

A New Approach for Electing a Coordinator in Anonymous System

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Abstract— Coordinator failure is one of the most critical problems in distributed systems. Whenever a coordinator is not functioning in distributed system, election algorithm is one of the best approaches to enable the active node as a coordinator to perform some useful tasks. There is Randomized Leader election algorithm which is used to elect leader in anonymous system but has some drawbacks. In this paper, author is going propose an election algorithm for an anonymous system using the concept of Election Commission (EC) which is based on probabilistic model. Author has simulated the proposed algorithm along with already existing randomized election approach and result shows that proposed algorithm has better performance.

Keywords— Anonymous system, Randomized Election algorithm, Election Commission, Bankers Algorithm
Introduction

I. INTRODUCTION

Distributed computing is defined as the field of computer science and technology that uses distributed systems to solve the computational problems or information processing. A problem is divided into number of tasks or sub problem in distributed computing and each task made to run by one or more computer systems. Distributed system is a software system in which collection of autonomous system connected through a network that appears to its users as a single coherent system or a single system. The main goal of distributed system is to make the resources accessible i.e. sharing of information and services. In distributed systems, there is a possibility to add components which improves some parameters like availability, reliability, fault tolerance, scalability and performance.

There are two types of distributed systems: Anonymous distributed system and Non-anonymous distributed system. In anonymous distributed systems, all the process has same identification number and same features. In non-anonymous distributed system each and every processes or nodes have their own unique identification number and unique characteristics. Centralized control in distributed system aims to accomplish some specific goals such as synchronization, load balancing, mutual exclusion and time scheduling. This type of distributed system often needs an active node as a leader or coordinator for performing some specific tasks. Failure of a coordinator requires some extra tasks to elect another node as a future coordinator. A leader election algorithm in distributed computing is the process of electing a single process as the organizer, manager,

initiator, coordinator, or sequencer of some tasks distributed among several processes or computers.

Several algorithms had been proposed to overcome the problem of failure of the coordinator such as Bully election algorithm and Ring election algorithm. The main aim of proposed algorithm is to apply the leader election algorithm in anonymous distributed systems. Author is going to apply election algorithm in anonymous system where all the process has same characteristics with the help of Banker's algorithm and EC.

The order of the paper is as follows: Section 2 gives the previous related work. The proposed election algorithm in anonymous system is given in section 3. Section 4 gives performance analysis of the algorithm and Section 5 explains about the conclusion of this paper.

II. RELATED WORK

The improved bully election algorithm in distributed system proposed in [1] had given a new modified approach for electing a new process as a coordinator among various processes by improving the original bully election algorithm. In this author had proposed an optimized method for bully election algorithm so that it requires fewer messages passing. A new coordinator is elected after the current coordinator crashed is based on the message passing in between coordinator and other processes. Whenever a process wants to communicate to the coordinator, it registers the ID's of the processes. So in this way coordinator created the list of process ID's of the process. This list contains the information about the coordinator of the processes those are there in the system. Process with largest process ID from this list is considered to be the future coordinator of the system. The coordinator sends message with this largest process ID to all the processes so that whenever a failure of a coordinator is identified by any process, that process directly communicate with process with largest process ID. Whenever a coordinator is crashed, each process compares its ID with the received larger process ID. If its ID is bigger than ID of any other process, it decides itself as a coordinator and if it is smaller then it gives the control of election to the process with larger process ID. The main disadvantage in this algorithm is that the coordinator has only that process ID's which communicates with it.

A new approach had been given in [2] for improving the basic bully election algorithm. In this paper, the authors used the concept of set theory in which the processes that

are present in the system are classified into two subsets: Candidate set and Ordinary set. They classified the sets in such a way that, if there are k process in the system then $k/2$ process with highest applicants IF are kept in candidate set and rest of the processes are kept in ordinary set. When a process knows the failure of a leader, then it sends an election message to the processes belonging to the candidate set i.e. coordinator is always elected from the coordinator set only. This approach gives an efficient and fast election process to elect a leader in synchronous distributed system.

