



Catching Up with Live OTT TV in a Changing Landscape

Delivering live video over the Internet in a competitive market now requires high availability and making content available on-demand almost instantly



A CTOiC eBook written by Ben Schwarz and Philip Hunter, sponsored by Unified Streaming and Media Excel

On demand creates new challenges for OTT TV distribution

Delivering quality of experience with OTT TV services is now one of the biggest challenges facing both incumbent and emerging TV operators. Consumers expect to be able to access content wherever they are and whenever they want. Their expectations over quality of experience are rising all the time and they are not interested in the technical challenges of OTT IP vs. broadcast, since it's all just content to them. When their expectations are not met, viewers are prone to churn as competition is rising in many markets and there are usually alternative providers. Slow start-up, buffering and visual artifacts have for example become churn drivers. Live sports lies at the intersection between consumer expectation of quality and rights holders' growing demands for security. Service providers are also under cost pressures and so want to deliver OTT content as cheaply as possible while extracting maximum value from it. They want the ability to repurpose content as quickly and cost effectively as possible, so that subscribers can not only watch live but also on demand as soon as possible afterwards. Smooth integration of live and VoD gives operators opportunities for novel features around replay and targeting across multiple screens with new monetization potential.

This paper dissects these issues and identifies how operators and content owners can best meet these challenges against a background of fast evolving technologies and standards around live stream security and virtualization. We will see that these challenges are best met through a highly flexible ecosystem managed by trusted partners with a best of breed approach, so that optimum components can be chosen for the core components such as storage, encoding, streaming and security. The paper will also highlight how software is becoming more compartmentalized to allow greater choice there too and ensure changes can be made in one component or application without affecting the others.

Examples of real deployments will be given to highlight the benefits of a flexible ecosystem in enabling OTT services that combine live and on demand content within a single consistent user interface. Broadcaster RTL Nederland, digital terrestrial distributor Arqiva in the UK and transmission services provider Encompass are among those featured.

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The advent of OTT streaming and the new user experience

OTT has progressed rapidly from a best effort option to a core premium service for traditional pay TV operators, enabling TV Anywhere as well as new competitive service tiers. Delivery of premium video content over the Internet has quickly become commonplace and operators are having to respond fast by enabling the same high quality and availability for streaming that has long been taken for granted over traditional cable, satellite, digital terrestrial or IPTV broadcast TV. They must also ensure that the service emulates the high quality of user experience emerging operators are already providing. Netflix is the world's leading on-demand SVoD service, pursued by Amazon Prime and Hulu among others, all of which have raised the bar for customer experience in various ways, especially content discovery and ease of use. These operators do not provide live content at least for the time being, but Netflix especially has been a pioneer with its powerful recommendation engine and the intuitiveness of its UI.

It is true that traditional players have more recently started to deliver compelling user experiences directly to multi-screen environments, but still it is only a few leading operators such as Sky that have really closed the gap on Netflix. Nevertheless there is a growing sense that ease of use is a critical differentiating factor for emerging multiscreen services as part of the overall quality of experience. Indeed New Street Research analyst Jonathan Chaplin stated in a research note about AT&T's wireless strategy with regard to DirecTV: "(...) It seems that AT&T sees simplicity as the biggest differentiating factor of their mobile video service (...)"

In the UK Sky Go, the multi-screen TV Everywhere service for existing subscribers from pay TV behemoth Sky, is built with state-of-the-art user friendliness and simplicity and is highly successful in the market [out of Sky's 12.3 million TV subscribers in Q1 2016, 6.2 million had Sky Go]. With over 10 million subscribers across Europe as a whole adding in the totals from Germany, Austria and Italy, Sky Go is the continent's largest provider of mobile TV services.

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After general ease of use, consumers also increasingly expect flexibility over how, when and where they consume content. This is driving operators to improve synchronization between live and VoD within a coherent service offering and no longer in separate silos. There are many new opportunities for customer satisfaction and monetization but to exploit them operators need to bring on-demand and live together within a single workflow. That minimizes the time and effort required to make live content available on demand for a range of offerings including start over TV, delay TV, catch up, pause on live and instant replay. RTL in the Netherlands is one broadcaster that has successfully deployed live capture to VoD with a dramatic impact on customer loyalty as a result both of increasing video quality by 300% and reducing to minutes the time taken to make the content available on demand.

