

# ROBUST SELF-STABILIZATING MANAGEMENT FOR MANET

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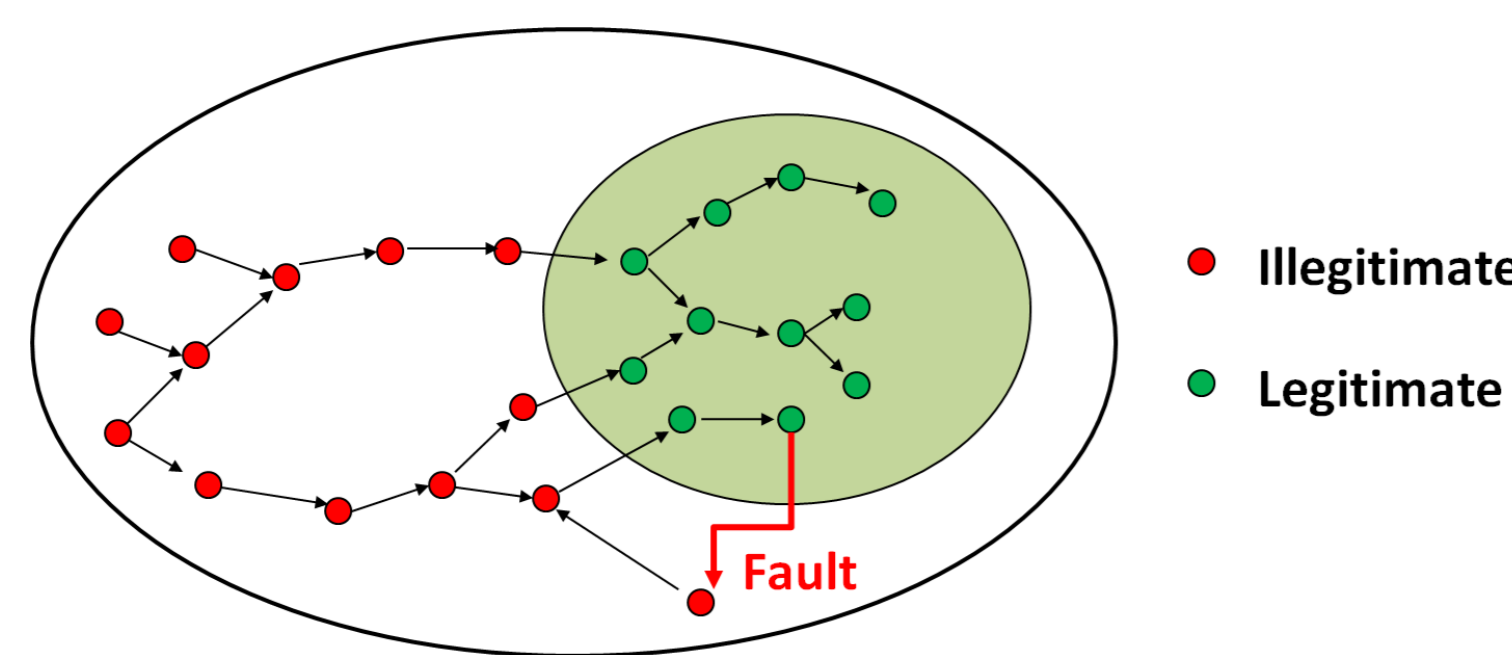
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## Self-Stabilization

Starting from any arbitrary configuration, a self-stabilizing system converges to a legitimate configuration and then behaves properly.

- + Recovering from transient faults without any hypothesis on the nature and the extent of faults.
- + No initialization phase.
- + Self-organization, Self-healing in ad hoc networks.
- During the stabilization period, no property is guaranteed.

