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HEAVY READING
WHITE PAPER

Producing Live 8K, 360-Degree Streaming Media Events: An Owner's Blueprint

A custom Heavy Reading white paper produced for Intel

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INTRODUCTION: BRINGING LIVE 8K, 360-DEGREE STREAMING MEDIA TO LIFE

Not all that long ago, advanced technologies and services such as live 4K and 8K video, point clouds for volumetric video, and immersive media like augmented reality (AR), virtual reality (VR), and mixed reality (MR) were generally viewed as wildly futuristic capabilities. Indeed, these offerings seemed reserved only for proof-of-concept designs or maybe next-generation service trials that would be conducted by a select few cloud and communications service providers.

But now these types of next-gen media services and technologies have quickly evolved into emerging real-world use cases. As a result, media users have moved swiftly from passively viewing content on static video screens to engaging in intelligent visual experiences dynamically presented in their homes, offices, theaters, stadiums, arenas, and other private and public spaces.

What is helping to transform the media world and make all this possible is a new visual media architecture known as the Visual Cloud. As conceived by Intel, the Visual Cloud is a next-gen media platform that draws upon advanced cloud-native technologies to deliver video and related services more efficiently and cost-effectively, manage network resources, offer real-time data analytics, and deliver more engaging content experiences than ever before. Thus, the Visual Cloud taps into the power of the cloud to perform the heavy lifting required to create, foster, support, and deliver rich new media technologies and services.

This white paper delves into a prime example of the rich new media technologies and services, exploring how the Visual Cloud can enable live 8K, 360-degree media streaming. In this paper, Heavy Reading discusses how content, service, and cloud providers, as well as other players, can produce 8K VR live streaming media events without streaming more than 4K worth of pixels. We also examine the value that this next-gen platform promises to bring to all players in the video streaming chain.

In short, Heavy Reading offers what amounts to an owner's blueprint for making the most of these new media capabilities.

LIVE 8K VR MEDIA STREAMING: MARKET DRIVERS AND BENEFITS

Market Drivers: Why Video Streaming Is Gaining Momentum

The market forces driving the media industry to develop and deliver more engaging, interactive live media streaming in a cost-effective manner are quite clear:

- Mounting consumer demand for live video streaming services
- The need for lower "glass-to-glass" latency
- Growing bandwidth capacity
- The emergence of new, more efficient media processing technologies
- A desire for greater revenue

Focusing just on the mounting consumer demand for live video streaming, consider how much media streaming traffic keeps growing, breaking consumption records throughout the world each year. As Akamai reports, the July 2019 live streaming of the Cricket World Cup match between India and New Zealand was the latest record-breaking event, attracting a peak load of 25.3 million concurrent viewers. That represented a 35% traffic increase over the IPL Final in May 2019 (18.6 million concurrent users) and an enormous 150% increase over the IPL Final in 2018.

Or, to cite more statistics from Akamai, consider that the releases of popular new video games now consume as much bandwidth as a whopping 106 terabits per second. That amount of traffic comes out to roughly the same amount as downloading 3,300 2-hour HD movies every second or nearly 12 million HD movies an hour.

The astonishing growth of video streaming has also fostered the development of new types of streaming video content and viewing behavior, such as e-sports, user-generated content, and binge watching. In addition, it has spawned the soaring use of video apps on popular social media sites such as Facebook, Twitter, and Snapchat, to name just a few.

Largely as a result, IP video traffic will make up an impressive 82% of all IP traffic globally (both business and consumer) by 2022, up from 75% in 2017, according to the latest Visual Networking Index (VNI) forecast from Cisco Systems. The VNI forecast projects that global IP video traffic will multiply an astounding fourfold between 2017 and 2022, generating a compound annual growth rate (CAGR) of 29%. Internet video traffic will account for the lion's share of that growth, also surging fourfold from 2017 to 2022 at a CAGR of 33%.

Moreover, live internet video will account for 17% of all global internet video traffic by 2022, growing 15-fold from 2017 to 2022, according to the VNI forecast. The volume of internet video to TV will increase threefold between 2017 to 2022, accounting for 27% of all fixed consumer internet video traffic by the end of the period.

Even more to the point, UHD (or 4K) video will account for 22% of all global IP video traffic by 2022, according to the latest VNI projections. UHD as a percentage of IP video-on-demand traffic will rise even higher to 35% by 2022.

As 4K streaming video becomes more and more common, demand for video will only continue to multiply. For example, Market Research Future projects that the global video streaming market will grow at a very healthy 17% CAGR rate through at least 2023.

