Practical Steps to Migrate TV Broadcast to Modern Streaming

By Broadpeak and Verimatrix

M-ABR advances video head-end processing and content security towards unified and future-proof formats, putting MVPDs on a par with pure play OTT providers.

Competitive pressures are intensifying for pay tv

In response to competitive pressures from established Pay-TV operators and aggressive over-the-top (OTT) entrants, service providers with a managed network have had to evolve from yesterday's "appointment TV" to a "TV everywhere" (TVE) experience that is increasingly becoming the norm. Not only millennials, but all subscribers want to get the maximum enjoyment out of a Pay-TV subscription, which means being able to watch their favourite programming at any time, any place and on any device.

As a result of the intensifying competition, Pay-TV subscriber numbers are declining in many parts of the world. In the United States, the fourth quarter of 2018 was the worst ever for traditional Pay-TV operators (known as multichannel video programming distributors, MVPD), as nearly 1.1 million homes cut the cord, which pushed the full-year decline to four million, according to research firm SNL Kagan's Q1 2019 analysis, covering the cable, direct broadcast satellite (DBS) and telco multichannel sectors.

The negative trend is expected to continue unless MVPDs take drastic action. This is an increasingly serious challenge since many cord cutters and potential new subscribers are choosing lower-cost services from virtual MVPDs. According to SNL Kagan, virtual multichannel subscriptions from services such as Sling TV, DirecTV Now, Hulu with Live TV, YouTube TV and PlayStation Vue together gained an estimated 2.1 million subs in the first nine months of 2018, compared to a decline of 2.8 million in the traditional MVPD segment.

Some traditional MVPDs are now also acting as vMVPDs, and content providers such as Disney are jumping onto the direct-to-consumer (DTC) bandwagon. This, of course, allows them to own the relationship directly with the consumer and gain access to cloud-based video analytics data. With delivery and subscriber behaviour insights, they can shorten the feedback loop not only on quality of service (QoS), but also on where to focus content creation to best align with subscriber consumption.

Progressive operators also understand that subscribers will find the content they want in any way possible. Hence operators are increasingly embracing subscription VOD (SVOD) services, such as Netflix, which otherwise would be competitors, and incorporating them as part of the overall operator-branded service and experience. These services are even integrated into the set-top remote control and operator-branded programme guide.

Nevertheless, operators still control linear channels, along with TVE features such as pause, trick play start over and catch-up. Linear TV comes with very high expectations on quality of experience (QoE), inherited from broadcast standards, and typically relies on dedicated video infrastructure. Since this infrastructure belongs to the operators, it is much easier for them to secure this level of QoE than for pure OTT players that can only rely on the best-effort scheme of the public internet. Linear – and live – content remains very interesting as it is, by far, the largest revenue generator for operators and poses a great opportunity to differentiate.

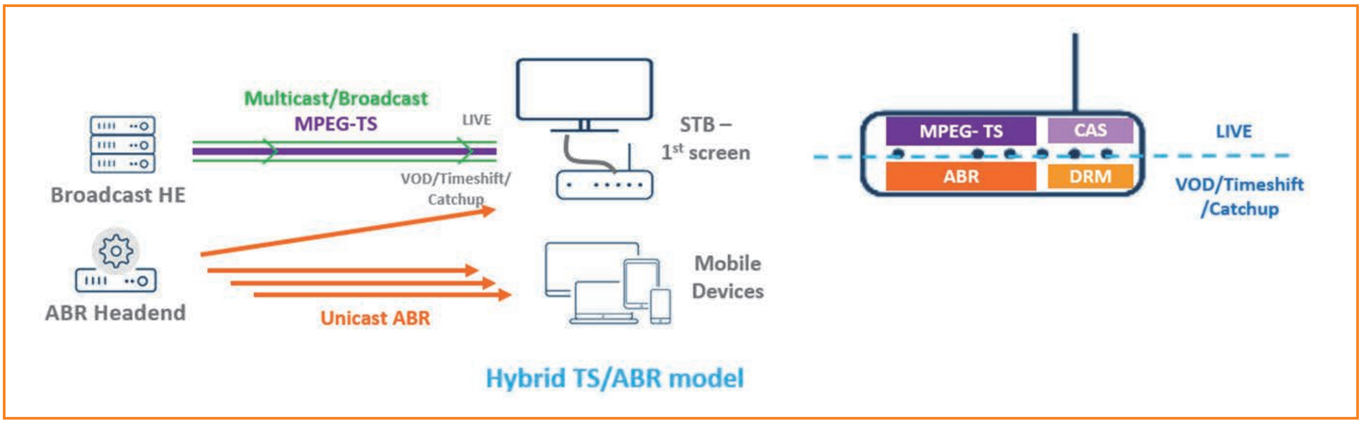
The core of MVPD competitiveness is a combination of offering the right content at the right place and time, while maintaining a perfect distribution of traditional linear channels and with the highest service reliability across all screens. Optimising network delivery is becoming increasingly important to provide the highest QoE everywhere.