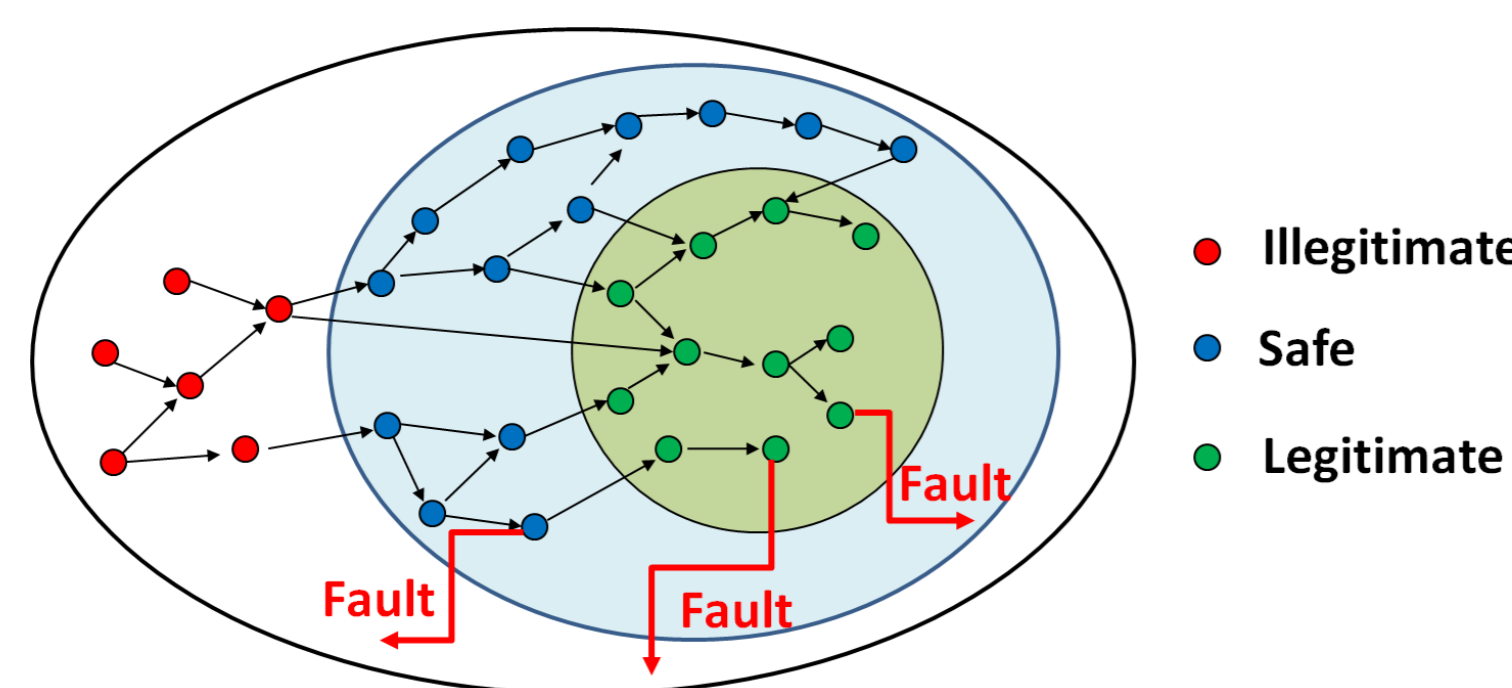


The behavior of self-stabilizing systems.

## Robust Self-Stabilization

### Objective:

- **Fast** convergence to a safe configuration.
- Once a safe configuration is reached, a minimum service is guaranteed.
- Convergence to a legitimate configuration preserving the minimum service.



