

SAMSUNG

White Paper:

The Ultimate Guide to 360 Video Production



Introduction: Why 360?

VR applications and 360 video have been employed for everything from fans virtually hanging out with celebrities to hospital residents studying brain surgery.

As virtual reality (VR) technology has entered the mainstream in the last three years, businesses and other organizations have begun to show increased interest in this new and powerful medium for engaging their customers, employees and other stakeholders. VR applications and 360 video have been employed for everything from fans virtually hanging out with celebrities to hospital residents studying brain surgery. The possibilities are vast — but how can 360 video benefit your business?

With the popularity of VR surging, many brands have

jumped on the bandwagon — but not all have yielded the desired results. We're now in a proving ground phase, where increased investment in VR or 360 video needs to start generating tangible returns.

This white paper aims to provide an introductory guide to the best practices for planning, producing and distributing 360 video content. It is intended for both brands and organizations considering further investment in 360 video content development, as well as for video production companies looking to move into this growing market.

3 Reasons Why 360 Video Is Important Today



Growing Audience

IDC forecasts global annual shipments of VR headsets to reach more than 40 million units by 2022, compared to fewer than 10 million in 2017.¹ This represents a rapidly growing audience of consumers looking for immersive 360 experiences. 360 video can also be experienced on virtually any modern smartphone.

Engagement

The explosion in streaming video over the past decade demonstrates the power of video, but also means it's increasingly difficult to break through. 360 video delivered through a VR headset delivers greater engagement and new opportunities to make interactive experiences, whether for training, sales, education or pure entertainment.

Low Barrier for Entry

With new 360 cameras and editing suites, creating 360 content today can be quick, cost effective, and fit almost every budget. Building game engine content and 3D models can be time-consuming and costly, but 360 video can capture real-world environments and be ready to view in a matter of minutes. Now is the time to start taking advantage of this exciting new medium.

Strategically Determine Your Investment in 360 Video



Organizations looking to create high quality 360 content or applications for presentation on VR headsets should invest in a professional grade solution such as the Samsung 360 Round, or hire a production company with experience in 360 that has access to such equipment.

Brands looking to add some variety to their social media content or website may consider leveraging consumer-grade cameras such as the Samsung Gear 360 to create short video clips. The learning curve is gentle for someone with general video production experience, and organizations can create and publish their own 360 video content in an afternoon.

However, organizations should also consider whether buying or renting camera and editing equipment fits into their workflow. If you intend to shoot 360 content frequently, there can be significant cost savings to owning the 360 camera gear. When considering a one-off project, renting equipment and hiring professionals may yield better results without the need for ramp-up.

Early research in heatmap analytics from YouTube showed that 75 percent of people viewing 360 content will spend most of their time viewing the frontal 90 degrees of the scene and don't look around or explore further.³ Let this be a clue that, if you want your audience to be inspired to look around and take in the full environment, your content should be designed bottom-up with 360 in mind. In other words, start with the presentation medium and work your way back. After all, if your project doesn't inspire the viewer to explore, is it worth shooting in 360 at all?

Don't Shoot 360 for the Sake of 360

360 video isn't the right answer for every project. Like any medium, it has its strengths and weaknesses. Here are a few "don'ts" to keep in mind when considering 360 video:



Don't shoot content that is too far away. If your viewer can't see what's going on, you'll lose their interest and their attention. In order to retain what they've learned from your experience, they need to be in the middle of the action.



Don't limit yourself to just the initial field of vision. Plan to create content that takes full advantage of the 360 medium by leading the viewer through the experience — in other words, think about how you can create a truly immersive experience where your viewer is part of the scene. For example, consider including a host in the frame to guide the viewer, similar to how traditional 16:9 framed content subtly directs the viewer's attention.



Don't assume that everyone will wear a VR headset. Some experiences or applications may be better experienced through a desktop by clicking and dragging, while others may be better suited for a smartphone or tablet.

Planning for 360 Success

With Samsung VR you can give viewers the chance to choose their own adventure and change the outcome of the story.

Interactive vs. Linear

Before you even start your project, it's important to determine how you want viewers to interact with your 360 content. At the very least, you can look around within a 360 video, but for the most part those stories are linear — the experience is the same each time. However, with custom applications or leveraging platforms like Samsung VR, you can give viewers the chance to choose their own adventure and change the outcome of the story.

You can also provide memorable learning experiences for education and training, and provide an opportunity for your users to answer questions or provide feedback on what they've learned.

How Will Your Project Be Viewed and Distributed?

Another related decision that must be made at the project planning stage is how your project will be viewed and distributed. This impacts every aspect of planning and implementation.

Audiences consume 360 content in several different ways, from clicking and dragging on a desktop to wearing an immersive VR headset.

When creating content to be consumed in VR headsets, it's absolutely vital that you stabilize the content as much as possible and design an experience that can be viewed without motion sickness. This should define the way you plan for every shot.

