



Using Bandwidth More Efficiently with Switched Digital Video



Switched Digital Video (SDV) offers tremendous promise for network operators seeking to more efficiently use bandwidth and deliver highly targeted content to subscribers. Motorola offers an end-to-end solution that allows cable operators to leverage their existing infrastructure to offer more channels and deliver a wide spectrum of niche programming to attract additional subscribers.

THE NEED FOR SWITCHED DIGITAL VIDEO

As consumer demand grows for more High Definition (HD) programming, on-demand choices, and high-speed data, cable operators need more bandwidth to meet these needs. It is believed that the greater the flexibility in channel selection, the greater the subscriber loyalty to the network operator.

By providing greater channel selection to subscribers and recovering bandwidth to offer more HD and more high-speed data services, operators can improve Average Revenue Per User (ARPU) levels and create long-lasting subscriber relationships. Video On Demand (VOD) and the availability of a greater number of channels provide a greater number of choices for consumers.

Niche content—such as ethnically oriented channels or special-interest channels—do not attract the mass subscriber interest of more popular channels, such as broadcast television channels, cable news channels, and sports channels. Channels focused toward small audiences that value specialized content are often not offered because they do not attract mass audiences.

But even though the audience for a given niche channel may be low, the aggregate of many niche channel audiences over a whole network can be quite substantial. These channels tend to engender extremely high loyalty by subscribers, which often translates into high loyalty for the network provider.

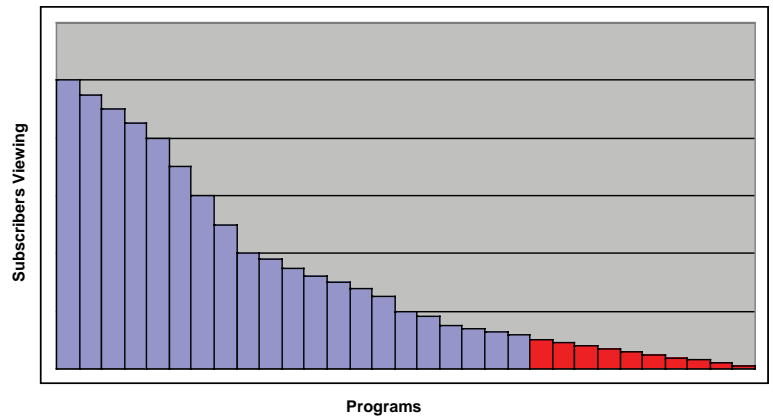
SDV allows operators to provide subscribers with access to highly focused content channels—without the need to commit dedicated bandwidth to each channel. Channels can be switched on to the network only when they are requested by one or more users. This process occurs as quickly as a subscriber can change channels, so users do not even realize that the content has just been added to the network. SDV allows cable operators to offer subscribers greater selection, while at the same time more efficiently using infrastructure bandwidth.

SDV can further reduce bandwidth overhead by helping cable operators cope with the dilemma of new codec introduction. Operators can switch MPEG-2 services to the vast majority of currently deployed set-tops, but take advantage of the advanced compression of MPEG-4 to switch services to newer set-tops that support it. This is possible because MPEG-4-capable set-tops can identify themselves as such when requesting a switched service, which allows the headend to send MPEG-4 content to that set-top.

UNDERSTANDING SWITCHED DIGITAL VIDEO

SDV allows cable operators to save bandwidth on the physical cable plant. In most cable plants today, every service (except VOD) is always available to authorized subscribers—whether anyone is watching it or not. Using SDV, however, channels that are less

Less-frequently watched channels can be deployed as switched services to drive down operational costs, increase the number of channels carried, and more effectively use HFC bandwidth.



frequently viewed can be designated as switched services. They are not broadcast throughout the cable network. Instead, they are placed onto the cable plant only if at least one set-top is tuned to that service.

The term “switched digital video” describes the types of video services in cable networks that are a hybrid between VOD and traditional one-way broadcast services. VOD switches a singlecast interactive program to a user. SDV switches broadcast video streams, making each stream available to one or more subscribers who simply join the broadcast stream just as they would with normal broadcast services.