Justin Hewelt, an internationally recognized TV user experience expert from [PayMedia](#) told us:

“There has been a congruence of improvements that have led to the enhanced customer experiences we're seeing now.

These are the key factors, which have redefined the UI, rather than any single provider or operator.

1. Bigger Screens resulting in more screen real estate to play with, allowing presentation of more assets on screen.
2. Better Chipsets allowing faster processing, faster refresh, and more efficient browsing.
3. The impact of Apple's design on all UIs resulting in fluid UI concepts mimicking our interaction with physical world objects.
4. Broadband Connectivity, which enables user activity to be tracked in real-time, via truly two-way networks.
5. Rich Metadata giving operators the ability to deliver high-resolution cover art for the majority of content and provide more comprehensive visible and invisible data fields that can help with content discovery.
6. Redefinition of Search enabled by the arrival of smartphones that have redefined how consumers can search for content using text (and now through voice recognition).

The need to build on shifting ground

IP streaming is still evolving rapidly through maturation of delivery and device display technology, with the main recent trends being the advent of live OTT including VoD capture, higher quality leading towards UHD and proliferation of mobile. According to Cisco's Visual Networking Index [white paper](#) published in February 2016, by 2020 75% of the world's mobile data traffic will be video, totaling 275 Exabytes (275 billion Gbytes), converging towards the percentage of video over fixed networks which will stand at 80% by then. The other significant trend will be a growing globalization of OTT services, signposted by various developments such as the European Union's [plans](#) to allow users to have cross border access to content they have paid for, which will encourage operators to provide multinational access to services via OTT.

As these broad trends unfold the underlying delivery infrastructure will continue to evolve, with content owners likely to go on having to deal with up to four alternative technologies for [adaptive bit rate streaming](#) (ABR or ABRS). This comes eight years after Microsoft's introduction of the first successful OTT technology in 2008: Smooth Streaming. Microsoft was rapidly joined by two rival proprietary ABR technologies from Apple and Adobe, respectively HLS (HTTP Live Streaming) and HDS (HTTP Dynamic (Streaming)). Then MPEG-DASH, a non-proprietary protocol, which we briefly discuss in the standards section (page 8), emerged in 2011. But even now well into 2016 it still isn't clear how the market will evolve, with HLS and HDS remaining widely deployed. This is just one example of the uncertainties continuing to dog the OTT field, which means that flexibility is a key requisite for the associated infrastructure.

Equally disruptive are changes in the marketing and business factors. Some broadcasters and TV networks are now selling packages to consumers by the channel rather than as discrete bundles. This of course has a major impact



on the traditional business models based on channel bundling. Conversely, usage patterns we are seeing with many early adopters of OTT technology are akin to another kind of bundling, since subscribers tend to choose between providers like Netflix and Amazon Prime on the basis of their total content packages.

Finally, the outcome and implications of the network neutrality debate are still unclear, with the boundaries still shifting and varying regionally. Europe in particular is taking a less strict line than the US by allowing service providers to prioritize fast lanes for certain specialized services including possibly premium video. So although unlikely, we could conceivably end up in a world where only Netflix streaming is at high quality, or on the contrary one where only your local operator’s streaming is.