Limitations of hybrid network content delivery

To fulfill the promise of TVE and provide access to online services in general, MVPDs have adopted a hybrid network delivery approach:

- **Broadcast/multicast** - Linear content for the primary screen, including live events, takes advantage of the operator's fixed and managed one-to-everybody (broadcast) or one-to-many (multicast) network delivery, and offers the ability to provide a predetermined prioritisation in the network. This might be an RF-based broadcast infrastructure, such as QAM transmission for cable operators, or traditional IPTV service based on MPEG-TS over IP multicast, targeting the primary screen through a set-top box.
- **IP/HTTP** - On-demand content (including VOD, catch-up TV, cloud PVR) for the primary screen is delivered in unicast mode over IP-based broadband networks, typically over the operator's content delivery networks (CDN) made from caching and streaming servers deployed in its infrastructure, with an agreed prioritisation. The final ("last mile") transmission is over the operator's broadband infrastructure which, in the case of cable operators, will typically involve DOCSIS-based unicast delivery. Again, the content is received through a set-top box. Live and on-demand content for tablets, smartphones, connected TVs and PCs inside the home network is delivered through the HTTP network, the same one that carries internet data. The delivery takes place in unicast, even for live content where a massive audience is watching the same content at the same time.

Content delivered over the managed network is transmitted via the old, but well-established, MPEG-2 transport stream (TS) format. In contrast, video to multiscreen is typically transported using HTTP protocols designed for unmanaged IP networks. Today, that means using adaptive bitrate (ABR) streaming protocols, especially HTTP Live Streaming (HLS) and the industry standard MPEG-DASH which, with its "best effort" delivery characteristics, will automatically adapt the video quality to each client device and to instant network conditions and provide the greatest user flexibility in choosing where and when to watch.



While all on-demand and multiscreen video content is now distributed in ABR format, live TV on the main screen is still using legacy MPEG-TS broadcast, implying dual operation and a complex mix of both technologies in the set-top box

> Unicasting of linear services to secondary devices (i.e. anything but the multicast-enabled IP set-top box) becomes a serious bandwidth resource issue.

This situation is, however, not ideal because mixing two different technologies in the set-top box is complex to implement and maintain. Also, some operators worry that TS might not be future-proof as it may impede their platform from getting the latest benefits that ABR technology brings to mobile devices, such as content personalisation and targeted advertising.

OTT business model versus ABR technology

It is important to distinguish between OTT services and ABR-based streaming because sometimes they get mixed up and are, perhaps inadvertently, used as synonyms. OTT video delivery usually refers to a virtual MVPD, which may or may not be a competitor to the managed network operator. The word 'virtual' denotes an operator that has chosen not to invest in building out its own network infrastructure, but rather piggybacks on a combination of CDN services (such as Akamai, Limelight, Amazon CloudFront) and, for the last mile, uses broadband networks established and managed by the incumbent network operator.

