Location-Aided Routing (LAR) in mobile ad hoc networks

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Abstract

A mobile ad hoc network consists of wireless hosts that may move often. Movement of hosts results in a change in routes, requiring some mechanism for determining new routes. Several routing protocols have already been proposed for ad hoc networks.

New approach to utilize location information (for instance, obtained using the global positioning system) to improve performance of routing protocols for ad hoc networks. By using location information, the proposed Location-Aided Routing (LAR) protocols limit the search for a new route to a smaller “request zone” of the ad hoc network.

Abstract

Mobile ad hoc networks consist of wireless mobile hosts that communicate with each other, in the absence of a fixed infrastructure

Host mobility can cause frequent unpredictable topology changes. Therefore, the task of finding and maintaining routes in MANET is nontrivial

An approach to decrease overhead of route discovery by utilizing location information by using the global positioning system (GPS) for mobile hosts

OUTLINE

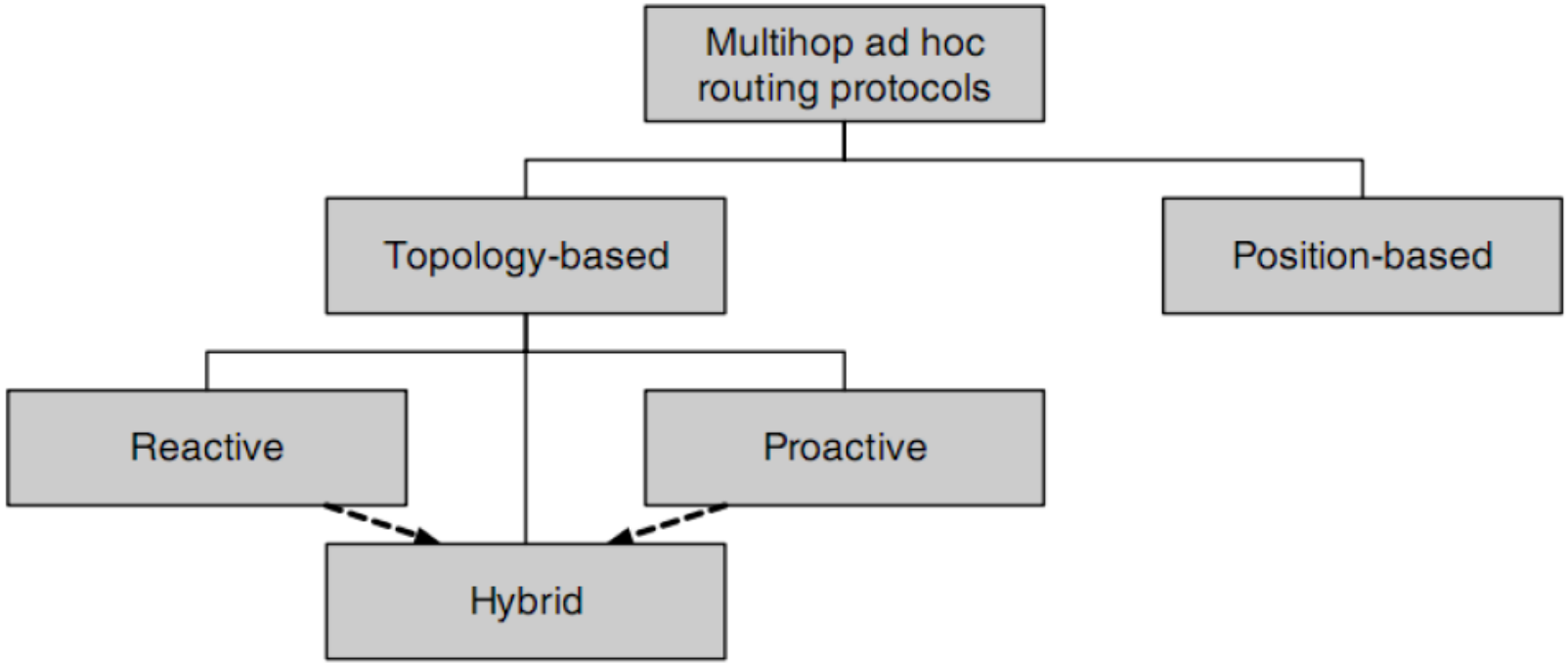
I.Design Rules
II.Related Works
III.Proposed Approach
IV.Performance Evaluation of the Approach
V.Several Optimizations to the Approach
VI.Conclusion

Design of routing protocols is a crucial problem in mobile ad hoc networks [5,32], and several routing algorithms have been developed

Adaption to the traffic patterns is harder than you imagine :)

The amount of routing related traffic may waste a large portion of the wireless bandwidth

Mobile Ad hoc NETwork Protocols



- **DSR** (Dynamic Source Routing)
  on-demand route discovery
- **AODV** (Ad hoc On demand Distance Vector routing)
  demand-driven route establishment procedure
- **TORA** (Temporally-Ordered Routing Algorithm)
  designed to minimize reaction to topological changes
- **ZRP** (Zone Routing Protocol)
  route discovery phase on-demand but limit in local neighborhood, hybrid
- ***DREAM***
  maintains location information of each node in routing tables and update periodically

[4, 8] for comperative performance evaluations

Difference between these MANET routing protocols

- The previous MANET routing algorithms do not take into account the physical location of a destination node
- proposed two algorithms to reduce route discovery overhead using location information (GPS)

3.1. Route discovery using flooding

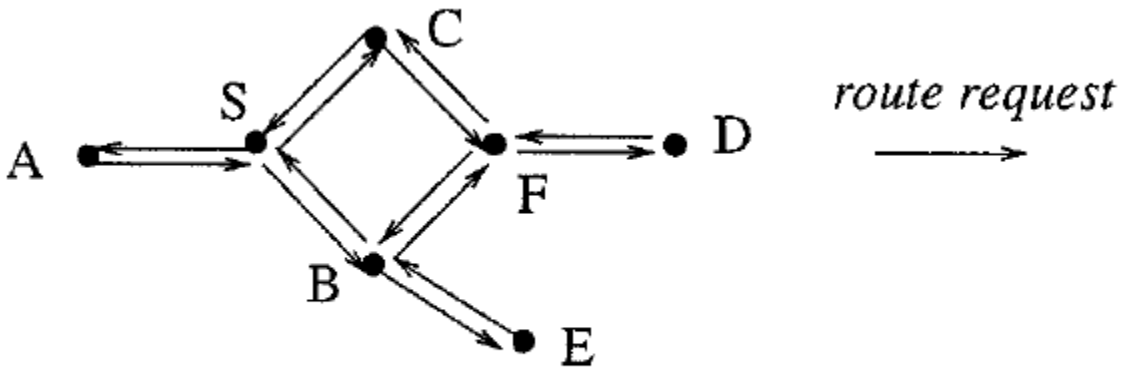


Figure 1. Illustration of flooding.

