Assignment 4

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Title: Any distributed algorithm for leader election.

Problem Statement:

To develop a ring algorithm and bully algorithm for leader election.

Objectives:

- To study about distributed algorithms
- To study primarily about election algorithm for coordinator selection

Theory:

Distributed Algorithm :

It is an algorithm that runs on a distributed system. Distributed system is a collection of independent computers that do not share their memory. Each processor has its own memory and they communicate via communication networks. Communication in networks is implemented in a process on one machine communicating with a process on another machine. Many algorithms used in distributed systems require a coordinator that performs functions needed by other processes in the system. **Election algorithms** are designed to choose a coordinator.

Election Algorithms:

Election algorithms choose a process from a group of processors to act as a coordinator. If the coordinator process crashes due to some reasons, then a new coordinator is elected by another processor. Election algorithm basically determines where a new copy of coordinator should be restarted.

Election algorithm assumes that every active process in the system has a unique priority number. The process with highest priority will be chosen as a new coordinator. Hence, when a coordinator fails, this algorithm elects that active process which has the highest priority number.Then this number is sent to every active process in the distributed system.

We have two election algorithms for two different configurations of distributed systems.

1. The Bully Algorithm –

This algorithm applies to systems where every process can send a message to every other process in the system.

Algorithm – Suppose process P sends a message to the coordinator.

1. If coordinator does not respond to it within a time interval T, then it is assumed that coordinator has failed.
2. Now process P sends an election message to every process with a high priority number.
3. It waits for responses, if no one responds for time interval T then process P elects itself as a coordinator.
4. Then it sends a message to all lower priority number processes that it is elected as their new coordinator.
5. However, if an answer is received within time T from any other process Q,
    - (I) Process P again waits for time interval T' to receive another message from Q that it has been elected as coordinator.
    - (II) If Q doesn't respond within time interval T' then it is assumed to have failed and the algorithm is restarted.

2. The Ring Algorithm –

This algorithm applies to systems organized as a ring(logically or physically). In this algorithm we assume that the link between the processes are unidirectional and every process can message to the process on its right only. Data structure that this algorithm uses is an active **list**, a list that has the priority number of all active processes in the system.

Algorithm –

1. If process P1 detects a coordinator failure, it creates a new active list which is empty initially. It sends election messages to its neighbour on the right and adds number 1 to its active list.
2. If process P2 receives message elect from processes on left, it responds in 3 ways:
    - (I) If the message received does not contain 1 in the active list then P1 adds 2 to its active list and forwards the message.

- (II) If this is the first election message it has received or sent, P1 creates a new active list with numbers 1 and 2. It then sends election message 1 followed by 2.
- (III) If Process P1 receives its own election message 1 then the active list for P1 now contains numbers of all the active processes in the system. Now Process P1 detects the highest priority number from the list and elects it as the new coordinator.

Difference between ring algorithm and bully algorithm:

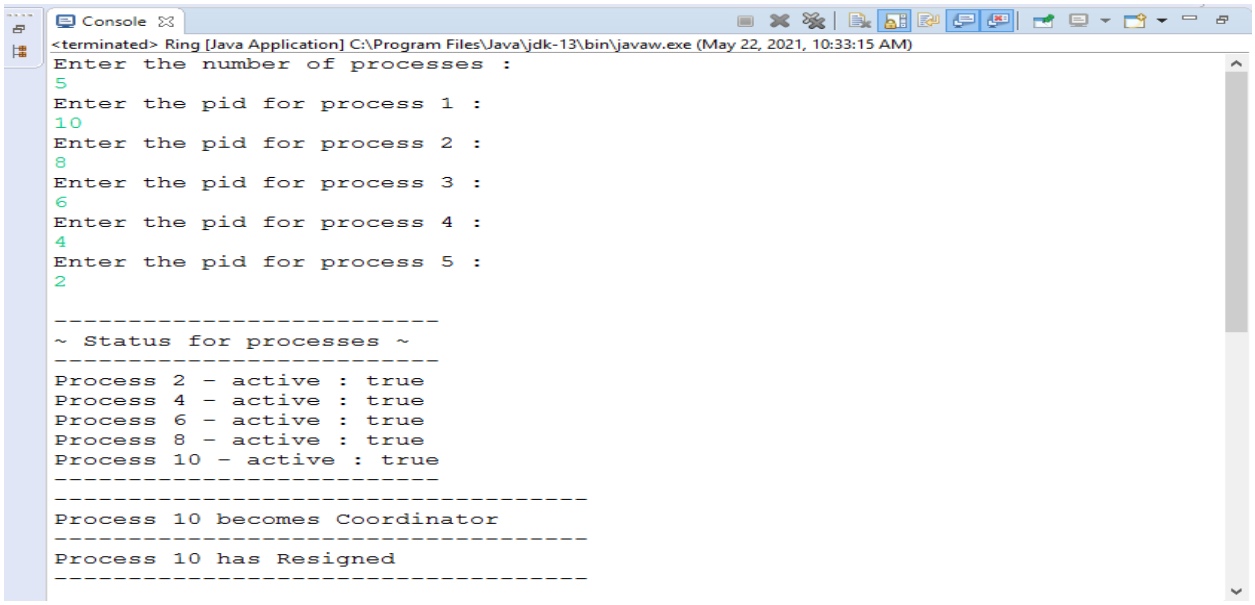
Criteria	**Ring Algorithm**	**Bully Algorithm**
Number of messages for electing a coordinator	2n	O(n^2)
Problems	An overlay ring topology is necessary	Large message overhead