OTT is therefore a business model more than a technology, and this category is represented by companies such as Netflix and Hulu, but also by content providers such as HBO offering DTC services.

ABR, on the other hand, is a technology – a protocol – for streaming content, originally intended for delivery over unmanaged networks, without direct QoS control by the entity originating the video service. ABR protocols are optimised to deliver streams with bitrates suitable for different screen sizes, from mere thumbnails up to full Ultra HD/4K, transmitted over unmanaged networks with variable bandwidth and service levels. ABR is also used by MVPDs to deliver content over their own networks for interactive services to the home.

Linear/live content to secondary screens

The success of ABR protocols, which are based on HTTP/TCP unicast, is also leading to a problem of its own with users increasingly choosing to watch live/linear services on secondary screens. Moreover, with ubiquitous IP video streaming devices such as Roku, Fire TV and Apple TV now outputting high-quality video to the primary screen, this clogs up DOCSIS and similar IP-based infrastructures, when multicast is not enabled. Even for cable and IPTV operators using broadcast or multicast to the primary screen, unicasting of linear services to secondary devices (i.e. anything but the multicast-enabled IP set-top box) becomes a serious bandwidth resource issue.

This is further compounded by the rapid growth in high-speed data services, which competes with IP video for the available spectrum and is always limited by definition — regardless of how much broadband throughput increases on a regular basis with advancements in network technology.

Therefore, the key objective for operators is not only to make the transition to all-IP video, but to also gain the ability to deliver managed linear/live services to any screen, while minimising the total bandwidth required and operational investments.

For live video delivery to multiple screens, operators must address two issues:

- **Scalability:** Viewing devices can only receive ABR unicast content, which means that 1M people watching the same content will imply 1M bandwidth resources used in the network. This is simply not scalable, especially for the main screens where the bandwidth at stake can reach 20Mbps for 4K HDR content.
- **Latency:** HTTP is 'bursty' and best effort protocol implies buffering in the player to guarantee a smooth playout without service interruption due to rebuffering. This leads to a delay of several tens of seconds between the live video watched on these screens compared to the same live event watched on a traditional IPTV or cable TV network, where MPEG-2 TS does not require more than a couple of seconds of buffering.

Video head-end and content security duplications

For MVPDs, the immediate consequence of using two different transport formats, i.e. MPEG-2 TS and ABR for set-top boxes and ABR for multiscreen, is the duplication of video head-end set-ups. One set of encoders and multiplexers is dedicated to the MPEG-2 TS content, and another set of encoders, packagers and streamers is required for the ABR-delivered content.

The same is true for content security. One system is needed for the managed network with TS format, usually conditional access (CA) whether smart card-based or cardless, and another digital rights management (DRM) system is needed for the ABR transported content. This is still true even if the content security system is offered through a unified head-end because the content security requirements are unique for each delivery network type.

So, the question arises whether it is possible to blend and unify the best characteristics of a managed network with ABR-based delivery. Should MVPDs abolish their owned-and-operated network infrastructure and transition everything to ABR service delivery? Or is there a way to unify the transport protocols for both MPEG-2 TS and ABR networks so that a single video and content security head-end can serve both? Can MVPDs utilise their managed networks more efficiently by moving away from the MPEG-2 TS format? How can MVPDs augment their existing head-end through integration with a cloud-based SaaS for DRM and analytics?

Two networks – one transport protocol = M-ABR

First of all, let's remember that managed network operators have one big advantage; control. They control their networks, content prioritisation and they inherently provide more reliable content delivery compared to unmanaged networks.

Secondly, for operators, multicasting is a method not usually associated with ABR protocols, as it has really only been used for MPEG-TS format streaming.

Marrying two previously incompatible, but fundamental, network technologies – multicast and ABR – truly brings forth the best of both worlds. ABR protocols provide the best possible QoE for any given device screen resolution, processing power and available bandwidth, and multicasting brings ultimate bandwidth efficiency.

