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To cite this version:

Laurent Bouraoui, Arnaud de la Fortelle, Anis Laouiti. OLSR improvement for distributed traffic applications. Fourth Annual Mediterranean Ad Hoc Networking Workshop, Jun 2005, Île de Porquerolles, France. pp.73-77, 10.1007/0-387-31173-4_9 . inria-00000964

HAL Id: inria-00000964
https://hal.inria.fr/inria-00000964

Submitted on 6 Jan 2006

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OLSR improvement for distributed traffic applications

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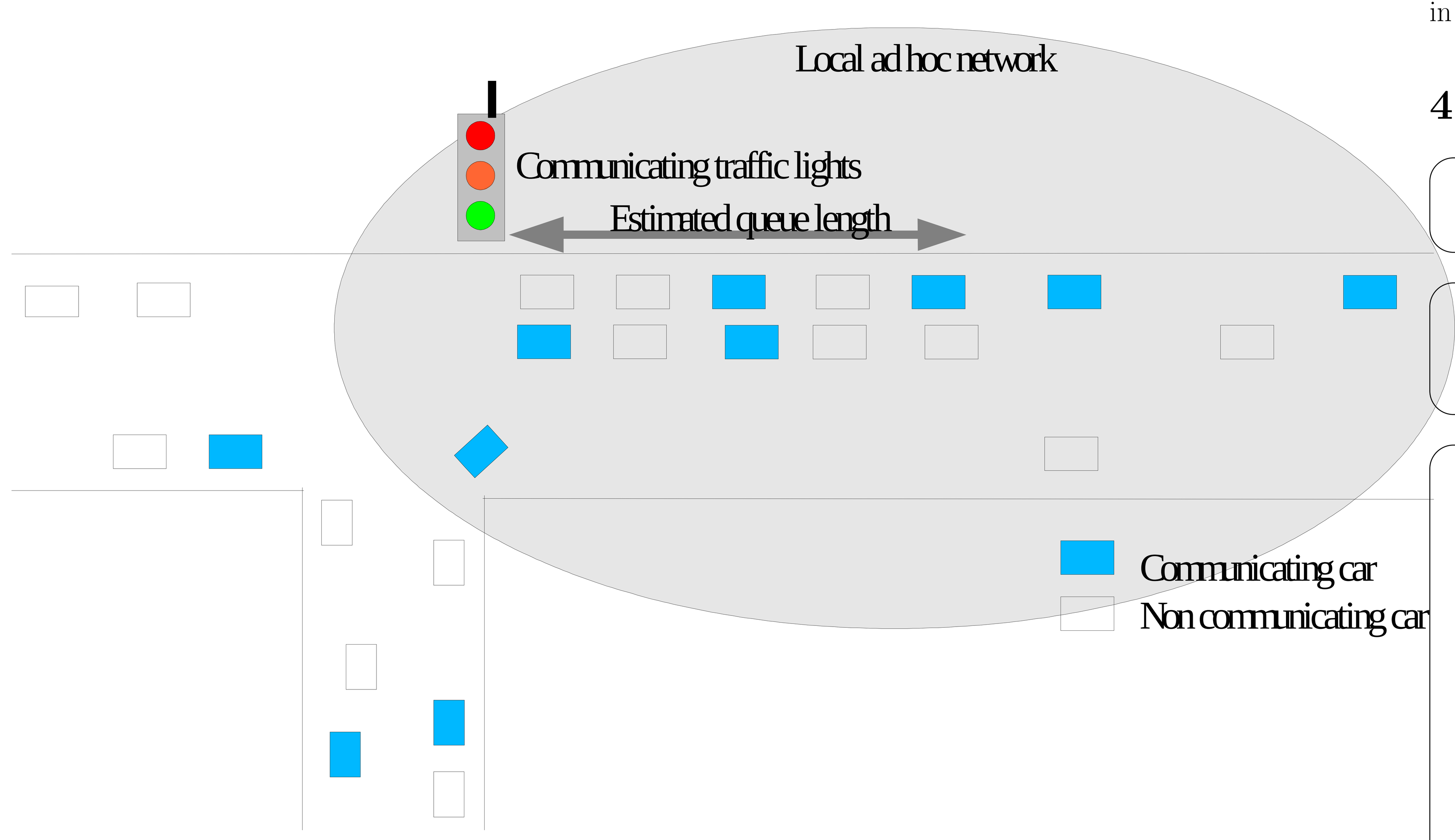
1 Wireless communication in transportation

To avoid the limitations of centralized communication systems for transportation (e.g. response time, scaling to very large numbers of vehicles, privacy), it is commonly admitted that local applications should rely on local communication, i.e. ad-hoc mobile networks.

