Computers and Electrical Engineering 000 (2016) 1–9

Contents lists available at ScienceDirect

Computers and Electrical Engineering

journal homepage: www.elsevier.com/locate/compeleceng

Analysis of clustered QoS routing protocol for distributed wireless sensor network☆

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ARTICLE INFO

Article history:
Received 10 March 2016
Revised 15 November 2016
Accepted 15 November 2016
Available online xxx

Keywords:
Clustered technique
Quality of service
Qos requirements
Wireless networks
Distributed architecture

ABSTRACT

A wireless network is a collection of wireless nodes within decentralized and distributed network architecture. This distributed architecture gives rise to issues concerning resilience, node mobility, link failure, routing overhead and drop rate. To avoid these issues and satisfy QoS requirements, a new routing protocol known as clustered QoS routing protocol (CQRP) is proposed. This routing protocol creates a cluster with a grouping of nodes and assigns a cluster head. This cluster head is used to assign an available link for the wireless node to avoid issues with resilience and link failure. Cluster members communicate with data packets through the cluster head. Through the use of this cluster head, quality of service requirements for a distributed network can be met. Experimental results show that the performance of the proposed clustered QoS routing protocol CQRP increases throughput, delivery rate and network efficiency, and decreases the drop rate, delay and routing overhead.

1. Introduction

A wireless network has a large number of wireless nodes, arranged in either a centralized or distributed architecture. In a centralized architecture, a central node will act as a server, while the remaining nodes act as clients. Client nodes can communicate only through the central server node. In distributed network architecture, each wireless node may act as either a server or a client. All the nodes in the network are able to communicate with each other independently, and are not dependent on a centralized server. This independent architecture may lead to security issues. To avoid this, clustering technology is introduced in a distributed wireless network. This forms a cluster from a group of nodes, and each cluster creates its own cluster head to enable efficient transmission between the source and destination. Another issue within wireless networks is the relatively high number of mobile nodes. These mobile nodes are able to enter or leave the network, and may cause unusable links. Due to this greater number of mobile nodes, topology maintenance is very difficult in a distributed wireless network. This node mobility and link failure may degrade the network performance and reduce the quality of service.

Tseng et al. [19] suggest a green clustering algorithm, based on a relative neighbourhood graph, to manage the number of nodes, bandwidth efficiency and transmission distance in the wireless network. This proposed algorithm reduces energy

☆ This paper is for CAEE special section SI-wls8. Reviews processed and recommended for publication to the Editor-in-Chief by Associate Editor Dr. S. Smys.

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http://dx.doi.org/10.1016/j.compeleceng.2016.11.019
0045-7906/

consumption and increases the network lifetime and battery lifetime of the wireless network. Arkian et al. [4] describe a stable clustering scheme for a vehicular ad hoc network to increase network performance and decrease mobility issues. Xu et al. [20] discuss performance-aware mobile computing based on video-on-demand for a vehicular ad hoc network, which addresses streaming issues. This technique is used to communicate join and leave messages, to store and search for messages, and to carry out tasks in a vehicular ad hoc network. Hammoudeh et al. [8] present a route optimization and load balancing protocol which is based on clustered technology in the wireless sensor network. This proposed routing protocol is also used to increase the delivery ratio and reduce the end-to-end delay. Sharma et al. [17] suggest a cluster-based multi-path routing protocol, based on clustering techniques and multi-path routing, for a wireless sensor network. This routing protocol is used to increase reliability and reduce energy consumption. Kapoor et al. [11] describe a dynamic allocation algorithm for increasing the lifetime of a wireless sensor network. This proposed algorithm is applicable within all types of energy-saving applications.

The organization of the paper is as follows: Section 2 deals with related work, Section 3 deals with Methodology, Section 4 deals with the proposed algorithm which is Clustered QoS Architecture and Routing Algorithm, Section 5 deals with the results and discussion, Section 6 deals with conclusion.

