A Framework for Reliable Routing in Mobile ad Hoc Network

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Outline

- Introduction
- AODVM routing
- Performance of AODVM
- A framework for reliable routing
- Performance evaluation of R-node deployment strategies
- Conclusions

Introduction

- Node failures :

  Harsh fading channel

  Power constrained (Battery drain)

  Node carried by pedestrains

- Design a *multipath routing* framework for providing enhanced robustness to node failures

Introduction

- We choose *AODV* as a candidate protocol and make modification to it , to facilitate the discovery of *node disjoint paths* from source to destination.

- Node disjoint

  Node disjoint path do not have any nodes in common , except the source and destination

Introduction

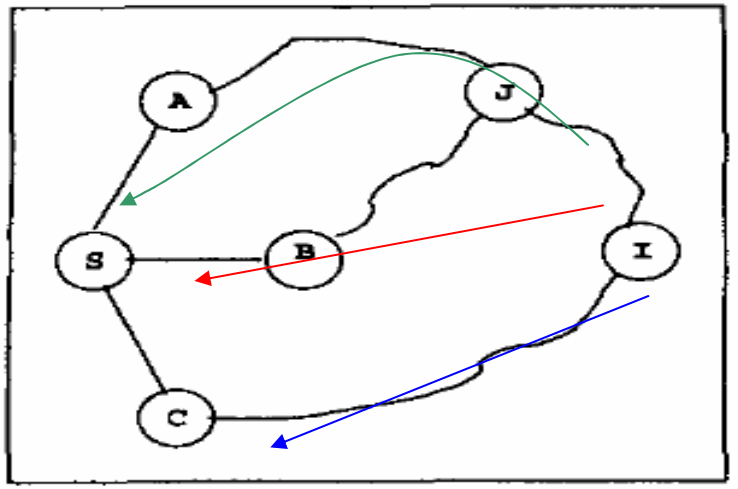


Figure 5. Illustration of Property 1. S floods a packet in the network. A, B and C are neighbors of S. J transmits only the first arriving copy of the packet (from A or B) and suppresses the latter. Two copies are received at I, one via C and the other via A or B. Thus I finds two node-disjoint paths to S.

AODVM routing

- AODVM (Ad hoc On-Demand Distance Vector Multipath)
- RREP packet contains a field called "*last_hop_ID*"
- Intermediate node receives RREP from its neighbor and add a routing entry to its routing table

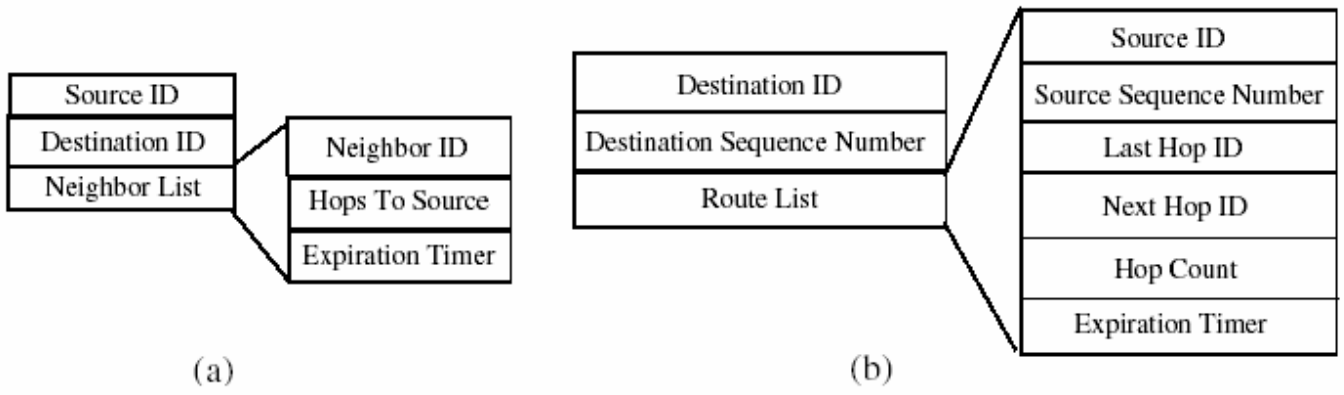


Fig. 2. (a) Structure of the each RREQ table entry in AODVM
(b) Structure of the each routing table entry in AODVM

