Cooperative Media Processing and Streaming

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Abstract

Peer-to-peer (P2P) systems have emerged as a large-scale, distributed platform for resource sharing that offers cost effectiveness, increased autonomy, scalability, and reliability. Even though P2P systems have been used successfully for sharing static multimedia files, using overlay networks to serve dynamic multimedia content has only recently received attention. Applications include Internet telephony and television, audio and video conferencing and streaming of music or movies. Providing multimedia applications over P2P is particularly challenging due to both application and system characteristics. Multimedia applications pose end-to-end soft real-time and QoS requirements on data transmission, including fast and reliable transfer, guaranteed minimum throughput, bounded jitter and latency. Peers on the other hand are heterogenous in their processor capabilities, transmission loss rate, and network inbound/outbound bandwidth, and share their resources with other applications. Moreover they are dynamic, in that they can join, leave or fail without a priori notification. In lack of a central manager with an accurate global view of the large-scale system, there is no straightforward way to schedule the independently arriving application requests in order to trade-off their QoS requirements.

In this work [1] we present adaptive media streaming and transcoding techniques for large-scale peer-to-peer systems. Our system deploys a transcoding service and targets on-demand media streaming. The users select media objects and specify the formats they can accept. Transcoders are used to convert the objects to the desired formats. Transcoding enables the system to adapt to different user requirements (e.g. codec, bitrate, resolution). This way, peer heterogeneity in terms of decoding software is addressed, as well as particular needs, such as those of energy-constrained devices, wireless nodes, or impaired users. Yet, transcoding is only one example of a media processing operation required by a user. Other real-time operations may include pattern recognition in the video stream or image synthesis.

Multiple streaming paths with collaborating transcoding peers are constructed and the media objects are delivered to the users through several sub-streams, utilizing different nodes in the system. Each transcoding peer is able to adapt to changing resource conditions locally to maximize the transcoding quality. Quality adaptation is important because of the dynamic nature of the system: Peers join and leave independently, application tasks arrive unexpectedly, and resources such as the network are shared with extraneous load. In our local adaptation technique every transcoding peer periodically solves an optimization problem to adjust the output quality of the different streams it is providing, according to the available resources.

Since the resource availability in the system is largely affected by peer and application dynamics, the streaming quality may vary with time in an unpredictable way. Therefore we empower the end receiver of a multimedia stream to coordinate the operations of all the service-offering peers in a session to address quality fluctuations. The receiver periodically calculates a desired quality interval for the whole stream and propagates it to the participating transcoders. By coordinating the transcoding operations we ensure that the end users' quality requirements are not violated, while at the same time the quality fluctuations in the aggregate stream remain smooth and within user acceptable levels.

We carry out an extensive performance evaluation of our techniques through simulations. We compare our coordinated streaming mechanism against both an adaptive and a static scheme. The results demonstrate the scalability and performance of our approach and show that it can satisfy the QoS requirements of P2P media streaming.

References

[1] F. Chen, T.Repantis, and V. Kalogeraki. Coordinated media streaming and transcoding in peer-to-peer systems. In *Proceedings of the 19th IEEE International Parallel and Distributed Processing Symposium (IPDPS), Denver, CO, USA*, April 2005.