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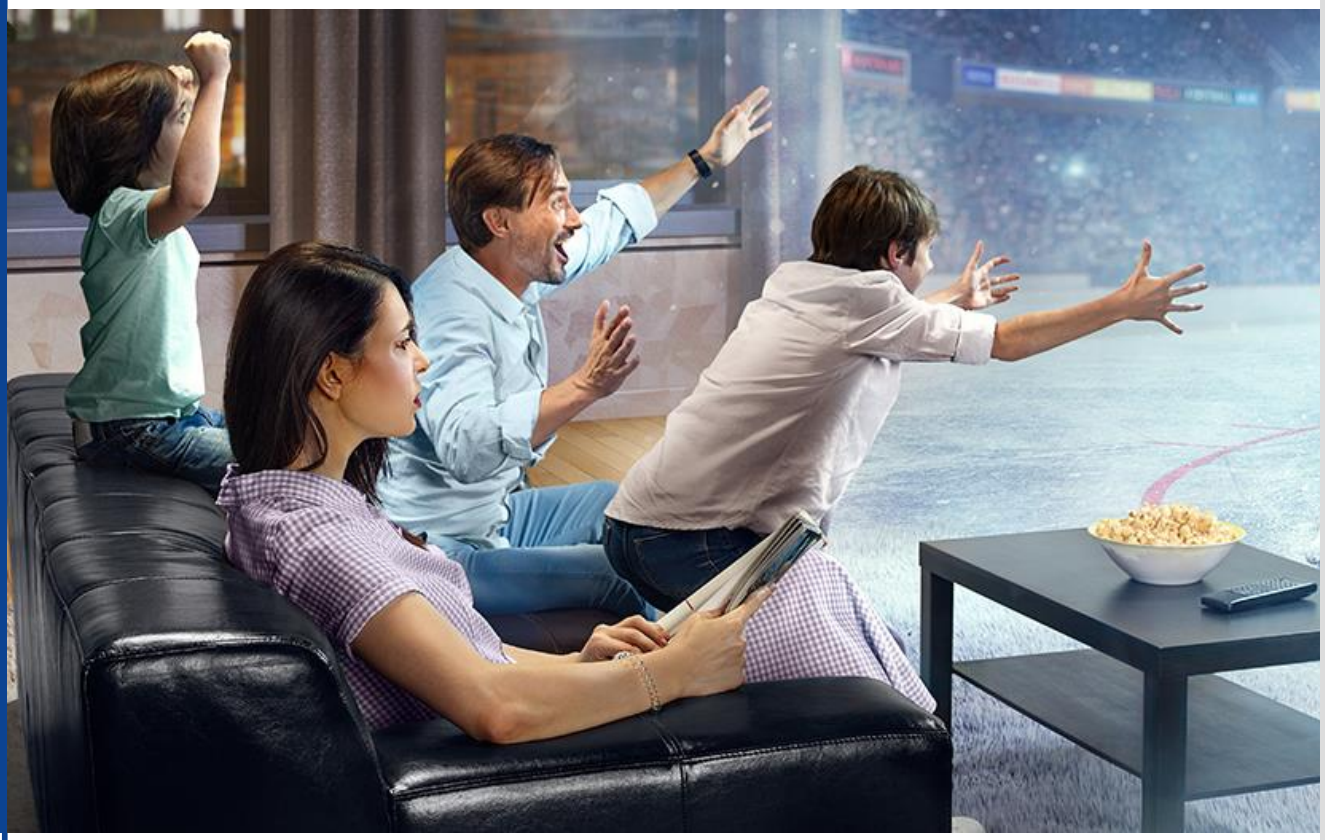

WHITE PAPER

LEVERAGING OTT VIDEO STREAMING TECHNOLOGIES

How Pay-TV operators can generate new businesses in a managed broadcast/multiscreen environment with Technicolor and Broadpeak

broadpeak

technicolor.com

Traditional Pay-TV operators started with broadcast and linear TV. More recently, Over-The-Top (OTT) services introduced Video-On-Demand and other interactive services, which have had a strong impact on Pay-TV business. Operators answers require technology innovations; Broadpeak developed them, and Technicolor helped their implementation.

The first part of this white paper clarifies how OTT disrupts Pay-TV, and therefore the need for a strong reaction.

The second part describes operator counterpropositions from a business, service definition and operations standpoint. It highlights the resulting technical challenges addressed to the technology suppliers.

