Chapter 12: Multiprocessor Architectures

Lesson 10:

Cache Coherence Problem and Cache synchronization solutions─ Part 2

Objective

- To Understand update based and directory based cache synchronization mechanisms

Update- based protocols

Update based cache coherence protocol

Events Start	Processor P_1	Processor P_2	Processor P_3
	No Copy	No Copy	No Copy
P_1 reads line	Writable copy	No Copy	No Copy
P_2 reads line	Writable copy	Writable copy	No Copy
P_3 writes line (updates sent to P_1 and P_2)	Writable copy	Writable copy	Writable copy
P_2 reads line (sees values written by P_3)	Writable copy	Writable copy	Writable copy

Update-based protocols

- Allow multiple processors to have writable copies of a line

- When a processor writes a line that one or more other processors have copies of, an *update* occurs, transmitting the new value of the data in the line to all of the sharing processors

Invalidation-based or update-based protocol

- Depending on the application, either an may deliver better performance

- Update-based protocols can achieve better performance on programs where one processor repeatedly updates a datum that is read by many other processors

Invalidation-based or update-based protocol

- Invalidate protocol requires one transaction per write-run, and invalidate uses spatial locality: one transaction per block

Invalidation-based or update-based protocol

- An update protocol provides lower latency between write and read

- It can be more efficient to send each new value of the datum to all of the processors that need it than to invalidate all of the copies of the line containing the datum each time it is written

Problem with snoopy bus protocol

Problem with snoopy bus protocol

- Cannot be used for a multistage network
- The system bus is not available for snooping

Problem with snoopy bus protocol

- Snoopy bus protocols at a remote node increase delays there.

- This increases latency and reduces memory bandwidth

Directory based protocols

Directory-based protocols

- Better if at the remotes a directory (or directories) maintained

- The request thus sent to the specific caches only

- The processor sends point-to-point requests to the processors via the network

13

Directory-based protocols classifications

- Full-map directories (look for full information map in master directory)

- Limited directories, and chained directories (look for information in the first directory, if it is not found there, in the second, then the third and so on).

Two different aspects of different Directory-based protocols

- Which method of maintaining information in the directory
- How contents stored in the directory

15

Maintaining information about memory blocks into directory

- Two methods
- Centralized
- Distributed

Central Maintaining information about memory blocks into directory

- Disadvantages─ bus contention and search delays

Distributed Maintaining information about memory blocks into directory

- The advantage─ each processor in the system can easily get where they need to go for "directory information" for a particular memory block

- A set-associative cache of directory information tree that maintains inclusion

- Higher levels trees keep a replica of lower sub-trees

Directory-based protocol limitations

- The limited capacity for replication

- The cost of complex design implementation when using hardwired control

- Limitations on physical address space to map the information

Summary

We Learnt

- Update based snoopy bus protocols

- Directory based protocols

- Full map directory based protocols

- Limited directories based protocols

End of Lesson 10 on

Cache Coherence Problem and Cache synchronization solutions─ Part 2