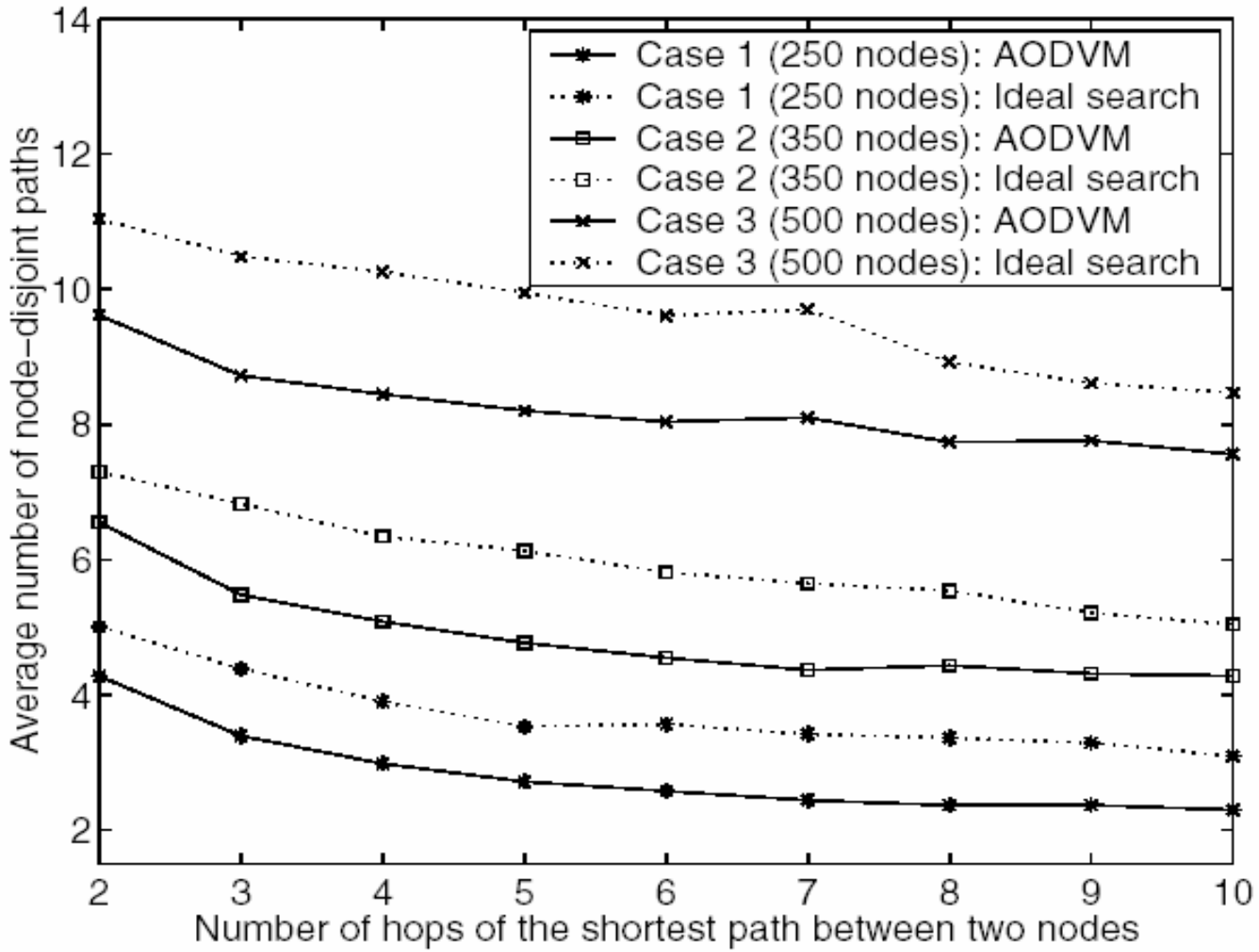
AODVM routing

- When destination receives duplicate copies of the RREQ packet from other neighbor , it update its sequence number and generates RREP for each of them.
- When an intermediate node that receives an RREP message cannot forward it , it generates an Route Discovery Error message to the neighbor that forward RREP
- The neighbor receives the RDER that will attempt to forward the RREP to a different neighbor

