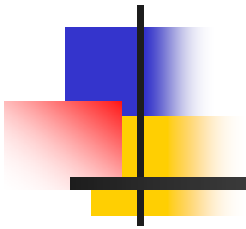

Performance Evaluation and Improvement of Broadcasting Algorithms in Ad Hoc Networks

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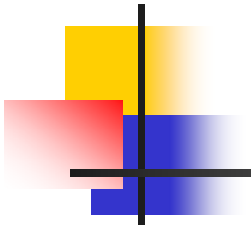
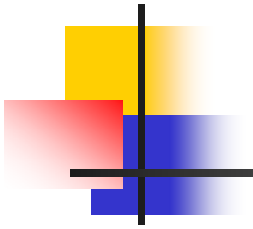


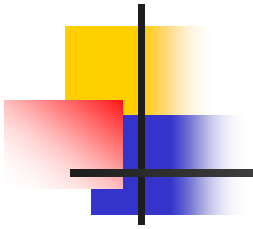
Ad Hoc Networks

- No base station, self-organized
- Energy and bandwidth constraint
- Mobility sensitive (vehicular ad-hoc)
- Applications
  - Vehicular networks
  - Disaster relief
  - Military task

Application of Broadcast Algorithms



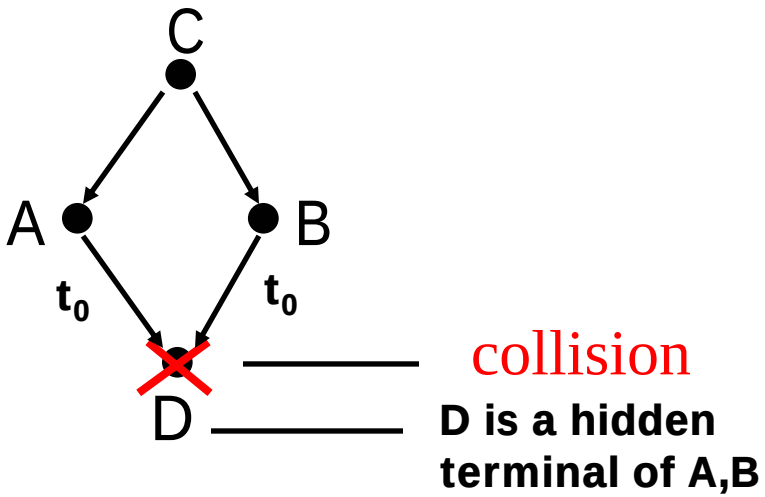
- Route searching (DSR, AODV, ZRP protocols)
- Location discovery (location-based routing)
- Information dissemination (sensor network)

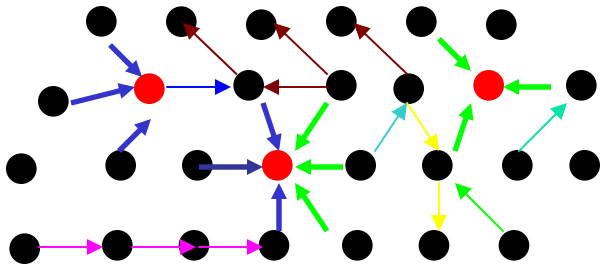


Broadcast Features

- Broadcast packet size is small
- No prior global topology knowledge
- No synchronization
- Unreliable --- 100% reliable required in some cases
- No acknowledgement of any kind, no RTS/CTS dialogue,
- Broadcast frequency is much higher for mobile scenarios

