Chapter 11. SOM: Spiral-Fat-Tree-Based On-Demand Multicast Protocol in a Wireless Ad-Hoc Network

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Best Paper Award in IEEE ICOIN-15

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The 15th IEEE International Conference on Information Networking (*ICOIN-15*)

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SOM: Spiral-Fat-Tree-Based on-Demand Multicast Protocol in a Wireless Ad-Hoc Network

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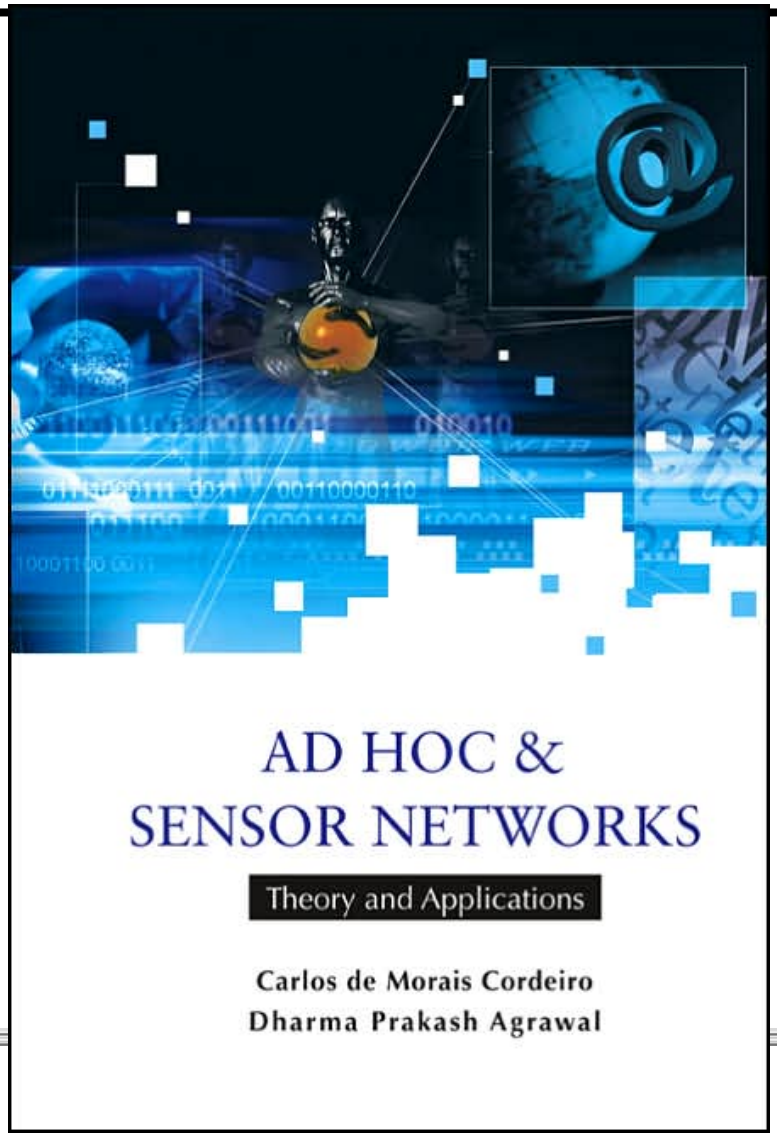


Outline

I. Introduction

- Propose a new **multicast protocol** in the **M**obile **A**d-hoc **NET**work (MANET)
- Develop a **simulation platform** to evaluate the performance of our protocol

Mobile Ad-Hoc Network

- **Mobile Ad-hoc NETwork (MANET)**
  - Formed by wireless hosts which may be mobile
  - Without (necessarily) using a pre-existing infrastructure
  - Routes between nodes may potentially contain multiple hops

- **Design Difficulty:**
  - **Node mobility**
    - Topology is changeable

Existing Multicast Protocols

- **Tree-based multicast protocols**
  - There in only path from source to destination
- **Mesh-based multicast protocols**
  - Source to destination has two or more paths

Classification of Multicast

- **Proactive Multicasting Protocol**
  - Pre-Build a Shared Multicast-Tree
- **Reactive Multicast Protocol**
  - On-Demand to Construct a Multicast-Tree

A Comparison Table

	Protocol	Proactive/Reactive	Multi-Path	Location-Aware
Tree-based multicast protocol	CBT	Proactive	×	×
	AODV	Reactive	×	×
	DVMRP	Reactive	×	×
Mesh-based multicast protocol	CAMP	Proactive	✔	×
	FGMP	Reactive	✔	×
	ODMRP	Reactive	✔	✔
	Ours(SOM)	Reactive	✔	×

Tree-Based Approach

- **CBT** [ACM SIGCOMM 93]
  - Core Base Tree protocol
  - Proactive
- **AODV** [Mobicom 99]
  - Ad hoc On Demand Distance Vector protocol
  - Reactive (or called as On-Demand)
- **DVMRP** [ACM Transactions on Computer Systems]
  - Distance Vector Multicast Routing Protocol
  - Reactive

Mesh-Based Approach

- **FGMP** [Cluster Computer 1998]
  - Forwarding Group Multicast Protocol
  - Reactive
- **ODMRP** [IEEE 8-th ICCCN '99]
  - On-Demand Multicast Routing Protocol
  - Reactive

- **All on-demand protocols are implemented and compared in our simulator.**

Drawback of Existing Protocols

- **Existing on-demand protocol wastes heavy Blind-Flood packets**
- **Reconfigure multicast-tree frequently**
  - Due to the problem of node mobility

Motivation

- **The robustness of multicast-tree of existing reactive protocols is weak**
  - The motivation of this paper is to enhance the robustness of mutlicast-tree

Contribution

- **This paper presents a special multi-path approach**
  - to enhance the robustness of multicast-tree
- **Propose the Spiral-Fat-Tree-based scheme**
  - Advantage: reduce the probability of re-configuration of multicast-tree

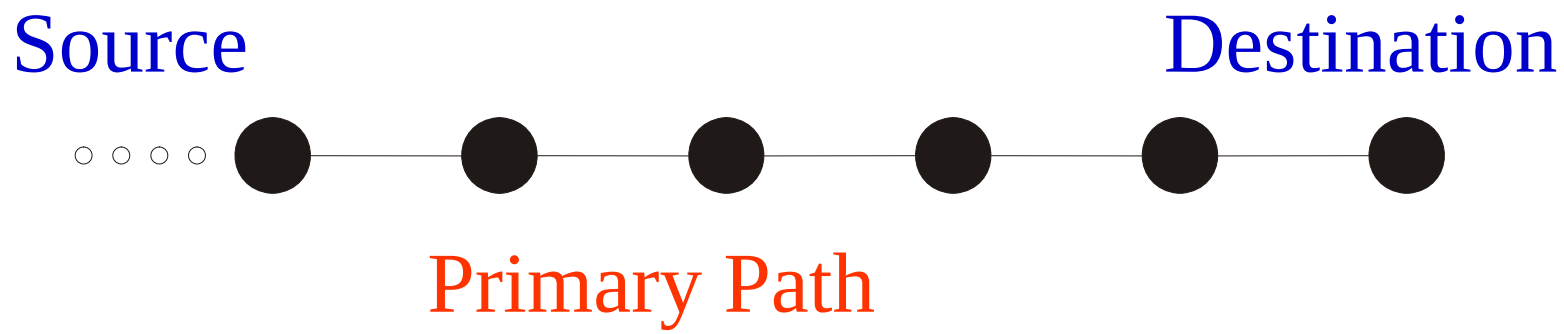
II. Base idea

- **The basic idea of Spiral-Fat-Tree-Based Scheme is**
  - Spiral-Path
  - Spiral-Tree
  - Spiral-Fat-Tree

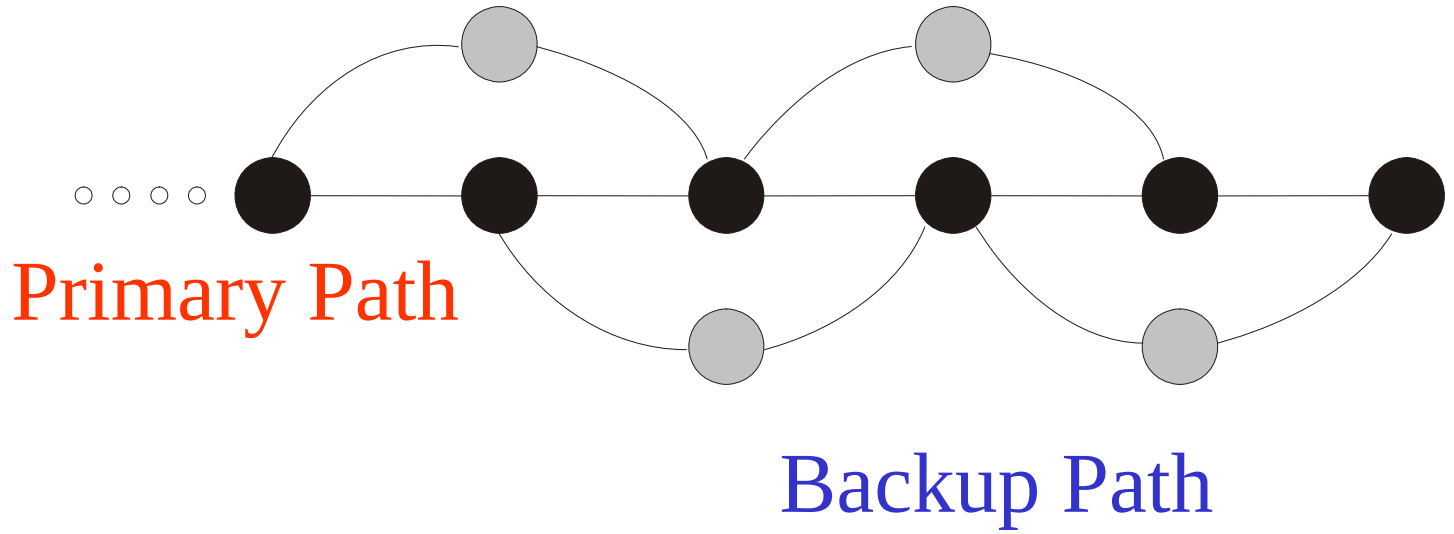
Spiral-Path

- **A special robust-path (spiral-path) is adopted.**
  - This idea originated by our previous paper, which has been presented in *IEEE ICCCN 2000,* Las Vegas, U.S.A.
  - To appear in *IEICE Trans. on Communications*.
- **Using the spiral-path to possibly construct a robust fat-tree structure**

