



Wireless E-Mail Efficiency Assessment

RIM BlackBerry and Microsoft Direct Push
(Including iPhone)

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Rysavy Research Wireless E-Mail Efficiency Assessment

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1 Overview

An increasing number of users are taking advantage of wireless e-mail, which has become the most successful wireless-data application for wireless networks. Being able to respond to e-mail in real time makes workers more productive, recovers time that would otherwise not be available for productive use, and allows companies to serve their customers better. Increasingly, consumers also are using wireless e-mail—as pricing plans become less expensive and e-mail-capable devices such as smartphones and feature phones become more affordable.

With wireless e-mail rapidly reaching the point where it serves tens of millions of subscribers—and before long, hundreds of millions of subscribers—it is important to consider the effect that wireless e-mail systems have on wireless networks, especially given the finite data capacity of these networks. It is equally important to consider the end-user experience of these systems.

Under sponsorship from Research In Motion (RIM), Rysavy Research, working in conjunction with Quality in Motion, Inc., has conducted a series of tests to quantify the data consumption of RIM's BlackBerry solution versus Microsoft's Direct Push solution. Direct Push was initially available with Service Pack 2 for Microsoft Exchange Server 2003 on the server and Windows Mobile 5 on the device in combination with the Messaging and Security Feature Pack (MSFP). Rysavy Research first published test results in 2006. These results are also summarized in Appendix E. An update to the report in April 2008 provided comparison results for Exchange Server 2007 SP1 and Windows Mobile 6.0, and these results are summarized in Appendix D. This report updates the efficiency comparison looking at current RIM BlackBerry capabilities in BlackBerry Enterprise Server 4.1.6.9 versus Microsoft Direct Push as currently implemented on Exchange Server 2007 SP1 and Windows Mobile 6.1.

The tests, detailed below, demonstrate that RIM's solution remains significantly more efficient in its network usage, resulting in a much lower network load for an operator. The efficiencies also translate to a better user experience, with e-mails and attachments available much faster as well as improved battery life. This paper discusses the nature of wireless e-mail, wireless network capacity, how both Microsoft Direct Push and RIM BlackBerry work, the testing environment, the tests performed, and the test results.

2 Wireless E-Mail Systems

Wireless e-mail systems have become successful because they adapt an application intended for wireline networks to wireless networks. Traditional e-mail systems were designed using a model where e-mail clients poll e-mail servers for e-mail. Although it is possible to use such an approach with wireless connections, for handheld devices, this approach consumes excessive data, is slow, and does not result in an ideal user experience.

An optimized wireless e-mail system provides the following types of features:

- **Push.** Rather than e-mail clients polling for data, the system “pushes” messages to the device.
- **Efficient.** Since some messages can be very large, the system makes it possible for users to read just the first part of the message rather than

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download the whole message. The user can then obtain additional portions of the message as desired.

- **Fast.** The system compresses the data to minimize communication time.
- **Efficient Attachment Handling.** Users typically want to view attachments, rather than manipulate them. The most efficient approach lets the user view the attachment portion by portion and in a format optimized for the display on the device.
- **Mailbox Synchronization.** Users can work with just one “mailbox,” so that the handheld inbox is synchronized with the desktop or laptop inbox.
- **Security.** The system encrypts communication on an end-to-end basis and does not depend on any security provisions in the wireless network.
- **Sophisticated Management Tools.** The wireless e-mail system provides tools for easily managing, updating, and adding user accounts.

It is significant that the approaches used to minimize network communication also result in the best user experience. The less data sent over the wireless network, the faster and more reliable the user experience, and the better the device's battery life.

What became apparent in our testing is that there are very different implementation approaches for wireless e-mail and that the efficiency of these approaches can vary widely. One reason the efficiency of the wireless e-mail system is of particular concern to wireless operators is the limited capacity of their networks.

3 Finite Wireless Capacity

Rysavy Research has published extensively on the capacity of wireless networks, including a series of publicly available white papers for 3G Americas.¹

Networks are becoming much faster than ever before. With technologies such as High Speed Packet Access (HSPA) and CDMA2000 EV-DO (Evolution Data Optimized), users experience typical download throughput rates of 1 megabit per second (Mbps) and often higher. However, what many people do not realize is that the capacity of these networks is relatively finite. Even though the wireless technologies use sophisticated approaches to maximize spectral efficiency, laws of physics impose a limit on the maximum number of bits per second per Hertz, relative to noise, that any wireless technology can communicate in a radio channel.

Today's most advanced deployed networks achieve a spectral efficiency of about .75 bps/Hz/sector.² This means that a system such as UMTS/HSDPA operating in a 5 MHz radio channel with all of its capacity dedicated to data will only have 3.75 Mbps of total sector capacity for all of the users in that cell sector.

EV-DO networks have similar constraints, with similar spectral efficiency, and typically only one radio channel of 1.25 MHz available for high-speed data.

Consider also that a voice channel consumes from about 6 to 12 kilobits per second (kbps) of capacity, depending on the exact vocoder and wireless network technology. A user operating at 1 Mbps, however, consumes one hundred times the data bandwidth of

¹ <http://www.3gamericas.com>.

² 3G Americas white paper, “EDGE, HSPA and LTE – Broadband Innovation, September 2008”. Most cell sites are divided into 3 sectors.

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the voice user. Even though data usage tends to be sporadic, users can consume far more capacity with data communications than they can with voice communications. In round numbers, a voice user with a 1,000-minute plan can consume about 100 megabytes (MB) of voice data in a month³. However, a data user can consume this much data watching just 15 minutes of YouTube. Similarly, downloading large e-mail attachments can also consume many megabytes of data. For this reason, operators are sensitive to the types of applications their users engage in as well as how much capacity they need to provision per user. This is especially the case because many operators globally have not yet deployed 3G and because those that have typically only partially upgraded their networks to 3G. Hence, 2G and 2.5G networks with their more finite data capacity will be with us for many years.

