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Performance Analysis of ANTHOCNET and ANTDSR Protocols

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Abstract: ***In recent years many efforts have been made on routing the data in mobile ad hoc networks efficiently. Subsequently, several specialists have provided distinct routing protocol for ad hoc networks, especially routing protocols depending on behavior of ants. This is on the account of the utilization of genetic algorithms that has various benefits like minimized control messages, re-usability of bandwidth and enhanced power control. Various nature inspired algorithms are proposed by analysts to minimize the energy utilization in mobile ad hoc networks. The aim of the paper is to throw light on the critical issue of energy optimization in mobile ad hoc networks to minimize the total energy consumption required to route data. The paper presents ANTDSR where ratio of Euclidean distance and pheromone level is taken into account while making path between source and destination.***

Keywords: mobile ad hoc network, ant colony optimization, genetic algorithms, antdsr

1. Introduction

In recent years, huge improvements have taken place in the technology used to build digital electronics, Micro-Electro-Mechanical Systems (MEMS) and wireless communications. Hence there is an immediate need for the development of minimal effort, low-force, multi-purpose little sensor nodes that can convey crosswise over short distances. There has been an immense measure of investigation into routing in wireless sensor networks. As communication between nodes is fundamental to most provisions, routing in wireless sensor networks is considered very critical. The basic architecture of MANET consists of nodes that are dynamically self-organized into arbitrary and temporary network topology without any infrastructure support. The advantage of employing MANET is to offer a large degree of freedom at a minimal cost in comparison to other networking solutions. Routing is characterized as the act of moving information from source to destination in a network. The primary objective of routing protocols is to minimize delay, amplify the network throughput, maximize network lifetime and maximize energy efficiency. Determining optimal routing path and internetwork packet transfer are the two basic activities involved in routing. Mobile Ad-Hoc Network is the fast developing engineering from the previous 20 years. The increase in their prevalence is as a result of the ease of deployment, infrastructure less and their dynamic nature. MANETs made another set of requests to be actualized and to give proficient better end-to-end communication.

Swarm intelligence-based routing deals with the issues that need to find paths to goals by emulating the conduct of real biological species searching for food through pheromone deposition. Since 1999, there has been an incredible enthusiasm toward applying swarm intelligence to handle the static and dynamic advancement issues. Such issues have been unraveled utilizing cooperative agents that correspond with one another modifying the environment.SI is defined as the “emergent collective intelligence of groups of simple agents”. Swarm intelligence is concerned with the design of intelligent multi-agent systems by taking inspiration from the collective behavior of social insects for instance ants, bees, wasps, as well as from other animal societies such as flocks of birds or schools of fish.

Swarm intelligence (SI) is a novel field that was originally defined as an attempt to design algorithms inspired by the collective behavior of social insects and other animal societies. Nowadays, SI refers to the study of the collective behavior of multi-component systems that coordinate using decentralized controls and self-organization. The SI frameworks include popular frameworks such as Ant Colony Optimization (ACO) and Particle Swarm Optimization (PSO). Most of the work in the field of SI is inspired by collective behaviors observed in natural systems such as insect societies, flocks of birds.

The basic principle of an ant routing algorithm is mainly the depositing of pheromone on the path followed by the ant. They follow simple rule of following the path which has higher concentration of pheromone. The pheromone concentrations on a path allow the other ants to find their way to the food source. Thereby more ants follow the same path and more and more pheromone is deposited on the path which is the shortest route to the food source. AntHocNet is a multipath routing algorithm for mobile ad-hoc networks that combines both proactive and reactive components. It is based on the shortest path behavior observed in ant colonies and on the related optimization framework of Ant Colony Optimization. Unlike the original ACO algorithms for wired networks it doesn't keep up courses to all conceivable ends at all times however just sets up ways when they are required at the begin of an data session. This is carried out in a reactive route setup phase, where source launches reactive forward ants to find multiple paths to the destination and backward ants return to the source to set up the paths. As per the common ACO practice, the paths are situated up as pheromone tables demonstrating their individual quality. After the route setup, data packets are directed stochastically over the distinctive ways after these pheromone tables.

2. Related Work

Rahul S.Kale1 [9] has discussed parameterized study of energy efficient protocols and how energy is one of the most important constraints for networks such as MANET. In this paper benefits & limitation of various routing protocols have been studied for energy management in MANET by representing three main parameters - energy, delay and throughput. It has been concluded that the particular protocol can be used according to the requirement. But as the MANET covers the very vast area it is applicable to both small and large scale area.

