



Mobile Application and Services Monitoring – A Primer

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1. Introduction

Monitoring the performance of websites as they are experienced by desktop-based end users isn't a new concept. For years, content owners have recognized the need for continual monitoring on the Web because of the high correlation between performance, the user experience, and, ultimately, adoption. In the online world there are low barriers to switching when speed and availability expectations are not met.

Measuring performance is not a new concept to mobile either. However, until recently performance in mobile has been synonymous with voice quality. When network coverage and dropped calls were the only metrics that mattered, it wasn't surprising that performance monitoring was mostly a concern for the mobile network operators. *Data* performance was less of a concern when mobile content, applications, and services took a backseat to *voice*. However, with the mass consumer popularity of advanced smartphones and SMS, the accurate delivery of content, applications, and service over mobile data networks has become increasingly important to content owners.

Companies with a more mature Web presence are now embracing mobile channels and making them a key part of their growth strategy. However, for companies making the move from Web to mobile it is important to understand that performance-monitoring solutions that worked on the Web cannot be simply applied to mobile. Managing the mobile end-user experience requires an understanding of how it's different from the Web end-user experience.

Once the differences between mobile and the Web are clear, it also becomes clear that unique technical requirements govern accurate monitoring, measurement, and understanding of the mobile end user experience. This paper will explain the challenges and opportunities of monitoring mobile content and offer strategies for accurately monitoring the mobile end-user experience.

2. Understanding the Mobile Ecosystem

Long gone are the days when landlines were the primary means of communication. Mobile devices have become ubiquitous, and a complex mobile ecosystem has come into being as mobile technology has evolved.

This ecosystem now consists of mobile content providers, mobile enablers, and infrastructure providers such as aggregators in addition to the network providers and device manufacturers that have existed since day one. The goal of the evolution of mobile has been to bridge the gap between mobile and desktop to deliver an optimum experience to users on their mobile devices.

2.1 What makes mobile content different from Web-to-desktop content?

As will be described in detail below, mobile content is different in many ways from Web-to-desktop content. The mobile world is fragmented—there are thousands of mobile device models, with different form factors, operating systems, and browsers. On the Web this is not an issue. This means that even though similar technologies are generally used to build

Websites for mobile devices and desktops, and even though in some cases the same Web server might also be used to send content to both, multiple versions of the mobile content need to be created, stored, and delivered.

In addition, website content is downloaded very differently to a mobile device than to a desktop browser in order to provide the desired end user experience.

Web Content on a Mobile Device	Web Content on a Desktop
The mobile device connects to the operator network.	Desktop connects to the ISP.
Every mobile request goes through the operator's backbone.	ISP routes through the Internet to download content.
Content server sends different content depending on device capability.	Content server sends same content for every request.

Did you know that performance varies by geography and network?

Unlike Web content downloads to desktops, mobile downloads can vary dramatically based on time of day, network operator used, and geographic location. For example, a mobile Website can take twice as long to download in San Francisco as compared to another operator in New York, London, or Tokyo. If a content-monitoring strategy does not include monitoring content from various geographic locations, it is impossible to know what the end users are experiencing.

2.2 Device-specific mobile content—a monitoring challenge

One of the most important differences between mobile and desktop-based Web content is the need for mobile content to be tailored for the various characteristics and capabilities of a particular device. This added level of complexity affects development of monitoring strategies, and it must be taken seriously in order to truly understand how the full spectrum of end users accessing mobile content will experience it.

Clearly this expansion of the scope of content monitoring is one of the major differentiators from a desktop-based Web monitoring strategy. With literally hundreds of device types in circulation and more coming on the market each day, attempting to understand the end-user experience by manually testing content on each device is cost—and time—prohibitive; automated monitoring strategies are required.

2.3 What is the impact on performance monitoring?

In the Web world, both the user interface and the delivery mechanism have been standardized for years. However, mobile content must be routed to the user through an operator network, and additional operator-specific content may be added during the download. Also, different devices render content differently, so when the Web server detects a specific device type it may choose to send a variant of the generic content to the requesting device. Finally, different devices are capable of handling the various components of a download differently (for example, images, text, and third-party content)—which can dramatically vary download time. This means that performance-monitoring techniques that work with desktop-based Web content will necessarily fall short in a mobile Web environment.