In [3] Modified bully algorithm using Election Commission proposed is used to improve the performance of the bully election algorithm. In this authors had used a new term called EC which is used to reduce the total number of messages required for the election process. EC is defined as the electoral administrative body that plays an important role with leader election mechanism. This EC has the prior information about process ID of all the processes those are there in the system. Whenever a process finds that the current coordinator crashed, it sends an election message to EC. EC first verifies about the failure of coordinator and if it is then it sends an alive message to the processes with higher process ID which are currently present in the system. If that process is alive then it sends back a replay message to EC. After that EC declares that process as a current coordinator and informs about the same to all the remaining processes.

In the networks considered in the [4], processes do not have any distinct identification. The main objective of this paper is to explore possibility and limitations of leader election algorithms in which the processes having the same identity numbers. Author had considered the communication modes as port to port, broadcast to port, port to mailbox and broadcast to mailbox and for each and every mode; authors had given an algorithm for counting the number of processes having similar identification. Also they proposed an algorithm for solving the leader election problem and for this problem they had given a graph theoretical characterization of the solvable class. For the purpose of identification, they had partition the whole network in such a way that each part is keeping distinct local processor identification.

There is no leader election algorithm in anonymous system because of indistinguishable properties of processes. In “Symmetry Breaking in Anonymous networks: Characterization” authors had characterized the possible cases in which they can elect a coordinator among all the processes in an anonymous system by a deterministic algorithm. They had given a precise characterization about impossibility of leader election in Symmetric network. Author obtained simple probabilistic algorithm for leader election in anonymous networks called as Randomized Leader Election algorithm [5] [6]. For breaking the symmetry in anonymous system authors assumed that the processes are provided with a fair coin. After that each process flips a coin and communicates an outcome with other processes. The process with outcome as Head is elected as a coordinator. In this if only one process gets an outcome as Head then there is no problem. But if more than

processes get an outcome as Head or Tail then this algorithm repeated until there is exactly one process with outcome as Head. This algorithm suggests that it takes at least two iterations to elect the coordinator but it founds that it took more than two iterations to elect the coordinator. It also requires more number of messages in this process.

There are several structures of the system where one can apply the election algorithm. Structure of system may be ring network or complete graph [7].

III. PROPOSED WORK

In this paper, author has proposed a new approach for electing a coordinator in anonymous system. Here every process first communicates with EC by sending a message containing resources information to EC. In Anonymous system, processes have same identity. On the basis of this information EC will apply banker’s algorithm and finds a safe sequence in which processes will execute. Depending on the sequence EC will assign a Virtual ID to each process. After applying virtual ID to each process, EC instantiates election algorithm for first time. It will communicate the coordinator of the system to all processes by sending message containing coordinator of system. Fig 1 describes algorithm for this.

When any process detects coordinator is not working i.e. coordinator crash, process asks EC about it. EC will check about it by sending message to Coordinator. If response is not given by coordinator EC will initiates EC and select new Coordinator from the remaining live processes based on the Virtual ID. EC will communicate about new coordinator to all live processes by sending messages to each. This algorithm is shown in fig 2 and fig 3 gives describes system.

```

1) for i=1 to total process
    send_process_message_EC(resources)
2) EC performs setID( )
3) EC performs init_election()
4) for i=1 to total process
    send_EC_message_Process( Coordinator)
    
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Fig 1. Algorithm for Initialize Election

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1) Process Pi detects crash of Coordinator.
    Pi send_process_i_message_EC(crash)
2) EC checks crash
    send_EC_message_Coordinator(isLive)
3) if crash
    EC performs init_election()
    for i=1 to total process
        if(process_i(isLive))
            send_EC_message_Process
            (New_Coordinator)
    
```

