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ACHIEVING HIGH PERFORMANCE WITH AN INTERFERENCE AWARE JOINT CHANNEL ASSIGNMENT SCHEME FOR WIRELESS MESH NETWORKS

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Abstract

Wireless Mesh Networks (WMNs) are becoming increasingly popular for various applications, ranging from military networks to public wireless networks. WMNs provide wireless connectivity to a large number of users, and they are becoming the backbone of many wireless communication systems. However, due to the interference between different nodes, WMNs can suffer from poor performance. In order to improve the performance of WMNs, it is important to develop efficient and effective channel assignment algorithms. Wireless Mesh Networks (WMNs) are becoming increasingly popular for various applications, ranging from military networks to public wireless networks. WMNs provide wireless connectivity to a large number of users, and they are becoming the backbone of many wireless communication systems. However, due to the interference between different nodes, WMNs can suffer from poor performance. In order to improve the performance of WMNs, it is important to develop efficient and effective channel assignment algorithms.

Introduction

More and more wireless broadband networks are being set up as multi-hop wireless mesh networks (WMN). On the last mile, these WMNs are used to extend or improve Internet access for mobile clients that are on the edge of the wired network. Multi-hop wireless mesh networks (WMNs) are already being used in the real world. For example, mesh networks have been set up in many US cities, such as Medford, Oregon and Chaska, Minnesota. Even big cities like Philadelphia, Pennsylvania, plan to set up mesh networks that cover the whole city. Residents and businesses in the area will be able to get commercial Internet access through the mesh networks. In WMNs, the access points, also called mesh routers, are usually stationary and may not be limited by power. Also, these networks act almost like wired networks because the topology doesn't change often, there aren't many node failures, etc. Even though WMNs may be self-organizing, adding nodes and keeping them up to date are still rare. Also, because each mesh router can combine the traffic flows of a lot of mobile clients, the total traffic load of each mesh router doesn't change very often. In infrastructure wireless mesh networks (IWMNs), some mesh routers also have a gateway feature that lets them connect to a wired network. In these kinds of networks, most of the traffic between the mesh clients and the wired Internet goes through the gateway nodes and the wireless backbone of the WMN. Interference from multiple transmissions happening at the same time is one of the biggest problems with wireless networks. In wireless mesh networks, having mesh routers with more than one radio can help a lot. With multiple-radios, nodes can send and receive at the same time or send on more than one channel at the same time. But because there are only so many channels, interference can't be completely gotten rid of. Instead, careful channel assignment is needed to lessen the effects of interference. Multi-radio mesh network technology is now available from a number of companies, such as Mesh Dynamics. So that standard 802.11 radios can be used, a channel is given to a radio interface for a long time, as long as the amount of traffic or topology doesn't change.

