MULTICAST ABR: READY TO MAKE YOUR VIDEO CARPOOL?



WHITE PAPER

ENENSYS

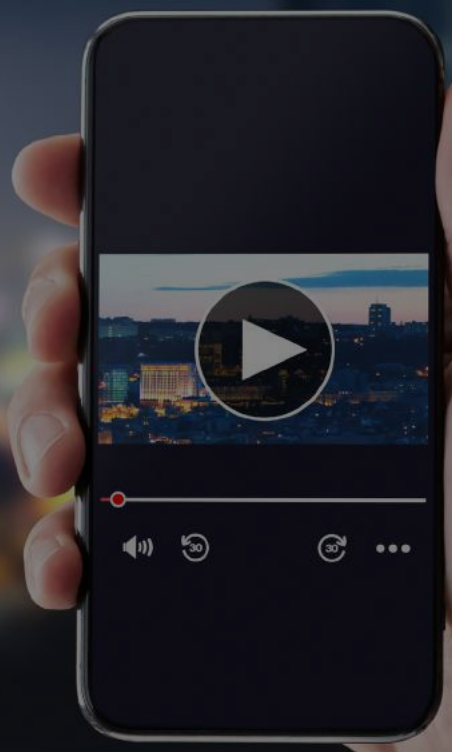
INTRODUCTION

Studies show that video viewing accounts for more than 65% of all Internet traffic. OTT services, and especially video subscription services, have become quite popular and successful. OTT platforms such as Amazon Prime Video, Apple, or Dazn, are progressively buying online rights for live sports events, getting the exclusivity to broadcast these contents online. The latest Soccer World Cup showed record numbers of viewers tuning in to watch the matches through streaming platforms. The arrival of the football big star Lionel Messi within Major League Soccer, the US soccer league, as well as the Thursday Night Football programme generated peaks on the US broadband networks. The traffic was then **four times higher than normal**. All these programs have one thing in common. They are all distributed from an OTT platform **where the viewing experience makes heavy use of operators' broadband and mobile networks**.

To cope with this growing load, content providers and operators have all been forced, at great expense, to increase their CDN capacities. This is also forcing operators to increase their backbone bandwidth considerably, at great expense once again, in order to properly serve the various CDNs spread across their network as close as possible to the audience, in order to provide the best video service quality. **This has not prevented some bad viewing experiences**, with macroblocking or buffering when bandwidth is insufficient or the CDN is unable to serve these traffic peaks .

Worse still, the common response from operators to the increase of video-based traffic is to add more and more CDNs in their network. It cannot continue indefinitely, especially regarding the energy consumption required, which only worsen their ecological footprint. Given that most broadband and mobile operators are aiming for carbon neutrality by 2030, there is an urgent need to find solutions that manage these traffic peaks without adding these extra network elements consuming too much energy at a very high cost.

If we were to draw an analogy with road transport, this would mean building ever more freeway lanes to cope with growing traffic. That is not the answer to support the peak loads of commuters traveling to work, tourists or fans traveling to the stadium to support their favorite team. Alternatives exist and are well known: car-sharing, car-pool lanes, development of public transport...



With the ever-increasing consumption of video content and the objective to reduce ecological footprint and to limit CAPEX/OPEX costs, can we imagine a video content pooling system?

With the ever-increasing consumption of video content and the objective to reduce ecological footprint and to limit CAPEX/OPEX costs, can we imagine a video content pooling system? In fact, the technology already exists: it's called **Multicast ABR for broadband networks and mobile networks**.

This technology enables efficient, scalable delivery of LIVE linear video streams over IP networks, and it is set to become essential in the years to come. This White Paper gives more details on this technology: Multicast ABR.

© Shutterstock



© Shutterstock

THE CHALLENGES OF **LIVE VIDEO BROADCASTING OVER IP NETWORKS**

Broadcasting live video over IP networks poses a certain number of challenges. Here are some of the main ones:

1. **Bandwidth limitation**: Linked to the number of viewers, Live video requires a large amount of bandwidth to stream in real time, and network congestion can occur when too many viewers are watching the same video stream. This can lead to buffering, poor video quality and an overall poor experience for viewers.

2. **Network latency**: Latency is the time it takes for a video stream to reach the viewer. Live video delivery requires low latency to ensure that viewers receive the video in real time, which can be difficult on IP networks with varying levels of congestion.