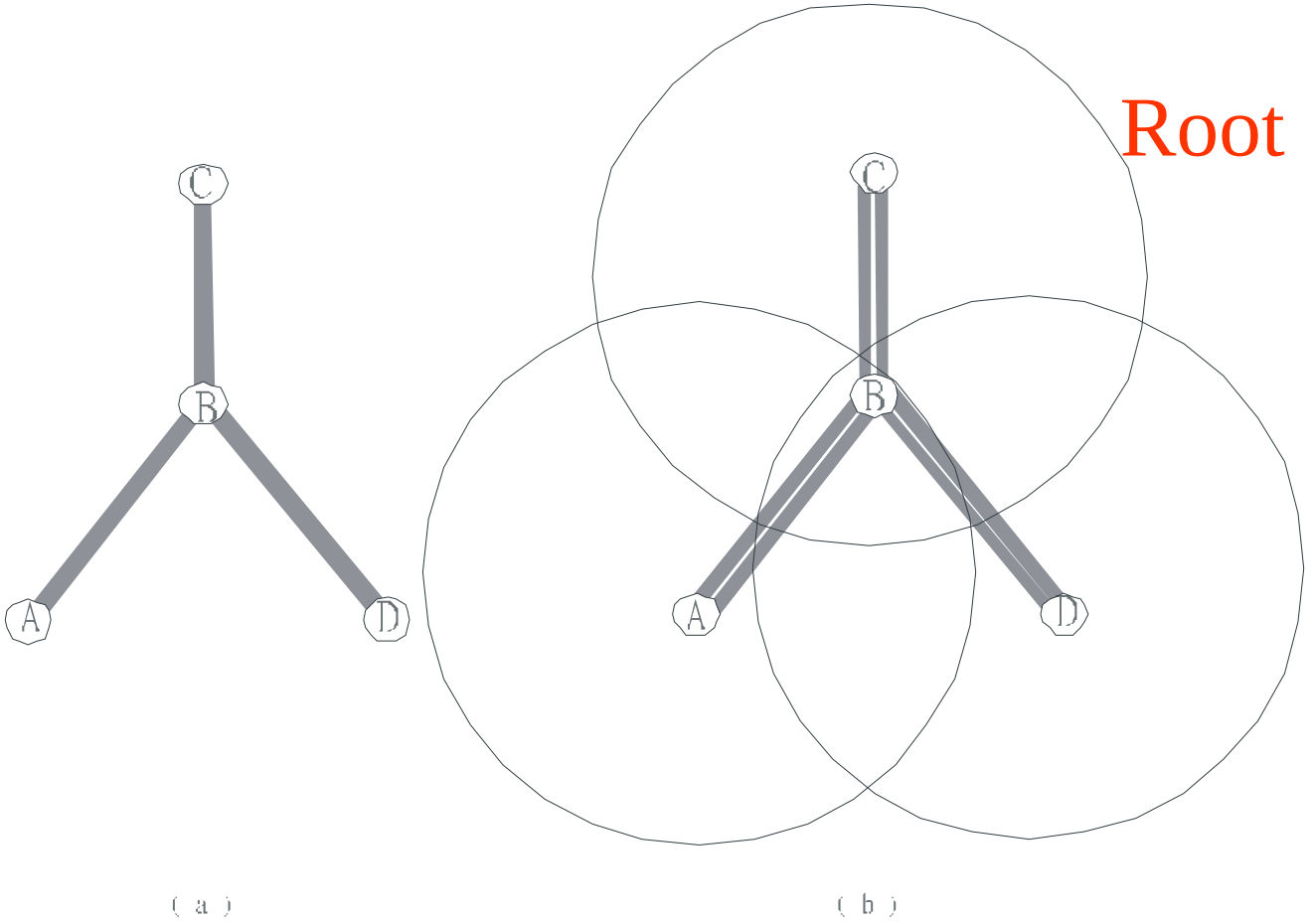
A path



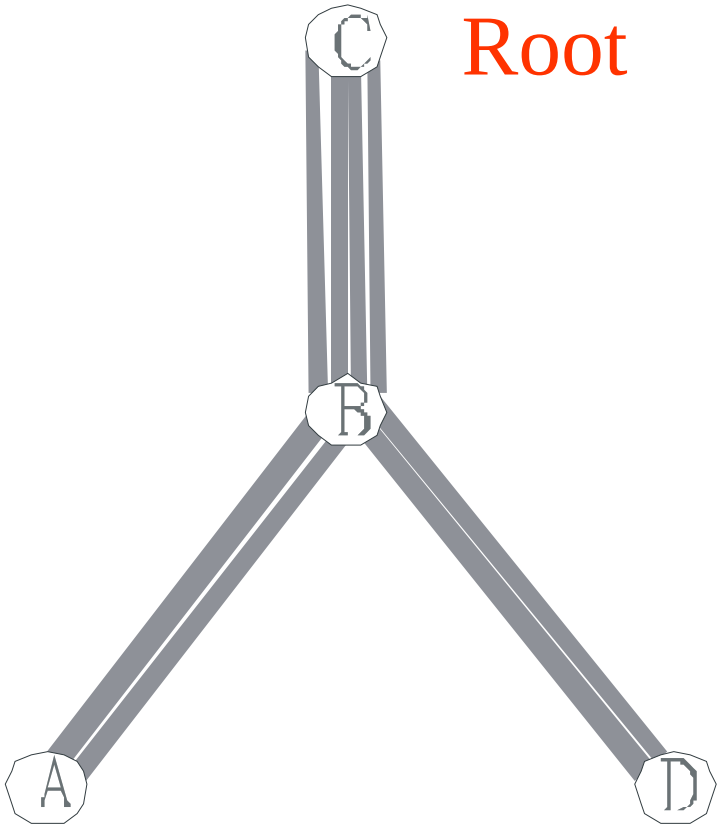
Spiral-Path



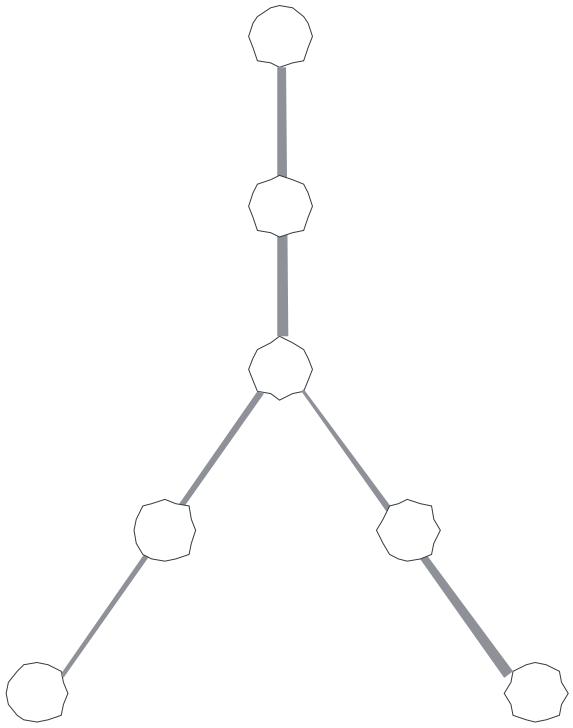
A Tree Structure



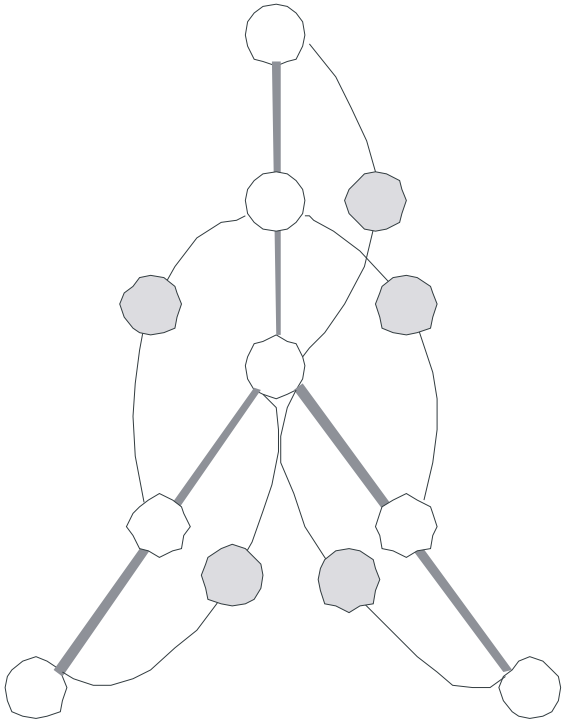
A Fat-Tree Structure



Spiral-Tree

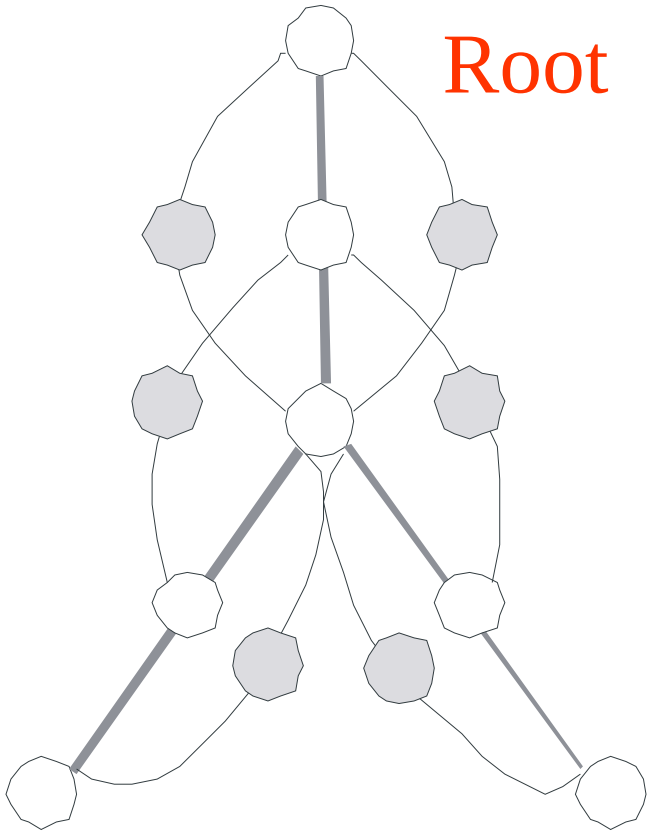


(a)



(b)

