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Improving Efficiency of Self Reconfigurable Techniques in Wireless Mesh Networks

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***Abstract*— In this paper, we describe the improvement in self reconfigurable technique in wireless mesh network. 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 Multiradio WMN to recover from link failure in an autonomous way. ARS checks and makes the necessary changes in the network. Based on the changes generated the network is reconfigured. We use AODV routing protocol for routing.**

***Keywords*— Multiradio 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. Fig.1 shows the example of Wireless mesh network 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].

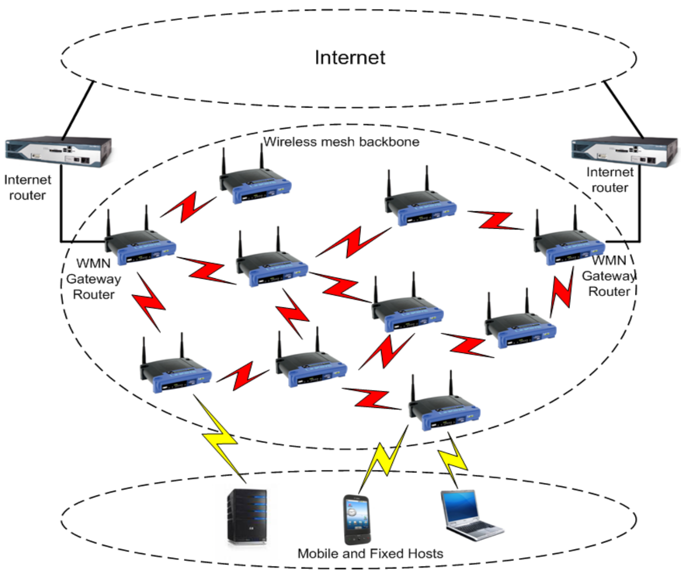

Fig.1. Wireless Mesh Network

Resource allocation algorithm: Allocates the resources initially. The drawback is even though they provide an 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. But problem is we need to know configuration of all neighbouring nodes in mesh along with the faulty link(s) [17].

Fault- tolerant routing protocol: can be used to avoid the faulty links. The examples is local rerouting, multipath routing. They are 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 Multiradio WMN to configure automatically its local network settings such as channel, radio and route alignment, so that it can recover from the link failures. In its heart the ARS is consisting reconfiguration planning algorithm 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. The remaining paper is explained follows- section II – Need of self reconfiguration, section III- ARS architecture, section IV Methodology, section V- Performance Evaluation and V- Conclusion of the paper.

II. Motivation

A. *Need of Self Reconfiguration:*

The following examples illustrates why self- reconfiguration is necessary.

Recovering from Link- quality degradation: The other collocated wireless networks can interfere and degrade the link quality of wireless links in WMNs [21] [19]. For example, cordless phones, Bluetooth that operate on similar or adjacent channels causes significant losses or collisions in the transmission of packets.

Satisfying dynamic Quality of Service demands: Depending on spatial or temporal locality the links in some areas may not be suitable to accommodate the increasing quality of service demands from end users [20]. Consider the links within a conference room may have to relay a large amount of data/video traffic during the session. Similarly, the relay links present outside the conference may not be able to satisfy the requirement of all attendees. The communication failures between links can be avoided by reassigning their channels with the unutilized channels available nearby.

Copying with heterogeneous channel availability: Links in some areas may be unable to access the channels during a period of spectrum failures. If the channel is being used for the emergency response then some of the links need to free the current channels.

B. *Network Model:*

Multiradio WMN: The network model is consisting of the mesh nodes, wireless links that are based on IEEE802.11, and a gateway that will act as a control gateway. Each node is having n- radios. Each channel for radio and link assignments is made using global channel/link assignment algorithms initially [9], [16], [17]. It is assumed that the interference among the multiple radios of a single node is negligible by using shields. The gateways are connected to the Internet via the wired links, and to the other routers via wireless links.

Link Failures: we mainly focus on the channel-related link failures that are the result of narrowband channel failures. For long term failures that last for weeks or months the network- wide planning algorithms are suitable and for the short term failures that occur in order of milliseconds the dynamic resource allocation can be sufficient. In this paper the hardware failures are not considered.

QoS Support: Each operating mesh node will periodically send its local channel usage and the quality information to control nodes via the management messages for its entire outgoing links. After that gateway is based on data from mesh node will control the admission of requests for voice or video flows. Then the networks will run the routing protocols. The route discovery and recovery algorithms are included in this routing protocol, which can be used to maintain the alternative paths in presence of link failures.

