QoS in Wireless Mesh Networks- A Review

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ABSTRACT

This paper is a review on QoS issue of Wireless mesh networks. QoS comes up with a great collection of networking technologies and procedures that guarantees the capability of a network to deliver with predictable consequences. WMNs have emerged as a flexible, reliable and cost effective way of providing broadband internet access over wide areas through multi hop communication. This paper has reviewed different routing protocols used in the WMNs. The overall objective of this paper is to explore the various short comings of the routing protocols of WMNs.

Indexing terms/Keywords

WIRELESS MESH NETWORKS (WMNs); QUALITY OF SERVICE (QoS); FLOODING; COLLISION AVOIDANCE; SECURE TRANSMISSION; CONGESTION CONTROL.

Academic Discipline And Sub-Disciplines

E-Security

SUBJECT CLASSIFICATION

Wireless Mesh Networks

TYPE (METHOD/APPROACH)

Literary Analysis

Council for Innovative Research

INTRODUCTION

Wireless Mesh Networks (WMNs) is a key technology, supporting a variety of several emerging and commercially interesting applications e.g., neighbourhood networks, community and broadband home networking. To provide adaptive and flexible wireless Internet connectivity, it has been evolved as one of the most promising concepts for auto-configurable and self-organizing wireless network with multi hop and mesh technology. Network connectivity is automatically maintained and established by all the nodes in the mesh network. It also serves as a cost effective technique for establishing robust and reliable broadband access between Internet service providers (ISPs) and other end-users. The general architecture of WMNs consists of three distinct elements: mesh gateway, mesh routers and mesh clients. Static mesh routers form the wireless backbone, mesh clients interconnect to each other and access the network through mesh routers.
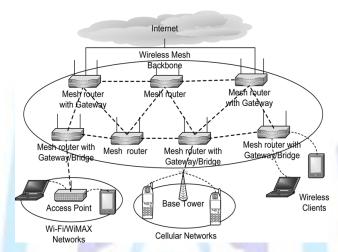

Fig 1: Network Architecture of wireless mesh network

The multi-hop nature of WMNs and the rapid growth of throughput demands lead to multi- channels and multi-radios structures in mesh networks, but the interference of co-channels, as a main problem reduces the total throughput, especially in multi-hop networks. Therefore, the use of orthogonal channels and multiple-radios are two efficient solutions for decreasing co-channels interference and improving the network throughput.

QoS in Wireless Mesh Networks

QoS (Quality of Service) refers to a vast collection of networking technologies and techniques that guarantees the ability of a network to provide with predictable results. Various elements of network performance that come under the scope of QoS often include availability (uptime), bandwidth (throughput), latency (delay), and error rate. QoS involves prioritization of network traffic. QoS can be directed at a network interface, towards a specific server or router's performance, or in specific applications. So as to insure that networks are performing at the desired level, a network monitoring system can be deployed as part of QoS.

For supporting audio and video, real time communications, QoS provisioning is very much essential. As compared to the wired networks, the provisioning for QoS of wireless networks is far more challenging concept due to the following reason:

•The unavailability of any central coordination authority

• Mobility of node

• Limited battery power

• Multi-hop communication

•Disputation for accessing the wireless channel

QoS Routing

Due to interference among various transmissions, the QoS routing in multi-hop wireless networks is formidable task. In case of multi-channel wireless network, since two transmissions using the same channel may get in with each other so there exists interference. The request of QoS connection usually accompanies bandwidth requirement and QoS routing seeks a source to destination route with requested bandwidth [16].The wireless mesh routing protocol offers QoS guarantees from source to destination when its interacting end-points fall inside the network range and from the client to the internet gateway when the traffic is directed to the internet. The QoS metrics are maximum end-to-end delay and minimum bandwidth. The available stable route is selected by the protocol when multiple routes are present.

The various advantages of WMNs are as follows:

• Moderate up-front cost,

• Facile network maintenance

• Robustness

• Reliable service coverage

• Rapidly deployable, self-healing, self-organizing and it have low transmission power.

