Capgemini engineering

GOOD TIMES FOR OVER THE TOP

What it takes to build successful OTT solutions

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Executive summary

Over the top (OTT) is a platform that delivers media content through on-demand and live video over the internet. It allows viewers to watch content on multiple platforms such as mobile devices, smart TVs, laptops, and tablets. The OTT market has grown significantly in the last few years and is projected to post strong growth through 2025. The coronavirus pandemic acted as a catalyst for OTT market growth in 2020.

This surge in OTT demand is incentivizing new players to enter the market. Prominent players in the OTT space include Netflix, Hotstar, Hulu, Disney+, HBO Max, and Amazon Prime. The OTT industry faces some technical challenges that could hinder market growth if not adequately addressed. With multiple evolving OTT technologies to choose from and digital technology advancing rapidly, OTT service providers must have the right technologies and strategies to gain an edge over the competition.

The topics covered in this paper include:

- Key OTT technical challenges in OTT solution development, models, components, and critical features
- A comprehensive look at the essential components of OTT solutions that consist of a content delivery network (CDN) strategy, monetization models, hosting, streaming protocol, transcoder, cross-platform support, security practices, payment gateways, and user profiling
- Capgemini Engineering's point of view on hybrid and custom OTT architectures using AWS
- Comparisons between custom and commercial OTT back-end solutions

Introduction

Over the top (OTT) streams media content directly to viewers over the internet without the need for traditional cable, broadcast, or satellite platforms. It can provide services in various categories such as video, music, podcast, audio and video streaming, and gaming. OTT lets viewers watch content anytime and anywhere through an internet connection on computers, laptops, mobile devices, and smart TVs. The improvement in internet accessibility and adoption through high-speed data networks has been the driving force behind the OTT market's tremendous growth in the last five years.

2020 was a turning point for the OTT industry because of the COVID-19 pandemic. Having limited access to cinemas, malls, and other entertainment sites, people turned to OTT for their daily dose of entertainment, boosting OTT's growing popularity to an all-time high.

Home entertainment through OTT offers viewers multiple content choices, the flexibility to watch content from anywhere, and a seamless experience through personalization. The unprecedented growth is an incentive for more businesses to launch OTT offerings.

There are exciting opportunities ahead for OTT service providers. Of course, every opportunity comes with challenges and the OTT industry is no different as service providers face technical challenges that could hinder growth.

The global OTT market is expected to grow at a CAGR of 15% from 2021 to 2026, according to an EMR report.

Top technical challenges for the OTT industry

OTT service providers need the right strategy and partnerships with technology experts to overcome challenges. Here are three areas to focus on:

Viewer retention
It is easy for users to switch between OTT service providers as there are many competitors, and the volume of content is large and diverse. The primary challenge is to attract and retain subscribers who are loyal to your OTT solution. Retaining viewers requires engaging content, a unique user experience, and personalization.

Quality content delivery on multiple OTT clients
OTT content can be viewed through multiple OTT clients, such as smartphones, smart TVs, and tablets, and many operating systems including Android, iOS, LG OS, Samsung Tizen, and tvOS. Adaptive streaming and streaming metadata synchronization on different OTT clients are significant technical challenges. These challenges become more complex with the unpredictability introduced by wireless interference and signal loss on Wi-Fi and cellular networks. OTT client technology choices should consider high quality, stable viewing experiences, efficient content discovery, and maintainability across all devices and operating systems.

Performance and scalability
OTT broadcasts high-resolution video content that requires high processing power on the back-end and an efficient content delivery network (CDN) at the edge to dynamically switch content resolution depending on the bandwidth available to the end-user's device. Also, the OTT solution should be scalable to meet surges in demand.