N.Umapathi et.al [8] has presented a protocol for routing in ad hoc networks using dynamic source routing and Swarm Intelligence based ant colony optimization to optimize the node pause time and mobility. The simulation results show that the algorithm builds routes based on node pause time achieving better packet delivery ratio and end-to-end delay and the improved performance of routing in the network.

Richa Sharma et.al [10] has introduced a new DSR protocol named as DSR-ACO which helps in finding the available path to send the packet considering remaining energy of all nodes in the network. The available path may be larger in comparison to DSR but it will surely optimize the path to transmit the packets. It has been observed that DSR-ACO works better than DSR. It makes the network more energy efficient and also improves the network lifetime. The throughput of DSR-ACO is also good.

CH. V. Raghavendran et.al [3] has introduced the nature inspired routing algorithms for MANETs derived from the ant colonies and bee colonies. Many conventional routing algorithms have been proposed for MANETs. The paper gives an idea that SI has recently captured much attention in network routing researches. Besides the presence of conventional approaches, a number of new studies have proposed Swarm Intelligence for MANET routing. The basic mechanisms is Ant colony and it turns out to become an interesting solution where routing is an issue. Ant- based routing is getting more popular because of its adaptive and dynamic nature. A number of Swarm Intelligence (SI) based algorithms were proposed by researchers.

Friday Onyema et.al [5] has suggested a heuristic way to reduce energy consumption in WSNs routing process using Ant Colony Optimization. The paper explains that wireless sensor networks (WSN's) have become an important and challenging research area in recent years and the nodes bearing limited power in Wireless Sensor Networks are deployed to gather useful information from the field. Since in WSNs it is critical to collect the information efficiently, swarm intelligence based optimization technique known as Ant Colony Optimization has been utilized in network routing. In this paper, three Ant Colony Optimization algorithms, the Ant System, Ant Colony System and improved Ant System and their application in WSN routing process are proposed. The simulation results show that Ant Colony Optimization is an effective way to reduce energy consumption and maximize WSN lifetime.

Anjali et.al [2] has been proposed to reduce energy consumption in WSNs routing process using Ant Colony Optimization. Three Ant Colony Optimization algorithms known as the Ant System, Ant Colony System and improved AS have been introduced and their application in WSN routing process have been described. The simulation results show that ACO is an effective way to reduce energy consumption and maximize WSN lifetime.

K.Syed Ali Fathima, et.al [6] has proposed a protocol that is achieved by using ACO algorithm to optimize routing paths, providing an effective multi-path data transmission to obtain reliable communications in the case of node faults. The aim of the paper is to maintain network life time in maximum, while data transmission is achieved efficiently. The paper evaluates the performance of ant base algorithm and AODV routing protocol in terms of Packet Delivery Ratio, Average end-to end delay and Normalized Routing Load and concludes that overall performance of ant based algorithm is better than AODV in terms of throughput.

Adamu Murtala Zungeru, et.al [1] has depicted three changes to the EEABR calculation to further enhance its energy proficiency. The changes to the first EEABR are based on mostly three aspects- another plan to keenly introduce the routing tables giving priority to neighboring nodes that simultaneously could be the destination, intelligent update of routing tables in case of a node or link failure, and reducing the flooding ability of ants for congestion control. The energy efficiency improvements are significant particularly for dynamic routing environments. The method is also compared and found to also outperform other swarm based routing protocols such as sensor-driven and cost-aware ant routing (SC) and Bee sensor.

Fatemeh Rismanian Yazdi, et.al [4] has discovered a new Ant-routing algorithm with colored pheromones and clustering techniques for satisfying users' Quality of Service(QoS) requirements in Wireless Sensor Networks. The paper highlights the fact that to detect the best route from a source node to the destination node is a critical issue. The proposed algorithm takes in to account the traffic diversity, and provides a different routing using various QoS metrics. Data traffic has been classified into several categories according to the required QoS. This supports traffic classes with orthogonal requirements by using colored pheromones. The use of color is to mark various trails appropriate to the different traffic classes.

M. Ben Ahmed, et.al [7] has proposed a novel routing approach using an Ant Colony Optimization (ACO) algorithm for Wireless Sensor Networks. Comparative performance test results of the proposed approach are included. Simulation results show that proposed algorithm provides promising solutions allowing node designers to efficiently operate routing tasks for maximizing the network lifetime.

