Hewlett Packard Enterprise

THE CONVERGENCE OF 5G AND ATSC 3.0 OPENS A NEW ERA OF COMMUNICATIONS

Edge-to-cloud infrastructure, platform as a service enables digital transformation of the broadcasting industry

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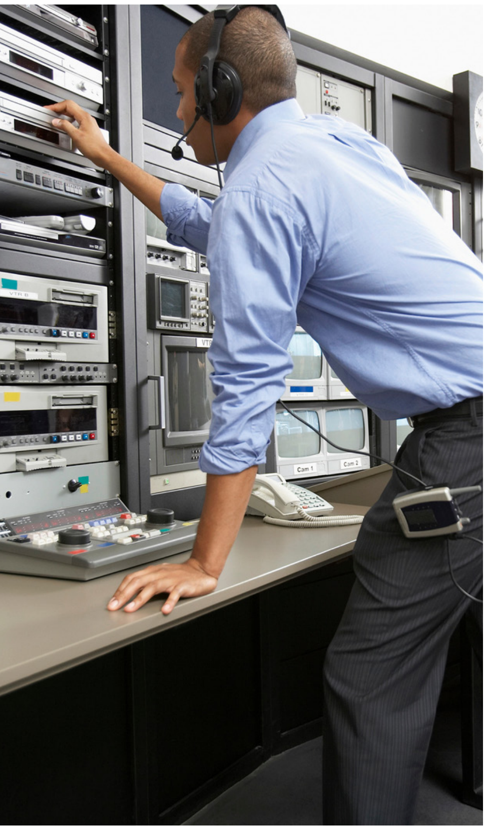
INTRODUCTION

Transformation of the cellular industry to 5G and the broadcast industry to the new ATSC 3.0 digital transmission standard[1] is the biggest change in content transmittal since the emergence of the commercial internet. Connectivity will form the backbone of the economy in this new era of communication. In this era, the convergence of multiple technologies leads the next wave of digital transformation, opening new choices, expectations, and challenges to clients, providers, and distributors.

Expanded access and choices on the client side provide each client with multiple connectivity options—ranging from 5G to ATSC 3.0 to Wi-Fi. In this choice-rich environment, broadcast content consumers will expect the ability to tailor their content streams and receive latency-free content. At the same time, nontraditional "customers" such as embedded software providers, connected device manufacturers, and "autonomous everything" services will use the same wireless distribution pathways traditionally found in broadcast networks. Content providers and distributors will have many ways to transmit digital assets and data to targeted or mass audiences and will need effective, reliable, and cost-efficient methods to do it.

Harnessing the potential of multitechnology convergence in this choice-rich environment will mandate that service providers have access to an optimal mix of the best and most efficient technologies (5G, broadcast, broadband, or even satellite) and the knowledge of how to optimally push traffic over each, when and where needed.

[1]The Advanced Television Systems Committee is an international, nonprofit organization dedicated to developing voluntary television standards.



Prepare for the challenges and opportunities of the new era of broadcasting

To survive and thrive in this new era, broadcasters and service providers will evolve to use an edge-to-cloud infrastructure, platform as a service (PaaS). As businesses undertake this transformative journey to become ATSC 3.0 providers, they must plan for changes on multiple fronts:

- Adoption of the ATSC 3.0 digital standard: Set a strategy to create new revenue streams from broadcast, while engineering to manage the costs of network and security complexities new to the broadcast industry.
- Automation and orchestration to enable edge readiness for content delivery: Establish a network edge infrastructure to house traditional playout assets as well as multicast distribution nodes, ad service nodes, and tenancy zones for multicast customers, powering the distribution of customers' digital assets from ingest to consumption.
- Broadcast core: Build out a fully IP-based, end-to-end product workflow (deliverable over a combination of broadcast and 5G/IP services) and leverage it to provide localized and personalized content and advertising to consumers.
- Monetization of infrastructure and spectrum: Prepare to monetize the new ATSC 3.0-supporting infrastructure through broadcast as a service (BaaS), where a television station may rent a broadcast service from a hosting company and enable new revenue streams by renting out portions of the allocated spectrum via wholesale as a service.

This white paper provides considerations specific to the stringent and unique needs of broadcasting businesses on this convergence journey.

1. BROADCASTING MEETS MOBILITY WITH ATSC 3.0

As a first consideration on this journey, broadcasters start with the basics: a path to adopt the ATSC 3.0 digital standard.

This new standard is the key to using 5G delivery technologies, offering more services within the same 6 MHz of bandwidth, reaching more viewers in more locations and on more devices, opening revenue streams based on targeted advertising, and discovering new possibilities associated with file datacasting.

As the broadcast industry makes the transition from the legacy ATSC 1.0 to ATSC 3.0, the FCC has asked broadcasters to pair up and share the same frequency: While one broadcaster hosts its own plus its partner's ATSC 3.0 services, the other partner will host their own and their partner's ATSC 1.0 services. This enables both broadcasters to simulcast the same programming in ATSC 1.0 and ATSC 3.0, per the FCC mandate.

The evolution of broadcasting

To assess the advantages that ATSC 3.0 has opened to the broadcasting industry, let's first revisit the evolution of broadcasting capabilities.

From analog to digital

The ATSC 1.0 protocol has been the standard for digital broadcasting since the transition from analog to digital television started back in 2009.

ATSC 1.0 introduced the digital element: The availability of subchannels within a single 6 MHz frequency band. These subchannels could carry either alternative programming choices or information streams that would multiplex into opportunistic and unused space in the existing usable 19.4 Mbps stream capacity of a 6 MHz channel with MPEG-2.

Moving to a digital signal was a leap forward for broadcasting. It enabled far superior picture and sound quality, longer transmission, multicasting capabilities, and lower broadcasting costs—while freeing up significant portions of the broadcasting spectrum.

For all its advances, ATSC 1.0 has significant limitations:

- First, the differentiated programming streams that ATSC 1.0 enables are available in the same time slot, but broadcasters that still rely on only legacy ATSC 1.0 can direct these streams toward big subsets of the primary mass market. By nature of its rigid linear technology, ATSC 1.0 cannot support the ability to offer personalized advertising, which holds greater revenue potential than nontargeted advertising.
- Further, the data transport function of ATSC 1.0 is only nominally multicast capable: Its ability to offer differentiated services beyond mass-audience reach is severely limited. In the increasingly competitive field in which broadcasters play today, consumers expect the ability to curate their own programming needs with content from many sources, aggregated over broadband IP networks. ATSC 1.0 does not enable this capability.

