An Analysis and Overview of Wireless Routing Protocols

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Abstract: Problem statement: In the past, the main focus of the research in the wireless network is to provide optimal routes between source and destination nodes. The wireless routing is required additional computational effort than wired routing in order to fulfill the major wireless characteristics such as battery power constraints, frequent mobility and less processing. **Approach:** In addition to wired routing the wireless routing requires some characteristics, such as scalability, higher throughput, lesser packet loss and providing QoS. The wireless routing protocol is categorized based on routing update mechanism, based on routing topology and based on special resources like energy aware and location aware. **Results:** Routing in the wireless network is classified as proactive, reactive and hybrid routing protocols. These routing protocols are discussed in this study with the experimental result. **Conclusion:** In this study, an analysis is described on the existing routing methodology which is proposed for solving various routing issues in the wireless communication.

Key words: Computer communication, wireless networks, mobile adhoc network, routing protocol

INTRODUCTION

In the past few years, the wireless communication emerges enormously in the computer communication industry. Based on its higher demands and necessity, there are many research issues in the wireless communication such as Optimal routing protocols, Traffic Management, Providing QoS, Offering reliable services, Effective Transport Control Protocol (TCP), Medium Access Scheme, Energy Management, Scalability, Load Balancing, Efficient Node Deployment, Self-organization and Service Discovery. The wireless communication has two major types of network, which are (1) infrastructure based network and (2) adhoc network. Both of these wireless networks spreads its importance in everyone life through cellular communication and Mobile Adhoc Network (MANET). In which, the cellular communication is a infrastructure based communication and the MANET is an adhoc network. The cellular communication is evolved as 1G for circuit switching, 2G for circuit and packet switching, 3G for video conference and4G for IP based networks. The NGN is in the current research in the cellular communication which is also termed as 5G+ (5G and above). There are many recent researches are proposed (Akyildiz *et al*., 2005; Lee and Knignt, 2005; Chandra and Baskaran, 2011) in the NGN, in which Akyildiz *et al*. (2005) proposed architecture and design of the next generation network, Lee and Knignt (2005)

discussed the requirements of the NGN and Chandra and Baskaran (2011) proposed barrier free service architecture for providing reliable transmission in the NGN. This study is further focusing in the routing protocol of the wireless communication.

The routing protocol lies in the network layer, the task of wired routing protocol is simply exchanging route information and finding feasible path, but in the wireless routing there are some more tasks are added to meet the wireless environment which includes minimum power requirement, utilizing minimal network resources like bandwidth, gathering and updating link failures. Therefore, in order to provide optimal routing in the wired cum wireless environment, the routing protocols is need to fulfill the following major challenges and requirements.

The challenges of wireless routing are suitability, mobility, bandwidth constraint, Error-prone and shared channel, Location dependent contention and Resource Constraint like battery power, buffer size. The requirements of routing protocol in the wireless network are quick route configuration, loop free routing, minimum route acquisition delay, distributed routing approach, minimum control overhead, scalability, QoS, time sensitive traffic and security.

MATERIALS AND METHODS

The mathematical model for routing problem is as follows. Let $V = \{a, \ldots, z\}$ be a set of cities, $A = \{(r, s)$

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: r, s € V} be the edge set and δ(r, s) = δ(s, r) be a cost measure associated with edge (r, s) € A. The routing is the problem of finding a minimal cost closed tour that visits each city once, also called Traveling Salesman Problem (TSP).

In this case, the cities r € V are given by their co-ordinates (x_r, y_r) and δ(r, s) is the Euclidean distance between r and s, then it is Euclidean TSP. If δ(r, s) ≠ δ(s, r) for at least some (r, s) then the TSP becomes an Asymmetric TSP. Choosing a single feasible solution is called a single path while choosing all possible feasible solution is called a multi-path. In which, the multi path routing avoids traffic and helps to improves the network efficiency.

Routing Information Protocol (RIP) and Open Shortest Path First (OSPF) using Distance Vector (DV) and Link State (LS) respectively are the major traditional routing protocol which is used for wired single path routing. Dijkstra-Old-Touch-First (D-OTF) with multipath routing extension is an extended version of conventional Dijikstra's shortest path algorithm that computing all lexicographic-lightest paths from a source to every other node in the network. OSPF version 2 (IGI, 2000) and OSPF- optimized multi-path (Villamizar, 1998) are some of the extended version of multi path routing protocol using traditional OSPF.

In wireless, as every node may forward data from other nodes, the network resources usage like limited energy, limited bandwidth andlimited processing power should be fairly distributed across the networks nodes to avoid the high consumption of the resources in some network nodes and low consumption in other nodes. The routing algorithm should deal with the rapid changes in the network and should have the ability to optimize more than one network parameters in the network. Therefore, the goal for designing an optimal routing protocol for wireless environment may be termed as; it must be fully distributed, adaptive to frequent topology changes, loop free, localized control and must provide QoS.

