OPENWAVE®

Media Optimization for Mobile Networks

An Intelligent Solution to Reduce Costs, Enhance the User Experience and Improve Network Efficiency

About Openwave

Openwave Systems Inc. (Nasdaq: OPWV) is a global software innovator delivering context-aware mediation and messaging solutions that enable communication service providers and the broader ecosystem to create and deliver smarter services.

Building on our mobile data heritage, Openwave mobilizes the internet with predictive solutions based on real-time analytics that mediate among all the different ecosystem elements and enhance every mode of IP traffic. The result is a 360-degree view of users, the network, devices and services that enable our customers to proactively optimize network resources, launch smart mobile services quickly, and provide a contextually relevant user experience. Openwave is a global company with a blue chip customer base spanning North America, Latin America, Australia and New Zealand, Asia, Africa, Europe, and the Middle East. Openwave is headquartered in Redwood City, California. For more information please visit www.openwave.com.

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Executive Summary

The proliferation of mobile devices, along with improvements in device capabilities and network bandwidth, have caused a tremendous increase in mobile data volume. Among the various forms of mobile data, video is quickly becoming the dominant data type in carrier networks.

Given the popularity of video sites such as YouTube, Hulu, and Metacafe on wireline broadband networks, it should come as no surprise that consumers are projected to exhibit the same behavior on wireless networks. As video traffic quickly consumes more of the available bandwidth, mobile service providers are experiencing tremendous strain on their networks.

There are ways that service providers can approach the bandwidth shortage issue. Until now, one approach has been to add network capacity through additional equipment CAPEX. Unfortunately, this strategy is expensive and provides only a short-term solution. Not all service providers have the financial strength to simply throw money at the problem, nor does that guarantee a sustainable solution.

Gaining attention from service providers today is the Openwave Traffic Mediation solution, targeting bandwidth consumption through intelligent technology that helps them use their network assets more efficiently, while at the same time increasing revenue.

The Traffic Mediation solution is an end-to-end solution framework including components such as media and web optimization, policy management, intelligent analytics and revenue enablers that integrate seamlessly in combinations tailored to meet the needs of service providers in the mobile ecosystem.

This paper discusses various media optimization technologies and best practices that can help service providers cope with the exponential growth of mobile video data without resorting to expensive CAPEX/OPEX solutions, while also providing an enhanced user experience and increased network efficiency.

Introduction

The Growth of Mobile Data

Mobile data usage on service providers' networks is growing at an unprecedented pace. With the introduction of powerful smartphones and attractive data plans, subscribers are downloading and consuming data 24 hours a day. For many subscribers, mobile devices have become an indispensable part of everyday life. In addition to laptops and handsets, new mobile devices such as tablets, gaming consoles, navigation systems, monitoring tools, etc, are becoming internet capable - further driving mobile data growth.

