Independent Zone Routing (IZR): An Adaptive Hybrid Routing Framework for Ad Hoc Wireless Networks

Prince Samar, Marc R. Pearlman,
Zygmunt J. Haas, Member, *IEEE*

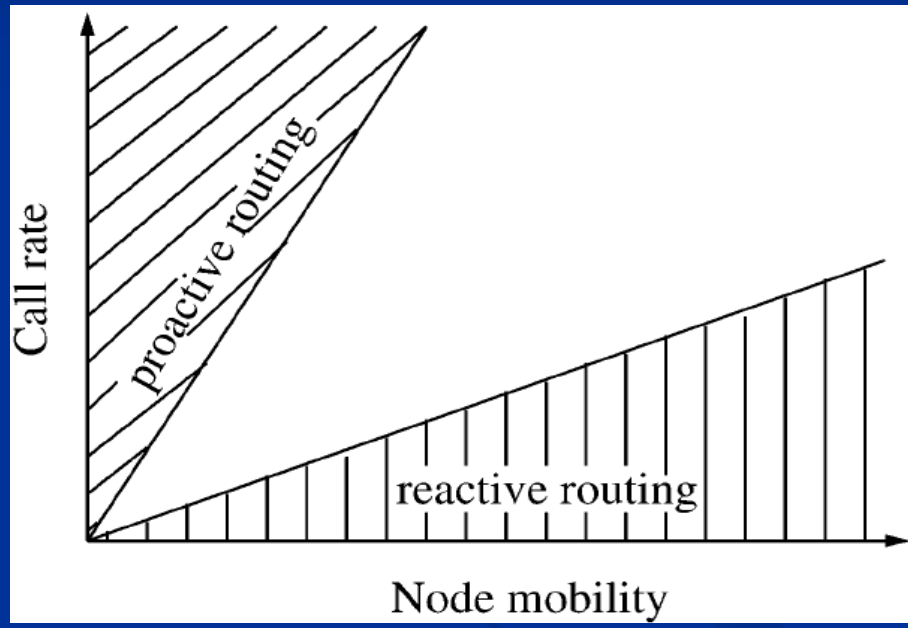
OUTLINE

- INTRODUCTION
- ZONE ROUTING FRAMEWORK
- IZR
- PERFORMANCE EVALUATION
- CONCLUSION

INTRODUCTION

- For the case of a two-protocol framework, protocol A would operate locally, while the operation of protocol B would be global.

- As the scope of protocol A is increased, more information becomes available to protocol B, thereby reducing the overhead produced by protocol B.



INTRODUCTION

- Having independently sized routing zones capability would allow nodes to automatically configure their optimal zone radii, thus making the framework truly flexible.

- IZR would not only reduce the routing overhead, but would be responsive to the needs of the network traffic as well.

ZONE ROUTING FRAMEWORK

- IARP (intra-zone routing protocol)
  - Neighbor discovery by periodic broadcasting of HELLO beacons.
  - Each node periodically broadcasts its link state for a depth of R hops.