Beyond this, you need to decide whether your project will be delivered in monoscopic or stereoscopic format. Stereo adds a level of depth and immersive realism to the scene by giving objects in the foreground 3D definition. It's most suitable for applications where positioning, clarity and precision are key concerns.



For example, think about instructional content produced for pilots in training on a new aircraft. The goal is acclimatizing the trainees to a specific environment and control configuration, so the detail stereoscopic video provides is key for maximizing training realism. If the trainees will mostly or entirely view the content on a flat TV or monitor screen, stereoscopic offers no benefits and will require more resources to produce. In this case, monoscopic is the preferred format.

One ideal use for monoscopic is with live action footage for journalistic use cases, where you intend to move the camera or don't have complete control over how your subjects are positioned. In these scenarios, it's often easier to get better results and stitching with monoscopic.

Ultimately, the decision about monoscopic versus stereoscopic shooting comes down to an analysis of viewing formats, budgeting and the type of footage you intend to shoot.

Think About Your Distribution Strategy Upfront

There are a multitude of options for distributing interactive and non-interactive 360 content. Here are some of the distribution options you might consider:

- 1. Demo in Person.** Many brands will show content face-to-face at a tradeshow or event, or even as part of a sales meeting. Content is typically side-loaded to a mobile device or computer to be demonstrated. This gives you complete control over how your content is displayed on a desktop, mobile device or VR headset.
- 2. Social Video Platforms.** 360 video can be uploaded to popular social media websites such as YouTube, Facebook or Vimeo to reach large audiences. There are also more VR-targeted platforms — such as Samsung VR, Littlstar and VeeR — where a great majority of the audience will view your content in headsets.
- 3. Custom Application Development.** To have more control over your brand experience, you might consider building your own VR applications to publish directly to compatible app stores. This makes your brand more discoverable in these VR app store environments. Application development also opens up the realm of interactivity for your 360 content, rather than a more linear video experience.
- 4. App Platforms.** There are several VR application frameworks already in place that will allow you to easily distribute your 360 content for the various headsets and app stores in one swoop. However, some of these may limit your ability to customize.

Demystifying Capture Methods

There's not just one way to shoot 360 video.



Stereoscopic 360

Refers to 360 content with a perspective for each eye, creating a sense of depth and separating objects from the foreground and background. This often requires that both left and right eye videos be displayed in the same video container; meaning resolution in the viewport is halved. Requires 3D glasses or a headset.



Stereoscopic 180

Refers to stereo 3D content for only the front 180 degree field of view. This can be great for content that has most of the action facing the front, and several platforms take advantage of not needing to display the rear pixels — optimizing delivery in higher resolutions. Requires 3D glasses or a headset.



Mono 360

Refers to a 360 video without 3D depth. This is generally the most cost-effective content to shoot, and can be streamed at higher resolutions since it's only a single channel. Parallax can also be more forgiving in tight areas when shooting mono, allowing for easier stitching on objects close to the camera.

Pre-Production

Schedule everything! Even if you aren't 100 percent sure when things will happen, make assumptions based on your ideal timeline.

Writing and Storyboarding for 360

Writing for 360 is about perspectives, not frames. It's not about what you're looking at, so much as where you are. Each scene will typically have a default opening view, but where the camera sits is just as important as what is happening around it.

Storyboarding in 360 requires that you cast aside the idea of the frame, and instead block out what will happen around the camera. The position and height of the camera define your perspective. Rather than wide, medium or close shots, consider whether the viewer would be standing, seated or crouched. A close-up becomes less about optical zoom and more about moving the camera closer to your subject.

