Report Submission

CON101- Introduction to Computer Science and Engineering

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1 Introduction

When only one program access a particular memory space, we can safely say
that what is the value stored at any particular instance of time.

But when more than one program access and modify the same memory space,
then it depends on the sequence i.e when the value is changed and by which
program. Thus to ensure the memory consistency, we define the notion of
sequential consistency. And TSO, PSO, and RMO are the memory models
related to sequential consistency.

2 Sequential Consistency(SC)

- The output should be the same as in a time sharing processor.

- Threads issue commands of memory in program order.

- It does not proceed to assigning next memory block and waits until the
  previous ongoing operation terminates.

- A read is said to be complete only when the value is returned to read.

3 Total Store Ordering(TSO)

Consider the following example where two threads are running simultaneously
on same memory block. Here, instead of waiting for the commands to execute,
we could instead place it into a store buffer. Since the buffer is in core memory, it
is pretty fast to access. When the processor is free, it will unhide the commands
present in this store buffer. Thereby, we hide the delay which is necessary for
one command to be executed.

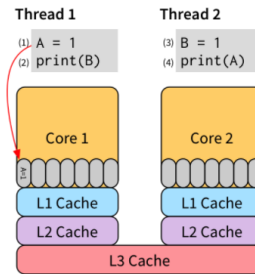Store buffering preserves single-threaded behavior.

Figure 1: Two threads running on same memory block.

4 Partial Store Ordering(PSO)

- Partial Store Ordering (PSO) is more relaxed memory sequential consistency(SC) model as compared to the Total Store Ordering (TSO).

- It has all the relaxing criteria of TSO and additional thing that PSO only guarantees writes to the same location is in order whereas writes to different memory location may not be in order at all.

- In this case, the processor may shuffle the writes in a way that does not match the original order.

- It become very inefficient when number of threads is very large. So, we have to come up with various levels of relaxation in consistency.

5 Relaxed Memory Ordering(RMO)

- Relaxed Memory Ordering(RMO) is a more relaxed memory consistency model compare to the Partial Store Ordering(PSO).

- The ordering of reading and writing may be shuffled.

- Weak Ordering Model

- Release Consistency Model (RCsc / RCpc)

- Digital Alpha, Sparc V9 RMO, IBM Power PC. Except Alpha, rest all allows shuffling of the two reads at the same block.

- RCpc and PowerPC allow a read to return the value of another processors to write early.

6   Conclusion

All the 3 models are useful depending on the use case. There is a trade off between sequential consistency and performance.

The example of writing 1 and 0 clarifies that giving more and more relaxation is also not good at times and the computer behaves "abnormally" which is not desired when it comes to mass production and scaling.

Also in areas like medical and nuclear research, it becomes more and more important that computer does not "breaks" and works as it is expected to work.

7   References

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