

SWITCHED UNICAST: IT'S NOT JUST ABOUT CAPACITY

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Abstract

Switched unicast is a form of switched broadcast in which each subscriber receives a unique program stream. The benefits of switched unicast extend beyond reclaiming network capacity. This paper discusses the benefits of a switched unicast implementation, exploring issues such as addressable advertising, content personalization and transformation, along with other opportunities for overall enhancement of the subscriber's viewing experiences. Additionally, cable operators can get precise viewership statistics without relying on TV audience rating firms, since intelligent switched unicast systems monitor and respond to all subscriber activity, and can store data about which programs subscribers are watching.

The paper also examines the role of switched unicast in enabling more open conditional access systems, expanding choices of set-top boxes and other subscriber devices, and driving innovations such as edge-based rate shaping and adoption of universal edge QAMs that further enhance bandwidth efficiencies.

REVIEW OF SWITCHED BROADCAST

Switched broadcast came of age in 2005 with major cable operators beginning deploy the technology in several locations. Switched broadcast leverages the field-proven concept that the actual viewership of programming at a specific time within a

local area is a fraction of the total number of offered programs.

Switched multicast delivers programs only when and where requested by viewers, unlike legacy broadcast systems that deliver all programming to all subscribers. If a subscriber wants to watch a program that is currently being delivered to other subscribers within the same node, or service group, the subscriber simply joins the existing switched multicast session. As a result, there is no capacity consumed in delivering the program to the additional subscriber. This methodology optimizes bandwidth and resource efficiency in enabling the creation of virtual programming capacity and bandwidth without the correlated physical expense of creating and dedicating precious bandwidth and associated QAM resources.

Bandwidth reclamation is an imperative for cable operators wanting to expand services and enhance their competitiveness. Switched broadcast enables cable companies to offer services spanning HDTV, VOD IPTV and higher speed broadband, without needing to upgrade HFC capacity.

Additionally, by moving some, or all, of the broadcast digital tier to the narrowcast spectrum, cable operators are able to significantly increase the amount of programming offered. The so-called "long tail effect" demonstrates that there is a large aggregate demand when many specialized offerings are made available.

Adoption of a switched services model, therefore, enables operators to both increase revenue opportunities by successfully motivating subscribers to purchase premium packages, while mitigating competitive threats from satellite broadcasters and telcos, and media companies using the Internet to sell video directly to consumers.

The key building blocks of a switched multicast network are shown in figure 1. These are:

- Clamping sub-system;
- Edge sub-system;
- Management server;
- Client software.

The clamping sub-system converts incoming broadcast programs to a predetermined constant bit rate value. Though not absolutely required, the normalization of all programs to a constant bit rate allows a faster and simpler switching

mechanism, and paves the way for QAM resource sharing with similar services such as VOD. The bit rate most often chosen is one that resembles the program parameters for VOD streams. The clamped programs are multicast to all hubs using a Gigabit Ethernet transport network.

The edge sub-system replicates program streams and directs them to the appropriate edge QAM, in response to directions from the switched broadcast manager. Edge switching capabilities can be integrated into the QAMs or can be a stand-alone entity upstream of the QAMs.

Client software resides on a subscriber's set-top box. When a program is selected, the client conveys the channel request upstream along with information that uniquely identifies the node-group location of the set-top box. The client functionality can be easily integrated into the tuning firmware of future set-top boxes.

