The New Frontier of Custom Digital Service

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Abstract

The growing subscriber demand for advanced digital services, such as video, internet access and telephony, creates a lucrative opportunity for both cable operators and other service providers. To effectively compete against broadcasters, DTH satellite operators and telcos with xDSL, MSOs must solve the two major issues facing them during a digital service rollout.

The first is efficiently using available system bandwidth to maximize service delivery options. The second is creating customized analog and digital services that can be targeted for specific customer demographics. Achieving bandwidth efficiency and customized service delivery capability is desirable from an operational perspective, providing flexibility and scalability. Equally significant is the improved ability to deliver the quality and quantity of content and service options that customers are coming to expect.

New technologies that enable content customization, digital rate adaption and the opportunistic bit stuffing of data into video streams allow cable operators to address both the bandwidth efficiency and custom service delivery objectives, opening the door to expanded revenue opportunities. The new abilities enabled by these technologies provide cable operators with a differentiable advantage as the broadband service marketplace becomes increasingly competitive with the entry of non-traditional service providers.

CHALLENGES FACING CABLE OPERATORS

It used to be simple. MSOs provided cable television service and telcos offered data and telephone service. Though they had the same customers, MSOs and telcos weren't competing. Now, thanks to deregulation, new network operators and the explosion of internet services, MSOs are competing with telcos, broadcasters and satellite operators to offer subscribers advanced broadband services. Cable operators can offer services, such as telephony and internet access, that consumers traditionally received from other service providers. The challenge is that those other providers have an equal opportunity to move into the video arena, the traditional preserve of cable, and offer consumers the same bundle of services.

Cable operators have several advantages over these other providers. Cable has a significant market penetration edge over satellite and xDSL service, and the subscribership for both technologies has yet to meet early expectations. In addition, cable operators boast a high-speed advantage over traditional telco solutions when it comes to internet access. However, cable operators have several challenges to successfully address in order to maximize their market share and ensure long-term profitability.

Telcos have long offered a variety of custom services to their subscribers that can be bundled as the individual customer desires. This allows targeted marketing. By contrast, cable operators have established a tiering system, in which the customer has two or three levels of service to choose from, plus premium channels. Cable operators may be taking advantage of various available satellite feeds, but find their hands tied when it comes to customizing how they deliver that content. Consequently, there is little difference between the packages offered by various cable operators in different regions.

While operators could address this issue by decoding and re-encoding each feed, if they choose to avoid that expense, they are left with a satellite feed taking a large portion of their bandwidth. Add in local content and advanced services such as internet access or Video-on-Demand, and you quickly have more content than you have room for.

The second challenge for cable operators is significantly expanding their service offerings without a corresponding increase in allocated bandwidth. It is not the most viable option to increase the amount of content by reducing the quality of signal, because cable operators are now sharing a competitive arena with satellite and telco operators that have a reputation for reliability and quality far exceeding that of cable.

Cable operators must take further strides to ensure that they can deliver high-quality, customized service offerings reliably and consistently. System downtime, signal degradation or loss, or taking an inordinate amount of time to implement promised upgrades is not an option.

A major concern is how to provide quality service without exceeding budget plans. Another challenge for cable operators is to expand the volume and variety of service offerings economically, react to subscriber demands quickly and become telecommunications providers, not just cable TV providers, seamlessly.

DRAWBACKS OF CURRENT DIGITAL SERVICE DELIVERY MODELS

The current digital service delivery model is to access remote satellite feeds and transmit the content on to subscribers, however it has inherent drawbacks that prevent it from being the solution cable operators need in the new market environment.

There are currently two solutions for processing remote satellite feeds. The first is to simply transmit the feed as is. While this is an inexpensive solution and certainly provides a comprehensive programming line-up, it puts unwanted limitations on the operator. This unaltered satellite feed is now taking up bandwidth, but only a portion of the program offering may actually be of interest to large groups of subscribers.

The second, traditional solution is to locally encode all programming. In this model, digital satellite feeds are decoded then re-encoded. This model provides the flexibility to customize the feed, dropping individual programs at will. This solution requires an enormous outlay of resources, however, both in the acquisition of expensive encoding equipment, and in the space and powering requirements to operate that equipment. Each hub site now must house complex equipment that will require more maintenance by skilled workers. As a system grows, expenditures will grow at a rate that is not beneficial to the bottom line. The decode/re-encode solution also has a technological disadvantage, as each time the signal is manipulated there is a corresponding loss of signal quality.

