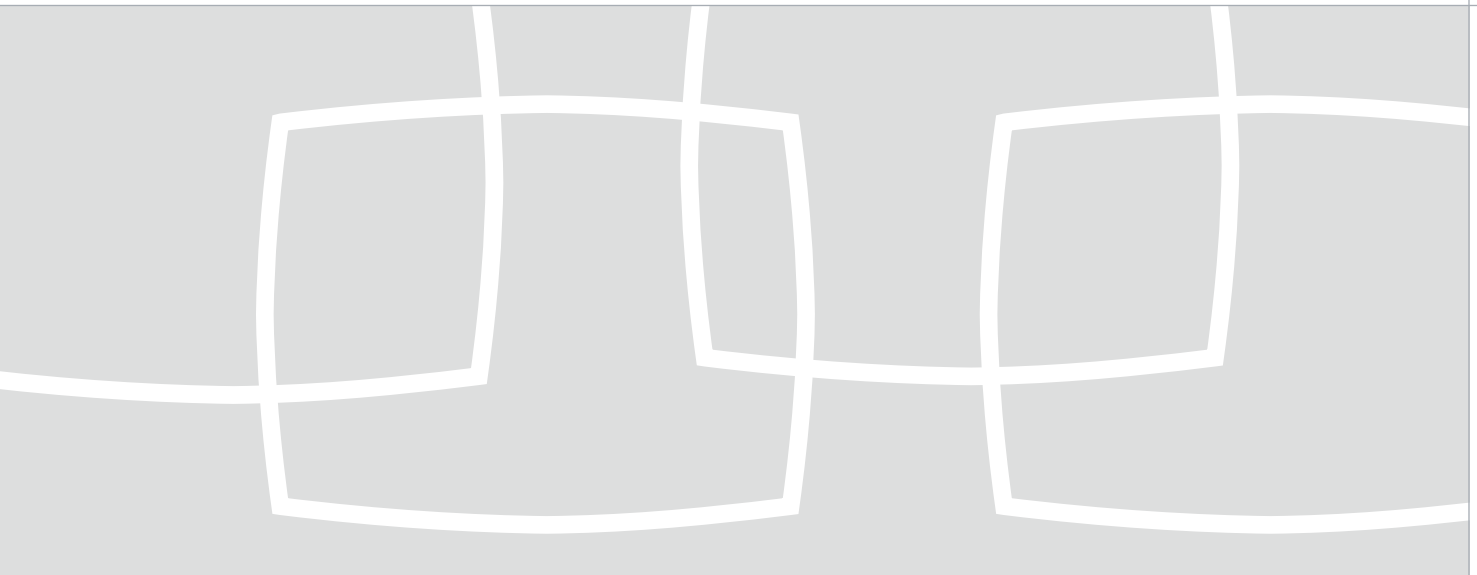


## Real Time Recording

The Shift from On Demand to Personal Television



SeaChange has, for a long time, been a believer in personal television. As one of the first companies to launch video on demand (VOD) in the 1990's, we have focused our research and development with that vision in mind. In 2002, we were one of the first companies to make the move from basic on-demand to real-time recording. The purpose of this paper is to examine some of the the most popular applications of real-time recording, and discuss their benefits in on demand television.

Before we discuss the various implementations of real-time recording, let's look at the traditional headend infrastructure as depicted in Figure 1. As indicated, in the traditional broadcast model, the signal comes in from its source (typically a satellite receiver), is decrypted, re-encoded, modulated and integrated into the spectrum.

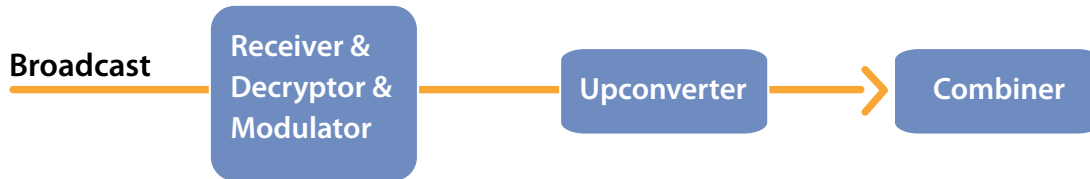


Figure 1. Traditional Broadcast Headend Flow

If we look at Figure 2 we can see how the traditional broadcast model changes when content is real-time recorded. In this example, the output of the headend receiver is split and the signal is sent to a de-multiplexer or encoder which is managed from a scheduler. The recording scheduler performs several important functions, including:

- Storing the business rules that are the parameters for the entire real-time recording system.
- Managing the schedule of recording start/stop.
- Creating metadata files.
- Interfacing to VOD systems.

