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EXTENDING MEDIA PRODUCTION TO THE CLOUD

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ABSTRACT

Extending media production to the cloud can increase production capacity and ease the operational burdens of content creation and distribution. With everyone from larger media enterprises to individual artists looking to capitalise on the efficiency and scalability that the cloud offers, Avid undertook a number of cloud test drives with select media organizations in Europe and the U.S. to develop deeper understanding of cloud workflows. Avid systems deployed in Microsoft Azure data centres spanning broadcast and post production, social media and asset management, and workflows for production, craft editorial, social media publishing, and archive. Using early learnings from these tests, this paper examines how virtualisation and cloud are impacting content creation, which aspects of content production are currently ready for primetime in the cloud, which aren't best suited at present, and what this all means for production workflows – today and in the future.

INTRODUCTION – A CHANGING MEDIA PRODUCTION AND DISTRIBUTION CHAIN

Extending media production to the cloud can help meet the operational and financial challenges of media's rapid digitisation, dramatically increasing production capacity and easing the financial burden of content creation and distribution for all – from individual artists to larger media enterprises. Virtualized content production can offer myriad benefits: access to the best talent regardless of location, increased agility and scalability, and the means to produce and distribute more immersive, dynamic and relevant content. New technologies and solutions are delivering on the promise of cloud and fundamentally re-shaping content creation and distribution workflows.

But, at the present time, not all facets of content production are equally suited to the cloud. While some media creation functions benefit greatly from cloud deployment, the cloud doesn't make sense for all disciplines in the workflow – at least not yet. For the areas that aren't as well suited today, it's only a matter of time before technology addresses what's lacking. Increased availability of bandwidth will address most of the current issues over time. Eventually all content creation functions will be aided by the cloud, providing substantial operational, creative and financial benefits.

This paper examines which aspects of content production are currently ready for primetime in the cloud, which aren't best suited at present, and what this all means for today's production workflows. To inform this analysis, Avid has conducted a number of cloud test drives with select media organizations in Europe and the U.S. Over the course

of several months, we conducted cloud test drives with a broad cross-section of content producers, including two public service media companies in Europe, one state-funded broadcaster in the Middle East, one large private entertainment group in Europe, one national public broadcaster in North America, and two large media and entertainment conglomerates in the United States.

These tests were designed to elicit a deeper understanding of the impact of the cloud on content creation workflows. For these test drives, we deployed systems in Microsoft Azure data centres to explore a range of real-world use cases spanning broadcast and post production workflows. The results have shed light on where we are today, where we are going, and how we're going to get there.

WHERE WE ARE NOW – VIRTUALISING CONTENT CREATION

For cloud technologies and tools to be beneficial for content creation workflows, they must satisfy creative workflow needs while fitting within production constraints such as
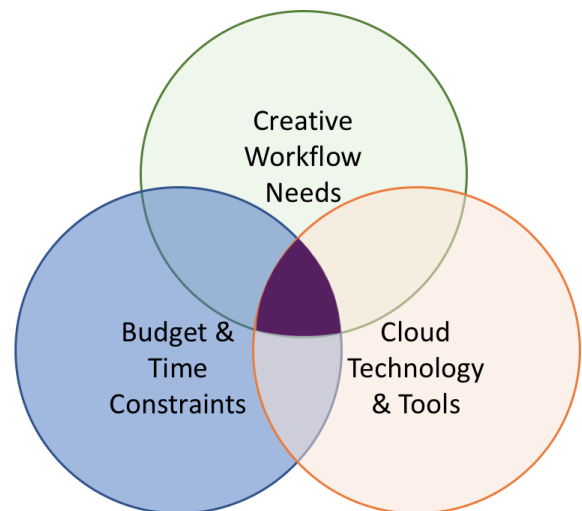

Figure 1 – Cloud Viability Venn Diagram

budgets and production schedules. In the early stages of the media ecosystem's journey to the cloud, there was very little intersection between the circles in this cloud viability Venn diagram. But, as shown in Figure 1, we are starting to see more content creation tasks fall into the cloud sweet spot, and that sweet spot is growing rapidly.

