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A Novel Method of Dynamic Self Reconfigurable Wireless Mesh Network

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Abstract—Wireless mesh networks (MMNs) are an emerging technology right now. During their lifetime, multi-hop wireless mesh networks (WMNs) experience frequent link failures caused by channel interference, dynamic obstacles and/or applications bandwidth demands. These failures cause severe performance degradation in WMNs or require expensive, manual network management for their real-time recovery. This project creates a Dynamic network Reconfiguration System (DRS) that enables a multi-radio WMN to autonomously recover from local link failures to preserve network performance. By using channel and radio diversities in WMNs, DRS generate necessary changes in local radio and channel assignments in order to recover from failures. Our evaluation results show that DRS outperforms existing failure-recovery schemes in improving channel-efficiency by more than 90%and in the ability of meeting the applications' bandwidth demands by an average of 200%. The paper is implemented by using .Net programming in windows operating systems.

Keywords—WMNS, .NET, DRS,

I. INTRODUCTION

Wireless mesh networks are an emerging technology right now. The use of mesh wireless networks may bring the dream of a seamlessly connected world into Reality.WMNS are being developed for variety of applications such as internet, public safety environment monitoring [1]-[3]. Unlike traditional ad-hoc wireless networks that have been motivated by mobile scenarios like the future battlefield, mesh networks have commercial applications such as community wireless access [11, 12]. In such networks, most of the nodes are either stationary or minimally mobile. They have also been evolving in various forms (e.g., using multi-radio/channel Systems [4]–[7]) to meet the increasing capacity demands by the above-mentioned and other emerging applications. However, due to heterogeneous and fluctuating wireless link conditions [8]–[10], preserving the required performance of such WMNs is still a challenging problem. Maintaining the performance of WMNs in the face of dynamic link failures remains a challenging problem. However, such failures can be withstood (hence maintaining the required performance) by enabling mr-WMNs to autonomously reconfigure channels and radio assignments, as in the following examples.

• Recovering from link-quality degradation

The quality of wireless links in WMNs can degrade (i.e., *link-quality failure*), due to severe interference from other co-located wireless networks. For example, Bluetooth, cordless phones, and other co-existing wireless networks operating on the same or adjacent channels cause significant and varying degrees of losses or collisions in packet transmissions. By switching the tuned channel of a link to other interference-free channels, local links can recover from such a link failure.

• Satisfying dynamic QoS demands

Links in some areas may not be able to accommodate increasing QoS demands from end users (*QoS failures*), depending on spatial or temporal locality. For example, links around a conference room may have to relay too much data/video traffic during the session. Likewise, relay links outside the room may fail to support all attendees' Voice-over-IP calls during a session break. By re-associating their radios/channels with underutilized radios/channels available nearby, links can avoid communication failures.

• Coping with heterogeneous channel availability

Links in some areas may not be able to access wireless channels during a certain time period (*spectrum failures*), due to spectrum etiquette or regulation. For example, some links in a WMN need to vacate current channels if channels are being used for emergency response near the wireless links (e.g., hospital, public safety). Such links can seek and identify alternative channels available in the same area.

To overcome these limitations we propose a Dynamic network Reconfiguration System (DRS) that allows a multi-radio WMN (mr-WMN) to dynamically reconfigure its local network settings—channel, radio, and route assignment—for real-time recovery from link failures. DRS is equipped with a reconfiguration planning algorithm that identifies local configuration changes for the recovery, while minimizing changes of healthy network settings. Briefly, DRS first searches for feasible local configuration changes available around a faulty area, based on current channel and radio associations. The paper is implemented by using .Net programming in windows.

Next, DRS also include a monitoring protocol that enables a WMN to perform real-time failure recovery in conjunction with the planning algorithm. The rest of this paper is organized as follows. Section II. provides the design rationale and algorithms of DRS. Section III describes the implementation and experimentation results on DRS. Section IV shows in-depth simulation results of DRS. Section V concludes the paper.

II. THE DRS ARCHITECTURE

In proposed system a network is assumed to consist of mesh nodes, IEEE 802.11-based wireless links, and one control gateway. Each mesh node is equipped with' n' radios, and each radio's channel and link assignments are initially made by using global channel/link assignment algorithms**.** DRS is a distributed system that is easily deployable in IEEE802.11-based mr-WMNs. Running in every mesh node, ARS supports self-reconfigurability via the following distinct features:

This DRS involves 5 phases.