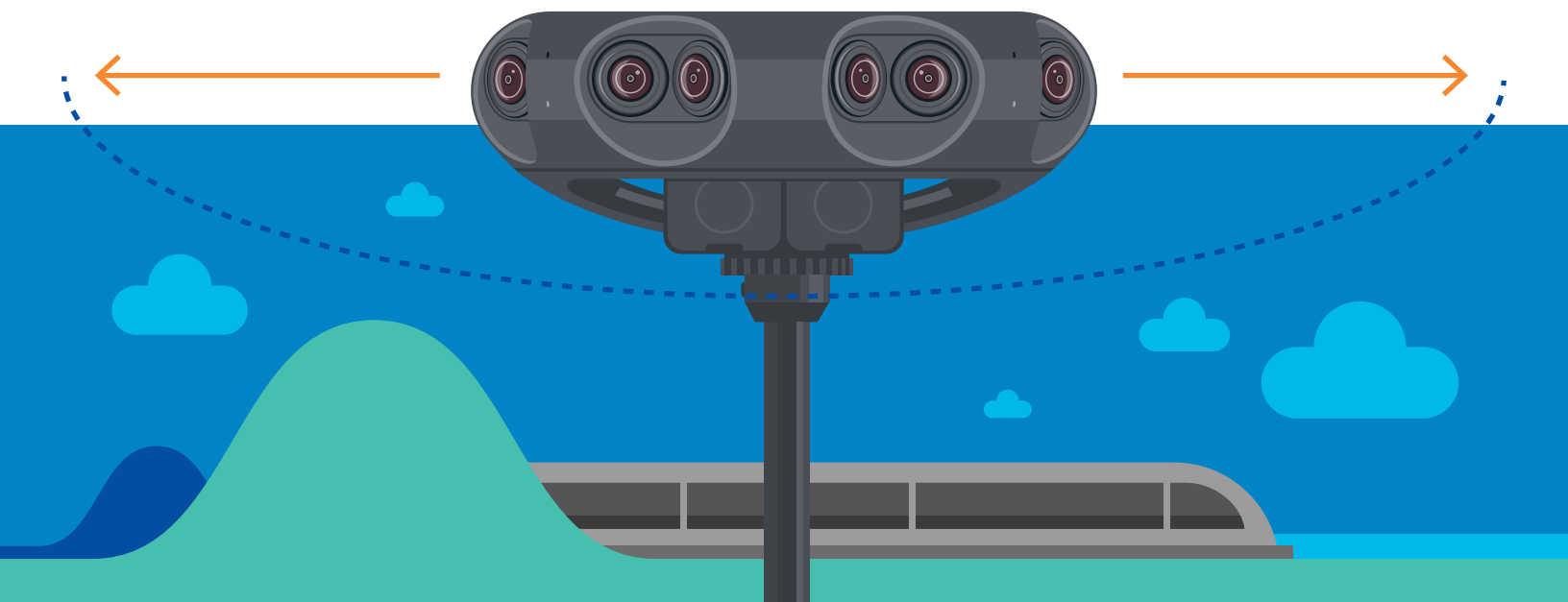
For the simplest form of 360 storyboarding, draw top-down diagrams as circles with the camera in the center, and consider also including a quick sketch of the opening POV from the camera perspective as an aside. Beyond this, you can also do previsualization utilizing 360 cameras on a set to take panoramic 360 images, or mock scenes in 3D software as a two-dimensional mapping of the image, called an "equirectangular." The important thing to

remember here is that you have to utilize some kind of 360 player application for your client or stakeholder to be able to review previs (previsualization) in this manner.

Shot List and Schedule

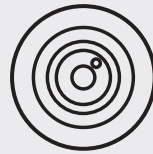
The next step is defining a shot list. Consider your script and your scenes, and determine which other perspectives to shoot for safety. Evaluate all of your moving or dynamic shots that are mounted to people or vehicles, and think about "safe" static alternatives you can shoot in the event that these shots make your viewing audience motion sick. Don't forget to think about parallax challenges, and the distance of your subject to your camera. Some 360 cameras, especially stereoscopic, may require a minimum distance for an effective stitch. Plan which camera you will use for each shot, based on the size of the scene and how close objects and people need to be to the camera.

Schedule everything! Even if you aren't 100 percent sure when things will happen, make assumptions based on your ideal timeline. Plan for which cameras and equipment you will need to be available for each scene, and if possible, anticipate which settings you'll need to use in advance.



The 360 Round — Key Specifications

The Samsung 360 Round is a professional grade, durable and compact 360° VR camera. Able to create and livestream content up to a 4Kx4K resolution, the 360 Round comes with everything you need to create compelling 360 video content.



17 lenses in a stereoscopic 8-pair configuration plus a single topside lens for professional-quality 3D 360 content



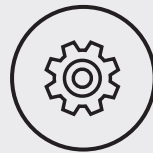
Capable of capturing 4Kx4K using standard production equipment



IP-65 water and dust resistance lets the 360 Round capture content in challenging filming environments



Built for hours of continuous shooting with a compact, unibody chassis and factory calibrated sensors that reduces heat and power consumption



The included software enables controlling and stitching shots, as well as expandable connectors and ports to hook up additional gear

Scouting and Gear Packing

Whenever possible, scout your locations before you shoot. By nature, 360 video generally requires a 360-compatible set. This means you won't be hiding unsightly messes and production gear outside the frame. What you see is what you get, and this can require a lot of planning. If a scouting trip is not in the budget, see if people at the location can provide panoramic photos shot with a smartphone. Take note of the available light from fixtures or windows and what it will be like during the time of day you plan to shoot.

When packing for your shoot, never underestimate the amount of additional storage and battery capacity you will need on location. 360 video cameras are demanding, both on batteries and in card space. It's always better to have spares than to have to wait to offload and verify data.

Double down whenever you can to build redundancy. If a camera fails, you'll want to be able to swap it out and keep shooting.

Make sure you bring the right tools for the job:

1. Consider the space. Tight quarters can present stitching challenges. Large cameras with many lenses can make for a difficult challenge, with parallax in settings such as the interior of a car.