The resulting technology is called multicast ABR (M-ABR), also sometimes referred to as multicast-assisted ABR. IPTV DASH is another term to describe this concept since it brings the benefits of the MPEG- DASH standard to managed IPTV networks.

ABR is also being used to deliver content to the primary TV screen represented by next-gen IP-based set-tops. The purpose of M-ABR technology is to enable all subscriber devices in the home to be ABR-based and to leverage the bandwidth efficiencies of IP multicast for linear/live content delivery.

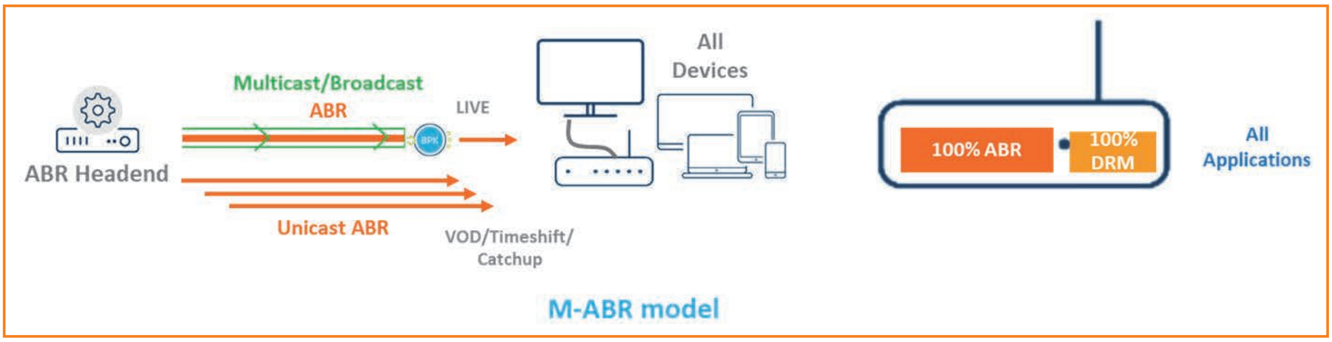
Thus, by unifying the core streaming protocol for all screens, a single video and content security head-end can be established. This allows for resource optimisation that is otherwise not possible with the separate head-ends, as mentioned earlier.

The result is a merger of the worlds of traditional TV and connected devices that capitalises on their respective strengths while eliminating their shortcomings. M-ABR enables the delivery of managed linear/live services to any screen, while minimising the total bandwidth required. DRM applies to both live and on-demand content and, by using appropriate integration of a cloud-based solution to manage the relationship of native DRMs with device compatibility, it does not impact head-end expansion and the integration work for the operator is greatly simplified.

