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Channel allocation using ARS and BFS-CA analysis in WMN

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Abstract— ***Wireless Mesh Networks (WMNs) consist of mesh routers and mesh purchasers for their life, multihop wireless mesh networks (WMNs) expertise frequent link failures caused by channel interference, dynamic obstacles, and/or applications' information measure demands. Dynamic channel allocation for effective autonomous network reconfiguration system (ARS), by analyzing ARS, it shows that by mistreatment ARS alone it wont give a comfortable result like network quality, leader distribution issues etc, thus so as improve the network performance we have a tendency to attending to implement a brand new conception Breadth 1st Search Channel Assignment (BFS-CA) algorithmic rule against with ARS in order that it\'ll multi radio configuration for mesh network and channel assignment issues. we have a tendency to demonstrate our solution's through the analysis of a epitome implementation in Associate in Nursing IEEE 802.11 in ns2. we have a tendency to additionally report on an intensive analysis via simulations. in an exceedingly sample multi-radio state of affairs, our resolution yields performance a lot of gains compared***.

Index Terms— ***IEEE 802.11, multiradio wireless mesh networks(mr-WMNs), E-ARS, BFS-CA networks, wireless link failures.***

I. INTRODUCTION

The channel assignment formula proposes for wireless mesh networks. Routers in such networks are stationary. Whereas user devices, like laptops and PDAs, will be mobile. Such devices go with routers. In ARS there's a frontrunner node that is chosen by cluster member thus whenever link failure happens that info is given to the leader node. Leader node forward that info to entree and every one the practicality (like routing designing, reconfiguration) performed at entree and challenge to leader node. Finally, all nodes within the cluster execute the corresponding configuration changes.

The most downside of dynamic channel assignment is that it results into modification in configuration, thus to avoid this resolution is that build obligatory one radio of mesh router to work on default channel. This default radio is of a similar physical layer technology IEEE 802.11a, 802.11b or 802.11g. A second downside is channel assignment may end up in disruption of flows once the mesh radios area unit reconfigured to completely different frequencies. to forestall flow disruption, direct flow over default channel. Channel Assignment (CA) in an exceedingly multi radio WMN atmosphere consists of distribution channels to the radio interfaces so as to attain efficient channel utilization and minimize interference

1.1 Literature survey for WSN

Capacity of Multi-Channel Wireless Networks: Impact of Number of Channels and Interfaces: This paper studies how the capacity of a static multi-channel network scales as the number of nodes, n, increases. Gupta and Kumar have determined the capacity of single-channel networks, and those bounds are applicable to multi-channel networks as well, provided each node in the network has a dedicated interface per channel.

Routing in Multi-Radio, Multi-Hop Wireless Mesh Networks

This paper present a new metric for routing in multi-radio, multihop wireless networks. We focus on wireless networks with stationary nodes, such as community wireless networks. The goal of the metric is to choose a high-throughput path between a source and a destination. Our metric assigns weights to individual links based on the Expected Transmission Time (ETT) of a packet over the link. The ETT is a function of the loss rate and the bandwidth of the link. The individual link weights are combined into a path metric called Weighted Cumulative ETT (WCETT) that explicitly accounts for the interference among links that use the same channel. The WCETT metric is incorporated into a routing protocol that we call Multi-Radio Link-Quality Source Routing.

A Survey on Wireless Mesh Networks:

Wireless mesh networks (WMNs) have emerged as a key technology for next-generation wireless networking. Because of their advantages over other wireless networks, WMNs are undergoing rapid progress and inspiring numerous applications. However, many technical issues still exist in this field. In order to provide a better understanding of the research challenges of WMNs, this article presents a detailed investigation of current state-of-the-art protocols and algorithms for WMNs. Open research issues in all protocol layers are also discussed, with an objective to spark new research interests in this field.

Distributed Quality-of-Service Routing in Ad Hoc Network

In this paper, propose a distributed QoS routing scheme that selects a network path with sufficient resources to satisfy a certain delay (or bandwidth) requirement in a dynamic multihop mobile environment. The proposed algorithms work with imprecise state information. Multiple paths are searched in parallel to find the most qualified one. Fault tolerance techniques are brought in for the maintenance of the routing paths when the nodes move, join, or leave the network. Our algorithms consider not only the QoS requirement, but also the cost optimality of the routing path to improve the overall network performance.

