

**White Paper**

**Measuring and  
Tracking Perceptual  
Video Quality**

## Executive Summary

Consumers today are watching huge amounts of video content on mobile devices. But the companies responsible for creating and delivering this content are still searching for the right business models to increase monetization from these video services. This is especially true of mobile operators, who see tremendous strain on their networks from video traffic (with little corresponding revenue).

Mobile operators need ways to monetize video traffic, and are considering methods like subscriptions and pay-per-view models. Once consumers are asked to pay more for video content, however, they are likely to have increased expectations for high quality. Today, operators do not have adequate tools for managing the quality of video as it is delivered to mobile devices, so meeting these increased customer expectations can be difficult.

This paper explores this problem, and proposes ways that the Dialogic® VisionVideo™ Software Solution can help address this issue. The VisionVideo solution measures and reports perceptual video quality on specific content. This gives mobile operators (and other companies in the video creation and delivery chain) valuable information to help them monetize their rapidly-growing video services.

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## Introduction

In recent years, consumers' lives have been changed by the convergence of high-speed wireless communications technology and widespread availability of IP video content. Throughout the world, people are using their mobile devices to access and watch video content, with some using video as a way to communicate with friends and family, others to gain information, and still others simply for entertainment.

Content creators and publishers have found themselves with a new channel of distribution for their work. Short-form and long-form video pieces are now readily available for streaming over mobile networks, and new larger-screen devices (like tablets) are allowing consumers to better enjoy the experience.

The growth of the mobile streaming industry is staggering. As an example, Cisco reports <sup>[1]</sup> that “global mobile data traffic nearly tripled (2.6-fold growth) in 2010, for the third year in a row.” Cisco further forecasts that mobile data traffic will grow at a compound annual growth rate (CAGR) of 92% through 2015 <sup>[1]</sup>. And video is clearly a driving force behind this growth – 66% of all mobile data is predicted to be video traffic in 2015, by which time Cisco predicts 4.2 Exabytes of video will be carried in the world's data networks <sup>[1]</sup>. (An Exabyte is equal to one quintillion bytes – a lot by any measure.)

Data and forecasts notwithstanding, there is also the immeasurable impact of mobile video on the everyday lives of millions – even billions – of people in the form of YouTube videos on smartphones, movies on tablets, commuters watching broadcast television on their mobile devices, etc. The net effect is that consumers are enjoying unprecedented access to video content while on the move. And consumers are showing a desire to continue to consume this content in ever-increasing amounts.

## But All Is Not Well For Everyone...

Although consumers are thrilled by the abundance of video content available on mobile devices, other stakeholders in this market have concerns. This is largely because members of the mobile video ecosystem – those companies responsible for creating and delivering video content to consumers – have not been able to find and implement a path to monetize the consumption of this content to their liking.

Consider some of the entities that are involved in providing video content to mobile consumers:

