S-Manet Simulator

Abstract

The** S-Manet **toolbox is developed on top of** Scilab**, a scientific software package for numerical computations providing a powerful open computing environment for engineering and scientific applications. The mains goal of** S-Manet **relies on the analysis of the global connectivity of a Mobile Ad hoc Network (**MANET**). In fact the topology of a** MANET **is in a constant change due to the mobility of nodes.** S-Manet **allows to measure the impact of Ah doc network protocols on the effectiveness of connections between mobile nodes. Recent works suggest to use multiple paths algorithms in order to improve the data traffic behavior. In fact route diversity aims to avoid local congestion phenomenon and reduce the traffic variability. As far as we know,** S-Manet **is one of the first attempts that take simultaneously routing, user demand and network topology into consideration.

Introduction

Wireless networks present significant advantages from conventional wired infrastructures. For instance, their low cost permits to promptly realize temporary networks. *MANET*s cover a large range of applications, e.g. collaborative communication, sensoring (fire, flood) and public safety communication. Recent investigations conclude that *MANET*s represents the most reasonable and relevant solutions to bring communication capabilities in regions where expensive wired connections are not yet well deployed, or where a fast deployment is required.

Thus wireless networks facilitate data communications in geographical areas where common wired infrastructures are not directly reachable. *MANET*s are a challenging solution to provide Internet connectivity in such environments. A *MANET* does not rely on a pre-defined communication infrastructure. Its topology is dynamically maintained and depends on the mobility of its components associated to users. Each node locally cooperates with its neighbors in order to build a global network topology.

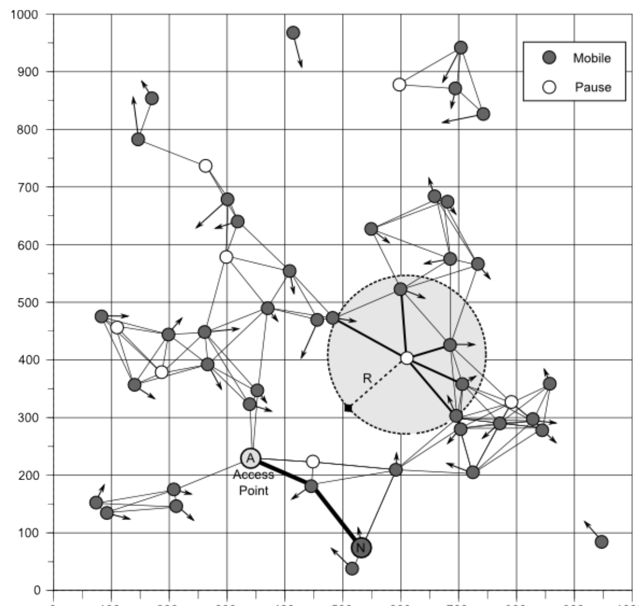

Figure 1 A MANET topology is dynamic and depends on the user mobility model.

Figure 1 represents a snapshot of a *MANET* topology configuration generated with the *S-Manet* toolbox. Nodes are moving inside a square area of side 1000 distance units. The velocity of nodes is displayed according to arrows. The displacement of nodes finally generates local changes on the *MANET* topology. We have built a simulator on top of *Scilab* in order to study the nodes mobility impact on *MANET* topologies. In fact we aim to analyze the effectiveness of routing protocols on a changing *MANET* topology.

The data traffic should not be studied without taking into account the network topology, and the transmission and routing protocols used on it. Two general trends can be distinguished. To one side, network researchers aim to simulate several mobility models, and their direct consequences on the global network topology that supports real data propagations. To the other side, some scientists point at the analysis of transmission protocols and their impact over simple changing topologies based on non-realistic mobility models. They generally study the effectiveness of new protocols in respect with network simulators such as *ns-2* **[1]**. But simulations consume large time and computational resources. This is the reason why scenarios on small topologies with simple mobility models are generally used in order to avoid an explosion of the simulation duration.

Our contribution relies principally on the development of a complete network simulator that analyses the complex impact of routing and transmission protocols, user demand, and network topology on the data traffic behavior. *S-Manet* is the third toolbox of our project. It is dedicated to *MANET*s. Two existing toolboxes, named *NTG* and *NTS* are already available. Network Topology Generator (*NTG*) **[2]** enables to produce random topologies in order to study the impact of routing algorithms on the effectiveness of transmission protocols used by data communications. Network Traffic Simulator (*NTS*) **[3]** aims to simulate random traffic on a network topology in order to evaluate the mutual effects between routing algorithms, transmission protocols, user demands and data traffic. In the current stage of our project, we consider now the case where network nodes are mobile. *S-Manet* manages their displacement and the topology performance of a *MANET* in either free space or constrained environments.

S-Manet Simulator

We have designed a new *MANET* simulator based on the matrix computing power of *Scilab* **[4]**. A topology is totally described by the quantity of nodes n belonging to the network, their locations, and the links characteristics (l direct 1-hop edges between nodes). A link is defined by a starting node (*head*), a finishing node (*tail*) and a weight (w) needed in the path performance between network entities. We propose to randomly place nodes inside a square that defines the network coordinates bounds. Let L be the square side length. Then a topology can be stored into five vectors that describe the network graph:

- *nodex* (respectively *nodey*) is a vector composed by n values: it provides the x-coordinates (respectively y coordinates) of each network node,
- *head* (respectively *tail*) consists of a vector $(1, l)$: it gives the starting (respectively finishing) node of each network link,
- *length* represents a vector of l values that correspond to the weight of network links.

