Gossip-based data distribution in mobile ad hoc networks

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Mobile Ad Hoc Networks

- Infrastructure-less wireless networks
- Fully decentralised
- Composed by devices with limited capabilities
- Examples:
  - Sensors
  - Personal Digital Assistants (PDAs)
  - Laptops
- Characterised by an high failure rate
  - Devices fail or are disconnected
  - Intermittent connectivity due to node movement and interference

Applications

- Cooperative applications:
  - in remote or hostile locations
    - Search-and-rescue operations
    - Military operations
    - Field surveys
  - in ad hoc gatherings of users
    - Meetings
    - Airports
    - Shopping malls

Data storage

- How to increase data availability in MANETs?
  - posts to a white board
  - SIP/SLP records
  - data collected in field surveys

Requirements

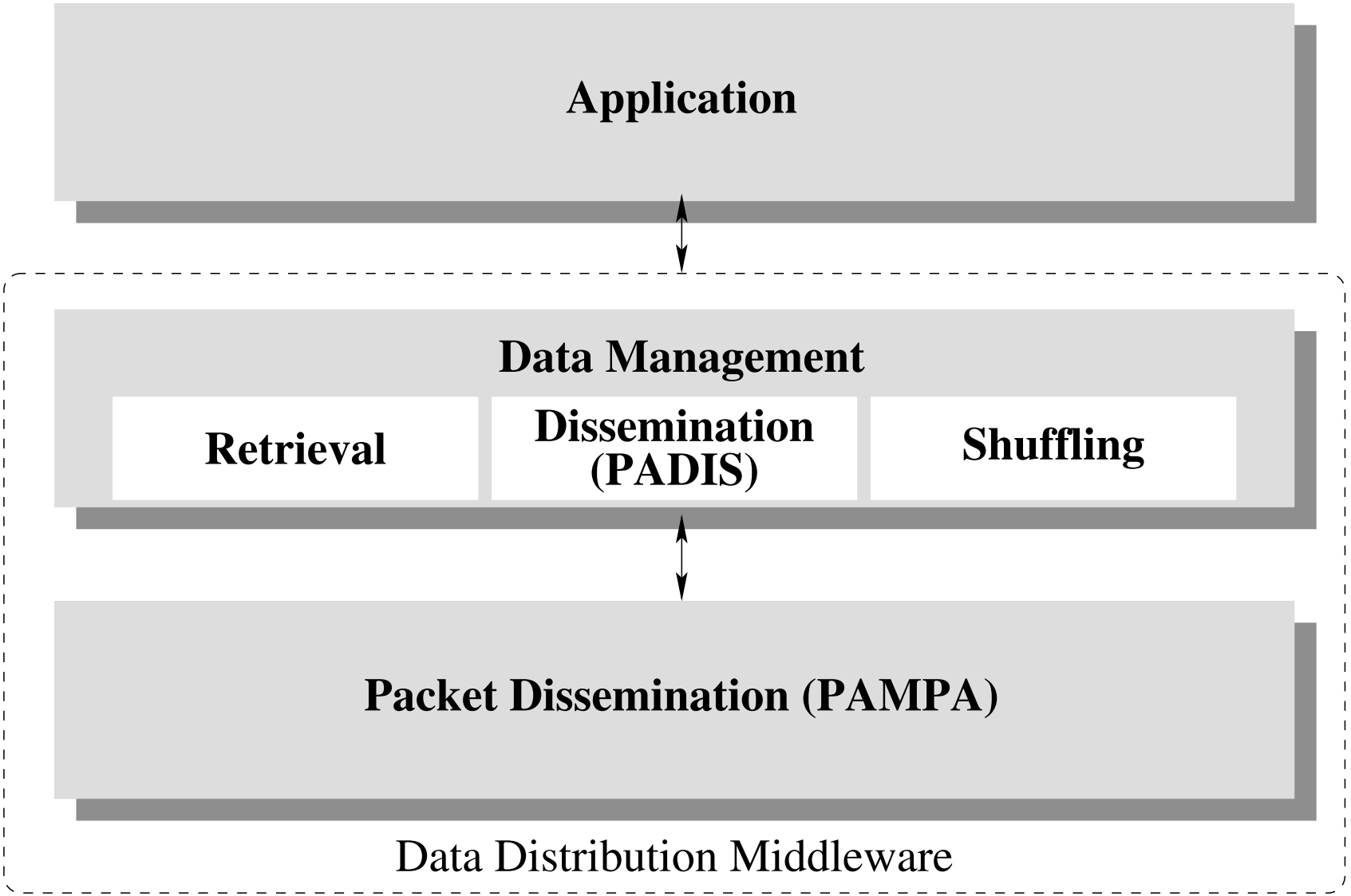
- Replication
  - Nodes may fail or become disconnected
- Save resources
  - Moderate number of replicas and messages
- Geographical distribution of the replicas
  - Tolerates localised interference
  - Reduces latency
  - Saves bandwidth
- Broad applicability
  - Nodes are not aware of their location
  - Nodes cannot anticipate the data they will require
  - Distribution should be stable even with node movement

