

TV AND DIGITAL VIDEO

The role of cloud in content **production and delivery**



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INTRODUCTION

TV and video production and distribution are undergoing a period of disruptive change that looks set to continue for the foreseeable future, with:

- Massive growth in IP-delivered and over-the-top (OTT) video
- The rise of multiscreen viewing and TV Everywhere
- Rapid evolutions in consumer devices and viewer behaviour

To take advantage of the opportunities offered by these massive changes — and deal with the challenges they present — content owners, producers and broadcasters, and the service providers who support them, are looking at new ways to create, store, manage and distribute TV and digital video content. For example, they're increasingly adopting IP workflows, and blurring the traditional boundaries between production and distribution of content.

This white paper explores the growing role of public and private cloud and virtualised environments in today's content production and distribution workflow. Drawing on findings from research interviews conducted with companies throughout the value chain, it highlights:

- The benefits and potential drawbacks of cloud adoption
- The factors to take into account in order to strike the right balance between dedicated infrastructure and cloud
- The impact of cloud adoption on hosting and connectivity

It will be of interest to companies involved in the production and distribution of video and TV content, especially:

- Content owners and distributors — including studios, post-production companies, broadcasters and OTT service providers
- Providers of media solutions and services — technology and service providers who support content owners throughout the production and distribution workflow

A companion white paper, 'The challenges of IP TV and video delivery', looks in more detail at the rise of multiscreen viewing and TV Everywhere, and the strategies companies are adopting to meet consumer demand.

RESEARCH METHODOLOGY

UK-based research agency FirstPartner undertook qualitative research to explore the commercial and technical challenges facing digital media companies. In-depth telephone interviews were held with a range of companies representing all stages of the video production and distribution workflow.



DIGITAL VIDEO PRODUCTION AND DELIVERY: AN INDUSTRY IN TRANSITION

To meet consumer demand for IP-delivered and OTT video, content producers and distributors are adopting IP-based workflows, software- and cloud-based services, and hybrid distribution models.

The video production value chain and workflow are experiencing a period of rapid change. End-to-end IP workflows are becoming more commonplace, and the traditional distribution value chain is becoming less clear cut, as studios and channel operators increasingly distribute content to consumers directly as well as through third-party broadcasters and multi-system operators (MSOs).

Many organisations are finding that their roles — and the expertise and resources they need access to — are also changing. For example, production companies and studios must now manage parts of the distribution workflow that were traditionally the domain of broadcasters and cable companies. At the same time, many broadcasters, MSOs and cable service providers are moving from a directly controlled, dedicated distribution infrastructure to a hybrid model that incorporates OTT delivery, cloud-based infrastructure and third-party distribution partners.

As a consequence, providers of software- and cloud-based outsourced services are increasingly relied on for solutions ranging from collaborative production and storage facilities to encoding, workflow management and distribution services.

Providers of software- and cloud-based outsourced services include:	
Adobe	AFrame
Avid	Brightcove
Cisco	Deluxe
Elemental	Envivio
Ericsson	Harmonic
MobiTV	RGB Networks

“We’re seeing a shift towards cloud services which is commensurate with a shift to software and more IP-based services. No one quite knows the degree to which conversion will happen: how much of the broadcast spectrum will be converted towards Unicast, how many of the services will move to pure software, how many of those pure software services will end up being cloud orchestrated — but the fact is that there is a trend that is palpable. That’s clear. The industry we serve is in transition.”