Spiral-Fat-Tree



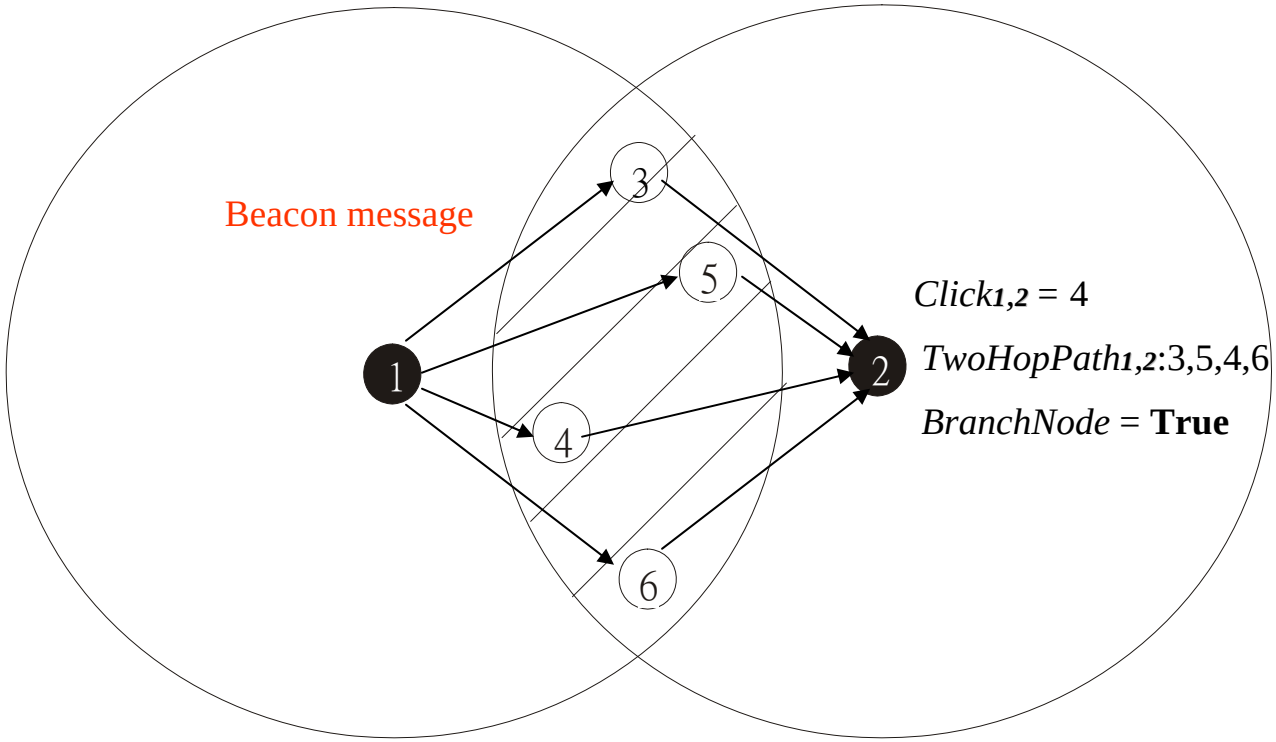
III. Our SOM (Multicast) Protocol

- **Step 1:** Identify the **Branch-Node**
- **Step 2:** Construct the **Spiral-Fat-Tree**
- **Step 3:** Maintain the **Spiral-Fat-Tree**

Step 1: Identify the Branch-Node

- Each node periodically sends *Beacon message* within 2-hops
- A node is said as a branch-node if there exists at least two distinct paths from a same node.

