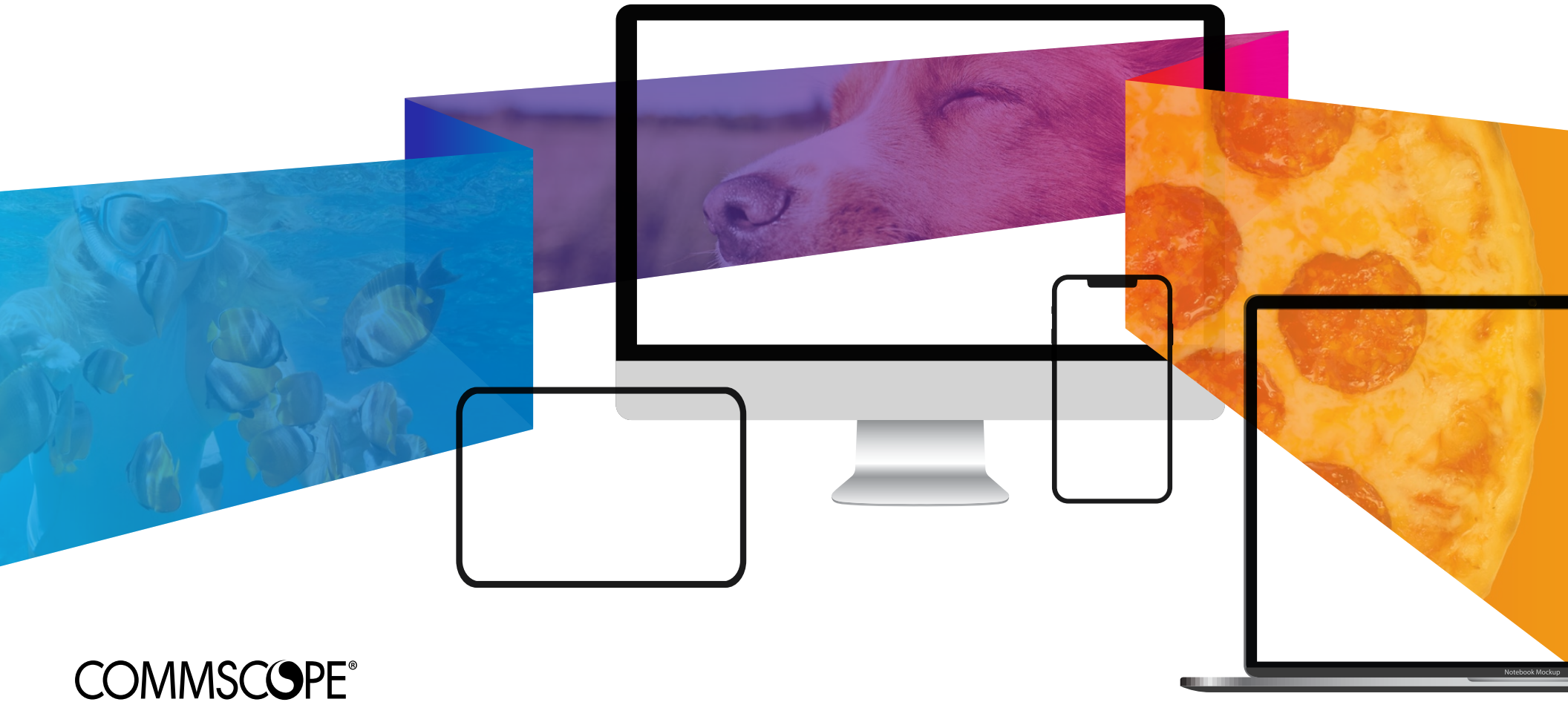
Overcoming the top 5 challenges in server-side IP ad insertion

How agile manifest manipulation can help service providers improve monetization and deliver a "real TV" experience



COMMSCOPE®

Contents

Introduction:
IP video advertising: new opportunities, new challenges

In a traditional broadcast model, where video services are delivered via QAM, viewers have become accustomed to a specific experience. In contrast to the increasingly popular subscription video on demand (SVOD) and over-the-top (OTT) services, the legacy set-top box-enabled video experience represents what we call "real TV"—it's reliable, predictable, and consistent in quality, with no buffering or unexpected lags.

From an advertising perspective, the across-the-board dependability of "real TV" stems from several constants upon which the legacy system has been built:

- Content and advertising are delivered to one type of end device: a set-top box
- Content preparation and delivery are tightly integrated into the operator's platform
- There are a limited number of time slots allotted for advertising
- Audience is defined in terms of geography and basic demographics
- Tools for monitoring and measuring ad performance are well established

The stable, hardened architectures crafted upon these constants allow service providers to monetize their investment by selling, executing, and billing for advertising with confidence. They have mastered the process of inserting advertisements into programming. As a result, viewers know what to expect regarding commercial breaks, and advertisers can depend on the ability to serve their content at regular intervals and with seamless quality—without gaps, glitches, or interruptions.

Enter IP video

The possibilities opened up by the concept of TV everywhere, on any device, are virtually endless. They extend into the advertising realm and enable exciting new monetization opportunities. The most significant, perhaps, is the ability to target ads more granularly to increase ad revenue. This opportunity likely explains why the addressable TV advertising market is expected to grow from $15.6 billion in total worldwide revenue in 2019 to $85.5 billion by 2025[1].

However, IP video is a dynamic medium with a number of challenging variables:

- The universe of devices and players is constantly changing and expanding
- Content must be optimized for a wide range of device and player requirements
- Video content originates from multiple encoders, packagers, ad delivery systems, and content delivery networks
- The timing of advertisements and programming can be extremely dynamic
- Ad measurement involves monitoring millions of unique streams across multiple network and client devices
- There is no one-size-fits-all service provider architecture

$15.6 BILLION in 2019

$85.5 BILLION in 2025

ADDRESSABLE TV ADVERTISING MARKET GROWTH

Each of these adds a layer of difficulty when striving for a "real TV" experience and has the potential to introduce buffering, video quality, and timing issues. In more troublesome cases, a particular ad might not play at all during a designated time slot—resulting in lost revenue for the service provider and diminished confidence for the advertiser.

