Wireless Computer Networks and Associated Energy Efficient Protocols

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Abstract**—**A wireless network is a computer network that uses a wireless network connection such as Wi-Fi. It allows homes, telecommunication networks and businesses to avoid the costly system of introduction of cables into a building or between equipment locations. Wireless telecommunications networks are administered and generally implemented using radio communication. This implementation takes place at the physical level (layer) of the OSI model network structure. Wireless Sensor Networks (WSNs) is a combination of many sensors. These sensors send data to various base stations but there is a limitation with the sensors that is they have small energy and hence gets exhausted soon. To address this issue a lot of work has already been done. Various routing protocols have been proposed earlier for energy efficiency for both homogeneous and heterogeneous environments. Also in order to prolong stability and network lifetime energy consumption is reduced at the network level. In this paper we will review Reactive and Proactive Protocols with a special emphasis on proactive protocols that are used in the energy efficient wireless computer networks and will perform a comparative analysis of Proactive Protocols namely FSR, OLSR, DSDV.

Keywords**—**Efficient; Networks; Proactive; Reactive; Wireless.

Abbreviations**—**Destination Sequenced Distance Vector (DSDV); Fisheye State Routing (FSR); Optimized Link State Routing (OLSR); Wireless Sensor Network (WSN).

I. INTRODUCTION

AD hoc networks and various sensor networks are crucial in network centric warfare. The movement of nodes, the energy constraints, and the scale of the network all impose formidable design challenges. Given the wide range of design options, we do need to have a fundamental understanding among various tradeoffs. In this paper, we take a theoretical approach to analyzing the amount of energy consumed by general wireless ad hoc networks in which links are subject to block fading and network topology varies in time. Basically two design paradigms are considered: proactive networking and reactive networking. By proactive networking we mean that all links between nodes and all routes between source-destination pairs are maintained and updated regardless of the data traffic. When a message arrives, it travels through a predetermined route to its destination. The reactive networking, in contrast, assumes no predetermined routes, nor does it maintain links at the physical layer. It finds a route only when a message is to be delivered from source to destination and establishes a link just before the transmission is to be scheduled. Irrespective of the fact that whether it is a proactive networking or reactive networking there always is some amount of energy dissipation which must be controlled. The need for energy efficiency is a problem that derives from the constraints imposed by battery capacity and heat dissipation which are opposed by the desire for miniaturization and portability. Technologies for heat removal have traditionally improved at a slower pace compared with the increasing computation expected and the decreasing size of wireless terminals. Energy efficiency is one of the way out: doing more work per unit of battery energy consumed and heat dissipated. Energy efficiency in future wireless terminals can be achieved using low-energy protocols, context dependent, predictive shutdown management. Network functional partitioning will be used to reduce computation done at the terminal.

This paper is very well organized in sections as follows. In Section II, gives us the background information on routing and various protocols that are effectively and efficiently used in wireless networks, section III briefly describes the protocols under consideration in this paper. Section IV discusses the issue of throughput of protocols. Section V presents the comparison of various protocols. Finally, Section VI presents the conclusion of the work done.

