Broadcasting in DT-MANETs from Simulation to Real-life

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1 Context

Mobile ad hoc networks, a.k.a. MANET, are self-organizing wireless networks formed by groups of mobile devices, also called stations, able to communicate with each other in a decentralized way, without the help of any pre-existing infrastructure. Two stations can communicate if and only if they are both within their communication range, thus, a station can only communicate with devices located in its neighborhood. Among MANETs, the class of DT-MANETs represents a particular category. DT-MANET stands for *Delay-Tolerant* or *Disruption-Tolerant* Mobile ad hoc network. In such networks, there is no guarantee that a path always exists between any couple of stations. From a graph point of view this means that the connection network may be composed of more than one connected component, besides, these networks are also called *disconnected* networks. Within connection graphs, nodes and edges may appear and disappear at any moment, but, it is usually supposed that a journey exists between any couple of nodes. A journey between two vertices s and d is defined as a set of timely ordered edges such that s is an extremity of the first one and d an extremity of the last one [BF03]. Then, thanks to the mobility of stations, if a journey exists between s and d, an information may travel between both devices. Assuming this hypothesis, sharing information between users implies that some stations play the role of *data mules* for carrying information. The particular constraints of DT-MANETs have led us to propose a suitable broadcasting method for disconnected networks : the DFCN broadcasting protocol. Using MADHOC [mad], a DT-MANET simulator that includes urban-like mobility models, we performed many tests in order to compare, theoretically, the performances of DFCN with respect to other broadcasting methods. The simulations indicate that, in the context of DT-MANET, DFCN reaches better performances than other broadcasting methods found in the litterature. The next step for validating the method was to implement it on real-life plateforms. This has been done and this is the object of this demonstration.

2 Broadcasting in Disconnected Networks

Many broadcasting protocols actually consist of strategies for the determination of dominant sets.These techniques make the implicit assumptions that the mobility (if some) is low and that the network is non-partitioned (meaning that all nodes are reachable through multi-hop connections). Some other protocols, proposed more recently, feature more dynamic approaches (such as self-pruning [WC02, SW04]), in which the mobility is central issue. The protocol presented in our paper belongs to the latter category. More precisely, we consider realistic networks such as mall and Metropolitan Ad hoc Network [CGMT03]. Such networks have two important properties :

- the node density in the network may vary greatly. A very sparse network is as realistic as a very dense one, as illustrated in Figure 1.The difficulty of dealing with such variations of density is that the protocol needs to be efficient when the network is made of several disjoint parts as well as when it is highly connected.
- a network may be composed of thousands nodes roaming all across a city.

In such network, the broadcasting process cannot propagate data to all nodes : only a subset of the nodes can be reached at a particular time.

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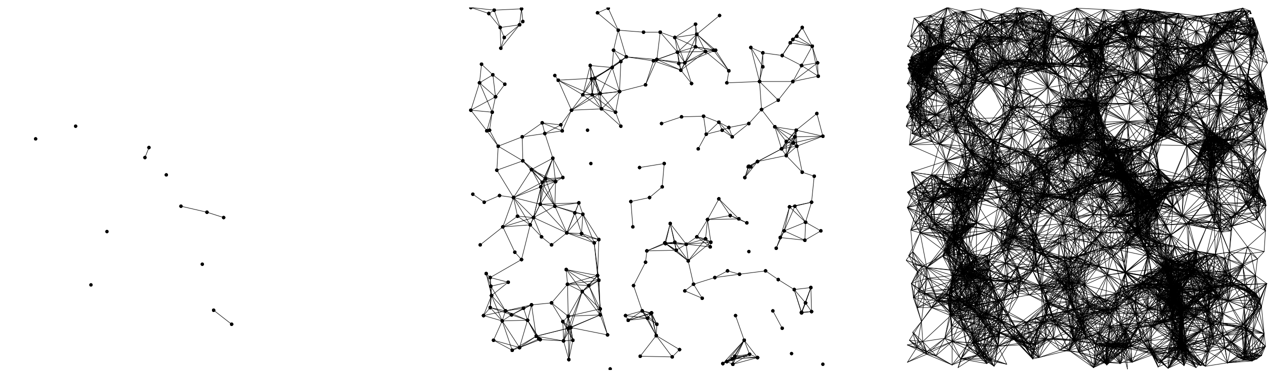

FIG. 1 – *Broadcasting in a low density network (figure on the left,* $50 nodes/km^2$*) is difficult because the protocol needs to make a very good use of the mobility to achieve a good coverage. When the density increases (figure in the middle,* $1000 nodes/km^2$*), the connectivity gets better, but the network may be partitioned. When the density is highly connected (figure on the right,* $5.000 nodes/km^2$*), the broadcasting protocol must be bandwidth-efficient in order to minimize the risk of packet collisions.*