III. ARS Architecture

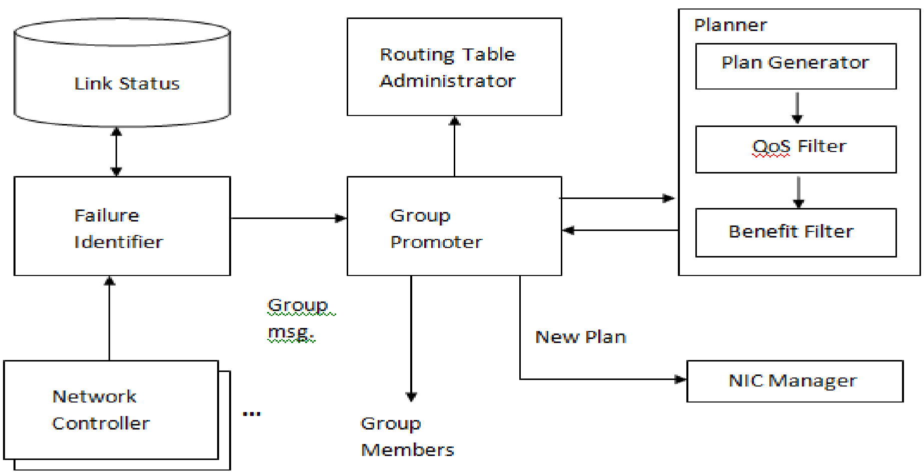

Fig.2. ARS Architecture

The fig.2 shows the architecture of ARS. ARS is provided with a hook so that it can capture and send the packets related to ARS similar to the group formation data. In addition, it also includes:
1] Network planner – that will generate the network reconfiguration plan in the gateway.
2] Group organizer – is responsible for the formation of local groups in mesh routers.
3] Failure detector – it interacts periodically with the network monitor that is in device driver and also keeps up-to-date link status.
4] Routing table manager - manages the state of the routing table.

Planning For Reconfiguration of Network:
To generate localized reconfiguration planning is the basic function of the ARS.A reconfiguration plan is defined as a set of links configuration changes that are necessary for a network to recover from the link failure on a channel, and there are multiple reconfiguration plans available for a single link failure [1] fig. 3 depicts the reconfiguration planning in the ARS. Initially the connection of network is going on so that a feasible reconfiguration plan that includes the channel, link & route channels in case of link failure is generated.

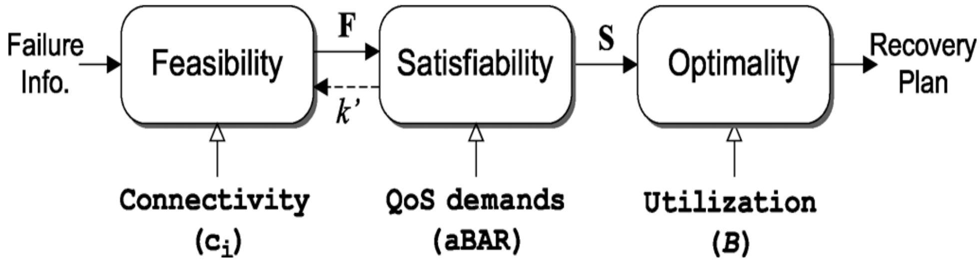

Fig.3. Localized reconfiguration planning in ARS

1) Feasible plan Generation:
ARS will detect the necessary changes in the local links so that the link failure can be removed. ARS maintain the exiting connectivity of the network.
The challenges to ARS in generating the feasible plan are-
- Avoid faulty channels.
- Maintaining network connecting and utilization.
- Controlling the reconfiguration changes.

2) QoS-Satisfiability Evaluation:
From the set of the feasible plans generated ARS has to choose the plan that satisfies the QoS constraint. Even though it is ensured all the plans generated will be avoiding faulty links, they may not satisfy the QoS consraint.ARS has to filter out such plans.

3) Choosing Best Plan:
ARS is having plans that also give the QoS constraint, now ARS will have to select a path that will have evenly distributed links capacity.

IV. METHODOLOGY

ARS runs in every mesh node and supports self reconfigurabiltiy through following distinct features:-
Localized reconfiguration: -
ARS generate reconfiguration plans that allows for changes of network configuration only in the vicinity where link failures occurred.
QoS-aware planning:
QoS-satisfiable is done by ARS by following steps:-
1. Estimating generated reconfiguration plans is estimated for QoS -Satisfiability
2. Expected benefits are derived in channel utilization.
Using link-quality monitoring for autonomous reconfiguration: Distributed manner ARS exactly monitors the quality of each node. ARS detects local link failure based on given links CSOS constraints and some measurements and finally sorts networks reconfiguration.
Cross layer interaction: There is interaction of ARS with networks and link layer for planning in link layer.

Algorithm:
1. Controlling period (Tc)
1 for each link m does
2 calculate link quality (lq) with the help of passive monitoring.
3 end for
4 send result to a gateway g of control.

2. Failure identifier and group organizing period (to)

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if link l is not satisfies link requirement r then
ask on channel h of link l of a group organizing
end if
if permission is permissible then start a leader election process
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3. Planning time (M, tp)

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if node e is a leader after election then
planning request message (h, m) to a gateway;
else if node is a gateway then
set Mn send again request for reconfiguration
for Mn generate a configuration plan (p)
leader of Mn collect the reconfiguration plan (p)
end if
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4. Reconfiguration node (p, TR)

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if p has changes of node e then
allot the changes to link at t
end if
relay p to neighbouring node, if any
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The above algorithm shows the operation of the autonomous reconfiguration system. There are four phases in the algorithm as described below:

1] *Controlling Period*: This period checks the link quality by passively monitoring the nodes and the results are forwarded to the controlling gateway.

