



FAST FORWARD

Implementing Live-to-VOD Services On-Premises or in the Cloud

TABLE OF CONTENTS

Introduction	3
Enriching the Live TV Experience	3
Catch-Up TV – Never Miss a Show	3
Start-Over TV – Back to the Beginning	4
nPVR Services – Just Hit Record	5
Pause-TV – Time for a Break	7
Delay TV – Spanning All Time Zones	8
Multiscreen – Same Features, Different Device	8
How is Elemental Addressing Live-to-VOD?	9
An Opportunity for Cloud-Based Solutions	10
Conclusion	11
Building a Complete Package	11

TABLE OF FIGURES

Figure 1 – Catch-up TV workflow: convert live content into VOD assets for future playback	4
Figure 2 – Start-over TV workflow: start a live program that is underway from the beginning	4
Figure 3 – nPVR workflow: Pick and choose programs to record and play back later on any device.....	6
Figure 4 – Pause TV workflow: Time-shift content as it's viewed	7
Figure 5 – Delay TV workflow: prime time content can be delivered when users expect it.....	8
Figure 6 - Elemental Live-to-VOD workflow	9

INTRODUCTION

ENRICHING THE LIVE TV EXPERIENCE

Today, the lines between live TV and video-on-demand (VOD) services are blurred. Hitting the pause button to take a quick break during a live football game is no longer just a farfetched impulse; it's a practical expectation. Replaying a scene from a live TV broadcast is as simple as hitting the rewind button and catching up on a favorite show is just a menu option away. Though these VOD features make perfect sense to end users, implementing them requires good forward planning.

This paper focuses on how pay TV operators can best enrich the live TV experience with VOD-based features. It does not cover traditional pay-per-view VOD, but instead looks at how pay TV operators can add value to live broadcasts by creating VOD assets in real time both on-premises and in the cloud. Though customer satisfaction and loyalty are important objectives for operators, so too is monetization. Live-to-VOD capabilities offer new ways to package live content alongside targeted advertising.

In addition to the technological choices involved in implementing live-to-VOD services, there are also a number of legal and contractual scenarios that need to be considered. Some premium content owners do not allow pay TV operators to repackage live broadcasts into VOD content while others will encourage it in return for revenue sharing. Regulations concerning catch-up TV and nPVR services also vary by market, sometimes requiring technological workarounds in order to ensure compliance. To better understand the issues involved, let's first look at the different types of live-to-VOD services and how they can be implemented.

CATCH-UP TV – NEVER MISS A SHOW

In order to remain competitive, most pay TV operators now offer pay-per-view or subscription-based VOD services alongside a live linear TV lineup. However, free VOD services such as catch-up TV are proving to be extremely popular. According to IHS Screen Digest¹, over 90 percent of pay TV VOD views consist of free content, mostly catch-up TV. This can be partly explained by the success of over-the-top (OTT) offers like Netflix which bypass pay TV operator packages. However, catch-up TV is also an attractive alternative to on-demand movies, further adding value to a pay TV operator's line-up. A few years after the privately owned French TV broadcaster M6 launched its catch-up TV service, 6Play, it was accessed by more than eight million households per month through set-top boxes and smart-TVs (smart-TVs accounted for 54 percent of the access), and increasingly through smart phones and other connected devices. This added further value to both M6, as an advertising platform, and to the pay TV operators carrying its channels.

Though catch-up TV is often perceived by providers as an easy-to-implement VOD service, there are a number of technical and legal issues to consider. First, it's important to work out the most efficient and cost-effective way of including live-to-VOD capture and delivery within existing broadcast workflows. Populating catch-up TV menus with the correct program guide information also requires matching VOD content with EPG (event program guide) data. Storage and speed also come into play. How much space will catch-up TV files require and how quickly after a program ends can these assets be made available to subscribers?

