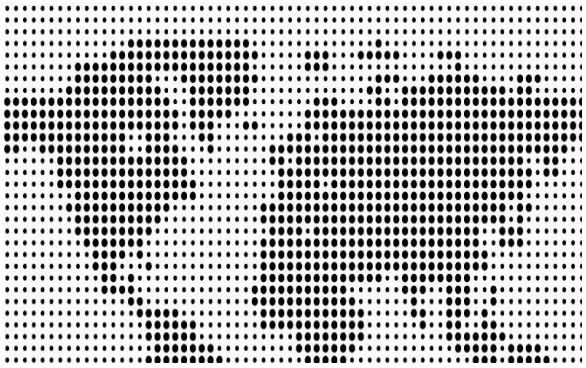
THE TRULY MOBILE WEB

Part 2: Streaming Multimedia More Smoothly



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Summary

"Watching video on my phone isn't bad, but it isn't as good as it is on my computer."

As users start relying on the mobile Web for entertainment and social media, they're saying this about video.

Meanwhile, the sun never sets on video standards, as industry players and technologies continue to shift. In the Web Technologies initiative, Qualcomm has been working with Adobe to modify Flash® Player, the vehicle for most of the video and multimedia on the Web today, and the Qualcomm Innovation Center, Inc. (QuIC), has been working on open-source technologies like the HTML5 <video> element and open, standards-based HTTP adaptive streaming since 2009.

MAIN MESSAGE:

THESE OPTIMIZATIONS TO WEBKIT-BASED BROWSERS ALLOW DEVICES TO DELIVER MULTIMEDIA STREAMS TO RIVAL DESKTOP-QUALITY VIDEO, WITH THE GOAL OF CATCHING UP TO AND SURPASSING THE WIRED WEB.

These optimizations to WebKit-based browsers are designed to allow mobile devices – especially those based on the Snapdragon™ mobile processor – to deliver multimedia streams to rival the quality of service (QoS) of desktop-quality video, with the goal of catching up to and surpassing the wired Web. Among the results:

Product/Technology	Web Technologies improvement[1]
HD video running in Adobe® Flash® Player	720p in-browser HD at 30 frames per second[2] on Snapdragon
True HD video running in Adobe Flash Player	1080p in-browser HD video playback on Snapdragon
HTML5 <video>	Hardware-accelerated, in-page, multiple-stream playback

This paper describes the technical details behind these optimizations and explains the vocabulary of the mobile Web in the terms that wireless carriers, device manufacturers and application developers need to know. Readers will discover how

[1] All numbers for benchmarks are averages, as tested by QuIC on Qualcomm Snapdragon™ 8655 Mobile Development Platform (MDP), unless otherwise indicated. Results may vary.

[2] Tested at http://www.youtube.com/watch?v=Se6rnczYABw&hd=1 measuring Adobe Flash Player decode fps on HTC myTouch 4G and LGE Optimus 2X. Tested by Qualcomm on Snapdragon 8255.

they can take advantage of Web Technologies optimizations to provide a user experience befitting the Truly Mobile Web.

Background

Three compelling factors are shaping the evolution of video on the mobile Web: user adoption, quality and hardware-based security.

User adoption

As shown in Figure 1, the number of U.S. mobile subscribers watching video on their mobile devices rose by more than 40 percent year-over-year in both the third and fourth quarters of 2010, according to The Nielsen Company, ending the year at nearly 25 million people[3]:

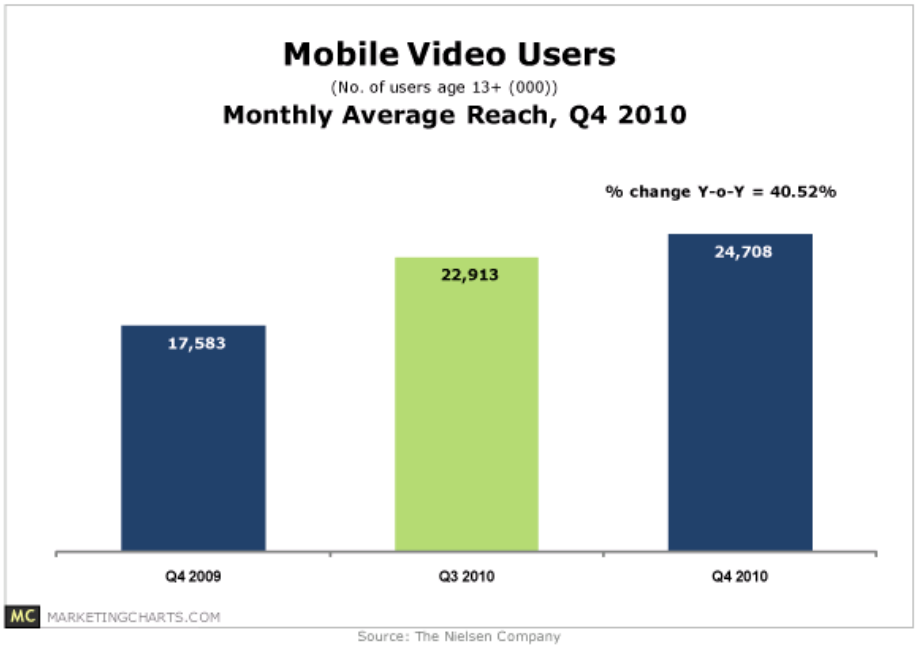

Figure 1 - Mobile Video Users, U.S.