3. **Content protection**: Live video content is often valuable and subject to piracy or unauthorized distribution. It is important to implement effective content protection measures to prevent unauthorized access or copying of content.

4. **Quality of Service (QoS)**: Live video broadcasting requires a high level of QoS to ensure a consistent, high-quality experience for viewers. This is sometimes tricky to achieve on IP networks, which are subject to congestion and network performance.

5. **Device compatibility**: Live video needs to be compatible with a wide range of devices and platforms, including desktop computers, mobile devices, smart TVs and game consoles. It can be difficult to ensure that the video stream is compatible with all devices, and that viewers can access the video stream on their preferred device.

6. **Quality of Experience (QoE)**: due to potential network bandwidth limitations and CDN traffic costs, content providers or network operators are tempted to reduce the bandwidth and the image quality to maximize the number of user connections on their service, at the expense of the quality of experience.

Delivering live video over IP networks is not straightforward. **But despite these challenges, streaming consumption continues to grow**, and technology providers must develop solutions to enable content providers and operators to offer their audiences the best possible user experience.

A FEW NOTIONS ON **ADAPTIVE BITRATE** AND **ADAPTIVE STREAMING TECHNOLOGIES**

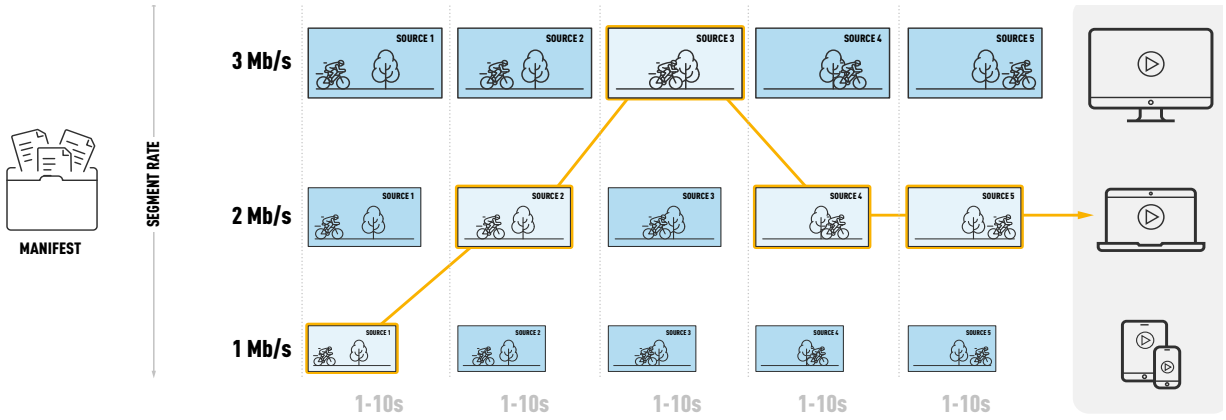
ABR Overview

In the early 2000s, a new technology called ABR streaming (Adaptive BitRate streaming) emerged, allowing dynamic media stream adaptation to provide in real-time the best quality for every end-user, based on its network profile.

ABR streaming is based on an encoder that enables a single source media (video, audio…) to be delivered at different quality levels by dividing it into several small chunks. Called "media chunks", they are basically files containing a certain amount of content: HD video, SD video, low resolution video, stereo audio track in English, 5.1 audio track in English, stereo audio track in French…

The size of each chunk is related to its duration and bitrate: for example, 3 seconds of video at 4MBits/s provide a chunk of 1,5 MB.

Those chunks are used to build different quality profiles such as UHD profile, HD profile or SD profile which are then indexed into a unique file, called "Manifest". The Manifest is then transmitted through signaling and provides the description of the different profiles and how to get the different chunks.