We consider mobile nodes. As a consequence, the network topology must be computed in real time in order to see its evolution. In fact on the one hand several links can appear because some nodes become visible to each other after their displacement. Their distance becomes smaller than their communication range R (see **Figure 1**). On the other hand, several links can disappear because some nodes are keeping away from each other after their displacement, especially because their distance becomes greater than R. Thus the corresponding links are lost.

In the first release of *S-Manet*, we make a distinction between two classes of nodes:

- moving nodes that modify the global *MANET* topology,
- Access Point (*AP*) nodes that are fixed and provide a gateway to the global Internet.

Moving nodes are represented in respect with gray disks, accompanied with a velocity vector that points their destination. Each arrow length is proportional to the corresponding node speed. When a node reaches its destination, it stays at the same position during a fixed duration (see white disks in **Figure 1**). During this inactive movement, it can be used as a Relay Point by its neighbors.

For each network topology configuration, the k-modified Dijkstra's algorithm **[5]** is applied between a selected node (*N*) and the closest Access Point (*A*). Thus a set of alternative path is performed for the defined connection (see **Figure 2**).

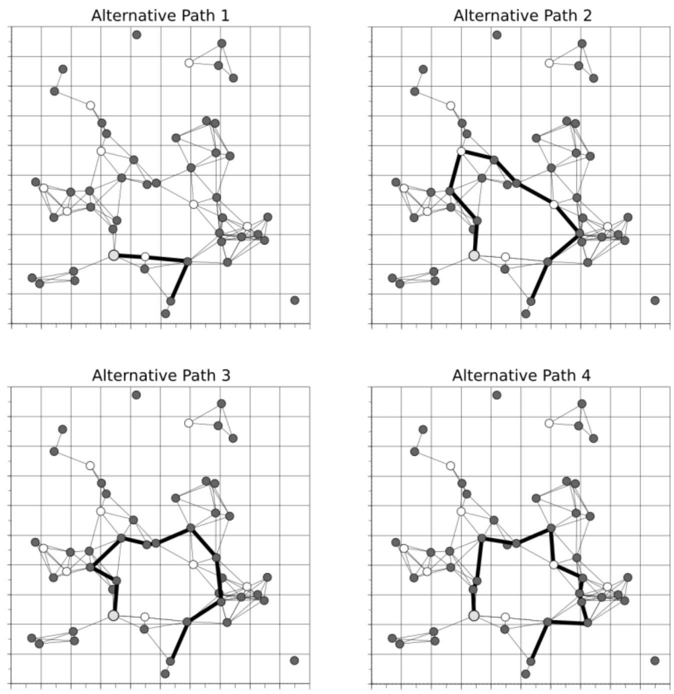

Figure 2 Application of the k-modified Dijkstra's algorithm between *N* and *A*.

As a consequence connection packets can be transmitted on multiple maximally disjoint paths, and that until the network topology moves to a new configuration (addition of new links or removal of old links).

S-Manet permits to analyze the effectiveness of this multiple path concept on different networking scenarios, and for several mobility models. We assume now that there exist at least two distinct access points. We have already considered 5 types of scenarios:

- ***Multi Access Points Mode:*** a moving node is allowed to connect itself simultaneously to reachable gateways in order to increase its networking capabilities in terms of quantity of connections towards the Internet. In this mode, the node under consideration performs, stores and updates the shortest path towards each accessible access point.
- ***Closest Access Point - Roaming Mode:*** a moving node is only interested in the closest Access Point that can be reached by the defined *MANET*. It only uses in this case the shortest path towards this gateway in order to support its data connections.
- ***Multiple Paths to the Closest Access Point - Roaming Mode:*** this mode is similar to the previous one, except that multiple paths are utilized between a node and the closest *AP*. These multiple paths are performed in respect with the k-modified Dijkstra's algorithm.
- ***Mobile Point-to-Point Connection Mode:*** two mobile nodes want to establish a data connection between them. The connection shortest path is calculated and updated when the network topology changes. In this mode, connection packets always follow a single path if the topology stays stable. However, the path is updated when topology breaks occur.

- ***Multiple Paths for Mobile Point-to-Point Connection Mode:*** this mode is similar to the previous one, except that multiple paths are used between connection nodes. Route diversity has been suggested in order to improve the connection Quality of Service (*QoS*).

Conclusion and Perspectives

S-Manet is a new specific toolbox developed on top of Scilab, a scientific software package for numerical computations providing a powerful open computing environment for engineering and scientific applications. *S-Manet* aims to analyze the global connectivity of a Mobile Ad hoc Network (*MANET*) and its dynamic behavior due to the mobility of nodes. Route diversity has been suggested as a relevant solution in order to deal with the *MANET* complexity. Multiple Paths schemes permit to enhance the data traffic behavior. In fact route diversity aims to avoid local congestion phenomenon and reduce the traffic variability. We are currently improving *S-Manet* by adding new features as other mobility models that take into account realistic movement and communication constraints.

In the next step of our project, we aim to define global metrics that facilitate the distinction between *MANET* protocols according to their effectiveness on a mobility model. We are developing now enhanced and more realistic mobility models. They are based on the consideration of obstacles in the geographic area where nodes are moving.

References

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[5] F. Melakessou, U. Sorger and Z. Suchanecki. 2008. “MPTCP: How Can Route Diversity Improve the Internet Traffic.” In Proceedings of *the Special Issue in Communication of ECTI-EEC Transactions on Electrical Engineering, Electronics and Communications.*