At its core, the cloud is all about tapping into the power of virtualisation – abstracting the physical components of a system into logical components that can be flexibly re-arranged and re-configured as business needs change. Instead of managing static, inflexible physical resources like servers, storage arrays, network switches, workstations, and physical facilities, you can virtualise your infrastructure into a pool of logical cloud resources that can be dynamically allocated to teams and projects.

For large media enterprises, the cloud can deliver significantly higher utilisation and increased agility, enabling greater efficiency and flexibility. Convergence of media workloads into standard IT technologies and practices can also reduce overall spend while integrating content pipelines. In a recent audit of their infrastructure utilization, a large international news broadcaster that participated in Avid's cloud test drives found that their average utilization of on-premises CPU resources was only 13%. This insight has further cemented their resolve to transition to elastic, virtualized cloud infrastructure to increase their efficiency, while lowering their total costs.

For content producers, beyond cost efficiencies, the cloud promises increased creativity and collaboration by making infrastructure, tools and data accessible from anywhere. Additionally, the cloud's elastic scalability enables content creation teams to spin up virtual production environments as needed, then spin them down again – all with lower up-front costs, instantaneous deployment, and no long-term commitment. As always, the devil is in

the details. Not all aspects of content creation are suitable for cloud deployment today.

A FRAMEWORK FOR ASSESSING CLOUD VIABILITY

Through early test drive learnings and ongoing technology research and development, we have identified seven main criteria that help determine efficacy of the cloud for specific content creation applications. Although there are other factors that come into play, these are the core indicators.

Location
Where content creators are located is extremely significant in analysing the viability of the cloud for content production. Is the workflow distributed or co-located? A distributed workflow will benefit more from more virtualised production in the cloud. With co-location, the benefits of the cloud are reduced to data protection use cases such as archive and disaster recovery.

Workload
The key workload question is predictability. Static "bare metal" provisioning can be highly efficient for predictable workloads. But unpredictable workloads are impractical to manage with traditional, inflexible infrastructure and benefit greatly from the elasticity of the cloud, scaling up and down directly in line with capacity needs.

Data Sets
The scale of data in your workflow is another critical determinant. Public cloud business models are typically calibrated to enterprise IT applications that are much less data intensive than professional media applications. Heavy media can be more problematic in the cloud due to the additional storage, bandwidth and processing required. Further, egress charges can make it expensive to move your data out of the public cloud. The proliferation of 'heavier' production formats, including HDR and 4K, presents a significant challenge for the cloud. At present, tasks that involve lighter media such as proxies are both more cost-effective and practical in the cloud.

For example, one test drive participant (UFA in Germany) asserted that for UHD projects, proxy editing in the cloud would be more sensible than high-resolution working, in order to reduce costs and upload times. Even the most compressed UHD production formats require over 200 Mbps per stream, whereas high quality HD proxies may require only 1-5 Mbps, yielding a massive reduction in cost and transfer times.

Collaboration
The number of contributors in a given production workflow is an important cloud consideration. For an artist working alone, the cloud doesn't have as much to offer. But if that artist is collaborating with others, the cloud can spark creativity and increase efficiency by promoting easy data access and sharing. Generally, if a production involves many contributors—multiple editors, sound engineers and VFX artists, for example—then the cloud offers many benefits.

Interactivity
For production tasks that require very low latency interactivity, cloud deployment can be problematic. With the cloud, there are inherent delays in data access due to the distance traveled and the number of hops required to transfer the data. Live media production tasks are less tolerant to latency. For example, an artist singing into a microphone needs to hear

their voice and the other tracks simultaneously with no delay. Similarly, when a colourist is adjusting a colour control surface, image processing delays will be extremely distracting to the creative process. By contrast, non-real time tasks like special effects rendering involve no interactivity and are therefore ideally suited to the cloud.

