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GLOBAL REPORT

SCALING THE FUTURE OF TELEVISION

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Managing scalability for key television stakeholders as streaming and broadcast converge

This paper examines the importance of deploying scalable technology solutions to support the television industry's transition towards a converged broadcast and streaming model. It identifies the biggest scalability challenges faced by each of television's major stakeholders — Content Providers, Pay TV Operators and Advertisers — as they target growth through this convergence with streaming. It concludes by discussing the role of the cloud and managed service providers in helping these stakeholders achieve scalability.

Making streaming work as part of a converged television experience requires extending content and advertising operations across an almost infinite combination of devices, operating systems, screen size and resolution, content source, content rights, time, location, syndication strategies and advertising platforms. Scaling operations across this fragmented ecosystem is critical to allow television to catch-up with, and stay ahead of, consumers' expectations. Scalable solutions will enable revenue growth, improve cost-management, and perhaps most importantly free stakeholders to experiment with new, technology-driven business opportunities that come from the industry's restructure around streaming.

Content providers are using streaming to go direct to the consumer, allowing them to maintain closer relationships with viewers and develop more informed content strategies, in expectation of greater aggregate revenues from their assets. They face scale challenges in managing delivery, device compatibility, and navigating the more complex rights management landscape that bypassing television's established value chain creates.

Many pay TV operators are becoming content super aggregators, creating value for streaming services and viewers, and driving their own growth by curating streaming content alongside their incumbent activities. They face scale challenges in deploying platforms capable of managing high volume app integration and then in creating a unified experience across both their own content services and streaming apps.

Advertisers are moving to fully addressable models for television advertising, utilizing the ability to understand and target individuals that streaming affords. They face scale issues from the greatly increased volumes of demographic and audience segmentations, buyers and sellers of inventory, versions of advertising content, and in executing campaigns across a fragmented platform landscape.

To address the need for scale, all stakeholders should consider advancing cloud migration of processes and workflows to microservice-based models to scale resource procurement. They should also consider harnessing the technical expertise and ready-made scale that managed service providers can offer. By deploying scalable solutions, however they chose to do it, stakeholders will transform their business for success in television's streaming era.

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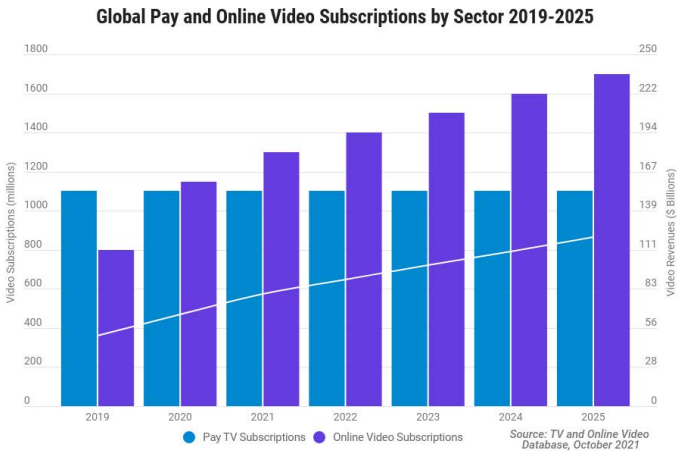
How does streaming create a scale issue for television?

Viewers have embraced streaming because it enables them to engage with content on their terms, providing them with a highly personalized experience. Each viewer has a unique set of needs beyond their taste in content — which device they wish to use, where they want to watch, when they want to watch, and how they wish to pay for it. Delivering this personalization through streaming greatly increases fragmentation in all television operations, creating a huge technical challenge for industry stakeholders. It requires making television operations work across an almost infinite combination of devices, operating systems, screen size and resolution, content source, content rights, time, location, syndication strategies and advertising platforms – to name just the headline considerations.

Television has grown to be a successful industry through broadcasting, which mitigates fragmentation to achieve scale by using standards and through limited choice:

- in content and timing, through linear delivery
- in location, by operating over fixed infrastructure
- in device, by supporting only television screens.

