Paper Review: Distributed Snapshots: Determining Global States of Distributed Systems

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1 Summary:

The goal of the paper is to determine the global state of a system. In the absense of a shared global clock or memory, where each process can read its own state and the messages it sends and receives, the authors describe an algorithm that can be used to infer a "meaningful" global system state. The paper also discusses stable property detection which can be reduced to the global state detection problem.

2 Description:

In a distributed system void of a shared global clock or memory, all processes cannot record their local states at the same instant.
In addition to this, the global state detection algorithm should run concurrently with other processes without altering other computations.
To add to this there is another layer of complexity for the global state that is captured to be composite or meaningful. Furthermore, the network could have arbitrary delays.
Also, the global state thus recorded must be "meaningful".

To address these issues the authors describe an algorithm, in which each process records its own local state, independently. The state of a communication channel is recorded with the cooperation of the two processes the communication channel is incident on. The cooperation of the two processes is achieved by sending a marker by a process that is sending the message along the communication channel, which acts as a signal to the receiver, to appropriately record the state of the incident communication channel.

The paper also describes the model of a distributed system to correctly identify the components of such a system along with the relationship between different components. These components include, processes, states of processes, states of the channel in terms of the messages sent along the channel and events ocurring in the system defined in terms of processes and channels.

The authors also extend the global state detection algorithm to devise an algorithm for stability detection.

3 Strong points:

1) The paper identifies and formulates relationships among local process states, global process states and points in a distributed computation which makes the description of a distributed system and it's interaction clear and easy to understand.
2) The algorithm described by the author is quite simple and intuitive.

3) The mathematical proof of the correctness of the global state detection algorithm is novel and might serve as a reference for the proofs for future research.
4) An algorithm for stability detection (some important problems like deadlock detection fall in this category) along with it's proof of correctness was also described in this paper.

4 Weak points:

1) The assumptions made by the distributed system model described in this paper such as infinite buffer, error free delivery are too extreme and unrealistic.
2) The authors fail to account for the failures in the communication channels such as packet loss or incorrect order of packets.
3) The termination of the algorithm is not explained in these scenarios, for eg. what would happen if the marker is lost. Then the global state reported by the system would be incorrect.
4) In modern scenarios communication channels can exist between more than two processes and this cannot be applied.

5 Improvements:

The algorithm can be improved to handle failure scenarios in the absence of the assumptions made by the model described.
For example in modern distributed systems that use commodity hardware prone to failure, error free delivery cannot be assumed.
A way to introduce some fault tolerance would improve the performance and relevance of the algorithm in modern scenarios.