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Autonomous Network Reconfiguration System In Wireless Mesh Networks

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Abstract— Wireless Mesh Networks (WMNs) are deployed in various applications such as public safety, wireless internet services, environment monitoring due to its effectiveness, inexpensive and comfortably. They have also been evolving in various forms such as multiradio/channel systems to meet the increasing capacity demands. However, WMNs may experience frequent wireless link failures due to channel interferences, dynamic obstacles and application bandwidth demands. Autonomous Network Reconfiguration System (ARS) that allows a multi-radio WMN (mr-WMN) to autonomously reconfigure its local network settings such as channel, radio, and route assignment for recovery from wireless link failures. In this paper, we present an Autonomous Network Reconfiguration System to reconfigure the network to provide continuous and an uninterrupted network settings with a reconfiguration plan. ARS has been evaluated through matlab simulation. We provide the simulation results to show the effectiveness of our proposed system.

Index Terms— Autonomous Network Reconfiguration System, Frequent Link Failures, Link Quality Monitoring, Multi Radio Wireless Mesh Network, Reconfiguration Planning, Uninterrupted network services, Wireless Mesh Networks.

1 INTRODUCTION

Wireless mesh networks (WMNs) is an emerging technology that uses wireless multi-hop networking to provide a cost-efficient way for community or enterprise users to have broadband Internet access and share network resources. Due to its fast deployment, easy maintenance and low upfront investment compared with the traditional wireless networks, WMNs has gained considerable awareness in recent years. There are many applications based on WMNs, such as public safety, environment monitoring, and wireless Internet services, the Portsmouth Real-time Travel Information System (PORTAL) which is used to provide real-time travel information to passengers, broadband home networking and so on.

Wireless mesh networks consists of mesh routers and mesh clients, where mesh routers have minimum mobility and form the backbone of WMNs. WMNs provide wireless network access for both mesh and conventional clients. The integration of WMNs with some other networks such as the Internet, cellular, sensor networks, IEEE 802.11, IEEE 802.15, IEEE 802.16, can be accomplished through the gateway and the bridging functionalities in the mesh routers. In WMNs, the mesh clients can be either stationary or mobile, form a client mesh network among themselves with mesh routers. The main objective to develop WMNs is to extend the coverage range of current wireless networks without sacrificing the channel capacity.

WMNs have been evolving in various forms such as multi-radio/channel systems to meet the increasing capacity demands by the emerging applications. Multi-radio technologies can be used to solve the problem of improving link capacity and reliability in WMNs due to the diminishing cost of hardware. To improve the scalability of WMNs, each node in the network is equipped with multiple channels which can also enhance the capacity and throughput of the network. Multi-hop wireless mesh networks experience frequent link failures caused by the channel interferences, dynamic obstacles, and bandwidth demands. These downfalls cause severe performance degradation in WMN.

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Autonomous network Reconfiguration System (ARS) that enables a multi-radio WMN to autonomously recover from local wireless link failures to preserve the network performance. By using the channel and radio diversities in wireless mesh network, ARS generates necessary changes in local radio and channel assignments in order to recover from those failures. Next, based on thus generated configuration changes, the system co-operatively reconfigures the existing network settings among local mesh routers.

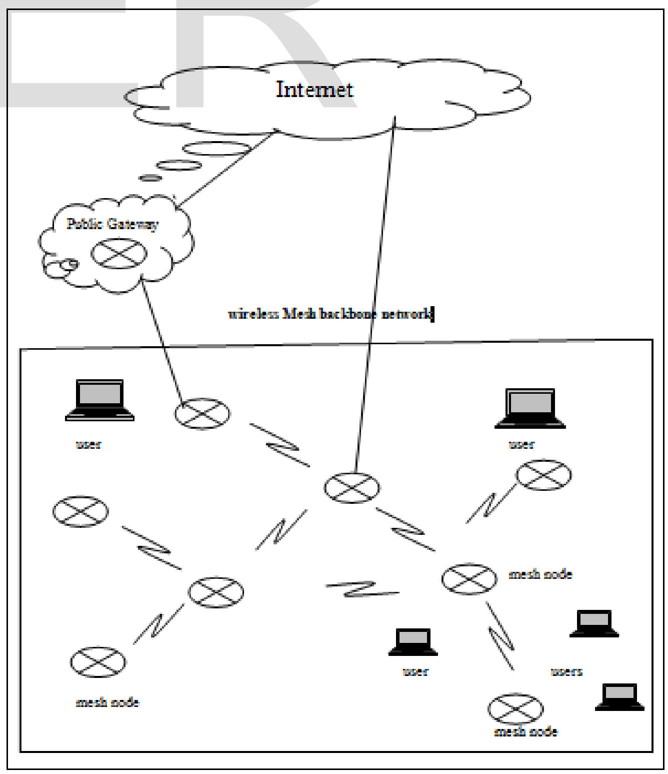


Fig 1. Wireless Mesh Network

To improve the performance of the ARS, the reconfiguration plan is made based on the energy of the nodes and thus network settings has been protected with continuous reconfiguration among the nodes.

