CS 525M – Mobile and Ubiquitous Computing Seminar

Flooding-Based Geocasting Protocols for Mobile Ad-Hoc Networks

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Introduction

- MANETs (Mobile Ad-hoc NETwork)
  - Like any ad-hoc network, no fixed network architecture
  - Scenarios for ad-hoc networks include search-and-rescue, friend-or-foe recognition, home networking, file sharing, etc.
    - http://computer.howstuffworks.com/mote.htm
    - http://www.kazaalite.com
- Multicasting
  - Commonly used in wired/wireless environments to distribute data to multiple recipients
  - Cheaper than establishing multiple unicast sessions (esp. in MANET topologies)
  - MANET multicasting difficult due to constant topology changes

Multicasting, Geocasting

- Multicasting
  - A multicast group shall be defined as a collection of nodes. Nodes that which to participate in a multicast shall be required to explicitly register to the group prior to participation.
- Geocasting
  - Variation of multicasting; used to propagate data to several nodes in a specified geographic (or *geocast*) region (i.e., *geocast group*)
  - Implicit group joining – dependent on node position at time of geocast.
  - All nodes shall know their geographic location (GPS-based)

Concept - Geocast Flooding

- Simplest approach to multicasting
- Applied to geocast groups/regions…

```
if (node ∈ geocast_region)
        accept_packet();
endif

if (packet_is_new)
        broadcast_to_neighbors();
endif
```

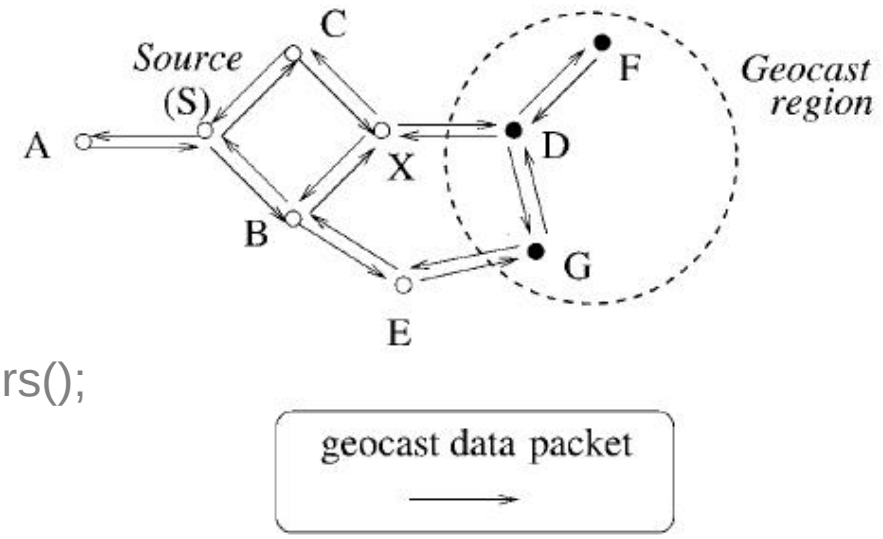


Figure 1. Illustration of *geocast flooding* algorithm.

Concept – Forwarding Zone

- Nodes forward packets if they are contained in the forwarding zone
- Goal – increase probability of delivery while reducing transmission overhead
- Applied to geocast flooding…

```
if (node ∈ geocast_region)
      accept_packet();
endif

if (packet_is_new &&
   (node ∈ forwarding_zone))
      broadcast_to_neighbors();
endif
```

