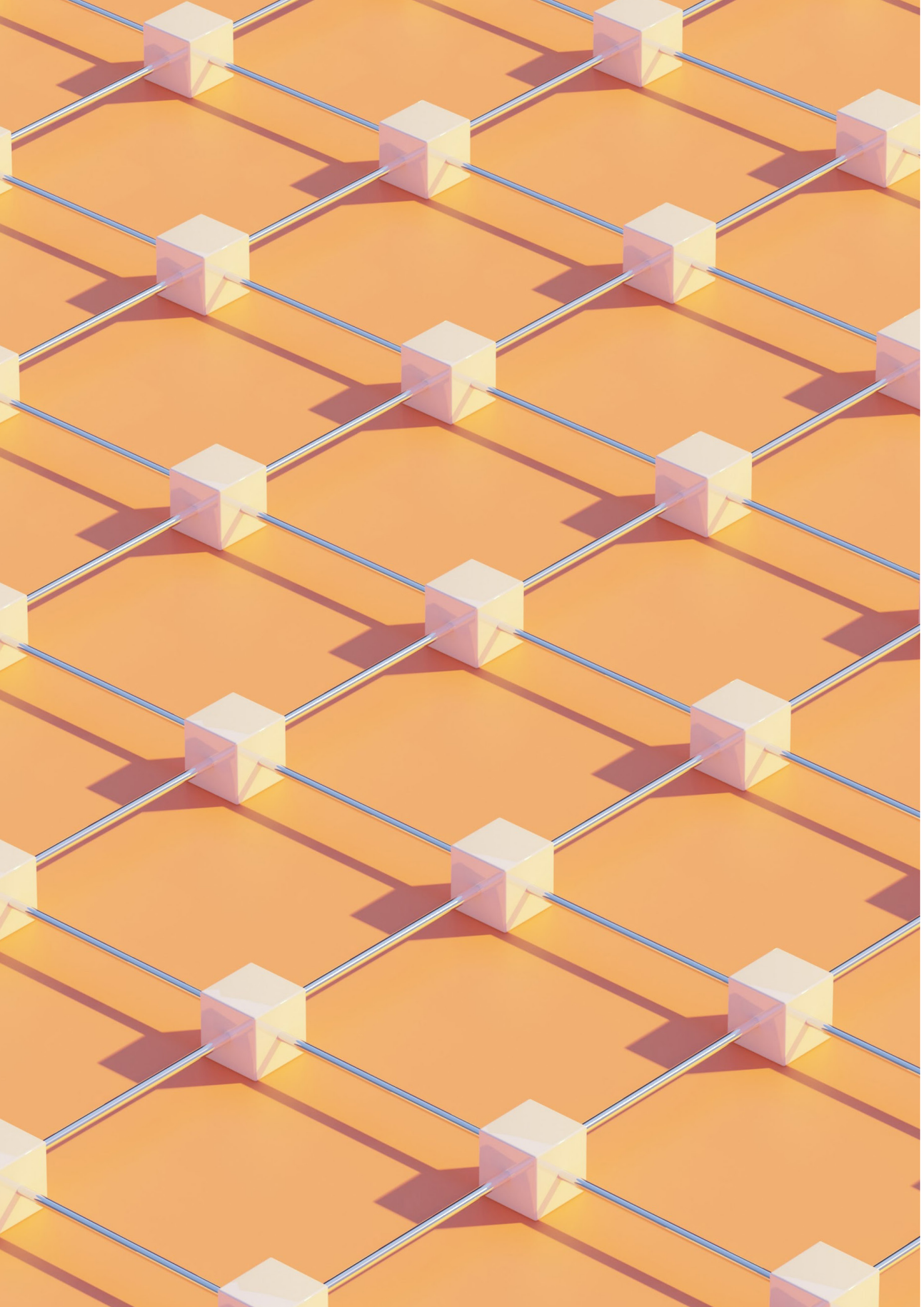

BROADCAST
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Connecting IT to Broadcast

# The Big Guide To OTT

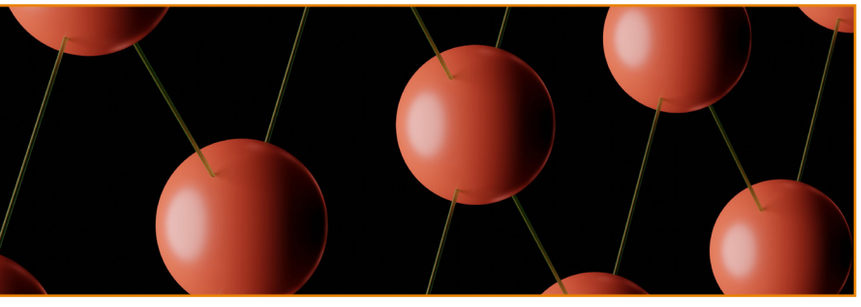
# Part 1 - Back To The Beginning

*A Themed Content Collection from The Broadcast Bridge*

Themed Content Collection

# Part 1 Contents









# Series Overview

*By Paul Martin. The Broadcast Bridge.*

***The Big Guide To OTT provides deep insights into the technology that is enabling a new media industry.***

As OTT delivery grows, driven by both consumer demand and content provider strategy, there are many adjustments to manage. They include new production approaches, scaling content distribution, personalising, protecting, and monetising content, and assuring audience QoE.

Content providers are delivering a mix of live, linear, and on-demand content. Business models are blending - subscription with advertising and direct-to-consumer with service aggregation. The internet-enabled OTT delivery model is driving the media industry through a giant transformation.

There are many broadcast disciplines to leverage in OTT – the concept of "broadcast-grade streaming" means streaming should match broadcast's capacity for highly consistent, highly scalable delivery of high-resolution content at low latency. There are also new disciplines for content providers to embrace, like delivering highly personalized content and building new relationships with consumers and ISPs.

The OTT technology domain builds on core broadcast distribution disciplines and adapts them to internet-based delivery. New contribution methods, ultra-low latency encoding, and high speed broadband streaming, could mean that 'streaming-grade' will become a new gold standard for content delivery. But the fixed and mobile broadband networks we rely on, and the myriad of devices we use, mean that we need to work differently to manage content accessibility and quality. So while the content may be largely the same, there are significant differences to manage between the worlds of OTT and OTA.