Its success was bound to the idea of viewers expecting to watch similar things, at similar times of day, in similar locations on similar types of devices. This solution is no longer aligned with viewers' expectations of all that the television experience should be, with streaming offering something more flexible to their individual requirements.



Streaming subscriptions have now overtaken pay TV subscriptions globally, such is their appeal to consumers, but crucially streaming revenues lag those generated by pay TV. Streaming services provide

a net positive revenue increase to the overall value of the television industry, but annual revenues per user are substantially lower for streaming than for pay TV services. A streaming service operating over the same location as a pay TV service with the same number of subscribers, will in all probability generate far less subscription revenue than the pay TV service, but will still need to provide its customers with an equivalent quality of experience and service. Managing the costs of this against lower subscription revenue is compounded by the need to increase investment in exclusive content to differentiate streaming services, demonstrate the ongoing value of subscriptions, and maintain growth. Content providers are the driving force behind this change and believe they can derive greater value overall from their content by launching their own streaming services than by syndication alone. They require scalable solutions to maximize their audience reach and growth potential, while enabling them to manage the costs of meeting or exceeding consumers' expectations.

Pay TV operators have an opportunity to capture streaming growth by becoming super-aggregators through partnerships with streaming services. This is valuable to streaming services because it provides them with ready-made audiences for expedited growth and helps pay TV operators maintain relevance in the face of shifting consumer preferences. To succeed at super-aggregation, pay TV operators must overcome the scale challenge of providing a platform that can efficiently integrate apps and makes it easier for viewers to discover content across them than it would through other platforms.

Advertising also has an important role to play in television's streaming-based growth story by monetizing content and services beyond subscriptions. Streaming ultimately offers television advertising the opportunity to transition to a fully addressable model able to deploy highly targeted advertising in individual streams. It needs scalable solutions to get there; processing to understand user preferences, and systems to plan and execute campaigns across fragmented programmatic platforms.

It's common for broadcast and streaming to be discussed in binary and antagonistic terms because of the disruption to the status quo, but streaming can be used to play a supportive role to broadcast and pay TV operations. User preferences and behaviors better understood through streaming can inform decisions about broadcast scheduling, content acquisition and content syndication.

Solving the scale challenges of streaming becoming part of the television landscape is about more than just meeting customers demand, it will transform the television industry. Stakeholders can use streaming to develop stronger, more successful relationships with viewers through a better understanding of individual needs. This understanding can also be leveraged to utilize business resources more effectively, directing investment and strategic decisions. Streaming solutions must deliver all of this and have quality and reliability whilst remaining cost-effective. If these conditions are met, then a solution can be said to be scalable.

Scalable solutions support growth. Service launches, geographic

expansion, hit content availability and live event coverage can cause huge, and sometimes unpredictable, spikes in demand for access and advertising. Systems need to be able to expand rapidly to address this demand, or risk missing out on capturing these growth opportunities.

Long-term growth is underpinned by customer retention, so it's pivotal to deploy solutions that are responsive to changes in consumer preferences and continue to provide optimum quality of service and experience as expectations and behavior change.

Scalable solutions support cost management. Scalable systems must be able to expand rapidly to handle periods of peak demand or new functions, but they must also be able to scale down during lulls in demand or when functions are retired. By doing this, only the resources to support exactly what is needed at any given time are procured, avoiding over investment.

Scalable solutions will also help manage costs by automating workflows around available resources, directing resources as required for real-time usage, and scheduling less time-sensitive operations for quieter periods.

Scalable solutions support innovation and agility. Having systems that can quickly scale up and down with proportional costs affords greater freedom to experiment with new business ideas. New services, features, monetization models, and processes can be quickly trialed without substantial capital outlay, and their success analyzed and acted upon. The costs of fast failures are low and easily contained, whilst successes can be rapidly understood and scaled for value creation.