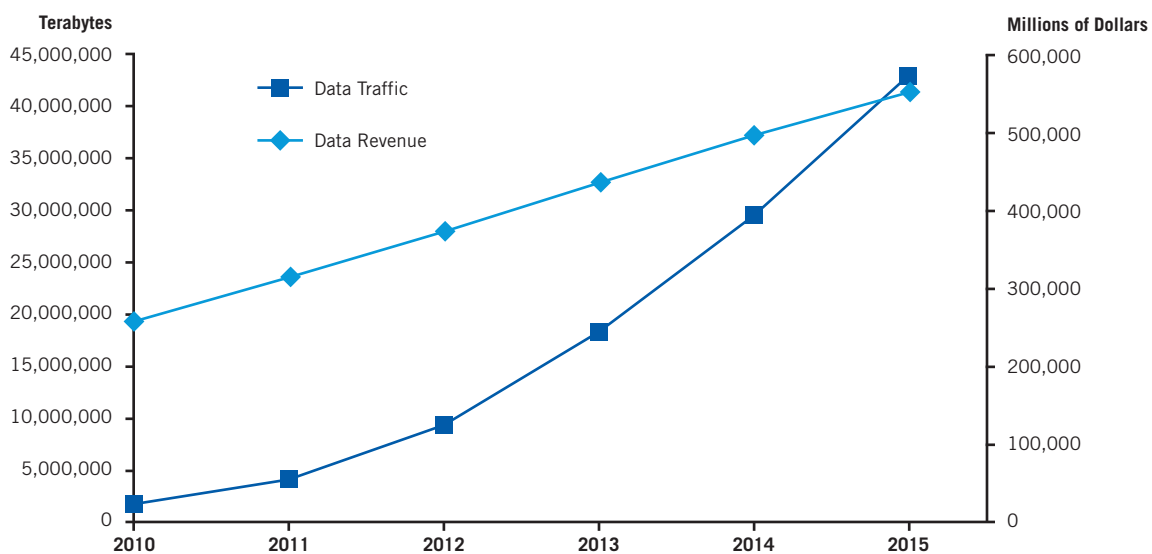
- **Content Publishers:** Publishers (e.g., movie studios, television networks) create video content, often for display in a variety of formats and to a variety of audience types.
- **Content Aggregators, sometimes called “Storefronts”:** Aggregators (such as Hulu, Netflix, or MobiTV) collect content from different sources and present it to consumers through a single portal. They add value by providing a single source for content, a single human interface for the consumer, and a single billing method for easier administration.
- **Advertisers and the Advertising Networks:** This includes companies that buy advertising to sell their products and services, as well as some of the entities that broker advertising space in mobile environments like Google (through its AdMob subsidiary) and YUME Networks.
- **Content Delivery Networks (or CDNs):** CDNs assist companies in managing their web presence. By providing companies with services such as local content caching and content adaptation, CDNs try to bring a higher-quality experience to consumers of the internet-based multimedia content of those companies.
- **Telecommunications Carriers:** Mobile video content, like most of what is communicated through phone networks or over the internet, is transported by telecommunications carriers. Companies like AT&T, Telefonica, or BT transport high volumes of IP data (including mobile video) through their networks.

- **Mobile Network Operators (or MNOs):** Mobile consumers are typically customers of an MNO. These companies (e.g., Verizon Wireless or Sprint in the United States, Vodafone in Europe, NTT DoCoMo in Asia) transport video content through wireless networks to consumers' end devices.

Many of these entities can rightfully claim that they are not receiving enough value in return for their contributions and roles in creating and/ or disseminating mobile video traffic. What it boils down to is the technological innovation which has led to the rapid increase in consumption of content is moving faster than the innovation of business models that would enable the companies to receive value commensurate with their investments.

Although this mismatch between investment and payback has, to at least some degree, affected all members of the mobile video ecosystem, it has likely been most dramatically felt within and among the MNOs. These companies are experiencing tremendous increases in data traffic carried through their networks, primarily as a result of increased video consumption. However, their revenues in return are not keeping pace with this increased traffic.

A July, 2011 study titled, "Forecast: Mobile Data Traffic and Revenue, Worldwide, 2010-2015" by market research firm Gartner <sup>[2]</sup> highlights this issue, and how it might become even more serious. According to Gartner, mobile data traffic is expected to grow 26-fold between 2010 and 2015, while mobile data revenue is predicted to double in this same time frame. This is illustrated in the figure below:



Source: Gartner "Forecast: Mobile Data Traffic and Revenue, Worldwide, 2010-2015" (June, 2011)

Figure 1 – Graph showing growth of mobile data traffic vs. mobile data revenue

If this indeed happens, MNOs will need to make significant investment in network infrastructure to support this dramatic increase in network traffic. And yet the status quo of revenues and business models are not equipped to support this level of investment. This is perhaps the most significant issue being faced by mobile operators today.

