Efficient Flooding in Ad Hoc Networks: a Comparative Performance Study

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Introduction

- Flooding
  - The basic mechanism to propagate control messages
  - Ex. route query flooding of reactive routing scheme
- Blind flooding
  - All nodes in the network (re)-broadcast the packet
  - Inefficiency
    - Redundant and superfluous packets
    - High probability of collision and contention
    - Heavy congestion of wireless medium

Introduction (2)

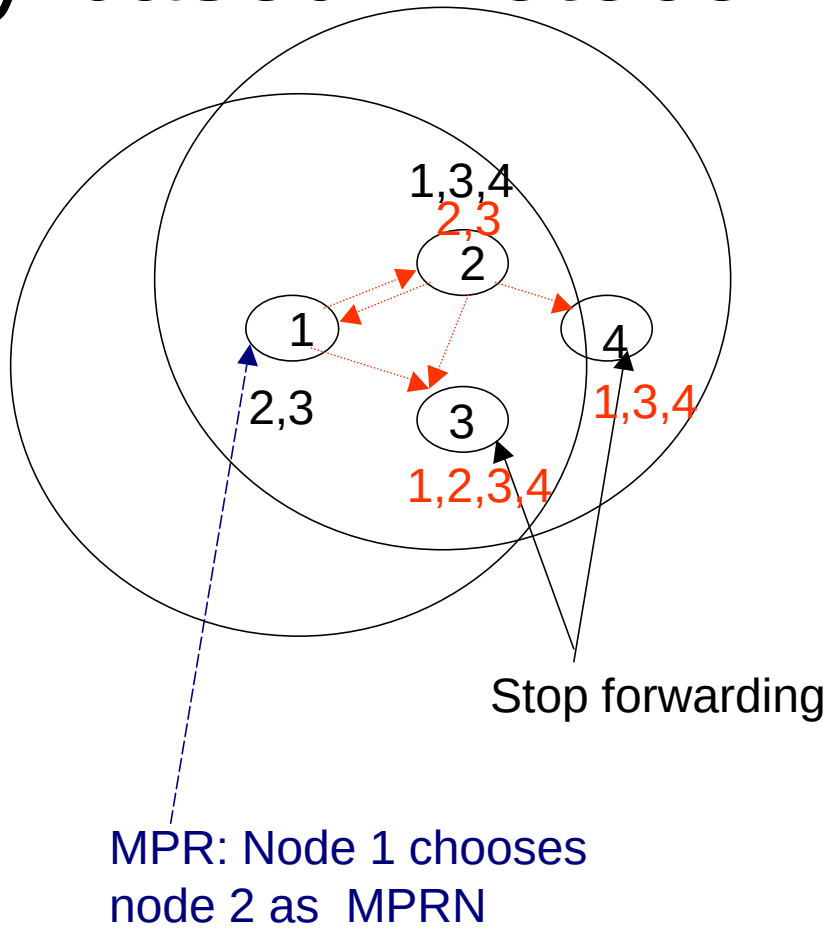
- Efficient flooding
  - A subset of dominant neighbors re-broadcast the flood packet to guarantee complete flooding
- Contributions
  - We classify and evaluate existing efficient flooding schemes

Overview of Efficient Flooding

- Neighboring topology based protocol
- Source-tree based protocol
- Cluster-based protocol

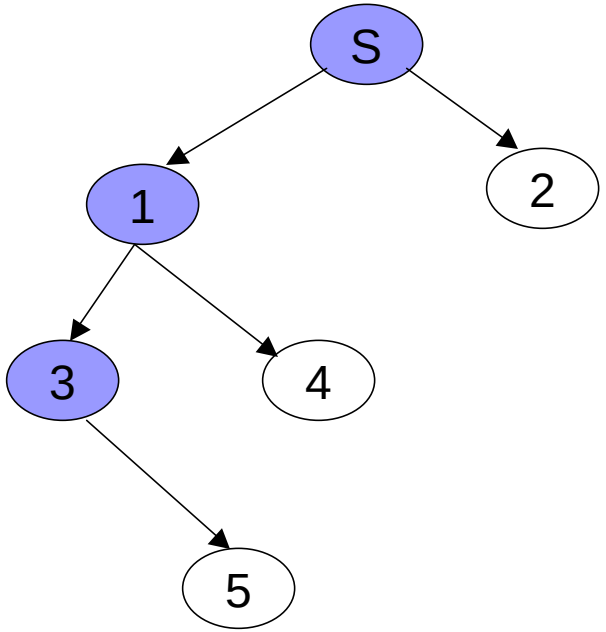
Neighbor Topology based Protocol

- Multi-Point Relay (MPR)
  - Use neighbors' information within two hops
  - Selects a minimal subset of forwarding neighbors (MPRNs) that covers all the nodes two-hop away
- GAF
  - Use location information to choose minimal set of dominating nodes
  - Excluded from our study due to the assumption of (extra) position information



