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A STRUCTURED GROUP MOBILITY MODEL FOR SECURING WIRELESS MESH NETWORKS

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Abstract: Multi-hop wireless mesh network is experience link-failure due to channel interference and dynamic obstacles, which causes performance degradation of the network in Wireless Mesh Networks. The paper proposes "Autonomously Reconfigurable Wireless Mesh Networks system based upon IEEE 802.11" for mr-WMN to recover autonomously in case the network failure occurs, to improve the network performance. In this paper, we describe the self reconfigurable mesh networks. A wireless mesh network has to face problems such as dynamic obstacles; bandwidth demands channel interference, etc. This kind of failures causes performance degradation in wireless mesh network. The Autonomous reconfiguration system presented over this paper helps a multi radio WMN to recover from link failure in a autonomous way. ARS monitors and generates the necessary changes in the network. Based on the changes generated the network is reconfigured.

Index Terms: - Multi radio wireless mesh networks (mr-WMNs), wireless link failures, autonomous reconfigurable networks.

I.INTRODUCTION

Wireless Mesh Networks: WMN is a network that is created through the connection of wireless access points that are installed at each node. It consists of mesh clients, mesh routers and gateways. Nowadays WMNs are used widely and are rapidly undergoing progress [2]. Though WMNs are widely used they face problem due to frequent link failures. To overcome these failures many solutions have been proposed such as resource allocation algorithm, greedy channel assignment algorithm and fault tolerant routing protocols [1].

Resource allocation algorithm: Allocates the resources initially. The drawback is even though they provide a optimal solution they require the global configuration changes, which is not suitable in case where frequent link failures occur [14] [16].

Greedy Channel- Assignment: Changes the setting of only faulty links. The problem is that we need to consider configurations of neighboring nodes in mesh along with the Faulty link(s) [17].

Fault- tolerant routing protocol: Can be used to avoid the faulty links. The examples of fault tolerant routing protocol is local rerouting, multipath routing. This routing protocol depends on redundant transmission, which requires the more amounts of network resources than the reconfiguration in link-level network [18]. The autonomous reconfiguration system (ARS) overcomes above mentioned limitations. ARS enables multi radio WMN to configure automatically its local network settings such as channel, radio and route alignment, so that it can recover from the link failures[9][10]. In its heart the ARS is consisting reconfiguration planning algorithm [7] that will identify the configuration changed within local network for recovery, thus minimizing changes of healthy network. In other words, ARS will initially search for the local Reconfiguration changes that are available around a faulty area. Then, accordingly will impose current network setting.

ARS also consist of monitoring protocol that enables a WMN to perform real-time recovery from failures. It also prevents the ripple effects. The monitoring protocol runs in every mesh node and it periodically measures wireless link conditions. Depending on measurement information ARS determines the failure of link and generates the reconfiguration plan.

A wireless mesh network (WMN) is a communication network made up of radio nodes organized in a mesh topology. WMNs are a promising next generation wireless networking technology. They intend to deliver wireless services to a large variety of applications in personal, local, campus, and metropolitan areas. WMNs are expected to basically resolve the limitations and to significantly improve the performance of wireless LANs, PANs, and MANs. They will have a great impact the development of wireless-fidelity (Wi-Fi), WiMAX (worldwide inter-operability for microwave access), Ultra Wide Band (UWB) [1] [7] and wireless sensor networks.

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A. Wireless Mesh Network Infrastructure

Wireless mesh network infrastructure is considered as the network providing cost effective and dynamic high bandwidth networks over a specific coverage area. Mesh architecture sustains signal strength by breaking long distances into a series of shorter hops. Intermediate nodes not only boost the signal, but cooperatively make forwarding decisions based on their knowledge of the network, i.e. perform routing. Such architecture may with careful design provide high bandwidth, spectral efficiency, and economic advantage over the coverage area. The Wireless Mesh Network infrastructure is shown in the Figure 1.The Role of Access Points (APs) [1] in WMN is it provides internet access to Mesh Clients (MCs) by forwarding aggregated traffic to Mesh Routers (MRs), known as relays, in a multi-hop fashion until a Mesh Gateway (MG) [10][11] is reached. MGs act as bridges between the wireless infrastructure and the Internet. WMNs are comprised of two types of nodes: mesh routers and mesh clients.

