International Journal of Engineering and Technical Research (IJETR)
ISSN: 2321-0869 (O) 2454-4698 (P), Volume-6, Issue-1, September 2016

Survey on Cross-Layer Design Optimization of OLSR Protocol in MANETs

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***Abstract*— Mobile Ad-Hoc Network (MANET) is a popular type of wireless network that is formed by a collection of mobile nodes. Each device in a MANET is free to move independently in any direction, and will therefore change its links to other devices frequently. Each node must forward traffic unrelated to its own use, and therefore be a router. The popularity of mobile and hand held devices equipped with wireless interface are creating a new challenge for Quality of Service. The wired network has also not been able to fulfill end-to-end guarantees. In this paper, we present a behavior OLSR protocol in MANET. The Optimized Link State Routing (OLSR) is a table-driven and proactive routing protocol that was designed for mobile ad hoc network. OLSR protocol is an optimization of the pure link state algorithm. In an effort to improve the performance of wireless networks, there has been increased interest in protocols that rely on interactions between different layers.**

***Index Terms*—MANET, Cross-Layer, OLSR, QOS**

I. INTRODUCTION

In the recent past these three categories of networks have been used for civilian, emergency and military applications. A lot of work has been contributed in the area of cross layer design for wireless networks.

The cross layer architectures have been proposed to guarantee protocols cooperation by sharing the network status information while still maintaining separation among the OSI model layers [1]. The routing metric widely used in the most popular routing protocols [2], [3] is the minimum number of hops. Therefore, in order to achieve the best quality of service (QoS), routing protocols should consider the cross-layer approach to extract QoS metrics such as current channel state as well as the quality of each link.

Routing is a challenging issue in ad hoc network since nodes are mobile and the topology of the networks is ever changing. Besides, all nodes need to communicate via wireless infrastructure.

Routing metrics used such as shortest path, link quality, power conservation and position location will reduce route discovery time and also message update cost. When compared to wired networks, mobile networks have unique characteristics. In mobile networks, node mobility may cause frequent network topology changes, which are rare in wired networks. In contrast to the stable link capacity of wired networks, wireless link capacity continually varies because of the impacts from transmission power, receiver sensitivity, noise, fading and interference. In addition, wireless mobile networks have a high error rate, power restrictions and bandwidth limitations.

MANET is an autonomous collection of mobile users communicating over a relatively bandwidth constrained wireless link with limited battery power in highly dynamic environments. Because of high mobility of nodes, each node is supposed to function as a transmitter, host and a router. In MANET, the topology of the network may change rapidly and unpredictably over the time. The network in MANET is decentralized. In MANET, a wireless node can be the source, the destination, or an intermediate node of data transmission. When a wireless node plays the role of intermediate node, it serves as a router that can receive and forward data packets to its neighbor closer to the destination node. A collection of wireless mobile nodes can vigorously establish the network in the absence of fixed groundwork [4]. Because of these features, routing is a serious issue and a competent routing protocol needs to be chosen to make the MANET trustworthy [5]. The most popular routing protocols in MANET are AODV (reactive) and TODV (on-demand), OLSR (proactive) and TORA (on-demand). Reactive protocols find the routes when they are needed. On-demand protocols find a route on demand by flooding the network with route request packets.

II. LITERATURE REVIEW

In Mobile ad hoc networks routing is a challenging in dynamic changing environment and has received tremendous amount of attention from researches [4, 5, 6]. This has led to development of many different routing protocols for MANETs, and each author of each proposed protocol argues that the strategy proposed provides an improvement over a number of different strategies considered in the literature for a given network scenario. There are numerous routing protocols which have been proposed for mobile ad hoc networks and there is no standard scheme that works well in scenarios with different network sizes, traffic overloads, and node mobility patterns. Moreover, these protocols are based on different design philosophies and proposed to meet specific requirements from different application domains.