Content providers, Pay TV Operators and Advertisers need to deploy scalable solutions to fully benefit from the growth opportunities presented by the television industry's evolution around streaming. Stakeholders that deploy scalable solutions this will have transformed their business to be ready for success in the streaming era.

Where are scale considerations greatest for key stakeholders?

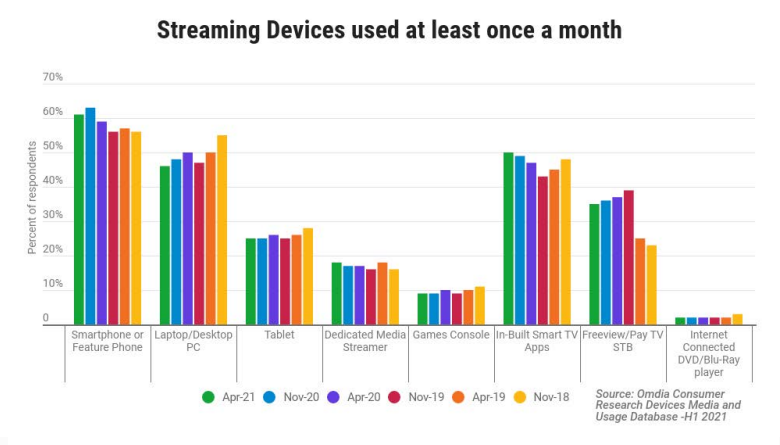
Content providers, Pay TV Operators and Advertisers all experience different scale challenges. This section examines how each television industry stakeholder is affected by scale as they adapt to embrace streaming.

CONTENT PROVIDERS

In eschewing the established value chain, content providers going direct-to-consumer aim to generate a greater aggregate revenue from each content asset by capturing a larger share of both consumers' content spend and their value as an audience to advertisers. They must bear much of the cost of managing delivery to many types of devices whilst maintaining quality of over unmanaged networks

themselves. This is complicated by the need to increase investment in content creation and procurement to keep subscribers engaged and prevent churn with a steady flow of new programming. This global increase in video services offers content owners more options for syndicating and distributing content, creating complex global deals which requiring flexible distribution and management.

Device reach, supporting apps across a large range of devices with hardware and software specifications beyond the streaming provider's control, generates significant development and ongoing support cost. The hardware and software environments for mobile, tablet and computer/notebook devices are relatively consolidated. Almost the entirety of this market can be reached by launching Android, iOS, macOS, Windows or even browser-based apps. TV screens exist in a much more fragmented ecosystems making them more difficult to reach. There is a relatively large number of smart TV, pay TV STB, streaming media devices, and games consoles hardware and software to be supported. Not only is it the most challenging segment to reach, it's also the most important in terms of the frequency of usage by viewers.



As well as the app development and support cost there is also a substantial amount of work involved in content preparation for these devices. There's a large variety of screen sizes, aspect ratios, resolutions, dynamic ranges, video codecs, audio codecs and DRM schemes to support. This can be managed in non-real-time for non-linear viewing, but requires significant amounts of computer resources to managed for real-time live distributions.

Delivery Systems need to be built to scale with fluctuating viewing demand. Demand for television viewing is not constant. It varies throughout the day, and according to scheduled and unscheduled events. Live events and even premiers of popular non-live content can cause spikes in concurrent usage, which quickly subside once the event is over. Building delivery systems that constantly operate at peak concurrent usage levels is not only an inefficient way to procure resources, but it can also be a barrier to growth if delivery can't keep pace with subscriber acquisition. Multicast has not proved a practical solution to this: where the same stream is accessed by multiple viewers akin to broadcast. Its efficiencies are predicated on concurrent linear viewing – the broadcast model of TV. As soon as viewers engage in non-linear activities, pausing, rewinding, start-over,

