

**Evolving Switched  
Broadcast Beyond First  
Generation Deployments**

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PAPER

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## **1.0 INTRODUCTION**

Switched broadcast has moved from being an engineering concept to a deployed solution, field-proven and production-ready. The initial benefit of switched broadcast is bandwidth reclamation, enabling cable operators to expand offerings to include hundreds of SD and HD programs, long-tail content, and other service expansions.

This paper looks at what may come next, as the functionality of current switched broadcast systems evolves to offer more than bandwidth gains. Switched multicast and switched unicast are both forms of switched broadcast. In a multicast environment, a subscriber wanting to watch a program already being delivered to a service group simply joins the existing switched session. Switched multicast is the basis of switched broadcast systems being deployed today. In a unicast deployment, each subscriber receives a unique program stream.

The benefits of switched unicast include targeted addressable advertising and increasing personalization of content, along with other opportunities for enhancement of subscribers' viewing experiences. Additionally, cable operators can get precise viewership statistics without relying on third parties, and can liberate themselves from proprietary encryption systems.

Switched unicast can be seen as an alternative to switched multicast, or an enhancement to it. This paper examines paths for upgrading legacy broadcast systems to switched broadcast, and explores triggers for switched unicast implementations. It also describes the potential for dynamically transitioning networks between multicast and unicast tiers, and the benefits that result from doing so.

## **2.0 OVERVIEW OF SWITCHED BROADCAST**

In 2005 switched broadcast moved from being an engineering concept to a deployed solution, field-proven and production-ready. Already installed by one major North American cable operator in two markets, it is supporting over one million homes passed today. Field trials are ongoing and additional deployments are expected in 2006.

Switched broadcast, also known as switched digital broadcast and switched digital video, dramatically reduces the amount of network capacity required to provide subscribers with all the programs they want to watch. Switched broadcast delivers programs only when and where requested by viewers, unlike legacy broadcast systems that deliver all programming to all subscribers, all the time. This is accomplished, essentially, by providing a subscriber's STB (set-top box) the ability to communicate with a network-side video platform about which program the subscriber wants to watch in real-time. The switched broadcast system responds by delivering to the viewer's service group only those programs being watched by subscribers within that group, and the STB tunes to the appropriate program.

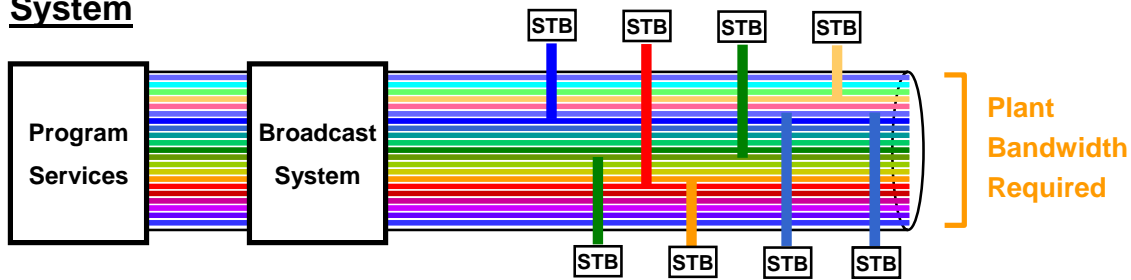
Switched broadcast leverages the concept, validated by numerous pilot programs, that the actual viewership of programming at a specific time within a local area is a fraction of the total number of offered programs. By reclaiming the bandwidth that would otherwise be needed to deliver unwatched content, switched broadcast offers cable operators the opportunity to expand the amount of programming on offer. The "long tail" effect, a theme increasingly discussed within the industry, refers to niche programming that, although unlikely to appeal to

a mass audience can nonetheless represent a significant source of revenue for cable operators able to deliver it to their customers economically. Long tail content includes cult movies and programming likely to appeal only to certain ethnicities.