The current solutions for handling remote satellite feeds require balancing flexibility versus expense and quality, a choice that operators are more reluctant to make when faced with increasing competition and subscriber expectations.

Another key consideration when trying to achieve the optimum balance of flexibility and efficiency, is that many satellite feeds arrive statistically multiplexed. When re-transmitting this feed as is, it is simply a matter of allocating the bandwidth for the feed as delivered. However, once grooming techniques are applied to the feed, a bandwidth allocation problem is, once again, encountered. Dropping programs from the feed reduces its required bandwidth allocation, and operators must still reserve enough bandwidth to allow for the maximum bit rate that could be needed.

A desire to use every Hz of available bandwidth makes it tempting to compress yet another video program into the multiplex to take advantage of the small amount of bandwidth reserve. Cable service is already vulnerable to charges of lower quality standards, compared to satellite or telco service, so achieving greater bandwidth efficiency at the expense of signal quality is to be avoided.

The current model does not effectively provide the cable operator with both flexibility and bandwidth efficiency, while maintaining quality and good economical value.

Solving these challenges with a patchwork of solutions is possible, but will inevitably cost more and create a more complex, and therefore unstable, architecture. Cable operators can achieve maximum flexibility and bandwidth efficiency with one economical, complete system solution.

Significant new technology developments can be incorporated into existing system architectures to achieve this ideal, balanced system solution. Content customization techniques, digital rate adaption and opportunistic bit stuffing provide a complete solution that allows flexible service customization and efficient bandwidth utilization as part of an integrated and reliable system solution.

ADVANTAGES OF THE NEW DIGITAL DELIVERY MODEL

While satellite sources alone may provide adequate television programming, to become a full-service provider, cable operators must begin to access content from a new range of networks. These include video from servers to provide Video-on-Demand and IP networks to provide IP data, interactive services and IP telephony. And there will still remain the requirement to integrate local content, whether analog or digital at its source.

The first goal is to increase service options, without correspondingly increasing the complexity of headend and hub designs and without investing in overlapping network architectures to handle the transport of the various services.

It is not enough to be able to groom the various transport streams. The ability to multiplex the resulting program streams together, regardless of source, into a single custom multiplex, allows an increase in variables from which to select, and therefore increases freedom when building a business. The ideal system can integrate these functionalities seamlessly.

Figure 1 illustrates the ability to incorporate input from a variety of content sources and create a seamless custom service package for subscribers.