Thus, the performance of a mobile ad hoc routing protocol may vary dramatically with the variations of network status and traffic overhead. The performance variations of mobile ad hoc network routing protocols make it a very difficult task to give a comprehensive performance comparison for a large number of routing protocols. There are three different ways to evaluate and compare the performance of mobile ad hoc routing protocols. The first one is based on analysis [7] and uses parameters such as time complexity, communication complexity for performance evaluation. In the second method, routing performance is compared based to simulation results [7, 8]. The last method is implementing routing protocols and analyzing their performance using data from real-world implementations. This method is not suitable for comparison of large number of routing protocols. Considering the dynamic network features, metrics for

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evaluating performance of mobile ad hoc network routing protocols are proposed in [8].

Cross layer optimization schemes and algorithms between different protocol layers are investigated with an objective of shedding light on open research problems and new approaches are covered in [9]. In recent study [10], cross layer based proactive routing protocol CL-OLSR based on OSLR routing protocol for WMN is proposed.

III. Cross Layer Design

To fully optimize wireless broadband networks, both the challenges from the physical medium and the QoS demands from the applications have to be taken into account. Rate, power and coding at the physical layer can be adapted to meet the requirements of the applications given the current channel and network conditions. Knowledge has to be shared between (all) layers to obtain the highest possible adaptively

Cross-layer design is a promising approach in mobile Ad-Hoc networks and it is considered as one of the effective methods to enhance the performance of a wireless network by jointly designing multiple protocols. In contrast to layered architecture technique, which is not efficient for Ad-Hoc wireless networks [11], cross-layering allows communication between non-neighboring layers as well as reading and controlling the parameters of one layer from other layers [12, 13]. Cross-layering technique also allows parameters to be passed to the adjacent layers to assist them in determining the operation modes that will suit some requirements imposed by the nodes. In addition, this technique adapts the changes in wireless links and network topology and thus makes future networks self-behaving..

As per as the architecture is concern, it plays a vital role in the designing of a system. Architecture in system design pertains to breaking down the system into modular components systematically specifying the interactions between the components. The significance of the architecture is difficult to exaggerate. Modularity provides the abstractions needed for the designer to understand the overall system. With the abstraction of the system it is easy to develop and design it concurrently with fewer efforts. A good architectural design can thus lead to quick proliferation. The popular OSI Model and the well-known TCP-IP Model, The OSI Model consists of seven layers viz. Application layer, Presentation layer, Session layer, Transport layer, Network layer, Data Link layer and Physical layer. However the TCP-IP consists of five layers in which the upper three layers of the OSI model is merged as a super layer “Application layer”. Network protocols are divided into independent layers. Each of these layers is designed separately and the interactions between these layers are performed with the help of well-defined interfaces. In the layered architecture, UDP packets are sent to and fro from the network layer to the application layer via the transport layer. This communication causes some avoidable delay which degrades the overall performance of the network. If we can design a direct application layer- network layer interface bypassing the transport layer, we can save the end to end delay and hence the overall network performance can be improved.

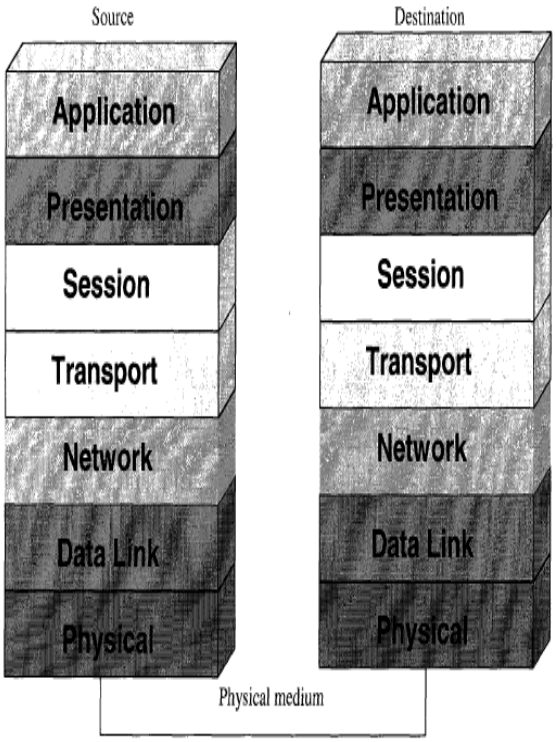

Figure 1: Open System Interconnection Reference Model

The purpose of the TCP/IP was to connect a number of devices to the Internet with a high-speed communication link. As shown in figure 2, TCP/IP has four layers: Application, Transport, and Internet and Network Access layers. Each layer in the TCP/IP model corresponds to one or more layers of the seven layer open systems interconnection model.

