Your audience expects “broadcast quality” from your online video but are you meeting their needs? In this whitepaper, you’ll learn what you must do to optimize the Quality of Experience and assure that you are consistently delivering the best possible video.
Table of Contents

Introduction .................................................. 3
What is Quality of Experience (QoE)? ...................... 3
Embracing QoE ................................................ 4
The QoE Lifecycle ............................................ 5
How to Optimize QoE .......................................... 5
  Infrastructure and Playback ................................ 6
  Measurement .................................................. 7
  Common KPIs ............................................... 8
  Selecting a Measurement Framework ....................... 9
Case Study: CHILI S.p.A ..................................... 9
The Future of Optimizing QoE ................................. 10
Conclusion ..................................................... 10
About Limelight Networks ................................. 11
About NICE PEOPLE AT WORK (NPAW) .................. 11

Figures and Tables

Figure 1: NPAW Quality Benchmarks ....................... 4
Figure 2: The QoE Lifecycle ................................ 5
Table 1: Selecting Delivery Infrastructure ................... 6
Table 2: Example KPIs to Measure for Video QoE .......... 8
Introduction

By 2019, 80% of all Internet traffic is expected to be video. Although that should seem like a growing opportunity for many organizations to engage with their audiences, there’s a catch—rather than becoming easier, delivering video is actually becoming more difficult thanks to a growing number of connected devices and audience mobility. Content owners and publishers must address dozens of obstacles to ensure that their video is consumable on any device, anywhere in the world. Only it’s not just connection speeds and devices that are causing concern. Viewers are demanding the same “broadcast quality” experience for online video that they get from traditional television. This places a significant burden on publishers to produce not only compelling content but to also deliver it in a fashion that meets consumer expectations. Failing to do so can spell disaster for both an organization’s content and the brand itself.

What is Quality of Experience (QoE)?

For online video, Quality of Experience can be difficult to pin down because of the diversity and complexity of the value chain, where handoffs are many and accountability is unclear. QoE is often derived from a variety of elements:

- **Content**—the resolution and quality of the video delivered from studio through the encoding process. A 4K-encoded video is going to be of a higher quality than one encoded for standard definition.
- **Content Distribution Network (CDN)**—the performance of the network and servers that are physically delivering the video.
- **Network Operator**—the state of the last-mile access network (i.e., its capacity, congestion, and performance) and its ability to deliver the content when requested.
- **Device and Application**—the quality of the end-user device (i.e., memory, processor power, disk I/O, etc.) and the application through which the content is rendered.
- **User Behavior**—how the user is interacting with the device and the client application through which they are watching the content (i.e., do they have a lot of applications open).

Because of the diversity of the ecosystem responsible for those elements, measuring all of the related variables can seem impossible. And to complicate the situation, an acceptable QoE can change between regions, platforms, and devices. To that, the end-to-end view must be vastly simplified, reduced to a small set of metrics that can be measured and reported on regularly.

But measurement can’t begin until there is consensus across the organization. Critical groups, each responsible for different parts of the QoE, must work together if optimization is to ever happen.
Measuring QoE: Industry Best Practices

A study by ARRIS found that 34% of consumers report having problems streaming or downloading video at least 50% of the time. And another recent study from NICE PEOPLE AT WORK (Figure 1) found that when a viewer experiences a buffer ratio higher than 2%, the chance of churn increases by 30%. Conversely, the same study also found that end users experiencing a buffer ratio lower than 1% will watch 2.3x more content. NPAW has aggregated data across the YOUBORA Analytics platform, from a variety of countries, to identify industry best-practices for a number of critical KPIs.

Embracing QoE

Measurement, though, is only half of the challenge. The other half is fine-tuning and optimizing the elements reflecting those KPIs, which requires a commitment, across the organization, to deliver the highest QoE.

Because there are many technological and process-related components to QoE, ensuring that your organization can deliver the highest level to your viewers requires cooperation amongst three critical groups:

- **Business**—this group is responsible for providing customer service to your viewers. Let’s face it, there will be issues with quality, access, billing, etc. And part of the experience of watching a video relates to the level of service that users receive when problems do arise. Are they ignored? Brushed off? Put on hold for eternity?

- **Technical**—this group is responsible for making sure that the video gets delivered in the first place. At the heart of your video publishing empire is a delivery architecture. If content is king, then delivery is queen. You need a bullet-proof platform through which to deliver your video content if you are going to provide the highest level of QoE.