## What Can Be Done?

As noted above, many companies within the mobile ecosystem likely are not receiving what they would consider proper compensation for their roles in delivering mobile video to consumers. Traditional business models have not provided the ability to obtain revenue to handle the surge of new traffic from mobile video, and the concern is that the situation will only get worse as traffic continues to grow.

Some are responding by trying to resist the surge. For example, carriers are introducing caps on data usage or limits on the amount of bandwidth consumed at any time. In one particularly well-reported example, Comcast instituted a process to throttle traffic for users that had approached their bandwidth limits for some time interval<sup>[3]</sup>. Other carriers, including Verizon Wireless and AT&T have recently abandoned their “all-you-can-eat” wireless data plans and introduced plans with data caps<sup>[4]</sup>.

These approaches are mostly focused on restricting usage by the consumers that use a disproportionate amount of the network resources. As an example, Cisco reports that the top 1% of mobile data users is responsible for generating 20% of mobile data traffic. And the top 10% of users generate about 60% of the traffic<sup>[5]</sup>. The issue becomes where to draw the line, as even typical consumers of mobile video may get caught bumping against a data cap – the New York Times estimates that 20 minutes of video viewing per day will burn up the data allowance of some Verizon Wireless plans<sup>[6]</sup>. And in the end, there are serious questions as to whether steps like these can even address the issue, as placing limits on usage likely will not satisfy all customers, nor will it likely cover the revenue gap.

As an alternative, MNOs are looking for new value-added services that can generate higher average revenue per user (ARPU). MNOs are currently experimenting with a variety of services in an attempt to generate additional revenue from video-related services. Many are focused on entertainment features<sup>[5]</sup>; video ringback tones being one example. Another example might be a special event where a popular celebrity appears on live video chat with his or her fans. Consumers, especially younger consumers, have shown a willingness to pay for this type of entertainment feature.

For the mainstream market, however, there is still the issue of identifying ways to properly monetize the video content that is most widely viewed. Verizon’s “Verizon Video” service is an example where consumers pay a fixed price per month for access to video content<sup>[6]</sup>. Verizon also offers packages of premium content (e.g., American football games) for an additional fee. MNOs are offering premium video content as a way to encourage viewers to pay more as they consume more network resources.

## The First Step Has Already Been Taken

Consumers are showing a willingness to pay extra for premium content such as sporting events, pay-per-view concerts, or Video on Demand movies, albeit with an expectation that the premium content will be delivered with reliability and quality. As a first step in getting this premium content to users, there has been a slew of changes and responses in the industry, including:

- **New network technology.** MNOs are quickly introducing 4G networks – As of December, 2011, Verizon has deployed its Long Term Evolution (LTE) service to 200 million Americans in 190 markets<sup>[7]</sup>. While making this investment, Verizon is also marketing this service to consumers, raising expectations for the download speed on a 4G network<sup>[8]</sup>.
- **New devices.** The introduction (and rapid market acceptance) of the iPad and other tablets has brought the use of mobile video for entertainment into the mainstream. As an example, when Apple announced its 2010 list of the top ten free apps for the iPad, the list included Netflix, Movies by Flixster, and IMDb (movie database that includes the ability to stream trailers)<sup>[9]</sup>. In 2010, consumers using tablets consumed five times as much mobile data as consumers using smartphones.<sup>[11]</sup>
- **Greater availability of mobile video content.** For several years, MNOs have offered service plans that include access to a pre-identified selection of video content. The Verizon Video service is an example of this – for a monthly fee, consumers can watch entertainment that is made available by Verizon. However, in recent months, some Content Publishers are making their own video content available directly to consumers; HBO GO is an example. And consumers are accessing video content “over the top” using services like Hulu Plus (available on iPhone, iPad, and some Android devices) to bypass the content restrictions of some MNO-based plans.