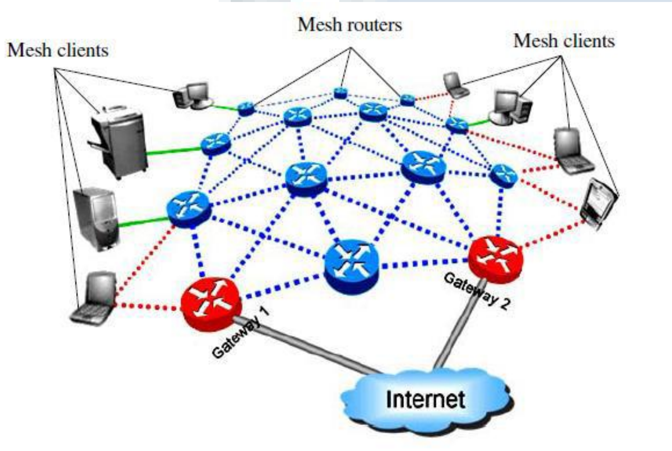

Fig.1Wireless Mesh Network infrastructure

Mesh routers have an additional functionality called Gateway and bridging functionality. This functionality is used to connect WMNs with other preexisting networks like IEEE 802.15, IEEE 802.16, wireless -fidelity (Wi-Fi), WPAN, WLAN, WiMAX (worldwide inter-operability for microwave access), WiMEDIA [15][16][18], Internet, Cellular, wireless Sensor networks etc. Mesh clients can either be stationary or mobile. These nodes can either form a network of mesh clients or a network comprising of both mesh clients and mesh routers. The client nodes with Network Interface cards (NICs) can connect directly to the mesh routers. The ones without NICs can connect themselves to mesh routers via, for example Ethernet.

II.RELATED WORK

A considerable amount of work has been done to solve the problems in WMNs and to build a healthy wireless network and Network reconfiguration needs a planning algorithm[1] that keeps necessary network changes (to recover from link failures) as local as possible, as opposed to changing the entire network settings. Existing channel assignment and scheduling algorithms [7] [9] provide guidelines such as throughput bounds and schedule ability for channel assignment during a network deployment stage.

Limitations of Existing Approaches Network reconfiguration needs a planning algorithm that keeps necessary network changes (to recover from link failures) as local as possible [9], as opposed to changing the entire network settings.

Disadvantages of existing approach:

1. Cannot avoid propagation of QoS [3] failures to neighboring links.
2. Unsuitable for dynamic network reconfiguration.

Addressed issues in WMN

- Frequent link failures caused by channel interference, dynamic obstacles, and/or applications bandwidth demands.
- Severe performance degradation in WMNs due to link Failures [9] [13].
- Expensive manual network management for their real-time recovery.

Securing Wireless Mesh Networks WMN is distinct from MANETs in that it uses multiple radios and relies on a high-speed back-haul network [9] [10] itself; often wireless that optimizes network performance and provides gateways to the wired Internet and other wireless services. Model-checking techniques and Implementation techniques [12] are used. The advantages of this approach are that it requires only minor changes to the MAC protocol and that it can work with standard hardware [1] [7]. Alternative authentication protocols that are lightweight and do not place restrictions on mesh formation remain an area. The experience of the Commines protocol [1] [15] shows this is possible but underscores the importance of rigorous validation.

A Structured Group Mobility Model for the Simulation of Mobile Ad Hoc Networks, This paper presents the Structured Group Mobility Model (SGMM) [16] [17], which parameterize group structure and generate movement sequences for use in simulations. The Routing algorithms [1] are used, the advantage that it allows a user to accurately describe the real-world behavior of groups with inherent structure. This paper presents a study of real-world group movement scenarios for mobile ad hoc networks. Groups in real-world MANET scenarios exhibit internal structure. A mobility model that captures structure inherent in groups produces different results than those that do not capture structure will continue to refine the SGMM with an eye toward broadening its application. In particular although described four real-world scenarios where groups move with internal structure have only simulated hierarchical [5] [6] military vehicle movements. Approximation Algorithms for Partial Covering Problems obtain a polynomial-time approximation scheme for k-partial [10] [11] [15] vertex cover on planar graphs, and for covering k points in Rd by disks. The Approximation Algorithms and Set cover algorithm [16] [18] are used. It presented improved approximation algorithms for a family of partial covering problems, upon these ideas and by employing semi definite programming. It has been shown that partial vertex cover in graphs with maximum degree d can be approximated.

