Dynamic Channel Allocation using ARS and BFS-CA in WMN

A. S. Devare, M. P. Wankhade

Abstract— Traditionally in wireless networks, nodes were operating with a single radio, due to the cost associated with having multiple radios on a node, which was high. Several methods were proposed which aimed to improve the network throughput, for single-radio wireless mesh networks. However, with lowering costs, it has become possible to equip a node with multiple radios. Having multiple radios on a node opens several possibilities and options as to how these radios can be utilized to improve some of the important characteristics of the nodes and the performance of the network. Several interesting studies have been performed on multi-radio nodes and have concluded that in some cases, having multiple radios can considerably improve the throughput and network performance. In this we use the concept of a multi-radio mesh node to analyze the performance of wireless mesh networks in different conditions with different channel assignment schemes. We look at new ways to try and improve the network throughput in wireless mesh networks performance, such as delay, bandwidth, probability of packet loss, delay variance (jitter), and throughput.

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

I. INTRODUCTION

The channel assignment algorithm proposes for wireless mesh networks. Routers in such networks are stationary. Whereas user devices, such as laptops and PDAs, can be mobile. Such devices associate with routers. In ARS there is a leader node which is chosen by group member so whenever link failure occurs that information is given to the leader node. Leader node forward that information to gateway and all the functionality (like routing planning, reconfiguration) performed at gateway and send back to leader node. Finally, all nodes in the group execute the corresponding configuration changes.The main drawback of dynamic channel assignment is that it results into change in network topology, so to avoid this solution is that make mandatory one radio of mesh router to operate on default channel. This default radio is of the same physical layer technology IEEE 802.11a, 802.11b or 802.11g. A second drawback is channel assignment can result in disruption of flows when the mesh radios are reconfigured to different frequencies. To prevent flow disruption, redirect flow over default channel. Channel Assignment (CA) in a multi radio WMN environment consists of assigning channels to the radio interfaces in order to achieve efficient channel utilization and minimize interference.

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1.1 Literature survey for WSN

Self-Reconfigurable Wireless Mesh Networks

This paper given associate Autonomous Network Reconfiguration System (ARS) that allows a multi radio WMN to autonomously pass though wireless link failures. ARS generates a good reconfiguration arrange that needs solely native network configuration changes by exploiting channel, radio, and path diversity. moreover, ARS effectively identifies reconfiguration plans that satisfy applications' QoS constraints, admitting up to two times additional flows than static assignment, through QoS aware coming up with ARS's on-line re configurability permits for period failure detection and network reconfiguration, therefore rising channel potency a lot of. [2]

Interference-Aware Channel Assignment (BFS-CA)

The channel assignment downside in WMNs within the presence of interference from co-located wireless networks is addressed in . The authors propose a dynamic, centralized, interference-aware algorithmic rule aimed toward rising the capability of the WMN backbone and at minimizing interference. This algorithmic rule relies on associate extension to the conflict graph thought referred to as the multi-radio conflict graph (MCG) wherever the vertices within the mcg represent edges between radios rather than edges between mesh routers. To complete the drawbacks of a dynamic configuration, the planned answer assigns one radio on every node to work on a default common channel throughout the network.

This strategy ensures a standard network property graph, provides alternate fallback routes and avoids flow disruption by traffic redirection over a default channel. This theme computes interference and information measure estimates supported the quantity of interfering radios, wherever associate busy radio could be a at the same time operative radio that\'s visible to a mesh router however is external to its network. additional over measure of simply the quantity of interfering radios is taken into account not enough as a result of it doesn\'t indicate the quantity of traffic generated by the interfering radios. as an example two channels may have an equivalent variety of busy radios but one channel is also heavily used by the interfering radios compared to the opposite. so every mesh router additionally estimated the information measure used by the interfering radios.

Each mesh router then derives two separate channel rankings. the primary ranking is per increasing variety of interfering radios. The second ranking is per increasing channel utilization. The mesh router then merges the two rankings by taking the common of the individual ranks. The ensuing ranking is employed by the CA theme.

