Distributed Algorithm

Assignment 04

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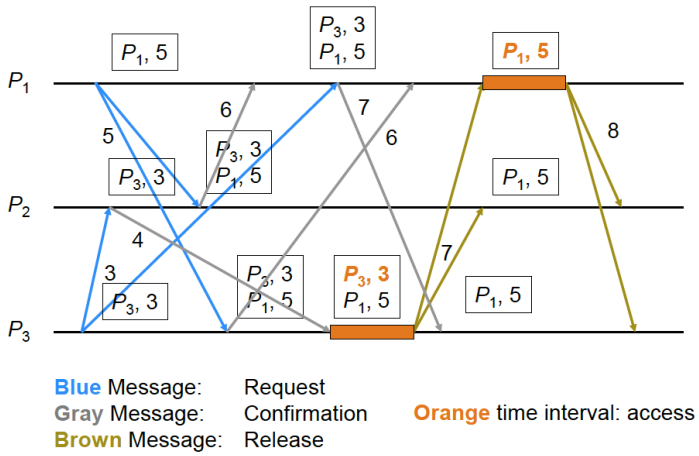
1 Lamport

Given the original FIFO case below (from the lecture's slide):



If this algorithm runs in a non-FIFO channel environment, Confirmation message of P_3 to P_1 could arrive ealier than P_3's Request message. Then for P_1, it would be confused and access the resource which is currently been using by P_3. [1]

2 Ricart and Agrawala

a) Ricart and Agrawala have been shown that the deadlock is impossible. [3] If deadlock is possible, then all nodes should be waiting for one or more confirmations. Since the only possibility that a confirmation is being waited by one node is that this node's request is deferred by some other node.
So, there should be a circle of nodes, each one sent its request to its next but waits for another reply. In this situation, the sequence number / node number pair of the request recieved by each node should be greater than its own, which, in a circle, is impossible.

b) In the original algorithm, the node should wait for $n-1$ confirmations before it can access the resource. In order to allow (maximum) $k \in \mathbb{N}$ nodes at once, we can change the rule: **A node could access the resource after it receives $n-k$ confirmations.**

3 Maekawa

a) Yes, the algorithm is still feasible. As shown in [2], if n is not a square of an integer, we can create a degenerate grid. Which means that we could find a $m > n$ which m is a square, and construct the set using m. Then we can replace numbers from n to m by numbers below n respectively and remove the sets constructed for nodes greater than n.

b) In triangular case, there are even less messages needed to be sent because each sets contains less nodes than in quadratic case. But since every two sets intersect with only one nodes, so triangular arrangement is less robust than the quadratic's.
[2] also shows that $N = K(K-1)+1$, for (N is the number of nodes, K is the number of nodes in one set).
When $K-1$ is a power of some prime, finding S_i is equivalent to find the finite projective plane of N points. For other K, we can create a degenerated set just like the previous sub-problem. Even if N can not be represented by $N = K(K-1)+1$ for any K, similar method to create a degenerated set could be applied.

References

[1] L Lamport. Time, clocks, and the ordering of events in a distributed system. *Communications of the ACM*, 1978.

[2] Mamoru Maekawa. An algorithm for mutual exclusion in decentralized systems. *ACM Transactions on Computer Systems (TOCS)*, 3(2):145–159, 1985.

[3] Glenn Ricart and Ashok K. Agrawala. An optimal algorithm for mutual exclusion in computer networks. *Communications of the ACM*, 24(1):9–17, January 1981.