[3]*Cited in http://www.marketingcharts.com/direct/mobile-video-users-rise-40-yoy-in-q4-16804/nielsen-mobolie-video-users-q42010-mar11gif/*

Quality

Users accustomed to the large screens, high throughput and ample system resources of the wired Web fret about the video experience on the mobile Web. They're not the only ones concerned:

"Everything people are watching online, they want to see on their mobile phone," said Francisco Varela, YouTube's head of platform partnerships..."They want the true YouTube experience they can get at home." Varela also said that another challenge YouTube is facing is the growing pressure to increase both the speed and video quality on mobile devices – two factors that are key to expanding YouTube's viewership on mobile phones...Varela said most mobile YouTube video consumption is coming over WiFi rather than 3G networks because the quality is better.[4]

YouTube's content represents over one-third of total video traffic on wireless networks worldwide[5]. When they feel pressure from customers and competitors to improve quality, the problem is real.

Security

Also limiting the availability of premium or paid content is the lack of end-to-end, hardware-based security on most smart mobile devices. Several online video services have designed applications specifically for streaming; however, they protect their streams using software-based digital rights management (DRM) and limit their offerings to non-HD resolutions.

It is anticipated that, as devices come to support secure streaming in dedicated hardware, content owners such as studios will authorize premium content in both 720p and 1080p HD on mobile devices.

[4] *Quoted in Fierce Broadband Wireless, September 2010; http://www.fiercebroadbandwireless.com/story/youtube-grapples-speed-video-quality-mobile-devices/2010-09-27*

[5] *Cited in http://www.informationweek.com/news/infrastructure/traffic_management/showArticle.jhtml?articleID=226300281*

Getting Mobile Video Right - Fundamentals

Not only do more people want video on the mobile Web, but more of them also want high-quality video. As the factors mentioned above affect the evolution of video on the mobile Web, several more factors affect it on the device.

- Most mobile processors built into phones are not designed to stream multimedia smoothly. When the browser identifies a video stream, it hands the stream off to the CPU to decode in the device's memory. So it is tempting to think that high-quality mobile video is a matter of a more powerful processor and more memory. But video also taxes network bandwidth, display components, battery life and the wireless modem as well. Getting mobile video right is **more than simply beefing up hardware**.

- Browsers are made to handle HTML pages, and a video stream is not an HTML page. Thus, the browser has historically had to depend on the video player plug-in, which introduces inefficiency. Even when the browser displays the video in the page, it is in fact relying on the **separate player application,** which is using a software library, or codec, to decode the stream.

- Video rendering occurs at the end of the browser's chain of events, as depicted in Figure 2. On low-tier processors, the browser hands the work of decoding the video stream to software libraries running on the main processor; however, in advanced architectures, the processor provides **video acceleration on dedicated hardware** to speed up the decoding of streams. The codec's format (e.g., H.264), resolution, frame rate and profile affect the user experience that a given device can render.

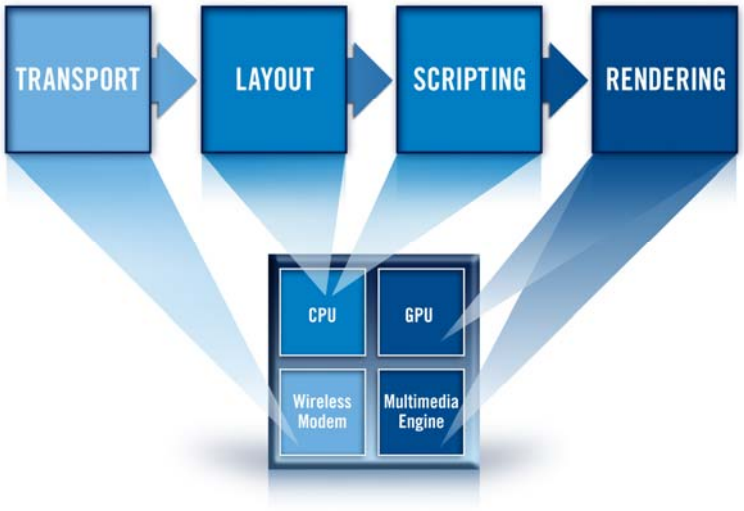

Figure 2 - Browser functionality and Snapdragon

Mobile video landscape

Evolving technologies are in the mobile video mix as well.