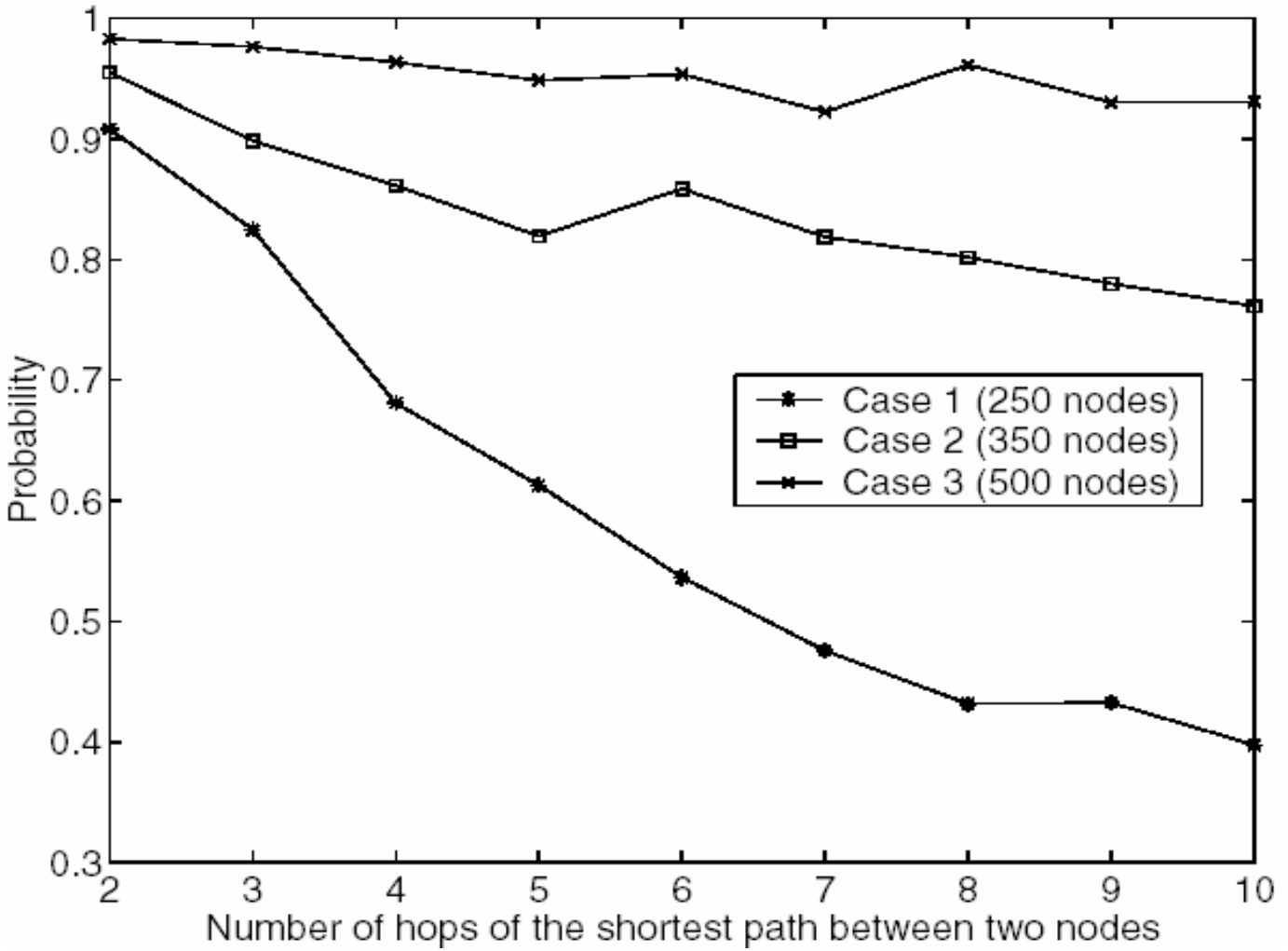
Performance of AODVM

- The average number of node-disjoint paths that are discovered per route inquiry
- The probability that number of node-disjoint paths discovered in any route inquiry is no less than a certain preset threshold *K*
- Case 1：250 nodes Case 2：350 nodes Case 3：500 nodes uniformly in 2500m*2500m rectangular region

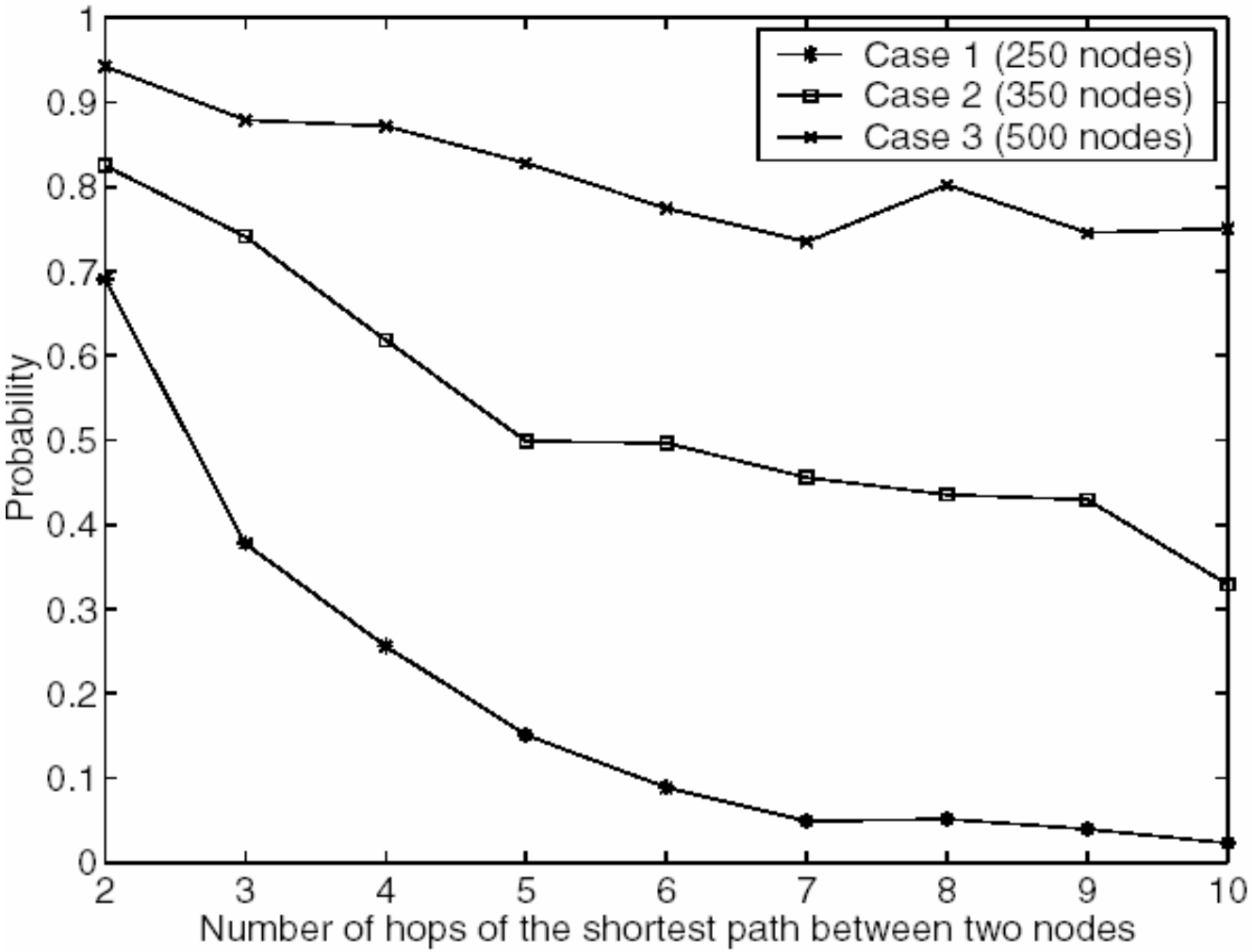
Performance of AODVM



Performance of AODVM



Performance of AODVM



Performance of AODVM

- We note that when the node density is high , we can find an acceptable number of node disjoint paths to provide robustness to node failures
- In order to route information reliable , a certain number of “reliable nodes” should be placed in network.
- We propose that a set of these reliable nodes be deployed in ad hoc network for the purpose of increasing reliability and security