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Extensive simulations show that high call admission ratio and low-cost paths are achieved with modest routing overhead. The algorithms can tolerate a high degree of information imprecision**.**

Interference-Aware Channel Assignment inMulti-Radio Wireless Mesh Networks:

The capacity problem in wireless mesh networks can be alleviated by equipping the mesh routers with multiple radios tuned to non-overlapping channels. However, channel assignment presents a challenge because co-located wireless networks are likely to be tuned to the same channels. The resulting increase in interference can adversely affect performance. This paper presents an interference-aware channel assignment algorithm and protocol for multi-radio wireless mesh networks that address this interference problem. The proposed solution intelligently assigns channels to radios to minimize interference within the mesh network and between the mesh network and co-located wireless networks. It utilizes a novel interference estimation technique implemented at each mesh router. An extension to the conflict graph model, the multi-radio conflict graph, is used to model the interference between the routers. We demonstrate our solution's practicality through the evaluation of a prototype implementation in a IEEE 802.11 testbed. We also report on an extensive evaluation via simulations. In a sample multi-radio scenario, our solution yields performance gains in excess of 40% compared to a static assignment of channels.

RSVP A New Resource Reservation Protocol:

The current Internet architecture as embodied in the IP network protocol over's a very simple service model point to point best effort service recent years several new classes of distributed applications have been developed such as remote video multimedia conferencing data fusion visualization and virtual reality It is becoming increase singly clear that the Internets primitive service model is inadequate for these new applications this inadequacy stems from the failure of the point to point best effort service model to address two application requirements First many of these applications are very sensitive to the quality of service their packets receive For a network to deliver the appropriate quality of service it must go beyond the best effort service model and allow owns which is the generic term we will use to identify data trace streams in the network to reserve network resources Second these new applications are not solely point to point with a single sender and a single receiver of data instead these applications can often be multi point to multipoint with several senders and several receivers of data Multi point to multipoint communication occurs for example in multiparty conferencing where each participant is both a sender and a receiver of data and also in remote learning applications although in this case there are typically many more receivers than senders In recent years there has been a of research activity devoted to the development of new network architectures and service models to accommodate these new application requirements Even though there are rather fundamental between the various proposed architectures there is widespread agreement that any new architecture capable of accommodating multicast and a variety of qualities of service can be divided into distinct components which we identify and describe .

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

During their life time, multihop wireless mesh networks(WMNs) experience frequent link failures caused by channel interference, dynamic obstacles, and/or applications' bandwidth demands. These failures causes ever performance degradation in WMN so require expensive manual network management for their real-time recovery. This paper presents an autonomous network reconfiguration system (ARS)that enables WMN to autonomously recover from local ink Failures to preserve network performance. By using channel and Radio diversities in WMNs, ARS generates necessary changes in Local radio and channel assignments in order to recover from failures. Next, based on the thus-generated configuration changes, the system cooperatively reconfigures network settings among local mesh routers.

Routing in Multi-Radio, Multi-Hop Wireless Mesh Networks:

We present a new metric for routing in multi-radio, multihop wireless networks. We focus on wireless networks with stationary nodes, such as community wireless networks. The goal of the metric is to choose a high-throughput path between a source and a destination. Our metric assigns weights to individual links based on the Expected Transmission Time (ETT) of a packet over the link. The ETT is a function of the loss rate and the bandwidth of the link. The individual link weights are combined into a path metric called Weighted Cumulative ETT (WCETT) that explicitly accounts for the interference among links that use the same channel. The WCETT metric is incorporated into a routing protocol that we call Multi-Radio Link-Quality Source Routing. We studied the performance of our metric by implementing it in a wireless test bed consisting of 23 nodes, each equipped with two 802.11 wireless cards. We find that in a multi-radio environment, our metric significantly outperforms previously-proposed routing metrics by making judicious use of the second radio.

Towards Throughput Optimization of Wireless Mesh Networks in Disaster Areas:

Wireless mesh networks (WMNs) have received increasing attention in recent years, due to their attractive advantages, like easy network deployment, stable topology, robustness, and reliable coverage. In disaster area, they allow us to quickly recover network access services even if the existing network have been seriously destroyed by terrible disaster. However, one of the most important challenge in disaster recovery is to optimize the throughput to ensure high network performance. In this paper, our research is towards the problem of throughput optimization in wireless mesh networks. We take into account the gateway selection and channel assignment that can efficiently relieve potential congestion, alleviate the interference of close-by transmissions, and maximize the throughput in wireless mesh networks

II. MOTIVATION

Some of the problems related to wireless communication are multipath propagation, path loss, interference, and limited frequency spectrum.

