Performance Analysis of Non Hybrid and Hybrid Routing Protocols with Routing Metrics in Wireless Mesh Networks

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Abstract:

Wireless mesh network has been considered as a viable solution to offer broadband connectivity to rural community due to its ability to provide extended coverage and scalable deployment. However, there are still impediments that need to be addressed in terms of throughput degradation, latency and interference due to multi hop transmission and potential isolated nodes. In this contribution, an investigation of suitable routing protocol in the context of providing rural broadband communication is presented by evaluating various of routing approaches, namely non hybrid and hybrid routing protocols. There are still research issues needs to be addressed in terms of its performance degradation due to unexpected behavior of routing protocols under different network scenarios. In this paper, after thorough investigation, suitable routing protocol is suggested with the help of appropriate measurement using routing metrics. Even though IEEE task group has adopted IEEE 802.11s as standard for integrated mesh networking as also suggested default routing protocol and default routing metrics, it is very much needed to investigate the performance of different categories of routing protocols under different network scenarios. The performance evaluation of non hybrid routing protocols such as ad hoc on demand distance vector (AODV) and optimized link state routing Protocol (OLSR) and hybrid routing protocols such as Hybrid Wireless Mesh Protocol (HWMP) and GREENIE are considered in each category under different network scenarios. The impacts of varying traffic loads, number of sources, network size and real time and non real time applications on Wireless Mesh Networks using metrics have been invested through simulation. The simulations are carried out with three different routing metrics. The considered metrics include hop-count, ETX and ETT. GREENIE has a clear advantage compare to HWMP, AODV and OLSR in terms of maximizing throughput and minimizing end to end delay for real time applications and OLSR has clear advantage in terms of maximizing throughput and minimizing end to end delay for non real time applications.

Keywords- Wireless mesh networks, routing protocols, AODV, OLSR, HWMP, GREENIE, performance, evaluation, network scenarios, metrics

I.INTRODUCTION

In current scenario the one third of the world wide population is going to online users since the numbers of the Internet users are increasing very rapidly [1]. The connecting the unconnected is a required to fulfill the global needs. Especially in rural areas the availability of Internet service is low and not accessible. In urban and rural area, Wireless mesh networks (WMN) have the potential to provide ubiquitous and high-speed broadband access to both fixed and mobile users, with low operation and management costs.

WMNs most promising application is to provide access to information where wired infrastructure is difficult or economically infeasible to deploy specifically in rural area. WMN in the context of rural areas is suitable for its features such as high scalability, cheap-to-deploy and ease-of-maintenance [2].

Wireless Mesh Network has been envisioned as a feasible solution to offer broad connectivity to rural community and ability to provide next generation wireless networking which gives extended coverage and scalable network deployment. The next generation wireless networks can be used in wireless community networks, wireless enterprise networks, transportation systems, home networking and last-mile wireless internet access. However, there still issues exits that need to be addressed in terms of degradation in network throughput, delay and interference problems due to multi hop transmission and potential separated nodes. In order to provide interoperability, many proprietary mesh solutions were developed by individual vendor but IEEE forms a task group called IEEE 802.11s to develop an integrated mesh networking solution.

The WMN routing protocols can be classified as proactive, reactive and hybrid in general. In case of proactive protocols, the routes to all destinations are maintained regardless of whether these routes are needed or not. Thus, this may waste the bandwidth because of unnecessary transmission of control messages when there is no data traffic. Reactive routing protocols only set up a route between a source and its destination when required. While, hybrid routing protocols combine both reactive and proactive routing to increase the overall scalability in the networks. In this paper, protocol from non hybrid (OLSR,ADOV) hybrid (HWMP,GREENIE) and performance of each of them are evaluated using routing metrics under different network scenarios and traffic applications. The heart of Wireless Mesh Networks is Routing Protocols which control the formation, configuration and maintenance of the topology of the network. Most routing proto cols for wireless mesh networks are ex-tended unicast ad ho c routing protocols. Existing unicast routing protocols like for example AODV, DSR are not suited well for wireless mesh networks as in such networks, most traffic flow between a large number of mobile nodes and a few access points with Internet connectivity. In this period, the performance evaluation of recently developed scalable routing protocol for this type of communication that is designed to scale to the network size and to be robust to node mobility has been carried out. The performance evaluation of ad hoc on demand distance vector (AODV), optimized link state routing Protocol (OLSR), hybrid wireless mesh protocol (HWMP) and GREENIE are considered as popular protocols in each category under different network scenarios. The considered metrics include hop count, EXT and ETT. The impacts of varying traffic loads, number of sources, network size and real time and non real time applications on Wireless Mesh Networks using metrics have been invested through simulation.