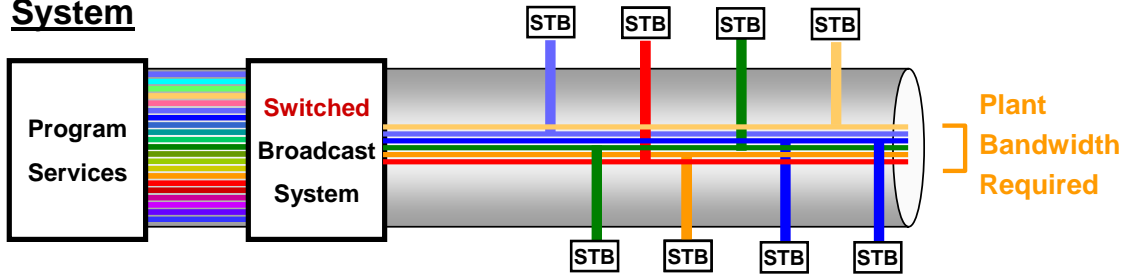
Additional bandwidth savings are achieved by allowing more than one subscriber within a network node, or service group, to access the same program stream. If a subscriber wants to watch a program that is currently being delivered to other subscribers within the same node, the new viewer simply joins the existing switched session. As a result, no additional capacity is consumed by the incremental subscriber. This practice, known as switched multicast, is the basis of switched broadcast systems deployed today.

Bandwidth reclamation is an imperative for cable operators wanting to expand services and enhance their competitiveness. Switched broadcast presents cable companies the opportunity to offer hundreds of SD and HD programs, along with releasing network capacity for higher speed broadband, more on-demand subscribership, and future services.

**Legacy Broadcast System**



**Switched Multicast System**



*Figure 1: Bandwidth benefits of switched broadcast, with subscribers accessing the same programs streams in multicast sessions*

Figure 1 shows how switched multicast dramatically reduces capacity consumption. Bandwidth reclamation is achieved by delivering programs only when and where requested by subscribers and by allowing subscribers viewing the same program to share a switched multicast session.

Switched unicast is a form of switched broadcast in which each subscriber receives a unique program stream. The technology employs a similar process to switched multicast except that

a subscriber is allocated dedicated bandwidth whenever a program carried on the switched tier is requested.

Switched unicast consumes less bandwidth than traditional broadcast methods even though each subscriber has a dedicated program stream. This is because, as with switched multicast deployments, programs are delivered only when requested by subscribers, unlike legacy broadcast systems that deliver all programming to all subscribers, all the time. The bandwidth benefits of switched unicast are demonstrated by the two examples that follow.

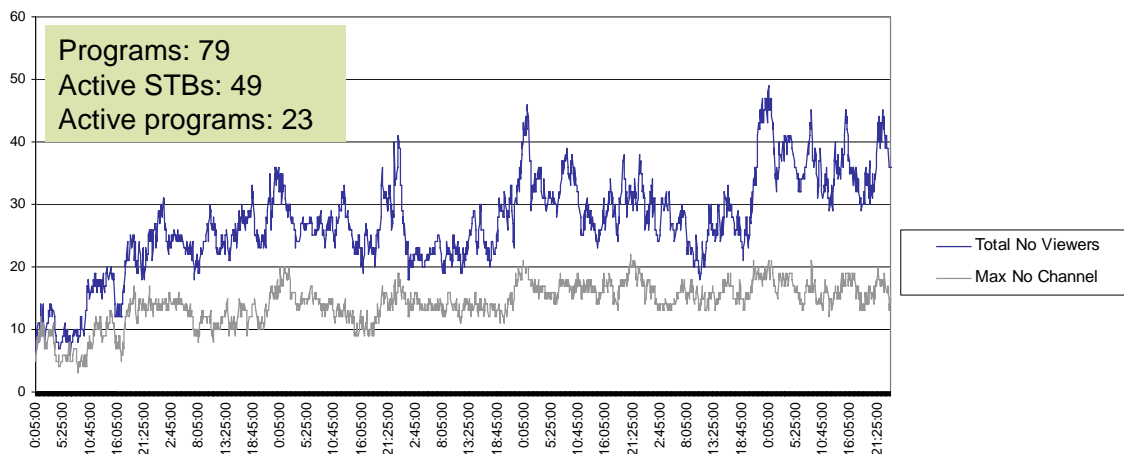


Figure 2: Viewership over a twenty four hour period (field trial A)

Figure 2 shows the results of field trial A. Data was collected over a twenty four hour period. In this example there were 79 programs available to viewers, but the maximum number ever watched at one time was 23. This aptly demonstrates the ability potential for bandwidth savings using switched multicast.

The bandwidth benefits of switched unicast stem from the fact that the maximum number of STBs active at any one time was 49, so that even if each subscriber were to receive a dedicated program stream, the total amount of bandwidth consumed would still a third less than in a legacy broadcast environment.