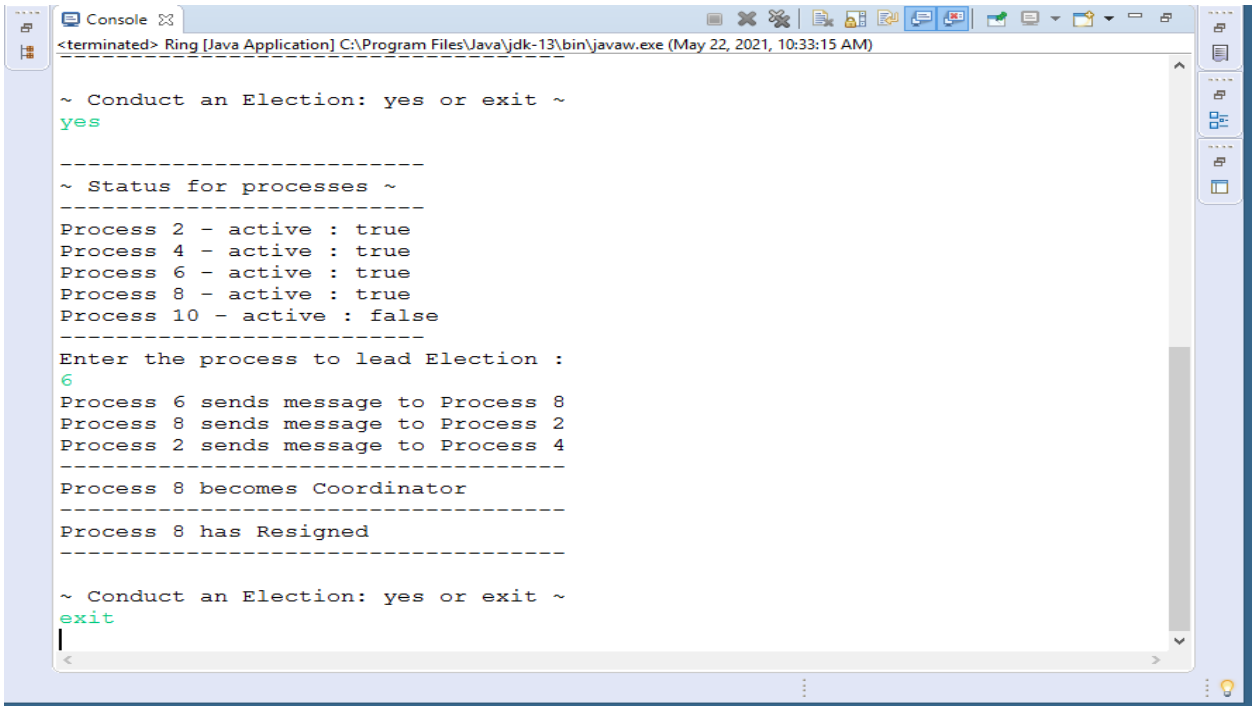
Assume that :

n = Number of processes in the distributed system.

