FOTOS –
Fail Over and Take Over System

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Erlang/OTP selling point

- It is very easy to create multi node systems with load balancing and failover in Erlang/OTP!

  or…

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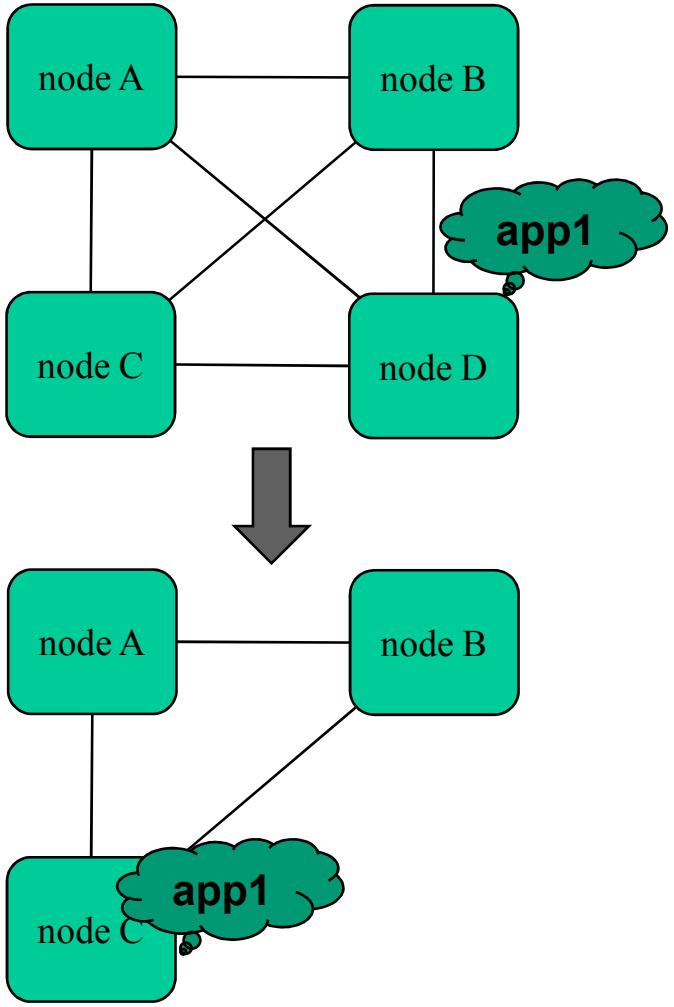
It is very easy to create…

```
[{kernel,
  [{distributed,
    [{app1,
      [nodeD,
       nodeC,
       nodeB,
       nodeA]}]
   }]}].
```



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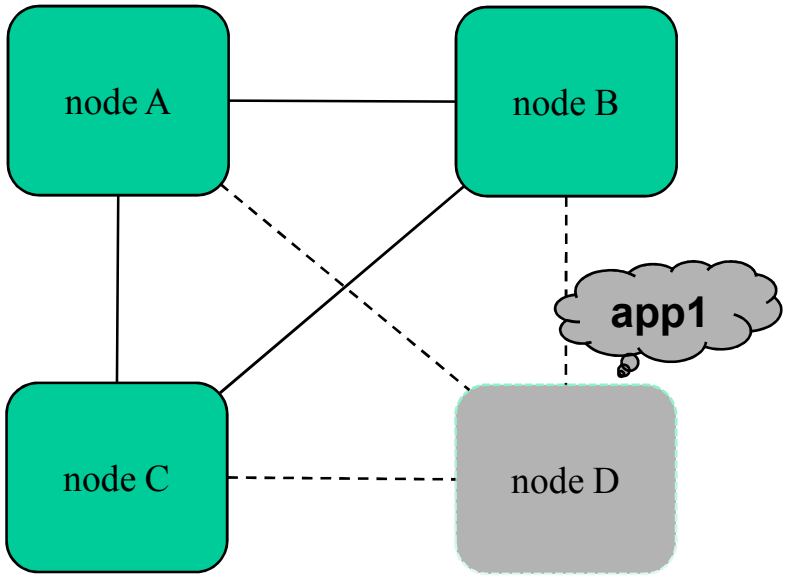
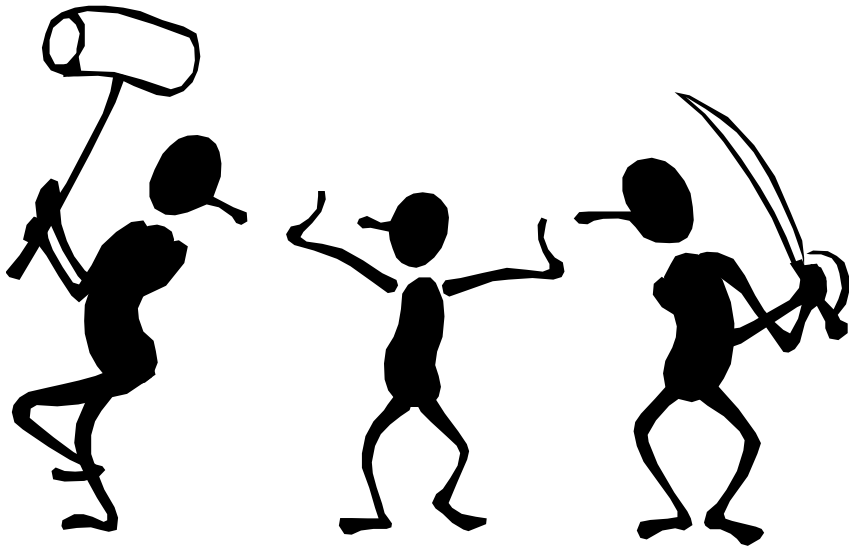
What is failover?