To preserve wireless capacity, it is clearly important that applications operate as efficiently as possible. A wireless e-mail system that consumes much less data than another wireless system is going to have much lower impact on overall network data loading, thereby leaving greater spectral resources available for other users. This becomes ever more important as the number of wireless e-mail users keeps rising. More efficient wireless e-mail translates to a better user experience for all users and provides for a greater return on investment in wireless infrastructure and spectrum.

4 Overview of Testing

To test the efficiency of different wireless e-mail systems, Rysavy Research developed a test system that replicates operation over a wireless network, but in a controlled environment. Rather than use an actual wireless network, the test system uses an advanced wireless network emulator. Communications with the handheld device occurs over a wireless connection provided by the network emulator, with all protocols identical to those used by a commercial network. The network emulator also allows the capture of data traffic, which we then analyzed for precise measurements of data communicated across the wireless interface.

We used controlled test messages of different types, varying both the size and content. We designed the messages and attachments to be representative of what users might receive in a real-world situation. This paper describes the test messages and test apparatus in detail in subsequent sections.

We also configured the mail servers to represent real-world usage, and further configured the servers to communicate with our test wireless network using the same protocols as used in commercial wireless networks.

We repeated each test five times. Given a high degree of consistency in the measurements, we achieved a high level of confidence in the test results, which are presented in the next section.

5 Summary of Test Results

The following table summarizes the test results. The first column indicates the message size in bytes, the second column the type of attachment if any, the third column the size of the attachment, and the fourth column the combined size of the message plus attachment. Subsequent columns show the results for Direct Push and BlackBerry, listing the total number of bytes communicated over the radio interface as well as what

³ Looking at the downlink.

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percentage that number of bytes constitute relative to the size of the message (plus attachment if any). We tested Direct Push using three devices: the Motorola Q9h, the HTC TyTN II (the AT&T version is called the "Tilt"), and the Apple iPhone 3G. We tested Windows Mobile devices both with and without the Microsoft System Center Mobile Device Manager (SCMDM).

A percentage value greater than 100 percent means that the wireless e-mail system communicated more bytes than the original message size, whereas a percentage value lower than 100 percent means the wireless e-mail system communicated fewer bytes than the original message size. Lower percentage values represent better wireless efficiency.

Table 1: Summary of Test Results⁴

Msg Size	Attach Type	Attach Size	Msg + Attach	DP, Motorola		DP SCMDM, Motorola		DP, TyTN II		DP SCMDM, TyTN II		DP, iPhone		BlackBerry 9000	
				Sent OTA	% Sent	Sent OTA	% Sent	Sent OTA	% Sent	Sent OTA	% Sent	Sent OTA	% Sent	Sent OTA	% Sent
5120	None	0	5120	12147	237%	15051	294%	11077	216%	13547	265%	18634	364%	3445	67%
10240	None	0	10240	14668	143%	17923	175%	13767	134%	16641	163%	22888	224%	6121	60%
20480	None	0	20480	20244	99%	24447	119%	19552	95%	23030	112%	32041	156%	11527	56%
136737	None	0	136737	134060	98%	152889	112%	133656	98%	154224	113%	180044	132%	68757	50%
5120	JPG	152148	157268	267867	170%	299132	190%	266817	170%	297764	189%	271454	173%	14613	9%
5120	PDF full	363139	368259	564186	153%	629022	171%	563110	153%	626489	170%	570480	155%	577645	157%
5120	PDF text	363139	368259	564186	153%	629022	171%	563110	153%	626489	170%	570480	155%	85856	23%
5120	Word Doc	511488	516608	594921	115%	667484	129%	593882	115%	665745	129%	601919	117%	41922	8%
5120	PPT file	966144	971264	1438081	148%	1599568	165%	1436744	148%	1598236	165%	1453720	150%	329103	34%
5120	Excel	51200	56320	34395	61%	41039	73%	33310	59%	39714	71%	40675	72%	10126	18%

Appendix C of this paper provides actual test results. It shows the results of each individual test run as well as the data communicated in both the downstream and upstream paths.

Observations about the test results include:

- In nearly all cases, BlackBerry was significantly more efficient than Direct Push.
- In nearly all cases, BlackBerry sent less data over the air than the original file size. In some cases, the amount sent is only a small percentage of the original file.
- In most cases, Direct Push consumed more network resources than the original file size.
- In all cases, Direct Push with SCMDM was less efficient than Direct Push without SCMDM.

⁴ Sizes in bytes. Sent over the air includes both downstream and upstream transmissions. For messages/attachments available in portions, the test engineer requested "More" until the device received the entire message and attachment if any. Direct Push does not support text view of PDF documents.

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- One method by which BlackBerry achieves gains in network efficiency is by having efficient file viewers.⁵ In contrast, Direct Push downloads the whole file before the user can view it. On handheld devices, users generally want to view attachments rather than actually manipulate the files.

The more efficient data communication employed by BlackBerry has a number of important benefits. First, since it communicates less data, e-mail messages arrive faster. Given widely varying signal propagation environments, especially when mobile, this can mean the difference between receiving a message now or much later, in the event that a device loses the wireless signal for a period of time. Second, on any usage-based pricing plan, the user can send or receive many more messages for the same dollar amount. Third, the operator obtains a significant benefit by having a much lower load on its network. Finally, the user achieves better device battery life. The bottom line is a much more effective use of network resources with BlackBerry and a significantly better overall experience for the user.

6 Conclusion

Cellular operators are experiencing good success with wireless data services. In fact, data for many operators now accounts for over 20 percent of their revenues.⁶ Wireless e-mail is one of the leading applications, with significant acceptance by businesses and now increasing adoption by consumers. While tens of millions of people are using wireless e-mail today, the potential is for hundreds of millions in the next several years.

Operators are also promoting data service for other applications, such as mobile office productivity applications, Web browsing, and video and music downloads. With some data applications easily consuming an order of magnitude more network resources than voice communications, network capacity is an important consideration. Given the finite capacity of wireless networks—even 3G networks—compared to wireline networks, it makes excellent sense to emphasize applications that are efficient in their use of available bandwidth.