Broadcast Storm Problem



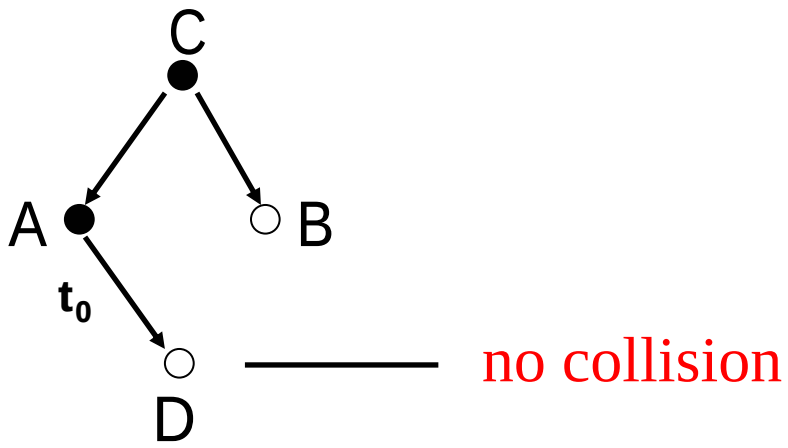


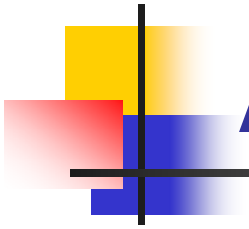
The straight forward broadcast approach (flooding): Each node rebroadcasts a newly received message.

- **Many messages are broadcasted simultaneously to the whole network**
- **Increase the number of hidden terminals, leading to network-wide collisions and contentions**

Reduce Broadcast Redundancy

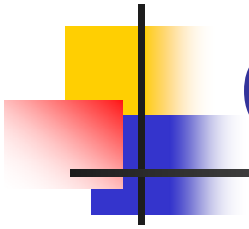
- Alleviate the broadcast storm problem
  - Reduce no. of transmitting (forward) nodes while still covering most nodes in the network.
- These special forward nodes form a Connected Dominant Set (CDS).
- Finding a minimum CDS is a NP hard problem, so need to design heuristic methods.





Ad Hoc Broadcast Algorithms

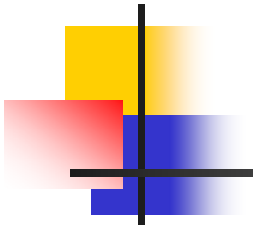
- Probability based algorithms
  - Fixed probability
  - Counter-based
  - Distance-based
- Sender based algorithms
  - Multi-point Relay (MPR)
  - Dominant Pruning (DP)
  - Partial Dominant Pruning (PDP)
- Receiver based algorithms
  - Self Pruning (SP)
  - Wu and Li's Marking Methods (Rule1-2,Rule K)



Our Work

- Analytical models for various broadcast algorithms
- Mobility sensitive broadcast algorithms
- Broadcast algorithms in route searching

Mobility Sensitive Broadcast Algorithms



- Mobility can harm protocol performance.

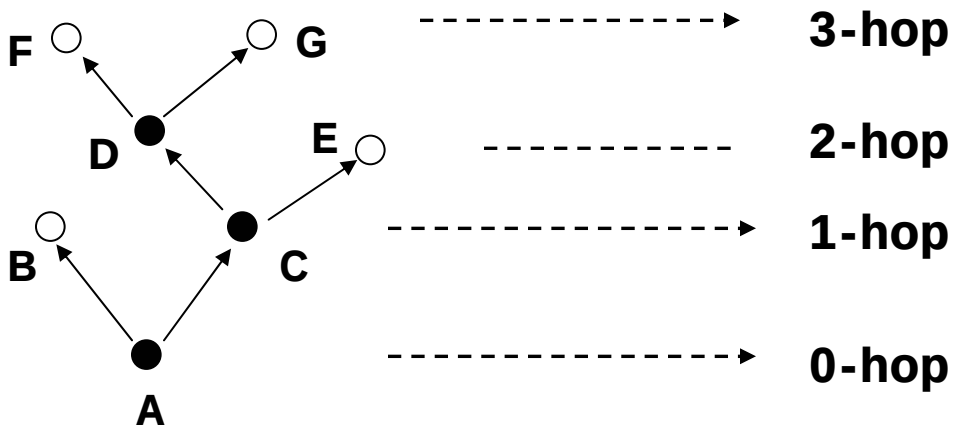
- Objective: Design mobility sensitive mechanisms on top of existing broadcast schemes.

