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THEORY ASSIGNMENT - IV

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Building m-value consensus using binary consensus:

Goal:

- All the threads should agree on a given thread ID i.e same value

- The value agreed upon by a thread should have been proposed by some other thread in the system

- Non crashed threads should terminate with in finite number of steps.

Taking the above points into consideration, let's develop a m-value consensus using binary consensus.

- A thread proposes a value v.

- These are stored in a 1-d array or a vector so that every thread can access the proposed values.

- Capture the thread ID and loop over the thread ID where all threads agrees.

- Store thread ID as agree on which all the threads agree.

- The loop however iterates binary log times of number of threads, and at every iteration of the loop, the i'th bit of ID will be filled using binary consensus.

- At the end of loop, the thread should wait and check until the agreed value equals to ID at each bit.

- It can be achieved using a loop and it ensures that all the threads agree upon the proposed value.

- The final proposed value which all the threads agree upon is the m-value consensus result.

pseudo code :

```
m_valued_consensus(value,no_of_th):

    propose(value)
    proposed_array<int>

    id <- this.thread.ID
    for i from 0 to log(no_of_th):
        agree_bit[i] <- binaryConsensus[i](id[i])

        while proposed_array[id] != -1 and agree_bit[i->0] == id_bit[i->0]:
            id = (id+1)%n
    return proposed_array[agree]
```

Correctness:

Let's verify the three points mentioned in the goal of the assignment.

Agreement:

It is clear from the pseudo code that, in final all the threads agree upon the same value(while wait ensures). The value returned is the decision value of m-valued consensus developed from binary consensus. So, the agreement condition is satisfied.

Validity:

As all the threads are agreeing upon some proposed value V of some thread, atleast one other thread in the system should have proposed the value. So the validity statement is also satisfied.

Wait Freedom:

As the loop ends, every thread will return some value that all the other threads agreed upon. Clearly as the loop iterates, it stops after a certain number of steps suggesting it as a finite number of steps(binary logarithm is used apparently to deal with bits ensuring finite number of iterations/steps). So, the wait freedom statement is also satisfied with the proposed algorithm.

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