These challenges may seem daunting, but they can be overcome with an agile system that's built around a dynamic, intelligent, and configurable server-side ad insertion solution based on manifest manipulation. This key software platform can help ensure that all the moving parts that comprise IP video advertising not only operate as expected but do their part to mitigate issues in a way that's transparent to the viewer.

The end result is an experience that is not only as good as "real TV," but better.

Why is manifest manipulation so important?

In IP television, video is delivered as a series of adaptive bit rate (ABR) segments. The client receives a manifest that lists the location of the content segments and the available bit rates. A manifest manipulator can customize this list for each individual playback session, making it the command and control center for the entire video experience. In an optimized architecture, every request for content is handled first by the manifest manipulator, and it interacts with multiple ecosystem components to create the user experience. Thus, every single user playback is dependent on the ability of the manifest manipulator to perform its activities correctly—every time.

Perhaps more importantly, the manifest manipulator must know how to respond when the rest of the ecosystem doesn't perform as expected. As the command and control platform for IP video delivery, the manifest manipulator should be able to accommodate incomplete, inaccurate inputs from other systems, or even a lack of input, and make this transparent to the end user experience.

Overcoming the top 5 advertising challenges in an IP video environment

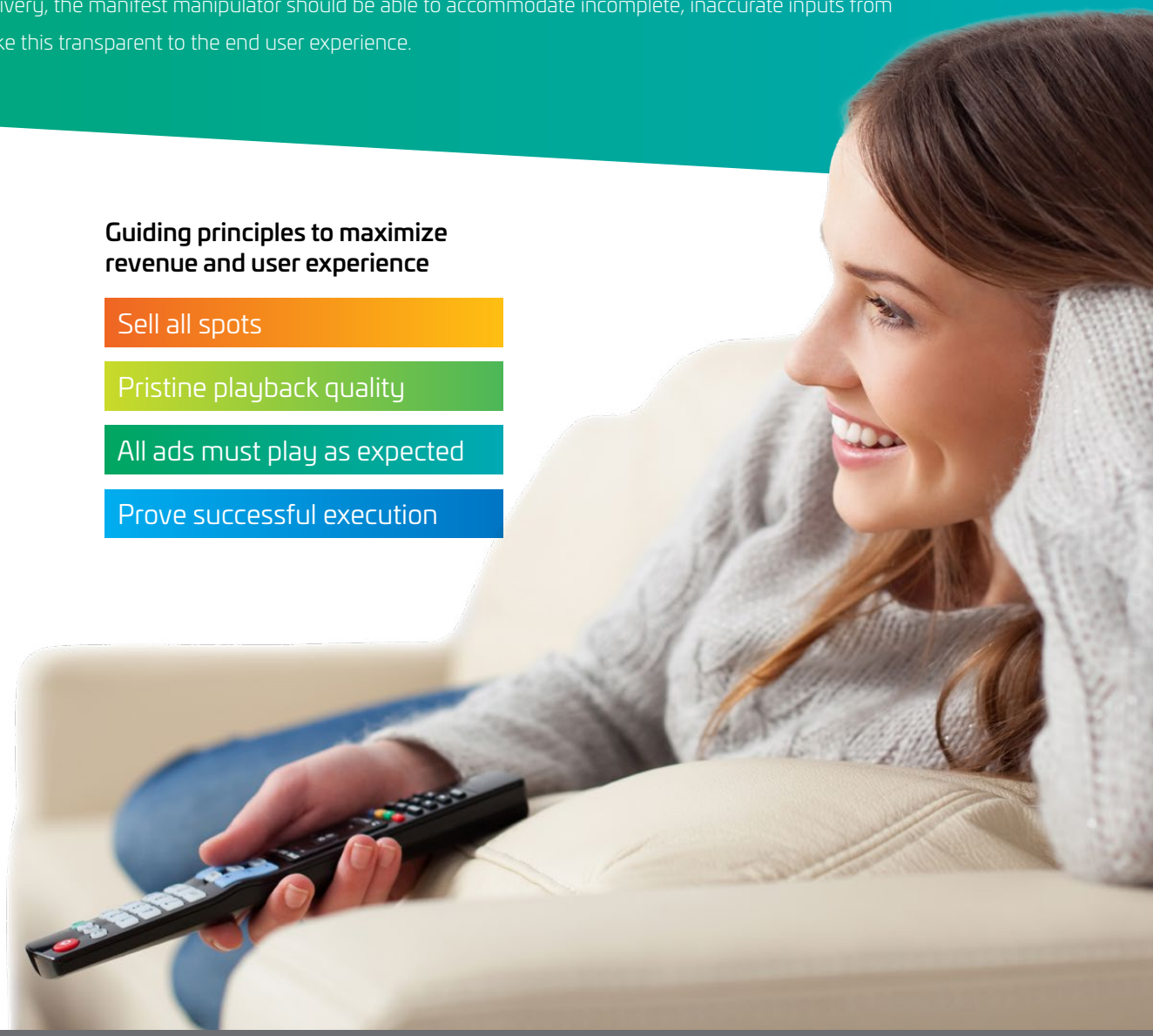
Advertising should follow several principles for the service provider to maximize revenue and maintain the "real TV" experience. No spot should go unsold or unfilled, the quality of playback must be as pristine as possible, and advertisements must play as expected—with the ability to prove that they executed successfully on the end device. But, in the dynamic IP video environment, that's not so simple. Service providers are likely to encounter several roadblocks that threaten both the user experience and their ability to maximize monetization.