To the subscriber, SDV services are indistinguishable from traditional broadcast services. A given SDV service is not always streamed on any given portion of the hybrid fiber-coax (HFC) network; instead, an SDV service is placed on the HFC network only if one or more subscribers tunes to that service. Once a switched service is streamed, subsequent subscribers on that same segment of the HFC network will tune the same SDV stream as the first subscriber. Since multiple subscribers share the same switched stream, the usual VOD controls such as pause or rewind are not allowed. When the system detects that no subscriber is tuned to a particular SDV stream, that stream is marked for reclamation and can be removed from the HFC network to make room for other subscriber-requested channels, if necessary.

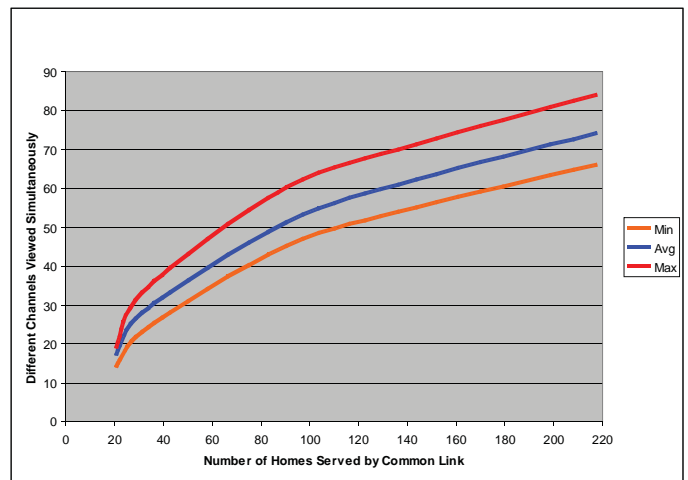
The primary benefit of SDV is that it allows Multiple System Operators (MSOs) to offer a set of services to their subscribers using only a fraction of the HFC bandwidth needed to broadcast those channels to all customers. On any given portion of the plant at any given time, many channels being offered are not being watched by anyone. By streaming only those channels that are actually being watched, the MSO can offer a set of channels and consume (typically) 50% to 75% less bandwidth compared to traditional broadcast.

SDV allows cable operators to recover HFC bandwidth and offer new channels in a way that consumes minimal additional bandwidth. MSOs can start by offering the less popular channels as SDV, since bandwidth is saved only when no one in a given service group is watching a particular SDV service. The most popular channels may remain traditional broadcast channels indefinitely; however, operators can switch less popular channels to address niche programming preferences.

ANALYZING CUSTOMER VIEWING PATTERNS

The main advantage of using SDV services is bandwidth savings. A relatively small portion of the plant spectrum is allocated to carrying SDV services, but this portion of the plant will not have the capacity to simultaneously carry all of the switched services. A rule of thumb is that 80 percent of the subscribers are watching 20 percent of the content, and the least-watched channels are prime candidates for being offered as switched services.

The smaller the nodes, the fewer the number of different channels that are viewed simultaneously. Cable operators that appropriately size the number of homes served onto smaller service groups can benefit from substantial bandwidth reclamation.



Monitoring demographics and capturing detailed usage metrics is essential to the successful delivery of SDV services. By analyzing subscriber viewing patterns for all available programs, cable operators can identify services that could be offered as switched services. The more popular services remain available as always-on broadcast channels, while niche programs are switched at the service group level instead of broadcast to all subscribers. Operations personnel can monitor utilization to help operators appropriately size the capacity allocated to switched services, ensuring a high statistical likelihood that a subscriber would rarely be denied access to a service because of bandwidth constraints.

For example, imagine a cable operator that offers 60 channels as switched services, and reserves bandwidth to deliver 30 of these at a time. If a subscriber selects a switched service when 30 other switched services are being watched within the service group, that subscriber will be denied access until one of the other switched services being watched is switched off. The challenge for operators is to minimize the pool of bandwidth allocated to SDV services, while also minimizing the probability that a set-top request for a service will be rejected due to a lack of bandwidth.

Cable operators can benefit from segmenting homes served into smaller service groups, since the smaller the service group, the fewer the different channels that will be watched simultaneously. They can therefore reclaim large chunks of bandwidth by setting smaller node sizes and switching relatively low-demand services efficiently.

TRANSPARENT ACCESS FOR SUBSCRIBERS

Users can select a switched service in the same manner as they select broadcast channels. The switched channels can be mapped to virtual channels in the Electronic Programming Guide (EPG). A subscriber can pick up the remote to scan through the available programming and select a channel. The switched digital management system receives that request, and if no one else is watching that channel it will place the content on the network for that set-top. If someone else is already viewing that programming, the switched digital management system realizes that the channel is already available and the set-top is provided access to the channel.