R-Tree [1] [7] [15] is a Dynamic Index Structure for Spatial Searching present the results of a series of tests which indicate that the structure performs well, and concludes that it is useful for current database systems m spatial applications. Search algorithm, Insert algorithm and Deletion algorithm [1] [7] are used. The linear node-split algorithm proved to be as good as more expensive techniques. It was fast and the slightly worse quality of the splits did not affect search performance noticeably. Preliminary investigation indicates that R-trees would be easy to add to any relational database system that supported conventional access methods. Structure would work especially well in conjunction with abstract data types and abstract modules to streamline the handling of spatial data [15] [16].Some Methods for Classification and Analysis of Multivariate Observations The k-means concept represents a generalization of the ordinary sample mean, and one is naturally led to study the pertinent asymptotic behavior, the object being to establish some sort of law of large numbers for the k-means. The K-means clustering algorithm [1] [7] is used. Numerous classifications cheaply and thereby look at the data from a variety of different perspectives is an important advantage. Another general feature of the k-means procedure which is to be expected on intuitive grounds and has been noted in practice is a tendency for the means and the associated partition to avoid having the extreme of only one or two points in a set.

Convergent subsequences of the sequence of sample k-centroids will have their limits in the class of unbiased k points. Certain difficulties encountered in the proof of theorem 1 are caused by the possibility of the limit of a convergent sequence of k-points having some of its constituent points equal to each other. Clustering by Passing Messages between Data Points Clustering data [10] [11] by identifying a subset of representative examples is important for processing sensory signals and detecting patterns in data. The Max-sum algorithm and Expectation maximization (EM) algorithm [1] [7] one advantage of affinity propagation is that the number of exemplars need not be specified beforehand. Affinity propagation has several advantages over related techniques. Methods such as k-centers clustering K-means clustering and the expectation maximization (EM) algorithm store a relatively small set of estimated cluster centers at each step. Understanding their limits is a main open challenge. At the lowest level this means controlling the convergence properties or the quality of the approximate solutions that they find. A more ambitious goal is to characterize the problems where they can be useful.

Wireless mesh networks: a survey WMNs are anticipated to resolve the limitations and to significantly improve the performance of ad hoc networks, wireless local area networks (WLANs) [1] [17], wireless personal area networks (WPANs) and wireless metropolitan area networks (WMANs), are undergoing rapid progress and inspiring numerous deployments of the Sophisticated algorithms and Topology control algorithms [1] [7] [18]. The analysis is simplified by taking advantage of the low mobility feature of WMNs. The advantages brought by such physical layer techniques will be significantly compromised. Despite its advantages, an entirely new transport protocol [1] [15] is not favored by WMNs due to the compatibility issue. WMNs will lose the autonomic feature. However, current WMNs can only partially realize this objective. Current security approaches may be effective to a particular attack in a specific protocol layer [1] [13], but lack a comprehensive mechanism to prevent or counter attacks in different protocol layers.

Comparison of Routing Metrics for Static Multi-Hop [5] [6] Wireless Networks: A routing algorithm can select better paths by explicitly taking the quality of the wireless links into account. The Routing algorithm, Link-Max Life algorithm and their implementation takes advantage of 802.11 link-layer [2] [7] acknowledgments for failure detection. The primary advantage of this metric is its simplicity. Once the topology is known, it is easy to compute and minimize the hop count between a source and a destination. The primary disadvantage of this metric is that it does not take packet loss or bandwidth [9] [13] into account. There is the overhead of measuring the round trip time. We can reduce this overhead by using small probe packets (137 bytes). The metric doesn't explicitly take link data rate into account.

III.AUTONOMOUS SYSTEM

Some challenges in WMN propelled the ideas towards thinking and achieving gainsays.

***A. Motivation* What is the need for Autonomous system?** To improve and maintain the performance of WMN in case of dynamic link failures in the network, to withstand failures by

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enabling mr-WMNs [10][11] and to autonomously reconfigure channels and radio assignments, as in the following examples.

- Due to severe interference from collocated wireless networks the quality of wireless links in WMNs degrades (i.e., link-quality failure). Hence there is a need of recovery system that can successfully recover from link failure [9] [13].
- Satisfy the QoS demands.
- Maintaining compatibility with different types of network.