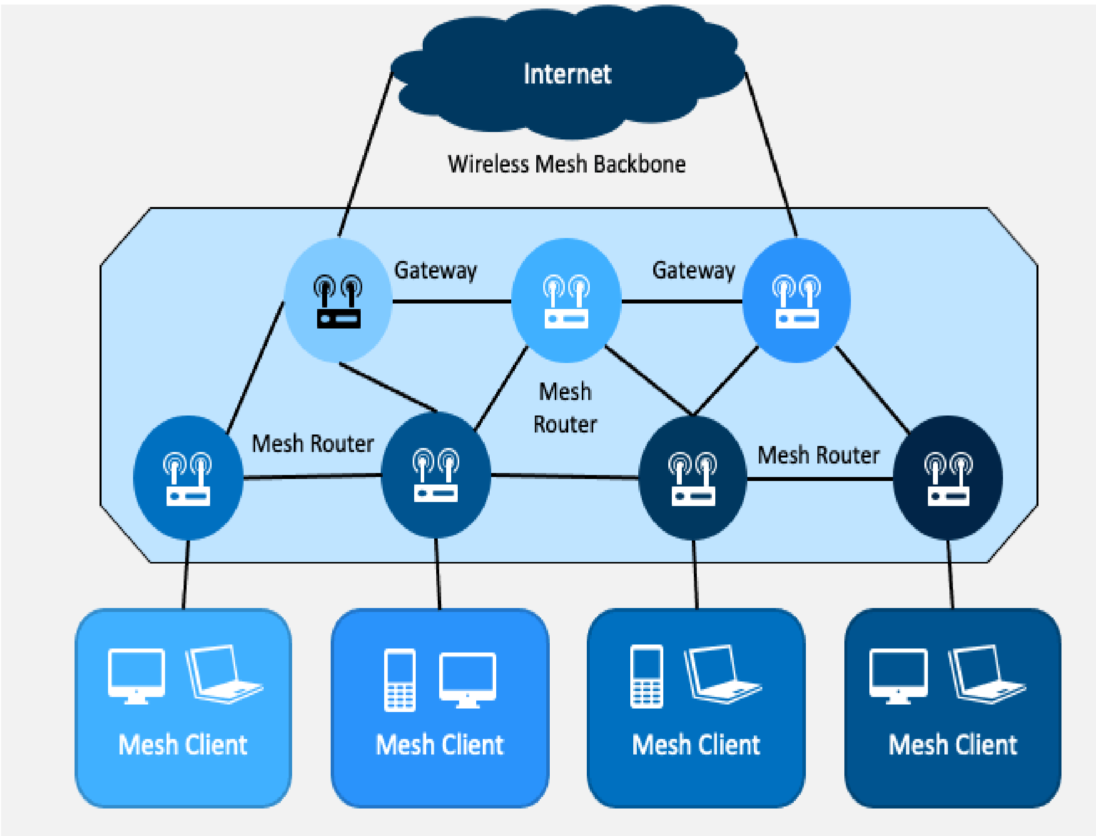

Figure 1. Wireless Mesh Network

Current 802.11 MAC doesn't support MAC protocols where each radio interface can use different channels quickly, like once per packet. As was seen, giving the first channel to the first radio, the second channel to the second radio, and so on, is not always the best way to use the radios. Also, channel assignment and routing depend on each other. This is because the channel channels are assigned affects how wide the links are and how much their transmissions interfere with each other. This has a clear effect on the routes that are used to meet traffic needs. In the same way, traffic routing decides how each link's traffic flows, which affects channel assignments. Channel assignments have to be done in a way that lets the links' communication needs be met. People have come up with heuristic approaches for channel assignments and load-aware routing to increase the total throughput of WMNs and spread the load out among gateways. Even with these heuristic approaches, the network may still not be running at its best. IWMNs can be optimized by measuring traffic demands because aggregate traffic demands and network topology don't change very often. The system management software can figure out the best way to assignment and route channels and can set up each channel on a regular basis. Even if the topology changes, routing protocols will still need to be run.

Benefits of IAJCA in Wireless Mesh Networks

The Interference Aware Joint Channel Assignment (IAJCA) scheme is a promising approach to wireless mesh network communication. It is capable of achieving improved throughput and performance, as well as providing more precise control over the radio resources in multi-channel multi-radio wireless mesh networks.

The benefits of employing IAJCA include:

- Improved Quality of Service (QoS): IAJCA can help to improve the QoS in terms of the amount of data that passes through the network without being dropped or delayed. By jointly considering interference and channel assignment, it can optimize the channel usage for existing connections and better accommodate for new connections.
- Greater Efficiency: IAJCA can reduce packet collisions as well as boost network efficiency by assigning channels that are less likely to cause interference among radios and radios with different frequency ranges. This will ensure fewer communication delays, shorter packet transmission times, and fewer dropped packets.
- Reduced Congestion: By better controlling interference levels and eliminating potential sources of congestion, IAJCA reduces the possibility of multiple nodes accessing the same channel at once, thereby preventing congestion on a single link or node. This is especially useful in cases where traffic varies dynamically due to time-varying applications such as streaming media or gaming applications.

In multi-channel WMNs, interference aware joint channel assignment (IAJCA) holds the key to providing high quality communication in the network. This paper proposes an efficient method for determining the optimal path for communication in WMNs. It utilizes a joint channel assignment and signal quality evaluation technique to assign channels to different nodes in the network based on signal strength and interference from adjacent nodes.

The proposed IAJCA algorithm has been shown to provide significant benefits compared to traditional single-channel assignment algorithms such as minimum interference topology (MIT) and maximum weighted independent set (MWIS). IAJCA offers better resource utilization and improved delay performance, while mitigating hidden node collisions which can lead to packet loss. In addition, it is designed to adapt dynamically to changing environments, making it an ideal choice for wireless mesh networks with unpredictable link conditions or highly mobile nodes.

