WINS Lab Beamer Presentation Template

Dolev-Klawe-Rodeh and Echo with Extinction Leader Election Algorithms

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Outline of the Presentation

1. Outline
2. Problem and background
3. Design and methods
4. Major findings
5. Conclusion and recommendations

The problem

In an election algorithm, each computation should terminate in a configuration where one process is the leader.

The Problem Name

Selection a leader ensures continuous coordination between entities. These algorithms also provide a means to recover from failures of the coordinator. Define leader in a directed ring and undirected networks.

Distributed system is a collection of independent processes that communicate with each other and cooperate achieving a common goal.

Dolev-Klawe-Rodeh and Echo with Extinction Leader Election Algorithms

This presentation presents the detailed explanation of the leader selection algorithms;

Choosing the leader in a circular ring, where processors choose a single leader with the greatest ID at the end of the Dolev-Klawe-Rodeh algorithm.

Choosing the leader in undirected network working for any topology, Echo Algorithm with Extinction.

- Determinaton of the algorithms time complexity and message complexity.
- Outputs of the algorithms.
- Conclusion and trade-offs.

Motivation/Importance

The leader has the responsibility of system management.

For example the client-server model of resource management:

The server is the a leader. Client processes send requests for resources to the server

A centralized database manager maintaining a queue of pending read and writes and processes offering a simple solution with manageable complexity.

When the leader (i.e., coordinator) fails, a new leader is needed to be elected. Selection a leader ensures continuous coordination between processes.

Various election algorithms have been proposed for the leader election. Bully Algorithm has been presented by Gracia- Molina in 1982. But its disadvantage is it requires that every process should know the identity of every other process. So it increases traffic.

There are also various ring election algorithms.

The Chang-Robert algorithm targets a directed ring. The idea is that only the message with highset ID completes the trip.

Franklins case, message in uses an bidirectional ring to improve for complexity.

Dolew Klawe Rodeh algorithm changes the Franklins algorithm to unidirectional ring meaning a message cannot travel in both direction.

Echo algorithm with extinction can work for any topology. The Echo Algorithm facilitates the selection of a leader orcoordinator among the processes in a distributed system.

Dolev-Klawe-Rodeh algorithm

The Dolev-Klawe-Rodeh algorithm uses directed rings which messages cannot travel in both directions.

Active process whose ID is p and next active neighbors are q and r.

The Ids are collected at r. There are three cases to evaluate the election process. If

$$p > q$$

and r; r remains active and progress to the next election round If

$$p < q$$

or r; r becomes passive If p=q and r; r becomes the leader.

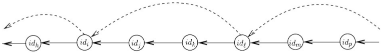


Figure: Ring topology

Echo algorithm with extinction algorithm

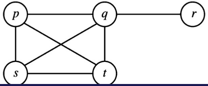
Propagate an ”echo” message through the network. Echo messages are forwarded among processes, so every process knows others’ status or candidacy. Processes that haven’t heard from any higher-priority process declare themselves as leaders and broadcast victory messages. When a process p in a wave q is hit by a wave r. If

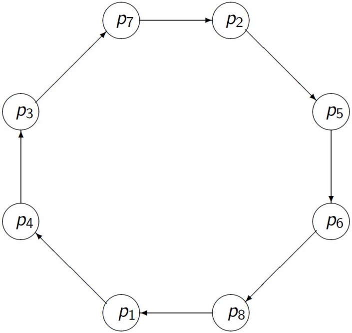
$$q < r$$

then p makes the sender its parent, switches to the wave r. If

$$q > r$$

then p continues with the wave tagged with q. If q=r then p treats the incoming message according to the echo algorithm of the wave q. If the wave tagged with p completes by executing a decide event at p, then p becomes the leader.





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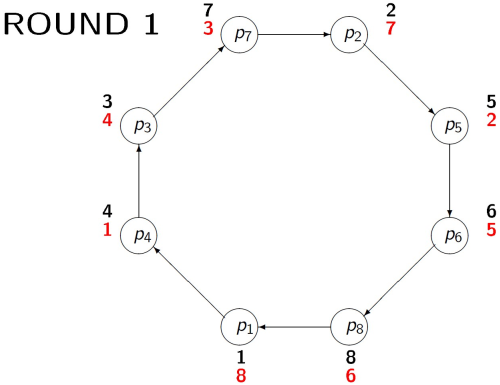