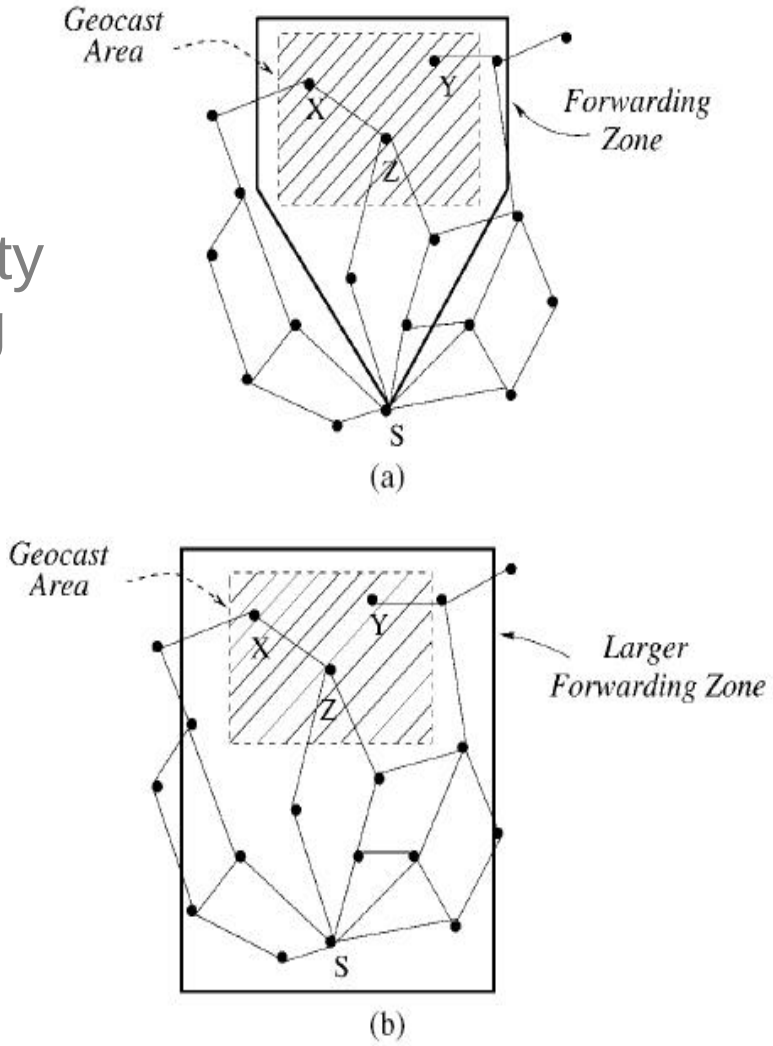


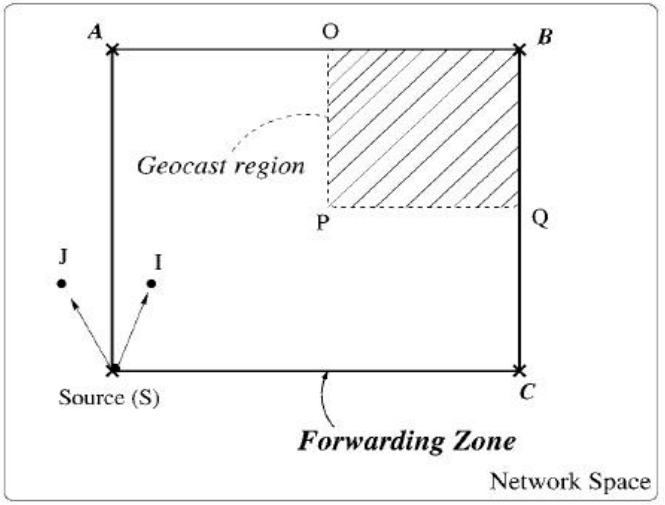
Figure 3. Definition of forwarding zone.

Geocasting Protocols

- Flooding-based Geocasting (baseline)
- Static Zone Scheme
- Adaptive Zone Scheme w/one-hop flooding
- Adaptive Distance Scheme

Static Zone Scheme

- Forwarding zone:
  the smallest rectangle that includes current location of source S and the geocast region, such that the sides of the rectangle are parallel to the X (horizontal) and Y (vertical) axes.
- Source coordinates included w/geocast packet
- Static – forwarding zone never changes during propagation from node to node



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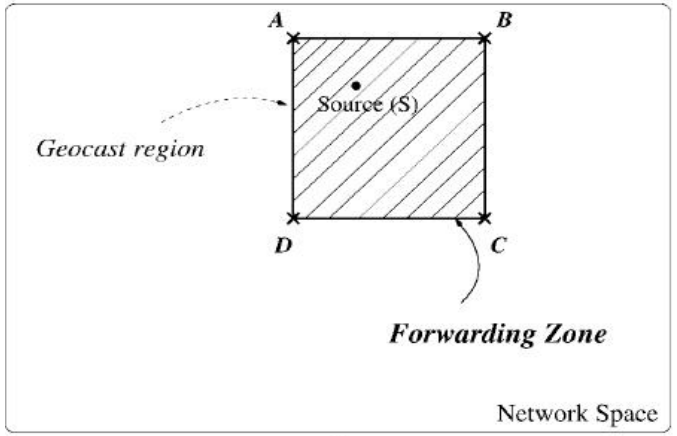


(b)

Figure 4. Static zone scheme. (a) Source node outside the geocast region. (b) Source node within the geocast region.