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This theme, known as the Breadth first Search Channel Assignment (BFS-CA) algorithmic program, uses a breadth first search to assign channels to the radios. The search begins with links emanating from the gateway node; whereas links fanning outward toward the sting of the network are given lower priority. The default channel is chosen such its use within the mesh network minimizes interference between the mesh network and collocated wireless networks. channel c at router i. The default channel is then chosen because the channel with the smallest amount Rc worth. The assignment of non default channels, on the opposite hand, is predicated on the data within the mcg wherever it\'s associated to each vertex its corresponding link delay worth (computed supported the Expected TRM or ETT)

The CA theme additionally related to every vertex a channel ranking derived by taking the common of the individual channel rankings of the two radios that form up the vertex. the common is vital as a result of the assignment of a channel to a vertex within the mcg ought to take under consideration the preferences of each end-point radios that compose the vertex. Once channel assignments are determined, the mesh routers are notified to re-assign their radios to the chosen channels as represented in details in To adapt to the ever-changing interference characteristics, the CA sporadically re-assigns channels. The regularity depends ultimately on however oft interference levels within the mesh network are expected to vary.[1]

Capacity of Multi-Channel Wireless Networks Impact of number of Channels and Interfaces

This paper studies however the capability of a static multi-channel network scales because the variety of nodes will increase. The capability of monophonic networks, and people bounds are applicable to multi-channel networks further, provided every node within the network features a dedicated interface per channel.[4]

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

This paper presents a brand new metric for routing in multi-radio, multi hop wireless networks. we have a tendency to specialize in wireless networks with stationary nodes, like community wireless networks. The goal of the metric is to decide on a high-throughput path between a supply and a destination. Our metric assigns weights to individual links supported the Expected transmission time (ETT) of a packet over the link. The ETT could be a perform of the loss rate and also the information measure of the link. The individual link weights are combined into a path metric referred to as Weighted cumulative ETT (WCETT) that expressly accounts for the interference among links that use an equivalent channel. The WCETT metric is incorporated into a routing protocol that we tend to decision Multi-Radio Link-Quality supply Routing.[5]

A Survey on Wireless Mesh Networks

Wireless mesh networks (WMNs) have emerged as a key technology for next-generation wireless networking. as a result of their advantages over different wireless networks, WMNs are undergoing fast progress and provoking various applications. However, several technical problems still exist during this field. so as to supply a much better understanding of the analysis challenges of WMNs, this text presents an in depth investigation of current progressive protocols and algorithms for WMNs. Open analysis problems all told protocol layers also are mentioned, with associate objective to spark new analysis interests during this field.[3]

From all literature review papers I am getting some idea related with dynamic channel assignment, autonomous network reconfiguration system in Wireless mesh network. Some of the problems related to wireless communication are multipath propagation, path loss, interference, and limited frequency spectrum. 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 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

II. MOTIVATION

The channel assignment algorithm proposes for wireless mesh networks. Routers in such networks are stationary. Whereas user devices, such as laptops and PDAs, can be mobile. Such devices associate with routers. In ARS there is a leader node which is chosen by group member so whenever link failure occurs that information is given to the leader node. Leader node forward that information to gateway and all the functionality (like routing planning, reconfiguration) performed at gateway and send back to leader node. Finally, all nodes in the group execute the corresponding configuration changes.

The main drawback of dynamic channel assignment is that it results into change in network topology, so to avoid this solution is that make mandatory one radio of mesh router to operate on default channel. This default radio is of the same physical layer technology IEEE 802.11a, 802.11b or 802.11g. A second drawback is channel assignment can result in disruption of flows when the mesh radios are reconfigured to different frequencies. To prevent flow disruption, redirect flow over default channel. Channel Assignment (CA) in a multi radio WMN environment consists of assigning channels to the radio interfaces in order to achieve efficient channel utilization and minimize interference.

We can then build a dynamic channel allocation using ARS algorithm that will, according to the appropriate set of properties about the current channel utilization, choose and dynamically assign the best channel for the links in our wireless mesh network. We can then evaluate the performance gains offered by this allocation engine.