The remainder of this paper is organized as follows: Section II discuss related work carried out in analyzing the performance of scalable routing protocols in WMNs. The scalable routing protocols considered for simulation are presented in Section III. Section V elaborates the simulation environment and the simulation result are analyzed and discussed in Section VI. The conclusion for this simulation is drawn in Section VII.

II. RELATED WORK

Recently, routing protocols and associated metrics for wireless mesh networks have been extensively examined [5]. Wireless Mesh Networks considered having common features with mobile ad hoc networks. Many of the routing protocol for WMN are derived from the ad hoc networks. IEEE 802.11s used HMWP [6] which is based on Ad hoc On demand distance vector (AODV) and Microsoft mesh network [7] was based on Dynamic Source Routing (DSR).

All the existing routing protocols used in WMNs completely depend on the IP layer and enable multi-hop communication. The major problem with focusing only on network layer is it cannot capture the nature of the wireless link perfectly [8]. It is common that, wireless links are more vulnerable than the wired and multi-hop routing protocol has responsibility of managing these wireless links. Although IEEE 802.11s has set HWMP as a default routing metrics and default routing metrics, there is no effort seen to study the behavior of these protocol under varied network scenario and possible high end applications.

Recently the video streaming over wireless mesh networks (WMNs) has been taken great interest among the users. Due node mobility and scalability there can be decrease in the perceived video quality on receivers with increasing of path failure. There is a study on god hybrid routing protocol for data dissemination which efficiently and effectively routes packets in a wireless mesh networks and employs proactive and reactive routing protocols based on the node mobility (GREENIE) [18] for efficient video streaming over WMNs.

III. Non hybrid Routing Protocols in Wireless Mesh Networks

We have considered two types of non hybrid routing protocols for evaluation under different network scenarios in this paper, namely AODV (reactive), OLSR (proactive). In this section the operation of each routing protocols are explained briefly. .

A. Ad hoc On Demand Distance Vector Routing Protocol

This protocol performs Route Discovery using control messages route request (RREQ) and route reply (RREP) whenever a node wishes to send packets to destination. To control network wide broadcasts of RREQs, the source node uses an *expanding* ring search technique. The forward path sets up an intermediate node in its route table with a lifetime association RREP. When either destination or intermediate node using moves, a route error (RERR) is sent to the affected source node. When source node receives the (RERR), it can reinitiate route if the route is still needed. Neighborhood information is obtained from broadcast Hello packet.

As AODV protocol is a flat routing protocol it does not need any central administrative system to handle the routing process. AODV tends to reduce the control traffic messages overhead at the cost of increased latency in finding new routes. The AODV has great advantage in having less overhead over simple protocols which need to keep the entire route from the source host to the destination host in their messages. The RREQ and RREP messages, which are responsible for the route discovery, do not increase significantly the overhead from these control messages. AODV reacts relatively quickly to the topological changes in the network and updating only the hosts that may be affected by the change, using the RRER message. The Hello messages, which are responsible for the route maintenance, are also limited so that they do not create unnecessary overhead in the network. The AODV protocol is a loop free and avoids the counting to infinity problem, which were typical to the classical distance vector routing protocols, by the usage of the sequence numbers. [9]

B. Optimized Link State Routing Protocol

Optimized Link State Protocol (OLSR) 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, more details about MPR can be found later in this chapter. 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. [10]

OLSR uses two kinds of the control messages: Hello and Topology Control (TC). Hello messages are used for finding the information about the link status and the host's neighbors. TC messages are used for broadcasting information about own advertised neighbors which includes at least the MPR Selector list. The proactive characteristic of the protocol provides that the protocol has all the routing information to all participated hosts in the network. However, as a drawback OLSR protocol needs that each host periodically sends the updated topology information throughout the entire network, this increase the protocols bandwidth usage. But the flooding is minimized by the MPRs, which are only allowed to forward the topological messages.