The following parts are more deeply technical. They outline the answers developed together by Broadpeak and Technicolor. These items build a coherent solution and should not be split apart.

The overall conclusion shows that operators adopting this approach have a strong position and a bright future.

Contents

OTT disruption

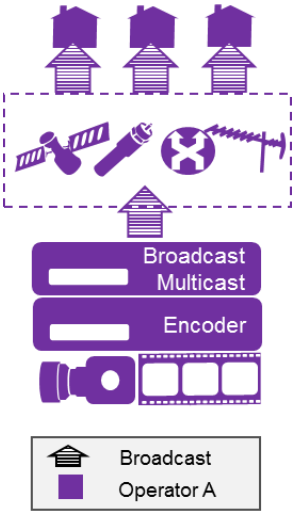

Figure 1: Broadcast/Multicast

Pay-TV started off with operators delivering both live and pre-recorded TV content to set top boxes over Cable, Satellite, Terrestrial or IPTV. This business relies on a critical-mass model with a large customer basis and uses a linear paradigm with programs and channels.

Then, Internet Service Providers (ISP) distributed commoditized access. When the internet had reached maturity, Over-The-Top video distribution started. A third-party service, independent of the ISP, distributes pre-recorded video to individual users, over the Internet, with point-to-point unicast connection to servers.

OTT enables business innovations:

- **Ubiquity**. OTT services are accessible to any customer with Internet access, whatever the provider, or the territory, via both mobile and cable/wi-fi driven technologies.
- **Larger footprint**. Bigger customer bases enable higher scalability for content, applications, and server infrastructure.
- **New interactive services**. The new protocols enhance non-linear services with more personalized recommendations and services, voice-based User Interfaces. The integration of social networks brings people together and encourages binge addiction to media consumption.
- **New usages**. Server infrastructure does not restrict the size of content catalogues, so long-tail niche content becomes possible. Every user can find video that suits his or her own needs.
- **New customers**. OTT service providers have heavily invested in new series / films. Their advertising targets millennials who have not developed allegiance to broadcast brands.

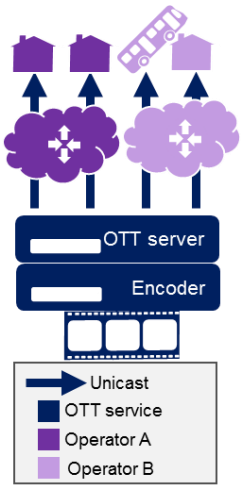

Figure 2: OTT

This strategy has become remarkably successful. YouTube, Netflix, Hulu, Roku were the first truly popular OTT services, rapidly joined by Amazon Prime Video, HBO, and now followed by WarnerMedia, Disney+, Apple TV+ [1]. They deliver premium content with strong customer impact [2].

These new services required significant technological innovation, and this investment created value. Adaptive Bitrate (ABR) protocols such as Apple HLS or MPEG DASH adapt video quality to the device or network conditions, and better personalize the content. ISO-BMFF [3] [4]. supersede legacy MPEG-TS (Transport Stream) and enables new services through Media Timed Events [5]. Digital Rights Management (DRM) replaces the traditional Conditional Access System (CAS), allows new monetization means, simplifies set-top-box security architecture and Wi-Fi.

Pay-TV reactions

The impact of OTT was significant: **The traditional broadcast lost most of the value of films and series**. Pay-TV operators reacted with business, services, and operation innovations, and addressed challenges to their suppliers.

[1] https://www.technobuffalo.com/disney-plus
[2] https://www.androidheadlines.com/2019/04/disney-plus-streaming-app-first-look.html
[3] https://mpeg.chiariglione.org/sites/default/files/files/standards/parts/docs/N18093_ISOFF(TS).pptx
[4] https://www.w3.org/TR/mse-byte-stream-format-isobmff/
[5] https://www.w3.org/TR/media-timed-events/

Focusing on Live TV

From the onset, Pay-TV had invested substantially in live events. Operators had already set up key business relationships including content purchasing and advertising, while OTT is still largely absent from this business.

Broadcast/multicast also offers distinct technical advantages. The infrastructure allows low latency and scales by design: if the number of customers is multiplied by 2, server and infrastructure costs stay constant, while OTT costs are doubled.