3. Mobile Monitoring Strategies

The mobile environment does not consist of a single delivery system to a standardized device interface. Therefore, different strategies need to be deployed to monitor different types of content. Both emulated devices and real devices are employed for mobile monitoring, and a review of both content delivery and monitoring objectives will help determine when each should be used.

3.1 Real device monitoring

Did you know that there are two ways to download content over the operator's network?

Mobile devices connect to operators differently than PCs equipped with aircards. Mobile devices connect to the operator and its backbone before downloading content from the Web server. Aircards connect only the operator's cell tower and not its backbone, and directly download content from the Web server. Differences in access methods cause a dramatic difference in the end-user experience.

Monitoring mobile content performance on a real target device will clearly provide the most accurate information about end-user experience, but at a relatively high cost. Nevertheless, sometimes real device monitoring is the only choice. For example, the growing popularity of smartphones has led to a growing market for native applications residing on a device.

Companies building applications for popular smartphone platforms for Apple, Android, BlackBerry, Nokia, Palm, and others need to track what happens when their applications are downloaded and installed on a specific smartphone and are interacting with various device components such as the operating system, touch screen, or camera. **To accurately test the functioning of native applications, monitoring performance on real mobile devices is the only solution.**

There are, however, many classes of applications and services that can be monitored using device emulation, and those will be covered below.

3.2 Monitoring mobile websites and services via emulated devices

Emulated device monitoring is well suited for websites and services that are accessible by a broad range of mobile devices. These devices range from simple-feature phones to sophisticated smartphones. Many Websites and services require only a browser to render the page and do not depend on the operating system of the device (for example, SMS). **To accurately monitor such services on a broad range of possible combinations in the mobile ecosystem, the monitoring solution needs to be able to emulate the vast array of devices available.**

Emulation technologies must contain, along with a wide range of device profiles, an awareness of the multiple factors comprising the end-user experience. In addition, they need to have the diagnostic capability to quickly pinpoint the root causes of failures when something goes wrong. In the mobile environment it is especially necessary for content providers to know if their servers are at the heart of the problem—or if they should hold the operator accountable.

Emulated device monitoring can be performed by content owners in two separate modes:

- **Over-the-air monitoring for true end-user experience**

This requires a measurement solution that truly emulates the entire technology behind mobile downloads—including the actions of the operator network that sits between the Web server and the end user's device.

- **Direct-over-the-Internet monitoring to measure only the availability of content without the impact of operator networks**

By using this method, you can quickly identify the root cause of failures experienced by end users.

3.3. Device Emulation: over-the-air monitoring

When choosing to emulate a mobile device to measure the true end-user mobile experience, it is important to make sure that the monitoring solution chosen is capable of accurately representing the target device—that is, the device for which the content is designed. If an emulation product is not specifically designed for mobile measurement, the content

provider can be seriously misled during the test period. The result: unhappy end users and lost revenues. Over-the-air monitoring requires a solution that is capable of:

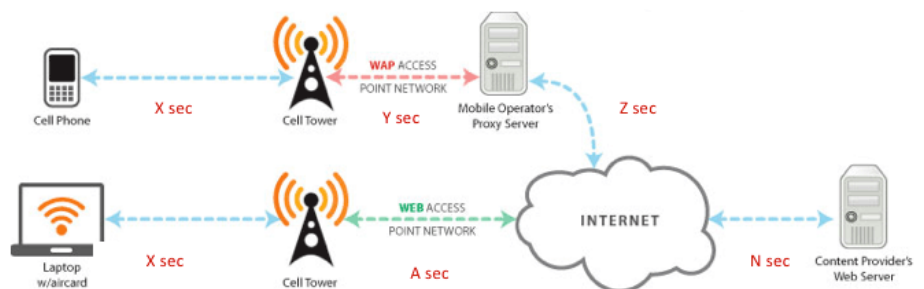
- Accurate measurement of content routing
- Accurate measurement of operator-specific content added during download
- Accurate measurement of device-specific content from Web server
- Accurate representation of device-specific multithreaded behavior on the mobile browser

3.3.1 Accurate measurement of content routing

When a mobile device issues a request to download content, the following steps occur:

- The mobile device connects to the network operator cell tower.
- The cell tower sends each request to the operator proxy server.
- A WAP Access Point Network (APN) is used to access the operator's proxy.
- The operator proxy communicates with the content provider's Web server and delivers content to the mobile device.

