

Dynamic Allocation of Clustering Technique in Ad Hoc Wireless Networks



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Outline

- Motivation
- Related researches
- System model
- Dynamic allocation of clustering algorithm (DACA)
- Performance evaluations
- Conclusion



Motivation

- In highly dynamic topology ad hoc network, it is hard to manage
 - The DACA technique was proposed to predict moving directions of nodes and handoff to the proper cluster dynamically in highly dynamic network topology
- Clustering techniques
 - Reducing routing table size
 - Reducing the communication overhead
 - Stabilizing network topology
 - Be ease of location management
 - Providing a simple and feasible power control mechanism



Related researches

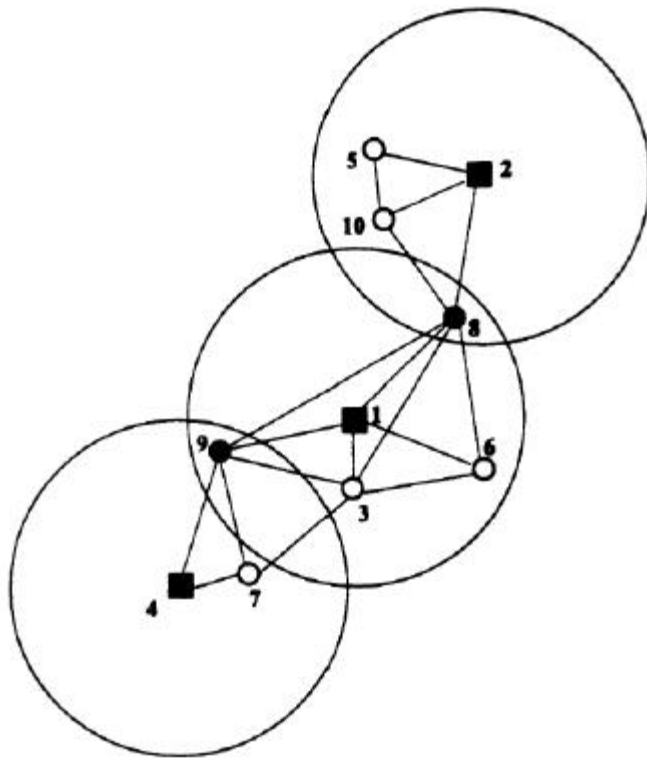
- Cluster-head election algorithm
 - Lowest-ID cluster algorithm
 - highest-connectivity (degree) algorithm
- Existing clustering algorithm
 - Power control
 - A clustering technique for large multihop mobile wireless networks



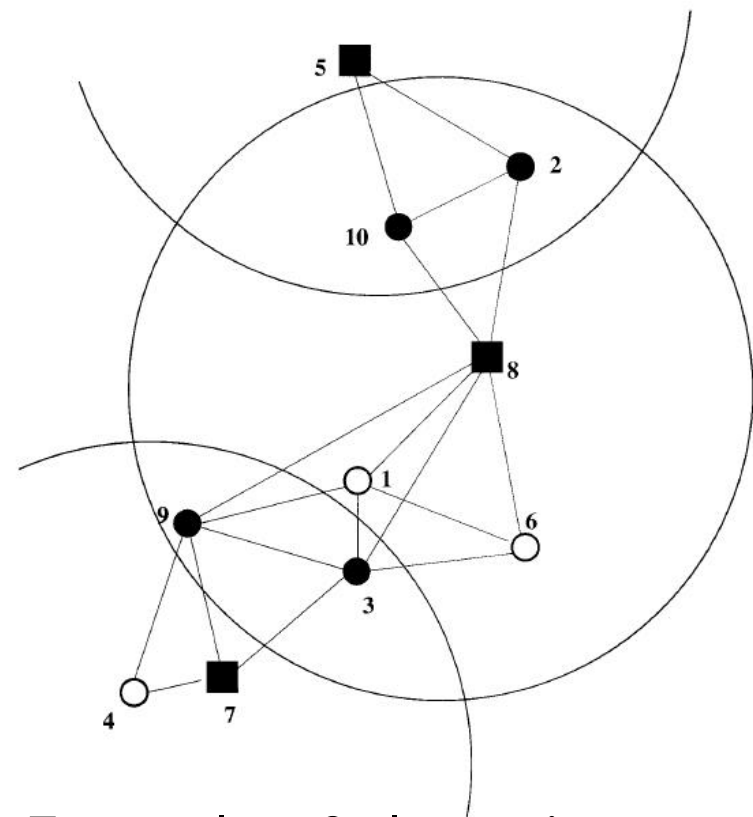
Cluster-head election algorithm

- Lowest-ID and highest-connectivity (degree) algorithm
- The major drawback is assumption for the clustering setup is that the node do not move while the cluster formation is in progress.

Cluster-head election algorithm(Cont.)



Example of clustering formation (lowest-ID)



Example of clustering formation (highest-degree)

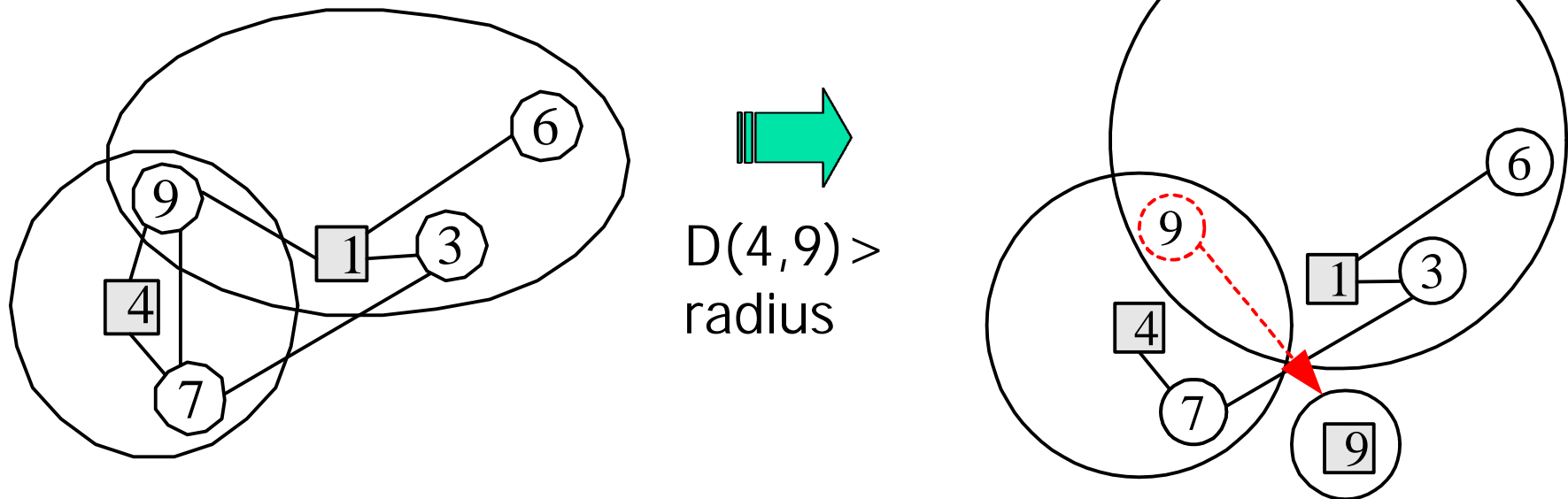


Clustering with power control

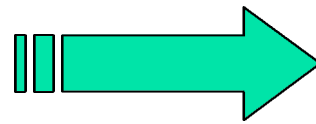
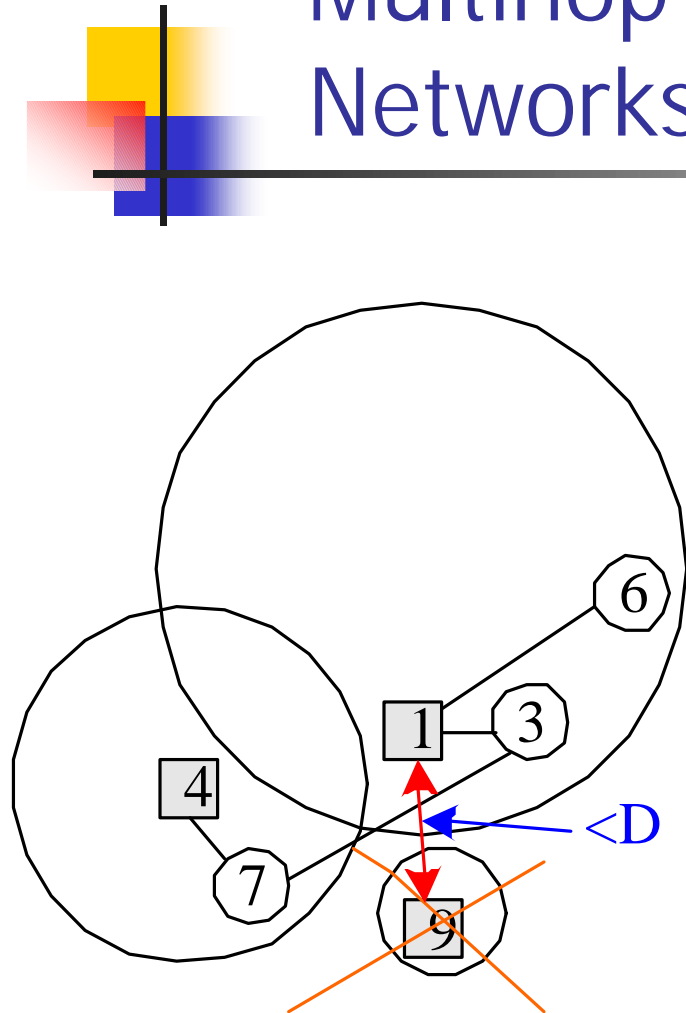
- Reducing impacts of mobility
- Adaptive transmission power on the performance
- power economy
- Creating several clusters of small sizes so that can expect better channel utilization and provide better service by increasing/decreasing pilot transmission power of the cluster-head