3. Routing in MANETs

Routing protocols facilitate distinguished mechanisms to create and maintain the routing tables of the nodes of the network and discover a route between all nodes of the

network. There should be enough versatility in routing protocols to adapt to any type of topology to permit arriving at any remote host in any network.

A vast research account exists for the development of routing protocols in MANETs. The development and improvement of the protocols is dependent on the particular application demands and the architecture of the network. However, there are a few elements that ought to be contemplated when creating routing protocols for MANETs. The protocol should take care of self-configuration, fault tolerance, delay and so forth. An alternative vital paradigm in the configuration of a sensor network is data delivery time since it is critical.

4. Swarm Intelligence in MANETs

Swarm intelligence-based routing deals with the problems that need to find paths to goals by emulating the conduct of real biological species searching for food through pheromone deposition.. It is very challenging task to outline and implement routing schemes that are able to effectively and efficiently support information exchange and processing in MANETs. A number of theoretical issues and practical limitations must be thoroughly taken into account. In order to maximize network's lifetime, the mechanisms adopted for route discovery and information routing need to be energy efficient. Since the nodes usually operate in an unattended fashion, the network is expected to display autonomic properties which mean the protocols must be self-organizing and robust to failures and losses. Last but not least, the routing protocol must be able to handle large and dense networks, and the associated challenges resulting from radio interference and from the need to discover, maintain, and use potentially long multi-hop paths.

Swarm intelligence (SI) is a novel field that was originally defined as an attempt to design algorithms inspired by the collective behavior of social insects and other animal societies. Nowadays, SI refers to the study of the collective behavior of multi-component systems that coordinate using decentralized controls and self-organization. The SI frameworks include popular frameworks such as Ant Colony Optimization (ACO) and Particle Swarm Optimization (PSO). Most of the work in the field of SI is inspired by collective behaviors observed in natural systems such as insect societies (e.g., ACO), flocks of birds (e.g., PSO).

5. Ant-Colony Optimization

Swarm Intelligence (SI) is the local interaction of many simple agents to achieve a global goal. SI is based on social insect metaphor for solving different types of problems. ACO is an algorithm based on the behavior of the real ants in finding a shortest path from a source to the food. In ACO, a number of artificial ants build solutions to the optimization problem at hand and exchange information on the quality of these solutions via a communication scheme that is pheromone deposit on the path of the journey performed by it. This algorithm uses the conduct of the genuine ants while searching for the food. It has been watched that while venturing out from its home to the sustenance, the ants store a certain measure of pheromone in its way. Again while returning, the ants are subjected to follow the same path marked by the pheromone deposit and again deposit the pheromone in its path.

In this way the ants following the shorter path are expected to return earlier and hence increase the amount of pheromone deposit in its path at a faster rate than the ants following a longer path. ACO takes motivation from the behavior of the ants. These ants deposit pheromone on the round in order to mark some favorable path that should be followed by other members of the colony. The paths visited by the ants frequently are kept as marked by the pheromone deposit whereas the paths rarely visited by the ants are lost because of the lack of pheromone deposit on that path. This happens in light of the fact that the pheromone vanishes by certain sum after certain interval. As a result the new ants are intended to follow the frequently used paths only.

6. Motivation

Nature inspired routing protocols have been becoming the focus of research because they achieve the complex task of routing through simple agents which traverse the network and collect the routing information in an asynchronous fashion .In mobile ad hoc networks the on demand multi-path routing protocols addresses certain issues such as message overheads, link failures and node's high mobility. More message overheads occur due to increased flooding. Packets are dropped by intermediate nodes due to frequent link failures. Moreover the overall throughput and the packet delivery ratio are reduced in high mobility scenarios [9]. Energy consumption is the most challenging issue in routing protocol design.

In ad hoc networks mobile devices are battery operated and the battery technology has not been enhancing that well. Therefore power consumption is likely to remain an issue in mobile wireless network routing. The overall lifetime of the entire ad hoc network can be increased by improving the power consumption balance among nodes and the network connection. In most of the existing protocols, a mobile node may consume all its energy to participate in the operation without considering the remaining energy.

It is utmost crucial to consider the energy efficiency of the underlying algorithm while designing a MANET protocol, as such networks has strict power requirements. Swarm intelligence-based routing which utilizes the behavior of real biological species searching for food through pheromone deposition while dealing with problems that need to find paths to goals has been proposed to deal with some of the challenges of the MANETs. The ability of social insects to self-organize relies on four principles: positive feedback, negative feedback, randomness, and multiple interactions.