In other words, broadcasting with ATSC 1.0 is still “just” television—siloed from the needs and opportunities of today’s mobile world.

ATSC 3.0: The next big leap

The IP-based ATSC 3.0 standard changes the playing field. ATSC 3.0 ushers in a large-scale advance for broadcasting technology that brings together the capabilities of over-the-air (OTA) broadcasting, the internet, and a host of additional use cases that provide the opportunity for broadcasters to generate new revenue streams.

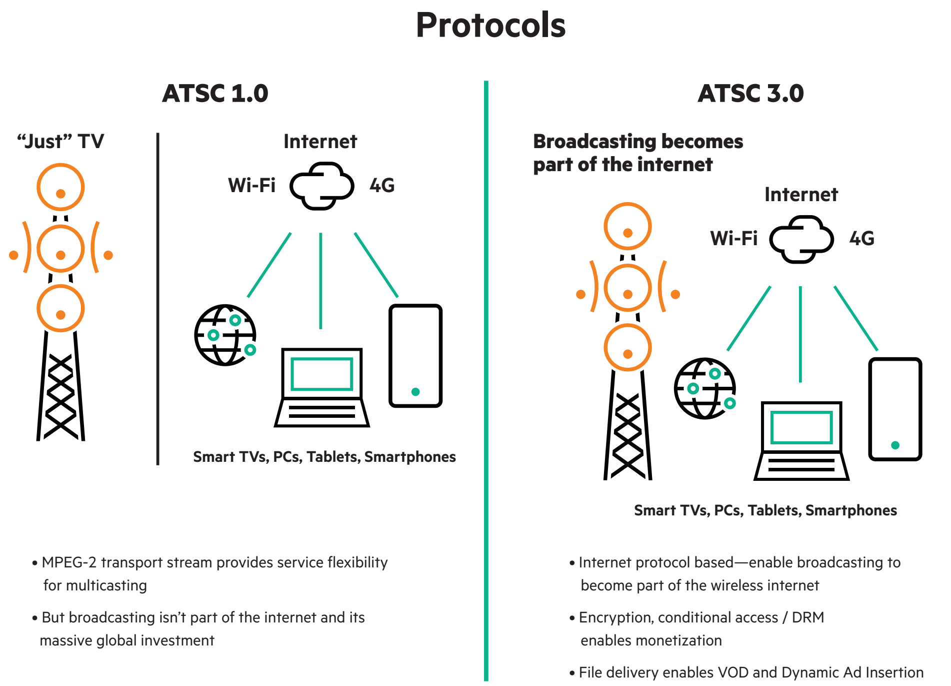


FIGURE 1. ATSC 1.0 vs. ATSC 3.0

The combination of ATSC 3.0 and gains in compression and frequency management made since the original digital television revolution introduces another leap forward. In the ATSC 3.0 world, a 6 MHz frequency channel using current ATSC 1.0 transmission parameters and covering a similar area will hold an estimated capacity of 26 Mbps (enabled via 256 QAM)—about 33% more than the 19.4 Mbps capacity of ATSC 1.0 standards. This additional space enables a move toward 4K delivery because of the increased channel capacity and compression capability for a primary content stream. This capability can help broadcasters better compete with streamers who already offer 4K delivery on their platforms.

ATSC 3.0 can also agnostically leverage any transmission method to deliver content and allow the seamless move from one transmission mechanism to another based on the receiving device, product reach, or service and signal capabilities.

A range of new functionality for broadcasters

Some key functions enabled by ATSC 3.0 include:

- **Slicing.** Segments of a television station's edge server capacity can be configured to transmit data to different ATSC 3.0-capable devices, providing the right services for each use case and enabling connected intelligence opportunities such as artificial intelligence (AI) and machine learning (ML). Likewise, network spectrum can be configured to offer specific bandwidth slices for different purposes.
- **Edge orchestration.** Edge orchestration makes it possible to dynamically and automatically allocate and release spectrum and broadcast system resources in a virtualized, cloud-based environment.
- **Leased spectrum facilitation.** Monetize excess broadcasting spectrum capacity by leasing these bits to other entities that will use them to deliver their own content, data, or even internet services.
- **Interactivity and audience measurement.** In ATSC 3.0, user equipment is connected via the IP backbone. This provides additional flexibility to target regions with specialized services, for example w focused advertising by subregion, thereby driving additional revenue.

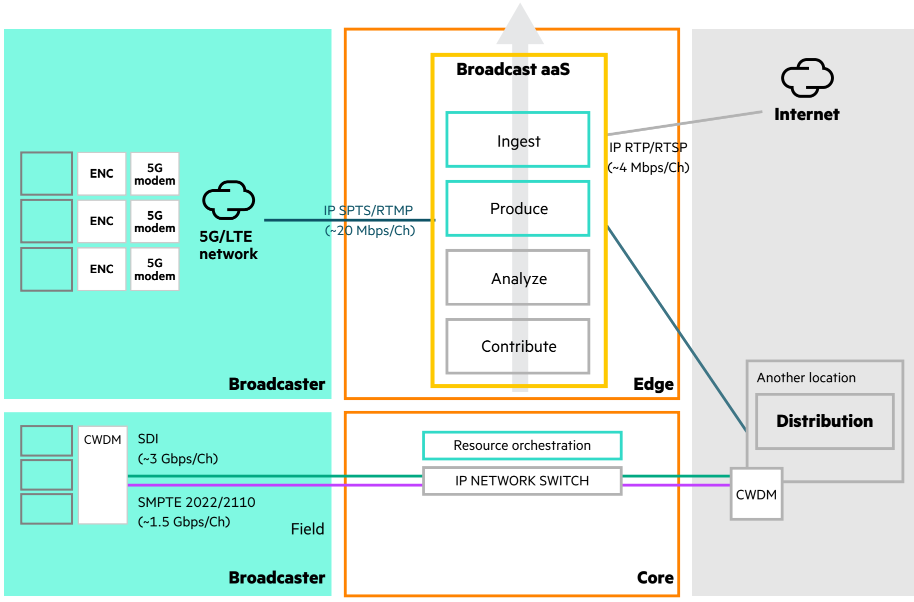
Tapping the potential of ATSC 3.0

Broadcasters who adopt ATSC 3.0 are sure to benefit from the increased customer satisfaction from a number of improvements and new capabilities. Consumers will benefit from a number of new advantages. For example, ATSC 3.0 enables better audio performance (ATSC 3.0 uses the newer Dolby AC-4 audio compression technology and MPEG-H 3D audio coding standard and supports up to 7.1.4 channel audio, including support for side channels). ATSC 3.0 also enables improved video performance with lower broadband bandwidth requirements; deeper indoor reception; improved mobile reception; access to 4K content; and advanced emergency alerting.