- The ability of peer nodes to detect the failure of a node and resume its responsibilities.



Failover…

- Detect failing node, and
- **Decide who resumes which responsibilities.**



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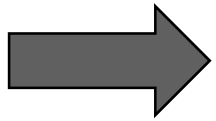
Failover…

- Decide who resumes which responsibilities.



All nodes must agree on which nodes are in fact part of the network!

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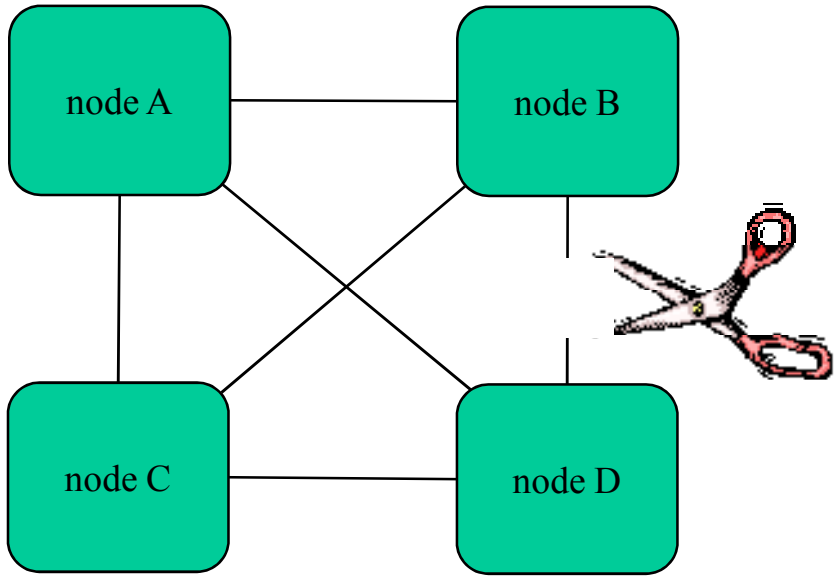
It is very easy, or…

- The distributed application controller does not handle network failures.