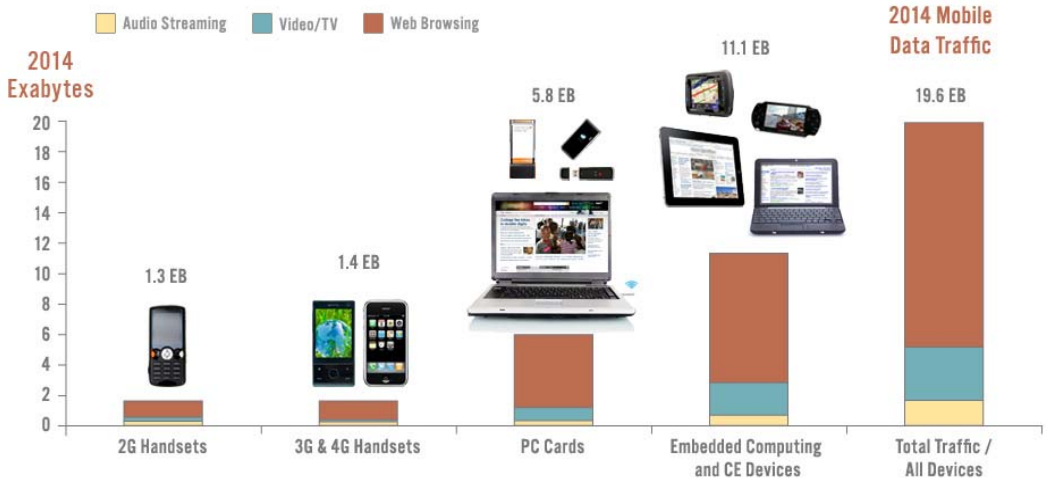

Figure 1 - Mobile Data Traffic by Type: By 2015, total global wireless network traffic could be 24 times greater than 2008 levels, according to Analysis Mason. At the current rate of growth, it will take only four years for mobile traffic to reach one Exabyte per month – half the time it took fixed-line traffic to reach the same milestone.

The Rise of Mobile Video

Mobile video demand continues to grow with improvements in device and network technology. First, mobile devices are becoming more powerful, with the capability to perform complex video encoding and decoding. Second, large-view screens have become the dominant trend in newer phones, especially within the smartphone category. Finally, mobile networks can now provide enough speed to stream videos to handsets or laptops and deliver quality viewing performance to end users.

With the proliferation of 2.5G/3G networks around the world and the rollout of LTE networks in some markets, mobile service providers are in a position to deliver quality video services to their subscribers today. With more powerful mobile handsets and larger screens, as well as increased network speed, it is expected that video will become a significant portion of all mobile traffic. The Cisco Visual Networking Index predicts that over 60% of mobile data will be video by 2014.[1]

This prediction is no surprise given that over the past two years, average YouTube video size and bandwidth have increased from 20MB to 30MB with a corresponding increase in bit-rate from 300 Kbps to 500 Kbps. In addition, many web advertisements today are delivered as videos instead of flash animation.

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[1] Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, February 2010

To effectively *manage* the explosion of mobile data traffic, mobile service providers need a solution that can:

- Reduce data traffic volume by using different optimization techniques such as compression to deliver optimal visual quality
- Improve the user experience through intelligent caching and delivery mechanisms
- Monitor consumption intelligently so that policies for services and tariffs with differing rates can be appropriately introduced
- Improve network resource usage between different users and traffic types to ensure an overall optimal response to the user

Mobile Media Delivery Challenges

Unpredictable Network Bandwidth

In general, the higher the video bit-rate, the higher the visual video quality. In order to deliver a high bit-rate, the underlying network infrastructure must have enough bandwidth from the video source to the end-user device. Unlike wireline networks where service providers typically have control over the end-to-end network, mobile networks are more unpredictable.

For example, wireless signal strength can vary greatly depending whether the mobile device is indoors or outdoors. If there is any obstruction in the line of sight between the device and the cell tower, signal strength can degrade significantly. In some instances, the device might have to revert to connecting to an older network technology (i.e., from 3G to 2.5G) due to insufficient buildout of the service provider's next-generation network. These network issues translate into long buffering, packet loss and jittering; all of which adversely impact the end-user experience.

Variety of Mobile Devices

In addition to environmental factors, a wide variety of mobile devices exists in the network today. Mobile devices are typically classified into three categories: feature phones, smartphones and laptops. As more devices become internet capable, the list of categories continues to increase. Service providers must consider the video capabilities of all of these different devices and deliver the best user experience to the subscribers.

Mobile Video Delivery Protocol

There are currently two methods for delivering mobile videos to end uers. The first is through web-based plug-ins such as Adobe Flash Player, which is based on HTTP Progressive Download. HTTP Adpative Streaming is the next-generation version of HTTP Progressive Download. The second method is through stand-alone players, using streaming protocols such as RTSP.

HTTP Progressive Dowloand

HTTP Progressive Download (HTTP-PD) is the most popular method of viewing video on the Internet today. With HTTP-PD, video is downloaded to the client player via the HTTP protocol as one large file. Most players will start playing video as soon as enough data is received to play back the video. If the file download speed exceeds the play back rate, the player buffers the file by storing the data in the local device.

If the file download speed cannot keep up with playback speed, the player will stall and wait for data. An example of an HTTP-PD player is Adobe Flash Player, which is used to play YouTube videos.

