Interference and Congestion Aware Routing in Multi-radio Wireless Mesh Networks

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Abstract— **In order to maximize the network throughput many works have been processed in Wireless Mesh Networks. But all of the proposed systems are based both advantages of the static and dynamic channel allocation approaches have been combined to improve the throughput, where each mesh node has both static and dynamic interfaces. Adaptive dynamic on either purely static or purely dynamic channel allocation approaches. In current proposed system Channel Allocation (ADCA) protocol is used to reduce the delay in the network and considers the optimization of throughput. Interference and Congestion Aware Routing (ICAR) protocol balances the channel usage in the network. Advanced Encryption Standard is used to provide security. The hybrid architecture shows better adaptively to change the traffic than purely static approaches.**

I. INTRODUCTION

Wireless mesh networking [1] has attracted great research recently. Wireless Mesh Network has become a promising technology that has the potential to enable many useful applications. The major problem facing mesh networks is the capacity reduction due to wireless interference [2] [3] [4]. Technology advances have made it possible to equip a wireless mesh router which can be configured to different channels, with multiple radios, and thus reducing network interference.

Therefore, a major challenge in multi-channel wireless mesh networks is the allocation of channels to interfaces of mesh routers so as to maximize the network capacity excellently. There are currently two approaches for channel allocation the first is, static approach and the second is dynamic approach.

In static channel allocation, permanent channels will be assigned to each interface of every mesh router. In second approach that is dynamic channel allocation, an interface will switch from one channel to another channel frequently. Both strategies have their own advantages and disadvantages. Static strategies have lower overhead because they do not require interfaces to switch channels.

However, they depend on stable and predictable traffic patterns in the network. For example, [5] [6] [7] require that

the exact traffic profile is known beforehand, while [8] [9] assumes knowledge of statistical traffic patterns. Dynamic strategies have higher overhead than static strategies because they require frequent channel switching, such as [10] [11] [12] [13]. The dynamic strategies are more appropriate when the network traffic changes frequently and is unpredictable however, as the channel allocation can be changed with the changing traffic. There are several important issues to be discussed in the hybrid wireless mesh network.

(1) The system architecture:

where one radio works as dynamic interface and the other radios work as static interfaces in each node.

(2) The channel allocation for dynamic interfaces:

MMAC [11] is currently one of the most efficient dynamic channel allocation protocols. The channel assignment in MMAC will be optimized for the improvement of network throughput. Adaptive Dynamic Channel Allocation protocol (ADCA), was proposed which considers optimization in both delay in the channel assignment and throughput. ADCA is able to reduce the packet delay without degrading the network throughput when compared with MMAC.

(3) Network routing decision:

In the hybrid structure, for the purpose of transmitting the data we have static links and dynamic links. For the purpose of improving the network throughput we propose an Interference and Congestion Aware Routing protocol (ICAR). There are currently two approaches for channel allocation the first is, static approach and the second is dynamic approach.

2. RELATED WORKS

Wireless mesh networking is becoming an important technology that enables many useful usages, which including community networks, broadband Internet access, broadband home networks etc. A survey has been provided. A major problem facing multi-hop wireless networks is the capacity reduction due to interference among adjacent wireless links.

There have been some studies on the effect of wireless interference on the same channel, and on partially overlapping channels. With constraints from conflict graph, and gave the lower and upper bound of the problem which they formalized it as a multi-commodity flow problem.

In order to increase the interference and also to increase the throughput there have been many studies on how to assign limited channels to network interfaces in a multi-radio multichannel wireless mesh network the most basic channel allocation strategies are as follow:

1) When the interfaces of the channels are assigned permanently then it is called static channel allocation.

2) When interfaces are allowed to switch to different channels, then it is called dynamic channel allocation.

For each mesh node, when one interface acts as static interfaces then another interface acts as dynamic. The constitution of a major portion of the traffic in the network is the channel allocation of static interfaces which aims at maximizing the throughput from source to destination. In heuristic algorithms, for each gateway a load balanced tree is constructed. With regard to the user-gateway throughput the goal of the tree construction is to allocate bandwidth fairly to each user.
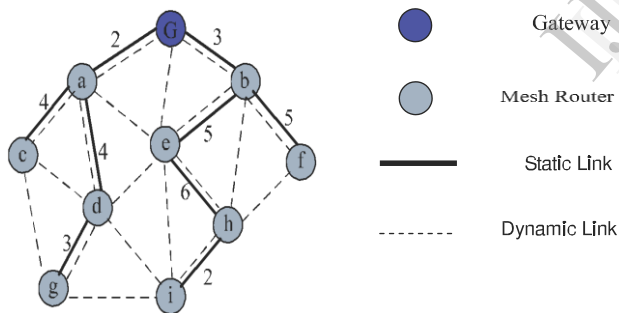

Figure 1. The Hybrid WMN Architecture

Each link can then be assigned channels, after the topology has been constructed. The links closer to the gateways are given higher priority to be allocated with less congested channels. The bold lines represents the tree topology is shown in which is named as static links. The figure illustrates the channels assigned to static links. Dynamic interfaces work in an on-demand fashion.