**The Big Guide To OTT** is a multi-part series. Each part tackles a different theme and there are three or more articles per part.

*Available now:*

**Back To The Beginning**

*New Parts coming in 2023:*

**OTT Content Origination**

**Broadcast Grade Streaming**

**Customer Experience (CX)**

**The Business Impact Of QoE**

**Monetization & ROI**

**Managing Latency**

**Internet Infrastructure**

**Content Delivery Networks (CDN)**

**Assuring Viewer QoE**

**Streaming Sustainability**

# The Principles & Terminology Of The OTT Ecosystem

*By Paul Martin.* *The Broadcast Bridge.*

***A description of the OTT Ecosystem from transmission to consumption, with discussion of the differences between push and pull systems, video distribution methods and the terminology of Live, Linear and Video On Demand TV.***

**OTT is becoming more and more prevalent in the world of video consumption. Some people would say that it will become the dominant form of video delivery in years to come as the underlying technologies expand, develop or mature, and consumer behaviour continues to revolve around convenience, flexibility and personalization. Recent OTT launches and refreshes from major media businesses like NBC, Disney, Warner Media, CBS, RAI, BBC, ITV, SRG and RTL show how important OTT is to their future.**

But to many people working in video production and distribution, especially those who have worked a long time in the Broadcast industry, the technical components used in OTT-based delivery are relatively unknown. Also, because OTT is still relatively new compared to other video distribution methods like terrestrial, satellite, cable and even telco's "IPTV", and it has disrupted the established broadcasting business models, long-held industry terminology is being used in new and different ways.

If the 2010s witnessed the fast-growing early childhood of OTT in the Media & Entertainment industry, the 2020s will see it develop and mature through its adolescent years. There are clear building blocks in place and some forward-looking visions of the future. Now is the right time for a comprehensive description of the technologies used in OTT that highlights the key functions and their technological evolution. This article provides an overview of the OTT ecosystem for anyone who needs to become more familiar and confident with how OTT works.

We need to start with a few definitions that will follow us as we talk about the OTT ecosystem.

## Live, Linear And Video-on-Demand

Since the introduction of OTT video services, the previously established world of video delivery by linear TV channels and Pay TV services has been disrupted and certain terms have become unclear. We will be using the following definitions when discussing OTT:

- Linear – scheduled content that can be live content or pre-recorded content.

- Live – scheduled or unscheduled content that is happening now. Live content can have certain sensitivities, like latency, that require special attention in OTT delivery.

- Video-on-Demand or VOD – unscheduled, file-based content, generally presented in some form of content library, that is available when requested.

## Distribution Methods

Video is delivered to end consumers over a variety of networks:

- Terrestrial – the oldest method of broadcasting, with RF signals transmitted to RF receivers (antennas) that connect directly to televisions.

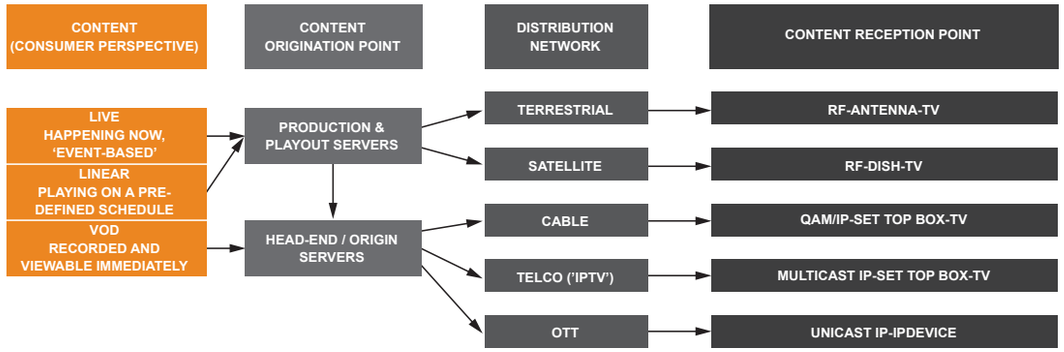



*Figure 1 – CDNs are more than just a high speed link between network peer points.*

- Streaming – the delivery of video in a continuous set of IP packets for consumption once sufficient packets are available on the consumer device.

- Progressive Download – the delivery of video over IP for consumption once enough content is stored in the local device.

- SVOD, TVOD, AVOD, and BVOD – different business models for VOD services. SVOD (Subscription-based), TVOD (Transaction-based, e.g., pay per view), AVOD (Advertising-supported), and BVOD (Broadcaster VOD services, often from public service broadcasters).

- Satellite – RF signals are transmitted to satellites in orbit around the earth and relayed to RF receivers (dishes) that connect into set-top-boxes and televisions. Signals can be encrypted if necessary.

- Cable – RF signals and/or IP signals are transmitted through fiber and coaxial cables to a set-top-box for a fully managed, closed network TV service.

- Telco "IPTV" – IP signals are transmitted through fiber and coaxial cables to a set-top-box for a fully managed, closed network TV service.

- OTT – IP signals are requested (pulled) and transmitted (pushed) through

fixed and mobile broadband networks ("broadband" is meant in its widest form to include 3G, 4G, 5G, ADSL, Fiber, etc.) to unmanaged IP-connected devices like mobile phones, tablets, computers, smart TVs and IP set-top-boxes. The network path is either partly managed or fully unmanaged for the video services it is supporting.

- Free to air and Pay-TV – two different business models that are independent of the network type used to deliver the video.