1. Monitoring network phase.
2. Failure detection
3. summing formation
4. Generating localized reconfiguration plan
5. Implementing reconfiguration

1. Network monitoring

In this 1st module each mesh node monitors the quality of its outgoing wireless links at every t_m sec (eg.10 sec) the status of the results are reported to the gateway.

2. Failure detection phase

System detects the failure by comparing the current link state information with that in the existing database. After detecting the failure status is send to the next stage.

3. Group formation

In this phase whenever a failure is detected all the mesh nodes that use a faulty channel are grouped together and one of the group members will be elected as a leader by using the well-known bully algorithm and this leader node will send a plan request message to the gateway.

4. Generating the localized reconfiguration plan

This phase is again broken down into 3 sections.

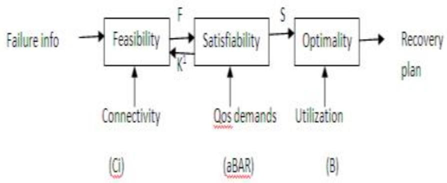

Figure 1: localized reconfiguration plan method

Firstly the **'**feasibility' section, in this it takes two inputs i.e. failure information & connectivity (c_i) constraints which produces a set of feasible reconfiguration plans 'F'. The next section is QoS- satisfiability evaluation that Applies QoS constraints to 'F' and ultimately produces a set of QoS satisfiable reconfiguration plans 'S'. From the reconfiguration plans the next task is to choose the best plan. This is the main task in this module by selecting the best plan we perform the reconfiguration effectively. Here we get the best plan by applying utilization this action constraints on the above set's'.

These 3 sections are illustrated as follows,

The feasible plan generation consists of 2 steps

Step (1): for each link possible changes are generated.

Step (2): All the generated changes of the neighboring links are combined & there by forming a set of feasible plans 'F'.

These steps are as shown in below figures.

Primitive changes	Description
Channel switch $(S(A_i, B_j)_{\alpha\to\beta})$	Radios A_i and B_j of link AB switch their channel (α) to other channel (β).
Radio switch $(R(A_i, B_j)_{\alpha\to\beta})$	Radio A_i in node A re-associates with radio B_j in node B, tuned in channel (β).
Detouring $(D(A_i, B_j))$	Both radios A_i and B_j of link AB remove their associations and use a detour path, if exists.

Figure 2: Primitives changes to each link

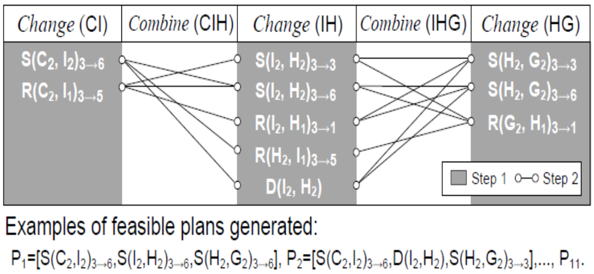

Figure 3: links are combined

And next QoS- satisfiability evaluation section also consists of 2 steps.
Step(1): For each feasible plan we will estimate links bandwidth .Based on bandwidth the next process is done ie satisfiablity for each link is analyzed.
Step(2): we will check the bandwidth requirement satisfiability for each link by using the formula BAR = q/c where q- given bandwidth requirement ,c-link's capacity.
Finally, a particular feasible plan is considered as a QoS satisfiable plan only if BAR < 1 for each link. Depending up on the BAR less than the choosing the best plan is done. Choosing the best plan section also consists of 2 steps.
Step(1): we will estimate the benefit function for each QoS satisfiable reconfiguration plan 'p'. And is calculated by using the formula,
$B(p) = 1/n \quad \sum^{n}_{k=1} \beta(k)$
Where, p- QoS satisfiable configurations plan. β(k)- Relative improvement in the air-time usage of radio 'k'.

$$\beta(k) = \begin{cases} \epsilon_1(k) - \epsilon_2(k) & \text{if } \epsilon_1(k), \epsilon_2(k) > \delta \\ \epsilon_2(k) - \epsilon_1(k) & \text{if } \epsilon_1(k), \epsilon_2(k) < \delta \\ \epsilon_1(k) + \epsilon_2(k) - 2\delta & \text{if } \epsilon_1(k) > \delta > \epsilon_2(k) \\ 2\delta - \epsilon_1(k) - \epsilon_2(k) & \text{if } \epsilon_2(k) > \delta > \epsilon_1(k) \end{cases}$$

Where €1(k) and €2(k) are estimated aBARs of a radio K in existing configurations and in new configurations respectively and δ the desired channel utilization n- number of radios whose β(k) has been changed because of plan 'p'.
step(2) : The plan having the highest value of B(p) will be chosen as the best reconfiguration plan. There are some situations where multiple plans have same value of B(p). Then in that case we will break the tie among those multiple plans by choosing the best plan which involves less no. of link configuration changes.
This is how a reconfiguration plan is generated.

