Principles of Distributed Computing
Exercise 7

1 Concurrent Ivy

Consider the tree for the Ivy shared variable protocol in Figure 1. There are three concurrent requests placed by the nodes $v_1, v_2$, and $v_3$. The token is initially held by the circled node labeled $r$. We assume synchronous execution.

a) Give the order of serviced requests.

b) Draw the tree after the last request has been served.

c*) Show that in an asynchronous setting, Ivy incurs at most an $O(\log n)$ overhead in amortized message complexity.

![Figure 1: Tree for Question 1.](image)

2 Tight Ivy

In Theorem 7.12 it was shown that, on average, acquiring a lock requires at most $\log n$ steps, where $n$ is the number of processors.

Show that this bound on the number of steps is tight by constructing a tree consisting of $n$ nodes in which each request requires $\log n$ steps if all requests are performed sequentially by suitable nodes in the tree.\(^1\)

\(^1\)Hints: Assume that $n$ is a power of 2. Construct a tree whose topology remains the same with respect to the token holder after each request.