Design and Analysis of QoS Routing Framework integrated with OLSR protocol for Multimedia Traffic in Mobile Adhoc Networks

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***Abstract*—MANETs (Mobile Ad-hoc Networks) is the self organizing wireless structure of mobile hosts. Wireless media is used for communication in MANETs. Considering the developing requirements for multimedia and real-time traffic applications in real world, QoS (Quality-of-Service) support is essential in MANETs. But most of the characteristics of MANETs make QoS support a difficult problem. It is challenging to support QoS routing in MANET due to dynamic behavior and mobility of the hosts. The OLSR (Optimized Link State Routing) protocol can be efficiently used in MANETs to provide QoS routing because of its dynamic MPR (Multi Point Relay) selection criteria and proactive nature. In this paper, a design of QoS routing framework integrated with OLSR protocol is proposed and also analyzed using network simulator. Proposed QoS framework combines a bandwidth estimation algorithm with explicit resource reservation, QoS routing and connection admission control (CAC). OLSR protocol is extended for QoS framework to solve performance issues related to node mobility using cross layer approach. Results after simulation conclude about efficiency of the proposed QoS routing framework.**

Keywords- QoS; Quality-of-Service; QoS routing; QoS framework; bandwidth; delay; OLSR; routing protocols; resource reservation

I. INTRODUCTION

A Mobile Ad-hoc Network (MANET) is an infrastructure-less, multiple hop wireless networks with mobile hosts. Thus, a MANET is self organizing and self configuring wireless network. In this network, connectivity among hosts or sometimes to other network is provided with the help of hosts themselves. Attending QoS support such as available bandwidth, end-to-end delay, probability of loss, rate of error and cost of links are extensively addressed in the perceptive of internet applications [2-3, 7-9]. Internet applications are having very limited scope in MANETs due to the dynamic topology and bandwidth restriction. Some QoS routing solutions are proposed earlier for internet applications in spite of this limited applicability [4, 6, 10-12]. Link State Routing (LSR) looks more promising for QoS routing support in MANETs as comprehensive information of connections is obtainable by all participating hosts. It enhances the opportunities to form a route by a host which meets up with the complete set of QoS routing characteristics. In LSR protocol, participating nodes stores all the required information for routing. As a reason, OLSR (Optimized Link State Routing) as in [1] is used as a routing protocol in this proposed work. Along with regular routing information OLSR can be also used to store additional QoS routing information like bandwidth and delay to select QoS supported path formation. OLSR provides a flexibility to select MPR (Multi Point Relay) based on any specific QoS parameter which can be extended for further MPR selections until it reaches to destination host.

When a design for QoS solution is thought of for MANETs to pursue bandwidth, delay, throughput, resource reservation, connection admission control should not be negotiated. Protocols viz. OLSR-ETX [5], OLSR-MD [5], QoS-OLSR [9], CAC-OLSR [10], CLD-OLSR [13], QOLSR [14], CLQ-OLSR [17] etc. were very carefully designed, however they were found unable to attain various QoS requirements. None of the above regulates the stipulation of focal points, channel assets and cross layering diagram for MANETs. So it is in fact prerequisite of a QoS structure that can be successfully significant to whichever tradition and furthermore gives QoS parts like cross layering, stream classifier, reservation flagging, association affirmation control etc. Hence, it is emphasized to formally design and analyze QoS requirement using well-defined framework.

II. REVIEW OF QOS FRAMEWORKS

In [18], authors presented a QoS framework called INSIGNIA (In-band Signaling with Admission Control). INSIGNIA is an IP (Internet Protocol) based framework that supports adaptive services for MANETs. Authors have shown design, implementation and evaluation of INSIGNIA containing in-band signaling and soft-state resource management. These two factors of INSIGNIA are very suitable for mobility support and end-to-end QoS route for highly dynamic topology change in MANET. An independent network layer solution without use of MAC layer is provided. The signaling data needed for QoS support is encapsulated in data packets itself. So that framework becomes “lightweight”.

The main drawback of presented framework is designed explicitly for AWNs (Adhoc Wireless Networks) where there is no consideration of mobility and reservation of resources is also not deal with.