- Route Discovery, Route Request, Route Reply, Route Error
- Always node S try to reach to node D

3.2. Preliminaries

- Location Information (*via GPS in 2D, assumption with no error*)
- Expected Zone

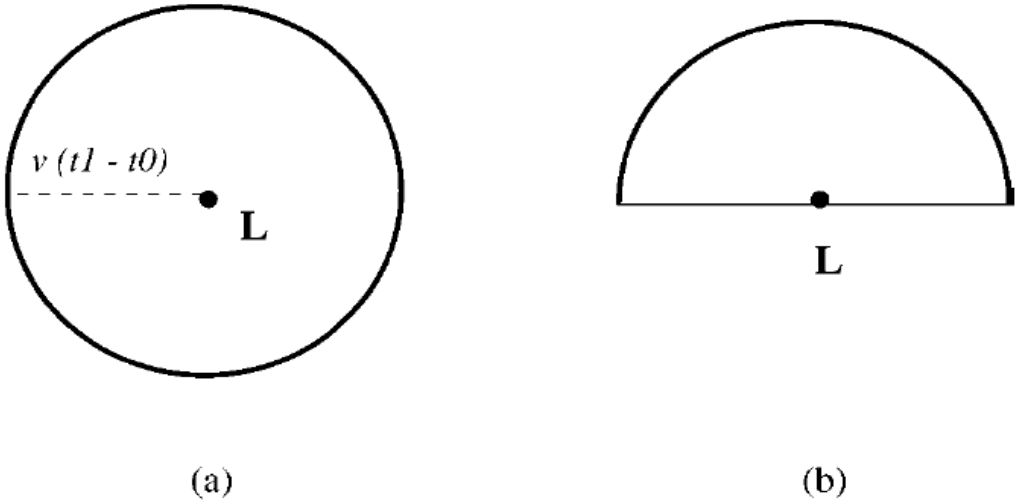


Figure 2. Examples of expected zone.

- Request Zone

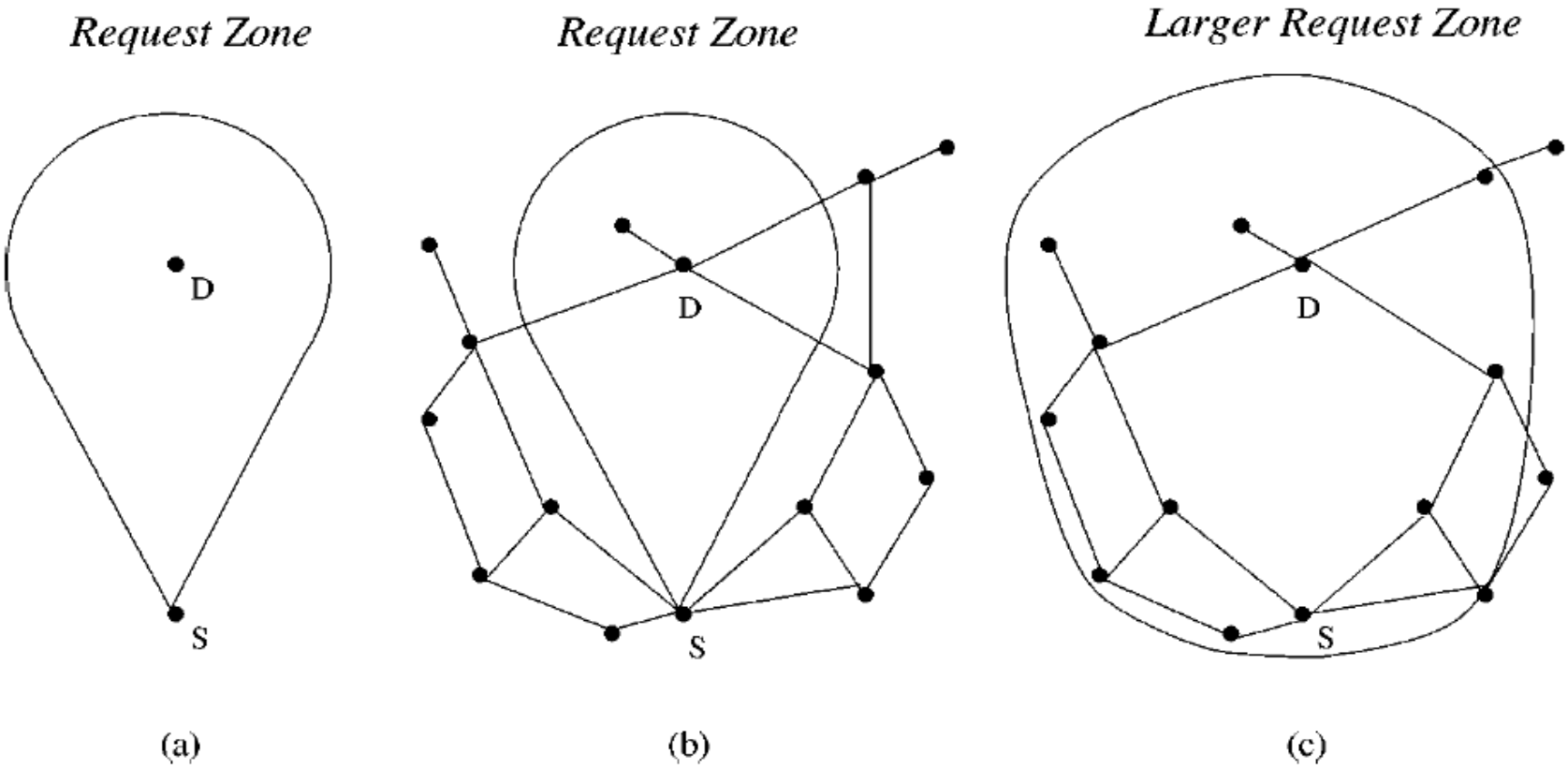


Figure 3. Request zone. An edge between two nodes means that they are neighbors.

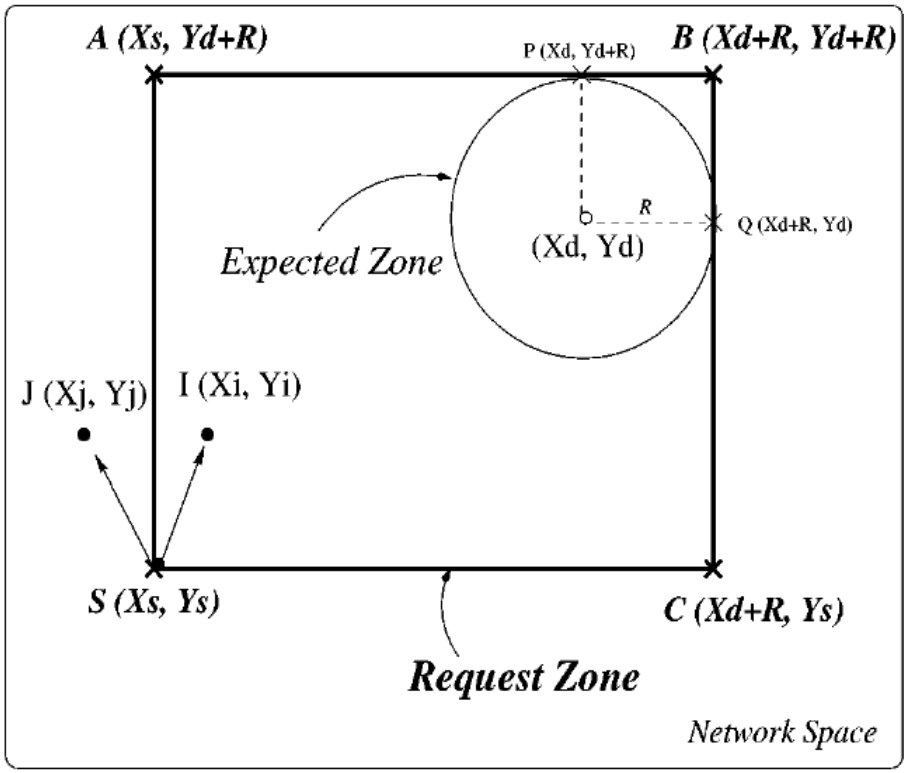
3.3. Determining membership of Request Zones

- LAR algorithm requires that a node be able to determine if it is in the request zone for a particular route request