Hence, broadcast/multicast is always more efficient for live than OTT when customer numbers become massive [6]. So, live, notably sport, lies now at the heart of Pay-TV, and creates a strong brand loyalty.

Therefore, operators need to boost the value of Pay-TV on live, for instance by extending its reach on second screens.

Embracing all interactive services

Pay-TV also added interactivity like OTT providers, and benefited from the same ubiquity, larger footprint and new services. Customers can enjoy VoD, Catch-up TV, recommendations and social networking.

Any Pay-TV operator is free to reach users over the Internet, targeting its own customers, or acting as an OTT provider towards its competitors' client base.

However, the ability to compete effectively in this area is still very much dependent on third party applications, ABR and other supplier's technologies. The integration of technologies requires a common technical framework to develop a shared roadmap. A bespoke set top box middleware was never really designed for such purposes.

Therefore, **operators need a technical backbone that enables innovation.**

Simplifying infrastructure

Pay-TV operators use ABR for interactive services on all platforms and for live on mobile devices and companion screens, where expectations are lower than on the main screen.

For the same Live services on set top boxes, ABR is unable to secure bitrate and latency on par with subscribers' expectations. So, operators rely on broadcast/multicast technology that guarantee the proper QoE.

This scheme is complex, and, sadly, also means Live on main screen cannot use technical innovations enabled by ABR.

Therefore, **operators need to merge ABR and broadcast/multicast technologies**.

This unification would also have side benefits:

- **Unification of tools at the head-end**: all transmissions use ABR technologies.
- **Simplification of transitions**: the operator gradually converts existing broadcast / multicast services to M-ABR.
- **Dynamic allocation**: the operator can manage dynamically the split between broadcast / multicast and interactive transmission according to real-time conditions, such as the popularity of event, bandwidth, network availability or promotional offers.

[6] typically, around 250,000 users, but the barriers changes with local conditions and technology

- **Cross-fertilization:** ISO-MBFF formats include new metadata that enable new services. Broadcast/multicast can also use them. It also enables DRM and allows IPTV operators to use the same device and encoders for IPTV and OTT distribution.

Figure 3: Latency

However, this unification creates a technical challenge: Sport and other events require real-time low latency. A Facebook goal notification on the smartphone is a huge frustration if the STB shows the striker still lining up the shot.

But OTT service providers initially designed ABR protocols and formats for VoD and not for live, so they did not care about latency. A typical ABR stream would be 20 seconds behind a broadcast signal, which is intolerable for a high-end live service.

So, **modern Pay-TV requires a low-latency ABR protocol.**

Optimizing ISP network

Many Pay-TV operators are also ISPs. OTT is a point-to-point (unicast) technology acting between the server and the client device, via the network. When applied to Live services, the following issues arise:

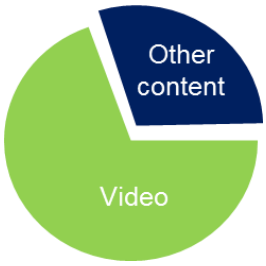

Figure 4: Internet bitrate

- **Server scalability:** The server cost increases with the number of simultaneous users. Cloud technology can dynamically adapt server infrastructure, but still generates high OPEX.
- **Network scalability:** Like servers, its cost increases dramatically with usage. In addition, video already makes up the highest proportion of Internet traffic -up to 73% according to Cisco [7]-, so current infrastructures are not capable of allowing the video traffic to double in size.
- **Concentration**. Extremely popular live events, such as key football matches, attract users in huge quantities, which amplify dramatically the scalability problems. The French sports channel RMC Sport learned it at its expense [8].
- **Limited live OTT services.** Due to the above constraints, third party OTT services providers have difficulties to deliver Live services. Popular sports rights owners have started their own OTT service. NeuLion [9] delivers OTT **4K live sport events** with low latency, serving National (USA) Football League. FuboTV, Red Bull, Twitch, ESPN, MLB.TV [10] or NBA.TV [11] are also widely popular, but do not have the same scale as Broadcast.

In addition, rumors are spreading about the desires of major event producers, such as UEFA [12] or FIA Formula One World Championship to launch their own OTT live services.
So, **ISP need to improve the scalability of Live OTT**.

If there were a solution available, ISPs would lower their CAPEX, and could even think about proposing a “Scalability and QoE deal” to third party OTT live service providers [13].