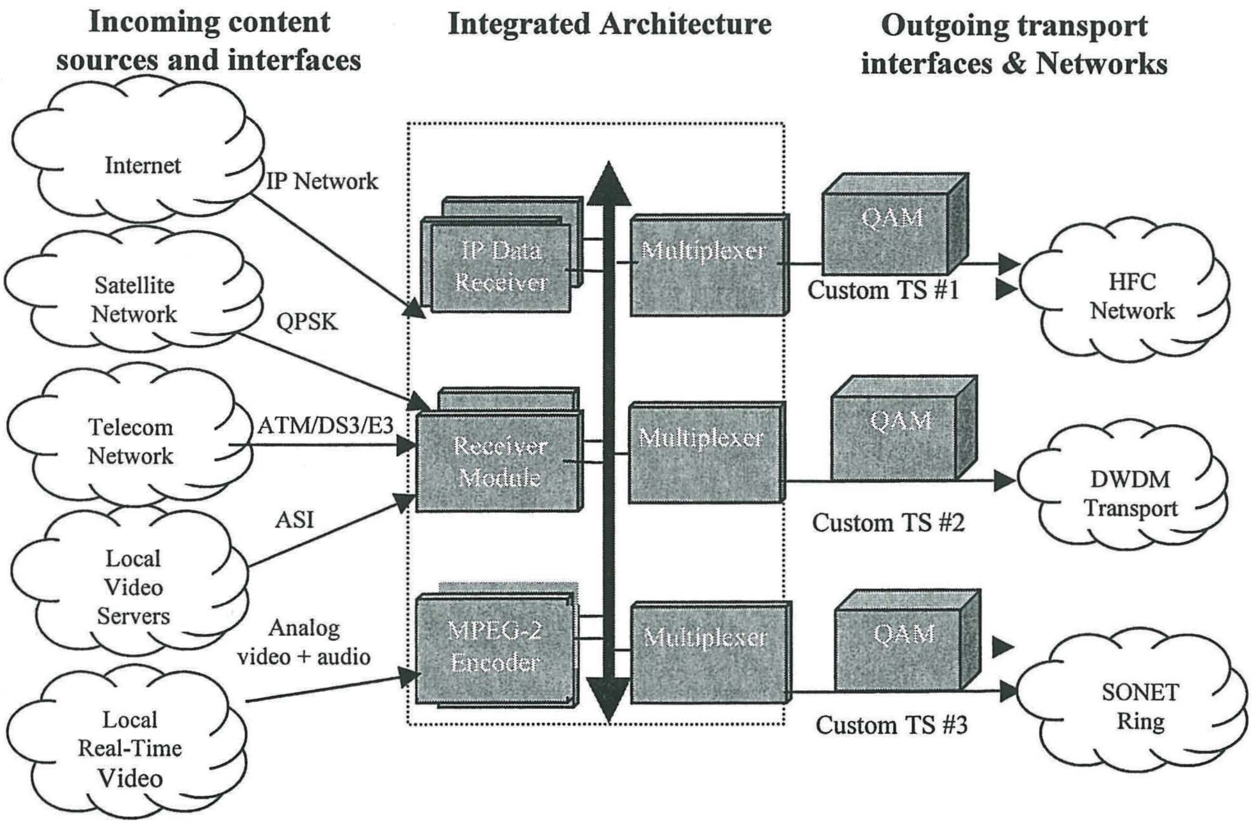

Figure 1: Network Transport Options

While Figure 1 illustrates a wide range of service delivery options available with a single system, Figure 2 illustrates the specific advanced digital services now available for delivery to subscribers with this architecture.

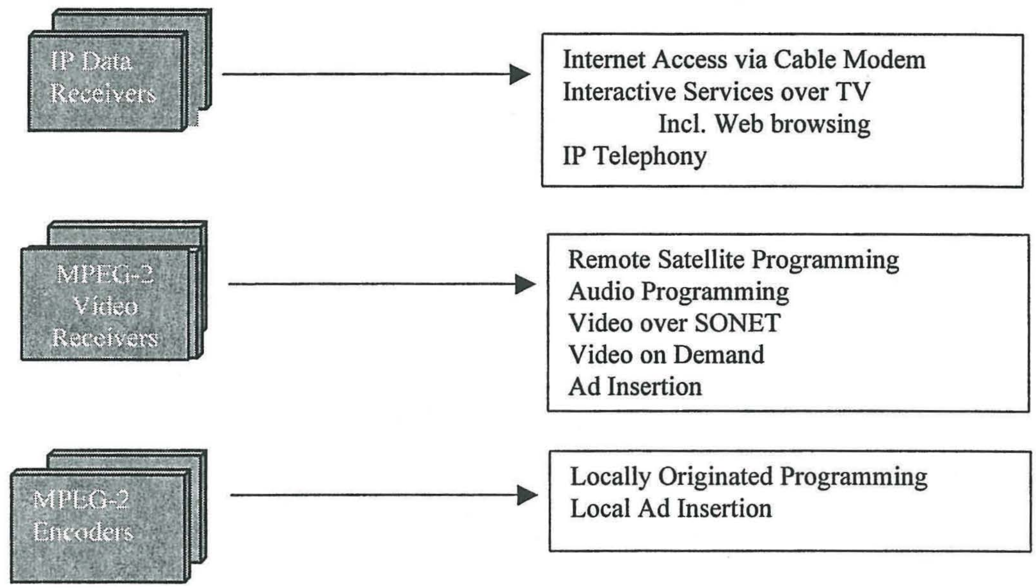

Figure 2: Custom Service Delivery Options

DIGITAL RATE ADAPTION

With all of these service options, the next goal is to create a custom multiplex, utilizing available bandwidth as efficiently as possible, without sacrificing quality.

Two new technologies facilitate this process. The first is digital rate adaption, which takes statistical multiplexing a vital step forward. The second is the opportunistic insertion of data into available bandwidth within video transport streams.