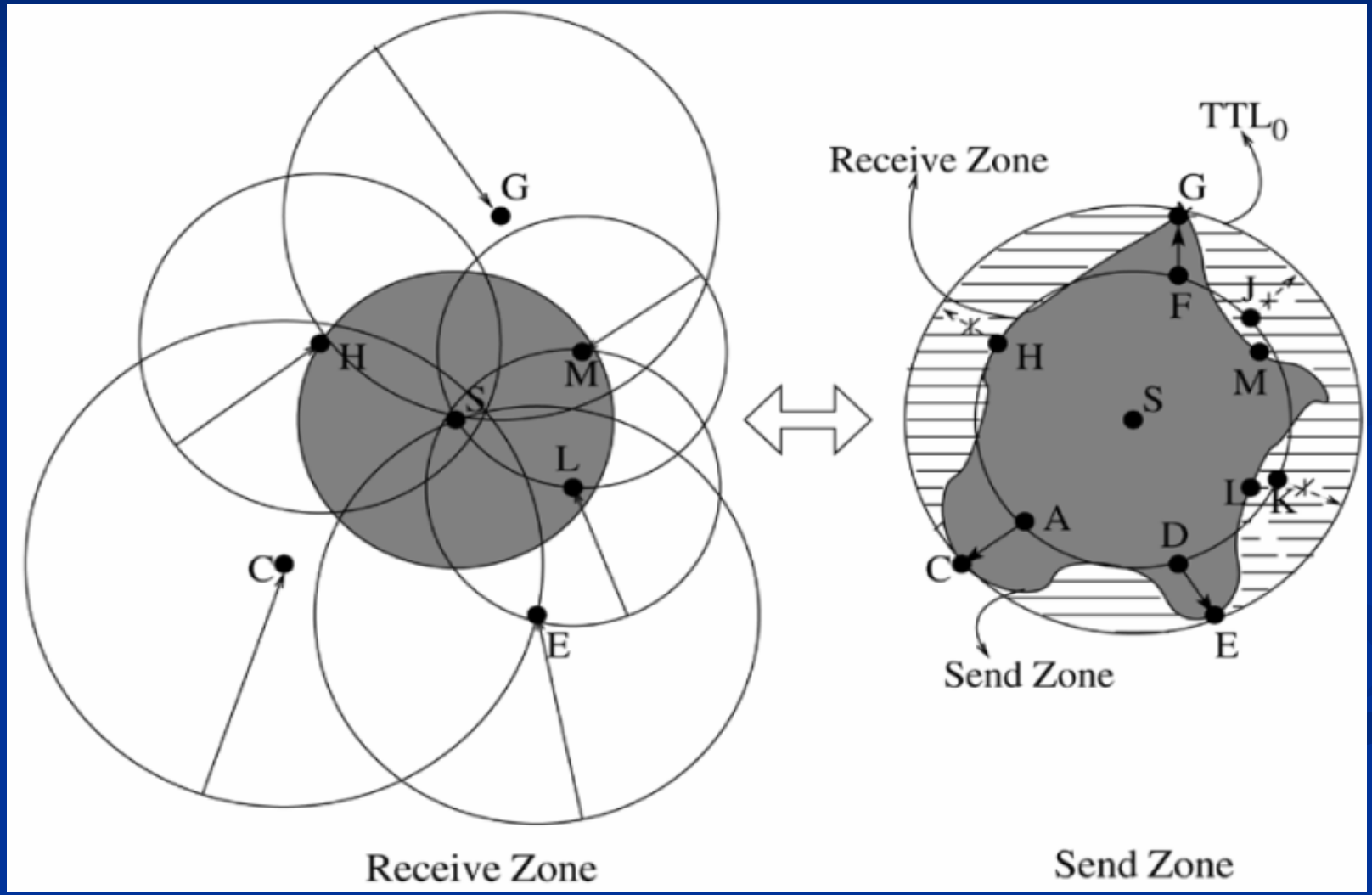
ZONE ROUTING FRAMEWORK

- IERP (inter-zone routing protocol)
  - Using bordercasting to discover routes.
  - Bordercasting can exploit the IARP information to direct query the peripheral nodes.
  - A covered node is defined as one that belongs to the routing zone of a node that has received a route query.

IZR

- **Routing zone or Receive Zone:**
  - The neighborhood around each node about which a node proactively maintains routing information is called its routing zone.
- **Send Zone:**
  - A node is expected to broadcast proactive updates to the members of its send zone.

IZR

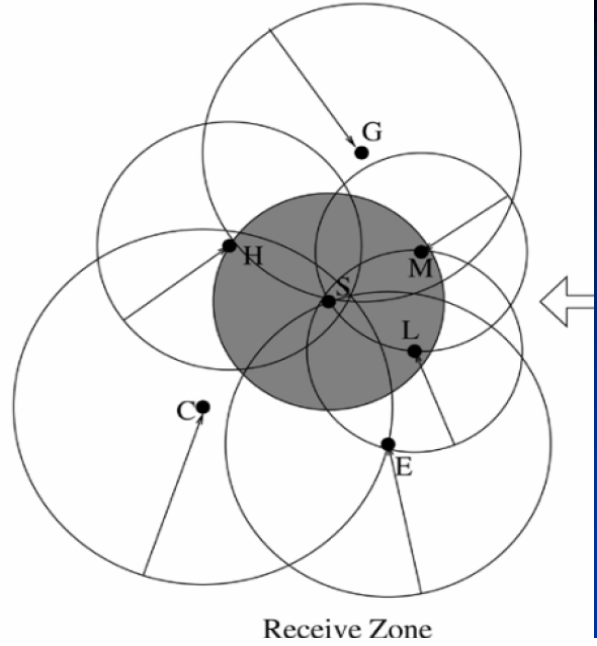

G
H
M
S
L
C
E
Receive Zone
TTL0
Receive Zone
G
F
J
H
M
S
L
K
A
D
C
E
Send Zone
Receive Zone
Send Zone