With these changes in place, there is the very real situation of a growing number of premium content consumers (like those using iPads to watch movies on Hulu Plus over Verizon's LTE network) having an entirely different set of expectations than the person who simply wants to keep watching 3G video on a smartphone without a lot of "bells and whistles." And members of the mobile video ecosystem need to be prepared to address this situation both now and going forward.

## Moving Toward Providing a High-Quality Video Experience

As consumers are asked to pay more money for premium services, their expectations, particularly as to video quality, will rise - it's a quid pro quo. As such, members of the mobile video ecosystem will need to implement solutions to help manage those higher expectations. In other words, the responses from those in the ecosystem have been effective in making delivery of premium content possible, but the focus will need to shift to taking the necessary steps for users to receive the premium content with the quality and reliability that justifies the rates that the users are being asked to (or will be expected to) pay to receive this premium content.

In an effort to step up the quality of premium content, MNOs are deploying higher-speed networks, CDNs are caching content closer to the consumer, and Publishers are using new techniques to capture video in higher quality. But what is lacking in these solutions is the ability to actually measure that the premium has actually been delivered to the consumer with the desired - or perhaps promised - level of quality. Without this ability, members of the mobile video ecosystem will likely continue to find it difficult to increase ARPU based on video-related value-added services.

## Measuring Video Quality

As an initial step toward improving video quality, these companies need to be able to measure video quality. When considering a solution for the measurement of video quality, four factors in particular are important:

### The Ability to Measure Perceptual Quality

To determine the quality that a viewer will encounter, it stands to reason that a solution would want to measure the experience as it is actually seen by the viewer. But many of today's solutions do not achieve this objective, especially among tools that are commonly used by the MNOs to measure video quality.

Many MNOs use network management systems that can approximate, but not actually measure video quality. These systems collect information about the condition of the underlying transmission network - characteristics like lost packets, jitter, or delay - and then attempt to extrapolate this information into a measurement of the quality of the video being carried over that network. This method is not seen as being a reliable measure of perceptual quality.

For example, consider a typical video stream being sent through a network. Rather than a steady stream of information (as is common in voice transmission), video is sent in irregular-sized chunks. First, a "reference" frame (or I-Frame) is sent, which contains all the information needed to create an image. Then, for some period, only the changes to that image are sent. After some pre-determined time (typically a few seconds), another reference frame is sent to redraw the image. The result of this process is that video is typically sent as periodic bursts of data, followed by intervals when much smaller pieces of information are sent.

Now, let's consider this process taking place on a network with a small amount of packet loss. A traditional network management system would report that a network with low packet loss was generating a high-quality signal. This means that a quality measurement solution based solely on network characteristics would expect that high quality video would be delivered via this network. But even if the amount of packet loss is small, it could occur at a point during the process where the impact on quality would be significant, such as during the transmission of a reference frame. If that was to occur, one of the more significant portions of the video transmission would be interrupted, and the video quality would suffer even though the quality measurements would not suggest that significant problems were encountered. Conversely, if the network had relatively high packet loss, but all the lost packets occurred during the period when only changes were being sent, the viewer might not experience poor quality despite quality measurements that would indicate that problems had occurred.

Moreover, these results can either be amplified or dampened depending on the content of the video itself. A “talking head” video (for example, a largely motionless newscaster reading headlines) can suffer extensive packet loss without significant loss of quality because there is not much movement in the scene (and therefore little data being sent after the reference frame). On the other hand, “high action” content (for example, a basketball game with many quick moving images) will likely be affected by even a few lost packets. In these cases, existing quality measurement systems also could produce inaccurate measurements.

The overall takeaway is that quality measurement solutions that utilize network-based quality measurement systems are not reliable enough due to situations that can arise under normal circumstances. And although these methods may have worked well enough for measuring the quality of voice calls, video presents a new set of challenges that require the rethinking of conventional measurement methodology.