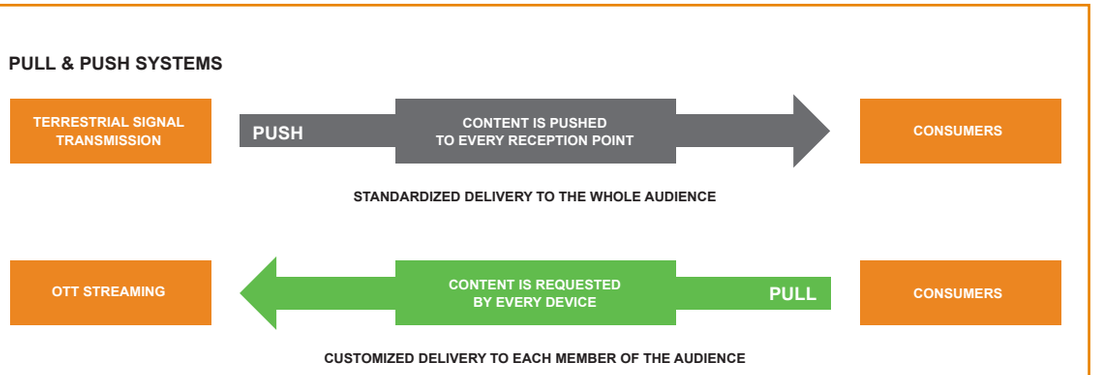



*Figure 2 – Push-Pull systems are core to the operation of the internet and hence OTT delivery.*

OTT is therefore a video distribution method that uses the internet to deliver content to IP-connected devices. OTT is not a business model or a type of video service.

## The OTT Ecosystem – From Transmission To Consumption

OTT operates as a pull system, basically because the internet operates as a pull system. Pull systems were industrialized by manufacturing businesses as they looked for more efficiency while offering more customer choice. Push systems, or batch manufacturing systems, were becoming less popular as the demand for choice increased. And people had realized that unnecessary inventory was expensive to keep. So the main principle of a pull system is to deliver material into the process only when required. If it is not required, it is inefficient and unnecessary to deliver it. Naturally, as efficiency and choice are balanced with commercial imperatives like faster lead-times or buying in high volumes for lower unit costs, some systems combined pull and push to optimize their delivery in terms of speed, price and choice.

The internet was constructed as a pull system, to move information over a network of inter-connected devices. Original information is generally stored in one place with a specific IP address and delivered when requested. It can be stored locally or in other locations, but it is inefficient to store content in every place it might conceivably be required. OTT video must fit into this internet ecosystem. Content caching has therefore become critical to deliver large video files to consumers at the lowest possible speed and to utilize network capacity in the most efficient way. The development of point-to-point video delivery over fiber, coaxial and mobile networks has followed a steady path towards central storage, fast networks and content caching.

A device in the OTT ecosystem is not a passive receiver that continuously receives every available video stream available to it. It must request a stream in order to receive it. This means that unicast is the dominant delivery method, which brings certain benefits such as personalized video services, but which also means the centralized video platforms must work well with network and caching infrastructure to deliver video at low latency.

Because broadcasting is a push system and OTT is a pull system, the concepts and paradigms of content distribution are almost opposite. Broadcasting relies on scheduled viewing of live and pre-recorded linear content, OTT has developed first and foremost around on-demand viewing. In a production setting, live TV is complicated to deliver. In a distribution setting, VOD is complicated to deliver efficiently. In an OTT distribution setting, VOD places pressures on parts of the ecosystem that Broadcasters haven't been accustomed to dealing with, like central storage and content origination, driven by the need to deliver thousands of different files on-demand to millions of individual consumers. At the same time Live and Linear content in OTT faces latency and quality pressures that have been fixed for decades in over-the-air and managed network video services but which now resurface in the relatively open and unmanaged networks used for OTT.

Pull systems have entire textbooks written about them. For this OTT Ecosystem article this high-level overview of the principles lays a foundation to talk about the core functions used in OTT services, such as encoding, origination, caching, peering points, access networks, video players, and more. These functions can be aggregated into services like Online Video Platforms (OVPs) or Content Delivery Networks (CDNs), but the core functions remain the same. Video has to be processed, stored and managed. Consumers have to request content, be authenticated and receive content. Services have to be monitored and controlled.

# The Main Components Of The OTT Ecosystem

*By Paul Martin.* *The Broadcast Bridge.*

***We describe the various elements of OTT systems including; intelligent ingest, ABR conversion, DRM & DAI, Packagers, Edge Processing, ISP's & Internet Exchange Providers, QoE monitoring and client applications.***

All video services begin with some form of content production and acquisition, so we will assume this is constant regardless of the content distribution method.

From that point on, the OTT Ecosystem contains a set of functions that differ significantly from a terrestrial or satellite distribution model, but which are very similar to those used in cable and telco "IPTV" distribution models. At a high level, the functions cover content processing, content storage and networking. But in the detail of each function there are significant differences between OTT and the other distribution methods that span everything from video formats to key performance indicators for quality of experience. This article describes each function and some of the key development areas being addressed today as OTT services expand.

Starting from the left, management of the content through intelligent ingest and categorization supports content monetization as well as the user experience of content search and discovery. Metadata management helps create a personalized viewing experience that is enabled by unicast delivery. Customer management refers to authentication, preference-capture and billing processes. Digital Rights Management (DRM) ensures content is only delivered to devices in permitted geographical locations that comply with the content rights. Dynamic Ad Insertion (DAI) can be applied at different points in the ecosystem to insert specific advertising for the individual viewer, which is an example of just-in-time delivery of the personalized experience that OTT enables.

Whether the content is a live stream or a file, it must be prepared for OTT delivery, which focuses on the bit-rate that will be processed successfully by the delivery network and played by the requesting device. Adaptive bit-rates are now the standard compared to constant bit-rates so that streams can be sustained even in networks with highly variable performance. The goal is to sustain the stream, not to interrupt it, as consumer satisfaction is better when streams are sustained.

The Packager function wraps the video stream in the correct container to be received by different end devices which generally use Apple, Android or Microsoft operating systems. Just-in-time packaging is popular because not every live stream or VOD file needs to be prepared in every package type. The Origin is internet-facing and is normally integrated with DRM systems for just-in-time encryption of the video before it is streamed over the internet. The Packager and Origin functions have developed to integrate closely with Storage to support efficient, large-scale VOD libraries and timeshifted TV viewing on live and linear streams. Storage can be as simple as direct-attached drives, but for larger content libraries the storage is often a multi-petabyte storage system that is routinely ingesting, streaming and recording streams and files. An additional form of storage is the Shield Cache (also known as "Origin Shield") which provides protection to the Origin by storing the streamed content and managing the interfaces either to the CDN(s) or to the end consumer devices.

