SWITCHED BROADCAST CABLE ARCHITECTURE USING SWITCHED NARROWCAST NETWORK TO CARRY BROADCAST SERVICES

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Abstract

Bandwidth is a precious resource in any cable network. Today, Cable MSOs broadcast hundreds of digital channels over HFC networks to all cable subscribers. These channels occupy a sizable part of the plant RF spectrum, yet at any given moment, most channels remain unviewed. Significant RF spectrum can be reclaimed by switching "less popular" broadcast channels according to user demand.

A narrowcast switched video network for VOD services is already in place in many large cable systems today. This switched network provides digital video content to subscribers on demand, occupying bandwidth only when a title is requested and sent over the HFC.

This paper will discuss the existing switched narrowcast network architecture as a scalable, cost-effective, flexible and "switched broadcast ready" network.

INTRODUCTION

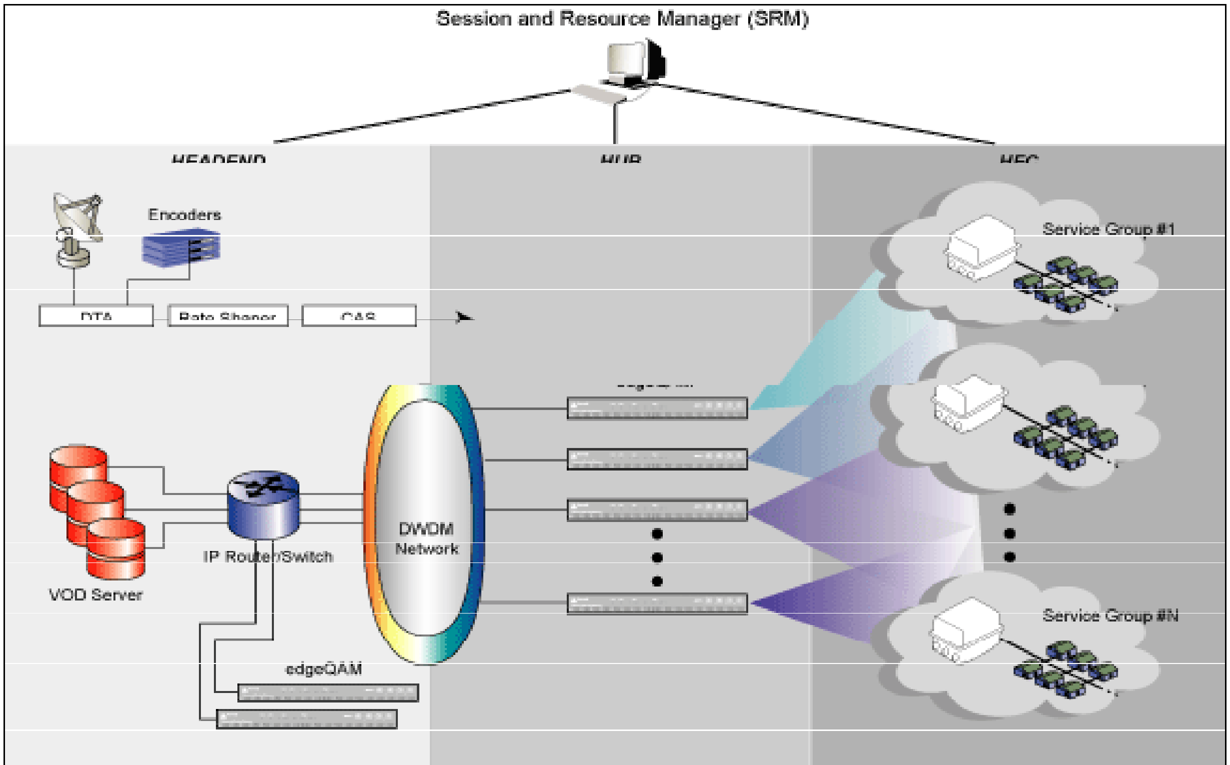
Bandwidth is a valuable resource for cable operators. They are constantly trying to leverage their existing infrastructure to expand their broadcast channel line-up and offer as many revenue-generating services as possible. Possible new services include video-on-demand (VOD), high-speed data or voice-over-IP (VoIP).

A switched broadcast architecture allows operators to offer a virtually unlimited number of broadcast programs while freeing costly bandwidth for revenue-generating services. The switched broadcast model dynamically switches a broadcast channel "on", via the narrowcast channel to which the subscriber is connected, when a subscriber attempts to tune in the channel. Operators can also add an array of specialty or targeted channels without increasing their systems' broadcast channel spectrum or capacity.

