SkyCast: The satellite digital broadcast relay service

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Abstract

The SkyCast project investigates the feasibility of relaying digital broadcast audio and video services over local area networks and broadband home access networks. It consists of a set of servers that receive digital programming from DVB-compatible satellites. Clients connect to the servers using the RTSP and HTTP protocols and receive the relayed digital programming through unicast or multicast connections. A variety of other value-added services around the core system such as programming directories and video disk recorders are also considered. Finally, we examine the possibility of redesigning the current analog video transmission architecture for cable TV around the SkyCast and Video Disk Recorder (VDR) services.

1. Introduction

Direct Broadcast Satellites (DBS) have been in operation for several years now and services like DirecTV, Primestar and EchoStar are continuously gaining in popularity, especially in rural areas where cable TV coverage is insufficient. The most widely adopted standard for transmission of digital video and audio programming is the Digital Video Broadcasting (DVB) system [3]. DVB is used in the United States by the Echostar network, which employs 2 and soon 4 satellites to offer more than 300 channels of video programming.

DVB is based on the MPEG series of standards [1] for video and audio transmission. Video signals are converted from analog into MPEG streams and then uplinked to the satellite. Every satellite has in the order of 16 transponder frequencies, each of which carries a 27 Mbps signal.Typically, every transponder can accommodate approximately 6-7 channels of video and 3-4 channels of CD quality audio for broadcast radio programming. By tuning to a particular transponder, a satellite receiver is capable of receiving the entire programming of that transponder (by contrast, TV sets can tune only to one 6MHz analog signal at a time). As a result, a single tuner can be used to relay multiple program streams.

With this enormous quantity of programming available in digital form, we initiated the SkyCast project. SkyCast explores the feasibility of relaying the digital content to low-end clients using a local area network, and further investigate a service infrastructure around the delivery of digital media. With corporate networks becoming more capable and efficient in carrying multimedia streams, services like SkyCast integrate the transport of traditional video programming in an existing networking infrastructure. The development of SkyCast has further raised some interesting issues regarding the expansion of such delivery services in the broadband home access market.

2. Architecture

2.1 Media Transport

The SkyCast project is an experiment that tests the feasibility of relaying digital programming over local area networks. It is complementary to the AT&T labs Livenet project [2], and in fact, the two may be integrated in the near future. The target architecture of SkyCast is shown below. A set of servers equipped with DVB satellite receiver cards receive programming directly from a direct broadcasting satellite. Each server then separates the content into program streams which are then available for transmission to a client. The computation load on the server is minimal since no decoding of the data stream is necessary, but only some processing of the MPEG transport multiplex to extract the desired audio and video elementary streams.
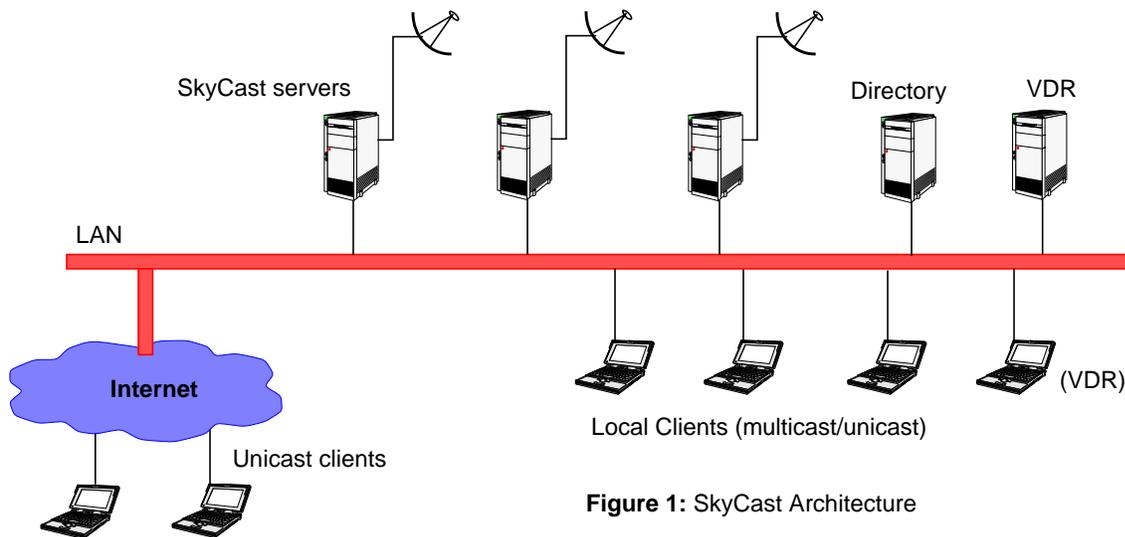