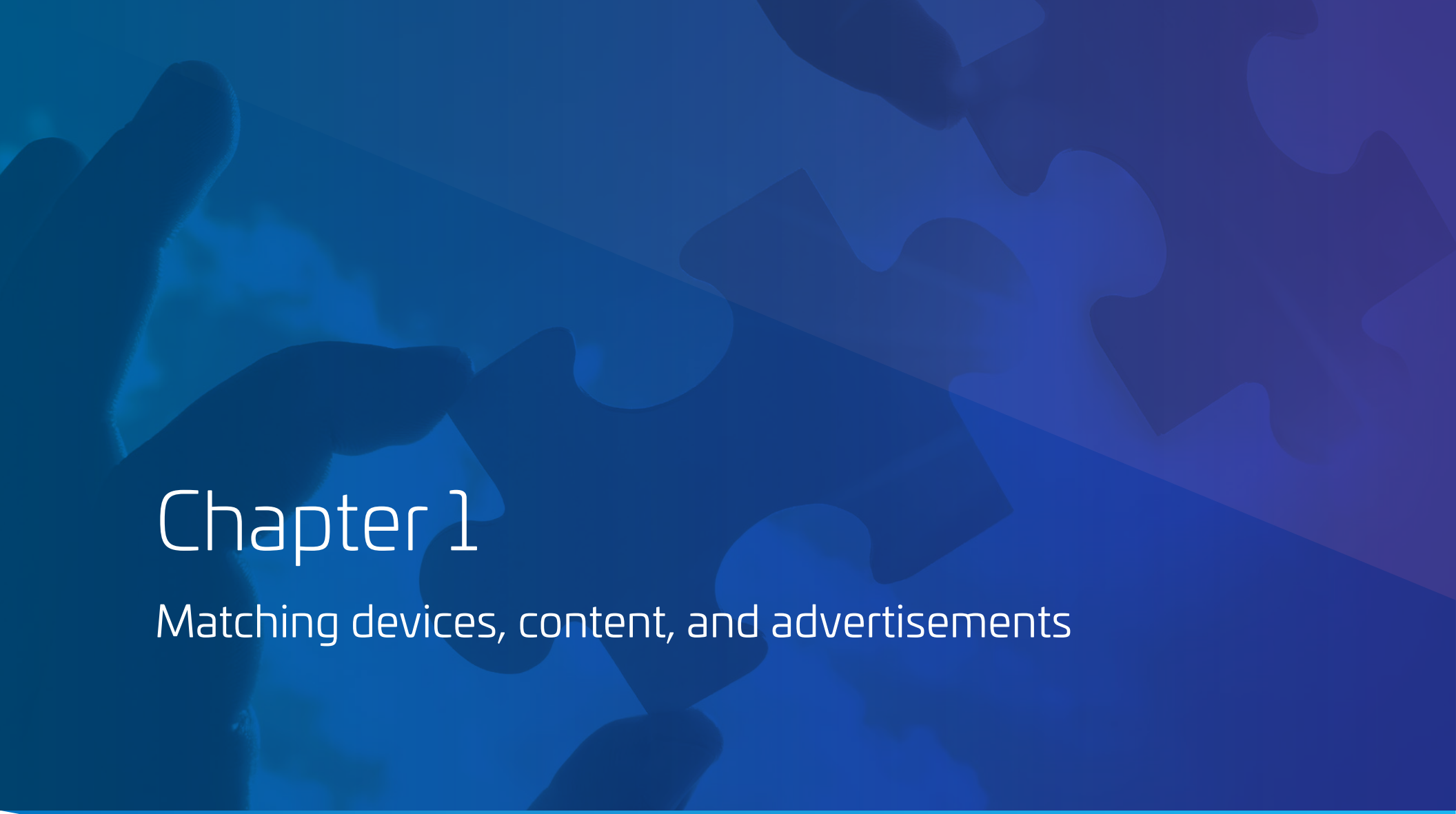
These include:

- Matching devices, content and advertisements
- Supporting a range of business models
- Scaling and for growth and peak traffic
- Monitoring and analyzing ad execution
- Maintaining precise timing across ads and content

Guiding principles to maximize revenue and user experience

- Sell all spots
- Pristine playback quality
- All ads must play as expected
- Prove successful execution





Chapter 1

Matching devices, content, and advertisements

Matching devices, content, and advertisements

In the IP space, service providers cannot always control the ecosystem. To offer consumers the flexibility they crave, operators must be able to support the continually expanding field of client devices and their respective players.

The challenges to doing so in the chaotic IP-enabled arena can be categorized into three main areas that are dependent upon one another:

- The constant need to recognize and support the parameters of new devices
- The ability to select and optimize the correct content for the end device
- The alignment between ad and content format

The work of adding new devices and supporting new players is non-stop and requires service providers to dedicate precious staff and budget to creating, testing, and deploying profiles that accommodate device changes as quickly as possible. Doing so can require significant resources, since there is an ever-expanding set of devices and each may handle certain ad insertion use cases and reporting activities differently.

Delivering manifests appropriate for each device profile is imperative, because, if the content does not suit the characteristics of each endpoint—big-screen smart TV, OTT streaming client, gaming device, smartphone—a viewing session will be marred by interruptions, buffering, and other detractors to the "real TV" experience. When compounded, these glitches can impact revenue, since service providers cannot bill for ads that aren't executed successfully. This can result in make-good obligations and lower inventory yield, and can even trigger a revised rate structure.

Optimizing ads for multiple devices and content formats can be chaotic.

Meanwhile, while the content is tied to the device, the advertisement must be tied to the content. Both are arriving continually from varied sources and via different encoders and packagers. There likely will be a variety of formats available for each. If the ad representation does not line up with the content, the viewer, once again, will notice the difference in quality during the break—something that would not happen in a "real TV" scenario.

Bit rates are some of the most important parameters to align in IP. Content must be packaged at the appropriate bit rate for the end device. Lower bit rates will not look acceptable on a 4K TV, for example, while smartphones can produce a quality picture at relatively low bit rates. It follows that, if

the content is transmitted at a certain number of bits per second, the advertisement must fall within a similar range or the change will be disruptive to the user.

Codecs also matter. There are various encoding algorithms used to compress television services for IP transmission, including H.264 or HEVC for video and AAC or AC-3 for audio. If the advertisement does not use the same codec as the content, the client may have a problem with playback.

The use of different content packaging standards must also be accommodated. There are two main ABR protocols: HTTP Live Streaming (HLS) and Dynamic Adaptive Streaming over HTTP (DASH). While these share the same core concepts, there are technology differences that affect manifest manipulation. For example, with HLS, audio and video profiles may require separate manifest requests; DASH delivers all representations of the stream in the media presentation description file.

Thus far, the variations discussed have been generic—based on device type and manufacturer—but there are also finicky, less common iterations. For example, a content stream could have audio tracks for three different languages, with a viewer watching in Spanish. The ad break comes along, but the advertisement only includes an English language track. The absence of the correct audio track can cause issues with the content stream, change its language track, or produce an error in ad execution.