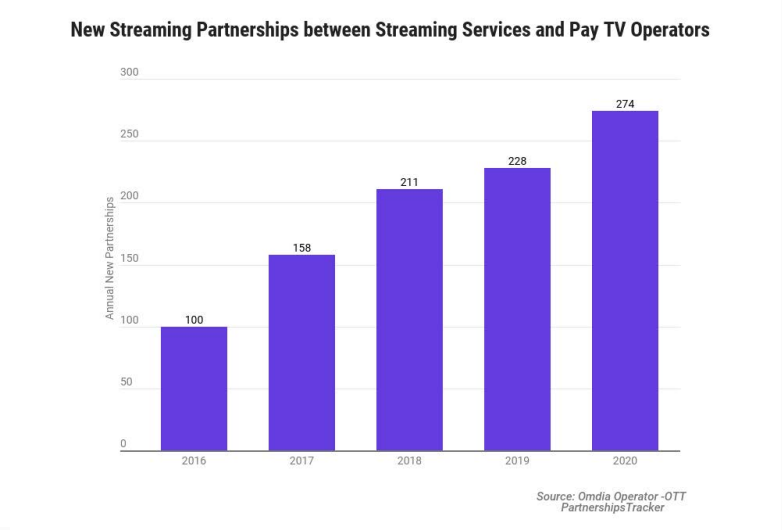
or recording they are given a unicast stream and the efficiencies are lost.

A better approach is to utilize systems which can scale resources up and down with demand. This is particularly critical as live content becomes ever more a part of the streaming landscape. Beyond CDN capacity, systems for authentication, content security, payment and addressable advertising, to name just a few, need responsive elastic capacity to ensure they continue to operate at high concurrency and don't negatively affect user experience.

Rights management and compliance is another area where scale must be managed because streaming adds layers of complexity to managing what can be shown where and when. Streaming allows for viewers to watch on a range of devices, many of them mobile, and through browsers, and accounts can be logged into from any geographic locations. Systems must be in place to ensure customers' viewing circumstances comply with the rights to show the content and any local regulations. Such systems require the effective exchange of metadata between content providers and video service providers. Live, linear rights management adds extra considerations for blackouts, content substitution and advertising, which must all be applied whilst maintaining a high quality of user experience, or missing substitution or advertising opportunities.

PAY TV OPERATORS

Pay TV operators face similar scalability considerations as content providers where they maintain responsibility for the delivery of streamed content and must deploy similar solutions. Pay TV operators can continue to be valuable partners for content providers with direct-to-consumer strategies by repositioning themselves as super aggregators of streaming services.



Partnerships between pay TV operators and streaming providers are growing. This is because partnering pay TV operators offers streaming services multiple benefits:

- **Distribution & Audience:** provides streaming services access established pay TV customer bases and business lines.
- **Platform/Device Integration:** allows streaming service content

to be discovered alongside other TV content and consistently demonstrate the value of the service.
- **Bundling:** provides a range of strategies to secure subscriber growth: from soft-bundled introductory offers, hard-bundled permanent subscriptions, and even through to multi-service super bundles.
- **Carrier Billing:** lowers the barrier to subscribing to a streaming service by using established pay TV billing arrangements to ease payment.

These partnerships are successful because of the convenience they provide viewers. The modern TV experience for many consumers is a confusing mix of hopping between apps, devices, passwords, and billing arrangements as they search for content. App-centric video distribution effectively adds a layer of obfuscation between the viewer and the content available to them; they must enter each app to find the content within. This can only be remedied by access to all content through a single device and user experience, with a unified discovery mechanism. A complete television experience for many viewers must extend beyond apps and include broadcast/linear programing where more locally focused content resides.

Aggregation platform strategies need to comprise software and hardware for optimum performance. A set-top box or some form of pay TV operator provided hardware, such as an operator-embedded TV, must be a consideration. It remains the only way to guarantee a customer can access the service on any TV they own, and for operators to retain complete control over the user experience and available content. The hardware can be very lightweight compared with past set-top boxes, with most of the core aggregation functions happening via cloud-assisted software functionality.