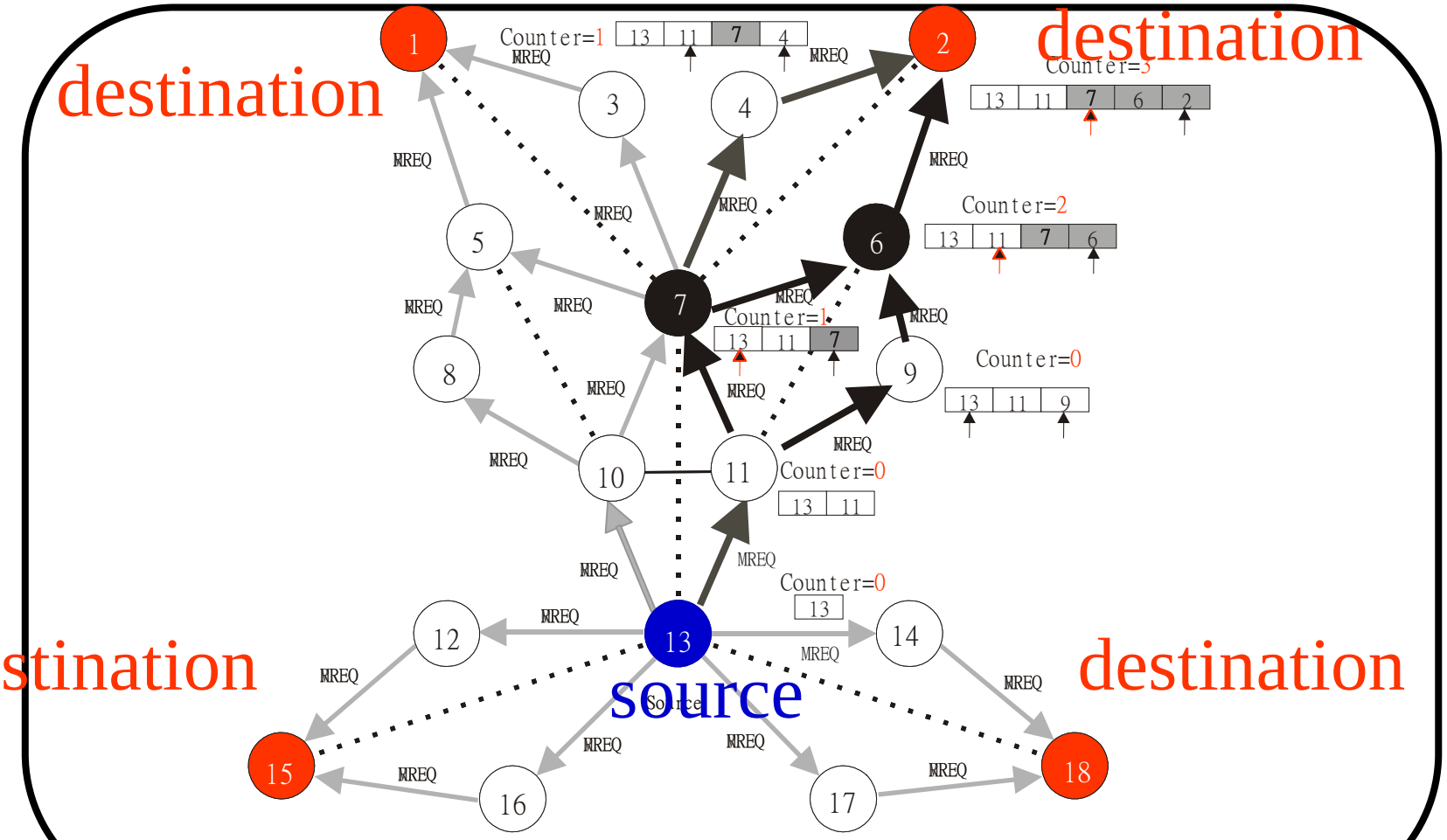
Branch-Node


Beacon message
1
2
3
4
5
6
Click1,2 = 4
TwoHopPath1,2:3,5,4,6
BranchNode = True

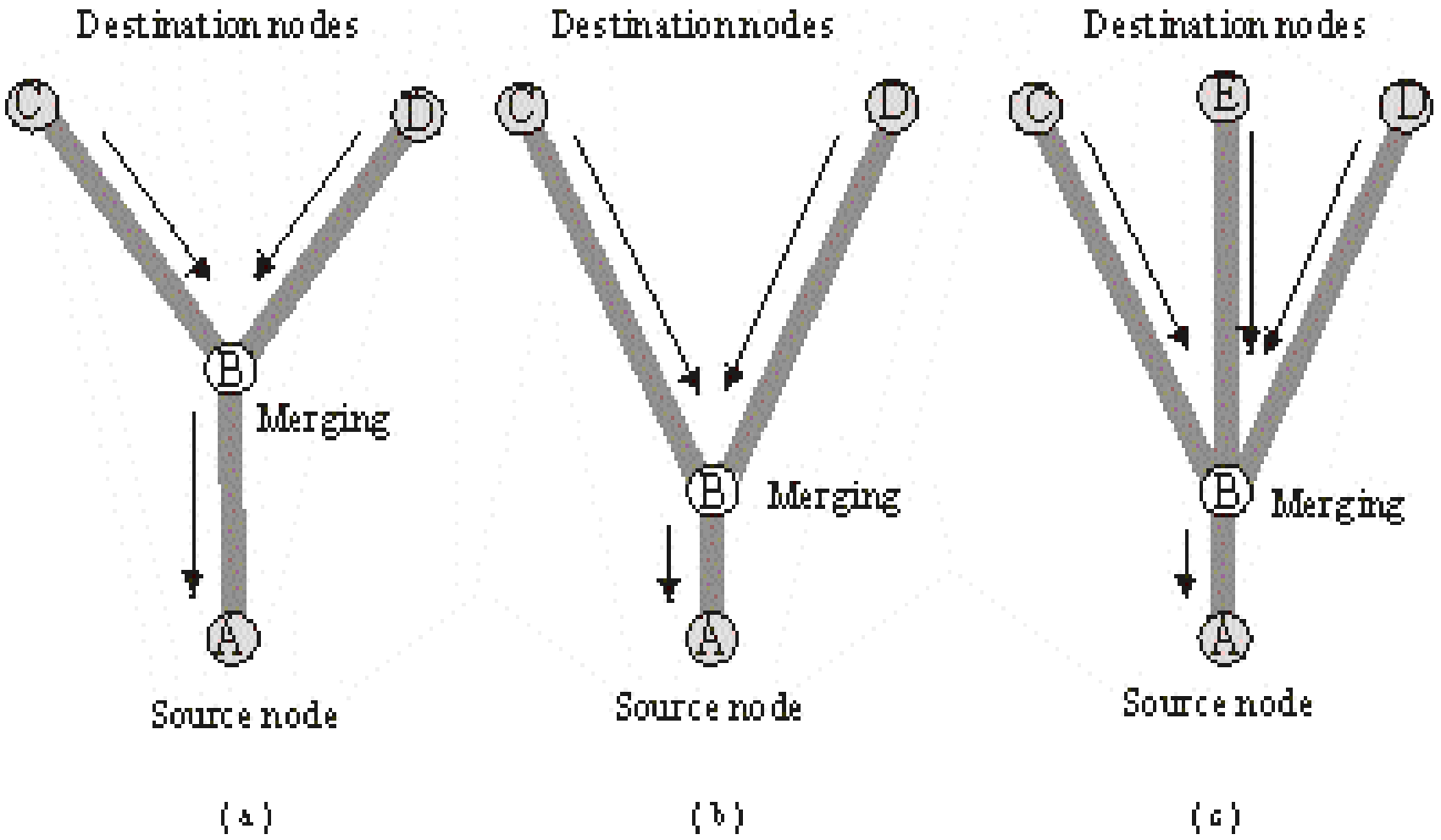
Step 2: Construct the Spiral-Fat-Tree

- ***Multi-Path Searching*** **Phase**
- ***Multi-Path Merging*** **Phase**

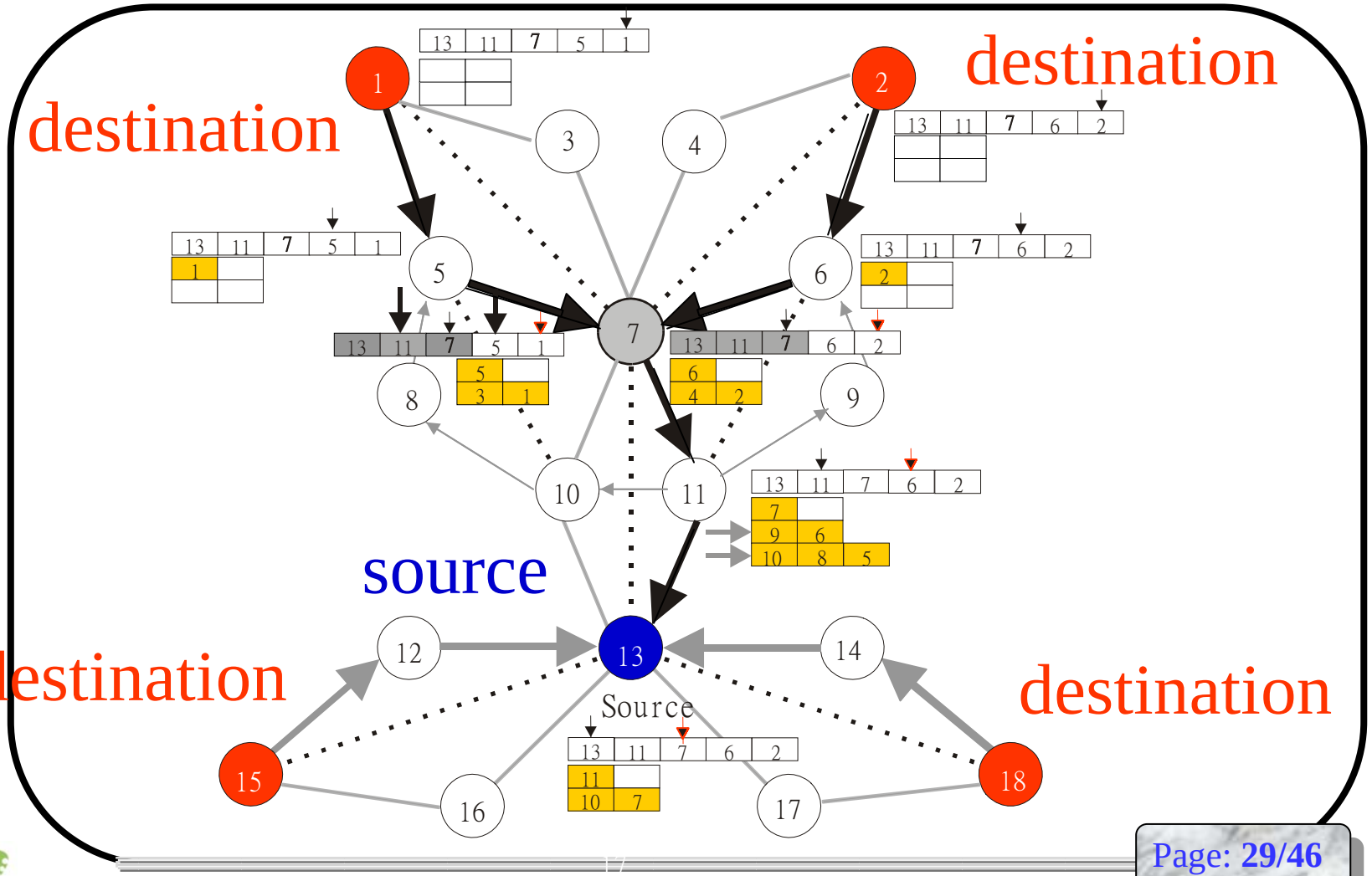
Multiple-Path Searching Phase



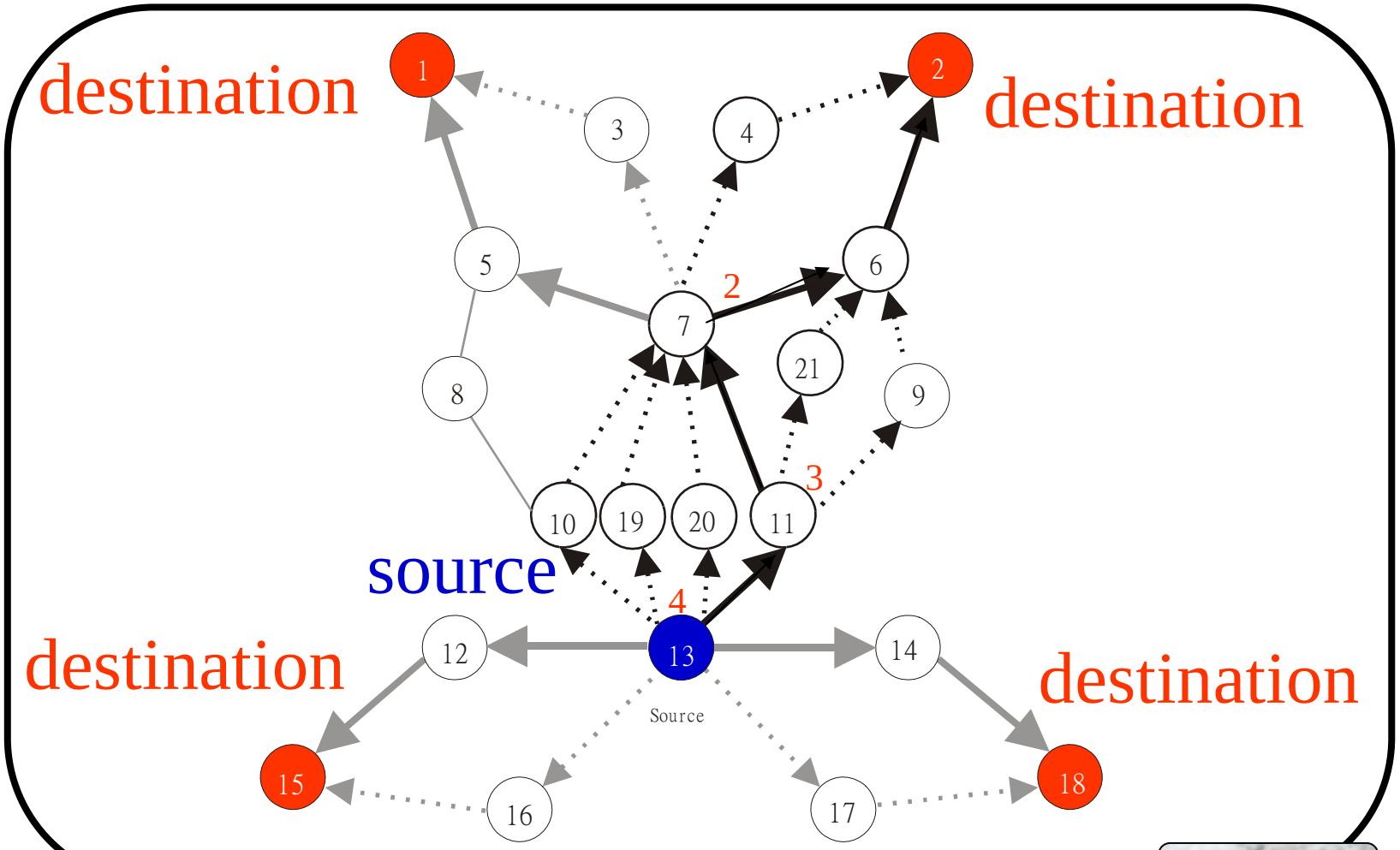
Merging Criterion



Multi-Path Merging Phase



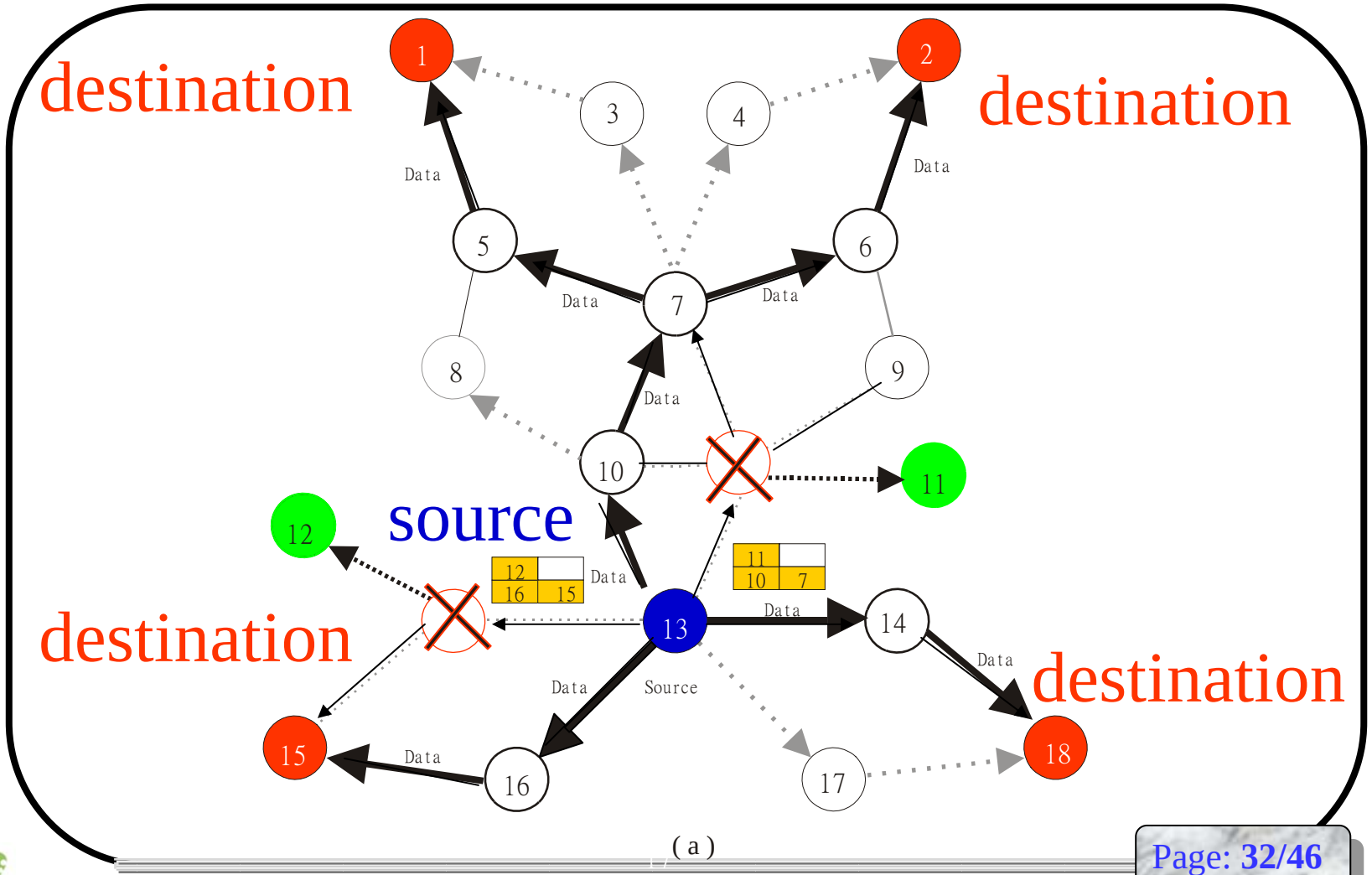
A Possible Spiral-Fat-Tree



Step 3: Multicast-Tree Maintenance

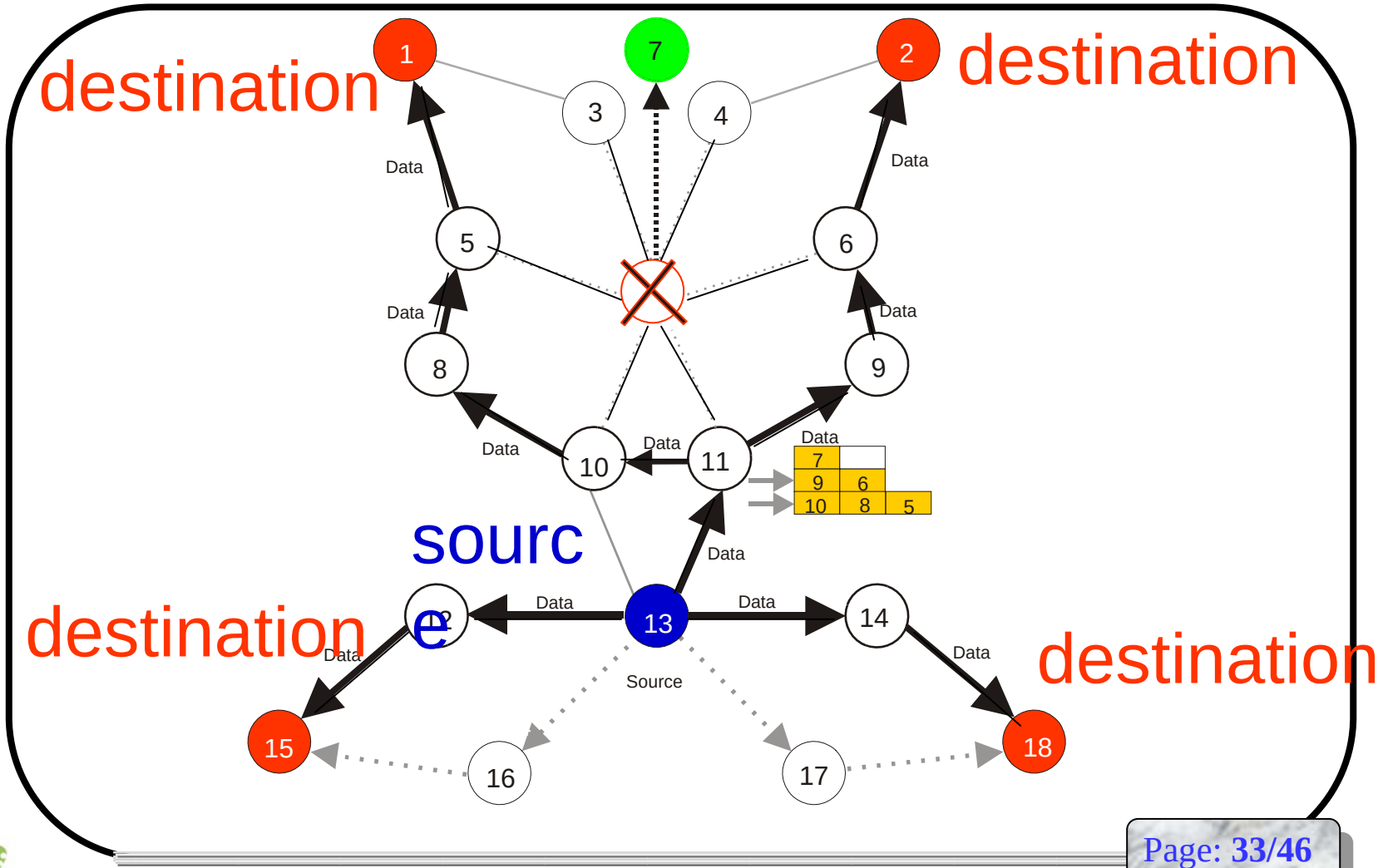
- **A node is said as a failed node if the node is moving out the original transmission radius**

Case 1: The failed node is not a merged node



(a)

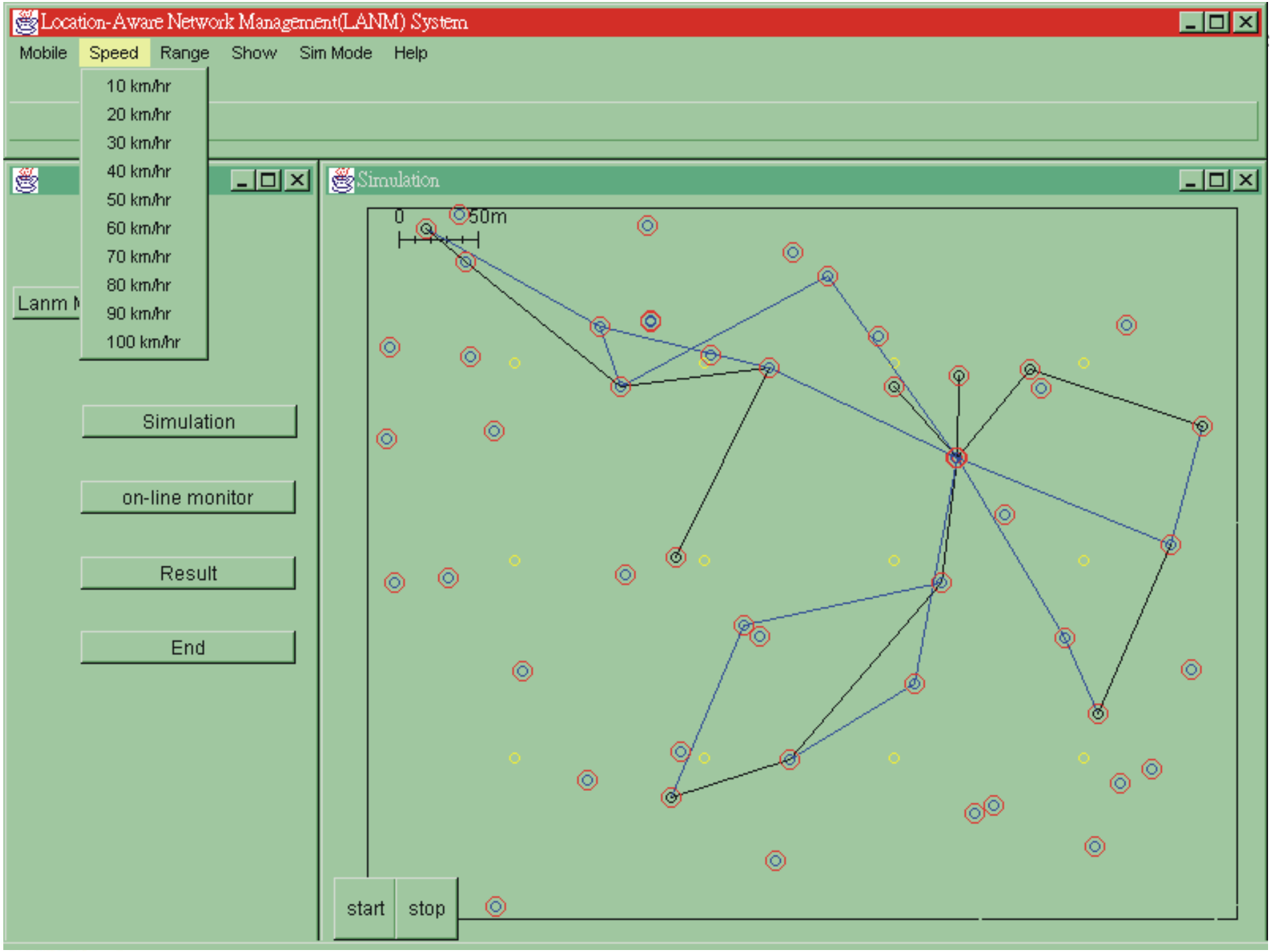
Case 2: The failed node is the merging node



IV. Performance Evaluation

■ Simulation environment

- Can choose 50, 75, 100 nodes in 500*500 meters
- Transmitter range can be 50,100, 150 meters
- 1 source v.s. 4~12 destination nodes
- Speed 10~100 km/hr
- Five protocols are implemented and compared.
  - AODV, DVMPR, FGMP, ODMRP, and SOM.


Location-Aware Network Management(LANM) System
Mobile
Speed
Range
Show
Sim Mode
Help
10 km/hr
20 km/hr
30 km/hr
40 km/hr
50 km/hr
60 km/hr
70 km/hr
80 km/hr
90 km/hr
100 km/hr
Lanm M
Simulation
on-line monitor
Result
End
Simulation
0
50m
start
stop

Performance Metrics

RE (REachability)

- The number of all destination nodes receiving the data message divided by the total number of all destination hosts that are reachable, directly or indirectly, from the source host.

RB (ReBroadcast)

- The number of REQUEST packets for all mobile hosts in MANET.