This white paper described a set of wireless efficiency tests conducted by Rysavy Research that compared Microsoft Direct Push with RIM BlackBerry. These tests were done in a controlled test environment that replicates operation over a wireless network. In nearly every test performed, BlackBerry was significantly more efficient than Direct Push. BlackBerry consistently conserved bandwidth while Direct Push generally consumed more bandwidth than the original message.

The efficiency of RIM's solution benefits not only operators but also customers who consume a smaller amount of data, thus reducing monthly costs on some pricing plans, improving the speed with which users receive e-mail and attachments, and improving device battery life.

⁵ For example, the BlackBerry PDF viewer allows viewing of just the text, which can make viewing documents far more efficient.

⁶ Chetan Sharma, <http://www.chetansharma.com/usmarketupdateq108.htm>

7 Appendix A: Wireless System Overview

Although Direct Push and BlackBerry provide a similar service to the end user, the overall architecture and system implementations are very different. This section describes how the two e-mail systems work as well as how they differ from each other.

7.1 Microsoft Direct Push

The Microsoft implementation has two main system components. First is the Microsoft Exchange Server, which is primarily responsible for sending and receiving e-mail messages. This requires Exchange Server 2007 or Microsoft Exchange Server 2003 with Service Pack 2. The second component is a device running Windows Mobile 6. This report provides detailed test results for Exchange Server 2007 SP1 with Windows Mobile 6.1 and the iPhone, and summarizes previous test results.

Once Direct Push is enabled on a client, Exchange will attempt to communicate with the respective device and synchronize messages on the server with the handheld. This solution requires the device to maintain a TCP connection with the server, accomplished by using a combination of heartbeat notifications and sustained TCP connections. Initially, the device sends a notification request to the server. This request contains a heartbeat interval, which is simply the maximum amount of time the device will wait until sending another notification request. If new mail arrives on the Exchange Server before the heartbeat expiration, Exchange notifies the device over the active connection.

The device will in turn request the new mail. If no new mail arrives before the heartbeat expires, the device will simply send the server another notification request to let it know that it is still waiting. All mail synchronization occurs over HTTP. This means that if the administrator fails to enforce HTTPS, e-mail is sent and received in the clear. Some wireless networks encrypt the radio link, but the encryption only protects a portion of the total end-to-end connection.

Microsoft Direct Push makes good use of standard networking protocols such as HTTP and TCP. TCP, however, is not an ideal protocol for wireless connections. For example, TCP algorithms can misinterpret a poor signal connection as a congested network. This results in inappropriate responses such as engaging the Slow Start algorithm, which further slows down communications. Direct Push at this time is not nearly as optimized for a wireless environment as BlackBerry, which employs protocols specifically designed to withstand the variations experienced in wireless connections and to minimize the amount of data communicated.

7.2 BlackBerry

The RIM system and protocols are implemented in a much different manner. One important element of the system is the BlackBerry Enterprise Server (BES). This component consists of several Windows Services, which maintain the synchronization state of the system and communicate directly with the Exchange Server as well as with the RIM registration and data servers at the RIM Network Operations Center (NOC).

When the Exchange Server receives a message, it notifies the BES via the Messaging Application Protocol Interface (MAPI) subsystem. The BES then communicates that a message is available to the RIM NOC, which in turn notifies the device of the pending message by sending a UDP message. The device and the RIM NOC then communicate to confirm availability. The BES then processes the message and sends it via UDP-based protocols to the device.

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The BlackBerry messaging protocols are designed to minimize the amount of communication across the wireless network, compared to the HTTP- and TCP-based approach used by Microsoft Direct Push. For instance, Direct Push transferred 15,051 bytes for a 5 KB⁷ message with a Windows Mobile device; the BlackBerry solution transferred only 3,445 bytes for a 5 KB message.

8 Appendix B: Test Environment

This section provides a detailed description of the testing environment, including the overall testing approach, the test messages, message sending approach, data analysis used, the Microsoft Direct Push test environment, and the RIM BlackBerry test environment.

8.1 Overall Testing Approach

Although the two systems we tested differed substantially in overall architecture and implementation, we were able to use a common testing environment to test each system. The primary test equipment was an Agilent 8960, a highly sophisticated wireless test system. This equipment combines a radio interface with a General Packet Radio Service (GPRS) Serving GPRS Support Node (SGSN) and Gateway GPRS Support Node (GGSN). In other words, it emulates an entire cellular operator network. The wireless device under test cannot differentiate between this and a commercial operator network. The Agilent equipment is able to capture the data traffic and make the IP traffic carried over the GPRS protocols available for analysis.

GPRS supports IP networking and provides a representative wireless environment for both Microsoft Direct Push and RIM BlackBerry. Though there are faster networks available, such as HSPA and EV-DO, the protocols used at the IP level for the wireless e-mail systems are the same. Essentially, the differences in the wireless technologies are at layers 1 and 2, so measuring the efficiency of the protocol at layer 3 (IP) over the wireless link provides a true “apples to apples” comparison of the wireless e-mail systems.

Both wireless systems involve accessing mail on a Microsoft Exchange Server. The server hosted the accounts to which we sent test messages. We configured the Exchange Server to either send messages directly to the device in the case of testing Microsoft Direct Push or allow interaction with the BlackBerry Enterprise Server.

The next element of the test architecture was an Ethereal capture server. Ethereal, as described further in the next section, actively captured—via the Agilent equipment—all the data traffic being sent to and from the handheld device.

The final element was a .NET test message creation and sending component. This component was a Windows .NET application written specifically to send the messages in the test matrix to the Exchange Server. The next section describes this process in greater detail.

8.2 Test Messages

To test the efficiency of the two systems, the test plan used a range of messages to approximate data usage in a real-world scenario. The messages had a range of body

⁷ In this document, 1 KB = 1024 bytes.