For a video environment, a measurement solution stands to benefit in terms of reliability by examining the video stream itself – looking at the pixels of the video to determine impairments, and then determining if those impairments are likely to be perceived by the end consumer of the video. This leads to a true measure of perceptual quality.

## **The Ability to Track Quality on a Specific Piece of Video Content**

Another shortcoming of certain solutions employed for video quality analysis is that they provide only an indication of the general quality of video being transmitted through a network, instead of more reliably identifying a specific piece of video content and then tracking the content as it is transmitted through the network via a “content identification” technique. Such a technique allows for a specific piece of video content to be given a unique identifier at the time of creation or time of ingestion, whereby when that same video clip is subsequently played, the unique identifier can be captured and used to determine the identification of that content. Using a content identification technique, it is possible to determine not only that specific content was played on a specific device, but also that it played with an acceptable level of quality.

For some applications, content identification might have intrinsic value well beyond the quality measurement. For example, with mobile video advertising, companies that place video ads can be reluctant to spend significant portions of their advertising budget in the mobile space, perhaps due to a concern that it is too difficult to actually determine the outcome or impact of the advertising. Also, they might be rightfully worried that the target viewer for the ad was going through an area where the wireless coverage was poor when the ad was transmitted, or that some impairment prevented the advertisement from being viewed with full impact, if at all.

But if the advertiser could receive validation that its specific ad was played on a specific device with the expected quality, then the advertiser could have higher confidence in the effectiveness of their advertising campaign. That could open the market for more widespread embracing of video-based advertising, and in turn increase advertising rates.

This is just one example of benefits that can stem from having the ability to accurately measure the perceptual quality of a specific piece of video content.



## The Role of the “Trusted Third Party”

A solution that measures perceptual video quality will likely be called upon to report problems and diagnose the cause of those problems. Sometimes this means reporting that a transcoding function has gone wrong, that parameters were set incorrectly, or even that the original capture quality of the video was poor. Operators will want to be able to trust the independent integrity of the measurement system if the diagnoses are to be believed.

Consider a situation where the measurements are being made and reported by the same system that does the transcoding. Would it be likely that such a system would blame a problem on poor transcoding, which the system itself is responsible for? Could measurements from this system be completely trusted given this underlying “conflict of interest”?

A reliable way to address this issue is to employ of a measurement solution provided by an independent third-party as a way of obtaining unbiased, impartial measurement results.

## Seamless Integration into Existing Workflows

The companies in the mobile video ecosystem have established workflows related to the creation, preparation and delivery of video content. A vendor that is looking to introduce new solutions for measuring and tracking quality will want this new solution to fit seamlessly into these existing operations. It likely will not be acceptable to some or all parties involved for the vendor’s solution to be separate from the overall workflow when measuring and reporting on quality measurements. Work force automation requires that a deployed solution automatically perform measurements, return results to system administrators, and issue alarms and alerts when problems are detected, without causing changes to well-established workflow processes.

These workflows vary among the different members of the ecosystem. Carriers have a suite of Network Management systems with well-defined interfaces for alarms and alerts, and the use of protocols such as SNMP (Simple Network Management Protocol) may be required to integrate into a carrier’s environment. Content aggregators may have their own systems and network operations centers, with a different set of systems and protocols; for example, video content may need to be retrieved from Content Management Systems – this will likely require different types of interfaces from those required for the network management environment.

A solution for quality measurement can benefit from supporting easy integration into existing workflows across the ecosystem, and flexibility becomes a key consideration when evaluating quality measurement solutions that need to work in various operations environments.

## Turning All of This Into Revenue

Armed with the ability to measure and track video quality, MNOs are able to manage the level of user experience that they deliver. This capability allows them to offer differentiated service levels where some regular customers may choose to accept “best effort” video service, while other customers instead desire (and are willing to pay more for) the promise of a better overall experience. This type of differentiation is possible, if the MNO is able to employ solutions that are capable of validating that these other customers are receiving what they’re paying extra for. This in turn can lead to increased revenue without sacrificing customer satisfaction, adding up to increased ARPU to help close the gap between traffic growth and revenue growth.