Streaming technology provider

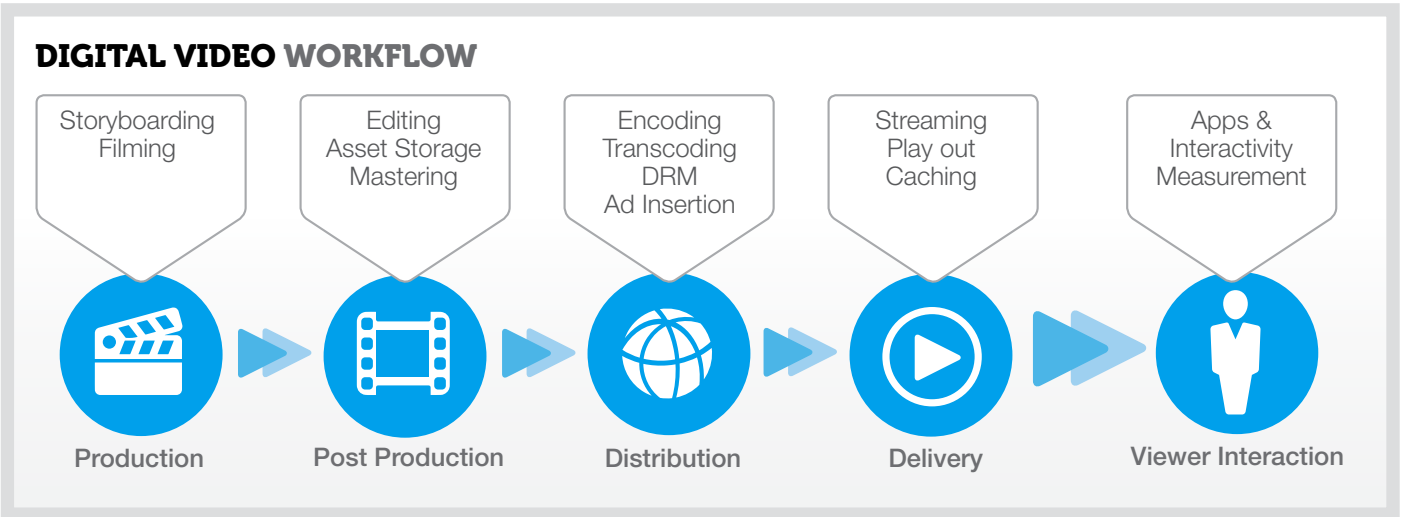


Figure 1. The digital video workflow

INTO THE CLOUD?

Cloud is key to solving many of the challenges faced by content owners, producers and distributors, and the service providers who support them. When planning how far and how fast to move into the cloud, the opportunities, challenges and benefits that come with cloud must be considered.

Given the increasing adoption of IP-based workflows and software- and cloud-based services, it's clear that cloud has a role to play in the new-look video production and delivery workflow. What opportunities does cloud open up, what challenges can it help to resolve, and what benefits can it deliver? And what do companies need to consider when planning for and deploying cloud-based infrastructures and services?

It's worth examining these questions from two perspectives:

- The owners, producers and broadcasters of digital video and TV content
- The technology vendors and service providers that support them

DEFINING CLOUD

The term 'cloud' is often used loosely to denote different services and infrastructures, which can lead to confusion and inconsistency. For clarity, we've defined the main cloud models that are relevant to digital video production and distribution in an appendix starting on page 14.



PERSPECTIVE ON CLOUD: CONTENT OWNERS, PRODUCERS AND BROADCASTERS

Cloud is already finding a role at studios, post-production companies, broadcasters, OTT service providers, cable and IPTV companies. Some companies have taken tentative first steps towards the cloud; while others have fully embraced it.

Major studios, broadcasters and production houses are adopting cloud-based collaborative editing and storage solutions in the production and post-production stages of the digital video workflow. For example, Fox Networks uses cloud services from AFrame to streamline sports and news collection and the production workflow. Studios that get involved in cloud early on can gain first-mover advantage when it comes to driving standards, as well as security and other process controls.

Media owners and distributors offering OTT services have implemented the most significant cloud-based deployments to date. High-profile examples include Netflix, Channel 4's 4oD and BBC iPlayer. In 2013 the BBC migrated the ingest, transcoding, media storage and playout functions of its VoD service onto a public cloud infrastructure, to solve the challenges of serving content to a myriad of mobile devices and tablets, and scaling to meet consumer- and schedule-driven fluctuations in demand.

Our research suggests that these leading OTT VoD distributors and smaller content owners and enterprises are most likely to have adopted a cloud-centric model. They're taking advantage of third-party SaaS transcoding, delivery and other services, or are hosting their own applications and storage on IaaS.

On the other hand, larger broadcasters and MSOs are generally deploying dedicated hardware or on-premises virtualised infrastructure for core workflow applications, storage and archiving. This is because:

- They can take advantage of existing data centre infrastructure and IT resources
- Their scale keeps the costs of purchasing and maintaining hardware down
- They need to maximise ROI from existing assets
- They believe on-premises deployment offers better control and content security

“The larger the media enterprise the more likely it is that they have a data centre infrastructure they can take advantage of, that they have staff that can go out and procure the commodity hardware and set up the cloud environment that we require to run our service... There is also that level of security and privacy that very large content providers are looking for when they do things in house, because they prize the security of their content over everything else.”

Streaming service provider

Will even the larger, established organisations ultimately migrate to the cloud? Some leading broadcasters and content owners have deployed high-profile cloud initiatives, particularly for live streaming. For example, NBC adopted Microsoft Azure and iStreamPlanet's live streaming services to deliver coverage of the Sochi Winter Olympics.

“The Olympics is something that happens only once every two years and it is massive. It is the perfect scenario for public cloud hardware infrastructure.”