FOTOS

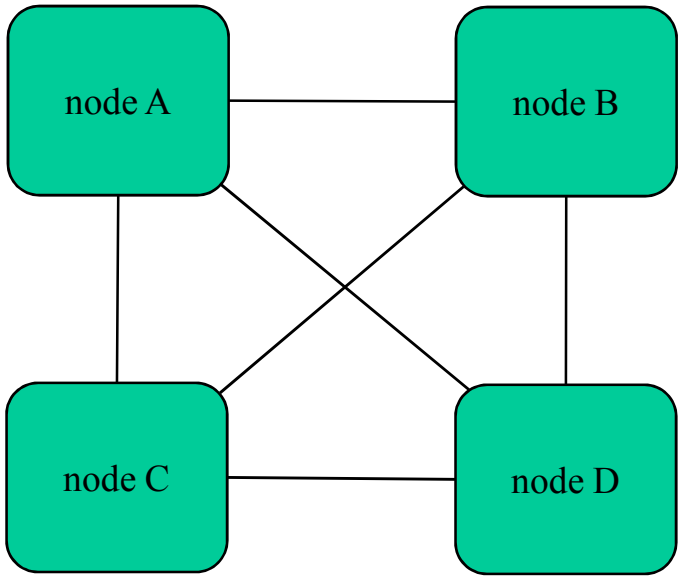
- Monitoring of the network and maintain a network of operational nodes.
  - Without having to elect a leader.
- A simple database with vector clock controlled updates.

Assumptions

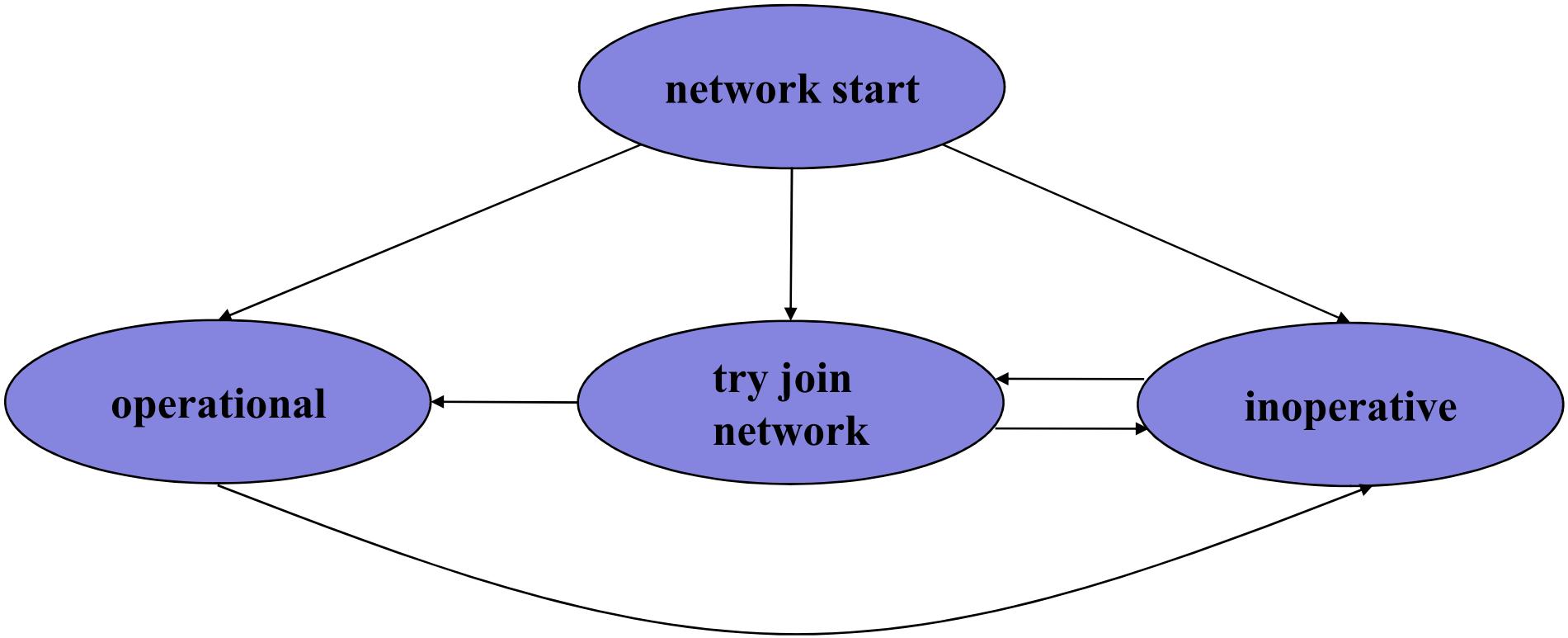
- All nodes are loyal and follows “the rules”.
- Messages between two nodes are delivered in the same order as sent.
- External means of detecting a partitioned network.