There are variety of wireless routing protocols (Murthy, 2004) such as Dynamic Source Routing (DSR), Destination Sequenced Distance Vector (DSDV), Adhoc On-demand Distance Vector (AODV), Wireless Routing Protocol (WRP), Cluster-head Gateway Source Routing (CGSR), Source Tree Adaptive Routing (STAR), Optimized Link State Routing(OLSR), Flow Oriented Routing (FSR), Hierarchical State Routing (HSR), Associatively Based Routing (ABR) and Signal Stability based Adaptive Routing (SSA) are included in IEEE802 family standard. These algorithms can be classified into two groups: table driven routing protocol (DSDV) and source initiated on demand routing protocol such as AODV, DSR and Temporally Ordered Routing (TORA). Another category is called hybrid routing protocols which offers the best features of both table driven and on demand routing protocols.

The DV and LS is perfectly suit in the wired routing but it is not an optimal routing protocol for wireless routing. These routing protocols are suitable for smaller networks with low mobility but do not scale well in larger dynamic environments due to the periodic and global dissemination of topology updates. The on-demand routing uses a query response mechanism like route request and route reply for discovering and maintaining routes for each individual session. This provides scalability than the DV and LS, however, flooding of route queries limits the performance under conditions of high mobility and high traffic loads. The hybrid routing uses a cluster or hierarchical network architecture for group of nodes in the clustered architecture, the cluster may be formed statically and dynamically and then apply different routing strategies within and between these clusters. The hybrid routing also provides scalability in static clustered networks or situations involving group mobility but it occupies an excessive control overhead for route maintenance in order to choose cluster head.

The AODV is optimal for intra segment routing and the DSR is optimal for inter segment routing. Therefore, Bai and Singhal (2006) proposed an extended hybrid version of AODV and DSR, called DOA (DSR over AODV). In which, DSR is proposed for inter-segment and AODV is proposed for intra-segment routing for improving packet delivery ratio. However, it requires more control overhead and complexity when implementing in the real time.

Instead of segment, a zone based routing protocol are also proposed for wireless network, in which Zone-based Hierarchical LS(ZHLS) and Boundary mapping and boundary state (BSR) are the major routing protocols. The ZHLS is a hybrid routing protocol, which uses the geographical information for route discovery and route maintenance. The ZHLS applies the proactive approach inside the geographical zone and reactive approach beyond the zone. Lemmon and Musumeci (2008) proposed the BSR for MANET which also uses the geographical information for route discovery and route maintenance, which consists of two components. The first component is an improved forwarding strategy called as Greedy-Bounded Compass and the second component is a Boundary Mapping Protocol (BMP). The first component is forwarding data packets around the defined boundaries

without looping and the BMP is used to maintain LS information for boundaries.

Proposed cost matrix agent based routing algorithm which uses the minimum-cost matrix. The next-node matrices are also calculated from the typical adjacency-cost matrix which is used to represents the link costs of the network. For efficient routing methodology, this study uses the link costs instead of hop counts as a routing metric. All the nodes in networks maintain the same information on the minimum-cost matrix. When a node needs to transmit data to a destination, the path can be quickly calculated using the maintained minimum-cost and the next-node matrices. These calculations are taken place using mobile agent which floods in the network and collects information about the network or subnet. A leader node which works as the agent calculates the minimum-cost matrix and the next-node matrices and transmits them to all the other nodes in a network.

Load Balanced Ad Hoc Routing Protocols (LAOR) proposed by Toh *et al*. (2009), is delay-based load balancing scheme which is an extension of AODV routing. It has many similarities with AODV such as it also has two phases, route discovery and route maintenance. LAOR achieves load balancing by minimizing the estimated total route delay and route hop count. A node initiates route discovery by sending a Route Request (RREQ) when a valid route to the destination is not available in the routing table. The major difference than AODV is, if an intermediate node receives a duplicate RREQ with a smaller total delay and hop count, it updates this route in the routing table. The destination node then sends a reply message (RREP) when it receives the first RREQ. If duplicate RREQs received at the destination node have smaller total delay and hop count than previous ones, it sends an RREP message to the source node to change the chosen route immediately. When the source node receives the RREP, it initiates data packet transmission.

The swarm intelligence algorithms like Ant Colony Optimization (ACO), Artificial Bee Colony (ABC), Fire Flies and Particle Swarm Optimization (PSO) are attracts the recent research for optimization problems. There are many routing protocols (Chandra and Baskaran, 2011; Mohan and Baskaran, 2011a; Lopez-Ibanez and Blum, 2010; Li *et al*., 2011) are proposed in the recent years using ACO for wireless communication. In which, (Chandra and Baskaran, 2011) reviewed the research on variety of ACO implementation in many engineering application like Travelling Salesman Problem, Routing, Scheduling, Image Processing and Load optimization in electrical engineering. Mohan and Baskaran (2011b), the author

proposed ACO for wireless routing using priority model which is formed based on the availability of the wireless nodes. Lopez-Ibanez and Blum (2010), the beam search is applied with existing ACO for adhoc routing. Li *et al*. (2011), the author proposes a energy efficient routing for wireless routing. The SI techniques are proved optimal in many engineering applications (Chandra and Baskaran, 2011) and also in the wireless routing than the above discussed methodologies. This study further explains the overview of ABC which may be applied for wireless routing in the future.

