ABSTRACT

An Ad-hoc wireless is composed mainly of mobile hosts that communicate with each other without fixed infrastructure and no central administration. The main problems associated with these networks are the unpredictable mobility of hosts and a modest flow of communication. In this context, a major problem is partitioning the network in groups called clusters, giving a hierarchical organization. This work presents a deterministic self-stabilizing clustering algorithm for Ad-Hoc networks based on PSO (Particle Swarm Optimization). The proposed approach creates clusters and controls the nodes mobility to ensure more stability for the system. To increase the network life and reduce the answer time of user queries, it proposed also a replication strategy based on the non-similarity degree. The simulations show that the cooperative approaches (clustering, mobility and replication) minimize the energy consumption and increase the QoS of the system.

Keywords: Ad-Hoc Networks, Clustering, Cluster-Head, Energy Consumption, Load Balancing, Network Life, PSO, Replication, Similarity

1. INTRODUCTION

Mobile networks Ad-Hoc, consist in a big number of mobile units moving in any environment, using wireless like a mean of communication. These networks have the particularity to auto-create, auto-organize and auto-manage themselves and don’t rest on any stationary infrastructure (Naah & Okoampa, 2014). The different components communicate using wireless links, potentially mobile links, and can be brought to enter or to come out of the network at all times. Some of the constraints of the network Ad-Hoc are: lower bandwidth capacity, a limitation of the source of energy and a disconnection of network because of the mobility of the node (Kumar et al. 2011). To improve the performance of the Ad-Hoc network and to guarantee the scalability, we can use the clustering technique. This technique consists in a virtual carving of the network in groups near geographically. These groups are called clusters. They are identified by a particular node named Cluster Head. The cluster being constituted then of the Cluster Head and all nodes that are connected to it. The majority of clustering strategies don’t take into consideration the connectivity of the network and the management of user queries which minimizes the reliability and the life span of the system. In this paper, we propose a new strategy to manage the clustering, the mobility and the user queries effectively without reducing the network life and the user’s satisfactions. The proposed
approach can be divided in three stages: Clustering, mobility control and replication. The clustering combines between two important metrics (the connectivity and the energy) for the selection of Cluster Head. The control of mobility is used to improve the connectivity of the system, so we assume that the nodes have the possibilities to control their mobility and choose their best positions in the system, the control of mobility is based on the meta-heuristic method PSO (Particle Swarm Optimization). Finally the adaptive replication is implemented to minimize the energy consumption caused by the management of the queries and to improve the answers time system.

The rest of this paper is organized as follows: Section 2 cites some existing clustering techniques in the literature. Section 3 describes our contribution based on three cooperative approaches: the clustering, the mobility control and the replication, each approach in explained in details with some illustrating examples. Section 4 presents the experimental results. The conclusion and the perspectives are presented in Section 5.

2. RELATED WORKS

Figure 1 shows a classification of clustering algorithms in Ad-Hoc networks. We interest rightly to the algorithms (Schema) based on PSO (Particle Swarm Optimization), since it constitutes an integral part of our algorithm (for the other clustering techniques, more details can be found in (Bentaleb et al. 2013)). The PSO based clustering is classified in three categories: PSO-C (Heinzelman & Chandrakasan, 2002), MST-PSO (Co et al. 2008) and PSO-clustering (Guru et al. 2005). We will explain each strategy in the next paragraphs.

In (Guru et al. 2005), the authors proposed an algorithm named PSO Clustering, which have four variants of PSO: PSO-TVIIW (PSO with time varying inertia weight), PSO-TVAC (PSO with time varying acceleration constants), HPSO-TVAC (Hierarchical PSO-TVAC) and PSO-SSM (PSO with supervisor student mode) for energy aware clustering. This algorithm is only applicable when each node fixes the range of the Omni-directional transmission, the sensor field should be mapped into a 2-Dimensional space and nodes are randomly distributed. After deployment of the nodes, the nodes are static and the positions of the nodes are known to the base station (see Figure 2). The base station

Figure 1. The algorithms of clustering in an ad-hoc networks (Kumar et al. 2011; Singh et al. 2013)
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