Whether a channel is broadcast or switched is transparent to the subscriber, and cable operators can provide consumers with seamless access to a greater variety of programming while efficiently managing bandwidth.

Cable operators can realize major bandwidth savings. For example, switching 40 channels and assuming that no more than half of them will be in demand at a given time, an operator can save 12 MHz of bandwidth while providing easy access to a broad array of content.

	Broadcast	Switched
Total number of analyzed services	40	40
Total number of services available at a given time	40	20
Services per QAM	10	10
Number of QAMs	4	2
Bandwidth required	24 MHz	12 MHz
Bandwidth savings		12 MHz

CALCULATING BANDWIDTH SAVINGS

Bandwidth savings can be easily calculated to show the economic advantages of SDV. For example, consider a scenario where a cable operator identifies a combination of 40 existing and new channels that carry special-interest programming.

Assuming 10 services per QAM, 4 QAM channels would be needed to carry all 40 services simultaneously. At 6 MHz per QAM channel, this would require a commitment of 24 MHz (4 QAM channels multiplied by 6 MHz).

But major bandwidth efficiency could be achieved if instead the cable operator chose to offer those channels as switched services. Assuming 10 services per QAM, only 2 QAM channels would be needed to carry 20 services simultaneously. The cable operator would therefore only need to allocate 12 MHz to deliver access to 40 channels, reclaiming 12 MHz of bandwidth that could be used for other offerings, such as HD channels or digital simulcast.

The cable operator could provide access to any 20 channels at a given time. The probability that subscribers would try to access more than the 20 channels available at the same time would be extremely low. By sizing demand and selecting the right channels to be switched, cable operators can deliver flexible access to a wider array of content. And by carefully tracking utilization per channel, they gain hard usage data that can be leveraged when negotiating financial agreements with content providers.

MAJOR DRIVERS FOR SWITCHED DIGITAL VIDEO DEPLOYMENTS

Several market drivers are encouraging MSOs to deploy SDV. Using SDV, cable operators can:

Make more efficient use of network bandwidth without plant rebuild. Cable operators can postpone or avoid the cost of upgrading from 850 MHz to 1 GHz infrastructure, and can offer new channels without major infrastructure upgrades.

Benefit from edge devices as more flexible resources. Edge QAMs can be used for broadcast, SDV, VOD, and possibly even high-speed data in the future.

Offer vastly larger numbers of channels to compete with telcos. SDV allows cable operators to migrate low-demand broadcast services to become available as switched services, and to add new channels onto existing plant.

Generate incremental revenue through highly focused advertising opportunities. Data on usage patterns can be clearly measured and tracked, allowing cable operators to create opportunities for highly targeted advertising programs.

Ease the transition to advanced codecs. The SDV management system could potentially know which set-tops support advanced codecs such as MPEG-4, allowing operators to benefit from maximum compression while still enabling service delivery to deployed set-tops that support MPEG-2.

Improve failover protection. The SDV management system allows operators to move switched services to alternative QAM devices if a QAM fails.

MOTOROLA OFFERS END-TO-END SWITCHED DIGITAL VIDEO SOLUTIONS

Motorola's end-to-end SDV solutions allow cable operators to more efficiently use existing infrastructure by switching channels in response to subscriber demand. Cable operators can not only reclaim bandwidth, they can also add niche programming that addresses the specialized interests of diverse subscribers. Offering greater depth of programming options can allow MSOs to compete successfully with telecommunications carriers, differentiating their offerings by the range of content available to address the interests of subscribers.

Motorola also offers the professional services expertise to help operators design, deploy, and operate SDV solutions. SDV is an emerging solution for cable operators. Motorola has products available today—with new products and features available soon—to enable operators to implement SDV cost-effectively. Support for open SDV solutions is essential, and Motorola plans to support industry-standard architectures to allow mixing of network components from different vendors.

MOTOROLA SDV MANAGER

The Motorola SDV Manager, added to the SDV portfolio through the acquisition of Vertasent, is responsible for managing which SDV streams are active at any given time and for directing set-tops to the appropriate streams. It keeps track of who is watching which channels, and it communicates with the edge QAMs to tell them when to switch content on or off. All set-top channel-change requests go through the SDV Manager. For each incoming SDV channel-change request, the SDV Manager either directs the set-top to the existing stream carrying the requested program, or attempts to bind the program to an available shell session in an appropriate edge device.