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Multipath Propagation is, when a signal travels from its source to destination, in between there are obstacles which make the signal propagate in paths beyond the direct line of sight due to reflections, refraction and diffraction and scattering. Path loss is the attenuation of the transmitted signal strength as it propagates away from the sender. Path loss can be determined as the ratio between the powers of the transmitted signal to the receiver signal. This is mainly dependent on a number of factors such as radio frequency and the nature of the terrain. It is sometimes important to estimate the path loss in wireless communication networks. Due to the radio frequency and the nature of the terrain are not same everywhere, it is hard to estimate the path loss during communication. During communication a number of signals in the atmosphere may interfere with each other resulting in the destruction of the original signal. Limited Frequency Spectrum is where, frequency bands are shared by many wireless technologies and not by one single wireless technology.

Wireless mesh networks (WMNS) are being developed actively and deployed widely for a variety of applications, such as public safety, environment monitoring, and citywide wireless Internet services. They have also been evolving in various forms (e.g., using multi radio/channel systems) to meet the increasing capacity demands by the above-mentioned and other emerging applications. However, due to heterogeneous and fluctuating wireless link conditions, preserving the required performance of such WMNs is still a challenging problem. For example, some links of a WMN may experience significant channel interference from other coexisting wireless networks. Some parts of networks might not be able to meet increasing bandwidth demands from new mobile users and applications. Links in a certain area (e.g., a hospital or police station) might not be able to use some frequency channels because of spectrum etiquette or regulation

III. ARCHITECTURE OF SYSTEM

As shown in fig 1.1 block diagram is a process by which the system requirements are translated into a representation of system components, interfaces, and data necessary for the implementation phase. The software design specification shows how the software system will be structured to satisfy the requirements. It is the primary reference for code development or system implementation and, therefore, it must contain all information required by a programmer to write a code. fig 1.1 shows that block diagram of system in that base station act as gateway ,it store all the node and packet transmission information .base station perform all main functions, if node identify link failure it call failure detection mechanism then according to bully algorithm among the all node form a group choose leader node create a plan send to base station then route manager check best quality of link in routing table accordingly apply changes .

In ARS link failure is occur then before moving to planning or rerouting we apply the BFS-CA algorithm BSF-CA This scheme present a centralized, interference-aware channel assignment algorithm and a corresponding channel assignment protocol aimed at improving the capacity of wireless mesh networks by making use of all available non-overlapping channels

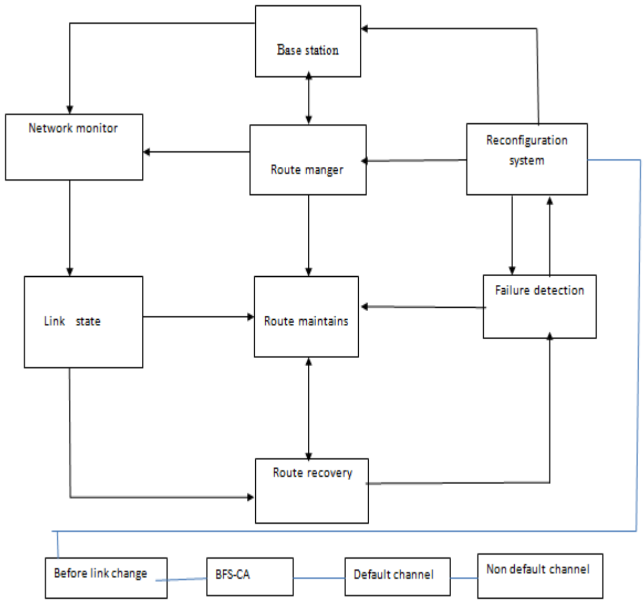

Fig 1.1 block diagram

IV. DESIGN FLOW DIAGRAM and algorithm

Algorithm:
Algorithm for ARSCA
Step 1: Generate topology
Step 2: Start flooding information and Channel assignment in server
A: for every link/node do
B: Exchange neighbor Nodes information.
C:end for
D: send neighbor node information to the gateway
Step 3: Select source node.
Step 4: Establish path from source to destination
Step 5: Start packet transmission.
Step 6: If packet received by node is destination then directly send packet to destination
Step 7: Then gateway receive monitoring result
Step 8: It Check node/link failures
Step 9: then group formation function execute Using bully algorithm Identify leader, group announcement function
step 10: next check for planning ,before planning check channel assignment using bfs-ca and Calculate interference, create MCG, calculate link delay, assign channel
step 11:next send planning request and receive planning request
step 12: Generate Reconfigure plan and add information to planner list
Step 13: send reconfigure plan, receive Reconfigure plan
Step 14: update energy
Step 15: Stop

The fig 1.2 ARSCA Algorithm mainly monitors mesh network. And then starts flooding information for every node in a mesh network. On link degradation and link/node failures it starts reconfiguring failure node/link by detecting through continuous monitoring. In ARS link failure is occur then before moving to planning or rerouting we apply the BFS-CA algorithm BSF-CA

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This scheme present a centralized, interference-aware channel assignment algorithm and a corresponding channel assignment protocol aimed at improving the capacity of wireless mesh networks by making use of all available non-overlapping channels.