Factors to consider before defining an OTT solution strategy

Software development starts with an understanding of the needs and pain points of the customers and businesses. We have identified five essential factors that are required for a successful OTT solution. (See Figure 1)

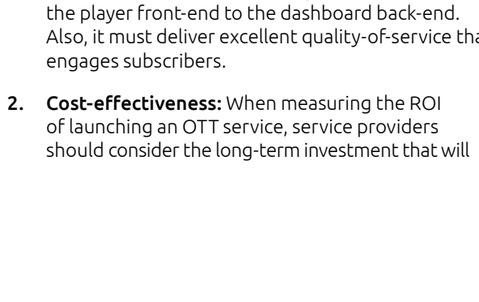

Figure 1: Top five factors to consider for a successful OTT solution strategy

Source: Capgemini Engineering

1. **Customizable:** One of the most important criteria to measure OTT success is customer engagement. An OTT solution should be fully customizable, from the player front-end to the dashboard back-end. Also, it must deliver excellent quality-of-service that engages subscribers.

2. **Cost-effectiveness:** When measuring the ROI of launching an OTT service, service providers should consider the long-term investment that will be required. Commercial solutions may look cost-effective to start with, but the lifetime license payment may exceed the investment needed in the hybrid model.

3. **Monetization model:** There are three main revenue models to consider that can be blended to form a hybrid model:

   a. **Ad-based video on demand (AVOD):** In the AVOD model, the business generates revenue by charging advertisers a fee for running ads. This model has an advantage in gaining consumers, as content consumption is free as long as consumers are willing to watch ads.

   b. **Subscription video on demand (SVOD):** In the SVOD model, businesses charge a recurring fee to consume the content. Subscribers gain access to content based on the subscription plan they select.

   c. **Transactional video on demand (TVOD):** Also called pay-per-view, the TVOD model charges consumers a one-time fee to view a video.

   d. **Hybrid video on demand (HVOD):** The HVOD model combines the AVOD, SVOD, and TVOD models. OTT providers design their monetization model to maximize revenue. For example, they could provide a premium services subscription option, a pay-per-view option, and a free ad-supported service. The HVOD model can increase the user base for OTT providers and help the service provider transition users from a free service to a subscription model.

4. **Deployment strategy:** OTT providers always have the option of on-premises development and cloud deployment. Considering the pros and cons of on-premises hosting, cloud hosting has a significant advantage in scalability and time-to-market. While cloud adoption is essential, selecting the best way to implement the cloud model is up to the business. A hybrid model is one of the best ways to implement cloud infrastructure into the organization.

5. **Time-to-market:** This is one of the most critical aspects of an OTT solution strategy. If OTT service providers want to launch services quickly, then commercial solutions offer an advantage. However, when OTT service providers plan for the long term, adequate time should be allocated to develop and integrate the OTT solution.

OTT solution development models

Choosing the best development model is very important for the success of the OTT solution. Depending on the focus of the organization, there are three primary development models to consider:

In-house OTT solution development

This includes building all components in the OTT solution in-house. This option should be regarded as if the focus is on technological evolution and building core intellectual property.

Commercial solutions

There are multiple commercial off-the-shelf OTT solutions available in the market. These solutions offer two models, Software-as-a-Service (SaaS) and Software-as-a-Product (SaaP). SaaS is a pre-built OTT back-end that service providers can utilize on a monthly subscription basis. SaaP provides a white-label OTT back-end that includes software that the service provider can customize to their requirements.

Hybrid models

This approach is a combination of the in-house and commercial off-the-shelf models. The OTT ecosystem consists of basic building blocks where the maturity and stability of the components are essential. The market is so vast that there are mature solutions readily available for these basic components. Depending on the business objective, time-to-market, and technology investment appetite, OTT service providers can decide which components to develop in-house and which components to purchase. Then, all the components can be integrated to build a complete OTT ecosystem.

OTT ecosystem

Five building blocks comprise the end-to-end OTT ecosystem. (See Figure 2)

OTT client

The OTT client is the end-user interface for streaming media content that includes laptops, smartphones, tablets, and connected TVs. Clients consist of an OTT front-end application that handles the user interface, decoding and decryption to play the media, and a device abstraction layer to render the media that depends on the underlying platform.

Content delivery network

A CDN delivers content to the OTT client. It consists of caching servers placed at strategic locations worldwide that work together to provide the content closest to the OTT client. A CDN reduces the load on content servers and facilitates the scaling of the OTT system.

