Quality of Experience for Mobile Data Networks

Superior Quality of Experience with Citrix ByteMobile Smart Capacity™

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Subscriber Expectations Drive Definition of Quality of Experience (QoE)

Mobile subscribers expect their mobile devices to provide high-quality data connectivity and performance at all times. Any interruption in data services is as critical as an interruption in voice services. However, while voice services have a standardized measurement of quality – MOS (Mean Opinion Score) – there is no equivalent measure of quality for mobile data services. Mobile data services encompass a wide variety of content types and usage patterns – including email, Twitter, YouTube, Facebook, Instagram, Snapchat, and App Store downloads – all with different characteristics. Depending on the application being used, mobile subscribers have varying quality expectations for mobile data performance and usability.

Defining Subscriber Quality of Experience

When subscribers consume mobile content, their QoE is not determined strictly by the speed improvements achieved through deployment of faster wireless technologies such as LTE. Subscribers make subjective assessments of their mobile QoE based on a combination of factors that affect their applications: speed, smoothness, latency, and clarity. Subscriber QoE is based on factors such as:

• The amount of stalling in the video being viewed
• The time required to download a webpage
• The resolution of the video content being viewed
• The responsiveness of a mobile app

Improving the mobile QoE allows operators to significantly increase subscribers’ consumption of mobile data services. The better the experience, the longer and more frequently subscribers will consume content.

How Citrix ByteMobile Improves Quality of Experience

Citrix ByteMobile Smart Capacity solutions offer operators the capability to improve both QoE and network efficiency. With deployments in over 125 operators in 60 countries, including 8 of the world’s top-10 tier-one carriers, Citrix ByteMobile solutions reach nearly two billion subscribers worldwide.
Citrix ByteMobile deployments provide measurable QoE results. Actual use cases clearly demonstrate that Smart Capacity enables operators to:

- Provide performance-based QoE enhancements that:
  - reduce stalling
  - provide faster web downloads
  - accelerate mobile apps
  - Implement intelligent quota-breach enforcement

- Promote subscriber usage while roaming

- Enable premium user experiences that:
  - deliver high-resolution YouTube videos regardless of access method
  - mitigate monopolization of network resources
  - provide quality-aware optimization

**Dramatically Reduces Stalling of Mobile Video**

Depending on network conditions and time of day, mobile videos stall between 5% and 35% of the time. Even 4G/LTE networks can get congested and experience stalling. Stalling can last from seconds to minutes and leads some subscribers to abandon their sessions, causes subscriber frustration and loss of interest, lowers video consumption and eventually increases churn.

Traffic management solutions that have proven effective at controlling application traffic do not work as well with video traffic because these solutions are applied at the application layer through packet shaping and blocking. Video is based on a variable bit rate; its peak rates can exceed the shaped bandwidth of traditional traffic management solutions, leading to clipping, stalling and a poor mobile video experience.

A video advertisement demonstrates an operator’s awareness that mobile video QoE affects subscriber satisfaction. It shows a child watching an animated video on a smartphone. Each time the video stalls, the child becomes upset. When connectivity is restored, the child smiles and laughs. After an especially long stall of the video, the child cries loudly until the mother replaces the device with a Vodacom-enabled smartphone that runs the video seamlessly. This is a clear demonstration of how mobile QoE is perceived by the subscriber.
This video advertisement demonstrates an operator’s awareness that mobile video QoE affects subscriber satisfaction:

http://www.youtube.com/watch?v=pvmzr7FXI
Smart Capacity video optimization reduces stalling by 30% to 50%. To achieve this, Smart Capacity applies a series of techniques that reduce the amount of video bandwidth being consumed, creating headroom when networks are under load. Smart Capacity applies just-in-time video pacing to eliminate wasted downloads. It uses quality-aware transcoding that compresses videos to levels ranging from visually lossless, to near lossless, to visually apparent. When a subscriber’s video session is at risk of stalling, Smart Capacity applies dynamic bandwidth shaping, adjusting the compression level to match the available network capacity so that video delivery to the subscriber can continue uninterrupted. Working together, these capabilities all significantly reduce stalling while maintaining high QoE.