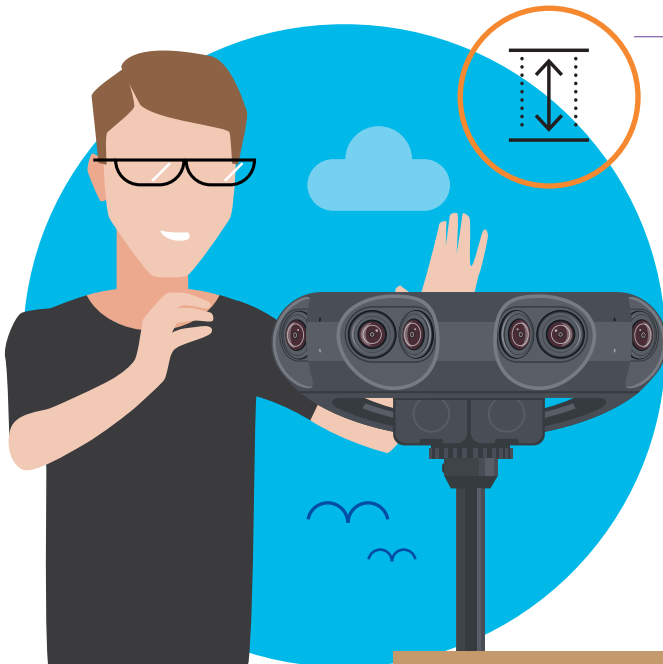
2. Consider the environment and weather. Not all 360 cameras are weatherproof. If there's a chance that your camera could get splashed or rained on, have a plan to protect your camera or use a camera with an IP65 rating⁴ or better.

3. Consider lighting. If you aren't lighting the scene beyond natural or available light on location, low-light capability may be a deciding factor in choosing cameras.

When considering audio gear, think about microphones you can conveniently mount beneath the camera, or hide on set without being seen in the 360 view. This usually consists of a variety of portable recording devices, lavaliers and spatial audio microphones.

Production

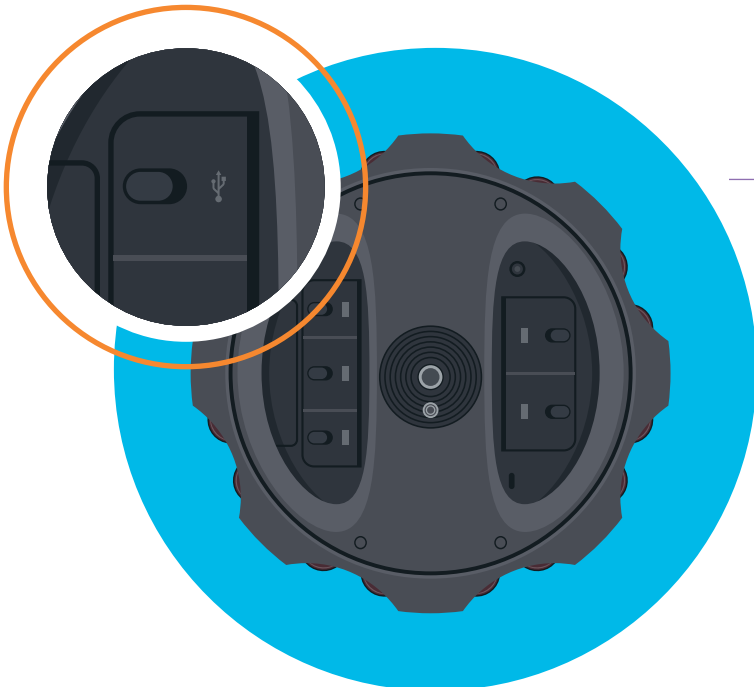
As with writing, directing 360 is not about what is seen in the frame, but about perspective. The camera position effectively defines your viewer's placement in the 360 experience.



Directing Action in 360

As with writing, directing 360 is not about what is seen in the frame, but about perspective. The camera position effectively defines your viewer's placement in the 360 experience. The height of the camera and distance to the subject will have a more significant effect on the viewer than in conventional filmmaking. You also need to think about where the viewer will look and how they are likely to interact with the scene. Make use of occasional visual or auditory cues to draw the viewer's attention to specific elements.

Distance from camera to subject can change the viewer's comfort level. Imagine being just 12 inches away from the face of an actor — it's a very intimate feeling. You might get this close with your partner, but not with the barista at your local coffee shop. On the other hand, it would feel awkward to be having a casual conversation with someone from 15 feet away. This is where monitoring and testing on set can help.



Live Monitoring on Set

One of the early challenges with production in this medium was the ability to quickly monitor your shot. Back when VR filmmakers had to shoot with arrays of separate cameras that couldn't be stitched on the fly, it was difficult to get a sense of your scene. Fortunately, there are now many options to monitor rough stitched content, even in the VR headset directly.