IV Hybrid Routing Protocols in Wireless Mesh Networks

We have considered two types of hybrid routing protocols for evaluation under different network scenarios in this paper, namely HWMP and GREENIE. In this section the operation of each routing protocols are explained briefly.

A. Hybrid Wireless Mesh Protocol (HWMP)

This protocol has the flexibility of combining the on demand and proactive features and work well with any kind of topology. HWMP routing protocol make use of AODV for on demand protocol primitives and destination sequence distance vector DSDV [10] for proactive protocol primitives. This protocol is used as default routing protocol in IEEE 802.11s in MAC layer. The path selection is done in IEEE 802.11s using air time link metric which is also a default link metric [7]. Routing metric airtime is radio aware metric which can measure the amount of channel resource consumed when a frame is transmitted over a wireless link. There are four control messages are specified in HWMP which are the root announcement (RANN), path request (PREQ), path reply (PREP) and path error (PERR). It also contains three important fields such as destination sequence number (DSN), time-to-live (TTL), and metric except for PERR. The count to infinity problem is prevented using DSN and TTL and the metric field helps to find a better routing path than just using hop count.

As in case of AODV reactive routing mode, the process of broadcasting of route request packet is similar to PREQ broadcast by source Mesh Point (MP) to a destination MP. Thus, the received PREQ packets are newer or better path to the source, MP will again broadcast the updated PREQ. The destination MP in turn will reply back with PREP. During forwarding the control packets PREQ, in case if intermediate MP has no path to destination MP, it just forwards the PREQ element. The few mesh points in WMN will receive the large proportion of the traffic which is destined and offers access to a wired infrastructure and the Internet. A proactive tree based routing mode will be useful in building the same distance vector methodology as used in Radiometric AODV (RM-AODV) and the root node will periodically broadcasts a PREQ element in case of proactive mechanism. An MP in the network receiving the PREQ creates/updates the path to the root, records the metric and hops count to the root, updates the PREQ with such information, and then forwards PREQ. Thus, the presence of the root and the distance vector to the root can be disseminated to all MPs in the mesh. In the proactive RANN mechanism, the root node periodically floods an RANN element into the network. When an MP receives the RANN and also needs to create/refresh a route to the root, it sends a unicast PREQ to the root. When the root receives this unicast PREQ, it replies with a PREP to the MP. Thus, the unicast PREQ forms the reverse route from the root to the originating MP, while the unicast PREP creates the forward route from the originating MP to the root.

B. GREENIE

GREENIE is a hybrid routing protocol for data dissemination which efficiently and effectively routes packets in a wireless mesh network and intelligently employs proactive and reactive routing protocols based on the node mobility. It distinguishes mobile from static nodes and selects the most stable path between a source and a destination which leads to higher perceived video quality on receivers. This protocol carefully considers the mobility of the nodes in order to associate the different routing task to the WMN nodes. GREENIE handles both static routes and on demand routes composed of static routers and gateway. Mesh routers exchange their routing tables among themselves using the proactive routing protocol and this reduces backbone network to use the proactive mode. The idea is to use proactive routing protocol where the conditions of links among mesh routers (MRs) do not change drastically. The conditions of links between mobile nodes and MRs or between mobile nodes can change unpredictably and abruptly. In fact, routes from a mobile node to the MRs or to the gateways or between any two mobile nodes in the hybrid WMN may include non-stable links. In this case, reactive scheme is appropriate for this kind of communication paths. The static mesh nodes make use of both schemes (reactive and proactive) where as mobile mesh nodes use a reactive mode. The use of a reactive protocol in the MR even when they are already designed with the proactive one guarantees the compatibility with the mobile nodes. The use of a reactive routing protocol in the mobile nodes provides an efficient self-healing method because the link-layer feedback has been activated. In this protocol, both proactive and reactive routing protocols are implemented in the MAC layer of each MR and node. The transfer of the routing procedures to the link layer is necessary since the mesh routers need to run both schemes simultaneously.