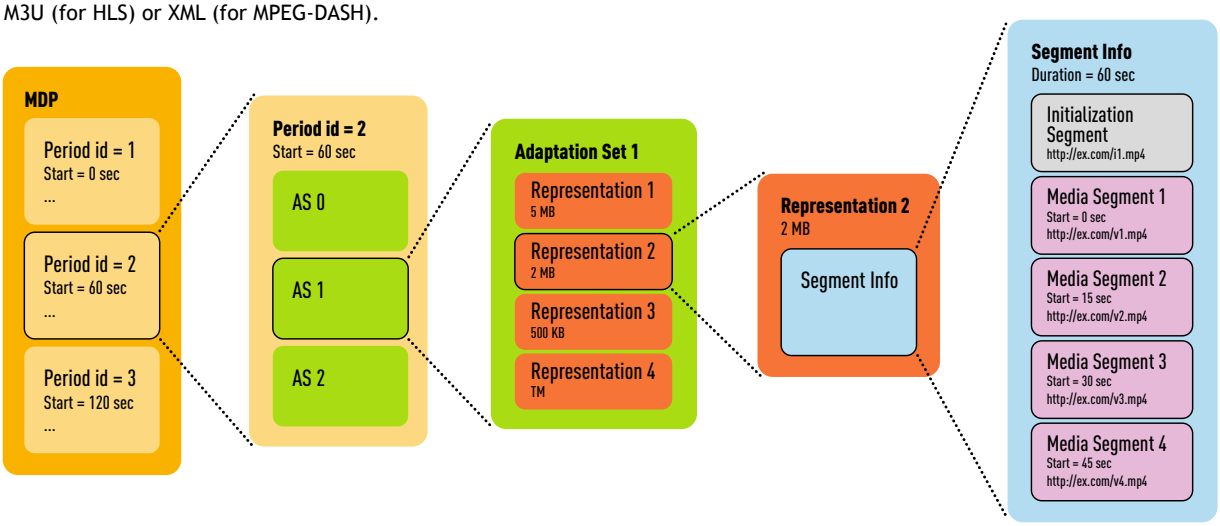


For the user, the media quality will automatically adapt depending on the available bandwidth.

What is a Manifest?

A Manifest is a metadata file that contains information about the live service stream, such as the location of video and audio chunks and their associated bitrates, resolution, framerate, sampling… The Manifest is usually written in a format such as M3U (for HLS) or XML (for MPEG-DASH).

Structure of a Manifest



The Manifest file plays an essential role, enabling the client to adapt the video stream to the network conditions of each viewer. Indeed, when the ABR stream is delivered, it notably takes into account the screen size, device capabilities, device resources, network conditions and available bandwidth. The viewer's device is thus capable to select the appropriate chunk according to observed conditions and adjust on the fly and for each individual the profile and the quality of the video streamed.

It ensures a smoother viewing experience by preventing buffering or interruptions. Depending on the available bandwidth , the viewer can start watching standard definition streams, then switch to high definition if the available bandwidth increases. The reverse is also possible.

Adaptive Streaming Technologies

There are different technologies used to package the chunks and define the Manifest. The most populars ABR streaming technologies are DASH, HLS, and CMAF. These technologies, built on top of HTTP to access the manifest and the chunks, are client-driven, as the adaptation and decision of the resolution/bitrate are taken by the client application and can be dynamically changed.

These technologies require a dedicated unicast delivery per device, which means having a point-to-point connection between the user device and the CDN storing content. To handle a large number of connections requiring different ABR technologies, operators are required to put a large number of CDNs in place, with a lot of cache servers along the network.

HLS - HTTP Live Streaming

HLS is the adaptive bitrate streaming protocol developed by Apple, and was released in 2009. The chunks (media segments) are generally stored in **MPEG-TS format**, and the Manifest is called a "playlist", using the M3U8 format.

DASH - Dynamic Adaptive Streaming over HTTP

DASH was developed by MPEG (Motion Picture Experts Group) and the first release was published as a standard in April 2012. The chunks (media segments) are generally stored in **ISO base media file format** (e.g. MP4 file format) and the Manifest, called "MPD" (Media Presentation Description), is using XML format.

CMAF - Common Media Application Format

CMAF was also designed by MPEG, starting in 2016, with the purpose to simplify the online video delivery of chunks by packaging the data under a uniform transport container, bringing together both HLS and DASH protocols. It allows to store the data only once, with one manifest for HLS and one for DASH into the same encoded data.

HOW **MULTICAST ABR** WORKS?

Multicast ABR basics

Multicast ABR is a technology that combines the advantages of Adaptive BitRate video transmission technology and IP Multicast to optimize the delivery of linear live video content over IP networks.

In Unicast ABR, a single copy of the different selected profiles of the video stream is sent for each receiver requesting it, meaning the file is sent as many times as the number of receivers. It quickly becomes resource-intensive as it requires additional bandwidth for each new viewer connecting.

