Live Video

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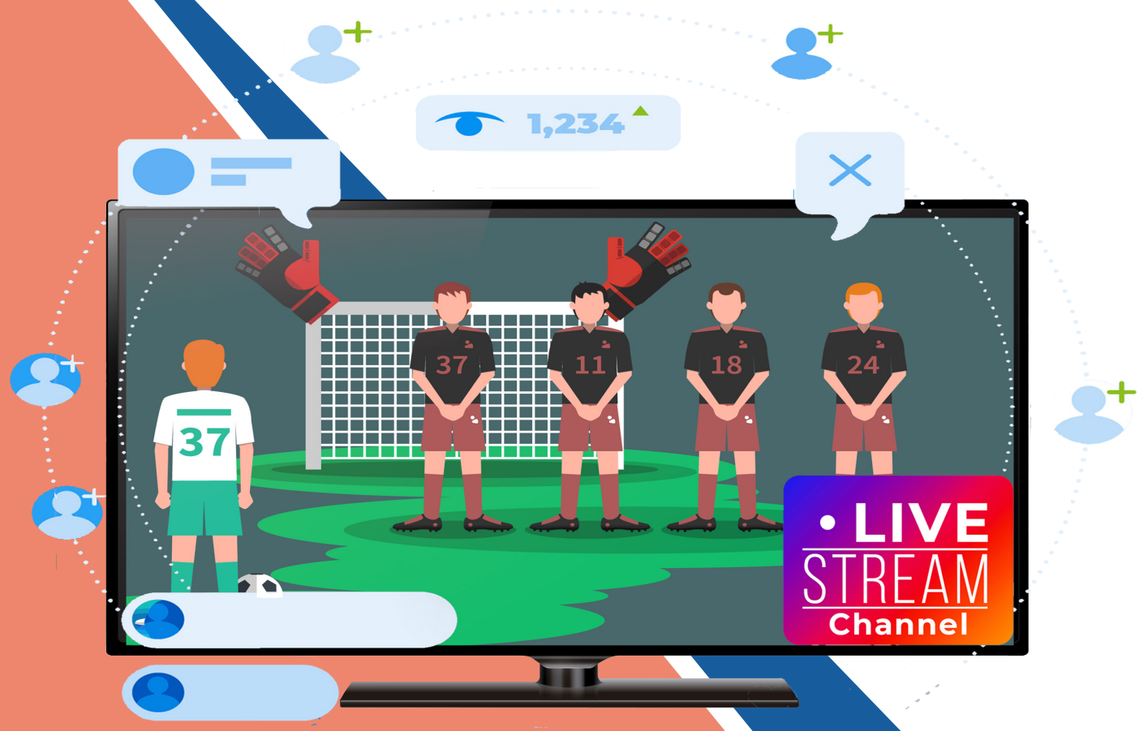


Internet distribution of major sport events, such as TIM Serie A, has proven that a transition from traditional digital television to video streaming is now technically viable at scale. Streaming content management and distribution platforms on broadband and UBB, including 5G, are gaining a central role. OTT video streaming services use, to date, a combination of adaptive protocols (ABR streaming) in unicast with a set of different Content Delivery Networks (CDN).
The complexity of OTT streaming distribution architectures can lead to very different levels of overall Quality of Experience (QoE) for a specific service. To overcome these issues, a solution capable of ensuring service levels comparable/better to those of the broadcast television system is necessary. TIM is working to evolve its network infrastructures and services to support content streaming distribution with innovative platforms (e.g. in the Head-End), increasing the CDN capacity and using Multicast-ABR. TIM can enable an open, common and interoperable initiative at a national level, capable to satisfy Italian content market specific requirements and to ensure its future evolution.

Introduction and Context

Introduction

2021 represented a turning point for the offer of digital audiovisual content in the Italian market. Distributing major sport events on the internet, such as Serie A TIM, highlighted that transition towards streaming is now not only technically viable, but represents entertainment natural evolution in our country as well.