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sizes as well as a variety of attachment sizes and types. The following table shows the test messages used.

Table 2: Test Message Types

Message Body Size	Attachment Size	Attachment Type
5 KB	0 KB	N/A
10 KB	0 KB	N/A
20 KB	0 KB	N/A
134 KB (HTML)	0 KB	N/A
5 KB	149 KB	JPEG
5 KB	355 KB	PDF File with Text and Images,
5 KB	500 KB	Word document
5 KB	944 KB	PowerPoint presentation
5 KB	50 KB	Excel spreadsheet

The first three test cases sent only a message without an attachment. This represents the majority of e-mails users receive. The test engineers created the contents of these messages by selecting random segments from a variety of news articles. This form of text represents the text used in typical e-mails and enabled the wireless e-mail systems to engage their compression schemes.

The fourth test case was an HTML message that included both HTML content and JPG and GIF images.

The next five cases all added an attachment of various size and type. The test engineers chose attachments that represent the types of documents sent by a typical office worker. These include a JPEG image file, a PDF document (viewed in full and also viewed in text mode on the BlackBerry), a Microsoft Word document, a Microsoft PowerPoint presentation, and a Microsoft Excel spreadsheet. When sending attachments, the test plan called for a consistent and small message body to determine how the system managed the attachment and to minimize the effect of the message body in the test results.

8.3 Message Sending

To ensure test consistency and accuracy, the test system employed an automated mechanism to send the test messages. This consisted of a Windows .NET application that allowed the test engineer to send any of the messages on the matrix to any of the test accounts being used for the testing. This application was controlled via scripts that would send any of the messages in the test matrix to any of the devices.

The test application is a command line application that takes several parameters. The first parameter is the message file to use. There were 5, 10, and 20KB message files available for testing. The next parameter is the attachment file to use. This could be any of the variety of attachment files available. The following parameter is a switch which specifies whether or not the message body is HTML. The final parameter is the message destination e-mail address. To increase test and workflow efficiency, we created a script for each test case that supplies the proper parameters.

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When the test engineer ran the test script, the .NET application was launched with the proper parameters for the message in the test matrix. The application—utilizing the System.Net.Mail APIs available via the .NET runtime—created the message by pasting the contents of the specified text file into the message body and then attaching the specified file, if any, to the final message. The message then traveled to the specified recipient. This application and script allowed the engineer to easily send any of the given messages on the matrix efficiently and without having to navigate through multiple steps using a mail client such as Microsoft Outlook or Microsoft Outlook Web Access.

8.4 Data Analysis

To analyze the efficiency of each messaging system, the test system captured the amount of data transferred. To do this, we used a Microsoft Windows-based packet capture utility called Ethereal.

The test engineer was able to use Ethereal to capture all the data transferred over a single physical network. Once Ethereal captured the data, the test engineer could view it on a packet-by-packet basis, allowing an analysis of exactly how much data the wireless e-mail system transferred to communicate an e-mail message.

To automate the testing process and help eliminate potential human error, the test engineer used the 'Endpoints' dialog in Ethereal to determine the total number of bytes transferred to and from the device. This also reported at which layers this data transfer occurred (e.g., TCP, IP, Ethernet, etc.). Using this dialog, the test engineer was able to easily and accurately determine the amount of data transferred in any specific test. For each message type in the test matrix, we did five separate runs and then averaged them to produce the test result summary. As shown in the actual test results in Appendix C of this document, the runs were highly consistent with each other. This allowed us to conclude that five runs was a sufficient number to accurately represent the performance of these systems.

8.5 Microsoft Direct Push Environment

Testing the data throughput with the Windows Mobile and iPhone devices with Direct Push was quite straightforward; all components required for the testing could be hosted on the same physical network and configured in-house. Testing Direct Push with Microsoft's System Center Mobile Device Manager, however, was slightly more complex. The Agilent 8960 was moved to an external network and an SCMDM Gateway Server was configured with one network interface on the external network and one network interface on the internal network with the Exchange Server. Additionally, an SCMDM Enrollment Server and an SCMDM Management Server were configured on the internal network. A VPN tunnel was established between the device and the Exchange Server through the SCMDM Gateway Server when testing with SCMDM data. Client devices included a Motorola Q9h, an HTC TyTN II and an Apple iPhone 3G (OS 2.1). We also configured the Outlook mobile e-mail settings to work with the test Exchange Server, which required a test account on the server that supported mobile access and Direct Push. We configured a PC with Microsoft Outlook to access the mobile test account and then synchronized the mobile device to the PC using ActiveSync. We also configured the Active Sync settings to enable Direct Push even when the device was roaming. Upon synchronizing settings with the device, Direct Push is enabled.

For actual e-mail reception, we set up the device to communicate with the Agilent 8960 inside a shielded transmitter box. This allowed the device to connect at an RF level with the test system but prevented it from receiving any other RF signals that may have been

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present in the environment. At this point, the device could communicate via the Agilent 8960 with the Exchange Server.

Once we established this connection, the test engineer could send messages to the test account and capture traffic data to and from the handheld. The following figure illustrates the test configuration.