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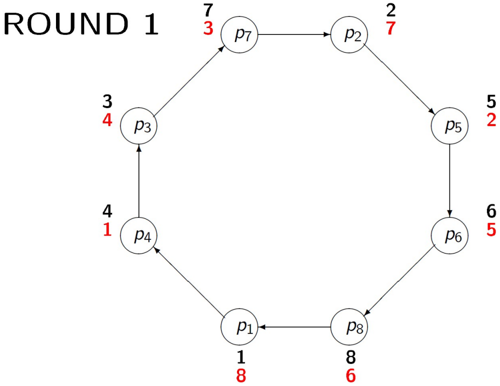

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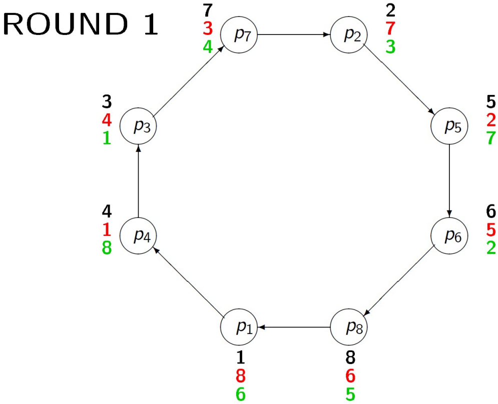

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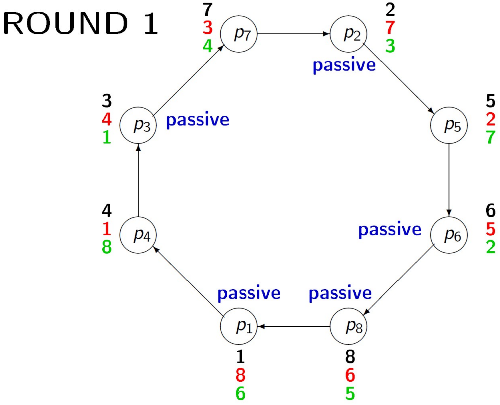

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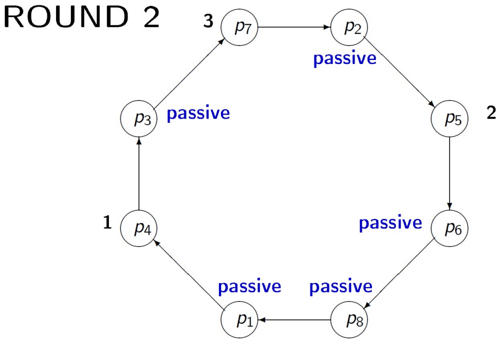

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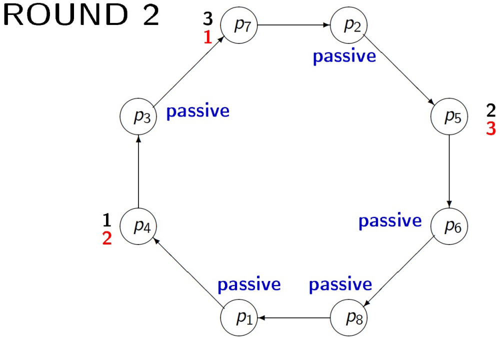

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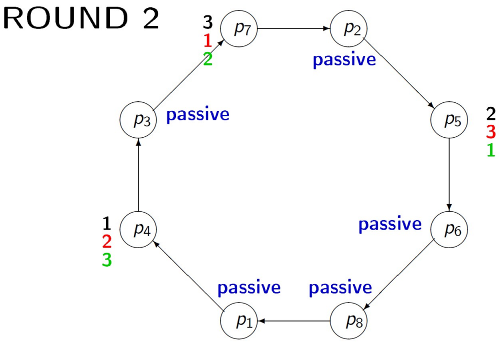

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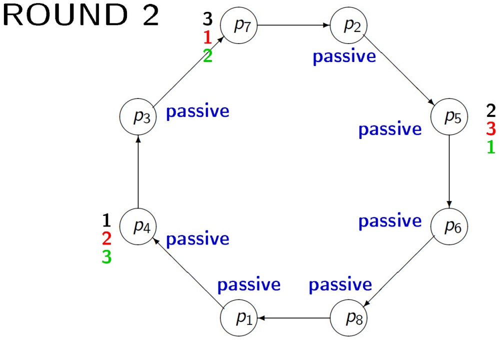

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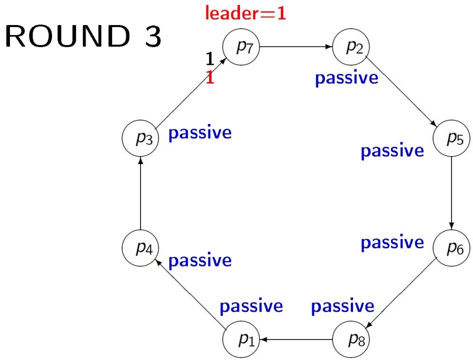