Thus, there still appears to be no end in sight for consumer demand for more and better media streaming services. Thanks to trends like these, even as standard 4K media streaming continues to evolve into a mass-market service, content owners, service providers, and technology developers are all vying for ways to bring more complex video streaming to market as effectively and efficiently as possible.

Benefits: Better Video, More Compelling Stories

One key benefit of 8K, 360-degree streaming is quite evident: higher resolution pictures. 8K is a much higher resolution standard than 4K, quadrupling the total number of pixels produced, just like 4K did with 1080p. Specifically, 8K VR offers 8192 x 4096 resolution, or approximately 8,000 horizontal pixels. In contrast, 4K VR relies on around 4,000 horizontal pixels at 4096 x 2048 and 1080p.

While the number of pixels supporting 4K VR may sound fairly high, all those pixels are actually not enough to produce very high resolution pictures. But, by quadrupling the number of pixels involved, 8K VR can go a long way toward resolving that issue.

In addition, 8K, 360-degree streaming will clearly deliver more compelling, immersive video, ushering in what Intel likes to call "a new era of storytelling." Netflix's ground-breaking select-a-path film, *Black Mirror: Bandersnatch*, offered a prime example of this beckoning era. As reported last year, Netflix saved each choice that viewers made while watching the film's 12 different endings. All this data could then be used to decide the course of future productions. In a 2019 presentation in Mumbai, Netflix vice president of Product Todd Yelling said the streaming giant is now "doubling down" on producing interactive content, thanks to the popularity of that first feature film.

More Benefits: Helping Business Leaders Connect

One prime early use case for live 8K VR technology is broadcasting business conferences and meetings to larger, remote audiences. Intel and its various tech partners – including Akamai, Tiledmedia, and Iconic Engine – have already leveraged live 8K VR streaming technology to produce the first annual Visual Cloud Conference and beam it to a global audience. That landmark conference, which took place during the International Broadcasting Conference (IBC) in Amsterdam in September 2019, featured six different events with hundreds of app downloads.

LIVE 8K VR STREAMING: THE KEY CHALLENGES

While the benefits of producing live 8K VR video streaming are enticing, the challenges are at least as formidable. In this section, Heavy Reading delves into the chief challenges and complications that the media industry is facing with the glut of new, more advanced video and other visual services.

The sizable roster of challenges includes the following:

- The growing complexity and bandwidth requirements of the increasingly rich new services.
- The lengthy time-to-market and soaring costs of introducing and delivering new media services to users.
- The rapidly rising expectations of media users for less buffering, fewer time delays, and a better TV quality customer experience.
- The fact that streams are becoming more and more individualized. Instead of all viewers getting the exact same stream, each viewer now gets their very own part of their very own content in their very own quality with immersive media and interactive storytelling. The dimensions include: What is **my** story? What is the viewport and resolution of **my** device? What quality can **my** device support? What bitrate can **my** internet link support?
- The lack of experience in creating/designing such content.
- The need to future-proof systems for developing, processing, and delivering next-gen services like streaming video, immersive media, and cloud gaming.

Grouping together all these challenges of producing, processing, and distributing 8K VR media streaming services effectively and efficiently, several main categories emerge. These categories include the lagging quality of the video streams themselves, the limited reach of the new media platform, the high costs and lengthy time of producing, processing, and delivering the streams, and the steep bandwidth requirements of processing and delivering the streams.

For instance, consider a critical factor that makes the production and distribution of high quality 8K VR images so costly and challenging today, as spelled out by Tiledmedia, one of Intel's leading Visual Cloud partners. A VR camera usually consists of a set of conventional video cameras that record a piece of the environment. Special stitching software then combines all these various video images into a single spherical video in the form of an equirectangular projection or ERP (a flat map of the Earth is one example of an ERP).

Using their VR headsets, media users will see only a small fraction of that sphere at any point in time, or about one-eighth of the complete picture in popular headsets. However, newer headsets that show more are now coming on the market.

Because the video plays right in front of the viewer's eyes, magnified by special lenses, the resolution needs to be very good. The industry standard in VR is to use 4K video for the entire sphere. While 4K VR uses 4096 x 2048 pixels, users will see only about 1000 x 1000 pixels per eye right in front of them, resulting in a lackluster visual experience at best.

With 8K video (8192 x 4096 pixels), the image becomes considerably clearer. But to deliver that kind of quality to the user, a huge number of pixels must be sent: the equivalent of about 16 HD channels, requiring some 60 Mbps-100 Mbps. Even if all those bits of data could be sent across an ordinary content delivery network (CDN), very few video reception devices could actually decode it.