¹On-Demand and Catch-Up Television Services - http://www.my-mip.com/RM/RM_MIPWORLD/2013/documents/pdf/resource-centre/whitepapers/miptv-mipcom-screendigest-on-demand-catch-up-television-whitepaper.pdf

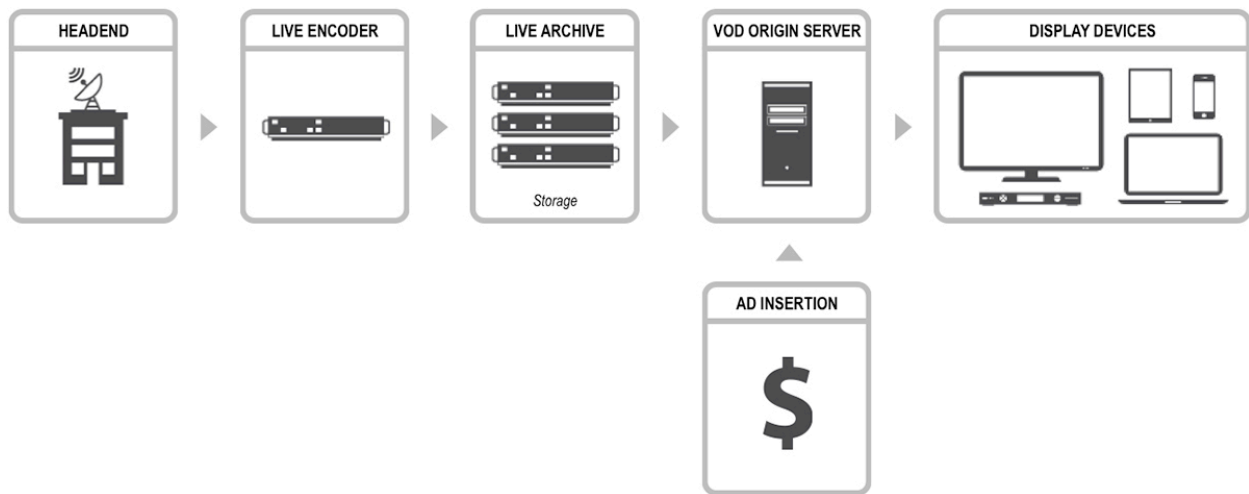


Figure 1 – Catch-up TV workflow: convert live content into VOD assets for future playback

Another key technical challenge is how to best implement ad insertion technologies. Catch-up TV is an excellent opportunity to monetize content through targeted advertising. In some cases, the ads may differ depending upon whether a TV, tablet or smart phone is in use. For example, smart phones tend to be used by a single individual, whereas tablets are often shared amongst members of the same household. Advertising needs to adapt according to the audience.

Regulations concerning catch-up TV can differ greatly from market to market. In Switzerland, for example, a pay TV operator can offer catch-up content for a maximum of seven days after a program is broadcast. In some cases, broadcasters will allow pay TV operators to include content through an STB-based catch-up TV service, but not through second screens, as this may compete with the broadcaster's apps.