The SDV Manager also maintains the periodic SDV channel table (also referred to as the "mini carousel") that allows set-tops to determine the currently available switched channels and their respective "tuning triplets," the three pieces of information that fully define how to acquire a given MPEG program—the carrier frequency, MPEG program number, and modulation mode. The SDV Manager keeps track of the number of set-tops tuned to each SDV service. Those services that are no longer actively tuned by any set-tops will be marked for recapture and removed from consuming bandwidth on the HFC network until a subscriber requests them.

MOTOROLA SDV RESOURCE MANAGER

The Motorola SDV Resource Manager (SRM), also added to the SDV portfolio through the Vertasent acquisition, manages the headend portion of the SDV subsystem. It tracks usage of all edge QAMs, binds/unbinds sessions on the edge devices, and requests shell sessions from the global session and resource manager.

SMARTSTREAM ENCRYPTOR MODULATOR

Motorola's SmartStream Encryptor Modulator (SEM) family of products provides cable operators with the means to perform encryption, modulation, and upconversion functions within the digital headend. These edge QAM products support SDV interfaces as part of a complete solution.

The SEM significantly lowers the barrier to entry in SDV and VOD environments. Providing high-speed interfaces to servers and content aggregation systems, the SEM performs multiplex creation, encryption, 64/256 QAM modulation, and upconversion



The SEM V8 (pictured) supports SDV interfaces

across the full HFC band. The SEM provides system operators with the necessary tools to launch narrowcast services as the HFC infrastructure evolves to allow subscribers to watch what they want, when they want.

NETWORK ENCRYPTOR

The Motorola Network Encryptor supports centralized encryption of the SDV content using Motorola's proven MediaCipher® conditional access system, which offers industry-leading security and access control for the delivery of MPEG digital signals. The Network Encryptor supports both VOD and SDV systems, and it allows cable operators to encrypt channels centrally so they can continue to leverage legacy, non-encrypt-capable QAM devices at the edge.

Today, most cable operators encrypt 10 to 12 services into Multi-Program Transport Streams (MPTS) for distribution. The Network Encryptor encrypts and transmits Single Program Transport Stream (SPTS) traffic flows, providing cable operators with the granularity to distribute encrypted services to individual nodes over Gigabit Ethernet (GigE). Instead of sending a bundle of services to fulfill customer requests, cable operators can save bandwidth by encrypting and transporting individual services in response to specific customer requests. Each switched service is carried from the headend to the edge QAM as an SPTS traffic flow. The SPTS is carried as an entity across the network and is transmitted using an IP multicast destination address. This method provides for the most flexibility, since it allows each service to be routed individually, as opposed to having to route an MPTS traffic flow that contains the desired service plus nine or more bundled services that may not even have been requested.

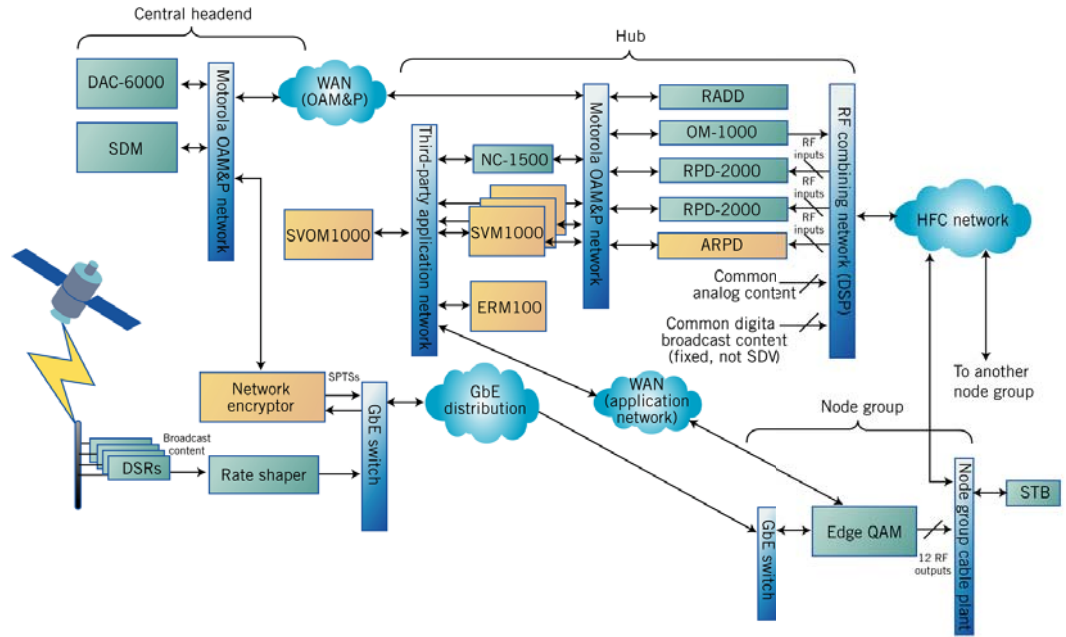
The Network Encryptor can also use IP multicast to deliver SPTPs to multiple nodes. It is a 1 RU chassis with GigE input and output.