Another example of the bandwidth savings that switched unicast offers is provided in Figure 3. The data were obtained from field trial B, this time over a four day period, Sunday to Wednesday. In this example 172 programs were available to viewers, but a maximum of only 70 watched at any time, and the number of active STBs peaked at 110.

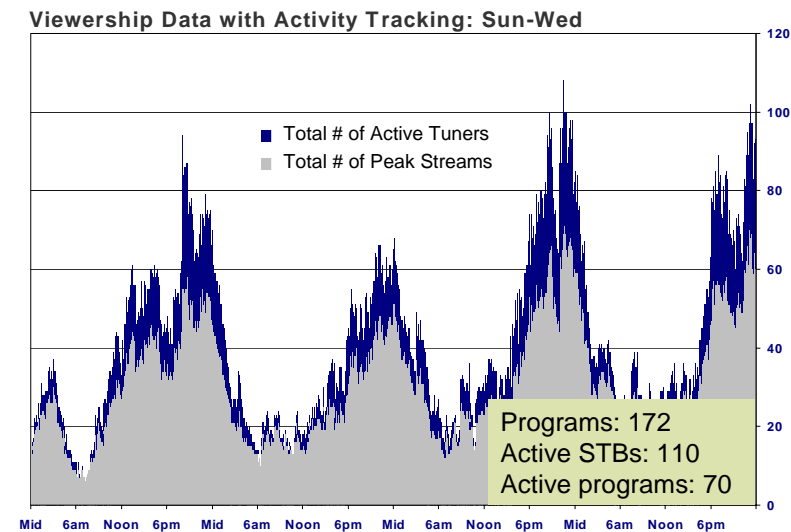


Figure 3: Cycles in viewership over a four day period (field trail B)

Switched unicast significantly reduced the amount of bandwidth required to deliver the programming that subscribers wanted in both trials. The ratio of dedicated program streams to program choices peaked at 0.62 in trial A and 0.64 in trial B. Additional field trials currently underway will yield more insights into the bandwidth savings that switched unicast enables.

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.

**3.0 IT'S NOT JUST ABOUT CAPACITY**

Switched unicast, however, offers cable operators much more than simply spectrum reclamation. Key benefits to cable operators of deploying switched unicast include:

- Addressing target ads towards specific subscribers;
- Reducing channel change times;
- Personalizing content available to subscribers;
- Collecting precise viewership data without relying on third parties;
- Expanding operator choices of conditional access systems;

- Widening consumer choices for CPE.

Each of these topics is discussed briefly in the following sections. For fuller descriptions see Ran Oz, “Switched Unicast: It’s Not Just About Capacity”, NCTA Technical Papers, April 2006.

### 3.1 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. Recent studies, such as the “On Demand” report completed by CTAM in June 2005, reveal that marketers are willing to pay a premium if their ads are likely to meet with higher response rates.

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 car show. Subscriber #3, an avid traveler in her fifties, receives information about cruises in the South Pacific.

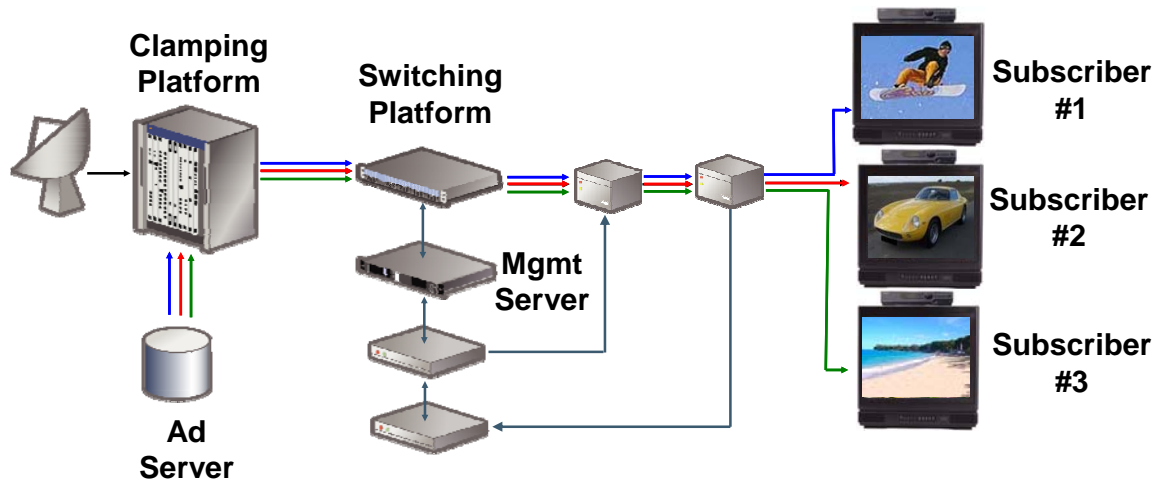


Figure 4: Addressable advertising delivers ads to subscribers most likely to respond to them

Switched broadcast systems have awareness of subscribers’ viewing patterns, providing cable operators with information that can help 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 he may be currently watching a different network.