A framework for reliable routing

- R-nodes

  Those nodes be allowed to participate in routing along multiple routes between the same source-destination pair

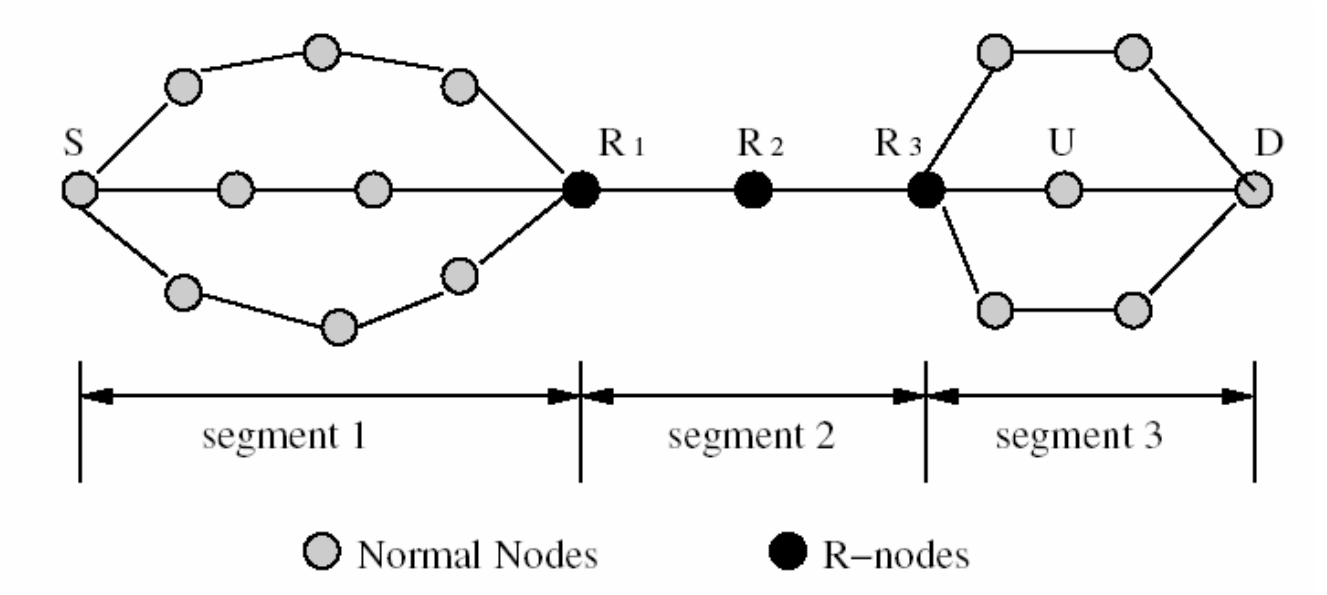
- Reliable segment

  A segment is joined between two R-nodes

- Reliable path

  Be make up by number of Reliable segment

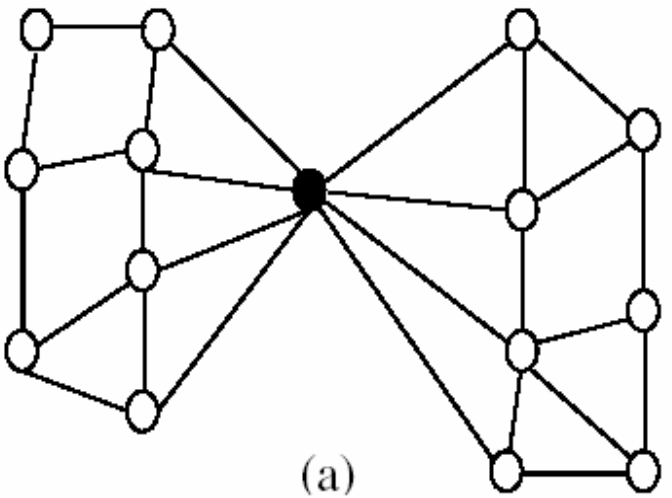
A framework for reliable routing



There are three R-nodes R1, R2,and R3.

The value of *K* is three

A framework for reliable routing



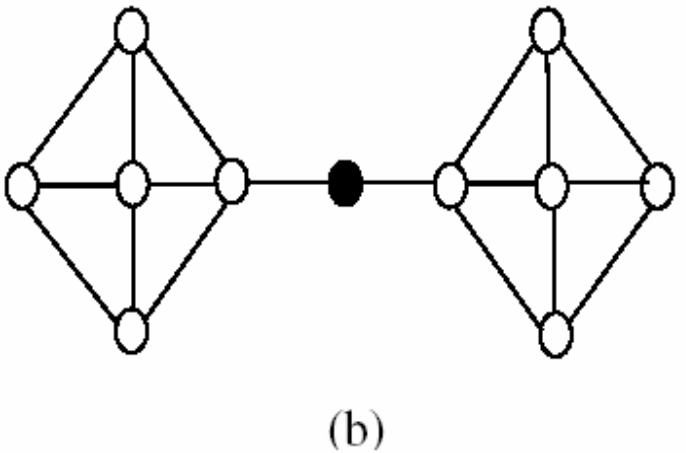


Fig. 7. (a) The maximum-degree node (the black node) is the bottleneck node in the network. (b) The minimum-degree node (the black node) is the bottleneck node in the network.