Related Work

Protocol	Node Movement	Location Awareness	Access Prediction	Replica Refresh/ Leveraging
Simple Search	●			
Rumour Routing				
*-SAF	●		●	○
Aut. Gossipping	●		●	○
Non-Unif				
*-DAFN	●		●	○
*-DCG	●		●	○
7DS	●			
Sailhan et al.	●			
Double rulings		●		
GLS	●	●		○
CacheData	●			
DCS	●	●		●
CachePath	●			
R-DCS	●	●		●

●: feature of the algorithm ○: implicitly provided

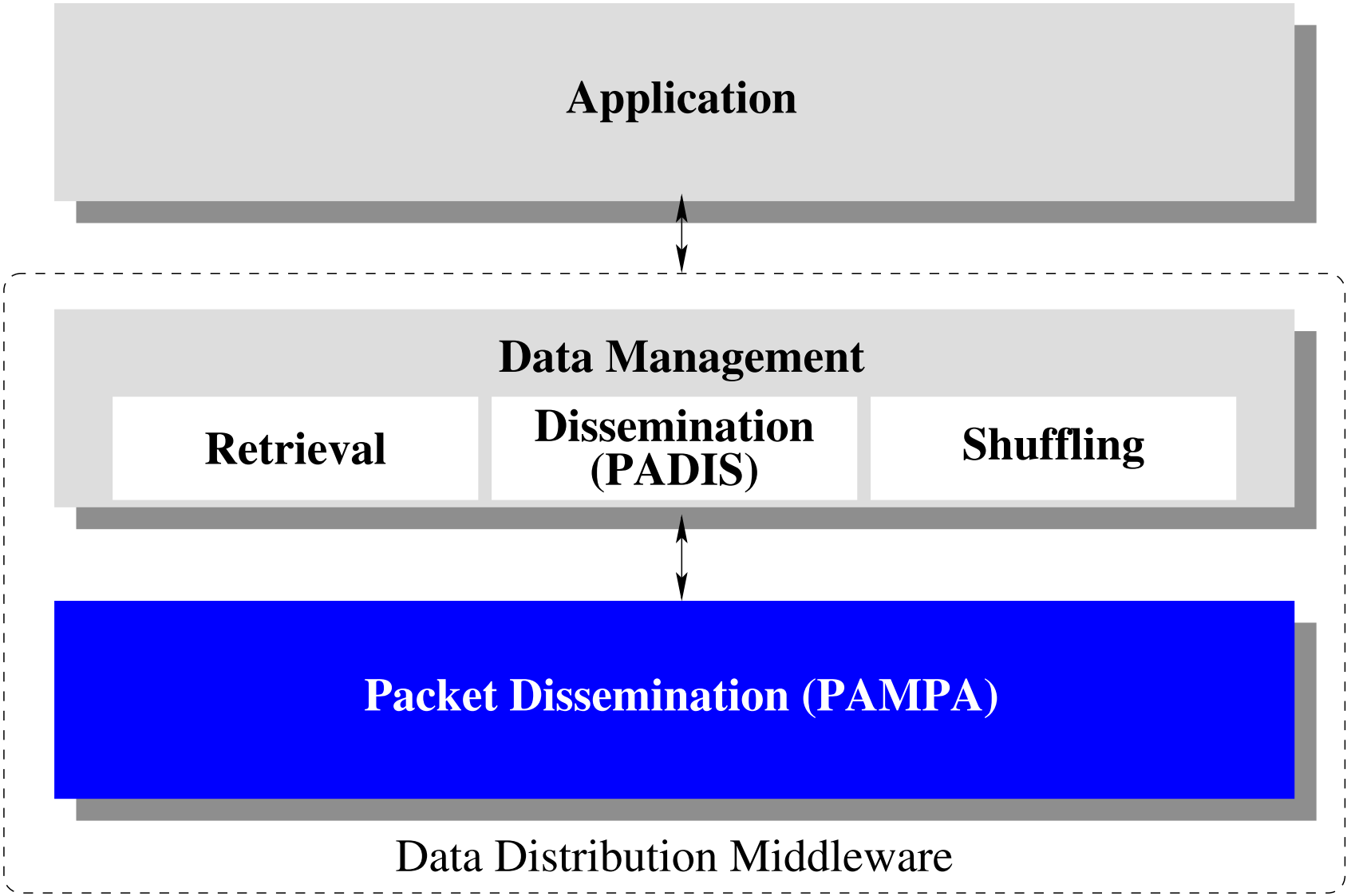
Components


Application
Data Management
Retrieval
Dissemination (PADIS)
Shuffling
Packet Dissemination (PAMPA)
Data Distribution Middleware

Contributions of the thesis

- A broadcast algorithm for MANETs
  - Requiring a limited number of retransmissions per broadcast
- A data replication algorithm for small sized data items
  - Providing geographical distribution of the replicas
- Shuffling algorithms
  - Leverage the replica distribution in the presence of node movement
- A data gathering algorithm
  - To retrieve an unspecified number of items using a small number of messages