Adaptive Zone Scheme

- Similar to static zone scheme, except nodes replace source coordinates with current node
- Can lead to poor performance with a less-than-optimal MANET topology

```
if (node ∈ geocast_region)
      accept_packet();
endif

if (packet_is_new &&
   (node ∈ forwarding_zone))
      replace_forwarding_zone();
      broadcast_to_neighbors();
endif
```

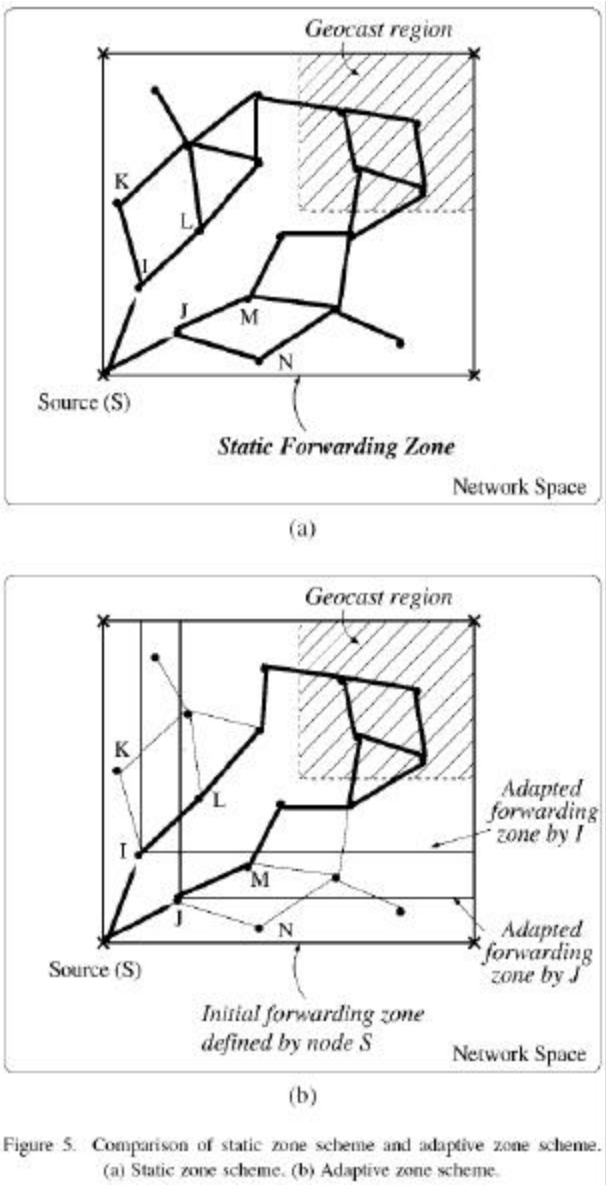


Figure 5. Comparison of static zone scheme and adaptive zone scheme. (a) Static zone scheme. (b) Adaptive zone scheme.

One-Hop Flooding

- In situations where topology is less than ideal, introduce one-hop flooding
- Allows propagation of packet to nodes outside of forwarding zone
- Greatly increases propagation probability

```
if (node ∈ geocast_region)
        accept_packet();
endif

if (packet_is_new &&
   (node ∈ forwarding_zone))
        replace_forwarding_zone();
        broadcast_to_neighbors();
elif (packet_is_new)
        revert_forwarding_zone();
        flood_to_neighbors();
endif
```