Adobe Flash®

Most users enjoy video distributed over the Web through Adobe Systems' Flash technology. On both desktop and mobile devices, the Adobe Flash Player works as a plug-in that talks to the browser through an API, but it is a separate player application. Over 95% of Websites use some kind of Flash for video animation, games and ads. The sheer ubiquity of Flash content – an encoding technology proprietary to Adobe Systems – makes it a force to reckon with, even as other encodings gain acceptance.

HTML5 <video> element

"HTML5" describes an array of capabilities for the next generation of browsers. It includes the <video> element, which offers the potential to launch and run one or more concurrent videos in the browser without relying on a separate player application.

On the desktop, HTML5 <video> content runs embedded within the base Web page and if available, takes full advantage of acceleration on dedicated hardware. Most mobile browsers, however, have not yet caught this wave. They can play the content back in the page, but cannot decode it on the device's dedicated hardware; or, they

can retain full hardware acceleration, but only by launching the separate player application.

HTTP adaptive streaming

Progressive streaming is currently the dominant model for delivering video from a website to a browser: once the player has downloaded enough of the video file to fill its buffer, playback can begin and the browser can continue downloading the remainder of the file in the background. Progressive streaming is simple in that it involves a single media file, but if playback goes faster than download, the video will pause or stutter while the buffer refills; therefore, the quality of playback is subject to network conditions. In this model, the only decision the device makes is whether to ask for more data from the server.

HTTP adaptive streaming is an alternative technology that relies on more intelligence in the device, as depicted in Figure 3:

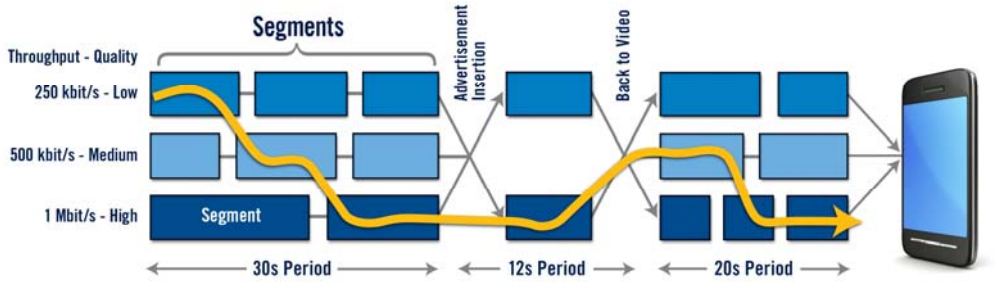

Figure 3 - HTTP adaptive streaming

Content owners keep different versions of the same content in small segments on the server, based on the bit rate at which each was encoded. For instance, a server might hold a movie in low, medium and high resolutions, each broken into 1000 segments. The client starts by downloading the first segment, then makes intelligent decisions on the fly about which resolution it can support for the next segment, depending on variables such as buffer status, network latency and display resolution (e.g., full screen). The client requests the next segment from the server at the highest practical resolution and continues adapting its requests to the quality of service as the movie plays.

Four important implementations of adaptive streaming are gaining prominence: Adobe HTTP Dynamic Streaming, Microsoft Smooth Streaming, Apple Live Streaming, and a newly specified industry standard called Dynamic Adaptive Streaming over HTTP (DASH), which both the Moving Picture Experts Group

(MPEG) and the 3G Partnership Process (3GPP) have endorsed. With the mobile Web especially vulnerable to network conditions – users moving between base stations, good zones, bad zones – adaptive streaming is even more important for mobile video than for video on the desktop.

Optimizations at the operating system level

The optimizations for HTML5, Flash Player and adaptive streaming extend beyond the level of the browser and plug-ins to the OS. As shown in Figure 4, QuIC is making changes in the Browser Front End and OS Platform layers, especially in the Multimedia Framework of Android and Chrome OS. Furthermore, Qualcomm's close collaboration with Adobe enables it to provide optimized code to the Flash Player code base, noted in the Plug-ins layer.