Figure 1: SkyCast Architecture

Every server provides a directory of services that contains all programming available through that server. Clients connect to the directory, select a program and obtain further information required to connect to the relayed program stream. Most client applications available today support streaming from Web or other media servers through unicast connections. Since IP multicast is rarely available from ISPs, this has been a popular solution to the content delivery problem. This model however does not scale due to its unicast nature, and further (especially in LAN environments) results in a tremendous waste of bandwidth. In such environments, multicast is a better solution. The industry is now looking closely at new streaming protocols such as RTP and RTSP that support multicast as a solution to the local delivery problem. In fact the new RealPlayer G2 from Real Networks is RTP/RTSP and multicast capable. However to be 100% compatible with all client applications we will support both regular unicast streams using HTTP and RTP/RTSP. The former are usually sufficient and acceptable for audio transmission but can quickly become a great burden on the network when carrying video streams.

2.2 Services

We are currently working on two services that complement the media relay system.

2.2.1 Programming Directory

The Programming Directory is provided through a Web interface and lists the content that is available for transmission from all SkyCast servers. The directory can be upgraded dynamically by the servers, which in turn, have access to the transponder program directory stream. This stream is created by the operator of the satellite service to serve as an on-line directory for set-top boxes, etc. By clicking on a particular program, the user link launches a player application that connects to the appropriate server using RTSP or HTTP.

2.2.2 Video Disc Recorder (VDR)

Another application that is currently under development allows the user to examine programming from the directory and then record programs off-line using a drag and drop interface. The VDR connects to a server when the desired program starts and copies the stream to a local disk. It does so for all programmed recordings. Later the client can retrieve the desired programming from the VDR's disk as if it was connecting to a server. Interactive stream control commands such as /pause/ resume/fast-forward etc. can be implemented.

Since for this application multicast does not produce any bandwidth savings, there are several advantages in moving the VDR service to the client itself. In this case, playback is performed through the local hard drive and does not involve any network transmission.

One can imagine a delivery service of digital content though a combination of SkyCast and VDR: SkyCast servers play the role of a diskless digital media library (at a very low cost since no storage is required). Users are able to compose the programming of their liking every day and watch it at their leisure. One can mix and match news, movies, video clips, etc. and even switch between them during playback since the disk is a random access device. In addition, the user can connect to the server to receive live content. This architecture may benefit significantly content providers as well, since they can use the entire 24hr period to transmit content that is typically delivered only during prime time. Further, traditional VCR-type functions have become a mere drag and drop operation from the directory server to the local VDR application. Programming the recording device is now easy.

3. Current Status and Future Work

At the time this paper is written (June 1997) we have completed a server prototype using a Comstream DVB adapter to receive a signal from the EchoStar 1/2 satellites which carry the Echostar Dish Network programming. The server is a PC running Linux. The current server software extracts program streams and relays them to the client through an HTTP session. Due to bandwidth limitations for unicast applications at this time we are only relaying audio streams from the CD quality audio programming available on almost every transponder. Popular clients such as Winamp, x11amp and RealPlayer G2 can connect to the server with no modification and receive programming. The directory is implemented through an HTTP server running on the same machine. Since most video programming from these satellites in encrypted, we can only receive some promotional or of limited interest channels. Later this year, we are incorporating new receiver hardware that gives us access to the full programming of these satellites.

At the same time we plan to configure a multicast capable RTSP server which will allow more scalable deployment of video services. This will be provided to us through the Livenet II project. Other members of our lab are working on the implementation of the VDR service at the client side.

We are also investigating the applicability of this delivery method in AT&T's new broadband home access environment. It is possible that instead of broadcasting analog video over AT&T's cable lines, the same bandwidth is used for digital services, one of which is the relay of video programming. It is possible that significant bandwidth savings can be achieved through this video-on-demand model. However, unlike other interactive TV trials, the SkyCast service can be deployed at very low cost since it does not involve storage facilities. Part of this cost can be moved to the client applications that run the VDR service. The "on-demand" model has the potential of expanding tremendously the choice of video programming available to cable TV customers, since an array of SkyCast servers can make available more content than what the cable network is able to carry (typically 120 analog or 500 digital TV channels.

The home page of the SkyCast trial can be found at http://mosquito.research.att.com

Acknowledgements

References

[1]   ISO/IEC 13818, Parts 1-3: "Information technology -- Generic coding of moving pictures and associated audio information", 1996.

[2]   A. Basso et. al., "LIVENET: Real-Time high quality video/audio over non guaranteed QOS networks", http://videotalks.research.att.com/livenet/livenet.html

[3]   Digital Video Broadcasting (DVB), http://www.dvb.org