Improved Internet Traffic Control using Analyzed Mobile Application Usage Logs

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***Abstract*— This research focuses on how analysis of mobile application usage logs can be applied to Software Defined Networks (SDN) to improve fairness and load balancing in Internet traffic control. We believe that our proposed research can be used to tackle several networking issues such as bandwidth/resource allocation and fairness between applications. Through preliminary analysis, we show that our methods, can indeed enhance network performance.**

Keywords—Traffic control; resource allocation; data analytics

I. INTRODUCTION

Analysis of mobile network usage data has recently gained much interest, as it can be used to predict individual as well as crowd behavior of users in the network [1,2]. Especially, analyzed information from mobile data can be directly applied back to the network itself, which allows better understanding of the network status, and thus allows real-time control and management from the service provider. We believe that this is a very interesting issue in future networking, especially in Internet-of-things where control of large-scale deployment of devices is of utmost importance. To achieve this goal, we will apply a specific dataset to a SDN-controlled network, allowing the network controller to give network modifications to the routers based on the observed prediction results.

In mobile log analysis researches such as work by Lim et. al. [1] and Xu et. al. [2], authors have exploited mobile application usage logs from mobile devices to characterize conduct of mobile application users. However, as characterized by these two works, majority of these analysis researches focus on methodologies and discovering aspects of human behavior, while not actually attempting to apply the results on realistic network service scenarios to improve its performance. We believe that through analyzed data, networking functions can be greatly enhanced. For example in the work by Zhou et. al. [3], WCMP is proposed to balance data traffic based on the changing multipath network topology, to show the effectiveness of variation in flow bandwidth and the performance of traffic load balancing. We want to enhance from these state-of-the-art works by using analyzed datasets, which allows more accurate and real-time recognition of dynamic changes in the user behavior. This allows us to propose improved internet traffic control to guarantee QoS for each application.

Our dataset is anonymized data from a Wi-Fi service provider in France, containing logged information of mobile application usage over a span of 122 days in five different Wi-Fi cloud sites. For more details regarding the data and methods on analysis, please refer to work by Lim et. al. [1]. Using this data, we aim to control the incoming/outgoing traffic inside a network of routers. As our initial research, we propose some resource allocation methods, namely proactive and reactive resource allocation. We present preliminary analysis of our designed schemes using NS-3 simulator. Through this, we also derive our next steps of this research and future goals.

II. PROPOSED SCHEME

Through our initial research, we show how analyzed information from mobile data can be applied in resource allocation in router networks that connect mobile users. Let us assume a SDN network that provides connection between Internet service providers (ISP) and mobile users through access points (e.g. Wi-Fi). The controller of SDN manages an analyzed data repository, which has access to classes of application behavior that can be analyzed and predicted through methods as proposed by Lim et. al. [1]. In this example, the controller is aware of daily usage per mobile application in every 30-minute interval, allowing it to periodically disseminate this information to routers.

A. Proactive resource allocation

Upon receiving predicted per-application usage from the coordinator, each router will allocate resource to each application for every link that it maintains to other routers. The allocation is proportional to the overall predicted usage of every application and the link capacity. For example, if a streaming video application had 100 MB/s usage in a total of 200 MB/s for all applications, for a link where its capacity is 100 MB, it will be allocated 50 MB. If a network becomes congested due to excessive data request and generation, this method can provide fairness to all applications, and prevent dominantly used applications (e.g. video streaming, search) from using too much of the available bandwidth.

To show the effect of proactive resource allocation, we evaluate our method using NS-3 simulator. We configure a simple p2p network with two routers in the network, with one router forwarding all the data to the receiving router. The link capacity is configured to 100 MB. For data traffic, we select