A framework for reliable routing

- Deploying R-nodes to support reliable routing framework
- A min-Cut algorithm and our modification
- The distributed R-node deployment strategy
- Modifications to AODVM

A framework for reliable routing

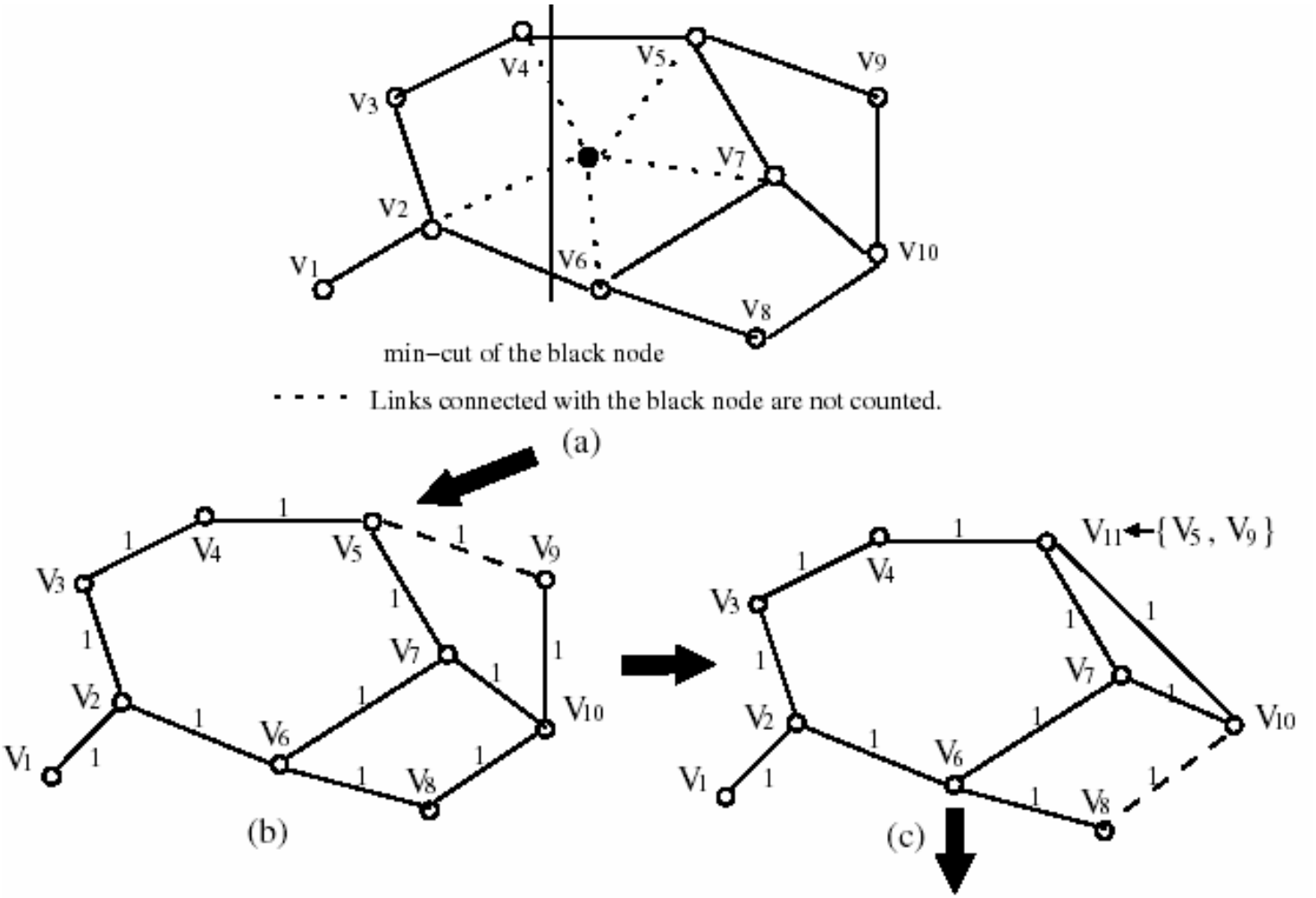
- In order to determine where the R-nodes ought to be placed, it is required that each node compute the *min-cut of a partial graph*

- It then runs the min-cut algorithm with the following *modification*:

->*The outermost links are contracted first, and the links that are closest to the node are contracted last.*