2 Related Works

Multi-hop wireless mesh networks experience frequent link failures. These failures cause severe performance degradation in WMN. Maintaining the performance of WMNs in the case of dynamic link failures [2] is a challenging problem. The quality of wireless links in WMNs can degrade due to interference in other collocated wireless networks, dynamic obstacles, channel interference and/or applications' bandwidth demands. There are many solutions to recover the WMNs from wireless link failures.

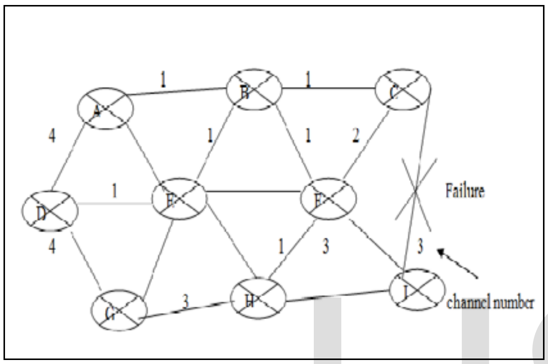


Fig 2. Multi radio WMN with link failure

First, Channel assignment and scheduling algorithms [1] provides schedulability for channel assignment during the deployment of network. But these algorithms often require global network changes because they are not consider the degree of configuration changes from previous network settings. These algorithms cause network service disruption, on static or periodic network planning, and thus are unsuitable for dynamic network reconfiguration that has to deal with frequent local link failures.

Next, greedy channel-assignment algorithm, which considers only the local areas in channel assignments, and thus reducing the scope of network changes than the channel assignment algorithms. However, this approach still suffered from ripple effect, in which one local change stimulates the change of additional network settings at neighbouring nodes due to association dependency among neighbouring radios [5]. This undesired ripple effect might be avoided by transforming a mesh topology into a tree topology, but this transformation decreases network connectivity as well as path diversity among mesh nodes. Third, Interference-aware channel assignment algorithms [10] can minimize interference by assigning orthogonal channels as closely as possible geographically. These algorithms may require global network configuration changes from changing local QoS demands, results in network disruptions.

ARS, that was used for recovering a multi-radio WMN from those problems discussed above. ARS generates reconfiguration plan that autonomously recover the mr-WMNs from wireless link failures. ARS systematically generates the reconfiguration plans together with the QoS aware planning, and it is done only after monitoring the link quality. ARS generates the reconfiguration plans into three processes like Feasibility, QoS Satisfiability and optimality together with different constraint levels such as connectivity, QoS demands and utilization.

First, the ARS [8] detect the faulty links or channels. Next, once it detects a link failure, ARS in the detector node triggers the formation of a group among local mesh routers that use a faulty channel, and one of the group members is selected as a leader, for coordinating the reconfiguration. Then, the leader node sends the planning request message to a gateway [3]. It will synchronize the planning requests, if there are multiples requests are acquired. and generates a reconfiguration plan for the request. Then, the gateway sends a reconfiguration plan to the leader node and the group members. Finally, ARS generates a reconfiguration plan that requires only local network configuration changes by exploiting channel, radio, and path diversity.