But well beyond customer satisfaction, ATSC 3.0 opens a range of previously nonexistent opportunities for broadcasters. These new capabilities include:

- **Generating new advertising revenue.** Access new advertising revenue streams by using 5G network capabilities to deliver ads that are targeted at the level of locations, households, or even individuals.
- **Freeing up broadcast spectrum for leasing out for data services.** Combine available spectrum through bit pooling. After providing the required television service, it's possible to combine the leftover bits to monetize through leasing. For example, spectrum can be leased to providers of applications such as driverless cars, extra last-mile bandwidth and other services, or large-scale software upgrades.
- **Monitoring active services.** Monitor the health of the service chain and apply self-healing capabilities. Because ATSC 3.0 has an IP backbone, in addition to quality of service (QoS), broadcasters will be able to measure quality of experience (QoE) on end-user devices and work on remedies to enhance the experience accordingly.

Further, the combination of ATSC 3.0 and 5G provides a way to address the known limitations of 5G reception in some interior locations. Using broadcasters' high towers with single frequency design at lower frequencies than typical 5G deployments can help address these limitations. This capability is important because as a broadcast entity the user device can receive ATSC 3.0 without having to transmit back to the TV tower. This combination will give indoor viewers a better overall receiving experience than from 5G mm wave deployments.



Ultimately, ATSC 3.0 in combination with 5G provide the key to unlock the full potential of the broadcast spectrum for both broadcasters and consumers.

2. AUTOMATION AND ORCHESTRATION STREAMLINE THE SHIFT TO A VIRTUALIZED BROADCASTING ENVIRONMENT

To leverage these combined capabilities of ATSC 3.0 and 5G, the broadcasting infrastructure must shift to a cloud-based, virtualized environment. This requires significant changes for broadcasting businesses and infrastructure: Automation and edge orchestration will make it all work by enabling broadcasters to dynamically and automatically allocate and release spectrum and broadcast system resources in this environment. Together, automation and edge orchestration make it possible to deliver on the goal of end-to-end service management where broadcasters can automate and orchestrate services from the edge to the core—deploying, managing, and monitoring multicast, unicast internet protocol television (IPTV), or over-the-top (OTT) channels in a multivendor environment from a single interface.

Shifting application intelligence toward the edge

A great deal of "processing" potentially can occur on broadcasting content during its lifecycle. This processing can include functions such as software elements (real-time editing, encode, decode, or transcode) or other functions (such as acquisition of serial digital interface [SDI] data; SDI to IP gateway and light transcoding; rendering farms; and secure reliable transport [SRT] gateways) as far out as the camera operator or the broadcast tower edge.

The cloud-based, virtualized broadcasting environment brings the cloud application intelligence that traditionally lived mostly in centralized data centers closer to the point where services are consumed. Taking this processing power to the edge significantly improves network performance.

Toward a self-orchestrating, self-healing broadcast network

The broadcast network should be able to handle the processing, stringent traffic demands, and capabilities necessary to support the IP protocols for any use case—from replacing the outside broadcasting (OB) van with 5G IP uplinks to a remote studio; to carving out different QoS slices for outside broadcast, consumers, and enterprise B2B; to telemedicine and more.

The broadcast network should also incorporate AI and ML. By coupling AI and ML in the virtualized cloud environment with a switch operating system, a connected edge infrastructure can both:

- Orchestrate the broadcast network infrastructure and the demands placed upon it.
- Ensure steady broadcast operations from edge to edge by monitoring for potential issues ranging from configuration mistakes to physical issues and flag them for intervention before they escalate into a problem.

Planning for the unique demands of the "broadcaster's edge"

In the broadcasting industry, performance demands are exceptionally high, and tolerance for failure (or even error) is miniscule. Businesses in numerous industries have already undertaken the process of modernizing their infrastructures to move processing from the edge to the cloud and consume the resources in an as-a-service model. But because of the stringent demands of the broadcasting industry, the requirements for a broadcasting-specific edge infrastructure are a class apart.

This specialized infrastructure can be thought of as the "broadcaster's edge." This is both the point at which content is first created (where creativity and technology touch for the first time), and conversely the point of transmission (where the audience touches the content as the producer imagines it to be seen). The important part of this concept is that both points of this edge are designed to create an "experience."

Essential elements of the broadcaster's edge

A broadcast chain must have several key traits to make it possible to successfully create that experience for the content creator, the broadcaster, and the audience who receives the content.

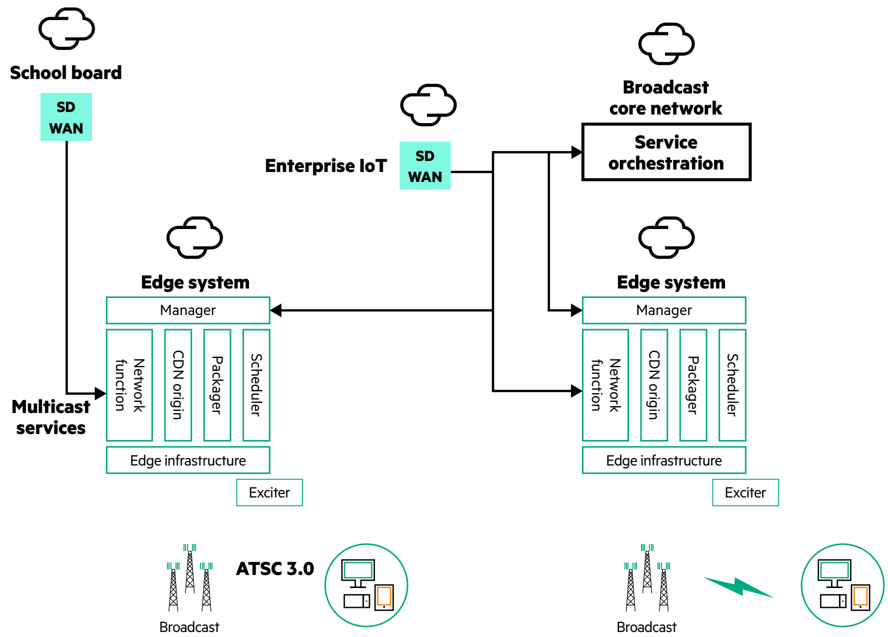


FIGURE 2. Key traits of the broadcaster's edge

The broadcaster's edge must be:

- Robust: Held to the highest standards of a service level agreement (SLA) so that the air is never lost during any part of the transmission
- Predictable: Able to give the broadcast operator visibility into how the infrastructure will react when a problem occurs—and able to ensure service maintenance for the air chain under all conditions
- Scalable: Capable of ebbing and flowing based on the values of the content and audience, as well as accepting a proportional risk model based on the operator's appetite
- Cost effective: Able to deliver on these infrastructure-related factors in an economically feasible way, as broadcasters will continue to be asked to "do more with less" even in the new era of communication

3. THE BROADCAST CORE NETWORK PROVIDES THE FOUNDATION TO SUPPORT 5G AND ATSC 3.0 CONVERGENCE

Competing in today's world of social media and individually monetized offerings requires the ability to create unique offerings and deliver them in flexible, targeted ways. These offerings must be consumable on-demand and at scale points where niche products can deliver a profit.

To efficiently deliver a content payload to the ATSC 3.0 client, broadcasters need a broadcast core network—a fully IP-based, end-to-end workflow. The broadcast core network is a collection of functions that can scale ATSC 3.0 from local station transmission into a nationwide network, harmonizing services across multiple networks and enabling vital new use cases—especially datacasting. The broadcast core conducts the entire broadcast chain (from content creation to manipulation and packaging to transmission) over an IP network.

Broadcasting businesses operate in a world where the "plant" of technology is always multithreaded and often builds in the redundancy of multiple, independent broadcast "chains" from source to sink. Traditionally, only the asynchronous elements of the chain (such as edit or post) have been handed over to IT-like services. But IP has become today's transport mechanism of choice. Going forward, "IT-based" services, powered by an IP transport, will take the lead in content delivery. Over time, the role for traditional HD-SDI or ASI-delivered video essence will continue to shrink until content is, for the most part, delivered by IP from end to end.

The broadcast core network changes the competitive landscape by enabling domains to support instant channels and hybrid broadcast/OTT content. Broadcasters that get this right can then offer a unique mix of high-quality content with unique user feeds and highly targeted content—programming for, and reaching, the precise audiences that a broadcaster wants to target—ranging from the masses on down to one organization, household, or individual.

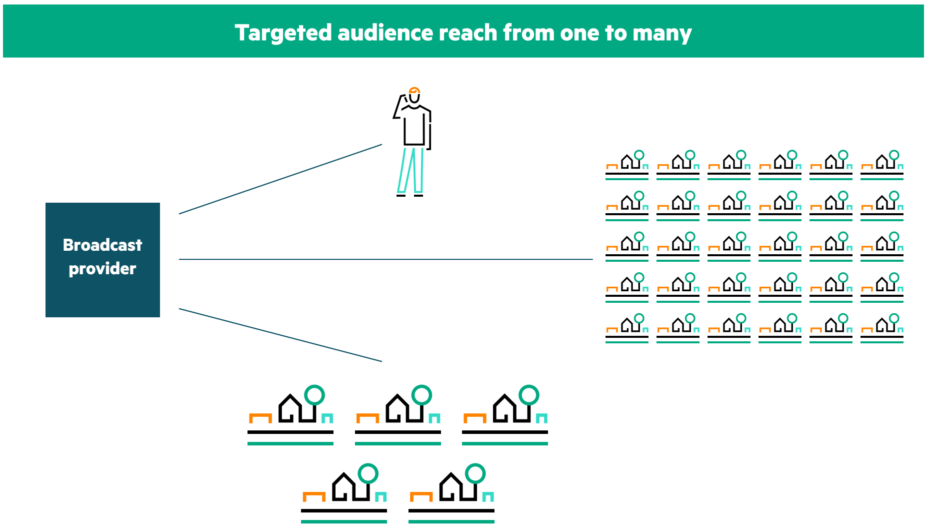


FIGURE 3. Broadcast core network

The broadcast core network also eases the barrier to entering new markets. Traditionally, the cost to reach a minimum viable threshold of viewers posed the biggest barrier to market entry. This barrier drops sharply in a "TikTok" world where advertisers can take interest in even one or two content views by the right consumers.

Supporting the journey toward convergence

Moving to a broadcast core network will be essential to enable the capabilities necessary to fuel continued business growth in the era of 5G and ATSC 3.0 convergence. Implementing the new ATSC 3.0 standard in tandem with building a broadcast core will transform how content is handled and manipulated across the broadcast center and broadcast chain, all the way to the consumer edge.

In fact, embracing ATSC 3.0 makes it possible to create more airtime. By offering delivery of unique and targeted content that best serves the targeted demographic, a single air slot can provide enhanced value. The capabilities of ATSC 3.0 mean that in one allotted time slot, content providers will be able to interweave mass-market content products with highly targeted or individualized content that ranges from programming to reach a particular consumer to advertising directly to a single niche demographic.

Broadcast core networks will converge with 5G to enable a balancing act: Whether viewers acquire content by mobile device or by television, broadcasters will be able to distribute any content with optimal economics. Enabled by the broadcast core network, broadcasters will be able to achieve hyper-localized content and targeting—with a return channel capability to determine how the content resonates.

A foundation for services at scale

Following a 5G-service-based architecture, the broadcast core network will streamline the efficiencies of spectrum usage and provide maximum flexibility to content delivery.

Specifically, a core network can enable broadcasting businesses benefits such as:

- Efficiently offer numerous services across regions and markets.
- Enable orchestration, automation, and zero-touch operation of services.
- Allow clients to discover services from the core network.
- Provide clients with up-to-date entitlement to services.

- Offer security by allowing broadcasters to identify users and provide specific services to which each user is entitled, based on which services are included in their subscriptions.
- Provide additional benefits for consumers in hard-to-reach, remote areas that lack strong broadband connections.
- Enable new use cases such as allowing a broadcast hosting company to serve as a broadcast virtual network operator (BVNO)—leasing spectrum resources to other companies on demand—or as a mobile virtual network operator (MVNO)—selling unused network capacity to other operators.