An alternative monitoring strategy is to measure downloads by using a standard desktop-browser-based monitoring system connected with an Aircard to make the request. This technology, however, is routed directly through the Internet. While it does represent the experience of a laptop-equipped "road warrior," it can't possibly provide an accurate representation of a mobile device request, as the example below demonstrates.



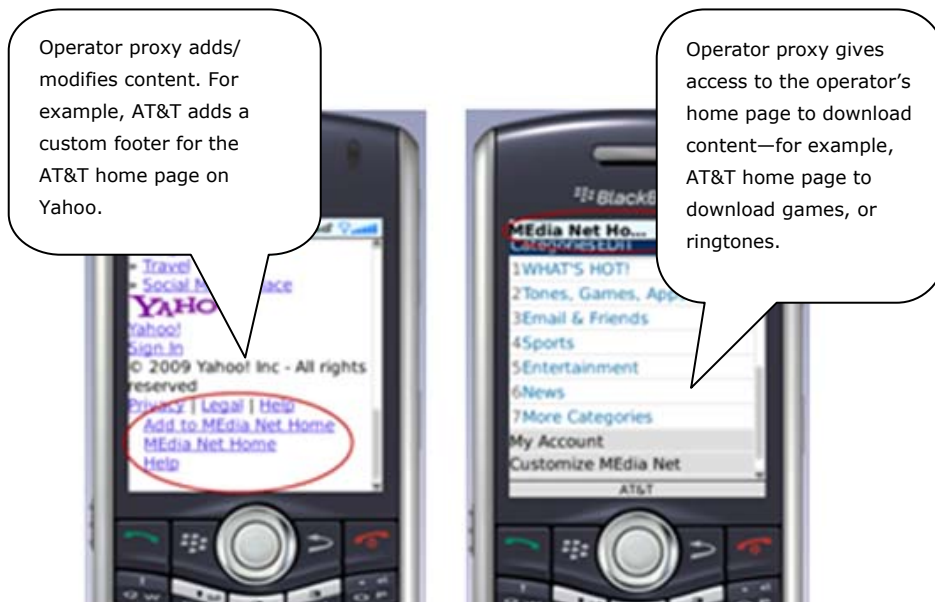
A true performance-monitoring solution that emulates mobile devices must connect to the network operator just as the mobile devices would. Operator certification of the modems is a good way of ensuring accurate connectivity. The emulator should also use the WAP APN settings to connect to the operator's proxy server, just as a mobile device would. By following the same path that a mobile device would use, the emulator can then accurately measure the time to download mobile content. In the case above, elapsed time to download content from the Web server is "X + Y + Z + N" seconds, just as it would occur on a mobile device.

Why there is no “one device fits all category” for mobile monitoring

There are literally hundreds of devices, all with different capabilities, on the market. Nevertheless, users expect to have a positive experience when accessing mobile content no matter which device they have.

As a broad rule of thumb, identify device-specific content for devices important to the content provider’s application or geography, and block the rest into a manageable number of content groups. Four popular levels of content are:

- Smartphones that can accept HTML programming and offer a rich, Web-like experience.
- Rich-content phones with large screens that accommodate rich imagery, support fast downloads, and accept XHTML code.
- Smaller-image devices that have more limited ability to process pages and images quickly and utilize WML code.
- Basic mobile devices that can accept text.



If an emulation solution is not specifically designed for mobile content, it may mistakenly use Web Access Point Network (Web APN) settings and connect directly to the Internet without going through the operator’s proxy. In this case, the download measurement would be “X + A + N” seconds, the time it would take to do the same content download on a desktop. A content provider would have a download measurement that would be significantly different from that experienced by the end user.

3.3.2 Accurate measurement of operator-specific content added during download

An operator’s proxy server often adds to and/or modifies the content that has been sent by a mobile-content Web server. The mobile users receive the modified content on their mobile devices for a tailored user experience. If the measurement solution does not connect to the proxy server, it cannot possibly represent what the mobile user experiences on a mobile device.

Access to the operator proxy server is also required to access the operator’s home page and download the operator’s content, such as games and ringtones (see above image on the right). **Without access to the operator proxy server, it is not possible to measure the true mobile end-user experience.**

3.3.3 Accurate measurement of device-specific content from Web servers

People unfamiliar with mobile may assume that they can emulate a mobile device by sending a mobile user agent string in a Web browser. After all, it is a common practice in Web performance monitoring and functional testing to emulate various browsers—for example, Firefox or Chrome—so why shouldn’t this work for emulating mobile devices as well? In the mobile environment this technique does not work well.