When compared to IP layer, it is possible to use two different independent forwarding tables in the MAC layer. This allows MR to be more efficient for routing the received packets in the WMN. Since the link layer forwarding tables do not contain any information about any node outside the local network, the memory resources are smaller. The time accessing the table is reduced and also having less routing over head. It is possible to use the existing information in the MAC header in order to update the route information to the source directly and efficiently. The MAC layer does not exclusively inform about the destination but also includes information about the previous node. Thus, the receiving node can update the routing information concerning the previous node. Most of the hybrid protocols use a classification of the destination nodes in the source and when source needs to know a route to a destination, it already identifies in which routing structure it should look for it. But this condition does not hold in GREENIE, because the proactive and the reactive forwarding tables may contain the information associated with the same destination node. GREENIE promotes the use of the most stable links so that the routing information kept in the proactive routing table is preferred. GREENIE uses the proactive and reactive nodes derived from the OLSR and the AODV/DYMO [19] routing protocols, respectively.

Simple Algorithm for GREENIE [18] is listed below:

```
Algorithm   GREENIE (packet, route, proactive_cache,
reactive_cache)
BEGIN
Step1:  Packet is received
Step2:  IF (packet_type = proactive)    update routing table and
Goto Step 5 END;
Step3: IF (packet_type = RREQ)    BEGIN
                    IF (route=valid_route in proactive_cache)
                     BEGIN
                           Send RREQ to Reactive Protocol
                           Include Route Information found
                    Goto Step 5
                     END;
                    ELSE   IF (route=valid_route in
                              reactive_cache) Reply RREP
                              ELSE      Retransmit RREQ
                    Goto Step 5
                    END;
Step4: ELSE IF (packet_type = DataFrame)    BEGIN
               IF (route=valid_route in proactive_cache)
               BEGIN
               Forward packet toward its destination using
                existing route information in the proactive
                or reactive cache
                Goto Step 5
                END;
               ELSE   IF (route=valid_route in reactive_cache)
               BEGIN
               Forward packet toward its destination using
                existing route information in the proactive or
                reactive cache
               Goto Step 5
               END;
              ELSE     Start Discovering Route and Send
                       RREQ
              Goto Step 5
              END;
Step 5: FINISH
```

V. SIMULATION ENVIRONMENT

The performance of different routing protocols in WMN environment is simulated using QualNet 5.2 [16]. The simulation software NS2 provides scalable simulations of wireless networks. The network topology of 250 static nodes are created and placed randomly within area of 1500 m x 1500 m. Each scenario simulation is ran over for 800 seconds and data collected over those runs are averaged. The 802.11 a/g is used as radio type and 802.11s standard as MAC protocol. The broadcast data rate in this simulation is 54 Mbps with Constant Bit Rate (CBR) traffic source, sending at a rate of 1 packet per seconds. The packets with 512 bytes size is scheduled on a first in first out (FIFO) basis [17]. A constant shadowing model with two-ray propagation path loss model is used in this simulation.

TABLE 1: Simulation Parameters

Parameter	**Value**
Simulation area	1500 x 1500 meter
No of Nodes	250
Radio Type	802.11 a/g
Non hybrid RoutingProtocol	AODV and OSLR
Hybrid Routing Protocol	HWMP and GREENIE
Simulation Time	800 seconds
Data rate	54 Mbps
Data type	CBR
Data packet size	512 bytes
Tx Range	250 m
Traffic Source/Destination	Random
MAC Protocol	IEEE 802.11s MAC
Path Loss model	Two-ray propagation

The performance of the routing protocol in WMN was evaluated by using several routing metrics. Specifically, four different quantitative metrics were employed, namely ETX, ETT, WCETT, airtime.