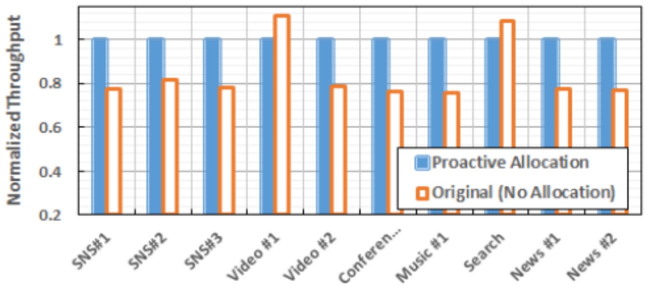

Fig. 1 Throughput of proactive allocation

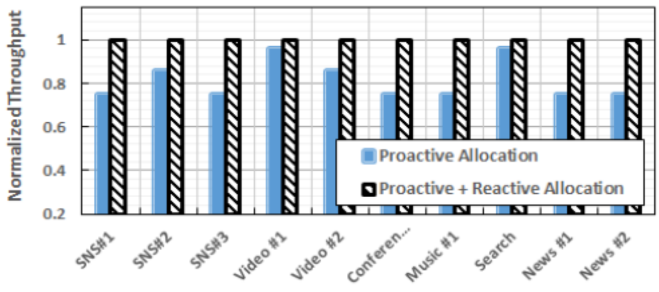

Fig. 2 Throughput of reactive allocation

the 10 most frequently used mobile applications in the network. These applications belong to different service categories, as shown in Figure 1. Data generation ratio of each application are generated per logged information acquired from the Wi-Fi dataset, with the total data rate configured higher than the link capacity to generate congestion. In Figure 1, we show the normalized throughput of each application when the proactive resource allocation method is used. Here, the normalized throughput represents the relative rate of the throughput when compared with proactive allocation method. As shown in Figure 1, proactive allocation scheme provides better fairness in throughput compared to not utilizing it. The reason that performances of video #1 and search application are lower for proactive allocation is because they generate the highest amount of data rate, and their data could not all be transmitted through the current link due to congestion. We believe that this can be easily solved by utilization of multi-path routing, which we will study as future work.

B. *Reactive resource allocation*

Although proactive allocation can guarantee some amount of fairness, it can also pose problems when outlying behaviors are observed in daily usage. Outlying behaviors occur due to various social events, such as sports games, accidents, public holidays, etc. These outliers affect usage of each mobile application in an unpredictable manner, making the prediction inaccurate. This poses two problems: Over-allocation, which results in wastage of bandwidth, and under-allocation, resulting in shortage of resources for a specific allocation.

To alleviate this problem, we apply modifications to proactive resource allocation by estimating the current traffic load of each application. For example, if a video streaming service has an allocated bandwidth of 100 MB/s while it generates a total traffic of 120 MB/s, it attempts to borrow a specific amount of bandwidth from another application that is underusing its resources. The router browses through the situation of all other application and borrows a specific unit percentage of bandwidth if available. For this work, we use an empirical unit value of {25%, 50%, and 75%}. For each application, the initial request of the lowest percentage is firstly made. Then, the request of the next unit of percentage is made only if borrowing the previous unit of percentage does not guarantee enough bandwidth for the borrowing application. This ensures that one application does not sacrifice all its resources to another application, while maintaining enough idle resources in case a new traffic request is generated.

Using NS-3, we analyze the performance of reactive resource allocation when outlying behavior occurs in the network. To generate an outlying behavior, we select a random application and increase its traffic by two-fold, while selecting another random application and decrease its traffic. Results are shown in Figure 2. The performance of proactive resource allocation is decreased because it cannot adapt to outlying events. However, reactive method can better cope with outlying events, thus providing higher throughput.

III. CONCLUSION AND FUTURE WORK

In this research proposal, we have shown a preliminary indication on how analyzed data can be used benefit network performance. Our first approach to verify our research, analysis-based resource allocation method, show interesting and positive results. However, in a more complex environment, more interesting traffic control methods can be applied using analyzed data logs in conjunction with the currently proposed methods. For example, the proposed methods cannot completely solve the congestion problem. Therefore, we will focus on further avoiding congestion through multi-path routing, which can be used to redirect only the dropped traffic (as seen in video app #1 in Fig. 1). Also, bandwidth sharing between different routes for different applications allows more organized per-traffic flows between routes. Finally, we plan to utilize existing open-source platforms such as ONOS [4] to implement our work on actual testbed routers.

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