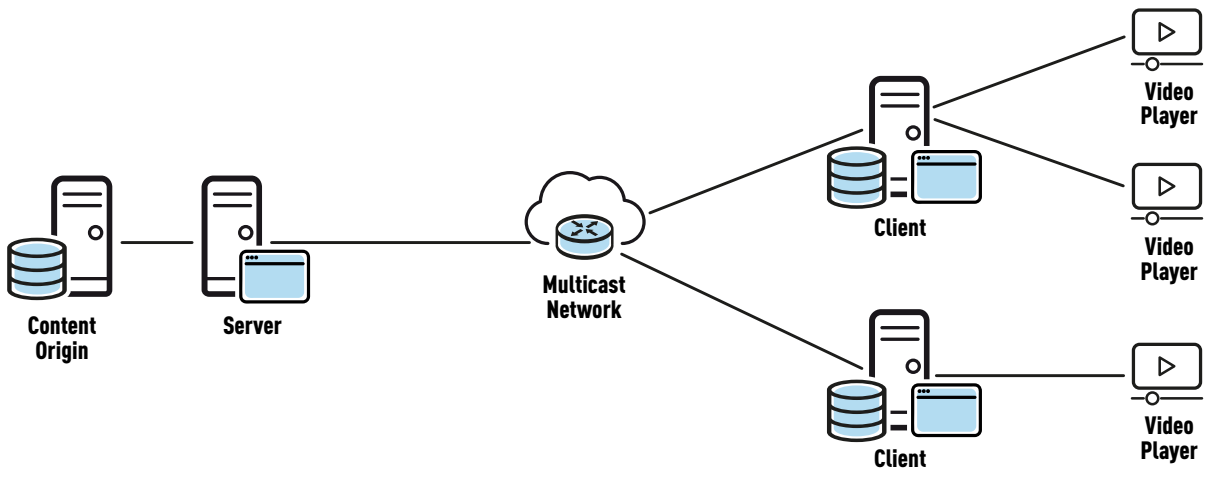
With Multicast ABR (mABR), a single copy of the different selected profiles of the video stream is sent over the network using multicast. The selected chunks are then delivered using multicast to the different receivers. The main important point here is that in multicast the file is sent only once, becoming particularly efficient when a large number of viewers wants to watch the same content concurrently. In that case, you only have to send the content once – whatever the number of users.

- As in ABR, the video source like a live stream is encoded into multiple bitrate versions (e.g., low, medium, high) and multiple profiles (ABR principle)
- The Multicast ABR server sends those different profiles - or the selected ones - as multicast streams over the network
- Receivers (player, home gateway, edge cache…) on the network can join the multicast group to access the content.
- Receivers embed a multicast/unicast converter to retrieve the content.

In addition, each viewer's device monitors its available bandwidth and selects the appropriate bitrate from the multicast streams to ensure a smooth viewing experience.

To deliver the files - chunks, manifest… - mABR can use different multicast file delivery protocols: FLUTE (mandatory), and ROUTE as an option.

Architecture of a basic mABR system

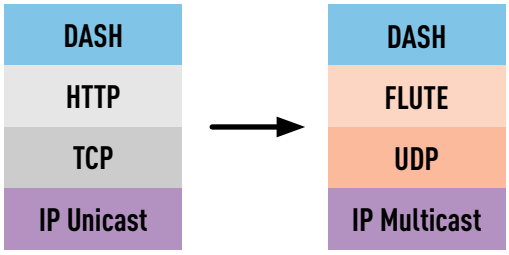


FLUTE (File Delivery over Unidirectional Transport)

FLUTE is a protocol combining various elements to provide reliable and efficient file delivery (notably for multimedia streaming) over a network by optimizing the transfer process, especially in environments where bandwidth is limited or the transmission may lead to errors. As its acronym stands, the data is transmitted in a **one-way direction** only, from a server to multiple clients. FLUTE notably uses:

- **FEC** (Forward Error Correction) to enhance reliability by adding redundant information to the transmitted data, allowing the receiver to correct errors without the need for retransmission.
- **ALC** (Asynchronous Layered Coding) protocol to manage the reliable and unordered delivery of data. ALC is responsible for maintaining the integrity of the transmitted data and ensuring that it reaches the destination in the correct order.
- **File Repair**: mechanism to manage the transmission and reception of repair data. This helps in recovering lost or corrupted parts of the file during transmission.
- **Acknowledgment and feedback mechanisms**: receivers acknowledge the reception of packets to optimize the transmission process.
- **File Delivery Table** (FDT) to provide information about the files available for delivery. It includes details such as file name, size and the associated File Repair Window.
- **Session description** to provide information about the parameters of the file delivery session, including details like the multicast IP address and port number.