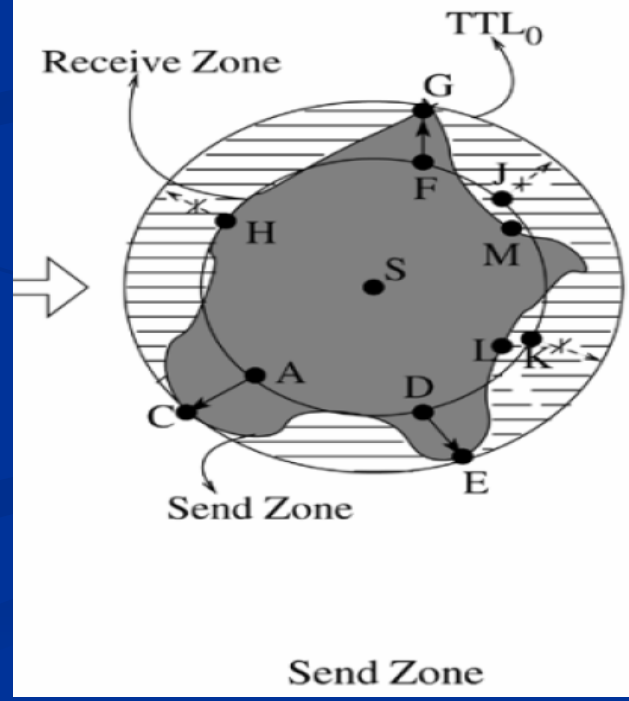
IZR
IARP

- Nodes S, C, E, L, M,G, H broadcast their zonebuilding packets to their routing zone members.
- Each node will receive a zone building packet from all those nodes to whose routing zone it belongs.
- Thus, C, E, L, M, G and H belong to S's send zone.

IZR
IARP

- In order to reduce the overhead, node A maintains information about C, D about E, and F about G.
- A node A maintain a list of all nodes for whom it serves as a peripheral node.
  - For each node S in this list, A maintains another list which consists of all nodes C.