Equipment
A content creation task that requires purpose-built equipment is not as well suited to cloud. In order to enable elastic scalability, cloud data centers are equipped with COTS (commercially available off the shelf) hardware only. Although custom, purpose-built hardware can be housed in co-location sites, this approach increases costs and inhibits scalability. To participate in cloud workflows, purpose-built media equipment is becoming increasingly IP-connected. But overall, production tasks that can be accomplished using software running on generic servers are best suited to cloud deployment.

Factor	Rating
Location	Distributed
Collaboration	Collaborative
Workload	Unpredictable
Data Sets	Light
Interactivity	Tolerant to Latency
Equipment	COTS
Environment	Generic

Figure 2 – Using the cloud in review and approval

Environment
Some content creation tasks require specialised physical environments. For example, a colour grading suite is a controlled environment, where lighting and even paint colors are carefully calibrated to project a neutral backdrop. A music studio designed for live recording or mixing is equally as specialized, constructed carefully to isolate the environment from outside sounds and to cultivate a pleasing or neutral sound on the inside. IP connectivity can allow specialised environments to participate in cloud workflows, but tasks that require no such specialisation can take better advantage of the ubiquitous access that cloud offers.

CONTENT CREATION DISCIPLINES AND THE CLOUD

A content creation function can be evaluated against the seven criteria defined above to formulate a cloud suitability scorecard. Working with our testers, we have analysed several content creation task areas to rate each one's suitability for cloud deployment patterns, determining which disciplines derive the most value from the cloud as it stands today.

The following are functions are **best suited** to the cloud at the present time:

Review and Approval

Per figure 2, applications like Digital Dailies and Review and Approval are perfectly suited for the cloud when evaluated against the established criteria. Stakeholders can securely stream, view and annotate proxy clips using standard internet connections and generic hardware like smart phones and tablets, easily taking part in an asynchronous creative process.

One test drive participant (BBC Northern Ireland) noted that cloud workflows were perfectly suited to review of rushes as well as review-and-approval workflows. For these workloads, data sets are light and easily managed in cloud data centres, participants can be anywhere, and interactive latency isn't as critical.

Factor	Rating
Location	Distributed
Collaboration	Collaborative
Workload	Unpredictable
Data Sets	Some Light (Proxies), Some Heavy
Interactivity	Tolerant to Latency
Equipment	COTS
Environment	Generic or Specialized

Asset and Workflow Management

Managing libraries of media assets and orchestrating content workflows are task areas that are generally well suited to the cloud (figure 3). Participants are typically distributed across facilities and departments.
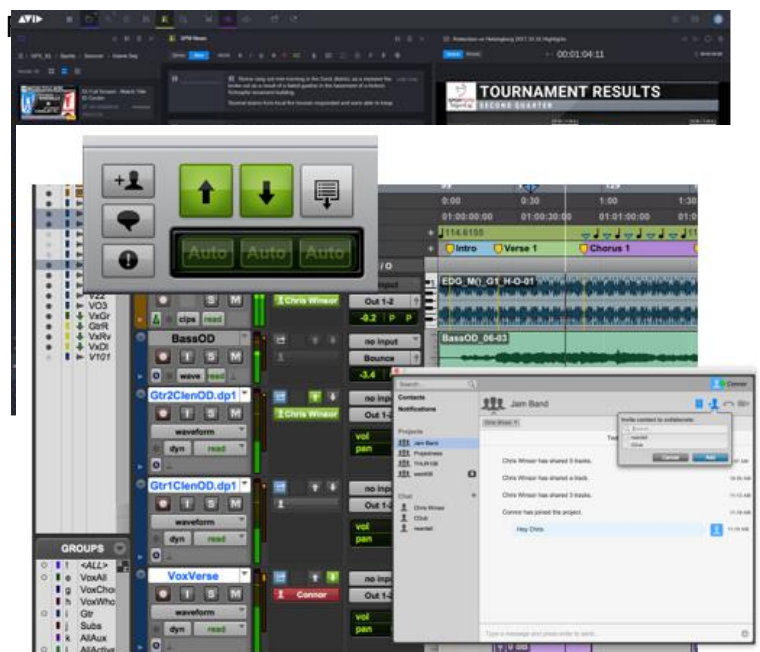
Asset management tasks focus primarily on lightweight metadata and are accomplished with lower

Interactivity	Tolerant to Latency
Equipment	COTS
Environment	Generic

Figure 3 – Cloud-based asset management

bitrate proxy media. Standard streaming technology provides adequate interactivity. Today there are numerous cloud services that provide access to projects, media and workflow tasks through a simple user-friendly graphical interface available (as pictured in figure 4) from any device.

