Diagnosis in Distributed Systems

A Presentation by
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Diagnosis

- Important to be able to figure out which component has failed
- In order to initiate recovery
- Multiple processes running and thousands of nodes.
  - Can a centralized algorithm work

System Diagnosis

- To figure out which component has failed if any.
- Based on testing by each node in most algorithms.
  - The test results are called *Syndromes.*
  - A centralized tester figures out the results of the syndromes using a graph.
  - N > (2t+1) where t is the number of faulty receivers needed to be diagnosed.
- Probabilitistic diagnosis and distributed diagnosis.

Group Membership Problem

- Trying to figure out whether your neighbor is functioning properly or not.
  - Keeping track of which processes have failed and which are functioning properly
- Varies from lose synchrony to virtual synchrony
- Broadcast based coordinator based and token ring based.

Poles Apart or R They ?

Membership Algorithm	System Diagnosis
Fail-Stop and crash failures	Failures detected by the test given
Testing might not be active	Testing is always active
They can tolrerate any number of failures	They usualy tolerate only a fixed number of failres like the PMC model
False alarms	They provide a guarantee with identification
Integrated with the application protocol	Not necessarily but run independently

NEW_SELF System Diagnosis algorithm

- Node P_i tests its neighbors and keeps it in list TESTED_BY(P_i).
- It receives the diagnostic information from all the fault-free nodes stores it.
- It retests all the nodes and verifies the information and validates it
- This information is forwarded to all nodes that test P_i .

Distributed Online Diagnosis

- Algorithm which guarantees ‘correct’ diagnosis.
- Under limited model (consistent liars), diagnosis is also complete.
- General case of unrestricted arbitrary faults also discussed.
- Technique shall identify node failures that occur during diagnosis algorithm execution
- Faults are manifested as corrupted diagnostic information maintained at node or exchanged between nodes.

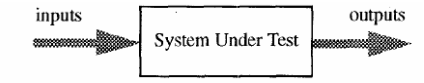
Setup

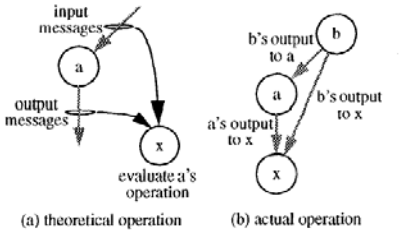
- Collection of distributed nodes, V(S) interconnected by bidirectional edges E(S)
- Each node assigned fault state s –

  0 – Fault free

  1 – Faulty
- Set of performed tests – Testing assignment
- Collection of corresponding test results- Syndrome
- Effect a distributed diagnosis.

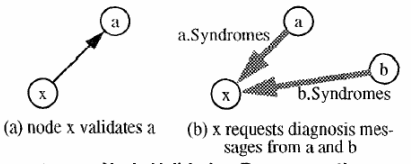
Node Validation Mechanism

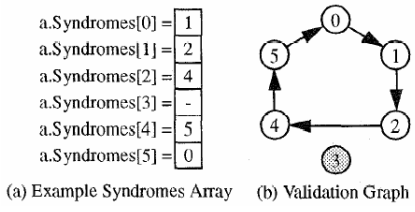




Features of Algorithm

- If Nx validates Na, represented as

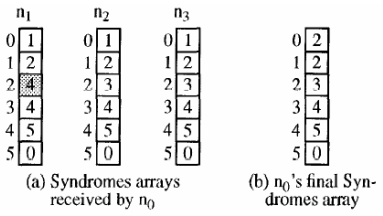




Algorithm for 1 consistent Liar

- Nodes are listed in sequential order.
- Node Nx requests syndrome information from next two nodes in ordered node list.
- If Ny does not validate with Nz, Nx requests information from next node, Nw.
- Nx identifies first node that validates with Nw as fault free
- Diagnostic information received from validated node is used to update local Syndrome array.

Example



(a) Syndromes arrays received by n_0

(b) n_0's final Syndromes array

Assumptions:

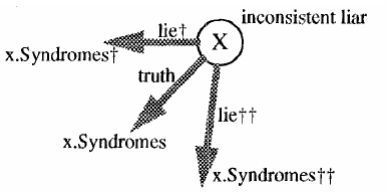
1) Every message transmitted by fault-free node is received correctly.
2) Receiver of message can identify sender of message.
3) Absence of message can be detected.
4) Every node can communicate with every other node
5) Faulty node distributes incorrect information to all nodes that requests information

Working of Algorithm

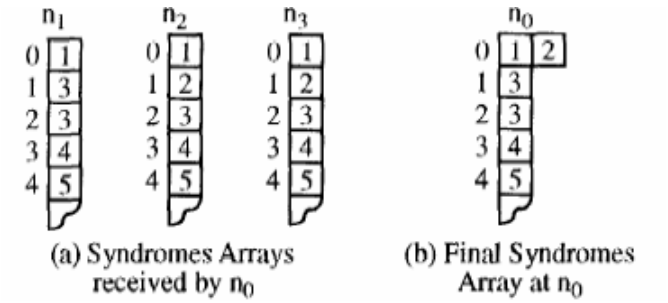
- Every fault-free node correctly identifies the nearest fault free node in the ordered node list.
- After one round of the algorithm, a validation path exists between any pair of fault free nodes.
- Syndrome entries corresponding to fault free nodes are identical in all fault free nodes after a fixed no. of rounds.

Extensions

- For t consistent liars where common-mode failure is possible, a validation path of length t containing t+1 nodes is found, to ensure that the first node in the path is fault free.
- For inconsistent liars, algorithm provides correct, but not complete diagnosis.



One Inconsistent Liar



(a) Syndromes Arrays received by n_0

(b) Final Syndromes Array at n_0

Pros and Cons of Algorithm

- Absence of centralized supervisor-controlled diagnosis.
- No assumption made about fault free node being able to accurately project state of node it is testing.
- Increased overhead owing to syndromes being passed irrespective of whether changes have been effected.

Fault Identification using Finite State Machine Model