A Popular Broadcast Algorithm --- MPR

Multi-Point Relay Scheme:

Nodes at *K+1* hop should be covered by *K* hop nodes.

Greedily select forward nodes.



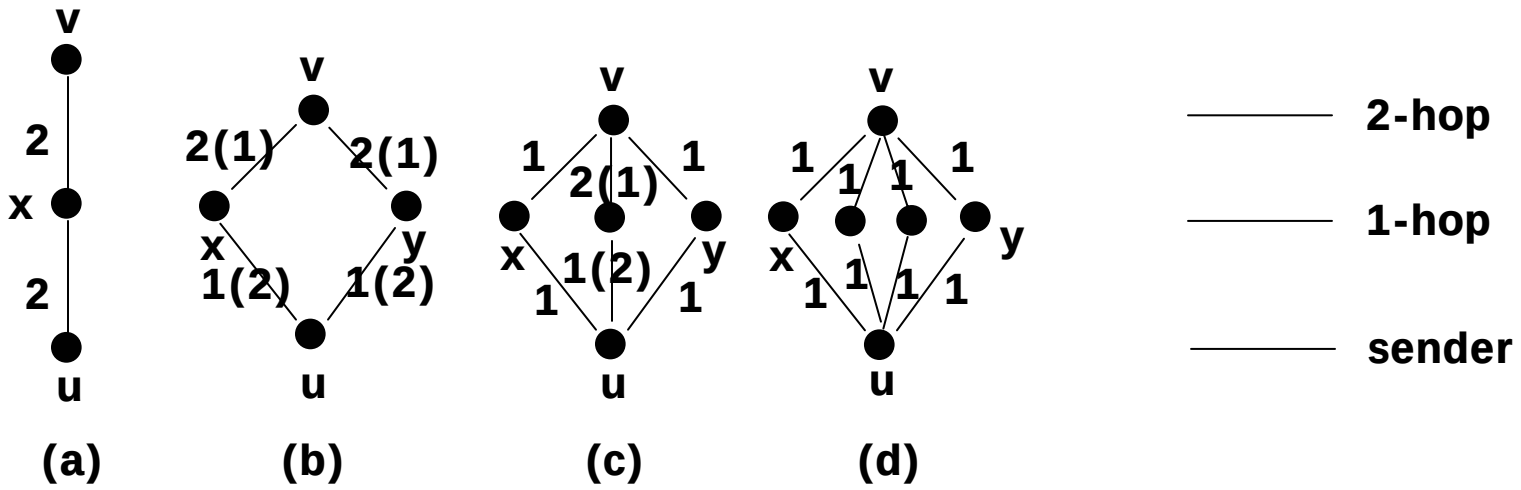
When nodes are moving...

Link AC is broken...

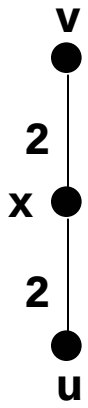
Adaptive Covering Method

- **Every node-pair is given a relative stability level (RSL) (1 or 2).**

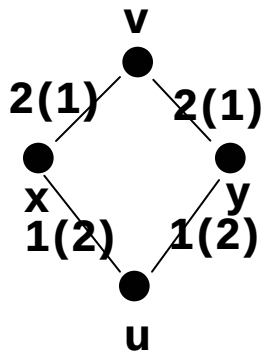
- **In mobile cases, the number of covering forward nodes is increased. RSL(u,x)*RSL(x,v)+ RSL(u,y)*RSL(y,v)+… >= 4.**



Probability Analysis



(a)



(b)