In ACO, ants approach from source to destination via number of paths. On their return, again they may use same number of paths. Whenever the backward ant agents come to the source via different paths where they store the pheromone value and time stamps at each intermediate node, so here traversing through multiple paths may result in loss of energy levels of the nodes. Taking this issue into consideration as well as considering the advantages of DSR protocol, a combination of both the protocols can be used to address this issue.

7. Proposed scheme

Ant Dynamic Source Routing (Ant-DSR) is a reactive protocol that implements a proactive route optimization method through the constant verification of cached routes. When antnet algorithm applies on DSR protocol the performance metrics is enhanced as it increases the probability of a given cached route. Mobile nodes maintain route caches that contain the mobile known source routes. As soon as the new routes are learnt, entries in the route cache are continually updated. The protocol is constituted of two major phases: route discovery and route maintenance. In Ant DSR (ADSR) the Forward ant(FANT) is added in the route request and backward ant (BANT) packets are added in the route reply of DSR. Forward ants are used to explore new paths in the network. Ants estimate the current network state by various parameters like trip times, hop count or Euclidean distance travelled. In ANTDSR we take the ratio of the pheromone value and the Euclidean distance of the various paths traversed from source to destination. The highest ratio value path will be selected by the backward agents in routing.

A. Proposed Method

In the proposed energy efficient DSR protocol each node will only use part of energy to transmit the data packets. This is done through a route discovery procedure. The reason that DSR is used as our base model is mainly due to the fact that it is a typical on demand protocol with less bandwidth and energy use. By this method, the nodes avoid using too much energy at one time and this can guarantee that the node with more power will be used to transmit the large size packets and the node with the less power will be used to transmit the small size packets.

B. Methodology

1. First and foremost step is the deployment of nodes.
2. Broadcast the FANTs from the ant colony towards the food source.
3. Ants from multiple paths reach the food source.
4. BANTs calculate the pheromone values and the Euclidean distance.
5. Get the ratio of pheromone value and the Euclidean distance.
6. Path with maximum ratio is selected for BANTS.
7. Data is sent using the selected path.

The proposed methodology is needed to be implemented in a tool. The tool opted for simulation of the proposed work is NS2.35.

8. Simulation Results

In this section, the proposed method has been simulated in NS2.35 and the simulation results are presented. The below graphs show the comparison of the energy consumed in AntDSR and AntHocNet. Initially 100 joules of the energy was supplied to the network and after the data is sent through selected path, it was observed that energy consumed in AntDSR is less in comparison to energy consumed in AntHocNet.