4. Implementing reconfiguration plan
Here firstly the gateway sends reconfiguration plan to the leader node then leader node distributes it to all other nodes in the group and then each node executes the corresponding configuration changes.

III. SIMULATION RESULTS

The implementation part is the most important phase of the project. In this phase, we code the entire project in the chosen software according to the design laid during the previous phase. The code has to be in such a way that the user requirements are satisfied and also not complicated for the user i.e., the user interface or GUI has to be easy to navigate. The code should be efficient in all terms like space, easy to update, etc. In this manner, we can complete the coding part of the paper and later it can be sent for testing before being delivered to the customer.

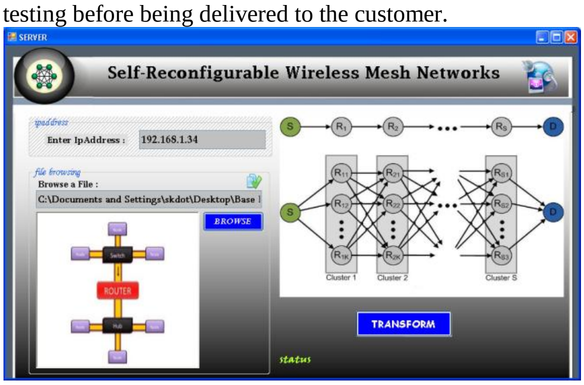

Figure 4 : Destination router IP address

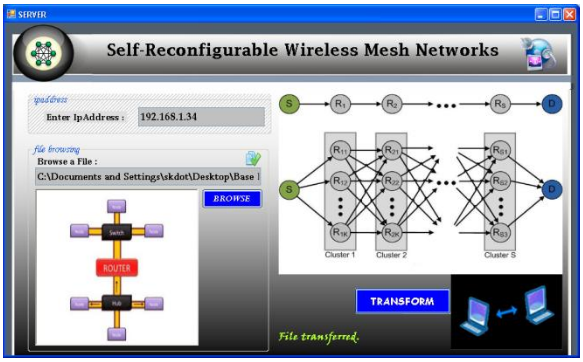

Figure 5: Acknowledge of data transmitted

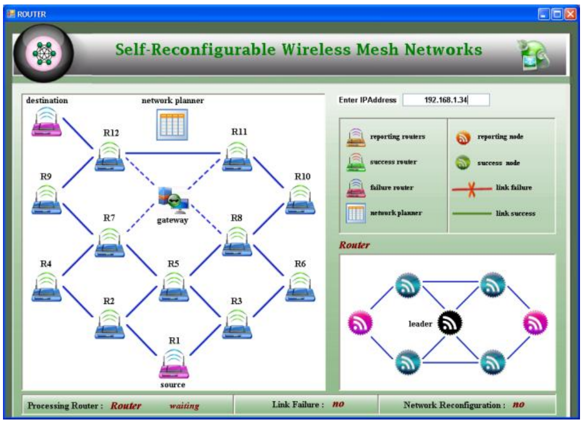

Figure 6: Output of Actual status of network

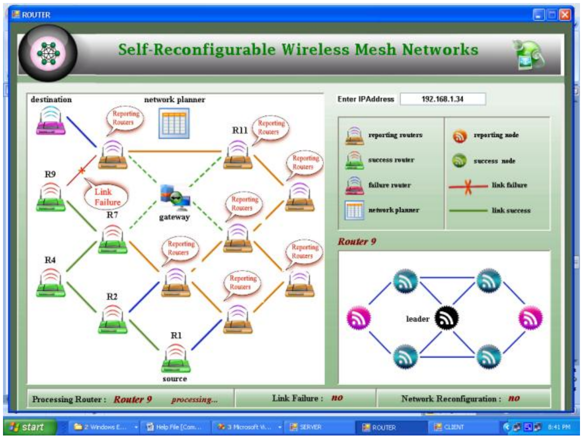

Figure7: Figure showing failure status and formation of group

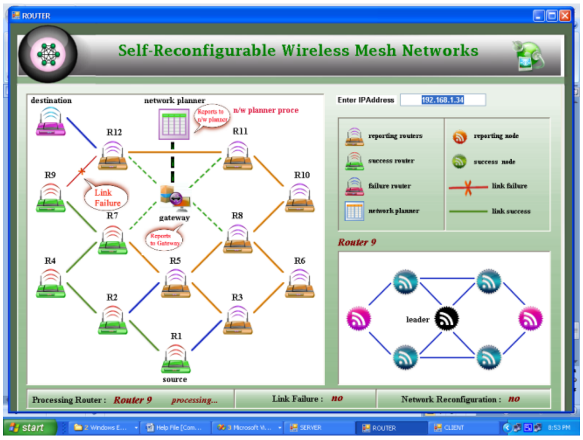

Figure8: figure showing the leader node sending plan request to gateway (r8 selected as leader)

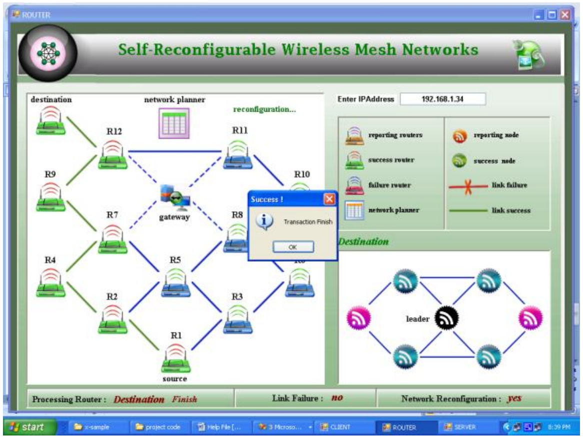

Figure 9: Reconfigured link

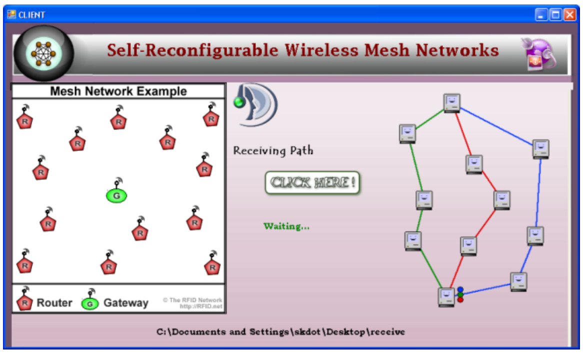

Figure10: Receiver status

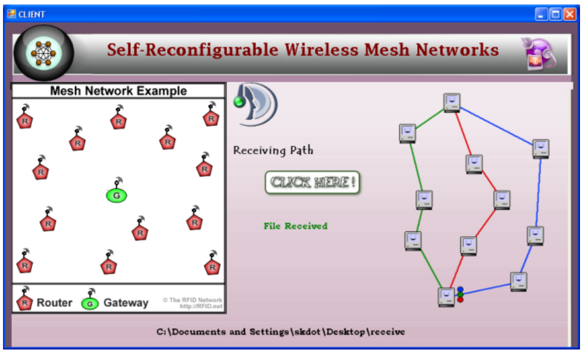

Figure 11: After reconfiguration figure showing file received

IV. RESULTS ANALYSIS

In this first we need to find the Destination router IP address is to be known to send the data .then we acknowledge the transmission of data that output can be seen from fig 5 .Actual status of n/w can be seen from fig 6. Where the 13 nodes interconnected status is shown. If at any given time if a node fails the failure status and formation of group is formed fig 7.then the leader node sends plan request to gateway for example here the node R8 selected as leader Reconfigured link. Then accordingly from the available node the best plan is selected and reconfiguration is done. Then after reconfiguration the receiver status can be seen from 11 after the file has been received.

V. CONCLUSION

This paper presented an Dynamic network Reconfig-uration System (DRS) that enables a multi-radio WMN to autonomously recover from wireless link failures. DRS generate an effective reconfiguration plan that requires only local network configuration changes by exploiting channel, radio, and path diversity. Furthermore, DRS efficiently identifies re-configuration plans that satisfy applications' QoS constraints, by use of DRS the channel efficiency is improved by 90 %.Our experimental evaluation on a windows-based implementation and ns2-based simulation have demonstrated the effectiveness of DRS in recovering from local link-failures and in satisfying applications' diverse QoS demands. Here 13 nodes are taken as example.

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