Multiple CDNs
Due to the high demand for OTT content, the traffic load on CDNs can push their capacity to the limit. In the multiple-CDN solution, traffic is distributed to multiple CDNs to reduce the chance of failure. CDNs are designated as primary or secondary. If a failure occurs in the primary CDN, traffic falls back to the secondary CDN.
The multiple-CDN solution provides reliable quality and availability of the service.

Transcoder
Seamless transcoding is the backbone of any OTT ecosystem and is essential for an uninterrupted viewing experience. Each OTT client has a unique requirement for video size, format, and audio. Seamless encoding to a wide range of devices enhances the reach of the platform. The OTT ecosystem should be capable of adaptive bitrate streaming to auto-adjust the quality and support multiple file formats.

Streaming protocol
Streaming protocols are responsible for delivering the data over the internet. They include RTMP-, RTSP-, and HTTP-based adaptive protocols such as Apple's HTTP Live Streaming (HLS), and Adobe's HTTP Dynamic Streaming (HDS) and Dynamic Adaptive Streaming over HTTP (DASH), also known as MPEG-DASH.

HLS is the most widely used protocol, as it supports adaptive bitrate streaming. This enables HLS to deliver the best quality video for a viewer's internet connection. HLS is also robust and effective.

Selecting a streaming protocol depends on the platform's requirements, such as scalability, latency, codec, and adaptive bitrate streaming (ABR). HLS supports most browsers and devices. MPEG-DASH is codec-agnostic.

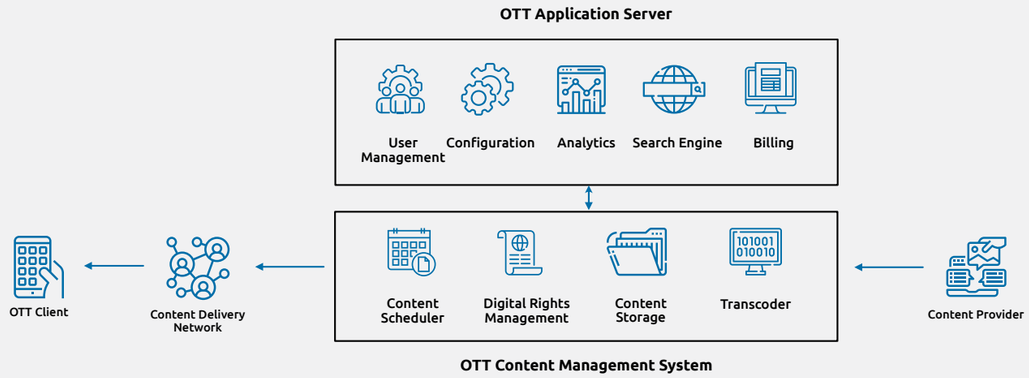

Figure 2: The OTT ecosystem

Source: Capgemini Engineering

Content management system

The content management system (CMS) is the core platform of the OTT ecosystem. It receives content from content providers, then processes, manages, and stores it. The CMS uses a transcoder to generate multi-bitrate and multi-resolution content from the source content provider. It stores the encoded content and has a scheduler to maintain the schedule and program information for the content that is made available to OTT clients.

The CMS also contains a digital rights management (DRM) component to prevent unauthorized redistribution of copyrighted digital media and limit how consumers can copy content they have purchased.

OTT application server

The OTT application server is a back-office server that handles various OTT back-end services, such as:

- **User authentication:** The user profile ID manages access to content based on the user's subscription
- **Billing management system:** As part of billing management, integration with various payment gateways supports different monetization models for proper billing to OTT users
- **Search engine:** The implementation of a robust search algorithm is essential for effective search of OTT content
- **Analytics:** The implementation of analytics to collect data for further analysis can improve the platform's service, performance, and quality
- **Personalized content:** Organized data makes requests easier to process and helps personalize recommendations. With the help of viewing history, location, and several other data points, customized content is delivered to the viewers. This enhances the viewing experience, which in turn increases the value of the service to the user