Source-Tree Based Protocol

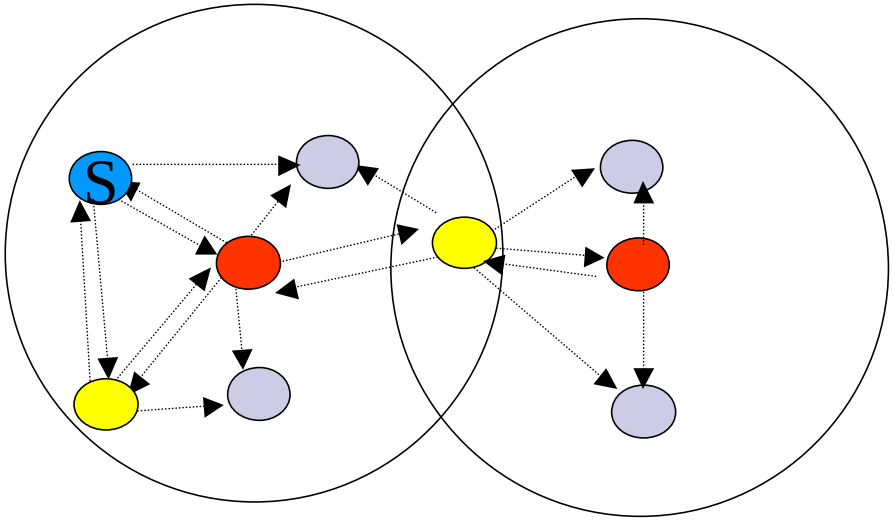
- Builds a sh-path source-tree rooted at the flood initiator
- Rebroadcast if a node is on shortest path and non-leaf
- “Reverse Path Forwarding”



Blue nodes (non-leafs) rebroadcast

Cluster-based Protocol

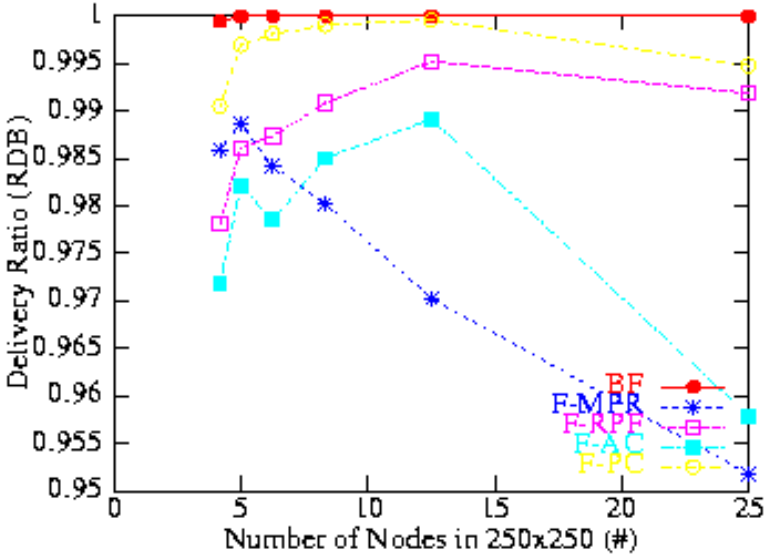
- Clustering: grouping nodes into clusters
- Cluster head: a representative node of each group
- Gateway: a node connecting more than two clusters
- Ordinary nodes: Others
- Efficient Flooding: only cluster heads and gateways rebroadcast
- Two clustering mechanisms
  - Active clustering: builds the cluster structure proactively
  - Passive clustering: builds the clusters passively, using on-going data traffic