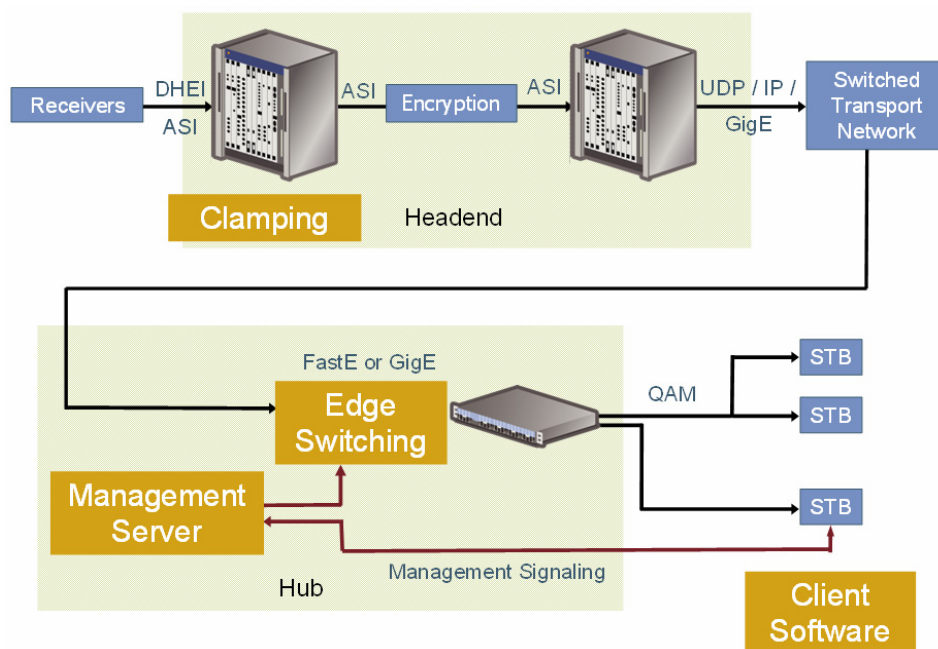


Figure 1. Components of switched broadcast systems

The management server uses the received channel number to identify the requested program and, consequently, the input port on the switch where the program is being received. Similarly, the switched broadcast manager uses the set-top box ID and associates the node group information to determine the downstream path that connects to the subscriber.

When an available downstream QAM and program resource are identified, the frequency and program information is returned via the downstream out-of-band channel to the set-top box, which decodes and displays the program using the normal tuning mechanisms. While the specific frequency and program number may vary with time, the channel number seen by the subscriber's set-top box is unchanged.

BANDWIDTH SAVINGS WITH SWITCHED UNICAST

Switched unicast is a form of switched broadcast in which each subscriber receives a unique program stream. The technology

employs a similar tuning process to switched multicast except that a subscriber is allocated new dedicated bandwidth whenever switched broadcast programming is requested. Switched unicast consumes significantly less bandwidth than traditional broadcast methods while allowing operators to offer highly customized programming. This is demonstrated by the two examples that follow.

Figure 2 shows the results of a recent field trial.

In this example 172 programs were available to viewers, but the maximum number ever watched a one time was 70. This demonstrates the potential for bandwidth savings in a switched multicast model. The bandwidth benefits of switched unicast stem from the fact that the maximum number of tuners active at any one time was 110, so that even when each tuner received a dedicated stream, the total amount of bandwidth consumed was less than with in a legacy broadcast environment.