Provides Faster Web Downloads

Citrix studied millions of mobile web page downloads across multiple mobile operators worldwide. Results showed that, on average, over 50% of web pages take more than 8 seconds to load and that 20% of mobile web pages take 20 seconds or more.\(^1\) When you combine that with the fact that nearly a third (30%) of mobile device owners give up on a download in 8 seconds or less, it becomes clear that providing faster webpage downloads will significantly improve mobile subscriber QoE.

\(^1\) Citrix Bytemobile Mobile Analytics Report Q1 2013
\(^2\) Citrix Bytemobile Customer Survey Q1 2013
Smart Capacity enables operators to provide measurably faster web downloads. Also, since the majority of mobile apps are web-based applications, Smart Capacity solutions also accelerate mobile apps without requiring any additional work from the operator or the mobile app developer.

Improving the mobile data experience results in improved standings in mobile network operator benchmarking tests. These tests quantitatively measure performance and allow mobile data consumers to better evaluate mobile network service providers. For example, P3 Group conducted a benchmark test of mobile data services in Germany in late 2012.

Figure 3. Average mobile web-page download times – without optimization. Source: Citrix ByteMobile Q1 2013 mobile Analytics Report

Figure 4: P3 Group benchmarking test of mobile data services in Germany 2012.
Improves Quality of Experience for Subscribers When They Need It Most

Network conditions constantly fluctuate; even within the same cell, while some subscribers have good experiences, others might not. At any given moment, some percentage of subscribers on the network might be experiencing poor video quality based on dynamically changing network conditions.

With Smart Capacity, those subscribers who would otherwise have a poor experience instead enjoy a significantly higher QoE as measured in reduced video stalling and improved web downloads.

By improving the quality of experience, mobile data usage often increases. For example, one operator observed a 27% increase in web browsing after Smart Capacity optimization was applied.

Figure 5. Fluctuating network conditions results in differing QoE within the same cell.

Figure 6. Improved Quality of Experience with Smart Capacity optimization.
Manages Quota Breaches

Effectively managing quota breaches can lead to an improved QoE for mobile subscribers – and additional revenue for operators. Optimization can be used to manage quota breaches in a variety of ways.

For example, instead of using aggressive blocking or shaping techniques that typically result in mobile video being unviewable, one large European operator offers continued video consumption to subscribers who go beyond their monthly data quota limits. An overlay message displayed on the subscriber’s smartphone or laptop screen provides a quota breach alert and offers an upgrade to a higher-quota plan, while continuing to allow the subscriber to consume videos. Once the quota is breached, any further videos delivered to the subscriber are optimized.

Consequently, with optimization, mobile subscribers can still access mobile video, and also be offered an upgrade to higher-quota plans or the option to top up their account in real time. This promotes continued video consumption, increases operator revenue and improves subscriber satisfaction. One operator who offers real-time plan upgrades expects to receive additional annual revenue of €1 million from this source.

Promotes Subscriber Usage While Roaming

Subscribers typically consume less video while roaming because of concerns over bill shock, exceeding quotas, slow download speeds and poor video quality. This can result in decreased QoE for the subscriber and a potential loss of revenue for the operator.

One large European operator employs Smart Capacity to effectively optimize video for roaming subscribers. Offering subscribers a way to spend less while roaming encourages continued video consumption – and also improves their QoE. Optimization is used to reduce bytes consumed, while also improving QoE and reducing stalling. Roaming subscribers can save money and still enjoy a quality video experience.

Enables Premium User Experiences

With Smart Capacity, subscribers receive a better YouTube viewing experience regardless of the method used to access videos. Normally, subscribers who access YouTube via a mobile browser are served higher-resolution videos than subscribers who access the same videos through a preinstalled YouTube application, regardless of the network or device type. By default, the YouTube server delivers lower-resolution videos to smartphones or tablets that request videos from a YouTube app.

