

WHITE
PAPER

Scaling OTT delivery to world-class live streaming events

How to manage growing audiences with confidence and offer high quality through network-optimized delivery.



Preface

As network providers, media businesses, social networks and infrastructure companies prepare for a new decade of unprecedented demand, Lumen wanted to take the opportunity to discuss what it considers some of the most important aspects of scaling a streaming platform to millions of concurrent viewers.

This white paper examines the importance of optimising one's network from origin to end-user device, discussing best practices for scaling live video delivery and explaining how a network-optimized CDN, along with mesh delivery technologies, can provide the scale and performance needed to deliver winning quality on game day.

Introduction

Dynamic growth in live video

From sporting events to concerts, political rallies to product launches, and season premieres to online gaming, live video is all around us.

Live streaming is deeply ingrained in viewers' online habits and continues to gain momentum. Across the globe, live video consumption is expected to grow 15-fold in the next two years, jumping from 5% to 17% of all internet video traffic.¹ In 2019, Lumen saw a 43% increase in peak bandwidth demand² and estimates that this trend will accelerate in 2020.

The growth in live streaming is propelled by both unprecedented viewer numbers on digital platforms and increasingly bandwidth-heavy rich media formats.

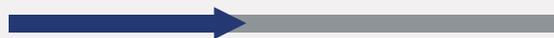
Live streaming is particularly prevalent in Asia, where a youthful population and a voracious appetite for gaming, sports and user-generated content have led to a proliferation of local live streaming actors, as well as keen interest from international platforms. 60% of the world's adolescents and half of all mobile users live in the Asia Pacific region.³

At the same time, viewers are tuning in on more devices than ever before. By 2022, 28.5 billion end-user machines will be connected to the internet - the equivalent of 3.6 devices per person for every individual on Earth⁴. With some of the highest mobile penetration rates globally, 67% percent of the population in APAC - 2.8 billion people - had signed up for a mobile service by the end of 2018⁵.

Furthermore, higher internet speeds, UHD adoption and the availability of rich, bandwidth-heavy media have together multiplied the effect of voracious user appetite.

Internet speeds are rising globally, which has catalysed large-scale adoption of high-end UHD-enabled streaming devices. In 2017, only 23% of flat screen televisions offered UHD; in 2022 nearly two-thirds will be streaming content in ultra-high-definition formats.⁶ As broadband speeds, mobile internet and device capabilities increase, adaptive bitrate systems adjust to make use of all available bandwidth, intensifying the impact on volumes streamed.

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A high-potential and high-risk undertaking

The immediacy of live video is a powerful engagement driver in an otherwise crowded content space. Media companies that secure the rights to high-profile live events have a unique opportunity to reach massive audiences, build brand loyalty and procure significant advertising revenue.

High-value content, however, can mean highly publicised hiccups, and delivering live content reliably to massive is a challenge that tests even the strongest infrastructures. Moreover, the proliferating number of devices, operating systems and networks that media companies must serve has fragmented the technology landscape and made delivering a consistent experience across one's entire user base all the more challenging. But like the athletes on the field, technologists cannot afford to drop the ball on game day.

In this high-stress and high-stakes environment, preparation, foresight and agility are key. Laying the groundwork for a live streaming event involves reinforcing every component of the video workflow: from ingest to encoding, formats, video player, ad serving, digital rights management, and features such as time-shifting, multi-language options, subtitles and multicam setups. Designing one's platform purposefully presents a clear advantage. It reduces the risk of error and lost revenue, while offering a more comfortable time-to-market and overall competitive edge.

While there are critical considerations all along the video workflow, this white paper focuses on one of the most critical yet difficult aspects of ensuring a successful live streaming experience: scaling delivery to peak-time audiences. We will discuss how to optimise one's content delivery network from origin to end-user, the importance of choosing providers that have keen network awareness at every step of the delivery chain, and best practices for crafting a technology mix that offers scale when it matters most.



Build a strong foundation with content delivery partners specialised in live streaming

Live streaming presents specific delivery challenges to consider when engaging with content delivery network (CDN) providers. A thorough audit of one's goals can help you move discussions along quickly and sift through feature sets effectively. Keep in mind that CDNs offer a broad range of services for various types of asset delivery and that not all features available enhance video performance.

For a video streaming platform, a number of feature sets are relevant when evaluating potential content delivery partners: geographic reach; encryption, digital rights management and network security; origin and workflow integration; transcoding and transmuxing; and support for major video formats, to name a few.