Additionally, since building profiles about subscribers’ interests adds tremendous value to targeted advertisements, the more enterprising cable operators may choose to 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.

For more detail on targeted addressable advertising see Steve Riedl and Paul Delzio, "Individually Targeted Advertising in a Switched Services Environment", NCTA Technical Papers, April 2006.

### **3.2 REDUCING CHANNEL CHANGE TIMES**

A feature of switched unicast is the ability to reduce and even completely eliminate the delay that can occur when changing from one program to another in a switched environment.

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.

### **3.3 CONTENT PERSONALIZATION**

Switched unicast offers unique opportunities to enhance subscribers' viewing experiences by allowing content to become increasingly personalized. Doing so better equips cable companies to fend off competitive threats from emerging Internet-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.

### **3.4 PRECISE VIEWERSHIP DATA**

Switched broadcast systems allow cable operators to get precise viewership statistics without relying on third parties such as TV audience research firms, because they provide insights into which programs are being watched in real-time. The information attained is especially valuable because it encompasses 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 broadcast 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 a voluntary basis, with subscribers choosing to “opt-in” in return for a free month’s programming, or some other incentive.

### **3.5 EXPANDING CHOICES FOR CONDITIONAL ACCESS AND CPE**

Cable operators are typically limited to a single choice of encryption system at present, and once adopted, changes are difficult. Switched unicast introduces the opportunity for a wider range of encryption algorithms to be utilized, liberating cable operators to select conditional access systems from a wider range of vendors, with fluid implementations.

This is achieved by the switched unicast system replicating program streams and routing each version 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.

Switched unicast 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.

### **4.0 EVOLVING BEYOND FIRST GENERATION DEPLOYMENTS**

A key driver for switched broadcast deployments is bandwidth reclamation. The capacity gains can be used by cable operators to add hundreds of HD channels to existing line-ups, offer subscribers “long tail” programming, increase broadband access speeds, or other service expansions.

A specific reason for deploying switched broadcast is to alleviate the bandwidth burden of digital simulcasting. Known as “switched simulcast”, this technique puts the digital versions of less popular analog networks onto a switched tier, so that this infrequently viewed content is delivered to set-top boxes only when subscribers want to view it.

An extrapolation of this deployment approach anticipates less popular programming from such networks as a home improvement or cooking network being provided to subscribers on the switched tier, while the more popular networks are broadcast to every STB using legacy approaches. This is shown conceptually in figure 5.

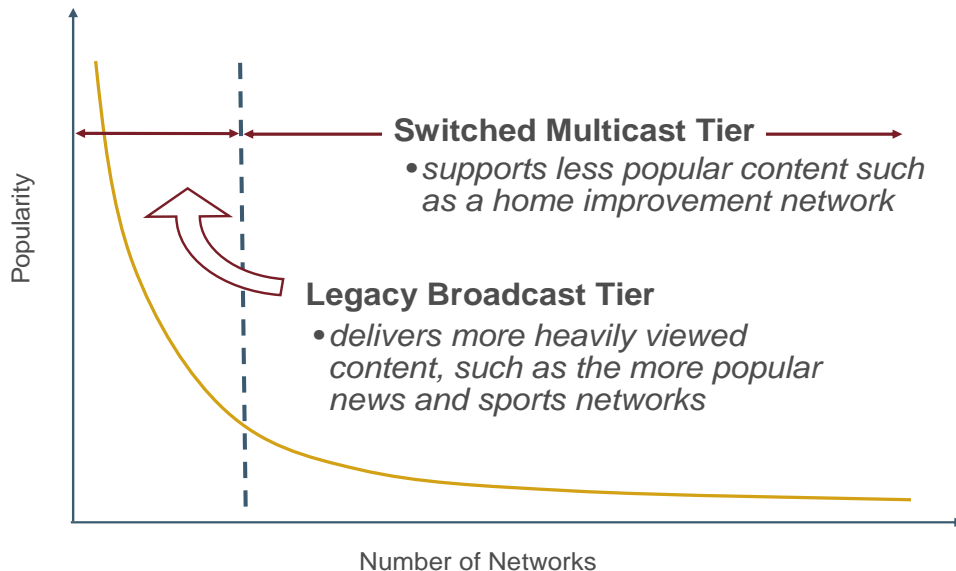


Figure 5: One approach to deploying switched broadcast - popular networks are broadcast, while less popular ones are switched

