Managing a Broadcast Infrastructure in Ad Hoc Networks in Presence of Mobility : A New Algorithmic Framework

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Outline

- Introduction
- Related works
- Definitions and Preliminaries
- The algorithmic framework
- Simulation results
- Conclusions

Introduction(1/2)

- In mobile wireless ad hoc networks, it is essential to have a broadcast infrastructure for disseminating data of broadcast nature and control information.

- Backbone nodes forward broadcast messages for others. Backbone formation is tightly related to the concept of connected dominating set (CDS).

Introduction(2/2)

- Backbone management in presence of mobility has been studied in a less extent.

- In mobile networks, backbone update involves a tradeoff between reliability and energy efficiency.

Related works(1/2)

- In [4], they showed that mobility is the major threat to efficient self-pruning protocols.

- In [18], the authors proposed to use two transmission ranges (power levels), the longer one for data transmission, and the shorter one for determining neighborhood, in order to improve backbone reliability.

Related works(2/2)

- In [8], at every node, its decisions of joining and leaving the backbone are made based on 2-hop topology information, which is exchanged periodically between nodes.

The framework's features

- Nodes do not need to acquire topology information other than its local one-hop environment.
- No location information is required.
- Decisions of joining and leaving the backbone are made individually.

Definitions and Preliminaries

- The networks are composed of
  - Backbone nodes (BNs) &
  - Non-backbone nodes (NBNs)

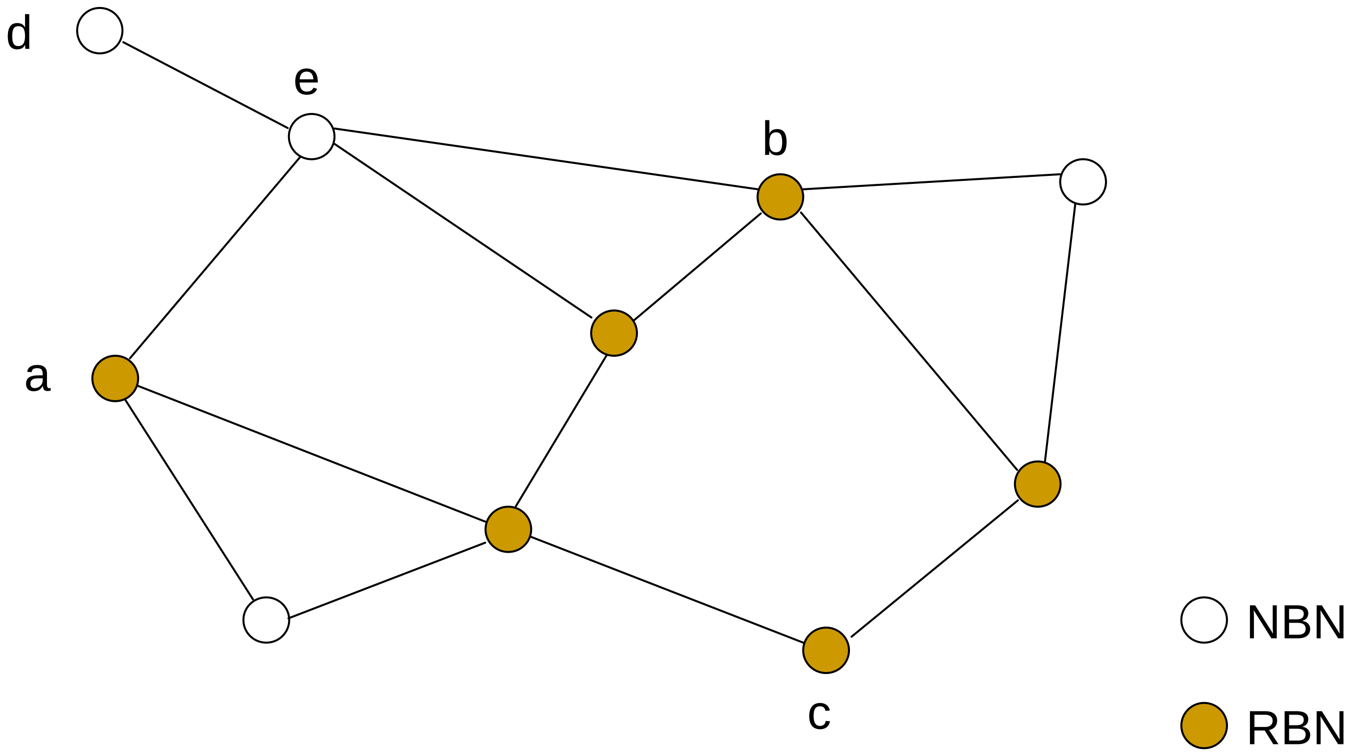
- A backbone node has two possible states
  - Regular state (RBN)
  - Pruning state (PBN)