3. SYSTEM MODEL

3.1. Adaptive Dynamic Channel Allocation (ADCA) protocol:

The throughput of wireless mesh networks can be dramatically increased by utilizing multiple channels instead of a single channel. MMAC [11] is a dynamic channel allocation protocol for wireless mesh networks, where each node has a single dynamic interface. In MMAC, the time is divided into control interval and data interval each of which is called as fixed length intervals. In the control interval, any two nodes that have data to transmit communicate on a default channel or control channel to negotiate the channel to use in the data interval. Pairs of nodes transmit and receive data on the negotiated channels in the data interval.The network capacity can be improved at the cost of in-creasing packet delivery delay by using MMAC protocol. When the traffic load is below saturation the unnecessary packet delay may be caused by MMAC, which can be illustrated by the examples in Fig. (2. 1). The Figure, assume A has some data to send to C.
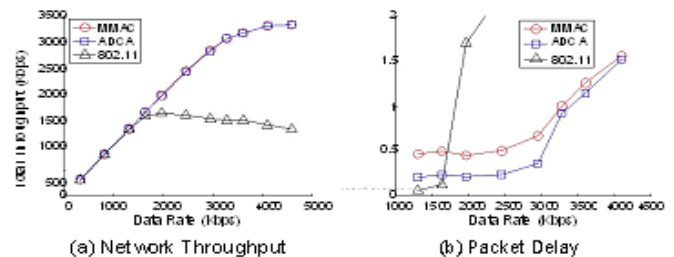

Figure 2. Performance of ADCA

The packets are transmitted from B to C according to MMAC the packets are transmitted from A to B, and then in the second interval t2, in the first time interval t1. Therefore, the packet delay is around two intervals. On the other hand, if we assign A, B and C with the same channel, and use 802.11 to resolve contention in this sub network, the packets can be transmitted from A to C within one interval. 2) In Fig.2 (b), assume A has some data to both B and C, with the aggregate traffic rate of less than R.

We can see that MMAC still needs two intervals to complete the transfer of message, which can be actually be done in one interval by assigning the same channel to all the three nodes. Just needs to alternatively transmit data to B and C to avoid collision. The reason why MMAC causes unnecessary delay in the above cases is that only pairs of nodes negotiate common channels in each interval, and thus each packet can be trans-mitted at most one hop away in one interval.

3.2. Interference and Congestion Aware Routing (ICAR) protocol:

The previous routing metrics proposed in wireless mesh networks include hop count, RTT, ETX, ETT, WCETT. These metrics aim at finding a good quality path. In this paper, with both static links and dynamic links our goal is to maximize the total throughput in the hybrid network. We want the routes of different flows to be selected efficiently thereby avoiding congestion in the network and the channel usages are balanced at each node. An interference and congestion aware routing metric was proposed as follows.
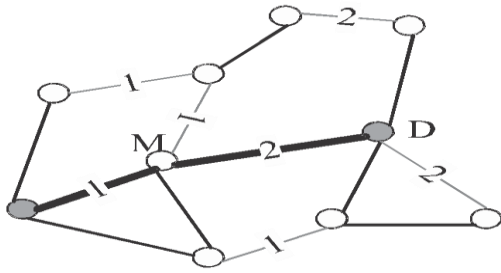
Figure 3. Effect of Interflow Interference

In Fig.3, assume the routing path of a flow from S to D is illustrated in bold lines, and the rate of the flow is r. All the wireless links that interfere with the routing path are plotted in grey lines. The transmission of flow will be consumed in the network while considering the bandwidth. The flow will consume bandwidth of r on link SM. However, there are three other links that interfere with link SM. We may think that the flow is also consuming the same bandwidth in the other interfering links as interfering links cannot be active at the same time. It is a similar case with link M D. Actually the flow consumes the bandwidth of multiple links in the network, although it is routed through two wireless links.

To describe it formally, let P be the routing path of a flow with rate r. For each link l 2 P, let IE (l) be the set of links that interfere with l (assume IE (l) also contains l). Let ET X (l) is the expected transmission count of link l.

3.3. channel negotiation: algorithm:

Pending Node
1:   Broadcast PNODE REQ message to notify its neighbours that it is a pending node.
2:   if receiving SWITCH CHNL then
3:   Switch to channel c indicated in the message.
4:   end if

Sending Node
1:   if its queue length for the receiving node < QT then
2:   Broadcast SNODE REQ message
3:   end if
4:   if receiving SWITCH CHNL then
5:   if it's receiving node (r) is not negotiating with any other sending nodes then
6:   Switch to channel c indicated in the message.
7:   Notify r to switch to channel c.
8:   end if
9:   end if

Receiving Node
1:   if the queue length of its sending node < QT then
2:   if receiving PNODE REQ then
3:   Send SWITCH CHNL message to the pending node including its own channel c.
4:   end if
5:    if receiving SNODE REQ then
6:   Send SWITCH CHNL message to the sending node including its own channel c.
7:   end if
8:   end if

4. PROPOSED SYSTEM

Hybrid architecture combines the advantages of both static and dynamic approaches. One interface from each router uses the static channel allocation strategy, while the other interfaces use the dynamic channel allocation strategy in the newly proposed architecture. From end-users to the gateway, the links working on static channels provide high throughput paths. The links working on dynamic channels enhances the network's adaptively to the changing traffic and the network connectivity.

