Probabilistic Packet Scheduling Scheme for Hybrid Pull-Push P2P Live Streaming Protocols

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***Abstract*—Hybrid pull-push P2P live streaming protocols are proposed to reduce the delay and the overhead of mesh based protocols and to improve the robustness of tree based protocols. In conventional hybrid protocols such as Coolstreaming, the partition of a given stream into several substreams is conducted in a static manner and each peer selects its parents without considering their upload availability. In this paper, we propose a new packet scheduling scheme for hybrid protocols based on the notion of randomization. Our scheme attaches a pseudo random number to each packet, and associates a subrange of random numbers to each parent-and-child pair so that a packet attached a random number will be forwarded through a link associated with a subrange containing the random number. The size of each subrange is determined by considering the upload availability of each parent. By taking such a dynamic, probabilistic approach, we could improve the efficiency of resource utilization, as well as the stability, flexibility, and the robustness against peer churns.**

***Index Terms*—Hybrid pull-push protocol, live streaming, peer-to-Peer system, scheduling.**

I. INTRODUCTION

With the widespread of broadband accesses, video over IP has attracted more and more users. In fact, the number of aceesses to YouTube exceeds 2 billion per day[1] and the percentage of streaming traffic is expected to occupy 91% of the Internet traffic by 2014 [2]. Many of existing streaming applications use *application layer* multicast solutions, since IP multicast, which is recognized to be the most efficient way to realize multicast applications, is not widely deployed until now.

Recently, P2P technology has been widely used in many fields due to its scalability and flexibility [7], [6]. Many works studied the usage of P2P technology in video on demand (VoD) and live streaming applications, including the design and analysis of efficient scheduling algorithms [4], [1]. P2P streaming protocols can be classified into *tree based* protocols and *mesh based* protocols. Tree based protocols are simple and efficient but are not robust against peer churns since the leave of a peer may affect a large portion of peers in the delivery tree. On the other hand, in mesh based protocols such as CoolStreaming/DoNet [9], each peer exchanges the availability of chunks using buffer maps, and tries to "pull" missing chunks from its neighbours. Mesh based protocols are robust against peer churns but incur a long delay and a heavy control overhead. The reader should note that although we could reduce the delay in mesh based protocols by decreasing the time interval for the exchange of buffer maps, it significantly increases the control overhead per chunk.

[1]http://www.youtube.com

To overcome such drawbacks of conventional protocols, hybrid pull-push protocols have been proposed in the literature. In Coolstreaming [8] proposed by Xie *et al.*, data chunks are arranged into several substreams, and each peer can acquire substreams from its neighbours by establishing a parent-child relationship as in tree based protocols. Such a hybrid pull-push protocol can certainly reduce both of the delay and the overhead of mesh based protocols. However, it causes another critical problem described as follows. Since each peer can have a limited amount of upload bandwidth, it could accommodate a limited number of children. Thus, it easily causes a competition among children, and the loser of such a competition should try to find other parent after being refused by the former parent. Such a wandering behavior of peers will not stabilize the overlay, which will significantly degrade the overall performance of the P2P streaming system.

In this paper, we propose a new scheduling scheme for hybrid pull-push protocols to overcome such an instability of the overlay network. The basic idea of the proposed scheme is to adopt *pseudo random* substreams instead of fixed substreams. The new substreams are dynamic, adaptive and generated by taking into account the availability of the upload bandwidth of the parents. In the new design, the data unit exchanged among peers is a packet. Although we could not complete an experimental evaluation, we expect that pseudo random substreams will outperform static substreams for the following reason. In static substreams system, each peer can not request a set of chunks less than the set supported by each substream. Thus few options are available for the peer to choose its parents, which increases the number of overloaded peers. On the other hand, as pseudo random substreams are dynamic and adaptive, each peer can request different portions of chunks from different peers according to their upload bandwidth. Furthermore, any peer will receive requests in proportion to its upload bandwidth which leads to more stable and flexible system.

The remainder of this paper is organized as follows. Section II overviews related work. Section III describes the proposed scheme. Section IV is devoted to the analysis of the system dynamics. Finally, Section V concludes the paper with future work.