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[7] https://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/complete-white-paper-c11-481360.html
[8] https://www.google.com/search?q=psg+liverpool+bug+RMC
[9] https://www.neulion.com/
[10] https://www.mlb.com/live-stream-games/subscribe
[11] https://www.nba.com/nbatv
[12] https://www.uefa.com/insideuefa/about-uefa/news/newsid=2610427.html
[13] https://media.netflix.com/en/press-releases/orange-and-netflix-ink-major-international-agreement

Challenges

Pay-TV operators have multiple ways to extend and strengthen their business and become more competitive than OTT. Achieving this revolution addresses the following technical challenges to their suppliers:

- Merging ABR and broadcast/multicast
- Delivering low latency for Live content with ABR
- Finding a technical framework that enables innovations
- Achieving a coherent end-to-end view of the services

Next chapters explore the answer developed by Technicolor and Broadpeak. They also show the coherence of the approach and how operators can build the next stage of Pay-TV by using these items together.

Merging ABR and broadcast/multicast: M-ABR

Broadpeak designed a first key element of the solution called **Multicast Adaptive Bitrate** [14] (M-ABR). Its rationale is to convey live content using multicast or broadcast technology as far as possible, and then convert it into unicast point-to-point. So, the major part of the distribution is scalable, while local distribution such as in-home Wi-Fi benefits from unicast OTT protocols with Adaptive Bitrate.

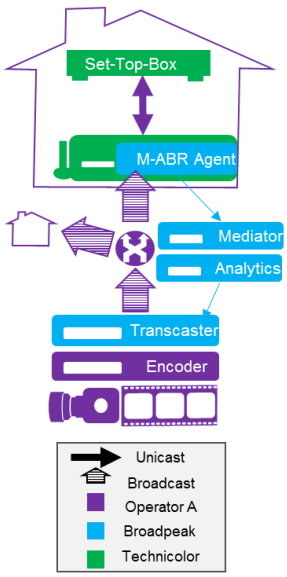

Figure 5: Multicast ABR

Cisco [15] adopted this idea, and Cable Labs made recommendations [16] standardized by SCTE. A more accurate DVB standard is expected at the end of 2019.

In the case of Broadpeak:

- Close to the origin server, a **transcaster** embeds ABR content within a multicast stream
- The transmission is very similar to traditional multicast except that it embeds video in standard ABR rather than MPEG-TS.
- If the service operator wants to simplify the system and still have comparable functionality to Broadcast, he can choose to use only one resolution and bitrate.
- The service operator can also embed multiple resolutions and/or bitrates. This enables multicast stream distribution to mobile devices with different screen resolutions and variable conditions within the Wi-Fi home network.
- The Content Delivery Network carries the content, using multicast, to a "**multicast to unicast agent**", also called **nanoCDN.** This can be either in the residential gateway, or the set top box.
- The nanoCDN converts back protocols to unicast and implements a mini HTTP streaming server to deliver ABR video to any screen, including devices not proper for broadcast/multicast.
- The **media player** inside the final rendering device is a regular ABR client, and therefore chooses the correct resolution and bitrate
- An **analytics server** aggregates feedback on usage, performs an analysis of Quality of Experience and takes right actions.

[14] https://broadpeak.tv/solutions/multicast-abr/
[15] https://www.cisco.com/c/en/us/products/collateral/video/open-media-distribution/datasheet-c78-740369.pdf
[16] https://apps.cablelabs.com/specification/ip-multicast-adaptive-bit-rate-architecture-technical-report/

- A **video delivery mediator** arbitrates between unicast and multicast for content with low usage rate

With M-ABR, Live content is sent only once to every end-user through the broadcast / multicast network: both servers and network infrastructures scale-up proportionally.

This technology has been been commercially deployed by Broadpeak at various operators and many others are underway. Technicolor and Broadpeak pre-integrated and evaluated various setups:

Gateway setup

The Broadpeak agent is pre-integrated on every Technicolor gateway, which is a key factor of M-ABR success, since Technicolor is the market leader for Broadband gateways.

Gateway installation stops the multicast transmission in the gateway and uses unicast Adaptive Bitrate to the STB and other client devices. This later protocol is more favorable to Wi-Fi and allows Set-Top-Box cost optimization.