Or, to cite another critical factor, 8K VR streams require an enormous amount of bandwidth for distribution over content delivery networks. Akamai, another Intel partner, estimates that it can take up to 120 Mbps to deliver one 8K VR stream from its origin to the ingest servers. That is a tremendous amount of bandwidth to push through a CDN, clocking well above Akamai's usual ingest limit of 75 Mbps. If nothing special is done to the stream, the CDN will have to ingest over 120 Mbps to the origin and then distribute 60 Mbps-100 Mbps to the user.

LIVE 8K VR MEDIA STREAMING: A PROPOSED BLUEPRINT FOR SUCCESS

Fortunately, these hurdles are not insurmountable. This section describes ways to overcome at least some of these various challenges using technologies and techniques that have already been developed and deployed in the field by Intel and its partners.

Focusing on the thorny bandwidth issues, for example, Tiledmedia has crafted a system that aims to help providers produce an 8K experience while transmitting and decoding much less information than seems to be required at first glance. Using a process called tiled streaming, the platform sends only what the user actually sees, not the entire spherical image.

Here is how tiled streaming works. The technology slices the overall image into many smaller, high quality "tiles." A typical setting for 8K VR is to use 96 tiles. It then sends, decodes, and displays only those tiles that actually appear in the user's field of vision, not the entire image.

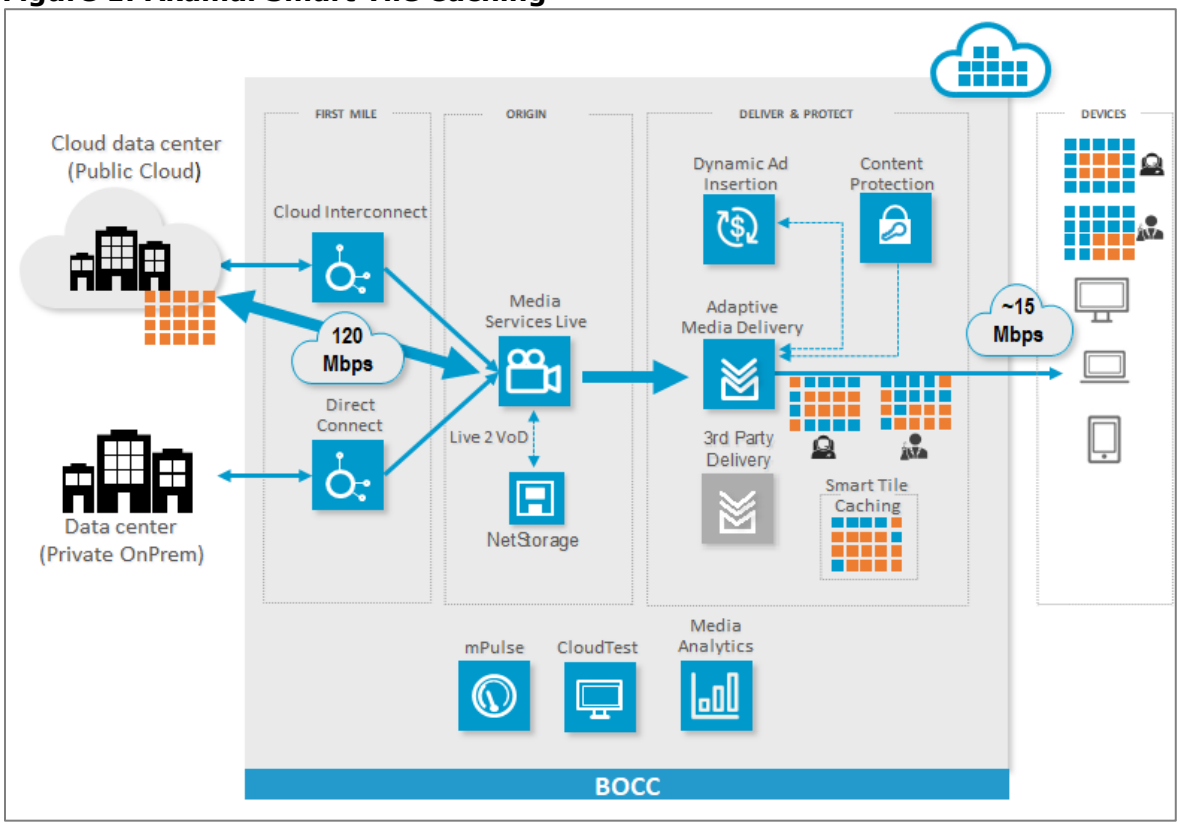
Not surprisingly, the real-time nature of the viewing experience, including the need to respond instantly to a user's head motion, makes this approach particularly challenging. When viewers turn their heads one way or another, the system must retrieve new high resolution tiles and then decode and display them – all within a tenth of a second.