But beyond the world of the network operators, other companies within the mobile video ecosystem can also introduce value-added features that rely on video quality measurement and tracking to position themselves to generate additional revenue. With the ability to measure the perceptual quality and track that quality as the video content moves through the ecosystem, companies can offer innovative services where video quality is a source of differentiation:

- **Content Publishers** will be able to confirm that arguably their most valuable asset – their video content – has been delivered successfully to the right device and that the quality of the delivered content met the expectations of the viewer. With this validation, content publishers are able to better leverage their content to generate additional sources of revenue. Publishers, for example, may extract higher prices for their content from distribution channels that offer a higher quality of user experience (and the resulting higher subscription rates).
- **Content Aggregators** can validate that their customers – the end consumers – have received their content at an acceptable level of quality. This provides opportunities to retain current customers and up-sell new features. Aggregators can also use this information in negotiations with Content Publishers, which in turn can lead to Publishers being more confident in having their premium content available. This validation can also help Aggregators identify problems that may have been introduced into the video stream during transmission.
- **Advertisers and Advertising Networks** can stand to benefit from this capability via confidence that their advertising content has been delivered to a specific device with acceptable quality. Instead of mobile ads being sent through the network with hope, but not assurance, that the content was ultimately delivered to the end consumers, advertisers can be confident that the ad reached its intended destination. This in turn can lead to the ability to charge higher advertising rates as well as more effective growth of mobile advertising.
- **Content Delivery Networks** will have the data they need to prove to their customers that video delivered using their services is arriving to the mobile consumer at an acceptable level of quality. Instead of relying on simulations and estimates of video quality at the consumer endpoint, CDNs can point customers to hard data.
- **Telecommunications Carriers** gain access to information that can give them the ability to differentiate their services based on quality. With the ability to measure video quality, carriers can use that information to agree to new Service Level Agreements (SLAs) based on video quality, helping them avoid further commoditization and providing value beyond that of being a “pipe” to deliver traffic.
- **Mobile Network Operators** gain another piece of information to solidify their relationships with their customers, increasing retention and reducing churn. With the ability to measure the perceptual quality of mobile video at the endpoint, MNOs can be confident of the level of service being delivered to their consumers. Further, the storage of this information can be valuable as a tool for proving compliance with SLAs and perhaps also for regulatory purposes.

Armed with information that results from perceptual quality measurement, the members of the mobile video ecosystem possess tools to increase the satisfaction of their customers, reduce churn, and provide a differentiated product. This translates into the ability to reduce commoditization and increase their ability to offer new revenue-generating services.

## The Dialogic® VisionVideo™ Software Solution

Dialogic offers a software solution that analyzes perceptual video quality and reports results to help companies in the mobile video ecosystem that are looking to monetize video content. Called the Dialogic® VisionVideo™ software solution, this product can provide valuable insight and information on the way that video (especially mobile video) is being displayed to an end viewer.

A key differentiating factor of the VisionVideo solution is its ability to identify and isolate problems that are inherent in the video stream – the kinds of problems that often cannot be quickly identified in systems that only measure network quality. As discussed above, this level of information can be extremely important in gaining knowledge of the true quality of experience of the end viewer.

Customers have deployed VisionVideo in two key applications. The following sections describe each of these applications.

## Content Adaptation

VisionVideo can be used by companies that adapt video content for display on multiple device types. In a typical video operation, video content is ingested in some format appropriate for broadcast, and is then adapted so that it can be displayed on phones, tablets, and other mobile devices. A typical video stream may be adapted for display on a dozen different devices, or more. This adaptation process often includes transcoding, trans-rating, and trans-sizing the video. Once the content has been adapted, it is typically cached so that it can be made available to consumers who request “Video on Demand” streams at some later time.