Unlike traditional statistical multiplexing, which is performed on constant bit rate transport streams, digital rate adaption is a new technology that allows the service provider to take a transport from multiple sources and do a final multiplex. The unique capability of this technology is that those transport streams can be either remote feeds or locally generated, and the original sources can be constant or variable bit rate. Cable operators can define bandwidth requirements and quality standards for their programming, and digital rate adaption enables a real-time constant bit-rate statistical multiplex to be created from these disparate sources.

The digital rate adapter analyzes the incoming bit streams, adapts the rates according to user-defined standards and creates a new statistically multiplexed transport stream. This flexibility also allows a higher bit rate per channel.

Figure 3 illustrates a solution for transmitting eight satellite programs and ten locally encoded channels, using traditional statistical multiplexing. This results in an average bit rate per channel of 2.7 Mbps.

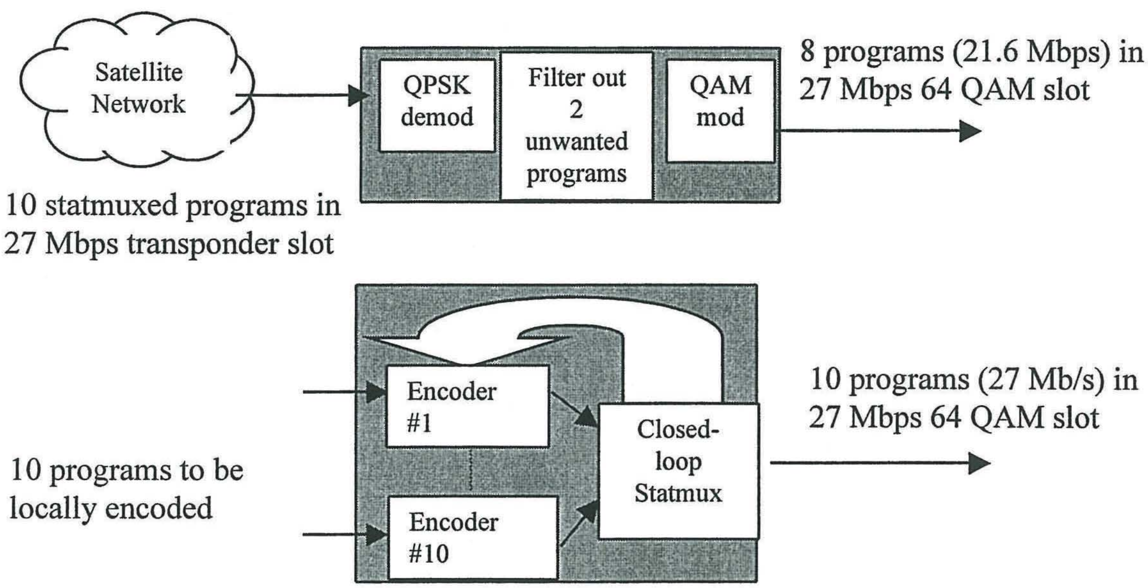

Figure 3: Traditional statistical multiplexing and program customization solution

Figure 4 illustrates how flexible digital rate adaption can provide a higher bit rate per channel and perform the same grooming function. This solution results in an average bit rate per channel of 3.0 Mbps.