RESULTS

In the last few years, the interest in the studies of Swarm Intelligence (SI) based optimization techniques is increasing. In SI, the organisms of animals and insects are studied for solving optimization problems and patterns generation. SI groups those techniques inspired by the collective behavior of social insect colonies, as well as other animal societies that are able to solve large-scale distributed problems. Like ACO, the Artificial Bee Colony (ABC) provides optimality in many aspects for variety of engineering problems.

Honey bees are insects that live in large colonies (around 50,000 bees as a colony) usually containing one queen and her progeny, some 20,000-40,000 female workers and 200-300 male drones. Meisel *et al*. (2010) is a detailed study of honeybee in the biological aspect and about the foraging behaviour. There are many syndromes observed like aggression syndrome, waggling dance, from the honey bee colony which is used for solving optimization problems. Although honey bees are depicted in many cave paintings dated from 6000BC, the first recorded observations of bee behaviour were made by Aristotle.

In the bee colony, Queen Bee is the head of the operation and maintenance and the scout bees and working bees are the labour. Initially, scout bees are assigned to find out best flower batches which contain more nectar than its neighbouring flower batches. When the scout bees identified such flower batches, the working bees are directed to collect nectar from the selected flower batches. Scout bees search randomly from one patch to another and the best flower batches are rated based on the combinations of some constituents, such as sugar content deposited in the nectar. Therefore a best flower batch is the food which has above certain threshold value of nectar presented in the flower batches. When a scout bee identifies such a flower batches and it go to the "dance floor" to perform a dance known as the "waggle dance".

This dance is essential for colony communication in order to inform the working bees about the selected flower batches. This waggling dance contains information regarding flower patches like the direction of the food source, its distance from the hive and its quality rating.

The algorithm of ABC requires a number of parameters to be set, namely: number of scout bees (n), number of elite bees (e), number of patches selected out of n visited points (m), number of bees recruited for patches visited by "elite bees" (nep), number of bees recruited for the other (m-e) selected patches (nsp), size of patches (ngh) and stopping criterion. The algorithm starts with the n scout bees being placed randomly in the search space.

The bees search for food sources in a way that maximizes the ratio Eq. 1:

$$F(\theta) = \frac{E}{T} \qquad (1)$$

Where:
E = The energy obtained
T = The time spent for foraging

Here 'E' is proportional to the nectar amount of food sources. In a maximization problem, the goal is to find the maximum of the objective function F (θ), $\theta \in R^P$. R^P represents the region of search area. Assume that θ_i is the position of the ith food source; F (θ_i) represents the nectar amount of the food source located at θ_i and it is proportional to the energy E (θ_i).

Let P(C) = {θ_i(C) | i = 1, 2... S} represent the population of food sources being visited by bees, in which, C is cycle andS is number of food sources around the hive. The preference of a food source by the worker bee depends on the nectar amount F (θ) of that food source. As the nectar amount of the food source increases, the probability with the preferred source by the worker bee increases proportionally. Therefore, the probability with the food source located at θ_i will be chosen by a bee can be expressed as Eq. 2:

$$P_i = \frac{F(\theta_i)}{\sum_{k=1}^{s} F(\theta_k)} \qquad (2)$$

The position of the selected neighbour food source is calculated as the following Eq. 3:

$$\theta_i(C+1) - \theta_i(C) \qquad (3)$$

And the stop criteria of the system is Eq. 4:

$$N_i(Q) - N_i(E) \geq H_{th} \qquad (4)$$

Where:
N_i (Q) = Represents the values of nectar of Queen
N_i (E) = Represents the values of nectar of Elite bee

And H_{th} represents the minimum threshold value of the Hive. At the end of iteration, each selected patch by the scout bee is identified. This promising algorithm can be applied to wireless like environment for routing issues.

DISCUSSION

The honey bee is a diffuse creature which can extend itself over long distances in multiple directions in order to find a large number of food sources and at the same time to find the best food source from the collection of food sources. For example, the food source of the bees are designated as flower patches, in which plentiful amounts of nectar or pollen is available. This nectar or pollen is the food of the bees and the task is collecting the enormous amount of nectar with less effort and visited by more bees, whereas patches with less nectar or pollen should receive fewer bees.

CONCLUSION

The objective of this study is, to provide short description on various existing protocols which is proposed till date for wireless routing in order to help the current researchers for a well start. Based on this objective, this study analyses, classifies and discuss the advantages and pitfalls of existing wireless routing protocols. This study also describes the mathematical model for routing, the difference in wired and wireless routing and the requirements of wireless routing such as random mobility. This study provided recent research in the wireless routing such as ACO, ABC. Therefore, it is concluded that the objective of the study is fulfilled and this study will fulfil the needs of researcher those initialized their research in wireless routing.

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