Streaming service provider

Cloud is clearly on the radar and the benefits — at least of running software solutions on private cloud or in virtualised environments — are well understood.

“I think [in three to five years] everyone is going to have some part of their operation in the cloud. Everyone is going to have hybrid infrastructure... It will be a mix of on-site infrastructure, hosted private cloud, and public cloud.”

Broadcast technology and process consultant

THE BENEFITS OF CLOUD: INCREASED FLEXIBILITY, REDUCED COST AND RISK

Cloud can help content owners, producers and distributors deal with variations in capacity requirements for functions like transcoding and playout. Variability in demand is inherent in delivery of multiscreen OTT content; OTT services are still on a steep and unpredictable growth curve. Public cloud — IaaS or SaaS — is the most flexible and lowest-risk way to provide easily scalable capacity without excessive capital investment.

“The cloud is certainly the answer to the scalability and reliability requirements that the video processing and media processing workload requires in order to meet the huge demand that just a few years ago wasn't there....”

“...if you look at how major content providers have been doing it — which has been using dedicated hardware in their own data centres — it is very expensive. And because the technology and the devices are changing so quickly, it is requiring big capital expenditures... Software is always going to be easier and cheaper to upgrade and maintain than hardware... You don't have to outlay that huge capital expenditure to enter a new market.”

Streaming service provider

Like public cloud, private cloud and virtualised environments will deliver flexibility and cost-reduction benefits. The dedicated, optimised hardware traditionally used for functions like transcoding and playout can be replaced by software-based deployments running in a virtualised environment on commodity hardware. Our research indicates that the benefits of this approach are understood by the industry.

“The operational advantage of the cloud is understood by our customers. We are being reactive to something they have told us, which is that they are willing to give up some benefits of hardware solutions — solutions running on bare metal — for the operational cost savings of running on uniform hardware.”

Video distribution solution provider



As well as lowering the cost of hardware purchase and operational support, this use of private cloud or virtualised infrastructure delivers processing and storage capacity that can scale more easily in line with variable demand.

“Cloud in video offers a variety of advantages, notably the ability to orchestrate usage with need. Imagine that you are doing ad insertion in a TV Everywhere environment where you are targeting individual users. The more users you have, the more simultaneous sessions you have and the more targeting you have to do, and that requires more computational resources. But at 2am you are not going to have the computational burden of a prime time slot, and you can utilise the resources to do other things, for example transcoding of on-demand video.”

Video distribution solution provider

However, for other organisations, the assessment of the benefits offered by cloud is still at an early stage.

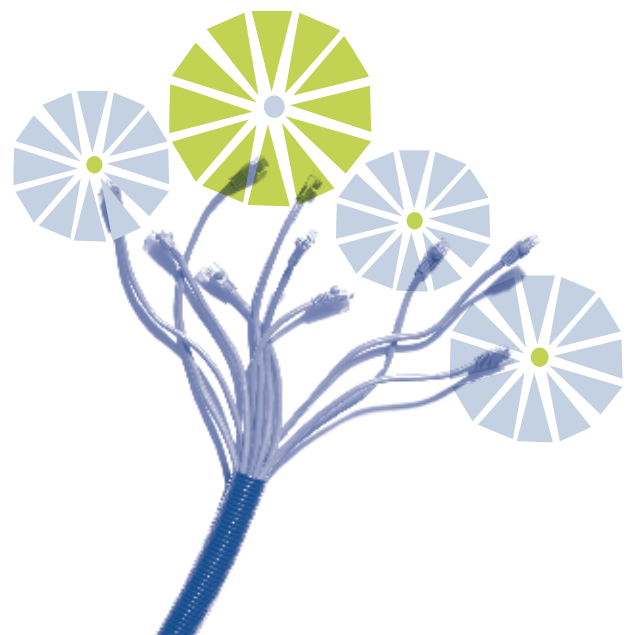
“We transcode in house and we use our own platform, but we also use commercially available pieces of kit that we plug into our content management system. The real challenge is being able to manage workflow of assets... we are discussing whether it would be beneficial to use any kind of cloud service. There is an expectation that at some point we may need to burst content into the cloud, but there is no real need at the moment, because now it is more static content and, due to the scale that we have, we are able to get a very good price on the equipment.”

Broadcaster and MSO

Cloud also fits well with IP-based workflows; and cloud-based broadcast playout could offer benefits to traditional broadcast in addition to IP distribution models.

“What we are now seeing is the potential to capture material on IP-based cameras which can then stream that video over IP networks right up to the point of distribution... And then cloud-based playout suddenly becomes a much more credible option. It allows you to essentially base your playout wherever you want to and it opens up all sorts of possibilities for centralisation of services, for disaster recovery that have traditionally been too expensive.”