A typical scenario is an intersection regulated by traffic lights (see below). Vehicles establishing communication in the vicinity of this place form an ad hoc network. Vehicles communicate information about speed and position. This information is partly processed by on-board peer-to-peer algorithms to calculate the waiting time at one traffic light. Moreover there are connections (vehicle-infrastructure) to a hot-spot that controls the traffic lights cycles depending of the queue length at each incoming street.



2 Properties of car ad hoc networks

Properties that an ad hoc routing protocol should satisfy to be adapted to the transportation applications:

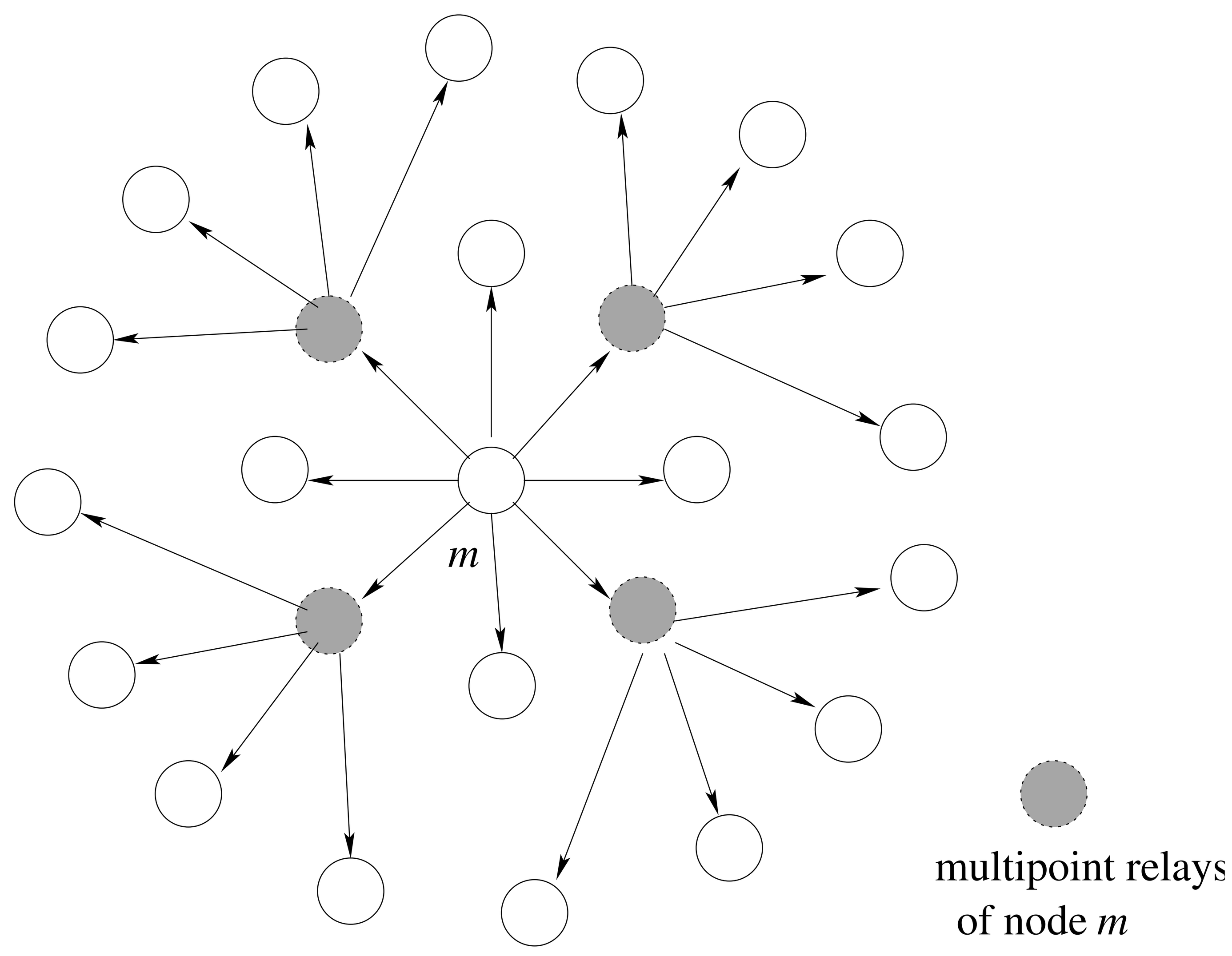
1. **Enabling communication and information exchange between cars.**
2. **High reactivity is required: in general car traffic is very dynamic.**
3. **Small car networks are preferred.**