- **Operations**—this group is responsible for maintaining and monitoring that delivery architecture, ensuring proactively that issues are resolved before users can pick up their phones or compose that email to customer service.
The QoE Lifecycle

Embracing QoE isn’t just a one-time event. You have to imagine it as a continual cycle because viewer expectations change constantly. What equates to quality one day may not the next. To help you envision QoE as a process, we have reduced it to four parts (Figure 2).

- **Occurrence**—the process begins when something happens to negatively impact the QoE.
- **Identification**—once the event has happened, it becomes critical to identify the source and the cause.
- **Resolution**—after the problem has been identified, it’s time to fix it by implementing changes where required (i.e., modifying CDN configuration, switching to a different delivery method, etc.).
- **Prevention**—the final part of the cycle is to prevent the issue from happening again which may require changes to the architecture itself.

As the wheel turns, those three groups—business, technical, and operations—orchestrate together to optimize QoE by making adjustments to infrastructure and playback through a comprehensive system of measurement.

How to Optimize QoE

The experience that your viewers have is a direct result of how you deliver your content. Whether you employ your own servers, utilize a data center, or work with a third-party content delivery network (CDN) like Limelight Networks, the mechanism through which you publish video impacts the QoE. But how you deliver also includes the means by which you analyze that infrastructure. Being able to gather data from the servers, from the network, and from the player itself is critical to providing the best possible viewing experience.

By fine-tuning infrastructure and playback through in-depth analysis and measurement, you can optimize your QoE to provide a video service that will keep your users satisfied and engaged.
Improving Your Online Video: Optimizing the Quality of Experience

**Infrastructure and Playback**

The beating heart of your delivery architecture is the infrastructure, comprising all of the computing (HTTP servers, media servers, etc.) and network elements (routers, switches, bandwidth) involved in delivering your video content. Whether you are using your own or relying on a third-party’s, optimizing the infrastructure means tuning those elements to maximize four attributes:

- **Reach**—this attribute represents the QoE you deliver to users who are far removed from your infrastructure. For example, a video publisher with servers in several geographic regions has a greater reach than a publisher who is only servicing requests out of a single datacenter (or their corporate network).

- **Scale**—this attribute represents the ability for your infrastructure to “expand” to meet user demands. For example, a video publisher with a large server footprint and a lot of additional bandwidth capacity can serve a “flash crowd” whereas a publisher with a limited footprint (a small number of servers and bandwidth) has little ability to meet a sharp spike in demand.

- **Availability**—this attribute represents the ability for your infrastructure to respond to a user request for video data.

- **Consistency**—this attribute represents how well the infrastructure provides video content over time. For example, an infrastructure that has fewer bitrate switches and buffering events has better consistency than one that doesn’t.

### How Are You Going to Deliver Your Video?

You’ve got video to deliver. The question is, “how?” Do you just throw it up on YouTube? Do you build out and operate your own CDN? Do you seek out a commercial content delivery partner like Limelight Networks? The table to the right lists out some of the QoE pros and cons to each alternative.

<table>
<thead>
<tr>
<th>Option</th>
<th>Pros</th>
<th>Cons</th>
<th>Ability to Optimize</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post to YouTube³</td>
<td>Easy to get content to a wide audience with simple publishing tools.</td>
<td>YouTube monetizes and recommends additional content from other publishers, sometimes even competitors. You lose traffic to your website and YouTube provides little insight to your video consumption.</td>
<td>None</td>
</tr>
<tr>
<td>Build your own CDN</td>
<td>You are in ultimate control of your QoE. It’s your equipment. By using your own infrastructure, in conjunction with a commercial CDN, you can gain redundancy for your delivery.</td>
<td>It’s labor and capital intensive to deploy and maintain hardware and software in the geographic regions you need. Operating your own CDN requires 24/7/365 management.</td>
<td>High</td>
</tr>
<tr>
<td>Use a commercial CDN</td>
<td>Globally-distributed infrastructure and highly-tuned content delivery services. 24/7/365 support for your video content.</td>
<td>Although commercial CDN services can be expensive over time, it is still far cheaper (as an OPEX cost) than building out and maintaining infrastructure.</td>
<td>High</td>
</tr>
</tbody>
</table>

**Table 1: Selecting Delivery Infrastructure**

³YouTube™
As indicated in Table 1, the option you choose will have a direct impact on your ability to optimize your QoE. For example, providing your video to a third-party video service is handing off the QoE to them. There’s nothing you can do when quality is poor. While building your own infrastructure enables you to fine-tune it, it also requires a significant level of expertise. And although you are handing off your content to a commercial CDN for delivery, you can work with their experts to fine-tune configuration when there is a QoE issue.