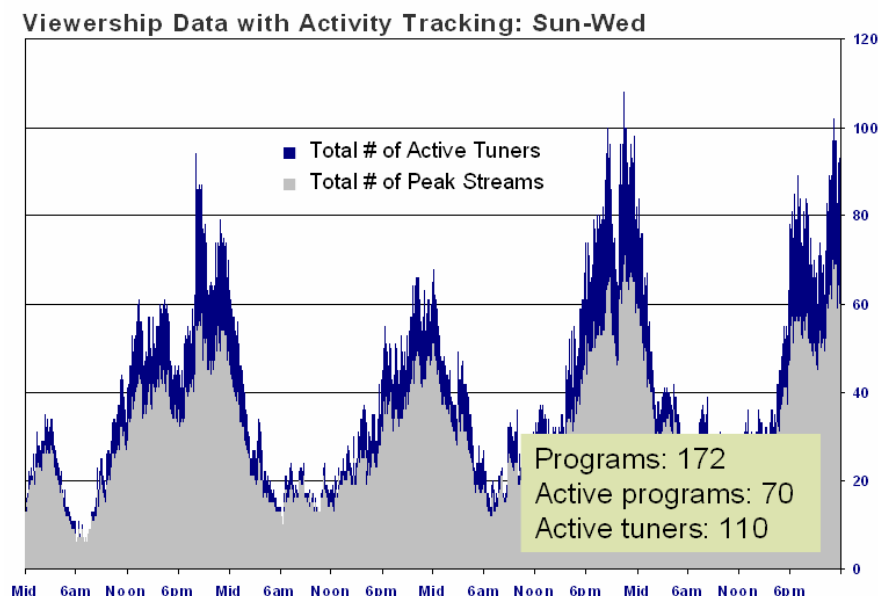


Figure 2. Bandwidth savings with switched unicast (Deployment A)

Another example of the bandwidth savings that switched unicast offers is provided in Figure 3. Just as in the previous example, the data presented here come from an actual field trial. In this example there were 79 programs available to viewers but a maximum of only 23 watched at any time, and the number of active tuners peaked at 49.

In both trials switched unicast significantly reduced the amount of bandwidth required to deliver the programming that subscribers wanted. The ratio of dedicated program streams to program choices peaked at 0.64 in deployment A and 0.62 in deployment B. Additional field trials currently underway will yield more insights into the bandwidth savings that switched unicast enables. Switched unicast, however, offers cable operators much more than merely bandwidth savings. Several compelling benefits of the technology are described in the following sections.

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It's worth noting that in neither field trial was the switched tier thoroughly analyzed to determine which programs should be switched and the optimum size of service groups. Consequently, the bandwidth savings potential of switched unicast is even greater than that shown in both figures. Ongoing field trials will yield more insights into the bandwidth savings that switched unicast enables.

Switched unicast, however, offers cable operators much more than merely bandwidth savings. Several compelling benefits of the technology are described in the following sections.

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In addition to bandwidth reclamation, switched unicast offers a variety of benefits. These include:

- Content personalization;

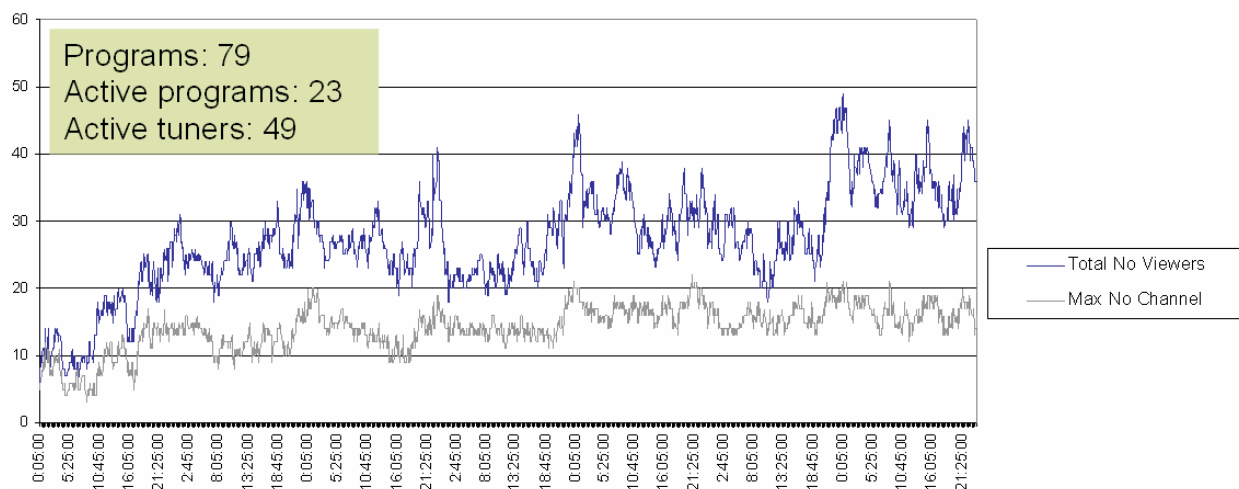


Figure 3. Bandwidth savings with switched unicast (Deployment B)

- Targeted addressable advertising;
- Precise viewership data;
- Expanded operator choices of CAS;
- Wider consumer choices for CPE.

