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ROUTING AND SCHEDULING IN WIRELESS MESH NETWORK

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ABSTRACT

Wireless networks over the year have undergone huge technological advancements. Due to integration of all three types of services viz. voice, data, video, during improvement in wireless technologies, bandwidth has become the most crucial network resource that needs to be optimized for these bandwidth hungry services. In multihop scenarios (in WMNs), performance depends on the routing protocol to properly choose routes, given the current network conditions. To efficiently optimize these wireless networks, efficient routing and scheduling techniques needs to be incorporated to improve Quality of Service (QoS). Routing and scheduling techniques have been analyzed. Different techniques in various technologies are discussed to improve network performance.

KEYWORDS: QOS, Scheduling Algorthim, Wireless mesh network.

INTRODUCTION

For wireless networking of next generation Wirless Mesh Networks (WWNs) proves to be a primal technology. Speedy advancements in WMNs is seen and also it inspires legion applications as WMNs have more advantages than many other networks either wired or wireless. WMNs are self-configured and self-organized in a dynamic manner, automatically establishing an adhoc network with the nodes in the network and also maintains connectivity in the mesh. Mesh routers and mesh clients are the type of nodes which comprises WMNs [1]. Because of multi-hop communications, a mesh router achieves more of the coverage with transmission power which is much lower. Multiple / many wireless interfaces which are made using the different access technologies or the same, is provided to a mesh router in order to improve the tractability of networking in mesh. Because of the minimal mobility, mesh routers constitute mesh backbone which is needed by the mesh clients. Though the mesh clients for mesh networking can also act as a router, simple and easy platform either software or hardware is needed for mesh clients than that for mesh routers. The advantages offered by WMNs are easy network maintenance, low up-front cost, reliable service coverage, robustness, etc. Mesh router's function of behaving as bridge / gateway results in desegregation of WMNs with many other type of networks. Mesh routers are also responsible for networking in a mesh amidst mesh clients and mesh routers [1]. Wireless Network Interface Cards (NICs) are used by the established nodes to get connected to MWNs in a direct manner though wireless mesh routers.

WMNs have undergone and are also undergoing rapid commercialization in many other application scenarios such as community networking, metropolitan high speed area networks, building automation, enterprise networking and broadband home networking. However, significant efforts in research are still required, for WMNs to be all it can be. For example, scalability is the issue in the present routing and MAC protocols; increase in number of nodes or hops in WMNs results in lowering of throughout [1]. Thus, the protocols which are presently available necessitate to be reinvented or enhanced in case of WMNs. In order to improve networking in WMNs, protocols' design of present wireless networks are being revisited by the researchers and same is the case with wireless sensor, ad-hoc and especially of IEEE 802.11 networks. WMNs's new specifications are currently under discussion by IEEE 802.15, IEEE 802.11, IEEE 802.16 which are the industrial standard groups.

Problem Statement

Statement is perceived to optimally schedule the data packets in order to enhance the requirement of WMNs. This can be done by differentiation of queueing of packets in the using granular QoS (end-to-end). A differentiated Queueing algorithm will be ensure optimal scheduling. The scope of our work will be as follows:

a) Study of design factors and architecture of WMNs.
b) Study of all the communication protocol;s.
c) Study of need for scheduling in WMNs.
d) Study of need for routing in WMNs.
e) Study of recent work in WMNs.
f) Formulation of differentiated queueing service algorithm, its implementation and comparison with earliest deadline first algorithm.

Organization of Thesis

There are five sections in the entire thesis. In the first section network architecture and critical design factors of WMNs are discussed. The second section comprises of layered communication protocols. The third section deals with the literature review or the recent work done in WMNs. The fourth section explains the Differentiated Queueing Service (DQS) scheduling algorithm. In the fifth section which is the final section analysis of the results in done as well as discussed.

WIRELESS MESH NETWORK ARCHITECTIURE

WMNs consists of two types of nodes: mesh routers and mesh clients. Other than the routing capability for gateway / repeater functions as in a conventional wireless router, a wireless mesh router contains additional routing functions to support mesh networking. To further improve the flexibility of mesh networking, a mesh router is usually equipped with multiple wireless interfaces built on either the same or different wireless access technologies. Compared with a conventional wireless router, a wireless mesh router can achieve the same coverage with much lower transmission power through multi-hop achieve the same coverage with much lower transmission power through multi-hop communications. Optionally, the medium access control (MAC) protocol in a mesh router is enhanced with better scalability in a multi-hop mesh environment.