Definitions and Preliminaries

- An NBN may change its state to RBN if some of its neighbors cannot reach each other. A BN *u* provides reachability to its neighbors.

- If these neighbors may be able to reach each other via BNs other than *u*, *u* can prune itself and become an NBN.

An example of changing states



The algorithmic framework

- Each node broadcasts probe messages regularly via the current backbone.
  - The probe message contains
    - Source
    - TimeStamp
    - TTL
    - Attribute => true or false
- When a BN received the message
  - If it is PBN, rebroadcast the message with attribute = true
  - Else, rebroadcast the message

The algorithmic framework

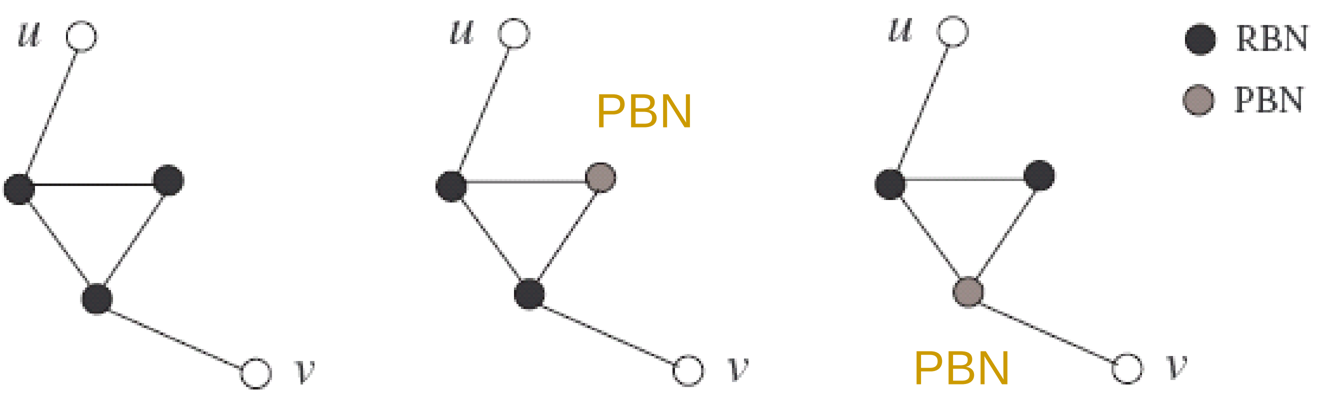


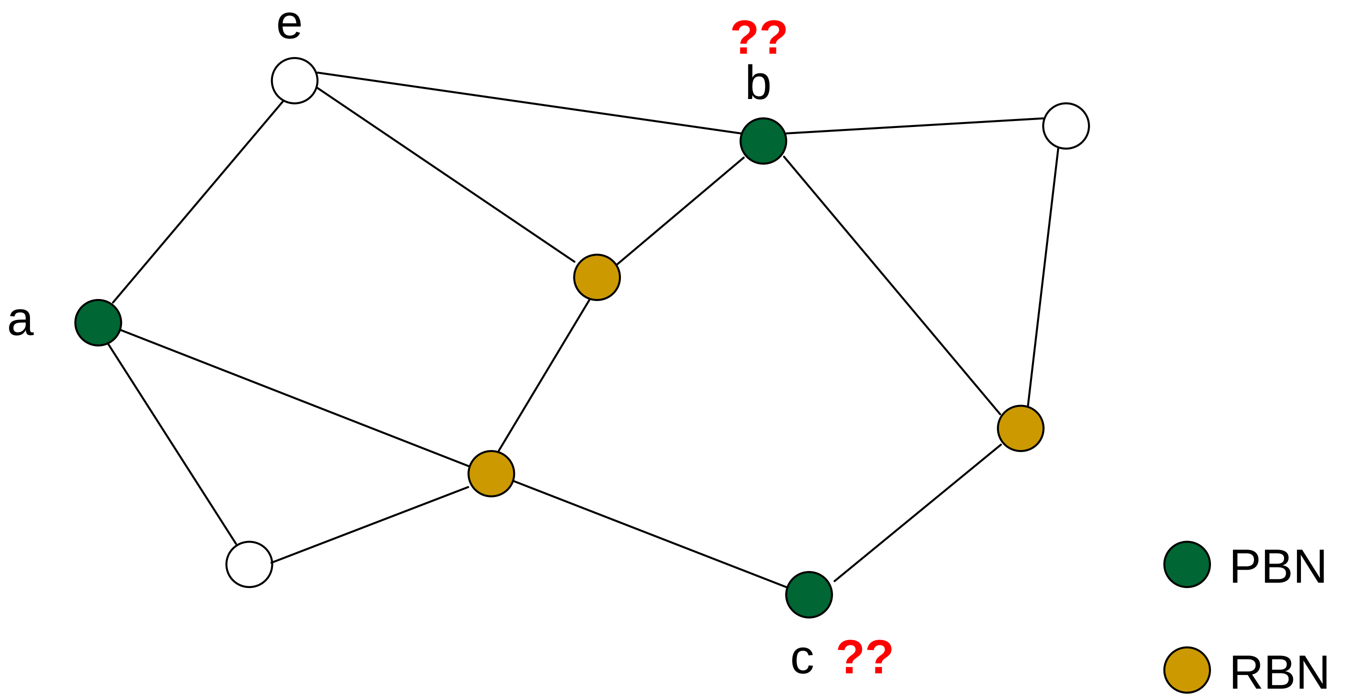
Fig. 1. Scenarios of backbone connectivity between two nodes

The algorithmic framework

- Every node has a database containing sources (within *k* hops) from which probe messages have been received. A node keeps at most two entries (of different attributes) for any source.

