White Paper

Evolution of Content Creation and Delivery

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Introduction

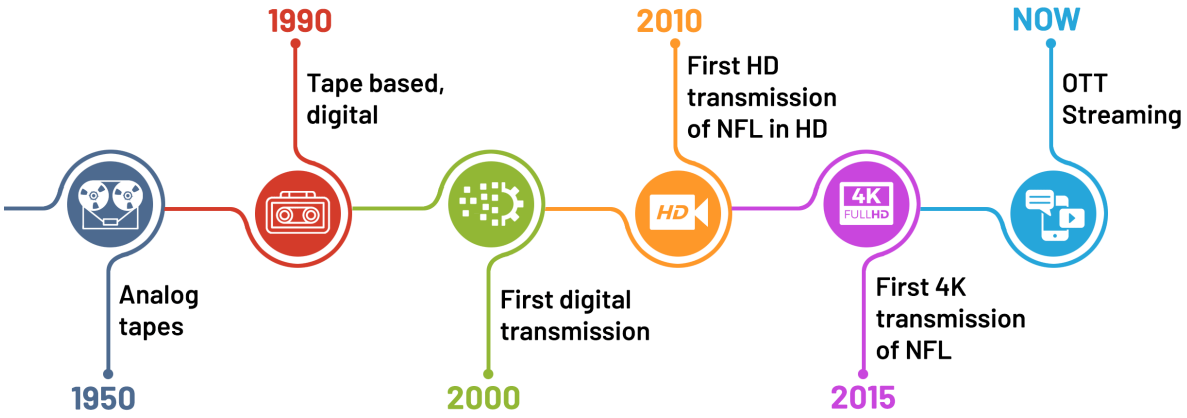
The media landscape has changed drastically over the last several decades. Since the year the first television was invented in 1927, technology has evolved to the point that watching black and white pictures on the television is a distant memory. Today's consumers are enjoying a wide range of content, anytime, anywhere on any screen, including TVs, smartphones, and tablets.

Behind the scenes, workflow and technology advancements have helped the media industry progress to where it is today. Not only is the content creation process different, the delivery, formats, and methods for inspecting content quality have changed too.

As a result of all this change, consumer demands have also shifted. OTT is growing. A recent report from Grabyo[i] found that the global market penetration of OTT services has hit 38%, with growth accelerating across all consumer segments. Video quality is more important to consumers today than it ever has been.

This paper will examine the tectonic shifts that have occurred within the video environment related to content creation, preparation, delivery, and quality control. It will also discuss why QC is critical today and explore the role it plays in enabling broadcasters to deliver high quality multiscreen video.

History of Content Creation and Delivery



History of Content Creation & Delivery

In the 1950s and 1960s television boomed. Between 1949 and 1969, the number of households in the U.S. with at least one TV set rose from less than a million to 44 million[ii]. As TV became more popular, the way that video was created and delivered simultaneously advanced.

Linear to nonlinear TV

Television began as a linear experience, where programs were scheduled and watched at a set time by viewers. Programs could not be fast-forwarded or watched at a later time. Content was available to people in two forms:

1. Linear broadcast.
2. Published content, via reels.

People who could afford to do so would buy reels and play them on giant-sized projectors. (That is how movies were distributed to cinema halls — by shipping reels, which took days to create copies for each cinema). Then VTRs emerged in the 1970s, and content could be transferred from reels to tapes. People could then buy or rent VHS tapes and watch movies and programs at their convenience. VTRs evolved into CDs, and CDs into DVDs. With each transformation, more content could be packed into less disk space, and the media became leaner. However, the mode of content acquisition and delivery remained the same.