But infrastructure isn’t the only element of QoE that you need to optimize. You also need to fine-tune the playback as well, which requires a system of code in your player and cloud services that can collect and analyze the data. Doing this on your own, though, would probably require months of development time and a commitment of future resources that, like running your own CDN, might not be your organization’s core business.

### Measurement

In order to deliver the best possible experience, you have to implement a system of measurement to provide the data against which to fine-tune your video experience. This system of measurement has to provide actionable data to take back to your in-house expert or your CDN partner which will allow them to pinpoint the root cause of QoE trouble whether it’s in the infrastructure or at the playback.

Without the ability to measure your QoE, you are operating in the dark. It’s critical to gather information about your viewers’ experiences in order to optimize the quality. This requires that you collect two kinds of data:

- **Infrastructure data**—this is data about how well the infrastructure performs in delivering the video to the player.
- **Playback data**—this is data about the playback experience with the video content you are delivering.

### Digging deep: Measuring the Individual Experience

In most cases, organizations delivering video will measure experience data on an aggregate level—they’ll get a picture of the average experience across their entire user base. And although that isn’t bad, sometimes organizations need much more granular information. They may require individual experience data in order to optimize QoE not for the entire user base but for a single player. The YOUBORA Analytics platform enables organizations to measure and track one-on-one connections, device used, CDN/ISP performance, and KPIs on a one-to-one basis. With this kind of detailed, individual data, organizations can truly optimize the end-to-end delivery for each viewer.
Common KPIs

Although there are a host of measurements you can take, you need to distill that information down to the relevant data points that reflect QoE for your infrastructure and player. The list below comprises a number of common data points that have been recognized by video publishers worldwide as critical to ensuring the highest QoE for video viewers:

<table>
<thead>
<tr>
<th>KPI</th>
<th>Data type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throughput</td>
<td>Infrastructure</td>
<td>The maximum amount of data that can be delivered</td>
</tr>
<tr>
<td>Consistency</td>
<td>Infrastructure</td>
<td>The variability in delivery speeds</td>
</tr>
<tr>
<td>Time to first byte</td>
<td>Infrastructure</td>
<td>The time it takes for the first byte of data to be received by the infrastructure</td>
</tr>
<tr>
<td>Bitrate</td>
<td>Player</td>
<td>The average bitrate consumed by the player</td>
</tr>
<tr>
<td>Play failures</td>
<td>Player</td>
<td>The number of times that the video failed to start or play</td>
</tr>
<tr>
<td>Completion rates</td>
<td>Player</td>
<td>The number of times that a specific video was watched through in its entirety</td>
</tr>
<tr>
<td>Time to start</td>
<td>Infrastructure</td>
<td>The time it took for the video to start playing</td>
</tr>
<tr>
<td>Length of play</td>
<td>Player</td>
<td>The average length of time that individual users watched the video</td>
</tr>
<tr>
<td>Buffer Ratio</td>
<td>Infrastructure</td>
<td>The number of times the video buffered versus playtime</td>
</tr>
<tr>
<td>Interruptions Ratio</td>
<td>Infrastructure</td>
<td>The ratio of play starts versus buffer events</td>
</tr>
<tr>
<td>Exits Before Video Starts (EBVS)</td>
<td>Player</td>
<td>The number of viewers who exited the video before it started</td>
</tr>
<tr>
<td>Ad clicks</td>
<td>Player</td>
<td>The number of clicks on ads presented through the video</td>
</tr>
</tbody>
</table>

Table 2: Example KPIs to Measure for Video QoE
Case Study: CHILI S.p.A.

Chili S.p.A. (Chili) is a transactional video on-demand provider, created in Italy in 2012 from a Fastweb spin-off. The company's mission is to offer clients a large catalog of on-demand video, TV series and movies. The catalog provided by Chili is one of the widest available at the moment: 5000 movies and more than 2000 TV series. The service is available to its more than 500,000 customers worldwide, on every connected device, from Smart TVs and game consoles to smartphones and tablets.