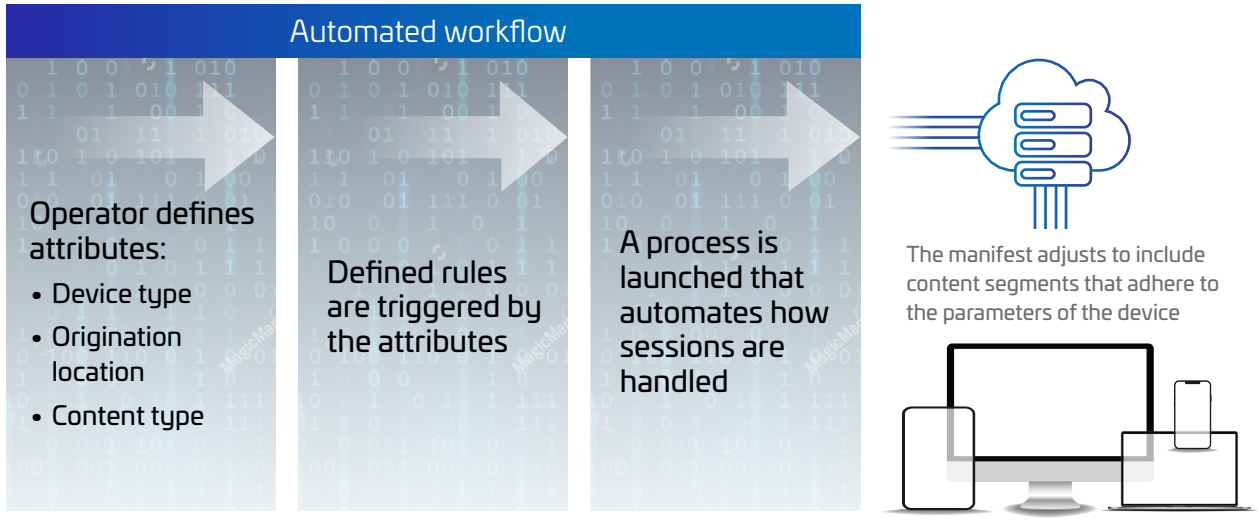
The solution: workflow automation

To keep content, advertisements, and devices in alignment, a different workflow has to be created for each unique situation. Doing this manually can not only be onerous on support staff, it can also introduce delays between when a new device or content type is available and when it's supported. That can lead to content and advertising errors.

With automated workflows that can easily be tuned system-wide, service providers can reduce the workload of constantly adding new devices and content formats and prevent the potential for ad playback errors associated with devices and formats that aren't supported properly. An automated workflow:

- Allows the operator to define attributes, such as device type, the location from which a request originates, and content type
- Defines rules triggered by those attributes
- Launches a process that automates how sessions are handled

For example, at the beginning of a session, clients make requests that include the attributes of the device. Following the rules of the preset



workflow, the manifest is adjusted to include only content segments that adhere to the parameters of the device. This improves the success rate of ad insertions while reducing errors that impact the user experience. It also significantly reduces the workload of maintaining the system when the only constant is change.

The service provider defines automated workflows based on operational priorities. It is possible to set a minimum quality level for high-resolution devices, for example. If a 4K TV queries, the rule dictates that the manifest list only the top three bit rates rather than the entire set. This automated ability to selectively make only the most relevant streams available can help mitigate network congestion and unnecessary strain on the manifest manipulator.

Remember that a quality user experience also depends on ad representations matching the characteristics of both the device and the content into which it is being inserted. The service provider also can define workflows that dictate how the manifest manipulator should apply the rules that normalize bit rate selection or language track when ad and entertainment content don't align. In the case where the required ad does not exist in the proper format, the manifest manipulator can leverage a workflow to trigger a transcode and generate an ad that meets the required parameters.

A manifest manipulator governed by automated workflows also improves operational efficiency by enabling a single representation of an ad to manage for any given format—HD, SD, and 4K, for example. The manifest manipulator generates a manifest for each situation from the superset. This reduces network strain by eliminating the need for multiple files and manifests for one advertisement in multiple formats.

Visibility into workflow success adds even more intelligence to the system. With it, service providers can weigh system configurations against behavior and make any necessary adjustments quickly. The operator can even go to any point in time and research the result of a policy. If things didn't go to plan, the rule can be tweaked to fine tune performance.

Chapter 2

Supporting a range of business models and opportunities

Supporting a range of business models and opportunities

IP Video expands advertising possibilities exponentially for service providers by making addressable advertising a reality. But there are additional benefits that stem from the nature of IP delivery. The platform can query and accept ad decisions from multiple ad decision services, which opens the market to third parties and allows the service provider to insert ads on behalf of other inventory owners.

This results in several opportunities for service providers who can:

- **Complement their direct sales approach** with private marketplace partners and/or programmatic platforms
- **Attract a larger and more diverse range of advertisers;** no ad spot goes unsold
- **Ensure no ad spot goes unfilled**
- **Engage in new business models** through revenue sharing deals with broadcasters and programmers

This last one is particularly compelling. Consider that, in a traditional U.S. cable model, service providers have approximately two minutes per hour to insert local ads. Cable programmers own the remaining ad breaks, which amount to approximately 10 minutes per hour. To quantify the opportunity, cable operators bring in approximately $6 billion per year in local ad revenue[2] while the cable networks generate approximately $24 billion in ad sales[3]. Taking this model to broadcasters would open up a total market worth $71billion[4].

Here is how it would work: a media company wants the ability to target ads during programming on one of its cable sports channels. A service provider can give the advertiser the means to drill down past a regional or local level; working together, they can deliver a message to the eyes of the specific groups or even individual viewers deemed interested in a product. This means a win for the programmer, which can charge the advertiser a higher rate; the service provider that gets a piece of the formerly unavailable advertising pie; and the advertiser, who optimizes marketing spend by reaching the right customers more efficiently.

Of course, executing a model such as this requires support for multiple ad decision services (ADS)s, which can introduce its own challenges. The manifest manipulator needs a method for determining who owns the ad and which ADS to query. Each has its own set of variables with which to contend, and each third party has its own process and back-end billing systems.