Key building blocks of the broadcast core network

The ATSC standards body is shaping the standards for the broadcast core network. The broadcast core will take its definitions from 5G core to the greatest degree possible, following a service-based architecture where the control plane is decoupled from the data plane (or more accurately, the data plane in ATSC 3.0 is the transmission chain).

Several key functions for the broadcast core network already are known to be similar in nature to a 3GPP 5G core network:

Transport function, control plane, and orchestrator. The transport function and control are necessary to create different slices within the network for the ATSC 3.0 core.

- An orchestrator (or “slice manager”) adds key flexibility and efficiency. The orchestrator makes it possible to dynamically allocate spectrum-to-data sources across multiple locations through a mesh of antennas.
- Enabling and offering services in a large-scale network requires zero-touch operation. The orchestrator automatically instantiates all necessary functions for any given services on demand and likewise automatically deprovisions them when they’re no longer needed. The utilized spectrum is then released back into the available pool.
- The orchestrator will have service definitions and an entitlement to services to enable it to register the necessary network components of every activated service into a monitoring system. This system will track the operational health of all components and report any issues so that automatic healing can be done to restore these services.
- Orchestration is a key function to enable the BVNO use case, discussed above, as automation is an essential feature to instantly activate a service.

Subscriber data management (SDM)

SDM is another important module in the ATSC 3.0 core network. SDM is needed to enable advanced services. It will provide:

- Authentication functionality to identify a customer’s receiving equipment and enable it to consume the multicast / broadcast services
- A function that exposes northbound interfaces to enable customer provisioning / deprovisioning of services
- A function to enable service discovery by which the SDM provides a pointer to the services specific to an identified customer’s subscriptions

Reimagining go-to-market strategies and revenue models

Broadcasters must reimagine go-to-market strategies and revenue models in this time of convergence.

Beyond table stakes

Clearly, enabling ATSC 3.0 is now the minimum point of parity to keep viewers engaged and satisfied. But the incremental costs of upgrading to add new modulation, exciters, and other hardware to support ATSC 3.0 will be unaffordable if broadcasters otherwise keep operating in an ATSC 1.0 world. Making these upgrades economically feasible requires a strategy to drive new programming streams and revenue models based on the expanded capabilities enabled by ATSC 3.0 and 5G.

Where to begin

The best starting point for this strategy will depend entirely on identifying the most immediate revenue targets and aligning to a positive cash flow position against that new market opportunity. Impactful multicast players with the highest run-rate advertising revenues typically will choose to target the broadcast and OTT content domain first, while other players with smaller advertising run-rate business will choose to focus on disruptive datacasting revenue opportunities.

FIGURE 4. ATSC 3.0 go-to-market strategies

- **Traditional broadcast revenues:** The dynamic content core is the critical first step for seeking the most immediate uplift on traditional broadcast revenues. This is the domain where the revenue streams associated with instant channels, event-driven content, ad personalization, and ultra-high-definition viewership are enabled.
- **Multicast revenues:** If multicast revenues are targeted, the edge deployment architecture is the critical first step. In this space, the content and software distribution caches intersect with scheduling and multitenant edge distribution to create new datacasting revenue opportunities both as a wholesale distributor and via edge hosting and transmission for client distribution platforms.

Converged network operation

Targeted advertising will certainly drive revenue opportunities in this new landscape. But in the end, broadcasters will find most of their new revenue opportunities in serving as a converged network operator and last-mile access provider. Because of the similarity of broadcast core network with 3GPP core network design, especially with respect to the control plane, ATSC 3.0 makes this unique opportunity possible. The same core network elements will interact with mobile radio access network (RAN) and with ATSC 3.0 broadcast chain to provide converged services. Both BVNOs and MVNOs will look to operate on the distribution side as offload channels for the carriers, as this will be the true driver for new revenue.

Monetizing the new broadcast content marketplace with dynamic content allocation for the broadcast core

One thing has not changed in the fast-evolving broadcast industry: Content is still king. Offering the right content for the right audience will continue to drive viewership. This means that creating fresh, compelling content remains a must. Yet harnessing the potential of the new broadcast content marketplace will require more than great content.

A modern broadcasting core will require a set of closely interconnected capabilities to help broadcasters make the most of this new content world.

Capabilities of a successful broadcasting core

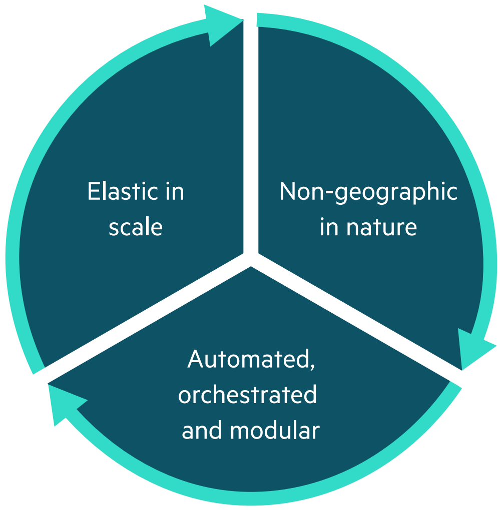


FIGURE 5. What makes a broadcasting core successful

The broadcasting core should be:

- **Elastic in scale:** Able to meet changing broadcast needs in a flexible, just-in-time way. It must be malleable to ingest, manipulate, and output in any format and at any scale, with delivery into and out of the core primarily over IP, as discussed earlier. As always, cost is a factor. The financial models involved here must ebb and flow with the needs of the content aggregator. Making these financial models work will require more than public cloud resources: Cloud hyperscale providers offer the ability to ebb and flow, but control and costs may not align with a broadcaster's business model. For these demands, on-premises, or near-premises, hybrid cloud models that provide elasticity to use hyperscale resources when required (while providing a pay-per-use capability) are more appropriate. This on- or near-premises model will also allow broadcasters to maintain sovereignty over the content while leveraging scale when needed. Content storage will be key to elasticity as well as to the other required capabilities. Again, content is king; it must be managed and stored with the respect it deserves. To do this, rely on robust, flexible storage constructs that can replicate and orchestrate content between broadcast centers and provide cloud elasticity for an always-available content assurance business model.
- **Non-geographic in nature:** Able to function beyond a single geographic location. To ensure constant resiliency and availability for content, the design should be non-geographic in nature. Ideally, this includes expanding the pool of staff beyond a single geographic location to manipulate the content—removing cost or time zone constraints typical of the traditional broadcast model.