ROUTE is an extension of FLUTE by the reduction in metadata frequency using template mechanism - FLUTE was designed for large files, and for a lot of small files while ROUTE may potentially be more efficient in terms of overhead.



Using multicast through FLUTE (or ROUTE) protocol can reduce a lot of the load on the server and network, as the video stream is only sent once over the network, regardless of the number of viewers.

Using Unicast when Multicast is not possible

When multicast broadcasting is not possible or not supported by the network, the Multicast ABR system can use unicast broadcasting to reach individual viewers. This ensures that the video stream can reach all viewers, even if multicast is not available on their network. Unicast is also used to recover potential loss of packets, ensuring high delivery quality.

Overall, Multicast ABR optimizes video delivery by using multicast technology to reduce the load on the server and network, and ABR delivery to adapt the video to the device and local network conditions of each viewer. This reduces network congestion and bandwidth consumption, making it an effective solution for large-scale live streaming events or content distribution in a network with many viewers.

How a receiver discovers the mABR services

On the network, multiple ABR services could be delivered using mABR. Each service is delivered in one or multiple multicast IP addresses. The receiver needs to discover the list of services and for each service, the different components that are being able to be received.

Service Discovery

The list of available services in mABR is provided by a "Service Discovery" channel which is delivered in a user-defined IP multicast address. It is a critical signalization component in mABR (called "multicast gateway configuration instance document") ensuring an easy selection of the content wanted to be decoded. It provides the receiver with the essential information about the video services offered within the mABR system with:

- **Available Services / Channel Lineup**: information about the video services that are currently available and typically includes details about different channels, programs, or content offerings.
- **Service Descriptions**: information about the content itself, such as the title, genre, language, and any relevant metadata.
- **Availability Information**: information about the availability status of the services, indicating whether a service is currently being delivered, whether it's available on-demand, or if it's scheduled for a particular time.
- **Unicast access**: URL used by the receiver to get the content in unicast if a chunk is missing or if the mABR service is not available
- **Report Server**: a dedicated server where a receiver can provide its report in terms of consumption, service access...

Manifest in mABR

The Manifest file plays an essential role in Multicast ABR. It provides a roadmap for how the video stream should be delivered to viewers. To ensure the optimum delivery of the manifest to all receivers, this file is also delivered in multicast. And each time the manifest is updated, this new version of the Manifest is delivered in the multicast stream. The Manifest is delivered in carousel mode (loop mode), to ensure a reception of this file at any time.