In [19], authors presented a QoS framework SWAN (Service Differentiation in Stateless Wireless Adhoc Networks) which is a stateless network system which utilizes distributed control computations to convey service separation in mobile wireless ad hoc networks in a basic, versatile and robust way. Authors have utilized rate direction for TCP (Transmission Control Protocol) and UDP (User Datagram Protocol) best-exertion development, and source based affirmation control of UDP enduring activity. SWAN utilizes Explicit Congestion Notification (ECN) to progressively direct conceded ongoing activity even with system flow brought on by versatility or movement over-burden conditions. A novel part of SWAN is that it doesn't need the help of a QoS-proficient MAC (Medium Access Control). On the other hand, soft real-time services are constructed by utilizing realistic best exertion wireless MAC improvement. SWAN utilizes cross layering course of action that uses framework and association layers information and it relies on upon Differentiated Services considered for traditional wired frameworks. The major issue of SWAN is that it is not overseeing reservation of resources that is truly a significant piece of QoS related controlling.

In [20], authors proposed that it is basic to keep up QoS progressively activity in MANET since a large portion of the internet applications require ensured QoS amid transmission. Authors have proposed PRTMAC (Proactive Real Time Medium Access Control) framework to ensure guaranteed QoS in the term of bandwidth and delay. It bolsters QoS by the asset reservation instrument. Once the assets are held, hubs get restrictive access on the asset. Proposed technique concentrates on exceptionally specific MAC protocols. It would require significant changes in the event of applying it on other routing protocols. In [11], a QoS framework named BRAWN (Bandwidth Reservation over Adhoc Network) was presented. The principle thought behind BRAWN is to permit end-to-end reservation of data transfer capacity in an adhoc wireless network. Reservation of resources is performed in an on-request way, so at whatever point an end-client begins an application with particular QoS needs, this application should work together with the reservation flagging module to set up a way before having the capacity to begin the information transmission. Likewise the recommended internal plan of the given framework known as BRAWN has associations between the various modules for setting up a QoS parameter. As observed with a few applications QoS asks for thinking about the operation of the tradition and request the benefits through the Reservation Signaling module. Major drawback of BRAWN to apply it on MANETs is it was proposed for static ad-hoc networks. Mobility issue of MANETs is not considered in BRAWN. Along these lines, so as to make BRAWN perfect with MANET, mobility issue must be tended to. BRAWN is purely works on network layer, so cross-layer advantages cannot be achieved. BRAWN design simply relies upon bandwidth estimation; there is no arrangement for delay estimation.

III. COMPARISON OF PROPOSED FRAMEWORK WITH OTHER QOS FRAMEWORKS

Table I shows the most popular QoS designs frameworks and their comparison for QoS assurance in MANETs. As shown, no particular QoS framework is capable to fully ensure QoS for today's real/non real time multimedia traffic flows in MANETs. So as a future work, a QoS framework for MANETs could have been proposed by considering factors like cross-layer advantages, resource reservation, connection admission control (CAC), multi-constrained QoS parameters, hard QoS assurance and proactive routing advantages.

TABLE I. COMPARISON OF QOS FRAMEWORKS

QoS Criteria	**QoS Frameworks**				
	INSIGNIA	***SWAN***	***PRTMAC***	***BRAWN***	***Proposed Framework***
Mobility support	Yes	Yes	Yes	No	Yes
Cross-layering	No	No	Yes	No	Yes
Resource Reservation	Yes	No	Yes	Yes	Yes
Connection Admission Control	Yes	Yes	No	Yes	Yes
Flow Classifier	No	Yes	No	Yes	Yes
QoS parameters	Band width	Band width and Delay	Throughput and Delay	Band width	Band width and Delay
Integrated Routing Protocol	TORA	MAC	DSR	AOD V	OLSR
Type of Traffic	Adaptive Flows	TCP and UDP	TCP	CBR	MPEG4 (CBR)

The following observations are made that should be considered upon designing a new QoS framework specifically for multimedia traffic in MANET.