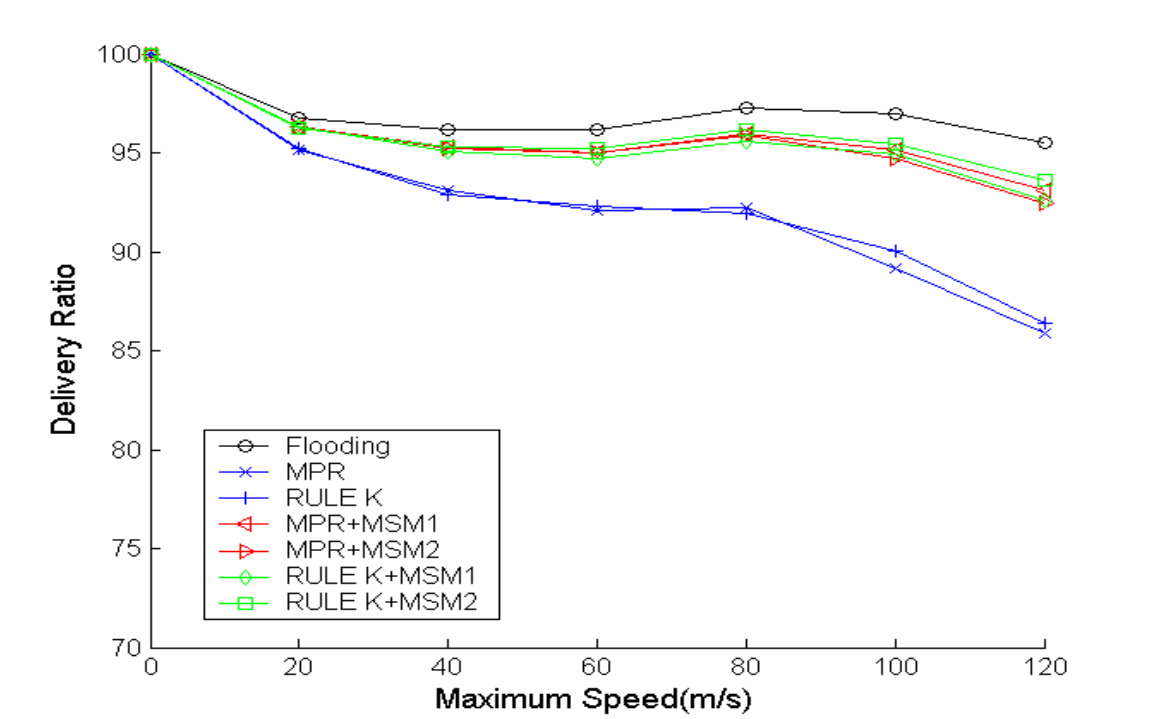
$$P'_{s1} = (P_2 P_{22})^2$$

$$P'_{s2} = 4P_1 P_{12} P_2 P_{22}$$

$$\Delta P_s = P'_s - P_s = 5(P_1 P_{12})^2 + 4P_1 P_{12} P_2 P_{22}$$

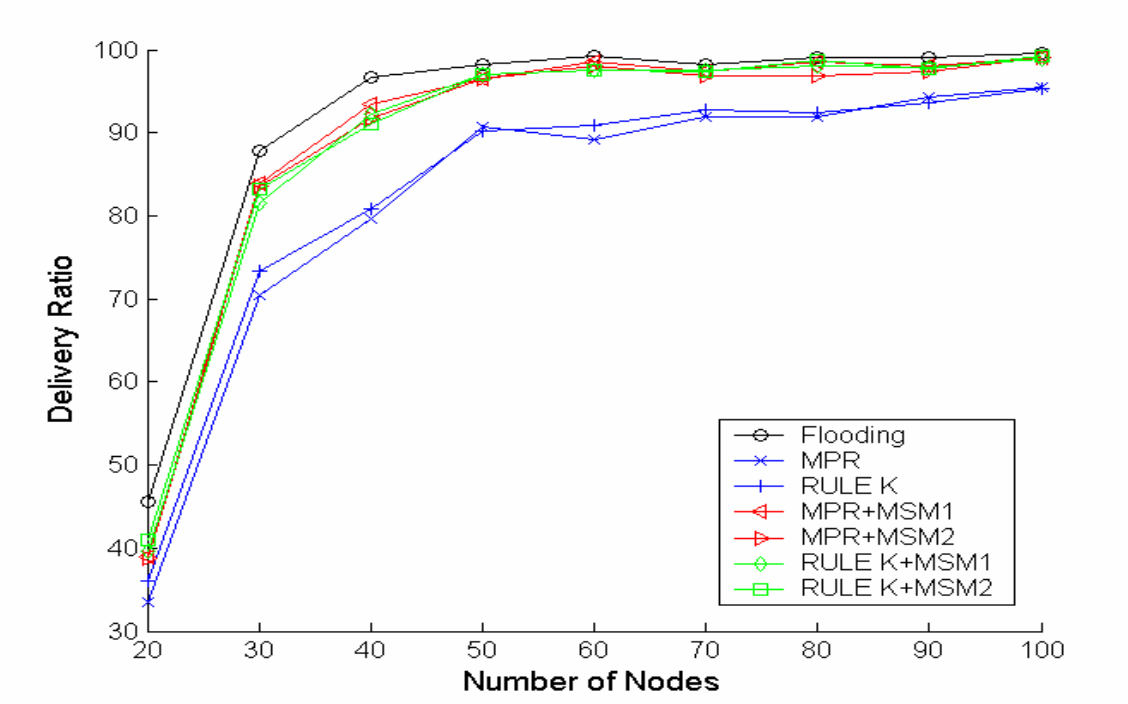
Numerical Results

Delivery ratio vs. maximum moving speed.



Numerical Results cont'd

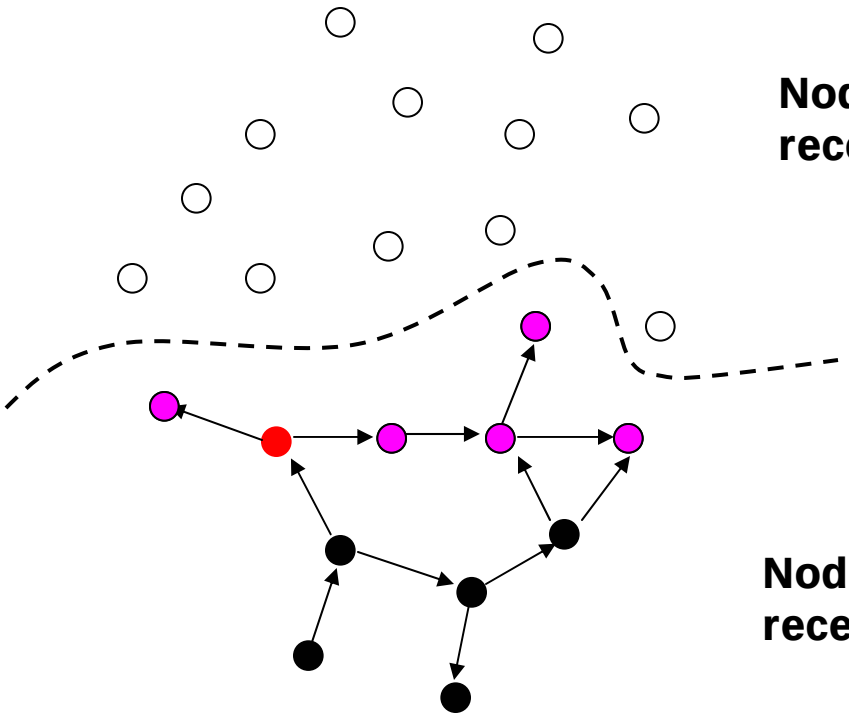
Delivery ratio vs. number of nodes.



Efficient Broadcast in Route Searching

- To find a destination, conventional method is to broadcast a route searching packet to the whole network.
- To reduce redundancy and save network bandwidth, route searching packets are transformed to termination packets after the destination is found.