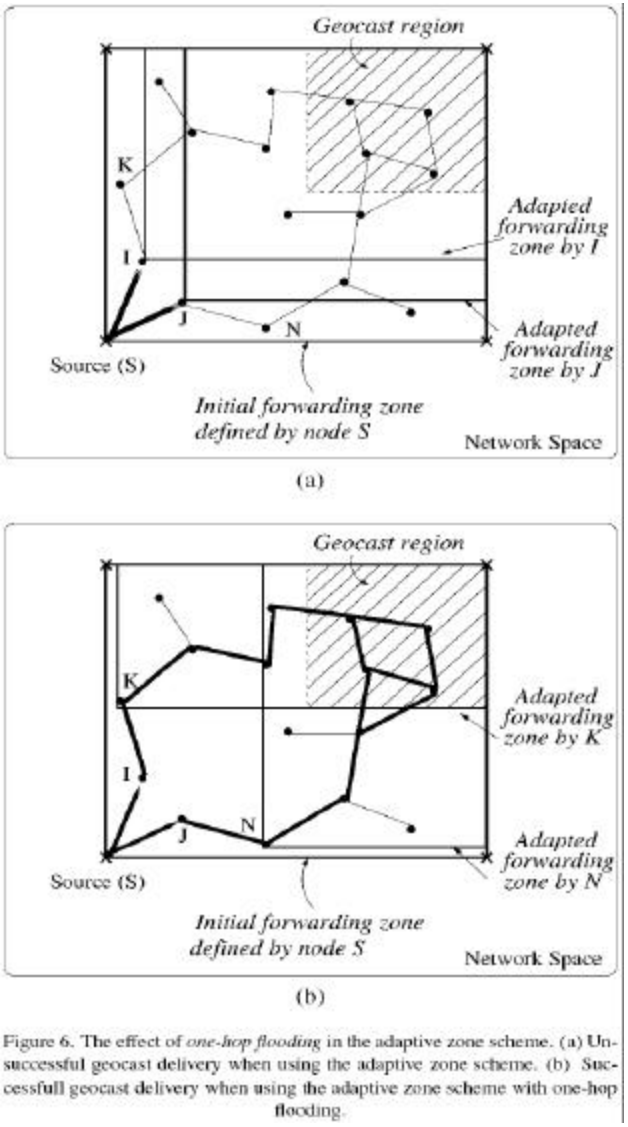


Figure 6. The effect of *one-hop flooding* in the adaptive zone scheme. (a) Unsuccessful geocast delivery when using the adaptive zone scheme. (b) Successfull geocast delivery when using the adaptive zone scheme with one-hop flooding.

Adaptive Distance Scheme

- Geocast packet includes:
  - Geocast region
  - Center of geocast region (X_c, Y_c)
  - Source location (X_s, Y_s)
- Similar problems occur as with adaptive zone without one-hop flooding (e.g., ‘deadlock’)

```
if (node ∈ geocast_region)
        accept_packet();
endif

if (packet_is_new &&
   (source_distance >= node_distance))
        replace_node_location();
        broadcast_to_neighbors();
elif (packet_is_new &&
        (source_node ∈ geocast_region))
        broadcast_to_neighbors();
endif
```

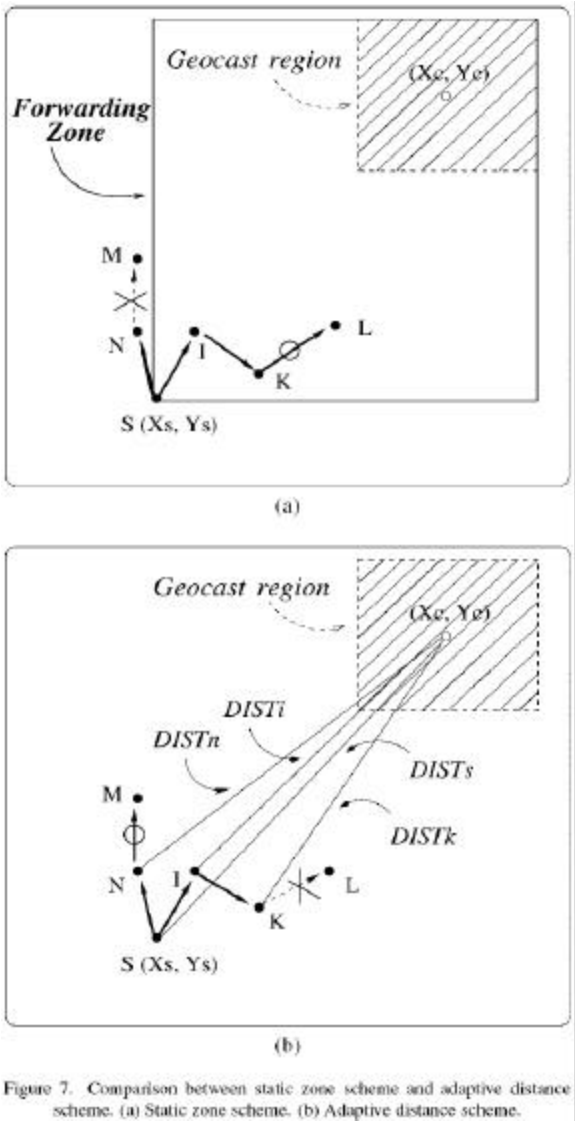


Figure 7. Comparison between static zone scheme and adaptive distance scheme. (a) Static zone scheme. (b) Adaptive distance scheme.