- INSIGNIA can be extended for scalability issue in MANETs. In order to tackle multimedia traffic handsomely some features e.g. cross-layering, flow classifier could be added further in future work.
- SWAN can be extended further by incorporating it with a proactive routing protocol (e.g. OLSR) to get maximum benefit of cross-layered information and to support multi-constrained QoS parameters.
- PRTMAC can be incorporated with a proactive routing protocol and connection admission control and flow classifier can be also added.
- BRAWN can be worked on in the future for dynamic mobile network (mobility) as it is just proposed and fitted for the static networks. There is no arrangement for checking delay estimation. It is single constraint

architecture; not a multi-constraint one. It can be likewise improved for versatility perspective too. So there is a decent extent of research for amplifying its segments for offering almost hard QoS ensures in MANET where nodes are widespread or versatile.

IV. DESIGN OF PROPOSED FRAMEWORK

Figure 1 shows an entire design of proposed framework which divided into various modules and presented in layered form. The main features of proposed framework are flow separation module, resource reservation, connection admission control (CAC) and cross-layer design advantages. Proposed framework is integrated with OLSR protocol as in [1] and OLSR protocol is assumed to be modified accordingly in design. Non-multimedia apps directly forward data to the best-effort routes. No special treatment will be given to non-multimedia apps. While Flow separation module selects QoS supported routes to forward multimedia apps data. Multimedia apps will make a request of resources which generates signaling of resource reservation and gets QoS route from OLSR protocol. Once QoS route is formed by OLSR protocol; resource reservation and connection admission control modules will remain in act until MPR selection reaches to destination host. The required information for calculating bandwidth and delay is obtained by taking support from MAC/Data Link layer by OLSR protocol on the basis of which the MPR selection is made. All major tasks of proposed framework are carried out in network layer. But QoS related information will be taken out from MAC/Data Link Layer.

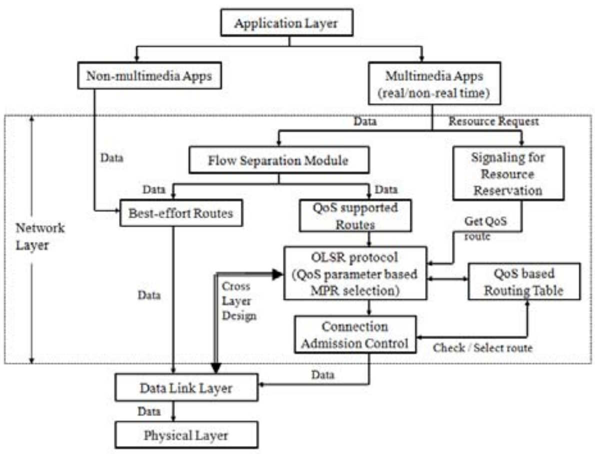

Fig. 1. A New QoS Framework Proposal.

V. ANALYSIS OF PROPOSED FRAMEWORK

The entire proposed framework is simulated in Network Simulator 2 (NS2). In Figure 2 the simulation scenario is given and as can be seen there are 50 nodes deployed within 1500x1500m^2 coverage areas. The multimedia traffic (MPEG4, UDP agent, Constant Bit Rate traffic) starts at the beginning of the simulation time. Until the end of the simulation time, part of this multimedia traffic flows between various pairs of connections. MPEG4 multimedia traffic is using video model based on IBP frames. The general list of parameters used in simulation is summarized in Table II. There are three different cases of routing protocols analyzed viz. naïve OLSR protocol as in [1], BRAWN framework in dynamic (mobility) scenario as in [21] and proposed framework. All three cases are compared with different values of simulation time (100, 200, 300 sec) and number of connections (10, 15, 20 pairs). As shown in Figures 3-5, delivery rate, end-to-end delay and throughput performance metrics are analyzed for Naïve OLSR, BRAWN framework with mobility scenario and proposed framework respectively. From the analysis of the results, it is concluded that: average delivery rate of 26.47% for proposed framework is better than Naïve OLSR and BRAWN framework with mobility scenario which are 17.98% and 23.11% respectively, average end-to-end delay which is 55.73 seconds for the proposed framework is better than Naïve OLSR and BRAWN framework with mobility scenario compared to 73.17 and 56.65 seconds respectively and average throughput of 1782.53 Kbps for the proposed framework is better than Naïve OLSR and BRAWN framework with mobility scenario of 1217.20 and 1456.97 Kbps respectively.