START-OVER TV – BACK TO THE BEGINNING

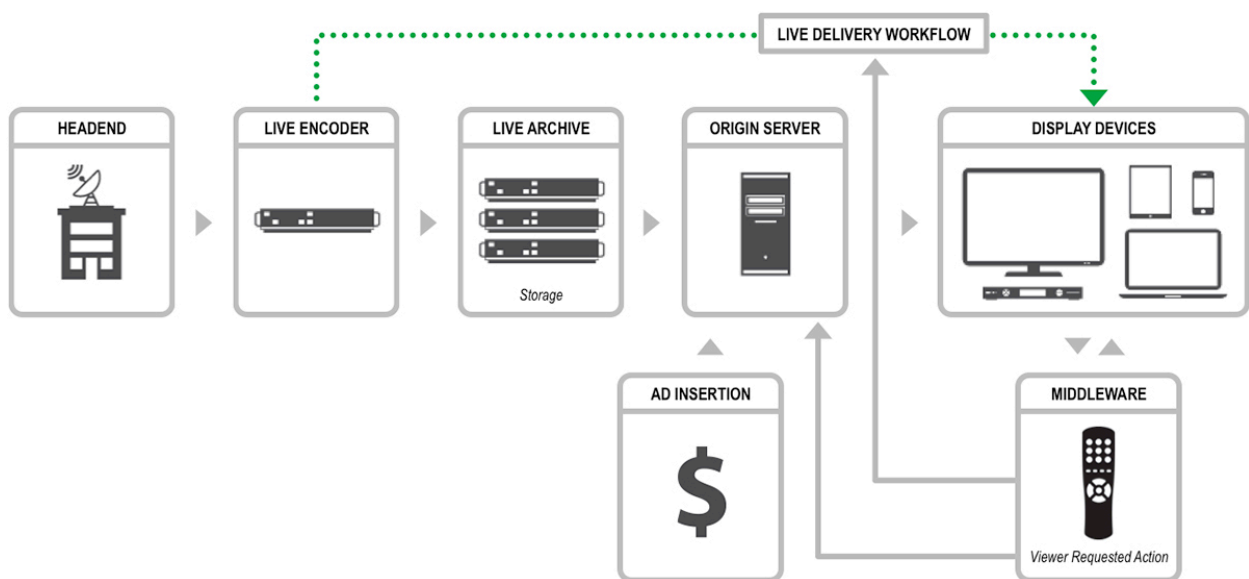


Figure 2 – Start-over TV workflow: start a live program that is underway from the beginning

Start-over TV, as its name suggests, allows viewers to replay a live broadcast, already underway, from the beginning. Unlike catch-up TV, start-over TV gives viewers the option to switch back to the live broadcast. This makes ad insertion trickier as the full length of the final asset is not always known in advance, especially with a sporting event or news bulletin. In most cases, it is simply not possible to remove and replace commercial breaks as this would allow viewers to skip them completely by switching back to the live broadcast. Therefore, any form of ad insertion or replacement needs to fit within the technical and legal boundaries of a live broadcast.

Since start-over TV content is recorded in real time, it is not possible to replace mass media commercials with personalized and targeted ads. Instead, targeted advertising needs to be streamed “on top” of existing commercial breaks and therefore, perfect timing is extremely important. Ad decision and replacement systems must adapt advertising material to match commercial break durations.

In many cases, a pay TV operator need also respect contractual obligations that do not allow for altering or skipping original advertising. Some European countries require that the user experience between live and start-over be identical with no edits, ad removals or ad insertions. Despite these constraints, it remains technically possible for start-over TV to share the same file with other live-to-VOD services such as catch-up and pause TV.

Elemental strongly encourages pay TV operators looking to introduce or enhance a catch-up TV offer to include start-over TV as part of the service. However, different ad insertion policies must be taken into consideration for both types of live-to-VOD services.

NPVR SERVICES – JUST HIT RECORD

The ability to create and store personal recordings of live TV content has been around since the invention of the VCR. Today’s viewers now take for granted that a DVR-type service is included with a pay TV subscription.

Offering local DVR or remote/cloud-based network personal video recorder (nPVR) functionality helps pay TV operators build customer loyalty. If a user is happy with the way an nPVR service performs, they will be less likely to move to a competitor and learn to navigate an entirely new interface. Coupled with a recommendation engine, an nPVR service is also an excellent incentive for subscribers to consume more TV content. Whether the video file is stored on a hard drive built into their set-top box or on a server in the cloud makes little difference to users, as long as the service is easy to use and works. Allowing the same familiar electronic program guide for both live content as well as for setting nPVR recordings provides a clean and intuitive user interface. nPVR can also be applied to catch-up TV. This allows subscribers to create a personal recording of a program from catch-up content before it is removed, in effect extending the service beyond the seven-day limit.

For pay TV operators, the ability to centrally store video files as a managed nPVR service offers many advantages over DVR. For starters, it’s a lot easier and less costly than managing hundreds of thousands of set-top box DVRs. Hard drives are the major single point of failure for STBs. According to a study by Backblaze, over five percent of hard drives fail within the first year of use. The number jumps to 22 percent over a four-year period. The average estimated cost of replacing a set-top box hard drive is roughly \$100. At a five percent failure rate, a pay TV operator with an installed base of one million STBs would have to replace 50,000 STB hard drives at a cost of \$1.5 million per year. It is, therefore, much more cost-effective to eliminate the hard drive from the STB and instead offer an nPVR service. The cost of maintaining a data center or ordering cloud-based storage specifically for nPVR is significantly lower over time.