Each of these is discussed in the sections that follow, along with an explanation of how innovations at the edge of the cable network are broadening the capabilities of switched unicast systems.

CONTENT PERSONALIZATION

The cable industry continues to look beyond traditional broadcast TV models, and is examining initiatives that will allow subscribers a higher degree of content customization. Switched unicast offers unique opportunities to enhance subscribers' viewing experiences by allowing content to become increasingly personalized. By enhancing their customers' viewing experiences, cable companies will be better equipped to fend off competitive threats from emerging Web-based video services.

Personalized news is one example of how programming can be chosen to reflect the interests of individual subscribers. Switched unicast systems enable content and subscriber interests to be correlated, allowing news summaries to be created that are more likely to retain the attention of viewers than traditional broadcast TV news programs. Enterprising newsrooms could record a series of short news stories on a wide range of topics, allowing cable operators to combine into personalized bulletins that address a subscriber's specific interests, whether it's baseball teams or Internet start-ups. A personalized version of a music network is another example of how switched unicast provides cable operators

the opportunity to offer increasingly customized content.

This type of personalized service could be offered as a premium service, potentially earning the operator additional revenues. Alternatively, personalized content could be offered at no additional charge, with the expectation that increased customer loyalty results.

TARGETED ADDRESSABLE ADVERTISING

Switched unicast provides cable operators with the ability to increase advertising revenues by delivering promotional messages that more closely match subscribers' interests: marketers are willing to pay a premium rate if their ads achieve improved response rates among their intended audiences. In fact, several recent research studies indicate that advertisers have a strong willingness to pay twice as much for an advertisement if there is a guarantee that it reaches a targeted audience.

Figure 4 illustrates how three subscribers, all watching the same program on the switched tier receive different ads during the commercial breaks. For example, subscriber #1, an avid teen snowboarder, receives an ad about snowboard sales. During the same commercial break, subscriber #2, a thirties-something bachelor, views an ad about an upcoming motor show. Subscriber #3, an avid traveler in her fifties, receives information about cruises in the Caribbean.

Switched unicast systems remember subscribers' viewing patterns and can use this information when determining which ads to forward. For example, a subscriber hopping to a soap opera after a significant

amount of time watching a sports network can receive an ad about an upcoming local sporting event.

Switched unicast also enable subscribers to undertake forms of ad telescoping activity. Telescoping enables a viewer to press a button on the remote control for more information or request a longer form of the ad or a brochure. Interested viewers can schedule an appointment with a retailer, receive a demo in the mail, or take part in a promotional contest.

Targeted advertising can be further enriched using nPVRs (networked PVRs). These enable subscribers to pause near-live broadcasts while telescoping. Once the ad has been viewed, the viewer can return to programming, at the place where it was paused.

By storing information about which programs individual subscribers are watching, switched unicast technology enables cable operators to collect precise viewership data. This not only yields insights into which programs are most popular, it also allows cable operators build profiles about their subscribers' interests. This helps cable operators determine which

promotional messages a subscriber is more likely to be interested in. For example, a subscriber that routinely tunes to a home improvement network may be interested in an ad about a sale at a local hardware store even though they may be currently watching something else. the home improvement network.

The ability to build profiles about subscribers' interests adds tremendous value to targeted advertisements. Accordingly, the more enterprising cable operators could explicitly ask their subscribers about their ad preferences. In return for providing a cable operator with a list of the subjects and categories they'd be interested in viewing ads on, subscribers could receive a complimentary gift or upgrade to an expanded service package, or some other incentive.