It is technically possible to deploy a pay TV service only as an app for consumer devices. The downside of this approach is that the pay TV app is just another app amongst other apps in a primary user experience controlled by the device manufacturer. For super-aggregation to be successful it must be the primary user experience. Scale with this app-based approach is limited by the resources available to develop and support the app across the ever-expanding consumer device landscape, in much the same way as it is for streaming services. A possible compromise might be to pick a “hero” consumer device to centralize development around, ensuring that there is always a device a pay TV operator can recommend for accessing its service on a TV screen. This strategy places outsized dependency on the capabilities, roadmap and industry relationships of a third party outside an operator’s direct influence. It also doesn’t solve the primary user experience problem, so arguably any cost saving benefit from avoiding hardware development is negated by the loss of control of the user experience.

The operating system for the hardware is also of critical importance to ensure that apps are developed for the platform. Pay TV operators can choose between operating systems based on how propriety or open they are. The more proprietary an operating system is the more exclusive it will be to its creator and the more control a pay TV

operator will have over the content available on it, but it will require more development resources to build and maintain. It may also be difficult to pursue third-party apps to support the platform without a sufficiently large installed base of devices. Choosing a more widely deployed, open platform may require less development resources and have a greater availability of apps supported by the app owners themselves but may come at the cost of a loss of exclusivity and control over visual and functional customization.

Unified Discovery is the next critical aggregation element to scale after gathering the content into a single user experience. Its success hinges on the metadata used to describe the content. A well-functioning content partnership will ideally include access to an app's metadata for search and discovery, but this isn't always the case. The metadata provided between different apps is likely to be inconsistent, with items detailed in one app missing from another. Broadcast content is also provided with metadata, but typically a much smaller amount than streaming. Achieving metadata parity across the entire content portfolio requires any gaps be filled. This is often performed by an in-house editorial team, but this becomes more difficult to scale as content libraries grow. This is often best remedied by procuring metadata from one or more specialist third-party providers, but automated metadata creation with be one of the first widespread applications for artificial intelligence and machine learning in the television sector.

The content discovery experience can be greatly improved by using recommendation engines to suggest content that viewers will find appealing, rather than leave them manually searching for content. These systems use machine learning algorithms to match content with user preferences. Scale is important for recommendation engines because the quality of their recommendations is directly proportional to the amount users and content that they process; as well as the quality of the metadata describing the content and the user. Recommendation is at the heart of content aggregation and has the power to be a strong differentiator for pay TV operators. There's a temptation to try to develop unique recommendation engines in-house because of this but pay TV operators should strongly consider how their own scale of subscribers and content compares with the scale and specialization benefits of using a third-party recommendation engine which can generally draw from a large sample size of users and content across its customer base of pay TV operators and other video service providers.

Voice control is emerging as a strong candidate solution for unified content discovery, particularly as it becomes more widely accepted in smart home and automotive application. This is another area where control over hardware design becomes important. Pay TV can decide where to put microphones of optimum user experience: Should they be in the remote control? What about as an app on a mobile device? If they are integrated into the STB, does it also need to have a speaker? How can they be turned off?

Cloud DVR should be a consideration for pay TV operators to level-up linear broadcast content with the non-linear functionality typical of