The main objectives of QoS based routing are optimal utilization of resources for improving total network throughput and graceful performance degradation during overloading conditions offering better throughput, Dynamic determination of feasible paths for accommodating the QoS of the given flow under various policy constraints such as provider selection, path cost etc. [4]

ROUTING PROTOCOLS

There are various criteria for classifying and designing routing protocols for wireless networks. For example what, when and how the routing information is exchanged, when and how the routes are computed. [6][4]

There exist various routing protocols that can be grouped as: periodic or proactive, on demand or reactive and hybrid protocols. Proactive protocols does the things in advance, it already determines the routes to various nodes so that when required they can be used. It needs to be in a continuously updated state of the network. As all the routes are to be discovered, the route discovery overheads increases with frequent topology changes and the it is difficult to maintain and update the information in the tables.
This may cause delay in data packets or even packets can be lost resulting in the reduced performance of the network. Various proactive protocols are Destination-Sequenced Distance Vector Routing Protocol (DSDV) AND Wireless Routing Protocol (WRP) [1]. Reactive protocols do not determine the routes in advance but instead create and maintain routes only on demand .Hence they are in general more scalable in nature [7].Examples of such protocols are DSR and AODV. Hybrid protocol is a basic routing protocol that is based on AODV and tree-based routing. It supports two types of path selection protocols. It uses peer link management protocol that uses mesh point to discover and track neighbouring nodes [17].

Destination Sequenced Distance Vector Routing Protocol (DSDV): DSDV, developed by Perkins and Royer (1999) is a table driven routing based on Bellman-Ford algorithm. The main purpose to develop it was to solve routing loop problem. The routing table maintains each entry using the sequence number, which if link is present is even else odd. This sequence number is generated by the destination and emitter needs to send this number with the next update. Routing information is distributed among the nodes by frequently sending the smaller incremental updates and sending infrequently full dumps (Charles and Bhagwat, 1994).

Dynamic Source Routing Protocol (DSR): DSR is similar to AODV except that it forms routes on demand when requested is generated. Instead of using routing tables at each intermediate node, it uses source routing. Source routing determination requires accumulating the address between the source and the destination of each node .The nodes processing the route discovery packets cache the accumulated path information. Thus to route packets, the learned paths are used. Since all routing information is maintained at mobile nodes, this protocol is based on source routing.

The comparison of the three routing protocols DSDV, DSR and AODV is shown in Table 1.

Ad-Hoc on Demand Distance Vector Routing Protocol (AODV): AODV uses an on demand approach for finding routes. It is capable of both unicast and multicast routing. To identify the most recent path, it employs destination sequence number. In AODV for data packet transmission, corresponding to each flow the source node and the destination nodes store the next-hop information.

From a single Route-Request it may obtain multiple routes to different destinations.it uses destination sequence number to determine up-to-date path to the destination. If the destination sequence number of the current packets received is greater than the last destination sequence number stored at the node only then the path information is updated by a node.

Table1: Property comparison of DSD,DSR and AODV [4][6].

Protocol property	DSDV	DSR	AODV
Loop free	Yes	Yes	Yes
Multicast routes	No	Yes	No
Distributed	Yes	Yes	Yes
Unidirectional link support	No	Yes	No
Multicast	No	No	Yes
Periodic broadcast	Yes	No	Yes
QoS support	No	No	No
Routes maintained in	Route table	Route cache	Route table
Route cache/table timer	Yes	No	Yes
Reactive	No	Yes	Yes

LITERATURE REVIEW

The objective of the literature review is to find and explore the QoS in Wireless Mesh Networks and also what are the different problems in existing protocols and techniques. The main goal of this literature review is to find the gaps in existing research and methods and also what will be the possible solutions to overcome these holes.

Govindaraj. E. et al.(2012) [1] have proposed a QoS aware robust multipath routing algorithm for wireless mesh networks. The aim of the protocol is to provide a QoS constrained route from source to the destination. So a multiple disjoint paths for a source destination pair. Hence for initial time interval, probe packets are sent along all paths simultaneously from the source to the destination. On receiving the probe packets, cumulative transmission energy, average delay and bandwidth are estimated for each path and a feedback report is sent to the destination. Therefore from the multiple paths, the robust best path is selected based on the feedback report from the destination. It also detects the changes in the path quality that hinders QoS requirements of the flows and reroutes the flow through alternative robust routes.

Ghosh Saurav et al.(2011) [2] have studied wireless mesh networks as an effective means to provide broadband internet. Connectivity, reliability and throughput being the major QoS concern areas in WMNs. WMNs use orthogonal communication channels and multiple radios to increase throughput, reduce interference and provide path redundancy, connectivity and reliability. A cluster-based approach is employed to divide the network into clusters hence localising the channel assignment problem in each cluster.

