

# Principles of Distributed Computing

## Exercise 6

### 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.

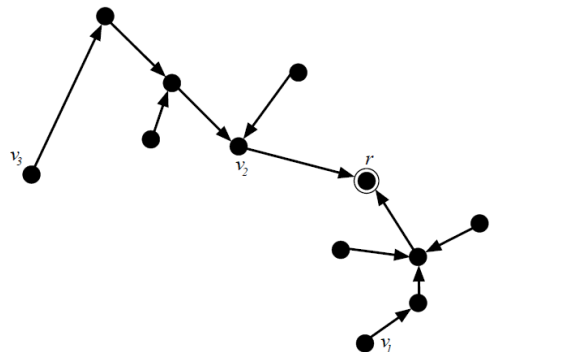


Figure 1: Tree for Question 1.

### 2 Tight Ivy

In Theorem 6.5 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.<sup>1</sup>

<sup>1</sup>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.