Figure 1: Microsoft Direct Push Setup

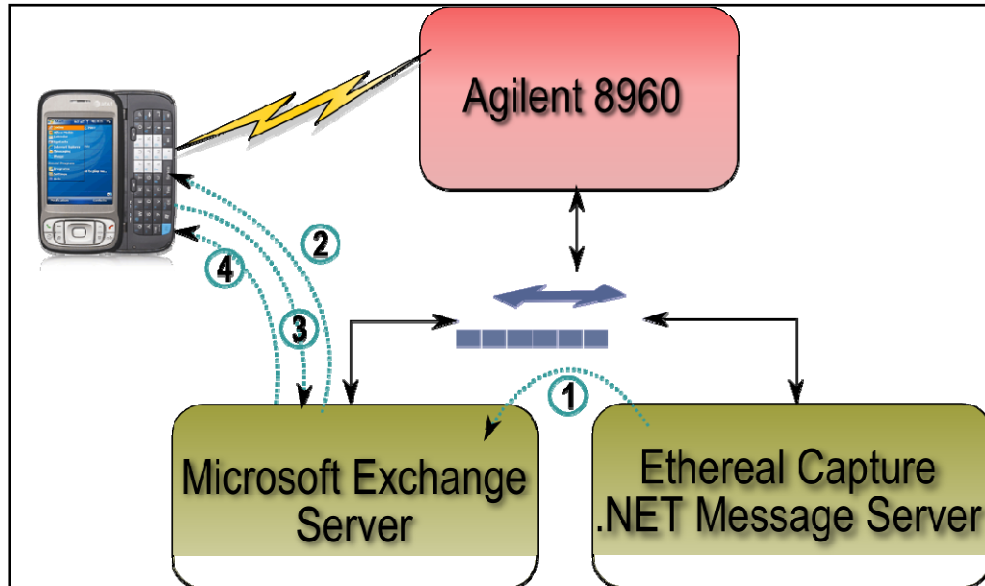


Figure 1 Legend

1. E-mail sent from test script to Exchange Server
2. Exchange Server notifies handheld of new message
3. Handheld requests new message from Exchange Server
4. Exchange Server sends new message to handheld

8.6 RIM BlackBerry Environment

Testing with the BlackBerry configuration required a more complex test configuration because it needed to include the RIM NOC in the communications path. Normally, messages sent to a mobile user flow from the Exchange Server to the BlackBerry Enterprise Server to the RIM NOC to the cellular operator, and finally to the mobile device. Messages from a mobile user flow in the opposite direction. Our test configuration emulated this entire communications path, as shown in the figure below. We used a Virtual Private Network (VPN) between our test network and the RIM NOC that carried both the BES to NOC communications and the NOC to wireless system communications. In commercial networks, this occurs across two separate networks.

9 Appendix C: Detailed Test Results

The following sections show the actual measurements for each test, including all five test passes. Italics show the average values. A figure illustrates the results.

9.1 5 KB Text Message, No Attachment

Microsoft Direct Push, Motorola Q9h

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	0	n/a	1259	4098	1361	5368	0	0	2620	9466	12086
5120	0	n/a	1309	4095	1481	5365	0	0	2790	9460	12250
5120	0	n/a	1309	4101	1361	5368	0	0	2670	9469	12139
5120	0	n/a	1307	4094	1361	5366	0	0	2668	9460	12128
5120	0	n/a	1309	4097	1361	5364	0	0	2670	9461	12131
<i>5120</i>	<i>0</i>	<i>n/a</i>	<i>1299</i>	<i>4097</i>	<i>1385</i>	<i>5366</i>	<i>0</i>	<i>0</i>	<i>2684</i>	<i>9463</i>	<i>12147</i>

Microsoft Direct Push SCMDM, Motorola Q9h

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	0	n/a	1844	4820	2258	6094	0	0	4102	10914	15016
5120	0	n/a	1892	4820	2258	6094	0	0	4150	10914	15064
5120	0	n/a	1892	4820	2258	6094	0	0	4150	10914	15064
5120	0	n/a	1892	4820	2258	6094	0	0	4150	10914	15064
5120	0	n/a	1892	4804	2258	6094	0	0	4150	10898	15048
<i>5120</i>	<i>0</i>	<i>n/a</i>	<i>1882</i>	<i>4817</i>	<i>2258</i>	<i>6094</i>	<i>0</i>	<i>0</i>	<i>4140</i>	<i>10911</i>	<i>15051</i>

Microsoft Direct Push, TyTN II

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	0	n/a	1145	3245	1305	5372	0	0	2450	8617	11067
5120	0	n/a	1191	3241	1305	5312	0	0	2496	8553	11049
5120	0	n/a	1193	3242	1305	5373	0	0	2498	8615	11113
5120	0	n/a	1191	3241	1305	5313	0	0	2496	8554	11050
5120	0	n/a	1191	3238	1305	5372	0	0	2496	8610	11106
<i>5120</i>	<i>0</i>	<i>n/a</i>	<i>1182</i>	<i>3241</i>	<i>1305</i>	<i>5348</i>	<i>0</i>	<i>0</i>	<i>2487</i>	<i>8590</i>	<i>11077</i>

Microsoft Direct Push SCMDM, TyTN II

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	0	n/a	1738	3776	2014	5972	0	0	3752	9748	13500
5120	0	n/a	1770	3776	2014	5972	0	0	3784	9748	13532
5120	0	n/a	1770	3760	2014	5972	0	0	3784	9732	13516
5120	0	n/a	1770	3776	2136	5972	0	0	3906	9748	13654
5120	0	n/a	1770	3776	2014	5972	0	0	3784	9748	13532
<i>5120</i>	<i>0</i>	<i>n/a</i>	<i>1764</i>	<i>3773</i>	<i>2038</i>	<i>5972</i>	<i>0</i>	<i>0</i>	<i>3802</i>	<i>9745</i>	<i>13547</i>