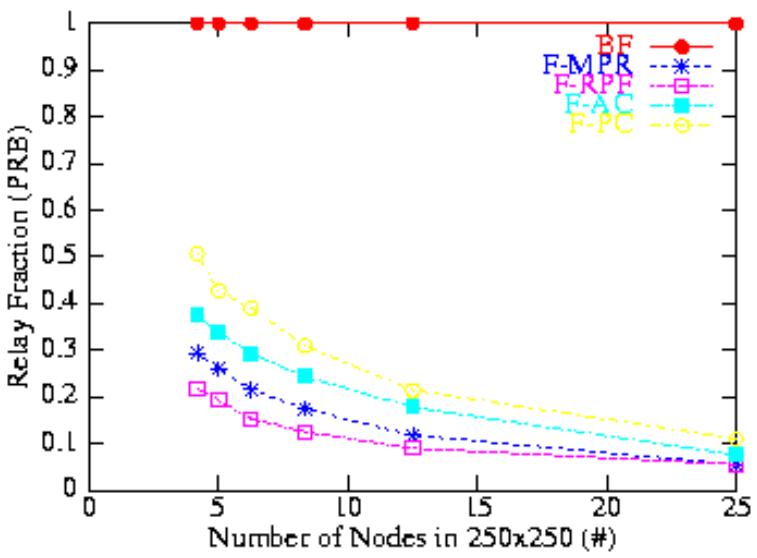
Simulation Study

- Environment
  - GloMoSim 2.0
  - Target protocols:
    - MPR (F-MPR)
    - Active clustering with Lowest ID algorithm (F-AC)
    - Passive clustering (F-PC)
    - Reverse path forwarding (source-tree based protocol) (F-RPF)
    - Blind flooding (F-BF)
  - Protocols
    - UDP/802.11 DCF/two-ray propagation model
    - BW: 2MBits/sec
    - Power Range: 250meters
  - Single source initiates flooding 4 times per second

Performance Test v.s. Density



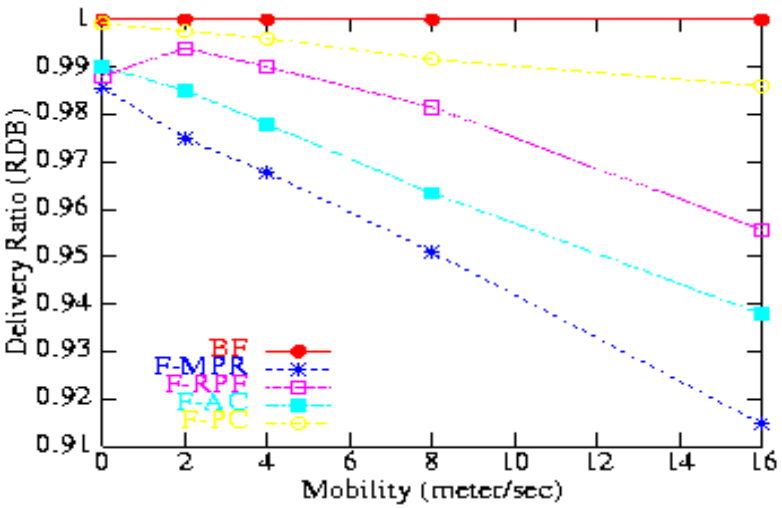
Delivery Ratio



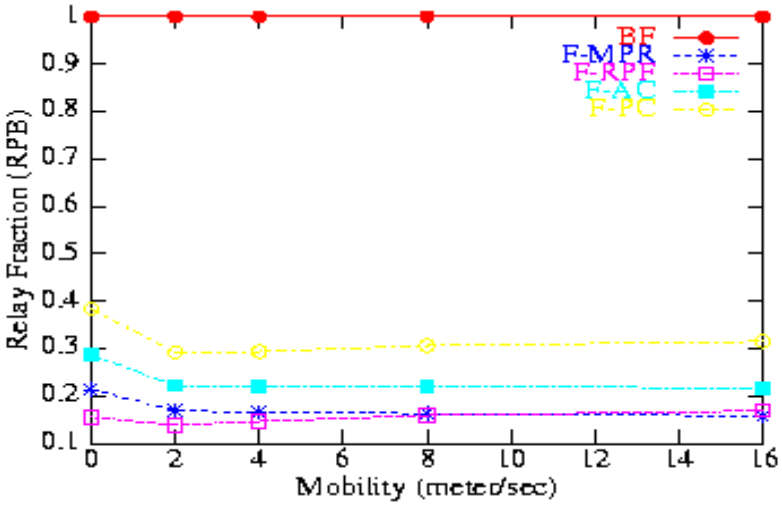
Forwarding OH

- Delivery Ratio rank:
  - F-BF >> F-PC >> F-RPF >> F-AC >> F-MPR
- Flooding efficiency rank
  - F-RPF >> F-MPR >> F-AC >> F-PC >> F-BF
- MPR suffers due to inaccurate neighbor information -> insufficient # of dominating nodes are chosen
- RPF works the best. But RPF needs a complex extension to be applied to multiple floodings (multiple source trees)
- PC works overall okay

