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An Adaptive Channel Based Grid Topology with Minimum Interference in WMN's

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Abstract

The wireless mesh network is basically a communication network made up of radio nodes organized in a mesh topology. These were working on two modes i.e. Infrastructure mode and AdHoc Mode. These modes were configured on IEEE 802.11 Standards. In this WMN, number of clients are connected to the access points (AP's) for dispenses the information. Each node has at least two interfaces that participated in the mesh environment. Every node sends a signal on to the other node using multiple radios on non-overlapping channel that helps to reduce the interference. The implementation of the mobility model relies on the standard parameters from the related research disciplines, such as transport planning. The resulting network will rely on a NAM (Network Animator) area. In this paper beholding the affect of channel interference on 802.11 standards is focusing on the two standards namely 802.11a and 802.11n standards. The Proposed Algorithm interacts with 802.11a and 802.11n standards which are opted by Access points and Clients. This Algorithm is dynamically assigning the channels so as to minimize the sum of interference. The advantage of channel assignment is causing minimum of delay. The channel assignment is necessary for routing the packets from source to destination node. This solves the problem of congestion and noise because sometimes link becomes longer. The assignment of channel can be categorized by static and dynamic approach. The static approach permanently assigns the channels to the two stations whereas dynamic channel assignment is the enhancement of network connectivity and ability to change the traffic due to channel switching approach. The dynamically channels are allocated to mesh routers on the basis of current traffic profile and these can switch from one path to another path using channel switching method. The Frequency switching has been implemented in this paper by using channel separation approach which helps to reduce the overlapping of channels in the network and on to the proposed Algorithm. The traffic sent by the clients is HTTP, FTP and CBR. The traffic was sent by different clients and on the basis of traffic we simulated the experimental test bed and which increased the throughput with minimum of delay on the wireless networks.

Keywords

802.11, Channel Assignment, Channel Selection, AP's, NAM, FTP, HTTP, CBR.

Introduction

Wireless mesh networks

Mesh networks is a virtual network which makes connection virtually or wirelessly in network and that connection is made with network nodes or hops. This technology is rapidly increasing in both home and business networking. It continues to improve reliability and decrease the production cost of networks as compared to the wired networks. The wireless mesh [16] networking has emerged as a promising technology for future broadband wireless access. When applying mesh networking techniques over shared wireless medium with limited radio spectrum, many new challenges are raised such as fading mitigation, effective and efficient medium access control (MAC), quality of service (QoS) routing [21], call admission control, etc. Wireless mesh networks (WMNs) consist of wireless laptops, PDAs etc. as shown in Figure 1.

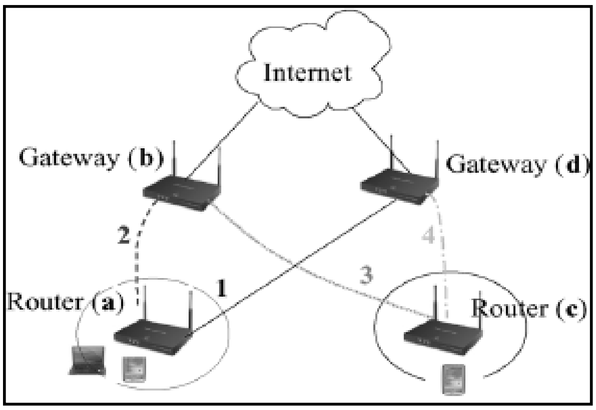

Fig. 1: Wireless Mesh Networks[22]

Multihop wireless mesh networks helps to enhance reliability, coverage, and reduced equipment costs [22] over their single-hop. Efficient channel assignment and routing is essential for the optimization of throughput of mesh clients. A mesh client network can be formed in an ad hoc manner and connected to one or more mesh routers. The mesh routers in fixed sites comprise a wireless mesh backbone to provide relay service to the mesh client networks and other access networks such as cellular networks The traffic volume in the wireless mesh backbone in a large-scale WMN can be very large and can vary from one mesh router to another, thus posing significant challenges on the MAC design.The self-organization nature of WMNs, it is desired to apply distributed MAC to achieve efficient resource utilization [9].