As described above, it is possible the advertisement is not available in the right format or quality level

to be playable on the service provider's network. And the ad still must match the constraints of the devices and content stream or it will not play correctly. An agile and intelligent manifest manipulator must adjust dynamically to these and other variables and configure the manifest to meet each unique situation in order to increase revenue without sacrificing quality of experience.

Solution: support for multiple ad decision services

Multi-ADS support helps service providers protect quality and revenue should an ad not be delivered, and capitalize on new shared business models. But the ability to quickly turn new ad sales partnerships into revenue depends on the time it takes to integrate ad workflows between the service provider and each ad sales partner's ADS. An agile manifest manipulator speeds up this process by tailoring the ad request going to the partner's ADS with the targeting parameters that matter.

First, when it comes time for a commercial break, the manifest manipulator typically queries the primary ADS. However, with a dynamic platform that can support multiple ADSs, a decision can be made to send requests to different ADSs based on the owner of the ad inventory for that break. A decision tree, known as a "waterfall," can be specified to guide ADS selection based on a range of inputs.

Supporting multiple ad decision services

A waterfall can happen in real time. The spot owner can utilize its own ad sales first in order to get the highest return. If there is an unsold or unfilled break, the request can be routed to secondary partners who will do the same. They can either place their own ad, or fan out and use an auction model to maximize the value of the break. To safeguard against unplayable ads selected to execute the break, extra "buffet" ads may be provided as a means to prevent dead air and maximize the break opportunity.

Chapter 3

Scaling and resiliency for growth and peak traffic volume

Scaling and resiliency for growth and peak traffic volume

With so much potential for IP video, scaling well is critical. The need to support growth touches all aspects of a system, but there are several overarching points that demand special consideration:

- The ability to cost-effectively start small with an eye to scaling to millions of streams
- The management of traffic spikes caused by the simultaneous streaming of live events, like the NFL Super Bowl
- The need to handle failures in both the underlying infrastructure running the manifest manipulator and in the ecosystem around it

With IP video, the challenges fall particularly with live channels. Consider that every household could have multiple devices running simultaneously for hours each day. That amounts to a tremendous number of streams—and potential advertisements that need to be served. Live events that attract large audiences add another complication because they cause spikes in streams during a defined period of time. Picture the requests coming in for ads to be inserted during a popular sporting event as if they are a crowd flooding the gate of a stadium. Because IP video advertising is addressable, it's possible that each person is seeing a unique set of ads during a given break, which only adds to the scalability challenge.

In addition to designing the manifest manipulator to keep up with a deluge of clients requesting streams, it must take into account other pieces of the advertising ecosystem. High utilization on the ADS, content origin, and the content delivery network (CDN) that delivers the ads could cause latency on the system. Without a way to account for varying response times, the ad revenue opportunity could be missed.

Delay isn't the only challenge. The problems of matching content to device—and advertisements to content—remain, only they must happen on a larger scale. There are more device variances to take into account; there is a wider range of bit rates and differences in codecs; and there is a greater likelihood that more than one ADS is being queried.

The solution: dynamic scalability

The manifest manipulator needs the agility and intelligence to successfully manage millions of requests from IP devices no matter how fast they come, and to account for varying response times from other components of the system. There are several goals to keep in mind to address scalability issues:

- Reducing latency
- Adapting to fluctuating workflows
- Ensuring resiliency and geo-redundancy
- Optimizing load distribution
- Allowing zero-downtime software upgrades and maintenance

To achieve each of these goals, the manifest manipulator should be horizontally scalable. Capacity is increased by adding nodes as needed. The process begins with designing software based on the latest in cloud deployment models.

Each of these nodes is designed as an instance of the full set of functionalities offered by the software. The load balancer distributes sessions, and the nodes share session state for resiliency without the need to go to a central system.

This means there isn't a limit on how many nodes can be added; they can be proactively provisioned in anticipation of an increased subscriber base, or can rely on elastic expansion that allows the service provider to dynamically scale the system as needed. Each node constantly communicates its health to the load balancer so it knows whether to send new queries to a particular node.

The node designated at the beginning of a session will continue getting the requests related to a particular stream. It doesn't matter how many nodes are operating—1,000 or 10,000—the session remains sticky to a node. This reduces traffic, which helps both with everyday management as well as alleviates some congestion during peak events.

However, the load balancer can reassign a session to an alternate node if the original is experiencing difficulty. Because of session state sharing across nodes, service continues uninterrupted. This resilience is important in maintaining quality of experience and maximizing ad revenue, even in the face of high volume.

Latency is a critical issue in a live stream, and the service provider can set policies that reduce its impact. For example, the manifest is cached so it is not constantly making redundant requests of the CDN. Similarly, where appropriate, ADS decisions can be cached to minimize the load on the ADS. Although these queries are relatively small, this reduction in transactions still provides noticeable relief when serving a large number of streams. Additionally, the manifest manipulator can be instructed by a peak-load policy to anticipate ad breaks and request ad decisions and content early. This spaces out back-end traffic so it is not causing bottlenecks to occur in other parts of the advertising ecosystem—particularly when there is heavy demand already.

Often, there is a failover plan for cases where latency cannot be mitigated adequately. A "fallback" ad is inserted to prevent dead air on the stream. This saves the viewing experience from being impacted because the viewer does not know that a targeted ad did not play, and the service provider preserves the revenue for the ad.

Chapter 4

Monitoring and analyzing ad execution

Monitoring and analyzing ad execution

One of the primary goals of monitoring and analytics is to maximize the yield of the ad revenue. With IP video, there could be millions of clients streaming a personalized version of the same channels. The challenge is to ensure proper, accurate, and timely reporting that the ads were inserted successfully at this scale. It is also important to design for flexibility to deal with the potential scenario where clients do not have the capability to "beacon" or report ad events back to the network.