TABLE 2: Application Type and Packet Size

Application type	**PacketSize (Byte)**	**Packet Interval**	**Duration**
CBR (Non Real Time)	512	10 ms	80s
FTP (Non Real Time)	1460	8 ms	60s

VoIP (Real Time)	160	20 ms	80s
Video Streaming (Real Time)	512	1 ms	20s

VI. RESULTS AND DISCUSSIONS

The performance of Non hybrid routing protocols: AODV, OLSR and Hybrid Routing Protocols: HWMP, GREENIE routing protocol was evaluated by varying the application traffic type, traffic loads and routing metrics. Simulation results obtained are discussed in detail.

A. *Different Application Traffic Types*

The performance of AODV, OLSR, HWMP and GREENIE protocols for wireless mesh networks is carried out through extensive simulations. Four different types of applications are used with different packet size and data rate. The complete transfer of data traffic is taking place from source node to gateway or from gateway to source node. The throughput of the proactive PREQ in HWMP is higher than reactive mode for all application type except VOIP. This was taken care by another hybrid routing protocol GREENIE which is more suitable to handle real time traffic applications. A number of simulations have been done to explore the performance of GREENIE and HWMP protocols for wireless internet access. Five different types of applications used with different packet size and data rate. All data traffic is either from source node to gateway (root node) or from gateway to source node. According to simulation, throughput of the HWMP is higher than reactive part for all application type except VoIP.

The main concern of real time traffic is to handle a video server which divides the video stream into 512 byte packets and disseminates them among existing applicant nodes in the network. The video stream is encoded using the CBR technique. GRENIEE protocol is not only restricted to video traffic. The capability of routing protocols is evaluated in terms of three performance metrics including the throughput of video packets, end-to-end delay routing overhead and jitter. . The first metric indicates the averaged number of received video packets per second in the applicant nodes who have requested the video stream from the server. These packets are received on receivers with no error. The second metric, end-to-end delay, states the transmission time between sending and receiving a video packets in the video server and an applicant node, respectively. Jitter is variation of arrival of packets leading to breaks in playing applications. Moreover, the amount of jitter measured for all considered routing protocols.

B. *Throughput for real time and non real time packets*

The locator is used to keep track of position of nodes in the hybrid WMN and tells which mesh node is connected to which mesh router. The locator keeps the position of node in the routing table which is related to mesh routers. The location information of each node is flooded to all nodes in the network. The packet is flooded for every time whenever changes occur in the locator tables. The locator can also collect information from locators in its neighbors for completely transferring their tables. The performance of AODV, OLSR, HWMP and GREENIE protocols for wireless mesh networks are carried out through extensive simulations. Two types of applications are used with different packet size and data rate. The complete transfer of data traffic is taking place from source node to gateway or from gateway to source node.

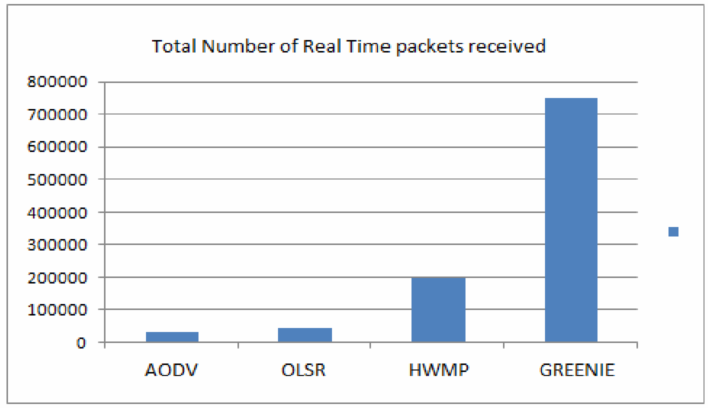

Figure 1. Total number of real time packets received by different routing protocols

The throughput of the hybrid protocol GREENIE is higher than reactive mode for all application type except non real time. A number of simulations have been done to explore the performance of hybrid and non hybrid protocols for wireless internet access. Two types of applications used with different packet size and data rate. All data traffic is either from source node to gateway (root node) or from gateway to source node. According to simulation, throughput of the GREENIE is higher than non hybrid for real time application type and OLSR throughput is higher in case of non real time applications.