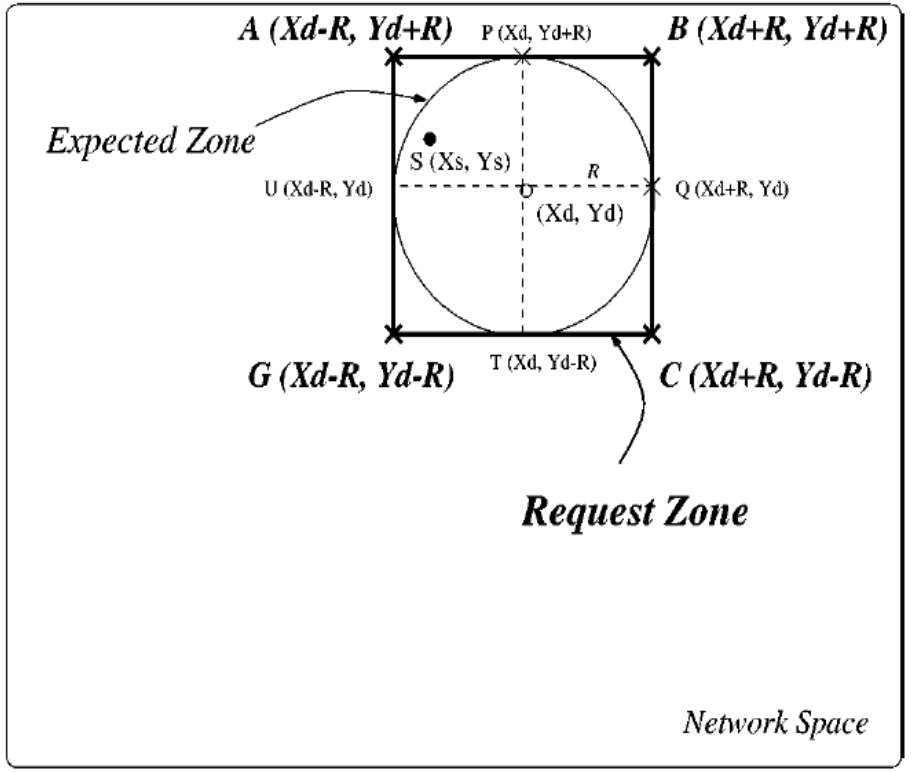
- the two LAR algorithms differ in the manner in which this determination is made (LAR 1 and LAR 2)

3.3.1. LAR scheme 1

- uses a request zone that is rectangular in shape



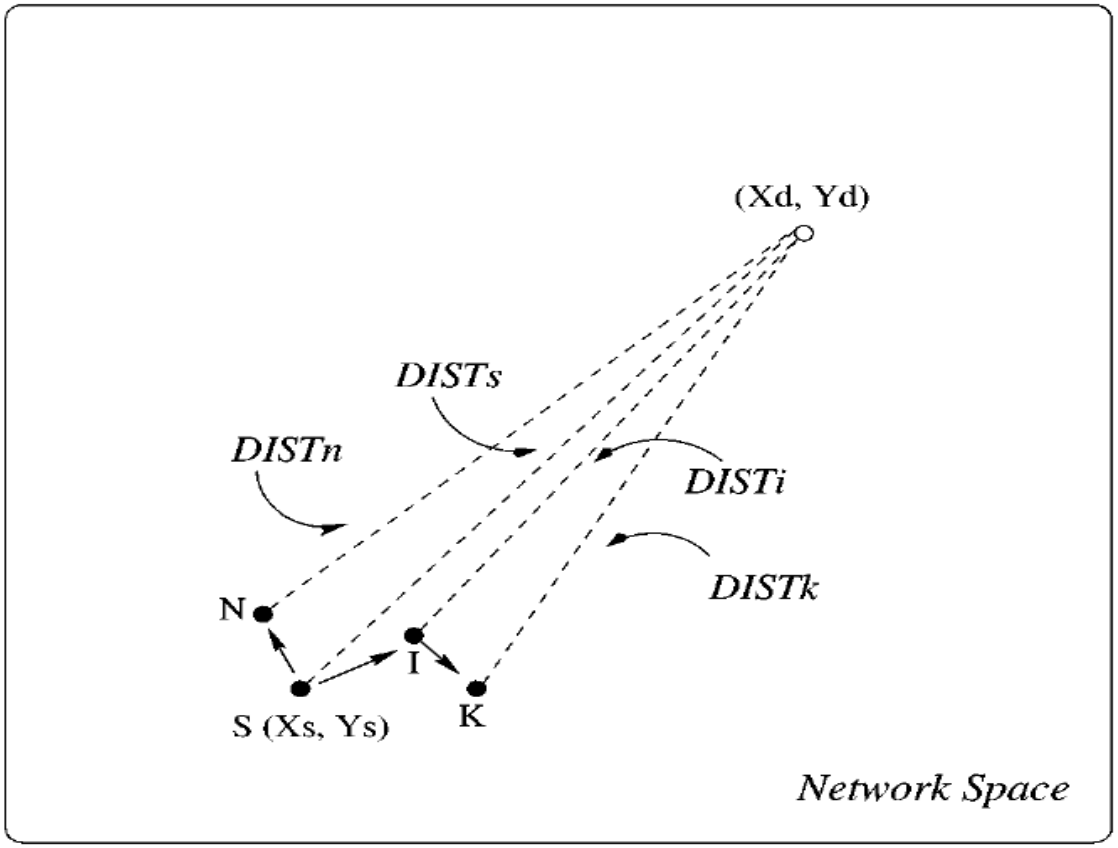
(a) Source node outside the Expected Zone