Fig 2. Algorithm for Coordinator Crash

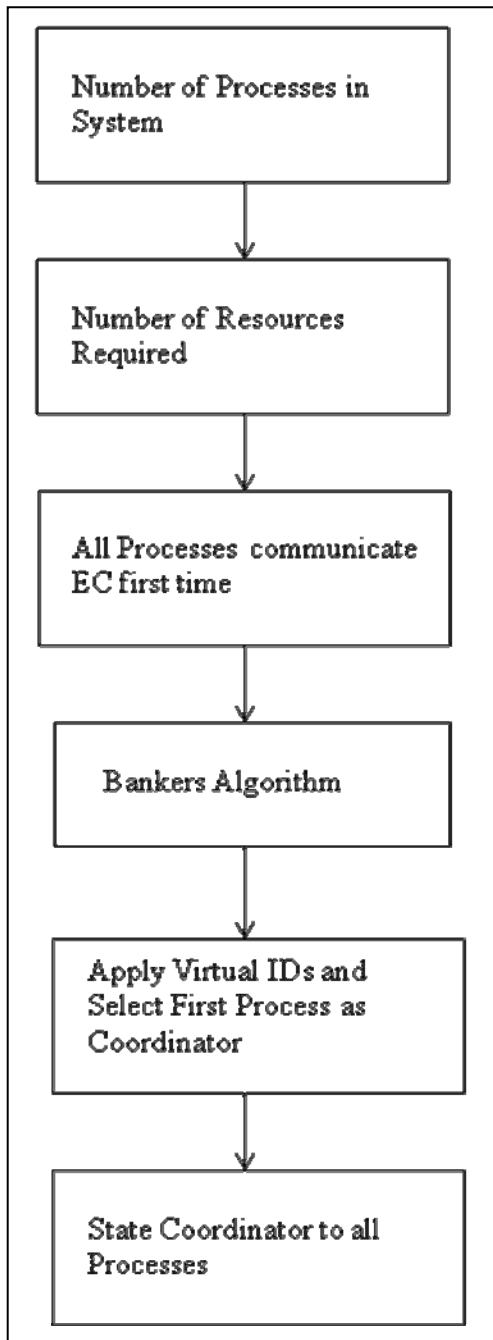


Fig 3. Initializing Election

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    1) send_process_i_message_EC( activate)
    2) EC checks process i.
       Process_i.isLive=true
    3) if isProcessNewCoordinator()
       for i=1 to total process
         if( process_i(isLive))
           send_EC_message_Process(New_
             Coordinator)
    
```

Fig 4. Algorithm for Reactivation of Process

When old coordinator recovers from crash it will communicate to EC. EC will initiates election again and sends message to all other process about the new coordinator as shown in fig 4.

IV. PERFORMANCE ANALYSIS

On the basis of simulation that we have carried out, comparing proposed system with the basic randomized leader election algorithm in anonymous system with respect to the number of messages it is found that proposed algorithm elects coordinator in system with less number of messages than existing randomized leader election algorithm. Randomized leader election algorithm requires more than two iterations for electing a coordinator. While considering performance of randomized leader election algorithm, we have considered two iterations for number of messages. But these numbers are very large compare to that required by our approach. After analyzing the simulation it is come to know that number of messages required in randomized leader election algorithm are $n*(n-1)$ where n is the total number of processes and for our proposed algorithm it is $2*n$. Comparison between Randomized leader election and proposed system is show in fig 5.

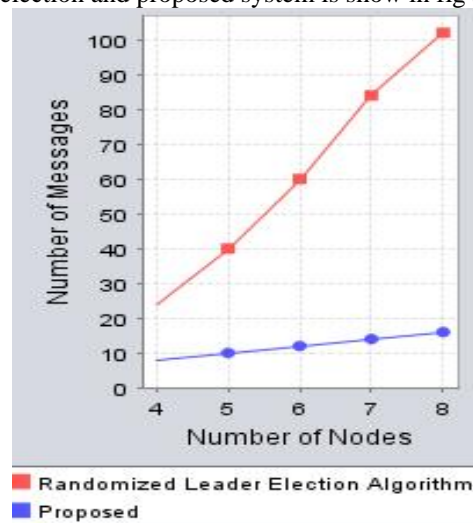


Fig 5. Comparison based on number of messages.

V. CONCLUSION

Results got from simulation shows that proposed election algorithm has better performance compare to existing Randomized Leader Election Algorithm for complete graph. Proposed algorithm required less number of messages. It also overcomes drawback of Randomized Leader Election Algorithm. Proposed algorithm helps to elect coordinator in anonymous system by breaking symmetry of anonymous system using real performance parameter. In future one can work this with ring structure.

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