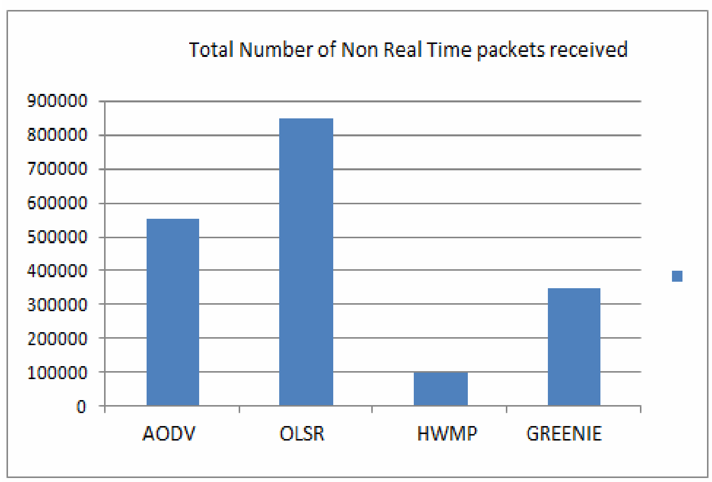

Figure 2. Total number of non real time packets received by different routing protocols

In the figure 1 and 2, all non mesh nodes request for the real time data frames from the video server and 30 mesh nodes relay on the received video packets to other nodes. But, the backbone of the mesh network is not suitable because mesh routers are fixed and using a reactive routing protocol increases the total required time for finding the optimal path between two mesh routers. HWMP protocol is based on tree-based routing and construction of tree always increases the total time required for data dissemination and not robust in high node mobility. GREENIE provides considerable enhancement of throughput even in high node mobility and clearly outperforms for real time traffic.

C. Average End-to-End Delay for real time and non real time packets

In case of increase in non mesh nodes, the end-to-end delay keeps varying for all the routing protocol. In figure 3, as expected, both OLSR and HWMP show higher end-to-end delays in comparison with AODV and GREENIE. HWMP has more end-to-end delay because of construction and handling of tree-based data transmission. The path redundancy in OLSR leads to more delay and degrades the performance.

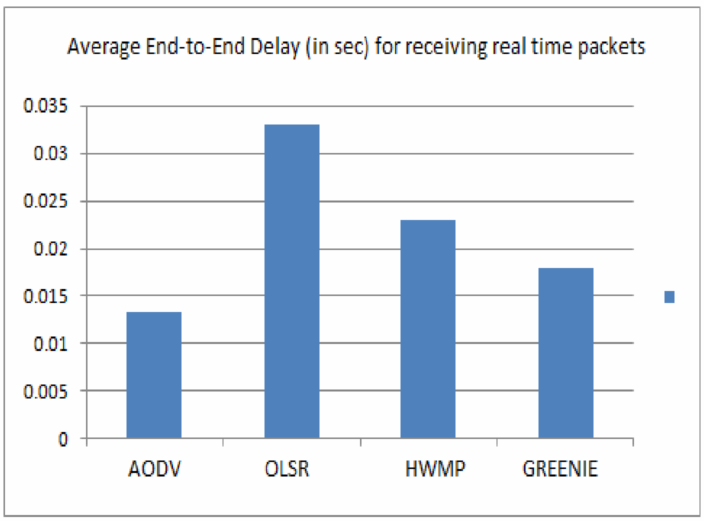

Figure 3. Average End-to-End delay for receiving real time packets

The HWMP protocol increases end-to-end delay moderately, whereas the introduced end-to-end delay by the OLSR routing protocol is fluctuated for different number of nodes. According to previous studies, 15 ms to 20 ms is an acceptable value for the end-to-end delay in video streaming over WMNs. Hence, all routing protocols, except OLSR and HWMP, could deliver video packets to applicant nodes before their playback time. This shows that an efficient hybrid routing protocol needs to consider many issues for providing considerable efficiency in data dissemination.