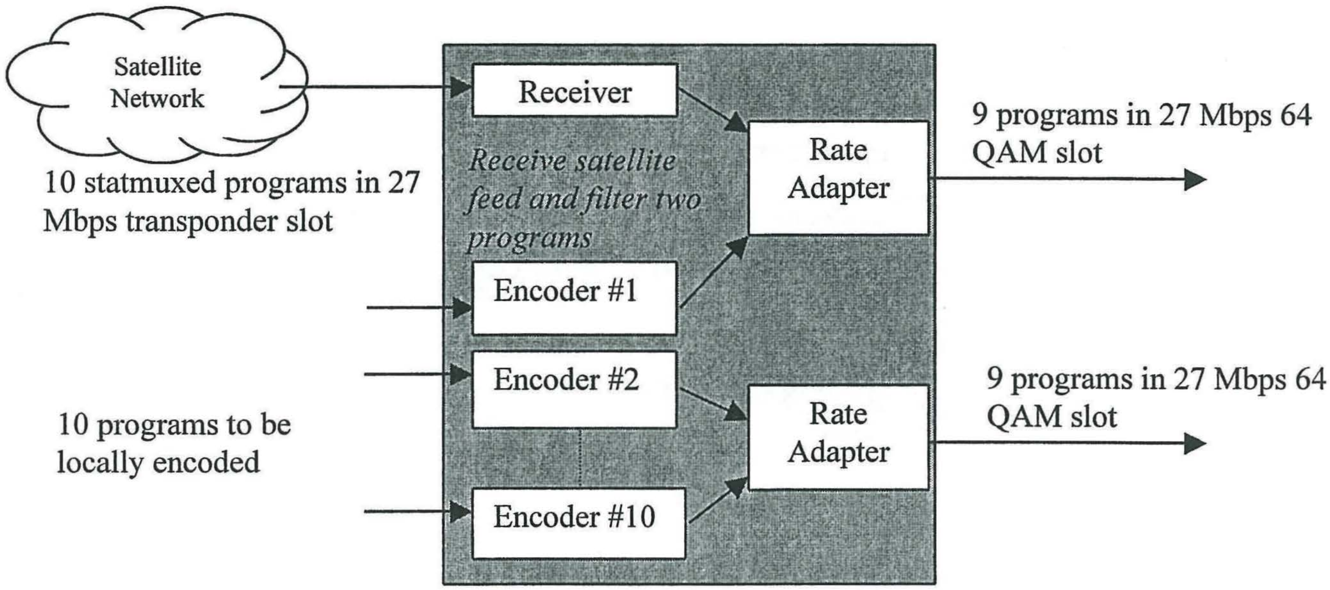

Figure 4: Digital Rate Adaption of both constant and variable bit rate transport streams

Figure 4 depicts the advantage of an integrated system approach to rate adaption and program customization. Being able to flexibly adapt constant and variable bit rate program streams in a one-step process provides, in this example, a 10% increase in program quality, while meeting the same bandwidth requirements.

Figure 5 depicts a typical application, with the cable operator receiving one HITS satellite feed that contains twelve statistically multiplexed programs, of which six will be kept. A Turner Broadcasting feed containing five constant bit rate programs is also being received, of which two CNN channels at 5 Mbps will be kept. Dropping nine channels between the two satellite feeds leaves eight channels to transmit and extra bandwidth.

Three programs are being locally encoded with resulting constant bit rate transport streams. Without adapting the rate of the satellite programs, the amount of bandwidth freed would be unpredictable, and therefore not suited to support these constant bit rate programs.

If the operator defines, however, the bandwidth of its QAM modulator, digital rate adaption will re-multiplex the local programs with the remaining satellite programming to match that defined bandwidth.