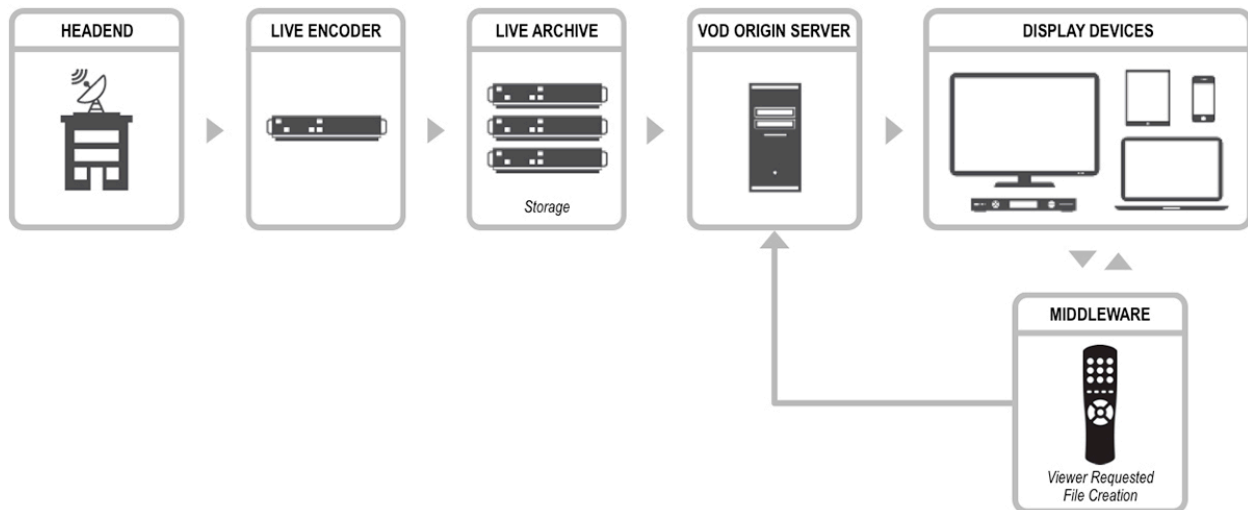


Figure 3 – nPVR workflow: Pick and choose programs to record and play back later on any device

nPVR also enables some interesting personalized ad insertion opportunities. Though some users might be accustomed to skipping through ads when viewing DVR content, if the ads are better targeted, the viewer may be less likely to do so. Also, it is possible to measure how many viewers watched the ads rather than skipping over them, allowing for a pay-per-hit advertising model.

In some cases, pay TV operators may prevent users from fast-forwarding ads when playing back nPVR recordings. As an alternative to traditional commercials, digital overlays can be highly effective and less intrusive. For example, a digital overlay with a link to an attractive travel package to Morocco would be not only relevant but also useful to a viewer watching a recorded travel documentary about North Africa.

Despite the seeming simplicity of running a centralized nPVR service, legal issues need to be taken into consideration, depending on the market. Sometimes the lines between nPVR and catch-up TV are blurred. For example, some pay TV operators might not be allowed to offer catch-up of certain premium content even though users maintain a legal right to record a copy for personal use. This gets tricky when the same file is used for both catch-up and nPVR, an efficient solution technically, but which can result in legal complexities. In the United States for example, individual recordings of TV shows are allowed under the famous 1984 Supreme Court Betamax decision, later extended to nPVR by a 2008 court appeal in favor of Cablevision, as long as the recordings are made at the direction of a user and only accessible by that same user. However, repackaging catch-up content as nPVR video is not always possible.

In designing and implementing an nPVR service, it is important to consider what type of storage system is best suited to both the existing broadcast workflows as well as legal requirements. In cases in which a separate storage system is required, rapid scalability and flexibility become very important. Unlike other live-to-VOD services, it is impossible to accurately predict how much storage the subscriber base will be using for nPVR. Setting a storage limit is one way of managing expectations, though if the limit is set too high then this could involve unnecessarily costly capital investments. Another, better option is therefore to rely on a third party cloud-based storage service to accommodate storage peaks.