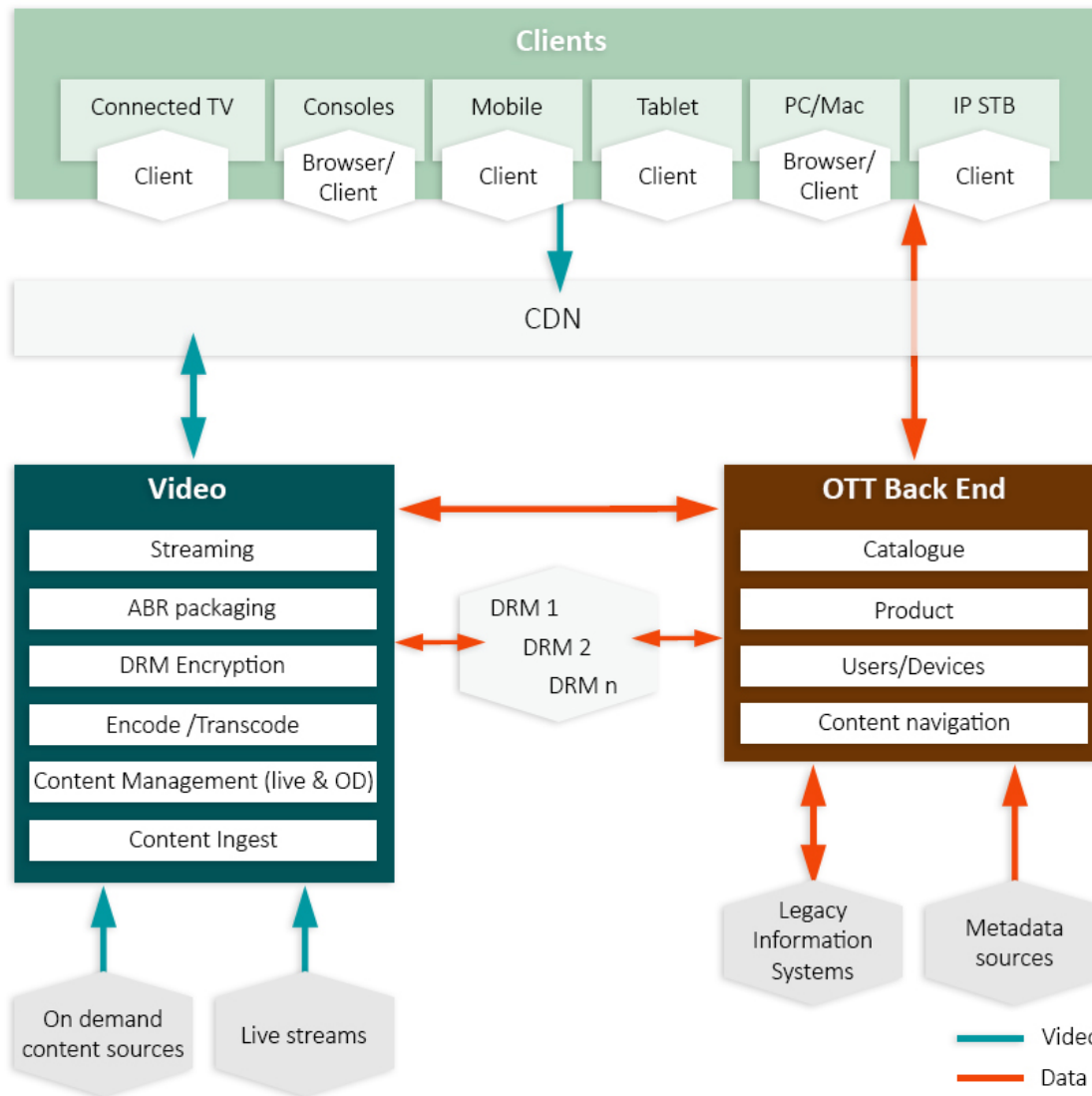
It is clear then that TV in general and live OTT in particular is in state of flux, requiring flexibility underpinned by an agile infrastructure.

3.1 The choice of one-stop-shop or best-of-breed components

Large one-stop-shop solutions may start off well because they can be tailored to the immediate requirement, but as the technology and business landscape changes they almost invariably fall out of line, becoming increasingly complex and expensive to keep up to date. Over time they get bogged down in inertia and resist those changes that are essential to remain competitive. They also fail to take advantage of emerging best of breed components that can enable advanced features and options.

Yet while an infrastructure built from best-of-breed components is necessary for the agility to ensure success, effective integration is also essential and issues

	Custom Build	Best of breed	1-stop-shop	Best of breed
	Non pre-integrated		Pre-integrated	
Tailored to operator needs	✓	✓		✓
Fast time to market			✓	✓
Scalability		✓		✓
Future proof		✓		✓
Ability to swap component out				✓
Standards compliant		✓		✓
Low integration risk	✓		✓	✓



associated with combining all the required parts can easily be underestimated. Choice of lead integrator is therefore critical for taking responsibility, managing integration costs and achieving competitive time to market for new services.

Standards and security: key ecosystem enablers

Standards in the streaming space bring operators the ability to plug-in best-of-breed components as they become available. Adhering to standards should ensure interoperability between all the components including key elements such as CDN, Origin Server, live ingest, DRM or client applications for mobile devices, connected TVs, PC/MAC and game consoles.