3 The Optimized Link State Routing (OLSR) protocol

OLSR is an optimization of a pure link state routing protocol. It is based on the concept of *multipoint relays* (*MPRs*) [2]. First, using *multipoint relays* reduces the size of the control messages: rather than declaring all links, a node declares only the set of links with its neighbors that are its "*multipoint relay selectors*". This means that we declare only a partial set of links to the network, which is sufficient to routing table calculation. The use of *MPRs* also minimizes flooding of control traffic. Only *multipoint relays* forward non duplicated control messages. In fact, each node maintains a duplicate set to prevent transmitting the same *OLSR* control message twice. This technique of *MPR* significantly reduces the number of retransmissions of broadcast control messages [1, 2]. The two main *OLSR* functionalities are Neighbor Discovery and Topology Dissemination.

3.1 Neighbor Discovery and Multipoint relay calculation

- Each node periodically broadcasts *Hello* messages, containing the list of neighbors known to the node and their link status.
- The *Hello* messages are received by all 1-hop neighbors, but are not forwarded.
- They are broadcasted once per refreshing period called the "*HELLO_INTERVAL*".
- *Hello* messages enable each node to discover its 1-hop neighbors, as well as its 2-hop neighbors. This neighborhood and 2-hop neighborhood information has an associated holding time, the - "*NEIGHBOR_HOLD_TIME*", after which it is no longer valid.



⇒ On the basis of this information, each node independently selects its own set of *multipoint relays* among its 1-hop neighbors in such a way all 2-hop neighbors of m have *symmetric* links with $MPR(m)$. This means that the *multipoint relays* cover (in terms of radio range) all 2-hop neighbors One possible algorithm for selecting these *MPRs* is described in [2].

3.2 Topology Dissemination

- Each node of the network maintains topological information about the network obtained by means of *TC (Topology control)* messages.
- Each node m selected as a *multipoint relay*, broadcasts a *TC* message at least every "*TC_INTERVAL*".
- The *TC* message originated from node m declares the *MPR selectors* of m and are flooded to the entire network by the mean of the *MPR* nodes.

