Chapter 4
A Simulation Methodology for Conducting Unbiased and Reliable Evaluation of MANET Communication Protocols in Disaster Scenarios

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ABSTRACT

The need for a Mobile Ad-Hoc Network (MANET) in environments where there is a lack of communication infrastructure, such as disaster or emergency scenarios, is critical to save lives. MANETs can be used as an alternative network that solves the problem of communications. The selection of an appropriate MANET communication protocol is crucial for the good performance of the whole network. Due to the great variety of communication protocols available for MANETs such as routing and broadcasting protocols, the selection of the most suitable one for disaster scenarios is a relevant task. Routing protocols and broadcasting algorithms are normally evaluated and compared using simulation-based studies. However, conducting reliable and repeatable simulation studies is not a trivial task because many simulation parameters should be correctly configured. In this paper, we propose a methodology for conducting reliable simulations of MANET broadcasting algorithms in disaster scenarios. The proposed methodology is focused on the source nodes selection based on different metrics.

INTRODUCTION

Communications in disaster scenarios are crucial, especially during the immediate hours after the disaster occurred, in order to coordinate the relief actions. Communications among victims and/or rescue teams can alleviate the possible disaster consequences and save lives. The coordination and organization of rescue teams may be crucial to reduce the damages of a natural or human made disaster, such as hurricanes, heavy floods, tsunamis or terrorist attacks. However, fixed communication infrastructure like cellular networks, which is normally used by citizens with their smartphones, can be malfunctioning due to the disaster damages.

For this reason, Wireless Mobile Ad Hoc NETworks (MANETs) (Lakshmi & Ibe, 2012)(Reina, Toral, Barrero, Bessis & Asimakopoulou, 2013) can be an appealing alternative communication network to be used in disaster response scenarios (Reina, Toral, Barrero, Bessis & Asimakopoulou, 2011)(Reina, Toral, Barrero, Bessis & Asimakopoulou, 2012). A MANET is an autonomous, infrastructure-less, self-configuring and self-healing system of mobile nodes connected to each other by wireless links (Jurdak, Lopes & Baldi, 2004). In MANETs, mobile nodes can communicate with each other directly whenever they are within the transmission range of each other or via intermediate nodes (Arfeen, Kazi, Memen & Hyder, 2007).

Routing protocols and broadcasting algorithms are the main communication mechanisms to establish communication among nodes in MANETs. On the one hand, routing protocols are an important research topic in MANETs. A routing protocol is used to exchange data packets between nodes in the network through a multi-hop communication path. In MANETs, each node learns about nearby nodes and how to reach them by discovery processes which are included in routing protocols. Such discovery mechanisms allow routing information to be exchanged among all mobile nodes (Zhang, Low & Ng, 2011). On the other hand, broadcasting algorithms are a one-to-all communication technique, where nodes disseminate the same information simultaneously to all their one hop neighbours. Both communication strategies are useful in disaster scenarios. Broadcasting algorithms can be used to spread out a warning message among the civil protection members participating in a rescue operation. Regarding routing protocols, they can be used by civil protection services to establish stable communication paths between first responders such as fire fighters and police officers. Both communication mechanisms have been actively investigated during the last two decades. As a result of this research, many routing and broadcasting protocols can be found in the literature. However, it has also been stated that there is a lack of rigorous evaluation studies of the proposed protocols.

The evaluation of MANET communication protocols (routing and broadcasting) by simulation is an important mechanism so far in wireless ad hoc networks. This is because real experimentation in multi-hop ad hoc networks is costly in terms of hardware requirements. A high number wireless devices is required, and as a consequence, there are only a few available testbeds in the world (Blywis, Günes, Juraschek, Hahm & Schmittberger, 2011)(Li & Zhu, 2013). For this reason, it is very important to obtain reliable simulation results. This is even more important in critical scenarios like disaster scenarios, where there is the necessity of establishing reliable communications in real time. However, MANET simulations have suffered from lack of credibility in the last decades, mainly because of the bad simulation practices followed by the research community (Trung, Benjapolakul & Duc, 2007)(Das, castañeda & Yan, 2000)(Pucha, das & Hu, 2007).

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