The ABR encoding, ABR transcoding, packaging, encryption, origination, storage and shield cache functions are often co-located, either on-premise and located next to the playout servers (for live and linear services) or in a cloud service that ingests the live streams and files.

Once a stream is originated it is "crossing" the internet. The miles of intricate transport networks and layers of caching servers (if present in the ecosystem through the involvement of a CDN supplier) now deliver the video to the end device. Intermediate Caching is routinely found in large networks that connect to multiple Edge Cache locations, storing popular video as lose as possible to the consumer and offloading traffic from the networks that connect the Intermediate Cache with the Shield Cache or Origin. Edge Caches perform the same function – they store content as close as possible to the end consumer and avoid consuming upstream bandwidth towards the Origin which can add cost and latency.

The concept of edge computing is an important subject to OTT delivery as

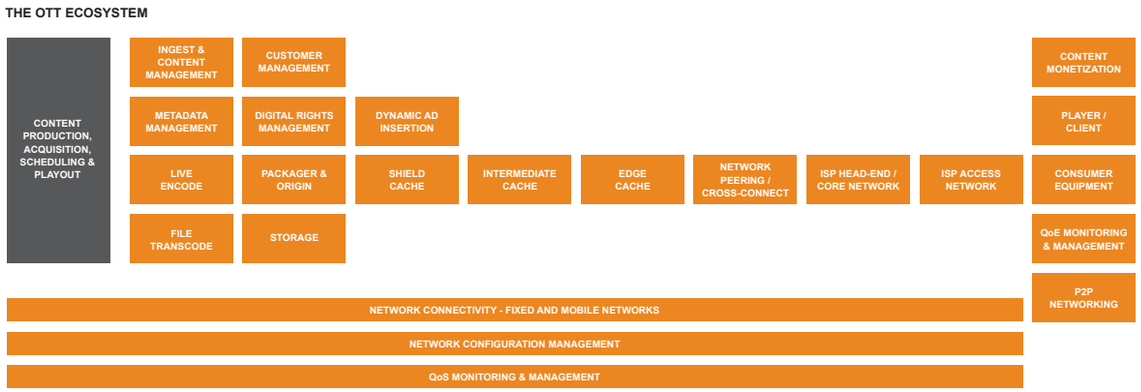



*Figure 1 – The OTT Ecosystem principle components.*

networks need to handle huge growth in traffic for video in general and must fulfil low-latency requirements for live video in particular. Just like optimizing a pull system, inventory (i.e. video) should ideally exist as close as possible to the consumer with the minimum level of "finishing" and maximum opportunity to personalize. Performing functions at the edge, wherever the edge can be, such as packaging for specific device types and inserting advertisements is the general future trend.

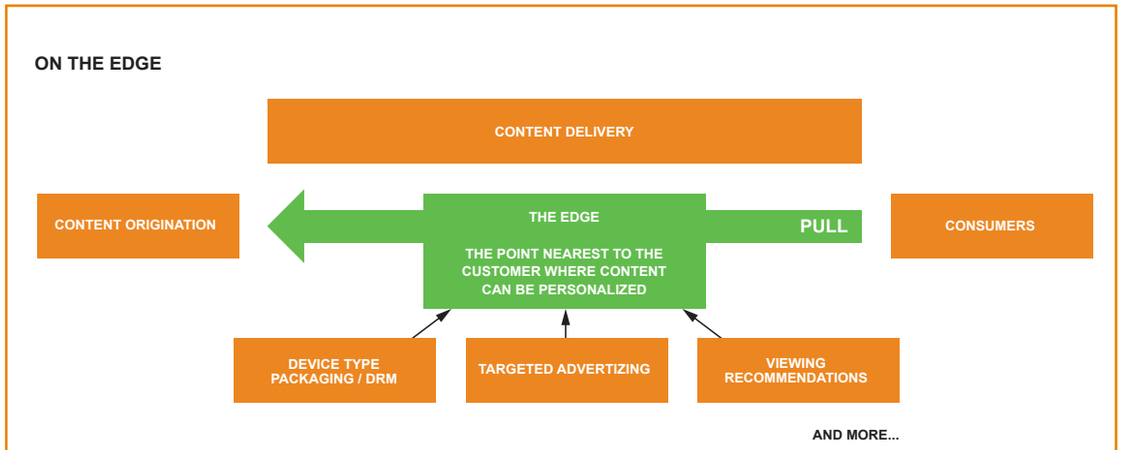



*Figure 2 – Edge components where the viewer's device activates the 'pull' sequence.*

Network ownership and management to reach end consumers means that Internet Service Providers (ISPs) will carry the content for the "last mile". Generally, this means more than the actual physical last mile, but the key point is that network operators that provide internet services are key partners in the OTT ecosystem. To connect to an ISP network is generally done in a "meet-me room" provided by Internet Exchange Providers (IXPs), like the London Internet Exchange (LINX) and the Milan Internet Exchange (MIX) that are hosted by Data Center operators. To reach the IXP from the origin-side of the ecosystem generally needs some form of leased line connection, purchased from a telco or CDN provider. At the IXP there are cross-connects between each incoming network and each outgoing network. This is the "peering point" as networks peer with each other. The capacity of the peering point is a key factor in the development of OTT services and increased bandwidth, especially as most Edge caches for OTT services appear on the origin-side of the peering point.

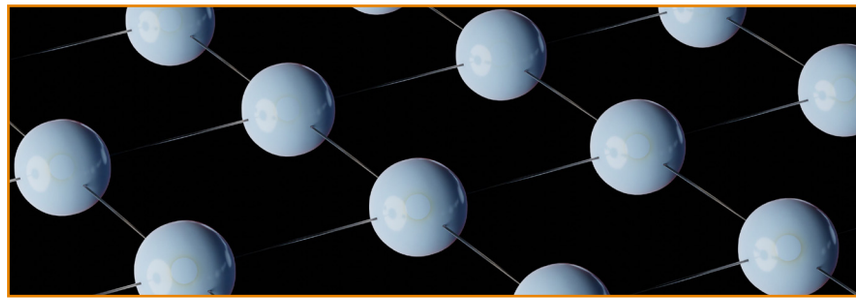
Once through the peering point, the content continues through the ISP's core network and access networks. OTT is unmanaged data crossing an ISP network, so it is separate to managed video services that ISPs may provide themselves. OTT video will generally follow the same network path as other unmanaged data like website traffic, software downloads, online gaming and videoconferencing.