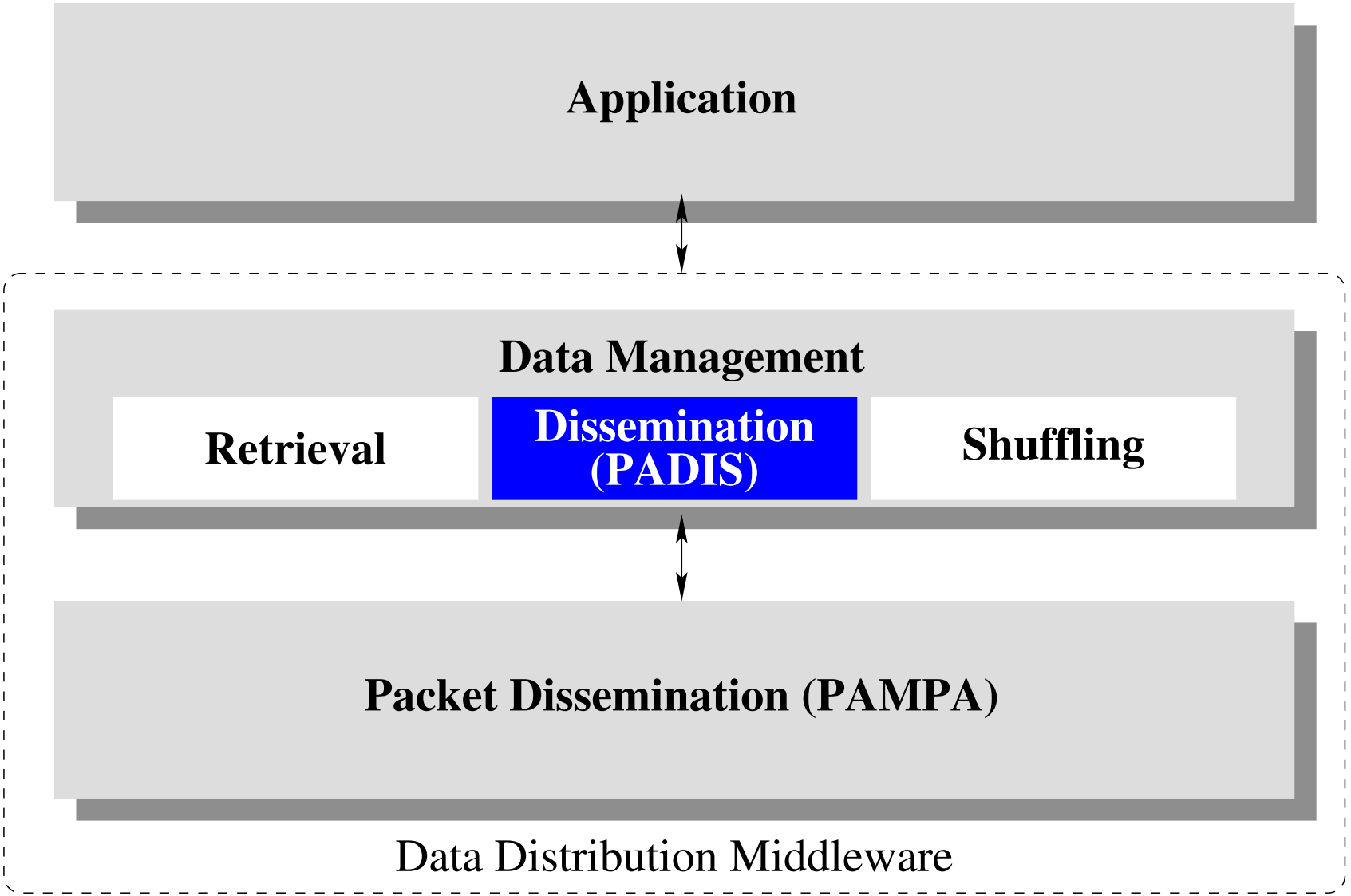
Components: Pampa



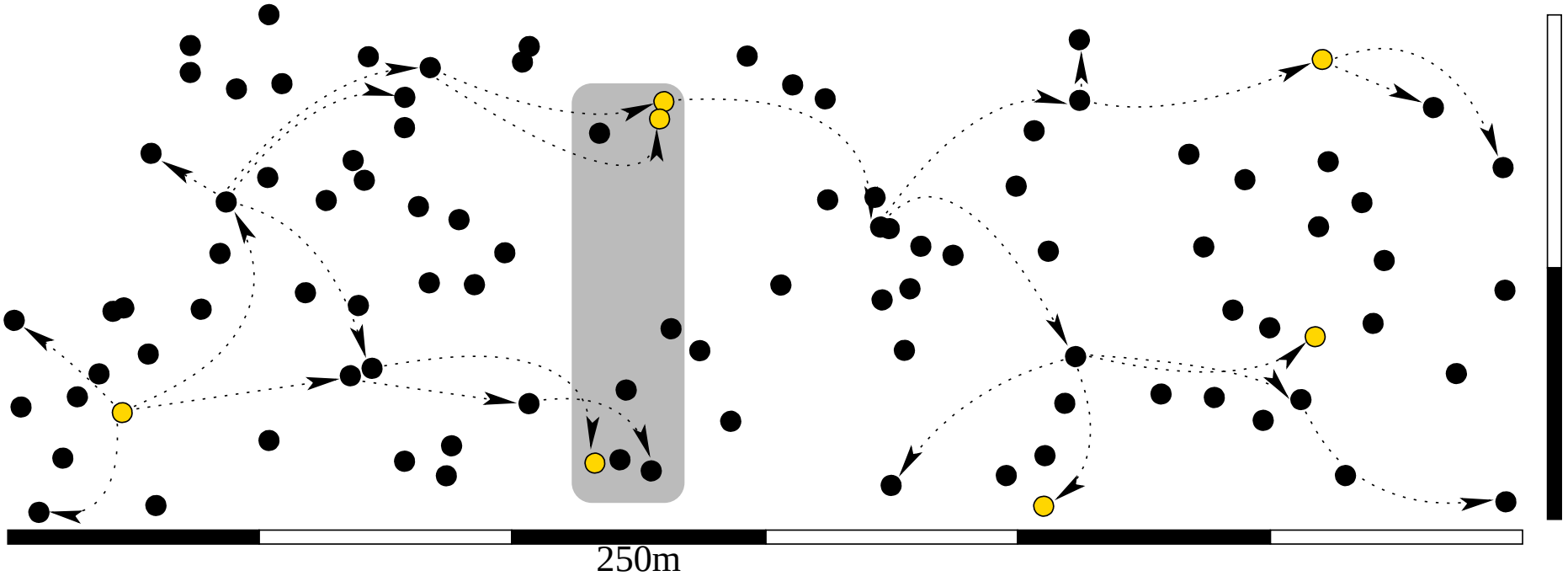
Results of Pampa

- *Power Aware Message Propagation Algorithm*
- Broadcasts with significantly less retransmissions than flooding
- Improves coverage or reduces retransmissions in comparison with other approaches
- Self-adaptive to node density
- Reduces the number of hops