VIEWERSHIP STATISTICS

Switched digital broadcast systems can be configured to store information about subscribers' viewing patterns. This allows cable operators to get precise viewership statistics without relying on third parties such as TV audience research firms. The

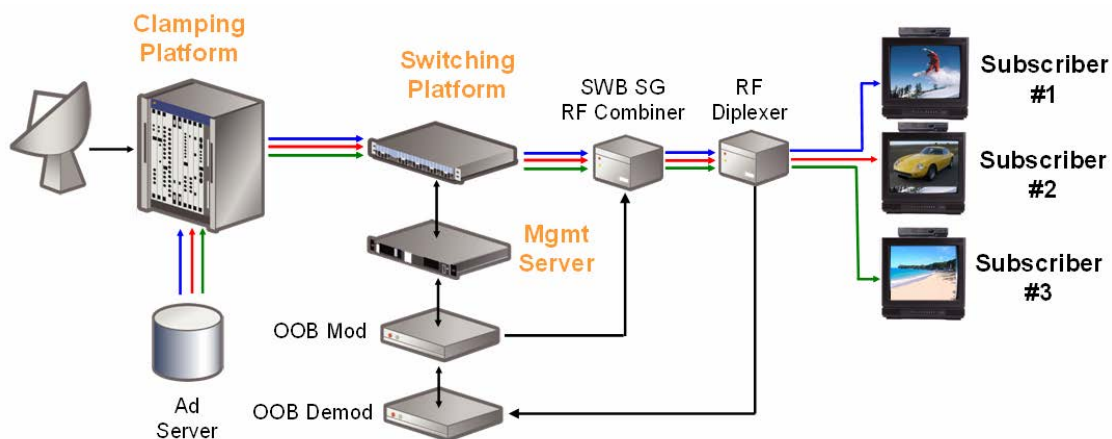


Figure 4: Subscribers receiving different ads though all view the same programming

value of this information is high because it provides insights into the viewing patterns of all subscribers on the switched tier, not just the subset of viewers that have been enlisted by audience rating firms, whose viewing habits may not necessarily represent those of the majority. Moreover, unlike viewers who track their viewing habits using diaries, switched unicast systems provide precise records without human biases.

Naturally, privacy restrictions surround the gathering of individual subscriber data, and the gathering of individual subscriber data could be implemented on an “opt-in” basis, with subscribers receiving a complimentary gift or some other incentive for participating.

EXPANDING CHOICES FOR CONDITIONAL ACCESS AND CPE

At present cable operators are limited to using proprietary system-based encryption methodologies. Switched unicast introduces the opportunity for a wider range of algorithms to be used when encrypting content. It achieves this by creating more than one version of each program stream and routing each one through parallel

encryption servers. Client software on each subscriber’s set-top box recognizes which encryption protocol it is compatible with, and requests that version from the switched broadcast manager. This concept is represented by Figure 5.

This liberates cable operators to select conditional access systems from a wider range of vendors, not just a few. It can also accelerate the transition from cable operators leasing and depreciating CPE (customer premise equipment) to subscribers buying their own devices. In turn, subscribers benefit from being able to choose from a wider variety, and price range, of set-top boxes, digital-ready TVs, PCs and other IP devices.