The theory behind switched broadcast relies on typical Pay-TV viewing behaviors. Within a particular service segment or node, only a handful of channels are being accessed at any given time. In other words, numerous channels are not being watched and there is a lot of bandwidth that could be saved or used for other services.

Many cable systems already have a narrowcast video network for VOD services in place. The most common network architecture for VOD uses standards-based commodity GigaBit Ethernet (GbE) switches to build a cost-effective switched network. Edge QAM devices with standard IP interfaces serve as gateways between the standard Ethernet/IP network and the HFC, and enable QAM sharing for multiple services. Switched broadcast is just another type of service that can use that narrowcast video network infrastructure and **share** the IP network and QAM resources.

The diagram below describes a typical VOD system running in parallel to a broadcast network.



SRM parallel Architecture

This paper presents a solution using an ***existing*** VOD infrastructure to enable a switched broadcast services overlay at ***nominal cost*** to the operator. The discussion will outline any required additions to an existing broadcast infrastructure in order to support a switched broadcast application.

THE SOLUTION

The solution presented here has been adapted from a standard Multicast IP solution. For several years, Telco operators have been providing video services over their standard IP networks. The video content may be provided on demand and transmitted to a specific Unicast address, or broadcast in Multicast IP groups into the IP network. Each client, in the standard IP solution, simply needs to join a multicast group in order to get the broadcast service. The IP router will send the service to the client once it is part of the group.

Using the same approach, the IP edge QAM device will join the multicast group following a subscriber's request to receive a switched broadcast service, and will forward the service to the QAM feeding the set-top box's Service Group.

A single edge QAM device can serve multiple service groups. Its MPEG-2 multiplexing core enables service **multicasting** at the edge of the network by duplicating the content and streaming it simultaneously to multiple destinations or QAMs.

THE SWITCHED BROADCAST SERVICES

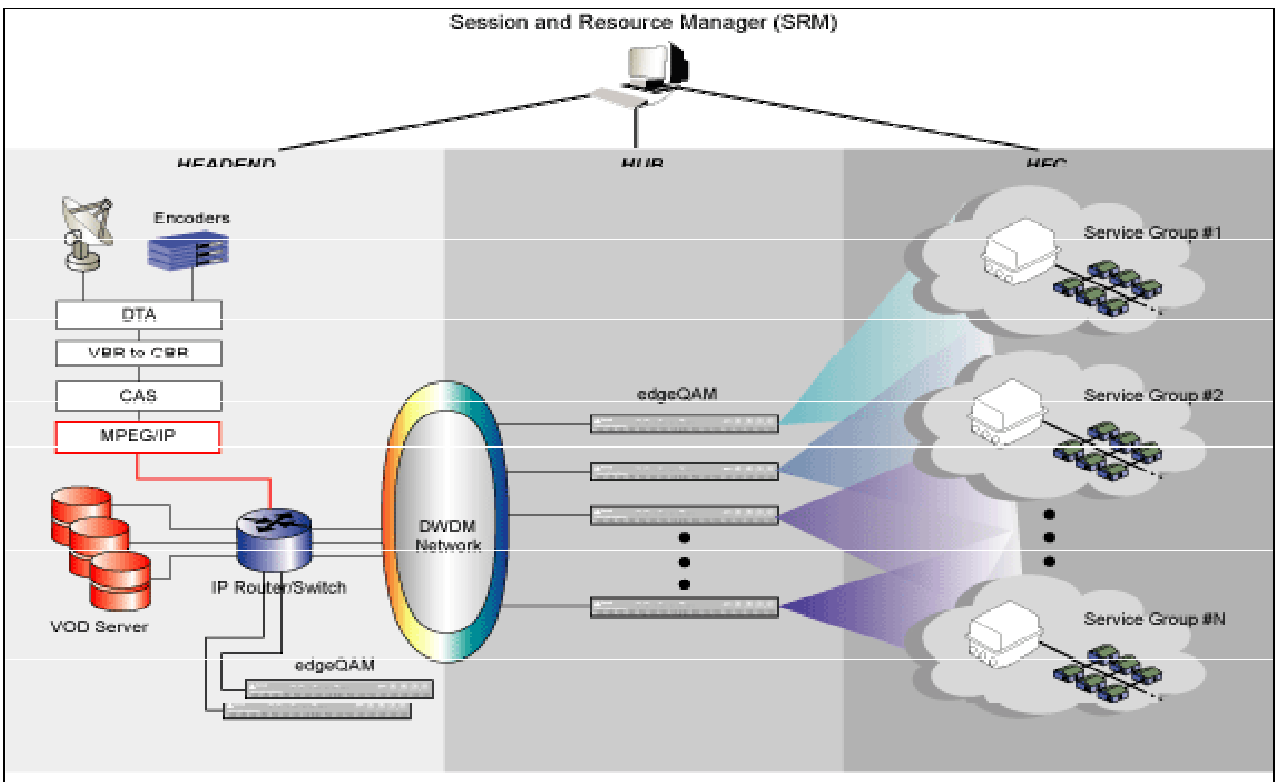
Content intended for switched broadcast can be any standard definition and/or high-definition video programming, or data content such as games or electronic program guides. The programs may be locally encoded or received off the air. The channels should be carefully selected as "less-viewed" programs relative to the entire broadcast domain in order to guarantee efficient use of network resources. For example, these channels could be niche programming, ethnic programming or local interest channels.