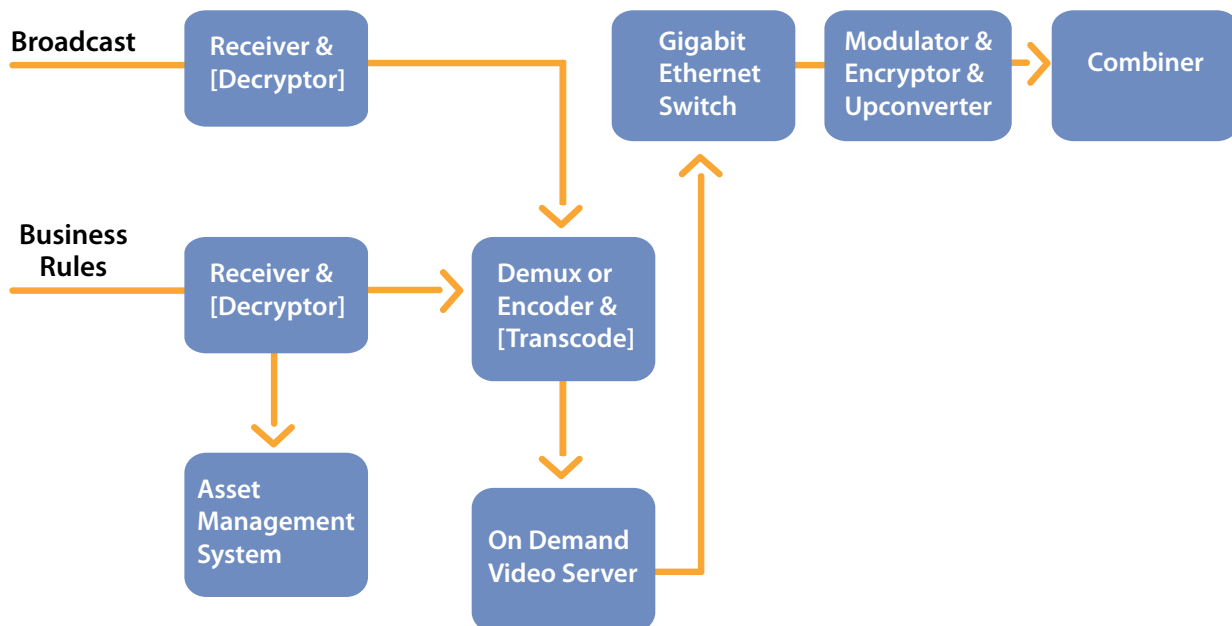


Figure 2. Real-Time Recording of Broadcast Content – Headend View

This brings us to the first implementation of real-time recording: **Schedule Based Recording**.

In any implementation of real-time broadcast recording, there must be an application controlling *what* and *when* recording should take place. In its simplest form, this application allows a user to look at a program guide-like grid on a PC screen and highlight the programs and times that should be recorded. Another implementation is to support a program schedule via an open interface. In this instance, the application controls the on/off functions of the encoder or de-multiplexer (see Figure 2) and automatically delivers the program metadata to the local asset manager via an open interface (typically the ADI format).

SeaChange has a schedule based recording application, called the SeaChange® Axiom™ Recording System, the most widely deployed real-time recording system in the world today with more than 50 systems currently in use in major cities. Working with a variety of encoders and de-multiplexers including Harmonic, Tandberg, SkyStream, Scientific Atlanta, EGT, Terayon and Bigband, the Axiom Recording System supports a web-based user interface that allows scheduling of programs to be recorded. With the simple user interface, programs can easily be tagged for recording, and the program guide data is loaded into the Recording System automatically. SeaChange's solution is integrated with Tribune Media Services guide data, BDS and can support other open interfaces as needed. Since recording data is loaded into the Asset Management system via an open interface, any ADI compliant Asset Management system can be supported.

The content encoded by the Axiom Recording System is imported into one or more VOD Systems in real-time, allowing the VOD System to offer the content on demand immediately. In its simplest implementation, this content becomes available as if it is any other piece of VOD content. The user would navigate through the On-Demand menu and select a program and watch it like any other asset. The only difference is that the content may still be encoding and uploading into the VOD System. This does not require any changes to either the VOD System or the client (STB) applications.

The end-user's (subscriber's) experience and the functions allowed (rewind, fast forward, etc.) are dependent on two items:

- The implementation by the operator.
- The implementation by the middleware or application in the set-top box.