When requesting content from a Web server, a mobile device intersperses headers that describe the type of device and its capabilities. The Web server recognizes the specific headers inserted by different devices and selects content that best supports the device making the request. For example, most Web servers have a selection of image types and choose which image to send depending on the header. In the mobile world, there

are hundreds of different types of mobile devices. Each one can support only certain content types and therefore each one intersperses different headers.

Request for content from the Web server with device-specific headers



Resource name	Type	Size	Access Time
wapimage?&h=100&w=320&v=WAP...	image/gif	4131	860 ms
wapimage?&h=100&w=320&v=WAP...	image/gif	3833	750 ms
wapimage?&h=100&w=320&v=WAP...	image/gif		
wapimage?&h=100&w=320&v=WAP...	image/gif		
wapimage?&h=100&w=320&v=WAP...	image/gif		
wapimage?&h=100&w=320&v=WAP...	image/gif		
wapimage?&h=100&w=320&v=WAP...	image/gif		
wapimage?&h=100&w=320&v=WAP...	image/gif		
wapimage?&h=100&w=320&v=WAP...	image/gif		

Web server sends .gif images in response to requests with device-specific headers:
 Page size = 40,160 bytes
 Download time = 21s 702ms

Request the Web server for content only using a mobile user agent string

Resource name	Type	Size	Access Time
wapimage?&h=100&w=320&v=WAP...	image/bmp	2957	1 s 625 ms
wapimage?&h=100&w=320&v=WAP...	image/bmp	3296	688 ms
wapimage?&h=100&w=320&v=WAP...	image/bmp	1389	344 ms
wapimage?&h=100&w=320&v=WAP...	image/bmp	918	594 ms
wapimage?&h=100&w=320&v=WAP...	image/bmp	1389	641 ms
wapimage?&h=100&w=320&v=WAP...	image/bmp	5215	953 ms
wapimage?&h=100&w=320&v=WAP...	image/bmp	4208	891 ms
wapimage?&h=100&w=320&v=WAP...	image/bmp	5029	875 ms
wapimage?&h=100&w=320&v=WAP...	image/bmp	4935	1 s 015 ms
wapimage?&h=100&w=320&v=WAP...	image/bmp	4542	703 ms

Web server sends .bmp images in response to a request with generic headers:
 Page size = 33,818bytes
 Download time = 8s 329 ms

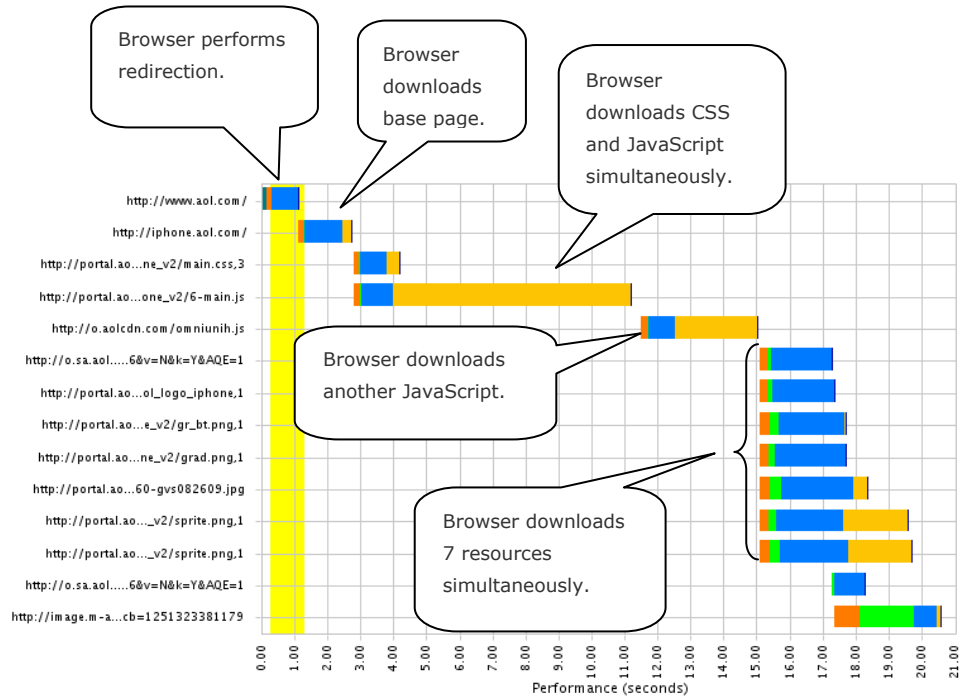
To accurately emulate a mobile device, the emulation product must send device-specific headers along with content requests to the Web server. A mobile Web server is designed to recognize the headers and send content types that the device can support. In the above example, a request with device-specific headers triggers a download with .gif images to "device x." In this case, the size of the downloaded page was 40,160 bytes and download time was 21s 702ms.

