

Transporting Real-time Media Over the Internet

- Internet-Übertragung von Echtzeit-Medien -

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Abstract: Die Internet-Übertragung von Echtzeit-Medien stellt besondere Anforderungen an Codierung, Transport-Mechanismen und System-Architektur. Es muss geringe Latenz und hohe Wiedergabe-Qualität bei gleichzeitig niedriger Datenrate erreicht werden. Dabei sind insbesondere neue Scheduling-Verfahren für Medien-Pakete leistungsfähig, die die Wichtigkeit und die Abhängigkeit von Paketen berücksichtigen. Verteil-Architekturen können Server am Rande des Netzes vorsehen (IPTV) oder beim Verbraucher im Home Media Gateway. Peer-to-Peer Verteilmechanismen sind besonders geeignet.

Extended Abstract

1 Introduction

Since the introduction of the first commercial products in 1995, and its subsequent phenomenal growth, Internet media streaming has placed new demands on source coding, network transport algorithms, and delivery architectures. The fundamental difficulty is due to the unpredictable packet delay, loss and throughput in the Internet. The challenge is to simultaneously maximize subjective quality at the receiver, satisfy the latency constraints and meet bandwidth limitations. The relative importance of these goals depends on the application. Conversational services, such as Voice over IP (VoIP), require low latency, with round-trip times less than 150 ms. For video-on-demand, the latency requirements are more relaxed. Commercial systems typically exhibit a 5-10 sec latency today, but, as higher quality Internet video increasingly competes with television broadcasting, latencies well below one second will have to be achieved.

2 Packet Scheduling

Early streaming systems simply transmitted media packets without consideration of the importance of individual packets or the prevalent channel conditions, except perhaps the maximum available bit-rate. The most significant recent advance in streaming technology is the emergence of rate-distortion optimized packet scheduling techniques that can take into account packet importance and knowledge about the channel in a Lagrangian formulation. The performance improvements achieved relative to non-Lagrangian heuristics can be impressive and greatly exceed the progress that has been made by considering compression alone. Rate-distortion optimized packet scheduling is increasingly becoming the intellectual core of the new area of media streaming. Algorithms of that type will ultimately be used in every network node involved in streaming audio or video.

Lagrangian packet scheduling can also minimize network congestion. Such formulations achieve just-in-time delivery of packets, minimizing the latency that other users experience when resources are shared. They are also needed to achieve load-balanced flow routing over multiple parallel paths.

Packet scheduling can be sender- or receiver-driven, or implemented in a proxy. It can be beneficially combined with adaptive media playout, where the playback time axis is unnoticeably warped using smart signal processing techniques, and with retroactive decoding, where late packets are decoded nevertheless and the decoder can “catch up” with media playout.

3 Media Delivery Architectures

Cable companies and telcos are competing to deliver “triple play” services to consumers, combining voice, video and data in one service contract. The competition is particularly fierce in the United States. Cable companies provide VoIP phone service over cable modems. To deliver entertainment television over DSL broadband access, telcos must roll out IPTV systems, which provide streaming video of live or stored content. The streaming media server is usually located at the edge of the network to achieve QoS requirements, while keeping control over stored content.

Streaming media servers can be located anywhere in the network. As mass storage further decreases in cost, we expect the percentage of video-on-demand to dominate live video streaming. This shift has already happened with music. Home media gateways might come pre-loaded with archives with 1000s of movies stored on their disk drive. Peer-to-peer media distribution would be an attractive mechanism with this architecture.

Even with massive storage in the home, the challenge of streaming real-time media over wireless home networks remains. To accommodate rapidly changing wireless transmission conditions, packet scheduling techniques again are the key to a low-latency solution.