(b) Source node within the Expected Zone

3.3.2. LAR scheme 2

- uses distances to target node



(b) LAR scheme 2

For some α β,

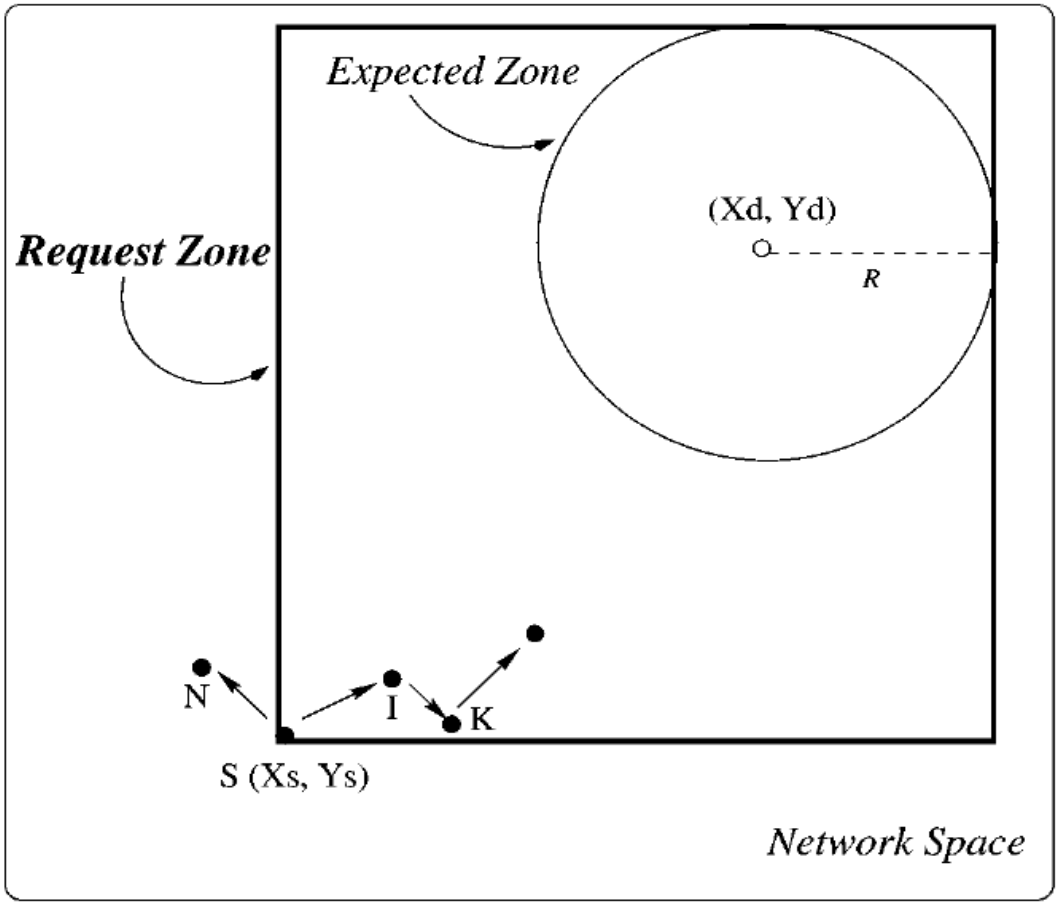
if α(DISTs)+

β> DISTi;

then node I forwards

(α = 1, β = 0)

3.3.3. LAR 1 vs LAR 2



(a) LAR scheme 1

4. Performance Evaluation

- Simulations using modified version of a network simulator, MaRS (Maryland Routing Simulator)
- Three routing protocols were simulated – basic flooding, LAR 1 and LAR 2
- Studied several cases by varying the number of nodes, transmission range of each node and moving speed
- Object is to show the usability of Location Information

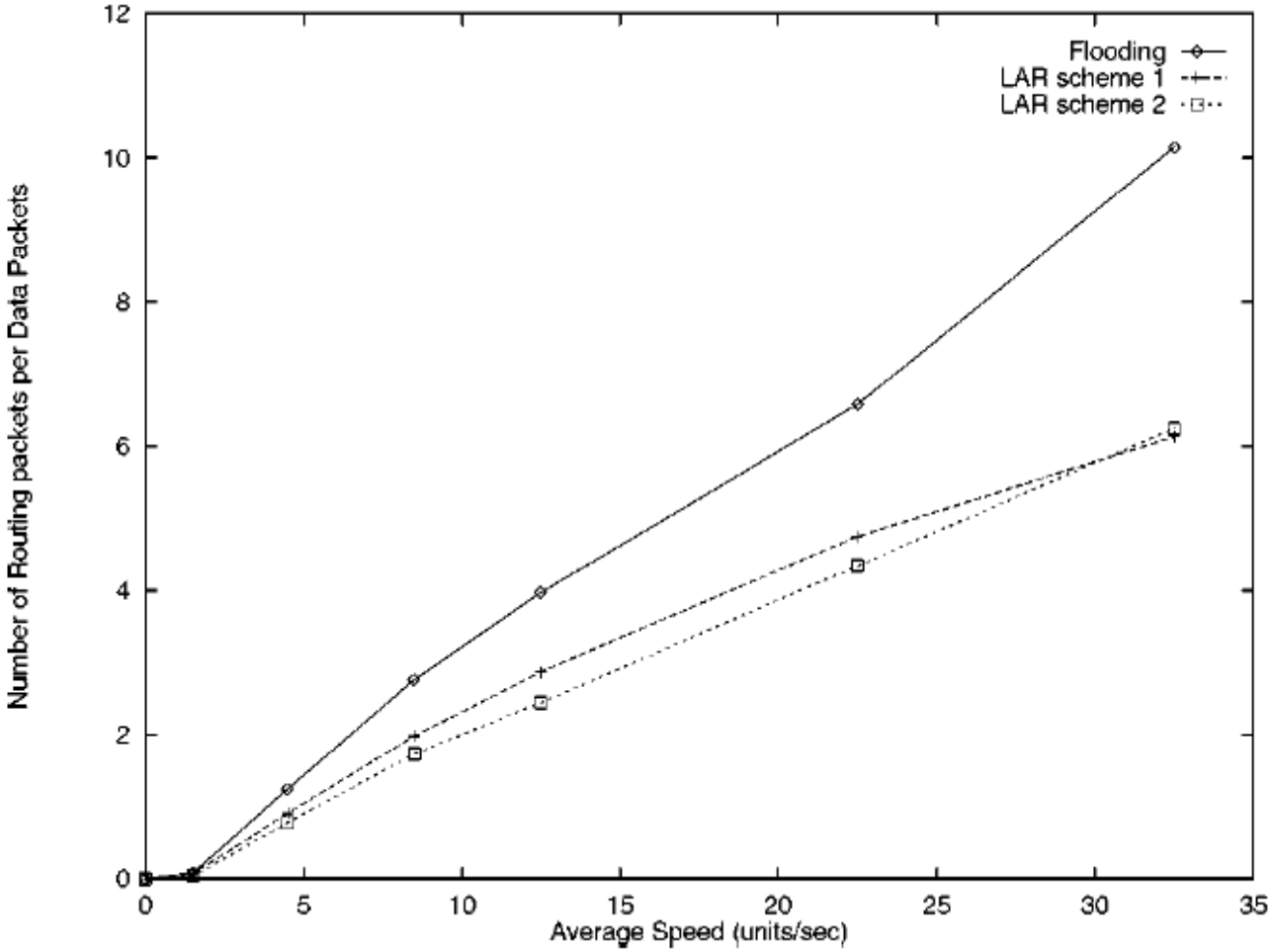
4.1. Simulation Model

In a simulation session;

- Number of nodes chosen to be different
- Uniform distrubiton of nodes in a given area
- Each node moves with an average speed
- Each node makes several moves and does not pause
- All nodes have the same transmission range
- Assumption of each node knows its current location accurately

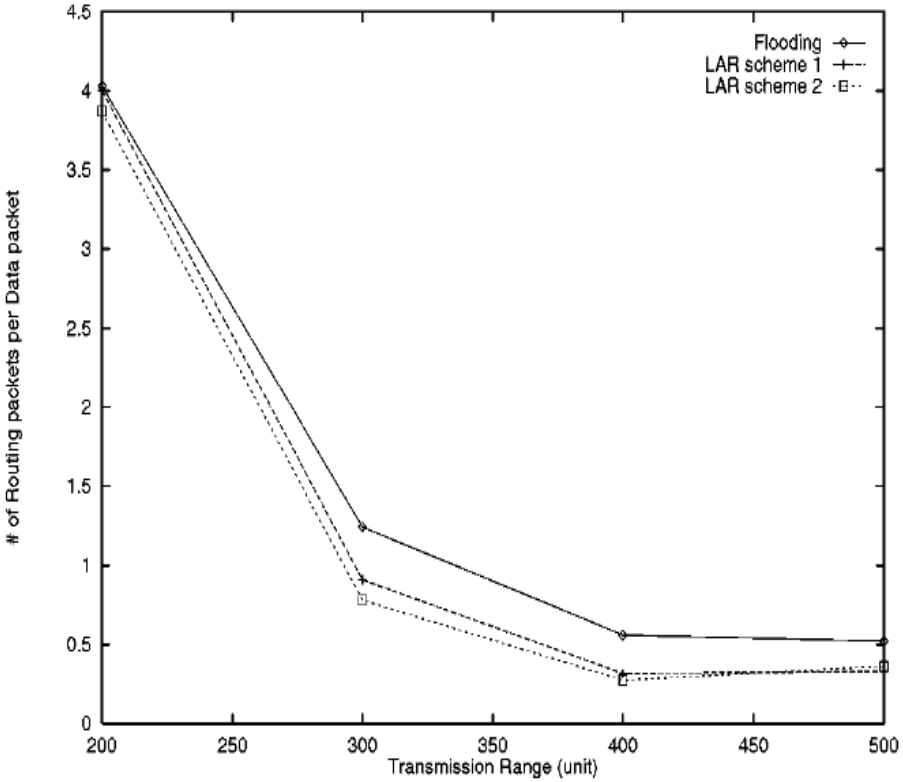
4.2. Simulation Results

The number of routing packets (RP) per data packet (DP) as a function of average speed