Components: PADIS



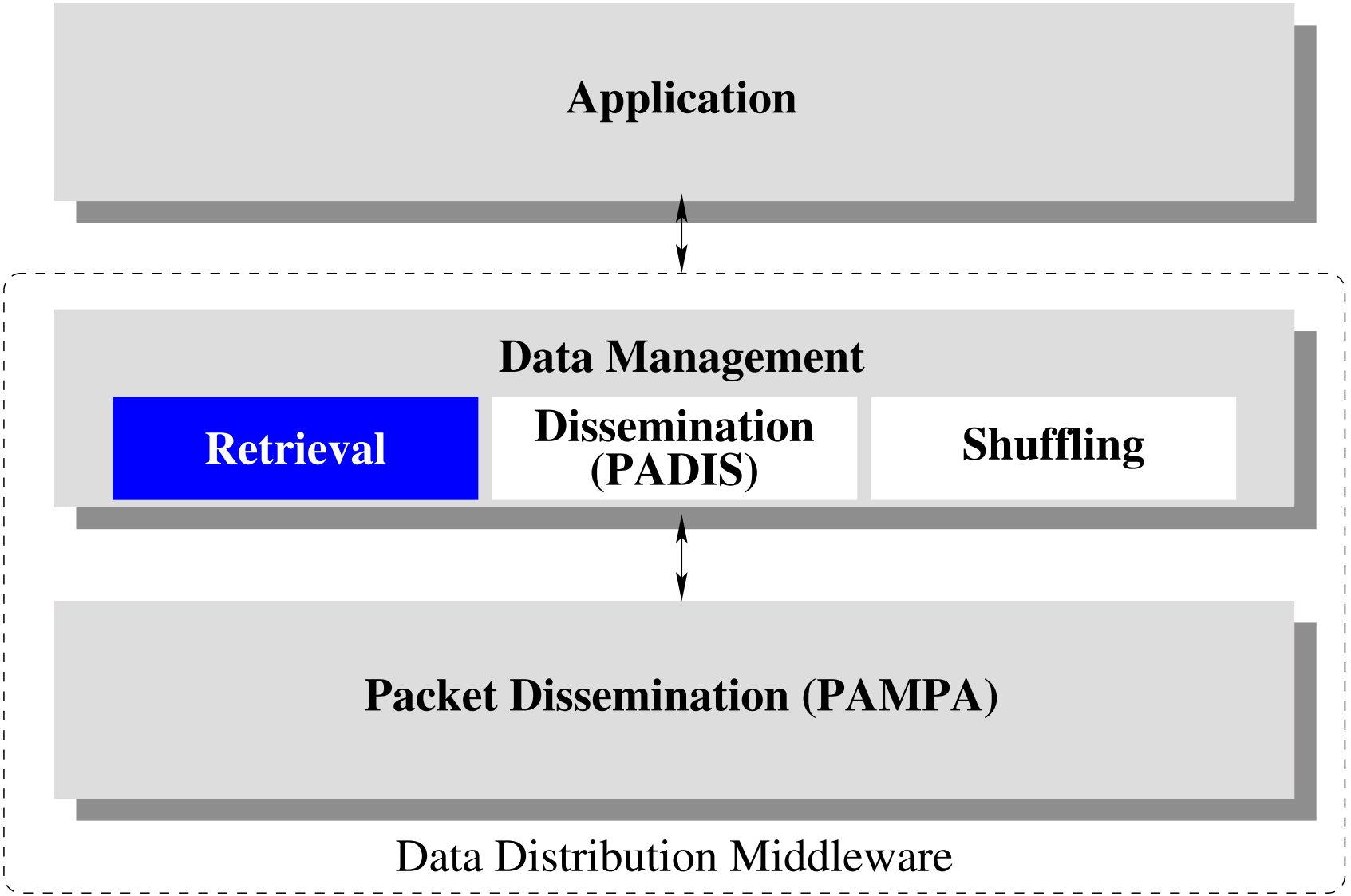
An example of data distribution



- ns–2
- 1500m×500m
- 100 nodes

- Arrows indicate devices that retransmitted
- 7 copies
- 26 retransmissions

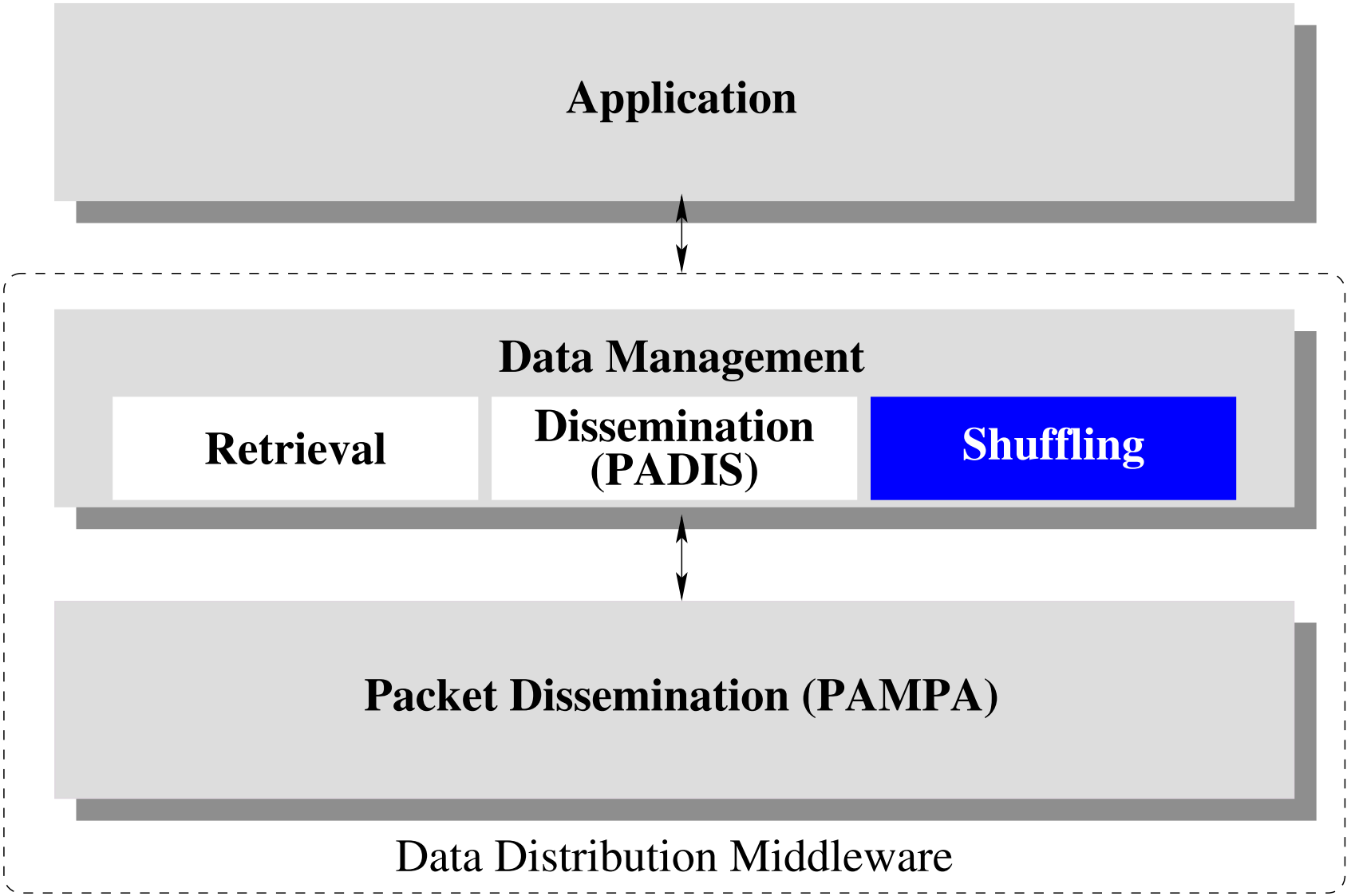
Components: Queries



Queries

- Two attempts
- Nodes first broadcast the query with a small TTL
  - Set by a configuration constant
  - Adapts to past experiences
- If no reply is received, broadcast to all nodes
- Replies are sent point-to-point
  - Use the route constructed during query propagation (like DSR)

