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Joint mobility management and multicast rate adaptation in software–defined enterprise WLANS

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ABSTRACT

The ever–increasing demand for mobile content delivery and multimedia services is bringing renewed interest in multicast communications in Wi–Fi based WLANs. Nevertheless, multicast over Wi–Fi raises several challenges including low data rates and coexistence issues with other unicast streams. Some amendments to the Wi–Fi standard, such as 802.11aa, have introduced new delivery schemes for multicast traffic as well as finer control on the low–level aspects of the 802.11 medium access scheme. However, the logic for using such features is left to the implementer of the standard. In this project we present SDN@Play Mobile, a novel SDN–based solution for joint mobility management and multicast rate–adaptation in Wi–Fi networks. The solution builds upon a new abstraction, named Transmission Policy, which allows the SDN controller to reconfigure a multicast transmission policy when its optimal operating conditions are not met. An experimental evaluation carried out over a real–world testbed shows that our approach can deliver significant improvements in terms of both throughput and channel utilization compared to the legacy 802.11 multicast schemes. Finally, we release the entire software implementation under a permissive APACHE 2.0 license for academic use.

Keywords: WLANs, Multicast schemes, Joint mobility management, Rate Adaptation.

INTRODUCTION

Although the worldwide success of the Internet is partly due to the simplicity and robustness of its layered network architecture, this architecture, developed for wired networks, is not efficient for multihop wireless networks. Cross-layer approaches have been proposed to enhance the adaptability and performance of these networks by jointly tuning the parameters of different layers. One of the critical performance metrics in multihop wireless networks is throughput. It is highly dependent on the configuration of routing, medium access, and physical-layer parameters and on their interactions; see, for example, in the case of a (conflict-free) scheduled network. Configuring a wireless network based on random access is much more difficult, and one might be tempted to simply use a so-called default configuration comprised, for example in the case of slotted ALOHA, of a minimum-hop routing and equal attempt probability. While one would expect that joint configuration of routing, medium access, and physical-layer parameters of a random access network can provide better performance than the default configuration, there is no clear indication so far on how much improvement can be achieved by joint design and how to jointly configure the parameters [1-5].

In a single-channel wireless network, during a transmission, the interference seen by a receiver is the additive interference from all the other simultaneous transmissions. As a consequence, it is essential to use a proper interference model when configuring the wireless network. The physical interference model

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based on signal-to-interference-plus-noise ratio (SINR) is the more realistic interference model for wireless networks.

RELATED WORK

A large body of prior work explores adaptive wireless multicast streaming system. This section outlines the most relevant pieces of work, which falls in the following categories. Application-layer rate adaptation. A tremendous amount of early work dynamically adapts application layer data rate (including video frames and FEC) to erroneous channel conditions for wireless multicast transmissions. Present an adaptive framework that consists of scalable video representation, network-aware end systems, and adaptive services. Under this framework, the streaming system is able to provide smooth change of perceptual quality to clients as wireless channel condition change. Subsequently, adaptive layered FEC-based control mechanisms are investigated. Most recently, a exploit FEC from multiple APs to achieve reliable video multicast. Most of these works adapt application layer data rate with the fixed underlying multicast transmission rate, which may severely under-utilize the network resource [6-10].

LITERATURE SURVEY

N. Golrezaei, K. Shanmugam, A. G. Dimakis, A. F. Molisch andG. Caire

Video on-demand streaming from Internet-based servers is becoming one of the most important services offered by wireless networks today. In order to improve the area spectral efficiency of video transmission in cellular systems, small cells heterogeneous architectures (e.g., Femtocells, WiFi off-loading) are being proposed, such that video traffic to nomadic users can be handled by short-range links to the nearest small cell access points (referred to as “helpers”). As the helper deployment density increases, the backhaul capacity becomes the system bottleneck. In order to alleviate such bottleneck we propose a system where helpers with low-rate backhaul but high storage capacity cache popular video files. Files not available from helpers are transmitted by the cellular base station. We analyze the optimum way of assigning files to the helpers, in order to minimize the expected downloading time for files. We distinguish between the un coded case (where only complete files are stored) and the coded case, where segments of Fountain-encoded versions of the video files are stored at helpers.

H. Wang, W. T. Ooi and M. C. Chan, “JurCast

Wireless multicast has been exploited to bridge the gap between the limited wireless bandwidth and the rapidly increasing mobile video traffic demand. Multicast of videos to a set of heterogeneous users over multiple wireless access points, however, is challenging because of the trade-offs between high transmission rate, load balancing, and multicast opportunities. In this paper, we present JurCast, a joint user and rate allocation scheme for video multicast over multiple APs. Our approach balances the trade-off between these factors by determining user to Access Points (APs) association, the video resolution version (quality) to be delivered for each session, and the transmission link rate for each video version.

PROPOSED SYSTEM

In this project, we first study the optimal joint configuration of routing, access probability, and transmission rate parameters in slotted ALOHA fixed wireless networks to maximize the minimum throughput of the flows under an interference model based on SINR. In this project, we study a simple MAC protocol and a simple network coding scheme to keep the formulation tractable. Our objectives are to provide insights on: 1) the interaction of routing, access probability, network coding, and transmission rate; 2) the throughput gains obtained by a joint design over a default design; and 3) throughput gains obtained by simple network coding.

Advantages

- Joint problems for multirate systems.
- Single-rate systems.
- Large networks
- Access probability and routing parameters.
- Very significant.

