Overlay Management Strategies to Improve QoS in Peer-assisted Live Streaming Systems

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by

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Abstract

With the increase in demand for live streaming services over Internet, Content Delivery Networks (CDN) are overloaded resulting in poor Quality of Service (QoS). To alleviate this problem, peer-assisted live streaming systems are being deployed to take advantage of self-scalability of peer-to-peer (P2P) overlay networks. In peer-assisted live streaming systems, peers retrieve stream content from other peers in the overlay apart from the servers. A major challenge in deploying these systems is to ensure QoS, while dealing with heterogeneity in lifetime and bandwidth of peers. This dissertation presents a few overlay management strategies to improve the QoS of peer-assisted live streaming systems.

First, we study the limitations of different overlay topologies in providing QoS under flash crowd, churn and heterogeneous bandwidth of peers. We found that the multi-tree overlay shows poor streaming quality, startup delay and resilience during churn, while the mesh overlay has larger playback delay and jitter. The hybrid tree-mesh overlay requires to minimize the delay of the mesh sub-overlay and precise prediction of stability of peers to organize them in the tree sub-overlay. Considering these issues, we propose a three-stage peer selection strategy to build a minimum delay mesh overlay. In the first stage, the tracker suggests some peers as prospective partners to a new peer. In the second stage, the new peer selects its partners out of these peers to retrieve stream content. The third stage is the topology adaptation phase of peers, where peers reposition themselves in the overlay to minimize the delay during peer churn. In all the stages, peers are selected considering upload capacity, propagation delay, buffering level and per-hop chunk buffering duration. The proposed peer selection strategy is compared with two existing strategies and the results show that the playback delay is reduced significantly along with a marginal improvement in startup delay.

Next, we propose an overlay management strategy for hybrid tree-mesh overlays to improve streaming quality, startup delay and upload capacity utilization despite heterogeneity in lifetime and bandwidth of peers. It organizes peers based on their serviceability, defined in terms of stability, streaming quality, upload and download

capacities. The peers with higher upload capacity are part of an extended CDN tree to facilitate stable seeders. A part of the upload capacity of the existing peers is reserved to form *virtual sources* that provide startup chunks for quick playback. The peers joining the mesh overlay select partners with the highest serviceability to ensure better streaming quality. They also adapt the topology by replacing partners based on serviceability and upload capacity utilization to maintain QoS during churn. A comparison with existing strategies shows that streaming quality and startup delay is improved significantly due to better upload capacity utilization of peers. It also results in offloading the CDN servers. Overall, the proposed overlay management strategies are found to improve the QoS in mesh and hybrid overlays that can further improve the scalability of peer-assisted live streaming systems.