Content distribution via IP becomes increasingly relevant and convenient in Europe. Telecommunication Operators (and broadcasters) are in a position to seize this opportunity.

In this transition, Telecommunication Operators are moving with different business models to offer Video Streaming solutions to end customers or broadcasters in Wholesale mode (Figure 1).

Video streaming: the new television

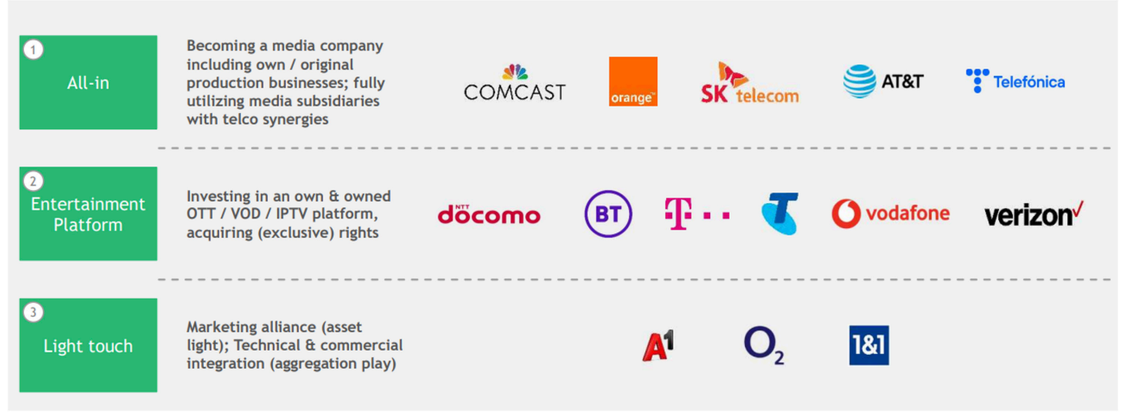
In Italy, streaming broadband and ultra-broadband content management and distribution platforms, including next-generation mobile networks (5G), are assuming an increasingly central role in broadcaster plans.

All broadcasters operating on the Italian market have started trials and, in many cases, real commercial streaming services to place beside traditional linear programming.

“Over-the-Top” video streaming services use, to date, a combination of adaptive protocols (ABR streaming) in unicast with a set of different Global Content Delivery Networks (GCDN) to handle the distribution of the video streams.

Different CDNs may differ in terms of performance, reliability, traffic management capacity, methods of interconnection and

Figure 1: Leading Telecommunication Operators opting for different competitive strategies



dissemination of distribution nodes on the Italian territory or just outside it.

Furthermore, by its nature, unicast distribution imposes scalability limits in traffic volumes linearly growing as a function of simultaneous access number to the same content.

The result is a non-uniform overall quality of experience (QoE), but also operational difficulty in identifying and resolving problems.

A situation that gets more critical as more highly popular live events' distribution is addressed.

These are consequences of using platforms and solutions originally conceived for web and html resource distribution and, over time, adapted, combined, and improved to manage audiovisual content, but still not aligned with the stability and performance characteristics typically required by broadcasters for their linear television services.

Current Situation

TIM video Platform

TIM has long focused on evolving its network infrastructures and services to support content streaming distribution.

Transition from traditional IPTV, managed and vertically integrated, to OTT on-demand mode on a variety of devices represented the first step of a strategy aimed at **creating a set of interconnected and interoperable platforms** for acquisition, content processing and delivery, including live, capable of ensuring service levels comparable to those of broadcast television system.
An infrastructure supporting in-house video services (TIMVISION), but whose components are also commercially available to third parties (e.g. CDN).

The recent technological **partnership with DAZN for Serie A TIM Championship** streaming distribution has further accelerated this evolution process, with major investments in capacity building on its CDN and new technologies' experimentation and adoption.
It has also enabled TIM, as a telecommunications operator and premium content distributor, to defend its customer base from competitors (a recent example is SKY Italia) that leverage on content offering to also propose their own connectivity services.