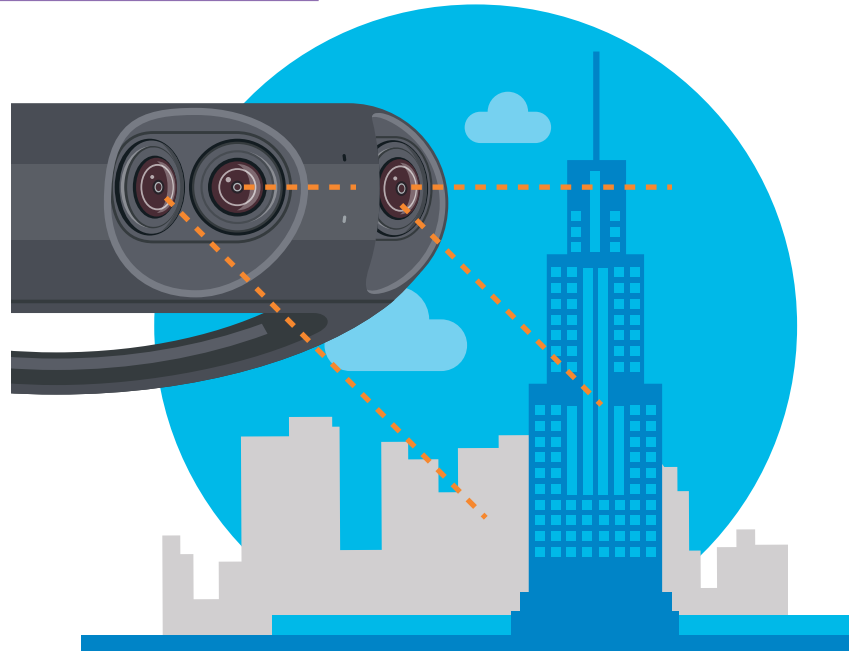
Today, many 360 cameras have Ethernet ports and the ability to broadcast a signal from Wi-Fi to tablets or other devices to be reviewed by the director or client, while hiding out of the view of the camera.

Setting the Scene

When preparing your set for the shoot, consider the entire environment, even the floor and ceiling. Leaving out a piece of gear or failing to hide a crew member could mean days of post-production time trying to fix a shot.

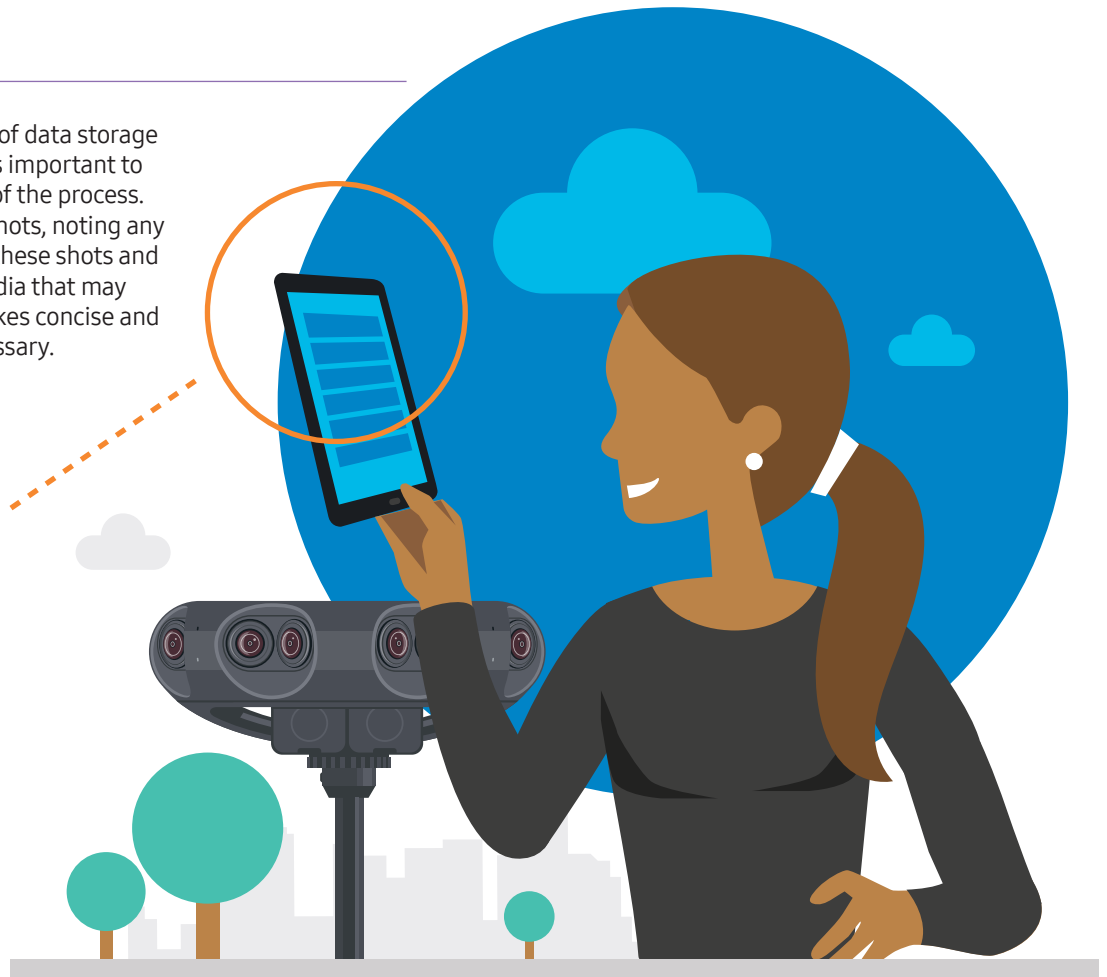
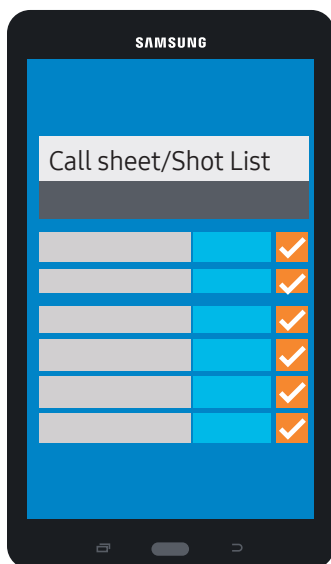
Lighting in 360 can be challenging because you don't have a huge space outside of the frame to place lights and stands. For this reason, you must either conceal the source of lighting, shoot with natural light or place lights in the scene and use clean plates to remove them in post. The majority of 360 filmmakers work with natural light. For this reason, the dynamic range and low-light capabilities of your cameras tend to be important.