Therefore, the hybrid architecture can achieve better adaptively compared to the purely static. Much increase of overhead compared to the purely dynamic architecture. The advantages of both the static and dynamic approaches are combined in the proposed hybrid architecture. In proposed system one interface from each router uses the dynamic channel allocation strategy. The other uses the static channel allocation strategy. AES algorithm provides more secure transmission of data.

4.1 Node Activation:

Much number of nodes can be created by the user as per the desire. Users enter the IP Address, PORT Number and Status of the node to register in the Database. If the nodes are already registered the intimation message will be sent to the user otherwise the nodes will be registered in the database.

4.2. Path Construction:

The path will be constructed as per the minimum/shortest distance. Then the channels will be allocated as per the channel switching. If the intermediate node is free static channel allocation will be used, if it is busy dynamic channel allocation will be used. The switching can be executed by ICAR protocol.
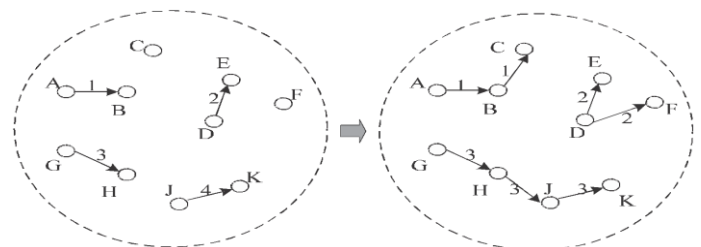

Figure 4. Path Construction

4.3 message transmission:

Finally the message will be transmitted from the source to destination. Initially static channel allocation will be chosen without ICAR protocol and the data will be transferred. If the intermediate node is busy dynamic channel allocation will be chosen with ICAR protocol. The secure transmission can be done by using AES algorithm.

5. CONCLUSION

In case of hybrid wireless mesh network architecture, each mesh node has both static and dynamic interfaces has been proposed. The newly, proposed adaptive dynamic

channel allocation protocol is to be used on dynamic interfaces. ADCA reduces the packet delivery delay without degrading the network throughput compared with MMAC. In addition, an interference and congestion aware routing algorithm in the hybrid network balances the channel usage in the network and therefore increases the network throughput. Compared to the purely static architecture, new approach is more adaptive to the changing traffic. The proposed new approach maintaining the adaptively to the changing traffic and achieves lower delay and high throughput when compared to existing hybrid architecture.

ACKNOWLEDGEMENT

REFERENCE

[1] F. Akyildiz, X. Wang, and W. Wang, "Wireless mesh networks: A survey," in Computer Networks, 2004.

[2] P. Gupta and P. R. Kumar, "The capacity of wireless networks," in IEEE Transactions on Infomation Theory, 2000.

[3] J. Padhye, S. Agarwal, V. N. Padmanabhan, L. Qiu, A. Rao, and B. Zill, "Estimation of link interference in static multi-hop wireless networks," in Internet Measurement Conference, 2005.

[4] K. Jain, J. Padhye, V. Padmanabhan, and L. Qiu, "Impact of interference on multi-hop wireless network performance," in MobiCom, 2003.

[5] Raniwala, K. Gopalan, and T. Chiueh, "Centralized channel assignment and routing algorithms for multi-channel wireless mesh networks," in MC2R, 2004.

[6] M. Alicherry, R. Bhatia, and L. Li, "Joint channel assignment and routing for throughput optimization in multi-radio wireless mesh networks," in MobiCom, 2005.

[7] M. Kodialam and T. Nandagopal, "Characterizing the capacity region in multi-radio multi-channel wireless mesh networks," in MobiCom, 2005.

[8] Raniwala and T. Chiueh, "Architecture and algorithms for an ieee 802.11-based multi-channel wireless mesh network," in INFOCOM, 2005.

[9] J. Tang, G. Xue, and W. Zhang, "Interference-aware topology control and qos routing in multi-channel wireless mesh networks," in MobiHoc, 2005.

[10] S.-L. Wu, C.-Y. Lin, Y.-C. Tseng, and J.-P. Sheu, "A new multi-channel mac protocol with on-demand channel assignment for multi-hop mobile ad hoc networks," in Proceedings of the 2000 International Symposium on Parallel Architectures, Algorithms and Networks (ISPAN), 2000.

[11] J. So and N. Vaidya, "Multi-channel mac for ad hoc networks: Handling multi-channel hidden terminals using a single transceiver," in MobiHoc, 2004.

[12] P. Bahl, R. Chandra, and J. Dunagan, "Ssch for capacity improvement in ieee 802.11 ad-hoc wireless networks," in MobiCom, 2004.

[13] W.-H. Tam and Y.-C. Tseng, "Joint multi-channel link layer and multi-path routing design for wireless mesh networks," in INFOCOM, 2007.