Modules

- Network Topology And Flows
- Flow(S) And Link(S) Selection
- Design Of Cross Layer
- Access Joint Routing
- Rate Allocation Optimization

Network topology and flows

Network topology is the arrangement of the various elements (links, nodes, etc.) of a computer network. Essentially, it is the topological structure of a network and may be depicted physically or logically. Physical topology is the placement of the various components of a network, including device location and cable installation, while logical topology illustrates how data flows within a network, regardless of its physical design. Distances between nodes, physical interconnections, transmission rates, or signal types may differ between two networks, yet their topologies may be identical optimal joint configuration of routing, access probability, and transmission rate parameters in slotted ALOHA fixed wireless networks to maximize the minimum throughput of the flows under an interference model based on SINR. The critical assumption to perform this study is that the channel gains are quasi time-invariant.

Flow(S) and Link(S) selection

We study the optimal joint configuration of routing, access probability, and transmission rate parameters in slotted ALOHA wireless networks with network coding to maximize the minimum throughput of the flows. We restrict ourselves to simple link-layer network coding without any opportunistic listening as it is too complex to analyze link-layer network coding with opportunistic listening for a wireless network and optimize the network parameters under a realistic interference model.

Design of cross layer

Cross-layer networking, where the physical and MAC layer knowledge of the wireless medium is shared with higher layers, in order to provide efficient methods of allocating network resources and applications over the Internet. In essence, future networks will need to provide ”impedance matching” of the instantaneous radio channel conditions and capacity needs with the traffic and congestion conditions found over the packet-based world of the Internet.

Access joint routing

Joint routing makes it a good candidate for a heuristic, even though it may be suboptimal. For comparison, both default and heuristic designs use the same single-path min-hop routing. Among all the min-hop paths for each flow, the one with the shortest distance (the sum of the physical distances of all links of the path) is chosen since the quality of a link often depends on the distance between the transmitter and the receiver. If the number of shortest-distance min-hop paths is more than one, e.g., in the grid network, the path yielding the maximum total traffic load is chosen to reduce collisions by decreasing traffic in the competing nodes. Hence, we do not claim that the min-hop path that we selected is the best among all the min-hop paths.

Rate allocation optimization

We now formulate the JRM-NC-RA optimization in derive the expression of the effective rate of a flow on a given link by combining the rates achieved by both types of transmissions (with and without network coding). Similar to the JRM-RA optimization problem in (11)–(15), we will use this expression to model the link rate constraints. In the JRM-RA optimization problem, we use the flow conservation constraints such that the arrival rate of a flow is equal to the service rate of the flow at an intermediate node. Unfortunately, these constraints are not sufficient to forbid a node to do more network coding than allowed with the available packets.

ALGORITHM

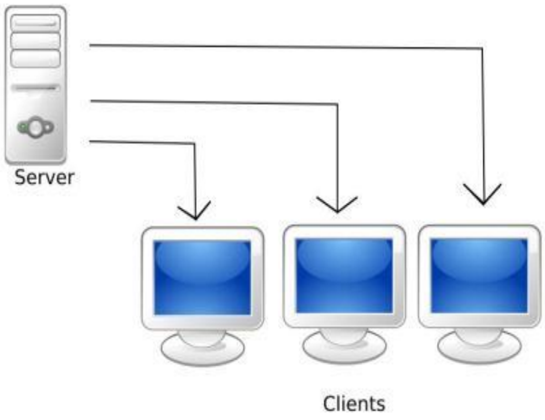
Medium Access Control [MAC]

The default configuration uses the same attempt probability at all nodes, equal to. For our heuristic, we first note that, once routes have been selected, it is possible to calculate the amount of traffic transmitted by each node assuming that each uplink flow has a throughput (and each downlink flow has a throughput). The values of clearly should depend on the traffic carried by node as well as the traffic carried by the other nodes. We conjecture that a good approximation would be of the type where the amount of traffic transmitted by node is and is an unknown factor depending on the network topology. Since it is not clear what is a suitable value of, after some tests, we decided to set.

We validated our conjecture by comparing the heuristic values of's determined using for the optimal routing (i.e., by using the values of's obtained by our numerical solution to the joint problem) with the values of's obtained by our numerical solution. The optimal and heuristic values of 's are shown in Fig. 3 for the Rand16 network where the node index for the gateway is 16. These results are surprisingly close and show that. Note that node 4 is the second closest node to the gateway, and its transmission probability is high due to the large amount of traffic routed through it.

We find that the maximum throughput difference is less than 1% and thus concluded that only a small amount of throughput is lost if the bidirectional network coding model is used instead of full network coding, for the networks under consideration and under the assumption that all the uplink flows (resp. downlink flows) have the same weight. We conjecture that even in a medium-size network the same is true to some extent. In the following, we use bidirectional network coding instead of full network coding to study multiple node mesh networks.

System Model



CONCLUSION

In this project, we have studied the joint configuration of routing, access probability, and transmission rate parameters in slotted ALOHA wireless mesh networks. We have formulated and solved several optimization problems for several wireless mesh network scenarios.

The studies for the single-rate systems show that

1) Compared to a default configuration, the optimal joint configuration of network parameters can improve throughput performance significantly;
2) In terms of throughput, it is better to optimize the MAC access probability parameters than the routing;
3) Throughput gains with optimized cross-layer design can be as high as 20% when compared toa design that only optimizes the MAC access probabilities. In addition:
4) We have proposed a heuristic configuration of the transmission probabilities based on the traffic load of the nodes that performs very well;
5) At low transmit power, a simple XOR network coding without opportunistic listening can yield no negligible throughput gains.

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