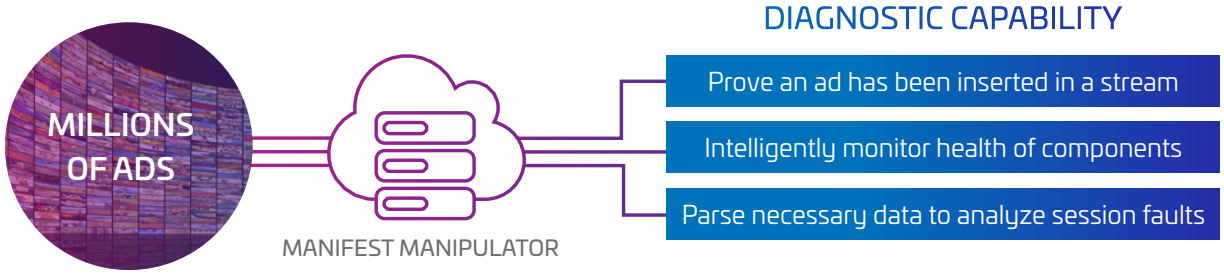
Especially when a service provider is taking advantage of third-party ADS systems to increase opportunities, the ability to demonstrate to the owners of these entities that an ad was delivered successfully is imperative. Targeted advertising matters little if the ad does not actually reach the viewer. The trick is proving addressability at scale while collecting, organizing, and delivering the necessary data that back-office systems need to track the successful insertion of billable ads.

What if the ad does not play as expected? The service provider might lose revenue on this one occasion but wants to diagnose the problem so the same error does not occur again. There are so many moving parts in the IP video ecosystem that could be the source of the failure; the challenge lies in gathering the right data from each system to determine where and why the error occurred.

The solution: flexible monitoring and analytics

An agile manifest manipulator at the heart of an ad system has perhaps the most complete view of the ad opportunities that flow through the system and can report on the number of ads delivered vs. ad avails to sell. It can be configured to prove that an ad has been inserted into the stream; has the intelligence to monitor the health of other components in the network; and is dynamic enough to parse the necessary data to analyze faults in a session.

Diagnostic capability is important because, if one component malfunctions or causes latency to occur, the potential is there for disruptions to the stream. The manifest manipulator has visibility into the response times of the ADS, the content origin, and the CDN serving ads. The first line of defense is for the platform to absorb or compensate for some degree of performance loss. But, if there is an extreme, unexpected condition, the manifest manipulator must be able to provide data for analysis. This way the service provider can make adjustments to better defend against problems that can threaten the "real TV" experience and impact monetization.



There are several key metrics the manifest manipulator can log:

- Success rate/errors for client requests
- Success rate/errors for all interactions with the ADS
- Latencies from CDN and ad request processing
- CDN errors from fetching the content and ad manifests
- Rogue requests
- Shifts between bit rates throughout the streaming session

There is increasing acceptance of the manifest manipulator acting as a proxy of measurement on behalf of the client. The manifest manipulator uses the feedback it receives from the client to beacon the ad events back to the ADS and other verification stakeholders, including referencing the tracking information that ties those reports with the original ad decision. The process repeats itself for each ad break and ad decision. With this information, the service provider can prove to the advertiser that the desired ad was inserted into the manifest.

An agile solution can not only traverse the full journey of a session by cross referencing its ID across session logs, but it also can parse the data to assist the service provider in producing dashboards. These types of tools analyze the overall performance of the ad insertion system and can help staff quickly determine where monetization opportunities might have been missed. They can also contribute the measurement of an ad campaign's success.

Chapter 5

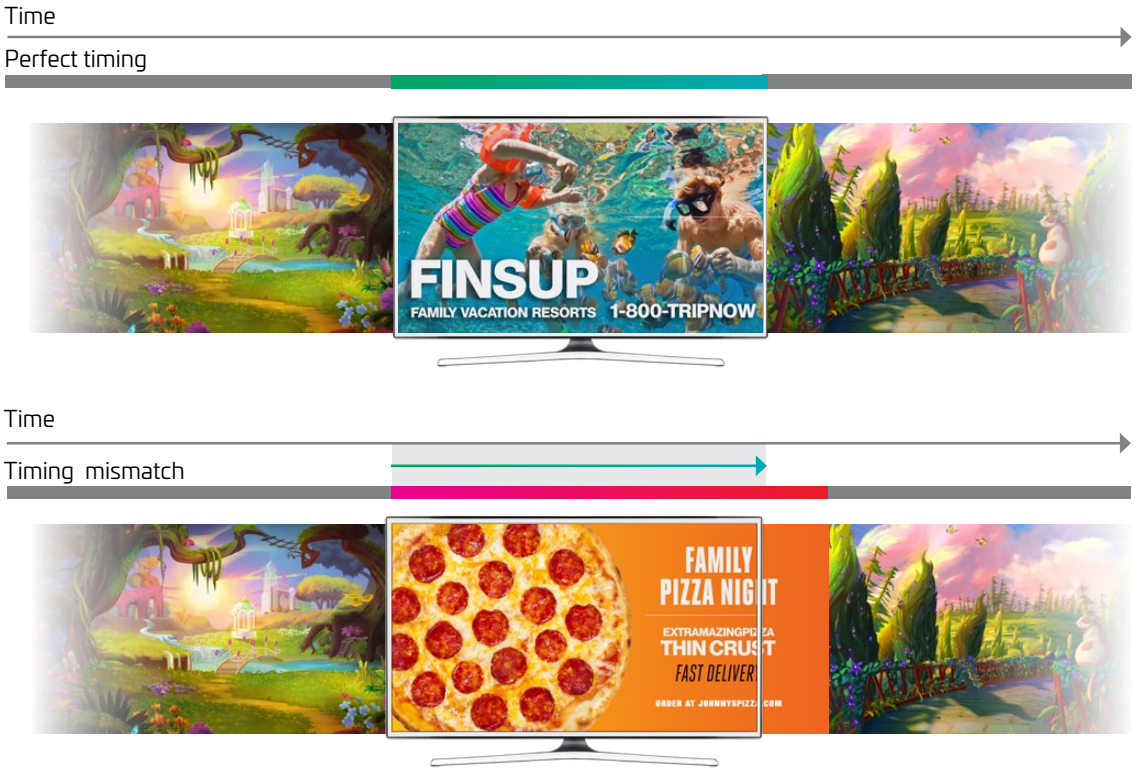
Maintaining precise timing across ads and content

Maintaining precise timing across ads and content

Of all the "real TV" scenarios, live streaming accounts for a significant portion of overall consumption. Ideally, content streams flow at an expected pace, ad breaks are precisely timed, and ads are inserted on cue. When timing mismatches occur between a break and the ads within it, serious issues can result.