IZR

route query

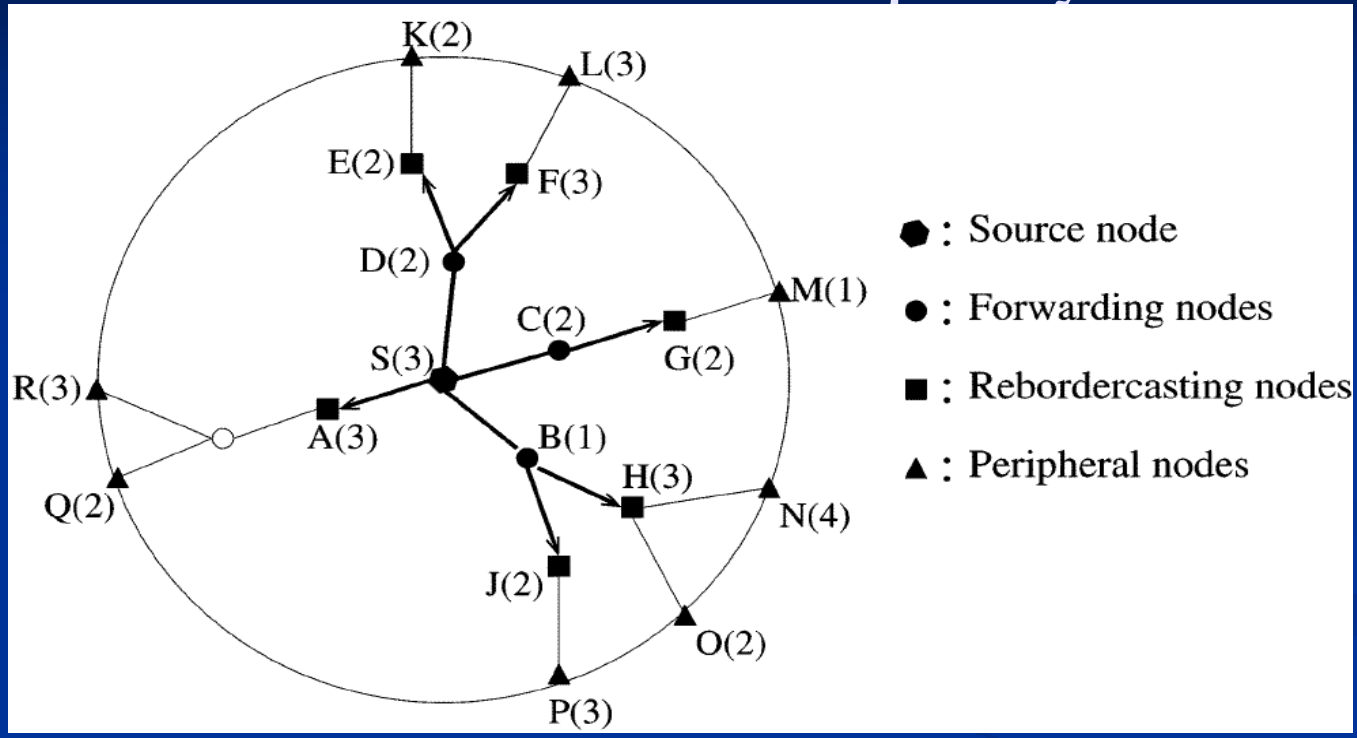
Source node constructs the bordercast tree to *uncovered* peripheral nodes.

S chooses rebordercasting nodes corresponding to each of its *uncovered* peripheral nodes.

S then sends the query packet to each of these rebordercasting nodes via the forwarding nodes, if any.

The rebordercasting nodes, on receiving the query packet, become bordercasting nodes and go back to step 1.

IZR route query



- This mechanism ensures that the query always gets bordercasted by nodes whose routing zones cover newer regions of network.

IZR
optimal zone radius

- A hybrid of *Min Searching* and *Adaptive Traffic Estimation* schemes is used to dynamically configure the optimal zone radius.