ISPs are generally focused on expanding bandwidth for all forms of voice and data services that consumers and businesses require. Video requires enormous and growing amounts of bandwidth, with ever-increasing format sizes and resolutions placing pressure on the world's networks. As more people consume more content through OTT platforms, the broadband networks – whether fixed or mobile – must keep up. Multi-billion £/€/$/etc investments in network capacity are being announced and managed continuously to support this trend.

Finally, but in fact within seconds or even milliseconds, the packaged content arrives in the end consumer domain. If it is being transported over a fixed-line network, the content will first traverse any consumer premises equipment, like a Wifi router or home gateway, where it will then connect to the device. In a cellular mobile network, this step will be bypassed, but as a result content may only be available in a lower bit-rate due to less bandwidth availability. 5G is expected to provide a big step forwards for mobile video delivery.



At the consumer device the content will be received by a player that is installed in the client application or browser. This will convert the video and audio packets and play them on the device. The client application for large-scale OTT services is customized for the OTT Operator to provide the best possible user experience. There are a range of commercially available clients that can be deployed, although many OTT operators develop their own.

Consumer devices are constantly evolving and continuously drive the whole industry forwards. 4K-ready and 3D-ready devices clearly set expectations that there will be 4K and 3D content to consume, even if there is very little content available. This is one area where OTT offers big benefits over terrestrial and satellite delivery, as the general investment in broadband networks is much greater than other networks and so it aligns well with delivering these higher-resolution content forms. In the consumer device arena, one of the main challenges for OTT Operators is the need to work with their client-side ecosystem to ensure compatibility and performance for the viewer.

Quality of Experience (QoE) monitoring and control is generally performed at the client-side for OTT Operators. Quality of Service (QoS) monitoring and control is managed at the server-side of the OTT Ecosystem. Key performance indicators like average bit-rate and rebuffering ratio can be observed on every individual device and automated decisions can be taken to improve performance if necessary, such as re-directing the device to a different CDN or even Origin. Correlation of client-side and server-side data supports proactive decisions for seamless viewing experiences.

A relatively new technology for handling OTT video is peer-to-peer (P2P) networking. This technology offloads traffic from upstream CDNs, Core Networks and Access Networks. Its primary use case is for large audiences for live events when most people are watching the same content at the same time and a consumer device can be treated as a local cache to proliferate a live stream. As OTT services face more pressure to scale efficiently, the management of multiple network types will be an important subject.

While video consumption is why consumers use an OTT service, there are important monetization opportunities for OTT Operators that an internet-based content service enables. A short click to online shopping, betting, and community-based activities can be an integral part of the viewing experience, with particular opportunities for more time-sensitive linear and live content. Clearly, the whole viewer experience is important to manage properly – being inundated with promotional materials in a subscription-based OTT service is not what most people expect – but this is an area that could bring value to both consumers and operators.

## The Future Of OTT

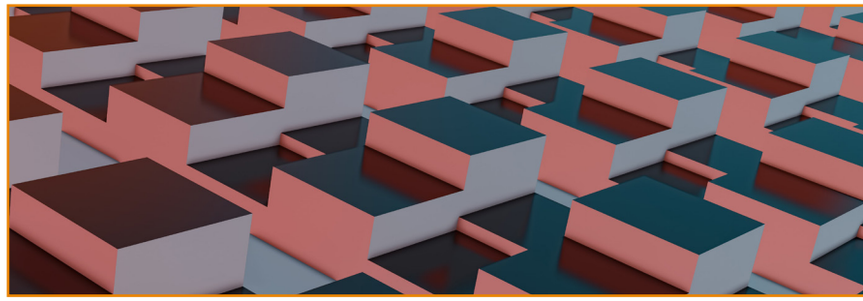
The 2020s will be an important decade of growth for OTT services around the world. It is possible, even probable, that by 2030 OTT will be the dominant distribution method in many countries where broadband networks are most advanced.

OTT gives unprecedented opportunity for personalized content delivery, which transforms the relationship between consumers and content providers and enables new methods of monetization.

Naturally this will lead to continued technology and business innovation.

The video processing and management technologies described in the OTT Ecosystem will therefore evolve to meet this demand. While the production side of the value chain will continue to innovate to deliver new and exciting consumer experiences, the distribution side will be dealing with the ever-present need to deliver content with efficiency, speed and quality.

It's going to be an exciting decade in the Media & Entertainment industry!



# The OTT Lexicon

*By Paul Martin.* *The Broadcast Bridge.*

***The world of streaming is defined by acronyms like SVOD, AVOD, FAST, OTT and more. But this leaves gaps and confusion in what is included in our OTT services. What does a service like BBC iPlayer include? What is watching the World Cup on RAIPlay called? Do we clearly capture live video streaming in our standard terminology?***

There is currently a morass of terminology in play, some of it enlightening, some of it confusing, and maybe it's all become a bit "OTT". As we begin what is bound to be another record-setting year for streaming, it seemed appropriate to start out with a review of how we describe ourselves in the streaming industry.

## Inspiration

This article was inspired by experiences at an industry event I attended at the end of 2022. These experiences confirmed that there is a relatively high level of confusion about the terminology we use in the streaming media industry, even among some of the leading managers and practitioners.

The first experience involved watching a presentation describing the differences between FAST and Linear TV, where one of the differences between the two was identified as there being "no need for infrastructure" for FAST. As a streaming executive involved mostly in the "infrastructure" side of the streaming industry, I felt this was an interesting, and perhaps confusing, perspective. This subject was discussed in detail over dinner with industry friends, who like me had worked in the traditional broadcast industry before moving to work in streaming.