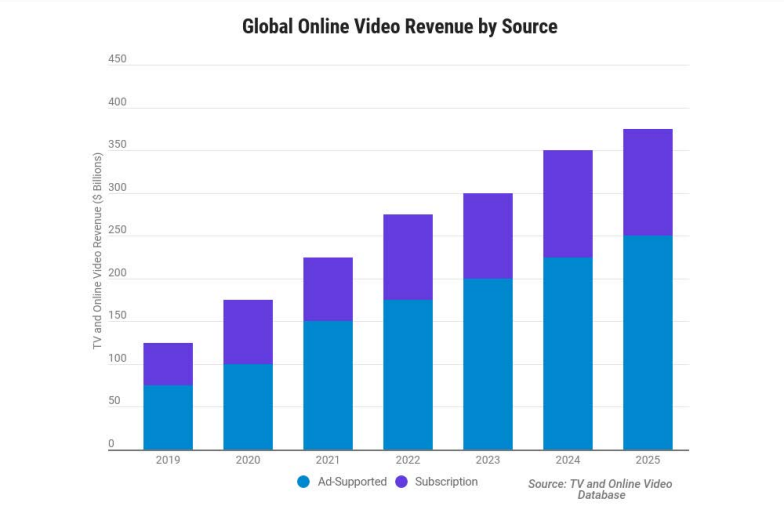
streaming. It imbues broadcast/linear content with pause, skip-back, start-over features so intrinsic to streaming, as well as more traditional recording features. It also allows for this functionally when viewing on non-STB devices, rights permitting, unifying customer experience regardless of how they chose to access the content. It's also essential for providing high quality user experience for live streaming on non-STB devices, where the efficacy of live pause and skip back features depends on the size of the available buffer chosen by the device manufacturer. It's common for these buffers to be very small, allowing only a few minutes of content to be held in the buffer, meaning that the pause and skip-back functions can only last for these few minutes. Cloud DVR mitigates this by putting a buffer in the cloud and enabling the pay TV operator full control over it.

Cloud DVR need not and should not be a value-added feature for subscribers at a cost to pay TV operators. There are a number of options for monetizing the service including fixed monthly fees for service enablement through to charging for storage capacity, but the most promising are the additional advertising opportunities it provides. Centralizing the storage of recorded content in the cloud and then delivering it to viewers as individual unicasts provides an opportunity to replace the advertising inventory using the addressable models associated with streaming. Advertisements can be replaced with something more targeted towards the household or viewer each time it's accessed, or for a complete replacement of the inventory when it becomes out of date.

How cloud DVR may be deployed varies according to local laws and contractual agreements with rights holders and has a huge impact on storage requirements for holding the content.Deploying cloud DVR at scale is highly complex from technical, operational, business and legal perspectives.

ADVERTISERS

Streaming offers the advertising industry the opportunity to move towards a fully addressable model for television advertising. Each stream/view on each device is unique which means that – business and legal rules permitting – so can the advertising inventory associated with it. Moreover, viewers' preferences can now be understood uniquely, facilitating a move beyond panel-based decisioning and household demographics to target specific audiences with specific targeted ads. Improvements in campaign performance measurement are naturally facilitated by streaming. The advertising industry must be prepared to embrace streaming because ad-funded services are going to be increasingly important as streaming matures and content providers look to expand viewership outside of subscription models. Ad-supported streaming revenue will experience a compound annual growth rate of 21% to 2025 almost double the 13% experienced by subscription streaming. Existing advertising workflows need to change to enable and unlock the benefits of streaming.



Volume will be the biggest scale challenge faced by the advertising industry in addressing streaming. Systems will need to support a hugely increased variation in audiences/demographics, buyers, sellers, and versioning to support the variety of devices and locations that streaming supports.

A huge number of audiences and demographics can be created by the ability to analyze individual viewer and household preferences. These can then be aggerated to various levels of size and specificity, tailored to the needs of buyers and sellers of inventory.

Streaming greatly simplifies video distribution by divorcing the need to own delivery infrastructure from the ability to launch a service, removing a barrier to entry for many content providers to launch their own services. This means there will be more streaming services selling advertising inventory. Advertising will be the core monetization model for many of these.

The improvements in audience segmentation and greater variety of available content will lead to there will be many more buyers of streaming advertising. Purchasing smaller amounts of more targeted ad inventory will appeal to a large group of buyers which previously believed they would or could not benefit from the scale and expense of broadcast television advertising.

Large scale television advertising efficacy will also be greatly improved by streaming. Buyers looking to reach large audiences can still do so but can use the enhanced segmentation to accurately target different demographics of the audience with different versions i.e.. advertising the same product or service but under different usage scenarios germane to different segments of an audience.