Related Work

Many researchers and authors have been working on the MAC (Medium Access Layer) to increase the performance of Wireless Networks. The MAC protocol enables the data service for transmission and receiving the payload across the physical data service. Earlier published research on WMN deployment design has concentrated into methods to use of multiple radios and advanced antennas, advanced routing, optimization algorithms, evaluating WMN capacity, and develops MAC modifications. Generic approaches to handle multiple optimization criteria in WMN deployment design do not exist and the following related proposals deal with a limited part of the field. Modifying the MAC protocol is one method to increase WMN performance but it does not remove the need for WMN deployment design.

In [5], the authors show that using a single radio, there exists only minor interference with channel separation of four channels.

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When the number of radios is increased, also larger channel separation is required. The advantage of source routing is that intermediate nodes [4] do not need to maintain up-to-date routing information in order to route the packets they forward, since the packets themselves already contain all the routing decisions. The number of network layer protocols [5] defined this paper to enhance the performance of the network. The different data rates being applied by the authors to compared the optimization of the Ad Hoc networks. The x-axis and y-axis are the positions of the nodes scattered on the topography area steeped the improvement of MAC layer. The 802.11s [6] wireless Mesh standard and implements a single broadcast domain and thus integrates seamlessly with other 802 networks. In particular, 802.11s supports transparent delivery of unicast, multicast, and broadcast frames to destinations. The optional 802.11s congestion control concept uses a management frame to indicate the expected duration of congestion and to request a neighbor mesh station to slow down. The Authors [7] is assumed that each message packet contains the location of both the source and the destination. As the messages propagate through the network, every intermediate node could easily compute. This Paper [8], presented an autonomous network reconfiguration system (ARS) that enables a multiradio WMN to autonomously recover from local link failures to preserve network performance. The ARS (autonomously reconfigure system) its local network settings channel, radio, and route assignment for real-time recovery from link failures. The accurate link quality information from the monitoring protocol is used to identify network changes that satisfy applications' new QOS demands or that avoid propagation of QoS failures to neighboring links. The deployed 802.11 standard into WMN Networks [3] has worked on two algorithms channel assignment and uses minimizing the number of mesh Access Points. The WMN channel assignment algorithm is genetic algorithm designed for static channel assignment. The target is to optimize existing network by selecting radio channels optimally. It is assumed that locations of APs have been designed by the network administrator to cover required areas. Each AP contains one or more wireless interfaces that may operate on allowed WLAN channels. The second Algorithm checks the necessity of each mesh point based on the WMN fitness. The algorithm operation is very simple. First, the fitness calculation is configured according to user preferences and the algorithm calculates the initial fitness of the network. Then, the algorithm checks each mesh point in random order by calculating the WMN fitness with and without the particular mesh point. If fitness is higher without the mesh point, it is disabled. Otherwise the mesh point is left to the network. The proposed solution [24] discussed the communication, types of service flows, and makes bandwidth allocation technique that was dynamic and fair, and utilizes the resources in an efficient way. In [25] wireless node may not be able to communicate with all of its neighbors via a single radio. The single radio listen on different channels when apply on tree based topology. The Algorithm has distributing load across channels by minimizing the co-channel interference between multicast trees. As a result, more than one transmission may be needed for a wireless node to forward a single multicast packet to multicast neighbors. This paper also alleviates the interference between multicast sessions by carefully constructing multicast trees.

Proposed Algorithm

In previous research, the author [8] explored to take re-routing constrains in to consideration to improve the network lifetime and provide efficient routing protocols. The autonomous reconfiguration system namely ARS that automatically configured the settings of the mesh nodes and considering link failure failures. The ARS does not use the concept of transmission range and interference range.Nodes discover a passive network topology, over which they then perform shortest-path routing to populate the routing table. It did not worked on the channel assignment due to which interference was maximized and in turn throughput decreased and delay increased. Our modification changes is to minimize the interference and to assign channels to wireless Access points and nodes with minimum network interference [23]. As in the previous algorithm discussed by the authors [8], it was hard to determine the optimistic path when there was multi-hop communication. The algorithm intelligently selects channels for the mesh radios in order to minimize interference within the mesh network and between the mesh network and co-located wireless networks. Each mesh router utilizes a novel interference estimation technique to measure the level of interference in its neighborhood because of colocated wireless networks.Whenever every node receives the broadcast message, it adds its own channel information and re-broadcasts the updated message to its neighbors. the radio propagation model is the key factor to determine which nodes can communicate. It influences frame collisions and errors in a simulation. The radio propagation models used in our approach and assumed an obstacle-free area or a free line-of-sight or both for communicating network access points. As a consequence, the communication range is modeled by a circle around a mobile nodes in network simulator.