Components: Shuffling

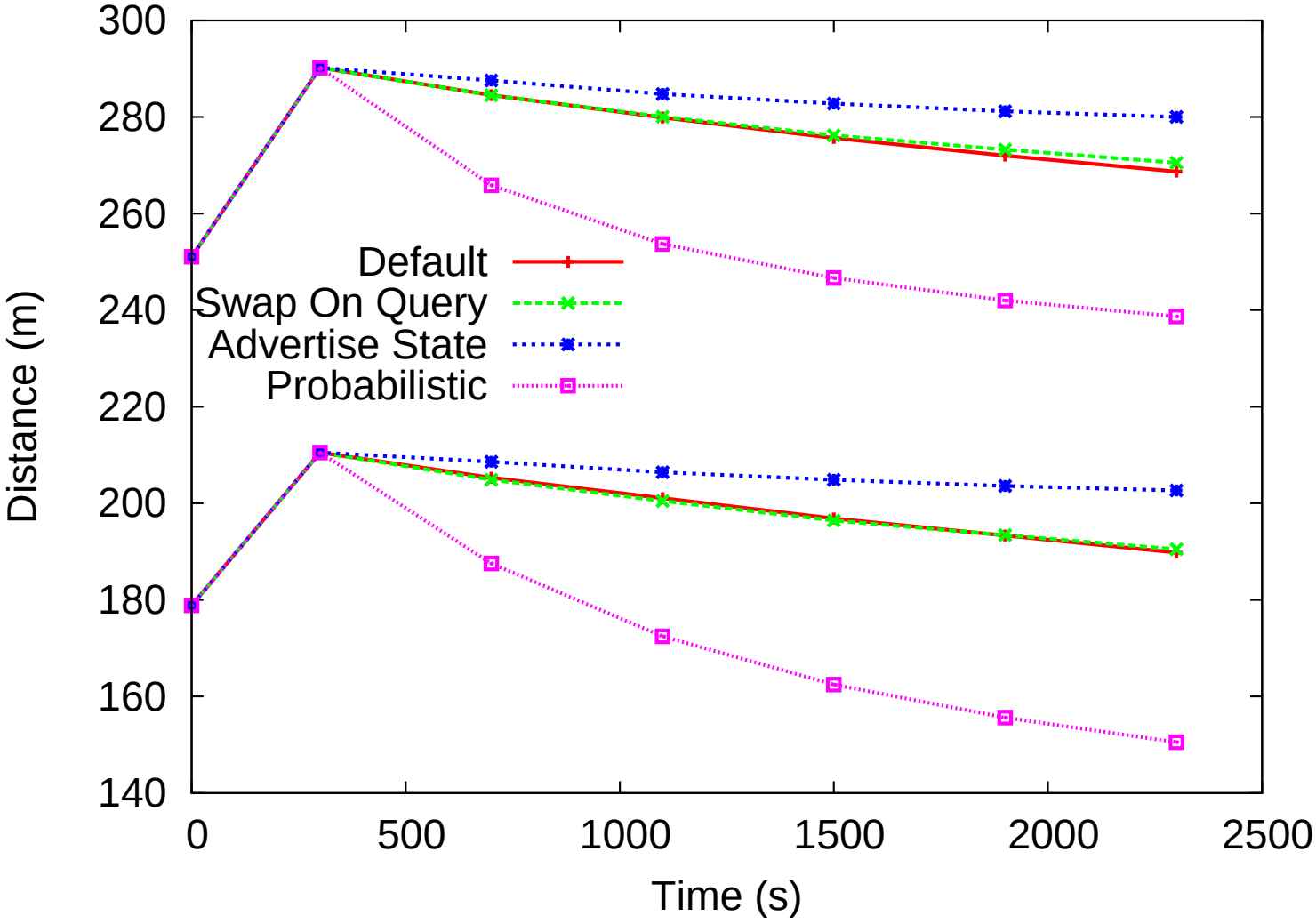


Shuffling algorithms

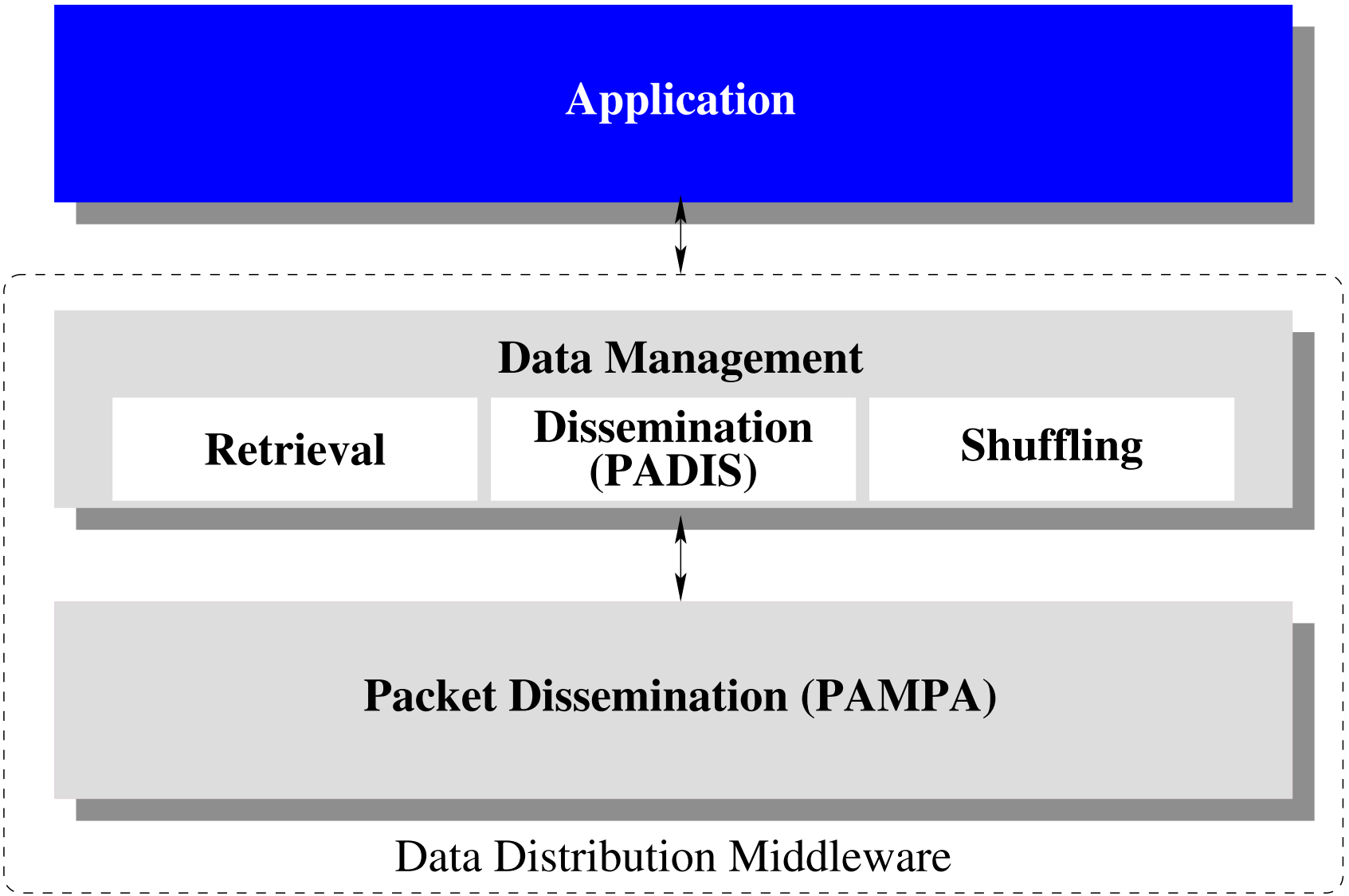
- Leverage replica distribution
  - In the presence of node movement
  - To mitigate failures of the initial distribution
- Triggered by queries
- Nodes negotiate the content of their storage spaces
- Four algorithms:

Algorithm	State information		Preserve # replicas
	Piggyback	On-demand	
Default			
Swap on Query		•	•
Advertise State	•	•	•
Probabilistic	•		

Benefits of Shuffling



Application



SIPCache

- Distributes SIP's Address of Records (AORs) on a MANET [Leggio:06]
- Contributions
  - Dissemination of AORs
  - Improves scalability
  - An efficient algorithm for performing queries with multiple replies

SIP	$\longrightarrow$	dSIP	$\longrightarrow$	SIPCache
Wired		One-hop MANETs		Multi-hop MANETs

Conclusions

- The thesis presents:
  - A broadcast algorithm
  - A data dissemination algorithm
    - Uses the signal strength to geographically distribute the replicas
    - Places a copy of each data item at a maximum (configurable) distance of every node
  - Shuffling algorithms
    - To leverage the distribution when nodes move
    - Piggyback data on query messages
- The algorithms were experimented in a testbed application

Future Work

- Experiment other shuffling algorithms
- Address:
  - Updates of data items
  - Self-configuration of the distance between copies
- Experiment the algorithms on different applications

Publications

- H. Miranda, S. Leggio, L. Rodrigues and K. Raatikainen. "A power-aware broadcasting algorithm". *PIMRC'06*. Finland. 2006
- H. Miranda, S. Leggio, L. Rodrigues and K. Raatikainen. "An algorithm for distributing and retrieving information in sensor networks". *OPODIS'06 (brief announcement)*. France. 2006
- H. Miranda, S. Leggio, L. Rodrigues and K. Raatikainen. "An algorithm for dissemination and retrieval of information in wireless ad hoc networks". *Euro-par 2007*. France.
- H. Miranda, S. Leggio, L. Rodrigues and K. Raatikainen. Chap. "Epidemic Dissemination for Probabilistic Data Storage". Baldoni et al.(eds.) *Global data management*. IOS Press. 2006
- S. Leggio, H. Miranda, K. Raatikainen and L. Rodrigues. "SIPCache: A distributed SIP location service for mobile ad hoc networks". *MOBIQUITOUS 2006*. USA.