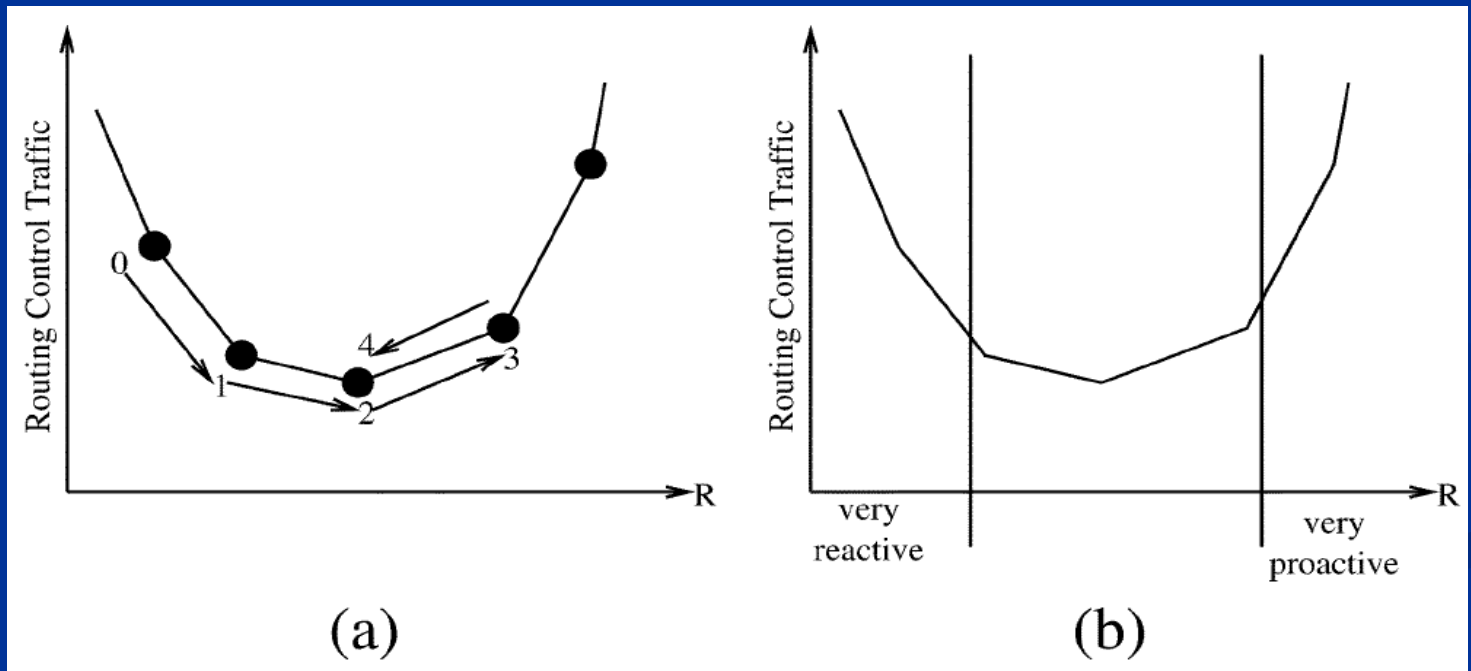


Fig. 6. (a) Min Searching. (b) Adaptive Traffic Estimation.

IZR
optimal zone radius

- **Min seatching:**
  - During each estimation interval, the amount of routing control traffic passing through the node is measured and find the min control traffic of local network.
- **Adaptive Traffic Estimation:**
  - The Adaptive Traffic Estimation scheme tries to track the optimal zone radius by iteratively increasing or decreasing the zone radius.

IZR
optimal zone radius

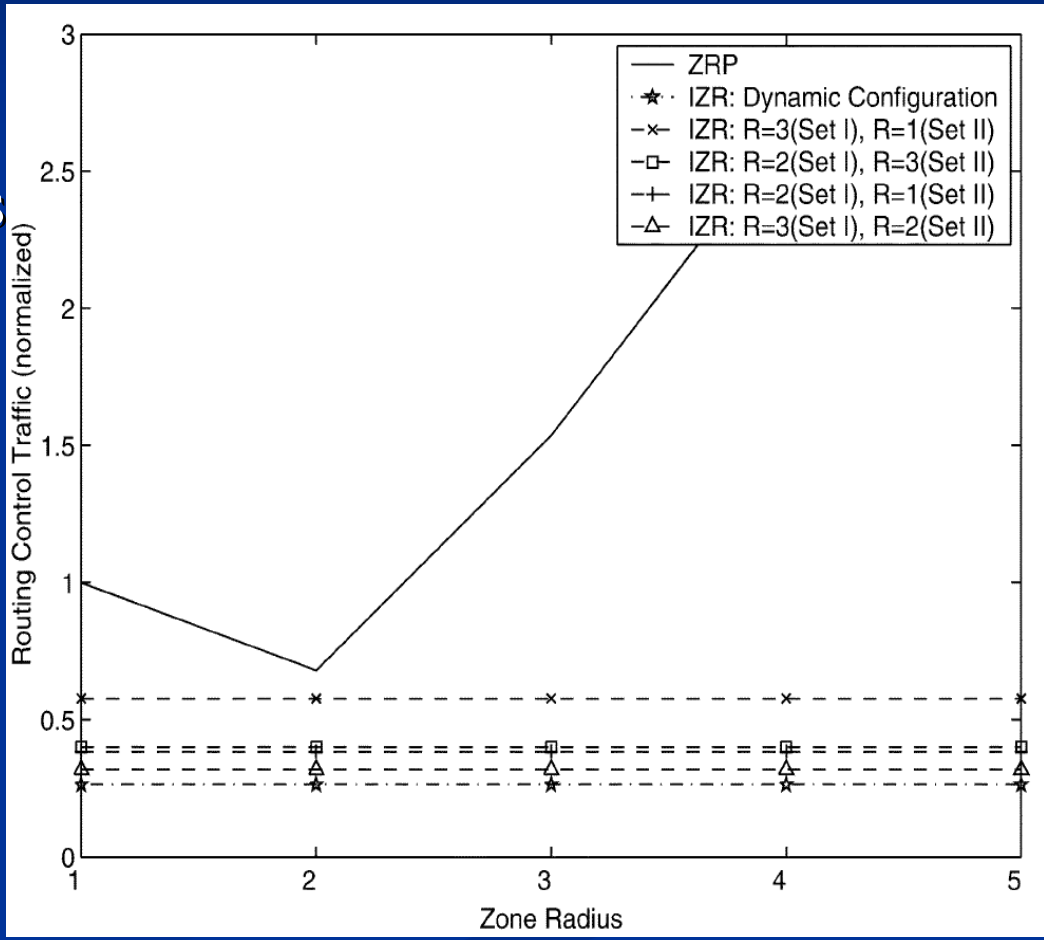
- **Adaptive Traffic Estimation:**
  - **Define:**
    - $\Gamma(R)$ **= traffic of IERP / traffic of IARP**
    - Γ_{thres} **=** $\Gamma(R)$ **of optimal zone radius.**
  - We define a parameter, H, to reduce the frequency of radius update.
    - if $\Gamma(R) > \Gamma_{thres} * H$, then radius is increased.
    - if $\Gamma(R) < \Gamma_{thres} / H$, then radius is decreased.
  - Due to the useful information provided by the Min Searching scheme, it may be beneficial to occasionally switch to Min Searching.