Important notations

l: is the link in between communicating nodes

CN: Channel Number

k: Number of orthogonal channels

C: Channel

Y: Interference

(1) Monitoring period $t_{m\ and}$ Channel Assignment C

1: **for every** link j **do**

2: measure link-quality **(l_q)** using passive monitoring;

3: **end for**

4: send monitoring results to an Access Points $\mathbf{A_p}$ and Clients $\mathbf{C_l}$;

5: for Channel Assignment

$C_{i,j}^{k}$ {

1: (i,j) nodes uses channel k

0: not used or supposed to assigned when it becomes 1 }

(2) Failure detection and group formation period t_f

6: **if** link l violates link requirements γ **then**

7: request a group formation on channel c of link l;

8: **end if**

9: participate in a Access Point $\mathbf{A_p}$ if a request is received from the Client $\mathbf{C_l}$;

(3) Planning period (M,t_p)

10: **if** node i is elected as a Access Point $\mathbf{A_p}$ **then**

11: send a planning request message (c ,M) to a Access Point $\mathbf{A_p}$;

12: **else if** node i is a Access Point $\mathbf{A_p}$ **then**

13: synchronize requests from reconfiguration groups M_n

14: generate a reconfiguration plan (p) for M_i;

15: send a reconfiguration plan p to a leader of M_i;

16: **end if**

(4) Reconfiguration period (p , t_r)

17: **if** p includes changes of node i **then**

18: apply the changes to links at t;

19: **end if**

20: relay p to neighboring members, if any

(5) Channel Assignment and Interference (C, X)

21: **if** X is the interference of number of orthogonal channels k then

X_i^k = { if ŕ is the radios of channel k then

1: Interference and 0: no Interference

}

Add from (1),

$C_{i,j}^k \leq X_i^k \in Y$ (Y represents interference on same channel)

$$\sum_{k \in K} C_{i,j}^k = 1$$

$C_{i,j}^k + Cx_{,y}^k - 1 \in Y_{i,j \in x,y}$

Y= min $\sum_{k \in K} C_{i,j}^k + \sum_{k \in K} C_{x,y}^k k$

(6) Channel Separation (SC)

22: SC <i,j> channel separation between i and j

23: CN: Channel Number

24: Y: Interference

25: **if** all nodes have not assigned channels

26: Find Ci ϵI, Cj ϵ J such that

SC <i,j> ϵ min Y

27: **if** the channels are assigned

Ci=I and Cj=J

and eliminate all unused channel number (Ci and Cj) ϵ min Y

28: **end if**

29: **end if**

30: **End**

Experimental Setup

The Network topology defined in this scenario shown in figure 2 explained the access point's, positions their frequencies and coverage areas. This multi radio multi channel scenario deployed on the 1000 m x 1000 m square area with connecting wireless link and composed by different clients in a coverage range of 20 meters. We observed significant interference between the nodes and access points in the same network environment when the antennas are placed close to each other, or they operate in orthogonal channels. The Access points will be used in IEEE 802.11a standard with frequency of 5.8 GHz and the clients will be able to communicate at 2.4 GHz with IEEE 802.11n standard. The clients are able to access the access points (APs) via radio propagation model i.e. two ray ground model. The data traffic for clients is a UDP stream with a packet size of 1024 bytes and round trip time is set to 2ms. The transmission rate is set to 11 Mbps.