A Clustering Technique for Large Multi-hop Mobile Wireless Networks

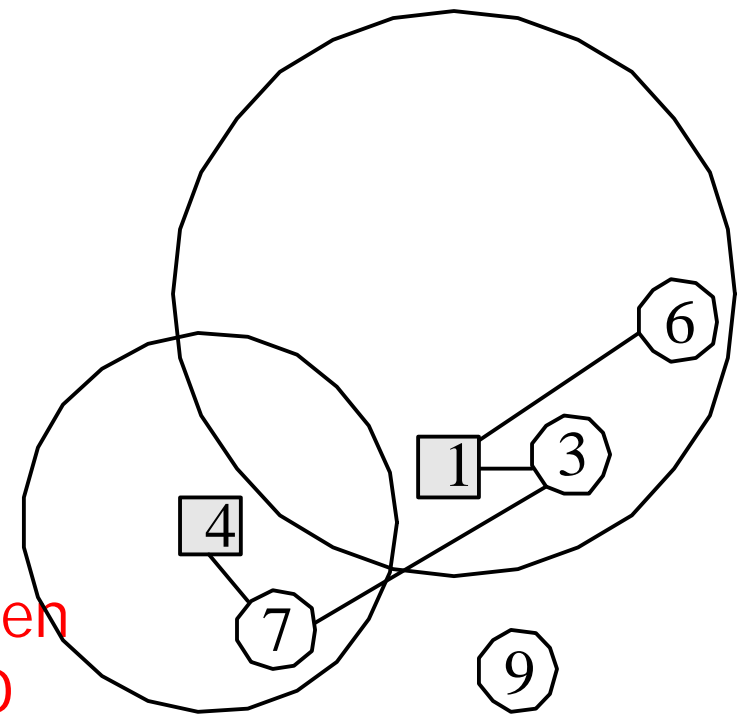
- Using hop distance to control cluster structure instead of number of nodes in cluster



A Clustering Technique for Large Multihop Mobile Wireless Networks(Cont.)



Distance between
CH 4 and 9 < D



Cluster(9)
Dismiss



System Model

- Notions description and Definitions
- Assumptions

Notions description and Definition

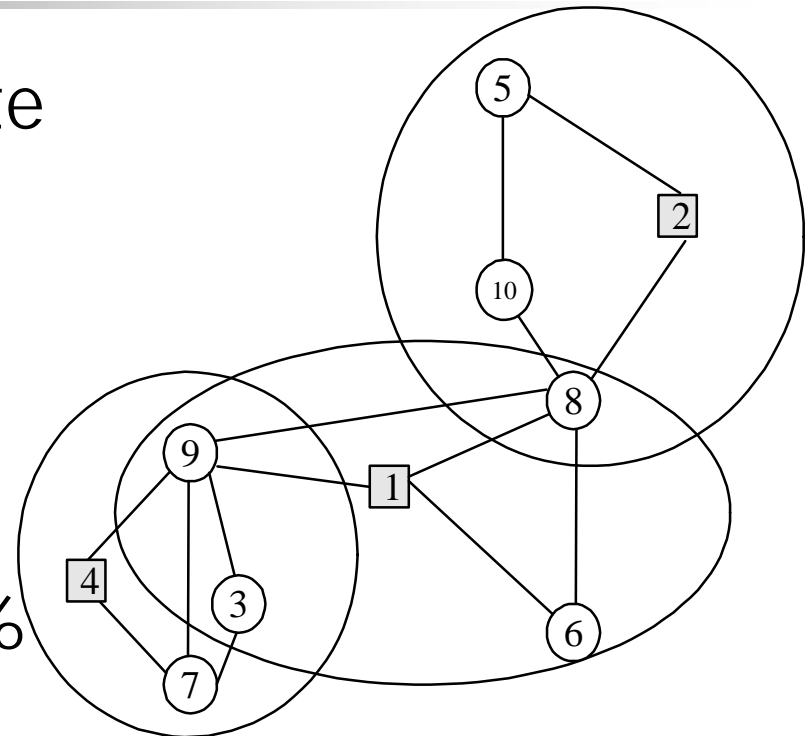
- The node role and state

- CH:1,2,4
- GW:8,9
- ORN:3,5,7,10
- OL:3,8,9
- NOL:1,2,4,5,7,10

- $OL_PERCENT(4) = 50\%$

- $LC = (x,y)$ by GPS

- The distance between two nodes u and v denoted as $D(u,v)$





Assumptions

- Each node know its own unique ID , the location coordinates by GPS, the role and all information of neighbors
- The information of a node include four fields: the ID of the node, the role of the node, the coordinate of the cluster and the overlapping state of node [ID, O_u , (x,y) , OL/NOL]
- we assume that a message sent by a node is received correctly within a finite time by all its neighbors



Assumptions(Cont.)

- Each node is aware of the presence of a new link or failure of a link when a neighbor node moves into or out of its transmission range
- The procedures of the clustering algorithm are not interruptible



Dynamic allocation of clustering algorithm, DACA

- Setup
- Maintenance
 - Node changes location
 - Cluster-head failure
 - Cluster overlapping



Cluster Setup

- If there is at least one neighbor of the node, then it sends it node information, [ID, ORN, (x,y), NOL] to all of neighbors
- The cluster-head is elected by lowest-ID or highest-connectivity algorithm
- Node forms a new cluster with itself as the cluster-head and sets it node information to be [ID, CH, (x,y), NOL]
 - it has no neighboring node
 - All neighboring nodes with lower ID belong to other cluster