Broadcast technology and process consultant



PERSPECTIVE ON CLOUD: TECHNOLOGY AND SERVICE PROVIDERS

A new generation of service providers is already offering cloud-based solutions to their customers. Established vendors face a number of challenges when migrating their hardware-based offerings to the cloud.

If content owners, producers and broadcasters are keen to reap the benefits of cloud, what does that mean for the technology vendors and service providers they rely on?

A new generation of service providers is emerging, offering solutions on a SaaS basis. Using a mix of virtualised infrastructure housed in dedicated data centres and public-cloud IaaS and PaaS, these companies offer cloud-based services to their customers who own, produce and broadcast content.

“On the transcoding side we are based on an elastic capacity model. The [transcoding engine] raises [public cloud] instances as needed, so if we have a major peak — as we have had when a customer sends their whole catalogue to transcode, we just scale with the cloud — that is not an issue for us. It’s the same with storage... in general we are using more open cloud providers and platforms than self-managed infrastructure.”

Video distribution service provider

Service providers report gaining similar flexibility and scalability benefits from the cloud as content owners, producers and broadcasters:

“The elastic growth and the pay-as-you-go model are very powerful. I am pretty sure that databases, websites and application servers will go more and more to the cloud while the more important part, the 'secret sources', will remain more under [service provider] control — but time will tell.”

Video distribution service provider

They also describe the suitability and reliability of cloud for supporting key processes, such as big data-driven analytics that require large-scale database services:



MIGRATING PROPRIETARY HARDWARE-BASED SOLUTIONS TO THE CLOUD

Established vendors who have traditionally provided dedicated technology solutions for on-premises deployment by their customers face the challenge of migrating their offering to the cloud, in line with their customers' increasing orientation in this direction. At the same time, they must compete with the new generation of service providers who are building their solutions in the cloud from the start.

Many hardware-based vendors have announced cloud migration strategies for their solutions, but the transition to a cloud-based model brings a number of challenges that must be addressed.

Firstly, a cloud-based business model is different from one based on on-premises hardware. The hardware model rests on high-value upfront sales with follow-on support revenues; adopting a cloud model requires the vendor to move to subscription-based pricing which generates income at a lower level over a longer period. Vendors will also need to invest in e-commerce and subscriber-management systems.

Secondly, moving to the cloud requires vendors to re-engineer their software architectures and data structures, and to manage the processing and storage resources and costs that would previously have been covered by the customer's upfront hardware purchase. This involves steps such as:

- Migration to a componentised architecture to enable easy integration and swap-out of services as newer, better and more cost-effective offerings come onto the market
- Professional wrapping and management of APIs and web services
- Ensuring high levels of security at multiple levels — physical, environment, application, media and metadata
- Penetration testing and constant review

These areas will require acquisition of new in-house skillsets and potentially new personnel, too.

Thirdly, the cloud model demands cost-effective and secure connectivity for upload of and access to large files, especially in the production and post-production stages of the digital video workflow. This must be achieved without obliging smaller production companies to invest in high-capacity dedicated bandwidth.

Overall, the business must reorient itself from product development and sales to service delivery, and develop coherent strategies for hosting its service delivery architecture and optimising connectivity. This reorientation requires development or acquisition of a new set of capabilities centred on service capacity, continuity, customer service and incremental product enhancement — a fundamental shift in the way the business operates that may involve an extensive change management program.



STRIKING THE RIGHT BALANCE BETWEEN DEDICATED INFRASTRUCTURE AND CLOUD

Hybrid infrastructure models look set to dominate for the foreseeable future. Getting the right balance involves weighing up the cost-effectiveness of the infrastructure, the security of content, and the interoperability of different infrastructures, platforms and services.

As we've seen, there are many compelling reasons for cloud adoption by content owners, producers and broadcasters, and the service providers who support them. However, as with any major change to the way a company operates, there are a number of areas that must be carefully examined beforehand:

- Cost-effectiveness of the infrastructure
- Security of and control over content
- Interoperability of infrastructures, platforms and services

COST-EFFECTIVENESS OF THE INFRASTRUCTURE

Optimising the cost balance between dedicated media production and delivery infrastructure, private cloud and public cloud involves balancing capital and operational cost, hardware efficiency, and cloud service provider pricing.

Private cloud and virtualised deployments — do lower purchase and maintenance costs come with an efficiency penalty?

Private cloud deployments using commodity servers can be cheaper to maintain and upgrade than dedicated specialist video hardware. This is increasingly the case as the speed of change in video delivery technologies is shortening the lifecycle of hardware encoders, leading to more regular upgrade cycles and increased capital costs.