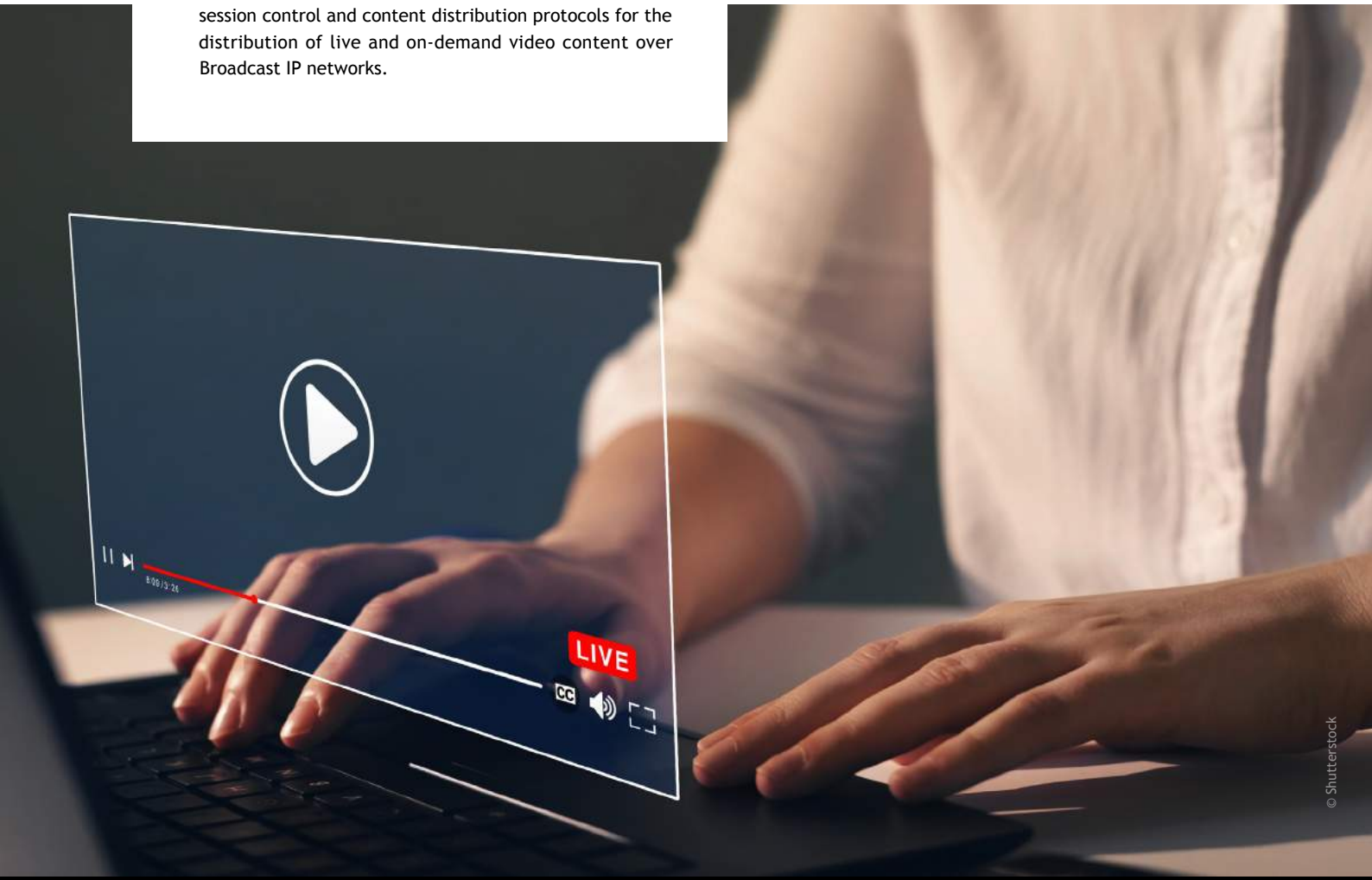
Multicast ABR standardization

The Multicast ABR (Adaptive Bitrate) technology is standardized by several organizations:

- **Digital Video Broadcasting (DVB)**: Multicast ABR is standardized by the Digital Video Broadcasting (DVB) Project, an industry consortium that develops standards for multimedia content delivery. **DVB has started to specify multicast ABR (DVB-mABR) in conjunction with DVB-I in 2020 with a first version available since 2022, and is now part of the new DVB-NIP standard.** It offers open standards for the distribution of video content over IP:
  - DVB-mABR: this specification includes protocols such as HTTP Adaptive Streaming (HLS), MPEG-DASH, and ABR multicast
  - DVB-I: this standard provides a unified architecture for the distribution of video content over IP, including specifications for live and on-demand content distribution, as well as specifications for subscription management, content search and user interfaces. In this standard, ABR multicast is used for live content distribution.
  - DVB-NIP: this specifies, over DVB mABR and DVB-I, session control and content distribution protocols for the distribution of live and on-demand video content over Broadcast IP networks.

- **Internet Engineering Task Force (IETF)**: Multicast ABR is specified in RFC 8551 «Multicast Using Bit Index Explicit Replication (BIER) with MPLS or IPv6» and describes how Multicast ABR can be used with Bit Index Explicit Replication (BIER) technology to provide streaming video content distribution to multiple clients using a single multicast stream.

This standardization ensures interoperability and compatibility between different IP video content delivery equipment and systems, facilitating the adoption and use of this technology by players in the content delivery industry.



© Shutterstock

BENEFITS OF MULTICAST ABR

As presented in the previous paragraphs, Multicast ABR is a technology that combines the advantages of multicast and ABR streaming to deliver live video content efficiently and cost-effectively over IP networks. With Multicast ABR, a single stream of video content is sent only once over the network to all interested viewers – unlike unicast, where each viewer receives a separate stream from the server.