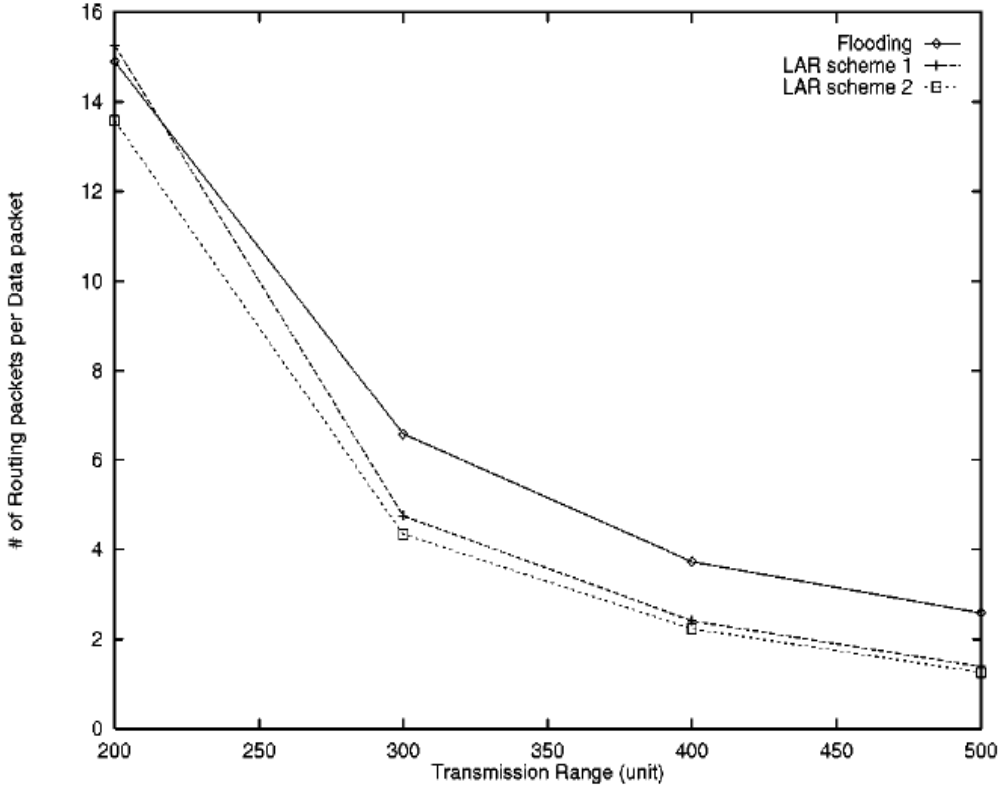


With higher speed, routing overhead to discover new routes also increases

Effect of varying transmission range



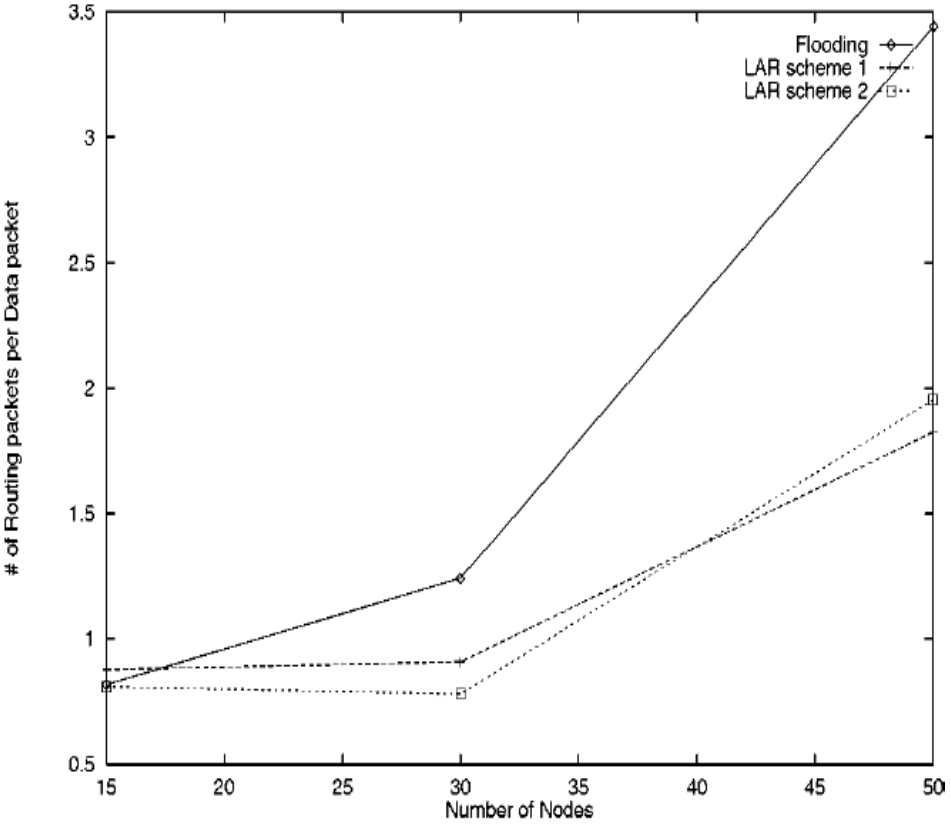
(a) Average speed 4.5 units/sec



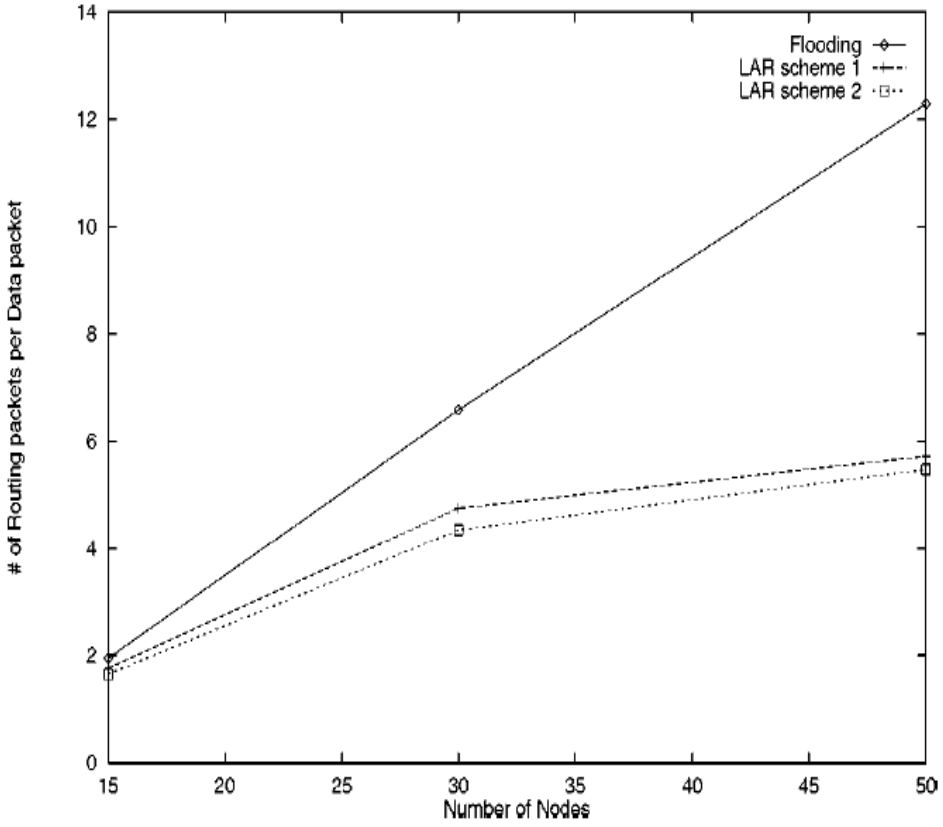
(b) Average speed 22.5 units/sec

With a smaller transmission range, number of neighbors for each node decreases