The algorithm 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 an interference estimation technique to measure the level of interference in its neighborhood because of co-located wireless networks. Assignment. The algorithm, called the Breadth First Search Channel Assignment (BFS-CA) algorithm, uses a breadth first search to assign channels to the mesh radios. The algorithm utilizes an extension to the conflict graph model, the Multi-radio Conflict Graph (MCG), to model interference between the multi-radio routers in the mesh. The MCG is used in conjunction with the interference estimates to assign channels to the radios. This scheme ensures that channel assignment does not alter the network topology by mandating that one radio on each mesh router operate on a default channel. While to prevent flow disruption, link redirection is implemented at each mesh router. This technique redirects flows over the default channel until the channel assignment succeeds. The Channel Assignment Server (CAS), which can be co-located with the gate-way, performs channel assignment to radios.

In assigning channels, the CAS satisfies the following goals Minimize interference between routers in the mesh: In satisfying this goal, first, the CAS should satisfy the constraint that for a link to exist between two routers, the two end-point radios on them must be assigned a common channel. Second, links in direct communication range of each other should be tuned to non-overlapping channels. Third, because of the tree shaped traffic pattern expected in wireless mesh networks, channel assignment priority is given to links starting from the gateway and then to links fanning outwards towards the edge of the network, Minimize interference between the mesh network and wireless networks co-located with the mesh: In satisfying this goal, the CAS periodically determine the amount of interference in the mesh due to co-located wireless networks. The interference level is estimated by individual mesh routers. The CAS should then re-assign channels such that the radios operate on channels that experience the least interference from the external radios.

The algorithm starts by adding all vertices from the MCG to a list, *V*. It does a breadth first search of the MCG to visit all vertices and assign them channels. The search starts from vertices that correspond to links emanating from the gateway the smallest hop count vertex is determined of all vertices in the MCG. All vertices with distance equal to the smallest hop count are added to a queue, *Q*. If vertices correspond to network links emanating from the gateway, their hop count is 0.5. These vertices are then sorted by increasing delay values This sort is performed in order to give higher priority to the better links emanating from the shortest hop count router (the gateway for the first BFS iteration). The algorithm then visits each vertex in *Q* and permanently assigns them the highest ranked channel that does not conflict with the channel assignments of its neighbors If a non-conflicting channel is not available, a randomly chosen channel is permanently assigned to the vertex. Note, however, that the default channel is never assigned. Once a vertex is assigned a channel, all vertices that contain either radio from the just-assigned vertex are placed in a list, *L*. All vertices from *L* are removed from the MCG. This step is needed to satisfy the constraint that only one channel is assigned to each radio. The radios in the list of vertices that do not belong to the just-assigned vertex are tentatively assigned the latter's channel.