2. Related work

Qayyum et al. [16] solve the database issues in a mobile ad hoc network using clustering technology. They propose a data replication system within a mobile ad hoc environment which increases reliability and scalability. These database issues occur due to node mobility and frequent disconnection, and are overcome by the proposed scheme. The results are evaluated using a network simulator. Li et al. [13] present a set of online and batch scheduling heuristics for a mobile ad hoc cloud-based computing system. This proposed scheme is acceptable for both user and system metrics, reduces complexity and increases network performance. Patel et al. [15] suggest machine learning techniques for a mobile ad hoc network, using a separation of normal and abnormal nodes based on the behaviour of the mobile nodes. This machine learning technique is used to identify black hole attacks, grey hole attacks and flooding attacks in mobile nodes. Chaudhary et al. [5] describe a neuro fuzzy classifier in binary form, which is used to detect normal and abnormal nodes in a mobile ad hoc network. This technique is suitable for both centralized and distributed architectures, and can be used within an intrusion detection system. Gurbhoo et al. [7] discuss new ways to improve network performance without changes in the network and with limited mobility. Their algorithm is analysed using a 3D ray trace propagation model. Ingle et al. [9] introduce a secure communication protocol for a wireless network which can avoid security issues. This secure communication protocol uses dynamic authentication, and distributes the essential initial condition. If the topology changes, a re-authentication process is carried out.

Dang et al. [6] describe an unsupervised detection algorithm for increasing the effectiveness and efficiency of a mobile ad hoc network. This algorithm detects malicious nodes, and learning algorithms are used to improve the network performance and reduce intrusion issues. Karaoglu et al. [10] discuss the importance of bandwidth efficiency in a mobile ad hoc network. Their technique uses clustering technology to increase throughput and to decrease energy consumption and inter-packet delay variation. Al Islam et al. [2] propose a neural network-based congestion control technique for wireless mesh networks which avoids congestion and collision. Sumathy et al. [18] present an optimization based on particle swarming, which is used to determine location and optimal route in a wireless network even in conditions of high node mobility. This technique can be used to increase throughput and reduce drop rate.

3. Methodology

On-demand multicast routing protocol (ODMRP) is used to improve bandwidth utilization in a wireless network. This routing protocol consists of two phases: the bandwidth request phase and the bandwidth reply phase. The generation of a bandwidth reply message is in response to a bandwidth request message from the destination node, and includes the traffic flow ID. Based on this information, the source will forward data to the destination, meeting the quality of services requirements through the use of quality of service routing protocols. This QoS routing may lead to high overheads, longer delays and significant bandwidth limitations. Maintaining the link state in a wireless network is very difficult, due to high mobility and topology changes. Another existing technique is the QoS-aware routing protocol (QARP), which is used to solve QoS issues generated by mobile nodes in a wireless network. This routing protocol is mainly focused on increasing network performance; however, this routing protocol can satisfy the QoS requirements by up to only 50%.

Aldabbagh et al. [1] describe a QoS-aware tethering heterogeneous wireless network for improving network utility. This technique improves the constant bit rate and best effort users using the cluster head, and this cluster head acts as an access point for the clients within the network. Al-Kahtani et al. [3] present a cluster-based mobility-centric node-scheduling scheme for machine-to-machine communication and machine-type communications. Narayanan et al. [14] suggest a vertical handover algorithm for a heterogeneous network. The handoff decision is made depending on the received signal strength of the mobile node. This algorithm reduces handover delay and call drop rate, and increases network performance. Kumar et al. [12] describe a routing protocol for a wireless sensor network which can increase overall performance. Data transmission is carried out through multi-hop communications.

Please cite this article as: N.V.S.S.R. Lakshmi et al., Analysis of clustered QoS routing protocol for distributed wireless sensor network, Computers and Electrical Engineering (2016), http://dx.doi.org/10.1016/j.compeleceng.2016.11.019