At a European operator, the ByteMobile platform has demonstrated that it can signal the YouTube server to provide higher-resolution videos to subscribers who access YouTube through an app. With Smart Capacity, tablet and smartphone
subscribers using the YouTube app and connecting through 3G and 4G networks can view the same quality videos as they would when viewing them through a browser. This improved QoE allows the operator to differentiate its services from those of its competitors.

**Mitigates Monopolization of Network Resources**

Video content providers such as Netflix, Hulu, Apple and others use adaptive bitrate (ABR) streaming protocols for premium content. There are several implementations of ABR protocols from Adobe, Apple, and Microsoft that all share a common approach. Effectively, they adapt in real time to network throughput and device CPU capabilities by dynamically increasing or decreasing the resolution of the video.

A key behavior of ABR streaming protocols is that they consume as much available network capacity as the content server can utilize and deliver the highest quality that the current network connection can support for a single video stream. For example, if the network can support throughput of 3.5 Mbps, then an HD video stream is sent to that specific subscriber – regardless of other, competing demands on bandwidth.

ByteMobile adaptive traffic management allows operators to mitigate the impact of ABR streaming protocols, thereby preventing a single request from a single subscriber from flooding the network and ensuring a consistent QoE for all subscribers.

**Provides Quality-Aware Optimization**

Higher-resolution videos drive a disproportionate percentage of overall wireless network traffic. For example, iPhone subscribers request high-resolution videos 27% of the time; however, these high-resolution videos generate almost 80% of the mobile video traffic on the network.

Wireless networks that support higher-resolution videos deliver a better visual QoE to their subscribers, but these videos must be effectively optimized to ensure that overall subscriber QoE is not negatively impacted.

Figure 7. Higher resolution videos create the most traffic volume on networks. Source: Bytemobile Mobile Analytics Report.
Many currently available optimization techniques optimize video “blindly”—resulting in either overly conservative implementations that leave room for additional optimization, or overly aggressive optimization that creates reduced video quality – thereby creating poor subscriber QoE. Smart Capacity applies video optimization that is visually lossless, providing the optimum QoE to each subscriber. Optimization is applied based on multiple factors such as the quality of the original video and the codec in use. Rather than merely using compression, Smart Capacity applies sophisticated optimization techniques to maximize the subscriber experience; for example, removing frames that cannot be seen or selectively reducing video quality for different parts of a frame.

Conclusion

The Citrix ByteMobile Smart Capacity platform provides an industry-leading adaptive traffic management and optimization technology that allows operators to improve subscriber QoE and maximize network efficiency. Smart Capacity monitors and manages all data traffic in an operator’s network. Integrated application detection, adaptive traffic management and optimization services dynamically adjust to network conditions in real-time, ensuring the best QoE possible. As a result, operators can boost mobile data usage, differentiate their networks, attract new customers and reduce churn.
About Citrix ByteMobile
Citrix ByteMobile Smart Capacity™ enables mobile operators to dynamically improve mobile subscriber quality of experience (QoE), increase available network capacity and better monetize over-the-top content. The T-Series Adaptive Traffic Management System is the industry’s only fully integrated traffic management system – delivering adaptive web and video optimization, DPI, caching, load balancing, analytics and policy control in an integrated, centrally managed architecture for efficient and streamlined deployment of multi-Tbps-scale traffic management across the mobile network.

About Citrix
Citrix (NASDAQ:CTXS) is the cloud company that enables mobile workstyles—empowering people to work and collaborate from anywhere, easily and securely. With market-leading solutions for mobility, desktop virtualization, cloud networking, cloud platforms, collaboration and data sharing, Citrix helps organizations achieve the speed and agility necessary to succeed in a mobile and dynamic world. Citrix products are in use at more than 260,000 organizations and by over 100 million users globally. Annual revenue in 2012 was $2.59 billion. Learn more at www.citrix.com.

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