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Improved Bully Election Algorithm for Distributed Systems

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Electing a leader is a classical problem in distributed computing system. Synchronization between processes often requires one process acting as a coordinator. If an elected leader node fails, the other nodes of the system need to elect another leader without much wasting of time. The bully algorithm is a classical approach for electing a leader in a synchronous distributed computing system, which is used to determine the process with highest priority number as the coordinator. In this paper, we have discussed the limitations of Bully algorithm and proposed a simple and efficient method for the Bully algorithm which reduces the number of messages during the election. Our analytical simulation shows that, our proposed algorithm is more efficient than the Bully algorithm with fewer messages passing and fewer stages.

Keywords: Bully Algorithm, Distributed Systems, Leader Election, Synchronization.

1. INTRODUCTION

Distributed computing is a decentralized and parallel computing, using two or more computers communicating over a network to accomplish a common task. Centralized control in distributed systems helps to achieve some specific goals such as mutual exclusion, synchronization, load balancing, and time scheduling. This type of distributed system often requires a unique node to play the role of leader or coordinator of the other nodes to take care of synchronization. As node crash failure is very common in distributed systems. Failure of a leader node requires special attention and needs extra tasks to elect another one to act as leader.

The collaborating processes are often identical. One of the central problems is election of a leader. Given a network of processes, exactly one process should take the decision that it is the leader. It is usually required that all non-leader processes are informed or involved in the process of the leader election. A leader election algorithm is one of the basic activities of distributed systems, as it acts as a basis for more complex and high level algorithms and applications. An important challenge in distributed systems is the adoption of suitable and efficient algorithms for coordinator election. The main role of an elected coordinator is to manage the use of a shared resource in an optimal manner which in turn maintains the coherency of the system even during partial failures.

1.1. Motivation

The main drawback of Bully algorithm is more number of message passing. As it is mentioned before the message passing has order O(n^2) that increases traffic in network. It also has five stages to decide the next leader which would waste a lots of time for the processes to resume their normal execution. Bully algorithm is a safe way for election; however its traffic is relatively high.

1.2. Contribution

In this paper, we have proposed a modified Bully algorithm which preserves all the advantages of the existing algorithm and at the same time eliminates the limitations of it by reducing

Simplifying the above formula, we get

$$T_m = n(n+1)/2 \qquad (5)$$

which is of O(n^2).

In our modified algorithm, considering worst case and assuming lowest process start election, then:

(i) Total number of election message sent to set (S) of n processes ($\{P_1, P_2, P_3, \ldots, P_n\}$) are ($n$ - 1).

(ii) Total response message received is (n - 1).

(iii) Informing to coordinator and coordinator to check with past coordinator involve two messages, and

(iv) Finally informing to every process by sending coordinator message is again (n - 1) message.

The number of message passing between processes for performing election is obtained from the following formula:
T_m = (n -1) + (n - 1) + 1 + 1 + (n - 1), or

$$T_m = 3n - 1 \ or \ 3n \qquad (6)$$

which is of O(n).

6. CONCLUSIONS

In this paper, we discussed the drawbacks of Bully algorithm and then we presented an optimized method for the Bully algorithm called modified bully algorithm. Modified Bully algorithm shows improved performance than the Bully algorithm. The additional advantages of modified Bully algorithm are that this algorithm is a very simple, having fail-safe mechanism, no parallel election, and reduced number of messages.

Our analytical simulation shows that our algorithm is more efficient rather than the Bully algorithm, in both number of message passing and the number of stages, and when only one process runs the algorithm message passing complexity decreased from O(n^2) to O(n). In this analysis we consider the worst case in modified algorithm. Result of this analysis clearly shows that modified algorithm is better than bully algorithm with fewer message passing and the fewer stages.

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