Monitoring of the network

- A network of operational nodes
  - A fully connected mesh of Erlang nodes.
  - Only nodes that can ”see” all other participating nodes may participate.

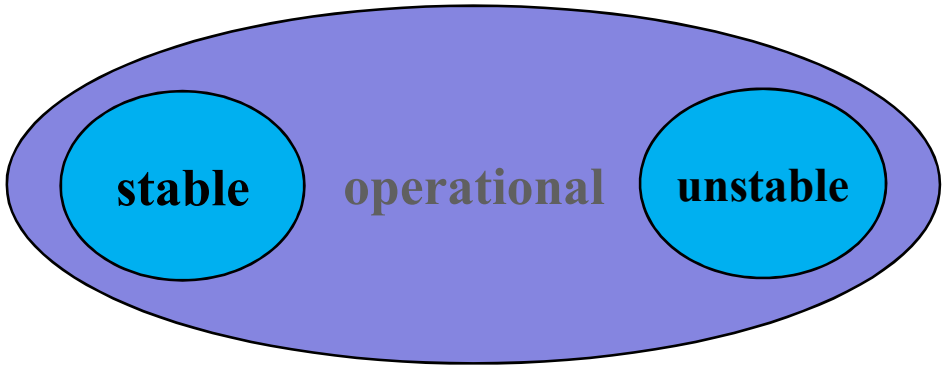


The node state machine



The node state machine

- An operational node may be either stable or unstable.

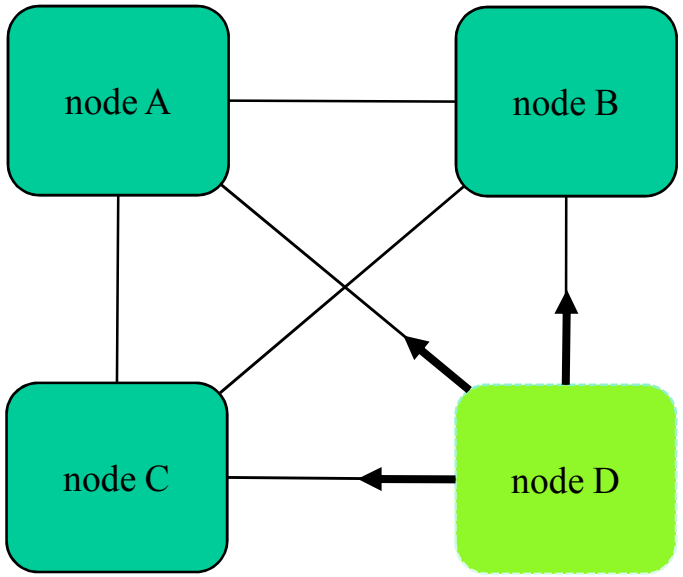


Network start

- The first thing a newly started node does is to try to start a network of operational nodes.
  - It contacts all known nodes to see if they want to help create a network of operational nodes.