ENABLING SWITCHED BROADCAST

The concept proposed in this paper suggests the use of existing components owned by the MSO to keep the capex investment nominal. Looking at the diagram below, which represents the modified architecture, it is clear that not much has been added. Using the same broadcast feeds, some will be forwarded to broadcast channels as they are currently, and some will be sent to the switched narrowcast network.

The same devices that were used before for rate shaping will now be used for VBR to CBR conversion. A new device should be added, converting the switched broadcast streams into SPTS (Single Program Transport Stream) over Ethernet/IP/UDP frames. The IP/UDP frames are identical to those being generated by the Video Server. A single 1-RU converter box costing less than $10,000 supports hundreds of SPTSs!

Most of the modifications needed to enable switched broadcast services happen in software, such as the Switched Broadcast application on the STB and the SRM (Session Resource Manager). The SRM is responsible for sharing the network and QAM resources between the VOD services, the switched broadcast services and other future services.
The diagram below shows the suggested architecture.



SRM Suggested Architecture

SO, HOW DOES IT WORK?

Each channel selected for switched broadcast will be transmitted into the streaming IP network as an SPTS over a dedicated IP/multicast group (multicast address). The QAM edge device emulates the RF portion of the network to an IP network and treats the switched broadcast channels as **standard** IP/multicast services throughout the network - from the video source to the subscriber's set-top box (STB).

Once a "switched broadcast" program is selected from the program guide, the STB forwards the request to the SRM. The SRM identifies the service group (SG) where the request originated, and checks the bandwidth availability of the QAMs feeding this SG (or zone).

The SRM provisions the appropriate edge device for the relevant multicast address, and sends information regarding which QAM should receive the stream. Upon provisioning, the edge device will "join" a multicast session and re-multiplex the stream into the appropriate MPEG transport stream/QAM. The SRM sends an acknowledgement to the STB, providing the QAM channel and the program ID.

In general, the process is nearly identical to the way a subscriber selects a VOD service. The primary difference between a switched-broadcast stream and a VOD stream is that streaming does not originate directly from a server or other storage device. Rather, the content is simply streamed off the broadcast services.

LEVERAGING THE BROADCST SERVICES

Other applications can be integrated into a switched broadcast infrastructure. An operator could easily provide all available locally-encoded content, generated in different regions, to all systems within a cable network. Doing so would require no extra bandwidth. Instead, only standard IP connectivity between the systems is required.

Virtual VOD (V-VOD)

Virtual VOD can be seen as an improved version of NVOD services using the narrowcast network. It still enables a level of VCR functionality, while dramatically reducing the bandwidth consumed by the NVOD service over the broadcast network. Another significant benefit is that V-VOD requires less streaming capacity than regular VOD services.