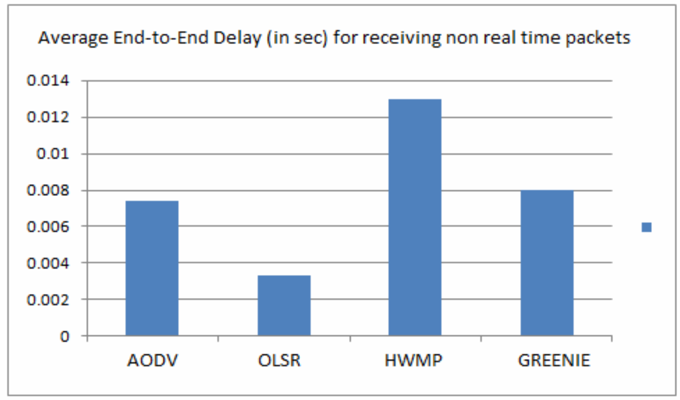

Figure 4. Average End-to-End delay for receiving non real time packets

As illustrated in Figure 4, although the hybrid GREENIE and the proactive scheme OLSR introduce low end-to-end delay in the system, the hybrid routing protocol provides, on the average, the least amount of end-to-end delay for different number of non mesh nodes without any fluctuation for non real time traffic. In contrary to HWMP, the AODV reactive routing protocol and GREENIE does not impose high end-to-end delay in the system because all packets use the same path and the initial cost of finding the path (the initial delay) is compensated by the other packets. However, the hybrid scheme has little more delay than the reactive protocol. According to the obtained results by the HWMP and GREENIE, a hybrid scheme which is based on both reactive and proactive protocols cannot necessarily provide high performances. Proactive routing protocol OLSR introduces the minimum end-to-end delay because it uses a predefined path in the routing tables and there is no mobile node in the network. However, it is not realistic to imagine a wireless network with no mobile nodes. The hybrid and proactive protocols provide approximately the same performances in terms of the total number of successfully received video packets and the end-to-end delay for real time traffic.

D. Routing Overhead for real time and non real time packets

This figure 5 shows the normalized values of routing overhead for different numbers of non mesh nodes for real time traffic. It is necessary to mention that all thirty mesh nodes participated in the routing. The proactive routing protocol OLSR has got more overhead messages. This is due to exchange of static tables between mesh nodes during dynamic change in the topology of the mesh network. The hybrid routing protocols HWMP and GREENIE shows approximately fixed routing overhead with low fluctuation for different number of non mesh nodes. The AODV and GREENIE provides the least routing overhead when the number of mesh nodes. In this simulation experiment, most of the routing packets are lost by collisions. Therefore, those routing protocols such as GREENIE and HWMP which send fewer routing packets provide better performances in terms of routing overhead when there is a large number of nodes in the network.

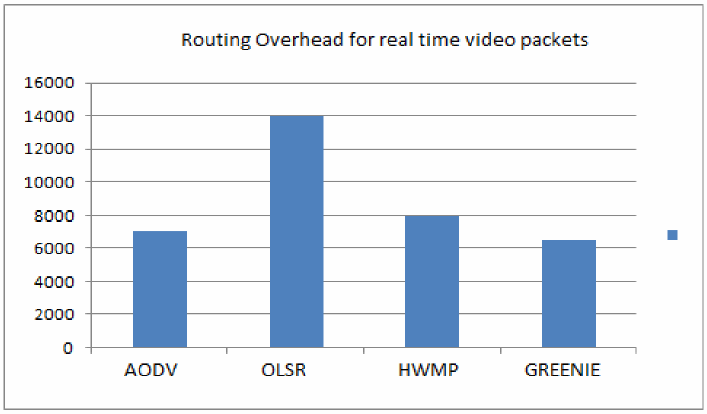

Figure 5. Routing overhead occurred for real time packets transmission

The figure 6 shows the normalized values of routing overhead for different numbers of non mesh nodes for non real time traffic. It is necessary to mention that all thirty mesh nodes participated in the routing. The hybrid routing protocol HWMP has got more overhead messages.