Rysavy Research Wireless E-Mail Efficiency Assessment

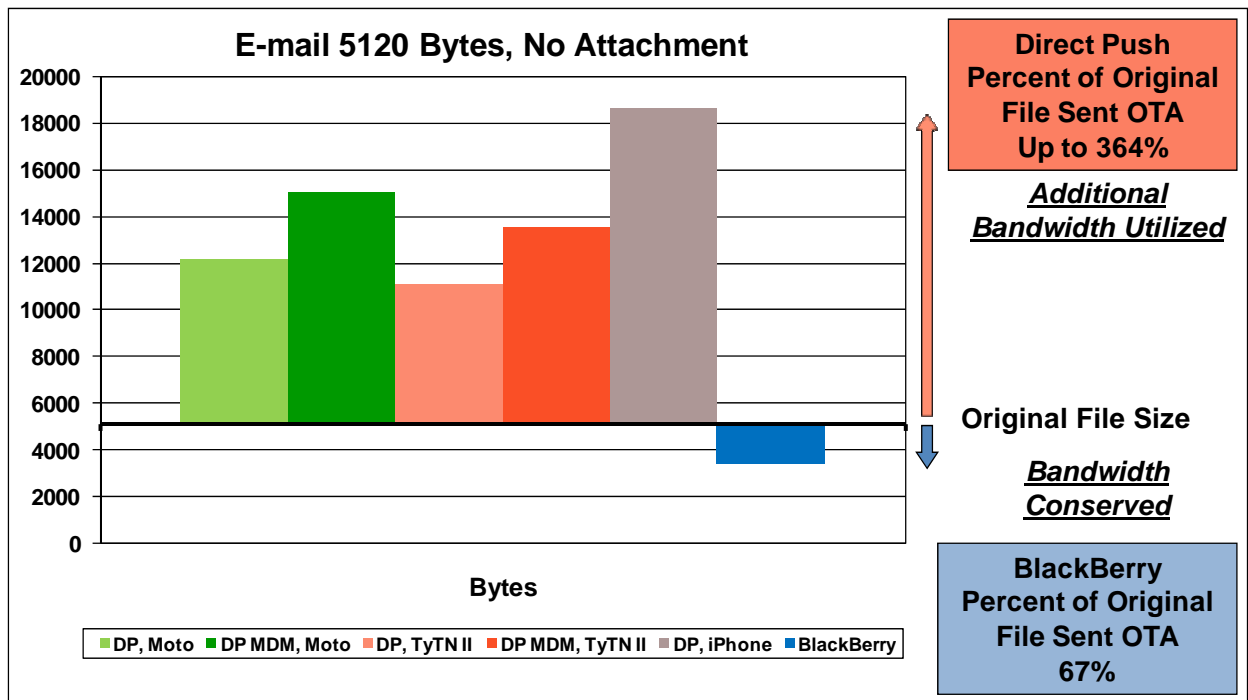
Microsoft Direct Push, iPhone

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	0	n/a	4203	6998	5284	2916	0	0	9487	9914	19401
5120	0	n/a	4195	6999	4417	2644	0	0	8612	9643	18255
5120	0	n/a	3719	6928	5284	2910	0	0	9003	9838	18841
5120	0	n/a	3653	6924	5284	2916	0	0	8937	9840	18777
5120	0	n/a	3860	6957	4417	2664	0	0	8277	9621	17898
5120	0	n/a	3926	6961	4937	2810	0	0	8863	9771	18634

RIM BlackBerry 9000

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	0	n/a	60	1042	390	1953	0	0	450	2995	3445
5120	0	n/a	60	1042	390	1953	0	0	450	2995	3445
5120	0	n/a	60	1042	390	1953	0	0	450	2995	3445
5120	0	n/a	60	1042	390	1953	0	0	450	2995	3445
5120	0	n/a	60	1042	390	1953	0	0	450	2995	3445
5120	0	n/a	60	1042	390	1953	0	0	450	2995	3445

Figure 3: Microsoft Direct Push versus RIM BlackBerry



Note: MDM in the legend refers to the Microsoft System Center Mobile Device Manager.

9.2 10 KB Text Message, No Attachment

Microsoft Direct Push, Motorola Q9h

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
10240	0	n/a	1307	4065	1481	7855	0	0	2788	11920	14708
10240	0	n/a	1309	4061	1421	7853	0	0	2730	11914	14644
10240	0	n/a	1307	4063	1527	7855	0	0	2834	11918	14752
10240	0	n/a	1307	4062	1421	7795	0	0	2728	11857	14585
10240	0	n/a	1309	4064	1421	7856	0	0	2730	11920	14650
10240	0	n/a	1308	4063	1454	7843	0	0	2762	11906	14668

Microsoft Direct Push SCMDM, Motorola Q9h

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
10240	0	n/a	1892	4788	2380	8876	0	0	4272	13664	17936
10240	0	n/a	1892	4772	2380	8876	0	0	4272	13648	17920
10240	0	n/a	1892	4772	2380	8876	0	0	4272	13648	17920
10240	0	n/a	1892	4772	2380	8876	0	0	4272	13648	17920
10240	0	n/a	1892	4772	2380	8876	0	0	4272	13648	17920
10240	0	n/a	1892	4775	2380	8876	0	0	4272	13651	17923

Microsoft Direct Push, TyTN II

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
10240	0	n/a	1193	3225	1485	7861	0	0	2678	11086	13764
10240	0	n/a	1191	3230	1485	7862	0	0	2676	11092	13768
10240	0	n/a	1191	3227	1485	7861	0	0	2676	11088	13764
10240	0	n/a	1193	3228	1485	7861	0	0	2678	11089	13767
10240	0	n/a	1193	3231	1485	7862	0	0	2678	11093	13771
10240	0	n/a	1192	3228	1485	7861	0	0	2677	11090	13767

Microsoft Direct Push SCMDM, TyTN II

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
10240	0	n/a	1770	3774	2380	8722	0	0	4150	12496	16646
10240	0	n/a	1770	3760	2380	8738	0	0	4150	12498	16648
10240	0	n/a	1770	3760	2380	8738	0	0	4150	12498	16648
10240	0	n/a	1770	3744	2380	8722	0	0	4150	12466	16616
10240	0	n/a	1770	3760	2380	8738	0	0	4150	12498	16648
10240	0	n/a	1770	3760	2380	8732	0	0	4150	12491	16641

