摘　要

随着现代网络技术的不断发展，流媒体服务已经得到了广泛的应用，目前主要有两种方式可以实现提供流媒体音视频的服务，即客户端/服务器模式和对等网络模式。其中，对等网络作为一种传输技术，使得大范围内的音视频直播和点播成为可能，成为当前支撑大规模并发流媒体服务的主流技术。虽然对等网络技术推进了流媒体服务的应用，但是仍然存在着许多问题和挑战，限制了流媒体服务性能的进一步提高。

针对于此，本文首先论述了流媒体系统中的已有技术及其存在的问题，然后从系统设计、拓扑维护策略和数据调度算法等方面进行了深入的讨论和研究，并在此基础上设计开发了一套基于对等网络技术的流媒体点播系统——AVStreamer3.0。在该系统中，采用了优化的拓扑架构模型和数据调度方法，能够满足流媒体点播系统的许多需求，如点播请求的异步性、用户的交互性操作和系统的可拓展性等。本文的主要内容如下：

首先，总结并分析了 P2P 及流媒体技术的发展现状，如典型的拓扑结构和数据调度算法的优缺点。

其次，提出了一种优化的拓扑结构体系模型。该模型包括可拓展性的分布式索引系统、区域级联分级模型以及基于内容分发网络的数据源接入方案和数据校验机制等，从而能够提供一个较好的适应大规模并发的拓扑框架。

第三，提出了一种创新的节点选择策略。该策略依赖于一种基于区域多级级联层的节点组织结构，充分考虑了节点之间的资源差异性状况，优先共享同一区域内资源相类似节点的数据，并且可以通过超级节点的辅助功能或迅速加入邻近的级联层应付拓扑危机。

最后，提出了一种基于节点线性预测的调度算法，目的是为了更好地支持点播交互性操作和改善用户的体验。为了提高对等网络的数据共享效率，该算法依赖于一种基于对节点综合资源的评价标准，综合考虑了节点资源的差异性特点。

目前，已经成功部署了 AVStreamer 流媒体点播系统，并在该系统中进行了一定规模的并发在线测试，展现出了较好的性能，满足流媒体点播的基本需求，对本文中所提出的相关策略作了进一步的验证。

关键词：对等网络；流媒体系统；视频点播；拓扑维护；数据调度

Research on Key technologies in P2P video-on-demand systems

Xu Yongze (Computer Application)

Directed By Gao Wen

With the development of network technologies, streaming services have been widely applied. Nowadays there are two basic and effective methods to implement this application: Client/Server (C/S) and Peer-to-Peer (P2P). As one kind of transmission technology, P2P makes streaming services on a large scale possible and becomes the popular streaming technology. However, there exist some problems and challenges for P2P streaming framework to impact the development of streaming.

In this paper, we generalize the characteristics of existent streaming technologies. Then we make a profound discussion and research on topology maintenance and scheduling algorithms and so on. Based on them, we design and develop a real-world P2P VoD streaming system (AVStreamer3.0), which have a high scalability and meet basic VoD requirements, such as asynchronous access and interactive operations. The content of this paper is as follows.

Firstly, we summarize and analyze the development of streaming technology to introduce our study angle, such as topology framework and scheduling policies.

Secondly, we propose a topology framework and optimize it in several ways, including a scalable distributed tracker system, a regional multistage model, a CDN-based source solution and a checkout mechanism. The aim is to provide a better framework for large-scale concurrent topology.

Thirdly, a node selection strategy is proposed and designed in the tracker. The strategy is based on a structure of multistage zones, which makes one node connect and share with these nodes which have similar resource status possible. And when falling into emergency, it can request the help of super nodes or join other close areas.

At last, we put forward a scheduling algorithm which is based on a node-prediction selection policy, to support interactive operations well. In order to improve P2P data sharing efficiency, the algorithm makes use of a resource evaluation criterion and taking into full account of the differences between them.

We have published an AVStreamer VoD system in real-world network, which withstands a scale of concurrent online testing and have good performance. It has proved that these policies can support VoD operations effectively and improve the system scalability.

Keywords: peer-to-peer, streaming system, video-on-demand, topology maintenance, data scheduling