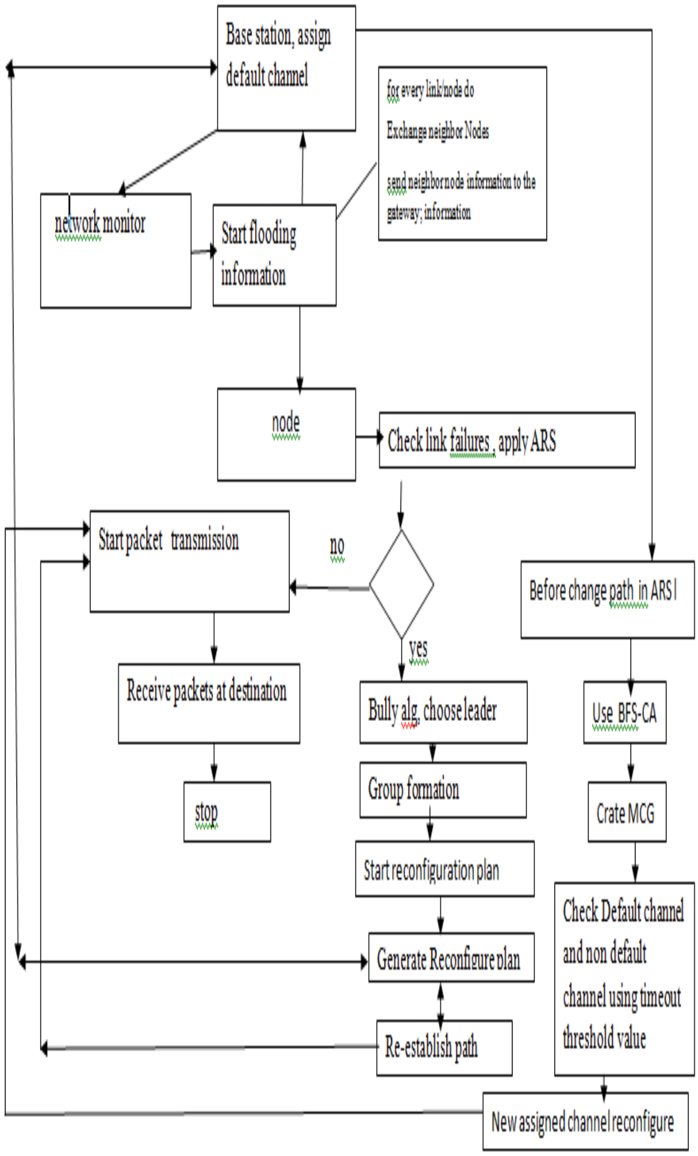

Fig 1.2 Design flow of system

Vertices at the next level of the breadth first search are added to *Q*. These vertices correspond to links that fan-out from the gateway towards the periphery. To find such links in the MCG, two steps are performed. In the first step, the router from the just-assigned vertex that is farthest away from the gateway is chosen; the farthest router is the router with the higher hop-count of the two routers that make up the just-assigned vertex. In the second step, all unvisited MCG vertices that contain a radio belonging to the farthest router are added to the list, Tail. This list is sorted by increasing value of the delay metric to give higher priority to better links that emanate from the farthest router. Finally, the vertices from Tail are added to *Q*. The above described algorithm continues until all vertices in the MCG are visited.

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If there is a link failure while transmitting a packet do use of bully algorithm and on that basis select leader node amongst them. Start reconfiguration and generate reconfiguration plan. Reestablish path. Any radio that is not assigned a permanent channel during the search, because vertices containing it were deleted, is permanently assigned one of the channels tentatively assigned to it.

Once channel assignments are decided, the CAS notifies the mesh routers to re-assign their radios to the chosen channels.

V. SYSTEM IMPLEMENTATION

The system uses the flat grid topology with parameters which is shown below

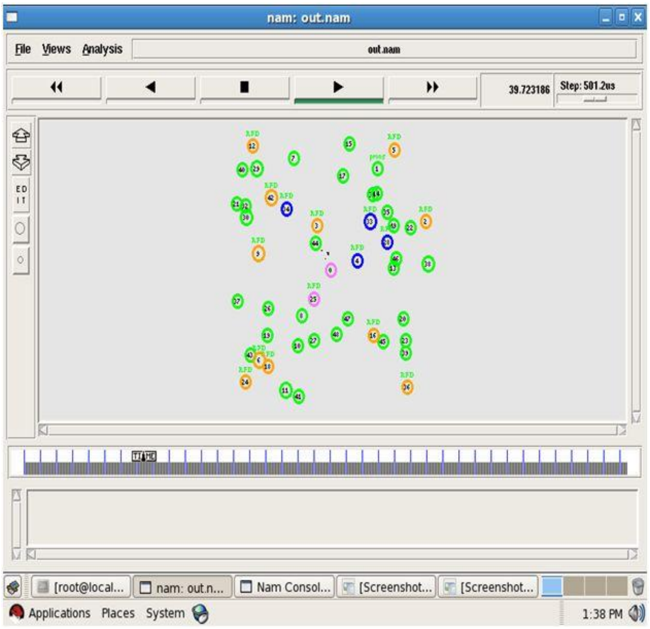
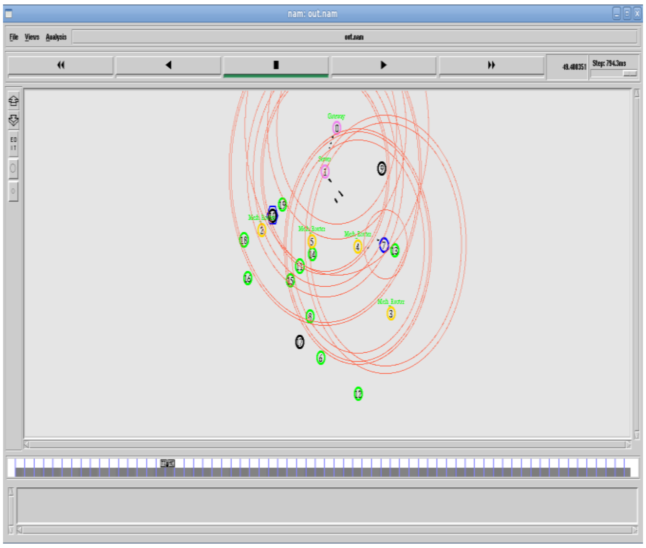


