

Dilip Krishnaswamy
Tom Pfeifer
Danny Raz (Eds.)

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Real-Time Mobile Multimedia Services

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of Multimedia and Mobile Networks and Services, MMNS 2007
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Preface

It is a great pleasure to present the proceedings of the 10th IFIP/IEEE International Conference on Management of Multimedia and Mobile Networks and Services (MMNS 2007).

The MMNS 2007 Conference was held in San Jose, California, USA during October 31 – November 2 as part of the 3rd International Week on Management of Networks and Services (Manweek 2007). As in the previous three years, the Manweek umbrella allowed an international audience of researchers and scientists from industry and academia – who are researching and developing management systems – to share views and ideas and present their state-of-the-art results.

The other events co-located with Manweek 2007 were the 18th IFIP/IEEE International Workshop on Distributed Systems: Operations and Management (DSOM 2007), the 7th IEEE Workshop on IP Operations and Management (IPOM2007), the 2nd IEEE International Workshop on Modeling Autonomic Communications Environments (MACE 2007), and the 1st IEEE/IFIP International Workshop on End-to-End Virtualization and Grid Management (EVGM 2007).

Under this umbrella, MMNS proved itself again as a top public venue for results dissemination and intellectual collaboration with specific emphasis on multimedia and mobility aspects of end-to-end services. These aspects of management are becoming a major challenge in the ability to deliver cost effective end-to-end multimedia-based services in the upcoming 4G wireless systems.

Contributions from the research community have met this challenge with 46 paper submissions from four continents, out of which 14 full high-quality papers and 4 short papers, presenting innovative work in progress, were subsequently selected to form the MMNS 2007 technical program. The diverse topics in this year's program include services and user experience, management aspects of wireless and cellular networks, monitoring and control, resource management, and multicast and IPTV management – all contributing to the management of real-time mobile multimedia services, as expressed in this year's motto.

The high-quality MMNS 2007 program is a delicate concoction based on the accepted papers of the original and novel contributions of all the authors who submitted their work to the conference, purified by the hard work of the MMNS 2007 Technical Program Committee members and the rigorous review process accomplished by this set of worldwide experts, cooked with the great help of the 2007 Manweek Organizing Committee, and spiced with the generous contribution of IFIP, IEEE and the sponsor companies, all of whom are gratefully thanked by the conference Technical Program Committee Chairs. In addition, we thank the Springer LNCS team for their support of these proceedings.

We have no doubt that the MMNS 2007 conference in the heart of Silicon Valley was another significant step towards the ability to develop, manage and control truly scalable end-to-end multimedia-based services over next-generation wireless networks.

October 2007

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Hybrid Overlay Networks Management for Real-Time Multimedia Streaming over P2P Networks

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Abstract. Recent growth of the multimedia content delivery over the Internet and the popularity of the peer-to-peer (P2P) architecture have opened new horizons for emerging novel services over the Internet. Currently, most of multimedia services are being offered to the end users by using set-top boxes installation on the client's premises, with integrated media storage capabilities and their adaptation. The organization of the end-clients in P2P fashion has great potential to change business models to offer new value-added multimedia services and therefore to generate substantial revenue for service providers. In this paper, we present a mechanism to organize the sender peers in hierarchical hybrid overlay networks. The objective of such organization is to facilitate the receiver peer (content consumer) to select best sender peers for the provision of better QoS (Quality of Service). To construct the hybrid overlay networks, peers offering the same video quality are placed together at the same level of overlay networks. The organization of sender peers within these overlays is subject to (1) the semantic of the video provided by the peer (base layer, or enhancement layers) and (2) the QoS offered by each peer along the end-to-end path. The proposed streaming mechanism is receiver-centric where receiver peer selects a number of sender peers from the overlay networks to receive media contents. The performance evaluation performed using ns-2 simulator shows that hybrid overlays organization mechanism is helpful to enhance the overall QoS by significant improvement in received video packets throughput, the packets drop ratio and transmission delay.