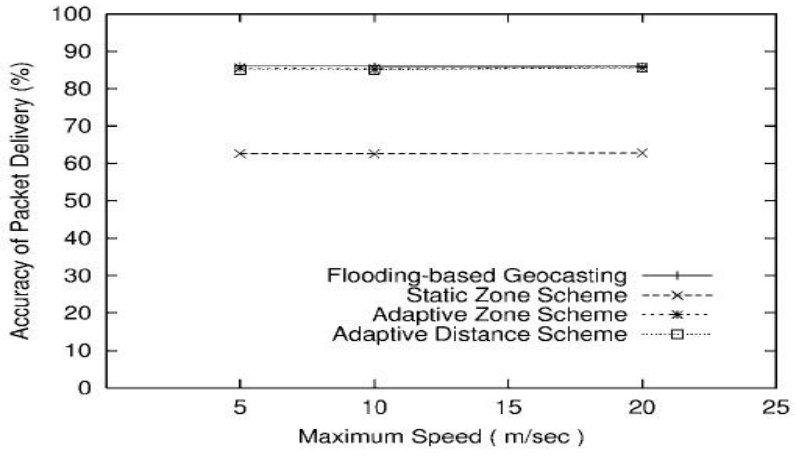
Simulation/Results

- Basics
  - Number of nodes {10, 30, 50}
  - Node locality derived via uniform distribution
  - Mobility – determines direction, speed, distance
    - Region {1000, 1000} (X vs. Y) units
    - Maximum speeds {5, 10, 20} units/sec
  - Movement pause patterns {0, 1, 3, 5, 7, 9} sec
  - Transmission range (250 units)
  - Wireless link bandwidth (2 Mbps)
- Simulation time varies inversely w/speed
- Geocast packet generation every 1 sec per maximum speed of 5 units/sec
  - Geocast frequency proportional to speed
- Geocast region defined {700,1000} ie, 300 units sq.

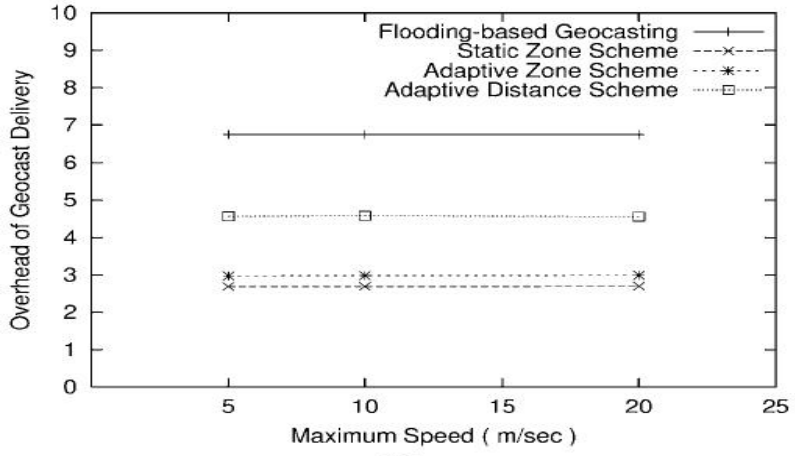
Geocast Delivery Metrics

- Accuracy – *the ratio of the number of group members that actually receive the geocast packet, and the number of group members which were in the geocast region at the time when the geocast delivery was initiated*
- Overhead – *the average number of geocast packets received by each node per geocast*

Results – Speed Variation



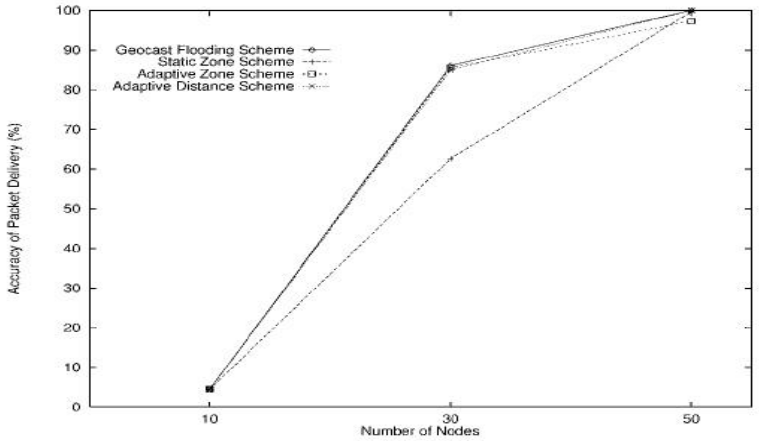
(a)



(b)

Figure 8. Comparison of three proposed geocasting protocols to geocast flooding with a variation of moving speed (for 30 nodes, and pause time of 0 unit). (a) Delivery accuracy versus speed, (b) delivery overhead versus speed.