A. Network Access Layer:

This layer is responsible for delivering data to the other devices on the attached physical network. In addition, it performs different duties such as: checks for errors, acknowledges of received frames and converts the data into electrical pulses.

B. Internet Layer:

This layer is responsible for addressing, packaging, fragmentation, and error detection and routing. The most important protocols operate in this layer are Internet Protocol (IP) and Address Resolution Protocol (ARP).

C. Transport Layer:

This layer is responsible for the end-to-end flow of data and for providing the application layer with session and datagram communication services. Two primary protocols operate in this layer: Transmission Control Protocol (TCP) and User Datagram Protocol (UDP).

D. Application Layer:

By this layer, the user applications can access the services of the other layers. Hypertext Transfer Protocol (HTTP) and File.

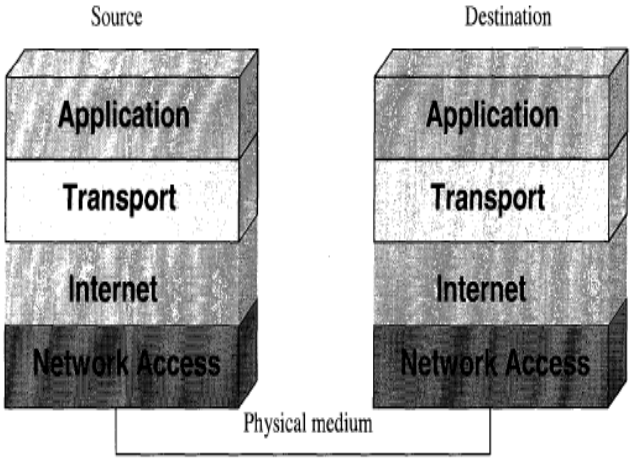

Figure.2: TCP/IP Model

IV. Optimized Link State Routing Protocol (OLSR)

OLSR (Optimal Link State Routing) protocol provides a more organized and efficient way to manage traffic control packets between two nodes based on a shortest path strategy [14]. As a proactive protocol, OLSR periodically exchange information among nodes in order to acquaint itself the network status. Consequently the routing tables of network nodes are maintained constantly updated with link state messages. However, the protocol limits the number of nodes that are allowed to forward link state messages in order help to preserve high network through-put.

Optimized Link State Protocol is a proactive routing protocol, so the routes are always immediately available when needed. OLSR is an optimization version of a pure link state protocol. So the topological changes cause the flooding of the topological information to all available hosts in the network. To reduce the possible overhead in the network protocol uses Multipoint Relays (MPR). The idea of MPR is to reduce flooding of broadcasts by reducing the same broadcast in some regions in the network. Another reduce is to provide the shortest path. The reducing the time interval for the control messages transmission can bring more reactivity to the topological changes. [15]

Link-state routes are more reliable, stable and accurate in calculating best route and more complicated than hop count. To update topological information in each node, periodic message is broadcast over the network. Multipoint relays are used to facilitate efficient flooding of control message in the network. Route calculations are done by multipoint relays to form the rout from a given node to any destination in the network.