The explosive growth in Wi-Fi deployments that operate in the same spectrum as wireless mesh networks, any static assignment will likely result in the operation of the mesh on channels that are also used by co-located Wi-Fi deployments. The resulting increase in interference can degrade the performance of the mesh network. For this reason our Channel Assignment algorithm addresses the channel assignment problem and specifically investigates the dynamic assignment of channels in a wireless mesh network. We chose the hybrid and centralized, interference-aware channel assignment algorithm BSF-CA as this channel assignment protocol aimed at improving the capacity of wireless mesh networks by making use of all available non-overlapping channels (i.e. IEEE 802.11) and that 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. Hence, our first improvement will try to introduce this new information into the algorithm. Second, we will develop an algorithm that can be used in a wireless mesh network with more gateways available, this because the BSF-CA algorithm is designed to work on single-gateway WMNs.

III. ARCHITECTURE OF SYSTEM

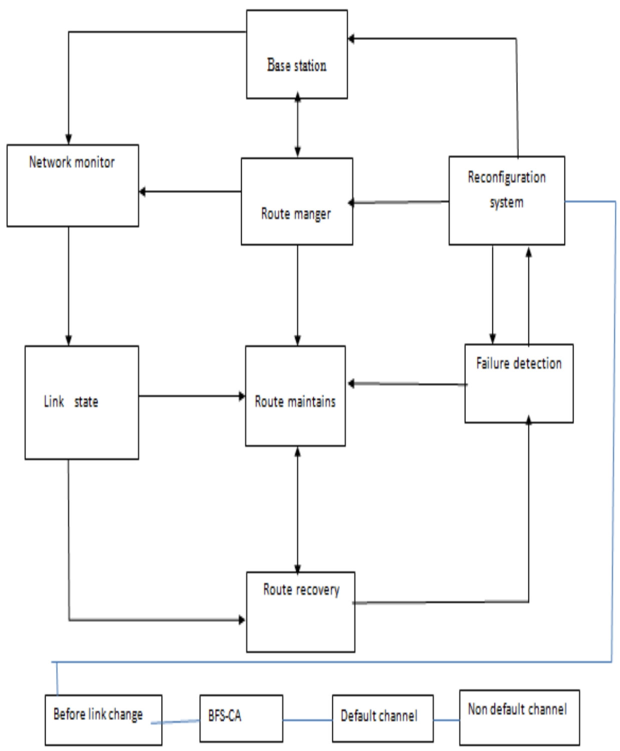


Fig 1.1 block diagram

As shown in fig 1.1 System design 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

IV. MATHEMATICAL MODEL

Step 1: Let R be the system which help to improve the performances.

R= {……..};

Step 2: Identify the input

R= { G, P, B, D, J, Tp }

Where,

A: wireless mesh networks are usually represented as a connected graph *G*(V,Z) where V represents the set of vertices associated with the nodes of the network and *A* the set of edges representing all the possible communication links.

i.e. Z={(i,j)/i,j € V, i ≠ j}

P: Routing path

B: Total available bandwidth

D: End to End delay

J: Jitter

Tp: Packet Loss Rate

Step 3: Identify the output as decision variable *xij* (where i is source and j is destination of routing path) on which we are going to take decision whether to select that routing path or not by considering input constraint such as energy consumption delay, bandwidth, packet loss ratio.

R= { G, E, B, D,J, Tp, *xij* }

Step 4: Identify the process Pr

R= { G, E, B, D, J, T_p, Pr}

Pr= { Pij, Bij, Dij, Jij, Tp }

Where,

P_{ij} = Energy affected on link (i,j)

B_{ij} = Bandwidth available on link (i,j)

D_{ij} = End to end delay on link (i,j)

J_{ij} = Jitter on link (i,j)

Energy to transmit per bit is given by,

$Pij=dij^{\alpha}$

Where Pij is the energy per bit required to reach j from i and dij is the distance from i to j. α is an environment dependent coefficient typically between 2 and 5. The transmission energy is well considered to be symmetric, i.e.

