Research Summary

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I have been active in networking research for eight years, publishing eight papers in networking areas including traffic engineering, wireless networks, mobile datasets and network resource optimization. Five of these papers were published during my MS studies, and three have been published since joining the PhD program at ODU.

I started my first research project in networking for my Advanced Networks course in my master program. I studied about Traffic Engineering (TE) in MPLS network. I proposed new multipath TE mechanisms to increase network bandwidth utilization [1]. In Traffic Engineering, bandwidth requests are specified in run time and dynamically. Allocation of bandwidth resources based on multiple constraints such as shortest path and lowest cost makes it an NP-hard problem. There are some heuristic methods to achieve near-optimal schemes. However, resources are still not fully utilized and many requests are blocked. We investigated the allocation of multiple paths for requests. These multiple paths should still satisfy the requirement of requests while providing the maximum utilization of bandwidth resources.

Then, I worked with my colleagues on improving the reliability in an MPLS network, and we published our *spare capacity allocation in survivable networks* paper [2]. One of the main requirements for survivable networks is the allocation of spare capacity to use in case of failure of a link. The spare capacity allocation results in inefficient usage of the resources in case the network is in normal condition. So, the idea is to share those spare capacities. Those capacities should be selected in such a way that minimizes the spare capacity while maximizing the survivability of network.

Next, in my master thesis [3] I focused on Mobile Ad hoc Networks (MANETs). Particularly, I developed a new routing algorithm to reduce end-to-end delay as a requirement for applications such as voice and video [5-6]. Most of works consider only bandwidth as QoS metric (bandwidth, delay, jitter, and throughput) requirements for finding routes. However, satisfying the delay requirement is more difficult in MANETs because of the high dynamics in the network topology. I developed a routing algorithm based on Ad hoc On-Demand Distance Vector Routing (AODV) to provide delay requirements of applications. I used three mechanisms to find the routes that could satisfy the delay requirement. First, based on the past movement of nodes, the future location of a node is predicted. If this node would provide a stable (unbreakable) link in coming times, it would be a potential node in path selection. Second, the buffer level of a node is considered as a metric. A node with high buffer level shows that it is forwarding a high amount of traffic. So, they will impose queueing delay to the coming packet. So, a lower chance of selection is set for those nodes. Finally, nodes with high speed are not selected. These nodes usually cannot provide a high data rate link in comparison to static or low speed nodes. To summarize, a route is found based on best node selection that provides the minimum amount of delay for the request.

Next, I continued my work after coming to ODU in a branch of MANETs, vehicular networks. I focused on charging of electric vehicles. I proposed a new mechanism for charging of electric vehicles at traffic lights, published in Intelligent Transportation Systems Conference (ITSC) 2011 [7]. We proposed installing a charging mat or any other type of inductive charging device at a traffic light. Vehicles would be charged while they are stopped at a red traffic light. Moreover, we investigated the possibility of adjusting a traffic light's schedule to minimize vehicles' need to recharge. There are many factors in the design of this charging system, such as communication between vehicles and electric charging management system, billing, vehicle specifications, and vehicle trip information. We developed a preliminary system and evaluated various scenarios. We are working on an extended version of this idea.

Due to the spread of sensing capability in mobile devices, many researchers have started looking into usage of the sensed information for network optimization. In this regard, I am evaluating content adaptation for mobile devices based on its context: light, wireless communication quality, device capabilities, etc. The idea of how the context should be used for bandwidth and power optimization was presented [8] in the poster session of INFOCOM 2012. Our content adaptation mechanism helps in reducing the bandwidth usage as well as power saving. For example, we send pictures or video at a resolution that is appropriate for the device's resolution and screen size. Unlike conventional methods that adapt content at a server or the client, our system adapts the content at the Access Point (AP). We investigated two architectures for content adaptation at AP: at a local proxy next to the AP and at the MAC layer of the AP. Our initial results are promising in saving power and bandwidth of mobile devices.

Finally, I worked on analysis of a big data set using the logs of mobile phones to predict the demographic characteristics (gender, age, job, and marital status) of users. It was a challenge organized by Nokia and our accepted paper [9] will be presented at Mobile Data Challenge (MDC) workshop, held in conjunction with Pervasive Computing conference 2012. The dataset contains a 10-month log of mobile usage for 80 users. *Acceleration, Application, Bluetooth, Calendar, Call log, GSM, Media, Media Play, System, WirelessLAN,* were the logged information for each user. We first pre-processed the data to extract features. More than 1100 features were extracted. Then various feature selection methods were evaluated, and finally the RELIFF method was used for feature selection. In the next step, various classification methods were used on selected features. Depending on the classification problem, 48%-89% accuracy was achieved. It was for the first time in classification domain to classify demographic information from mobile data set. Hence, it is a new area that can be investigated further.

References

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