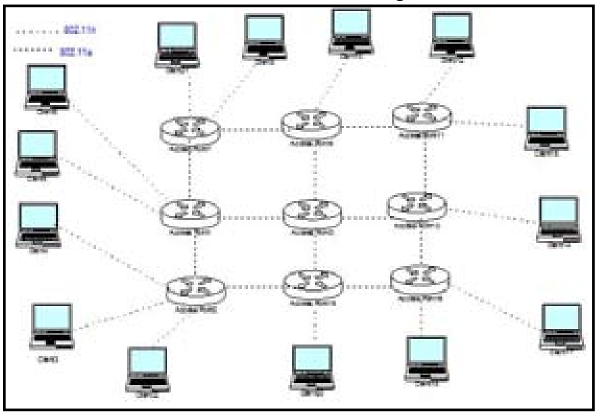

Fig.2: Experimental Setup with Mesh clients and Mesh Access Points

The selected channels include 7, 8, 42, and 46 for covering the orthogonal and adjacent channel cases. Each access point (AP) is tuned on a specific radio resource and each user can choose the AP to connect to. Each user can select one AP among all the ones whose coverage area includes the user's position (i.e. x, y and z positions). Two users selecting different access points (APs) that operate on the same frequency will interfere if they are in the range of both access points (APs) or are in the same range.

Initially the connection is setup in between the Client 6 to Client 10 with CBR traffic. There three access points have been used i.e. 1, 7 and 9. The channels selected from these access points are channel number 7 and 8 for transmission of data. The next connection is setup in between client 3 to client 14 with a traffic type HTTP; the hops 2, 19 and 13 have been transmitting from source to destination clients using orthogonal channels 42&46. The traffic type FTP has been configured between 20 and 12 clients with a transmitting rate 11 Mbps and 54 Mbps by using 19, 13&11 hops. The channels selected in between these access points (19, 13 and 11) are channel number 7 and 8. The channels share the frequency band so that sending and receiving clients transmitted/receiving the packets. The packets are placed on each channel and every node was responsible for maintaining the queue. Queues are served in order. A queue is inspected before an actual frequency switch; if the queue is empty the next queue in turn will be inspected.

Performance Results

In this paper simulation experiments comparing performance metrics of Previous Algorithm [16]. All simulations were run using the NS-2 simulator [9]. Numerous simulations have been chosen to illustrate the performance advantage gain in proposed algorithm through Wireless Mesh Networks (WMNs). The simulator parameters were varied in three dimensions:

(1) Throughput of WMN
(2) End-to-end Delay
(3) Jitter

Keeping in view results have been evaluated from the studied experimental setup and implemented with ns2 simulator [9]. The monitor module handles the selection of the channel and in the current transmission slot contends the next transmission time using the channel selection approach. The routing table containing information like hop count, destination node, source node advertised by AODV protocol [13]. The xgraph utilities of NS2 simulator obtain the number of results and are discussed in given below sections.

Throughput of WMN

The Throughput is the main performance evaluation metric adopted in the proposed research. Throughput measures the effective payload rate of successful transmission over the networks and counted in mega bit per second (Mbps) after 10s, the line goes upward direction and total bandwidth achieved from mesh a nodes is 73 Mbps. The average Throughput received from the network is 40 Mbps.

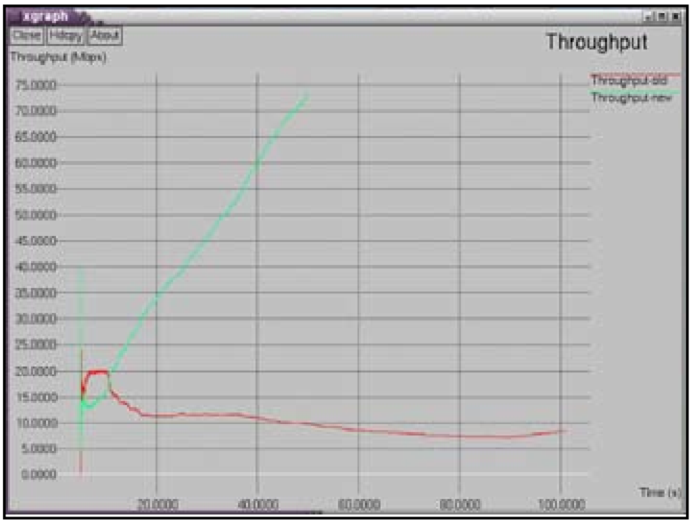

Fig. 3: Throughput of WMN

End-to-end Delay of WMN

The End-to-end Delay means the time taken to transmit the packet from source to destination machine. The minimum end-to-end delay achieved by proposed work is 1.0 millisecond as shown in fig.4. The delay can be reduced by transferring data packets successfully which improves the efficiency of the mesh networks.