Fig 1.3 screenshot of node position

The user interface is for dynamic channel allocation with nod .it will give user complete idea of nodes in simulation it will show packets traversing through nodes, mobility of nodes, roped packets, it will also show graph achieved by increase it through, packet delivery ratio for data transfer using different number of nodes, fig 1.3 shows the screenshot of node position

We have used ns-2 in our simulation study. Throughout the simulation, we use a grid topology with 10 nodes in an area of 500*500 meter , as shown in Fig.1.3. Each node is equipped with a four number of radios, depending on its proximity to a gatewayFor failure occurs instead of choosing next router that node is switched to another channel of same router.

Next, IEEE 802.11 wireless extension is used for the MAC protocol with a varying data rate and is further modified to support multiple radios and multiple channels. Finally, SRWMN protocol is used for routingIn these settings, ARSCA is implemented as an agent in both the MAC layer and a routing protocol before. It periodically collects channel information from MAC and requests channel switching or link-association changes based on its decision. At the same time, it informs the routing protocol of network failures or a routing table update There are several settings to emulate real-network activities. First, to generate users' traffic, multiple UDP flows between a gateway and randomly chosen mesh nodes are introduced



. **fig 1.4 screenshot of data transmission**

Each flow runs at 500 kb/s with a packet size of 1000 bytes. Second, to create network failures, uniformly distributed channel faults are injected at a random time point. Random bit error is used to emulate channel-related link failures and lasts for a given failure period. Finally, all experiments are run for 3000 s, and the results of 10 runs are averaged unless specified otherwise. Combining ARS and BFS-CA i.e. ARSCA we got minimized control overhead. Control Overhead is considered in two terms Route failure that takes new route so in this case traffic must be rerouted quickly and failure is recovered as per energy efficiency. Broadcast Communication so that transmit broadcast even though all nodes are not awake and stay awake regardless of sleep schedule. These two terms we have satisfied and got 20% less overhead as compared to ARS and 40-50% less as that of BFSCA as shown in fig 1.3

VI. ANALYSIS OF RESULT AND TRACES GENERATED

Below we shows the comparison of different protocol with different number of scenario. For comparison parameters are takes as follows:

- Number of packet send
- Number of packet received
- ,Number of packet drop
- Packet delivery ratio,
- Control overhead,
- Routing overhead
- Delay,
- Jitter,
- Control overheads

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Table 5.1 Comparisons of DCDD with different number of prongs

Parameter	Number of comparasion		
	Ars	**Bfs-ca**	**Arswith bfs-ca**
No of pkts send	2420	2402	2350
No of pkts recv	2372	2354	2302
Pkt delivery ratio	98.0165	98.0017	97.9574
Routing overheads	0.984401	0.979609	0.97828
Delay	0.0761954	0.0137874	0.00750427
Throughput	4859.22	4822.38	4715.94
Jitter	0.0713586	0.0717449	0.0734315
Total Energy consumption	0.77664	0.806968	0.721203

VII. RESULTS

Here the comparison of with different method is shown using graphs for different parameters as follows:

- Packet delivery ratio
- Contol overhead
- Delay
- Normalised routing overhead
- Throghput
- Drop ratio

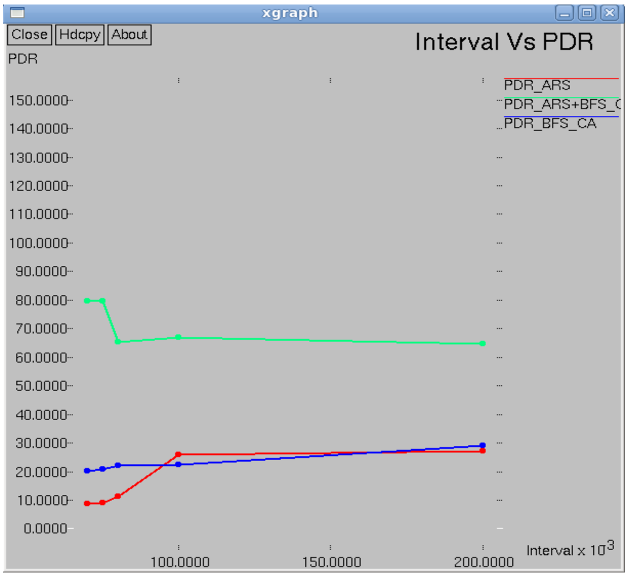

Figure 1.5 for graph interval vs PDR

In figure 1.5 for graph at X-axis the number of interval are taken and at Y axis the packet delivery ratio is taken. For getting results scenario of 30 nodes with different numbers of interval are taken.ARSCA used as routing protocol.

