# Chapter 12: Multiprocessor Architectures

Lesson 05:

## Shared Memory Systems– Memory Organization in Multiprocessors

# Objective

- To understand shared memory architectures of multiprocessor systems

# Shared memory systems

# Memory Organization in Multiprocessors

- Shared memory— the memory system handles inter-processor communication by allowing all processors to see data written by any processor
- Message-passing systems— communicate through explicit messages from a sending processor to receiving processor waiting for message (data)

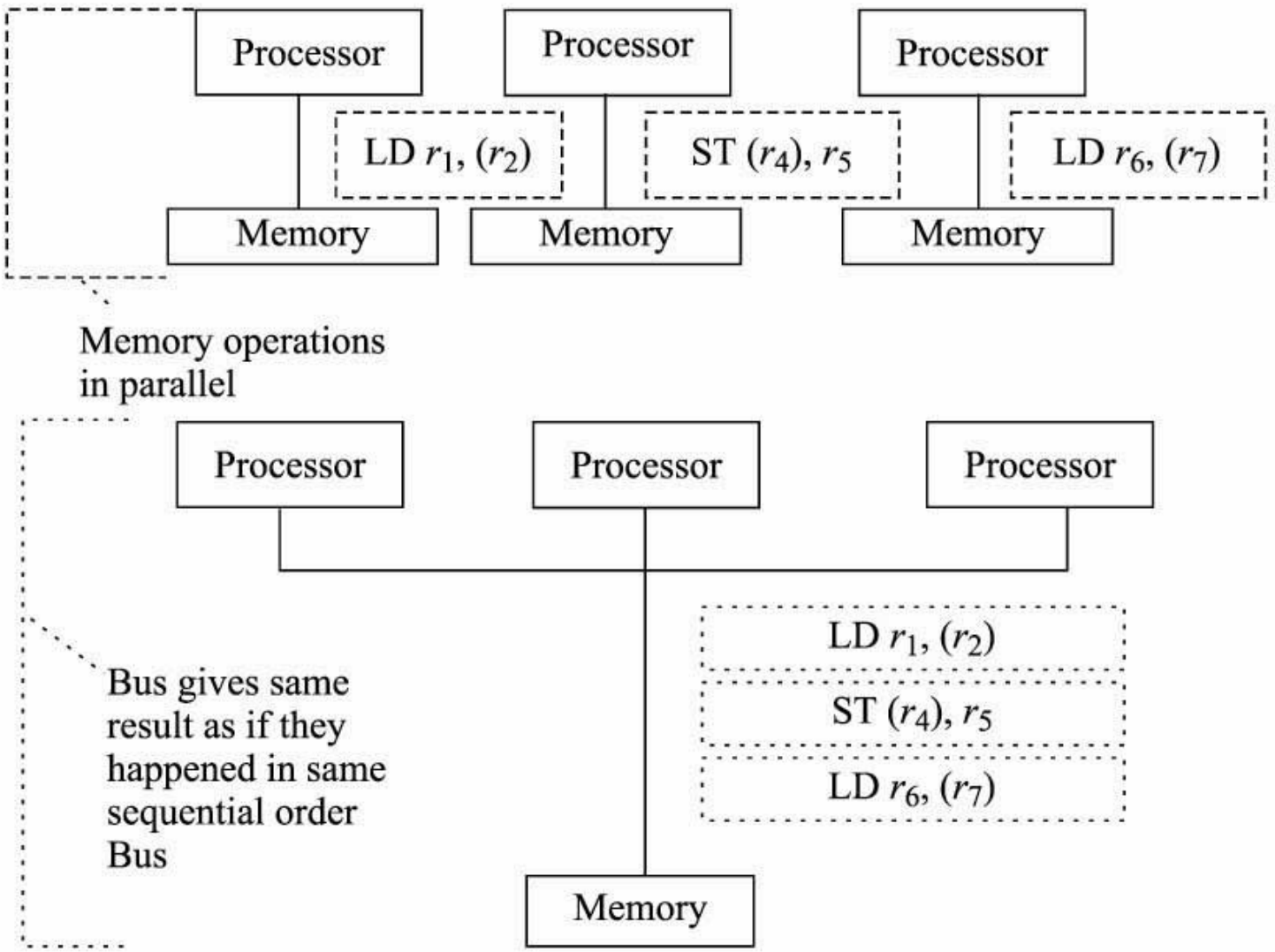
# Memory coupling

# Memory-coupling (consistency) model

- Memory coupling by a consistency model—Memory operations executed on one processor become visible on other processors
- Memory-coupling (consistency) model defines when the programs running on the processors will see operations executed on other processors

# Strong coupling

# Strong coupling consistency



# Strong coupling

- Strong Memory— the memory system acts exactly as if there were only one memory in the computer that different processors take turns using that

# Feature

- The memory system may execute multiple memory operations in parallel, but these parallel operations must generate the same result as if they were executed on a system that had a single memory system that was shared by all the processors