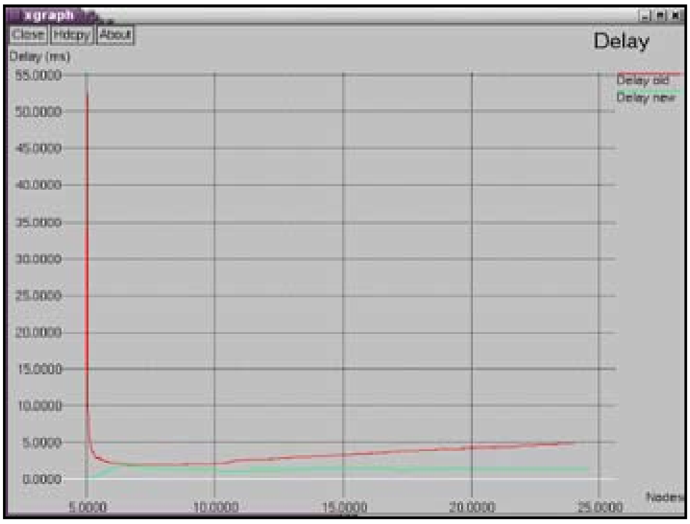

Fig. 4: End-to-end delay of WMN

Jitter of WMN

Jitter defines the variations in delay of packets from the sender to receiver side. It means the loss of packets at the receiver side. From the fig. 5 is analyzed that the jitter in the proposed work is minimum of 0.5 second as compared to previous work. The overall comparison of two algorithms is shown in the figure and it is observed that the proposed algorithm performs better than previous work.

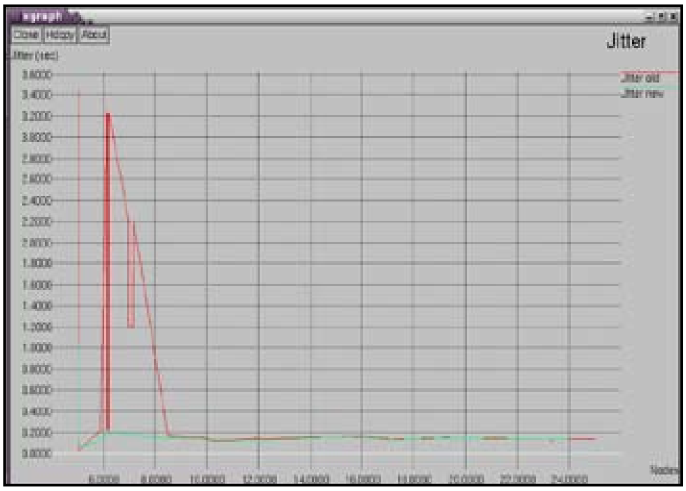

Fig. 5: WMN Jitter

Conclusion and Future scope

Conclusion

The dissertation work has concluded the results on cooperative communication, starting from the simplest form of cooperation, i.e. relay channels, and moving towards the more beneficial and fairer scheme of mutual cooperation. This work presented the framework in NS2 simulator for wireless Mesh type networks and compared with previous Algorithm. Present scenario will be improving the performance of WMN's and comparing to previous algorithm [8] with multiple channels which drastically improve the throughput in multi-radio wireless mesh networks.

Future Work

Test network can be formerly setup in the laboratory so the actual wireless Network hardware and software have arrived and the network analysis tool can be installed into the Networks system to analyze the results. The test scenarios generated in this dissertation report could be reproduced and actual traffic data obtained from the real test beds and then comparing with the proposed Approach. The simulation study will also be enhancing with new features such as the complete physical layer, i.e., transmission errors and unexpected delays, range efficiency and multi-path considerations.