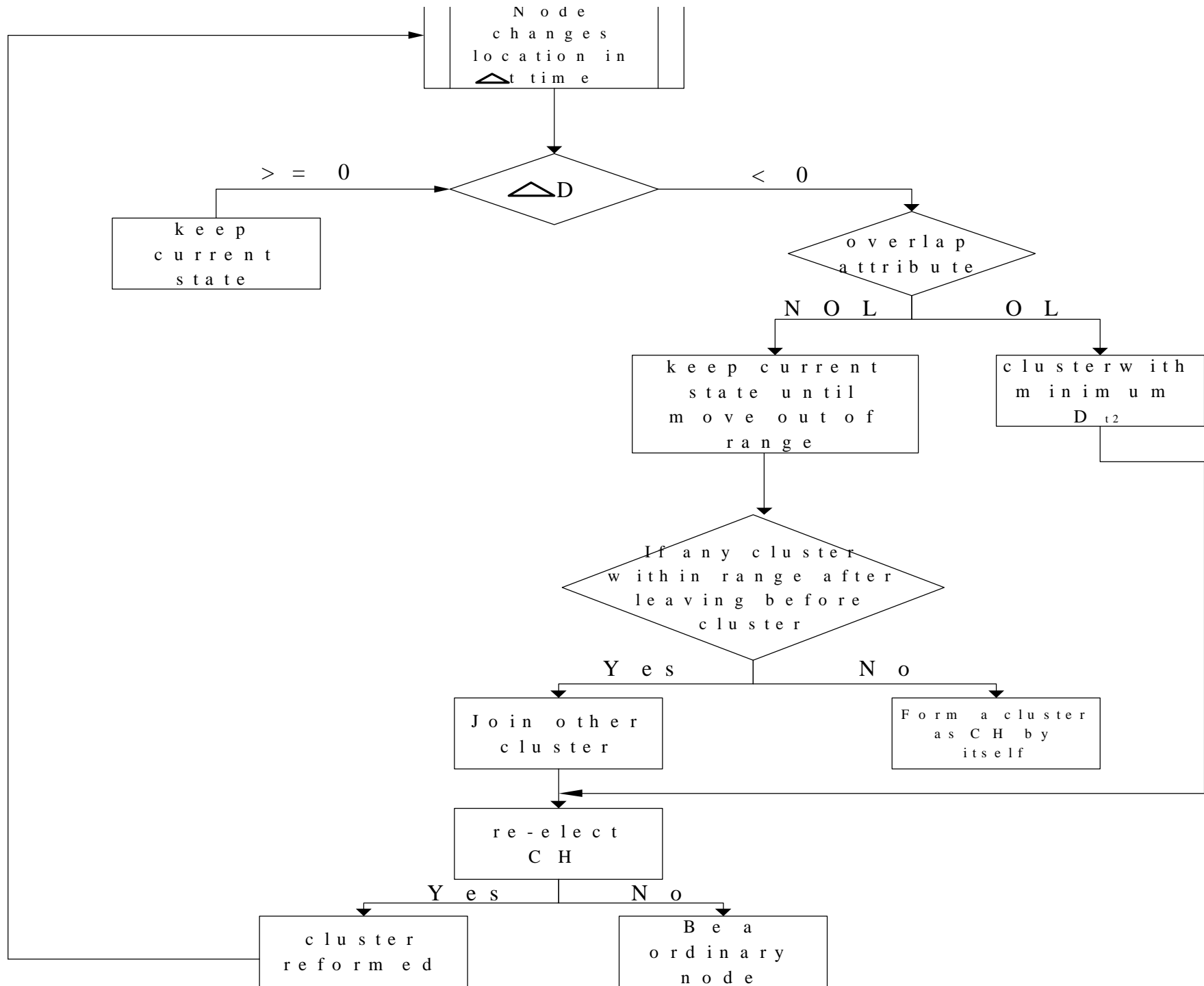
Cluster Maintenance

- Node changes location
- Cluster-head failure
- Cluster overlapping



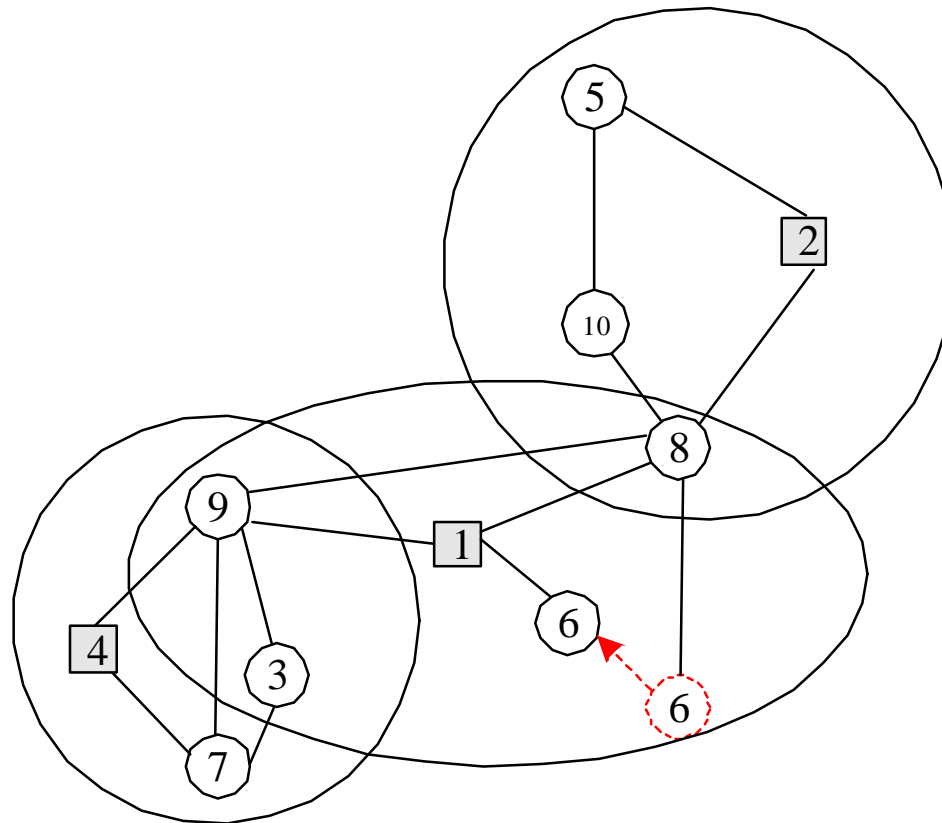
Nodes changes location

- Step1: After node moving, check the $\Delta D = D_{t_1} - D_{t_2}$ between the CH
- Step2: if ΔD is negative then proceed step4; otherwise proceed step3
- Step3: node keep current state, belong to the cluster as before
- Step4: check the node overlapping attribute, if it is a OL, handoff to other cluster which within transmission range and with minimum D_{t_2} ; otherwise, it belong cluster as before until out of transmission range to join other cluster or form a cluster as cluster-head by itself.



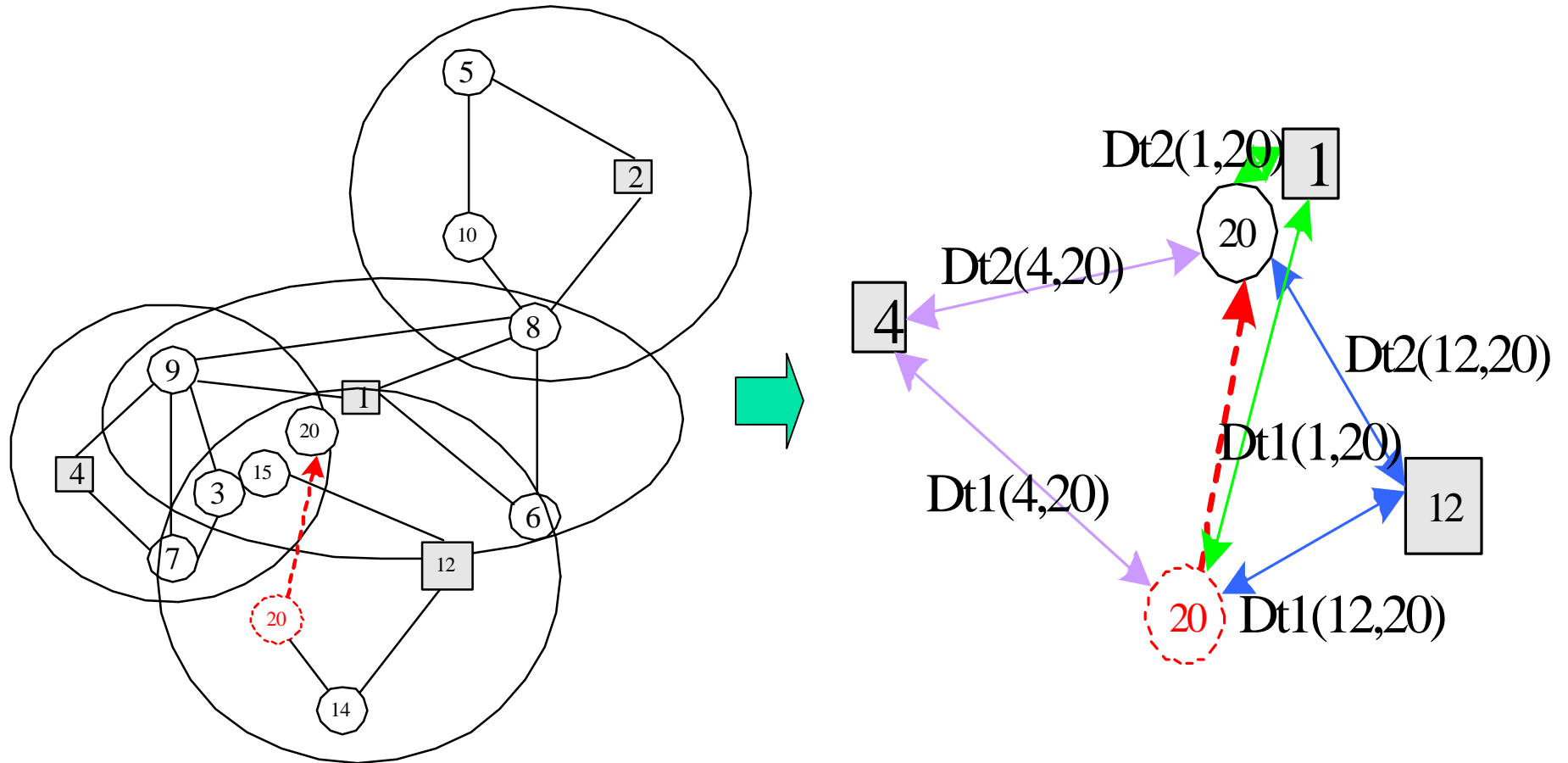
Node changes location example

- After changing location, node keeps current state

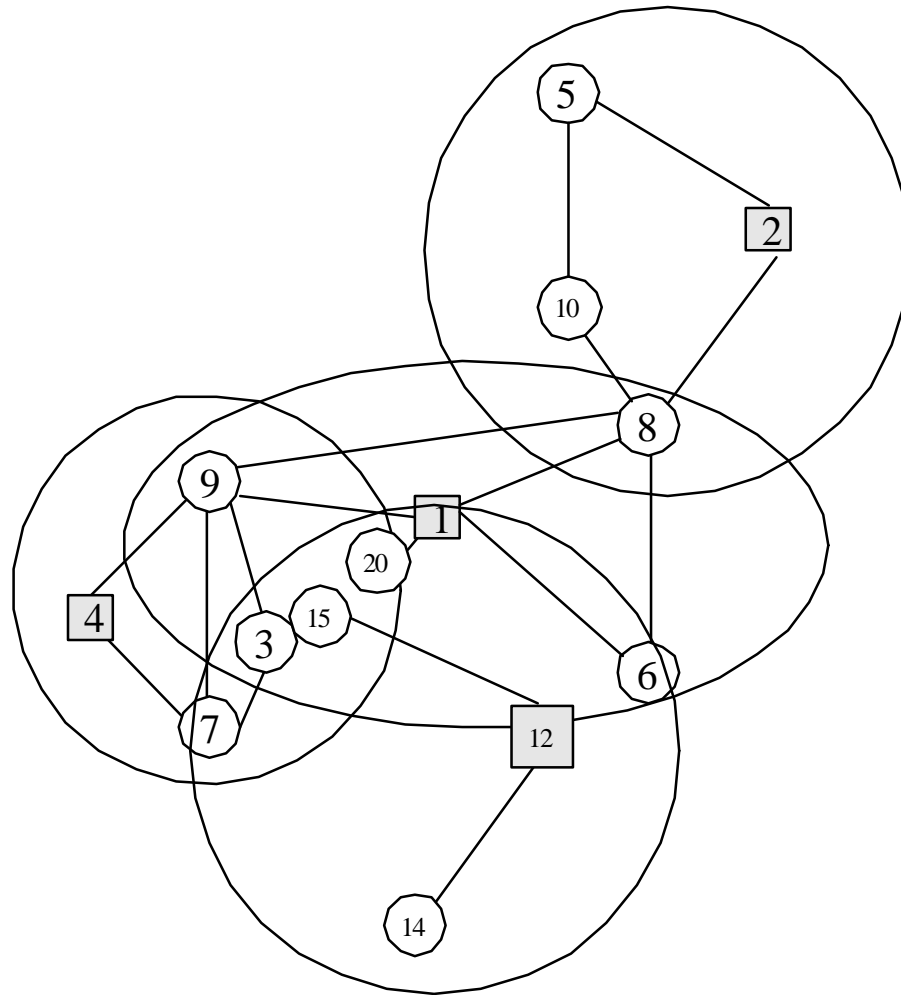


Maintenance Example(Cont.)

- Node handoff to other cluster

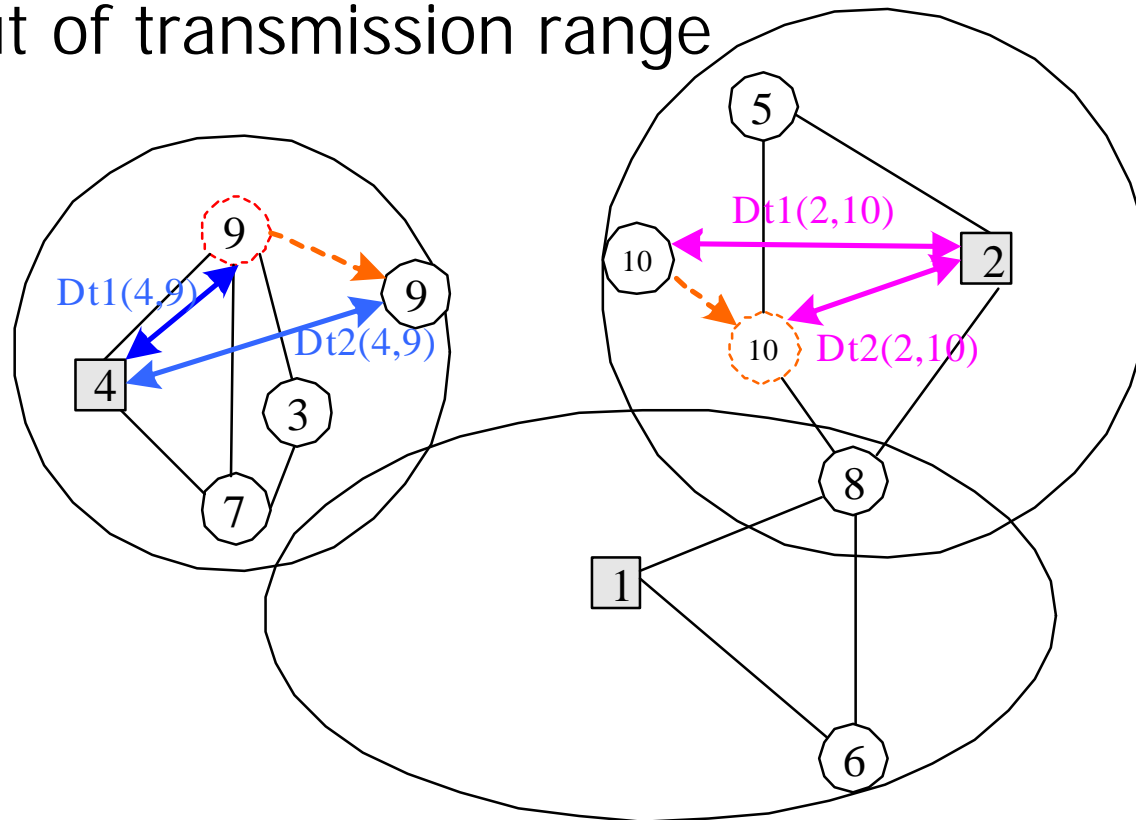


Maintenance Example(Cont.)