Pij = Pji V (i,j) € Z

Take,

min ∑ xij Pij
(i,j) € Z

Required bandwidth is given by,

min ∑ xij Bij
(i,j) € Z

Take min delay as,

min ∑ xij Dij
(i,j) € Z

Also consider min packet loss rate as,

min Tp

Take min jitter as,

min ∑ xij Jij
(i,j) € Z

Step 5: Identify failure cases

If Dij > Ds;

π > Tp;

Where, Ds – The maximum value of delay that Dij must not exceed ,π – Maximal value that Tp must not exceed

Step 5: Finally find xij

$$x_{ij} = \begin{cases} 1 & \text{if } (i,j) \in Pr \\ 0 & \text{otherwise} \end{cases}$$

So X_{ij} gives the route by considering channel assignment (Delay, Bandwidth and Packet Loss Ratio) with best effort values

NP complete or NP Hard

To decide whether the algorithm DC is NP complete or NP hard, it has to go through satisfybility test (SAT). If algorithm fails in SAT test then it is NP Hard problem otherwise it is NP complete problem. Following are the steps to prove whether the algorithm is NP complete or NP Hard.

Step 1: Show that the problem is in NP,

Step 2: Reduce an NP-complete problem by applying SAT test.

Step 3: Show that the reduction is a polynomial time function. In this arsca protocol ARS and BFS-CA algorithm the route request is broadcasted and then optimized path is selected by SINK node. This computation can be done in polynomial time. Hence the ARSCA algorithm is NP algorithm as the output of the algorithm varies according to change in input to get accurate and perfect output. Now to find whether the algorithm is NP complete or NP hard SAT test has to be applied on it. After applying satisfy ability test on various variables and functions of algorithm with consideration of different Boolean functions the algorithm gives accurate and deterministic output Therefore the ARSCA is a NP Complete algorithm.

IV . 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 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 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.

V. SYSTEM IMPLEMENTATION

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

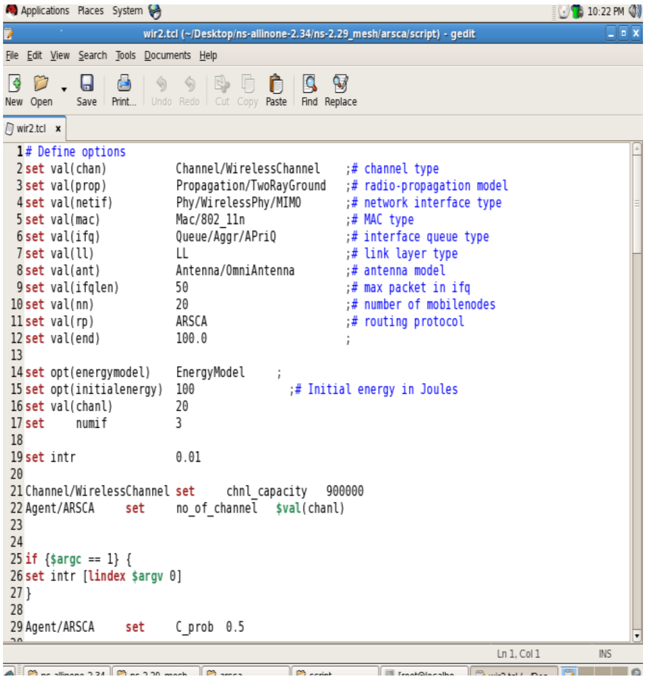


Fig 1.2 system parameter

In simulation 20 to 50 nodes are placed in flat grid topology. Number of nodes taken 20 as secondary receivers numbers is varying from link . For analysis of energy consumption the transmission power and receiving power values are taken as 0.02mw and 0.01mw. The scenario file contains the location of all 50 nodes. Figure 1.2 shows the node configuration code for sensor node. Here, different parameters that are used for configuring the node are shown in above

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 gateway

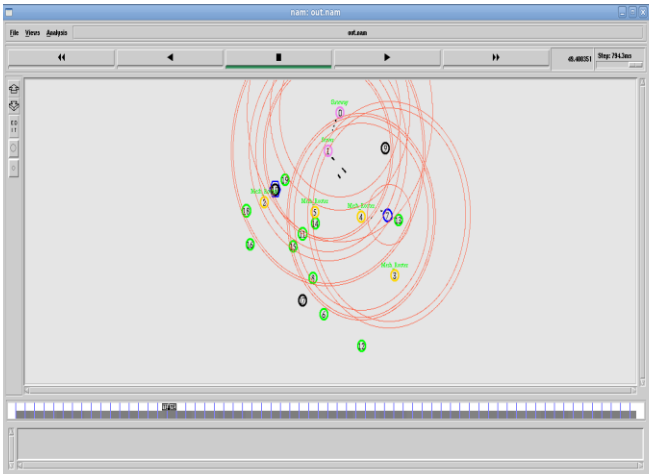


Fig 1.3 simulation of system

For 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 routing. In 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. 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

