IMPLEMENTATION AND PERFORMANCE EVALUATION OF A CHANNEL RE-ASSIGNMENT ALGORITHM FOR WIRELESS MESH NETWORKS

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Abstract: Channel assignment is among the most challenging issues for multi-radio wireless mesh networks, given the variety of objectives that can be pursued and the computational complexity of the resulting problems. The channel assignment problem has been also shown to be inter-dependent with the routing problem, i.e., the problem to determine the amount of traffic flow to be routed on every link. Such a relationship raises the need to re-compute the channel assignment every time the traffic pattern changes. However, channel assignment algorithms designed to assign channels from scratch will likely return a completely different configuration of radios, which would disrupt the network operation for the time required to switch to using the links established on the new channels. Experiments conducted to show that such a time may not be negligible, due to the resistance of routing protocols designed for wireless ad hoc and mesh networks to rapidly flagging a link as established/lost. Such a consideration, along with the observation that channel assignment algorithms may be sub-optimal, led us to the design of a channel re-assignment algorithm that takes the current channel assignment into account and attempts to cope with the new traffic pattern in the best manner possible while modifying the channel on a limited number of radios. In my project, I illustrate such a channel re-assignment algorithm and evaluate its performance by means of simulations.

Key terms: Wireless mesh networks, channel assignment, channel reassignment, algorithm design and analysis

I. INTRODUCTION

Wireless mesh networks (WMNs) have attracted a lot of interest from both the international research community and industries. Such an interest from industries is due to the possibility to cover metropolitan areas without a wired infrastructure, which makes WMNs a cost effective solution to implement, for instance, Wireless ISPs. Researchers, instead, have been attracted by the challenging issues related to the configuration and management of WMNs. One of such issues is the assignment of channels to radios in case mesh routers are equipped with multiple radios. The multi-radio configuration is becoming increasingly common, as routers may exploit the availability of multiple radios to simultaneously transmit and/or receive on different channels. Consequently, it is possible to reduce the interference and increase the throughput by carefully planning the assignment of channels to radios. It has been shown that the assignment of channels is not independent of the routing problem. Indeed, nodes using the same channel in a neighborhood have to share the channel capacity and hence the amount of bandwidth available on a link depends on how many nodes are using the same channel in the neighborhood. Then, the way channels are assigned affects the amount of bandwidth available on links and hence the channel assignment problem must be jointly studied with the routing problem. However, the joint channel assignment and routing problem has been shown to be NP-complete. Therefore, the proposals that recently appeared in the literature addressing such joint problem solve the channel assignment problem and the routing problem separately. A common approach is to first solve the routing problem, i.e., how to determine the amount of flow (referred to as the flow rate) to be routed on each link, and then to solve the channel assignment problem, i.e., how to assign channels in such a way that the resulting bandwidth available on each link exceeds the link flow rate. Since the assignment of channels depends on the set of flow rates, it should be re-computed upon a variation of the traffic load. However, frequent re-computations of the channel assignment are not desirable. Indeed, a new execution of the channel assignment procedure does not take the current assignment into account and thus will likely return a completely different assignment of channels with respect to the current one. Enforcing the new assignment will thus require changing the channels assigned to several radios.

II. EXISTING SYSTEM

A fundamental problem is the joint channel assignment and routing problem, i.e., how the channels can be assigned to radios and how a set of flow rates can be determined for every network link in order to achieve an anticipated objective. This joint problem is NP-complete. Thus, an approximate solution is developed by solving the channel assignment and the routing problems separately. The channel assignment problem turns out to be the problem to assign channels such that a given set of flow rates are
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III. PROPOSED SYSTEM

The Minimum Variation Channel and Rate Re Assignment (MVCRA-R) algorithm has been proposed, which takes the current channel assignment and the new set of flow rates into account and attempts to minimize the maximum total utilization over all the collision domains while constraining the number of radios that can be assigned a new channel and also attempts to cope with the new traffic pattern in the best manner possible while modifying the channel on a limited number of radios. In my project, I illustrate such a channel re-assignment algorithm and evaluate its performance by means of simulation.

IV. RELATED WORK AND CONTRIBUTION

The following are some important points

Channel
In telecommunications and computer networking, a communication channel, or channel, refers either to a physical transmission medium such as a wire, or to a logical connection over a multiplexed medium such as a radio channel. A channel is used to convey an information signal, for example a digital bit stream, from one or several senders (or transmitters) to one or several receivers. A channel has a certain capacity for transmitting information, often measured by its bandwidth in Hz or its data rate in bits per second.

Link
In telecommunications a link is the communications channel that connects two or more communicating devices. This link may be an actual physical link or it may be a logical link that uses one or more actual physical links. When the link is a logical link the type of physical link should always be specified (e.g., data link, uplink, downlink, fiber optic link, point-to-point link, etc.) This term is widely used in computer networking (see Data link) to refer to the communications facilities that connect nodes of a network.

Traffic
Network traffic is data in a network. In computer networks, the data is encapsulated in network packets. Network traffic control, managing, prioritising, controlling or reducing the network traffic. Network traffic measurement, measuring the amount and type of traffic on a particular network.

Network traffic simulation, to measure the efficiency of a communications network

Flow rate
Data transfer rate is comparable to traffic flow. In theory, the wider the highway and the higher the speed limit, the more traffic moves through. Just like traffic flow, which can be affected by obstructions, accidents and poorly designed highways, data transfer rate is subject to problems as well. Basic definitions, units, typical data transfer rates and comparisons will help define what factors make up a data transfer rate.