Software-driven innovation requires operators to retain the ability of plugging in the best-of-breed components and so future-proofing their investment. A standardized software environment enables different vendors to guarantee interoperability with only minor tweaks during implementation and testing.

Then MPEG-DASH is set to become the dominant standard for ABRS, promoted by [DASH-IF](#), a wide group of industry stakeholders. Like other ABRS technologies, DASH breaks streams into

small HTTP-based chunks each of which typically contains 2 seconds of video. With previous streaming technologies such as RTMP, the streaming server managed all the clients, whereas with DASH it is the client that requests each chunk of data, which is an inherently more scalable approach. Clients can request stream chunks at different bit rates depending on available processing power, screen size and bandwidth. This greatly reduces re-buffering and allows adaptation to changing network conditions.

The Common Encryption Scheme (CENC) is another key standard that brings security to OTT architectures in as future-proof a way as possible. It specifies standard encryption and key mapping methods that can be utilized by one or more digital rights and key management systems to enable decryption of the same file using different DRMs that enforce rights on given clients or target platforms. The scheme operates by defining a common format for the encryption-related metadata necessary to decrypt the protected streams. However CENC leaves the details of rights mappings, key acquisition and storage, and DRM compliance rules, up to the DRM system or systems supporting the CENC scheme.

The other area for standards is encoding, where HEVC has emerged from the traditional MPEG community but is meeting a stiffer challenge than in the past from new contenders based on alternative technologies. The arrival of live OTT has put more pressure on encoding performance and persuaded some vendors and operators that dedicated on-site hardware is required, even if cloud based software encoding is fine for on demand content. This has created demand for hybrid transcoding solutions that combine cloud and in-house systems to combine economies of scale and support for peak demands with the performance advantages of dedicated hardware.

There are many other relevant standards such as Ultra Violet (UV) and the Digital Living Network Alliance (DLNA) that can participate in OTT deployments and play a pivotal role in interoperability. UV is a cloud based digital locker for secure storage of media including video, allowing users to access the content under various business models including “download-to-own”, in principle from any device wherever they are. DLNA is a set of interoperability standards enabling secure transmission of content between compliant devices within the home.

What makes a good ecosystem?

An **ecosystem** is a distinct community operating in conjunction with its wider environment, whose components interact as a single coherent system. We'll look into the key ingredients of a successful OTT ecosystem in terms of integration, people, support, components and constraints such as need for responsiveness and avoiding vendor lock-in. Component suppliers like Media Excel and Unified Streaming contribute by making this approach future-proof through standards-based products, continuous support and clearly defined roadmaps. When implementing a streaming solution today, operators have several requirements, a key one being maximum availability through redundancy, which is one of Media Excel's unique selling points. They will also want robustness, which requires a flexible optimized streaming architecture and is where Unified Streaming comes in. There is also the need to be fast to market through simplicity and support for open standards so that new components can be added as easily as possible.

(Pre) **integration** of legacy systems with 3rd party components is a key consideration. Especially when multiple vendors are used, an integration project must be thoroughly planned and executed. The cost and complexity of the integration will depend on the independence of the systems along with the quality and standardization of the specified interfaces. Integration should not impose significant costs to build the service since it is likely in any case that extra costs will arise later on in the project life cycle. Note that the different domains vary significantly in their maturity as far as standardization is concerned. So for example integration of encoding is relatively straightforward but this would not be the case for a recommendation engine, which is less well standardized with vendors seeking to differentiate themselves through novel proprietary innovations.

Integration projects are inversely proportional in complexity to the level of completeness of an offering. However complexity also depends on the vendors involved in the project and can be reduced when all participants in the ecosystem are equally committed to interoperability so that best-in-class components can always be swapped in or out.

In the case of live OTT streaming operators need to check how many of the five high-level components are already pre-integrated:

1. The CDN
2. An Origin Server
3. The live feed ingest
4. The hosting of DRM servers
5. Off-the-shelf Client applications for mobile devices, connected TVs, PC/MAC, game consoles

A clear distribution of responsibilities is key for an ecosystem to be effective. But its size is also a good indicator of how future-proof it is. It needs breadth so that for example Media Excel boasts an ecosystem of well over 50 technology partners across all domains. But it also needs depth, and here we can cite Unified Streaming with eight different DRM partners including EZDRM, BuyDRM, castLabs, Verimatrix, Axinom, Conax, Irdeto and Vualto. Additionally, an ecosystem needs geographical spread, and on this count we find that Vualto is also an integration partner of Unified Streaming based in the UK, as is Vimond from Norway, Sad in Poland, Orca Productions Inc. operating out of Japan and QuickPlay (acquired by AT&T) based in the USA.