Linear to Nonlinear TV

With the evolution of the internet and broadband, the broadcast industry started dating IT developments. The industry developed an alternative to physical media — to deliver video electronically — allowing consumers to download content over the internet and play it on their TVs and computers. This signalled the arrival of VOD. VOD first appeared in the early 1990s, altering the way that consumers acquired and watched video. Then in 1997, Netflix was born and completely flipped the model of linear television on its head. Watching video today is much more of a nonlinear experience, enabling viewers to choose what they want to watch and

when they want to watch it. The nonlinear television experience is defined by interaction: viewers interact with video by choosing a show to watch through a SVOD service or setting a show to record for later. [iii]

Analog to digital

The shift from analog to digital occurred sometime in the 1990s and had a profound impact on TV. Digital TV ushered in a completely new way of transmitting A/V signals, relying on digital encoding as opposed to analog signals. The development of digital TV was considered extremely innovative and represented the first significant evolution in television technology since color television in the 1950s.[iv]

Digital TV opened up all the advances and developments in the DSP world to TV content. The curvature of TVs went from bulging out at the center to flat TVs, to a reverse bulge. Resolutions changed — QCIF to SD to HD and now we are not satisfied with even 4K. The aspect ratios evolved from 4:3 to 16:9. Digital content could be compressed, analyzed and processed in more ways than one could even imagine in the 1980s. The industry loved it. In some ways, things became simpler, but not in every way.

With the switch from analog to digital, a new level of complexity was introduced to the broadcast ecosystem. Multiple different standards were adopted for digital TV production and distribution. The U.S. adopted ATSC, while Europe embraced DVB. Other countries picked up variants of these. As researchers developed compression techniques, they dumped a number of formats on the media industry — MPEG-2, MPEG-4, HEVC, and many more. From an audio angle, many standards were created and had to be supported, including Dolby Digital, AC3, DD+, and LPCM. Subtitling was no different. More than 10 different closed captions and subtitle formats were developed and adopted over the span of 10 years. The technology and toolset providers were required to support them all. Within 20 years, the industry went from having a single analog format in the 1980s and early 1990s to struggling to support more than 50 formats, despite standards bodies like EBU, IEEE and ATSC doing their jobs. Broadcasters transitioning from analog to digital had to completely overhaul their infrastructure. On the consumer side, viewers without a digital TV had to use a set-top box to receive digital TV signals.

The transition from analog to digital broadcast started in 1996. DIRECTV launched the first digital satellite platform in 1994. Mass deployments started thereafter, with digital cable broadcasts launched in the U.S. in 1996 by TCI and Time Warner. In 1998, ONdigital launched the first digital terrestrial platform in the UK using the DVB-T standard.

Hardware to software

Until the end of 2000, the tech industry was happy supplying tools on proprietary hardware. Proprietary hardware had issues. Broadcasters were held at ransom by the tech suppliers, support took a long time, and they could not take advantage of Moore's Law. As hardware doubled in speed and capacity everyone and a half years, broadcasters were stuck with hardware and systems procured three years ago. There was clearly need for broadcast solutions to run on standard IT hardware to alleviate these issues. In the early 2000s the shift started happening. Many equipment vendors began replacing their traditional proprietary hardware-based equipment with standard IT-based hardware, software, and storage systems.

Running software solutions on commercial-off-the-shelf hardware opened up new workflow efficiencies, allowing the industry to improve hardware speeds and capacities, reduce dependencies on vendors, increase power savings, and reduce opex and capex costs. In addition, it requires less technical staff. Software solutions can more easily be scaled up and down, which is another key advantage of this technological shift.

Tape to file-based

Historically, video was recorded on tape. Most archives, broadcasters, universities, governments and television stations have accumulated and stored thousands of hours of content on analog tapes over the years. A typical broadcaster may have nearly 100,000 to 200,000 tapes of one-hour duration collected over a 10-year period. While a few stations might have Super 8 or U-matic tapes, the majority of the tapes are a mix of Betacam (SP/SX Digital/IMX), XDCAM or HDCAM.

At some point the industry recognized that tapes are expensive to back up and operationally inefficient. Preserving tapes requires space, maintaining correct tags, and sorting of the tapes in correct sequence. Moreover, tapes are more prone to wear and tear.

Perhaps most importantly, by design, tape workflows are linear and do not allow simultaneous processing of the same media. Masters used to be created in digibeta. From this point, several other digibeta, VHS or other media copies would be generated and processed in parallel for editing, technical QC, versioning or review. This resulted in duplicate workflows, complex management of versioning and long processing cycles. The sheer number of tapes that broadcasters owned became an issue.