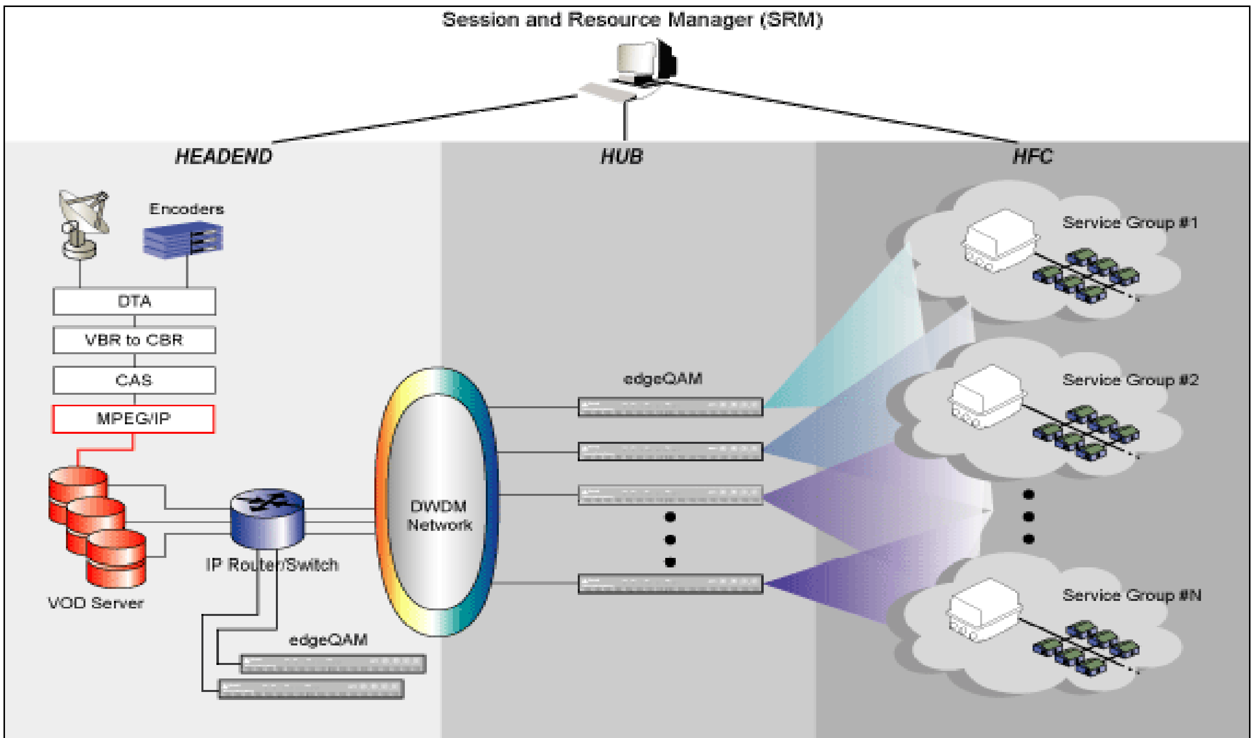
For example, ten two-hour movies that start every five minutes (or twelve times each hour) require 10 x 24 = 240 streams. At 3.75 Mpbs per stream, 240 streams require a total of 900 Mbps bandwidth. A single standard VOD server will suffice. The VOD server will stream all 240 streams regardless of actual user demand. However, as in the case of switched broadcast programs, the streams will be dropped at the IP switch connected to the VOD server and will not consume HFC resources unless requested by a subscriber.

In this architecture, switched V-VOD leverages the narrowcast QAM access to carry NVOD streams based on demand. While the concept does not require any in-band channels for NVOD, it does enable V-VOD so that each subscriber will not have to wait more than five minutes for a movie to start.

nPVR APPROACH

Network PVR (nPVR) is already providing broadcast channel programming per user demand. In the nPVR model broadcast channels are being recorded on Video Servers, the **same** Video Servers providing VOD services. The content is being provided to the user using the **same** narrowcast network infrastructure used for VOD services. The advantages of the nPVR solution are clear: it enables VCR control as well as very targeted Ad insertion. So, why wouldn't we use the nPVR model, which provides prime broadcast content on demand, for the more niche programming? The answer relates to storage cost and capacity, and to the narrowcast network cost. Nevertheless, the migration to Everything on Demand (EOD) will drive lower prices on Video Servers as well as the narrowcast network, enabling niche programming over nPVR infrastructure.

Again, The argument here is about minimal investment for the niche programming, and reuse of existing infrastructure. We are proposing a migration path from broadcast to switched broadcast (provided as another source into the switched narrowcast network) to nPVR.



SRM nPVR Architecture

SUMMARY

A switched broadcast architecture enables an unlimited expansion of the broadcast channel line-up while freeing up precious bandwidth for other revenue-generating services. New services could include Virtual VOD and local content distribution.

The solution introduced in this paper relies on standard "off the shelf" IP/GbE devices such as switches and IP edge QAM devices. Existing VOD systems based on these devices are scalable, cost-effective, flexible and "**switched broadcast ready**."

Minimal capital investment is required to enable switched broadcast services on a switched narrowcast network built for VOD services. **The same QAM and IP network resources can be shared between the different services.**