II. RELATED WORK

The objective of an energy efficiency assessment is to build a greater understanding of how energy is used within a company and how it can be reduced. So ways are identified to reduce costs through the more efficient use of energy. It involves the comprehensive analysis of energy use within a process, facility, site or organization and using that analysis to identify and evaluate ways to improve energy performance. The level of accuracy and number of opportunities found will be determined based on the level of analysis undertaken. A range of approaches based on certain key principles can be followed however. By following these approaches one can enable companies to increase the level of rigor and resources invested in assessments over time, as areas of potential and priority are identified. The main objective of routing is efficient energy communication ([Javaid et al., 2013; Tahir et al., 2013; Ahmad et al., 2013]). Hui Xu et al., (2010) discuss and present a unique framework of reactive and proactive routing protocols. Their model deals with scalability factor. Nianjun Zhou et al., (2005) give analytical model which deals with effect of traffic on control overhead whereas, Jacquet & Viennot (2000) presents a survey of control overhead of both reactive and proactive protocols. They discuss cost of energy as routing metric. Javaid et al., (2011), enhancing the work of Jacquet & Viennot (2000), calculate control overhead of FSR, DSDV and OLSR separately in terms of cost of energy as well as cost of time. Aron & Gupta (2000) presents link repairing modeling both in local repairing and source to destination repairing along with comparison of routing protocols. Xianren Wu et al., (2007) gives detailed network framework provides "statistical distribution of topology evolution" where nodes are mobile. Zhou & Abouzeid (2005) present brief understanding of scalability issues of network but the impact of topology change was not sufficiently addressed. Pan-long Yang et al., (2005) and Ben Liang & Zygmunt J. Hass (2003) present a very good mathematical network model for proactive routing protocols. We modify the said model by adding control overhead of triggered update messages within the network. Javaid et al., (2013A) discuss and contribute linear models for proactive routing in wireless multi-hop networks. To examine limitations of presented linear programming models DSDV, FSR and OLSR protocols are chosen from proactive routing protocols. Extending this work, Javaid et al., (2013B) presented linear programming for efficient throughput and normalized control overhead. Wasiq et al., (2013) contribute a path loss model for proactive routing in MANET environment. On the basis of analysis, DSDV is most efficient routing protocol under 802.11p. Arshadet et al., (2013) addresses the overall network connectivity and convergence issues for mobile Ad-Hoc and Vehicular Ad-Hoc networks. Security being the key aspect in Ad-hoc or multi-hop networks gains attention by Nasir Iqbal et al., (2013). In this vary paper, authors contributed a secure scheme for wireless proactive routing protocols. Bouk et al., (2012) gives a multiple quality of service selection mechanism considering Ad-Hoc networks. A detailed framework of route discovery and route maintenance is produced by Mahmood et al., (2012). Authors give a generalized model for reactive control overhead. However, in Mahmood et al., (2012A) contributed generalized routing overhead based on route calculation and route maintenance processes of a proactive routing protocol.

III. ROUTING PROTOCOLS

In order to find valid routes between communicating nodes routing protocols are used. They do not use any access points to connect to other nodes. It must be able to handle high mobility of the nodes. We can classify routing protocols into 3 categories:- Centralized versus Distributed protocols, Static versus Adaptive protocols, and Reactive versus Proactive protocols. In case of centralized algorithms, a central node chooses all the routes, while in distributed algorithms; the computation of routes is shared among the network nodes. In case of static algorithms, the route used by source destination pairs is fixed regardless of traffic condition. The only change that can happen is in response to a node or link failure. High throughput under a broad variety of traffic input patterns cannot be achieved by this type of algorithm. As far as adaptive routing is concerned, the routes used to route between source destination pairs may change in response to congestion [Kanakaris et al., 2010].

3.1. Reactive Protocols

In reactive routing, routes are discovered on-demand when trac must be delivered to an unknown destination. Various ad-hoc routing protocols such as AODV (Ad-hoc On-demand Distance Vector) and DSR (Dynamic Source Routing) are examples of this style. In these systems, a route discovery protocol is employed to determine routes to destinations on-demand, incurring additional delay. Once can say that these protocols work best when communication patterns are relatively sparse. These protocols work only for ending routes in a connected sub graph of the overall DTN routing graph as with the proactive protocols. However, they may fail in a different way than the proactive protocols. They will simply fail to return a successful route (from a lack of response), whereas the proactive protocols can potentially fail more quickly (by determining that the requested destination is not presently reachable). In a DTN, routes may vary with time in predictable ways and can be pre computed using knowledge about future topology dynamics. The employment of a proactive approach would likely involve computing several sets of routes and indexing them by time. The associated resource requirements would be prohibitive unless the track demand is large and a large percentage of the possible network nodes exchange track. The more attractive approach is the reactive approach. A related issue is route stability, which is nothing but a measure of how long the currently-known routes are valid. Route stability depends on the rate of topological change and with relatively stable routes one can employ route caching to avoid unnecessary routing protocol exchanges. If one has the future knowledge about topology changes, one can effectively do the caching in a DTN because it may be possible to know early about when to evict existing cached route entries.

3.2. Proactive Protocols

In proactive routing, routes are computed automatically and independently of track arrivals. Most Internet standard routing protocols and some other important protocols such as

DSDV (Destination Sequenced Distance Vector) and OLSR (Optimized Link-State Routing) are examples of this style. As far as DTN is concerned, these protocols are very capable of computing routes for a connected sub-graph of the overall DTN topology graph but they fail to provide paths to nodes which are not currently reach-able when asked. Despite this drawback, proactive routing protocols may provide useful input to DTN routing algorithm by providing the set of currently-reachable nodes from which DTN routing may select preferred next hops.