Building an OTT back-end on AWS

There is no one-size-fits-all solution for building an OTT ecosystem. The OTT ecosystem building blocks need to be seamlessly integrated. And the OTT back-end infrastructure must provide flexibility and scalability for ingestion, storage, processing, and distribution. Capgemini Engineering conducted research on a number of competitors during the selection process for a back-end solution provider. We selected AWS because no other cloud provider had such an elaborate set of services. Here we present a sample architecture of an OTT back-end built on AWS that balances flexibility and time-to-market. (See Figure 3)

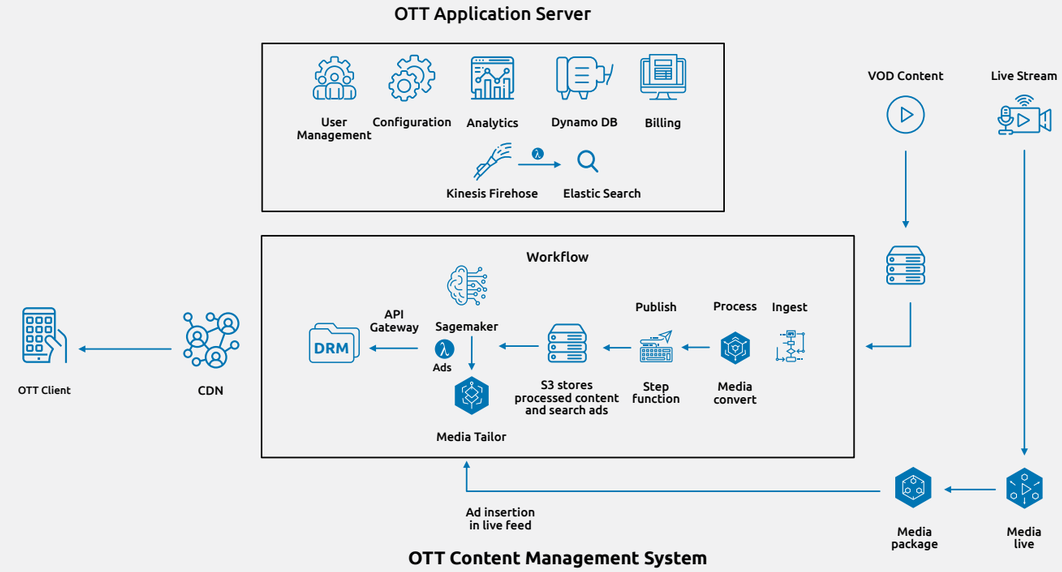

Figure 3: OTT backend system architecture based on AWS

Source: Capgemini Engineering

Components of the OTT content management system

Content ingestion and storage
There are many different sources of digital content. The raw media files can be ingested from a hard disk, on-premises or over the internet. In this example, Amazon S3 is used to store raw digital content from various sources, and Amazon Glacier is used for file-based archiving and long-term backup. Information that is not regularly used can be kept in Glacier. A policy can be created within S3 to access Glacier's data and determine when data will be retrieved. This way, only recently opened files are stored on S3. Older files, which are accessed infrequently, are moved to Glacier.

Content processing
AWS step functions are used to handle the content processing logic. They ensure that the logic is executed step-by-step and performed in the order listed. In case of a failure, AWS step functions run retry logic and maintain error handling. OTT applications are distributed and comprise many components. It is necessary to keep all the blocks together.

- AWS Lambda functions trigger the first step function workflow for content ingestion. Once the content is ingested, the step function workflow validates the source files and produces metadata from the source content
- The second step function creates a transcoding profile based on the metadata and submits a transcoding job to AWS Elemental MediaConvert. Once the video is transcoded, the third step function performs validation activity on the output file

AWS Elemental MediaConvert transcodes video content saved in an S3 bucket. Client devices have different screen sizes, resolutions, and bandwidth. To support each device, it is best to convert source videos into formats that are responsive to different networking scenarios.