How would the penetration of switched broadcast evolve beyond this point? The first possibility is that switched multicast is increasingly adopted, until all programs are on a multicast tier. A subscriber in a multicast environment wanting to watch a network currently being delivered to other subscribers within the same node can simply join the existing switched session. Consequently no additional bandwidth is consumed by the incremental subscriber. So, a cable operator could choose to switch all content, even that from the most popular networks, and still realize dramatic bandwidth savings.

Alternatively, switched unicast, which can be viewed as an alternative to switched multicasting, or an enhancement to it, can be added to the toolkit available to cable operators.

Switched multicast is a necessity because it enables spectrum to be reclaimed. Switched unicast is not a necessity, at least not yet, but it is desirable because of the opportunities it presents for revenue enhancement and improved subscriber satisfaction. In addition, switched unicast offers benefits similar to IPTV, allowing cable companies to match, even exceed the types of video services shortly to be offered by telecom service providers.

Switched unicast can be deployed incrementally, since switched multicast networks are upgradeable to unicasting. For example, a cable operator may initially implement switched multicasting to support "long tail" programming, or to enable digital simulcasting ("switched

simulcast”). Then, wanting to take advantage of targeted addressable advertising opportunities, evolve the legacy broadcast tier to a switched unicast environment.

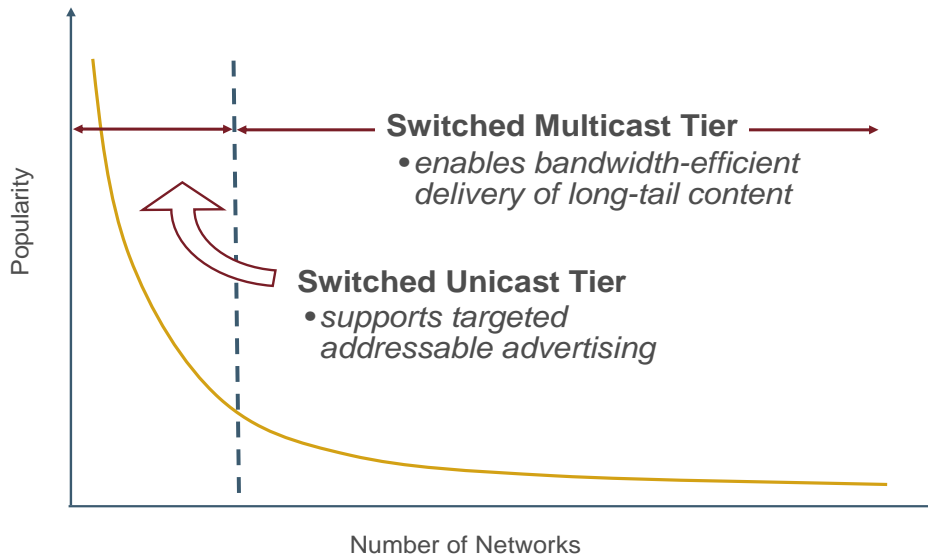


Figure 6: An evolution of a switched broadcast deployment - popular programs are carried on a unicast tier, while long-tail content is multicast

Figure 6 shows a combination of switched unicast and multicast that can enable higher advertising revenues (from the unicast tier) and broader choices of programming (on the multicast tier).

Alternatively, switched multicast can also be applied to the most popular networks, enabling spectrum to be reclaimed using the methods described earlier in this paper. It may be challenging, however, to make a strong case for applying switched unicast to the “long tail” networks, at least from the perspective of impacting advertising revenues. These networks are watched by viewers in narrow demographic groups that can be adequately addressed by the same advertisements.