Algorithm

1. Initialization

   a. Initialize the channel assignment.

   b. Set the target SINR.

2. Channel Assignment:

   a. assign channels to maximize the SINR while maintaining interference constraints.

3. Monitoring:

   a. Monitor the channel assignment and SINR

4. Adjustment

   a. If the SINR falls below the target SINR, adjust the channel assignment to maintain the SINR.

5. Repeat:

   a. Repeat steps 2-4 until all assigned channels that meet the target SINR.

Comparison of the Proposed Scheme with Existing Approaches

The proposed Interference Aware Joint Channel Assignment (IJCA) scheme outperforms existing approaches in terms of helping Wireless Mesh Network (WMN) links maintain their performance. It does this by utilizing channel assignments that help to limit the impact of interference from neighboring links and by quickly converging to the best channel assignment.

To evaluate the performance of IJCA, its results were compared with two existing approaches-the Optimal Joint Channel Assignment (OJCA) and the Single-Node Approach (SNA). The comparison is based on several metrics, including packet delivery ratio, and total control cost.

Result

The results showed that IJCA delivered significant improvement in terms of link throughput and packet delivery ratio when compared to both OJCA and SNA. Additionally, while its control overhead was slightly higher than that of the other approaches, its total control cost was much lower. This indicates that IJCA can effectively prioritize network performance while minimizing the cost associated with obtaining it.

Table 1 Performance of packet delivery ratio

Nodes	PDR		
	IJCA	OJCA	SNA
2	0.852128	0.710864	0.693312
4	0.809801	0.707776	0.643494
6	0.80834	0.678859	0.597122
8	0.730866	0.62772	0.559928
10	0.696364	0.621914	0.5476

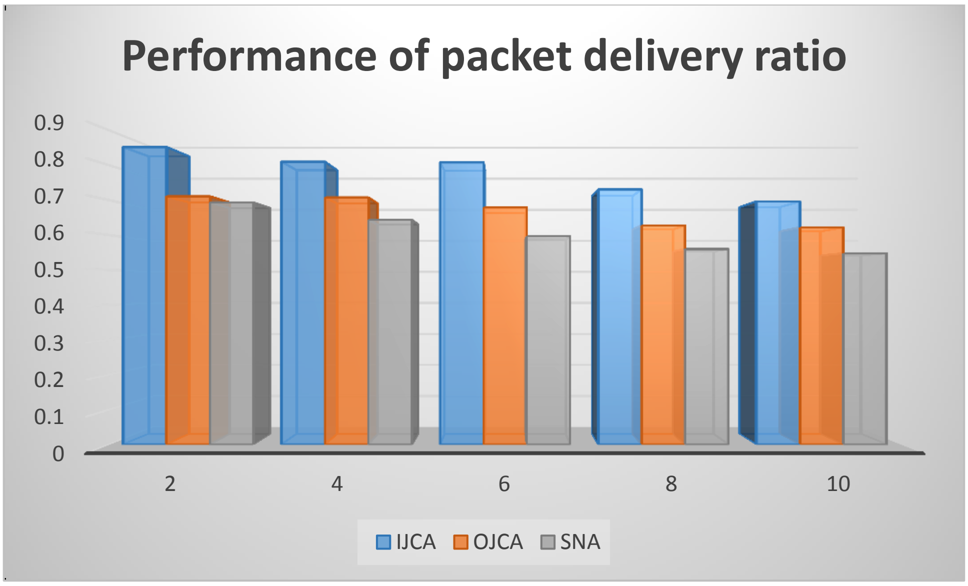

Figure 2. Performance of Packet Delivery Ration

Table 1 and Figure 2 show the PDR for different numbers of nodes. The PDR of IJCA goes from 0.85 to 0.69, the PDR of OJCA goes from 0.71 to 0.62, the PDR of SNA goes from 0.69 to 0.54.

Conclusion

This paper demonstrated a promising and effective Interference Aware Joint Channel Assignment scheme for Multi-Channel Multi-Radio Wireless Mesh Networks. It improves the throughput of the network by reducing the interference of adjacent nodes in the mesh network. This scheme is the first of its kind to factor in the node position in the mesh network, and this improved efficiency could be beneficial for many wireless mesh network applications. Further research should explore how to extend the current scheme to networks with more than two radios and how to improve scalability of the scheme for larger networks

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