HTTP Adaptive Streaming

HTTP Adaptive Streaming (HTTP-AS) is the next generation HTTP-PD protocol. Unlike HTTP-PD, which downloads the video as one large file, HTTP-AS requires that videos be broken into smaller "chunks". When the video player is almost done with one video chunk, another video chunk is sent. The advantage of sending small chunks rather than one large file download is that it uses network bandwidth more efficiently. Many users often do not watch the whole video, so downloading the entire video file can lead to wasted bandwidth.

With HTTP-AS, wasted bandwidth is minimized, since only a small chunk is downloaded at a time as the user watches the video. HTTP-AS also provides the capability to deliver media in several encoded bit-rates so the video player can dynamically switch between different bit-rates (according to network condtion) or client CPU process power. HTTP-AS will be supported by Adobe Flash Player, Apple QuickTime, Microsoft Silverlight and the HTML 5 standard.

Streaming

Video streaming requires a dedicated media server that transmits video to the client. Media server streaming allows users to jump to any part of an on-demand video without having to wait for the whole video file to download. Video streaming is often used for real-time broadcast video. Examples of streaming players are the Windows Media and RealNetwork players.

Technology for the Next-Generation Media Optimization Solution

Content-Aware Compression

Digital video is a series of frames delivered in rapid succession. Bandwidth saving is achieved if the data in each frame can be reduced. Service providers are often heistant to deploy a media optimization solution, fearing that it will negatively impact the end user experience. However, current compression algorithms can produce an excellent result that is almost indistinguishable to the human eye. In Figure 2, the video on the left is the original content while the video on the right has been compressed by 27%. To an average user, there is no perceptible visual difference between the two.

Figure 2 – Video Compression

The traditional video compression technique tries to reduce data contained in each frame by the same percentage. While this simple approach achieves the bandwidth savings goal, it ignores the user experience aspect of the equation. Human eyes are much better at detecting details in a static or slow-moving image frame than in fast-moving ones.

Therefore, an intelligent video compression algorithm should compress videos containing heavy motion content at a higher rate than a video with little or no motion.

Figure 3 – Traditional Compression vs. Context Aware Compression

In Figure 3, the video on the left was compressed using traditional compression techniques and achieved a savings of 21%. The video on the right was produced by Content-Aware compression and achieved a savings of 22%. Even though the compression rate is similar, the video produced by the Content-Aware compression has finer details than the video on the left. As a result, the viewer will achieve a better user experience when viewing the video on the right.

Dynamic Content Detection

Many mobile video optimization solutions on the market today depend on the use of a list of known video websites to determine whether to apply optimization services on content requested by users. With new video websites appearing every day, maintaining such a list is tedious and error-prone. A slightly better method is to examine the HTTP response of requested content to see whether video optimization needs to be applied. When a user makes an HTTP request, the HTTP response from the server typically contains the type of the content returned. As an example, the MIME type in the HTTP response for video content would be set to "video/x-flv." However, either due to misconfiguration or intentionally, sometimes the MIME type is not set to video for video content.

The ideal solution is to examine the returned content and determine *at run time* whether optimization needs to be applied. With the right implementation, *dynamic* content detection adds little or no delay as compared to maintaining a list of video websites or inspecting the HTTP response header.

Intelligent Video Caching

One characteristic of Internet videos is that they are viral in nature. A popular video can be requested thousands of times in a short period of time, putting significant strain on the mobile network infrastructure. One way to deal with popular videos is to cache them close to the user, instead of repeatedly retrieving them from the servers of origin.

However, simple caching is not enough to deliver mobile video. As mentioned earlier, mobile network conditions are highly unpredictable compared to the traditional wireline network. In addtion, there are numerous mobile devices, each providing differing viewing experiences to end users.

Instead of simple caching, the media optimization server should be able to pre-fetch the set of most popular videos and encode the videos ahead of time. In addition, the optimization server should also be able to encode and store the processed videos in the cache according to device type. This way, when popular videos are requested, the optimization server delivers optimized videos from the cache according to device type and network conditions. In addition, serving video from the cache reduces the time it takes for users to start watching the videos, enhancing their viewing experiences.

Just-in-Time Video Delivery

Many users of YouTube do not watch a selected video in its entirety. With traditional technology, during the time the user is watching the video, the video player is continuously downloading video and storing the content in its buffer. If the user stops watching the video before it is finished, the additional downloaded content is never viewed and the network bandwidth used to download the video is wasted.