- Every node shares its reachability database with one-hop neighbors.

An example of redundant PBNs



The algorithmic framework

- Node b and c will become RBNs.
- An RBN enters the PBN state from time to time in order to examine whether or not it can prune itself from the backbone.
  - So node b or c will prune itself

Simulation results

- Algorithm parameters
  - 50 mobile nodes
  - 750m x 700m
  - Each node is moving following the random way-point model
  - Initial TTL of a probe message = 4
  - Probing interval = 1 second
  - Database exchange interval = 1 second

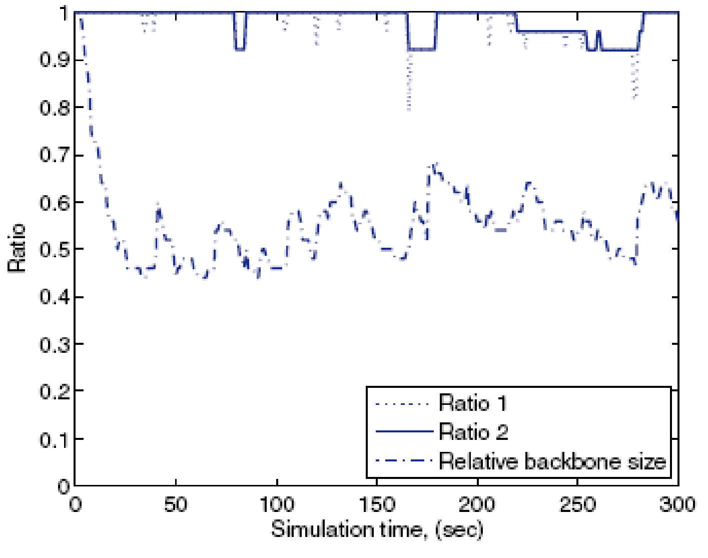
Simulation results

- Ratio 1 is the proportion of node pairs that are connected by the backbone in relation to the total number of node pairs computed as $1/2\ |V|(|V|-1)$.

- Ratio 2 shows the degree of connectivity of the underlying graph *G*, that is, the number of connected node pairs in relation to $1/2\ |V|(|V|-1)$.