- **Automated, orchestrated, and modular:** Programmatic (automated and orchestrated end-to-end). The processes around the content essence require a model of resilient, elastic, and programmatic manipulation—a capability to scale up and down based on the reach of the content essence and its output conduit. Realistically, in this model mass delivery is easiest to solve. It is the one primary service offering delivered over the broadcast transmission infrastructure to the edge consumer device. As the industry moves closer to individualized delivery or multidevice platform delivery, the single essence stream must scale to an infinite matrix of outputs based on the insertion of unique content or advertising segments that will drive viewership with the target consumer. This ability to scale is best achieved with cloud-scale computing resources that can be orchestrated on demand to manipulate and deliver the content essence in question. The ability to support these programmatic capabilities requires a highly modular component stack model. For this, the broadcast core model must take a modular, or farm, approach to components (encode, transcode, encapsulate, and delivery capabilities; logging; content management systems; rights management and approvals).

4. ADVANCES IN EDGE ARCHITECTURE OPEN NEW REVENUE STREAMS THROUGH BAAS AND WHOLESALE AS A SERVICE

To monetize the ATSC 3.0 marketplace, broadcasters must go beyond providing services themselves: They will provide a wholesale service to be consumed by other broadcasters and/or content providers.

Worldwide Internet of Things (IoT) spending is forecast to exceed $1 trillion in 2022[2], and edge architecture is evolving in tandem. These ongoing advancements in edge architecture have opened a range of new business opportunities for broadcasting providers and telecommunications businesses.

The ability to monetize infrastructure (through BaaS) and spectrum (through wholesale as a service) is an especially compelling opportunity. Forward-looking broadcasters and telecommunications companies have begun to unlock new revenue streams by selling services for consumption by broadcasters and other content providers.

BaaS entails making a full set of broadcasting tools available in the cloud in an on-demand model for rent by other broadcasters or other media companies. For the media companies that will pay to lease infrastructure in the as-a-service model, BaaS provides a compelling alternative to traditional, live content production.

Historically, live content production has been complex and expensive due to requirements such as:

- Low latency between actions by the live content producer and available live feeds
- A producer to travel to the event location and stay in an OB van to control live feeds from all the cameras at the event (perhaps some 5–10 cameras), and then a single feed must be carried over satellite link or dark fiber to the main headend in a headquarters or studio, where the live feed must again be distributed and transmitted to customers
- Infrastructure that must be laid down to connect each camera to a temporary production site

Rental of an OB van and satellite links

Now advancements on several fronts have converged to make remote production a reality. The combination of broadband technology, higher bandwidth, low latency (i.e., 5G connection), low-latency transcoders, and the proximity of the data center (the edge) to event locations can cut production costs to a fraction of their traditional levels. Producers can stay in their main studios, as all feeds reach the edge location, and control is done from the remote location into the software available at the edge.

[2] statista.com/statistics/668996/worldwide-expenditures-for-the-internet-of-things/

Remote production enabled by BaaS delivers a win for providers and consumers alike:

- Broadcaster or telecommunications companies that own a network with distributed edges can monetize their infrastructures.
- Media companies can produce content less expensively by leasing the capabilities they need when they need them, instead of having to invest in and maintain expensive infrastructure.

BaaS makes available on demand the typical production tools that media companies need when they produce content. This on-demand model frees up the infrastructure for other applications (such as IoT) because the tools only need to be activated when they are necessary for a given event.

Typical tools can include:

- Live ingest to receive a live feed from an event location and perform recording for future editing
- A mixer and video switcher software aggregating multiple feeds into a single view, which is mandatory for the producer to pick the actual feed that must go to distribution playout
- A playout server that enables the producer to move between a live feed and recorded available content such as advertisements or live feeds coming from a remote location

In this model, cloud-native applications and software can be efficiently controlled and orchestrated. Auto-recovery and zero-touch operation enabled by cloud infrastructure makes such scenarios possible.

As discussed in this video, Power of Partnership and Ecosystem, the combination of rapid advances at the edge, in cloud-native processes, and in other areas of technology is contributing to a new wave of innovation in the telecommunications ecosystem.

Combined with an edge platform, BaaS becomes even more achievable and effective. The proximity of cloud infrastructure to event location reduces latency and allows smoother production.

Multi-access edge computing (MEC) makes BaaS possible by enabling streaming over an IP network. The new edge architecture illustrated in Figure 7 offers an appealing alternative to the traditional, dark fiber-based method. In the traditional method, processing happens in the core network, where latency performance thresholds are slowed down or broken. By contrast, the new edge architecture makes MEC possible by enabling processing at the edge, which dramatically reduces latency.

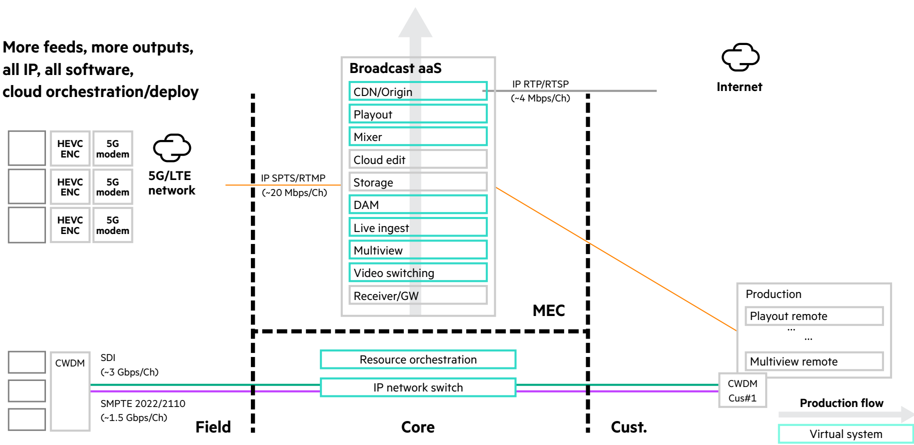


FIGURE 6. Illustrates two options for broadcastings methods

Traditional broadcasting

The bottom row illustrates the traditional (and still most common) way to transmit a live signal to a data center or studio. This method requires a dark fiber or leased line from the event location up to an IP core network of an ISP. Distribution to the customer site through another link could be based on coarse wavelength division multiplexing (CWDM) or dense wavelength division multiplexing (DWDM). This method ensures high bandwidth availability to a live SDI signal. A single 4K UHD will require 3 gigabits per second (Gbps).