In addition to communication infrastructures traditionally owned by an operator, today TIM has assets such as:

- TIMVISION, a streaming service and platform for on-demand and live content use, webTV and linear television channels offered over IP.
- A Content Delivery Network (CDN) with widespread Italian territory coverage through geographically distributed POPs.
- A platform able to generate multicast flows in the M-ABR standard.
- A contribution network able to acquire broadcast signals directly from major partners' video production centers in Milan and Rome, to support a multiplicity of formats and transport standards and to offer primary and secondary fallback connections to guarantee service continuity.
- A head-end capable of handling signals up to 4K resolution in a variety of formats and codecs, and production, transcoding, protection and packaging chains.
- A multi-DRM/CAS component aligned with content providers' most stringent requirements for on-demand and live digital content protection.
- A server-side digital watermarking application component.
- OTT cache hosting.

Video content distribution architecture

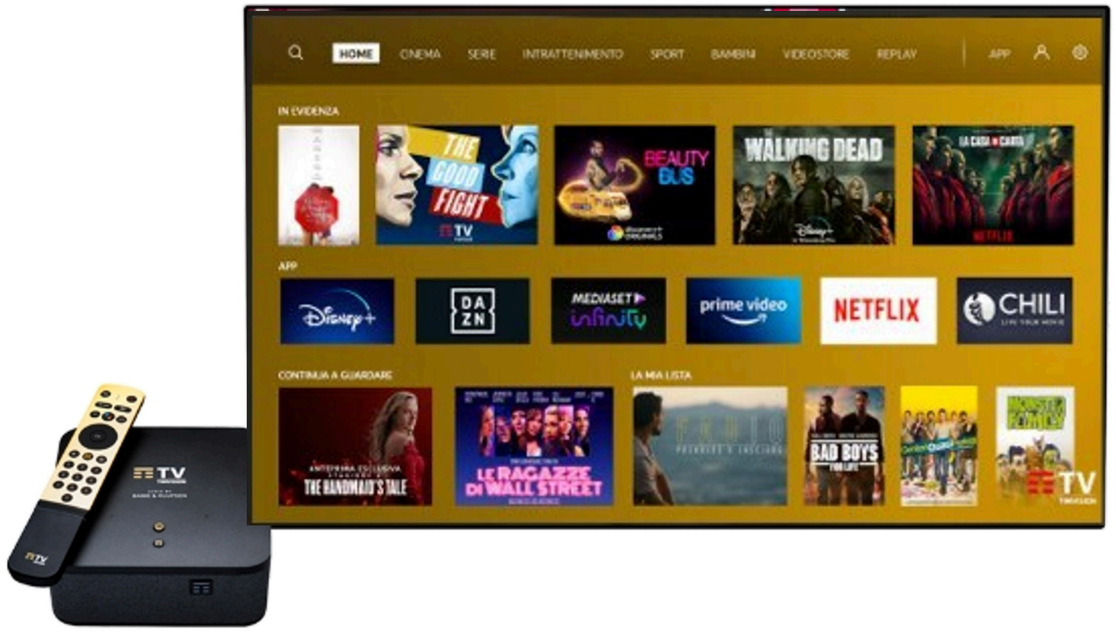
For several years TIM had a **CDN platform** distributed on all OPC POPs accessible to TIM fixed and mobile customers as well as to other operators' customers (e.g. for TIMVision services).

The platform is suitable for distribution of both VoD and live content. The TIM CDN is used to distribute TIMVision contents as well as those of CPs joining in a distribution contract (e.g. DAZN, Mediaset, etc.).

Since 2021 TIM has deployed in its network a platform for Multicast content distribution, compliant with ETSI M-ABR standard, capable of increasing overall scalability in case of massive events, such as sports, and integrated transparently with the existing ABR unicast model.

In parallel to traditional unicast CDN, the M-ABR platform can transport ABR streams from one or more acquisition points to the end user through an operator's **multicast network**, optimizing IP

Figure 2: Tim Vision Box and User Experience



packets replication at router level and avoiding traffic linear increase on network segments affected by an increasing number of concurrent requests.