3 Proposed Approach

The overall modules of ARS are,

3.1 Network Construction
3.2 Link Quality Monitoring
3.3 Planning
3.4 Reconfiguration

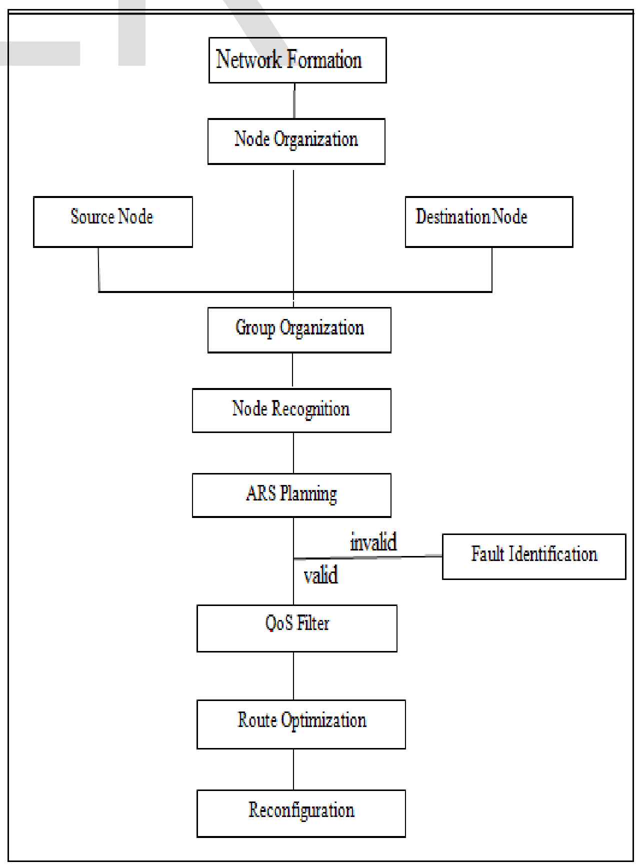


Fig 3. System Architecture

3.1 Network Construction

The network is to be constructed in the form of cluster. It should maintains the details of the node such as name of the node, data rate and the information about the neighbouring nodes to make the efficient route detection.

3.2 Link Quality Monitoring

In this module, the quality of the outgoing wireless links of every node is to be monitored to make the conclusion about those links in case of incoming and outgoing traffic and data rate. Hybrid link quality measurement technique is used here, to measure the status of the wireless network. It also maintains the information about neighbouring nodes.

3.3 Planning

In this module, the reconfiguration plans is to be identified based on the incident faults. By using the details of link-quality information the network is to be organized in to groups. Each router has a specific set of locations from which it can agree the data, and a specific set of locations to which it can send data.

ARS generates reconfiguration plans that localize network changes by dividing the reconfiguration planning into three processes.

i. Feasibility
ii. QoS Satisfiability
iii. Optimality

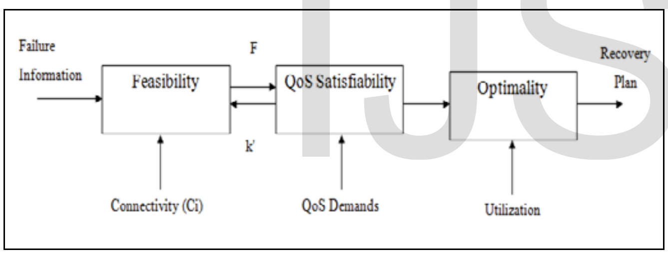


Fig 4. Reconfiguration Planning

i. Feasibility

Feasible plan generation is essential to search all of the valid changes in links' configuration and their combination around the defective area. Given multiple radios, channels, and routes, ARS identifies feasible changes that help avoid a local link failure but maintain existing network connectivity as much as possible.

ii. Qos Satisfiability

ARS identifies a suitable QoS satisfying reconfiguration plan, among the set of feasible plans by checking if the QoS constraints are met under each plan. Even though, every feasible plan ensures that a faulty link(s) will use the non-faulty channels.

iii. Optimality

ARS identifies a suitable QoS satisfying reconfiguration plan, among the set of feasible plans by checking if the QoS constraints are met under each plan. Even though, every feasible plan ensures that a faulty link will use the non-faulty channels.

3.4 Reconfiguration

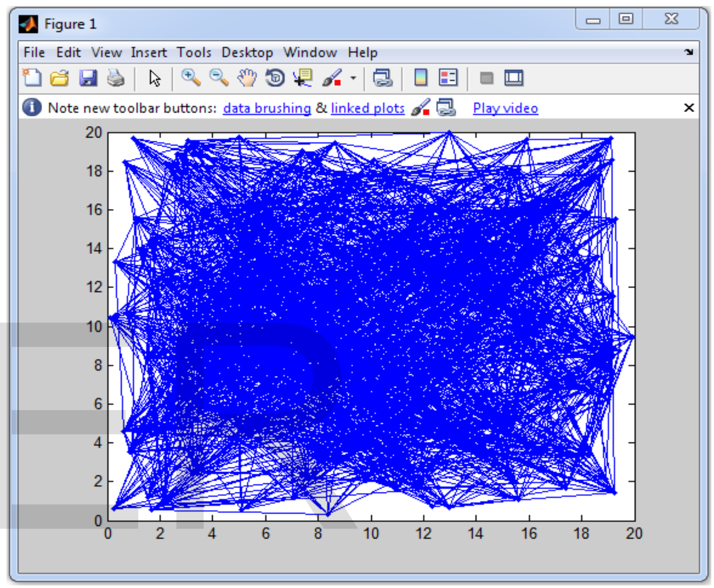
With the developed recovery plan, the ARS find out the optimal route, which provides high throughput between the source and the destination.