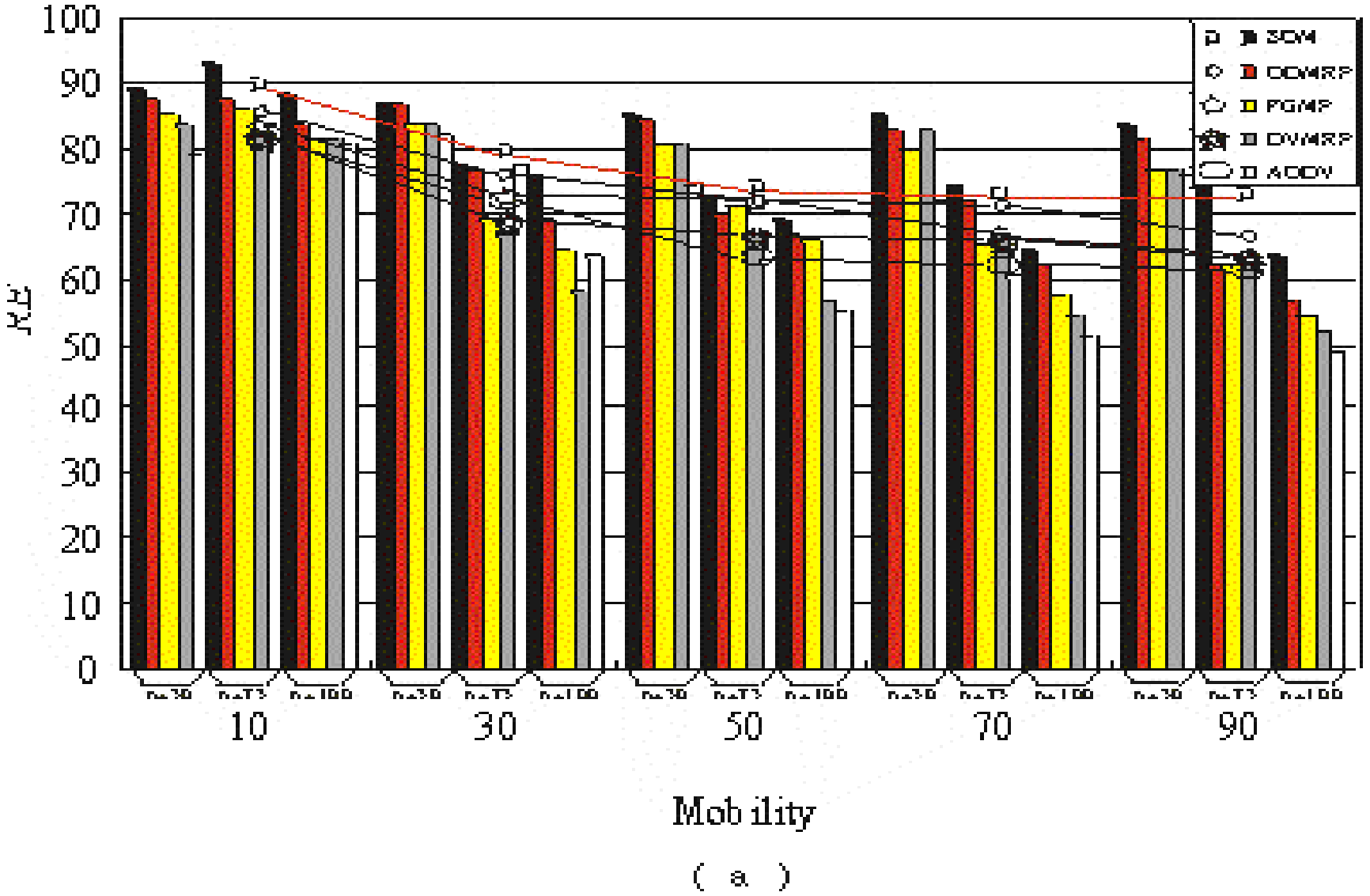
AL (Average Latency)

- The interval from the time the multicast was initiated to the time the last host finishing its multicasting.

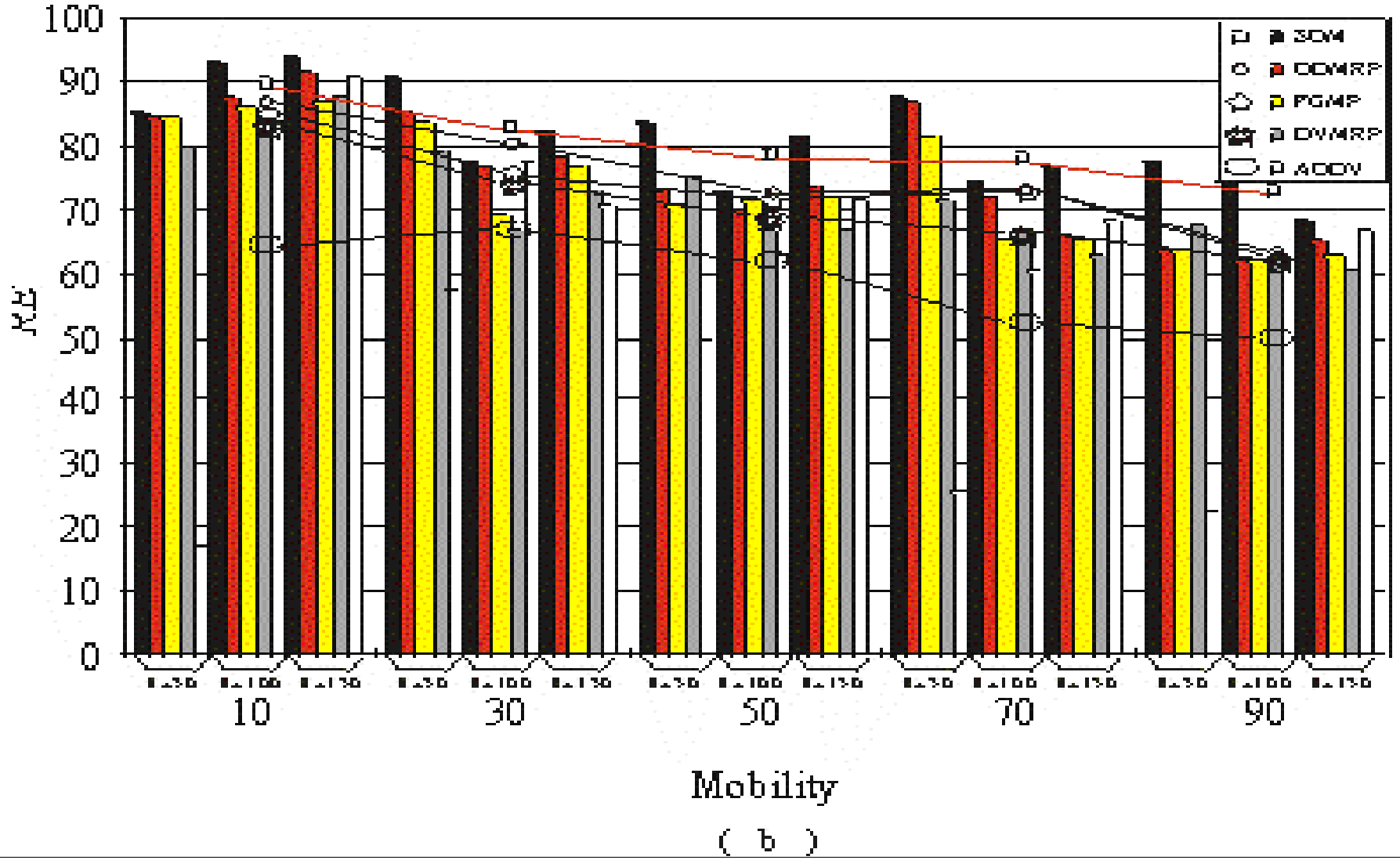
Performance of REachability (RE)

- An efficient multicast protocol is achieved by with high REachability (RE)

Performance of REachability v.s. effect of Number of Mobile Hosts



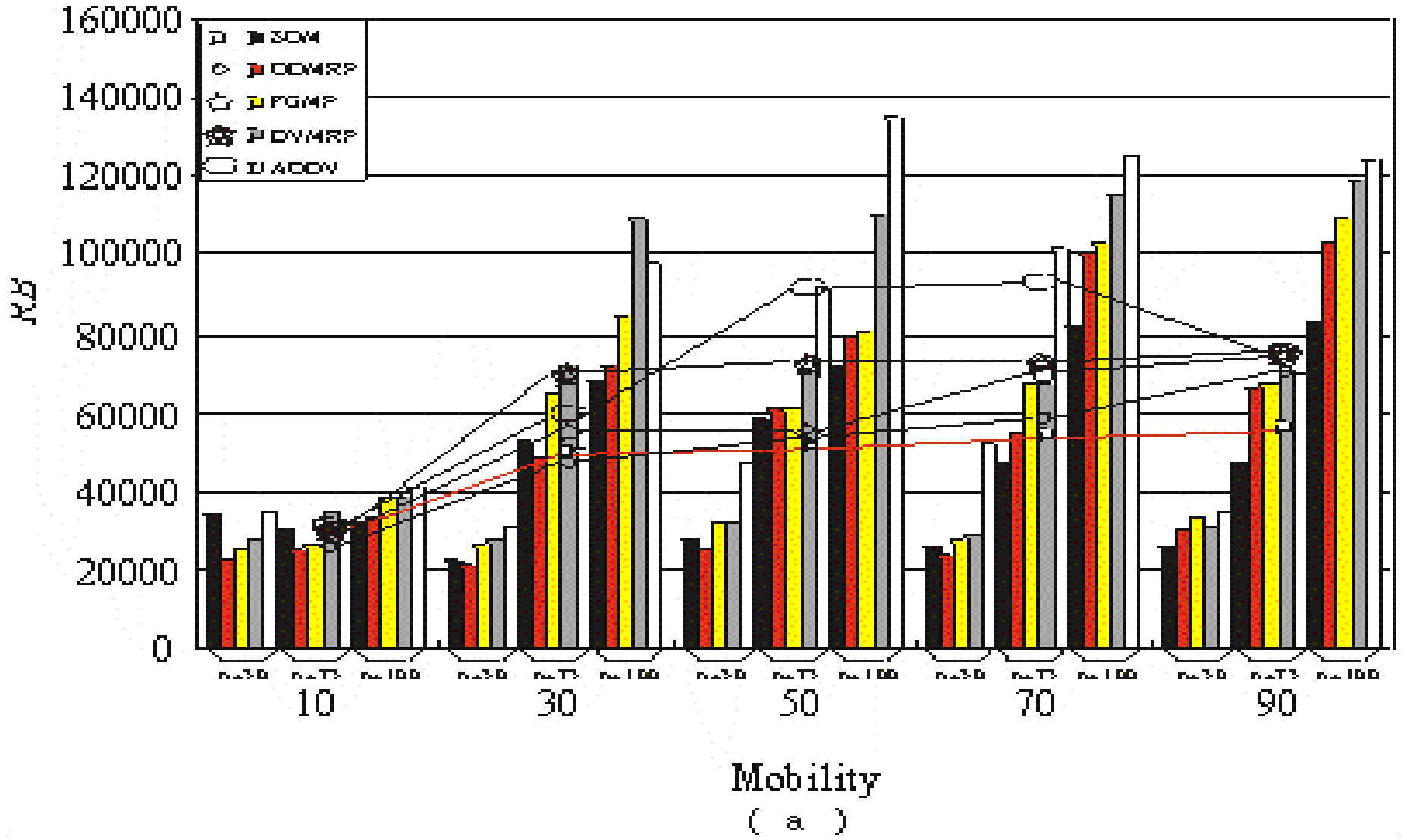
Performance of REachability vs. effect of Transmission Radius