AWS Elemental MediaConvert:

- Supports adaptive bitrate that plays videos on the client system based on the network bandwidth, resolution, and screen size
- Supports a wide range of MPEG-2, AVC, and HEVC 10-bit 4:2:2 codecs, and HDR 10 and HLG BT.2020 formats. Also, it can convert to and from SDR to HDE and SDR to HDR
- Produces thumbnails from the video by uniformly extracting distributed frames and providing a preview capability

AWS Elemental MediaLive is used for live streaming. Live media from content providers can be ingested directly to MediaLive as an input feed and produce ABR streams as output. If the OTT provider wants to insert ads while live streaming, it can create a MediaLive channel with two input streams for live streaming and ads. MediaLive channels are then scheduled to switch the input from the live feed to ads.

The output of an AWS Elemental MediaLive is ingested to AWS Elemental MediaPackage to package the live stream into HLS, DASH, and CMAF formats that are delivered to a MediaPackage custom endpoint and then to a CDN for distribution.

Content distribution
Amazon CloudFront is used for the distribution of content geographically. CloudFront works seamlessly with S3. Its primary function is to provide secure media content delivery globally with low latency and high transfer speeds. CDN is a globally distributed network of proxy servers. It caches content locally, which increases the speed of content downloading. CDN provides a built-in caching mechanism for video distribution.

Components of an OTT application server

Search engine
Amazon Elastic search is incorporated into an OTT solution. Building an excellent index lets users conduct free-text searches, and analyze and visualize log files.

Analytics
Analytics is changing the future of streaming by creating more precise and personalized recommendations. Analytics provides better predictions on the ads' offerings and helps upsell initiatives and cross-selling. Several third party applications can be implemented in our streaming system, including Google Analytics, Mixpanel, and Hive.

Amazon Kinesis Data Firehose is used for real-time data capture. In an OTT application, a data stream can be captured from real-time client devices simultaneously. The data stream is then sent to an analytical tool for analysis and displayed on a dashboard. Kinesis Data Firehose compresses and encrypts data before sending it to the destination, minimizing storage and adding a layer of security.

Recommendation engine
Machine learning is used to analyze video content and placement of ads or products accordingly. Amazon SageMaker can achieve this in conjunction with AWS Elemental MediaTailor. AWS Elemental MediaTailor is used to insert individually targeted advertising into its live, on-demand video streams without impacting broadcast-level quality-of-service. For on-demand content, it requests an ad from an advertising decision server (ADS). Based on the response from the ADS, it inserts relevant, targeted ads into the stream. Amazon SageMaker is integrated with AWS Elemental MediaTailor to recommend ad content and product placement for users in line with their preferences. Key demographic information such as age and gender are considered when showing ads.

User management
User data security is of utmost concern when building a software solution. Secure user management is essential to deliver reliable OTT broadcasts without any threats. OTT solutions should have security features that include: total control over user access, management of user profiles in a single account to maintain browser history, offline viewing, delivery of personalized content, subscription management, payment integration, refund, email update, onboard and offboard user, and rule setup.

Due to the dynamic nature of user management, Capgemini Engineering recommends building an in-house user management system.

Billing
Building a customized platform enhances the flexibility to choose the most suitable revenue model for the business. Models such as subscription-based and ad-based push TV and pay-per-view can be integrated into the platform. We recommend integrating popular payment gateways with the platform.

Digital rights management
The OTT ecosystem requires the support of multiple client devices. Every device supports one streaming format and one DRM system. Support on maximum devices also requires integration with multiple DRM systems. One way to achieve this is to implement an in-house licensing server and negotiate terms directly with DRM players available in the market. Another way is to use a multi-DRM solution company that integrates multiple DRM technologies to provide a unified API and works with various media-related solutions, such as players and encoders.

Comparison of commercial OTT solutions

This development model is best for OTT service providers who want to quickly launch a platform that does not require much scalability or many features. There are multiple constraints associated with the front-end design and back-end architecture of these off-the-shelf OTT solutions. Figure 4 shows a detailed comparison of popular solutions available in the market.