To optimize service provider bandwidth, a technique called Just-in-Time delivery is used by the media optimization server so that only enough data is delivered to the video player for the user to start viewing the video. If the viewer continues to watch, data is downloaded in “chunks” at a time, saving unnecessary download and its associated bandwidth consumption.

Figure 4 illustrates how Just-In-Time video delivery operates.

Figure 4 – Example of Just-in Time Video Delivery.

In the image on the left, the red download status bar shows that the player has downloaded more video into the buffer than what is needed by the player. In contrast, the image on the right shows a very small buffer because the media optimization server has intelligently downloaded only enough data for the viewer to watch the video. If the user decides not to watch the entire video, wasted bandwidth is minimized.

Dynamic Bandwidth Shaping

Based on the unpredictable nature of mobile networks, the available download bandwidth to subscribers cannot be assumed to be constant. If the incoming video bit rate is higher than the available network bandwidth, the video player

will stall or buffer while waiting for the content – often referred to as "screen freeze." A study by Tubemogul shows that 4 out of 5 users will stop watching a video if there is buffering or stalling during playback.[2] One way to solve this issue is by only delivering video at a bit-rate that is the same or below the available network bandwidth. In this scenario, the optimization server continuously measures the bandwidth available to the mobile devices and increases or decreases the encoded video bit rate accordingly. A better user experience translates to less customer churn and reduces the number of customer support calls.

HTTP Streaming Interface

HTTP-PD works by downloading video files using the HTTP protocol. When a mobile user requests a video, the optimization server retrieves the video from the origin server if the requested content cannot be found in the cache. With many optimization implementations on the market today, the optimization server must wait for the whole video file to be downloaded to its local memory before starting the encoding process, thus causing additional delay and degrading the user experience. A more advanced optimization server starts to encode the video as soon as enough data is received and then transmits the encoded video to the user, while at the same time dowloading and encoding the rest of the video from the server of origin.

Policy-Aware Optimization

Optimizing all videos in a network is one approach to solve the bandwidth shortage issue, but there is a more intelligent way. Service providers should base video compression levels not only on content type as mentioned earlier, but also on other parameters such as user plans, device capabilities, network conditions, time of day, etc. A policy-aware optimization solution enables service providers to offer innovative data plans to monetize their network assets and utlize their networks more efficiently. In addition, policy aware optimization can help service providers mitigate the effect on the network of subscribers who abuse their data plans (by downloading excessive amounts of video) by optimizing their videos at the highest compression ratio.

Clientless Deployment

Optimization technology should be deployed in a clientless fashion to avoid the installation of additional software on mobile devices. Installing additional client software on mobile devices causes service providers additional overhead to provision the devices and adds potentially expensive customer support calls if something goes wrong with the client software. Service providers also support many different devices with different operating systems, and maintaining and upgrading optimization client software could be a potential operational nightmare. A server-based optimization solution is much easier to install, upgrade and troubleshoot as compared to a client-based solution.

Optimization Statistics

Another area that is often overlooked when looking at media optimization solutions is the availability of data metrics that inform service providers what is happening with the media content in their networks. At a minimum, these metrics should include the number of videos processed, compression savings, processing time, and cache-hit ratios. These statistics not only provide the service providers a dashboard view of media optimization solutions, but can also be fed into an offline analytic engine to gain more insight into the traffic trend and user behavior.

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[2] Tubemogul, posted on NewTeeVee, December 10, 2009

Scalable Architecture and Ease of Management

Media optimization is a CPU-intensive process, and more than a few servers will be needed to handle the growing mobile video traffic. Service providers need a solution with an architecture that can easily scale as video traffic grows. However, a scalable solution alone is not enough; service providers also need a system that can be easily managed and monitored. It is also possible that the whole system can be installed in a geographically distributed deployment where a single management system must manage systems deployed in multiple sites.

Openwave Traffic Mediation Solution

Openwave's suite of Traffic Mediation products enables mobile service providers to manage the mobile data tsunami by optimizing their networks, protecting margins and growing new revenue streams, while profitably increasing mobile internet traffic.

