Channel Assignment and Provisioning of Deadline Driven Requests with Flexible Transmission Rates in Wireless Mesh Networks

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Summary
A wireless mesh network can be seen as a special type of wireless ad-hoc network. A wireless mesh network often has a more planned configuration, and may be deployed to provide dynamic and cost effective connectivity over a certain geographic area. A network with higher throughput will deliver better quality of service for band- width intensive applications such as video and voice streaming, VoIP, etc. A high throughput capacity WMN can support several users running bandwidth intensive applications simultaneously. The other advantage of using a WMN is that the geographical range of the network can be increased without disturbing the existing network topology. In this paper, we propose a Hybrid Channel Assignment scheme using nodes, the Channel Assignment Server CAS, as central node to collect information from the network and to assign channels to each radio interface. To implement this scheme we have considered many schemes used before and tried to take the best advantages of each one and eliminated all possible disadvantages. Starting from this idea we implemented a centralized channel assignment scheme that considers both interference and traffic load to assign channel to radio. The k-shortest path algorithm for deadline driven requests for multi-radio wireless mesh network is simulated using NS2 and compared with the BSF scheme.

Key Words :
Channel Assignment , Deadline Driven Requests, Flexible Transmission Rates, WSN , Wireless Mesh Networks

I. INTRODUCTION

A wireless mesh network (WMN) is a communications network made up of radio nodes organized in a mesh topology. Wireless mesh networks often consist of mesh clients, mesh routers and gateways. The mesh clients are often laptops, cell phones and other wireless devices while the mesh routers forward traffic to and from the gateways which may but need not connect to the Internet. The coverage area of the radio nodes working as a single network is sometimes called a mesh cloud. Access to this mesh cloud is dependent on the radio nodes working in harmony with each other to create a radio network. A mesh network is reliable and offers redundancy. When one node can no longer operate, the rest of the nodes can still communicate with each other, directly or through one or more intermediate nodes. Wireless mesh networks can be implemented with various wireless technology including 802.11, 802.15, 802.16, cellular technologies or combinations of more than one type.

The motivation for using multiple radios on node is to achieve higher throughput. A network with higher throughput will deliver better quality of service for band-width intensive applications such as video and voice streaming, VoIP, etc. A high throughput capacity WMN can support several users running bandwidth intensive applications simultaneously. The other advantage of using a WMN is that the geographical range of the network can be increased without disturbing the existing network topology. This is particularly desirable in network designed for small town or a campus, which may grow at some point in the future. If there is a need to increase the geographical range of a WMN then there is no need for a total network redesign. Instead, a simple solution for this problem is to add another, or a few, new mesh node(s) depending on how much area needs to be covered

The achievable capacity of wireless mesh networks depends on various factors like network size, traffic patterns and detailed local radio interactions. This thesis is focused on examining the impact of these factors alone and in combination, on the capacity of wireless mesh networks with several different network layouts and traffic patterns through simulations and analysis. Simulations are carried out using NS2 simulator and the results are obtained.

II. Related Work

The notion of an optical control plane [6] has rapidly ascended from being a mere concept to a detailed set of protocol standards developed with broad industry participation. In this paper, authors present a brief overview of optical control plane architecture and the associated protocols. Also examine the business drivers

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and inhibitors behind the optical control plane effort, the current state of the standards, interoperability status, and the open issues that need to be resolved before wide scale deployment of this new technology can begin.
High-end networking applications such as e-commerce, multimedia, distributed data analysis and advanced collaborative environments feature demanding end-to-end quality of service (QoS) requirements. Due to the heterogeneity exhibited by the Internet, a route from source to destination for such a flow may not be available which is comprised exclusively of QoS supporting path segments. Hence the flow must traverse one or more non-QoS path segments referred to here as reservation gaps. . In this paper [8], authors have studied the problem of reservation gaps and their impact on QoS and present a solution to address the deficiencies caused by such gaps, using an active network approach based on the mobile agent paradigm.
A deadline-aware-scheduling scheme for the lambda grid system is proposed to support a huge computer grid system based on an advanced photonic network technology [10]. The assignment of wavelengths to jobs in order to efficiently carry various services is critical in lambda grid networks. Such services have different requirements such as the job-completion deadlines, and wavelength assignment must consider the job deadlines. The conventional job scheduling approach assigns a lot of time slots to a call within a short period in order to finish the job as quickly as possible. This raises the blocking probability of short deadline calls. Authors have proposed to assign wavelengths in the lambda grid networks to meet quality-of-services guarantees. The proposed scheme assigns time slots to a call over time according to its deadline, which allows it to increase the system performance in handling short deadline calls, for example, lowering their blocking probability. Computer simulations show that the proposed scheme can reduce the blocking probability by a factor of 100 compared with the conventional scheme under the low load condition in which the ratio of long deadline calls is high. The proposed scheduling scheme can realize more efficient lambda grid networks.