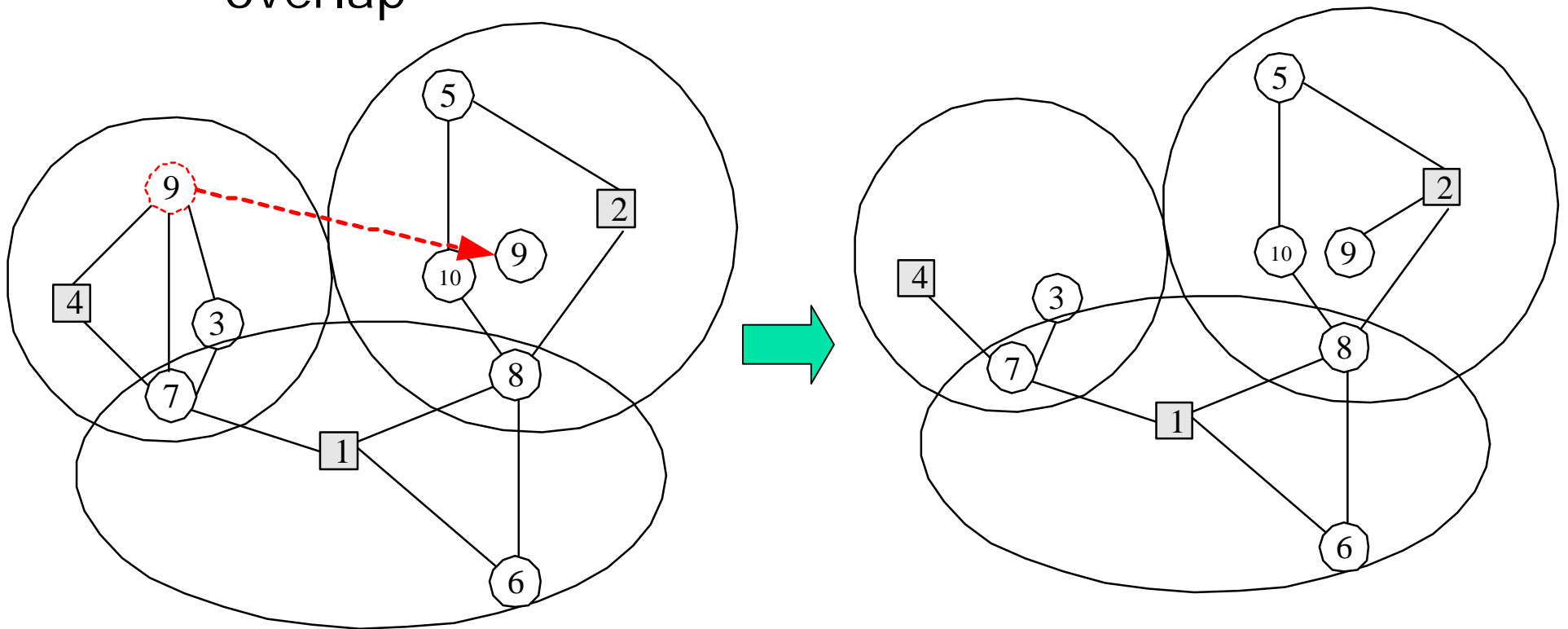
Maintenance Example(Cont.)

- Node changes location and overlapping attribute is NOL, so belongs cluster as before until moves out of transmission range



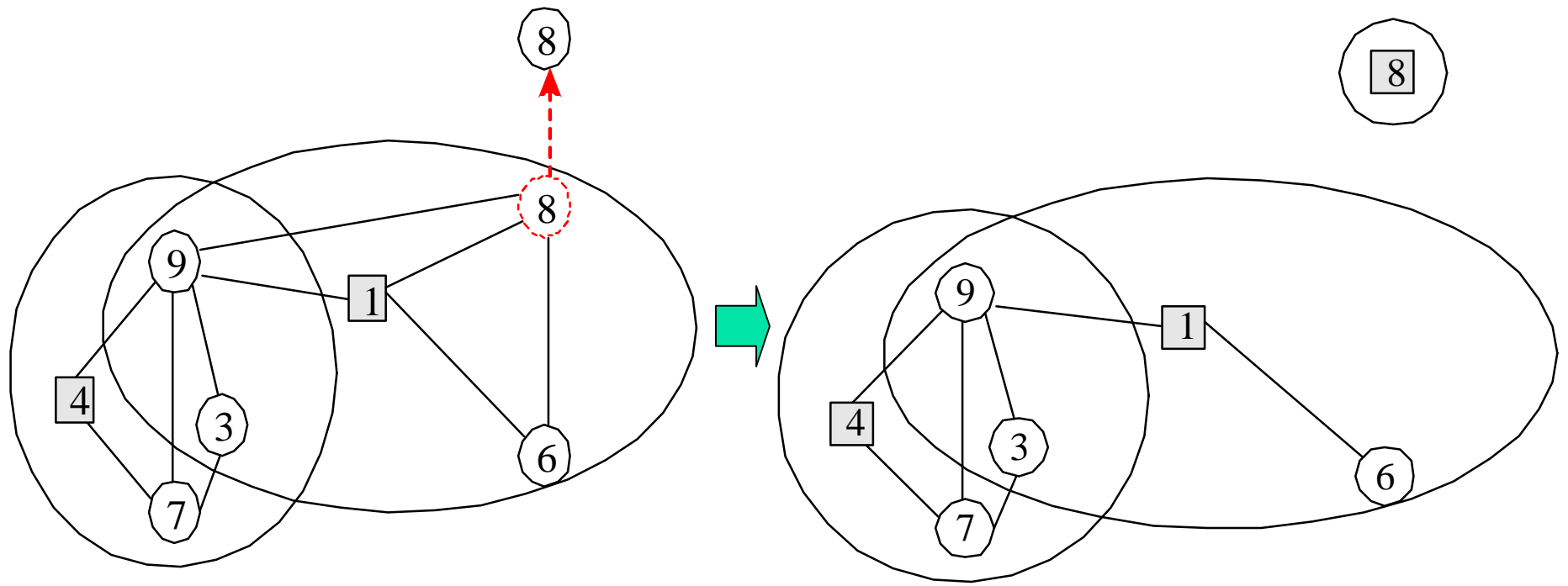
Maintenance Example(Cont.)

- Node handoff to another cluster which non-overlap



Maintenance Example(Cont.)

- Node handoff and forms a cluster by itself



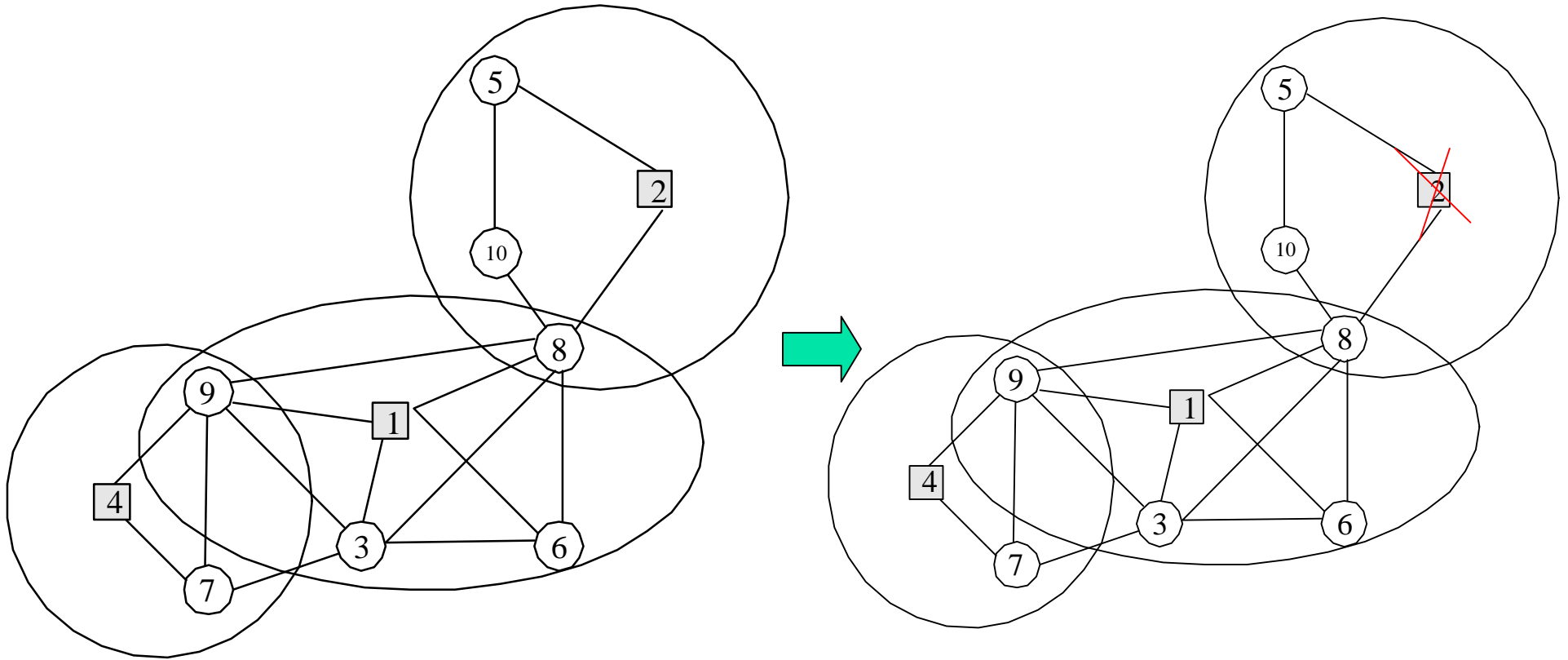


Cluster Maintenance(Cont.)