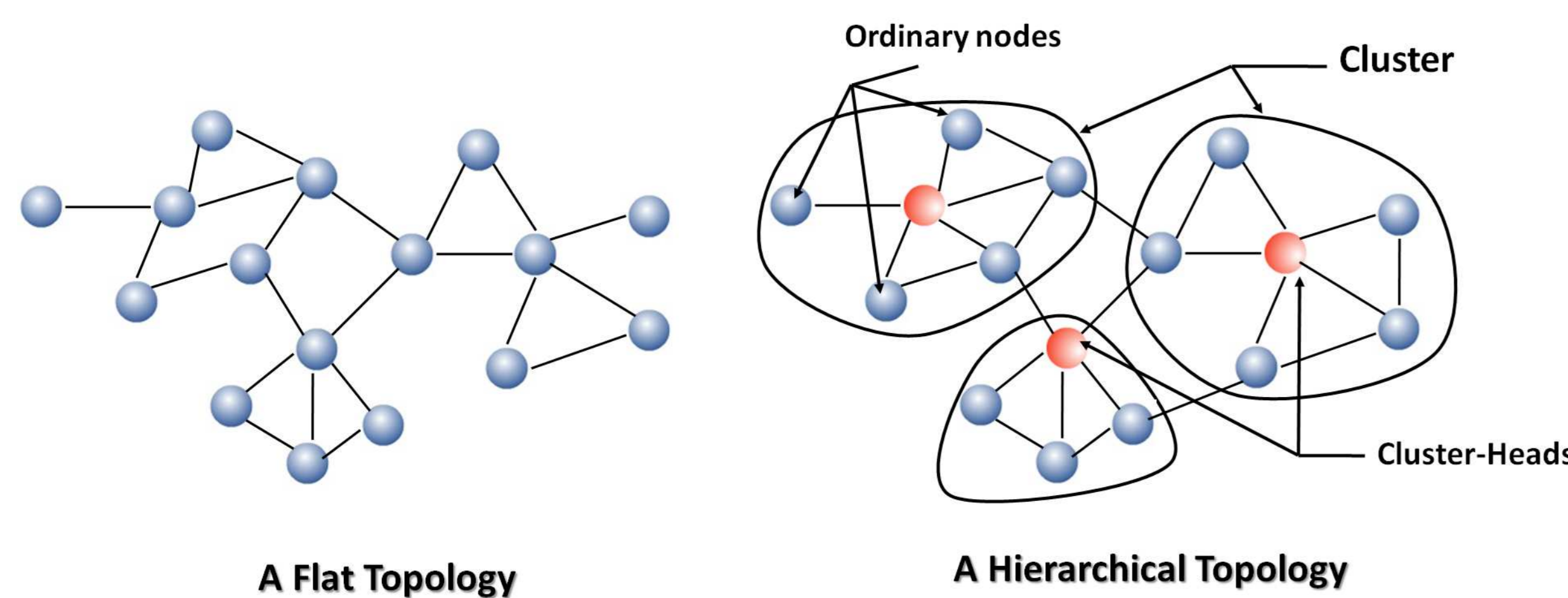
The behavior of robust self-stabilizing systems.

## Clustering in MANET

**Flat architecture of MANET** : All nodes are considered equal and take the same part in the routing and forwarding task.

**Limitation:** The flat architecture is **not scalable** on large scale network due to resource consumption (energy, and bandwidth), and communication overhead.

**Solution:** Providing a hierarchical organization over the network, as Internet and GSM. The organization must be dynamic to manage the mobility of nodes.  $\Rightarrow$  Clustering.



## Construction of weight based bounded clusters

### Why building weight based clusters ?

- Clusterheads have more tasks to ensure than ordinary nodes.
- Each clusterhead must be more suitable than its ordinary nodes.

The higher the weight of a node, the more suitable this node is for the role of clusterhead (memory and processing capacity + battery and transmission power + bandwidth ...)

### Why building bounded size clusters ?

- The clusterhead may not be able to handle all the traffic generated by nodes of a densely cluster.
- The power consumption of a clusterhead depends proportionally on the number of nodes of its cluster.

Controlling the number of nodes in a cluster will extend its clusterhead's lifetime (the stability of the cluster), and will ensure the load-balancing over the clusters.

### Weight based bounded size clustering properties:

- **Affiliation property:** each ordinary node affiliates with a neighboring clusterhead, such that the weight of its clusterhead is greater than its weight.
- **Size property:** each cluster contains at most *SizeBound* ordinary nodes.
- **Clusterheads neighboring property:** if a clusterhead *v* has a neighboring clusterhead *u* such that *u*'s weight > *v*'s weight, then the size of *u*'s cluster is *SizeBound*.