We choose to focus our attention here, however, on one of the most important criteria that set vendors apart when it comes to ensuring a successful live streaming event: network scale and topology.

Network-optimised video delivery

A technologist's main goal when delivering a world-class live streaming event is to offer audiences a smooth, high-quality experience.

This should also be a guiding principle in how your provider's content delivery network is designed.

Each CDN is different in its topology, node placement and performance, and connectivity within and across networks. Certain CDNs own their networks; others do not. Some deploy infrastructure everywhere, while others concentrate on deploying fewer, more powerful nodes in strategic locations. Some use hierarchical connections between nodes, others a mesh topology.

When evaluating potential partners, it is important to examine how the content delivery network will actually transfer bits from the origin to the end user. Where is its edge architecture based? Does it have direct relationships with ISPs or is it relying on public peering points? To what extent is it obliged to pass through networks it does not control?

In a live streaming use case, every millisecond can have an impact on end-user experience. Shaving off overhead throughout ingress, midgress and egress delivery is therefore critical.

As a general rule, we believe a good CDN candidate:

- Has sufficient connections in the regions in which you are delivering, whether measured by number of points of presence or by the performance of the nodes
- Has strong peering relationships with the ISPs in your most important markets
- Can freely direct traffic through the lowest-latency routes, avoiding Border Gateway Protocol (BGP) routing and congested peering points



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**— Mark Schultinga
Account Director and CDN Specialist, Lumen**

The Lumen CDN and its 120 global points of presence are specially architected into the Lumen IP backbone. We therefore enjoy direct control over the performance and delivery of content while minimising reliance on third-party infrastructure. Lumen leverages this ownership to reduce complexity in serving paths throughout the network.

For example, the company’s IP network is directly connected to major Cloud service providers including Amazon, Microsoft and Google. These strong links minimise round trip time between origin and caching servers, a significant advantage for live video as the origin is constantly providing new information as video segments become available.

As both a CDN provider and the one of the largest tier-1 providers,⁷ Lumen is in a unique position of leveraging its global physical network assets to provide direct connectivity into other ISPs, while generally avoiding public peering points.

With approximately 450,000 route-miles of fibre, over 2,200 public and private data centre connections and 5,000 direct interconnection relationships Lumen, offers deep penetration into ISPs across the globe for high levels of control of traffic distribution. The company has invested significantly in its infrastructure over the last year, building out points of presence in 11 key cities in Asia and tripling its peak capacity in the region.

Insofar as it owns the network, Lumen CDN can offer the quality of a real managed service. A large portion of internet traffic runs over the Lumen backbone. Unlike other major players on the market, Lumen owns the fibre, the cables and the servers that bring data from an origin to end users. With direct entries into ISPs across the globe, Lumen understands how each network operates, as well as the specifics of in-country infrastructure. Lumen therefore does not simply interact with networks: we leverage our intimate knowledge of network topology to find optimal routes.

Lastly, Lumen has put the vast amount of network data it has at its disposal to use, developing softwaredefined networking capabilities, automated network healing, and improvements in how data is routed through the core. This has a two fold advantage of improving our own CDN performance, as well as the performance of other CDN providers that benefit from our infrastructure.



450,000

route miles of
fibre globally



2,800+

public and private
data centres on-net



5,000

direct
interconnection
relationships

Mitigate risk with a multi-CDN architecture

A robust multi-CDN architecture with global reach, optimal traffic routing, and broad network penetration can provide a strong foundation for a successful live streaming event.

It goes without saying that relying on a single content delivery partner exposes a platform to both outages and degraded performance.

Even the best infrastructure can face struggling servers or systemic failures. In turn, even the slightest glitch can cause content to arrive at users more slowly, resulting in slower start-up times, rebuffering or lower-than-average bitrates. A multi-CDN approach offers precious redundancy as well as potentially taking advantage of any regional disparities in CDN providers.

If transitioning to a multi-CDN environment specifically for a live streaming event, consider time to market. The number of CDNs chosen, complexity of the selection and switching criteria, as well as the mechanisms deployed require integration and testing within your workflow and may conflict with current systems including advertising and token handling.

Building a video workflow that is multi-CDN ready from the start is advisable, even if CDN vendor candidates should all be able to accommodate industry standard approaches to token authentication, content invalidation, geo-filtering and caching / origin-fill rules.