III. Deadline Requirement Algorithm

The customer's main requirement is to meet the DDR's deadline. However, the service provider's objective is to design bandwidth- allocation policies that maximize network utilization and consequently minimize resources used. DDR is considered provisioned if we can choose, as the bandwidth allocated to node, is based on transmission rate.
Fixed allocation: Allocate a fixed amount of bandwidth to node, depending on its wavelength. We choose to allocate the maximum end-to-end available bandwidth chosen path or the minimum bandwidth required to meet's deadline.

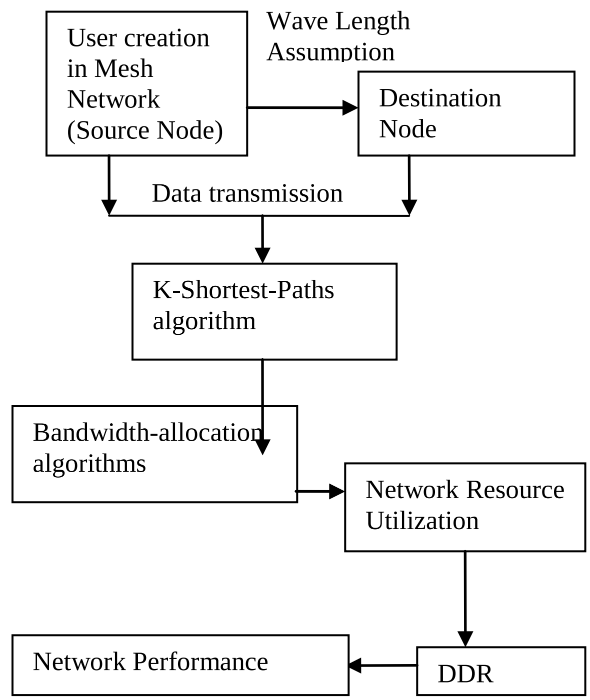

Figure 1.1 Modules interaction for Deadline Requirement Algorithm

Adaptive allocation: Use network-state information to improve the performance of the bandwidth-allocation algorithm. A first policy, simply called "Adaptive," uses link-congestion information to determine which fixed allocation policy to use. A second policy, called "Proportional," allocates bandwidth to each request proportionally to its changing rates.
Changing Rates: Allow the transmission rate of existing requests to change over time to accommodate new requests that cannot be provisioned otherwise.

Description:
Wireless mesh networks were originally developed for military applications and are typical of mesh architectures. Over the past decade the size, cost, and power requirements of radios has declined, enabling more radios to be included within each device acting as a mesh node. Mesh networks are self-healing: the network can still operate when one node breaks down or a connection goes bad. In data transmission and storage using encoding through finite-state machines, the feedback link that updates each finite-state machine after each encoding step presents a bottleneck for a high speed implementation. State updating is broken down into a feed forward part and a feedback part. In the feedback part, the state of each unit

can be updated with a single operation. This allows efficient implementation of the finite-state encoder for practically any data rate just by appropriate pipelining and parallel processing. Path can span over one or multiple light paths from source to destination of the request. The set of all light paths in the network forms the virtual topology. The term virtual link is used to denote a light path. Wavelength-division multiplexing is commonly applied to an optical carrier (Which is typically described by its wavelength), whereas frequency-division Multiplexing typically applies to a radio carrier.

IV SIMULATION ENVIRONMENT

The simulation environment used in this project is NS2. Evaluation is done in the same environment by writing codes in Otcl, which is the front end , followed by the compilation of the same, which is then translated to TCL scripts and then to C++- which forms the back end of NS2. At the end of compilation, 2 files are generated- the Trace file and the NAM file (Network Animator). Trace file includes various fields thereby giving all the details of the behavior of the network created, such as the packets sent and received, drop packets, type of packet(routed or data packets), sequence number of the packet etc.. NAM file gives the visual representation of the behavior of the network created. The various performance metrics can be evaluated by writing awk scripts to calculate the same and then use respective commands to execute it.

i) Simulation Parameters

The Simulation Area defines the area of the simulation environment where the network behavior can be judged. In this project the simulation area considered is 1000x1000 units. This defines the range to which the packets can be sent in the network established and also the area in which the nodes will be active for transmission. The transmission rate considered is 250m.