References

[1] *V. Loscri, "MAC protocols over wireless mesh networks: problems and perspective",J. Parallel Distrib. Comput.,,2008,pp.387 – 397.*

[2] *Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications, IEEE802.11, Manual,IEEE computer society, 1999,pp.1-512.*

[3] *Timo Vanhatupa, Marko Hannikainen, Timo D. Hamalainen,"Performance model for IEEE 802.11s wireless meshnetwork deployment design",J. Parallel Distrib. Comput.,2008, pp.291 – 305.*

[4] *Parminder Singh, "Comparative study between unicast and Multicast Routing Protocols in different data rates using vanet",IEEE,2014,pp.278-284.*

[5] *Jim Geier,"Wireless Networks first-step", Cisco Press, 2004.*

[6] *Guido R. Hiertz,Dee Denteneer,Sebastian Max,Rakesh Taori,Javier Cardona,Et.Al.M"Ieee 802.11s: The Wlan Mesh Standard", IEEE Wireless Communications,2010,pp.104-*

111.

[7] Kranthi K. Mamidisetty, Minlan Duan, Shivakumar Sastry and P.S. Sastry,"Multipath Dissemination in Regular Mesh Topologies",IEEE TRANSACTIONS ON PARALLEL AND DISTRIBUTED SYSTEMS, VOL. 20, NO. 8, AUGUST 2009,pp.1188-1201.

[8] Kyu-Han Kim,and Kang G. Shin,"Self-Reconfigurable Wireless Mesh Networks",IEEE/ACM TRANSACTIONS ON NETWORKING, VOL. 19, NO. 2, APRIL 2011,pp.393-404.

[9] www.ns2.org .

[10] Van Jacobson,"Congestion Avoidance and Control",Technical paper,SIGCOMM,1988, pp.1-25.

[11] K. W. Lien et al.," Improving TCP Performance Over Wireless Networks",IEEE 2008,pp.424-428.

[12] Charles Perkins. Ad Hoc On Demand Distance Vector (AODV) routing. Internet-Draft, draft-ietf-manet-aodv-00.txt, November 1997. Work in progress.

[13] Hiroyasu obata, "TCP performance analysis on Asymmetric networks composed of satellite and terrestrial links",IEEE, 2000,pp.199-206.

[14] Parminder Singh, "Performance issues and comparative study between TCP over wireless link approaches", ICACCT,2012 , pp.66-69.

[15] Fernando Correia a, Teresa Vazao, "Simple ant routing algorithm strategies for a (Multipurpose) MANET model", Elsevier, 2010, pp.810-823.

[16] Purvang Dalal , Nikhil Kothari and K. S. Dasgupta, "Improving Tcp Performance Over Wireless Network With Frequent Disconnections",IJCNS,2011,pp.169-184.

[17] M.Murugesan,A. Krishnan, "Reliable and Efficient Algorithm for Broadcasting in Asymmetric Mobile Ad hoc Networks",IJCA,2010,pp.29-32.

[18] Guoqiang Wang, Damla Turgut, Ladislau B¨ ol ¨ oni, Yongchang Ji, Dan C. Marinescu,"A Simulation Study of a MAC Layer Protocol for Wireless Networks with Asymmetric Links", IWCMC-ACM,2006,pp.929-935.

[19] Wissam Al-Khatib and K. Gunavathi,"A Novel Mechanism to Improve Performance of TCP Protocol over Asymmetric Networks", International Arab journal of information technology,2008, pp.66-74.

[20] Amitangshu Pal, Asis Nasipuri,"A quality based routing protocol for wireless mesh networks", Elsevier,2010 ,pp.611-626.

[21] M. Alicherry, et.al, "Joint channel assignment and routing for throughput optimization in multi-radio wireless mesh networks", International Conference on Mobile Computing and Networking, 2005, pp. 1960–1971.

[22] Maninder kaur Mangat and Jatinder singh saini, , "Performance Enhancement of channel efficiency in wireless mesh networks",International Journal of advanced studies in Computer Science and Engineering IJASCSE, Volume 3, Issue 7, 2014.

[23] Amir Esmailpour, Nidal Nasser,"A Novel Scheme for Packet Scheduling and Bandwidth Allocation in WiMAX Networks",IEEE,2011.

[24] Tehuang Liu,Wanjiun Liao, "Multicast Routing in Multi-Radio Multi-Channel Wireless Mesh Networks",IEEE,2010,pp.3031-3039.