Robust Video Transmission Over the Internet Multipath Routing & Network Feedback

Ritesh Sood
Department of Electrical & Computer Engineering
University of California, Davis
Email: rsood@ece.ucdavis.edu

I. Motivation

Multimedia applications, such as streaming video impose stringent bandwidth and delay requirements on the underlying network. The Internet, due to it's best-effort packet-switched nature, is ill-equipped to meet these requirements by itself. The problem is compounded further by the dynamic nature of the Internet which provides no guarantees about bandwidth availability or end-to-end delays. This eventually leads to congestion in the Internet resulting in packet loss that the multimedia application is unable to fully correct, despite inbuilt protection strategies.

The problem may be alleviated to an extent by adding redundancy (and thus robustness to loss) to the video stream. Multiple paths usually exist between a given source-destination pair in the Internet. Redundant data maybe transmitted over these extra paths to guard against losses on any one single path. These multiple paths may originate and terminate at nodes not necessarily the source and destination respectively. However, this solution requires intelligent handling of data by intermediate nodes, which is not afforded by routers alone.

II. Proposal

From the above discussion the following questions arise:

- How much and what redundancy to add
- How to forward these multiple data streams to the destination

A. The Question of Redundancy

Video data exhibits redundancy both in the temporal and spatial domains. A simple form of exploiting this redundancy might be to transmit even frames on one path and odd on another [1]. This approach is attractive for it's simplicity, but is clearly not the most efficient. *Multiple Description Coding* MDC is another solution [2], wherein multiple streams are created at the symbol level itself (as opposed to frame or packet) level. In all these studies however, dynamic variations in the network parameters have been ignored. Decisions regarding creation of multiple streams and choice of paths are based on simple probabalistic models of the channel. We might stand to gain a lot if dynamic information about the channel is collected and incorporated in creation and forwarding of these bitstreams.

Wavelet coding of the video followed by temporal filtering [3] arranges it in various levels of priority, suitable for the purpose of adding redundancy. Thus the most important spatio-temporal subbands may simply be replicated and sent on all selected paths, and this replication may be reduced for the remaining (less important) subbands. In this project, I will start with this simple scheme. The selection of the paths will be based on the following network parameters:

- Loss rate
- Bandwidth
- Delay

B. Network State Information & Packet Forwarding

Routers alone can not implement the desired tasks listed above. An overlay network infrastructure [4] is suitable for gathering the required network information and carrying out the forwarding. The following figure illustrates this concept (courtesy Ram Keralapura).

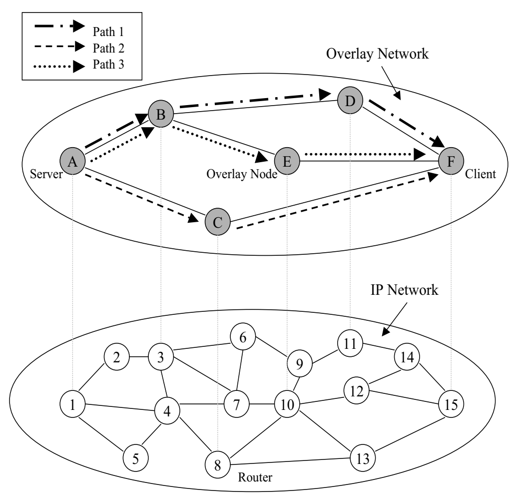

Fig. 1. Overlay Network

A new logical layer called the *Synergy Layer* running on top of the IP layer will provide the required network information. This layer resides on all routers and gathers information from the lower IP layer and passes it on to the overlay network.

REFERENCES

[1] J. Apostolopoulos, “Reliable Video Communication over Lossy Packet Networks using Multiple State Encoding and Path Diversity,” in *Visual Communications and Image Processing*, Jan. 2001.

[2] V. K. Goyal, “Multiple Description Coding: Compression meets the network,” *IEEE Signal Processing Magazine*, vol. 18, no. 5, 2001.

[3] J. C. Ye and M. van der Schaar, “Fully Scalable 3-D Overcomplete Wavelet Video Coding using Adaptive Motion Compensated Temporal Filtering,” in *ICIP*, Jan. 2003.

[4] W. Tan and A. Zakhor, “Real-Time Internet Video Using Error Resilient Scalable Compression and TCP-Friendly Transport Protocol,” *IEEE Transactions on Multimedia*, vol. 1, no. 2, 1999.