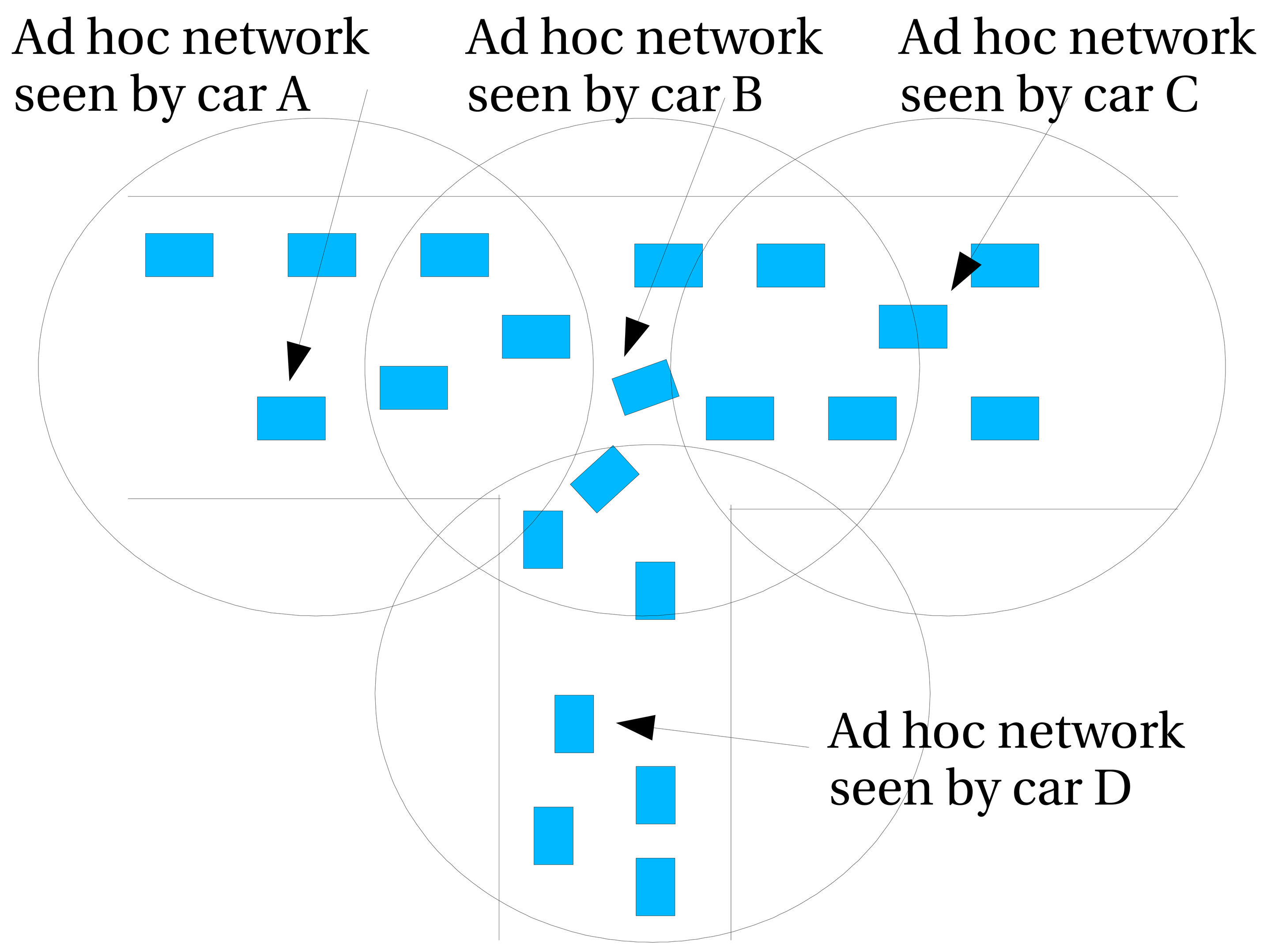
⇒ The neighbor information and the topology information are refreshed periodically, and they enable each node to compute the routes to all known destinations. These routes are computed with Dijkstra's shortest path algorithm [3]. Hence, they are optimal as concerns the number of hops. The routing table is computed whenever there is a change in neighborhood or topology information.