### **Set-Top Application Needs for Real-Time Recording (network DVR, Startover, TeleportTV)**

Although a great deal of the focus around real-time recording is on the headend side, the set-top client plays a major role. Most implementations of real-time recording will involve a set-top code change.

If VOD is already launched, the simplest form of real-time recording will not require a set-top change. In this case, content can "switched" between the live broadcast and the on demand version. It is quite feasible to have the real-time recorded content available within the VOD menu system. A subscriber can select the recorded program from the on-demand menu and play it with full rewind, pause, jump to the beginning, and fast-forward (to real-time) capability. In this implementation, however, each subscriber watching the broadcast would have their own unicast stream, not the most efficient bandwidth solution.

Most operators will want to have a subscriber watch the live broadcast on the traditional broadcast channel and be able to apply pause and rewind from the broadcast channel itself. This option requires that the set-top code that is managing content during broadcast be able to understand what to do with fast-forward, rewind, jump to the beginning, or pause commands. Typically these remote functions for on-demand are ignored during broadcast streaming. The client application would need to be modified to send a request to the Session and Resource Manager (SRM) that indicates a session startup request. Within each session startup request is the asset ID for the real-time recorded content that is being recorded onto the VOD server. Since broadcast content has no VOD asset ID assigned to it, the client will need to send the channel number so the VOD asset ID can be determined in comparison to the current channel map, and the asset can then be played on demand. The good news is that once these changes are made, a robust, scaleable system exists to support network Digital Video Recording (DVR).

[Time Warner has implemented an approach where the client supports only pause and skip-to-the beginning of the program. They call their implementation Startover™. SeaChange implemented a similar solution, called SeaChange®Teleport TV™ in 2003. Cablevision has implemented an approach where the client supports pause, rewind, and fast-forward back to real-time, simulating a local DVR, where a customer must request a recording. Comcast has implemented an approach of obtaining license rights on a corporate level and recording such programs proactively (without having a customer request the recording) so that the programs are available for viewing by the customers if they missed them. What is clearly evident is that there are various implementations that can be supported by this type of platform.]

## Network DVR

Network DVR (also commonly called nDVR, for network Digital Video Recorder, or nPVR for network Personal Video Recorder) has so many different meanings to different audiences, that it can make implementation confusing. First and foremost, network DVR is not the same as having a DVR – the main difference is that with a DVR the storage is local (i.e., in the set-top box), while with network DVR the storage is located remotely (i.e., in a headend). However, much of the functionality is the same, it's just what device performs the action that is different (STB vs. VOD Server). The idea of using a VOD system to simulate a DVR allows an operator to have more monitoring and management control, saves a significant amount of capital, allows subscribers to record more content than if they had their own DVR (and even if they have their own DVR) allows for easy upgrades instead of having a mix of outdated hardware throughout the customer base. nDVR also allows the simultaneous encoding of many channels, instead of being limited by the number of tuners in a local DVR. A typical network DVR service flow is depicted in Figure 3. Even with this flow there are various implementations of the service itself.