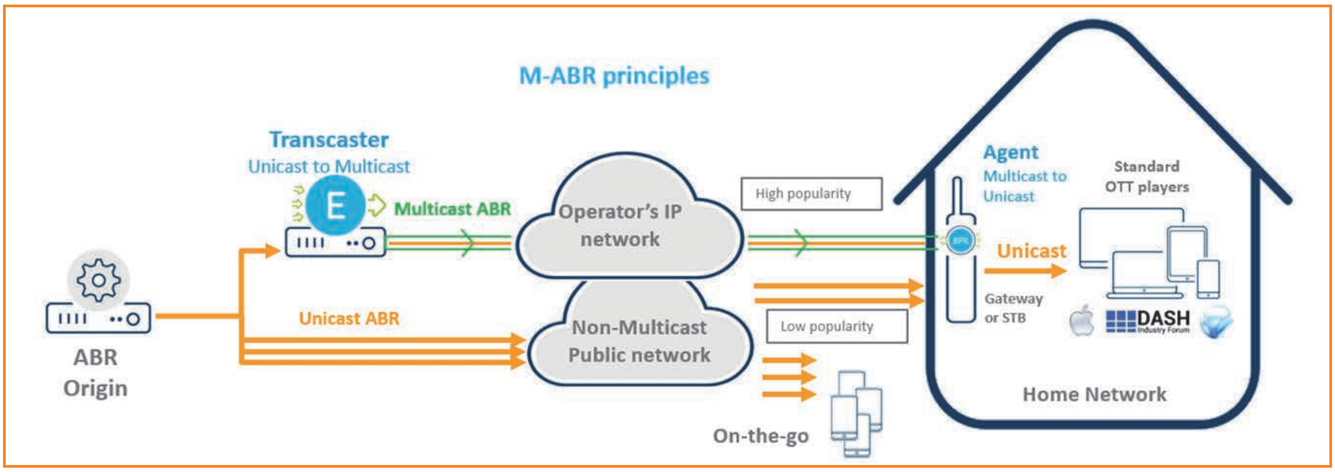
Content type determines delivery method

It is important to identify which type of linear content is to produce a high number of simultaneous viewings, like a premium league game. The concurrent audience demand will determine the delivery method i.e. whether multicasting or unicasting.

Incidentally, this is also an area where video analytics becomes key to determining the popularity and consumption patterns of content. Fortunately in this scenario, M-ABR comes to the rescue automatically.



Carrying ABR over multicast throughout the network ensures the same quality for Live as broadcast, making it possible for all applications and devices to use the same format and allowing a simpler, cheaper and more future-proof system



How M-ABR works

To realise a unified IP-based video delivery over a cable or IPTV network, an M-ABR architecture has been defined to take ABR video stream delivery to a higher level of efficiency. M-ABR is a complement to ABR-based linear TV by compensating for the rapid growth in bandwidth demand when introducing next-gen IP set-tops which support the primary TV screen.

The M-ABR technology relies on two main components:

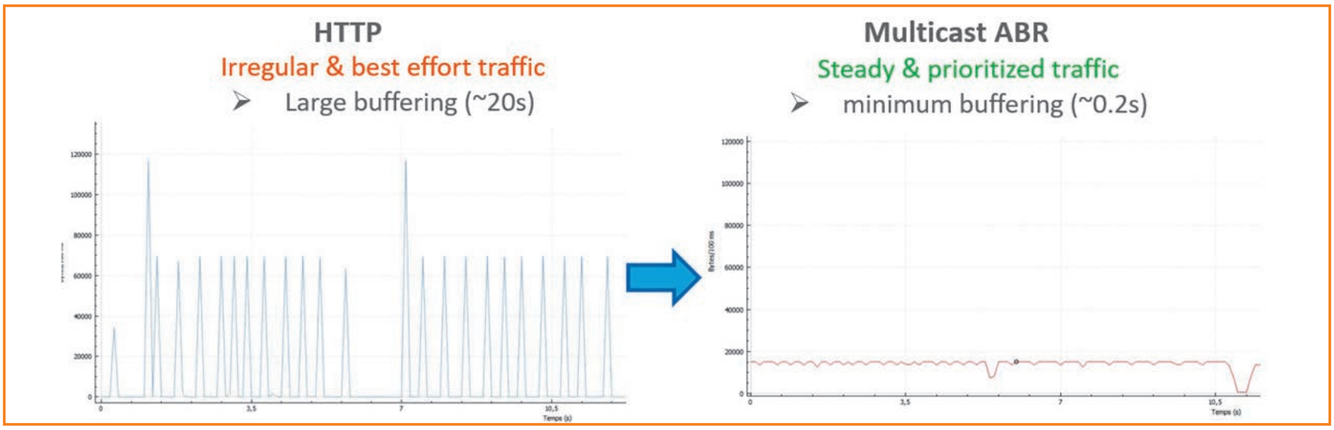
- Transcaster server located after the origin packager. It takes multi-layer packaged content in unicast at the input and encapsulates it in multicast before sending it through the operator's network.
- Multicast to unicast agent can be located in the home gateway or set-top of the end-user, and converts the multicast back into unicast so that it can be delivered seamlessly to the viewer's device, benefitting from the full range of ABR properties