When filming motion, plan to shoot static shots of the same subject matter for coverage. If the moving shot makes viewers motion sick while testing, you'll have a static version of a similar shot ready to swap in.



Log Everything!

Due to the tremendous amount of data storage required for shooting 360 VR, it's important to stay organized along each step of the process. Maintain an accurate log of all shots, noting any external audio devices used for these shots and the associated file names of media that may need to be synced later. Keep takes concise and try not to roll when it's not necessary.



Post-Production

When it comes to post, the biggest challenges are the tremendous technical and system requirements needed to work with the footage.

Technical Requirements

When it comes to post, the biggest challenges are the tremendous technical and system requirements needed to work with the footage. While the rest of the mainstream media is just starting to get used to a 4K workflow, VR filmmakers regularly have to deal with 6K, 8K or even larger footage — not to mention the fact that you're often working with multiple cameras that need to be stitched together, multi-track spatial audio and effects and titles that need to be done in that same huge resolution. And all that work is doubled when done in stereo.

For this type of work, you need late-generation CPUs, top-of-the-line GPUs, lots of RAM and loads of storage space. A typical project could easily consume 1 TB of data, even for a short, five-minute VR video. If you intend to work with a team, you'll need a fast and capable NAS on a gigabit network to have multiple people working on footage at 4K or higher over the network. You'll also want a plan in place for backups, as well as a very fast upload speed for storage of footage in the cloud or delivery. Cable is often limited in its upload speed, but fiber-optic can offer speeds as high as 1 GB per second.

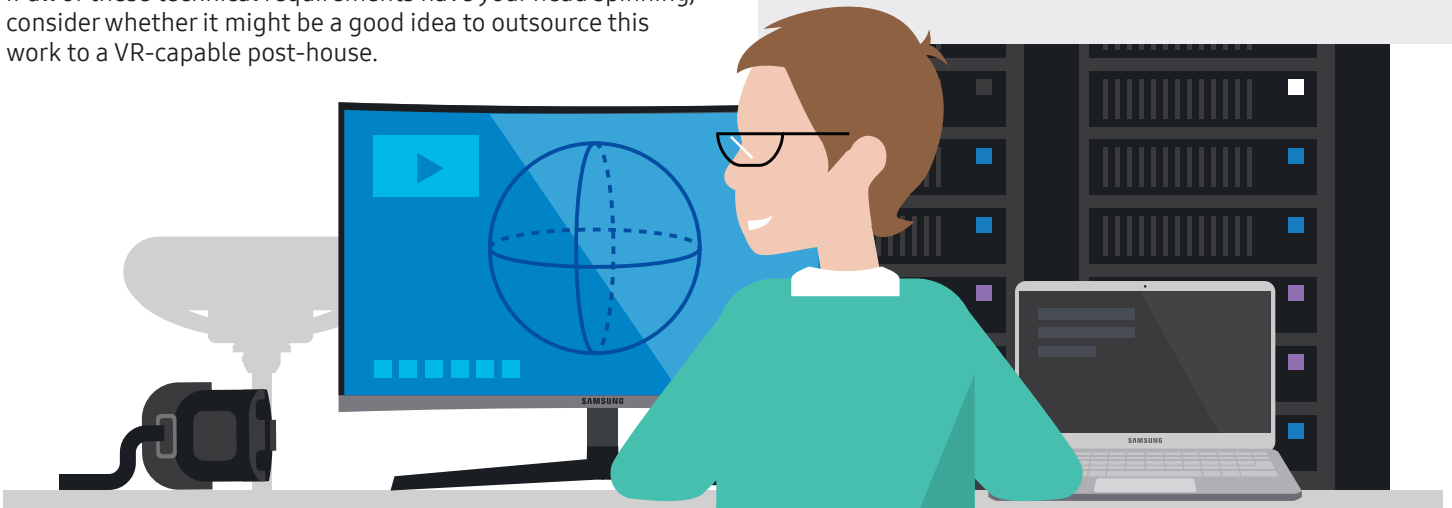
Render time will be one of the biggest bottlenecks that could slow down your projects and threaten your deadlines. For this reason, you might consider a render farm if you're doing any render-intensive projects, such as animating complex 3D models or particles.