Fragmentation of the programmatic advertising landscape makes it very challenging to plan campaigns, sell inventory, purchase inventory, deliver impressions and measure the effectiveness of a streaming campaign at scale. Addressable advertising requires that programmatic platforms be able to handle transactions, where the requirements of advertising buyers are matched with the available inventory from sellers. There are many different buy-side and sell-side programmatic platforms available, but little standardization exists within the industry for how they interact. This makes it hard to manage a campaign across all available inventory or maximize opportunities across all potential buyers. This challenge is compounded by the need for all the computation behind the transactions to happen quickly to avoid missing out on the opportunity to serve ads during available slots.

How to achieve scale?

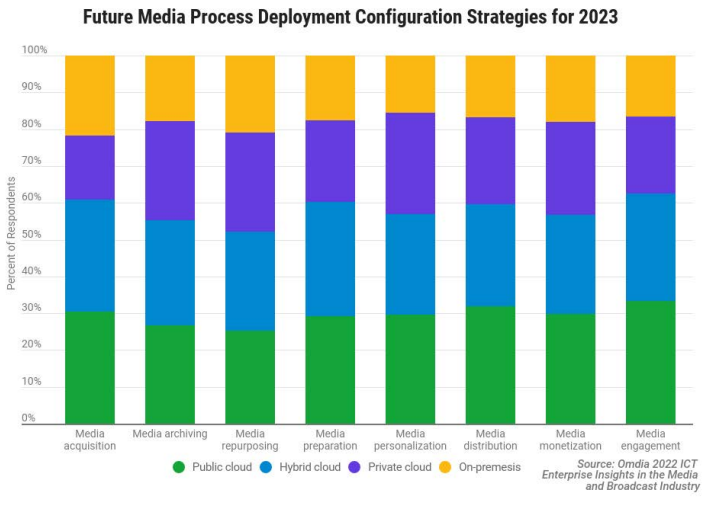
For all the discussion about the difficulties of streaming at scale, it has already inelastically raised consumer expectations of television. Most streaming services still operate in silos, born of streaming's initial adjunct to incumbent services, with multiscreen, virtual pay TV, SVoD, AVoD, all using different platforms, and broadcast entirely isolated. Each solution is typically designed to address a single opportunity in an evolving landscape of possibilities, dependent on meeting rooms and spreadsheets for coordination between them. These early streaming implementations are typically monolithic end-to-end systems, with the whole limited by the least capable element. Few are capable of scaling for the future where streaming and broadcast form a converged television experience.

The scale challenges to reach this future broadly fall into two groups:

1. Managing the availability of computation and networking resources to support services – compute for video versioning and analytics, storage for content and cloud DVR.
2. Managing compatibility between myriad systems, functions, devices and contractual agreements – ensuring apps work on devices and advertising campaigns are successful across multiple platforms. The television industry should look to the cloud and managed services providers for solutions.

PRIORITIZE CLOUD MIGRATION TO SCALE RESOURCES

An immediate benefit that cloud solutions provide for reaching scale is access to elastic and flexible resources. Optimum scalability will likely require a workflow to incorporate mixed private and public cloud resources in a hybrid environment. Growth, capacity and peak concurrency resources can be enabled through the public cloud, but costs can be managed by investing in private cloud resources as requirements become more understood. 83% of media companies surveyed for Omdia's 2022 ICT Enterprise Insights in the Media and Broadcast Industry report will be using, plan to use either private, public or hybrid cloud for at least one media process by 2023, with hybrid deployments planned to be the most common.