This parameter defines the speed with which the mesh clients move in the network. This is one of the prime parameters considered in this simulation. The performance metrics are evaluated versus speed having various values like- 5ms, 10ms, 15ms and 20ms.

Packet Size is the size of the packet that is transmitted over the network. The behavior of the network majorly depends on the size of the packet. The packet size considered here is 512 bytes.

Transmission Rate is the rate at which the packets are transmitted in the network. The performance of the 2 protocols is evaluated based on various values of transmission rate like- 0.064Mbps, 0.128Mbps, 0.256Mbps and 0.512Mbps.Variation in transmission rate can also lead to drop of packets. In networks, 2 types of traffic could be generated- TCP and UDP. TCP is primarily considered for wired networks and UDP for wireless networks. Various types of UDP traffic are available of which the Constant Bit Rate (CBR) type of UDP traffic is considered here.

ii) Performance Metrics:

1. The bit error rate or bit error ratio (BER) is the number of bit errors divided by the total number of transferred bits during a studied time interval.
2. End-to-end delay is the time it takes a packet to travel across the network from source to destination.

V. RESULTS AND DISCUSSION

We considered that the majority of the traffic within the mesh network is either from the user devices to the gateway or vice-versa. This traffic pattern is typical in wireless mesh deployments. Starting from this presumption, we have built a network scenario with this kind of traffic pattern that includes both internal interference and external interference. The duration of the main simulations is set for 3700 seconds, while the Non-Default Channel Timeout is set to 10 minutes (600 seconds).

In scenario 1 we considered internal interference transmitting several data flows during the same period of time; and a static type of external interference, because the amount of traffic generated by these external nodes is fixed during the simulation.

In scenario 2, we again considered interflow interference, but in addition, we changed the interference level of these external nodes, in particular the changed the interference level of the external nodes transmitting on the Default channel. In this case the variation is big enough to need a new Default Channel assignment procedure.

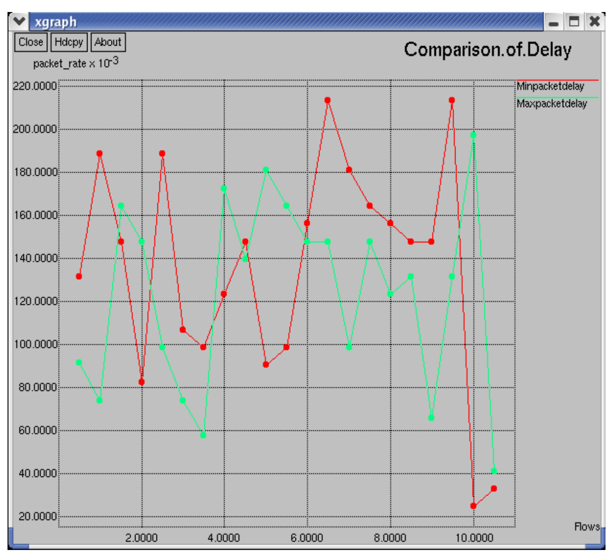

Figure 1.2 Analysis of Bit Error Rate (BER)