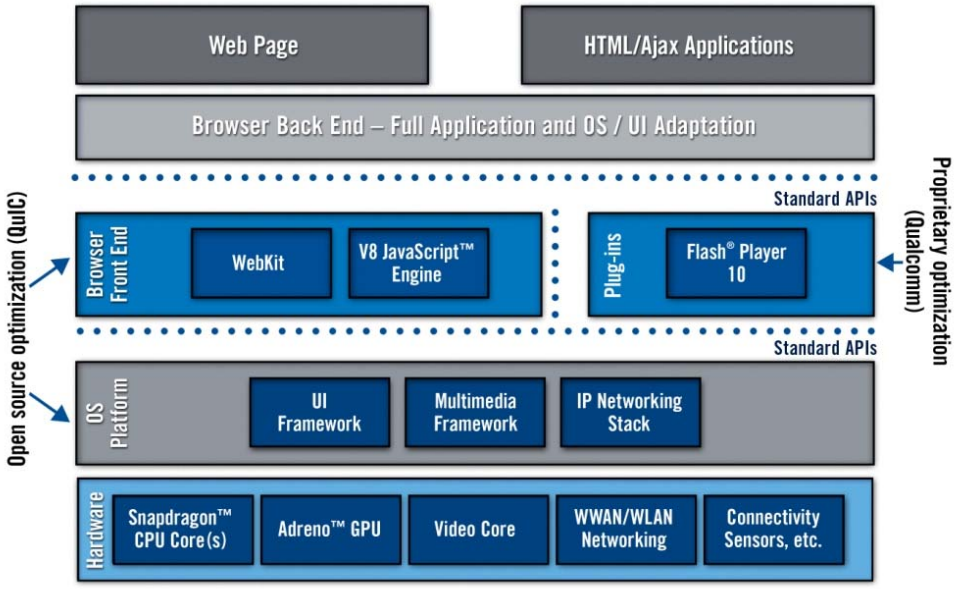

Figure 4 - Multimedia optimizations

Intelligent QoS in Multimedia Streams

Given these fundamentals and this landscape, Qualcomm and QuIC have optimized the most important elements in decoding and playing video, with emphasis on the hardware advantages of the Snapdragon mobile processor.

The essence of these optimizations is the most intelligent QoS under the current operating circumstances: network congestion, file resolution, encoding, on-device resources and any other conditions affecting the user experience of multimedia.

HTML5 <video> element

QuIC has successfully optimized the browser engine and tested in-page HTML5 <video> content, with full hardware acceleration and multiple stream playback on Snapdragon. This represents a first on a mobile device, and brings desktop-level capabilities to mobile devices.

Adobe® Flash® Player

Qualcomm has worked with Adobe on Flash Player to optimize it for Snapdragon's Multimedia Engine. The optimizations support Flash Player in two areas:

1. **Flash Player** – Qualcomm has optimized the Flash Player code to take full advantage of Snapdragon's Multimedia Engine for hardware acceleration. It has also provided these Flash Player optimizations back to Adobe, so that they flow to source code licensees and the Android™ market where they will improve Flash Player performance across all mobile processors.

2. **Stage Video** – Stage Video APIs let content developers use a new feature in Flash Player that separates non-video data (e.g., status bar, go/stop/pause buttons) from video data for more efficient use of CPU, memory and power. Qualcomm has worked with Adobe to incorporate this optimization to the underlying multimedia software provided to OEMs.

The result is high-definition playback at or near native frame-rates:

- On Snapdragon, HD 720p at 30 frames per second, with lower power consumption.

- On Snapdragon, in-page playback at true HD (1080p) of Flash 10.1 video.

HTTP adaptive streaming

Adaptive streaming for the following implementations is on the Web Technologies roadmap:

1. **Adobe** – In Flash Player 10.1 Adobe included HTTP Dynamic Streaming, which Qualcomm's work supports.

2. **Apple** – The implementation of Apple Live Streaming included in Android 3.0 will work efficiently and smoothly on Snapdragon-based devices. The improvements allow the browser to work adaptively and with detailed knowledge of Snapdragon's subsystems.

3. **MPEG-DASH** – QuIC has participated as the work-item lead, helped promote DASH with 3GPP and was the main author of the DASH specification in MPEG. In collaboration with Apple, Netflix and Microsoft, the company has worked on the standard. Although MPEG-DASH content has yet to be published, Qualcomm is working with content owners to bring this open standard to market.

The QuIC optimizations are feature additions to the software that Qualcomm ships with its Snapdragon mobile processor. They represent extra value in hardware and competitive advantage for Qualcomm's customers.

Conclusion

Users care most about having video perform as well on their mobile device as on the desktop; it's up to OEMs and developers to deal with the increasing volume and changing landscape of mobile video to keep users happy.

Qualcomm is in the unique position of understanding the mobile processor completely and building relationships with developers, content owners, device manufacturers and network operators. Its QuIC subsidiary develops actively for open-source software projects and industry standards. The resulting Web Technologies initiative not only helps device manufacturers achieve the goal of best-QoS multimedia streams and make their products stand out – especially on Snapdragon-based devices – but also spares them the investment in additional research and development to achieve it.

QuIC plans to continue these optimizations for Android, Chrome OS and other platforms, to keep industry and users on the path to the Truly Mobile Web.

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- Six Issues We Need to Address First
- Handling Mobile Web Pages Better
- Streaming Multimedia More Smoothly
- Developing Richer Web-based Applications

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