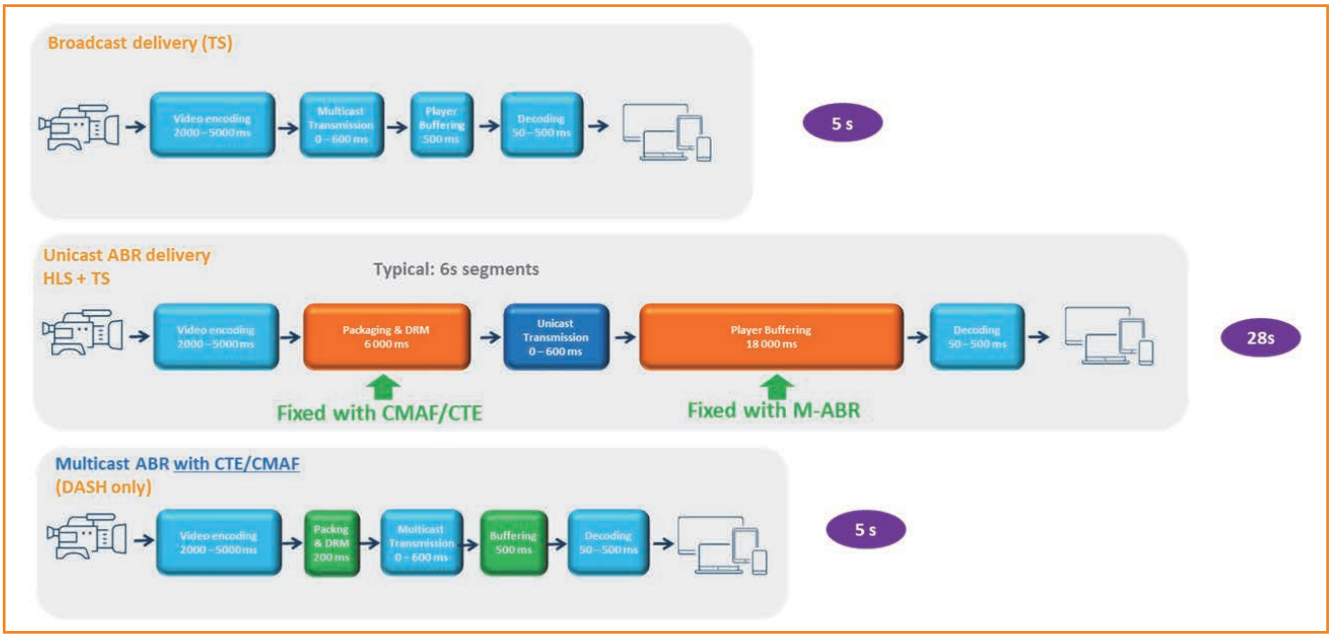
Latency

HTTP protocols suffer from one major drawback regarding live content delivery compared to a managed network, which is referred to as latency and usually measured in seconds. The typical illustration compares two neighbours watching a live game, one offered via a broadcast service over a managed network and the other through HTTP-based streaming. Suddenly, the streaming viewer hears his neighbour shouting with excitement because he is watching the game in real-time using a broadcast service, whereas the streaming service may be lagging 30-60 seconds behind. There are now technologies that can address this and enable streaming delivery with latency that is similar to broadcasting and IPTV.

By itself, the usage of M-ABR creates network conditions that allow the reduction of buffering in the player without impacting QoE. The traffic is brought from an unmanaged unicast HTTP network to a managed multicast network that is much more stable and has guaranteed resources. This means that there is no need to buffer more seconds of video than with traditional IPTV or cable TV.