1 Introduction

P2P networking frameworks have recently received a lot of attention by the research community, as they provide an efficient infrastructure to use available networking resources in a more transparent, scalable and cost-effective way. P2P networks were initially designed and were considered suitable for huge contents distribution across networks. These networks possess distributed, scalable, cost-effective, cooperative resource sharing, self-organizing, and many more characteristics that have encouraged service providers (SPs) to deploy many real-time applications over large scale heterogeneous networks. This is considered as a giant shift of technology that has changed the way people interact with the technologies. The most important real-time

applications based on P2P framework include: video streaming, video on demand, P2P based IP-TV, P2P gaming, signaling for IP telephony, etc. Overlay networks are considered as the most promising infrastructure for the deployment of distributed applications. Many existing multimedia applications over P2P networks are based on the organization of the participating peers in overlay networks. Many research developments have been observed overlay networks organization that address the scalability, efficient management, and self organization of overlay networks. The well known overlay networks like Content Addressable Network (CAN) [1], Chord [2], and Pastry [3] have been proposed for the Internet routing to guarantee better quality of service.

On the other hand, recent advances in audiovisual content coding have favored a widespread growing of multimedia streaming and Video on Demand (VoD) services. A number of home holders are subscribing to these services by the service provider through a set-top box. These boxes are generally equipped with specific functions such as storage space, on which the client can store programs, movies, and other desired contents. The service provider has full access for indexing, tracking and to use the contents available in these set-top boxes. These characteristics enable service providers to use such boxes as independent content servers. In the rest of paper, we refer these boxes as peers when used in P2P networks. The terms set-top-box and peer are used interchangeably. In fact, most of these boxes are capable of performing media content adaptation in accordance with the end client's requirements. These features extend the usability of these boxes to that of media servers for the end clients possessing different characteristics, i.e. heterogeneous clients. Another point of heterogeneity is related to the end-user connection. Most of the end-clients (service subscribers) connect to the network using ADSL (Asymmetric Digital Subscriber Line) or CMTS (Cable Modem Termination System), where uplink capacity is 3-8 time lesser than that of the downlink. If media content is requested from a single box, it cannot be achieved. In fact, a single peer might not be able to meet the requirements of any one request. In this regard, we propose to select multiple sender peers to cooperate in the streaming mechanism using multi-source streaming. The use of multiple peers for the service delivery reduces the load on the central server, reduces the start-up delay, latency, and improves the overall Quality of Service (QoS) of the system.

In this paper, we present a quality adaptive mechanism for the multimedia streaming and video on demand services over P2P networks. This mechanism is based on the organization of sender peers in hybrid overlay networks. These overlay networks are formed on the basis of offered video quality and end-to-end probing among the sender and receiver peers.

The network topology for multimedia streaming and video on demand services is illustrated in the Fig. 1 where different service clients with variant characteristics are connected to the network. In this topology, we consider only those peers which have the requested media contents and are willing to participate in the streaming mechanism. The receiver peer selects multiple sender peers to receive the media contents from the overlay networks. The received media contents are combined to decode the received video with a higher quality. The sender peers are selected from the different overlays on the basis of receiver characteristics and its preferences.