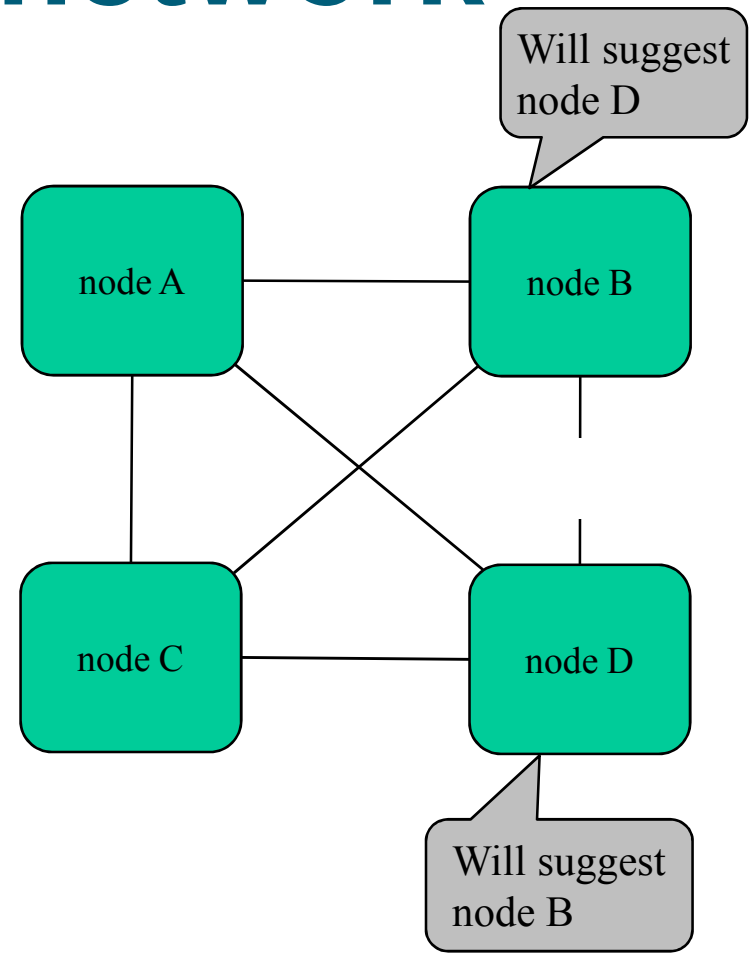
Joining a network of operational nodes

- A newly started node tries to join a network if it ”sees” all nodes.
  - An operational node may only object to a JOIN REQUEST if it does not include exactly all nodes that are operational, or
  - If it is participating in another procedure currently.