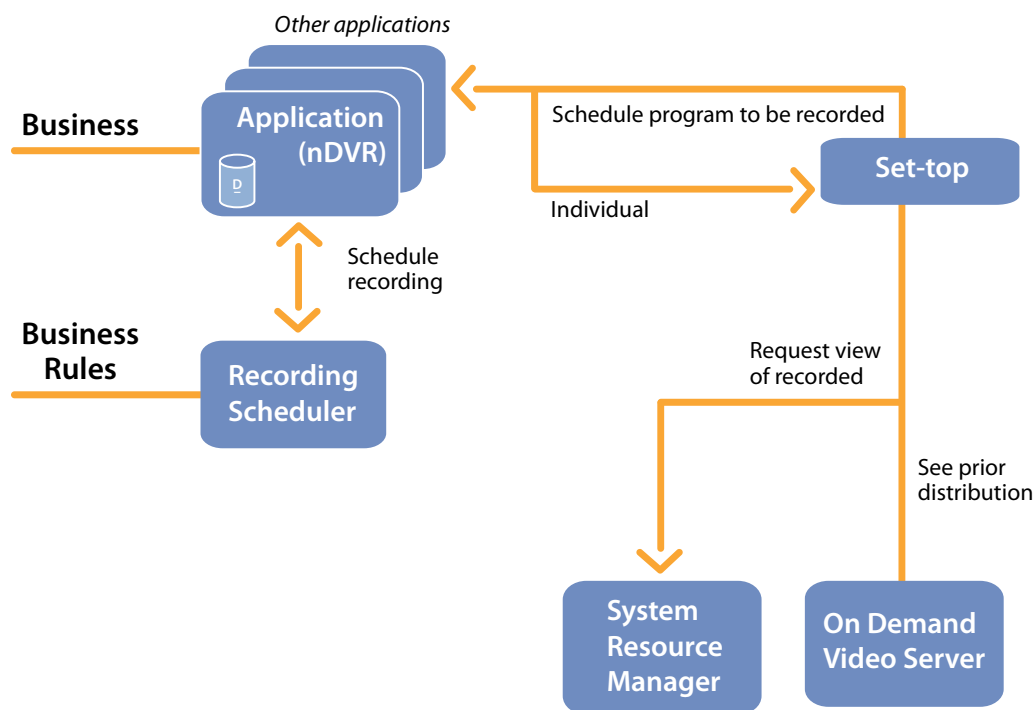


Figure 3. Network DVR Flow Diagram

With a DVR, the customer can typically browse through the program guide and highlight programs to record – either as a one-time event or on a repeating basis (daily, weekly, etc.) The amount of recording is limited by the amount of storage that the DVR has in it, and that storage is dedicated to the subscriber. The simulation of this environment with a network DVR solution is called *user-initiated recording*. Depending on the business rules, the subscriber may have a fixed amount of storage dedicated or be charged based on the actual storage available on the VOD Servers. It is flexible,

and based on the way the operator configures the system. As depicted in Figure 3, the subscriber, through the set-top user interface, schedules a recording (or a sequence of recordings); this request is passed to the nDVR application server. The application server is then responsible for interfacing to the SeaChange Axiom Recording System, which will then update the asset manager and manage the recording, as described in the previous section. User initiated recording is a bit more complicated than scheduled recording, because assets stored in the asset manager are available only to those subscribers that request that program to be recorded, which requires additional tagging. Such tagging is supported by SeaChange, such that any third party nDVR application (client and server) can be supported. Additionally, SeaChange is building a nDVR headend application in order to allow clients to interface to the SeaChange server without requiring another component. Clearly there are business rules that need to be set up within the nDVR application server. The SeaChange nDVR application server will allow the setup of these business rules in order to offer the operator maximum flexibility in implementing the network DVR service. These business rules include system usage parameters such as:

- Should the VOD system maintain a copy for each user (this choice is very impractical and causes excessive storage requirements) or have all users “share” a copy?
- What amount of space limitations should there be (all users get the same storage, storage alerts, storage pricing categories as nDVR service offerings, etc.)?
- Content deletion parameters (storage can be based on expiration dates or storage availability, for example).
- Viewing limitations of recorded content.

The goal of this model is that the subscriber experience be identical to the local DVR experience.

The second common implementation of nDVR is *operator-initiated recording*. Although the user still selects (or even may seem to initiate recording of) the program to be viewed, the operator, or actually the nDVR application server, is managing the recording schedule instead of the user. For example, an operator may record all programs available. A user could then “go backwards in time” on the program guide and select programs that have already aired. Or, the operator records a superset of programs proactively and tags the user recording requests, making only those tagged items available to an individual subscriber, although much more is actually available but is not allowed to be viewed. Operator initiated recording is similar to the flow shown in Figure 3, but the business rules that go into the nDVR application are extended beyond those listed for user-initiated recording in that they also include operator recording requests. Some examples of these extended business rules are listed here:

- Should the VOD system allow the user to watch the entire program if the recording started mid-way through, or should it bookmark the record point as the starting point?
- What programs should be recorded system-wide, regardless of subscriber availability?
- What controls should be available (pause, fast forward, rewind) for content that is operator recorded vs. user recorded?

The SeaChange nDVR application will support both user and operator initiated recording. Likewise, the SeaChange Axiom Recording System supports open interfaces to third party nDVR applications. In its simplest form, the SeaChange Axiom Recording System itself can be seen as an nDVR application server.

While, the majority of this section has focused on the recording aspect of network DVR, a major part of offering a network DVR service is the ability to pause a program during its live broadcast, rewind it, jump to the beginning, and fast forward back to the real-time broadcast point. Both user-initiated and operator-initiated implementations will support real-time pause functions (subject to the client requirements mentioned earlier). Either the business rules entered into the nDVR application or the client application itself can easily limit the use of certain on demand features. For example, some operators have implemented nDVR with the pause function only (pause and then play from the VOD server when un-paused), other operators have implemented nDVR with pause, rewind, and skip-back-to-real-time only (no fast forward support, i.e., no advertisement skipping), while others allow different combinations of features to be used. From a technology perspective, all of these options and others are easily supported by the SeaChange Axiom Recording System.