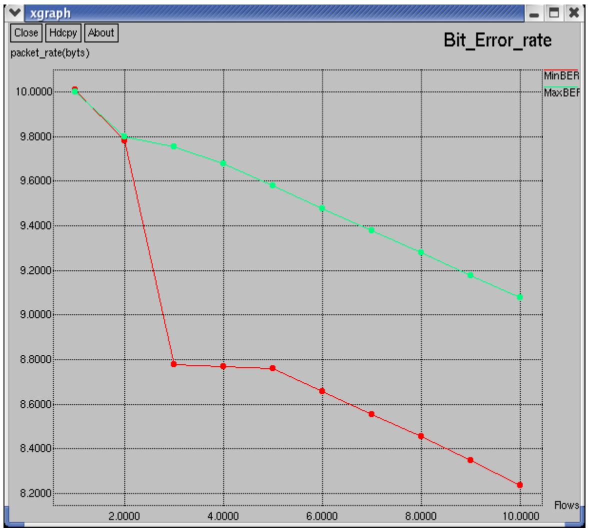

Figure 1.3 Comparison of Maximum and Minimum Packet Delay

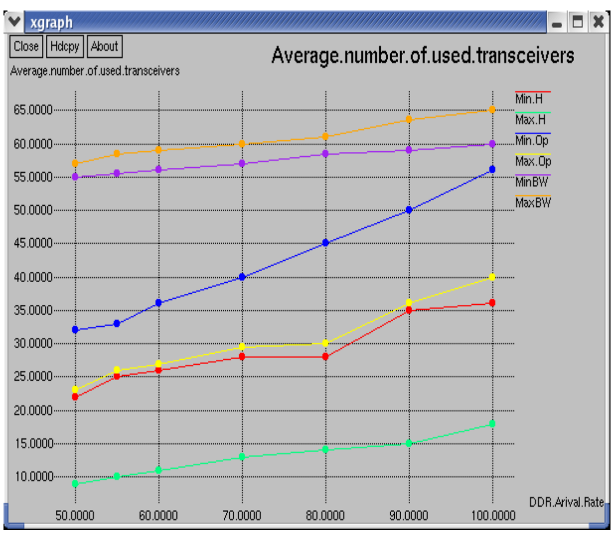

Figure 1.5. Average number of used transceivers

Internal Traffic Flows

During our simulations we sent up to twelve internal traffic flows, all ones connecting the gateway with a client node. These flows are Constant Bit Rate (CBR) flows, with packet size of 512 bytes and data rate equals to 400 Kbits/second. For all these flows the random that introduces random noise in the scheduled departure times is set to on.

External Traffic Flows

External nodes are situated at the center of the network and can interfere with all other internal nodes. External flows are Exponential traffic flows with packet size of512 bytes, data rate equals to 50 Kbit/second, burst time equals to 1000 ms and idle time between 20000 and 500 ms. This last parameter is used to vary the amount of traffic transmitting on a particular non-overlapping channel.

VI. CONCLUSION

A new approach to address the Channel Assignment problem in a Multi-Radio Wireless Mesh Network to maximize the total throughput has been introduced. We have considered a network environment with the presence of co-located wireless networks and also analyzed the Channel Assignment problem considering both, interference and traffic. The results obtained shows that the new Channel Assignment scheme is possible to achieve improvements of about 10% during the periods of time where we use the traffic information to assign channels and improvements of about 40% in the cases where we need to change the common channel after a reduction of its quality. This approach is efficient in networks where the number of nodes is not so wide. However, the scheme can be extended to cover large networks if we increase the number of Channel Assignment Servers (CAS) that could be co-located with the gateways. In this case, every CAS will perform the assignment procedure for its particular region of the network. The problems of provisioning DDRs over WDM mesh networks is studied by allowing flexible transfer rates and have also investigated the effect of using different node architectures (Hybrid and Opaque) on the performance of the network.

References

[1] Channel on demand: Optimal capacity for cooperative multi-channel multi-interface wireless mesh networks published in 2010

[2]Traffic and Interference Aware Scheduling for Multiradio Multichannel Wireless Mesh Networks by Chakchouk, N.; Hamdaoui, B. published in 2011

[3] Interference-aware power control for Multi-Radio Multi-Channel wireless mesh networksby Olwal, T.O.; van Wyk, B.J.; Djouani, K.; Hamam, Y.; Siarry, P.; Ntlatlapa, N.AFRICON, 2009.

[4] Provisioning of Deadline-Driven Requests With Flexible Transmission Rates in WDM MeshNetworks by Andrei, D.; Tornatore, M.; Batayneh, M.; Martel, C.U.; Mukherjee, B in 2010.

[5] Interference aware channel assignment in wireless mesh networks Authored by Massimiliano Slongo and Tinku Rasheed in 2008

[6] B. Mukherjee, Optical WDM Networks. New York: Springer, 2006.

[8] B. Mukherjee, "Architecture, control, and management of opticalswitching networks," in Proc. IEEE/LEOS Photon. Switch. Conf.,Aug. 2007, pp. 43–44.

[9] S. Huang and R. Dutta, “Research problems in dynamic trafficgrooming in optical networks,” presented at the 1st Int. WorkshopTraffic Grooming, San Jose, CA, Oct. 2004.
[10] K. Zhu and B. Mukherjee, “Traffic grooming in an optical WDM meshnetwork,” IEEE J. Sel. Areas Commun., vol. 20, no. 1, pp. 122–133,Jan. 2002.
[11] D. Saha, B. Rajagopalan, and G. Bernstein, “The optical network controlplane: State of the standards and deployment,” IEEE Commun. Mag., vol. 41, no. 8, pp. S29–S34, Aug. 2003.
[12] S. Balasubramanian and A. Somani, “On traffic grooming choices forIP overWDMnetworks,” in Proc. Broadnets, San Jose, CA, Oct. 2006,pp.