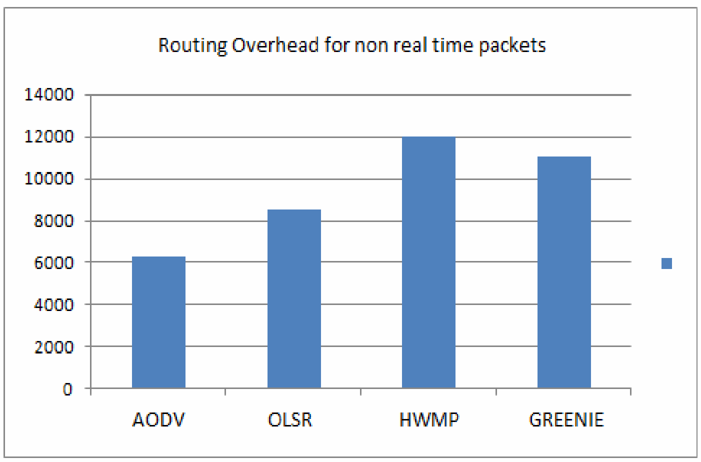

Figure 6. Routing overhead occurred for non real time packets transmission

This is due to finding of new path during dynamic change in the topology of the mesh network. The hybrid routing protocol GREENIE less overhead when compared to HWMP. However it has got more routing overhead messages than non hybrid protocol AODV and OLSR. The AODV and OLSR provides the least routing overhead when the number of mesh nodes increases.

In addition, the imposed routing overhead by proactive routing protocol decreases when the number of nodes increases. However, if the number of mobile nodes increases in the network, these types of routing protocols will suffer from high routing overhead, because they continually need to find new routing paths. As a result, because of a low introduced overhead to the network, GREENIE (hybrid) is more reliable for providing non jitter real time video transmission.

VII.CONCLUSION

In this paper, we have evaluated the performance of hybrid and non hybrid protocols using NS2 network simulator. From the simulation result, it is evident that when most of the traffic is from and towards internet, GREENIE hybrid protocol performs better than HWMP, OLSR and AODV Reactive (on-demand) method in terms of throughput, average end-to-end delay and overhead for real time traffic. The popular routing protocols OLSR, AODV, HWMP and GREENIE are simulated using NS2 network simulator. In case of non real time traffic OLSR performs better than other three hybrid and non hybrid protocols. The main requirement is fairly static nodes with the aims of achieving satisfactory performance in terms of high throughput and low delay. The present study deals with efficient hybrid routing protocol and compared it with the most important recently used routing protocols in WMNs for video streaming using NS2 simulator. The obtained results for the total number of successfully received packets, end-to-end delay, and routing overhead are depicted in the graphs with description. The results show that the GREENIE hybrid routing protocol outperforms others and provides higher quality on receivers for real time traffic. This work compares important existing routing protocols in hybrid and non hybrid categories with the in different scenarios for real time and non real time traffic. Simulation has been performed to quantify performance of various routing protocols while considering a number of network parameters such as traffic loads, application traffic and routing metrics. It was observed that these parameters have different impacts on OLSR, AODV, HWMP and GREENIE routing methods. Simulated results indicate that GREENIE and OLSR has additional benefits to WMNs as it reached the highest average throughput at lowest end to end delay in comparison to AODV and HWMP. In conclusion, we have investigated hybrid and non hybrid on the impact of different application type on routing protocol using different traffic types.

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