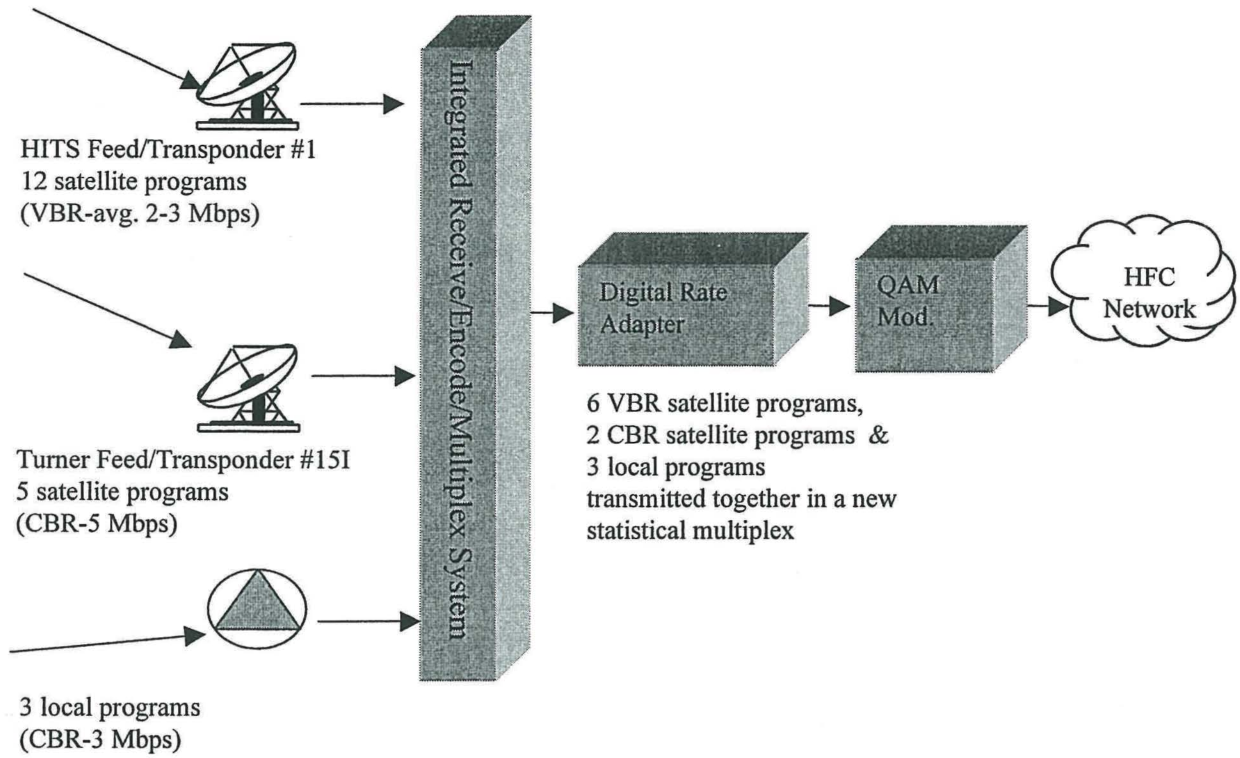

Figure 5: Typical Application

OPPORTUNISTIC BIT STUFFING

Even when optimizing bit rates via digital rate adaption, there is likely to remain a small amount of under-utilized bandwidth. This variable bandwidth reserve may, for example, vary between 1-3 Mbps at any given time.

Faced with this additional variable bandwidth, one option is to add another video program, but this will necessarily reduce the overall quality of every program.

A second option for using this extra bandwidth would be to use the 1-3 Mbps reserve to support IP-based interactive services. For example, the IP data traffic associated with an interactive service might require an average of 2 Mbps. Although the bandwidth reserve may sink below that mark, computers are accustomed to IP data arriving in bursts, not a steady flow, as is required for video.

Combining a variety of custom video and data services is like sending stones of all shapes and sizes down a single pipe. Even when fit together in the most efficient way possible, there will still be a little space left over. Opportunistic bit stuffing is like simultaneously shoveling sand down the pipe. It can fill in all of the little pockets of space available without slowing the delivery of the primary services.

The first step is to encapsulate IP packets into MPEG-compliant packets, assigning a Program ID, so that the data packets can be included in the Program Association Tables accompanying the MPEG-2 Transport Stream. These IP packets can now be inserted into the multiplex as bandwidth allows.

Every operator will want to utilize some combination of these technologies to optimize their own network. In an ideal, open system solution, one can scale in different services and efficiency-improving technology as your system expands.

In addition to optimizing bandwidth in a given headend's channel line-up, this new model can also have a significant impact on the bandwidth efficiency and economy of a larger cable network.

Consider a distributed HFC network with one primary headend and multiple secondary headends. The operator of such a network faces a cost versus quality dilemma. On one hand, the operator would like to centralize content origination, such as satellite reception, Video-on-Demand servers and ad servers, to the primary headend to minimize cost and maintenance requirements. On the other hand, the operator also would like the flexibility to customize the feeds as they are transmitted from each secondary location.

By utilizing rate adaption and bit stuffing technology, both goals are accomplished. For example, the optimum bit rate for a given video program in one secondary headend multiplex may be different from that in another secondary headend. Rather than placing two separate encoders or video servers in two different secondary locations, the video programming source can be located at the primary headend, and digital rate adaption and bit stuffing at the secondary headend location further customize the program.

Figure 6 illustrates a potential architecture, featuring this new model for digital delivery