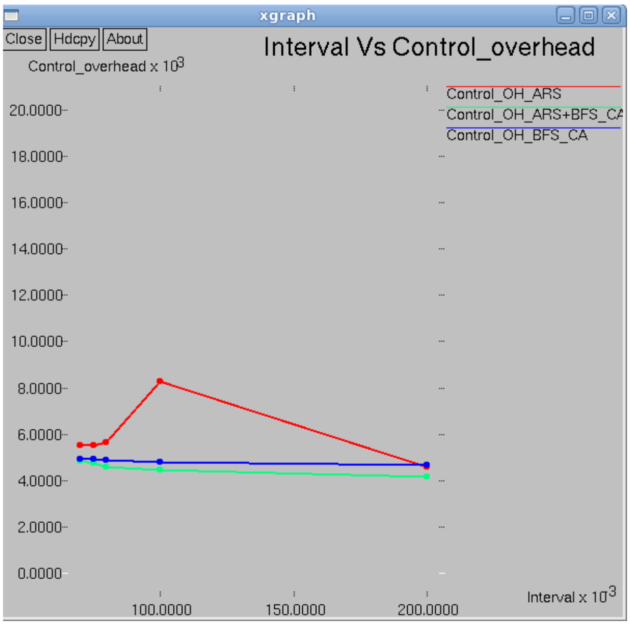

Figure 1.6 for graph interval vs CO

In figure 1.6 for graph at x-axis the number of interval are taken and at y axis the control overhead ratio is taken. For getting results scenario of 30 nodes with different numbers of interval are taken. ARSCA used as routing protocol.

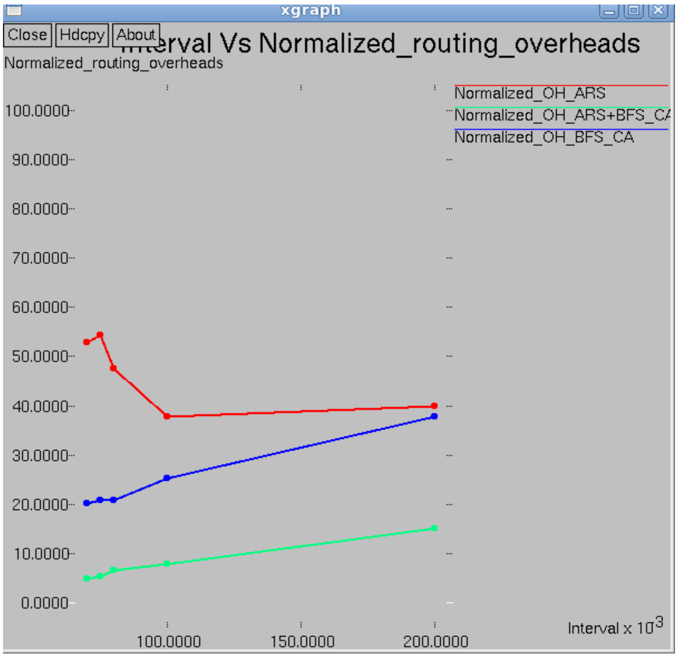

Figure 1.7 for graph interval vs NRO

In figure 1.7 for graph at x-axis the number of interval are taken and at y axis the normalized control overhead ratio is taken. For getting results scenario of 30 nodes with different numbers of interval are taken. ARSCA used as routing protocol

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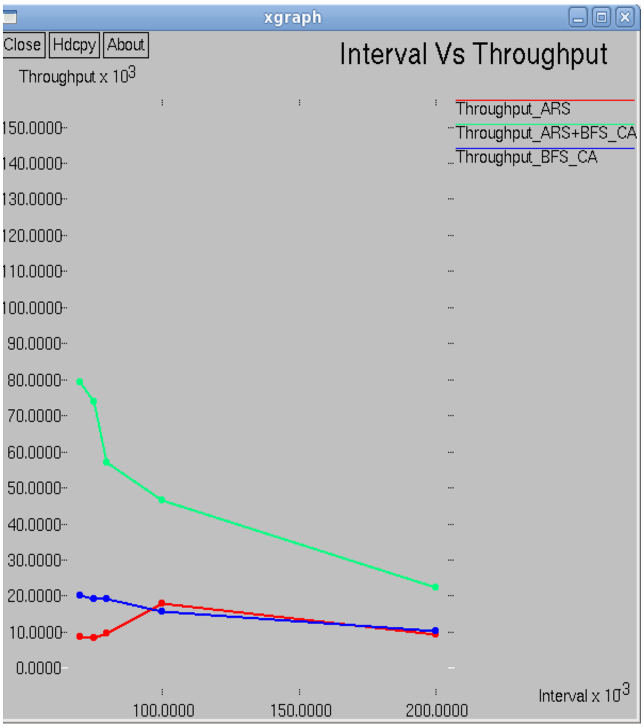