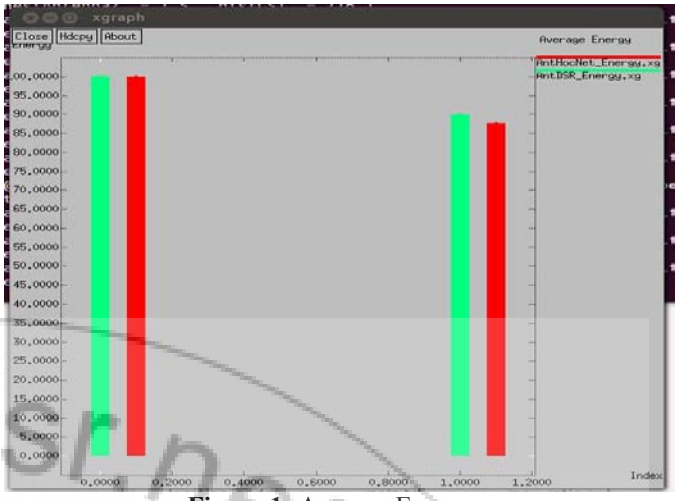

Figure 1: Average Energy

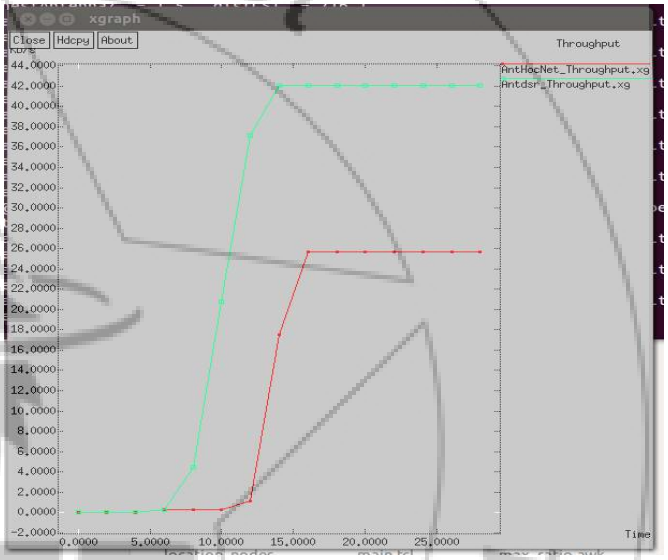

Figure 2: Throughput

Above graph shows the throughput comparison between AntHocNet and AntDSR. Throughput is amount of the data that is received at the destination in the network. More the throughput better is the performance of the network. Since throughput in AntDSR is 44Kbps and is 26Kbps in AntHocNet, so it is shown that AntDSR performed better than AntHocNet.

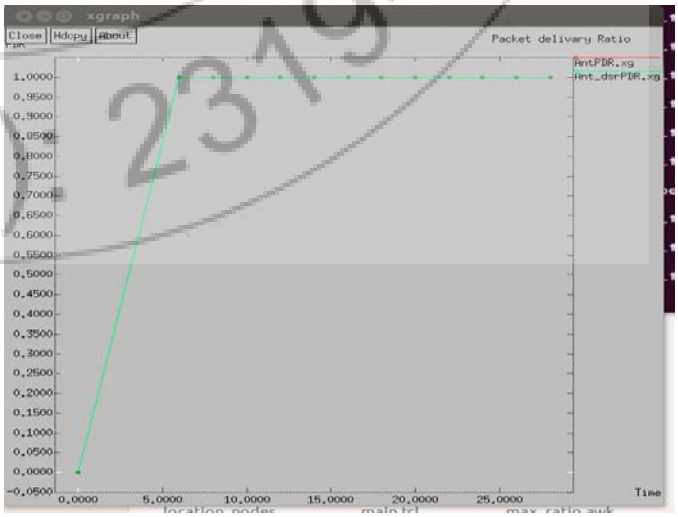

Figure 3: Packet Delivery Ratio

Above graph shows the packet delivery ratio. Packet Delivery Ratio is the ratio between number of packets received and number of packets sent. Both AntDSR and AntHocNet exhibit the same performance in terms of PDR

Figure 4: Delay

This graph shows the delay comparison. Lesser the delay, better the network's performance. AntDSR shows the delay of approx 7 ms whereas the delay in the case of AntHocNet was about 9.5 ms.

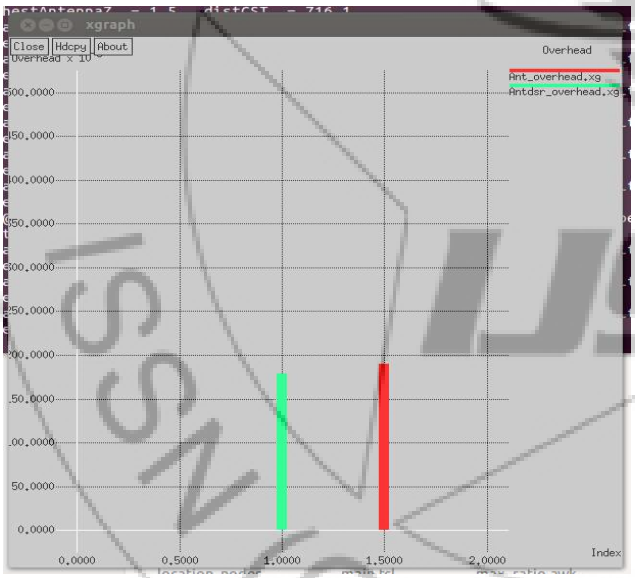

Figure 5: Overhead

Whenever the data is sent from any node, it appends a header on the packet. More the routing packets being sent in route discovery phase of the network, more is the routing overhead. The routing overhead for any network should be less. AntDSR exhibited less routing overhead than the AntHocNet.

9. Conclusion

The work reflects the idea that by using the simple behavior of ants and bees optimization and innovations in routing protocols can be done, that help outperform the standard MANET routing protocols like AODV We simulated both AntDSR and the AntHocNet and compared the performance of both the protocols. The various performance parameters considered for the comparison are- energy consumption, packet delivery ratio, throughput, overhead and the delay. AntDSR exhibited the better performance than AntHocNet. This section focuses on promising future research directions based on our current research. However, we would further like to expand our research and apply AntDSR in combination with genetic algorithms to enhance the performance of the network.

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