That makes multicast the right choice for any large-audience broadcast such as sport events, where thousands or millions of viewers watch the same content at the same time. Let's explore the identified advantages that make Multicast ABR the go-to solution for the future of streaming.

1. Constant High Quality without Latency for Live Premium TV Channels

Multicast ABR ensures an unparalleled streaming experience for linear TV. By maintaining a constant high quality without latency, viewers benefit from a seamless and uninterrupted video stream. This is particularly important for live events, where latency and quality defects impact significantly the user experience.

2. Highly Scalable CDN for Both Live and On-Demand Content

Scalability is a key element when designing modern streaming infrastructure, and Multicast ABR eases the process. Whether it concerns live broadcast or on-demand content, the technology allows scaling Content Delivery Network (CDN). That means that when user demand grows, the system can adapt to deliver a smooth and reliable streaming experience to a massive audience.

3. Natively Designed for 4G and 5G: Integration with Operators' Infrastructure

Multicast ABR is tailor-made for mobile networks, seamlessly integrating with operators' infrastructure. This native integration makes the technology easy to adopt for both operators and viewers. As the world transitions to 5G, Multicast ABR is positioned to unlock new possibilities in terms of speed, connectivity, and overall user satisfaction.

4. Fully Standard Solution: Compliance to 3GPP and DVB for Vendor Independence

Complying with industry standards is critical for interoperability and future-proof technology investments. Multicast ABR is a fully standard solution, compliant with 3GPP and DVB standards. This ensures vendor independence, allowing operators to choose within a pool of receivers while maintaining compatibility.

5. Lowest Ecological Footprint: Harnessing the Efficiency of Multicast

Environmental sustainability is a growing concern, and Multicast ABR technology addresses this by drastically lowering the ecological footprint. Thanks to the nature of multicast, the technology requires minimal hardware resources to deliver content to a large audience. This not only reduces energy consumption but also aligns with the global push for more environmentally conscious technological solutions.

6. Independent Quality of Experience and Quality of Service Monitoring

Monitoring is mandatory to ensure a flawless streaming experience. With independent monitoring solutions, both the Quality of Experience (QoE) and the Quality of Service (QoS) are supervised to reduce downtime and maintenance interventions. Operators can thus proactively maintain optimal user satisfaction.

7. Seamless Integration: Use with Existing CDN or Partner CDN Delivery

Whether operators have an existing CDN in place or rely on a partner CDN, Multicast ABR seamlessly integrates into their ecosystem. This adaptability simplifies the adoption process, allowing them to benefit from Multicast ABR without significant disruptions to their existing workflows.

CONCLUSION

In conclusion, Multicast ABR emerges as a comprehensive solution addressing the evolving needs of the streaming industry. From ensuring constant high quality for live content to its native integration with 4G and 5G infrastructure, Multicast ABR will for sure redefine the streaming landscape, offering scalability, compliance, sustainability, and advanced monitoring capabilities. As the demand for premium streaming experiences continues to surge, Multicast ABR stands at the forefront, shaping the future of digital content delivery.



© Shutterstock

WE **OPTIMIZE** | WE **SECURE** | WE **MONETIZE**

About ENENSYS Technologies

ENENSYS Technologies is a global provider of media delivery solutions, including those related to Multicast ABR. The company specializes in the development of products and solutions for digital TV and video broadcasting over IP networks.

ENENSYS has developed a range of Multicast ABR products, including its OTT@Scale solution based on MediaCast software products on the server side, and CubeAgent on the client side.

This solution enables broadcasters and content providers to deliver Live video content to large numbers of viewers over IP networks. It also works on LTE and 5G mobile networks.

ENENSYS also offers other Multicast ABR products, including its MediaCast ATSC 3.0 solution for the US market, its IPGuard switch for IP network redundancy, and TestTree StreamProbe for OTT stream monitoring.

Globally, ENENSYS is a recognized player in Multicast ABR, and its solutions have been deployed by broadcasters and content providers worldwide.

The company has expertise in the development of Multicast ABR solutions and has actively contributed to the development of industry standards related to this technology.

4A rue des Buttes - CS37734
35577 Cesson-Sevigne Cedex
FRANCE

Tel: +33 (0)1 70 72 51 70
Fax: +33 (0)2 99 36 03 84
contact@enensys.com

Sales
sales@enensys.com

Technical Support
support@enensys.com

www.enensys.com

ENENSYS