While DASH streaming provides a remedy for some timing issues by enabling new periods to start in the middle of media segments, HLS is less forgiving if not handled carefully, because clients are expected to play each media segment in full prior to playing the next. Timing mismatches reset the stream timeline and can affect the rate at which media chunks are downloaded by the client. Uncontrolled, this condition may worsen over multiple ad breaks and starve the client with so little locally-buffered content that it naturally responds by shifting to lower quality representations of the stream. Quite the opposite of a seamless ad insertion, the resulting effect is a severely degraded streaming experience for the end user.

Occasionally the ad break is cut short in order to return to unplanned programming, which can be the case with a breaking news update. This has the potential to cause a similar situation when ad segments do not align perfectly with the content segments they replace. Picture a live stream packaged at a rate of 6 seconds per segment and a 15-second ad being inserted. That ad would replace the first two 6-second segments but would coincide with the middle of the next segment, causing a 3-second difference.



Over time even small discrepancies in timing can add up, leading to what we at CommScope call "drift". This is when the stream the user experiences gets out of sync with the non-ad inserted content.

This situation can create a chain of errors that span an entire program or even longer. The lost revenue opportunities from ads that did not execute properly can be significant. But, with so many IP video choices for today's consumers, the negative impacts on the user experience can be far more detrimental as frustrated subscribers seek out more stable video services.

The solution: timing management

Fortunately, an agile manifest manipulator can prevent many of these timing and drift issues by making intelligent decisions that eliminate or lessen their impact. The decisions the manifest manipulator makes cannot be static. They must be made based on an assessment of the situation for the present ad break. Suppose the manifest manipulator is configured to control for a drift tolerance of up to 1 second. The next ad break occurrence is a 1-minute break, but one of the two ads is 30.2 seconds, and the other is actually 30.5 seconds.

In this case, the manipulator must act. Not inserting either ad would be a complete loss of opportunity. Skipping one ad also results in a loss of revenue. For this first instance, the manifest manipulator determines that the 0.7-second drift is within tolerance and runs both ads. Suppose another set of decisions for the next 1-minute break adds up to a 1-second overage. At that point, the accumulated drift has increased to 1.7 seconds, which exceeds the tolerance. The manifest manipulator then remedies the situation by truncating the content by one segment, which limits the drift to a range that's within preconfigured tolerances.

Over time, the drift never increases by more than one segment, which maintains enough margin in the client's buffer to avoid the symptoms previously mentioned.

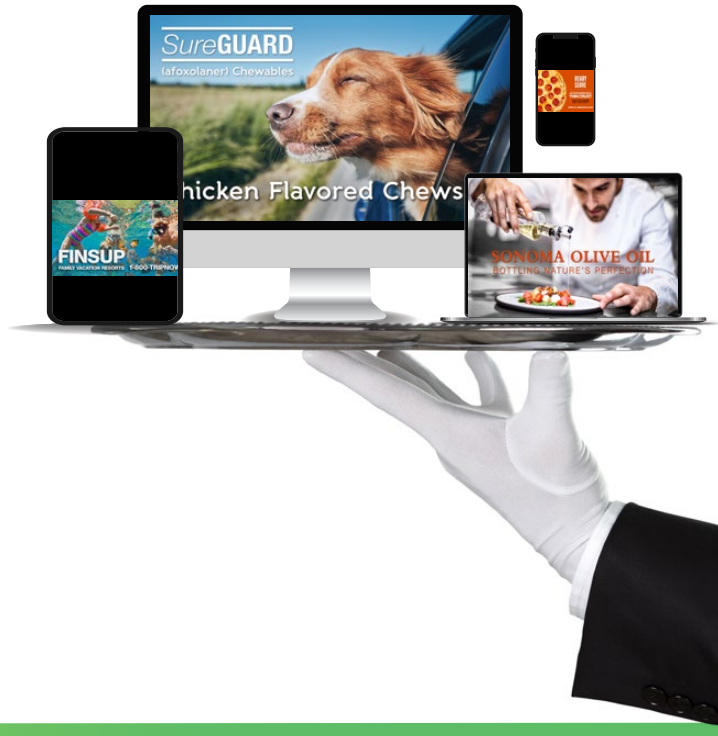
By managing timing issues and controlling drift, an agile manifest manipulator can prevent clients from being thrown off by changes and contribute to a pristine, "real TV" experience. It also prevents revenue loss by not eliminating or cutting off ads whenever possible.

Conclusion: The dynamic world of IP video requires agile manifest manipulation

The IP video environment is architected for constant change and customization, which opens up powerful new capabilities and opportunities for service providers and their subscribers. Chief among them is the ability to deliver personalized experiences and targeted ads across a wide range of devices. But the advantages of this dynamic environment bring with them a set of challenges that, if not managed, can create noticeable issues with video streams and threaten monetization.

To truly offer a "real TV" experience, service providers must match the dynamic world of IP video with an agile manifest manipulator. It must automate the process of adding new content and devices, while keeping ad quality aligned with that of the overall content stream. The manifest manipulator must be able to support multiple business models by connecting multiple ADS systems and routing ad requests appropriately. It must support rapid growth and spikes in traffic seamlessly. It must be able to unify data collection and delivery from a range of systems in the ad and content delivery chain. And the manifest manipulator has to be intelligent enough to absorb, resolve, and even prevent timing issues.

In short, as the backbone of video and ad delivery, the manifest manipulator has to be just as agile as the IP video environment itself.



Ready to get started?

When you're ready to learn more about the many ways an agile manifest manipulation solution can elevate the IP Video experience and improve monetization opportunities, we're ready to help. Our experts can design, install, and integrate solutions that bring the "real TV" experience to your subscribers on their devices of choice, while helping you seize new opportunities and maximize ad revenue.