Although the traditional setup ensures high bandwidth, it has several disadvantages. The architecture is inflexible and expensive. But most importantly, it is inefficient; it holds resources idle other than during the event.

BaaS

The top row illustrates the new option of BaaS as an alternative or complement to traditional broadcasting. Low latency of the 5G network, security provided through a 5G slice, and low latency of transcoding all help make this method feasible. Several new protocols such as SRT have evolved in the market to provide the required performance for BaaS use cases.

Compared to traditional broadcasting, BaaS carries several advantages. It can cost-effectively transmit a live signal over the 5G wireless network, relying on common infrastructure. This approach provides the flexibility required to transmit a live signal with a good amount of bandwidth to an edge location (MEC in Figure 7) where the required editing tools only need to be activated on demand on the day of the event. BaaS also allows new players to get involved and provide more competitive pricing vis-à-vis players that rely only on traditional broadcasting.

In practice, most of the providers that adopt BaaS will initially use a new hybrid architecture that combines the traditional and BaaS methods. This hybrid approach lets providers build out proof points about the benefits of these new opportunities while keeping continuity for a time via the traditional methods.

Wholesale as a service

With the help of the ATSC 3.0 standard, providers can also offer distribution as a service, or wholesale as a service. Wholesale as a service allows a provider such as a broadcaster or telecommunications company to rent out spectrum to other companies.

Spectrum rental is not limited to television channels. Providers can rent out spectrum to serve television channels or any other service that needs to be distributed in a multicast fashion, as discussed below.

Like BaaS, wholesale as a service benefits both providers and consumers:

- Providers: Key broadcasting and telecommunications players that have invested in upgrading their infrastructures from ATSC 1.0 to ATSC 3.0 can now further monetize the expanded bandwidth that ATSC 3.0 offers. Additionally, monetizing the spectrum by leasing out excess capacity helps ATSC 3.0 providers recoup the investments they made to upgrade their infrastructures for ATSC 3.0.
- Consumers: Media companies or other consumers can now rent ATSC 3.0 spectrum without the need to build costly infrastructure.

Multicasting

Multicast distribution is a key example of wholesale as a service or distribution as a service in action. Multicast distribution uses the capabilities enabled by ATSC 3.0 to automate datacasting in a one-to-many format, or multicasting, to IoT devices.

As shown in Figure 8, multicast can be enabled on the edge. Architecture that incorporates ATSC 3.0 with new cloud, SD-WAN, and orchestration technologies allows enterprise companies to rent spectrum dynamically and when needed.

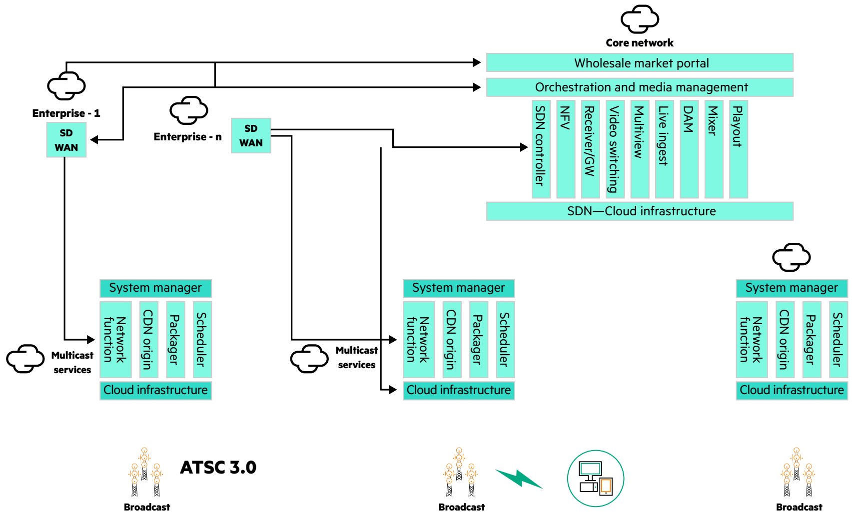


FIGURE 7. Enable multicast distribution on the edge with ATSC 3.0

Use case: Multicasting reduces cost per bit and network demands of smart vehicle updates

Largescale software updates for the automotive industry are an example of multicasting at work. Electric and autonomous vehicles require the continuous ability to update software for new functionality, bug fixes, and navigation. For autonomous vehicles in particular, safety is at stake, and car manufacturers must update software within hours—not days or months. Once hundreds of thousands of vehicles requiring software updates are on the road, broadcasting a multi-gigabit software update over a unicast network will cause network bottlenecks as periods of accommodation for terabits of traffic will be needed. As an alternative, ATSC 3.0 broadcasting service enabled by multicasting will make it possible to simultaneously deliver software updates to infinite numbers of IoT devices such as smart vehicles.

As Madeleine Noland, president of the Advanced Television Systems Committee, has described, ATSC 3.0 makes more efficient use of the bandwidth to deliver bits than LTE is able to do. This gives ATSC 3.0 broadcasters a fundamental cost advantage over the service providers that deliver bits via LTE.

The ATSC 3.0 Planning Team on Automotive Applications (PT5) is assessing opportunities and challenges of delivering ATSC 3.0 services (including video, audio, and other data) to vehicles. These include B2C and B2C applications such as broadcast updates for telematics and navigation, sensors for autonomous vehicles, and in-vehicle infotainment systems and content.

5. YOUR PARTNER IN BUILDING THE BROADCAST CHAIN OF THE FUTURE

Hewlett Packard Enterprise (HPE) has long focused on the edge-to-cloud PaaS. This is a series of capabilities that enable digital transformation—regardless of the industry—from the "edges" of a business all the way to whatever the instantiation of a "cloud" resembles for that organization—be that on-premises, hybrid, or public.