A second constraint explaining the longer latency observed in HTTP streaming comes from the fact that a live stream is fractioned into rather long successive segments (typically two to six seconds). In the common implementation, these successive segments have to be downloaded entirely at each stage of the delivery chain before they are made available to the entity





downstream. This has a significant impact on latency, in particular at the level of the packager and at the level of the player.

To reduce the latency further, it is therefore recommended to use MPEG Common Media Application Format (CMAF) combined with HTTP chunked transfer encoding (CTE). Both technologies follow the same principle, which is basically to subdivide these segments into much smaller entities, respectively at the video and at the transport level. This allows the dispatch of video segments while they are being processed, without waiting for each step to be completed.

Combining both M-ABR and CMAF/CTE chunking technologies enables these two constraints to be lifted and offers the possibility of deploying full ABR systems where latency is as good as broadcast. This has a great impact as, up to now, the extra latency induced by ABR streaming was considered too big of a regression to migrate live distribution from MPEG-TS to ABR format.

Practical migration strategies to M-ABR

For MVPDs, M-ABR brings the benefits of OTT functionality and managed networks together. The migration path and dynamics between them are key to a successful evolution. The core migration strategies include:

- **Infrastructure**

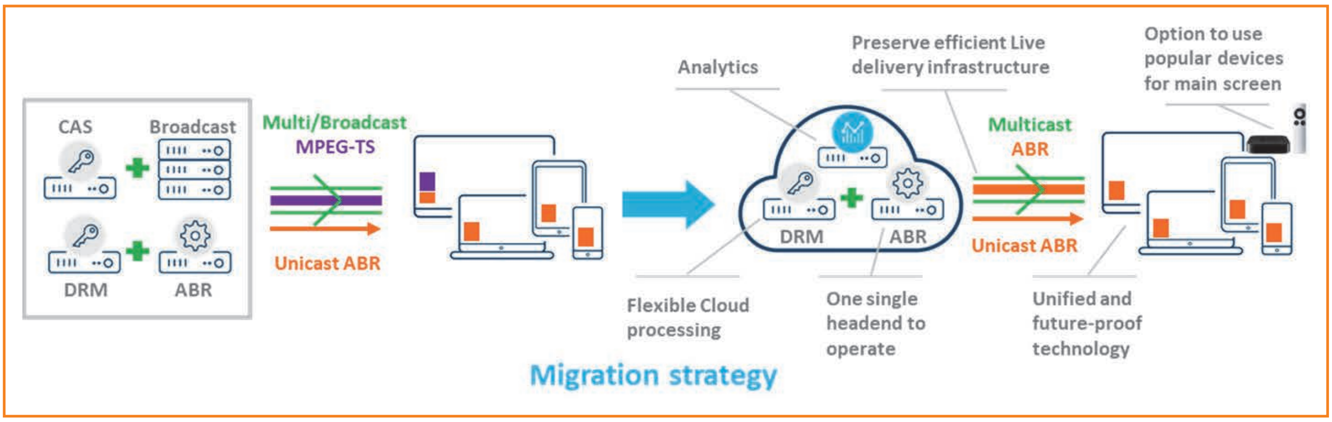
Re-use multicast infrastructure, which doesn't suffer from the OTT/internet TV issues previously mentioned, but with ABR streaming format instead of TS inside, balancing multicast ABR for linear/live services with unicast.

- **Receivers**

Progressively migrate the deployed set-top boxes to support ABR streaming formats (HLS and DASH) and corresponding encryption models.

- **Content security**

The evolution of a CA head-end can be achieved through integration with a cloud-based CA/DRM security solution, such as the Verimatrix Secure Cloud, avoiding substantial



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CAPEX investment and leveraging the benefits of scalable capacity as driven by consumer demand automatically.

- **Retail devices**

Encourage use of consumer-purchased retail ABR devices.