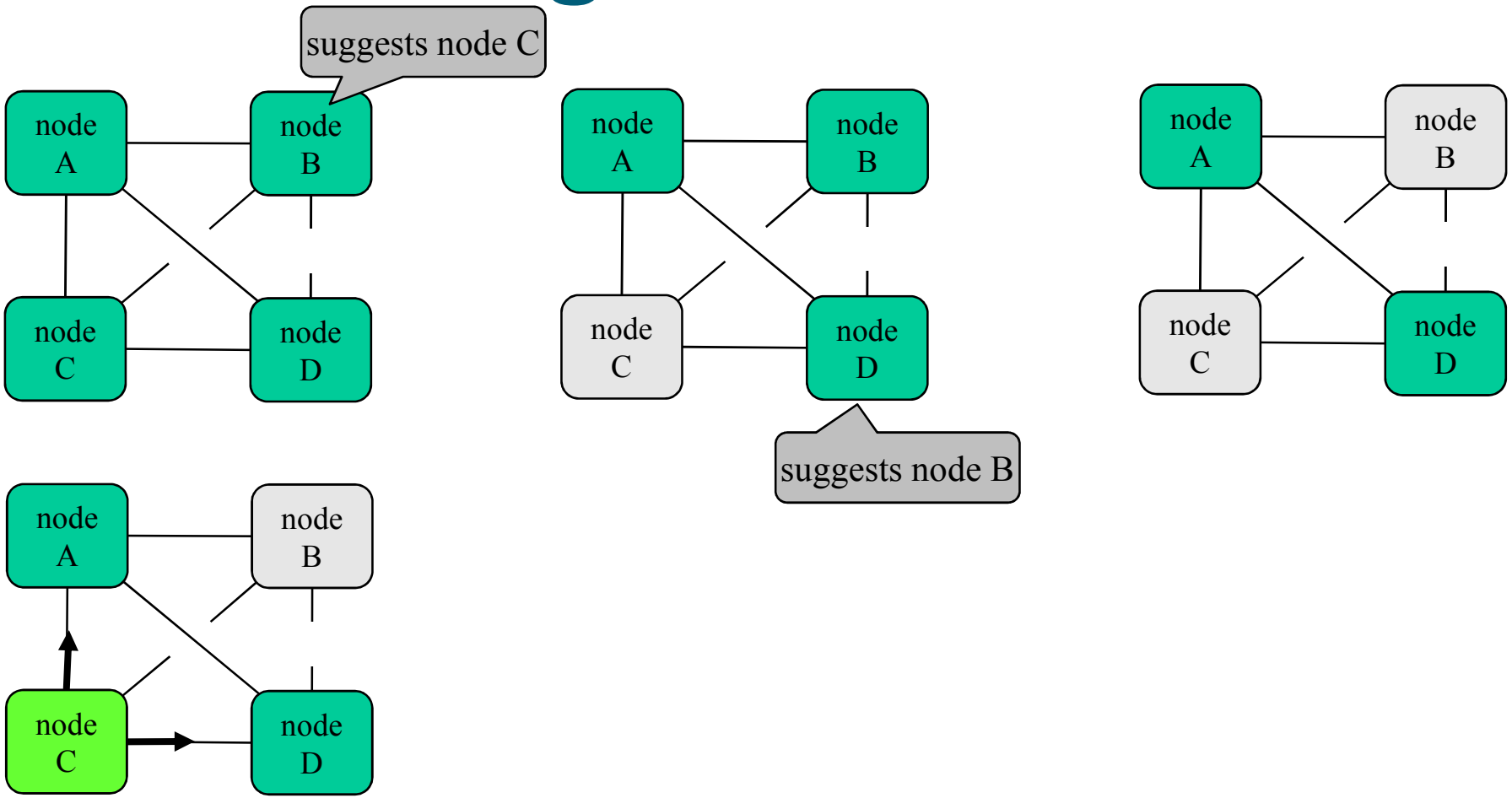


Monitoring of the network

- A node that detects a peer node failure suggests its removal.
  - A node may not be removed unless all other nodes (except the failed node) agrees.



Monitoring of the network



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Single failure optimization

- A node may only run one procedure at a time.
  - Removing or joining one node at a time.
- If multiple simultaneous failures, no guarantee the result is the most optimal possible network.

Network unstable

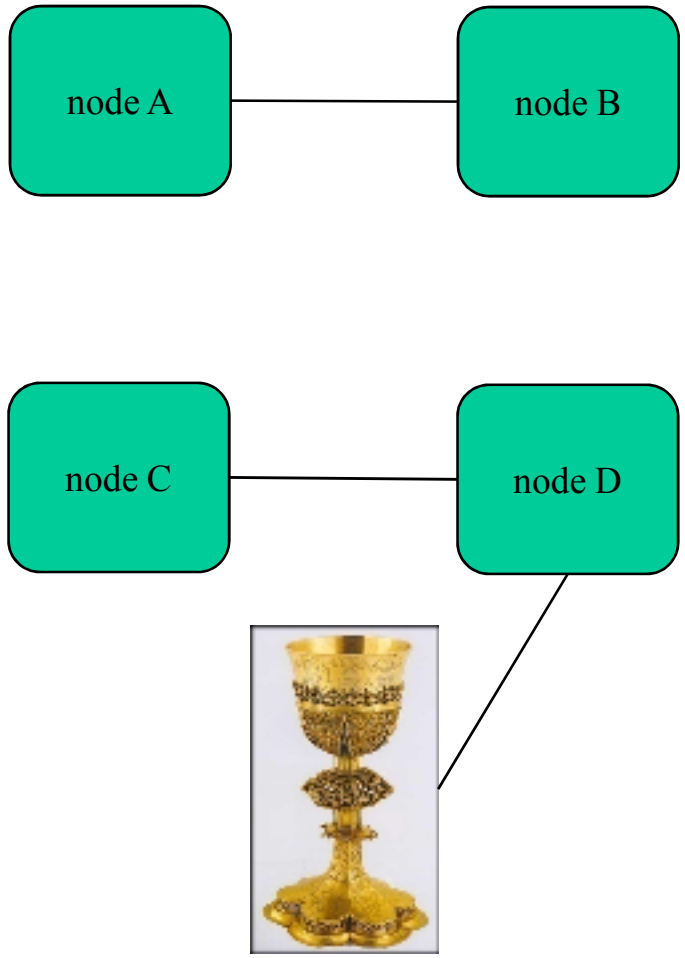
- As soon as a node learns of that a participating node is not visible from one or several nodes – the network is deemed unstable.
  - In first “person” (‘DOWN’ message).
  - “Rumor” from another node that wishes to remove the now failed node from the network of operational nodes.

There is no magic!

- You must still make fail-over and load balancing decisions!
  - Based on stable/unstable.
  - Based on changes of the set of participating nodes.

You must provide a “holy grail”

- In case of a completely partitioned network – a “holy grail” is needed to decide which network is the “real network”.



Some spin-offs

- 2 Phase Commit
  - 2 phase commit with rendezvous
- A Vector Clock

FOTOS summary

- Subscribe to stability status.
- Subscribe to changes in the set of operational nodes.
- Optimized for single failure.
- A simple database with vector clock protected updates.