Test Case Specification 1

Table 1.1 Test Case Specification 1

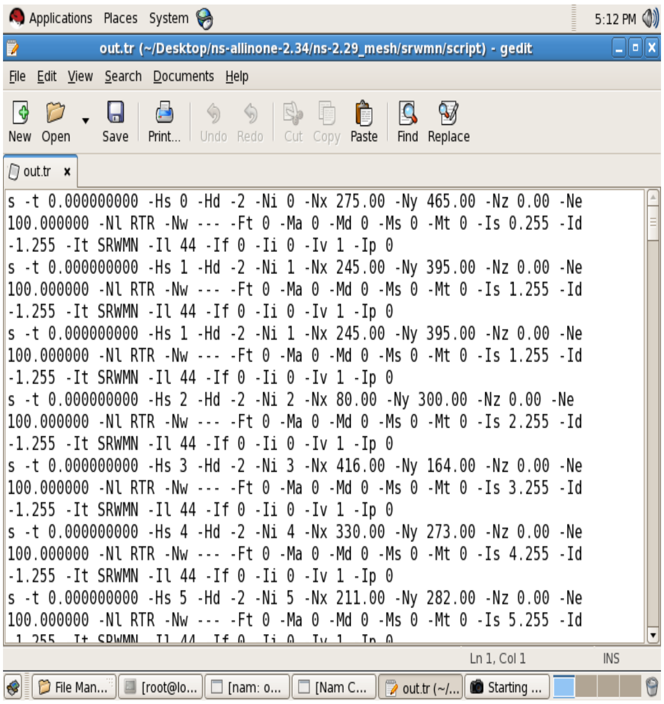
Test Case Specification Identifier	TCS_ #1
Test items	.tcl script for transmitting data packets with scheme by providing source and destination nodes in .tcl script.
Input specifications	Inputs required are: Start time, stop time and interval.
Output specifications	Output expected is:Using NAM tool it shows, Packets are transmitted from sender to receiver.
Environmental needs	This project assumes that nodes are placed in Flat-Grid topology.
Software	1. Red Hat Linux 5.0 or higher 2. NS-allinone-2.34 3. NAM tool

The above test specification used for next test by taking test items as number of link Test Case Specification 2

Table 1.2 Test Case Specification 1

Test Case Specification Identifier	TCS #2
Test items	Xgraph file that will display graph for comparison of energy consumption
Input specifications	Inputs required are: Trace file and AWK file
Output specifications	Output expected is: Using XGraph tool which shows, the energy consumption comparison graph.
Environmental needs	This project assumes that nodes are placed in Flat -Grid topology.
Software	1. RedHat Linux 5.0 or higher 2.NS-allinone-2.34 3. XGraph tool.

Above test specifications are used for other test i.e packet delivery ratio, packet loss and throughput. Test Procedure Specification output Trace generated by ptoject.tcl



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

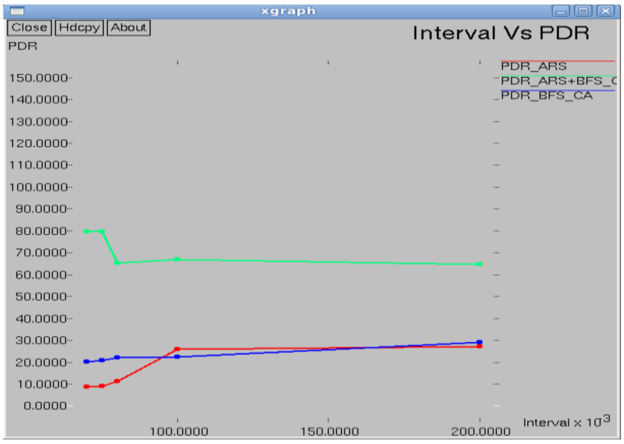


Figure 1.4 for graph interval vs PDR

In figure 1.4 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.