PERFORMANCE EVALUATION

- Simulation:
  - Neighbor discover is based of *HELLO* beacons transmitted at random intervals of mean T_{beacon}. If a new beacon fails to arrive within $2 * T_{beacon}$, a link failure is reported.
  - 100 nodes in an area of 1300 * 1300 meter^2.
  - 16 packet per second where each packet is 1000 bits.
  - IARP traffic is changes in link status detect by a node.
  - IERP traffic is initial route query and subsequent queries due to reported route failures.
  - Control traffic is based on number of control packet.

PERFORMANCE EVALUATION

- Total routing overhead for IZR as compared to the different zone radii settings of ZRP.
- Set I:
  - Speed = 1 m/s
  - Mean session interarrival delay =5 sec
- Set II:
  - Speed = 10 m/s
  - MSID = 25 sec
- H = 12



PERFORMANCE EVALUATION

- Simulation:
  - Speed: 0.5 m/s
  - MSID 3s
  - After 205s
    - Speed: 15s
    - MSID 200s

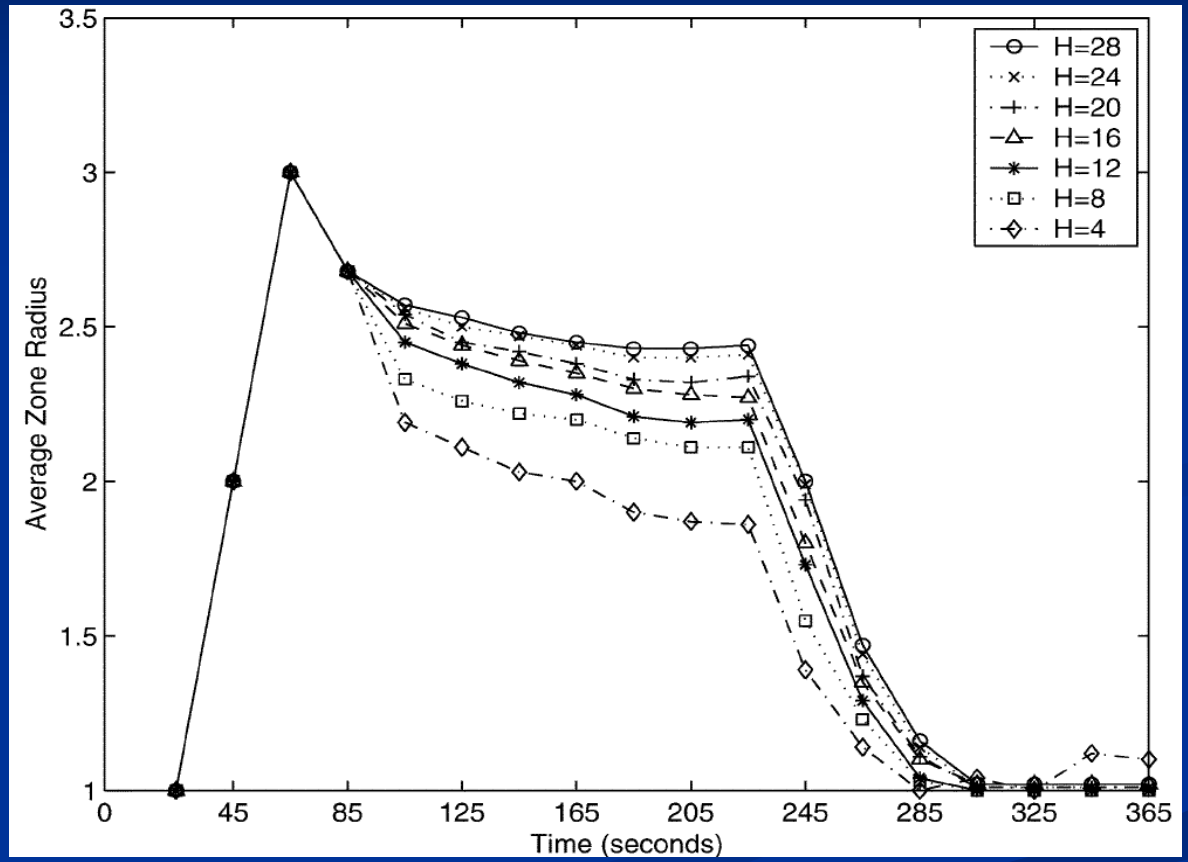
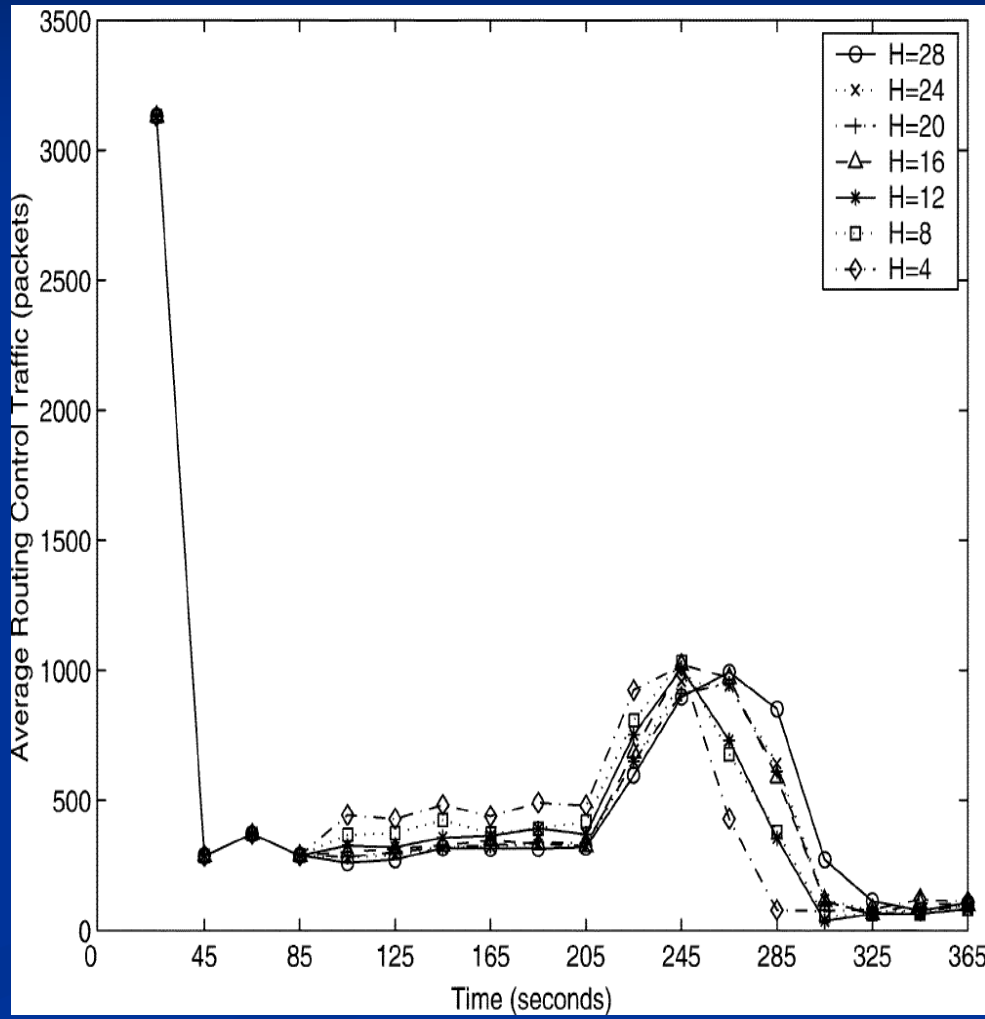


