2003 Paper 9 Question 5

Advanced Systems Topics

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

```
seen = CAS (address, old, new)
```

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

(*a*) Write pseudo-code for a simple spin-lock using `CAS`.   [4 marks]

(*b*) Why could this perform poorly on a large multi-processor system?   [2 marks]

Consider a singly-linked list of `QNode` objects, each with a boolean field `value` and a reference `next` to its successor (holding `null` at the tail of the queue). A shared location `l` refers to the tail node (or is `null` if the queue is empty).

(*c*) Define the folowing concurrent operations using `CAS`:

```
// Append a new node q to the tail of the list, returning
// the previous tail
QNode pushTail (QNode q);

// Remove q, which must have been at the head of the list,
// returning the new head
QNode popHead (QNode q);
```

   [Hint: note that `popHead` only needs to update memory when the queue becomes empty.]   [8 marks]

(*d*) Define a *queue-based spin lock* based on these operations.   [6 marks]

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