Motivated by these three and other possible benefits of using reconfigurable mr-WMNs, this work is proposed. ***B. Autonomous System*** **Algorithm 1**: AS Operation at mesh node

Step 1: Generate topology
Step 2: Start flooding information
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.
Step6: Check node/link failures else go to step 10
Step 7: Start reconfiguration and
e) Generate Reconfigure plan.
d) Re-establish path
Step 9: Start packet transmission
Step 10: Receive packets
Step 11: Stop

C. Overview of Algorithm

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 [5] [9] by detecting through continuous monitoring. Here the AS supports reconfiguration ability via the following distinct features.

• **Localized reconfiguration**: Based on multiple channels and radio associations available, AS generates reconfiguration plans that allow for changes of network configurations only in the vicinity where link failures occurred while retaining configurations in areas remote from failure [9] [12] [16] locations.

• **QoS-aware planning:** AS effectively identifies QoS-satisfy reconfiguration plans by:

1) Estimating the QoS-satisfy ability of generated reconfiguration plans; and

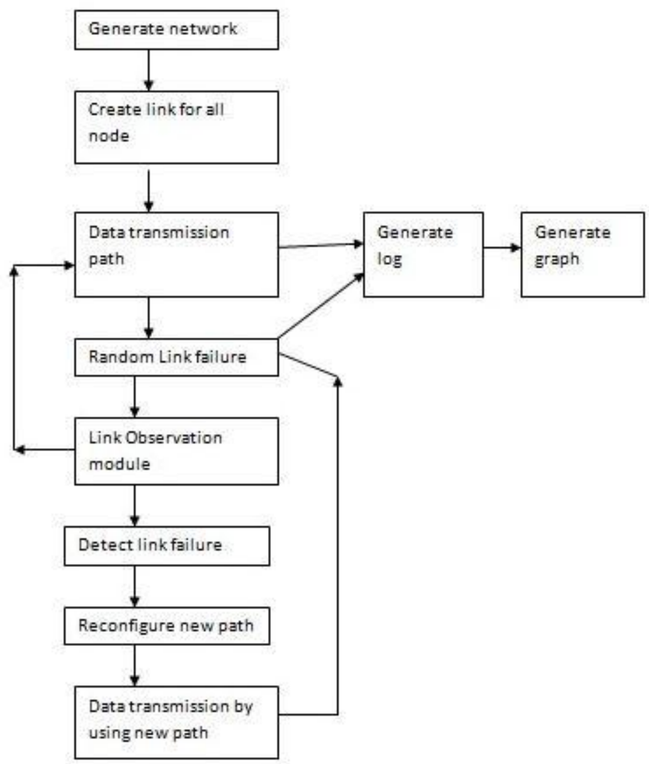
2) Deriving their expected benefits in channel utilization.

• **Autonomous reconfiguration via link-quality monitoring:** AS accurately monitors the quality of links in the mesh network.

IV. PROPOSED MODEL

1) ARS monitor the quality of the outgoing wireless links at every time period tm and then send the result to the control getaway via management message.

2) Once a control gateway has deleted a failure, ARS that are allocated in the detector node activates the group formation among the local mesh routers that are using a fully channel, after this a leader is elected among the group members by using bully algorithm for coordinating the reconfiguration.



3) Once the leader is elected it sends the planning request to the control gateway and the gateway synchronizes the planning requests and generates a reconfiguration plan for the request.

4) The reconfiguration plan is forwarded to the leader by the gateway and to the group members. All the member in the group reflects the corresponding configuration changes, and resolves the group

V. RESULTS

The simulation is done via NS2, thus the performance evaluation have compared the following network strategies:

Grid-mesh: The mobile mesh network follows the users by tracking only one randomly selected client. The network

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preserves the same grid topology as it moves over the application terrain. Specifically, WiMAX and LTE might be able to support broadband access for a given application terrain.

AMMNET: This is the own design experience of AMMNET, in which routers adapt their locations using only locally cached location information about some of the bridge routers. Global adaptation is also performed when the number of free routers at some user groups drops below a predefined threshold.

Global-AMMNET: Global-AMMNET is similar to the above AMMNET, except that global adaptation is performed by a randomly selected bridge router whenever any client moves out of the current network coverage area.