Effect of varying number of nodes

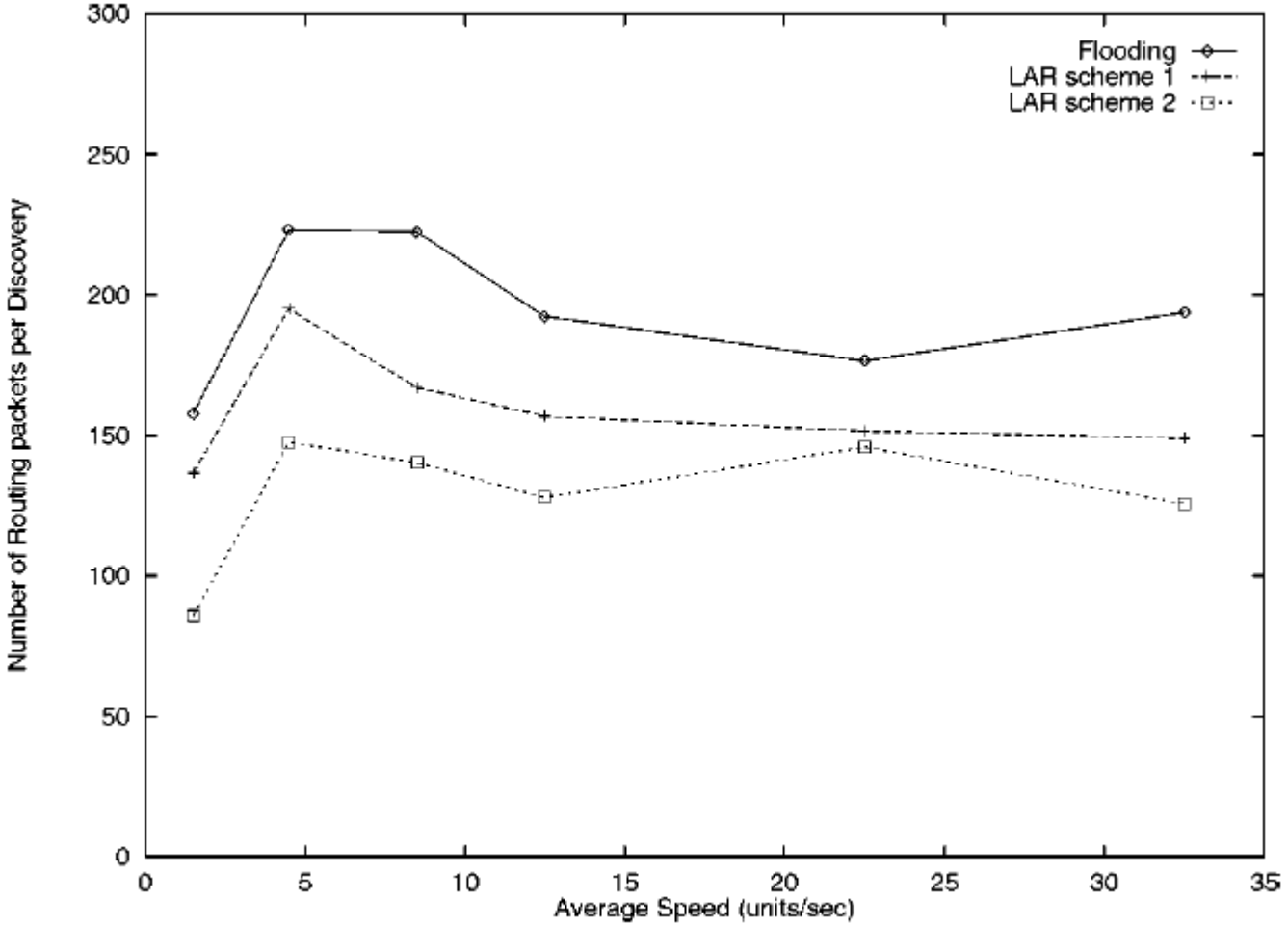


(a) Average speed 4.5 units/sec



(b) Average speed 22.5 units/sec

The number of RPs per discovery versus speed

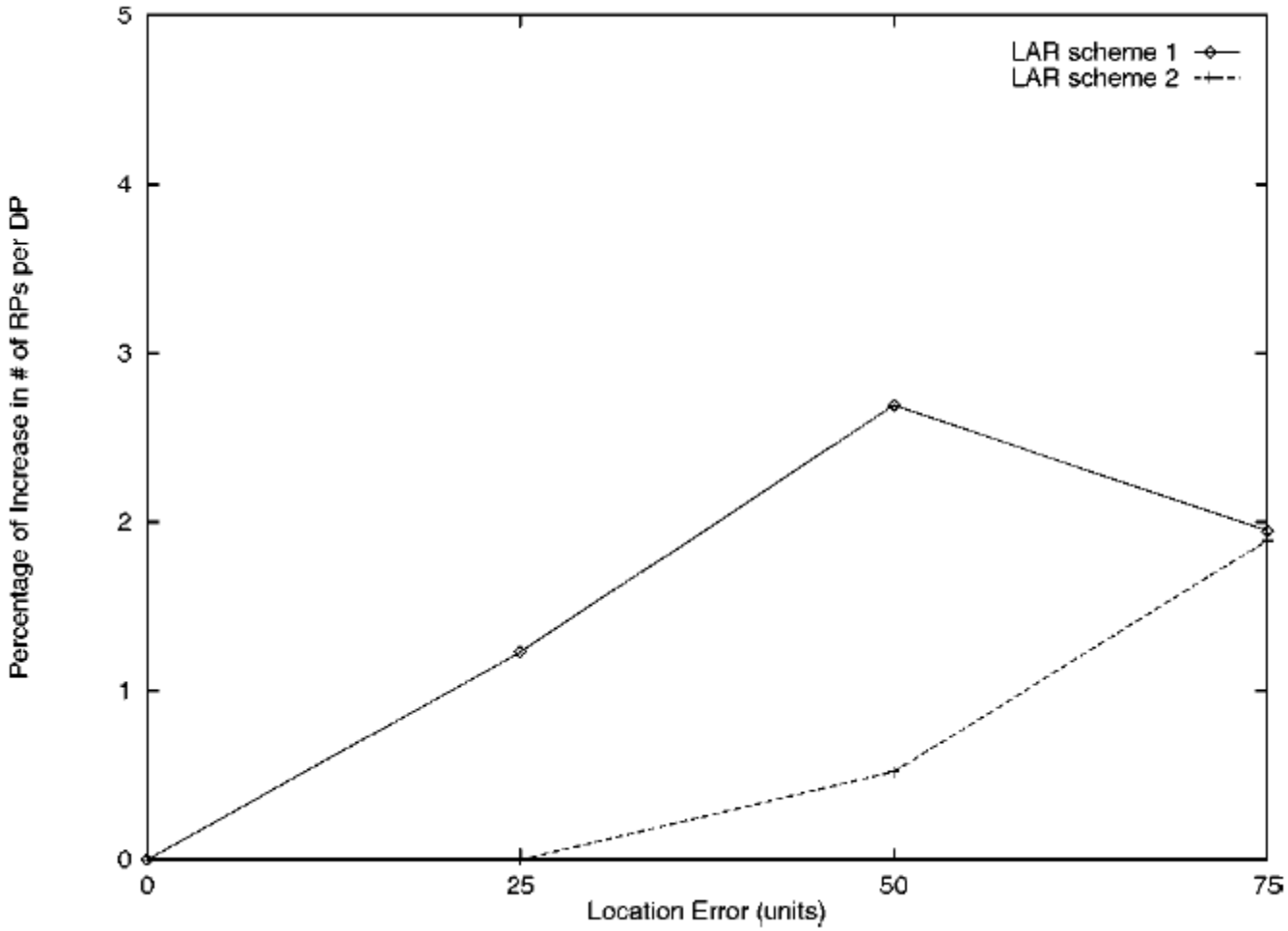


With higher speed, routing overhead to discover new routes also increases

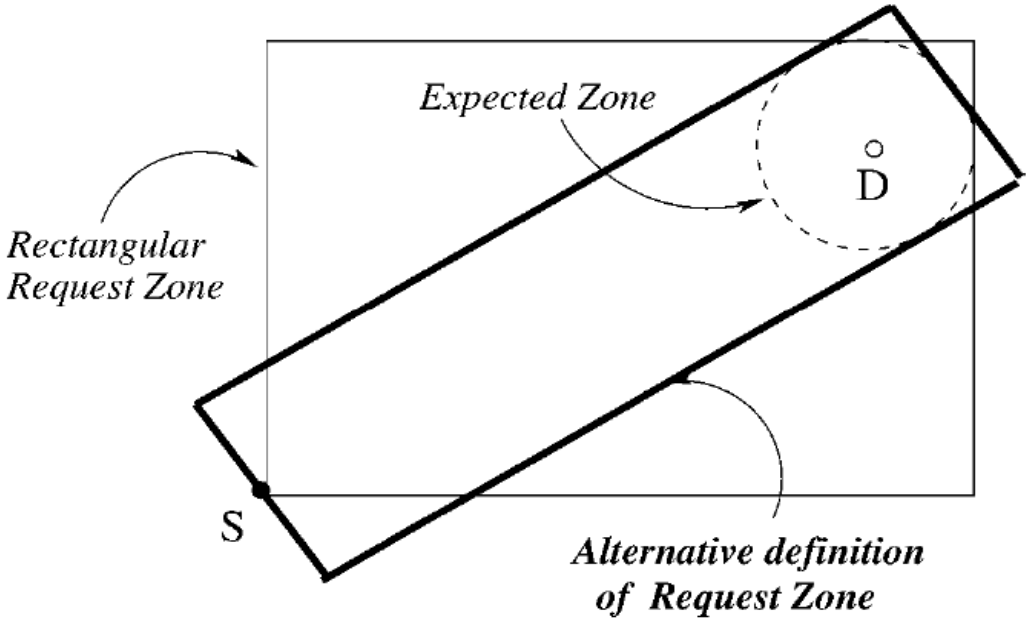