If all of these technical requirements have your head spinning, consider whether it might be a good idea to outsource this work to a VR-capable post-house.

Samsung 360 Round System Requirements

Post-production for 360/VR can certainly be demanding when it comes to resources. The system requirements for post-production with the Samsung 360 Round are a good benchmark to consider what you'll need for typical post-production with most high-end stereo 360 cameras.

- + Operating System: Microsoft Windows 10 Professional or above
- + CPU: Intel Core i7-6700K or above
- + Graphics Card: Nvidia GTX 1080 or above
- + RAM: 16 GB DDR4 or above
- + Power: 850 W
- + Storage: SSD 512 GB or more (recommended)



The Post-Production Process

1. Rough Stitch. Start by rough stitching everything you shot. Don't get too hung up on perfection during this step. Use mostly default settings so that each shot is good enough to review. If working towards an end deliverable at 6K or higher, you should also consider using 4K or lower proxies during the rough edit phase and swap in your high-resolution clips at the final stitch phase.

2. Edit. Create your edit from rough stitches. The goal of this phase is to edit your content for story, while ignoring the technical issues such as stitching, titles, color and other advanced visual effects for now. Avoid doing all of the complex tasks on clips that may not make the edit, as this would be a waste of cycles. The end result should be "picture lock," when you or your stakeholder or client have signed off on the story as it's edited.

3. Final Stitch. After picture lock, you can move on to final stitching for each of the segments from your edit. With these stitches, focus your efforts on stitching only the segment that made your edit. If your stitching software has bundled stabilization, run it specifically for the duration of this new clip. Sound design can also happen after this phase — it may be a good time to start testing and enhancing your spatial tracks.

4. VFX. Apply any visual effects as needed. This phase includes cloning or applying clean plates over equipment in the shot, such as tripod legs or tripod shadows, more stabilization if needed, titles and motion graphics, credits and branding assets. You can save time and headaches by working with post software designed for VR, which will ensure that your effects appropriately map to the sphere.

5. Final Touches and Render. As a final touch, apply any necessary color correction, sharpening or noise reduction as a last step. These types of effects, especially noise reduction, are very CPU-intensive and add a tremendous amount of render time, so it's best if they are the very last step. This is also typically when to lay back tracks from sound design.

Post-production for VR is currently seeing a lot of new support from software makers. Many custom tools have been designed to perform common tasks like rotoscope, motion graphics, color correction and composite in 360 that can be easily reviewed in a headset while you work.

Furthermore, camera manufacturers like Samsung are bundling their own software suites with their cameras to offer automated stitching and export of VR footage. Many providers are also offering stitching in the cloud.

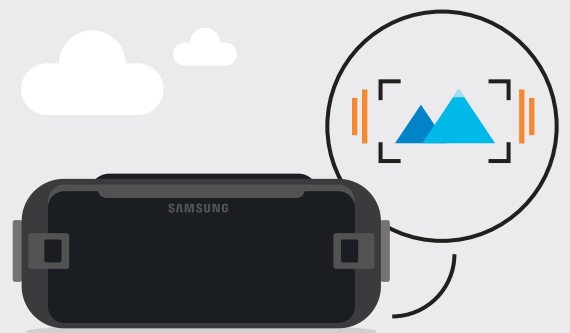
Since post can be so time-consuming and processor-intensive, it's important that you plan your process in stages to avoid redoing work and wasting cycles.

Stabilization Options

Stabilizing footage is a key technique for creating content to be viewed in the VR headset. Today, content creators have numerous options for stabilization in post-production.

These are some of the most popular options worth checking out:

- 1 Adobe Premiere CC 2018** supports native camera tracking stabilization support with the integrated VR comp editor.
- 2 Mocha VR** offers a suite of powerful tools not just for stabilization, but also tracking and rotoscoping in a 360 environment in stereoscopic or mono.
- 3 RE:Lens** is a powerful tool for stabilizing both unstitched and stitched footage, and to de-warp fisheye images from single lens cameras as well.
- 4 SynthEyes** is another suite of tools for authoring content in VR, offering stabilization, planar tracking and inserting and working with objects in 360/VR space both in stereoscopic and mono.



Distribution

Although distribution is one of the final steps in the process, as discussed in the planning section, you should start thinking about it from the very beginning of your project.

Determine Distribution Plan Before You Shoot

Although distribution is one of the final steps in the process, as discussed in the planning section, you should start thinking about it from the very beginning of your project. It's critical to consider how your audience will consume the content, as this ought to have a big impact on how you decide to shoot your project.