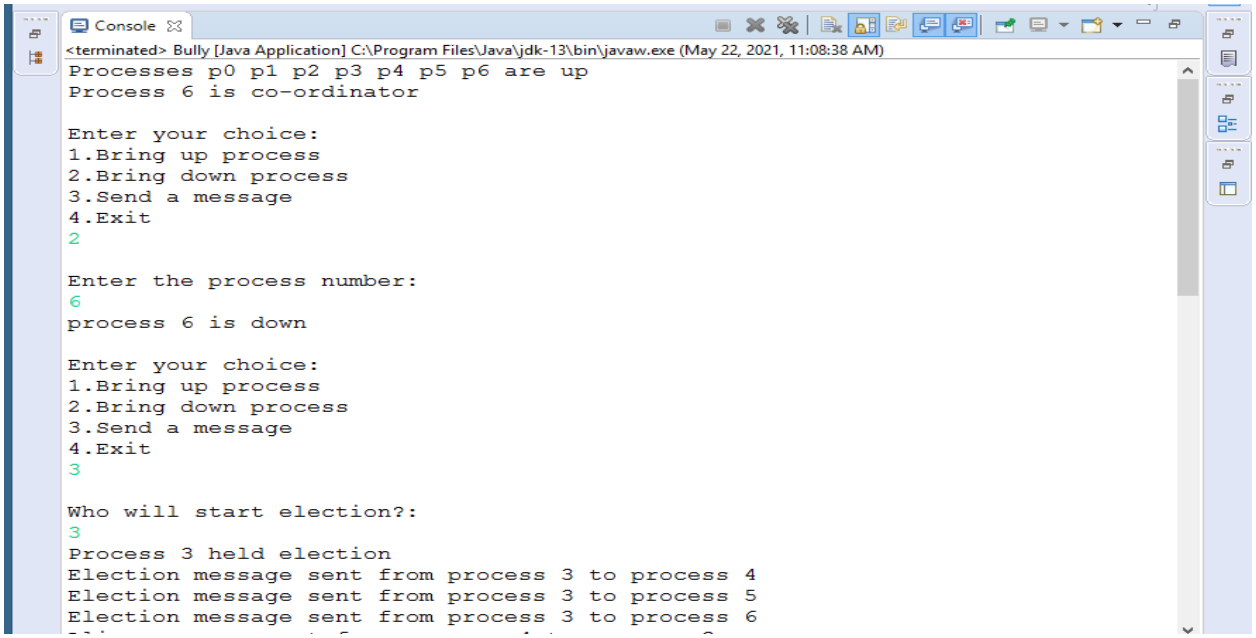
Output:

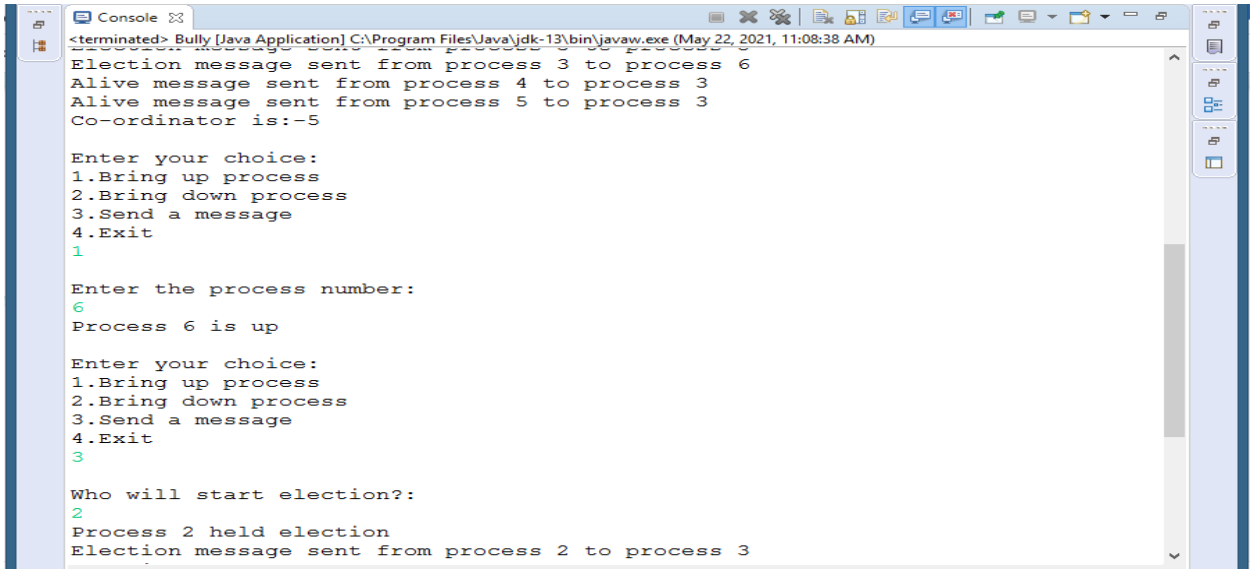
Ring Algorithm :