As for monetization, pay TV operators need to decide whether or not they wish to include ad insertion, and if they do, they need to accommodate the differences between catch-up TV and nPVR advertising. The latter needs to be far more targeted and less intrusive – otherwise the operator runs the risk of turning viewers off from the service.

PAUSE-TV – TIME FOR A BREAK

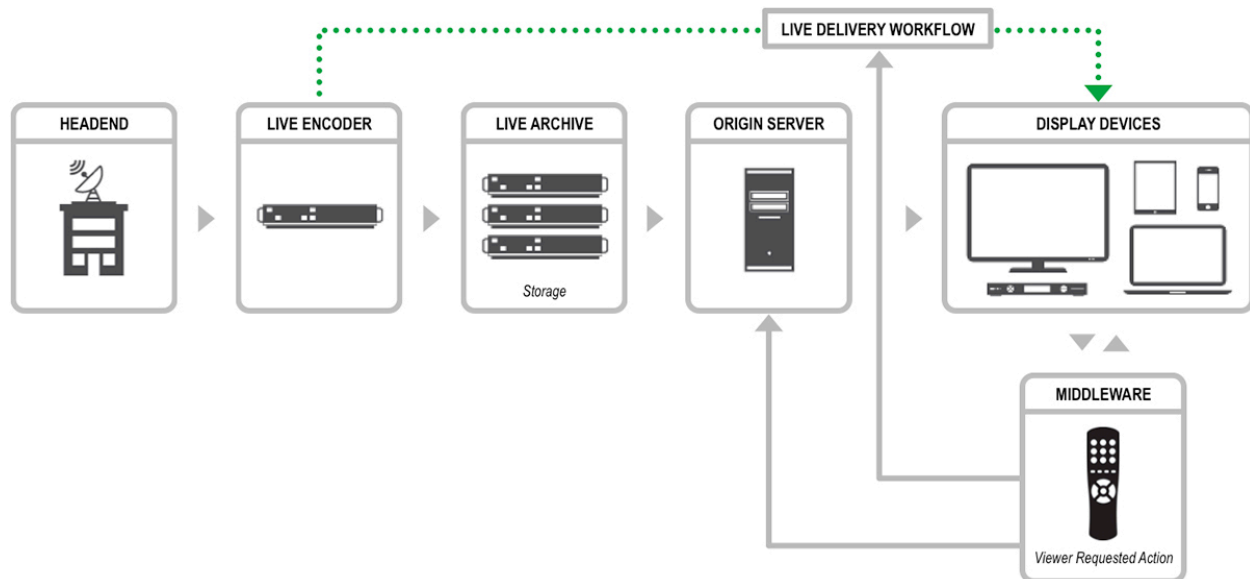


Figure 4 – Pause TV workflow: Time-shift content as it's viewed

Pause TV enables viewers to pause and later unpause a live television broadcast. This feature is perceived by viewers as a useful service that ensures they won't miss anything, even if they need to take a short break. Once playback is resumed, the viewer then has the option of continuing to watch from where they left off, with a slight delay of a few seconds or minutes. Alternatively the viewer can also fast forward, repause or simply return to the live broadcast.

Start-over TV is different in that end-users retain full control over channels and can pause any program they want, as if they are using a DVR with a local hard drive; whereas for pause TV, the channels and programs offered with this functionality are selected by the pay TV operator. This selection may depend on legislation in various countries and on the rights given by content providers. For example, depending on contractual agreements, in some cases sporting events can include a pause TV feature, but may not be made available in catch-up TV mode.

For contractual and legal reasons, pause TV may not often be used for skipping past ads. This means that there need be a way for the pause TV function to detect ad insertion points and disable fast-forward or skipping past those segments. Generally speaking however, users are generally allowed to turn off pause TV and go back to a live broadcast. Other legal considerations include how long a program can be "paused," especially if the pay TV operator doesn't have the rights to present the content in catch-up TV mode. For this reason it is important to clearly define the difference between pause TV and catch-up TV.