Performance v.s. Mobility



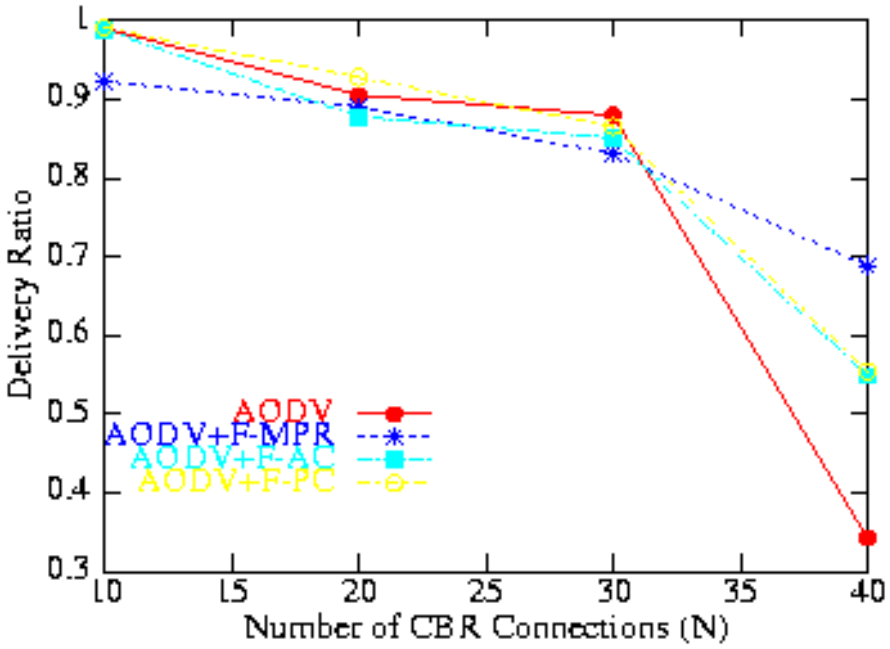
Delivery Ratio



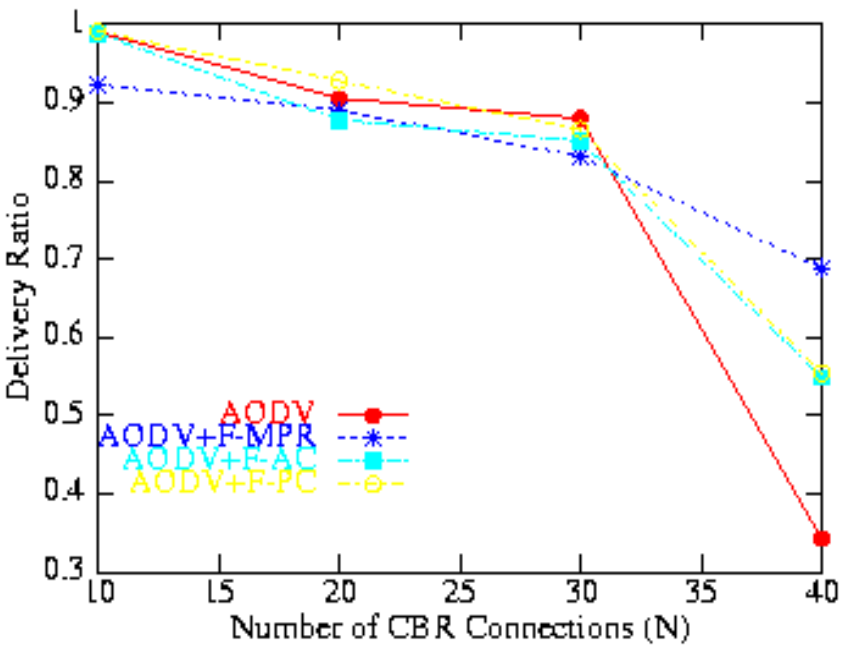
Forwarding OH

- Rank does not change from the previous results
- Passive clustering outperforms all (but BF): keep stable with increase of mobility

Applications : AODV



Delivery Ratio



Control OH

Efficient flooding improves AODV performance at heavy load
MPR works better than Pass Clustering at heavy load; but,
MPR requires periodic table exchange – unfit for on-demand rtng

Conclusion

- A comparative study of efficient flooding mechanisms
- Results:
  - Passive clustering performs well for a broad range of node mobility and network density values
    - Passive clustering is the most robust
  - Accurate neighbor information collection is very challenging due to unreliable pkt delivery
    - MPR, active clustering shows bad performance in high mobility
  - Each scheme has a different set of suitable applications
    - F-PC for reactive routing protocols
    - F-MPR, F-AC and F-RPF for proactive schemes