The architecture of WMNs can be classified into three main groups based on the functionality of the nodes.

Infrastructure / Backbone WMNs

The architecture is shown in Fig. 2, where dash and solid lines indicate wireless and wired links, respectively. This type of WMNs includes mesh routers forming an infrastructure for clients that connect to them. The WMN infrastructure / backbone can be built using various types of radio technologies, in addition to the mostly used IEEE 802.11 technologies. The mesh routers form a mesh of self-configuring, self-healing links among themselves. With gateway functionality, mesh routers can be connected to the Internet. This approach, also referred to as infrastructure meshing, provides backbone for conventional clients and enables integration of WMNs with existing wireless networks through gateway/bridge functionalities in mesh routers. Conventional clients with Ethernet interface can be connected to mesh routers via Ethernet links. For conventional clients with the same radio technologies as mesh routers, they can directly communicate with mesh routers. If different radio technologies are used, clients must communicate with the base stations that have Ethernet connections to mesh routers. Infrastructure / Backbone WMNs are the most commonly used type. For example, community and neighborhood networks can be built using infrastructure meshing. The mesh routers are placed on the roof of houses in a neighborhood, which serve as access points for users inside the homes and along the roads. Typically, two types of radios are used in the routers, i.e., for backbone communication and for user communication, respectively. The mesh backbone communication can be established using long – range communication techniques including directional antennas.

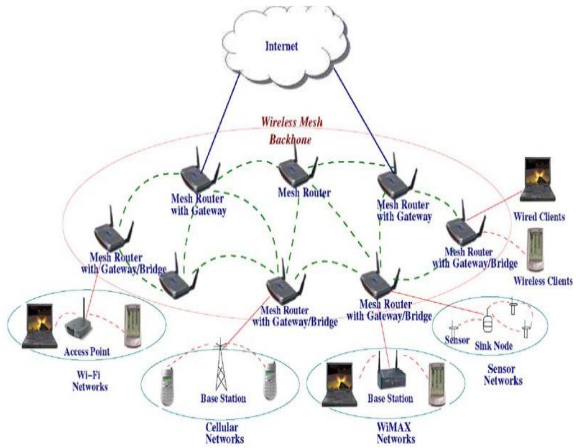

Fig.2.1.1: Infrastructure / Backbone WMNs

Clients WMNs

Client meshing provides peer-to-peer networks among client devices. In this type of architecture, client nodes constitute the actual network to perform routing and configuration functionalities as well as providing end user applications to customers. Hence, a mesh router is not required for these types of networks. The basic architecture is shown in Fig. 2.1.2. In Client WMNs, a packet destined to a node in the network hops through multiple nodes to reach the destination. Client WMNs are usually formed using one type of radios on devices. Moreover, the requirements on end-user devices is increased when compared to infrastructure meshing, since, in client WMns in Client WMNs, the end-users must perform additional functions such as routing and self-configuration.

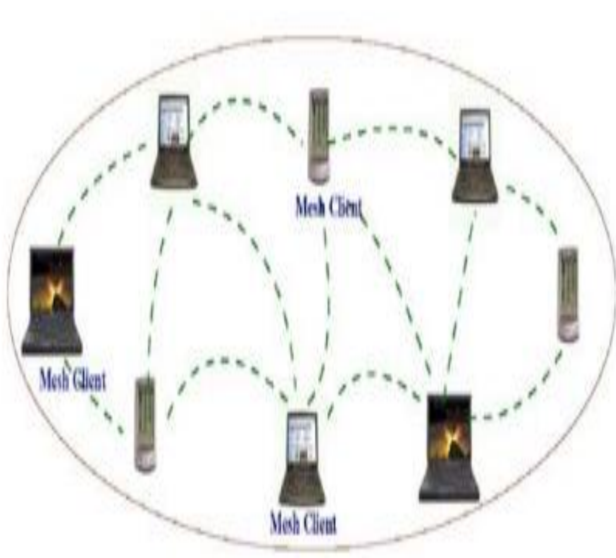

Fig. 2.1.2: Client WMNs

Hybrid WMNs

This architecture is the combination of infrastructure and client meshing as shown in Fig. 2.1.3. Mesh clients can access the network through mesh routers as well as directly meshing with other mesh clients. While the infrastructure provides connectivity to other networks such as the Internet, Wi-Fi, WiMAX, cellular, and sensor networks; the routing capabilities of clients provide improved connectivity and coverage inside the WMN. The hybrid architecture will be the most applicable case in our opinion.