4.3. Impact of Location Error

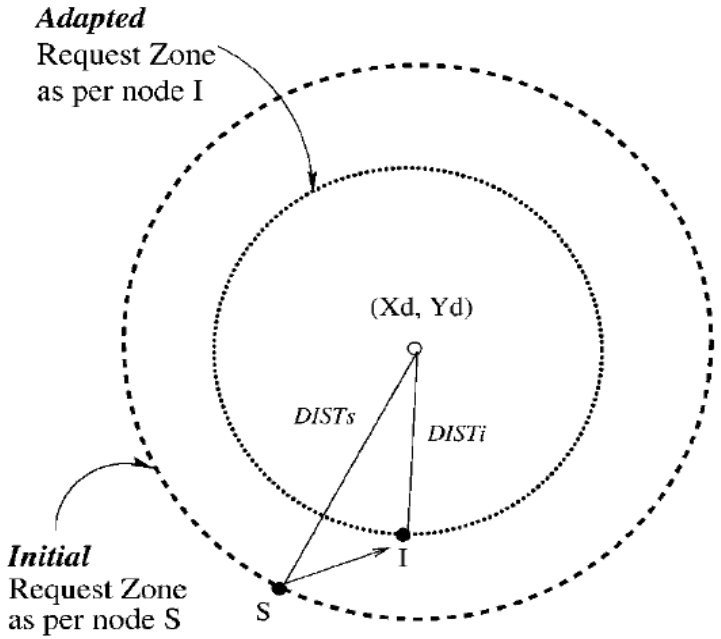
- The location of a node estimated using GPS may include some error
- Causes the estimation error of request zone
- With a larger location error(e), the size of request zone increases
  - bad news for LAR 1 scheme :)
- Routing overhead for LAR schemes increases with increasing location error