The OLSR protocol is developed to work independently from other protocols. Conceptually, OLSR contain three generic elements: a mechanism for neighbor sensing, a mechanism for efficient flooding of control traffic, and a specification of how to select and diffuse sufficient topological information in the network in order to prove optimal routes [11]. OLSR performance relay on HELLO and TC messages. The (TC) messages used for continuous keep of the routes to all endpoints in the system, the protocol is very proficient for movement patterns where an enormous subset of nodes are interacting with other enormous subset of nodes, and where the [source, destination] pairs change over time. Hello message the Multipoint Relay (MPR) Selector set is constructed which describes which neighbours has chosen this host to act as MPR and from this information the host can calculate its own set of the MPRs.the Hello messages are sent only one hop away but the TC messages are broadcasted throughout the entire network.

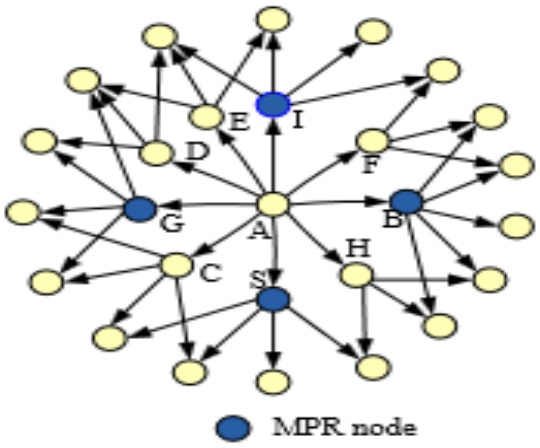

Figure 3: MPR nodes in OLSR

TC messages are used for broadcasting information about own advertised neighbors which includes at least the MPR Selector list. The TC messages are broadcasted periodically and only the MPR hosts can forward the TC messages.

There is also Multiple Interface Declaration (MID) messages which are used for informing other host that the announcing host can have multiple OLSR interface addresses. The MID message is broadcasted throughout the entire network only by MPRs. There is also a “Host and Network Association” (HNA) message which provides the external routing information by giving the possibility for routing to the external addresses. The HNA message provides information about the network- and the net mask addresses, so that OLSR host can consider that the announcing host can act as a gateway to the announcing set of addresses.

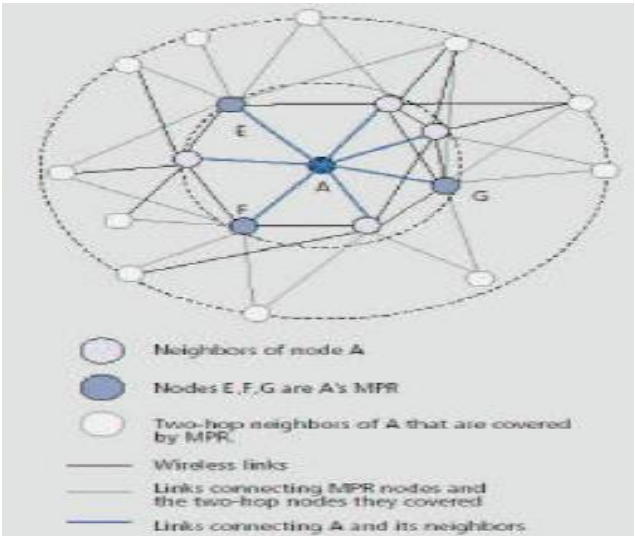

Figure 4: Optimal Link State Routing

The Multipoint Relays (MPR) is the key idea behind the OLSR protocol to reduce the information exchange overhead. Instead of pure flooding the OLSR uses MPR to reduce the number of the host which broadcasts the information throughout the network. The MPR is a host’s one hop

neighbor which may forward its messages. The MPR set of host is kept small in order for the protocol to be efficient. In OLSR only the MPRs can forward the data throughout the network. [12]

V. Conclusion

In MANET, the topology of the network may change rapidly and unpredictably over the time. The network in MANET is decentralized. A Cross Layer Design (CLD) approach is used to design a reliable routing protocol for MANET. OLSR protocol is proactive or table driven in nature, hence it favors the networking context where this all time-kept information is used more and more .The procotol also goes in favoure of the applications which do not allow long delays in transmitting data packets .OLSR protocol is adapted to the network which is dense, and where the communication is assumed to occur frequently between a large number of nodes.

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