Benefits of this content distribution method are many: from traffic peaks' efficient management on backbone and access networks to a consequent offload unicast CDN, up to, ultimately, a more stable experience compared to traditional streaming.

M-ABR technology is transparent to the user, and to apps and devices. It relies on ad-hoc software components capable of carrying out Multicast/Unicast conversion within the home network, maintaining intact content and ensuring existing players' streaming and playback logic correct functioning.

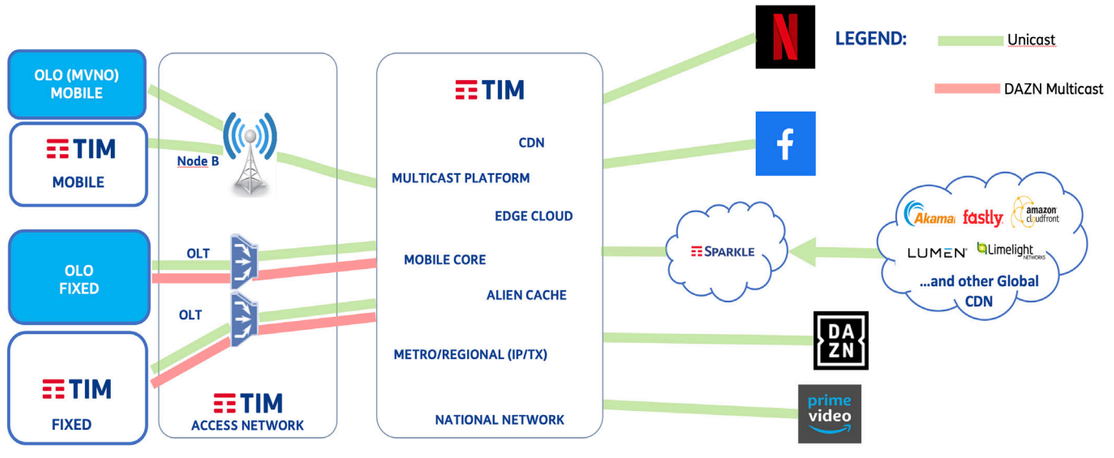
M-ABR platform introduced by TIM has high reliability characteristics being redundant both locally and geographically.

Over the last 4 years TIM has considered it convenient to **activate some OTTs' caches** (Netflix, Facebook, Google and, although with different characteristics, DAZN), identified as **Alien Caches**, in its network.

For OTTs convenience consists in the possibility to offer **better QoE** to end users (leveraging lower latency) while for TIM convenience derives from important **traffic offloading** in peering with TIS and in OPC's geographical links.

At the moment these alien caches are mainly used for VoD content; excepted DAZN caches which are used for live content (Calcio Serie A) and act as a backup with respect to TIM CDN.

Figure 3: Architectural Schema for video content (live and VOD) distribution



TIM OTT peering

Currently OPC (Optical Packet Core) backbone is connected to Big Internet through Sparkle at interconnection points in Milan.

However, it itself has direct connection points with main OTTs worldwide.
Direct connections (also called PNI) with OTTs are essentially functional to filling alien caches for video content delivery and for live contribution flows to CDN TIM and M-ABR platform.

Company Position and Guidelines

National Video Distribution Platform: an opportunity for TIM

Due to the upcoming transition to distribution via IP (forced also by the refarming of the DTT 700 MHz bands for future use by mobile operators), the options available to broadcasters to secure television system future are limited: build and operate a proprietary IP distribution infrastructure, facing huge up-front investments and technical-regulatory constraints or support and join an open, common and interoperable initiative, capable of fulfilling Italian content market's specific requirements and ensuring its future evolution.

TIM should exploit the opportunity that is being created in the television market to propose, at national level, **an innovative and horizontal infrastructure for content management and distribution over IP meeting broadcasters' operating in Italy specific requirements.** This infrastructure shall be, in principle, open to all the actors interested in distributing their own content. Compared to possible Business Model described in the first paragraph (Figure 1), the objective is to leverage on the Entertainment Platform model with the addition of dedicated advertising management.