## Advertising

The move from linear, time-based television to television on-demand has spawned significant debate on the business model for broadcasters and advertisers. Given that, advertising must be taken into account when selecting an implementation of real-time recording. There are legitimate concerns that on-demand will allow advertisements to be skipped, that advertisements will be outdated when watched, that advertisements should be replaced, and so on. To offer an operator the maximum flexibility in implementing an advertising strategy, the SeaChange Axiom Recording System will allow for a variety of implementations. The most simple, of course, is to leave the broadcast program as-is. The client can easily disable the fast-forward function, and ad skipping can be disallowed. The SeaChange Axiom Recording System will also enable ad tagging. In other words, SeaChange will insert digital cue-tones during encoding (or keep them when de-muxing, and therefore offer the operator the opportunity to replace the advertisements, if such rights are obtained).

Additionally, SeaChange has a sophisticated advertising platform SeaChange® AdPulse™ On Demand Advertising System, which allows the real-time detection of ads and the replacement of those on demand. Advertisements can be replaced for any nDVR streams and can be targeted based on a variety of criteria and recommendation engines. Today SeaChange is targeting advertisements based on demographic parameters such as zip codes, but the system has the ability to do subscriber specific advertising insertion.

Advertisements are simply content files that are ingested into the VOD system independent of broadcast or VOD content. This allows ads to be updated without having to touch other content. Likewise, ad schedules, targeting information, and business rules are managed separate of the nDVR or VOD service. Ads are tracked in sophisticated reports that allow for local reports, multi-site reports, campaign reports, and more.

On-demand advertising is appealing to advertisers as it eliminates the typical four-plus weeks of lead times required to embed ads into VOD content. It enables advertisers to rotate different ads within the same VOD content, increasing the value of the VOD ad buy; it enables advertisers to create a much desired point-to-point connection with the customer; and it allows advertisers to measure precise views. In addition, dynamic (on-the-fly) on-demand advertising is appealing to operators because it relocates the business of VOD ad insertion to the local VOD site. This ensures a means of monetizing free, on-demand content, it enables rotation of ads within VOD content (effectively increasing VOD advertising inventory), and it makes it practical to support advertisers' desire to update ads in VOD frequently by eliminating the re-ingest of the VOD asset in which the ad runs. The implementation of advertising on demand continues to evolve, but there is no doubt that dynamic, on-demand advertising will play a big role in the future of network DVR. From a technology perspective, the SeaChange AdPulse System will ensure the flexibility needed to do individual-based, system based, or demographic based advertisement completely dynamically.

SeaChange®  
 **Axiom™** Recording System

SeaChange®  
 **AdPulse™** On Demand Advertising System

## Summary

There are currently two real implementations of real-time recording: schedule-based recording, and network DVR. Network DVR has various implementations such as user-initiated recording and operator-initiated recording, and SeaChange supports both of these implementations. The SeaChange recording system is designed to be an open interface system, so once an operator has implemented the architecture for real-time recording, additional applications can be deployed – applications that can use the various open recording interfaces in order to build new services for the operator. SeaChange also offers several applications including the SeaChange® Axiom™ Recording Service Software for real-time schedule-based recording, the SeaChange Axiom Personal Scheduler for customer based recording to simulate a personal video recorder, and the SeaChange Axiom Session & Resource Manager for system resource management and the support of switched digital broadcast.

Each of the three applications has dependencies related to content rights and to the set-top box application. There is a lot of public debate about what content rights are needed for the implementation of both schedule based recording and network based DVR. The discussion of these issues is outside of the scope of this paper. The set-top application support is critical in being able to launch any of the three applications. In some cases, the SeaChange solution has been in place without the ability to launch due to the need for the set-top application to support the real-time interfaces. Any planning for a real-time recording system must include the software support from the set-top application developer. SeaChange works with a long list of middleware, EPG, and application companies.

In summary, there are three solutions that can be implemented from SeaChange, the SeaChange® Axiom Recording System™ (available now), the SeaChange® Axiom™ Personal Scheduler (available in Q4, 2006), and the SeaChange® Axiom™ Session & Resource Manager (available now with SDB support in Q3, 2006). Additionally, SeaChange will work with the companies of choice to implement the set-top client support.



For more information please contact your SeaChange Representative or visit our website at [www.schange.com](http://www.schange.com)