STB setup

Broadpeak M-ABR agent is pre-integrated in Technicolor Set-Top-Boxes and enables live linear channels over all access methods (cable, satellite, terrestrial, IP networks). Unlike unicast, where the content is delivered upon request and therefore requires a return path, multicast is a distribution where programs are pushed to all users and can easily be modulated to be carried over other media than IP networks.

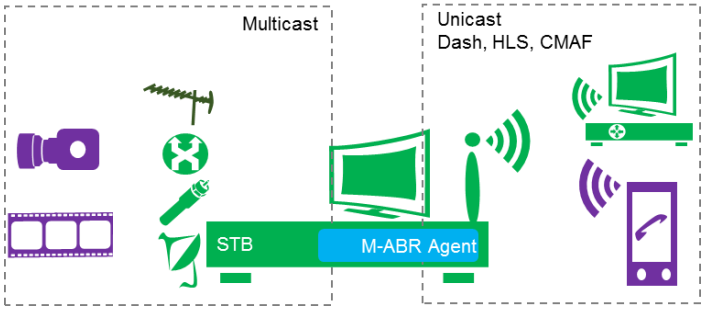

Figure 6: Multiscreen

In this context, the STB typically embeds several tuners, and functions as a gateway to smartphones, tablets, TVs, or secondary STB: they receive live best-in-class premium content with an unbeatable QoE, using unicast protocols such as DASH and HLS.

This scheme is particularly efficient when the Technicolor STB is a **Wi-Fi access point**, removing useless routing through the gateway.

In the case of IPTV [17], a legacy gateway can deliver M-ABR to a STB over Ethernet. The STB M-ABR agent addresses 2nd screen devices through Wi-Fi. This can be simpler than implementing a new model of gateway.

M-ABR enables efficient transmission of live video to unmodified companion screen devices in addition to the main screen.

Low latency: CMAF

CMAF is the “Common Media Application Format”, officially MPEG-A Part 19. It specifies a container for video, audio and metadata, derived from ISO-BMFF and compatible with both broadcast and HTTP-based delivery.

[17] https://www.theiabm.org/broadpeak-at-nab-show-2019/

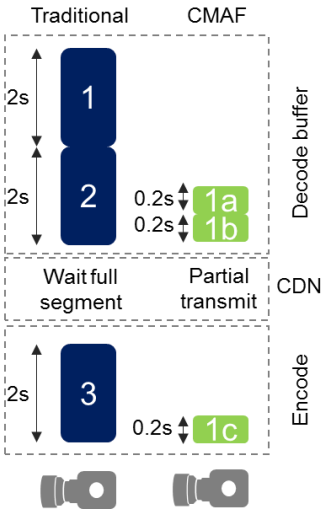

Figure 7: CMAF-LL

An overview of CMAF can be found in [18], a deeper dive in [19], and the standard in [20]. CMAF includes a Low-Latency profile, CMAF-LL. THEOPlayer [21], Akamai [22] and Bouqueau [23] have converging views about targeting a glass-to-glass delay below 1 second compared to broadcast:

- The encoding must follow stricter rules for GOP structure
- Segments are cut into smaller chunks, typically of a duration of 0.2 seconds.
- The first chunks can be transmitted to the client before the segment is finished in the encoder side. This saves the time to build the first segment.
- The media player must be optimized, which is not an issue on set-top-boxes and smart devices but requires expertise and deep interoperability testing.

CMAF-LL can be used in a pure OTT context, but Internet transmission still requires large buffers, so latency is still high.

Conversely, in a **broadcast / multicast** context, the Pay-TV operator grants the QoE. So, the number of chunks buffered in the decoder can be reduced. Broadpeak and Technicolor's collaboration has proven low latency:

- Technicolor pre-integrates CMAF-LL on its Android TV STB: the media player used by Broadpeak manages buffers optimally and allows the TV applications to display CMAF-LL encapsulated content with low latency, using either broadcast or broadband protocols. For instance, a SAT tuner can receive CMAF.
- Broadpeak fine-tunes the CMAF-LL media player, addressing the real-life conditions, notably for buffer size.
- CMAF-LL is transparent to Technicolor gateways, which simply convey CMAF transparently.
- Broadpeak supplied the CMAF-LL compliant transcaster, the streaming servers and test streams
- Technicolor used its "Wi-Fi experience house", a residential testbed, with actual furniture, dedicated to Wi-Fi interoperability between servers, gateways and STB, taking into account walls, a microwave oven, networking topology, repeaters, etc.
- This setup enabled real-life end to end tests, testing glass to glass (i.e., from source to screen), assessing the latency and the QoE.
- When CMAF-LL is transmitted over multicast, Ethernet is preferable to Wi-Fi: fewer transmission errors mean smaller buffers. Experiments show that a buffer of around 200ms is enough in most cases.
- When CMAF-LL is transmitted with HTTP-based protocols, Wi-Fi can be used, and the overall latency should be below 1 second.