Secondly, there are several options to consider when building a traffic distribution policy. Simple CDN selection based on geo-IP or region is commonly used to ensure that the user receives content from the appropriate content delivery network. DNS-based load balancing can then provide a minimum failover in the case of an outage.

Client-side telemetry meanwhile takes this approach to the next level, providing data that directly reflects end-user experience and offering midstream switching when conditions impair one CDN but not another. This is the only solution that can save a video session in the event that a CDN fails mid-session.

For important live streaming events, performance criteria should generally take precedence over commit management or other considerations. Best practices suggest that good data, close CDN collaboration, and the combination of DNS-based control tools and client-side telemetry enable the optimal multi-CDN environment.

Bring delivery to the outer limits of the edge with a mesh network solution

A robust multi-CDN architecture with global reach, optimal traffic routing, and broad network penetration provides a strong foundation for a successful live streaming event.

No matter how powerful the CDN, however, an influx of viewers at the most critical moment of the action will always be a challenge. An exciting game in which fans tune in en masse at kick-off, in the final minutes, or even in overtime can create network conditions which drive just as much action off the pitch as on it.

For these reasons, we suggest incorporating a new breed of delivery technologies to complete the delivery workflow.

A peer-to-peer delivery solution, often referred to as a “mesh delivery network,” takes the notion of a distributed caching architecture a step further. These delivery technologies incorporate consumer devices into an edge-based delivery architecture. Working in tandem as an overlay to the CDN infrastructure, they allow devices to source video segments from either a CDN server or another device viewing the same content at the same time.

In this way, mesh delivery keeps content as far out at the edge of the network as possible. When combined with a robust and network optimised CDN infrastructure, a mesh overlay can offer a number of advantages:

- Greater regional capacity, particularly in hard-to-reach locations, disparate groups of islands, or where CDN providers have weaker network penetration
- Improved footprint, as micro-caching on devices makes more segments across all formats and bitrates available closer to the edge of the network
- Flexibility in infrastructure dimensioning, eliminating the need to precisely predict traffic volumes and minimising the risk of inadequate or inaccurate CDN provisioning
- Reduced need to rely on ISP peering by keeping traffic within individual ISPs and subsections of ISP networks
- Overall performance enhancement compared to traditional caching infrastructures, especially during peak traffic hours



“ The very nature of our business means that we strive to make the transport of data as efficient as possible across all networks in every region of the world. A network-aware peer-to-peer video delivery solution furthers our goal of optimising performance for end users wherever they may be.”

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Account Director and CDN Specialist, Lumen

In choosing a mesh delivery partner for a live streaming event, several considerations should be made.

Device coverage

- PPeer-to-peer delivery is implemented into a video app via SDK or video player code. Choose a provider that has implementations for the largest number of devices that you serve. The more end user devices that can be included in the mesh network, the stronger the potential of the solution.

Track record

- As webRTC-based mesh technologies are relatively new, choose a trusted company that works with major media and entertainment companies who are willing to speak to the maturity and effectiveness of the vendor's solutions. Ensure that your partner has a proven track record delivering premium live content.

Quality

- Providers tend to measure performance differently. Some algorithms privilege CDN offload over quality considerations. Others make quality a priority, taking into account a range of device metrics to determine whether or not a segment should come from the CDN or from a peer in the network.

Network awareness

- It is important for a peer-to-peer solution to interact effectively with the ISPs and networks over which it is delivering. Peer-to-peer algorithms should be able to adapt dynamically to each ISP and optimise connections between devices accordingly.

With the acquisition of Streamroot in 2019, Lumen has armed itself with an industry leading peer-to-peer video delivery solution, the foundation for its global CDN Mesh Delivery platform. Streamroot solutions have been trusted for over five years by major national and international broadcasters. Its CDN Mesh Delivery has been used for major primetime sporting events including some of the largest professional tennis, cycling and rugby tournaments on the planet. During the largest international football tournament, Streamroot mesh delivery offloaded over 1.26 Tbps from the global content delivery infrastructure, safeguarding against congestion and providing a smoother streaming experience to football fans across the world.

Streamroot's Mesh Delivery solution offers wide device coverage across desktop, Android and iOS mobile devices and set-top boxes. Its algorithms take a quality-first approach, using metrics such as rebuffering, CPU, and battery life to adapt delivery to the resources of each device and help improve user experience overall during peak traffic hours.