But that same dinner revealed that my friends, who are leading practitioners in our industry, had not heard of the term "BVOD". This also resulted in a heated and enjoyable conversation as we discussed all the acronyms we use to describe different types of media delivery. As an editor focused on the streaming media industry, I was reminded that not everyone working in the industry reads the reports that our industry produces about itself, and not everyone uses the same terminology or understands the terms others are using to describe the space we are working in.

Following this conversation, I started to pay more attention to how streaming services were described in the media and industry articles. And it is confusing. FAST vs. AVOD vs. BVOD is just one simple example – a broadcaster's OTT service can easily be described as any of these 3 terms. SVOD services on the other hand, now include Live and Linear content, so why is it VOD? Even advertising is being included in subscription-based services. The lines are blurring.

On top of this, from a technology perspective, some important terms appear to be over-generalised to the point that they always need further clarification – like Edge and Head-End – or that are emerging in an already congested space and could do with some positioning against their peers – like HbbTV and DVB.

So, with this inspiration from my friends and industry colleagues, I decided to address the terminology confusion that

I've observed (and can sometimes feel myself), to at least serve as a reference point for fellow industry participants and analysts. Even if, as consumers, we can argue that we don't really pay much attention to how content types and streaming services are classified when we turn on our choice of streaming device, and simply think to "watch Netflix" or "see what's on BBC 1".

## Terminology

We use a long list of terms today in our industry. But as the streaming industry evolves, and streaming services become "multi-everything" (i.e., platforms, content types, business models), some of these terms can become confusing and even misleading. Let's start with the following list:

SVOD. AVOD. BVOD. FAST. Catch-up. OTT. Streaming. Linear. Live. Pay-TV. Free-to-air-TV.

Now let's consider the following services and think about how we would categorise them:

Netflix. Amazon Prime. DAZN. Peacock. ITVX. BBC iPlayer. Hulu. Tennis TV.

Netflix and Prime have always been thought of as SVOD, yet Prime includes a lot of live content, and Netflix is launching live streaming. Should they both be called SVOD?

DAZN is a live sports streamer, that also produces DAZN Originals and has linear content on its platform. DAZN is primarily a subscription service, but why would we call it SVOD?

Peacock and ITVX are ad-supported platforms, with premium ad-free tiers. But they include linear, live and VOD content. Would we use the term FAST to describe any of their content? Are they AVOD? Is their premium tier SVOD, even if it includes linear and live content?

Hulu is a subscription-based, ad-supported service. So is it SVOD or AVOD? But it includes Linear channels as well as VOD, so what do we call that?

BBC iPlayer is license-fee funded, so no ads and no subscriptions. It has been labelled as BVOD (Broadcaster VOD) in most analyses (along with other Broadcaster OTT services that are ad-

supported), yet it includes its linear channels and plenty of live events. So what should it be called?

Tennis TV is the ATP Tennis Tour's D2C offering that includes live and recorded content for tennis fans, that are not part of rights packages in various markets. Highlights packages and some VOD content is free, while live content requires a subscription. So how do we describe this?

This line of thinking caused me to come up with a primary observation which is that, particularly from a broadcaster's perspective, the terminology we use is very limiting, and specifically does not help us describe Live video streaming. The name "VOD" is almost synonymous with "streaming" and yet, as every one of these examples shows, VOD is always only one part of the content available on the platforms. And, more to the point, as we look to the future of streaming it is highly likely that live content and linear content will both be major aspects of how streaming services will grow and drive revenues for media companies in the future.

The development of FAST channels is a case in point. Two years ago, we had not described free, ad-supported, linear streaming services as "FAST", but they still existed. They were the same as the linear channels that many people would watch over-the-air or in a free-to-air TV subscription. Every national broadcaster's channels – literally all the household names you can think of per country – that have ad-supported business models and that were already supplying their linear channels as part of their free streaming services were arguably delivering FAST channels. It's why the debate between colleagues who have been in the broadcast industry so long and yet have also worked in streaming for many years turned quite heated and entertaining as we discussed the concept of FAST vs Linear (and it's why, to unpick some real nuances between linear and FAST, there will be a follow-up article on this subject). In the end, FAST may well replace the word "Linear", but before we go there, I have tried to create a way of considering all these names.

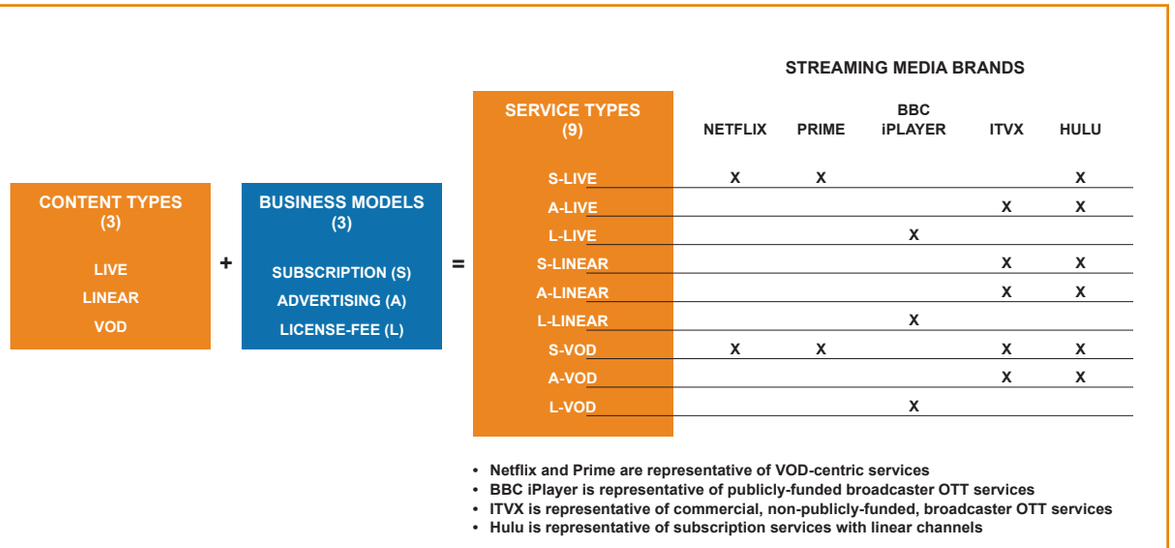



*Figure 1 – A new Lexicon for streaming services.*

## A New OTT Lexicon

The lexicon of OTT, in other words the vocabulary we use, could use some clarification to create order from the slightly or strongly confusing situation we can find ourselves in as we discuss the various types of services in the market. The following approach to defining OTT services helps us map content types and business model types into a set of service types that can be offered. With this model we can see how all 9 types of services available in the market are offered, in different ways by different providers.