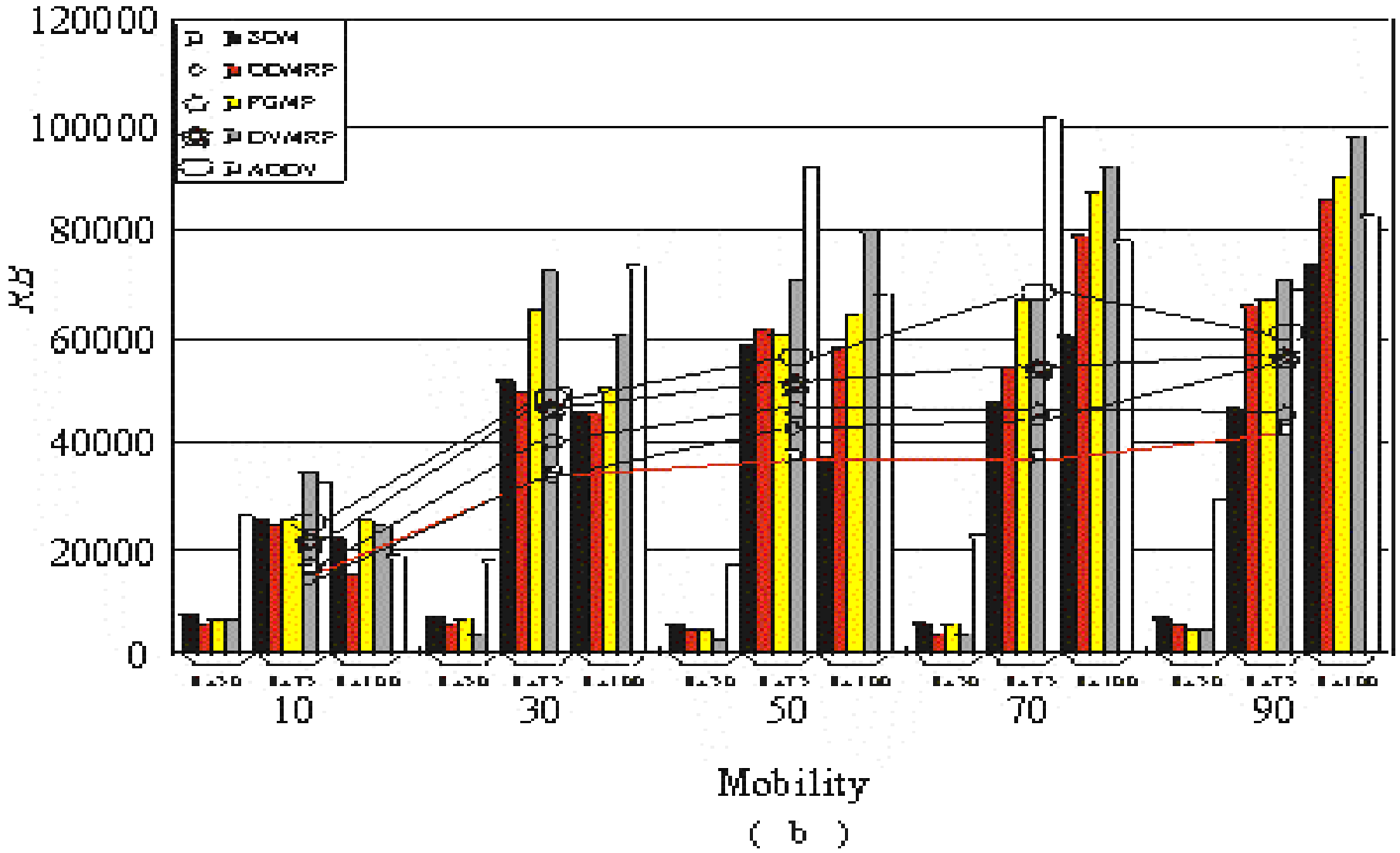
Performance of ReBroadcast

- An efficient multicast protocol is achieved by with low ReBroadcast (RB)

Performance of ReBroadcast vs. effect of Number of Mobile Hosts



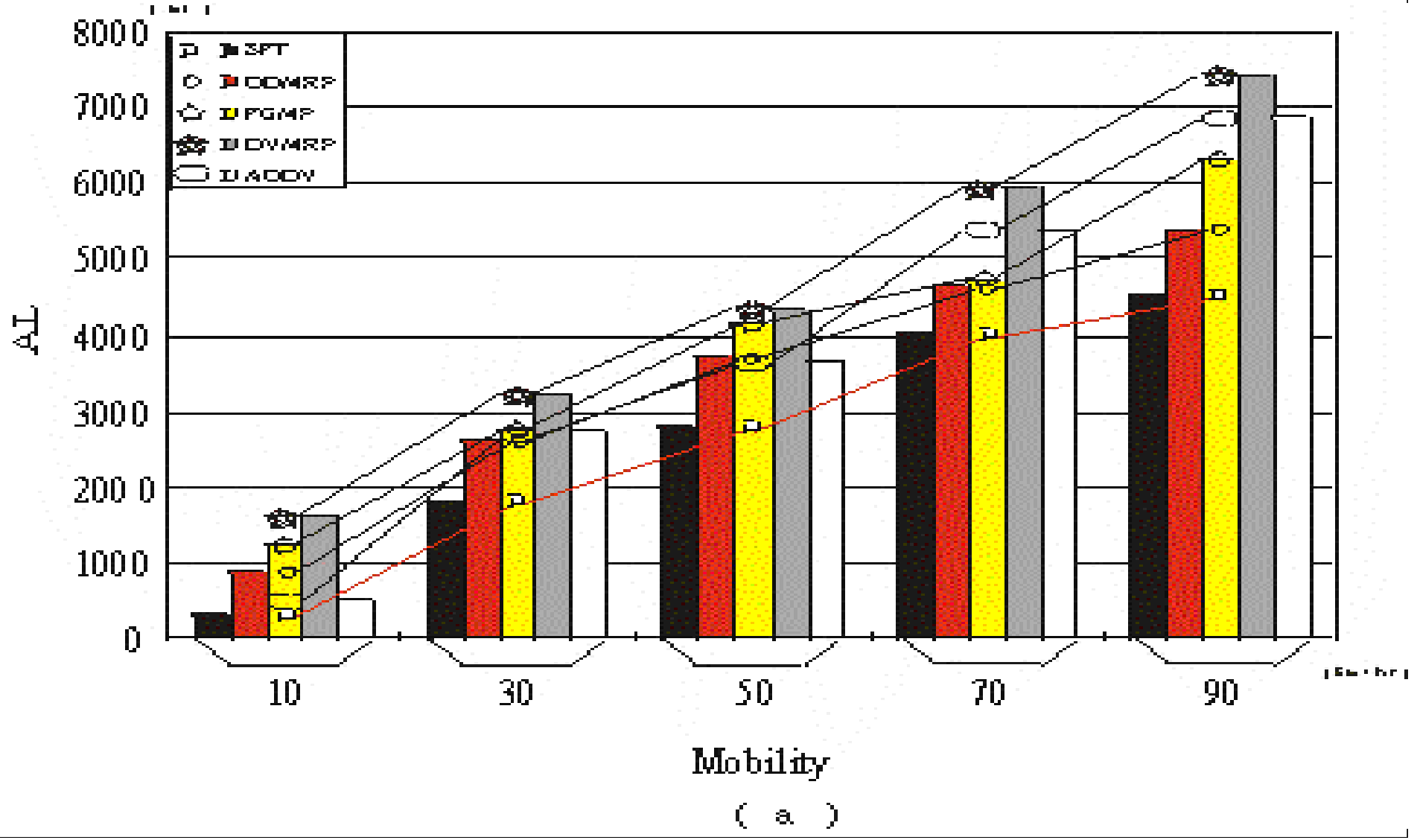
Performance of ReBroadcast vs. effect of Transmission Radius