# Strong Coupling vs. Loose coupling

- In contrast, systems with relaxed consistency may require more programmer effort, but they often achieve better performance than systems with strong consistency because the relaxed consistency model allows more memory operations to be performed in parallel

# Methods for Coupling

- On any processor, the results of a program must be the same as if the memory operations in the program occurred in the order that they appear in the program
- Out-of-order superscalar processors generally require this on any program they execute, so it is possible to implement strong consistency on an out-of-order processor

# Methods for Sharing and Coupling

- On all of the processors, the results of all memory operations must be the same as if they had occurred in some sequential order
- If one processor sees two memory operations happening in a particular order, all processors must see those operations happen in the same order

# Methods for Sharing and Coupling

- Strong coupling allows references to different addresses to proceed in parallel, because executing references to different addresses in parallel gives the same results as if they were executed sequentially

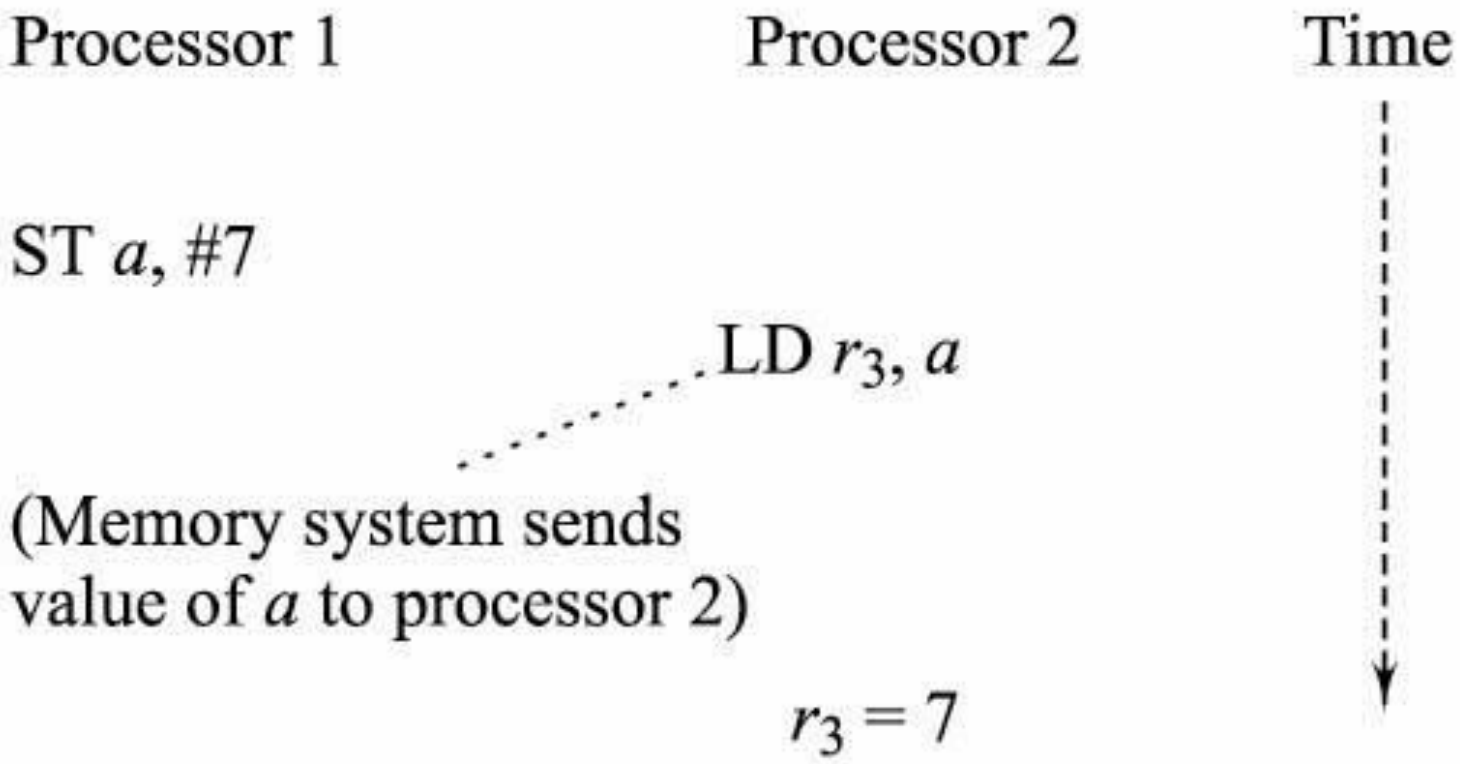
# Methods for Sharing and Coupling

- Multiple reads to the same address can also proceed in parallel, because they will return the same result regardless of whether they are executed in parallel or sequentially

# Methods for Sharing and Coupling

- However, reads and writes to an address or multiple writes to an address have to be serialized so that each write can be seen to have executed at a specific time

# Shared memory Example



# Summary

# We Learnt

- Shared memory
- Strong coupling advantages and disadvantages
- Loose coupling advantages and disadvantages

End of Lesson 05 on

**Shared Memory Systems– Memory Organization in Multiprocessors**