Fig. 2.1.3: Hybrid WMNs

RECENT WORK IN WMNs

The significant and recent work done in the field of wireless mesh networks is discussed below:

Load Balancing Algorithm for WMN

The Cluster Header Load Balancing (CHLB) algorithm has been proposed to ensure the QoS for different streams of data through the design of cross-layer to achieve the balance in load without fetching extra heavy load [2].

In this CHLB algorithm data flows are classified into different priorities and channel for data streams is selected [2]. For channel selection a function is used for weight evaluation given all the information of QoS in the intermediate nodes next to a node, of the all allowable channels, as each of the data stream has its own requirements for QoS such as delay, (BER). Bit Error Rate, delayetc. The actual flows' current value and the largest allowable links flow value are used to calculate the coefficient for load balance which in turn helps in the Periodical Load Balancing Lesser point-to-pint delay (average) and high throughput are the advantages provided by this algorithm. This has been shown by the simulation results that the proposed algorithm can give effective results of the load-balancing and has remarkably improved the performance of the WMNs.

Routing Algorithm for Inter-Cluster Load Balancing (RAILoB)

In order to improve the performance of traffic RAILoB has been set out in WMNs. This algorithm provides migration of traffic without the requirement of migration of the mesh route [3]. The scheme of clustering comprises additional two elements which are the boundary and the relay node other than the mesh router and the gateway. For the clusters which are heavily loaded the out points are the relay nodes, while for the clusters which are lightly loaded the connection points are the boundary nodes [3].

In the RAILoB algorithm for the migration of traffic two sub-paths comprises the full path. In the two sub-paths the relay node and the selected node has a path between them called as intra-path whereas the lighter gateway and the relay node has a path between them called as the inter-path found by using Dijkstra algorithm [3].As the relay and boundary nodes are in transmission range of each other, information exchange with the adjacent clusters mesh routes is allowed by the boundary and the relay and boundary nodes. So accordingly the boundary node and the relay node carries the traffic of the node which is loaded heavily in a cluster and send this traffic in a clusters' gateway which is lightly loaded as shown in figure 4.1.2.

Analysis of the RAILoB performance has been done varying gateway number and the results proved the improvement in performance of traffic in WMNs with multiple gateways when RAILoB mechanism is used for balancing the load.

Architecture and Algorithm for an IEEE 802.11 Based Multi-Channel Wireless Mesh Network

Using just a single/one channel networks which are multi hop use only a single, these type of networks does not often fully used the total available bandwidth in the radio range/spectrum. For the improvement of performance of a network usage of mesh networks which are multi radio as well as multi-channel has been suggested as a solution. An architechture(named Hyacinth) of wirelss mesh network (WMN) which is a multi- channel (5) equips each node of mesh network with several 802.11 Network Interface Cards(NICs).