However, it does not necessarily follow that today's private cloud deployments are always more cost effective than dedicated infrastructure. In addition to the processing and power inefficiency overheads associated with virtualisation, commodity servers can require a larger physical footprint in the data centre than optimised hardware. For these reasons, dedicated optimised hardware can still be the most cost-effective solution, particularly for companies that combine large-scale deployments with the buying power to negotiate prices down.

“A dedicated solution will typically use less power and be much denser, so conserves rack space for [operators] that have very limited space. Rack space is important — and power.”

Streaming solution provider

But this could all be about to change. Recent leaps forward in the performance of CPUs from Intel and GPUs from Nvidia have enabled hardware-based vendors to transition their technology to virtualised environments with no degradation in performance. Ericsson for example, launched its virtualised encoding platform in 2014. There will naturally be a transition period while this new generation of commodity server hardware is rolled out.

Public cloud — cost effective, if used carefully

Public cloud services remove the capital expenditure barrier and offer attractive pay-as-you-use pricing models — but there is still a need for caution. IaaS and PaaS pricing is competitive and generally moving downwards; but lifetime costs can still be high compared to dedicated or private cloud infrastructure, especially for large deployments. Getting the best value from public cloud depends on choosing the right type of service for each application. For example, organisations will need to:

- Carefully balance reserved and elastic (or on-demand) processing capacity
- Use more expensive, flexible storage only for assets that must be retrieved quickly and often; and less expensive archive-optimised storage for assets that are required with less urgency and frequency

“For storage, cloud versus on-site is a pure commercial decision, particularly for archive storage. With compute, cloud is more about flexibility and elasticity. I don't think people are going to archive multiple different formats. They are going to archive one or two with the model that if you need to resend content, you just push it through another transcode process, unless you know you are going to be reusing it, in which case it may be cheaper to keep the multiple copies.”

Broadcast technology and process consultancy

Organisations will also need to ensure they have connectivity to IaaS and PaaS providers that enables rapid, reliable and regular transfer of large files and data volumes to and from the cloud. Dedicated (private) connections can be more cost effective and secure — and deliver higher performance — than Internet access.

For organisations considering SaaS, the cost calculation is different again. In these cases, the service provider runs the infrastructure and software and provides it as a service, removing the need for the customer to build a platform and manage all the layers of the technology stack. Despite the convenience benefits, the customer still needs to integrate its workflow with the service(s) provided, manage that workflow, and manage the service provider relationship(s).

CONTENT SECURITY AND THE PUBLIC CLOUD

Content owners, producers and broadcasters are naturally concerned with maintaining the security of and control over their content, and this is an important factor when considering use of public cloud.

The distribution rights applied to some premium content restrict not only where it can be distributed, but also where it can be stored. Technology partners also impose restrictions. For example, some DRM licenses require the location where content is packaged and stored, and where keys are stored, to be defined. Restrictions like these currently limit the freedom of broadcasters and service providers to adopt public cloud infrastructure, if they cannot guarantee the physical location of content at all times.

So how can content owners, producers and broadcasters ensure the security of assets that are stored and processed in the public cloud?

Firstly, the public cloud is not inherently insecure. IaaS and SaaS providers prioritise the security and reliability of their services — probably to a greater extent than some content owners and producers — as it is fundamental to their business. Even so, organisations using cloud-based services must also take responsibility for content security by, for example, encrypting content. It may even be wise to store very high-value content only on dedicated infrastructure or in a private cloud.

Secondly, organisations must make sure that their business processes and culture do not create vulnerabilities that can be exploited by attackers. Given the security features that providers build in to their services as a matter of course, it is arguably the measures organisations themselves take to protect their content that really matter.

Whether content owners will come to adopt a more pragmatic approach remains to be seen. For the time being, however, the fact that some owners require full accountability for the security and location of premium content means that the need for dedicated infrastructure and private cloud persists.

INTEROPERABILITY OF INFRASTRUCTURES, PLATFORMS AND SERVICES

Interoperability becomes an issue for organisations that adopt any mix of dedicated infrastructure, private cloud and public cloud; and IaaS, PaaS and SaaS offerings. How do you ensure that a workflow supported by a mix of vendors and service providers will run smoothly?

At the physical level, fast, reliable connectivity to and between cloud providers is a key enabler of interoperability. Applications from different providers must integrate effectively and operate across multiple cloud environments, but the APIs that enable this integration tend to be quite fragmented. To enable more effective interworking, APIs need to become more structured and standardised.

There is also a potential development overhead associated with deploying applications across multiple infrastructures.