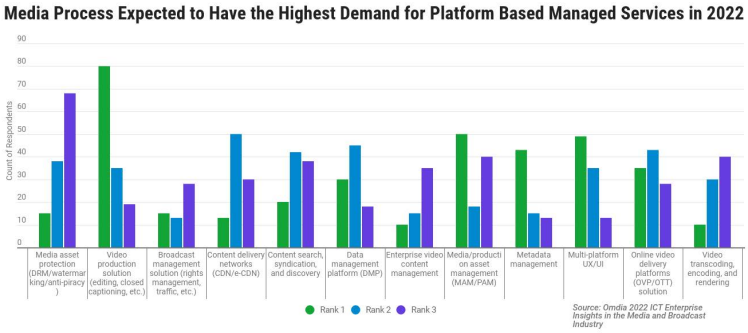
Prioritizing the migration of workflows into the cloud is a must for those that are not already doing so but moving monolithic solutions into the cloud alone won't solve scalability. Monoliths need to be rearchitected into microservices and modularized into their constituent functions to improve scalability. Adopting microservice-based workflows yields two principal benefits: Firstly, it allows scale to be managed at a functional level. Each microservice can be scaled independently of the others, whereas typical monoliths require the whole workflow to scale even when just a single function experiences a peak in demand. This approach also enables the individual functions to be maintained, upgraded and even replaced by alternatives with limited impact on the rest of the workflow, which provides greater agility for improving the end product; Secondly, microservices enable a single workflow to be configured to support a variety of tasks and services. Rather than building a new monolithic workflow to trial or launch a new service or business model, one based on microservices can be reconfigured to a support this – assimilating new functions as necessary.

Constructing a workflow with centrailized, modular functions in the cloud, greatly increases its configurability and programmability. This in turn opens the doorway to increased usage of artificial intelligence and machine learning throughout the workflow. Modularity enables the individual functions to be enhanced with AI/ML enabled features, such as context-aware encoding, automatic subtitling, or improving advertsing effiency, at scale without without disrupting the rest of the workfow. More profound uses of AI/ML will occur when it's applied across the workflow functions, to monitor, orchestrate and automate the workflowmore. This will achive a much higher level of optimization than human beings can alone, and will be a critical element to making workflows effective at scale across the growing number and variety of services they will need support as the television industry continues to evolve.

LEVERAGING MANAGED SERVICE PROVIDER EXPERTISE

Stakeholders in the television industry all face similar scale challenges, ingesting and processing content, managing app compatibility, executing advertising campaigns. Their core business priorities need to be on differentiating through content and use experience. Engaging managed service providers to create workflows can enable stakeholders to focus more on core priorities and less about the underlying technology. Managed service providers develop inherent scale and expertise by supporting many customers through these challenges. Most will already have the stable, scalable solutions to enable rapid growth and time to market, and their expertise will enable them to develop solutions for addressing new opportunities at scale, often with much greater agility than inhouse resources. In a modularized workflow, managed service providers can be utilized to provide a full end-to-end suite of microservices, or just a single specialized microservice as needed. Omdia's 2022 ICT

Enterprise Insights in the Media and Broadcast Industry survey show that the media industry intend to deploy managed services across a broad swathe of functions.



A final pertinent benefit of utilizing managed service providers is their ability to act as a buffer against technology vendor disruption. The television industry is restructuring around streaming, which has resulted in a period of ongoing consolidation and M&A amongst technology vendors as they grapple with the opportunities and challenges presented. Managed services provide the solutions for delivering television, and good ones will manage their vendor selection around these complexities, isolating customers from any impact and ensuring business continuity.

There is a strong economic argument for utilizing a combination of managed services and the cloud to build scale. It's entirely possible to build a converged broadcast and streaming television workflow in-house with dedicated resources, but it may not be a wise choice given the changeable environment of modern video distribution. Solutions built this way require heavy up-front investment in anticipation of growth and peak capacity. This approach begets over procurement, at the risk of under procurement, on resources that may not prove responsive to change, and may never be fully utilized before becoming functionally obsolete. The combination of cloud and managed service models provide a compelling alternative to this. Enabling stakeholders to procure only but exactly what's needed, providing costs that scale with success, allowing budgets to be spent where they matter most.