S.Kannan et al.(2011) [3] have discussed that Mobile Ad-hoc Networks (MANET) as self-organizing and self-configuring multi-hop wireless networks. Mainly due to the mobility of the nodes, the structure of the network changes dynamically. In mobile ad-hoc networks, a routing procedure is always needed to find a path so as to forward the packets appropriately between the source and the destination. Route changes and temporary link failures occur frequently in a MANET. Assuming that all packet losses are due to congestion, in such an environment TCP performs poorly. So a new mechanism TASR, TCP-aware source routing is proposed that can improve TCP performance in wireless Ad-hoc networks. So to reduce out-of-ordered packets, consecutive timeouts and retransmissions in TCP, TASR adds a hold state to an existing routing protocol. It consists of route discovery and route maintenance.

S.Kannan et al.(2010) [4] have studied Mobile Ad-hoc Network routing protocol. The main objective of the protocol is to overcome the hurdles created by the dynamically changing topology and hence create an efficient and correct communication path between any two nodes keeping in view minimum routing overhead and bandwidth consumption. Since an ad-hoc environment offers various challenges that do not exists in fixed networks, the design problem so the routing protocol is not so simple. So a number of routing protocols have been proposed for this purpose. The deep study and the comparison of the performance of the protocols have been done. Various protocols are Destination Sequenced Distance Vector, Ad-Hoc Demand Distance Vector, Dynamic Source Routing, etc.

Ishita Bhakta et al.(2010) [5] have studied Wireless mesh networks (WMNs) that consists of mesh clients that can be either stationary or mobile, static mesh routers through which the clients communicate with each other and with the other networks or Internet. Wireless meshNetworks have made their presencefelt with a promise of supporting variegated traffic ranging from real-time to best effort while providing coverage to large metropolitan areas.Multi-hop communication, the static nature of mesh nodes, the convenience of sufficient bandwidth resources,the existence of inherently error prone wireless channel and the need to transport multimedia traffic with different QoS budgets demands the design of QoS-aware routing metrics to improve the performance of routing algorithms. The detailed study of the motivations for new and quality-aware routing metrics has been done and provides with a detailed comparative analysis of some routing metrics that attempt to address these goals.

S.Kannan et al.(2010) [6] have studied and compared the performance of various mobile ad-hoc network routing protocols like AODV, DSI and DSDV. Meeting the challenges of the changing topology, the routing protocol aims at providing a correct and efficient communication path between any two existing nodes of the network hence minimising bandwidth consumption and routing overhead.

S.Karthik et al.(2010) [7] have discussed mobile ad-hoc network as a network that does not require any infrastructure or central administration, hence they are suitable only for providing temporary communication links. The main problem area in computer network is to design the network in such a way that it can efficiently cope up with the speed issue that is mainly required today. In a network the data packets have to be routed to the destination with minimum loss and delay and maximum packet delivery ratio, so there must exist an efficient robust and adaptive routing algorithm that satisfies all the quality of service requirements. Inspired by the behaviour of biological ants, Multi Agent Ant Based Routing Algorithm is designed from the ACO framework that consists of both proactive and reactive components. This technique increases packet delivery ratio, node connectivity and decreases average end to end delay. As node connectivity increases, the packet loss is reduced.

Ronghui Hou eta al.(2009) [8] has described hop-by-hop bandwidth guaranteed routing protocol in IEEE 802.11-based wireless mesh networks. Bandwidth is neither concave nor additive in wireless networks due to the interference among links. Bandwidth needs to be isotonic, the necessary and sufficient property for consistent hop-by-hop routing which is unfortunately not available. So to solve the problem an isotonic parameter is introduced that captures the available bandwidth metric so that packets can traverse the maximum and width path consistently according to the routing tables constructed in the nodes along the path.

Chi Harold Liu et al.(2009) [9] have studied Cross-layer design for quality of service (QoS) in wireless mesh networks that are expected to support various types of applications with different and multiple QoS and grade-of-service (GoS) requirements. In order to achieve the same various technologies have been exploited and algorithm needs to be designed. Since most of the existing works on cross-layer design focus on the interaction of up to two layersWhile the GoS concept is overlooked in wireless mesh networks, so a unified framework is proposed that exploits both the physical channel properties and multi-user diversity gain of WMNs and by performing intelligent route selection and connection admission control provides both QoS and GoS to a variety of applications.