## Robust Self-Stabilizing construction of bounded size weight based clusters

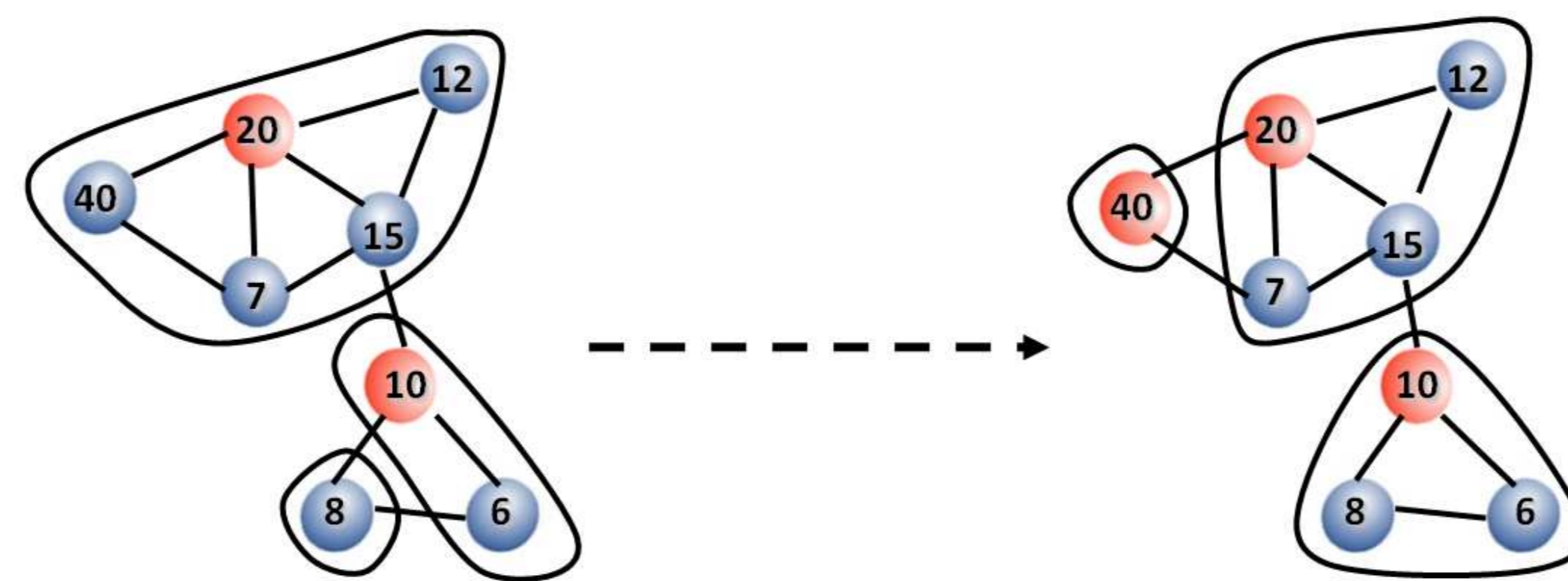
### Convergence to a safe configuration

A safe configuration is a configuration in which the minimum service is guaranteed.

### Minimum service :

1. Each node belongs to a cluster which has an effectual leader.
  2. Each Cluster has less than *SizeBound* members.
- The system converges to a safe configuration in at most **4 rounds** .

Clusterhead      Ordinary node      SizeBound = 3



Convergence to a safe configuration from an arbitrary one.

### Robustness under topology changes

The minimum service is preserved with respect to the following changes:

- the change on node's weight,
- the crash of an ordinary node,
- the failure of a link between (1) a clusterhead and a nearly ordinary node, (2) two clusterhead nodes,
- (3) two nearly ordinary nodes, or (4) two ordinary nodes,
- ...

### Convergence to a legitimate configuration

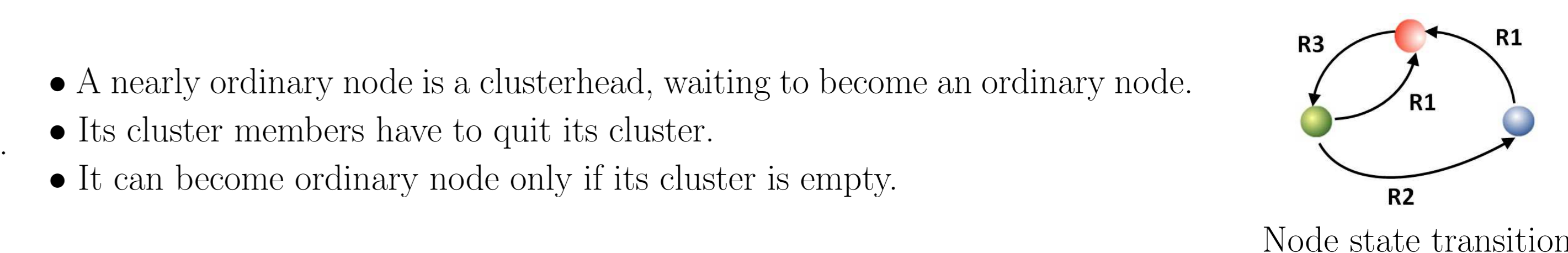
A legitimate configuration is a configuration in which the optimum service is guaranteed.