Network Operations

Sending, dropping packets.

Channel assignment

Channel assignment is nothing but how to assign the channels in such a way that the resulting bandwidth available on each link exceeds the link flow rate.

Channel reassignment

Channel reassignment is a technique which takes the current channel assignment into account and attempts to cope with the new traffic pattern in the best manner possible while modifying the channel on limited number of radios which will prevent the network connectivity from breaking and increases the throughput.

V. NETWORK ARCHITECTURE

A wireless mesh network (WMN) is communications network made up of radio nodes organized in a mesh topology. Wireless mesh networks often consist of mesh clients, mesh routers and gateways.

Wireless mesh network architecture

Wireless mesh architecture is a first step towards providing cost effective and dynamic high-bandwidth networks over a specific coverage area. Wireless mesh architectures infrastructure is, in effect, a router network minus the cabling between nodes. It's built of peer radio devices that don't have to be cabled to a...
wired port like traditional WLAN access points (AP) do. Mesh architecture sustains signal strength by breaking long distances into a series of shorter hops. Intermediate nodes not only boost the signal, but cooperatively make forwarding decisions based on their knowledge of the network, i.e. perform routing. Such an architecture may with careful design provide high bandwidth, spectral efficiency, and economic advantage over the coverage area.

Wireless mesh networks have a relatively stable topology except for the occasional failure of nodes or addition of new nodes. The path of traffic, being aggregated from a large number of end users, changes infrequently. Practically all the traffic in an infrastructure mesh network is either forwarded to or from a gateway, while in ad hoc networks or client mesh networks the traffic flows between arbitrary pairs of nodes.

Design

Flow Chart:

Channel re-assignment algorithm:

![Channel re-assignment algorithm Flow Chart](image)

Sequence Diagram:

![Sequence Diagram](image)

Use Cases:

![Use Cases](image)

Data Flow Diagram of channel re-assignment algorithm

![Data Flow Diagram](image)
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VI. ALGORITHM DESIGN AND IMPLEMENTATION

MVCRA algorithm implemented using atarraya simulation
Step1: Select the source node.
Step2: Initialize traffic aware protocol.
Step3: Send the packets
Send 100Kbps data from Source to Connection routers

Pseudo code of MVCRA algorithm

if(receiver==connected_router)

```plaintext
if(receiver==connected_router)
    router_list[]=getConnectedRouter(receiver)
    for(each link in routerList)
        bandwidth=checkBandwidth(link);
        status=checkStatusLink(link); if(bandwidth==100) {
            if(status!=busy)
                sendPacketintheRoute();
        }
    elseif(bandwidth==20)
        if(status!=busy)
            if(data==100)
                Pieces[]=dividePacketinto20Mbpieces
                foreach(piece in pieces)
                    sendPacketinRoute();
            elseif(data==60)
                Pieces[]=dividePacketinto10Mbpieces
                foreach(piece in pieces)
                    sendPacketinRoute();
            else if(data==10)
                sendPacketinroute();
        }
    elseif(bandwidth==10)
        if(status!=busy)
            if(data==100)
                Pieces[]=dividePacketinto10Mbpieces;
                foreach(piece in pieces)
                    sendPacketinRoute();
            elseif(data==60)
                Pieces[]=dividePacketinto10Mbpieces
                foreach(piece in pieces)
                    sendPacketinRoute();
            else if(data==10)
                sendPacketinroute();
        }
```

Here first we have to create a network topology with the help of simulation tool. The topology is made up of routers and nodes. Among the connected nodes one node is selected as source and rest are selected as receiver. When the packet is sent by the source first the algorithm checks which links(routers) are available to reach the destination, among that it will
choose the highest capacity link and the packet is sent through that link. Suppose if the highest capacity link is busy or is unavailable then the algorithm will check for the next highest link. Now if this link capacity is less than size of incoming packet then the packet will get divided by link capacity and then the packets will be forwarded. Same procedure is carried through the entire network.

VII. EXPERIMENTAL RESULTS

Tool used for simulation: Atarraya Atarraya, is a discrete-event simulation tool specially designed for testing and implementing topology control protocols for wireless mesh networks. The simulation tool includes structures for designing both topology construction and topology maintenance protocols. In addition, Atarraya includes several key algorithms and applications that along with its graphical user interface can be used to support teaching activities.

Fig1. Before deployment

Fig2. After deployment

Fig3. Wireless deployment

Fig4. Before topology creation

Fig5. Topology creation
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Fig6. Graph after sending 10, 60 and 100 kbps packet through 100 kbps router

Fig7. Topology with 100 kbps router busy

Fig8. Graph after sending 10, 60 and 100 kbps packet through 60 kbps router

Fig9. Topology with 60 and 100 kbps router busy

Fig10. Graph after sending 10, 60 and 100 kbps packets through 10 kbps router

Fig11. Graph at the junction
CONCLUSION

In this paper we presented the Minimum Variation Channel and Rate Re-Assignment (MVCRA-R) algorithm, which takes the current channel assignment and the new set of flow rates into account and attempts to minimize the maximum total utilization over all the collision domains while constraining the number of radios that can be assigned a new channel. With respect to MVCRA, MVCRA-R leverages the possibility to adjust the link transmission rates and presents some enhancements such as an improved definition of the link priorities. We performed simulation studies that confirmed that MVCRA-R roughly meets the constraint on the maximum allowed number of radio changes and outperforms channel assignment algorithm such as FCRA in terms of maximum total utilization of available bandwidth.

REFERENCES


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