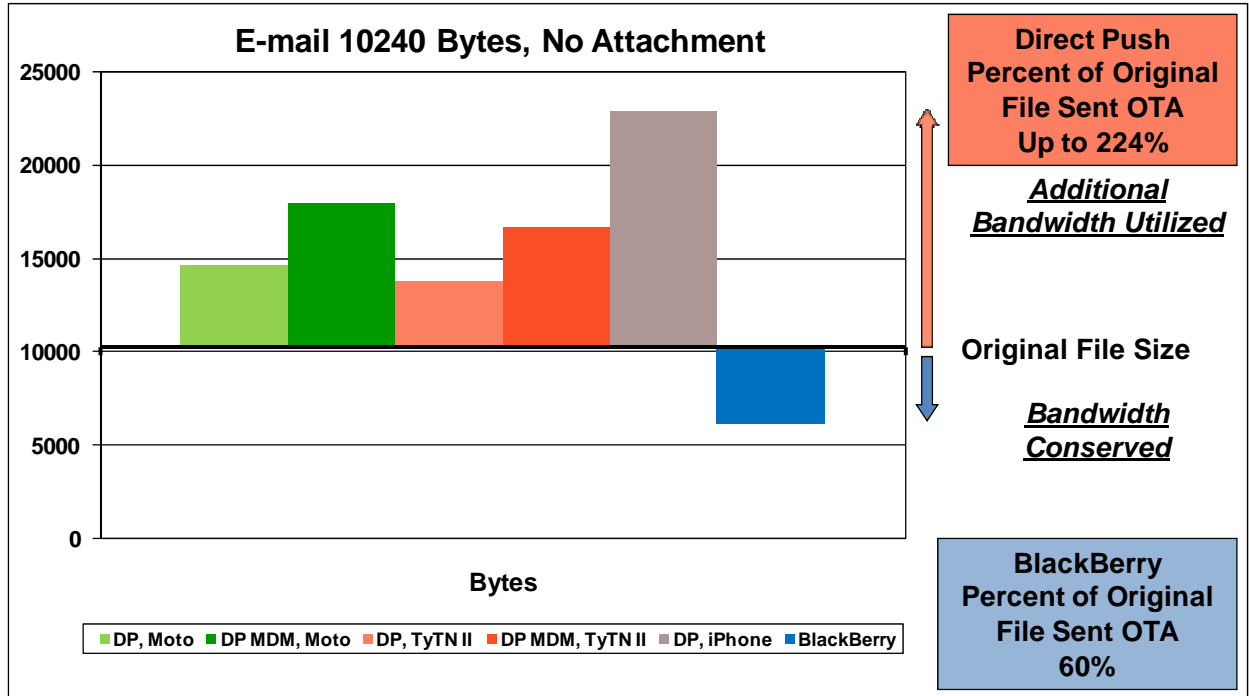
Microsoft Direct Push, iPhone

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
10240	0	n/a	3058	11875	4491	2664	0	0	7549	14539	22088
10240	0	n/a	3851	12144	4763	2850	0	0	8614	14994	23608
10240	0	n/a	3851	12214	5284	2916	0	0	9135	15130	24265
10240	0	n/a	3058	11865	4491	2644	0	0	7549	14509	22058
10240	0	n/a	2917	12142	4583	2778	0	0	7500	14920	22420
10240	0	n/a	3347	12048	4722	2770	0	0	8069	14818	22888

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RIM BlackBerry 9000

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
10240	0	n/a	60	1050	450	4559	0	0	510	5609	6119
10240	0	n/a	60	1050	450	4567	0	0	510	5617	6127
10240	0	n/a	60	1050	450	4559	0	0	510	5609	6119
10240	0	n/a	60	1050	450	4559	0	0	510	5609	6119
10240	0	n/a	60	1050	450	4559	0	0	510	5609	6119
10240	0	n/a	60	1050	450	4561	0	0	510	5611	6121



9.3 20 KB Text Message, No Attachment

Microsoft Direct Push, Motorola Q9h

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
20480	0	n/a	1309	4031	1661	13241	0	0	2970	17272	20242
20480	0	n/a	1309	4034	1661	13244	0	0	2970	17278	20248
20480	0	n/a	1307	4030	1661	13241	0	0	2968	17271	20239
20480	0	n/a	1307	4033	1661	13244	0	0	2968	17277	20245
20480	0	n/a	1309	4031	1661	13244	0	0	2970	17275	20245
20480	0	n/a	1308	4032	1661	13243	0	0	2969	17275	20244

Microsoft Direct Push SCMDM, Motorola Q9h

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
20480	0	n/a	1892	4752	3356	14458	0	0	5248	19210	24458
20480	0	n/a	1892	4756	3316	14480	0	0	5208	19236	24444
20480	0	n/a	1892	4756	3334	14458	0	0	5226	19214	24440
20480	0	n/a	1892	4756	3356	14442	0	0	5248	19198	24446
20480	0	n/a	1892	4756	3356	14442	0	0	5248	19198	24446
20480	0	n/a	1892	4755	3344	14456	0	0	5236	19211	24447

Microsoft Direct Push, TyTN II

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
20480	0	n/a	1193	3238	1905	13257	0	0	3098	16495	19593
20480	0	n/a	1191	3232	1905	13196	0	0	3096	16428	19524
20480	0	n/a	1193	3228	1845	13197	0	0	3038	16425	19463
20480	0	n/a	1193	3236	1905	13257	0	0	3098	16493	19591
20480	0	n/a	1191	3235	1905	13256	0	0	3096	16491	19587
20480	0	n/a	1192	3234	1893	13233	0	0	3085	16466	19552

Microsoft Direct Push SCMDM, TyTN II

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
20480	0	n/a	1722	3760	3234	14304	0	0	4956	18064	23020
20480	0	n/a	1722	3760	3234	14336	0	0	4956	18096	23052
20480	0	n/a	1722	3760	3234	14304	0	0	4956	18064	23020
20480	0	n/a	1722	3760	3234	14304	0	0	4956	18064	23020
20480	0	n/a	1722	3760	3234	14320	0	0	4956	18080	23036
20480	0	n/a	1722	3760	3234	14314	0	0	4956	18074	23030