ABR over multicast / broadcast with CMAF-LL and optimized player grant Live low latency and infinite scalability

[18] https://bitmovin.com/what-is-cmaf-threat-opportunity/
[19] https://www.slideshare.net/EricaBeavers/cmaf-101-by-cyril-concolato
[20] https://mpeg.chiariglione.org/standards/mpeg-a/common-media-application-format/text-isoiec-cd-23000-19-common-media-application
[21] https://www.theoplayer.com/blog/low-latency-chunked-cmaf
[22] https://speakerdeck.com/stswe/cmaf-low-latency-streaming-by-will-law-from-akamai?slide=25
[23] https://parisvideotech.com/wp-content/uploads/2017/07/Bouqueau-Weil_UltraLowLatencyWithCMAF.pdf

Consequently, these tests show that operators can safely use CMAF-LL in a broadcast/multicast environment, replacing MPEG-TS: the same infrastructure can manage Live and de-linearized content.

CMAF-LL enables ABR and broadcast / multicast convergence, and ISP network optimization

Framework: Android TV

We already saw that the number of OTT VoD and Live video services is exploding. Let us now consider the applications used by OTT providers to deliver their content on Consumer Premises Equipment (CPE). Disney is a good example, with a commitment for Smart TVs, Apple, Android, PS4 and Roku.

2018 sales of these solutions [24] explain the rationale of this choice: Due to fragmentation, any **Linux + HTML-5 STB solution is negligible** when compared to Android. Varying browser technologies, middleware APIs and graphics do not allow a single integration of each OTT service.

So, for STB, **Android TV is the only scalable way to manage the tsunami of OTT applications,** to allow their deployment and maintenance in an industrial way. RDK is probably the only alternative, thanks to the size and huge investment of Comcast.

In addition, Android TV is a very complete middleware and a standard integration framework. It helps overcome typical operational constraints by allowing an end-to-end test before the operator project starts. Partners can validate performance with realistic hardware, software, UI, services and real-life conditions. This kind of integration is impossible on legacy closed Linux systems.

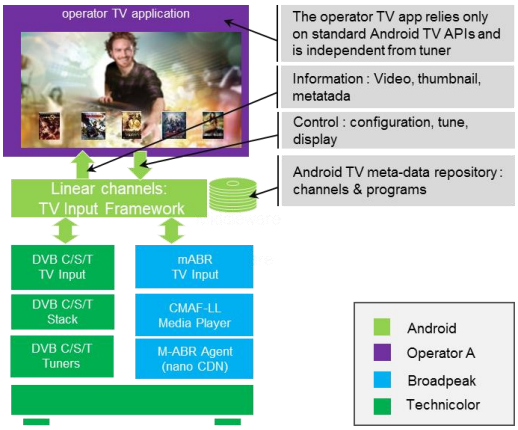

Figure 8: TV input Framework

A key example of Android TV benefits is the TV Input Framework (TIF) [25] that manages **linear** video streams with 3 layers:

- The TV application, under the operator's control, uses only standard TIF APIs, and is not aware of the underlying technologies such as M-ABR, CMAF-LL or DVB.
- The Android TV middleware supplies a uniform TIF abstraction layer which decorrelates the TV applications from the linear TV sources
- The STB manufacturer implements a TV Input below the TIF, for each video source. It is invisible to the TV application.

Broadpeak and Technicolor have collaborated to setup a specific TV Input that dynamically manages multicast and unicast ABR, supporting CMAF-LL for **live** content. It is tested using the unmodified standard "Live Channels" application from Google, so the operator knows that its own TV application will work.

So, the Android TV framework eases Technicolor and Broadpeak pre-integrations, securing the deliveries to Pay-TV operators and helping the transition from legacy broadcast formats to a ABR.