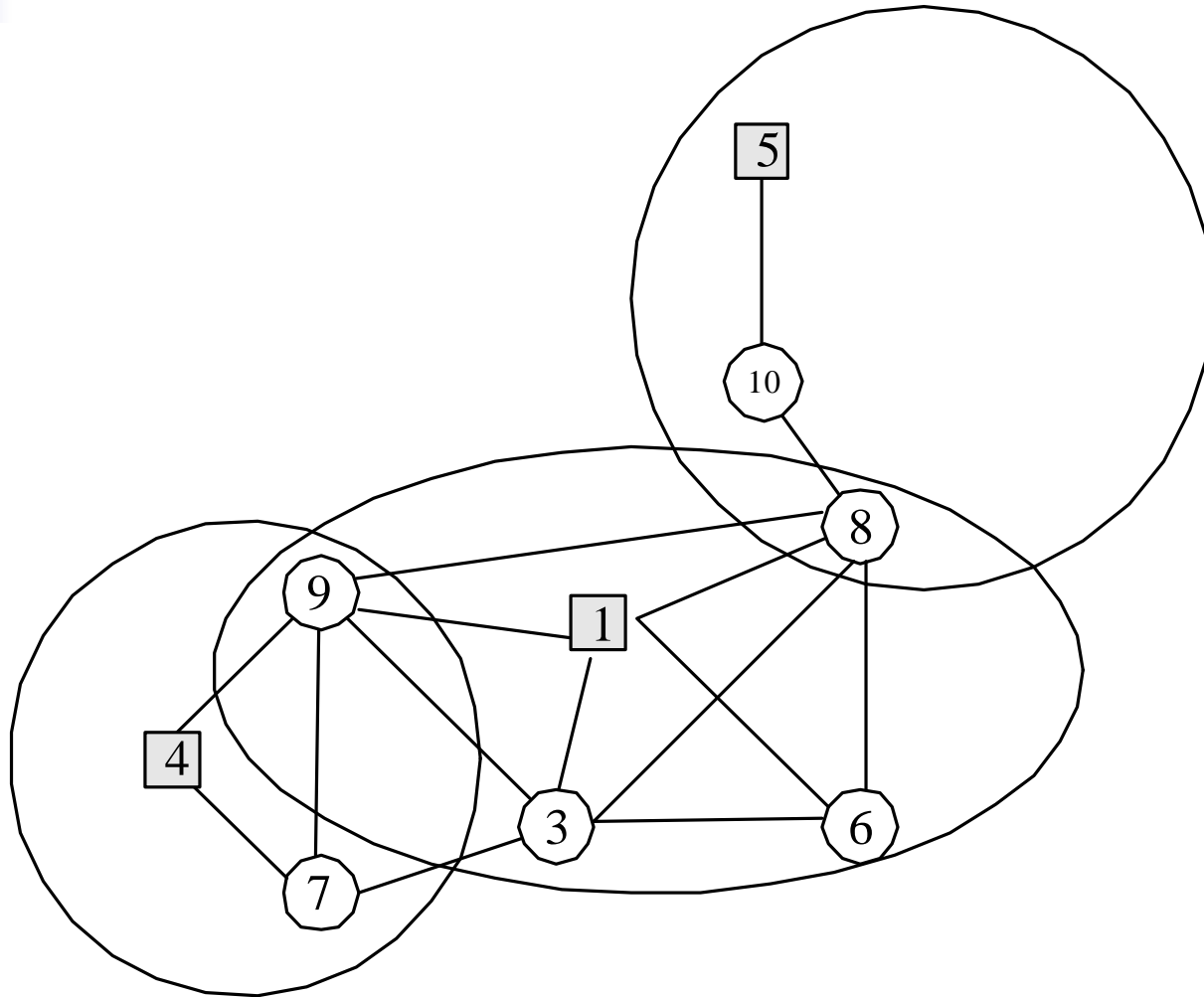
- Cluster-head failure
 - If cluster-head failure, the cluster node belongs that cluster have to determine new cluster-head or join other cluster
 - Re-elect CH by lowest ID or highest-connectivity
 - Adjust cluster by procedure `change_location`

Cluster Maintenance(Cont.)

- Cluster-head failure



Cluster Maintenance(Cont.)



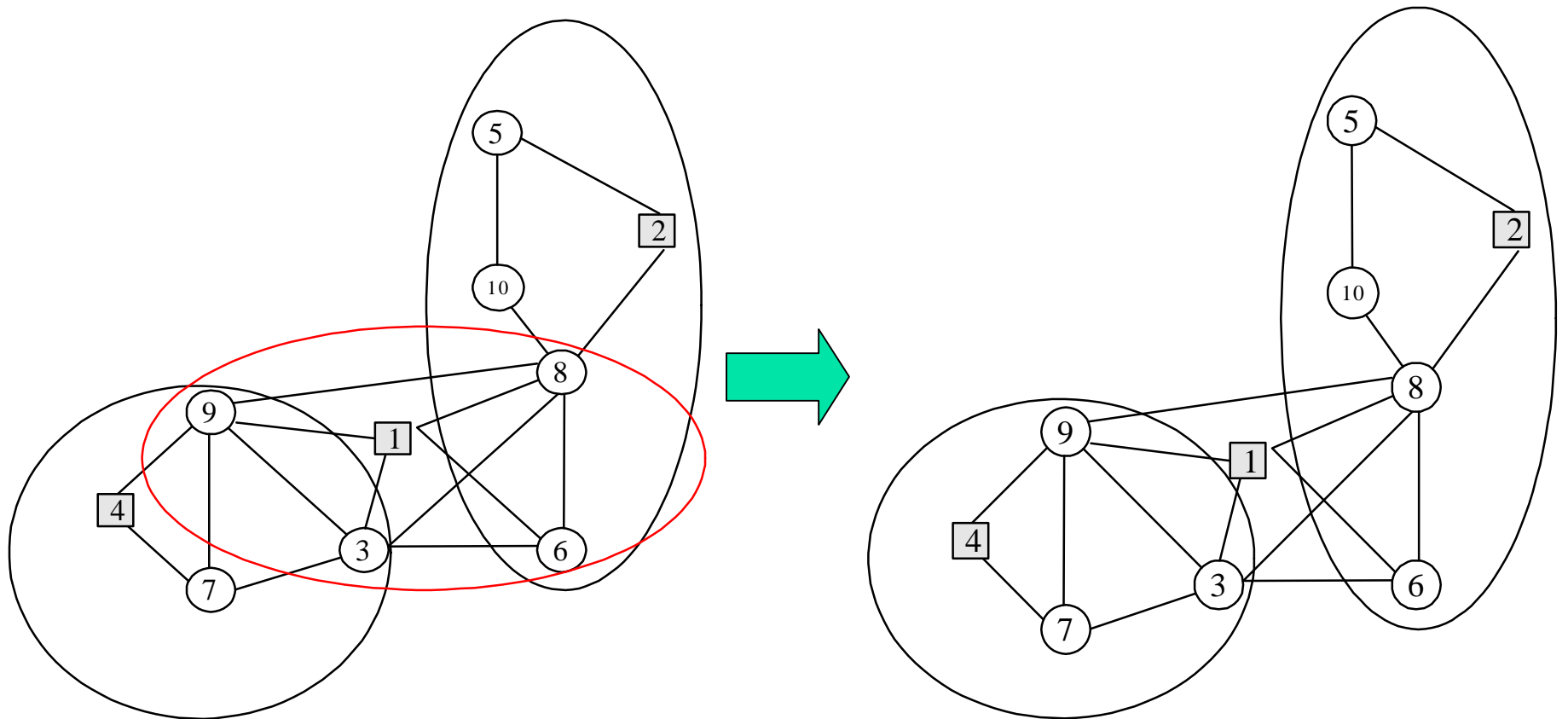


Cluster Maintenance(Cont.)