If the emulator relies on only the user agent string to request content from a Web server, the Web server will send generic image types. In the above example, the user agent string request triggered a download with generic .bmp images, which "device x," in reality, may not be able to support. The size of the downloaded page was 33,818 bytes and download time was 8s 329ms. The performance results between the two approaches will vary according to the differences between the download supplied by the request from the generic user agent string and the device-specific download. In this instance, the download measurements for "device x" vary by a huge factor.

3.3.4 Accurate representation of the device-specific multithreaded behavior of a mobile browser

Browsers on mobile devices download content depending on the number of simultaneous connections the device can make. Different devices have different settings and download content differently. Accurate simulation of how the browser downloads content to a mobile device is critical for the content provider's ability to understand the end-user experience and to troubleshoot in case of failures.

When the monitoring solution includes emulation of a mobile browser engine, representation of downloaded content is even more accurate. **Another critical part of emulation is the ability to provide device-specific information on the number of simultaneous browser connections the device can make.**



3.4 Device Emulation, direct over the Internet monitoring

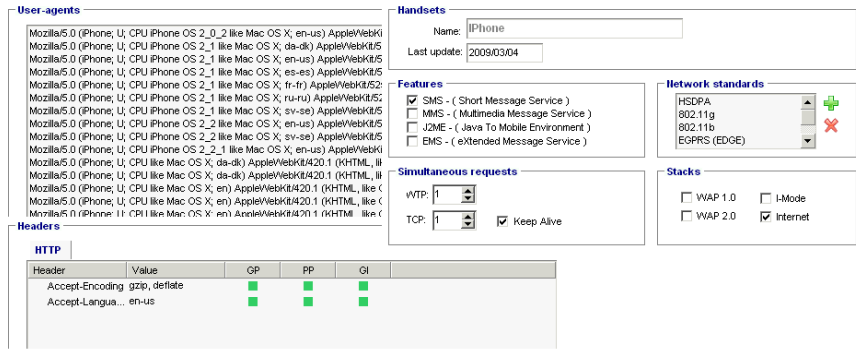
If a content provider wishes to measure only the availability of its own content regardless of the intervening operator networks, or needs to quickly identify the root cause of failures experienced by end users, it is sometimes more cost-efficient to perform measurements over the Internet backbone than over the air. There are two general scenarios where Web/IT Operations teams may want to consider using direct-over-the-Internet monitoring: monitoring the availability of the content on the Web server and pinpointing root causes of failure.

Direct-over-the-Internet monitoring enables the content provider to bypass the operator network to observe only how the content is organized and downloaded from the Web server. True device emulation is still required, however, to verify the end-user experience.

Why SLAs are important for mobile content

Most end users see the content provider as the responsible party when things go wrong, even though in many cases content providers have little control.

In the summer of 2009, 83% of the retailers with mobile commerce sites and apps looked to outside vendors for site design and implementation. With this additional complexity in an already complex mobile ecosystem, it is even more important that content providers establish Service Level Agreements (SLAs) with their operator networks and other technology partners and then continuously monitor performance to ensure that established levels of service are maintained.



True device emulation delivers user agent strings, headers, features, maximum redirection, etc.

Content providers depend on mobile operators for content delivery, but they rarely have control over the state of the operator network. If the operator network fails, mobile users do not receive content sent by the Web server—and they tend to blame the content provider for the outage.

Direct-over-the-Internet monitoring can make it possible to identify failures caused by a content company's own back-end infrastructure. These failures would manifest themselves regardless of operator network. But this method works only if the emulator has a complete list of device features required to accurately emulate the device. Unless the emulator is capable of completely describing the device, it is not possible to download content the same way a real device does. For optimum results, an accurate emulation of a mobile Web browser is also required.