The terminology used above to describe the 9 Service types might not be the most gripping. "FAST" and "VOD" are certainly helpful in that they are simple to say and easy to remember. But they disguise the idea of Live video, which is a key area expected to drive much more value in the media industry over time. We should be able to easily describe how live, linear, and on-demand content features in a streaming service. It would help us all communicate about our streaming industry more easily.

## Television

After this discussion about the latest video services terminology, I'd like to make a bid for TV or television to remain in our vocabulary, and if it doesn't then I'd like to see it replaced by something that could become as utilitarian and ubiquitous in the industry to cover all types of content we view. "Television" is from the Greek word "tele" meaning "far" and the Latin "visio" meaning "sight". This word's first recorded use was in 1900 in a paper presented by Constantin Perskyi at the first International Congress of Electricity during the World Fair in Paris. Over time "television" has come to be synonymous with the device in the living room or the content provided by broadcasters. But, whether we are streaming a video to our IP-connected device in the living room, our garden, or on the bus, or whether we are receiving it via satellite to a dish or via a transmitter to an antenna, it is still "content being seen from afar".

So, while 2023 is bound to contain a host of innovations and new breakthroughs for the world of streaming, we should remind ourselves that we are continuing to build on the long heritage of television which has its origins well over 100 years ago.

## Edge

Possibly one of the most important concepts in streaming media is "Edge". In its simplest sense, the Edge is about distributing data processing to a point that is as near as possible to the consumer. This is neatly related to the concept of just-in-time pull systems used in product manufacturing that leave the final assembly of a product to the latest possible moment that best combines flexibility, personalisation, and efficiency. In the media industry, our product is a video, either delivered live or on-demand. As streaming continues to grow, the concept of the Edge, and what we do at it (i.e., the Edge functions), will become more and more important because the systems we use must become more distributed in order to be scalable and

efficient for delivering lots of personalised content to very large audiences.

The word “Edge” has been around in the IT industry and the Media industry for a long time, but it has had a different evolutionary path in each domain, for a simple reason.

In IT, there is a concept that the source of data is the consumer (let’s include “employee” in this concept as well). This results in an exchange of data that is 2-way between the consumer and the receiving/responding entity (e.g., a business, government, etc.). In practice, a consumer enters data into a system (e.g., a search engine or an e-commerce website or a CRM database), and the system processes it and responds. To improve the responsiveness of systems, the ability to respond should be as close to the consumer as possible. And so Edge computing became a concept. Cloud service providers are major parts of the technical ecosystem to provide edge computing that makes the internet work quickly and efficiently. Building out compute locations that can host systems (i.e., software, applications) is at the heart of cloud service providers. But enterprise IT has been doing this in its own ways as well. For example, a retailer that deploys systems in each of its retail locations, on local servers, is effectively providing edge computing for its users. An oil rig operator with local servers deployed on individual oil rigs is doing the same thing.

Recent IT industry commentary has raised the idea that the word “Edge” in IT circles is so vague that it is almost becoming irrelevant. The point is made that Edge “products” have had various modifiers added to them in order to distinguish their purpose – for example, network edge, telco edge, near edge, far edge, industrial edge, and edge datacentres. It is understandable that in a vast 2-way communication ecosystem, while the concept of “edge” is straightforward, there can be a myriad of different use cases and deployment models. But in video streaming delivery, the situation is clearer, albeit there are still opportunities for confusion.

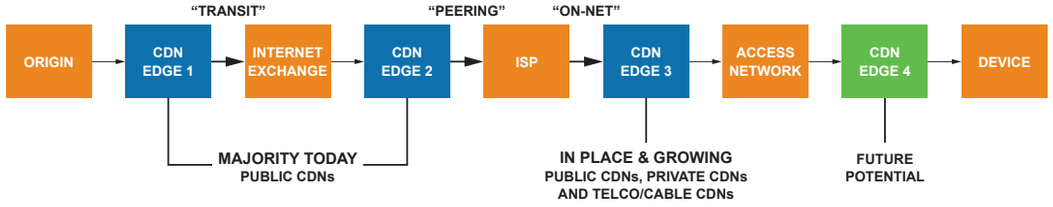



*Figure 2 – Edge locations in video delivery, used independently from one another or used jointly.*

The Edge in OTT streaming video is the server that distributes the video to the consumer, and it is the last link in the CDN chain before the video is transported into and across the ISP networks to reach the consumer. Differently to IT Edges, a Video Edge is a one-way traffic system as video is requested but then pushed on-demand, without consumer-driven modification to the data-set, from the server to the consumer.

As shown by Figure 2, these Edge Servers are found in 3 locations today. The primary location, CDN Edge 1, connects to ISP networks in a general way, labelled as “transit”. This is a general-purpose connection method that has the lowest level of quality control compared to the alternative deployment locations. The CDN Edge 1 will connect to an Internet Exchange of some type that provides onward connectivity to all ISP networks in that physical location. This approach is typically used when delivery volumes or peaks are lower, and the broadest reach towards all ISPs in the market is important for the CDN.

CDN Edge 2 takes things a step further by connecting to the ISP in a direct “peered” way. This creates guaranteed bandwidth for the CDN into that ISP network, but it does not necessarily provide guaranteed bandwidth to the OTT service provider using that CDN (i.e., if the CDN is a multi-tenant platform). Direct peering is used when the scale of delivery by a CDN to a single ISP reaches a point whereby there are quality of service and economic benefits to be achieved by setting up dedicated network capacity for the Edge egress to use.