“Developing for deployment in the cloud adds a bit of overhead for us — as we do both so we have a more fragmented environment to deploy into — but that is not specifically because we are using the cloud, it is because we are not just using one cloud provider.”

Video ad server

Cloud operating system initiatives such as OpenStack and OpenCloud are designed to orchestrate and manage large-scale cloud computing platforms, potentially across multiple data centres and service providers. These initiatives are garnering support from major IT players, and could be instrumental in enabling cloud adoption to move to the next level in the media sector.

CONCLUSION

Choosing the right location for dedicated, virtualised and private cloud infrastructure is critical to ensuring fast, reliable connectivity to partners, cloud service providers and CDNs.

This paper has looked at the role of cloud in helping content owners, producers and broadcasters, and the service providers who support them, address some of the challenges associated with TV and video production and distribution as the industry undergoes a period of massive change.

Plainly, cloud has a key role to play, especially for organisations that want easy scalability of compute and storage resources — but a pure-cloud approach is unlikely to meet all requirements. Organisations must consider costs, content security and interoperability challenges when planning how far and how fast to move to the cloud.

For the foreseeable future we expect the majority of studios, broadcasters and larger OTT content providers to deploy hybrid infrastructures across the post-production and distribution stages of the workflow. The technology and service providers who support them are likely to do the same. Most organisations will combine dedicated hardware or virtualised environments and private clouds with public cloud-based processing, storage and other services. They'll operate a mix of self-managed applications and processes running in private or public clouds and third-party managed services purchased on a SaaS basis.

Adopting this hybrid approach will enable organisations to progressively take advantage of the flexibility and workflow innovation that cloud offers, without risking content security or operational performance, or disrupting core workflow processes.

There will be complexities, however. Using multiple infrastructure and service providers to optimise cost, delivery capability and availability will require organisations to put effort into minimising interoperability issues. The key questions that will need addressing are shown in the interoperability checklist.

Interoperability checklist

If you're considering deploying your workflow across hybrid infrastructure, getting answers to these questions will help you minimise interoperability issues:

- How do we optimise the speed and cost of file transfers to and from our customers, cloud partners and CDNs?
- How do we handle the massive potential growth in the size and volume of these file transfers as demand for IP-delivered services and Ultra HD TV grows?
- How do we ensure that files are transferred and stored securely?
- How do we build in interoperability now and for the future?

THE ROLE OF THE DATA CENTRE — CONNECTIVITY AND UPTIME

Interoperability depends to a large extent on network connectivity, which is where the choice of data centre provider and location comes in. Locating your dedicated, virtualised or private cloud infrastructure in a data centre that enables you to optimise connectivity to your PaaS, IaaS and SaaS providers, and where connectivity and uptime are underpinned by rigorous SLAs, will be vital. Key aspects that will influence your choice of data centre are shown in the data centre checklist.

Data centre checklist

When selecting a data centre for colocating your dedicated, virtualised or private cloud infrastructure, check that:

- You have a wide choice of carriers to provide high-bandwidth, high-availability Internet and dedicated connectivity at competitive prices
- There is direct access to leading Internet exchanges to optimise connectivity and peering
- There is direct access to major public and private cloud providers
- You can cross-connect to leading CDNs, especially if you need to deliver high volumes of real-time traffic to partner CDNs
- Connectivity and uptime are assured by stringent SLAs

If you have very high-bandwidth file-transfer requirements with a small number of critical partners, it may be well worth colocating your infrastructure in a data centre where those partners have a point of presence. This will enable you to implement cost-effective, highly secure, direct cross-connects to your partners, significantly reducing your dependence on dedicated transit or Internet-based connectivity.

Colocating with key partners can also enhance the security of your content; and mitigate license compliance issues as there is no need to physically move premium or unencrypted content from one data centre to another as it progresses through the workflow.

Operators of cloud and carrier-neutral data centres, such as Interxion, offer digital media companies that want to deploy their own and hybrid infrastructures a highly secure environment, with the widest choice of connectivity options. Major carriers, Internet exchanges and CDNs have points of presence at these data centres, ensuring a highly competitive selection of transit connectivity and peering options in addition to high-capacity cross-connects among partner, supplier and customer organisations within the data centre. These neutral data centres are also home to cloud-based video service providers and specialist cloud providers, and offer solutions for direct connection to the main public cloud providers.

Selecting a data centre provider that can demonstrate an in-depth understanding of the media sector and has a track record of supporting media production and distribution companies can also be advantageous. This type of provider will be in a better position to advise you on hosting and connectivity options; to attract a diverse community of organisations from within and serving the media sector; and to support you in optimising the deployment of your infrastructure.

