bandwidth	

b) *Draw the channel dependency graph of this network.*

c) *Is a minimal routing on this network deadlock-free? Show your reasoning and give a deadlock scenario if it is not deadlock-free.*