Oracle: A centralized scheme that assumes location information of all clients is available. The routers can move to the assigned locations in the network instantaneously without any moving delay. This scheme is only used as a bound for the purpose of performance comparison. Unlike AMMNET that uses the locations of the bridge routers to approximate the distribution of the user groups in the application terrain and constructs the R-tree based on these routers accordingly, *Oracle* constructs the R-tree using the exact locations of the mobile users. When there are not enough available routers to provide full connectivity for all the clients, this scheme favors user groups (R-tree nodes) with a higher density of clients.

Performance of Network Coverage
The performances of the network coverage under different network scenarios are explained below:

- **Impact of Router Moving Speed**

The number of available mesh nodes is not enough to cover all the clients in the simulation terrain. In the network terrain, there are 27 mesh nodes are deployed for the simulation and they are classified into five groups. The moving speed of router varies from the mean speed of clients to six times of the mean speed of clients. More number of routers is required to provide the communication coverage for the entire terrain. Otherwise the coverage will be decreased. AMMNET tracking the missing clients continuously, if it fails to track some missing clients means the number of covered clients will be reduced. Free router need to move fast to cover the network boundary region.

- **Number of Router Required to Provide Entire Network Coverage**

Assume that clients in the network classifying into four group. The AMMNET requires more routers to cover all clients in the network. All other parameters maintain a fixed topology and many routers in the network are wasted without any clients. Global adaptation performed in the AMMNET does not reclaim all redundant intergroup routers. Therefore AMMNET require more routers to cover entire network. AMMNET is scalable with increase in the number of mesh clients if clients are partitioned into a limited number of groups. AMMNET framework supported for the large dynamic number of mobile users, if they are partitioned into only a few number of groups.

- **Impact of mobility pattern on network coverage**

The communication coverage for clients is separated into different numbers of groups. The number of clients within the coverage area and number of router used to provide the coverage for the entire network. By continuously tracking mobile clients in the network, AMMNET can adapt to dynamic topology to connect all the clients in the network. By partitioning the clients into small groups, the number of router required to connect the clients will be increased. Each router forwards data at the transmission bit-rate of 11mb/s. From the total number of clients, some of the clients are randomly select four pairs of nodes to transmit UDP flows in the network.

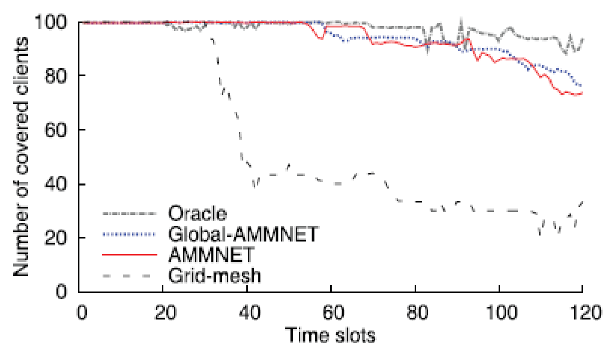

Fig 2 shows Number of clients covered by mesh nodes.

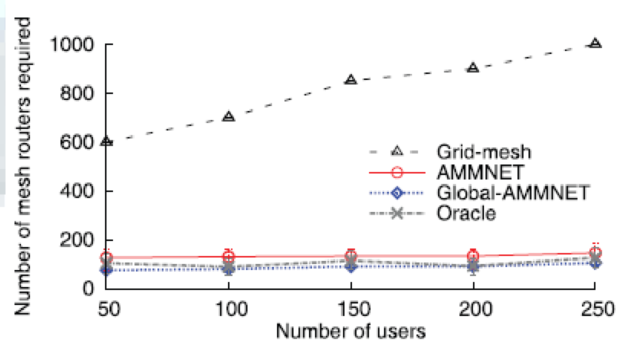

Fig 3 shows Number of routers required to cover various numbers of clients.

Performance of Data Forwarding
We let each MANET user act as a mobile router, which can transmit/receive its own data and also forward data for other users. The throughput of each method shown below, Oracle's throughput measured when the routing table in each router has been reconfigured after each topology adaption. The throughput of AMMNET is 33% greater than the Grid-based method, because some source destination pair is not served by

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any of the router. The throughput of Global-AMMNET degrades gradually when the moving speed increases.