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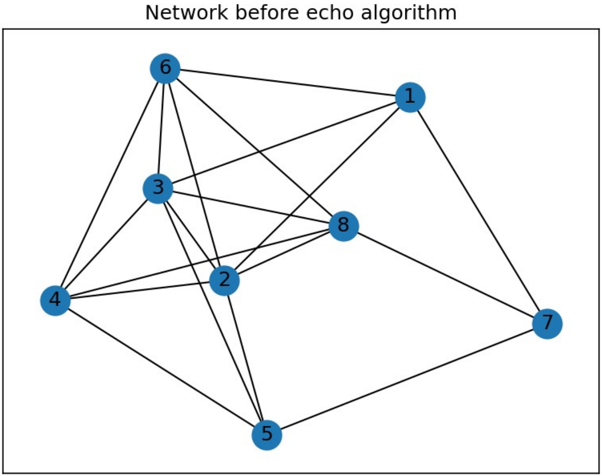


Figure: Network Before Echo Election Algorithm

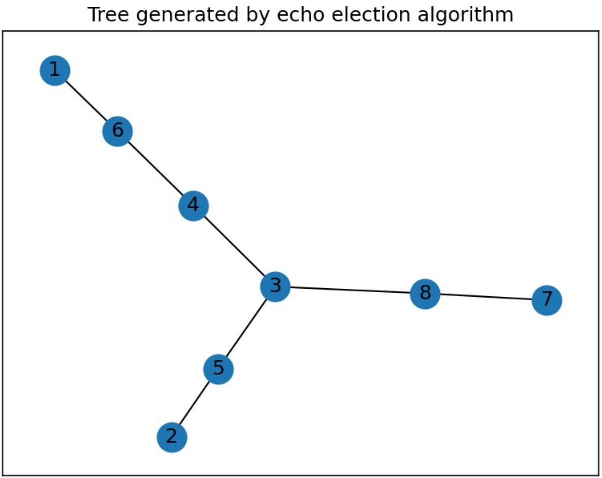


Figure: Network After Echo Election Algorithm

Time complexity

The time complexity measures the number of rounds or steps required for the algorithm to complete its execution. Eachround involves processes exchanging messages and performing local computations.

The number of processes is defined as N. Each round in the algorithm involves each process sending and receiving messages to and from other processes. Therefore, the time complexity is directly proportional to the number of messages exchanged in each round.

The time complexity of the algorithm in terms of the number of messages exchanged is linear: O(E)

Message Complexity

The Dolev-Klawe-Rodeh Algorithm The message complexity of the algorithm can be analyzed in terms of the the number of processes (N). Each process needs to send a request message to every other process in the network. The message complexity of the algorithm is O(NlogN).

Figure: Message Complexity of DKR Algorithm

Echo Algorithm with Extinction Time complexity

Theworst case message complexity of the Echo Algorithm with Extinction is O(NE) where there are at most N waves, at most 2E message in each wave.

Echo Algorithm with Extinction Message Complexity

The worst case message complexity of the Echo Algorithm with Extinction is O(NE), at most 2E message in each wave.