Also, the quality of the tapes deteriorates over time. In many cases the recoverability of the programs from the old tapes can no longer be guaranteed. It wasn't uncommon for a tape to be returned for archive twisted and worn out.

Tapes started becoming obsolete in early 2000, as file-based workflows emerged and more and more broadcasters began migrating to this new workflow. Initially, newer channels were launched digitally whereas legacy channels still existed in a tape-based workflow. Media files started coming through hard disks, FTPs, Signiant or Aspera tools along with legacy tapes like digibeta or VHS.

File-based workflows provide tremendous operational efficiency, as the ingested file in central storage can be simultaneously accessed by different departments and user groups like editors, journalists, graphics and post-production, censorship and directors. This cross-functional nonlinear workflow along with tight access control opened a new dimension of media processing. Broadcasters could access and retrieve files infinitely faster from archives. Making the files part of a digital workflow also meant that broadcasters could create online content for new audiences and monetization opportunities.

Delivery over managed networks to the internet

The final piece of the video workflow — delivery — has also undergone major transformations throughout the years. For a long time, traditional terrestrial, satellite, and cable television were the key ways to distribute video. Delivery was evolving in several different ways — from being pushed to being pulled by the customer and from using proprietary delivery infrastructure to using public infrastructure.

In the 1990s the premise of IPTV emerged. It wasn't until the mid-2000s that IPTV started being deployed at a mass scale. In 2005, SureWest Communications was the first North American company to offer HDTV channels over an IPTV service.

During the 2000s, the concept of video streaming emerged, partially thanks to the growth of high-speed broadband networks around the world. Then the question became: Why can't we deliver content over the top (OTT) of this well-laid out, publicly available internet backbone? OTT arrived. Smartphones were in the hands of almost every consumer, and the demand for video content anytime, anywhere on any device became a reality. OTT started replacing traditional broadcast around 2015. The number of U.S. broadband households subscribing to two or more OTT services has more than doubled since 2014, according to a study by Parks Associates. Nearly half — 46% — of all broadband homes had multiple OTT subscriptions in 2019, the study found, up from 33% in 2017 and 20% in 2014. [v]

OTT video distribution has changed the way that viewers watch TV. The old approach involved video being pushed out to a mass audience. Video delivered over the internet involves individual viewers requesting the content that they want.

Changes in Content Preparation

As video has shifted from a linear to nonlinear viewing experience, with content now streamed over the internet as well as managed networks, the general way that broadcasters and media companies prepare and deliver video has transformed completely.

Regional content gets localized on a global scale

Video delivery over the internet is easier to scale, making it possible for broadcasters and service providers to deliver localized content to viewers across all regions of the world. Look at Netflix, for example. Netflix started in the U.S. in 1997. By 2017 it was operating in over 190 countries, and today close to 73 million of its some 130 million subscribers are outside the U.S.[vi]

As broadcasters and service providers expand their global reach, they are preparing video content in a wide range of different languages. This means they are having to account for national and regional regulations, dubbing, and captions.

The path from fixed devices to handheld

A broadcaster used to only have to worry about delivering video to one screen: the TV. Today, there are a multitude of devices, including TVs, smartphones, tablets, and PCs. Each of these devices has a different screen size and supports different formats.

Format changes

Video formats used to be simpler when broadcasters were handling digibeta and VHS tapes. While these formats had their own limitations and challenges, they were fairly straightforward.

Now that video streaming has boomed, broadcasters are handling multiple formats in multiple resolutions. In order to cater to wide range of devices with multiple screen sizes, OTT content needs to be transcoded to various delivery formats, including HLS, DASH, MSS, and HDS. OTT content must also be encrypted with different DRM protection schemes, such as Microsoft PlayReady, Google Widevine, and Apple FairPlay. With so many variations to maintain, broadcasters are dealing with a massive amount of content.