An ecosystem is also the best business approach

An ecosystem approach is best placed to address the diverse technical, business and user experience challenges for service providers, while helping unlock the opportunities presented by streaming.

Firstly the rate of change discussed previously entails greater risk-taking than before. Disruptive new technologies appear regularly in the online video space at a rate common to the mobile telephony world but unprecedented until recently in broadcast TV. Vendors are adapting and growing their offerings, but the effect can be that the resulting solutions fit well together at project launch but then come to be unwieldy with too much overlap a few years later. The potential for failure grows too as competitive pressure shortens time-to-market and spurs risk taking. With a healthy ecosystem in place, components can be tried and if they don't work out, for technical, market or commercial reasons, they can just as easily be swapped out. This flexibility is the key to risk mitigation, as well as for accelerating time to market and exploiting the opportunities.

Flexibility and agility also imply being able to recognize mistakes and identify the right solution as fast and cheaply as possible. For some service providers this may require significant change management within a corporate culture that is not yet geared to the new mind-set. Working within the supplier ecosystem with a lead integrator that understands this can ensure that mistakes can be addressed at the time rather than accumulating and leading to ultimate project failure.

Flexibility and agility also imply being able to recognize mistakes

Pre-integration of the components is also important to reduce the complexities and risks associated with deployment. Operators are more and more reluctant to pay for integration costs in any case and will only accept as non-recurring engineering costs those involved with integrating their own legacy systems.

Arqiva, the UK's terrestrial infrastructure provider, has witnessed the business benefits of a flexible ecosystem with Media Excel's HERO encoders, deployed by Garland Partners, ensuring flexible and robust IP streaming at broadcast quality and yet highly competitive cost per channel. The high density HERO systems encode a variety of TV sources and output them as Microsoft Smooth Streaming video, while embedding time-sensitive data into all output streams.

How the OTT streaming market might evolve

OTT streaming has come a long way in the two decades of its existence, but remains in a state of flux with many challenges still being resolved in terms of scalability, flexibility, agility and security. Here are some of the hot topics we anticipate will preoccupy vendors and operators over the coming few years and for which this paper's two sponsors, USP and Media Excel, believe they are well prepared.

- Organizational impacts of the drive towards software, virtualization and the Cloud.
- This is about agility. The ability to host the key components of a system on different infrastructure poses technical and business challenges. Since many critical parts of the delivery chain will be hosted elsewhere, a new generation of real-time monitoring tools is needed to ensure conformance to the new SLAs that will be required. Operators will turn to leading integrators who are expert at large scale OTT integration to coordinate the end to end service delivery.
- UHD has become the buzzword encompassing several aspects of the next generation of video services, namely higher frame rates and screen resolutions, wider color palette and greater contrast and next generation audio.
- The gradual merging of live and On-demand content has already started. Depending on which study we believe anywhere between 10% and 30% of viewing is no longer linear. We believe linear content will become restricted mostly to news, entertainment events and live sports over time, but meanwhile from an OTT platform perspective the uncertainty isn't that hard to manage. Indeed Media Excel's Hero Live and Hero File are distinct products, but part of the same solution so that client devices can seamlessly switch between linear and on-demand streams.

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The importance of high availability

As OTT streaming comes of age as a primary distribution mechanism inevitably the spotlight falls increasingly on high availability. This is most important for live streaming, whether these are 24x7 linear services or high-profile single events in sport or entertainment. In all these cases the stakes are high with operators under pressure to strike a balance between operational efficiency and service uptime. The tension between these conflicting requirements is witnessed in the growing use of high-density encoding solutions, which increases operational efficiency but can also compromise availability by presenting a single point of failure with all the eggs in one basket.

Fortunately both Media Excel and Unified Streaming have long been aware of this potential conflict and appreciate that there is no real value for a high-density encoding solution that does not clearly address high-availability. The Media Excel architecture meets this challenge by ensuring full isolation between live services deployed on the same platform. This enables the failover automation to migrate individual services rather than the entire platform, which would impair the uptime of all hosted services.