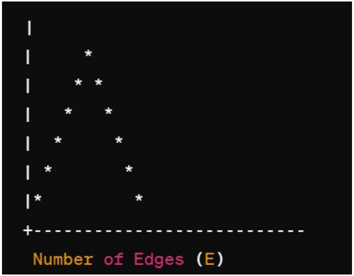


Figure: Message Complexity of EWE Algorithm

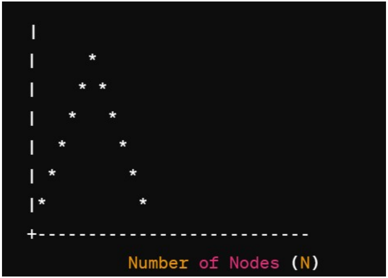


Figure: Message Complexity of DKR Experiment

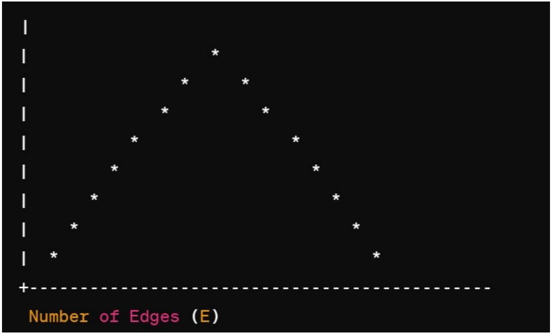
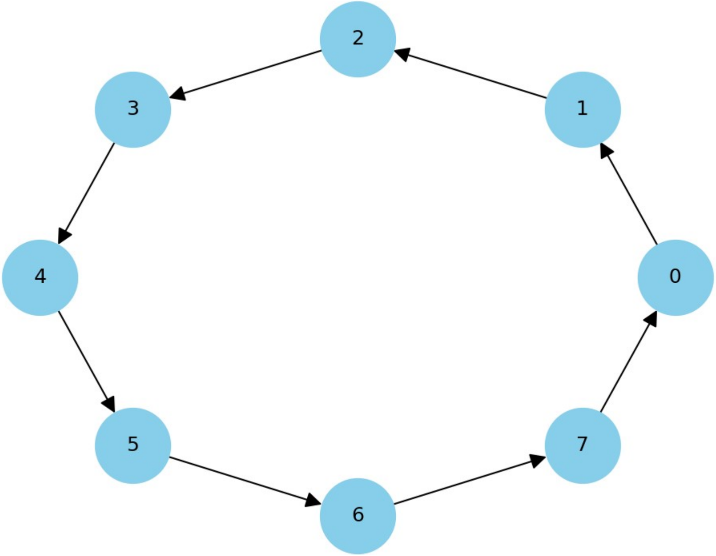


Figure: Message Complexity of EWE Experiment

Result



Nodes of DKR Experiment

Main Result of DKR Algorithm

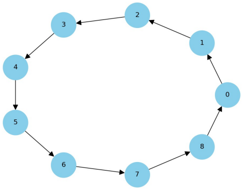
- Node 7 (ID: 7) sending alias to Node 0 Node 0 (ID: 0) received alias 7 from Node 7 Node 0 (ID: 0) sending alias to Node 1
- Node 1 (ID: 1) received alias 7 from Node 0 Node 1 (ID: 1) sending alias to Node 2
- Node 2 (ID: 2) received alias 7 from Node 1 Node 2 (ID: 2) sending alias to Node 3
- Node 3 (ID: 3) received alias 7 from Node 2 Node 3 (ID: 3) sending alias to Node 4
- Node 4 (ID: 4) received alias 7 from Node 3 Node 4 (ID: 4) sending alias to Node 5
- Node 5 (ID: 5) received alias 7 from Node 4 Node 5 (ID: 5) sending alias to Node 6
- Node 6 (ID: 6) received alias 7 from Node 5 Node 6 (ID: 6) sending alias to Node 7 Node 7 (ID: 7) received alias 7 from Node 6 Node 7 is the elected leader. Total messages sent: 44 Total messages received: 44 Leader is node 7 with alias 7

Result

The Dolev-Klawe-Rodeh (DKR) algorithm, designed for leader election in ring topologies, does not explicitly include a mechanism for dynamically handling nodes entering or leaving the network during its execution. Instead, it assumes a static set of nodes where each node knows the total number of nodes in the ring and can communicate with its immediate successor.

Total messages sent after adding new node: 91

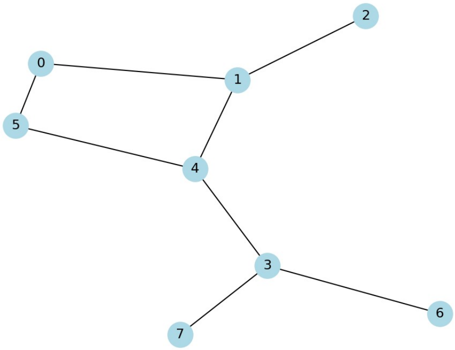
Total messages received after adding new node: 91



New Leader after adding node is 8 with alias 8

Nodes of DKR Experiment

Result

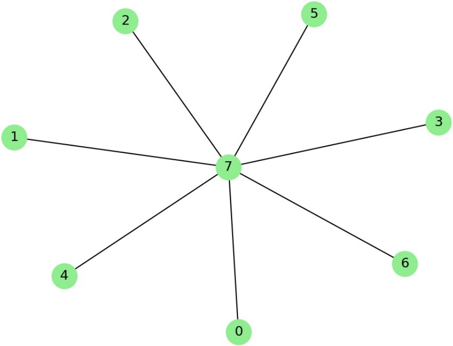


Nodes of EWE Experiment

Result

Nodes of EWE Experiment

Result of EWE Algorithm



Message Complexity of EWE Experiment

Conclusions

- The DKR algorithm is effective in ring-based networks with potentially large IDs and where the communication delay between nodes is uniform or predictable. It is more message-efficient compared to simpler algorithms.
- The Echo with Extinction algorithm offers an average-case complexity of O(N) making it an attractive option for scenarios where minimizing message passing is a priority. The extinction mechanism prevents nodes from perpetually echoing messages in isolated segments, promoting convergence towards a leader even amidst network disruptions.

References

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