Often, the very act of adapting the video will introduce errors. For example, transcoding parameters may be set incorrectly for certain types of content, causing artifacts to be introduced into the video stream. These types of errors can be particularly troublesome as they can be manifested in the video content each time it is streamed. This means if thousands of people watch that content, the same error may be seen thousands of times.

The VisionVideo solution can help address this problem by analyzing the video content “before” and “after” the adaptation process. For this application, VisionVideo analyzes two video files to look for the introduction of artifacts or other problems. Since this entails a file-based analysis, it can be completed in faster than “real time” – a one-hour clip can be analyzed in a few minutes.

The analysis that occurs with the VisionVideo solution is based on user-defined thresholds. This allows a system administrator to determine which problems are most important, and what the level of severity of the problem needs to be before it is reported. This level of flexibility allows VisionVideo to fit into and within a wide variety of operational scenarios. Perhaps more importantly, VisionVideo contains automated interfaces and workflow processes such that the identification, measurement, analysis, and reporting can happen without manual intervention, making it easy for the quality measurement to be seamlessly integrated into existing workflows.

When errors are discovered, the VisionVideo solution generates reports that not only identify the problem, but also provide pointers to the location of the problem within the video. This helps make problem diagnosis and isolation simple and straightforward. The end result is that VisionVideo can catch these problems introduced during the content adaptation process before these videos are streamed. To customers, this translates into the ability to reliably deliver a high quality video product and to provide their end viewers with an unparalleled video experience.

## Real-Time Streaming

The VisionVideo solution can also identify problems that may occur during live and real-time streaming of video content. For this application, the VisionVideo solution relies on software measurement “agents” – lightweight software processes that can access the video stream and collect information directly from a video. Each agent can give information about the video quality at that point, but the VisionVideo solution goes further: By distributing the VisionVideo agents throughout the transmission path, companies can measure and compare video quality at several points along the delivery stream. This comparison can be a key differentiator, providing the ability to determine where in a transmission path the video quality may have been degraded.

In this application, VisionVideo accesses a video stream directly and analyzes the quality in real-time. This analysis can occur on a 24/7 basis, amounting to constant monitoring of the video’s quality and issuing real-time reports if/when the quality degrades.

A key aspect of the VisionVideo real-time streaming application is the “mobile agent” – a software library that can be integrated directly into a mobile device, providing information on the video quality at the location where it is being viewed. The data generated by this mobile agent can also be compared against quality results of that video along the transmission path. This can provide tremendous value, since it allows companies not only to validate the quality that the user sees, but also to isolate where problems may have been introduced. In the end, this can provide not only a high-quality viewing experience to users (thereby increasing revenue and reducing churn) but also can give companies information to help in diagnosing problems and validating performance against SLAs.

We understand that any software integrated into an end device needs to be “ultra-lightweight” – i.e. have low processing overhead and a small “footprint.” We have designed our mobile agent with this in mind – its resource consumption is generally about 10% of that required for an H.264 decode function.

In sum, Dialogic’s VisionVideo software solution can provide an overall solution for analyzing, tracking, and reporting on perceptual video quality, addressing a key problem that has plagued those in the mobile video ecosystem.

An overall architecture of the Dialogic VisionVideo software solution is shown in the diagram below. For more information on the VisionVideo solution and how it can help provide value across the mobile video ecosystem, please visit [www.dialogic.com/Products/video-experience.aspx](http://www.dialogic.com/Products/video-experience.aspx).