While certain CDN providers have shied away from mesh delivery technologies, Lumen has whole-heartedly embraced them as a natural extension of its network. The very nature of our business is to make the transport of data as efficient as possible across all networks in every region of the world. A network-aware peer-to-peer video delivery solution furthers our goal of optimising performance for end users wherever they may be.

Secure pre-event agility and game day support

One final consideration should not be overlooked when building a technology mix for a major live streaming event. In addition to the strength of the network and ability to route traffic effectively at every step of the delivery process, live events require operational excellence from your delivery partners from day-one through, up to and after gameday.

Preparing for a live stream involves tight deadlines, mandatory production freezes, and juggling a number of vendors each with a unique testing and release schedule. Because time-to-market is limited, your content delivery providers should understand and practice agile dev ops, be able to work with your engineering and app release cycles, and have the expertise to offload operational delivery requirements from your team.

In choosing a partner, look for those that not only offer sufficient self-serve features and control over delivery configurations but that are also well-versed in executing managed services for complex integrations. Throughout the preparation process, providers should work hand-in-hand with you to set up staging, canary and test configurations to ensure that all parameters are correctly configured and all systems are interacting as expected.

On game day, SLAs are an important baseline. More important, however, is how providers intend to assist you during the event, monitor your streams, manage eventual failures and take corrective action.

In 2019, Lumen served nine of the world's ten largest media companies and transported more than 10,000 sporting events.

We are known not only for our ability to deliver products; we have worked for over 15 years to provide media companies comprehensive assistance in developing critical network infrastructure and making roadmap decisions.

The complexity of large-scale live streaming projects requires dedicated specialists that work alongside your teams and adopt a holistic approach to architecting delivery networks. Here, too, our multifaceted expertise as a CDN provider, mesh delivery solution and a tier-one operator, sets Lumen apart.

Lumen works alongside engineering teams via in-region experts, industry veterans with a deep knowledge of the media delivery workflow. For large live events, we offer a personalised approach, with custom professional support, configuration with your teams, as well as staging and product tests before game day. During the event, eye-on-glass monitoring of your platform and networks quickly identifies and diffuses any issue, either on our network or elsewhere in your video workflow.



Conclusion

Live streaming events offer a singular opportunity for broadcasters to set themselves apart from the competition and deliver viewers a lastingly memorable experience. Scaling delivery to growing live audiences is one of the greatest challenges online media businesses face today, but it should not get in the way of taking full advantage of the revenue, engagement and branding possibilities live events provide.

Proper planning and purposefully designing one's infrastructure by choosing network-optimised CDN providers, mitigating risk with a multi-CDN architecture, extending the network out to the far edge with a mesh delivery solution, and ensuring that your delivery partners are with you every step of the way can transform a stressful event into a game day win for engineering teams and audiences alike.

Footnotes

1. Cisco Visual Networking Index: Forecast and Trends, 2017-2022 White Paper.
2. Rowan de Pomerai, DPP, Delivering the IP Future, January 2020.
3. Virginia Harrison, BBC. Cashing in on Asia's huge appetite for live streaming. <https://www.bbc.com/news/business-42007408>. December 6, 2017.
4. Cisco Visual Networking Index: Forecast and Trends, 2017-2022 White Paper.
5. According to a GSMA Intelligence study.
6. Cisco Visual Networking Index: Forecast and Trends, 2017-2022 White Paper.
7. CAIDA AS-Rank, as of February 17, 2020

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Contact us

For more information about how Lumen’s comprehensive solutions can help your teams scale their infrastructure to win the live streaming game, contact us.

Why Lumen?

From content acquisition to storage, encoding and distribution, Lumen end-to-end video delivery solutions address your platform’s multi-faceted needs from a single provider. Benefiting from more than 15 years of experience tailoring CDN solutions for some of the largest global enterprises, Lumen today serves nine of the world’s ten largest media companies.

Over the course of 2019, Lumen strengthened its content delivery network (CDN) service capabilities in 11 cities across Asia Pacific to cater to growing demands from global broadcasters. Expanding our physical network footprint in APAC while enabling performance improvements in hard to reach markets with our mesh delivery solution can help provide Lumen customers a true competitive advantage.

In 2019, company was named a Leader in IDC MarketScape’s first Worldwide Commercial CDN Vendors Report for both the scope and scale of its deeply peered global network, but also for its technology innovation, notably in its acquisition of industry-leading mesh delivery provider Streamroot.