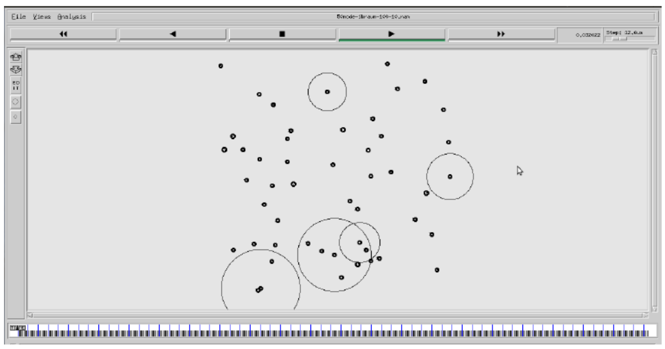

Fig. 2. Simulation scenario with 50 nodes.

TABLE II. SIMULATION PARAMETERS

Parameters	Values
Coverage Area	1500 X 1500 m^2
Number of Nodes	50
Transmission Range	250 m
Type of Traffic	MPEG4 (UDP agent, CBR traffic)
Video Model	IBP frames
Packet Size	512 Bytes
Routing Protocols	OLSR, BRAWN, Proposed Framework
Simulation Time	100, 200, 300 sec
Number of Connections	10, 15, 20 pairs
Scripts	AWK

VI. CONCLUSION

The difficulties confronted in QoS frameworks in MANETs are discussed and a proficient design and analysis of novel QoS framework of different QoS routing parameters is presented in this paper. A OLSR proactive routing protocol is integrated in the proposed QoS framework and cross-layering is exploited to get multi-constrained QoS metrics. Along with this, resource reservation and admission control is also proposed in the framework by modifying OLSR routing protocol. Simulation results based on delivery rate, end-to-end delay and throughput conclude about efficiency of the proposed QoS routing framework.

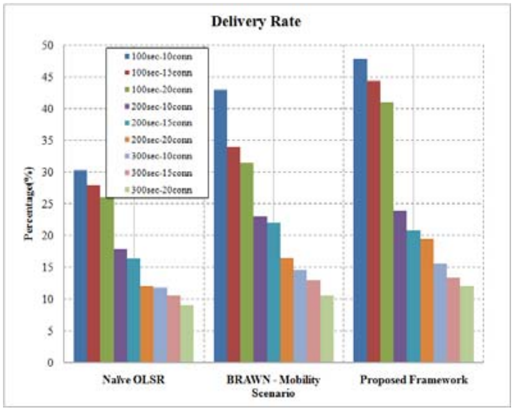

Fig. 3. Comparison of Delivery Rate.

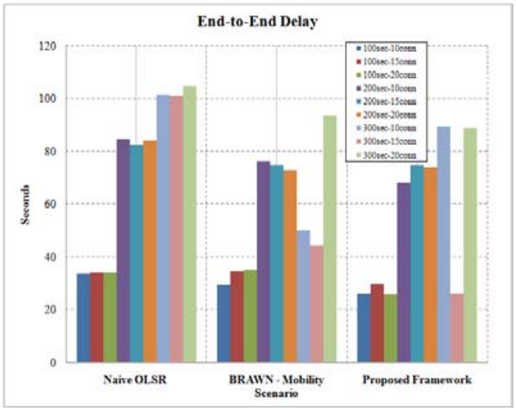

Fig. 4. Comparison of End-to-End Delay.

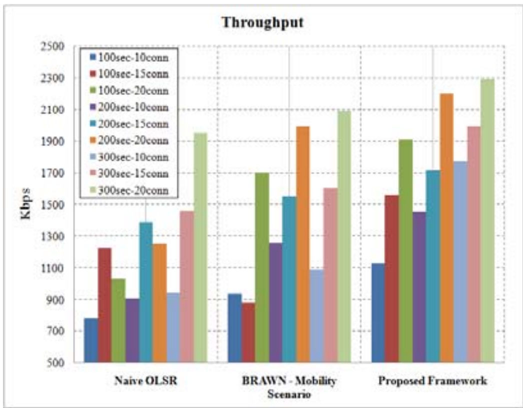

Fig. 5. Comparison of Throughput.

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