In a short period of time, Chili has achieved a leadership position in Italy as a top player in the digital distribution of movies and content, and for its highly specialized expertise in the development and management of video platforms. At the end of 2014, Chili began significant expansion of its services in Poland, Austria, Germany, and the UK. Leveraging its leadership as an independent company for on-demand videos, Chili has partnered with many top production companies in Europe replicating its own business model in other countries.

Chili’s growth is fueled by its ability to offer users high quality content and the best customer experience on any device anywhere. In 2012, Chili was one of the first companies able to introduce Full HD streaming content and in June 2015 they launched one of the first certified services for UHD content. Their customer base is growing as users are increasingly watching streaming content.
QoE is critical to Chili—users expect a “broadcast quality” experience no matter where they are, or on what device they are consuming Chili’s content. To ensure the highest QoE, Chili employs both Limelight Networks Orchestrate platform (for delivery and storage) and NPAW’s YOUBORA Analytics (for measurement).

“Working at Chili it is really important for us to look for state of the art technology. Making it easier and easier to access the platform will help us increase our customer base. Working with reliable partners such as Limelight and NICE PEOPLE AT WORK allows us to reach users wherever they are, which is extremely important to us, but also measure the user’s experience so we can fine-tune and optimize our technologies to deliver the best possible experience.”

– STEFANO FLAMIA, Chief Technology Officer at Chili

The combination of Limelight Orchestrate Delivery for infrastructure, with YOUBORA Analytics for measurement, gives Chili a unique, 360-degree view of the user experience and a far greater understanding of the video they are delivering. The scalable, reliable, and high-performance delivery platform coupled with rich user analytics provides Chili the tools they need to meet, and exceed, user expectations.

The Future of Optimizing QoE

As video publishers collect more data about viewers’ experiences with their content, there will be increasing opportunities to fine-tune QoE beyond what is capable today. For example, load balancing content delivery infrastructure today is handled through analysis of performance data. When one infrastructure is performing worse than another, a content publisher can switch to another (i.e., a different CDN). But performance is only one factor upon which to make the decision about infrastructure selection. What if a publisher could utilize more granular data to achieve better load balancing? For example, rather than just performance, a publisher might base load balancing decisions in the future on information gleaned from the CDN POPs or, perhaps, pricing.

Conclusion

Delivering the highest level of QoE to your viewers requires not only the right infrastructure but a system that enables you to measure how that infrastructure and your player is performing. By implementing a continuous process through which you identify, fix, and prevent QoE issues, you can optimize the experience for your viewers to ensure a higher level of overall satisfaction that directly impacts your bottom line.

2 As audiences move around, whether it’s to the neighbor’s house or 3000 miles away, they not only bounce around geographically but utilize different access networks as well each with varying degrees of speed and consistency.
4 http://www.arrisi.com/dig_library/white_papers/docs/ARRIS_Delivering_TV_Quality_Video_over_Wi_Fi.pdf
5 Or other third-party service
6 We recommend that if you have publicly-available content you publish it to both your website or OTT platform and YouTube to maximize your brand exposure and opportunities for engagement.
About Limelight Networks
Limelight Networks Inc., (NASDAQ: LLNW), a global leader in digital content delivery, empowers customers to better engage online audiences by enabling them to securely manage and globally deliver digital content, on any device. The company’s award winning Limelight Orchestrate™ platform includes an integrated suite of content delivery technology and services that helps organizations secure digital content, deliver exceptional multi-screen experiences, improve brand awareness, drive revenue, and enhance customer relationships — all while reducing costs.

About NICE PEOPLE AT WORK (NPAW)
NPAW is a big data and technology company serving the online media industry. Using real-time data, NPAW helps its customers to deliver flawless TV-quality experiences. The NPAW platform leads the industry in technologies integrated and devices supported, enabling customers to make smart business decisions using in-depth and complete data.

YOUBORA Analytics is a powerful centralized analytics and optimization platform for broadcasters and media groups providing real-time information on the delivered video experience, with granular data specific to individual end users. The high-resolution analytics tool helps organizations monitor and analyze audience QoS and engagement while optimizing delivery through the SmartSwitch CDN load balancing module.