2] *Failure Identification:* Once the control gateway obtained results, then gateway checks for the link failure. In case of failures the group is formed and a leader is elected.

3] *Planning period:* After electing a leader the reconfiguration plan is generated. There can be more than one plan for same link failure. The control gateway will choose the feasible plan.

4] *Reconfiguration node:* In reconfiguration node whatever changes are necessary for reconfiguration are made and the reconfiguration plan is relayed to the neighbouring node.

V. Performance Evaluation

We evaluate ARS in wireless network using network simulator. We describe first method of simulation and then present evaluation results on ARS.

A. *Method of Simulation:*

In our simulation, NS-2 simulator is used for study. In this simulator, we used 9 nodes to established network. AODV routing protocol is used as a link state routing protocol and Multiradio-aware routing metric (WCETT) are implemented and used for routing. In these setting, ARS is implemented as an agent in routing protocol. It collects channel data time to time and changes link association base on its decision. At that same time, information is send to routing protocol of network failure.

B. *Result Evaluation:*

We evaluate and compare results of network in both techniques static as well as ARS.

1) Impact on Throughput:

Throughput is the amount of work that can be performed or the amount of output that be produced by a system or component in a given period of time. It has a meaning similar to that of capacity. Fig. 4(a) compares the progression of link throughput achieved by the ARS and static methods. ARS effectively reconfigures the network on detection of a failure, achieving 450% more bandwidth than static assignment.

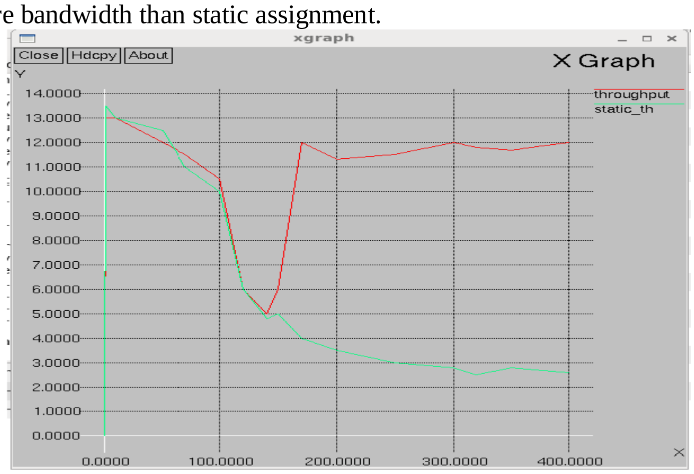

Fig4 (a) Impact on Throughput (MBpS)

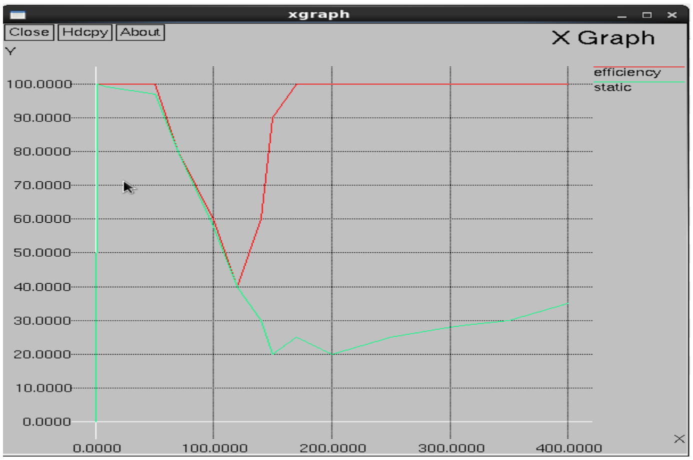

Fig4 (b) Effect on Channel Efficiency

2) Effect on channel efficiency:

ARS also improves channel efficiency (i.e., the ratio of the number of successfully delivered data packets to the number of total MAC frame transmissions) by more than 90% over the other recovery methods. Using the data collected during the previous experiment, we derive channel efficiency of the UDP flow by counting the number of total MAC frame transmissions and the number of successful transmissions. As shown in Fig. 4(b), ARS improves channel efficiency by up to 91.5%. On the other hand, using static channel assignment suffers poor channel utilization due to frame retransmissions on the faulty channel. Similarly, the local rerouting often makes traffic routed over longer or low link-quality paths, thus consuming more channel resources than ARS.

VI. CONCLUSIONS

This paper presented improvement of self-reconfiguration techniques in wireless mesh network. ARS system enables WMN to automatically change path of network locally. Using AODV routing protocol in ARS, throughput is increase up to 450% by static method. ARS also detect real time link failure and then reconfigure network so channel efficiency also improved up to 92% compare to static method.

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