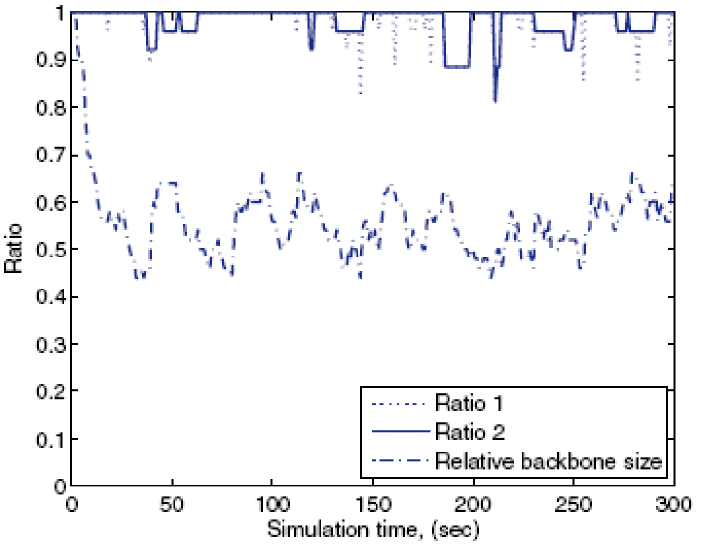
Low-density scenario

V = 4 m/s



(a) Low-density scenario

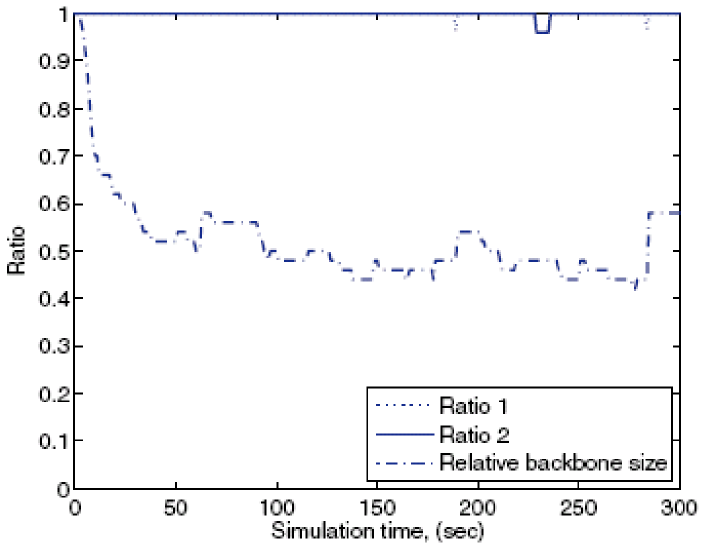
V = 8 m/s



(a) Low-density scenario

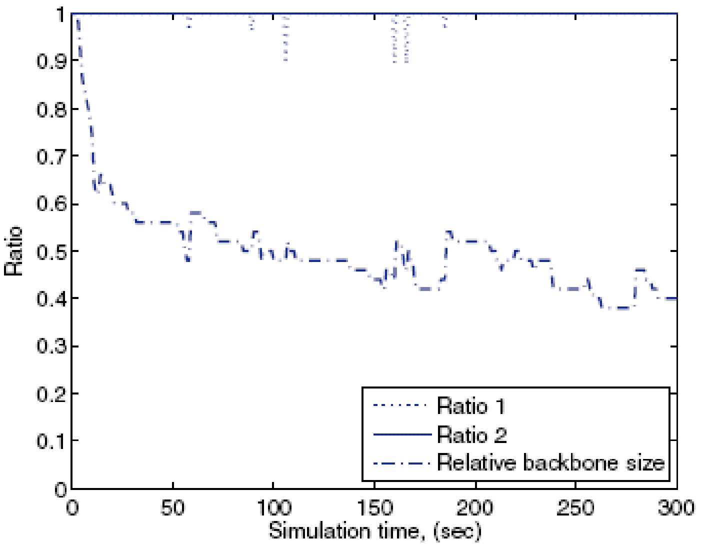
High-density scenario

V = 4 m/s



(b) High-density scenario

V = 8 m/s



(b) High-density scenario

Conclusions

- We have presented an algorithmic framework for managing a broadcast backbone in mobile ad hoc networks.
- The simulation results show that the proposed framework is effective in adapting backbone to topology change.