Performance Evaluation of WMN-GA Simulation System for Different Settings of Genetic Operators Considering Giant Component and Number of Covered Users

Admir Barolli, Seikei University, Japan
Makoto Takizawa, Seikei University, Japan
Tetsuya Oda, Fukuoka Institute of Technology, Japan
Evjola Spaho, Fukuoka Institute of Technology, Japan
Leonard Barolli, Fukuoka Institute of Technology, Japan
Kazunori Uchida, Fukuoka Institute of Technology, Japan
Fatos Xhafa, Technical University of Catalonia, Spain

ABSTRACT

In this paper, the authors propose and implement a system based on Genetic Algorithms (GAs) called WMN-GA. They evaluated the performance of WMN-GA for 0.7 crossover rate and 0.3 mutation rate, exponential ranking and different distribution of clients considering size of giant component and number of covered users parameters. The simulation results show that for normal distribution the system has better performance. The authors also carried out simulations for 0.8 crossover rate and 0.2 mutation rate. The simulation results show that the setting for 0.7 crossover rate and 0.3 mutation rate offers better connectivity and user coverage.

Keywords: Crossover Operators, Genetic Algorithms, Mutation Operators, Number of Covered Users, Size of Giant Component

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INTRODUCTION

WMNs distinguish for their low cost nature that makes them attractive for providing wireless Internet connectivity. Moreover, such infrastructure can be used to deploy community networks, metropolitan area networks, municipal and, corporate networks, and to support applications for urban areas (Chen et al., 2007), medical, transport, and surveillance systems. The main issue of WMNs (Akyildiz et al., 2005) is to achieve network connectivity and stability as well as QoS in terms of user coverage. This problem is very closely related to the family of node placement problems in WMNs (Muthaiah et al., 2008; Tang et al., 2009; Franklin et al., 2007; Vanhatupa et al., 2007; Amaldi et al., 2008; Zhou et al., 2007) among them, the mesh router mesh nodes placement. Here, we consider the version of the mesh router nodes placement problem in which we are given a grid area where to deploy a number of mesh router nodes and a number of mesh client nodes of fixed positions (of an arbitrary distribution) in the grid area. As node placement problems are known to be computationally hard to solve for most of the formulations (Garey et al., 1979; Lim et al., 2005; Wang et al., 2007), Genetic Algorithms (GAs) have been recently investigated as effective resolution methods. However, GAs require the user to provide values for a number of parameters and a set of genetic operators to achieve the best GA performance for the problem (Yao et al., 1993; Dezigner et al., 2006; Odetayo et al., 1997; Xhafa et al., 2008; Xhafa et al., 2007, 2009; Ochoa, 2002; Back, 1993).

In this paper, we deal with connectivity and coverage problem in WMNs. Because these problems are known to be NP-Hard, we propose and implement a system based on GAs, called WMN-GA. We evaluate the performance of the proposed system by different scenarios using different metrics such as crossover rate, mutation rate, giant component and covered users. We compared the performance of the system for normal distribution and different rates of crossover and mutation. Different from our other paper (Oda et al.), where we use as selection operator Linear Ranking, in this paper we use as selection operator Exponential Ranking. Setting the values of parameters in GAs has been and still is a major issue in GA research field. One such parameter is mutation rate. It has a considerable effect on GA convergence and, consequently in the quality of the found solution. For this reason we change the rates of crossover and mutation to see the behaviour of the system. By comparing the simulation results, we found out that the system has better behaviour when the setting of crossover rate is 0.7 and the mutation rate is 0.3.

The rest of the paper is organized as follows. We briefly mention most common application scenarios of WMNs in the upcoming section. The mesh router nodes placement problem is defined afterwards. We give a brief introduction of GAs in the following section. The WMN-GA system is presented in the next section. The simulation results are given in the section afterwards. In the last section we give some conclusions and future work.

APPLICATION SCENARIOS OF WMNS

There are a number of application scenarios for which the use of WMNs is a very good alternative to offer connectivity at a low cost. It should also mentioned that there are applications of WMNs which are not supported directly by other types of wireless networks such as cellular networks, ad hoc networks, wireless sensor networks and standard IEEE 802.11 networks.

A. Neighboring Community Networks

In a community, the usual solution is to deploy ADSL or cable. However, there are a number of limitations that WMNs can improve as shown in following.

• A large percentage of areas between the houses could not receive wireless services.
A Grid-Aware Emergency Response Model (G-AERM) for Disaster Management