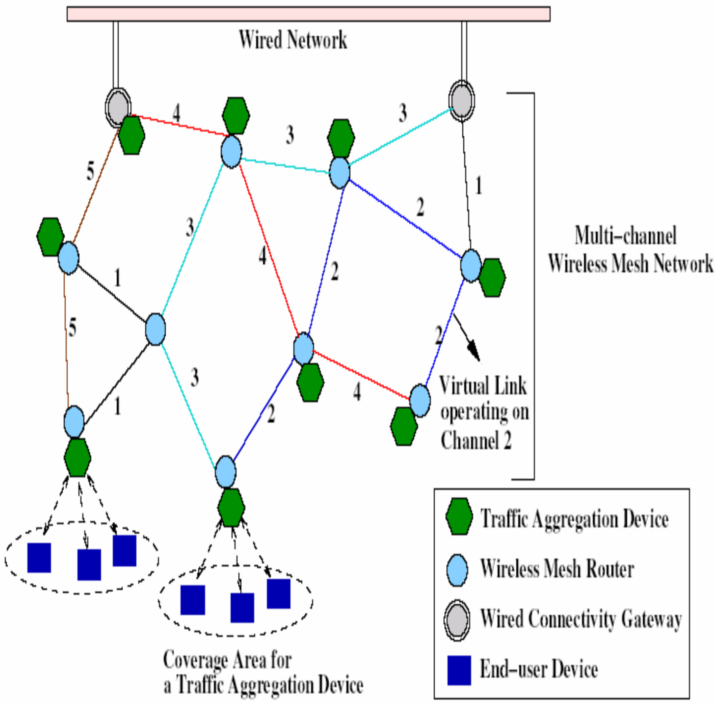

Figure4.1.3 The Hyacinth Architecture

In this architecture core of multi-channel WMN is joined to a wired network with the help of connectivity of wired gateways set. Each node of a WMN has several interfaces where each interface operate at a different radio channel (5). Each node of A WMN is furnished with a device for aggregation of traffic (similar to an 802.11 access point) for its interaction with the each mobile station. The WMN which is multi channel relays aggregated data from traffic aggregated device of mobile station from/to the network which is a wired network. Over the channel for the denotation of direct communication there are links among nodes which is indicated on the link by the numbers on it. In the above example, two wireless NICs are equipped into each node. As a result no node can used the number of channels more the two simultaneously. As depicted in Fig4.1.3 the network on the whole five different channels.

Assignment of a channel in the architecture of a multi-channel WMN is the central design issued. In case of a multichannel WMN the goal of assignment of channel is in a way that radio channel is bounded to each and every network interface such that for each link which is virtual the bandwidth which is available is proportional to the traffic/ load it required to carry. The important constraints that needs to b satisfied by an algorithm of channel assignment are

a) The number of NICs in a WMN node binds the total number of distinct channels which can be allotted.
b) Two nodes that require to communicate directly with each other it is must to have at least one of the channel to be common.
c) A radio channel’s raw capacity is limited within a zone of interference.
d) The number of radio channels which are non-overlapped is fixed.

So a proposition of distributed algorithm is made in which only load information of the local traffic to assign channels dynamically is utilized and also it has proved its better performance than centralized algorithm. With the mesh network having multi- channel there is a possibility that network throughout gets improved by a factor of 6 to 7 as compared to that of conventional mesh network having single channel.

In the above explained algorithm there is no prioritization of the service requests and also there is no scheduling involved using state information of dynamic link so that network resources get optimally utilized in WMNs.

SIMULATION AND RESULT ANALYSIS

Ns-2 is a discrete event simulator targeted at networking research. Ns provides substantial support for simulation of TCP, routing, and multicast protocols over wired and wireless (local and satellite) networks Ns-2 an object oriented simulator, written in C++, with an OTol interpreter as a front-end. The simulator supports a class hierarchy in C++ (also called the compiled hierarchy), and a similar class hierarchy within the OTcl interpreter (also called the interpreted hierarchy). Here NS-2 [8] has been used as the platform for simulation. Model for simulation which is adopted here for WMNs is originated by the CMU Monarch project which was for ad hoc networks.

The performance analysis was carried out using network simulator NS-2.34 version in a topology area of 500 x 500 m, with simulation time of 600 seconds.

Table 1: Simulation Parameters

Simulator	NS-2.34
Area	500 x 500 m
No. of nodes	50
Simulation time	600 Sec.
Radio propagation model	Two – ray ground
Traffic type	CBR
Antennae type	Omni Antenna
MAC protocol	IEEE 802.11
Ad – hoc routing protocol	AODV for EDF, DSR with DBF for DQS
Transmission power	0.6 W
Receiving power	0.3 W
Channel type	Wireless channel
No. ofchannels	4
Buffer size	200
Loss factor	1.0

Comparison with EDF is done because of previously discussed similarities among DQS and EDF.
Performance metrics used here for evaluation of the two algorithms are following:

(1) Average throughput
(2) Packet delivery Ratio
(3) Average delay.

CONCULSION

Future Wireless Networks (FWNs) are anticipated as a convergence of various kinds of technologies which are wireless, for example cellular technologies, Wireless Metropolitan Area Networks (WMANs), Wireless Local Area Networks (WLANs), Wireless Sensor Networks (WSNs), and conventional wired networks. Though the users will be unknown to the particular underlying network which is being utilized by the users' applications, the networks must be capable of providing the resource (hand/width) with assured Quality of Service (QoS). The users must be capable of moving smoothly among different technologies of networking, e.g., among WiMAX, Ethernet, 2G/3G/4G and WLANs, with rigorous requirements of QoS. As the hand width has become a critical network resource that needs to be optimized because of hand width hungry services that integrates voice, video and data, several techniques need to be developed.

So there is a requirement of efficient routing and scheduling techniques to utilize resources optimally. These efficient routing and scheduling techniques tend to reduce delay, packet loss and promote the efficient usage of bandwidth available. Thus efficient routing and scheduling techniques will provide an important solution to the future wireless networks.

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