ADVANCED RETURN PATH DEMODULATOR

The Motorola Advanced Return Path Demodulator (ARPD) is a dense return path device that provides the upstream link needed for set-top communications. With SDV, additional interactive communications are needed between the set-tops and the headend, which requires additional upstream bandwidth. Available in a high-density, compact (1 RU) design with up to 18 demodulators, the ARPD receives packets headed upstream, packs them onto a connectionless Aloha User Datagram Protocol (UDP) IP flow, and sends them to the SDV Manager. The ARPD allows cable operators to support the incremental upstream traffic flows required for SDV, using a dense, high-capacity platform that minimizes rack space usage.

Motorola SDV Architecture

Motorola offers end-to-end solutions for delivering switched digital services from the headend, across the transport network, and to each hub and node.



MODULAR CMTS PLATFORMS AND MULTI-USE QAMS

Motorola also supports Next-Generation Network Architecture (NGNA) and modular Cable Modem Termination System (CMTS) initiatives that decouple traditional CMTS functions into logical components that enable more cost-effective scalability. The Broadband Services Router 64000 (BSR 64000) will continue to be offered as chassis-based CMTS/edge routers, but this platform is evolving to also serve as a modular CMTS.

The first steps in the evolution of the BSR 64000 are the separation of upstream and downstream onto separate modules and the availability of separate QAM modules. This supports scalable growth according to market requirements and maximum flexibility for delivering high-bandwidth services. Cable operators can benefit from higher-density modules and greater flexibility in adding capacity to meet demand. This approach allows cable operators to reduce port costs while increasing their ability to share QAMs for DOCSIS®, broadcast, SDV, and VOD services. Later, Motorola will offer a decoupled CMTS solution.

By offering both system-level, chassis-based solutions and card-level, stackable components, Motorola will offer maximum flexibility for evolving the network. Cable operators can safely deploy additional BSR 64000 systems today, retaining maximum flexibility for supporting evolving architectures in the future and migrating to an all-digital IP headend.

SAMPLE SWITCHED DIGITAL VIDEO DEPLOYMENT

The example above provides a high-level overview of the Motorola solution for SDV. The Network Encryptor, centrally deployed in the headend, encrypts all of the switched services, which are transmitted over the optical backbone to each hub and node.

Each hub and node includes an SDV Manager, SRM, and SEMs. Motorola set-tops request a switched service by upstream communication along the Aloha UDP return path. Knowing which services are active on that network segment and which edge QAM devices have physical connectivity to each requesting set-top, the SDV Manager instructs the appropriate edge QAM to switch on the requested service.



TURN TO MOTOROLA FOR SWITCHED DIGITAL VIDEO SOLUTIONS

From the headend to the home, Motorola Connected Home Solutions offers standards-based, end-to-end solutions that allow cable operators to swiftly deploy switched digital video services to reclaim bandwidth, delay or postpone plant rebuilds, deliver a wider range of content, and create closer and longer-lasting bonds with subscribers.

Motorola offers a complete turnkey solution that can be integrated with existing infrastructure to provide cable operators with the flexibility to offer additional channels that only consume bandwidth when they are actually being watched. Motorola also provides the professional services expertise to help support SDV deployments and help cable operators implement best practices for deploying and managing SDV. For more information, please visit www.motorola.com/videoproducts.



MOTOROLA

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