3.2.1. Destination Sequence Distance Vector (DSDV)

Destination Sequence Distance Vector (DSDV) is a proactive routing protocol which is based on the distance vector algorithm. In proactive or table-driven routing protocols, each node maintains very up-to-date routes to every other node in the network. The transmission of routing information throughout the network is done in order to maintain routing table consistency. The routing table is updated at each node by finding the change in routing information about all the available destinations and the number of nodes reachable to that particular destination. Also, to provide loop freedom DSDV uses sequence numbers, which is provided, by the destination node. If it happens that a route has already existed before the information has arrived, transmission occurs without delay. For highly dynamic network topology, the proactive schemes require a significant amount of resources to keep routing information up-to-date and reliable. The node immediately updates the sequence number and broadcasts the information to its neighbors if a failure of a route to the next node happens. When a node receives routing information then it checks in its routing table. If it does not find such entry into the routing table then the routing table is updated with routing information it has found and if the node finds that it has already entry into its routing table then it compares the sequence number of the received information with the routing table entry and updates the information [Patil, 2012].

3.2.2. Fisheye State Routing (FSR)

It is a simple, efficient LS type routing Protocol. FSR exchanges the entire link state information only with neighbors. Link state exchange is periodical. Periodical broadcasts of LS info are conducted in different frequencies depending on the hop distances. FSR differs from the standard link state algorithm by the following: Having only neighboring nodes exchange the link state information and utilizing only time-triggered, not event-triggered link state exchanges using different exchange intervals for nearby versus far away nodes.

3.2.3. Optimized Link State Routing (OLSR)

The Optimized Link State Routing Protocol (OLSR) is an IP routing protocol optimized for mobile ad hoc networks, which can also be used on other wireless ad hoc networks. OLSR is a proactive link-state routing protocol, which uses *hello* and *topology control* (TC) messages to discover and then disseminate link state information throughout the mobile ad hoc network. Individual nodes use this topology information for computing the next hop destinations for all nodes in the network using shortest hop forwarding paths. OLSR uses multipoint relays to reduce superfluous broadcast packet retransmission and also the size of the LS packets. OLSR thus leads to efficient flooding of control messages in the network [Javaid et al., 2013C].

IV. Throughput in Proactive and Reactive Protocols

Proactive protocols first sense the environment and transmit data periodically. They consume energy continuously with time due to periodic transmission. Our main focus in proactive protocols is on increasing lifetime, throughput and to decrease energy consumption. Contrary to proactive protocol, reactive protocol is application dependent. It senses the environment periodically but transmits data only when its CV (current value) reaches to absolute value of the attribute. As data transmission consumes more energy than data sensing, so, in reactive network the throughput can be minimized or maximized as per its application. The throughput in reactive networks is inversely proportional to the network lifetime or its stability period. If transmissions are less the stability period and network lifetime will be prolonged as CV does not reach the absolute value. However, if the CV reaches HT value (absolute value) repeatedly then maximum number of transmissions will occur and nodes will die quickly.

V. Comparative Analysis of Various Protocols

Table 1: Detailed Comparison of Various Protocols

Feature	FSR	OLSR	DSDV
Protocol Type	Link State	Link State	Distance Vector
Topology Information	Reduced Topology	Full Topology	Full Topology
Route Discovery Packets	Link State Messages	Via Control Message Link Sensing	Via Control Messages
Update Information	Only Neighbor Information	2 Hop Neighbor Information	By Control messages

VI. Conclusion

A wireless network consists of autonomous mobile nodes, each of which communicates directly with the nodes within its wireless range or indirectly with other nodes in a network. For facilitating secure and reliable communication routing protocol is required to discover routes between various nodes. In this paper a brief overview of various protocols is done as well as their comparative analysis is done which can act as a benchmark for the implementation of various energy efficient networks using one of the protocols discussed above. In future energy efficient networks can be developed using the combination of star features of each energy efficient protocol. Also work can be done on the integration of protocols such that they can be brought together without much of a fuss.

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