- **Head-end**

Use the same ABR platform to feed not only mobile devices but also the ABR-enabled set-tops, gradually phasing out MPEG-TS format-> unified operation, which equates to simpler, lower OPEX vs operating hybrid OTT/IPTV-TS. This approach also helps mitigate costly device transition from legacy models and provides support for consumers who are bringing their own devices.

- **Cloud**

Upgrade all processes first to be cloud-friendly, so that they can progressively and seamlessly be transferred to the cloud at the pace that is relevant for each operator, which is applicable to content security and video analytics, as well as the head-end.

Benefits of migration to M-ABR

Migration from MPEG-2 TS to M-ABR provides such tangible benefits that the effort, while by no means trivial, will be proven worth it, including:

- A unified transport format across all types of networks.
- A single video processing head-end, possibly cloud-based.
- A single content security system supporting multiple DRMs, preferably cloud-based.
- Current set-top boxes are gradually replaced by ABR-capable receivers using a “cap-and-grow” approach.
- Lower set-top customisation costs with a focus on the operator-branded app and interface.
- Greater flexibility of viewers’ choice of retail CE devices, such as Apple TV, Android TV or Amazon Firestick, that will enhance the “stickiness” of the service and reduce churn.
- Choice and cost of client devices is shifted to the consumers, who can decide for themselves which kind of devices are right.
- Advanced QoE/QoS analytics across networks enhances customer satisfaction and lowers OPEX.
- Advantages of cloud-based head-end and processing.
- Advantages of cloud-based video analytics data.

On-prem or cloud-based video head-end?

This is an opportune time for operators to consider where and how such a unified video and content security head-end should be established. This consideration boils down to the question of whether to build yet another on-prem system, with its CAPEX and OPEX consequences, or perhaps choose a virtualised cloud instance.

In other words, should an operator build and manage a new video and content security head-end in its own and dedicated network operation centre (NOC), requiring staffing to maintain a reliable 24/7/365 operation? Or should it be outsourced to a cloud-based service provider that will instead allow the operator to focus on service differentiation and customer care, while not expending resources on the actual system operation?

Advantages of cloud-based SaaS solutions

A cloud-based and comprehensive software-as-a-service (SaaS) infrastructure enables flexible access to video processing and baseline content security solutions with subscription-based models providing a range of advantages and benefits:

- Simple and scalable SaaS subscription pricing models.
- Rapidly scale up to meet subscriber growth and event bursts.
- No on-premise hardware to purchase, configure and maintain.

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- Rapid deployment, reduced total cost of ownership (TCO) and increased agility.
- Accelerate time to market for new services.

A cloud-based multi-DRM solution enables MVPDs to deploy multi-screen services with the assurance that their cloud-hosted SaaS solutions will adapt to studio-required changes in security regimes while the advanced analytics tools help to maximise service revenue and ROI. As a convenient and cost-effective alternative to on-premise systems, it can also support of a vast range of pre-integrations with leading ecosystem partners.

Transitioning to cloud-based models would not only reduce both NOC CAPEX and OPEX, but also address other pain points while allowing the operator to retain full control of its service offer and subscriber relationships.

Conclusion

OTT streaming and traditional TV are rapidly converging into a singular economy, with powerful online actors that have dramatically shaken the well-established landscape. More than ever, it is vital for MVPDs to break free of the constraints of legacy technologies and to empower their systems to innovate as fast as newcomers, while leveraging their long-established strengths.

Broadpeak and Verimatrix have identified multicast-ABR distribution as a key technology essential for MVPDs who are embracing the cloud migration both for head-end processing and content security. They can evolve their head-end infrastructure by allowing for a controlled cloud migration without increasing on-premise CAPEX, while taking advantage of OPEX benefits.

M-ABR advances video head-end processing and content security towards unified and future-proof formats, putting MVPDs on par with pure play OTT providers. M-ABR preserves the efficiencies of a one-to-many distribution, which retains the key strategic advantage and value of high-quality live video.

Visit **https://broadpeak.tv** and **www.verimatrix.com** for further details.