One of the test drive participants focused on sharing news stories and content libraries between news bureaus around the globe. This test drive was particularly successful, enabling geographically dispersed teams to improve the quality of their news content by searching and accessing the best source material from across the global enterprise.

Content Sharing and Collaboration
The cloud can be highly effective for services that focus on content sharing and collaboration, as shown in figure 7. Leveraging cloud infrastructure, data can be

Figure 4 – MediaCentral | Cloud UX interface

automatically synchronised between collaborators over standard IP networks. For example, a cloud service that enables musicians and engineers to work on different tracks of the same song at the same time. Collaboration features are embedded directly into software user interface, making it easy and intuitive to upload tracks to share with collaborators, or download their tracks. These services can be highly scalable, with some featuring peak usage of more than 400,000 unique users per day.

Factor	Rating
Location	Co-located or Distributed
Collaboration	Individual or Collaborative
Workload	Predictable
Data Sets	Some Light (Proxies), Some Heavy
Interactivity	Tolerant to Some Latency
Equipment	COTS; Optional Specialized Hardware
Environment	Generic or Specialized

Figure 8 – Editorial workflows via the cloud

The following content creation areas fall somewhere in the middle of the suitability spectrum, with both **benefits and challenges**:

Animation

Some aspects of animation workflows are well suited to the cloud (figure 7). Animation artists require real-time interactivity as they fine tune the visual design, placement and movement of elements within a scene. As such, animation creation software is still best suited to deployment on individual workstations and laptops, not in the data centre. But the cloud can complement traditional installed clients by enabling file sharing, collaboration, and rendering at scale. 3D rendering is highly computation-intensive. Rather than capitalising large, on-premises render farms that may not be fully utilized, many animation houses leverage the cloud for peak workloads, taking advantage of the highly scalable computing available in the cloud.

Creative Editorial

Figure 6 – Music creation with cloud technology

Use of the cloud for editing functions is one of the most rapidly evolving areas of the content creation value chain today. Depending on the editorial workflow, cloud deployment patterns can take different shapes and feature different cloud viabilities as seen in figure 8. Here are three examples:

Factor	Rating
Location	Co-located or Distributed
Collaboration	Collaborative
Workload	Unpredictable
Data Sets	Some Light, Some Heavy
Interactivity	Artist Modeling (Low Latency) Rendering (Tolerant to Latency)
Equipment	COTS

Figure 7 – Animation workflows via the cloud

- Light editing, such as basic shot selection and rough cutting, can take place using proxy media and software that runs on generic servers in cloud data centres. Tools that offer good interactive performance from an HTML5-based user interface requires no client-side software installation so the entire user experience is streamed to the user from a central cloud data centre.

Using a smart phone, a tablet, or a laptop, producers and assistants can log, annotate, and assemble content over a standard internet connection.

Factor	Rating
Location	Co-located
Collaboration	Individual or Collaborative
Workload	Predictable
Data Sets	Moderate to Heavy
Interactivity	Requires Low-Latency Interaction
Equipment	COTS with Specialized Hardware
Environment	Specialized

- Full creative "craft" editing can now be accomplished remotely using desktop virtualisation (VDI) technologies. In this scenario, a fully featured non-linear editing (NLE) tool such is installed in a virtual machine (VM) in a standard server in a cloud data centre. This video editing tool can be accessed remotely over a standard internet connection, enabling editors to escape the confines of traditional edit suites, accomplishing their work from any location. Editors from UFA who participated in their test drive were initially skeptical about the quality of user experience when accessing an NLE in the cloud. Yet they found the interactive experience to be better than expected. Although the interactive latency was at times a little more sluggish than an on-premises edit suite, the UFA editors felt it was more than adequate for many editorial workflows. And the overall picture and sound quality were found to be acceptable.