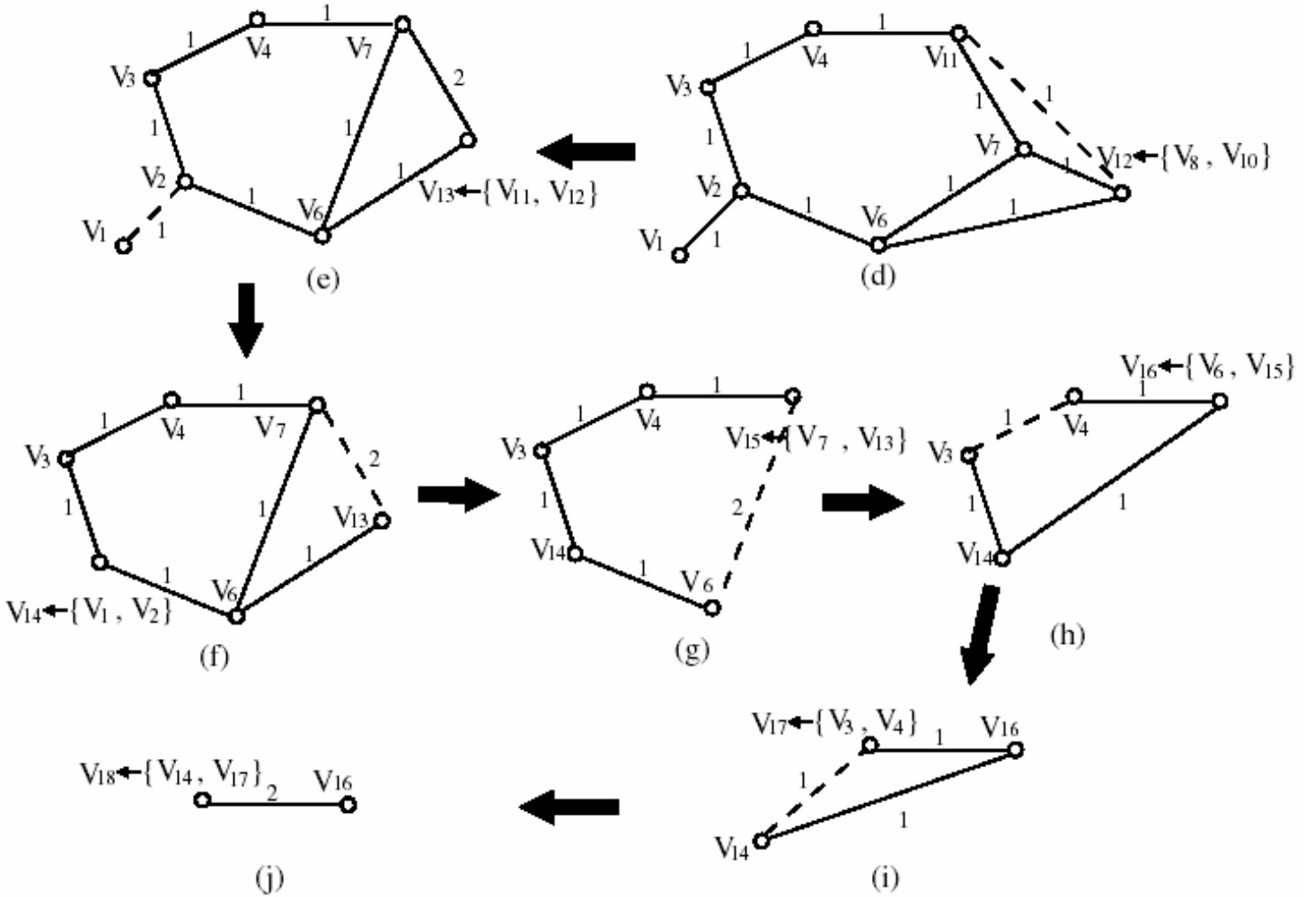
A framework for reliable routing

- A min-Cut algorithm and our modification



A framework for reliable routing

- A min-Cut algorithm and our modification



A framework for reliable routing

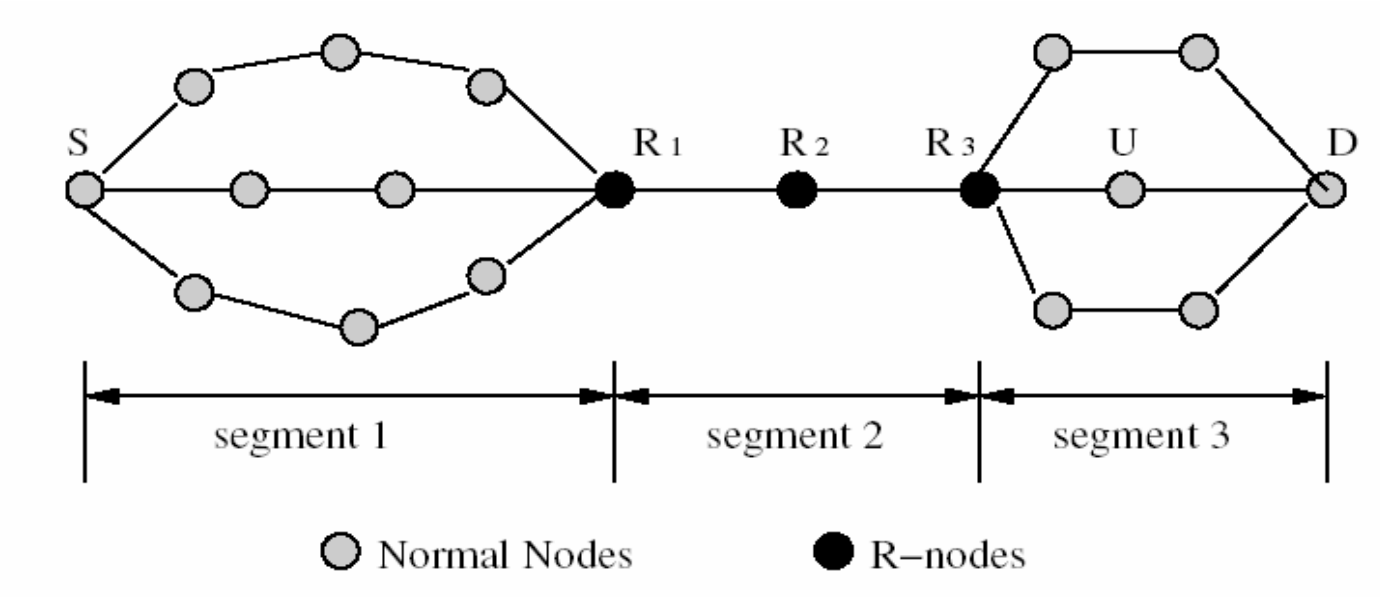
- The distributed R-node deployment strategy

- Each node periodically broadcast a HELLO message to its neighbor
- A node periodically calculates its min-cut value
- An R-node compare the min-cut value and the min-cut set size of the nodes in its K-hop neighbor