### Optimum service :

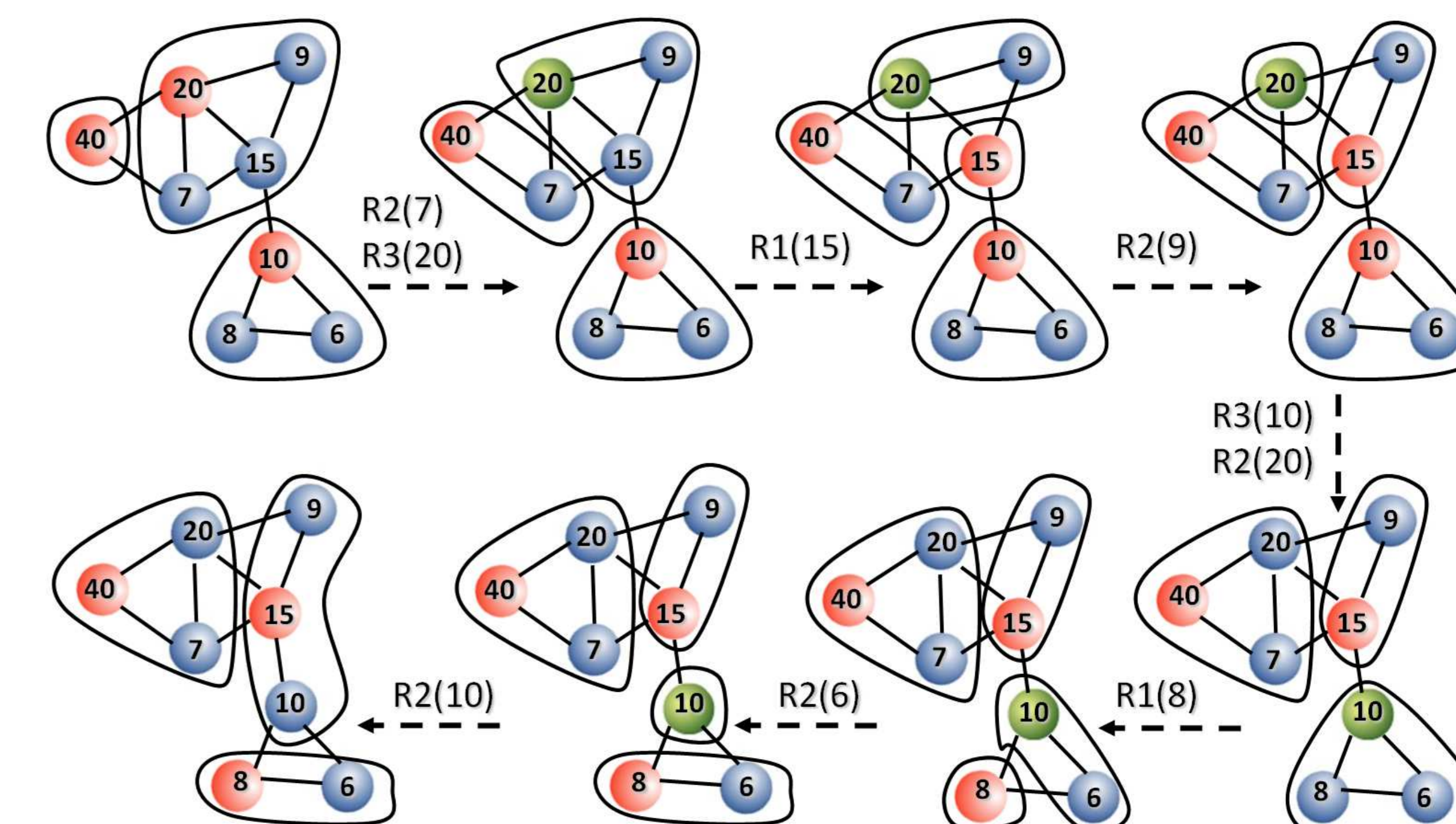
The network satisfies the **weight based bounded size clustering properties**.

- Starting from any configuration, and along any computation, a legitimate configuration is reached in at most  $\frac{7*|V|}{2} + 5$  rounds .

Clusterhead      Nearly ordinary node      Ordinary node  
R1: Election rule      R2: Affiliation rule      R3: Resignation rule



- A nearly ordinary node is a clusterhead, waiting to become an ordinary node.
- Its cluster members have to quit its cluster.
- It can become ordinary node only if its cluster is empty.