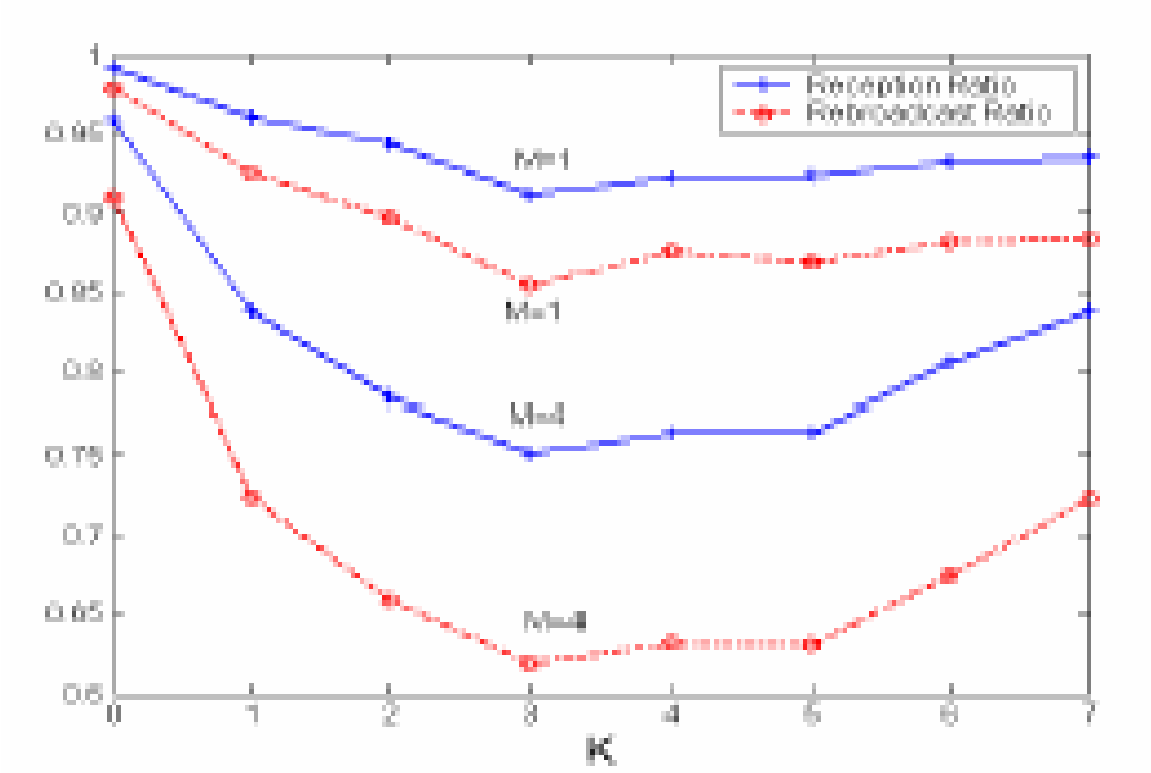
Limited-Hop Broadcast Algorithm



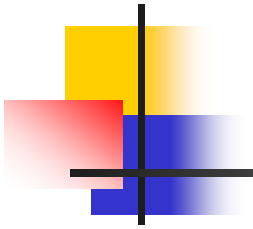
Nodes that have not received a packet

Nodes that have received a packet

Simulation Results

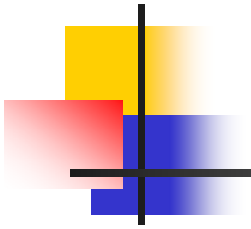


The network is composed of 80 nodes, M is no. of destinations, K is the limited hop no.



Conclusions

- Broadcast is a widely used technique in ad hoc & sensor networks.
- Efficient broadcast algorithms should be adaptive to nodal mobility.
- Performance can be analytically revealed.



On-going Work

- Broadcast algorithms in sensor location systems.
- Broadcast algorithms in vehicular communications.
- Exploiting feedback information to enhance broadcast efficiency.

Thanks!