4 Using OLSR in car communication

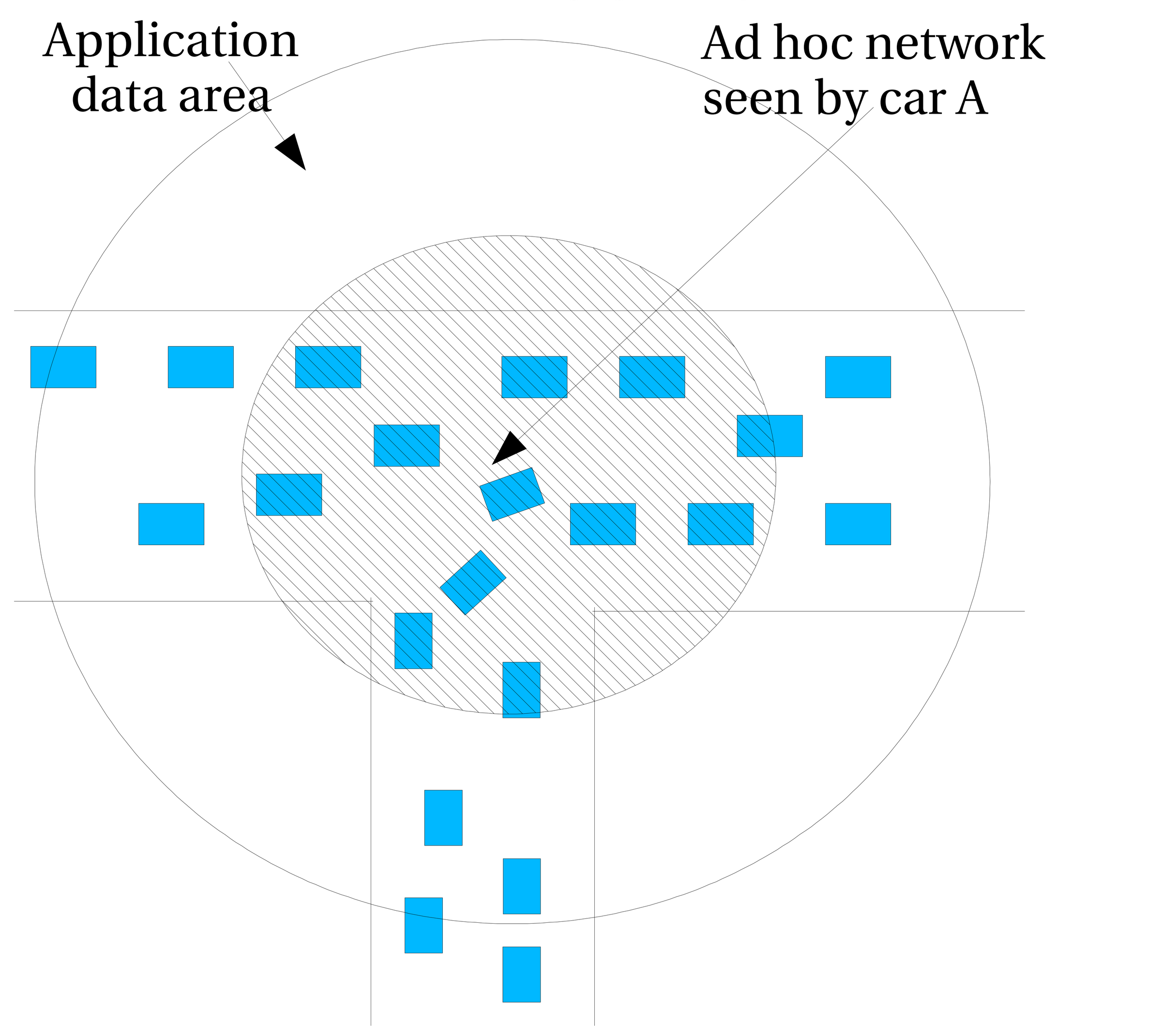
- ***OLSR* protocol satisfies the first property.**

- **High reactivity is reducing the refreshing period of topological information broacasted by *OLSR* (second property).**

- **Building small car networks.**



- *OLSR* control traffic propagation is restricted to a predefined area.
- This area should at least include the 2-hop neighbors, then nodes can select their *MPRs* and take profit from the optimized flooding technique of *OLSR*.
- The geographical information is included in control packets.
- Traffic coming from far cars is not relayed and simply droped.
- Each car will have a limited topology view of the global network.
- The routing table offers routes to all the nodes belonging to the predefined area.



- Data could be broadcasted outside these limited ad hoc networks.
- We can define a wider area, where application data could be relayed.

References

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[2] A. Qayyum, A. Laouiti, and L. Viennot. Multipoint relaying technique for flooding broadcast messages in mobile wireless networks. In *HICSS: Hawai Int. Conference on System Sciences*, 2002.

[3] A. S. Tanenbaum. *Computer Networks*. Prentice Hall, 1996.