- Hybrid scenarios offer the best of both worlds. Today there are video editing software solutions with cloud capability that allow editors to run fully functional NLE software from a laptop, while still accessing content from central cloud data centres. By allowing editors to intermix content that is stored locally on their laptop while also streaming shared content from centralized libraries in the cloud, this solution eliminates all creative barriers while enabling complete mobility.

Figure 10 – Cloud-based colour grading

Cloud editing has some drawbacks. Interactive latency can be more or less sluggish depending on your internet connection. Surround sound audio is not yet supported by VDI technology. High resolution monitoring from remote locations requires high-bandwidth connectivity that is not always available. And specialised peripherals such as control surfaces do not currently work well over VDI connections. But these technology limitations will be addressed over time and many creative editorial workflows are viable in the cloud today.

The following tasks are presently **not as well suited** to the cloud. Further technological advancements must occur before the cloud is beneficial for these scenarios:

Recording and Mixing

Per figure 9, live audio recording and mixing require specialized hardware in specialised environments. A recording studio or dub stage must be carefully constructed and tuned. Specialised equipment such as musical instruments, microphones and reference monitors

are essential. There is little tolerance for interactive latency as artists and engineers need to hear results immediately. In film post-production workflows, where hundreds of tracks are playing back in real time with high quality images, data sets can become expansive. For these reasons, recording and mixing tasks are not ideally suited to the cloud, other than complementary file sharing and collaboration services.

Colour Grading

As with live sound recording and mixing, colour grading is not well suited to the cloud (figure 10). Colourists work in carefully tuned environments, interacting with specialised equipment such as colour control surfaces and reference monitors. Stakeholders such as the director of photography typically attend colour grading sessions in person to ensure their creative intent is fully preserved, so remote collaboration is not usually required. Data sets are heavy, as high-resolution images are tweaked in real time. Overall, the cloud's intrinsic benefits are of little use to a colourist, other than for complementary workflow management and file sharing.

CONCLUSION: WHERE WE'RE GOING—A CLOUD-CONNECTED ECOSYSTEM

Factor	Rating
Location	Co-located
Collaboration	Individual
Workload	Predictable
Data Sets	Heavy
Interactivity	Requires Low-Latency Interaction
Equipment	COTS with Specialized Hardware
Environment	Specialized

Using the framework as presented, it becomes clear that some content creation activities are much more suitable to the cloud than others. Over time, the challenges will be solved by increased bandwidth and more intelligent system architecture. For example, intelligent edge caching can provide the best of both worlds – the elastic scalability of the cloud with the low-latency interactivity of a local system.

And while public cloud resources are generally more costly than traditional on premises infrastructure on a per-unit basis, total cost of ownership (TCO) can be lower for cloud solutions due to higher utilisation and lower operating costs. In a recent IDC study, more than 70% of respondents indicated that they achieved higher utilization of resources when using hyperconverged cloud infrastructure. Further, as public cloud platform vendors continue to compete aggressively on price, cloud deployment patterns are becoming increasingly cost-effective. One recent study showed that cloud prices have been declining at roughly 8% per year over the past several years.

Beyond the basic question of viability from a technical, financial, and operational perspective, the cloud offers unique advantages such as increased levels of security. Early in the journey to the cloud, many media companies considered the public cloud to be risky from a security standpoint. But several high-profile, on-premises data breaches have influenced a shift in thinking. Today media technologists readily embrace the reality that public cloud platforms are typically more secure than on-premises environments, both with respect to protection from data loss and protection from malicious attacks.

By connecting distributed teams, enabling fluid collaboration, and providing unique advantages such as increased security, the cloud will transform all aspects of media production and distribution. It's only a matter of time.