Switched unicast systems can serve as gateways to wider CPE choices by leveraging the OpenCable application platform, a middleware software layer specification intended to enable the developers of interactive television services and applications to design products that run successfully, independent of set-top or television receiver hardware or operating system software choices. The advanced encryption standard assists in the adoption

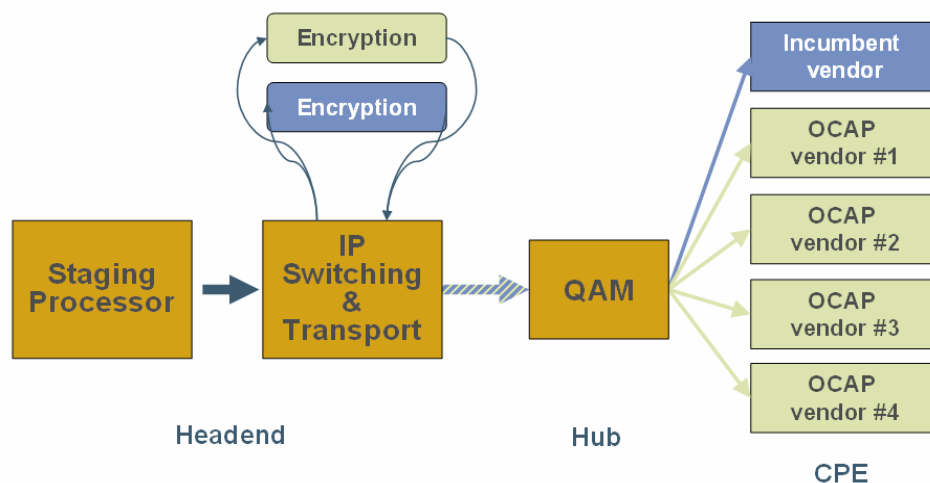


Figure 5: OCAP STB deployment with AES encryption

of open systems by defining a block cipher that allows encryption and decryption of programs irrespective of equipment vendor.

INSTANT CHANNEL CHANGE

The ability for subscribers to change programs without any perceived delay is a requirement of any type of network. It becomes more challenging, however, when each subscriber receives a dedicated program stream containing a single channel. In a switched unicast network each subscriber's set-top box is "parked" on a particular frequency and PID (packet identifier). When a subscriber requests a program, the unicast systems delivers the program to the subscriber's STB on the frequency that his set-top box is already tuned to. This helps eliminate latency from retuning.

An additional speed benefit is derived from the fact that the switched unicast system immediately sends the subscriber the most recent i-frame for the new program, avoiding the tuning delay that would occur if the subscriber's set-top box had to join a program stream already being broadcast and wait for next i-frame to be transmitted.

EDGE INNOVATION FOR BANDWIDTH BENEFITS

While switched broadcast provides cable operators the ability to reclaim large amounts of bandwidth, a combination of expanding subscribers demand for greater personalization, the growth of high definition TV and the need for high data speeds, will drive the need for continuous evolution of network infrastructures.

Aggregation of services at the edge of the network demands offers the opportunity for innovations that results in versatility and improved bandwidth utilization. Edge rate shaping is the first of these innovations.

Rate shaping at the network edge begins with information collected at headend. Intelligent video platforms analyses the complexity of each program and creates metadata that characterizes each program. In addition, each program is clamped at a variety of different bit rates. Metadata and clamped program streams are forwarded to hub locations.

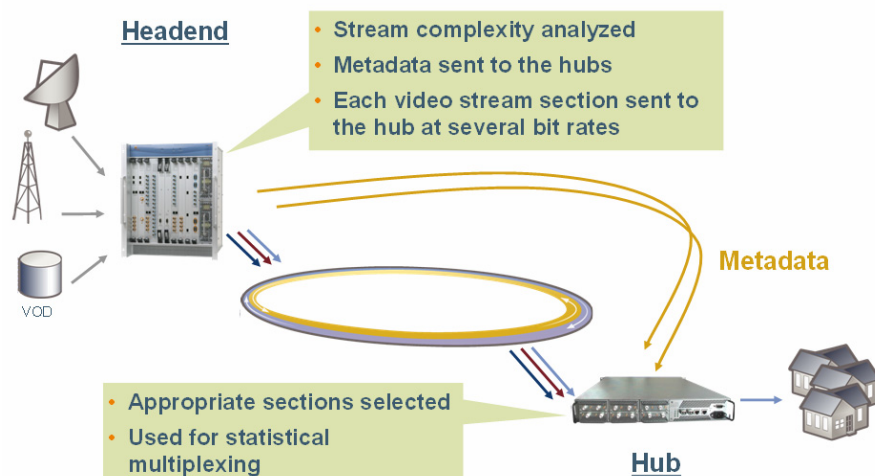


Figure 6: Rate shaping of program streams at edge locations

At each hub, edge video platforms dynamically examine the metadata and bandwidth availability on the network, and select the version of the program stream that both maximizes video quality and fits within available capacity. Edge rate shaping is shown in figure 6.