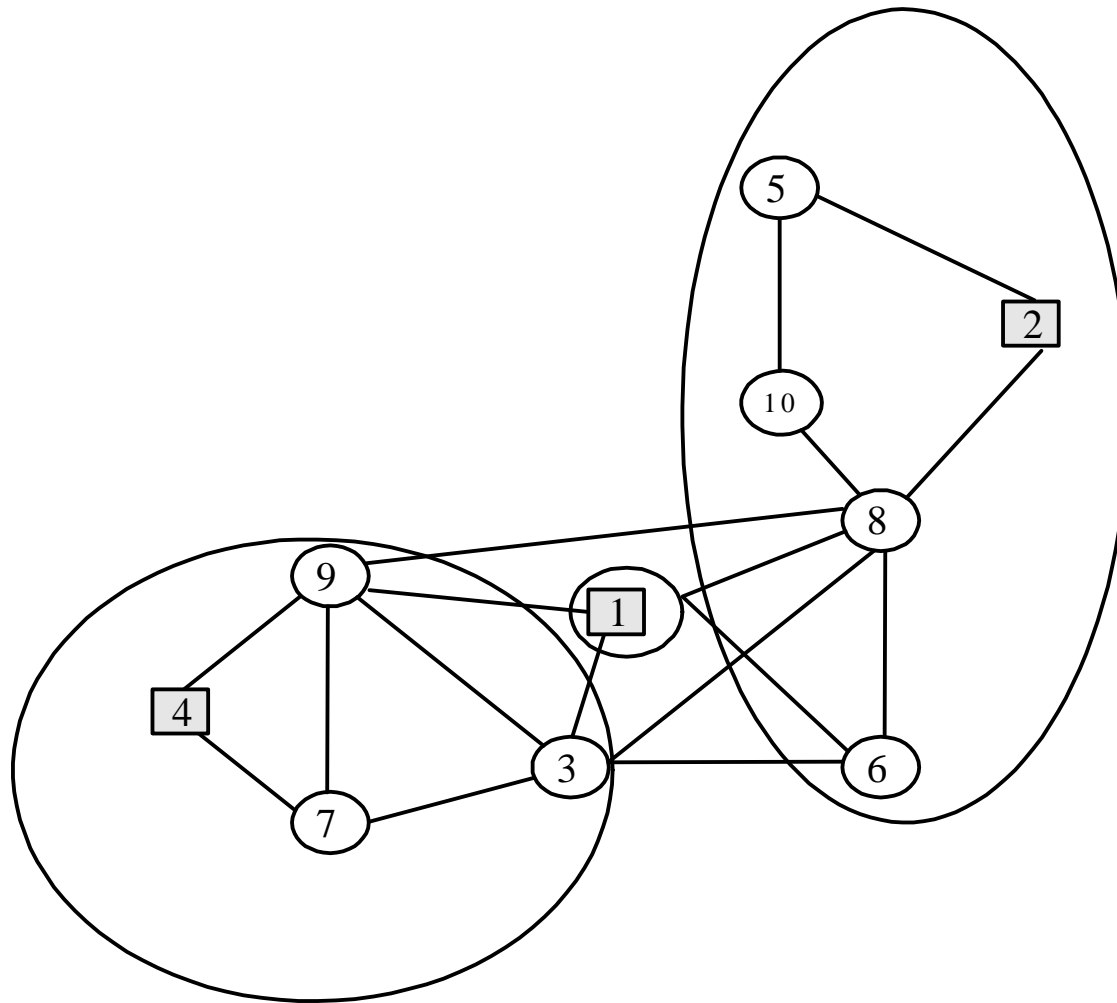
- Cluster overlapping
 - Overlap percentage is higher than threshold
 - the cluster overlap with higher ID or lower degree must be dismissed and have to be reformed
 - the nodes belongs the dismissed cluster have to join other cluster or form a cluster by itself

Cluster Maintenance(Cont.)

- Cluster overlapping



Cluster Maintenance(Cont.)





Simulation

- Simulation environment
- Performance evaluations



Simulation environment

- The network used in our simulation consists of 50, 100, 150 and 200 mobile nodes moving in constant speed in a square with 1km on each side.
- Transmission ranges (TR)
 - 50m, 100m, 150m, and 200m.
- Moving speeds
 - 1m/s, 5m/s, 10m/s, 20m/s, 30m/s, 40m/s and 50m/s.
- The nodes are initially randomly placed in the area.



Performance evaluations

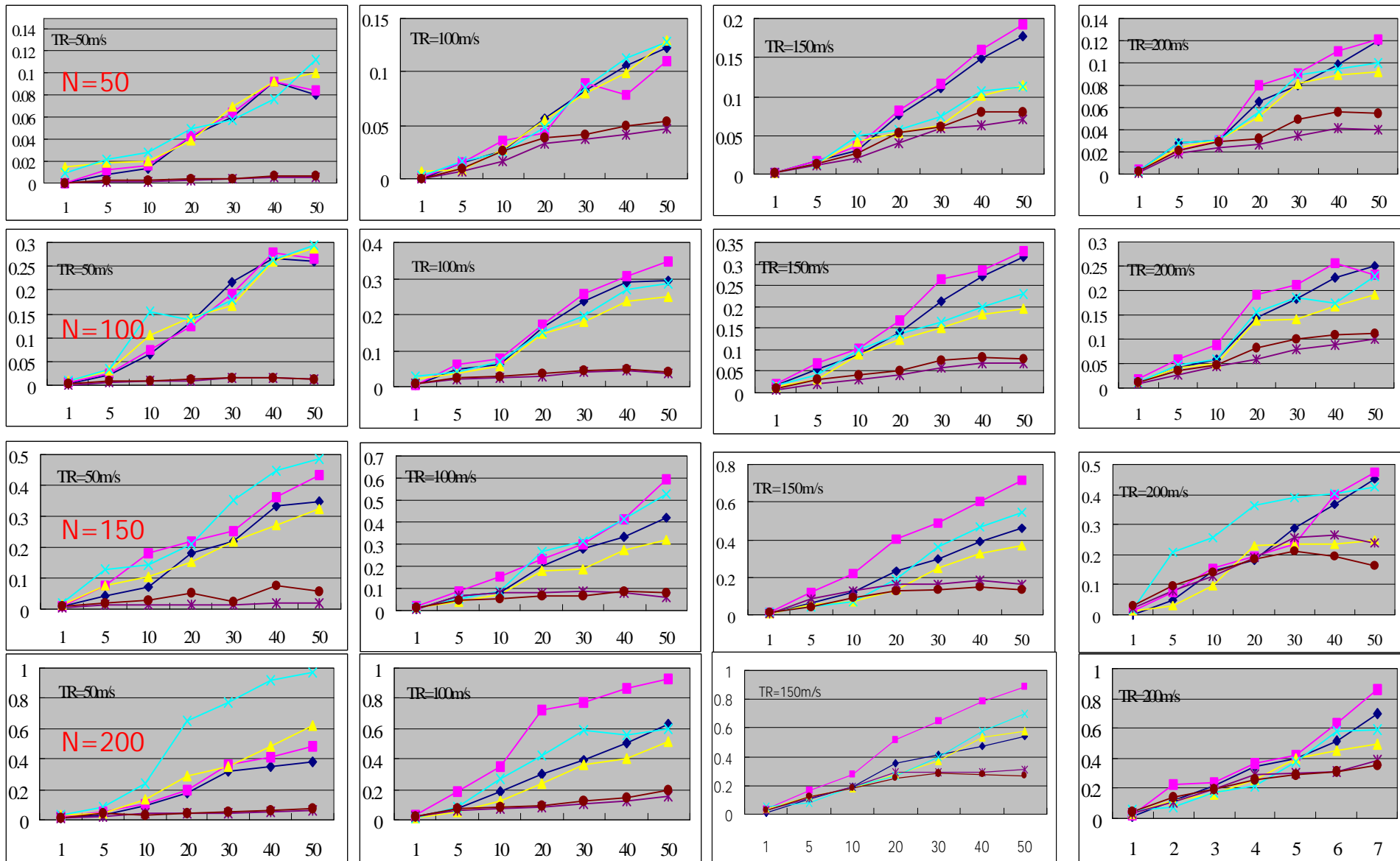
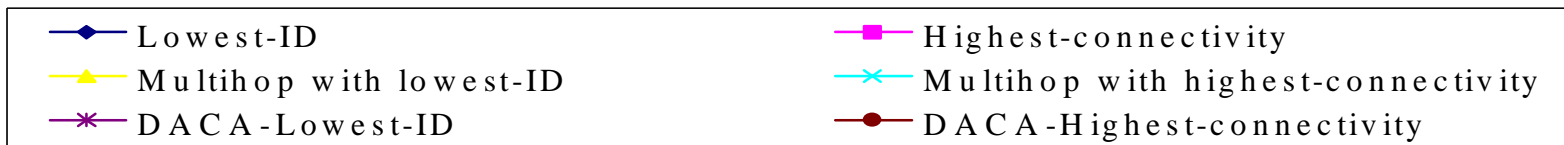
- The dropping probability of cluster-head
 - The dropping number of cluster-head per time for the clustering techniques with different various transmission ranges, the number of nodes and mobility speeds
- Network topology stability
 - The probability of nodes, which change their roles
 - The probability of nodes which change clusters (handoff)



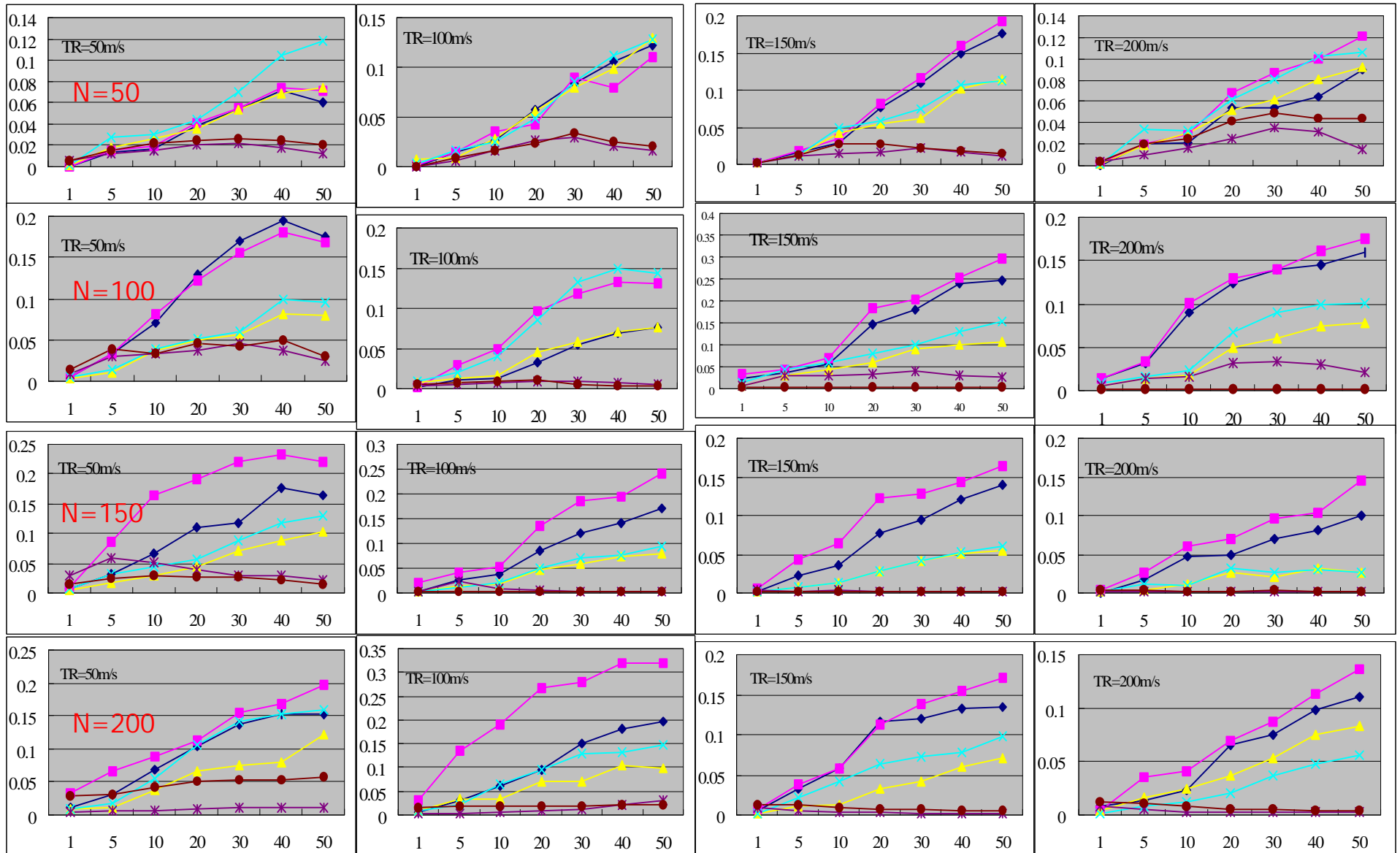
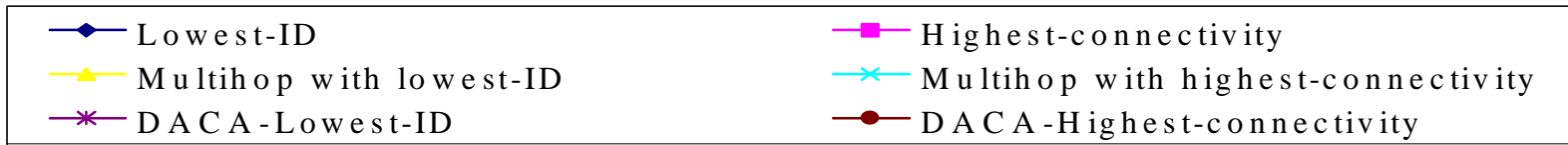
Performance evaluations(Cont.)