CONTACT US TODAY

Glossary of terms and acronyms

4K video
Video with a horizontal display resolution of approximately 4,000 pixels. 3840 X 2160 is the dominant 4K standard

AAC
Advanced Audio Encoding, a standard for digital audio compression (part of MPEG-2 and MPEG-4)

ABR
Adaptive bit rate, a method of video streaming over HTTP where the source content is encoded at multiple bit rates and then—based on the available network performance, bandwidth, and device capabilities—is matched to deliver the most optimum speed and quality

AC-3
An audio compression format developed by Dolby

ADS
Ad decision service or ad decision system, a platform that determines which ads to select for a given viewer based on various demographic and geographic parameters and available campaigns

CDN
Content delivery network, a network of servers that improves the availability, quality, and performance of content by caching it in close proximity to users

DASH
Dynamic Adaptive Streaming over HTTP, an adaptive bit rate technique that enables high-quality streaming of media content over the internet (aka, MPEG-DASH)

H.264
A compression standard for high-definition digital video (aka, MPEG-4)

HLS
HTTP Live Streaming, an HTTP-based adaptive bit rate streaming communications protocol developed by Apple

HEVC
High Efficiency Video Coding, a video compression standard that offers 25 to 50% better data compression than its predecessor, AVC, and supports resolutions up to 8192 X 4320 (aka, MPEG-H, Part 2)

Manifest manipulator
A software solution enabling server-side dynamic ad insertion, personalization, and analytics for IP video

MPD (MPD)
Media Presentation Description, a DASH manifest format that describes information about a media segment such as video resolution and bit rate

OTT
Over-the-top, usually a subscription video service that is competitive to broadcast television but delivered via IP

QAM
Quadrature Amplitude Modulation, a digital television standard format by which digital cable channels are encoded and transmitted via cable television providers

"Real TV"
A video viewing experience on par with traditional broadcast television in its reliability, predictability, and quality

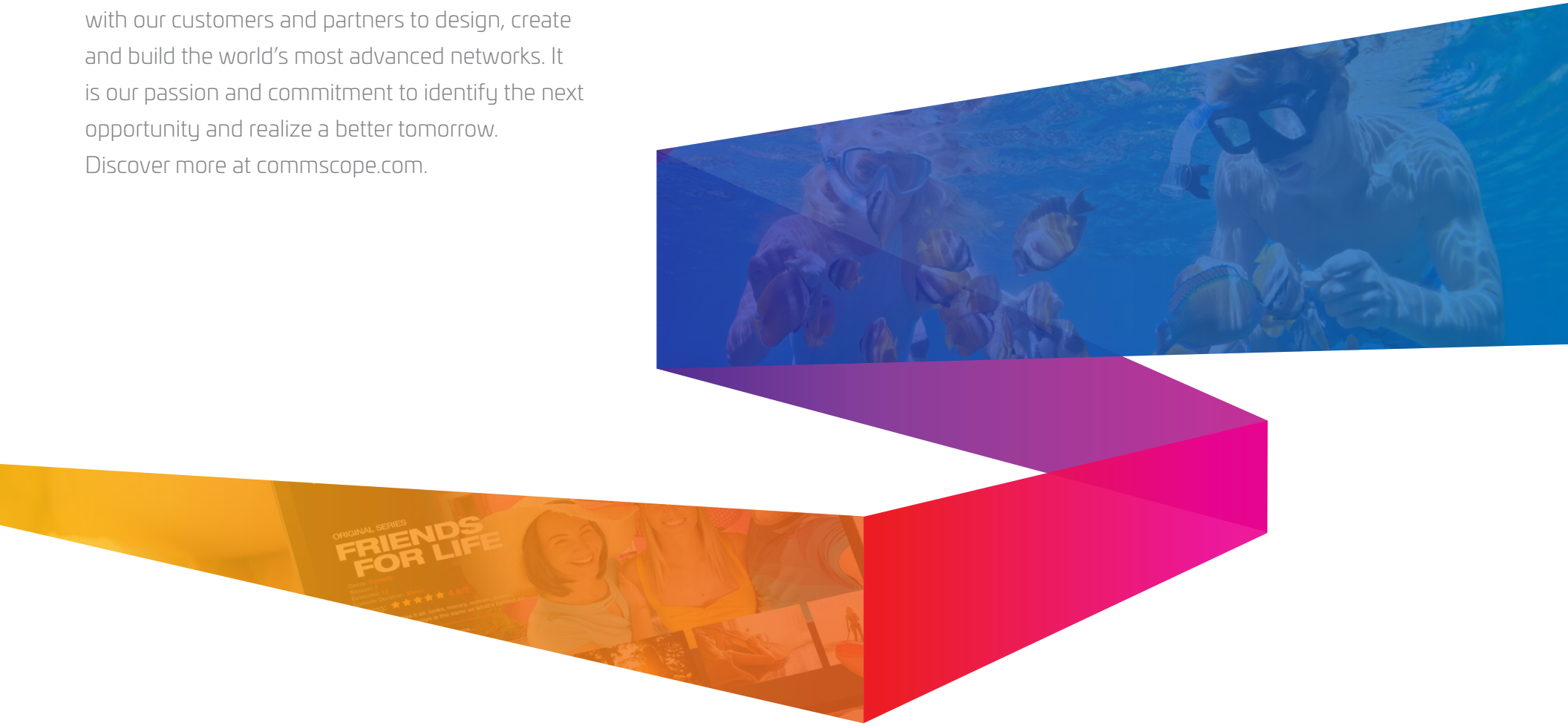
SVOD
Subscription video on demand, a video service where the subscriber typically pays a recurring fee to access a library of video content

Sources:

1. Anasia D'mello, Addressable advertising boom across all regions and platforms forecast by Rethink TV, 2020.
2. BIA ADVantage, U.S. Local Ad Forecast, April 2020.
3. S&P Global Market Intelligence, 2021.
4. eMarketer, Forecast for US TV Ad Spending, March 2020.

COMMSCOPE®

CommScope pushes the boundaries of communications technology with game-changing ideas and ground-breaking discoveries that spark profound human achievement. We collaborate with our customers and partners to design, create and build the world's most advanced networks. It is our passion and commitment to identify the next opportunity and realize a better tomorrow. Discover more at commscope.com.



www.commscope.com

Visit our website or contact your local CommScope representative for more information.

EB-115671-EN (04-21)