A framework for reliable routing

- Modifications to AODVM

- In each RREP packet , we include a “reliability flag”
- When RREP passes through an intermediate node , this flag is set to *RELIABLE* if this intermediate node is R-node
- Otherwise , this flag is set to *NORMAL*



Performance evaluation of R-node deployment strategies

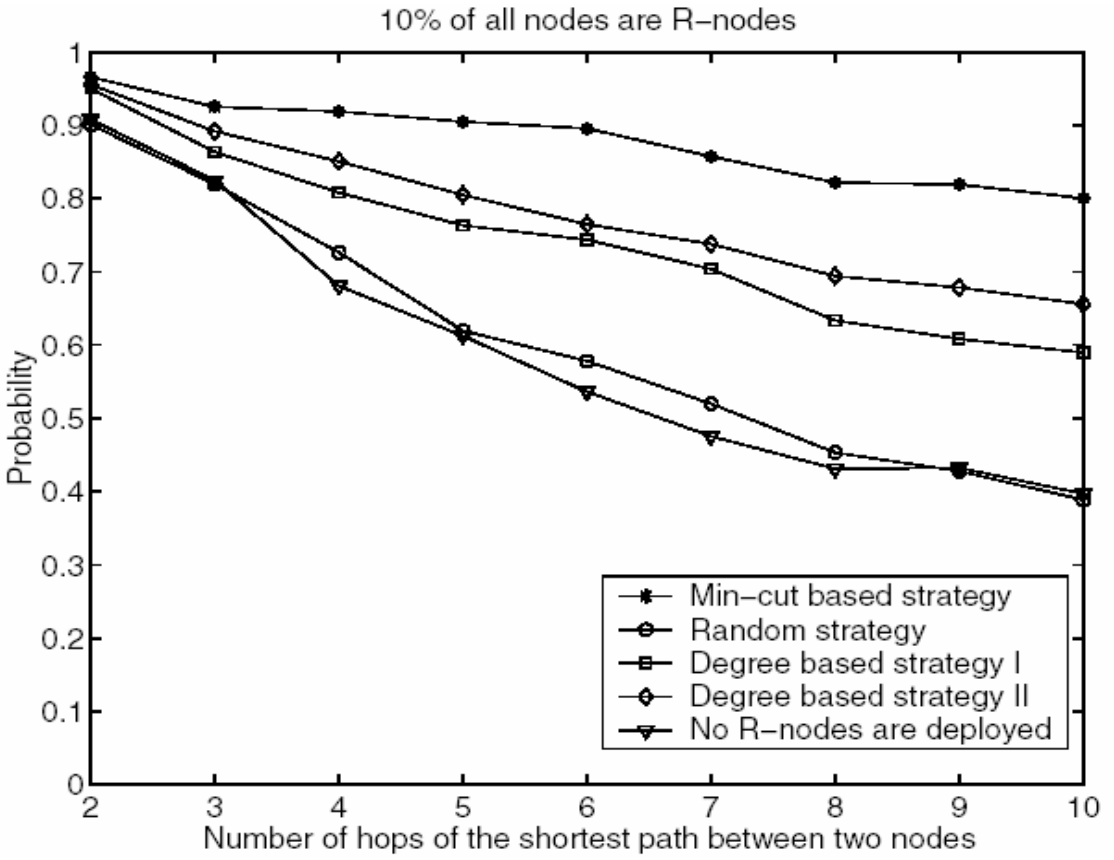


Fig. 10. Comparison of the performance of the various R-node deployment strategies with $\kappa = 3$.