But Tiledmedia says its tiled streaming system can manage that, switching tiles so quickly that users hardly notice the low resolution background layer. That layer is always present to prevent black areas from appearing in their field of view.

Turning to the major distribution challenges, Akamai and Tiledmedia have teamed up to develop a VR-specific configuration designed to increase the likelihood that the requested tiles will be available at the edge cache. This configuration enables providers to offer the optimal response when users move their heads around.

The configuration relies on the HTTP/2 protocol using multipart byterange requests and smart pre-fetching of tiles to the edge cache (see **Figure 1**). Note that a QUIC (HTTP/3) configuration is under development. With tiled streaming, a short request/response delay is much more important than for regular on-demand services. In this configuration, the "motion-to-high-resolution" latency is typically just three frames or less at 30 frames per second. After head motion, over two-thirds of high resolution tiles are in the user's viewport within those three frames. Given the way the human visual system works, this appears to be virtually instant to the viewer.

Figure 1: Akamai Smart Tile Caching



Source: Akamai

The application handles the final part of the stream delivery. Iconic Engine, another Intel partner that is an end-to-end provider of extended reality (XR) solutions, has a platform and a software development kit that includes Tiledmedia's ClearVR tiling technology. It is available for the Oculus ecosystem and other operating systems. Consumer apps are specific to each service provider or an event like the IBC. Intel and Tiledmedia are now working on further quality optimizations, seeking to use data gathered by the platform to improve encoding, caching, and delivery strategies.

In a similar vein, the other key challenges noted in the previous section can be overcome with a mix of already established technologies and techniques. Many of these are enabled by the Visual Cloud.

LIVE 8K VR MEDIA STREAMING: USE CASES

Although live 8K VR media streaming is a new phenomenon, some initial use cases for the next-gen service are already starting to emerge. This section explores a few of those initial use cases and suggests some others that may soon follow the early pioneers.

One prime early use case is broadcasting business conferences and meetings to larger, remote audiences. As mentioned earlier, Intel and its various tech partners, including Akamai, Tiledmedia, and Iconic Engine, have already leveraged live 8K VR streaming technology to bring the first annual Visual Cloud Conference to a global audience.

That conference – organized by Intel and occurring during the IBC in Amsterdam in September 2019 after just 8 weeks of planning – featured six different events with hundreds of app downloads. The idea was to bring together media technology leaders to discuss the opportunities, implementations, and challenges of delivering Visual Cloud services and showcase innovative technology solutions by multiple players across the ecosystem.

With the VR feeds available worldwide and accessed in 12 different countries around the globe, the inaugural Visual Cloud Conference attracted a standing room crowd onsite in Amsterdam, as well as virtual viewers elsewhere at the IBC and in other locales. Iconic Engine's backend logs show that the immersive media event generated an average remote viewing time of 38 minutes, demonstrating the value of the next-gen technology.

With business conferences representing a $1 trillion market globally by some estimates, the potential of using advanced immersive media for broadcasting conferences to remote audiences could be huge. For their part, IBC leaders say they intend to make the Visual Cloud Conference and live 8K VR streaming standard parts of their future conferences in Amsterdam.