Figure 1.8 for graph interval vs Throughput

In figure 1.8 for graph at x-axis the number of interval are taken and at y axis the throughput ratio is taken. For getting results scenario of 30 nodes with different numbers of interval are taken. ARSCA used as routing protocol.

VIII. CONCLUSIONS

The performance of ARSCA in WMN is considered for five different scenarios as 20 nodes, 30 nodes,40 nodes, 60, nodes, 100 nodes. Simulation result shows that efficective dynamic channel allocation without rerouting by applying BFS-CA it delivers more packets and gives maximum throughput as compare to SRWMN and IACA method .Packet delivery ratio is highly increased when traffic is high , considered as compare to SRWMN and IACA . End to end delay is significantly reduced in ARSCA Routing overhead is highly reduced in dynamic networks. Jitter is very less in ARSCA with dynamic network as compare to SRWMN and IACA routing. When the number of node is increased then delay is more. Throughput is significantly increased for ARSCA for WMN scenario with 20,30, 40, 60 and 100 nodes

Dynamic channel allocation for effective autonomous network reconfiguration system (ARS), by analyzing ARS, it shows that by using ARS alone it won't provide a sufficient result such as network quality, leader assigning problems etc, so in order improve the network performance we going to implement a new concept Breadth First Search Channel Assignment (BFS-CA) algorithm against with ARS so that it will multi radio configuration for mesh network and channel assignment problems.

ACKNOWLEDGMENT

I would like to express my sincere gratitude towards my parents, my family and friends, for always being there with me. With all respect and gratitude, I would like to thank all the people, who have helped me directly or indirectly. Without their silent support and encouragement for this work could not have been possible.

REFERENCES

1. I. Akyildiz, X. Wang, and W. Wang, "Wireless mesh networks: A survey," *Comput. Netw.*, vol. 47, no. 4, pp. 445–487, Mar. 2005.
2. K. Ramanchandran, E. Belding-Royer, and M. Buddhikot, "Interference- aware channel assignment in multi-radio wireless mesh networks," in *Proc. IEEE INFOCOM*, Barcelona, Spain, Apr. 2006.
3. M. Alicherry, R. Bhatia, and L. Li, "Joint channel assignment and routing for throughput optimization in multi-radio wireless mesh networks," in *Proc. ACM MobiCom*, Cologne, Germany, Aug. 2005
4. A. P. Subramanian, H. Gupta, S. R. Das, and J. Cao, "Minimum interference channel assignment in multiradio wireless mesh networks,"*IEEE Trans. Mobile Comput.*, vol. 7, no. 12, pp. 1459–1473, Dec. 2008
5. K.-H. Kim and K. G. Shin, "On accurate and asymmetry-aware measurement of link quality in wireless mesh networks," *IEEE/ACMTrans.Netw.*, vol. 17, no. 4, pp. 1172–1185, Aug. 2009.
6. P. Kyasanur and N. Vaidya, "Capacity of multi-channel wireless networks:Impact of number of channels and interfaces," in Proc. ACM MobiCom, Cologne, Germany, Aug. 2005, pp. 43–57.
7. A. Brzezinski, G. Zussman, and E. Modiano, "Enabling distributed throughput maximization in wireless mesh networks: A partitioning approach," in *Proc. ACM MobiCom*,
8. Los Angeles, CA, Sep. 2006, pp.26–37.
9. S. Chen and K. Nahrstedt, "Distributed quality-of-service routing in ad hoc networks," *IEEE J. Sel. Areas Commun.*, vol. 17, no. 8, pp.1488–1505, Aug. 1999
10. P. Bahl, R. Chandra, and J. Dunagan. SSCH: Slotted Seeded Channel Hopping For Capacity Improvement in IEEE 802.11
11. Ad Hoc Wireless Networks. In *ACM MobiCom*, Philadelphia, PA, September 2004.
12. R. Draves, J. Padhye, and B. Zill. Routing in Multi-radio, Multihop Wireless Mesh Networks. In *ACM MobiCom*, Philadelphia, PA ,September 2004.

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