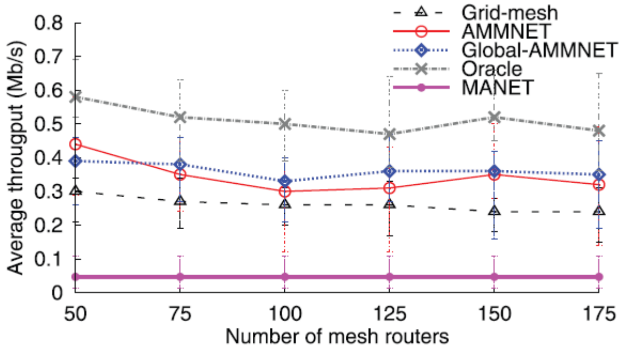

Fig 4 shows Impact of client moving speed

Wireless technology has been one of the most transforming and empowering technologies in recent years. It can forward data to mobile clients along with routing path and it is a robust against network partitioning. It can provide full connectivity to mobile clients AMMNET is fit for emulating the mesh clients in the application landscape, and arranging themselves into a suitable network topology to guarantee great network for both intra-group and intergroup interchanges.

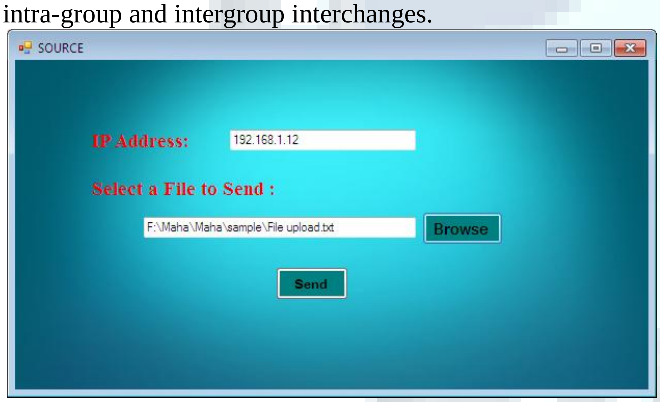

Fig 5 shows sending the data to the destination to provide its IP address.

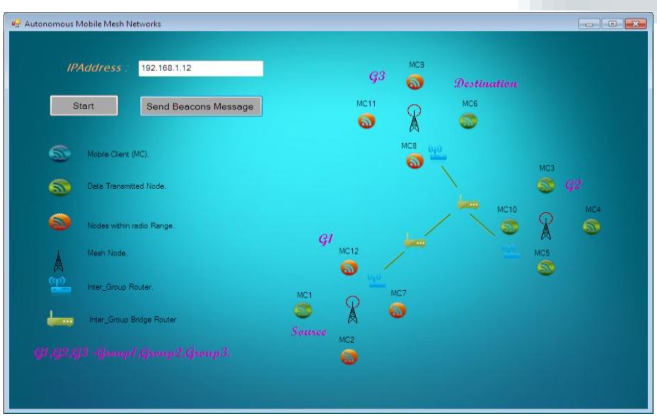

Fig 6: shows the network topology, here the intra-group and inter group routers are track mobile clients and dynamically adjust their topology accordingly to sustain the communication coverage for the clients

Fig 7: shows that the destination path must setup to receive the data successfully by the mobile client

The mesh clients initially concentrate in one group. All the mesh nodes position themselves within the same proximity to support communications inside the group. Mesh clients are moving in different directions. In this case the mobile mesh nodes reorganize themselves into a new topology not only to support intra-group communications, but also to support intergroup communications effectively preventing a network partition. The mobile mesh nodes adapt their topology to provide full connectivity for all the mesh clients.

VI.CONCLUSION

This paper attempts to build a healthy mesh network through AS. Autonomous System (AS) helps in resolving problems with link failures and recovery. Link failure and link recovery has been done with help of continuous monitoring. Once any changes or failure occur in WMN, Autonomous System (AS) starts reconfiguring the failure links/nodes. Evaluation results shows the success rate, Energy consumption, Throughput, link failure recovery and finally channel efficiency of AS is better than static (without AS) in WMN. Autonomous system proposed here is to increases the performance of WMN but energy consumption compared to system without using AS is more. Hence Energy consumption can be considered as an issue for the future work. We can solve this energy consumption issue by preserving and fulfilling the demands of WMN. Joint Optimization with Flow Assignment and Routing: AS decouples network reconfiguration from flow assignment and routing. Reconfiguration might be able to achieve better performance if two problems are jointly considered. Even though its design goal is to recover from network failures as a best-effort service, AS is the first step to solve this optimization problem, which could become future work.

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