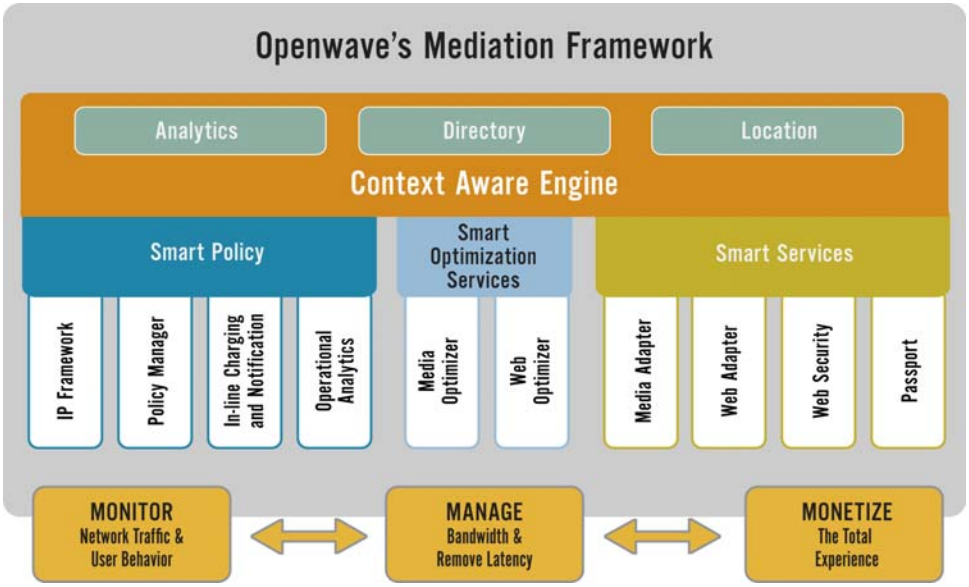

Figure 5 – Openwave Traffic Mediation Solution Architecture.

Openwave specializes in understanding what is happening in the data path, dealing with the diverse range of devices and networks, and applying real-time mediation services. Openwave's Smart Policy, Media Optimizer and Mobile Analytics enable the mobile service provider to offer guaranteed quality of service, differentiated services and new monetization options. Openwave's complete traffic management solution for the mobile service provider in an IP environment includes a scalable platform with distributed architecture, an ecosystem of vendors and an evolutionary approach.

Conclusion

Service providers face many challenges when delivering videos to mobile users. A next-generation media optimization solution is needed with the following features:

- **Content-Aware Bandwidth Compression**: Human eyes are much better at detecting details in static or slow-moving image frames than in fast-moving ones. Therefore, an intelligent video compression algorithm should compress videos containing heavy motion content at a higher rate than videos with light motion.
- **Intelligent Video Caching**: Current caching systems store only what users have previously requested. To better manage network bandwidth, a more proactive caching method is needed to anticipate the data users are likely to request so the data can be fetched and optimized ahead of time.
- **Enhanced Video Quality**: Service providers are concerned with the quality of the end-user experience when video compression optimization tools are deployed. Thus, a media optimization solution should provide data savings but also ensure smooth video playback at acceptable video quality.
- **Policy-Aware Optimization**: Instead of applying the same compression ratio to all users, feature-rich policy-aware optimization can help service providers derive more revenue from their subscribers and utilize network assets more efficiently.
- **Support for Next-Generation Streaming Protocols**: HTTP-PD (Progressive Download) is the most popular video streaming protocol on the Internet today, with YouTube being the most popular video website using HTTP-PD. HTTP-AS (Adaptive Streaming) is the next-generation streaming protocol, which promises better bandwidth management. It is expected that major video websites will move to HTTP-AS once standards are finalized.
- **Ease of Management**: Given the growth of mobile data traffic, mobile service providers are expected to deploy a number of servers, possibly across different geographical regions, to handle the process. An easy-to-use management tool is a must.
- **High Availability and Extensible Platform**: As mobile data continues to grow, the role of the optimization system becomes critical. As a result, the optimization platform must have high system up time and also be extensible to allow for future system enhancements and integration with other solutions.

Visit www.openwave.com for more information on how Openwave's Traffic Mediation solution can enable your company to successfully manage the constantly rising demand for mobile data.

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