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
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
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 to independently of $p$ [Haas 02]
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G S B D E F

A node retransmits a message with some probability $0 < p \leq 1$.
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
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
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