- The probability of cluster reform
 - When the cluster is dismissed or the nodes belong to the dismissed cluster have to join to a new cluster or form a new cluster by itself
- Power level
 - With the same number of nodes, transmission range and mobility speed, the smaller size of cluster and the smaller power level to consume. The smaller power level to transmit, the more efficient of power saving mechanism.
- The threshold of cluster overlap percentage
 - Comparing the effects of mobility speeds on the overlap percentage threshold of cluster

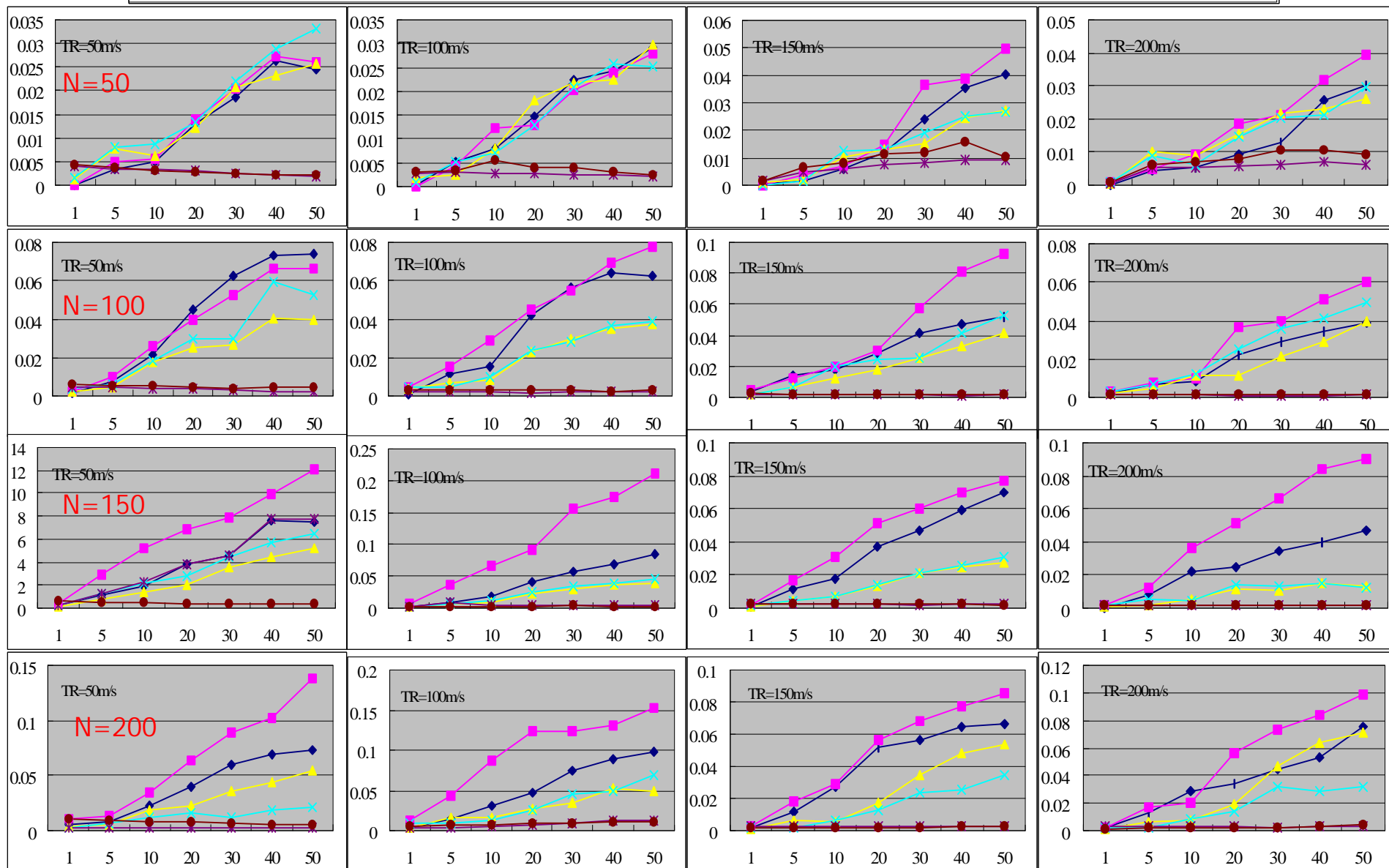
Dropping probability of Cluster-head



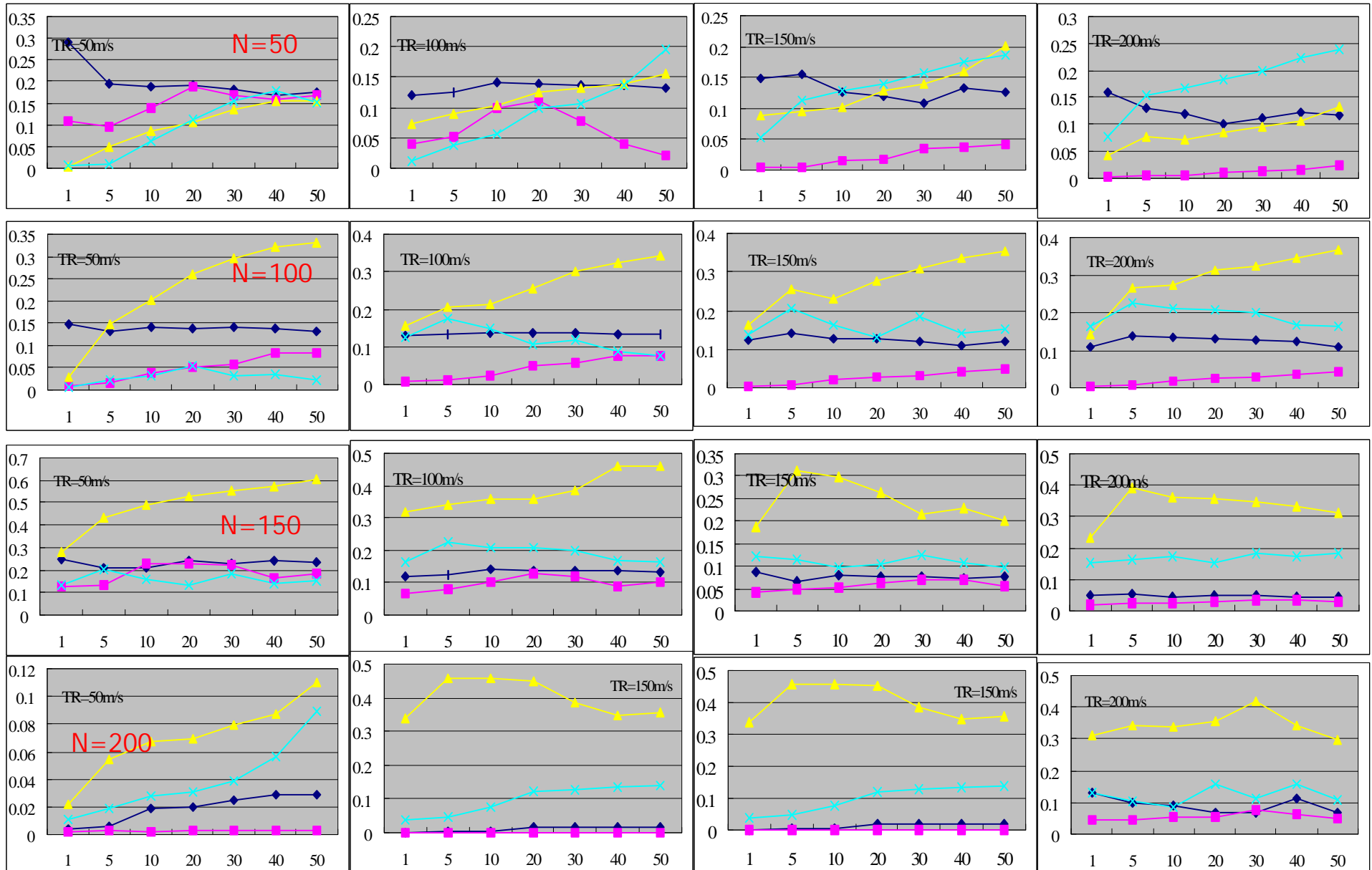
Network topology stability (probability of nodes, which change their roles)