Fig. Average zone radius of the nodes

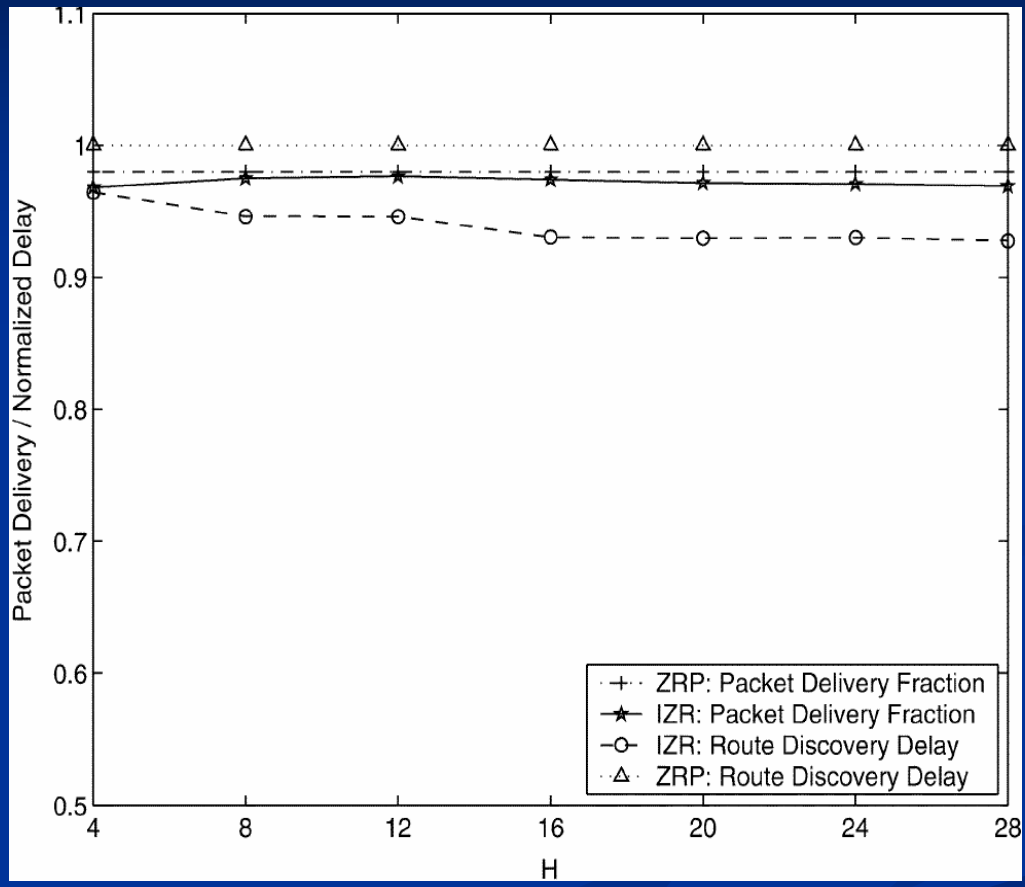
PERFORMANCE EVALUATION

- After 205s, the traffic is increased because of the change.
- The adaptive traffic estimation algorithm soon finds the new optimal zone radius.



PERFORMANCE EVALUATION

- The values are normalized to the mean route discover delay for the Zone Routing Protocol at its optimal configuration (radius=2).



CONCLUSION

- Hybrid protocol can provide a mount of benefits like ZRP and adaptive protocols can improve it.

- IZR provides a flexible solution to the challenge of discovering and maintaining routes in ad hoc networking environments, by adapting the balance of proactive and reactive routing.

END