While there exist numerous strategies for broadcasting data in MANET, very few are able to manage disconnected MANETs. In [HGB04] a new broadcasting protocol called DFCN (standing for Delayed Flooding with Cumulative Neighborhood) was proposed. At the time of its publication, this protocol outperformed all existing ones while being easy to implement, two reasons that have motivated our choice. The principle of this algorithm is very simple and relies on the use of two thresholds for avoiding the well-known ”broadcast-storm”, but also to self-adapt to the environment when the distribution of stations is not uniform. Indeed, depending on the environment, stations have to be provident in dense regions and prolix in sparse ones. DFCN method allows this adaptation by relying on neighborhood information. The effectiveness of the strategy was demonstrated by simulation using madhoc [mad].

3 Technical Details

The demonstration will be divided in two parts. In a first time a demonstration of madhoc will allow participants to understand the behavior of the algorithm through simulations.

In a second time, a demonstration of DFCN on real material will be carried out. The real-life demonstration will use about ten mobile devices (PocketPc and subnotebooks). These machines are equipped with WiFi 802.11b/g radio communication devices. One subset of these machines is running the application described above while another subset is observing and logging the communications for the purpose of the demonstration.

The software was designed to auto-configure the devices. It can be executed on any Windows Mobile^{tm} Wifi capable device without any extra human tuning. The network topology and the local representation of the network are monitored with subnotebooks running on Linux.

Références

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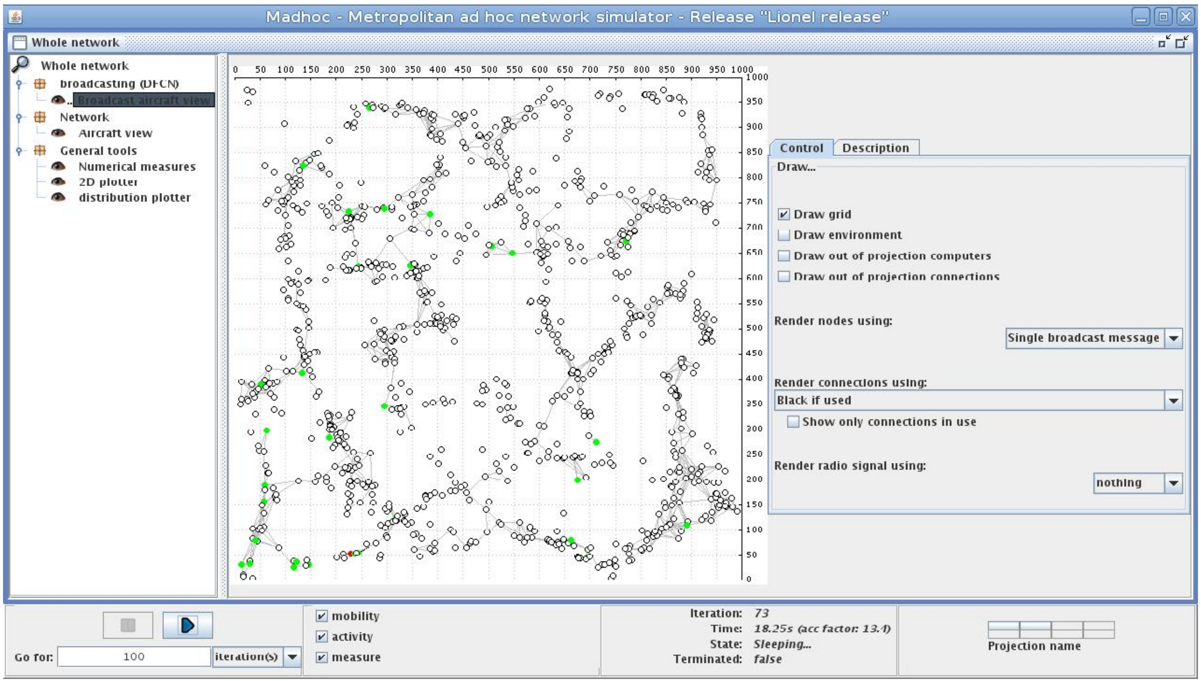

FIG. 2 – *A snapshot of madhoc, a DT-MANET simulator that includes human-like mobility models in urban-type environments.*

FIG. 3 – *A sample of devices that will be used for the demonstration. Subnotebooks (eee PC) are used only for monitoring. One or 2 eeePCs, 3 Qtek 9000 and 7 Qtek 2020i.*

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