7.1 High Availability by Design

It is essential to take account up front of each operator's unique technical circumstances and business requirements when designing for high availability. If the high-availability features are bolted on later and separately from the encoding solution itself, inevitably it will mask failures or mitigate them only as they occur rather than prevent or truly contain them. Media Excel's product line has been designed with high-availability in mind from day one and has already delivered 7 nines live streaming solutions to more than 12 million pay TV subscribers even in its first year of deployment, which equates to just 3 seconds of down time a year.

Seven nines availability (99,99999%) is achieved with a fully redundant 1+1 configuration where critical components such as power supplies and disk drives are all duplicated with both actively participating during normal operation. In designing high-availability it is

important that handover between different components be seamless. Unified Streaming recommends configuring the encoder to use (wall-clock) time in UTC format for live ingest. This is an informative mapping of the ingested media to a known clock (e.g. the same clock that is used by the EPG).

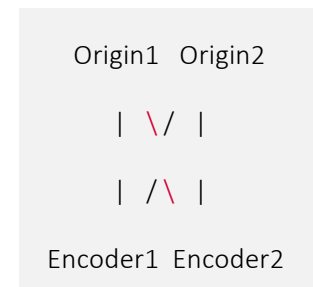
For many operations five nines availability will be more than sufficient as this still equates to just five minutes at most downtime a year on average. We can achieve that with N+1 redundancy, where N is some number greater than 1. In this case there are N+1 active components with one of them acting as the hot standby for the other N. This still delivers very high availability but less than 1+1 because there is an increased chance of two components failing at the same time which would then bring the system down.

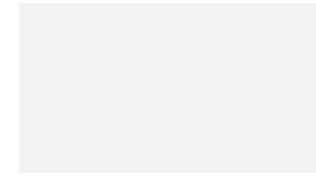
An origin server can host many channels, or by using recent technologies like Docker a channel can have its own origin, allowing for finer grained control, redundancy and independence. Australia’s Foxtel recently selected such a solution from Unified Streaming. Both live and VOD origins are “dockerized”, meaning that they are wrapped up in a common software container so that they run in the same way in all operating environments. This ensures faster operational control of the infrastructure and seamless integration into the workflow. The containers isolate applications and provide added protection.

7.2. Redundancy

For on-site, virtual, and cloud deployments, support for multiple levels of redundancy is critical. From the operating system and chassis to upstream and downstream service quality monitoring, a carrier-grade transcoding platform needs to leave nothing unchecked prior to actual deployment. Media Excel’s product line has been designed with carrier grade hardware redundancy as well as evergreen features to compensate for upstream and downstream service disruptions. This has contributed to its success with major Telcos and pay TV operators worldwide.

For true redundancy, redundant encoders need to feed redundant origin servers with mutual failover between the two, which Media Excel supports.





7.3. Heuristics and Monitoring

Failover requires more than just underlying redundancy but also intelligence in order to detect, respond to and report faults. Such mechanisms now should be intrinsic to a good failover architecture, which should incorporate high-availability logic that constantly monitors the health of both input and output feeds rather than merely determining whether a service is running. It should then compare this feedback against thresholds defined by the operator. Media Excel's solutions are constantly probed to provide a comprehensive report on input and output parameters, which are then taken account of in real-time in the decision-making process. Those heuristics, which include rate fluctuation, frozen frames and packet loss, are also available to the operator and can be fine-tuned to match the SLA expectations of services on an individual or group basis.

Origin servers can be monitored on many levels, from within the OS to APIs, which the server can make available to the operator's monitoring infrastructure.

The live-to-VoD opportunity

The distinction between live and VoD is blurring with the growing use of functions like pause and resume, which gives operators an opportunity to increase stickiness and generate new revenues. Catch-up or re-start TV bring Live TV and VoD closer together and require the creation of clips and the removal of unwanted content such as advertisements. This requires careful planning and deployment, with a flexible platform that combines live and VoD within a single workflow to reduce both capital and operational costs while ensuring maximum agility for deploying new features. For future-proof deployments, Unified Streaming can already use HEVC in live to on-demand integration, but with a best-of-breed ecosystem any disruptive approaches incorporating new codecs can also be integrated. Broadly we can identify six categories of live to VoD services, all of which present opportunities either for enhancing customer satisfaction, creating new revenues, or both. These are:

nPVR, with the ability to record selected content in the cloud for later consumption with the option of almost indefinite retention.