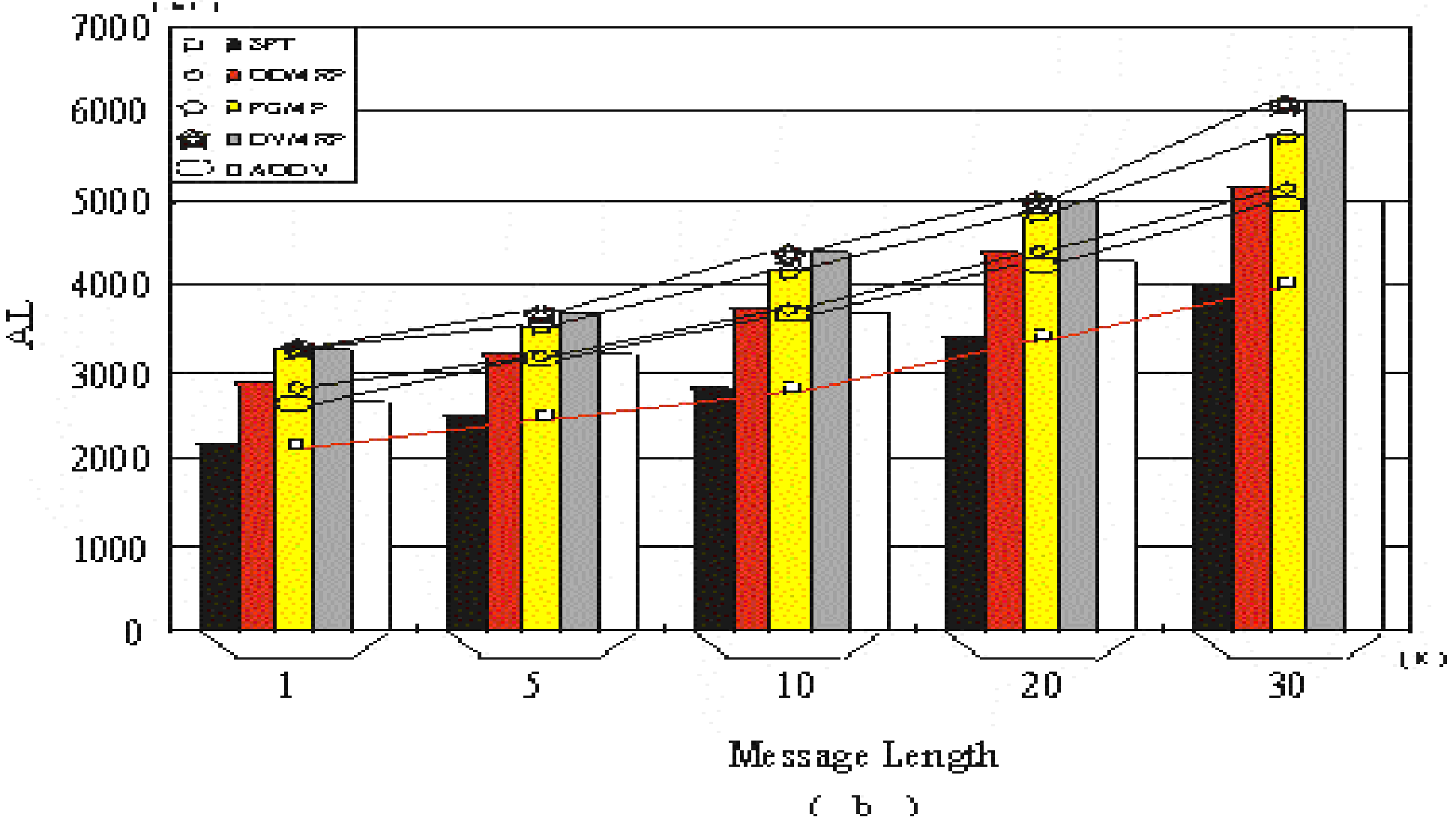
Performance of Average Latency

- An efficient multicast protocol is achieved by with low Average Latency (AL)

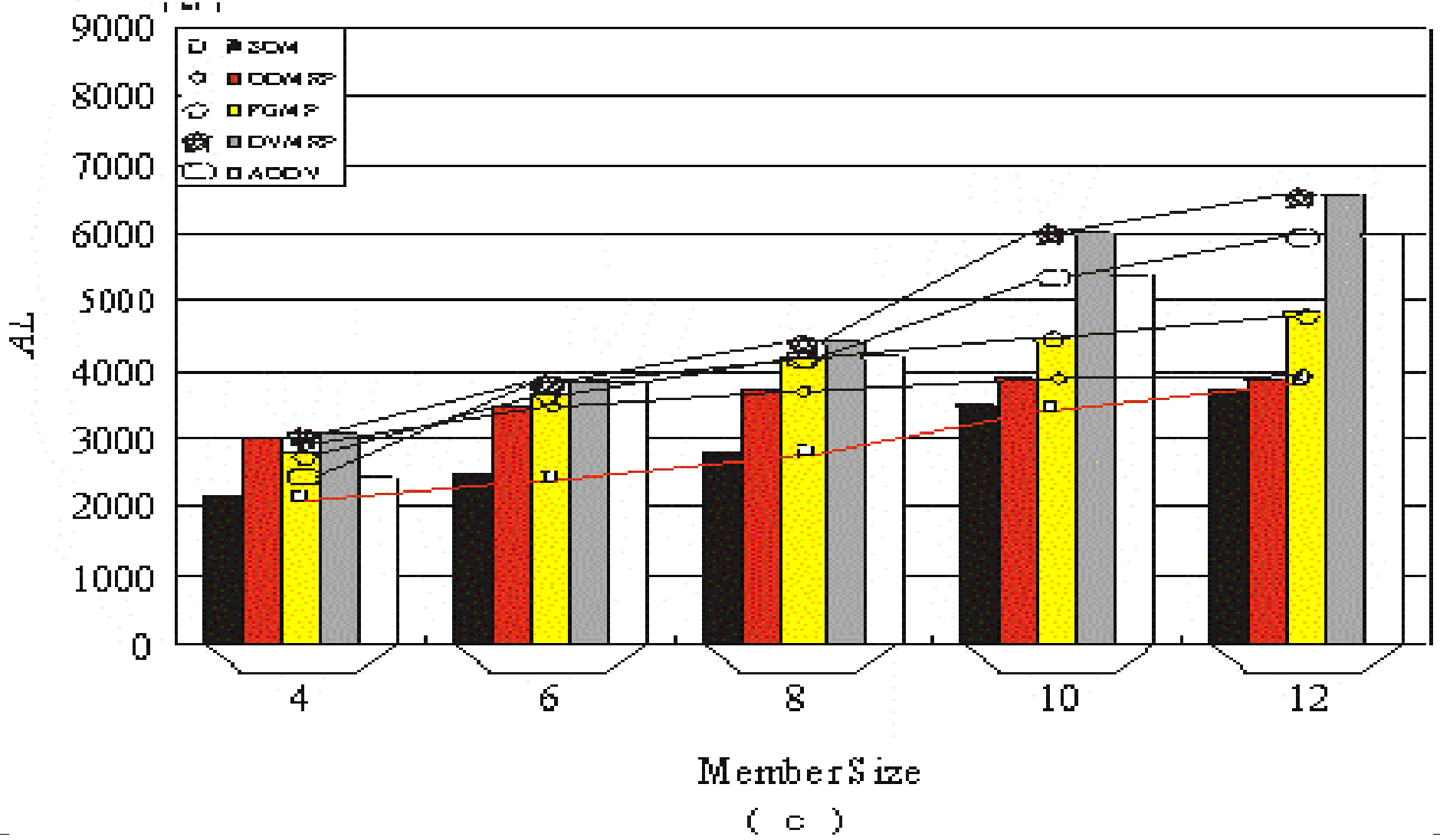
Performance of Average Latency vs. Effect of Mobility



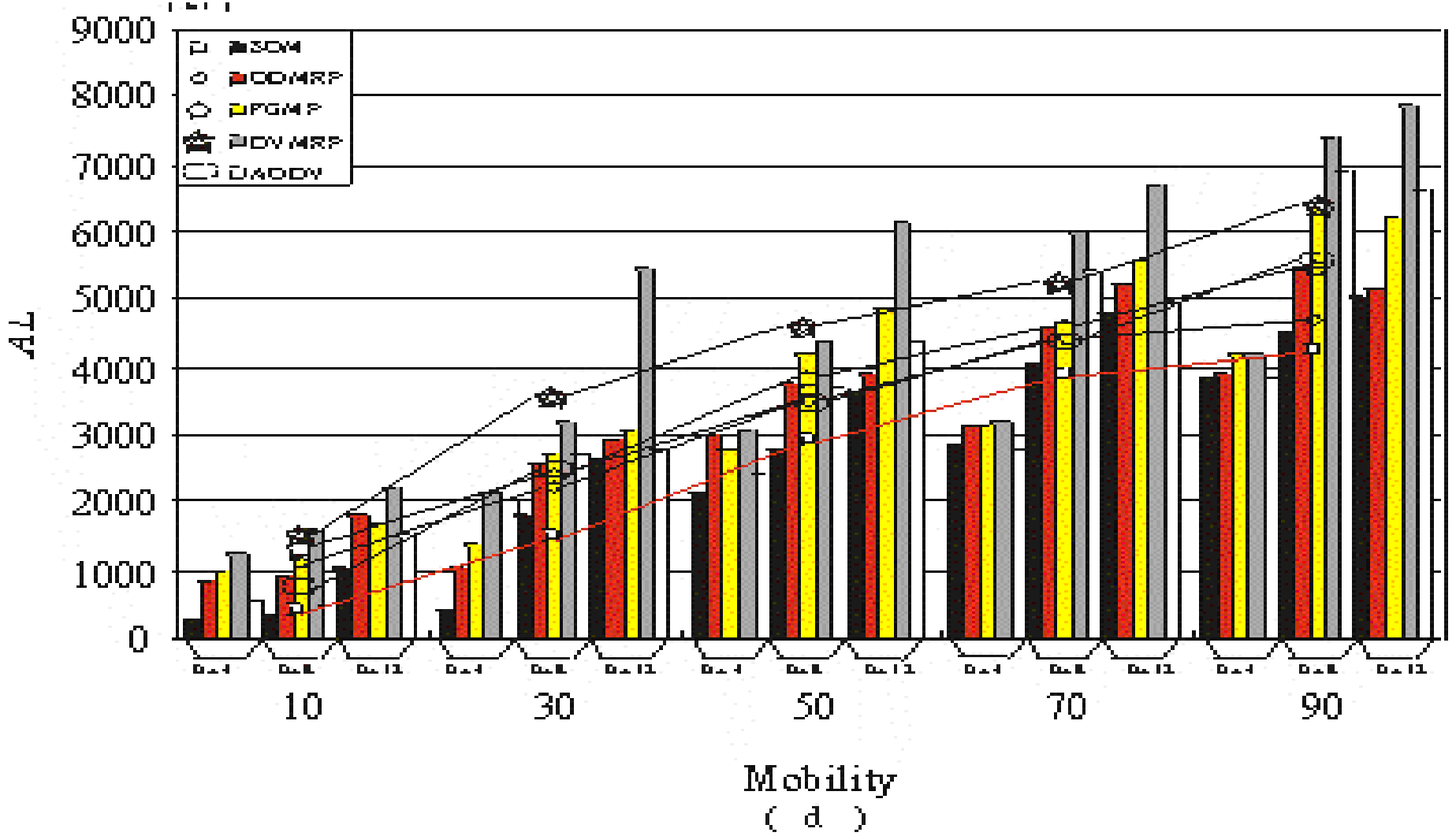
Performance of Average Latency vs. Effect of Number of Message Length



Performance of Average Latency vs. Effect of Number of Destination Nodes



Performance of Average Latency vs. Effect of Mobility with Number of Destination Nodes



V. Conclusion

- **This paper proposes a novel multicast routing (SOM) Protocol**
  - **Spiral-path-based** scheme
- **Our proposed protocol is truly efficient evaluated by our developed simulation platform**
- **Current Work**
  - Develop a QoS Routing Protocol using Spial-Path-Based Scheme

Homework #11:

1. What's multicast routing protocol in MANETs ?