Performance evaluation of R-node deployment strategies

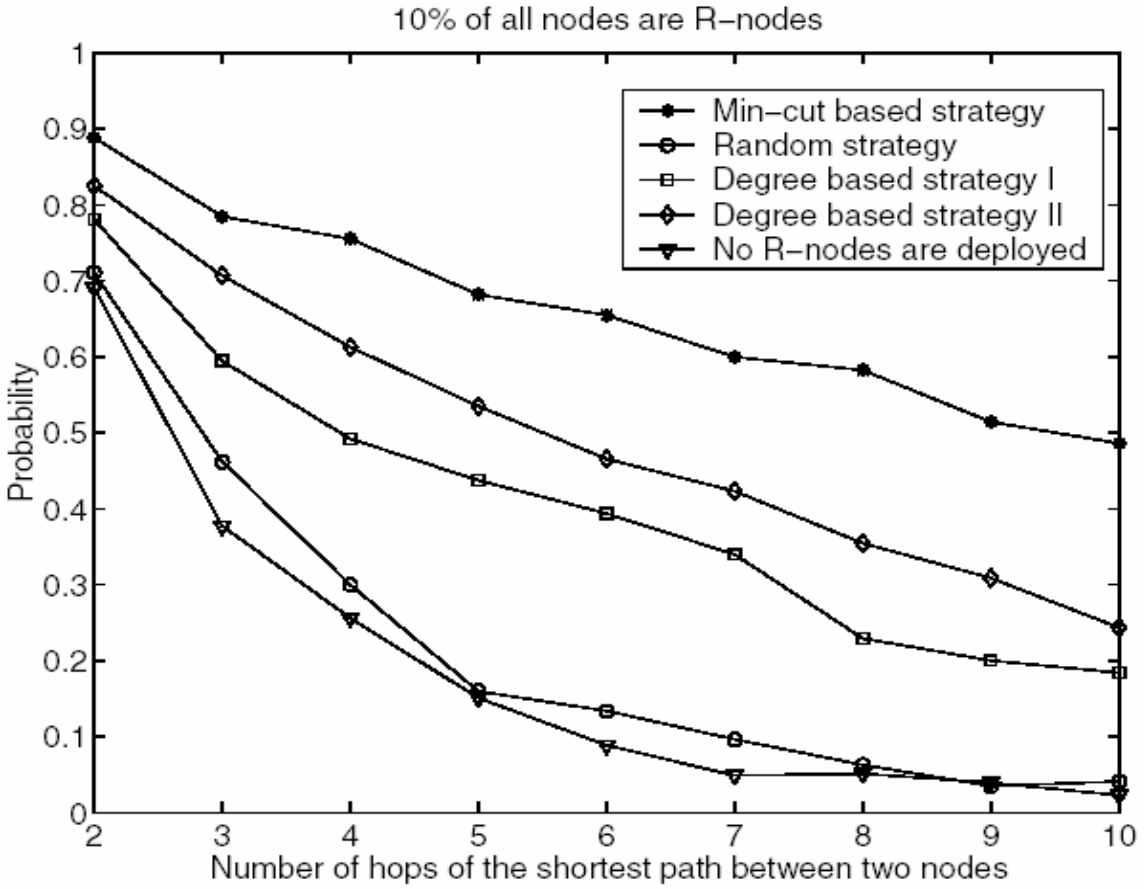


Fig. 11. Comparison of the performance of the various R-node deployment strategies with $\kappa = 4$.

Performance evaluation of R-node deployment strategies

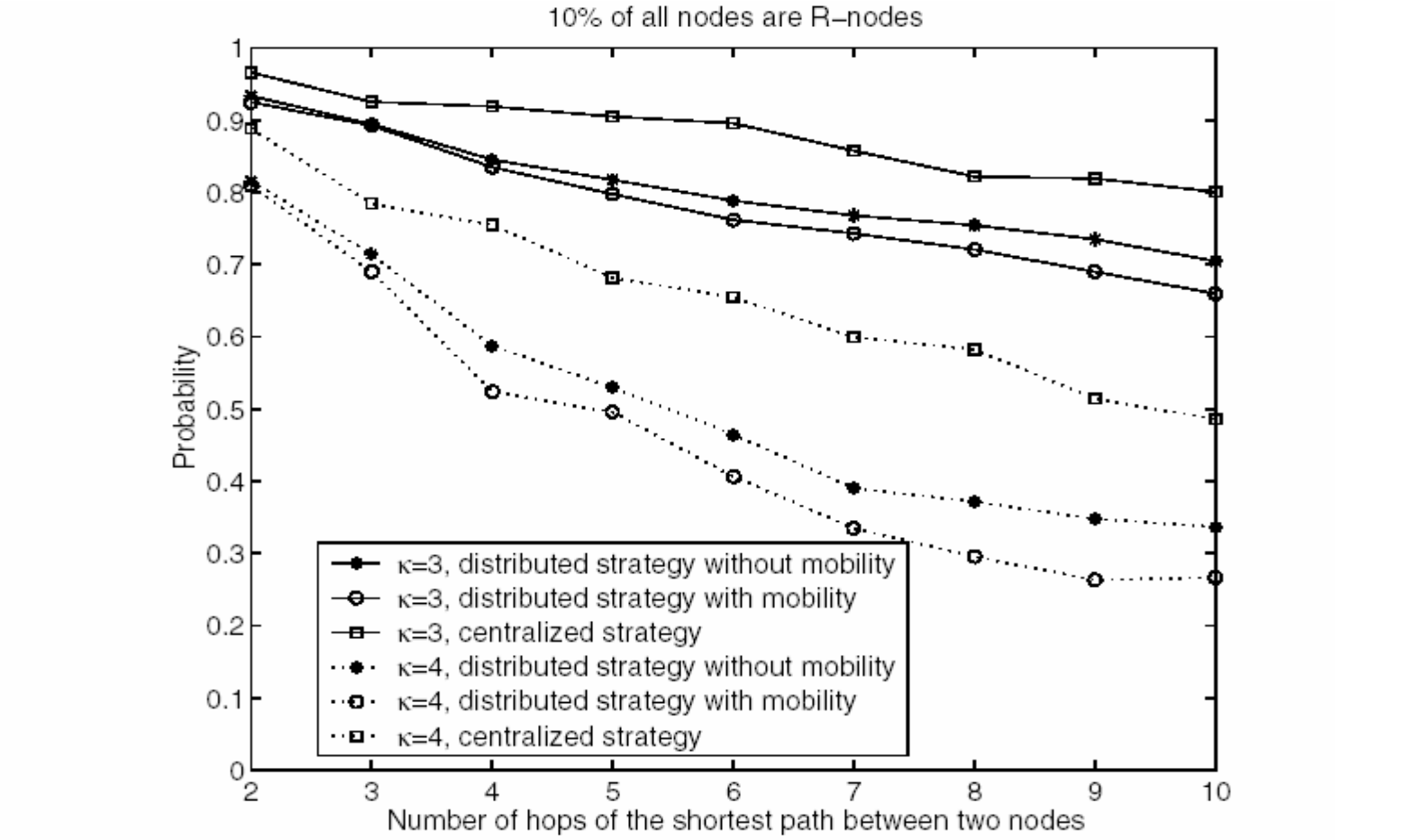


Fig. 12. Effects of mobility on the distributed R-node deployment strategy.

Conclusions

- Our objective was to provide robustness to both intermittent and long term node failures in ad hoc network
- Use of multiple node-disjoint route could potentially provide some tolerance to node-failures
- We show that our strategy has the best performance in dynamic topology changes due to low mobility patterns