## 5.0 DYNAMIC MULTICAST TO UNICAST TRANSITIONS

The previous section described how a cable operator, initially motivated to deploy switched multicast to overcome bandwidth constraints, could evolve towards an optimum combination of multicast and unicast that provides the best mix of bandwidth reclamation and revenue benefits. This section goes one step further and examines the opportunities enabled by switched broadcast systems capable of dynamically moving set-top boxes from a unicast tier to a multicast one, and vice versa.

Return again to figure 3, showing the cycles in viewership over a four day periods. During this field trial the maximum number of programs watched at one time was 70, while the average was close to 35. The number of programs available to subscribers was 172.

Additionally, the difference between the number of active tuners and the number of streams indicates the quantity of viewers sharing a multicast session. The larger the difference, the greater the amount of multicasting taking place. The amount of multicasting decreased during off-peak hours, because there were few programs capable of drawing a large audience. During these hours, usage patterns came closest to approximating a unicast model.

What figure 3 introduces, therefore, is that notion that there are scenarios that can justify dynamic transitioning between multicasting and unicasting. These include:

- Popularity of individual programs;
- Off-peak demand;
- Targeting addressable advertising;
- Exhausting unicast capacity.

These topics are discussed briefly in the following sections.

## **5.1 PROGRAM POPULARITY**

Up to this point, the discussion about which content to put onto a switched multicast tier versus a switched unicast tier has been based on network popularity, and assumptions that these allocations are static. However, the ability to dynamically transition networks between tiers in real-time, can shift the focus from decisions based on the popularity of networks, to decisions based on the popularity of individual programs.

Figure 2 underscores the benefits of moving a network from the unicast to the multicast tier when a single popular program causes a large number of viewers to turn on their television sets, with an accompanying spike in the number of active STBs. The ability of switched multicast to conserve capacity is particularly beneficial during these periods.

## **5.2 CYCLES IN DEMAND**

During off-peak hours, when total bandwidth consumption falls below total network capacity, an operator may choose to move some networks onto the switched unicast tier. The reason for the transition could be driven by advertising opportunities (see the following section) or the desire to offer personalized content, such as providing an individualized version of a music network to kids returning home after school.

## **5.3 TARGETED ADVERTISING OPPORTUNITIES**

During a multicast session, a cable operator may choose to unicast advertisements to individual subscribers. This may result from the cable operator having knowledge, perhaps as a result of information volunteered by subscribers (see section 3.4), that the interests of the viewing audience are equally divided into disparate segments. As described above, studies have shown that advertisers are willing to pay more when the probability of a response to their ads is higher.

## **5.4 OVERSCRIBING UNICAST SPECTRUM**

A cable operator that has chosen to allocate capacity within a service node to switched unicast content may decide that, after a specific number of unicast sessions have been reached, the next subscriber joins an existing program stream, if the opportunity to initiate a multicast session exists. This effectively moves the network from the unicast to multicast tier, at least within the service group.

This introduces the concept that there are different triggers for transitioning networks between tiers. One trigger is automatic and “on the fly”, the result of a cable operator exhausting pre-allocated unicast spectrum and initiating a multicast session for the N+1 subscriber. The next trigger is pre-programmed, and the result of a desire to unicast advertisements towards viewers of a specific program, carried on a “long tail network” that nonetheless draws a lucrative audience. A third trigger is an automatic, anticipated shift of one or more networks to the unicast tier during off-peak hours, perhaps for advertising purposes. A further trigger is just the reverse, an automatic, anticipated shift of a network onto the multicast tier during the timeframe that a very popular program is playing (see figure 2 for an example of the benefits of doing so).

## **6.0 CONCLUSION**

The first generation of switched broadcast systems is being deployed, primarily to alleviate capacity constraints. Switched broadcast, however, is about much more than bandwidth savings. The coming generations of switched broadcast systems offer significant benefits.

Switched multicast is a necessity because it enables spectrum to be reclaimed. Switched unicast is not a necessity, at least not yet, but it is desirable because of the opportunities it presents for revenue enhancement and improved subscriber satisfaction. A cable engineer has multiple options for deploying and evolving switched broadcast. These include, but are not limited to, a combination of legacy broadcast and switched multicast, all switched multicast, and a combination of switched multicast and unicast.

The ability to dynamically transition between multicast and unicast tiers adds the potential for another layer of refinement. There are a variety of reasons why the ability to move a network between a unicast and multicast tier is beneficial. A number of factors will drive these decisions, with advertising revenue opportunities being a major consideration. Ultimately, the choice of how to implement switched broadcast will be made on a case-by-case basis that best meet the business models of individual cable operators.