Features	uscreen	MUVI	dacast	VPlayed	kaltura
Video player	HTML5	HTML5	HTML5	HTML5	HTML5
Infrastructure	Cloud (AWS)	Cloud	On-premises and on-cloud hosting	Storage – cloud	On-premises and on-cloud hosting
Content delivery network (CDN)	Akamai	Akamai, Amazon CloudFront, Cloudflare	Yes	Akamai	Akamai, AWS, and Tata Communications – Kaltura easily integrates with all the CDN providers
Monetization strategy	SVOD, TVOD	AVOD, SVOD, PPV	AVOD, SVOD, TVOD	AVOD, SVOD, TVOD	
Security	Yes	Yes (DRM Protected)	Yes	Yes (DRM Protected)	Yes (DRM supported)
Payment	All credit cards, Stripe, authorize.net, PayPal, Accept, SIPA, direct debit	Stripe, PayPal and Authorize.net. Supports multiple currencies (USD, EUR, GBP, INR, etc.)	Major credit cards, PayPal, Paywall integration	Paywall integration	
Video hosting	Yes	Yes	Yes	Yes	Yes
Website customization	Yes	Yes		Yes (100%)	Yes (100%)
Video API access	Yes		Yes		
Third-party integration	Yes	Yes	Yes	Yes	Yes
Video CMS	VOD, Live streaming	Audio-on-demand, video-on-demand, live streaming	Yes	Audio-on-demand, video-on-demand, live streaming	Yes
Sales and marketing	Yes	Yes	Yes	Yes	Yes
Analytics	Yes	Yes	Yes	Yes	Yes
OTT app	Branded OTT app	Branded OTT app	APIs and SDKs support	APIs and SDKs support	
Platform support	All major platforms (iOS, Android, Roku, Apple TV, Fire TV, and Android TV)	All major platforms (iOS, Android, Amazon Fire TV, Roku, and Apple TV)	All major platforms		
Customization	Yes	Yes	Yes	Yes	Yes
Pros	4K UHD video, cost-effective, no revenue sharing, a better option for SVOD and VOD, website builder, branded OTT applications	Supports live video streaming, video-on-demand, audio-on-demand, physical products, and is feature-rich	Better for live streaming in terms of price	Better for live streaming in terms of price	Highly customizable, HD streaming
Cons	No support for audio channel, customization is limited, no support for AVOD	Expensive	Storage is paid by the user regardless of the plan	No free trials	Complex

Figure 4: Comparison of five leading OTT solutions
Compiled by Capgemini Engineering

Point of view

Now is a good time to be in the OTT business. However, OTT service providers must have the right business strategy to catch the consumer's attention by providing an engaging customer experience. To launch an OTT service, providers can choose between developing the platform or using a white-label OTT solution.

While defining the development and deployment strategy, OTT service providers should be mindful that the increase in online content has led to low switching costs and high churn. Multiple technological challenges must be handled at inception when building and deploying an OTT solution. Adaptive streaming, multi-device compatibility, content management (i.e., transcoding, hosting, and encryption), and a scalable back-end are a few of the factors that set apart best-in-class OTT providers.

Technology infrastructure is a critical success factor now more than ever. Capgemini Engineering brings the perfect blend of the media industry and technology expertise to partnerships with OTT service providers. We can help OTT service providers define the complete end-to-end solution, including the components that need to be developed in-house and those that can be licensed from third parties. Also, Capgemini Engineering can design and develop OTT clients and back-end components and integrate the complete OTT end-to-end system. We can then deploy it on IT infrastructure, or the cloud, for a product launch.

The future of OTT is exciting, and Capgemini Engineering's technical expertise across the OTT ecosystem makes us the technology partner of choice for OTT service providers.

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Capgemini Engineering combines, under one brand, a unique set of strengths from across the Capgemini Group: the world leading engineering and R&D services of Altran – acquired by Capgemini in 2020 - and Capgemini's digital manufacturing expertize. With broad industry knowledge and cutting-edge technologies in digital and software, Capgemini Engineering supports the convergence of the physical and digital worlds. We help clients unleash the potential of R&D, a key component of accelerating their journey towards Intelligent Industry. Capgemini Engineering has more than 52,000 engineer and scientist team members in over 30 countries across sectors including aeronautics, space and defense, automotive, railway, communications, energy, life sciences, semiconductors, software, and internet and consumer products

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