Direct-over-the-Internet monitoring is an effective solution that accurately monitors the availability of mobile content, without the impact of the operator network, at costs that are comparable to monitoring Web content for desktop browsers.

4. Keynote Mobile Monitoring Solutions

With more than eight years of experience in mobile monitoring and measurement, Keynote, the mobile and Internet Performance Authority, has the most comprehensive products available for measuring the true end-user experience of mobile content on mobile devices. Keynote's broad selection of emulation and real device capabilities means that you can get the solutions you need, tuned to your budget and your required outcome.

Keynote, known as the leader in providing on-demand test and measurement solutions for continuously improving the online experience, has extended the same robust capabilities found in its desktop-based Web performance monitoring and measurement solutions to the mobile market.

4.1 Mobile Device Perspective (MDP)

Keynote Mobile Device Perspective (MDP) can accurately monitor the true end-user experience for native mobile applications on real devices—especially smartphones—from locations around the world. MDP supports popular smartphones and tablets, including Apple iPhone 4, HTC Incredible, BlackBerry Curve 3G and others, allowing content companies to

monitor any type of application and measure the performance for any step/action of the application. By providing a true mobile-experience monitoring solution for native applications on real devices, MDP makes it possible to quickly identify issues and get diagnostics that help in troubleshooting. Metrics reported by MDP include:

- Response time
- Availability
- Signal strength

In case of an error, MDP also provides a screen snapshot of the LCD at the time of error.

Native applications can only be monitored on real devices. Keynote MDP is the best solution that provides customers with the ability to monitor their applications downloaded on real devices.

4.2 MWP for emulated device monitoring

Keynote Mobile Web Perspective (MWP) is a mobile-agent product that measures the mobile end-user experience from around the world, emulating the mobile devices. MWP is developed to comply with the WAP standards defined by the Open Mobile Alliance (OMA). In addition, Keynote has built a mobile stack for MWP that controls the incoming and outgoing traffic to the mobile operator. MWP also performs complete device emulation by sending the same headers as a real device, connects to the mobile network like an actual device, and downloads the same mobile content downloaded on the device. The result is the ability to measure the true mobile experience.

MWP can accurately emulate over 2,000 different devices, from simple phones to the latest smartphones with advanced capabilities. MWP requests and downloads content just like an actual device. Downloading content correctly is extremely critical for monitoring the experience of an end user accessing Websites from mobile devices. And once accurate measurements are collected, MWP provides the same level of detailed diagnostic information available with Keynote's Web performance measurement products.

Keynote understands that mobile website monitoring is different from desktop-based Web monitoring, and that simply connecting a desktop with an Aircard and sending a mobile user agent string is not sufficient. To meet the needs of mobile content owners, Keynote offers two MWP connection options for monitoring:

- **MWP over Air** is used to perform true end-user performance monitoring of mobile websites and services connecting to the mobile operator network and downloading content just like a mobile device. MWP monitoring with this connection option helps companies track how end users are experiencing a service and provides real-time alerts during service failures.
- **MWP performs operational monitoring, downloading mobile content directly over the Internet backbone bypassing the mobile operator.** MWP monitoring with this connection option is for companies that want to monitor the entire back-end system and receive alerts when end-user failures are not caused by the operator network.

Checklist for mobile monitoring success

Simple monitoring is not enough. A successful mobile monitoring plan entails an entire strategy, including the following elements:

- Make sure your monitoring solution comes from a company you trust—one with many years' experience providing true mobile monitoring.
- View active measurements through an intuitive Web portal interface.
- Trend the performance and availability of mobile content, services, and applications across different devices, networks, and locations.
- Benchmark your performance against your competitors.
- Receive customized real-time alerts.
- Use diagnostics to troubleshoot and resolve issues.
- Integrate with your mobile operations center.
- Feed mobile performance and availability data to your own software analysis tools.

4.2.1 MWP

- Keynote provides accurate measurement of content availability and makes it possible to troubleshoot a failure by downloading mobile content without the impact of the mobile operator. Even though the download route is different than over the air, MWP downloads the same content the same way a real device does because it supports the complete list of device features required for accurate emulation: user agent string, headers, device features, maximum redirections, and number of simultaneous browser connections.
- Keynote provides an accurate view of availability as viewed from most smartphones today, such as the Apple iPhone and Google Android-based devices. MWP has a real mobile WebKit browser engine, the mobile browser used by most smartphones.
- Keynote makes it possible to monitor globally. MWP is available from 50 global Internet backbone locations.