Main features of the National Video Distribution Platform (NVDP) shall be:

Seamless integration into the television ecosystem: linear content delivered via IP shall be provided with similar mechanisms to those currently available for broadcast content on TV receivers. This is possible through DVB-I technology support for definition, discovery and access to media services.

Hybrid Multicast/Unicast distribution mode: depending on the type of event, its popularity and support on network side, access gateway and user devices, the platform shall be able to transparently use either unicast or multicast distribution modes, maximizing solution scalability.

Possibility of Wholesale mode offering in video: important investments made by TIM for CDN platform expansion and M-ABR platform introduction could be exploited to create a wholesale services portfolio for video content distribution to be addressed to those OAOs that are not going to support infrastructure investments for video distribution.

Direct connections Evolution: apart from live events (that are very impulsive by nature) Global CDN regularly delivers several hundred gigabits of video content; it is worthy checking the opportunity to open further direct interconnections with other important ITZ players (OTT, CP, etc.) to get the end user "closer" to multimedia contents available on

global CDNs and to ensure greater resilience at the same time.

Mobile Streaming: mobile networks evolution allows video traffic management on smartphones and tablets no more as a simple appendix to the Main Screen offer, but rather as a real component integrated in a hybrid distribution platform. 5G Media Streaming (5GMS) defined by 3GPP and further eMBMS extensions are initiative to accelerate transition of the video architecture on mobile to OTT streaming models.

End-to-End delay: In Italy, terrestrial and satellite broadcast channels have delays estimated to be between 3 and 7 seconds, while streaming services based on ABR protocols typically have between 20- and 40-seconds delays, with peaks exceeding one minute in network congestion case.
However, already today, it is possible to reach delays comparable to those of digital television by adopting DASH and HLS solutions' low latency extensions.

Content Security and Protection: in compliance with requirements expressed by content providers, TIM platform integrates security measures and content protection technologies necessary to guarantee contents authenticity and their lawful use by users.

Thanks to MPEG Common Encryption (CENC) standard, content is protected to simultaneously support different Digital Rights Management (DRM) systems. Server-side watermarking techniques are also used to protect copyright and avoid unauthorized content re-distribution.

AD Insertion and Targeted AD: advertising space sale represents a primary income source for the television industry. It is therefore natural that a multi-network and multi-device model includes a wide range solution support to manage advertisements and increasingly accurate audience profiling, fully exploiting broadband connectivity potential.

Conclusions

TIM is today the only organization operating in Italy with infrastructure, technologies and skills to design and implement a convergent national platform for video content distribution.

The platform shall be horizontal, interoperable, and open to broadcasters, service and content providers.

Availability of existing content distribution assets in TIM is unique in the national industry landscape, allowing to start immediately the process of integration and technology evolution towards a single platform.
A national content distribution platform represents a central asset for the Media Industry development and, more generally, for the entire digital publishing market in our country, helping to strengthen its competitiveness at European and global level.■

Contributing Companies

Contributing companies to this article is: TIM Italy.

Acronyms

3GPP	Third Generation Partnership Project
5GMS	5G Media Streaming
ABR	Adaptive Bitrate
AENF	Architecture Enabled Network Function
CAS	Conditional Access Systems
CDN	Content Delivery Network
CP	Content Producer
DRM	Digital Right Management
DTT	Digital Terrestrial Television
DVB	Digital Video Broadcasting
ETSI	European Telecommunications Standards Institute
ITZ	International
M-ABR	Multicast Adaptive Bitrate
NVDP	National Video Distribution Platform
OAOs	Other Alternative Operators
OTT	Over The Top
OPC	Optical Packet Core
PNI	Private Network Interconnection
PNDV	Piattaforma Nazionale Distribuzione Video
QoE	Quality of Experience
TIC	Transparent Internet Caching
VOD	Video On Demand