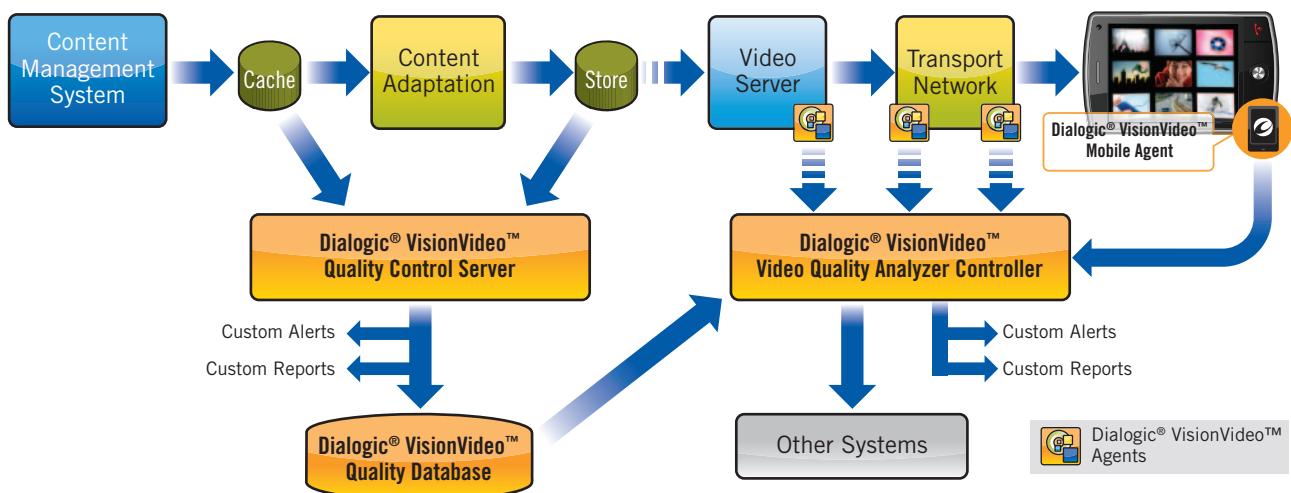


Figure 2 – Diagram showing overall architecture of the Dialogic VisionVideo Solution

## Summary – Mobile Experience Matters

The beginning of this paper focused on a significant issue facing MNOs – a mismatch between the forecasted dynamic growth of mobile data traffic and the revenue predicted to be generated by this traffic. Essentially, mobile data was seen as growing 26-fold in the period from 2010 to 2015, while revenues were only predicted to double. If this comes to fruition, it could very well create an unsustainable situation, where at some point mobile operators might not have the realistic ability to generate enough revenue to invest (or to justify continuing to invest) in upgrading the networks that carry this traffic.

To address this issue, MNOs can take several approaches, one of which is to try to limit the growth of data by enforcing caps on bandwidth or speed. However, this paper focuses on a different approach: increasing the ARPU of customers that enjoy mobile video services. One way of implementing this approach can be by offering differentiated levels/tiers of service based on the level of video quality delivered to the consumer, using the logic that some consumers would pay a premium for the opportunity to reliably receive a premium level of quality.

In furtherance of such a tiered model, it would be beneficial to be able to measure and track the quality of video being delivered in the form of perceptual quality, namely the quality as seen by the end consumer. Many existing so called quality measurement “solutions” do not track perceptual quality, but focus only on the performance of the underlying network used for transport. However, network characteristics frequently provide a poor estimate of the quality of the video being carried.

By instead analyzing the video content itself – at the pixel level if necessary – to judge the quality as it is presented to the end consumer, MNOs can validate the video quality that is actually being provided to consumers, and can use this information to support differentiated service offerings based on video quality. These different offerings in turn can help position MNOs to generate additional revenue based on a customer willingness to pay a premium price to receive a premium level of service.

What's more, quality information can be used by companies across the mobile video ecosystem as a way to generate additional revenue. Content publishers, aggregators, advertisers, and CDNs can all stand to benefit from having the ability to validate the level of video quality being delivered to a consumer viewing this content on a mobile device. There are opportunities for companies across this ecosystem to help increase revenue, reduce costs, and increase customer loyalty by offering a service differentiated by high quality video. The measurement of perceptual quality can be a first step toward managing a differentiated service.

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