DELAY TV – SPANNING ALL TIME ZONES

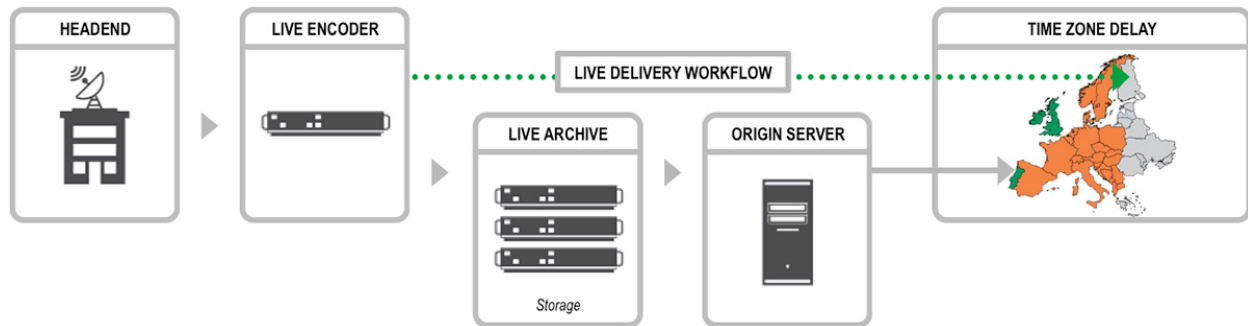


Figure 5 – Delay TV workflow: prime time content can be delivered when users expect it

Delay TV is a live-to-VOD-based replacement of a broadcast application that is traditionally referred to as tape delay. There are several scenarios in which delay TV may be used. For instance, a national TV broadcaster might want a television program to be aired at the same time across multiple time zones. This means that the program will be broadcast live in one time zone with another time zone receiving a recording of the program exactly one hour later. The broadcaster may send the same content more than once, or in some cases the pay TV operator may be required to implement its own delay TV service.

A use case exemplifying this application is a national broadcaster that not only uses delay TV functionality to serve local affiliates with the “right” time zone, but also plans to use targeted local advertisements for each affiliate. To achieve this kind of workflow, it is important to have a system that can recognize SCTE or manual ad insertion signals and process them accordingly.

Delay TV can also be used for broadcasting to overseas territories and military bases. In this case, it may be more efficient for a local pay TV operator to simply capture and record a live broadcast for delayed broadcast locally.

Finally, in some markets such as in India, pay TV operators may also be required to introduce a delay of a few minutes for live events published on OTT sites. Other potential uses of delay TV may include very short delays of a few seconds to be used for censorship purposes such as inappropriate language during a live event broadcast.

MULTISCREEN – SAME FEATURES, DIFFERENT DEVICE

Live-to-VOD services can be adapted to second screen devices such as PCs, smart phones and tablets. For example, a viewer might decide to pause a live broadcast on their TV set and watch the remainder of the program on their tablet. Live-to-VOD can also work across multiple screens simultaneously where the television set is used for the live broadcast of a major sporting event and a second screen is used for instant replay to better understand the game or to access alternative camera angles.

Formatting live-to-VOD content to fit second screen devices is not as straightforward as simply playing back content on a TV set. Firstly, it depends on whether the content is delivered to the second screen via a media gateway built into the set-top box or across the public internet as an OTT stream. With a gateway and STB, bandwidth requirements are fairly easy to manage, but OTT delivery requires some form of adaptive bitrate streaming such as Apple HTTP Live Streaming (HLS). Some pay TV operators may even offer both a gateway for optimal quality viewing of content at home and an OTT service for viewing over a

3G or 4G network. Not only do bandwidth constraints need to be taken into consideration, but also screen sizes and device types. There is no point in streaming HD or 4K Ultra HD video to a low-resolution smart phone, or to stream 5.1 or 7.1 audio to a system with only two speakers.