[24] https://www.statista.com/statistics/273268/worldwide-tablet-sales-by-operating-system-since-2nd-quarter-2010/
https://www.statista.com/statistics/266219/global-smartphone-sales-since-1st-quarter-2009-by-operating-system/
https://www.statista.com/statistics/263401/global-apple-iphone-sales-since-3rd-quarter-2007/
https://news.strategyanalytics.com/press-release/intelligent-home/strategy-analytics-samsungs-tizen-os-leads-global-smart-tv-market
[25] https://source.android.com/devices/tv

Shared vision: collaborative leaders

The last challenge from operator is less technical, and nevertheless crucial. How to grant that all technical items developed by various suppliers are interoperable, build a coherent end-to-end system and that new services can be safely operated and maintained?

This question is emphasized by the fast restructuration of the business of suppliers, under the joint pressure of OTT and Android TV.

- Android TV requires providers of key technology (SoC, CAS, STB, middleware, application / UI) to make large investments that are profitable only for large scale projects and kill smaller competitors.
- Each industry has a different investment cycle, R&D organization, and product lifespan, so companies concentrate on their core business.

Pay-TV operators should focus on collaborating with future-proof suppliers that have already adapted to the new Android ecosystem.

Technicolor

Technicolor is the undisputed leader for Android-TV Set-Top-Boxes, working with over 40 Pay TV operators. Technicolor has integrated, deployed and maintained Android-TV versions of all major key features:

- **Networks**: DVB C/S/T, ATSC, ISDB-T, multicast IPTV, OTT.
- **Security:** PlayReady, Widevine, Nagra, Conax, Synamedia, Viaccess-Orca, Irdeto, Verimatrix etc.
- **Netflix**. Technicolor has the largest number of Netflix deployments (more than 18) on Android TV.
- **Amazon Prime Video**. Technicolor has completed 7 Prime Video certifications, which gives Technicolor over 80% market share.

Broadpeak

Broadpeak designs and manufactures video delivery components for Content Providers and Network Service Providers deploying IPTV, Cable, Satellite, OTT and mobile services.

Its portfolio of solutions and technologies powers the delivery of movies, television programming and other content over managed networks and the Internet for viewing on any type of device. The company's systems and services help operators increase market share and improve subscriber loyalty with superior QoE. Broadpeak supports all its customers worldwide, from simple installations to large delivery systems reaching capacities of several million simultaneous streams.

Broadpeak has more than 100 customers worldwide, these operators serve continuously more than 220 Million of users, which results in streaming every month of more than 6000 Petabytes of video.

Collaboration benefits

Such a collaboration generates clear benefits for the operators:

- **Shared vision and mature processes**. Technicolor and Broadpeak have established long-term relationships and continuous pre-integrations with Google, Netflix, Amazon, NAGRA, Irdeto, Verimatrix, Broadcom, etc., and have invested in the proper R&D, quality and certification methods. Their teams are skilled,

have a significant experience, and share a common understanding of Pay-TV evolutions.

- **Products rather than projects.** Thanks to Android TV availability, Technicolor and Broadpeak are able to jointly anticipate market requirements and Technicolor can develop a roadmap of generic platforms, implementing and pre-certifying hardware, CAS & DRM, Broadpeak M-ABR & CMAF-LL, DVB C/S/T/IPTV, Android TV, Netflix, Amazon Prime Video, and end-to-end testing performances.
- **Industrial execution**. Android TV-based STBs share their hardware and software components as much as possible. This allowed Technicolor to industrialize the production process. Characteristics of this process are: sharing porting, certification, and maintenance, using standardized modules, fully automatic test tools, dedicated teams, and clearly isolated customer specific code.

Conclusion

OTT services have significantly disrupted the traditional Pay-TV business with innovations that simultaneously changed technology and market expectations for video services.

Pay-TV operators reacted by exploiting their strong assets: customer base, brand, network, popular live content, and the freedom to innovate.

This revolution addressed many technical challenges to key suppliers. Broadpeak and Technicolor developed a common answer, based on the convergence between ABR and broadcast/multicast.

The Android TV framework helped complete this work, and enables a new industrial paradigm, with pre-integration, end-to-end testing, product roadmaps, which is highly favorable to operators.

Pay-TV operators can now propose new interactive services, broadening the reach of their Live video offers and placing ISPs in a favorable position towards third-party OTT services. The proliferation of new types of content and services strengthens the aggregator role of Pay-TV operators, helping the consumer to get back on track in the service jungle and strengthens the operator brand.

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