4 Simulation and Results

The simulation is performed using Matlab. Based on the energy of the nodes, ARS identifies optimal route, which provides high throughput between the source and the destination. The following results explores the ARS simulation in Wireless Mesh Networks.

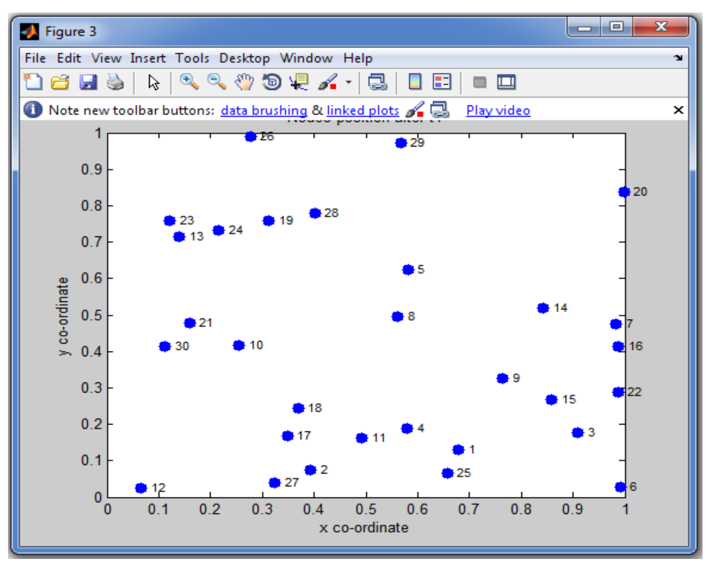
Fig 5. Mesh Network Construction

The above figure shows the simulation result of 'n' number



of wireless mesh nodes in the form of Wireless Mesh Networks.

Fig 6. Initial Network Reconfiguration



The above figure shows the simulation result of autonomous network reconfiguration system which is initially started in the wireless mesh network.

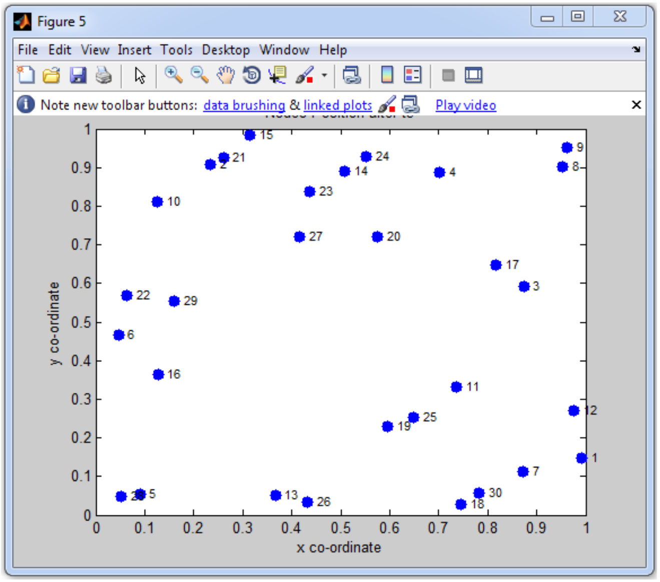


Fig 7. Continuous Network Reconfiguration

The above figure shows the simulation result of autonomous network reconfiguration system continuously happened in WMNs. Here Network Reconfiguration occurs for every 3 seconds of time period.

4 Conclusion

We presented the multi-radio Wireless Mesh Network that uses Autonomous Network Reconfiguration System to recover the problem of wireless link failures. ARS identifies possible changes that helps to avoid a local link failure but maintain existing network connectivity as much as possible. This paper proposed the Autonomous Network Reconfiguration System that provides the continuous and an uninterrupted network services by selecting the optimal route between the nodes based on the energy of the nodes in that network.

In future, the ARS can be developed with optimized route estimation in which, the link evaluation is to be done with the suitable routing metrics in WMNs.

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