Chi Harold Liu et al.(2008) [10] have discussed Wireless Mesh Networks that support various types of applications with different quality of service requirements. The inefficiency of the layered approaches that overlook the interaction between the routing algorithms and medium access control (MAC) has led to the design of cross-layered approaches. So a distributed, multi-constrain, cross-layer QoS routing algorithm is proposed that can simultaneous satisfy multiple QoS requirements. Thus efficiently proving various QoS requirements and achieving higher network throughput.

Anand Prabhu Subramaniam et al. (2008) [11] have studied multi-hop WMNs where each node is equipped with multiple radio interfaces and multiple channels available for communication. So there exists the problem of assigning channels to the communication links in the network. The number of radios on any node can be less than the number of available channels, obeying the constraint that the number of different channels assigned to the link is almost the number of radio interfaces of the node. So for the channel assignment, centralised and distributed algorithms are designed.

Wai-Hong Tam et al.(2007) [12] have studied the wireless mesh network that have throughput increase as an open and challenging research issue. The optimal solution being is to enable transceivers to efficiently utilize multiple channels dynamically. As the existing work does not consider the routing issue, so from the aspect of end-to end throughput the benefits of multipath routing in multi-channel WMNs are exploited proposing Joint Multi-channel and Multi-path control (JMM) protocol that combines multi-channel link layer with multi-path routing.

Parag S. Mogre et al.(2007) [13] have studied the wireless mesh networks, the various challenges that exists to provide QoS. So while developing any algorithm for supporting Qos, care needs to be taken that it is in accordance to the standards and has appropriate mechanism for the development of WMNs. So the study challenges highlight pitfalls and give pointers to realize QoS in WMNs.

Vinod Kone et al.(2007) [14] have studied WMNs that can provide seamless broadband connectivity to the network users with low maintenance and setup cost. To support the real time requirements the WMNs must have improved quality of service guarantees. So a routing protocol QUORUM is proposed that provides accurate QoS properties by predicting correctly the delay and loss characteristics of data traffic. It integrates a novel end-to-end packet delay estimation mechanism with stability aware routing policies that allows to more accurately follow Qos requirements by minimising misbehaviour of selfish nodes.

Krishna N. Ramachandran et al.(2006) [15] have studied the capacity problem in WMNs, that can be reduced by equipping the mesh routers with multiple radios tuned to non-overlapping channels. The channel assignment presents a challenge as co-located wireless networks are likely to be tuned to the same channels. The performance is adversely affected by the increase in interference. So an interference-aware channel assignment algorithm and protocol is presented for multi-radio WMNs that address the interference problem. It assigns channels to the radios to minimise interference within the mesh network and between the mesh network and co-located wireless networks. It uses a novel interference estimation technique implemented at each mesh router.

Jian tang et al.(2005) [16] have studied the throughput in WMNs that can be improved by multi-channel communications as compared to single-channel communications. The influence of the interference can be reduced by the use of multiple channels. The interference aware topology control and QoS routing in multi-channel wireless mesh networks with dynamic traffic has been studied. In such networks, channel assignment and routing are the two basic issues to be dealt with. Different channel assignment can lead to different network topologies. So a novel definition of the co-channel interference is present-ed.

GAPS IN EXISTING LITERATURE

The survey has shown that the most of QoS aware routing protocols has certain limitations. Following are the main limitations in earlier work:

1. Congestion Control: In case the congestion is the biggest issue that deteriorates the quality of service. The packet delay, loss and blocking of new connections are the typical effects.
2. Secure Transmission: The data send over the network needs to be confidential, so a secure channel or a confidential channel is required for data transmission.
3. Collision Avoidance: To avoid resource contention such that to avoid simultaneous attempts to access the same resource.
4. Flooding: There is graceful performance degradation during overload. So for better throughput and better performance the system needs to be modified to work in the hazardous conditions like overflow.

CONCLUSION AND FUTURE WORK

This paper has reviewed QoS issue of WMNs. WMNs have emerged as a flexible, reliable and cost effective way of providing broadband internet access over wide areas through multi hop communication. This paper has reviewed different routing protocols used in the WMNs. The review has shown that the existing work has neglected many issues. No technique is effective of every kind of circumstances. Congestion, secure transmission, collision avoidance and flooding have been found a critical issue to gain QoS.

In near future we will modify the existing routing techniques using cluster based data aggregation to enhance the QoS of WMNs further.

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