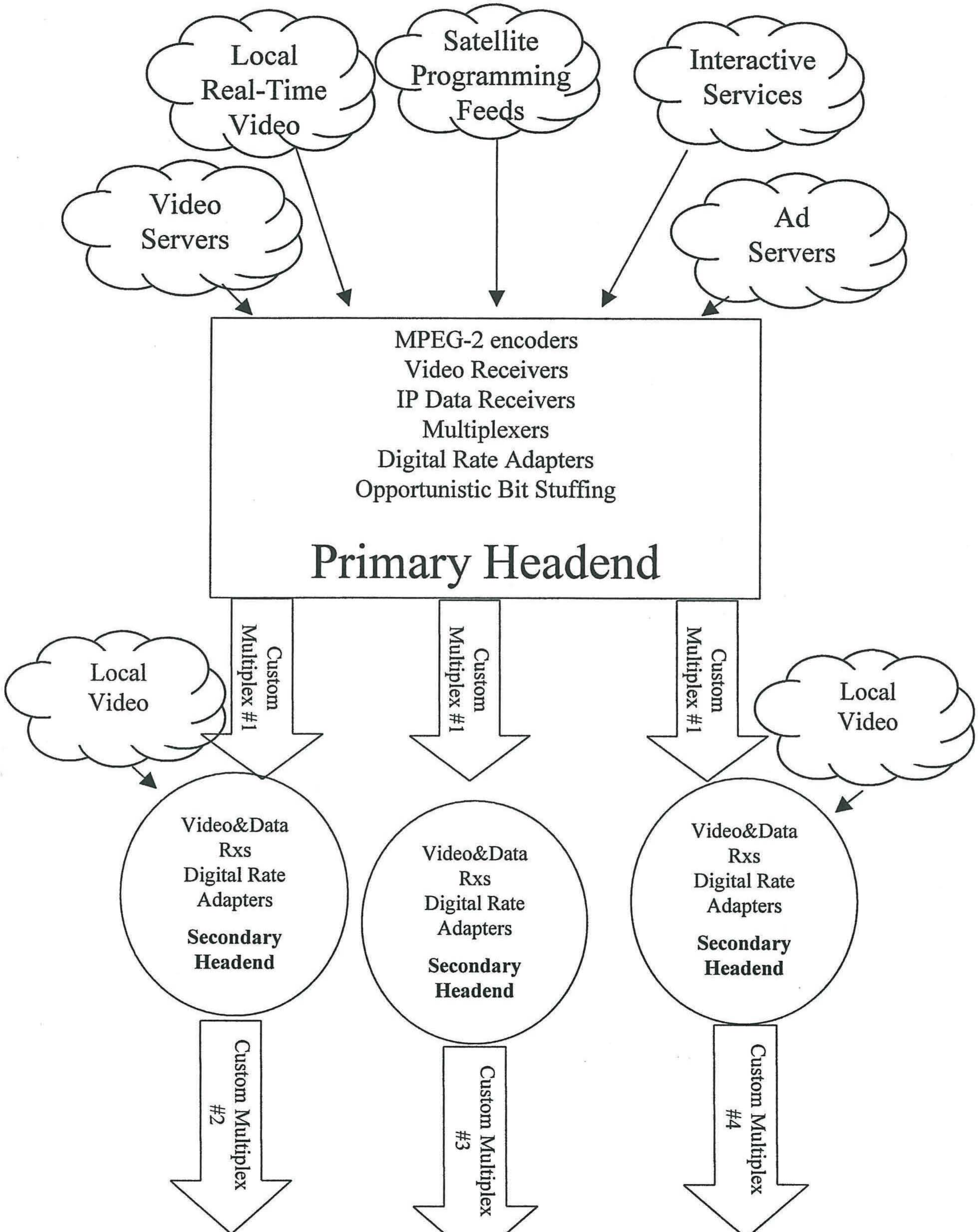

Figure 6: Sample Primary & Secondary Headend Requirements

CONCLUSION

Content customization, digital rate adaption and opportunistic bit stuffing provide the add/drop capability and program line-up grooming that allows targeted marketing to specific groups of subscribers, but without installing expensive decoding and re-encoding equipment at every hub, without a corresponding loss of signal quality and without leaving bandwidth underutilized.

This new model for digital service delivery has technological and business-driven benefits. It allows a new flexibility in choosing content sources and programming line-ups. The ability to combine the different content sources and perform bit rate analysis, remultiplexing and data insertion with a single integrated system ensures the cable operator the freedom to alter the make-up of custom services, as subscriber demands dictate.

Content customization, digital rate adaption and opportunistic bit stuffing allow cable operators to offer custom services, from their choice of content providers, while continuing to utilize their bandwidth as efficiently as possible. In today's increasingly competitive marketplace, taking advantage of these technologies will significantly improve cable operators' ability to respond quickly to market pressures and subscriber demands, taking full advantage of new revenue opportunities.