4.2.2 MWP over Air

- Keynote provides accurate measurement of mobile content download time. MWP over Air downloads mobile content over the same route as a mobile device.
- Keynote measures the true mobile end-user experience. MWP over Air connects to the operator proxy to reflect changes to download content inserted there.
- Keynote shows how downloads perform on specific devices. MWP over Air sends all headers like a real device.
- Keynote provides global monitoring. MWP over Air is available from 15 global locations with connections to 35 network operators.
- Keynote makes it possible to truly understand the end-user experience and to simulate the true mobile download experience for troubleshooting. MWP over Air uses a real WebKit mobile browser engine and an accurate number of device connections.

4.2.3 Mobile diagnostics and root cause analysis

MWP over Air and MWP both allow the content provider to quickly identify the root cause of failures experienced by end users. They provide the same kind of detailed diagnostics available for desktop Web troubleshooting, including a screen snapshot of the entire downloaded page, the number of resources, the URL for base page, and the URL and a snapshot of each individual resource.

With this level of detail, content providers get their Websites back online if failures are caused by their own back-end infrastructure. And, when the network operator is at fault, having clear information pointing out the problem is one of the most convincing ways to hold an operator to its commitments and avoid finger-pointing.

4.3 Monitoring the true end-user experience

In the mobile environment:

- If you want to understand the true end-user experience when running

native applications, Keynote MDP is the best solution offering real-device monitoring.

- If you want true end-user performance monitoring, Keynote MWP over Air is the best solution. Other solutions provide results that can be misleading under a variety of critical conditions.
- If you only need availability monitoring of your back-end systems, Keynote MWP is a cost-effective solution.

Use Case	Solution	What do you get?
Monitoring true end-user experience of native mobile applications (especially smartphones)	Mobile Device Perspective	<ol style="list-style-type: none"> 1. Monitoring from 15 global over the air locations and 35 network operators 2. Choice of real phones: Apple iPhone 4, HTC Incredible, BlackBerry Curve 3G, Samsung Focus, etc. 3. 24X7 monitoring to measure true end-user mobile experience, including response time and availability 4. Real-time alerts in case of failure 5. Snapshot of LCD screen at the time of error 6. True fidelity monitoring, but higher monitoring cost
Monitoring only the availability of a mobile website and services	Mobile Web Perspective	<ol style="list-style-type: none"> 1. Monitoring from 50 global Internet backbone locations 2. Choice of 2,000 devices for emulation 3. 24X7 monitoring to measure Website availability 4. Real-time alerts in case of back-end failure 5. Detailed diagnostics for troubleshooting 6. Cost-effective solution
Monitoring end-user experience for mobile website and services	Mobile Web Perspective over Air	<ol style="list-style-type: none"> 1. Monitoring from 15 global locations and over 35 live mobile operator networks 2. Choice of 2,000 devices for emulation 3. 24X7 monitoring to measure true end-user mobile experience, including response time and availability 4. Real time alerts in case of back-end failure 5. Detailed diagnostics for troubleshooting 6. Accurate monitoring of the mobile end-user experience without the cost of the actual devices

5. Summary: Don't Settle for Less than the True End-User Experience

As with any other measuring and monitoring solution, the quality of the collected measurements is critical to the success of the project. Keynote knows that taking shortcuts with incomplete device models or incomplete routing paths provides results that do not correspond with the real-world end-user experience.

When you need a mobile monitoring solution that reflects the true user experience, make sure you ask:

- Does this accurately measure response time on the route taken on a mobile network to the target Web server?
- How do I download content that has been added by the mobile operator in-stream during Web content download to accurately represent the end-user experience?
- Can I ensure that I'm downloading the exact content served by the Web server depending on the requesting device?
- Does this solution capture the multithreaded behavior of a mobile browser for specific requesting devices?

When you need to check the availability of your pure content and want to view it over the network, make sure you ask:

- How do I accurately measure only the availability of my mobile Web content, bypassing the mobile operator?

When you want to make sure that your native apps are providing a specific end-user experience, make sure you ask:

- Does this measuring and monitoring process run its tests on real target devices?

When choosing a vendor to provide mobile measuring and monitoring technology, make sure that the vendor has the technology and the depth of resources to provide test results that reflect the true end-user experience. Educate yourself on the issues and technologies available before making a decision. You are betting your company on it. Make the right choice. Choose Keynote.