For all these reasons, a live-to-VOD service needs to be able to repackage content, using recorded catch-up TV or nPVR content as mezzanine files, to a wide variety of devices supported by the pay TV operator. The system needs to be both scalable and flexible to support edge servers and third party CDNs.² With premium pay TV content, it is also important that live-to-VOD services incorporate DRM technology to protect valuable content regardless of the device used for playback. Finally, contractual issues also require consideration as some content owners might not allow programming to be accessed on second screen devices or for ad replacement within catch-up TV.

Whether it's catch-up, start-over, nPVR or pause TV, each live-to-VOD service implementation must also take into account the different types of screens and networks in use. Bandwidth, storage, monetization and security concerns can lead to complications that are quickly multiplied by the myriad viewing devices and scenarios involved. For this reason, it is critical to build live-to-VOD services on top of a system that is both highly flexible and scalable, ideally one that is based on software that is fully interoperable with third party devices, CDNs, ad insertion and DRM schemes.

As they look to the future, broadcasters and pay TV operators need to ensure they are ready to adapt their services to new as well as updated devices and protocols. By relying on a software-based approach rather than fixed-function hardware, live-to-VOD systems can be more easily upgraded to embrace new standards and features as they emerge. By also including a just-in-time (JIT) packager that can adapt video streams to network and device parameters in real time, pay TV operators can be prepared for whatever comes next.

HOW IS ELEMENTAL ADDRESSING LIVE-TO-VOD?

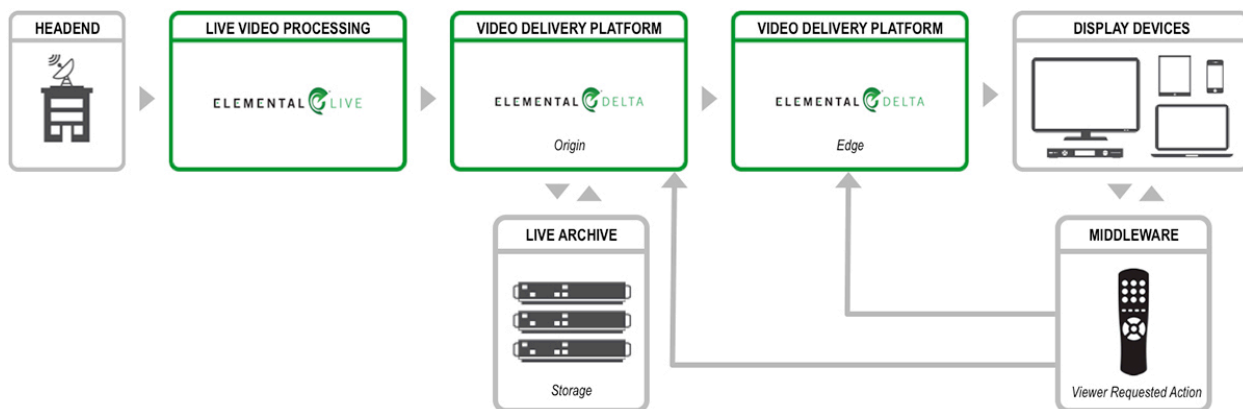


Figure 6 - Elemental Live-to-VOD workflow

Having worked with a wide variety of pay TV operators, content owners and third-party technology partners, Elemental is keenly aware of the technical and legal challenges involved in implementing live-to-VOD services. For live-to-VOD services to be both resource-efficient and cost-effective, they need to be

² For more information about the capabilities and practices of content delivery networks as related to video processing, read the Elemental white paper *CDNs Demystified*: <https://www.elementaltechnologies.com/resources/white-papers/cdns-demystified-streaming-technology-primer>

easily integrated into existing broadcast workflows from live broadcast capture and video encoding all the way to the edge and onto viewer devices. Software-defined video solutions from Elemental provide the foundation for a number of live-to-VOD services in the United States and in Europe. Elemental Delta at the origin or edge provides support for advanced live-to-VOD services destined for multiscreen devices.

A core component of Elemental Delta is JIT packaging, which can use a single live broadcast recording for re-packaging and formatting to a wide variety of devices on demand and on the fly. This includes adaptive bitrate streaming for adjusting picture quality and compression ratios to match bandwidth availability in real time. The system can wrap video content in different adaptive streaming formats including Apple HLS for iOS devices, MPEG-DASH for connected TVs and HTML5 players, Microsoft Smooth Streaming for gaming consoles, and Adobe HDS for Flash-based media players. Elemental Delta also creates the necessary profiles specific to different screen resolutions and sizes, and can handle multiple audio tracks and several formats for subtitling.

