A Power-Aware Broadcasting Algorithm

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Motivation

- Many protocols for Mobile Ad Hoc Networks (MANETs) require message broadcast because:
  - Membership changes
  - Nodes move
  - Location of some data is unknown
- Examples:
  - Routing protocols (e.g. DSR, AODV)
    - For route discovery
  - Reputation systems
    - For learning the reputation of an unknown node

Flooding

- The most common approach for broadcast in MANETs.
- Implementation:
  - Every node listening for a message for the first time retransmit it.
- Redundant
  - Only some of the nodes should retransmit
- Expensive
  - Power consumption
  - Bandwidth

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Questions

- A retransmission adds from 0 to 61% to the coverage of a previous transmission [Tseng 02]
- Which of S's neighbours should retransmit?
  - The more distant the retransmission is from the source, the better
- How to determine best candidates in run-time?
  - The optimal set of nodes for retransmitting changes with every message:
    - Nodes move
    - Don't have GPS or other location awareness mechanism
    - The source of the broadcast changes
    - Different node densities require different number of retransmissions

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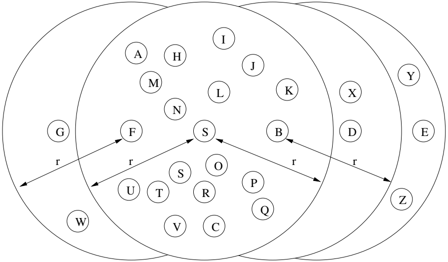
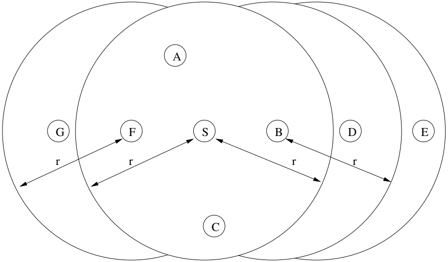
Probabilistic Approaches



- A node retransmits a message with some probability $0 < p \leq 1$
  - Flooding is a particular case with $p = 1$
  - Doesn't adapt well to different network densities
    - Less neighbours require more retransmissions (higher p)
    - Mitigation: If a node does not listen to enough retransmissions, due it independently of p [Haas 02]

Probabilistic Approaches



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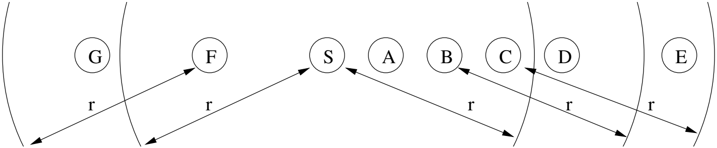
Counter-based approaches [Haas 02,Tseng 02]

- Nodes wait a bounded random time *t* and listen
- Retransmit if, at the end of *t*
  - the number of retransmissions listened is below a threshold *n*
- Adapts well to different densities
- Random selection of the nodes
  - No attempt to select those providing better additional coverage



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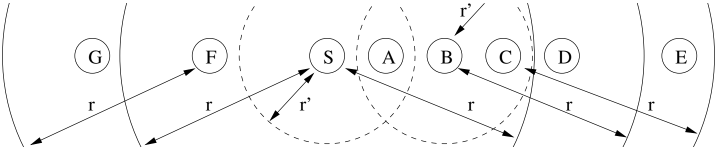
Power-based approaches [Tseng 02]

- Nodes wait a bounded random time t and listen
- Retransmit if, at the end of t
  - The maximum power of the reception did not exceed a threshold p
- The higher the power of the reception, the lower the distance to the source
  - Discards transmissions with a negligible additional coverage
- Random selection of the nodes
  - No attempt to select those that improve more the coverage



Improving Node Selection

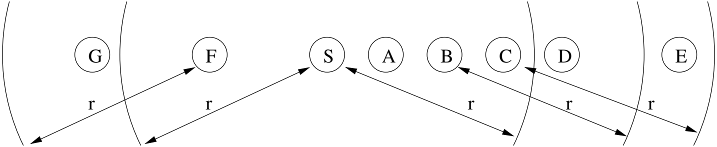
PAMPA Power-Aware Message Propagation Algorithm

Rationale Rank nodes for retransmission according to their distance to the source

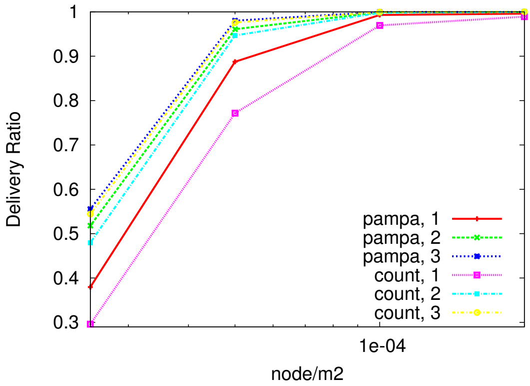
- Nodes wait a time t *proportional to the power of the reception* and listen
- Retransmit if, at the end of t
  - the number of retransmissions listened is below a threshold n

PAMPA

- Listens to the number of retransmissions
  - Adapts well to different densities
- Higher distance to the source ⇒ lower power at the reception ⇒ smaller wait time
  - Nodes to retransmit will be those that provide higher contribution to coverage

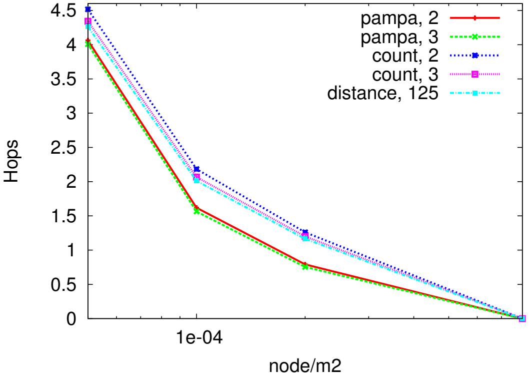


Evaluation



- Simulations in *ns–2*, Two Ray Ground, 100 nodes
- Pampa vs Power and Counter-based (for the same thresholds)
  - Doesn't matter which if nodes are close
  - Pampa increases delivery ratio
    - More evident in sparser networks

Evaluation - Number of Hops



- Number of hops travelled by a message before being delivered to each node
- Smaller in Pampa
  - Each retransmission covers more nodes

Conclusions

- Broadcasting appears to be unavoidable in MANETs
  - But flooding is an undesirable implementation
- Existing alternatives to flooding either
  - Don't adapt well to different densities
  - Don't take full advantage of the location of the nodes
- PAMPA
  - Nodes more distant to the source retransmit first
  - Prevent other nodes from retransmitting
  - Improves coverage in sparse networks
  - Reduces the number of hops required to deliver the message
  - Requires the same number of retransmissions than previous approaches