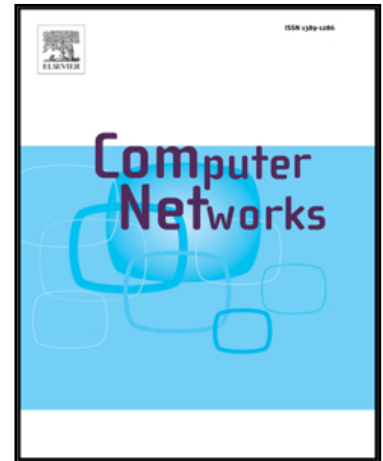


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# Viewing Experience Optimization for Peer-to-Peer Streaming Networks with Credit-Based Incentive Mechanisms

Xin Kang and Jing Yang

**Abstract**—Effective in fighting against “free-riding” and stimulating the cooperation between peers, credit-based incentive mechanisms are widely adopted in today’s peer-to-peer (P2P) streaming networks. This work considers a P2P multimedia streaming system that relies on credits for incentivizing peers to upload. The main problem of focus is to derive the optimal strategy for a peer, in terms of allocating its credits across different time slots, to maximize its long-term viewing experience. Especially, the dynamic changing feature of credits is taken into consideration when we formulate the problem, and the optimal credits allocation is shown to be a staircase-like function over time. Then, based on the characteristics of the optimal credits allocation strategy, an effective double-loop iterative algorithm is proposed. For the consideration of practical implementation, three low-complexity credits allocation strategies are proposed. It is shown that each of the strategies has its own feature and is suitable for a specific scenario. Then, as an extension, the proposed credits allocation schemes are reinvestigated for P2P streaming networks that adopt dynamic-pricing credits-based incentive mechanisms. It is shown that the previously obtained credits allocation strategies and algorithms can be easily applied to these systems with minor modifications.

**Index Terms**—Dynamic Resource Allocation, Network Optimization, Peer-to-Peer Networks, Credit-based Incentive Mechanism, Multimedia Streaming.

## 1 INTRODUCTION

With the rapid development of peer-to-peer (P2P) communication technologies, P2P streaming systems have become the most popular way to deliver multimedia content over the internet due to their low bandwidth requirement, high video streaming quality, and flexibility. However, “free-riding” [2], which refers to the case that a peer enjoys free service provided by other peers without contributing any resources, is common in P2P networks. This is due to the fact that most P2P systems merely rely on voluntary resource contribution from individual peers and do not enforce any compulsory contribution from peers. Free-riding tremendously degrades the performance of P2P systems. To enhance the performance of P2P

networks, various types of incentive mechanisms [3]–[7] for P2P networks have been proposed to tackle with the free-riding problem.

Incentive mechanisms encourage peers to make contribution to the system by providing service differentiation for peers with different levels of contribution. Peers with high level of contribution are usually given high priority in utilizing network resources. Generally, the prevalent incentive mechanisms can be categorized into *altruism*-based [4], *score*-based [5], *reward*-based [6], and *credit*-based mechanisms [7], [8]. Among these incentive mechanisms, the credit-based mechanisms are most popular in P2P multimedia systems due to their flexibility, scalability, usability and effectiveness. In credit-based incentive mechanisms, peers earn credits by providing service for other peers, and consume credits by paying for the service provided by other peers. Peers with more credits have more flexibility in choosing desired data suppliers and utilizing the limited network sources, and thus are more likely to receive high-quality data streaming. On the contrary, peers with fewer credits are much less competitive in accessing network resources. Thus, in P2P multimedia streaming systems,

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