With scalability and flexibility in mind, Elemental's video processing and multiscreen delivery solutions are all built with a software-based approach. This allows for the rapid addition of new live-to-VOD features and support for new types of devices as they are introduced to the market. Running on Linux, Elemental Live and Elemental Delta platforms allow for easy integration with third-party DRM systems, CDNs and ad-decision servers.

AN OPPORTUNITY FOR CLOUD-BASED SOLUTIONS

As discussed earlier, there may be challenges to overcome when designing a live-to-VOD solution. One challenge is scalability, and storage is at the heart of this issue. If a service provider receives rights from one or more content owners, a catch-up TV service can quickly comprise a huge catalog of VOD content, and storage resources have to grow instantly to accommodate this.

nPVR poses a similar challenge, especially in dealing with private copies of content. Imagine, for example, there is a highly popular television program, such as a season finale of a series, and that millions of users record it simultaneously. Storage needs will massively peak when the show is broadcast. The vast majority of subscribers recording this episode will likely watch it and delete it within three days. In this instance, a cloud-based storage solution such as Amazon's Simple Storage Service (S3) becomes relevant. Because of the inherent elasticity of Amazon S3, service operators will only pay for it when it is being used. This is very competitive cost-wise when compared to an on-premises storage solution where service operators traditionally have to size storage to accommodate the greatest possible load, even if it is used less than five percent of the time.

The benefits of cloud scalability enhance not only storage management, but also the broader end-to-end video delivery solution. When using cloud infrastructure, adding a new channel is fast and easy. Creating temporary channels, which a pay TV operator might use to augment coverage of a high-profile event such as sports, becomes practical. Temporary channels may have the same live-to-VOD features as primary channels, even if temporary channels are only needed for as little as a few days. All in all, the processing and delivery chain can be deployed for the time needed and then disabled, making it cost-effective for video operators to implement.

Cloud-based solutions are faster to deploy and usually require less operational resources than on-premises deployments. The logistics of managing hardware – racking machines, pulling network cables, defining the topology of new hardware, ensuring proper electric power and adequate HVAC to keep hardware cool for optimal performance – is no longer required. A full live-to-VOD service can be

configured using Elemental Live and Elemental Delta from an Elemental Cloud deployment in just a few minutes. This model adapts very well to live events or 24x7 linear broadcast.

CONCLUSION

BUILDING A COMPLETE PACKAGE

Introducing live-to-VOD services and features involves a number of technical and legal factors that can seem daunting when addressing multiple types of devices and networks. However, these issues can be efficiently managed by ensuring that the live-to-VOD system meets the following criteria:

- Automated creation of VOD assets from live broadcasts
- Support for multiple DRM technologies
- Use of mezzanine files for multiple VOD services to keep storage costs down
- JIT packaging to support as many devices as possible without draining bandwidth and storage resources
- Future-proofed JIT packaging to adopt new streaming formats and DRMs without the need to reprocess an entire catalog of content
- Ability to integrate with a wide variety of third party ad insertion technologies
- Software-based implementation for flexibility and scalability
- Ability to support different types of file storage modes, mezzanine or viewer-specific files, in order to meet legal requirements for nPVR services
- Live-to-VOD support across CDNs for OTT delivery
- Ability to integrate with cloud-based storage and software platforms to further increase flexibility and scalability

By meeting the above requirements, an efficiently configured live-to-VOD system, either on-premises or in the cloud, can become a key differentiator for a pay TV operator. This can position a pay TV operator against the competition and enable it to attract new subscribers based on feature richness, as well as drive new sources of revenue through live-to-VOD content monetization. When built upon a software platform, a live-to-VOD system can quickly scale up through on-premises or cloud-based video processing. Pay TV operators that continue to innovate live-to-VOD services will be able to build customer loyalty, extend market reach and generate new revenues streams.