CDN Edge 3 takes another step. The Edge moves inside the ISP’s own data centres, further along the network path towards the consumer. This location offers lowest latency in responding to a request for video from the consumer, because it avoids sending the content from a point further upstream that can potentially suffer from network congestion as all the video is transported downstream back towards the consumer. The most advanced streaming services, like Netflix, YouTube, DAZN, and BBC iPlayer use this model in a Private CDN mode (i.e., Edge server capacity dedicated to their own use). Some Public CDNs like Akamai have deployed Edge servers inside some ISPs around the world to provide best possible service to their customers. In addition, an IPTV or CableTV service, like BT TV or TIMVision, that uses a private CDN platform only for that particular service will have Edge servers deployed inside the ISP’s network. In a typical set-up within a single ISP’s network in Europe, Edge servers can be found in 5-15 locations (PoPs) to serve a single country.

CDN Edge 4 is a future possibility that could see Edge servers deployed at the closest possible position relative to the viewers. A country like the UK is expected to have about 1000 exchange locations in the future, as fibre to the premises is fully rolled out. This would offer potentially 1000 locations for Edge servers that could serve very localised markets. For Live and Linear streaming in particular this could be highly efficient as a “stream propagation method” that still supports timeshifted viewing (i.e., pause, rewind, fast-forward), while for VOD content there could be layered caching rules where most popular content would be highly distributed according to demand and less popular content would be cached in more centralised locations.

So when we talk about Video Edges, which are the last point of video management before sending the stream across the broadband network to the device, we need to be aware that the video Edge could be in a number of different locations.

## Head-End

Head-End is a long-used term, originating and still heavily used in the CableTV industry, that incorporates multiple

functions that prepare video for delivery to the consumer. In simple terms, after receiving the video signal from its source, the head-end receives them and converts them into a format for playing on televisions or other devices. But the head-end, like the Edge, contains a long list of functions (Figure 2) and options that can make one head-end very different from another. And these functions, rather than being fully centralised, can be

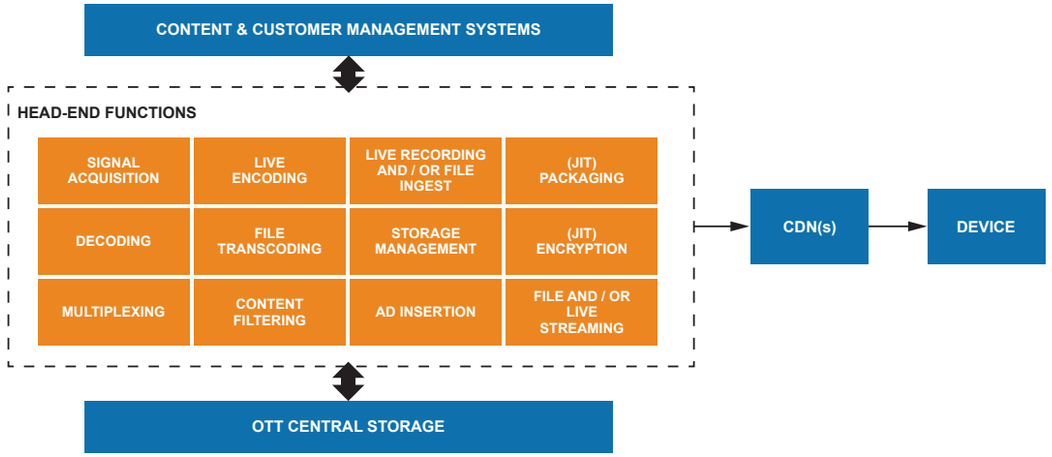



*Figure 3 – Head-End functions that can be centralised or distributed according to network topology.*

performed in multiple locations along a delivery chain before the final stream is originated to the consumer.

In many video delivery chains, there can be multiple "head-ends". A contribution head-end could receive signals, then decode and multiplex them before onward delivery. A primary distribution head-end could receive that multiplexed signal and encode it for adaptive bitrate delivery. In VOD workflows, the head-end could ingest VOD assets, transcode them and store them ready for onward delivery when requested. A secondary distribution head-end could package and encrypt the content before originating it to the CDN. Other functions like ad insertion and content filtering could be applied at different steps in this chain.

In OTT video streaming, the concept of a head-end can easily be called an origination platform. An "Origin" can be a single term that denotes packaging, storage management, encryption, ad-insertion and stream delivery, although encoding and transcoding are typically kept separate from the concept of an Origin.

While head-ends and origins are already being deployed in cloud platforms, which brings a range of operational and commercial benefits compared to fixed location and fixed capacity deployment models, several of the functions that we include in the head-end are candidates to become (or are already becoming) Edge compute functions. They would therefore take place inside the CDN rather than at the Head-end. Packaging and Encryption/Protection are two such candidates. CMAF (Common Media Application Format) could be used while streaming content from an Origin to an Edge, at which point JIT (just-in-time) Packaging into HLS, DASH or MSS would happen at the Edge. Protection methods like watermarking and tokenisation are also classic candidates for deploying at the Edge, given that individual streaming sessions are initiated at the Edge.

So, while the word "head-end" gives the impression that it is a highly centralised location for all manner of video processing functions, in reality those functions are already often distributed across multiple locations, and some of the key functions are already making their way to the Edge. So how long will the concept of a "Head-End" remain as we move towards a world of Edge computing? Time will tell.

The evolutions in Head-end and Edge technologies and deployment models are inevitably becoming more distributed and closer to us as consumers. Achieving maximum efficiency while operating at high performance and with more personalised services relies upon this more distributed delivery model. That said, there is a balance to find and one of the most interesting trends to watch in the streaming industry will be to see where, in the end, all the work to deliver streaming video actually gets done.

## Demystifying

Technology is full of opportunities to mystify and confuse. It's why we need engineers and developers to do their incredible work deep in the depths of software and electronics to deliver content to our screens. As a non-engineer, despite working in advanced technology companies my whole career, and as someone who focuses more on how the technology is used and delivers value to all of us in our everyday lives, I am continuously fascinated by how our content is produced and delivered.

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