Content Quality Evolution

As the video creation, preparation and delivery process has morphed from a simple monolithic to a complex multi-dimensional globally appealing process, ensuring the quality of content delivery has also grown exponentially. Visual inspection used to

be enough to detect issues with the audio and video stream. But now that broadcasters and service providers are handling a substantial amount more volume of content, with multiple encoding formats, resolutions, audio and captions in multiple languages, audio suited for different fidelities of end devices, multiple delivery mechanisms and many more complexities. All of these need to be verified and ensured before the broadcaster makes the content available for delivery. Delivering exceptional quality has become more challenging than ever before.

Today's viewers expect the same quality for OTT as broadcast. A study by research firm Sensum found that a viewer's negative emotions increase 16% while engagement decreases nearly 20% as a result of poor quality streaming experiences. The survey also found that 76% of participants would stop using a service if issues such as buffering occurred several times.[vii]

For these reasons, automated QC solutions are a critical and integral part of broadcast requirements today.

The role of automated QC today

The auto QC process is fast, efficient, consistent and reliable. When coupled with a manual review process it allows broadcasters and service providers to achieve higher levels of productivity and improved quality. There are multiple ways that automated QC systems speed up operational efficiency and improve accuracy.

Using an automated QC system, broadcasters can quickly check the quality of baseband video and audio, check the quality of closed captions and subtitles, ensure compliance with industry and government regulations, and address the wide range of OTT and on-demand delivery ecosystem requirements.

The Future: ML and AI

Traditionally, the focus of QC systems has been on compliance and technical quality checks. Classifying and categorizing content for censorship purposes and creating corresponding metadata is typically done manually.

However, VOD and OTT delivery require a much faster and wider variety of metadata generation for content classification. Aside from censorship purposes, broadcasters need to classify content that includes celebrities, events, and more.

In the future, broadcasters and service providers will increasingly rely on Artificial Intelligence (AI) and Machine Learning (ML) technologies, combined with computer vision techniques, to improve content quality. These technologies have a huge role to play in helping service providers develop more intricate QC algorithms. Next-gen algorithms will utilize these technologies along with natural language processing, visual text recognitions and other methods to accurately detect video and audio that includes violence, explicit content, alcohol, smoking, and more. General content classifications such as the nature of advertisements, celebrity identification, and presence of brands or objects within content is also becoming simpler with these new tools.

Conclusion

At the 92nd annual Oscars, at what is arguably the biggest night in the movie business, Netflix was up for the most nominations of any movie studio. The online streaming giant received 24 nominations at the 2020 awards show, including two for best picture. It marked the first time a streaming service had more nominations than Hollywood movie studios at the Academy Awards.

What does this say about the media landscape? It's rapidly changing. Over the years the media industry has endured major transformations, including the shift from linear to nonlinear viewing, tape to file-based workflows, analog to digital, and broadcast to OTT delivery. New formats have been developed, viewer preferences have changed, and of course technologies have advanced. Ultimately, today's broadcasters and service providers are managing a significant amount more content.

The stakes have never been higher for delivering high-quality video on every screen. And the chance for errors has never been greater, given the increased complexity of today's workflows.

Today, broadcasters and service providers need advanced auto QC solutions to provide exceptional audio-video quality on every device. They need QC solutions that go beyond providing simple audio and video checks, taking them to the next frontier of classifying and categorizing content using ML, AI and computer vision technologies. The path to success in today's competitive media environment can be challenging, but it is achievable with the latest auto QC solutions.

[i] https://advanced-television.com/2019/11/12/research-ott-penetration-hits-38/

[ii] https://livinghistoryfarm.org/farminginthe50s/life_17.html

[iii] https://en.wikipedia.org/wiki/Non-linear_media

[iv] Kruger, Lennard G. (2002). *Digital Television: An Overview*. New York: Nova Publishers. ISBN 1-59033-502-3.

[v] https://deadline.com/2019/10/half-of-broadband-homes-have-multiple-streaming-subscriptions-parks-associates-1202750361/

[vi] https://hbr.org/2018/10/how-netflix-expanded-to-190-countries-in-7-years

[vii] https://www.akamai.com/us/en/about/news/press/2017-press/quality-of-ott-video-streaming-experiences-directly-tied-to-viewer-loyalty-service-provider-success.jsp