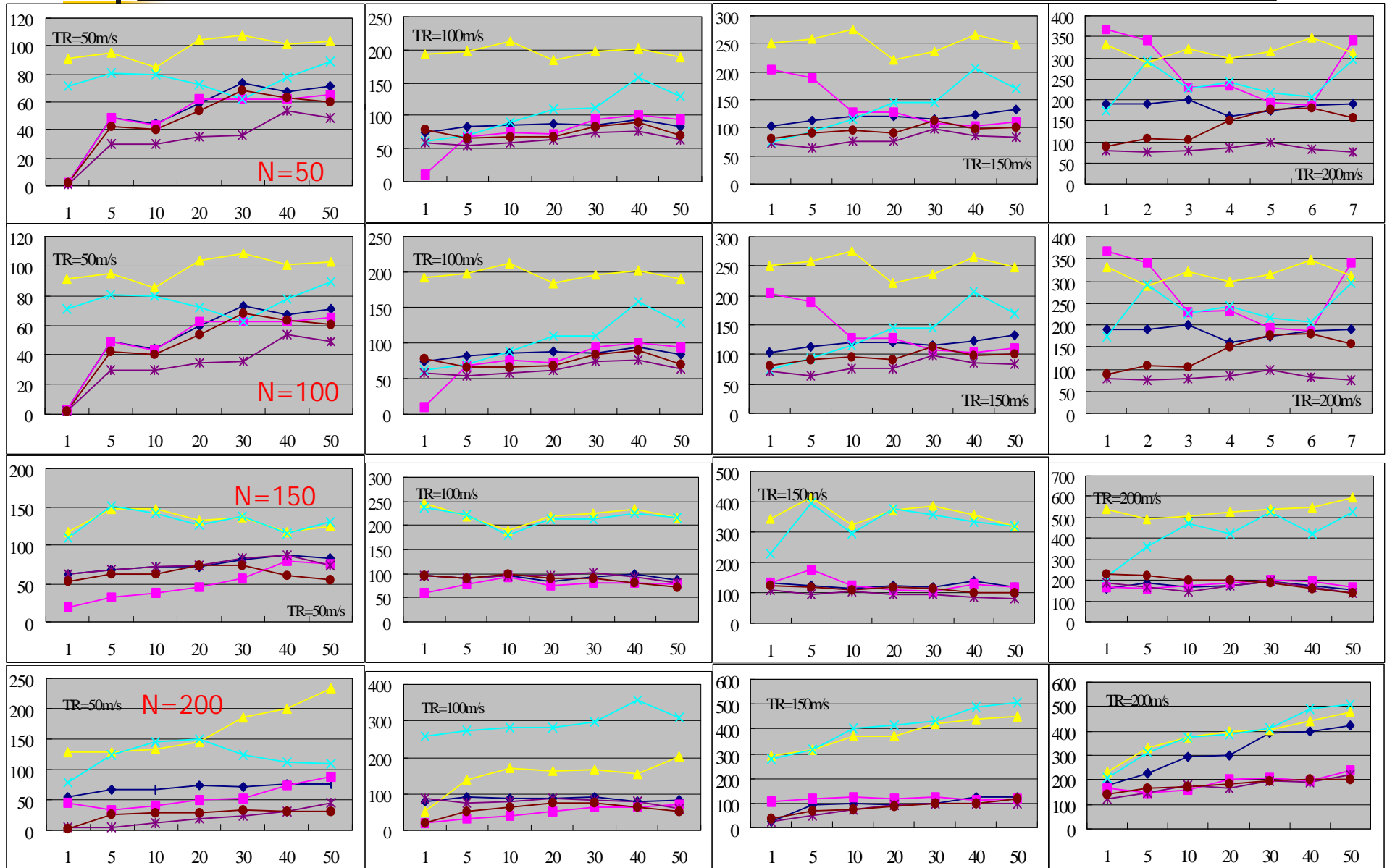
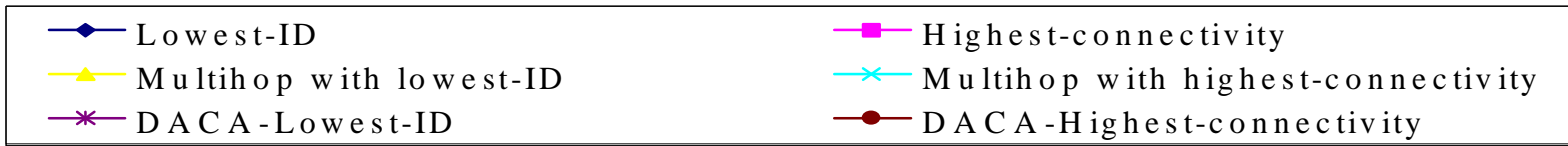
Network topology stability (probability of nodes handoff)



The probability of cluster reform



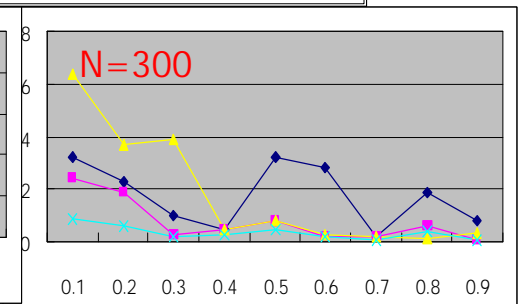
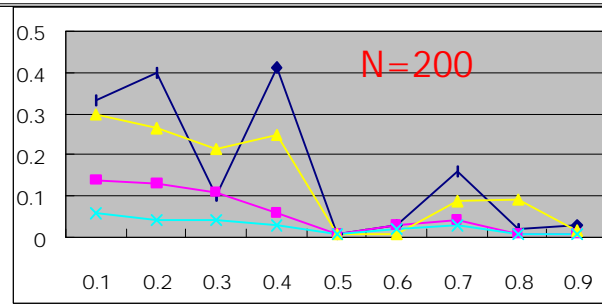
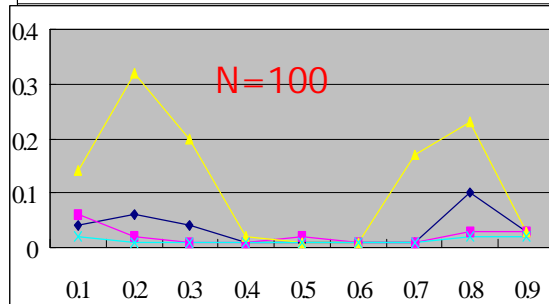
Power saving mechanism



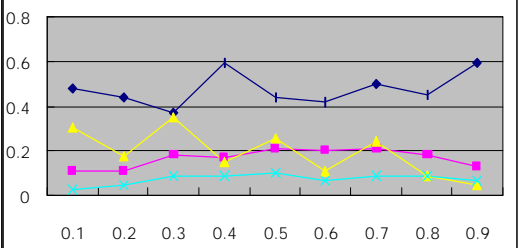
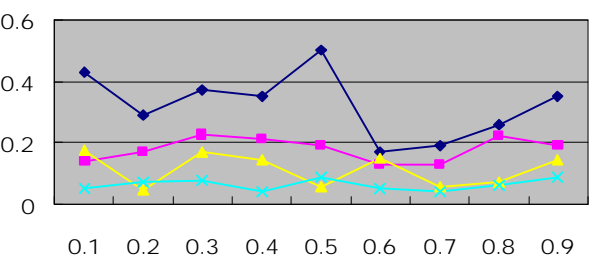
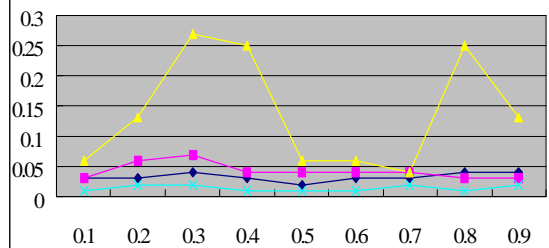
The threshold of cluster overlap percentage

- ◆ the dropping probability of cluster-head
- the probability of nodes, which change their roles
- ▲ the probability of cluster reform
- ✕ the probability of node, which change cluster (handoff)

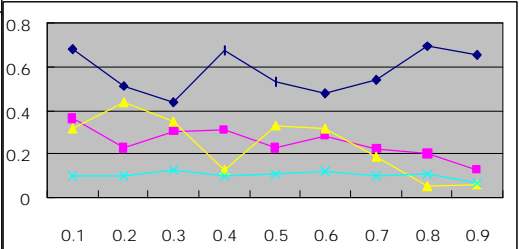
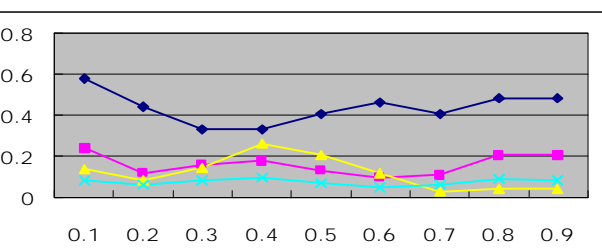
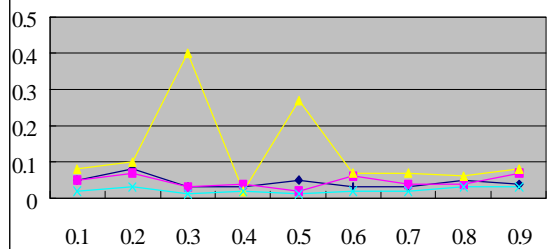
Mobility speed
=1m/s



Mobility speed
=10m/s



Mobility speed
=30m/s





Conclusion

- An objective of the research was to propose a novel DACA technique to cluster mobile nodes and validate better performance than the existing clustering techniques
- Contribution
 - To achieve significant system performance in highly dynamic network topology while dealing with clustering nodes process
- Reducing the dropping probability of cluster-head



Conclusion (Cont.)

- Stabilizing network topology
 - Increasing stability of the cluster structure in terms of the probability of nodes that change their roles, the probability of nodes that change clusters (handoff)
- Providing simple power saving mechanism of cluster structure
- In the future, we also can further investigate the related works based on the well-developed DACA technique