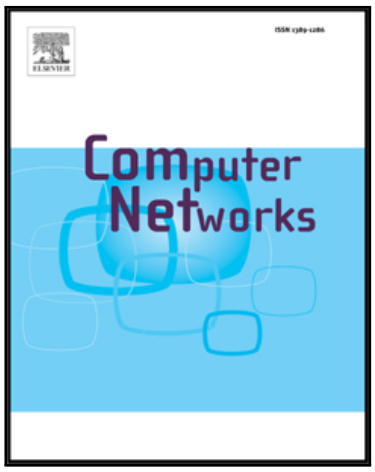

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User instruction mechanism for temporal traffic smoothing in mobile networks

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Abstract

With the recent spread of mobile devices like smartphones and tablets, the proportion of mobile device traffic as part of the total Internet traffic has been continuously increasing. Particularly, when a lot of mobile device traffic is concentrated in a wireless access network at a specific time, user throughputs drastically decrease, which results in the deterioration of communication quality. To solve this problem, temporal traffic offloading, which smooths traffic by moving peak traffic to off-peak time, has been proposed. However, since the conventional approaches were designed from the viewpoint of the operator, user satisfaction might not be improved even if traffic is smoothed. Therefore, in this paper, we propose a new mechanism that instructs users to delay their traffic to move part of the peak-time traffic to off-peak time to smooth traffic temporally. Our mechanism allows the user to decide whether to follow the instruction without forcing her or him to delay their requests so that her or his satisfaction is ensured. Our simulation study using a real traffic measurement dataset validates our mechanism in terms of traffic smoothing and user satisfaction.

Keywords: temporal traffic smoothing, user control, user response, utility
2010 MSC: 00-01, 99-00

1. Introduction

With the recent spread of mobile devices like smartphones and tablets, the proportion of traffic due to wireless and mobile devices as part of the total Internet traffic has been continuously increasing. It is forecasted by Cisco Systems that this proportion, which was 48% in 2015, will increase to 66% in 2020 [1]. A threat brought about by such a traffic increase is communication quality would be reduced when many communication requests are concentrated in a specific wireless access network. This happens particularly when a lot of people come to a specific place at the same time, for example, during commuting, at an entertainment event, or at an evacuation area after a natural disaster. The recent increase in mobile video delivery [2] could make the problem worse because the traffic volume per flow in video delivery is quite large. Ideally, sufficient capacity of the wireless access network, which depends on the frequency bandwidth and infrastructure, should be ensured beforehand so that such instantaneous excess traffic can be handled. However, in fact, this is unrealistic because the utilization rate would be low in ordinary traffic even though the infrastructure and operation costs are high. Therefore, some intelligent techniques need to be introduced to smooth the traffic.

A wide variety of techniques have been discussed in the context of traffic smoothing [3]. Access control [4, 5] and time- or frequency- domain scheduling [6, 7] also help to avoid serious problems caused by excess traffic like system failure. In this paper, we focus on temporal traffic offloading [8]. The basic principle of temporal traffic offloading is to move part of the excess traffic at peak time to off-peak time to reduce the peak traffic and handle the communication request within the network capacity. However, the standpoint of the conventional techniques is the operator side; they do not consider how user satisfaction would change when user requests are delayed by the system for offloading traffic temporally.

Therefore, to tackle this issue, in this paper, we propose a user instruction mechanism in which the wireless access system instructs users to delay their communication requests when it detects peak traffic. In our mechanism, the system estimates the throughput experienced by each user when she or he continues to communicate and when she or he delays her or his communication request. After that, the system informs the users of the estimated throughput through an instructing message. Then, the users decide whether they should follow the instructing message by themselves; our proposed system never forces users to delay their requests. Thus, our mechanism is beneficial because it can smooth traffic temporally without decreasing user satisfaction.

To validate our mechanism, we built a simulation scenario using real traffic data measured at a specific base

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