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Study of various Link Failure Detection Techniques and Link Recovery Mechanisms in Wireless Mesh Networks

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Abstract—Wireless Mesh Networks provide effective communication services to meet the growing needs of cost effective and dynamic bandwidth requirements over large distance. The functioning of wireless mesh networks may suffer from recurrent link failure which degrades the performance of network. Link failure detection and Link recovery is extremely important in improvising the performance of Wireless Mesh Network. This paper aims at presenting the review of various techniques used for link failure detection and the mechanisms used for recovery of wireless mesh network.

Keywords-Wireless Mesh Networks, Link Failure, link recovery, transmission errors, self-reconfiguration

I. INTRODUCTION

Development and deployment of Wireless Mesh Networks are being used for a wide range of applications such as, public welfare and protection, monitoring environmental conditions and citywide wireless internet services [1]. To meet the increasing capacity demands by these applications, wireless mesh networks are evolving in a variety of forms (e.g., using multiradio/channel systems [2]-[5]. But, retaining the required performance of such wireless mesh networks is challenging due to heterogeneous and unstable wireless link conditions [6-8]. For example, there may be channel interference from other existing wireless networks. Some parts of networks might not be able to accommodate increasing bandwidth demands from new users and applications. There are many solutions available for wireless mesh networks to recover from wireless link failures. But, they still have the following limitations. Theoretical guidelines for initial network planning are provided by resource allocation algorithms [9-11]. However, even though these algorithms provide an optimal network plan, these approaches often require global configuration changes, that are unacceptable in case of local link failures. In Section II related work pertaining to link recovery in Wireless Mesh Networks is described. Section III describes the need for self reconfiguration. Section IV covers the various methods available for detection of link failure and Section V concludes the paper.

II. RELATED WORK

There are various methods used for link recovery in wireless mesh networks [13]. Some of them are noted down below.

Resource Allocation Algorithm: This algorithm allocates the resources at the start. They use some theoretical guidelines for allocation of resources. This technique has drawback of Global reconfiguration Changes". 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 [10] [12]. A new method called "Joint Channel Assignment Method" was proposed by the authors Bhati, Li & Alcherry, which make use of mathematical concepts for handling the channel assignment and routing problem[10].The various issues like interference and channel availability are being taken into account in this technique

Greedy Channel Assignment: This technique abolishes the main disadvantage of "Resource Allocation Method by changing only the faulty link instead of changing the entire network. But the

drawback is , it is necessary to know the configuration of all neighbor nodes in mesh along with the faulty link(s)[14].

Fault Tolerant Routing Protocol: Routing protocols play major role in recovery of link failure. It can be used to strike out the faulty links. There are some of fault tolerant routing protocols available such as local rerouting, multipath routing. This routing protocol is based on redundant transmission, which needs more network resources than the reconfiguration in link-level network [15].

Autonomous Reconfiguration System (ARS): The autonomous reconfiguration system (ARS) proposed by Kim and Shin succeed in dealing with the above mentioned limitations [16]. This algorithm generates set of reconfiguration plans by considering the range of channel & radios of network. The reasonable plan is selected from the set of this reconfiguration plan. This increases the network throughput and also meet some QoS constraint of network. The prime drawback of ARS is that it is not cost effective reconfiguration technique.

III. NEED OF SELF RECONFIGURATION

The working of Wireless Mesh Networks is dependent on link. The performance of wireless mesh networks is highly affected by link failures. Link recovery can be managed by using hand-operated network management system. But it is highly expensive procedure and also unmanageable to implement in case of dynamic link failure [17].To succeed in dealing with all the above mentioned problems, self reconfigurability of network is highly needed.

Following are some of the examples that illustrate the need for self re-configurability.

Recovering from Link- quality decline: The link quality of wireless links in wireless mesh networks might be degraded due to the interference of other collocated wireless networks [18] [19]. For instance, cordless phones, Bluetooth that operate on similar or adjacent channels cause major losses or collisions within the transmission of packets.

Satisfying QoS demands: The links in some areas may not be appropriate to adapt the increasing QoS demands from end users [20]. For example, the links within a meeting room may have to transmit a huge amount of data/video traffic during the session. In the same fashion, the relay links present outside the meeting room may not be able to meet the requirement of all the participants. The communication breakdown between links can be avoided by reassigning their channels with the unutilized channels available nearby.

Channel usage based on priority: Links in some parts of areas might not be able to access the channels during a period of spectrum failures. If the channel is required for the emergency response then several links must need to free the current channels.

IV. DETECTING LINK FAILURE IN WIRELESS MESH NETWORKS

Detecting link failure plays significant role in working of wireless mesh networks. There are many techniques available for detection of link failure.

Detecting Link Failure by using Neighbor Discovery Technique: This Mechanism uses the concept of HELLO message. HELLO messages are sent by all the nodes of network
to all other neighbored nodes in its communication range. When the link receives number of HELLO messages, it is considered to be in good state and can be used for routing of packets. If there is absence of HELLO messages on link for specified time duration, it is considered that the link failure has occurred. Due to longer delay, this approach is not suitable for link failure detection in case of Real Time applications.

Detecting Link Failure by using Cross Layer Mechanism: In this Approach, the acknowledgement is sent for every frame received by MAC. The frame gets retransmitted if the acknowledgement is not received. Retransmission of the frame is repeated for specific number of times and after that the delivery is considered to be failed and frame is lost. Detection of link failure is performed on the basis of number of failed delivery occurred in MAC layer along with the information about transmission errors. When compared to neighbor discovery mechanism, the cross layer approach is advantageous.

The correctness of Link Failure detection is dependent on the correct identification of transmission errors. Mainly there are two types of transmission errors namely, transient error and permanent Error. Transient error can be abolished by retransmitting the frames in MAC layer. Whereas permanent errors have to be handled differently. The permanent link failure can be handled at routing layer by selecting alternate path for routing of packets during communication. It is very essential to detect the type of error correctly otherwise false alert occurs. The meaning of false alert is that the transient errors are misunderstood as permanent error. Due to such errors, the additional overhead of re-routing of packets may arise. To avail the better performance of wireless mesh network the false alert must be controlled and avoided.

V. CONCLUSION

As the need of wireless mesh network is increasing rapidly, detection and recovery of link failures and has become one of the most significant issues. In this survey, we have reviewed various Link Failure Detection techniques and also the methods used for link recovery in wireless mesh networks.

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