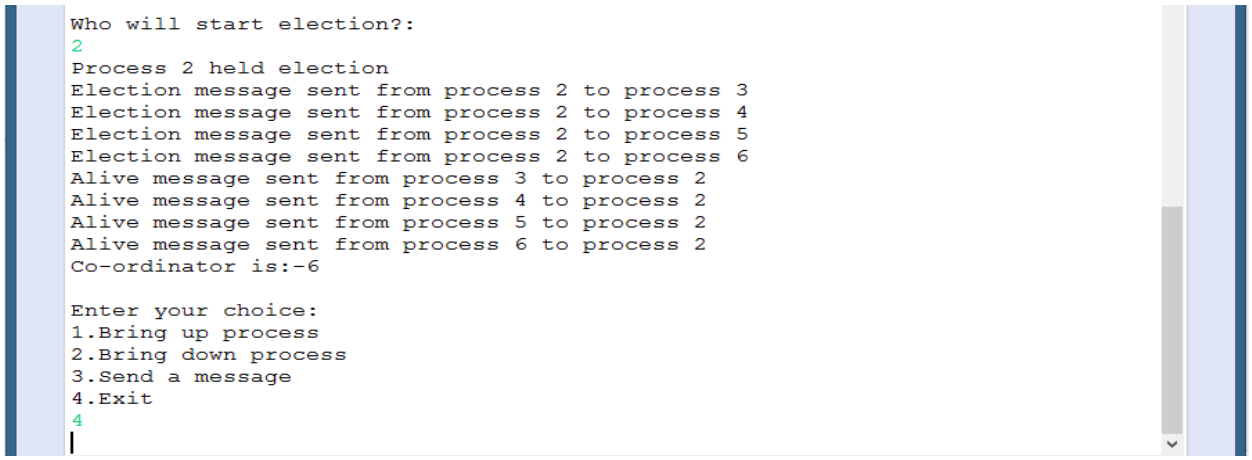




Bully Algorithm:


Console
<terminated> Bully [Java Application] C:\Program Files\Java\jdk-13\bin\javaw.exe (May 22, 2021, 11:08:38 AM)
Processes p0 p1 p2 p3 p4 p5 p6 are up
Process 6 is co-ordinator
Enter your choice:
1.Bring up process
2.Bring down process
3.Send a message
4.Exit
2
Enter the process number:
6
process 6 is down
Enter your choice:
1.Bring up process
2.Bring down process
3.Send a message
4.Exit
3
Who will start election?:
3
Process 3 held election
Election message sent from process 3 to process 4
Election message sent from process 3 to process 5
Election message sent from process 3 to process 6


Console
<terminated> Bully [Java Application] C:\Program Files\Java\jdk-13\bin\javaw.exe (May 22, 2021, 11:08:38 AM)
Election message sent from process 3 to process 6
Alive message sent from process 4 to process 3
Alive message sent from process 5 to process 3
Co-ordinator is:-5
Enter your choice:
1.Bring up process
2.Bring down process
3.Send a message
4.Exit
1
Enter the process number:
6
Process 6 is up
Enter your choice:
1.Bring up process
2.Bring down process
3.Send a message
4.Exit
3
Who will start election?:
2
Process 2 held election
Election message sent from process 2 to process 3


Who will start election?:
2
Process 2 held election
Election message sent from process 2 to process 3
Election message sent from process 2 to process 4
Election message sent from process 2 to process 5
Election message sent from process 2 to process 6
Alive message sent from process 3 to process 2
Alive message sent from process 4 to process 2
Alive message sent from process 5 to process 2
Alive message sent from process 6 to process 2
Co-ordinator is:-6
Enter your choice:
1.Bring up process
2.Bring down process
3.Send a message
4.Exit
4

Conclusion:

In this assignment, we learned about distributed algorithms like election algorithms which are used to elect a coordinator in the distributed systems. We implemented a ring algorithm and bully algorithm in this assignment.