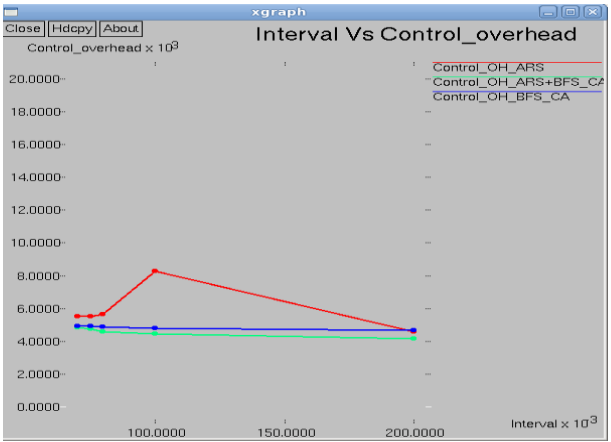


Figure 1.5 for graph interval vs CO

In figure 1.5 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.

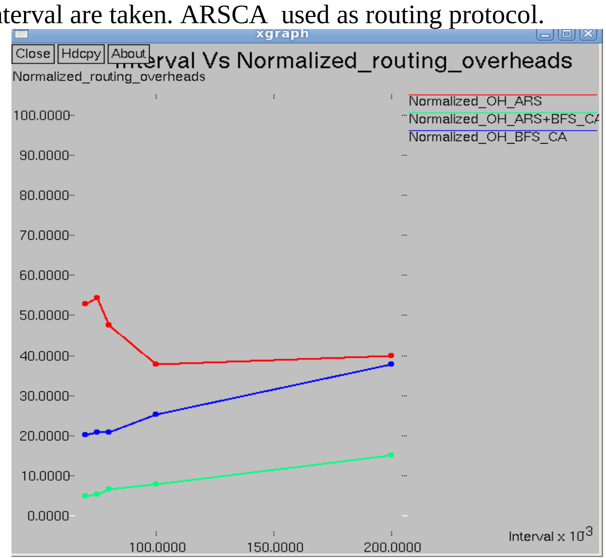


Figure 1.6 for graph interval vs NRO

In figure 1.6 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

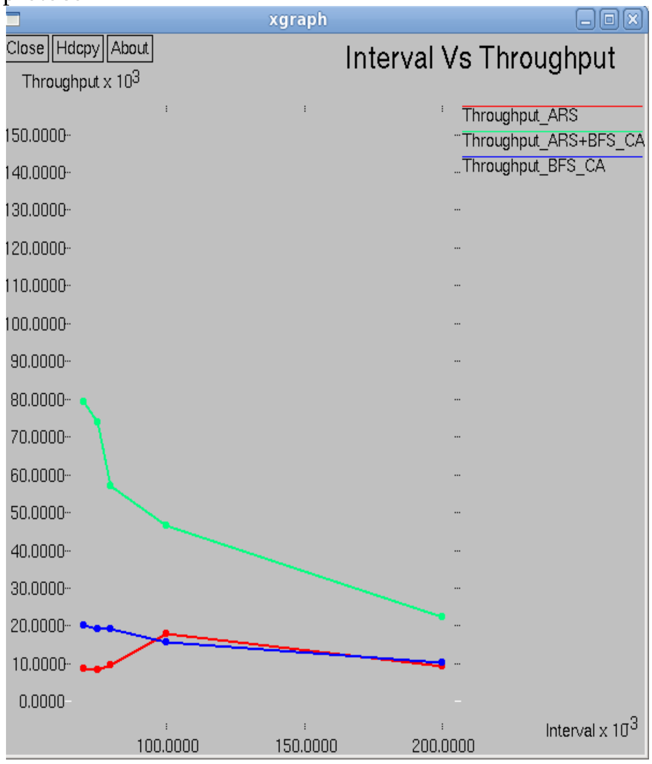


Figure 1.7 for graph interval vs Throughput

In figure 1.7 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.

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