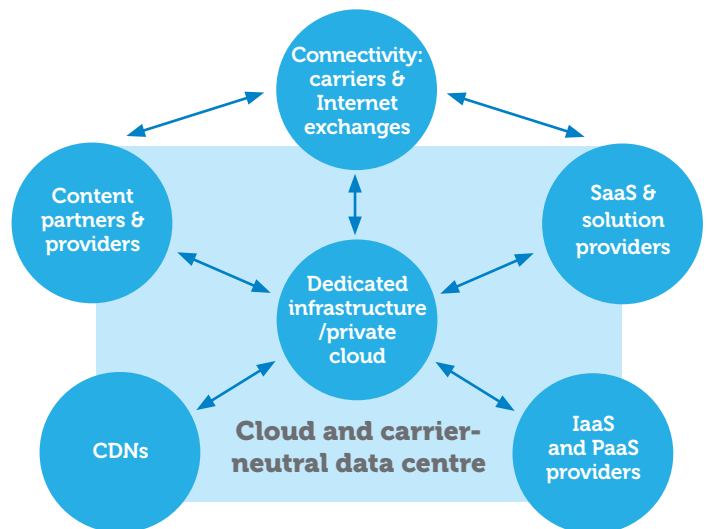


Figure 2. The cloud and carrier-neutral data centre environment

KEY TAKEAWAYS

- ✔ Consumer demand for Internet-delivered multiscreen viewing is growing rapidly
- ✔ Content and service providers are responding through increasingly rich VoD and OTT live-streaming services
- ✔ The resulting move to IP workflows is fragmenting the value chain and changing relationships
- ✔ Delivering multiscreen OTT services raises a number of challenges, including:
 - How to scale to meet growing but unpredictable demand
 - How to move increasing amounts of data to and from partners and cloud service providers, often in real time
 - How to transcode into multiple formats to reach multiple devices
 - How best to handle content security
- ✔ Cloud is a key enabler to mitigating many of these challenges, but a pure-cloud approach is unlikely to meet all requirements
- ✔ Hybrid models combining dedicated infrastructure, private and public cloud will be the favoured solution for most media companies for the foreseeable future
- ✔ Choosing the right location for dedicated or private cloud infrastructure can be critical, with connectivity to partners, cloud service providers and CDNs a major consideration

APPENDIX: UNDERSTANDING CLOUD AND SOFTWARE DEPLOYMENT MODELS

The term 'cloud' is often used loosely to denote different services and infrastructures, which can lead to confusion and inconsistency. For clarity, we've defined the main cloud models that are relevant to digital video production and distribution.

Infrastructure as a Service (IaaS)

This is the basic cloud service, providing resources such as virtual machines (VMs), network load balancers, storage and connectivity. In this model, computing resources such as CPU, memory, storage and network are added to a VM, on which an application is then deployed. The underlying infrastructure is managed by the cloud (or IaaS) provider; and the customer of the infrastructure maintains their own applications on it.

Platform as a Service (PaaS)

PaaS is the next layer up from IaaS. With PaaS, computing platforms, operating systems, databases and applications are delivered by the cloud provider. Customers deploy onto, and developers write code for, the platform. This is often a highly automated and scalable environment.

Software as a Service (SaaS)

The top layer is where the application software is installed in the cloud and accessed by the customer. The SaaS provider manages the software and all the underlying technology, effectively renting the software to its customers.

IaaS, PaaS and SaaS can all be deployed in public, private and hybrid cloud environments.

Public cloud

A public cloud infrastructure is one that is made generally available to enterprises and individuals by its owner. Public clouds include those owned by Amazon, Microsoft, Google and IBM.

Pros: initial cost savings, flexibility, scalability speed and ease of deployment.

Cons: possible lack of control, perceived security concerns, possibility of higher costs over the long term compared with dedicated infrastructure.

Private cloud

A cloud infrastructure operated for an individual organisation that uses it to run its own applications, to deploy software, or to offer SaaS to other enterprises. A private cloud can be installed on the organisation's own premises or in a third-party data centre.

Pros: the benefits of public cloud without any concerns about control and transparency; can be designed to meet specific requirements.

Cons: Less flexibility, less scalability and higher initial costs than public cloud.