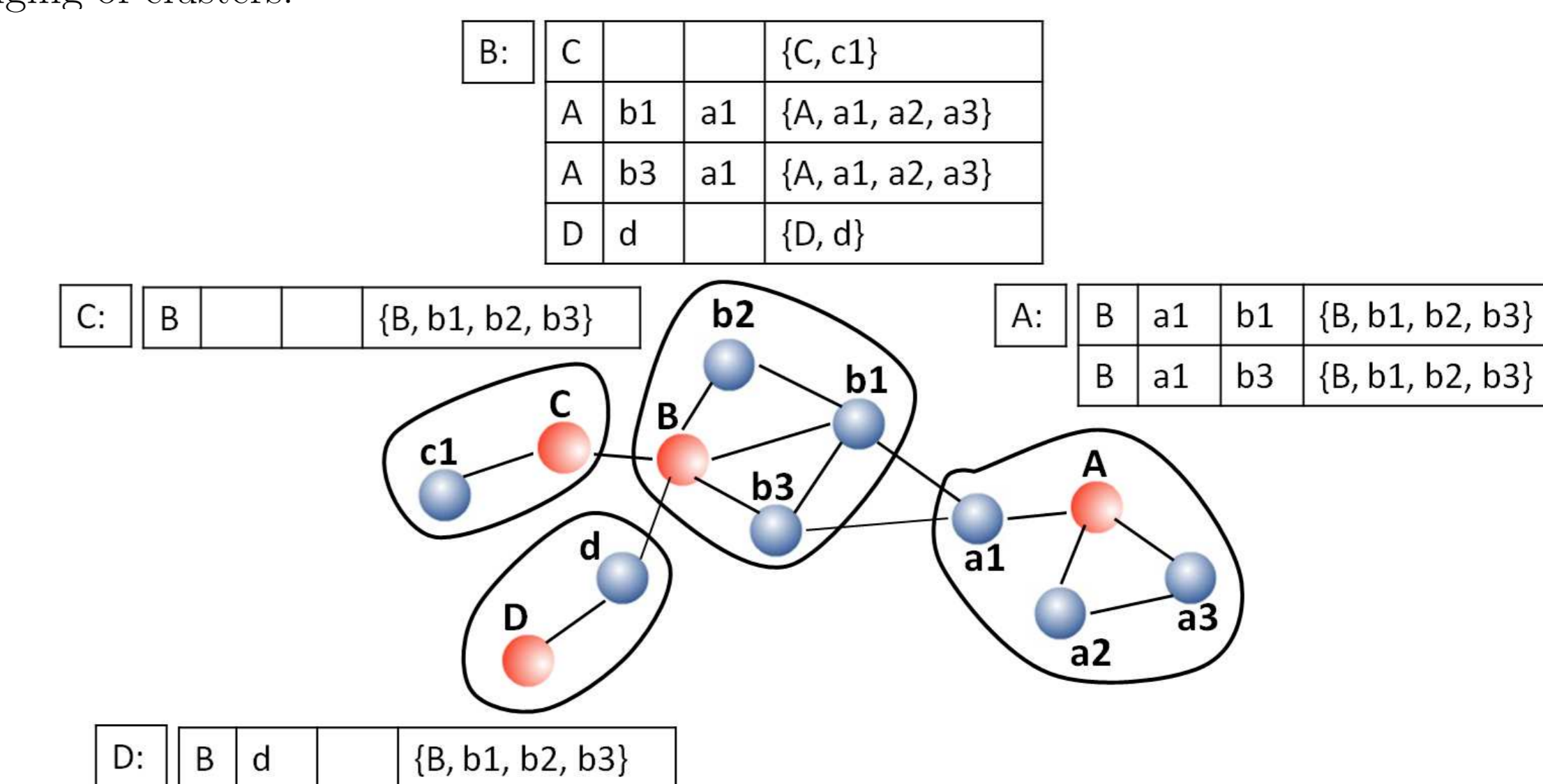
Convergence to a legitimate configuration.

## Futur project

- The design of a **Robust Self-Stabilizing hierarchical routing protocol**.

**First step :** Robust self-stabilizing local routing in clustered networks that handle, in a safe manner, the events :

- Election of new clusterheads,
- Resignation of clusterheads,
- Changing of clusters.



Robust self-stabilizing construction of local routing tables.