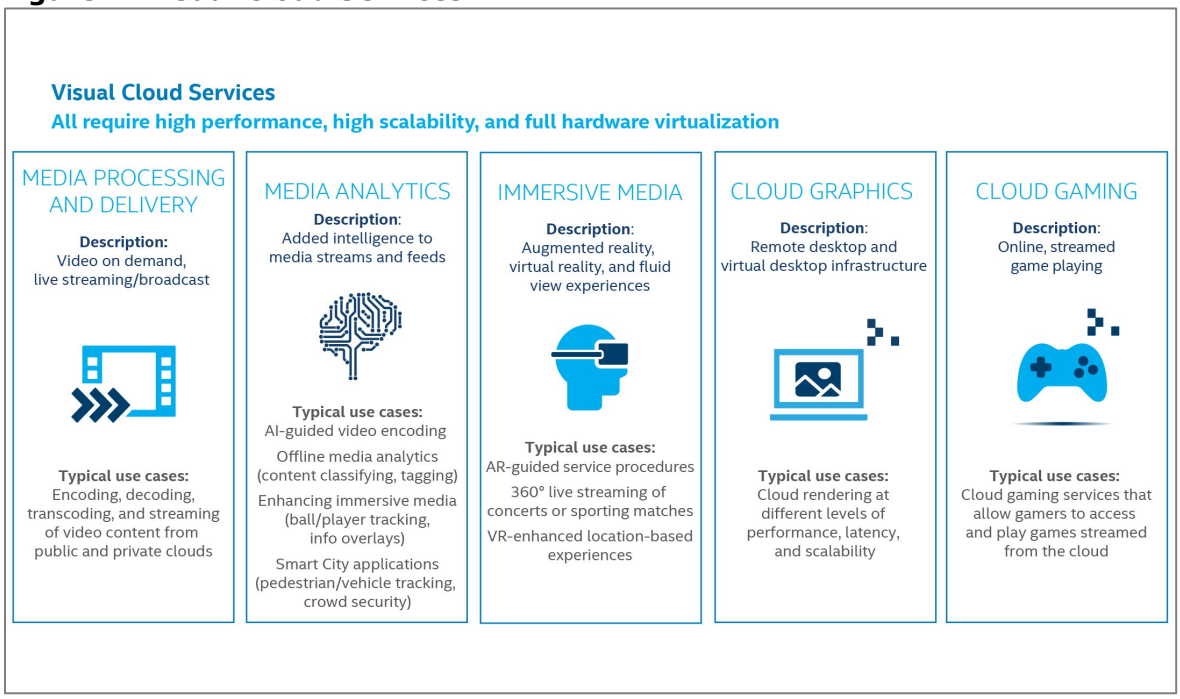
Proponents of the technology see myriad other potential use cases in the works for live 8K VR streaming. Those use cases include live coverage of sporting events, concerts, theatrical performances, artist exhibitions, and e-sports events, to name a few outstanding examples. Other possible use cases include producing holographic images or making global interactive VR presentations in the commercial space. For instance, imagine diving into an immersive meeting room where you can tap into a 3D world (6DoF) to describe/present any idea you have in mind.

THE VISUAL CLOUD: WHY IT MATTERS FOR LIVE 8K VR STREAMING

So just what is the Visual Cloud and how does it foster the new media paradigm and 8K VR live streaming? As mentioned earlier, the Visual Cloud is a next-gen media processing and delivery architecture that makes use of advanced cloud-native technologies to boost the efficiency of video compression, manage network resources, offer real-time data analytics, and deliver more engaging content experiences. Aimed at fostering a world of visual innovation, the Visual Cloud taps into the power and ubiquity of the cloud to carry out all the heavy lifting required for decoding, inference, rendering, and encoding of video and related media.

More specifically, as envisioned by Intel, the Visual Cloud leverages highly optimized cloud-native media, artificial intelligence (AI), graphics components, and a set of predefined reference pipelines to support a full range of visual services. These reference pipelines consist of advanced software ingredients across media, AI, and rendering. The goal is to enable developers to quickly evaluate, craft, and deploy new media services and applications and create new ways of storytelling – all without needing to invest heavily in deep, low level software tuning.

Figure 2: Visual Cloud Services



Source: Intel

As depicted in **Figure 2**, the roster of next-gen media services enabled by the Visual Cloud ranges from media processing and delivery to media analytics, immersive media, cloud graphics, and cloud gaming. What all five categories of services have in common is that they are heavily dependent upon high performance, high scalability, and full virtualization of hardware in order to be effective.

CONCLUSION

Even though 4K video streaming has not achieved universal deployment quite yet, live 8K VR media streaming is not only on the way, it has already arrived. As shown by the Visual Cloud Conference at the IBC in September 2019, this next-gen media service can be delivered effectively and efficiently to a sizable global audience using technologies and techniques that are commercially available today.

But live media streaming will keep evolving quickly as video and other media services keep transforming at light speed to keep pace with the rapidly growing expectations of both the consumer and business markets. As media users increasingly demand that their ever richer content be delivered to them anywhere, anytime, and on any device without frustrating delays, buffering, or excuses – and as media experiences become ever more immersive and interactive – demand for even more advanced streaming visual services will only continue to grow. There is no turning back now.

For more information on the companies mentioned in this paper, please click on the website links below:

- www.intel.com/visualcloud
- www.tiledmedia.com
- www.iconicengine.com
- www.akamai.com