Universal edge QAMs evolve network infrastructures and lead to significant cable operator benefits. UEQs (universal edge QAMs) are enabled by the adoption of modular CMTS (cable modem termination system) architectures. An M-CMTS has disaggregated functionality for best-of-breed performance, resulting in improved economics, and serving as a catalyst for both capacity increases and more flexible allocations of upstream and downstream bandwidth.

The edge QAMs used in M-CMTS platforms have the potential to be the same ones used in switched multicast and unicast systems. This introduces the possibility of eliminating “nailed-up” allocations of QAMs across data, VOD and switched broadcast services, replacing them with QAM capacity that is shared across services. Versatile edge QAMs enable dynamic

sharing of edge resources, in response to time-varying subscriber demands.

Figure 7 shows the UEQs can be dynamically allocated to support data, VOD and switched video services.

Universal edge QAMs are a vital milestone in the migration of cable infrastructures from fixed silos that are relatively bandwidth inefficient, to networks that are more versatile and more fully utilized.

CONCLUSIONS

Switched unicast is the evolution of switched broadcast systems that begun being deployed in 2005. Switched broadcast provides cable operators the ability to expand offerings to include HDTV, wider selections of on-demand content, increasing amounts of peer-to-peer file sharing, and other services, by dramatically reclaiming network spectrum.

Switched unicast, however, is about much more than bandwidth savings. The benefits of switched unicast include greater content personalization and targeted addressable

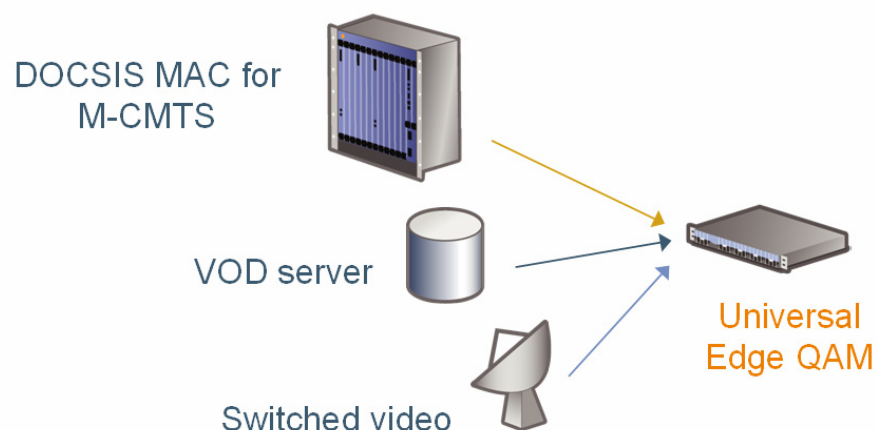


Figure 7: Versatile edge QAMs dynamically share data, on-demand and switched video

advertising opportunities, along with the ability for cable operators to obtain precise viewership statistics directly. These capabilities ultimately improve the viewing experiences of each and every viewer.

Additional operator benefits that can be derived from switched unicast include the freedom to select conditional access systems from an expanded choice of vendors, while

subscribers benefit from having wider selections of set-top boxes and other CPE.

The cable engineer deploying switched broadcast primarily to alleviate capacity limitations will find that once a switched network has been implemented entire new areas of service benefits appear, as described above, with accruing competitive benefits.