Advanced Systems Topics

A computer system provides a compare-and-swap (CAS) operation which is used in the following manner:

\[ \text{seen} = \text{CAS (address, old, new)} \]

It loads the contents of \texttt{address}, compares that value against \texttt{old} and if it matches stores the value \texttt{new} at the same address. All of this is performed atomically and the value read from the address is returned as \texttt{seen}.

\[(a)\] Making use of CAS, write pseudo-code for a simple multi-reader spin-lock. Your design should permit concurrent readers to enter their critical sections in parallel but ensure that writers gain exclusive access. Be sure to provide pseudo-code for each of the four operations supported by the lock, and describe the layout of the lock’s data fields in memory. \([10 \text{ marks}]\)

\[(b)\] Why might this simple spin-lock perform poorly on a large multi-processor system? How might you improve the lock to achieve better performance on such a system? \([4 \text{ marks}]\)

A programmer analyses a multi-threaded application and discovers that the majority of the execution time is spent contending for access to a shared data structure.

\[(c)\] Describe three methods for reducing lock contention amongst threads accessing a highly-concurrent data structure. In each case briefly describe a situation or workload to which the method is particularly well suited. \([6 \text{ marks}]\)