Catch up for viewing of previously scheduled linear content at a time of the user's choosing within a defined time window.

Pause on live so that users can stop viewing and resume later.

Start over TV allowing users to rewind to the beginning of a linear broadcast while it is actually showing. It differs from catch-up in that there is the option of reverting to the live or linear broadcast, since the content is still being played out within a schedule.

Delay TV, which is more for the operator than consumer, allowing broadcasts to be synchronized across multiple time zones. This may mean that subscribers in some regions see the content live while for others it is delayed, or it may all be held back.

Multi-screen options, which are a superset of the others as this includes all of them. For example a user might pause live on the main TV and resume viewing later on a tablet. Alternatively a user might hit the record button on a smartphone and view later on a laptop.

But multiscreen also brings unique opportunities in companion mode when a connected device is used in conjunction with the big screen TV. For example somebody on a smartphone could view a replay of a goal in a football match without interrupting the main transmission on the big screen.

Flexibility is required to enable these facilities, especially on an international basis. For example regulations over catch-up TV and nPVR vary by market, sometimes requiring technological workarounds in order to ensure compliance. In Switzerland, pay TV operators can offer catch-up content only for seven days after a programme is broadcast, but in other markets it is a month. There are also differences between content owners, with some allowing pay TV operators to include content through an STB-based catch-up TV service, but not through second screens, since the latter may compete with their own apps. The ecosystem needs to be able to embrace all these differences over regulations and rights.

There are also numerous technical factors that need to be handled, some of which relate directly to the associated opportunities. One such challenge lies in implementing ad insertion, where catch-up TV presents an excellent opportunity to monetise content through targeted advertising. Such opportunities can be maximized by also taking account of the device being used at the time and playing a different ad depending on whether this is a TV, tablet, laptop or smartphone. This can be important given for example that smartphones tend to be used by individuals, while TVs are more likely to be shared, with tablets and laptops somewhere in between.

Some of the processes involved have been documented by Encompass for its client, the UK broadcaster Channel 5, using Media Excel's HERO encoding platform. The platform generates a source video file that has been live captured to file from Encompass' London transmission control room. This file might contain advertisements, bars and tone, black, clocks, and other control items that should not be delivered to consumers. This file is saved as a .ts archive before being ingested into the editing suite and the source file is then transcoded to 15 unique delivery platforms. For the recent series of Big Brother, Encompass made substantial use of the HERO encoders providing live capture (file to VOD platform) as well as IP simulcast on 3X channels as multi-bitrate RTMP and HLS streams.

In the Live-to-VoD arena, time-to-view is critical for TV operators to remain competitive

In the Live-to-VoD arena, time-to-view is critical for TV operators to remain competitive and France TV for example recently [announced](#) that after bringing processes in house, all on-demand content is now available within 15 minutes of end of broadcast if not much sooner.

In the Netherlands, RTL has been particularly innovative in the Dutch consumer and advertising markets. Multiple locations acquire, process and broadcast content for RTL Nederland. The operator has implemented a multi-site HD live to VoD workflow with end-to-end delay under a minute, again based on HERO encoders that ingest HD Live content over SDI and Unified Streaming's Unified Capture recording and automating content replacement. The operation is particularly fast as only first and last chunks are encoded. Unified Capture (the tool) stitches clips together based on a playlist with timestamps from frame-accurate EPG of the play-out system. This itself is done frame accurately. The setup is designed to scale by simply adding more capture nodes to the capture farm: the queue manager can then start more jobs. In this way adding new channels with catch-up scales by adding low cost i7 nodes ('bricks').

Key takeaways

- OTT live streaming, especially premium sports, will be the fastest growing sector in pay TV over the next two years
- Quality of experience with **ease of use** must be delivered cost-effectively and securely for success in live OTT
- A flexible ecosystem allowing best of breed components to be deployed provides the best hope of meeting criteria for success in live OTT in an environment that is still rapidly changing
- Viewer loyalty and monetization can be enhanced by eliminating barriers between live and VoD with time to view as short as possible