Results – Node/Pause variation



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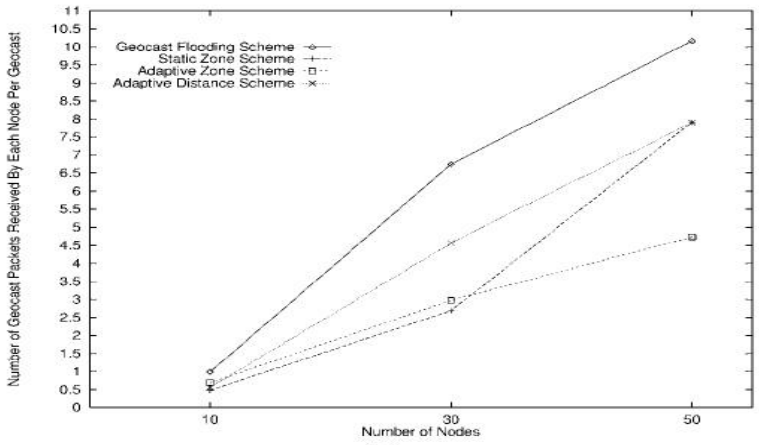
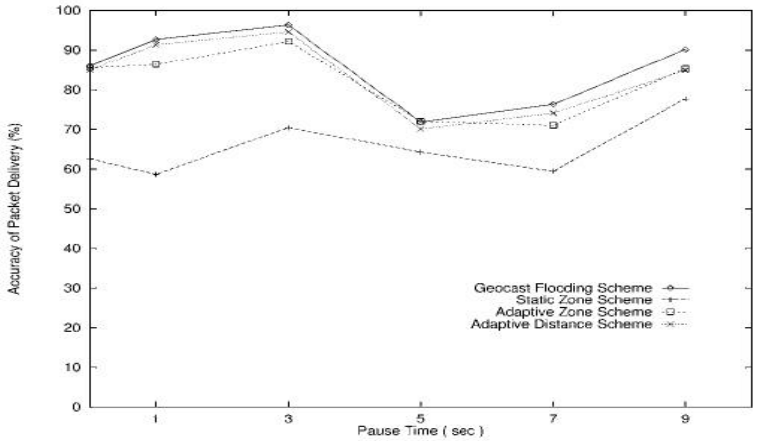
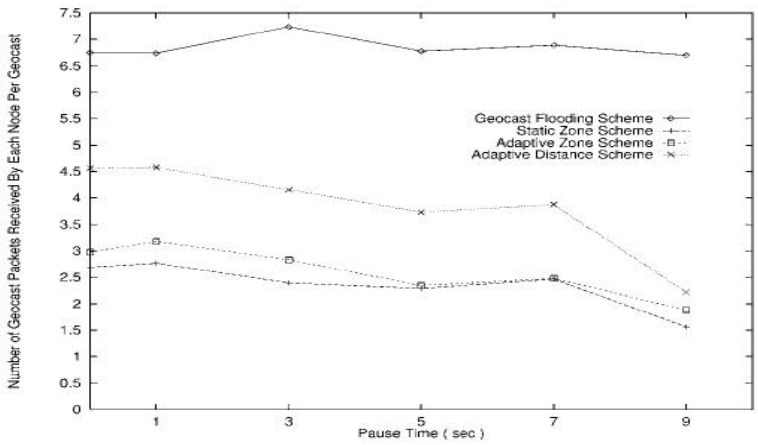


(b)

Figure 9. Comparison of three proposed geocasting protocols to geocast flooding with a variation of node numbers (for pause time 0, and maximum speed of 5.0 units/s). (a) Delivery accuracy versus number of nodes, (b) delivery overhead versus number of nodes.



(a)



(b)

Figure 10. Comparison of three proposed geocasting protocols to geocast flooding with a variation of pause time (for 30 nodes, and maximum speed of 5.0 units/s). (a) Delivery accuracy versus pause time, (b) delivery overhead versus pause time.

Conclusions

- All proposed protocols result in significantly lower geocast overhead
- It is possible to reduce overhead while still maintaining same level accuracy
- Adaptive zone scheme w/one-hop flooding is optimal of proposed protocols