From the edge to the cloud, HPE supports the building blocks of the broadcast chain. These building blocks include all of the areas shown below:

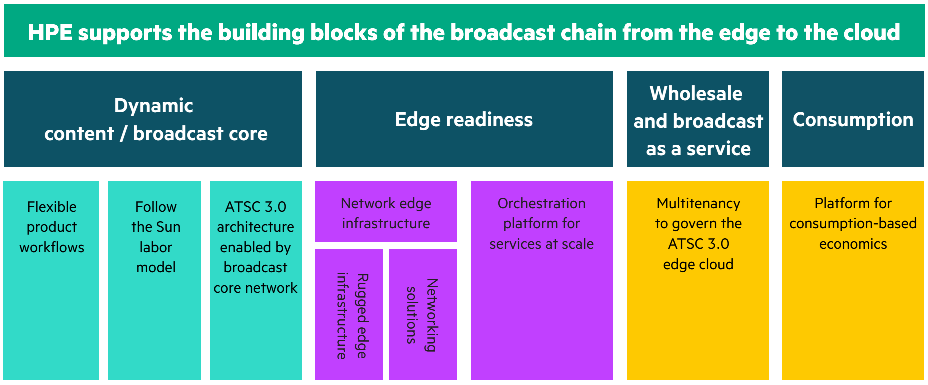


FIGURE 8. Enablement of the broadcast chain from the edge of the cloud

Supporting broadcasters in the transition to ATSC 3.0

As an active leader in the media and entertainment industry, HPE is committed to enabling the evolution and success of the ATSC standards. HPE supports the standards and builds the technologies that will enable broadcasters to define and implement the steps to harness the market-changing opportunities that ATSC 3.0 provides.

ATSC 3.0 leadership

Through the ATSC 3.0 standard, the ATSC leads the way in shaping the future of digital television. HPE contributes guidance to the go-forward ATSC standards as an active member of the ATSC.

- HPE leadership in the ATSC includes:
  - ATSC Planning Team 8: HPE served on and co-chairs the ATSC Planning Team 8—Core Network Technologies for Broadcast (PT8), which studied the core network concept and its applications to ATSC 3.0 digital terrestrial broadcasting, reported findings to the ATSC Board of Directors, and identified specific use cases and commercial benefits of broadcast core network technology.
  - ATSC Technology Group 3 (TG3): The new ATSC Technology Group 3 (TG3) develops and maintains voluntary, international technical standards, recommended practices, and other documents for the distribution of television programs and other data using advanced terrestrial broadcast technology, internet, and other transports. The ATSC Board has approved the formation of S43, a new working group on ATSC Core Network chartered to create a new broadcast core specification as part of the work of TG3 and its subcommittees to address implementation issues regarding ATSC standards and other documents. Implementing the improvements recommended by these working groups will vastly increase the opportunities to monetize the broadcast spectrum. HPE also serves on and co-chairs the S43 subcommittee.

Standards leadership across the industry

Making more than 100 contributions a year to standards bodies that impact the communications industry, HPE plays a role in a range of additional standards bodies and other initiatives. HPE takes part in standards groups and open source-policy initiatives and coalitions including:

- Standards groups
  - ATIS (Alliance for Telecommunications Industry Solutions)
  - NextG (Alliance for creation of 6GT and beyond standards), where HPE co-chairs the Next G Green G working group. (Learn more about the green vision for what's coming beyond 5G with in this video: telecomtv.com/content/spotlight-on-5g-day1/the-green-vision-for-beyond-5g-41805/)
  - ETSI (European Telecommunications Standards Institute), where HPE co-sponsors and drives ETSI ZSM
  - 3GPP (Third Generation Project), where HPE drove the specification for 3GPP TS 23.632 UDICOM for 4G/5G interworking
  - GSMA (Global System for Mobile Communications)
  - TMF (TeleManagement Forum)
  - IETF (Internet Engineering Task Force)
  - IEEE (Institute of Electrical and Electronic Engineers)
  - NGMN (Next Generation Mobile Networks)
- Open-source policy and coalitions
  - LFN (Linux® Foundation Networking)
  - TIP (Infrastructure Project)
  - O-RAN (Open-Radio Policy Coalition)
  - ORPC (Open Source Open Standards)
  - CNCF (Cloud Native Computing Foundation)

Enabling automation and orchestration in the virtualized broadcasting environment

HPE provides automation and orchestration to streamline the shift to a cloud-based, virtualized broadcasting environment.

Edge orchestration

HPE automation and orchestration solutions help broadcasters efficiently enable a cloud-based, virtualized broadcasting environment:

- **HPE Virtual Headend Manager Solution (vHM) and HPE Service Director** provide end-to-end service management to automate and orchestrate services from the edge to the core. Deploy, manage and monitor multicast, unicast IPTV, or OTT channels in a multivendor environment from a single interface.
- **HPE vHM** provides the virtualization and orchestration of the media functions that enable one-click channel deployment and channel failover in the cloud; it implements the "TV Channel Media Service" of HPE 5G Core Network Reference Architecture. This helps content providers reduce time to market for new services, increase operational efficiency, and reduce cost.
- **HPE Edge Orchestrator** brings cloud application intelligence closer to the point where services are consumed and bypasses the latency restrictions that come with processing cloud application intelligence in centralized data centers.

Self-orchestrating, self-healing broadcast network

HPE/Aruba's line of core switches handles the processing, the stringent traffic demands, and the capabilities needed to support IP for any use case. Broadcasters can couple AI and ML at "cloud scale" with a switch operating system designed from the ground up, ensuring operations to build a connected edge infrastructure that moves content from source to sink and provides high levels of AI-based assurance to the operational characteristics of the network.

Real-time compute capabilities at the edge

HPE has a line of robust and field-hardened, tried-and-tested compute capabilities that can extend broadcasting needs for software elements (such as real-time editing, encode, decode, or transcode) along with other functions (such as acquisition of SDI data; SDI to IP gateway and light transcoding; rendering farms; and SRT gateways) as far out as the camera operator or the broadcast tower edge.

Enabling the broadcast core network

A broadcast core network built on the same architecture as a 5G, service-based architecture will contain similar network functions as a 3GPP core network. HPE's 5G Core network software stack provides slicing, interworking with previous generation network technologies, and end-to-end automation. This stack is designed as cloud-native from the ground up. It includes stateless containerized network functions (CNF) from HPE and partners, a shared data environment (SDE), a common PaaS architecture, end-to-end management and orchestration (MANO), and automation framework. All are preintegrated on carrier-grade infrastructure as a service (IaaS). The stack is designed for end-to-end production.

Providing industry-leading infrastructure to open new revenue streams through BaaS and wholesale as a service

HPE offers a broad portfolio of products that uniquely couple networking, storage, and compute capabilities along with unified orchestration and cloud-scale consumption model. By deploying go-forward broadcasting services through HPE, you can jump-start your next generation of capabilities to grow market share and streamline operations.

LEARN MORE

Learn how HPE can partner with you to deliver a future-ready, edge-to-cloud PaaS offering and position your business for ongoing success in the new era of communication.

hpe.com/us/en/solutions/media-entertainment-digital-tv.html

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