Hybrid cloud

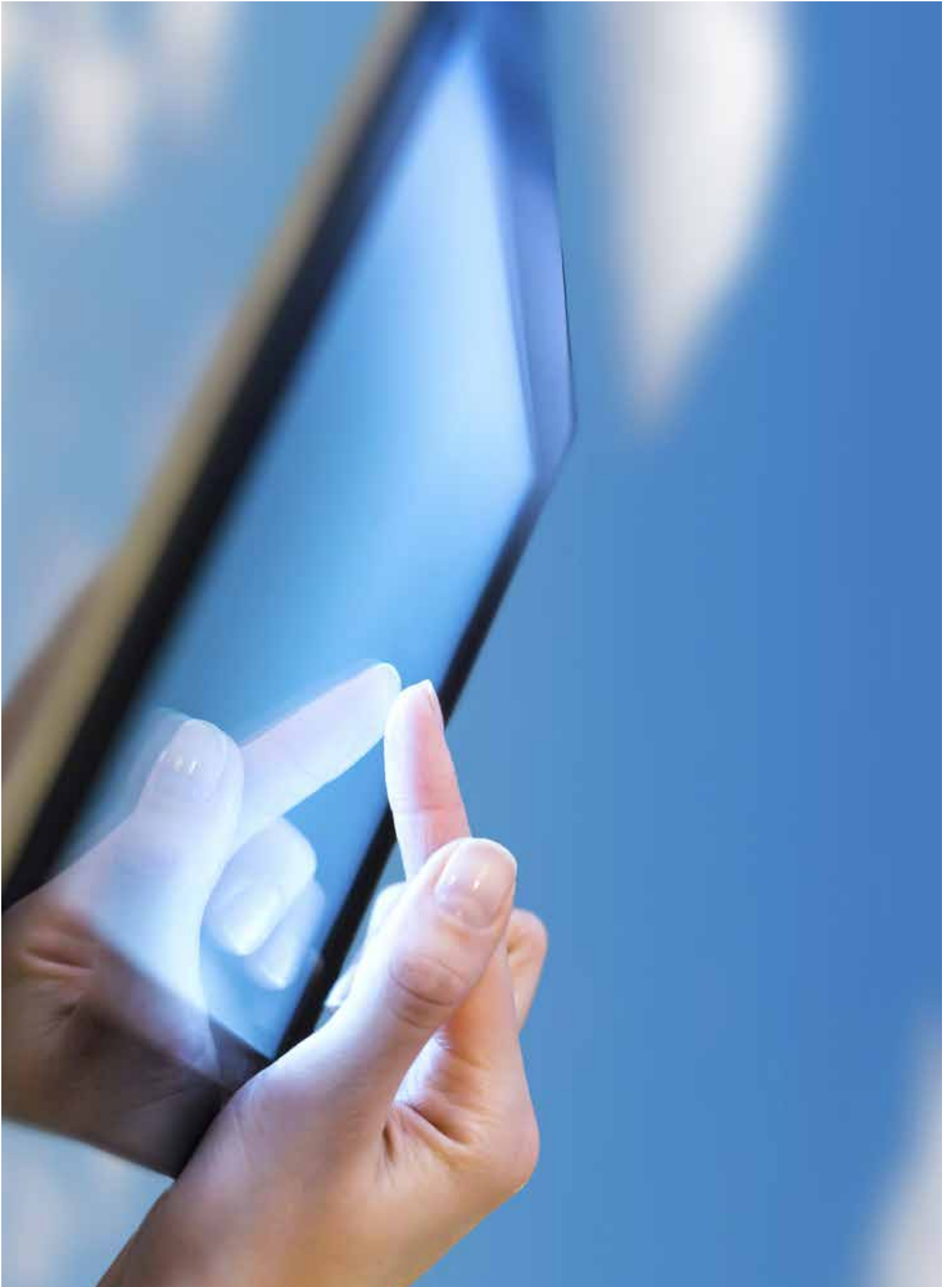
A combination of two or more compute platforms (for example, in-house infrastructure and public cloud) that are separate but connected, and enable data and application portability and interoperability, for example, bursting onto the public cloud to handle peaks in demand that exceed trended norms.

Pros: the best of both worlds — flexibility, scalability and savings with security and control.

Cons: the most complex solution to set up and manage, requiring specialist expertise and excellent connectivity.

Virtualisation

Virtualisation is the creation of a virtual version of a device or resource, such as a server, storage device, network or operating system where resource is divided into multiple execution environments. Virtualisation is most commonly associated with servers — the partitioning of a physical server into smaller virtual servers — a technique that helps organisations to make more effective use of compute capacity by running multiple applications on a single physical server.



INDUSTRY ASSOCIATIONS

Cofounder: Uptime Institute
EMEA chapter

Founding member: European
Data Centre Association

Patron: European Internet
Exchange Association

Member: The Green Grid,
with role on Advisory Council
and Technical Committee

Contributor: EC Joint Research
Centre on Sustainability

Member: EuroCloud

ACCREDITATIONS

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