When it comes to online distribution, not all platforms will show your content the same way. Some may not support stereoscopic 3D, while others may not support spatial audio. It's important when budgeting time or funds for wide distribution to understand the advantages and limitations of each platform and acknowledge that you may need to tailor your content to fit each one for the best results.

Live streaming 360 content can be process and bandwidth intensive, considering the resolution of the content and the real-time stitching needed to broadcast to VR. Like online distribution for linear projects, not all platforms support the same live streaming features.

When streaming VR content, you are at the mercy of upload speed at the user's location and the quality of their internet connection (though with 4G aggregated modems — and now 5G — this is becoming less of an issue). Due to limited bandwidth, bitrates have to be kept low to ensure a successful

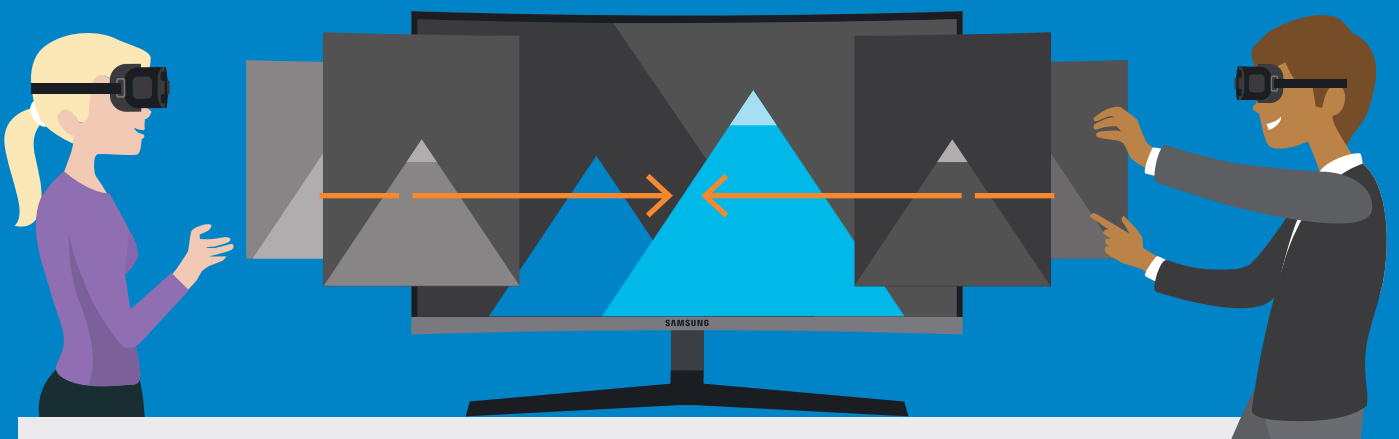
stream without buffering. Platforms like Samsung VR offer live streaming of the optimized H.265 codec, at as much as 4K per eye for stereoscopic content. H.265 can often provide a comparable quality level at half the bitrate of an H.264 video.

Application Development

Application development can also give content creators opportunities to introduce interactive elements to 360 videos that would otherwise provide only a linear experience. Stories could have branching narratives, allowing the viewer to change the outcome of the story based on decisions they make or what they look at.

Training modules can offer questions about what the viewer is seeing, or even track their attention to ensure they are focused on the most important part of the process. Decisions made in real-time can have consequences and show the learner different outcomes based on their choices.

Web application standards for VR, such as WebVR, are making it easier for your new applications to integrate with existing Learning Management Systems and legacy apps. These standards are paving the way for easy distribution of VR online, direct to the headset in the browsers we already use. Chrome and Firefox have both led the charge on incorporating VR display capabilities directly in the browser, but many more have started to follow.



Conclusion: Measure Your Success

Creating VR content is an investment in time and money, and to prove its worth it to stakeholders, a case needs to be made for a return on investment. Beyond just simple view counts, 360 content provides a variety of other unique metrics. You can evaluate where the user is looking by using heatmaps, whether or not they viewed in a headset, how long they were engaged, which scenes they watched and how they navigated the content.

Although 360 video is new to many, and requires some ramp-up time to learn, it can be incredibly engaging and rewarding to the organizations that adopt this new medium.

Content creators for either entertainment or enterprise have more utilities, cameras and platform solutions available to them than ever before. Creating 360 content can be cost-effective, have quick turn-around, and be easily employed by just about any industry. In order to future-proof your content, you need to start thinking outside the frame, and right now is a great time to start.



Learn more: samsung.com/360round

Footnotes

1 - International Data Corporation (IDC) Worldwide Quarterly Augmented and Virtual Reality Headset Tracker, March 2018

2 Ericsson Mobility Report, November 2017.

3 Wired, February 2017.

4 YouTube Creators Blog, June 2017.

5 Rated as dust tight and protected against water projected from a nozzle.

Learn more: samsung.com/360round | insights.samsung.com | 1-866-SAM4BIZ

Follow us:  youtube.com/samsungbizusa |  [@samsungbizusa](https://twitter.com/samsungbizusa)

SAMSUNG