4. Performance Evaluation

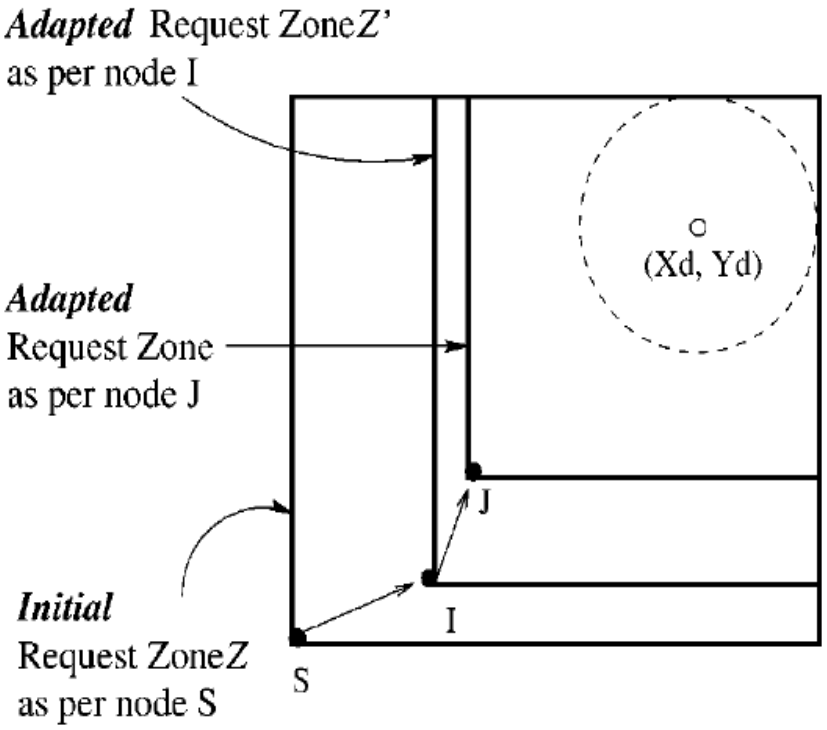


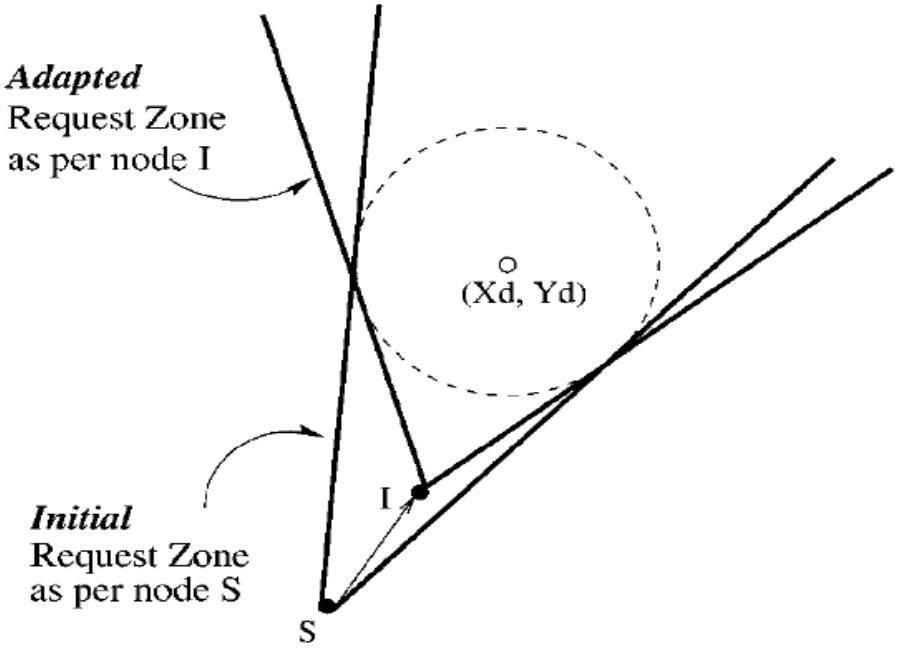
- **Alternative definitions of request zone (LAR 1)**



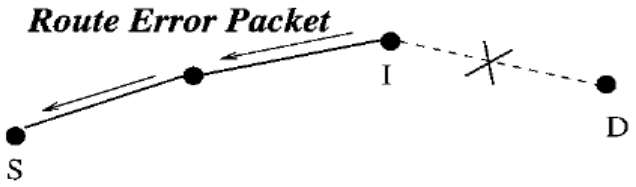


Produce new shapes by a stretch of imagination

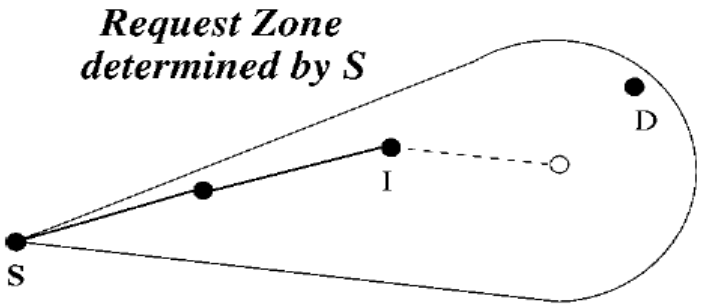




- **Up-to-date location info in mid-nodes**
- **Propogation of location and speed information**
  - Piggybacking the location information
- **Local Search**



(a)



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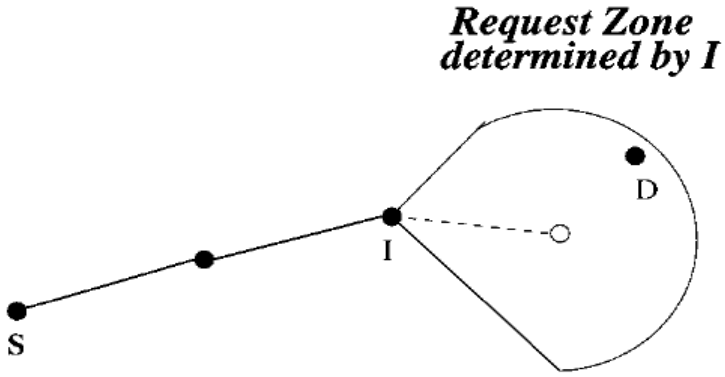
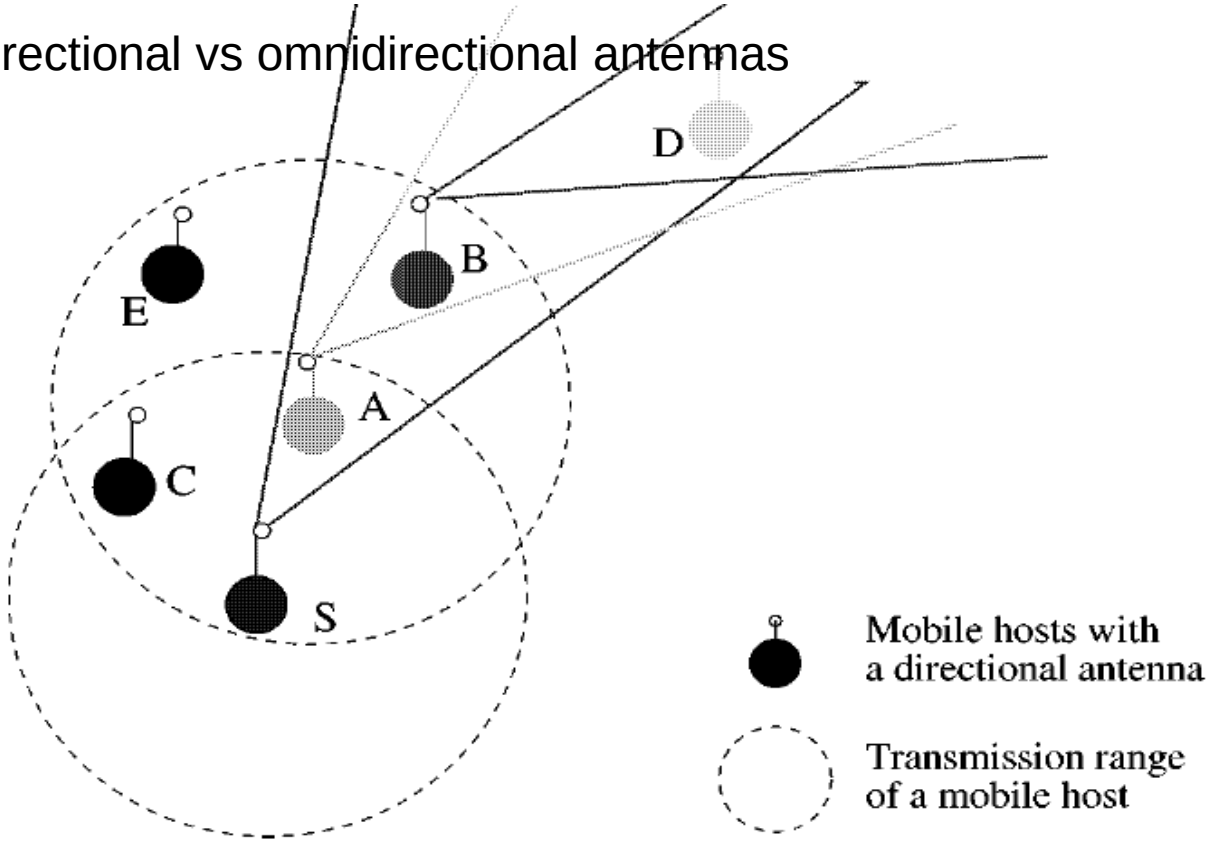


(c)

- **Combining with time-to-live (TTL)**
  - Limit the number of hops
- **Use of Directional Antennas**
  - Directional vs omnidirectional antennas



Conclusion & Questions

"Many resources and tricks on the Internet find you will, but solutions to all technical issues only in Source lie"