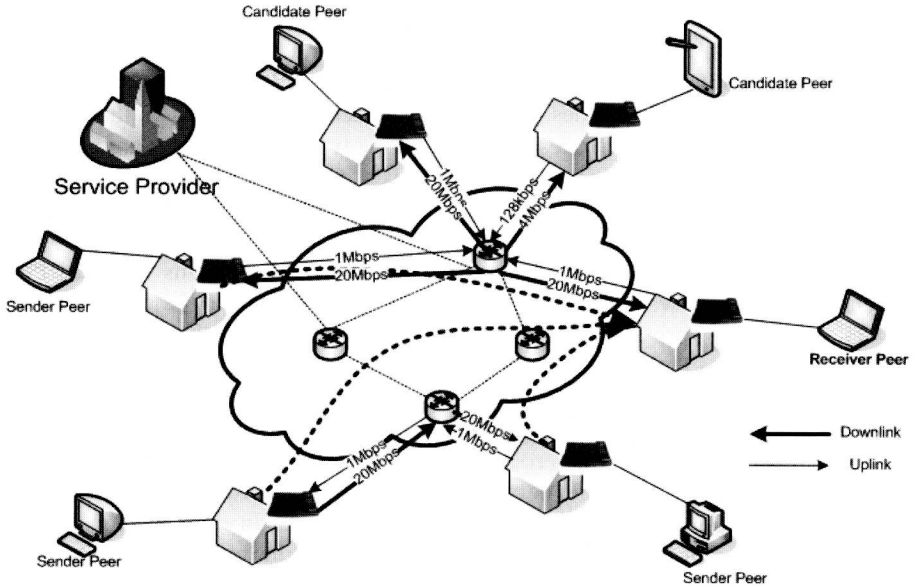


Fig. 1. Network Topology for Multimedia Streaming / Video on Demand

The rest of the paper is organized as follows. A brief motivation and some of the related work is presented in the section 2. Section 3 describes an overview of the scalable video coding (SVC) scheme. The proposed streaming mechanism based on the organization of sender peers in hierarchical overlay networks is given in section 4. The evaluation results of proposed mechanism using simulations are presented in section 5. Finally, concluding remarks are presented in section 6.

2 Motivation and Related Works

There have been significant studies carried out in the context of multimedia streaming applications and for the construction of overlay networks to enhance the QoS. Most of these studies have investigated and proposed solutions for the efficient routing algorithms, organization techniques, and self organization.

Zhang et al. [4] developed a framework for live media streaming that is based on data-driven overlay networks where each node periodically exchanges data availability information with other nodes. The management of nodes which join the networks is controlled by an origin node that is persistent during the life time of the streaming session. In the proposed mechanism, a scheduling algorithm is devised for heterogeneous clients. The nodes in the data-driven overlay network are organized in a Breath-First-Search (BFS) tree, where origin node is located at level '0' while any node at level 'k' can be reached in 'k' hops from the origin.

Tian et al. [5] presented a framework for the Hybrid Overlay Structure that is based on Random Walks. The proposed organization is locality-aware where nodes are organized in different clusters. Crespo et al. [6] proposed the “SON” mechanism for the organization of different nodes. The proposed mechanism is based on the semantic based organization of nodes. Nodes having the same type of media files are organized close to each other and therefore clustered together. The semantic based organization result into improvement of the system performance in terms of the efficiency in query search.

The organization of peers (nodes) in overlay networks systems also has been presented in research work such as CAN [1], CHORD [1], Pastry [2], and Tapestry [7]. These systems provide efficient routing mechanism for the structured P2P overlay networks. The major proposed solutions organized peers in overlay networks on the basis of distances, i.e. Locality-aware. The motivation behind our proposed mechanism is to use the overlay networks for the best sender peers selection in order to support heterogeneous clients and to improve the QoS while efficiently utilizing the available network resources. In our proposed hybrid overlay networks mechanism, we organize different sender peers in different hierarchical overlay networks considering both (1) the semantic of the video and (2) the QoS offered by each peer. The detailed hybrid overlay organization mechanism is presented in section 4.

3 Scalable Video Coding (SVC)

Multimedia content adaptation is considered as an important technique to provide QoS management for multimedia delivery over heterogeneous networks to meet the requirements of clients with distinct characteristics. Many video encoding schemes have been proposed for real-time applications operating for heterogeneous networks and terminals. Layered encoding and multiple description coding [8] are considered suitable for many applications including P2P services. At present, Scalable Video Coding (SVC) is considered most promising video encoding format for streaming application in heterogeneous networks and terminals [9]. A scalable video coding is used to produce highly compressed bit-streams, to generate a wide variety of bit-rates. An original SVC stream can be truncated to produce videos of different qualities, resolutions, and frame rates using respectively SNR (signal-to-noise ratio), spatial, and temporal scalabilities.

In this paper, we focus on the use of SVC video formats as an important component of the proposed P2P system while organizing the sender peers in hybrid overlay networks. The SVC characteristics make it more suitable for heterogeneous environments especially P2P networks. A layered stream representation of SVC in terms of spatial, temporal, and SNR resolution is shown in Fig. 2. In SVC encoding scheme, each quality tier is decodable with different characteristics. The first tier providing the basic quality of the video is called “Base Tier” while other tiers which are used to enhance the overall video quality of the base tier are called “Enhancement Tiers” [10].