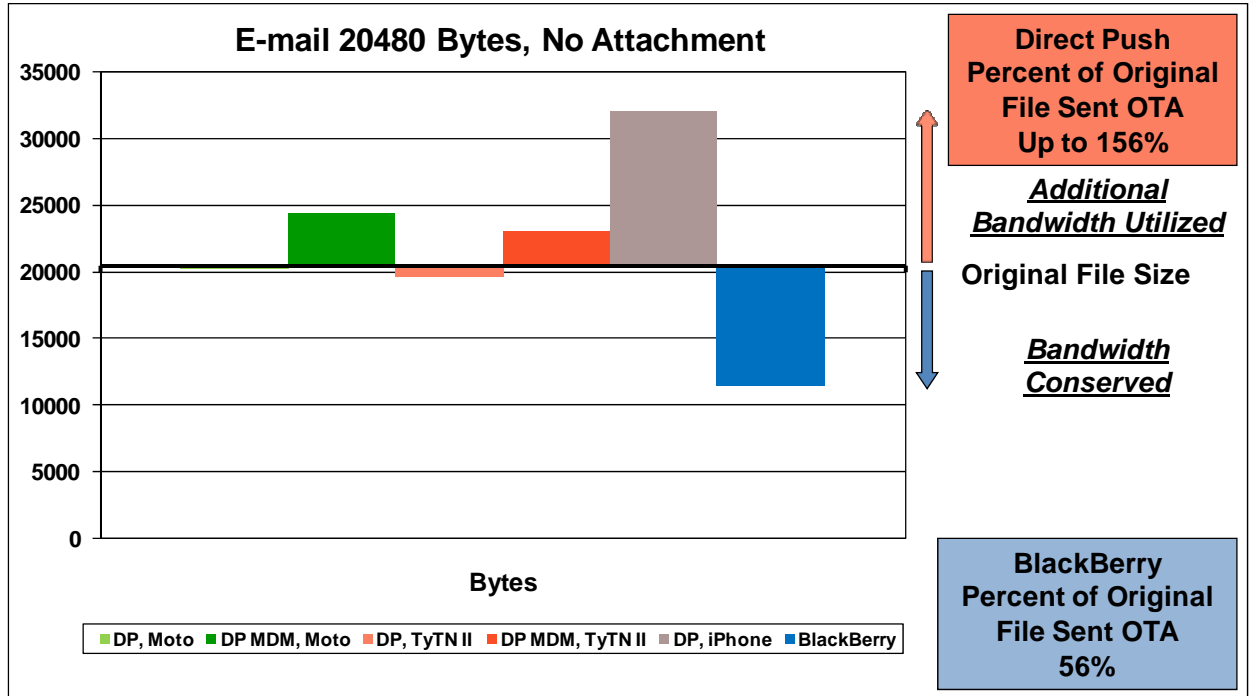
Microsoft Direct Push, iPhone

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
20480	0	n/a	4381	20367	4872	2852	0	0	9253	23219	32472
20480	0	n/a	3992	20362	4494	2646	0	0	8486	23008	31494
20480	0	n/a	4381	20367	5287	2918	0	0	9668	23285	32953
20480	0	n/a	4066	20360	4585	2786	0	0	8651	23146	31797
20480	0	n/a	3992	20362	4494	2640	0	0	8486	23002	31488
20480	0	n/a	4162	20364	4746	2768	0	0	8909	23132	32041

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Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
20480	0	n/a	60	1034	510	9923	0	0	570	10957	11527
20480	0	n/a	60	1034	510	9923	0	0	570	10957	11527
20480	0	n/a	60	1034	510	9923	0	0	570	10957	11527
20480	0	n/a	60	1034	510	9923	0	0	570	10957	11527
20480	0	n/a	60	1034	510	9923	0	0	570	10957	11527
20480	0	n/a	60	1034	510	9923	0	0	570	10957	11527



9.4 134 KB HTML Message, No Attachment

Microsoft Direct Push, Motorola Q9h

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
136737	0	n/a	1247	3901	2067	19457	12192	94447	15506	117805	133311
136737	0	n/a	1247	4008	2113	19568	12638	94573	15998	118149	134147
136737	0	n/a	1247	3898	1961	19457	12132	94509	15340	117864	133204
136737	0	n/a	1247	3901	1961	19459	13926	95117	17134	118477	135611
136737	0	n/a	1247	3902	1961	19460	13002	94453	16210	117815	134025
136737	0	n/a	1247	3922	2013	19480	12778	94620	16038	118022	134060

Microsoft Direct Push SCMDM, Motorola Q9h

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
136737	0	n/a	1892	4506	4242	21528	19716	101546	25850	127580	153430
136737	0	n/a	1892	4506	3722	21358	20870	101948	26484	127812	154296
136737	0	n/a	1892	4506	3600	21342	20026	101392	25518	127240	152758
136737	0	n/a	1892	4506	3722	21358	18610	101010	24224	126874	151098
136737	0	n/a	1892	4506	4242	21528	19546	101148	25680	127182	152862
136737	0	n/a	1892	4506	3906	21423	19754	101409	25551	127338	152889

Microsoft Direct Push, TyTN II

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
136737	0	n/a	1315	3900	2025	19398	11986	94595	15326	117893	133219
136737	0	n/a	1315	3906	2025	19398	11670	94463	15010	117767	132777
136737	0	n/a	1315	3904	2025	19397	11423	94283	14763	117584	132347
136737	0	n/a	1255	3908	2025	19400	13937	95207	17217	118515	135732
136737	0	n/a	1313	3902	2025	19400	12797	94769	16135	118071	134206
136737	0	n/a	1303	3904	2025	19399	12363	94663	15690	117966	133656

Microsoft Direct Push SCMDM, TyTN II

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
136737	0	n/a	1892	4506	3754	21406	20696	101904	26342	127816	154158
136737	0	n/a	1892	4506	3778	21236	20778	101384	26448	127126	153574
136737	0	n/a	1892	4506	4088	21236	21246	102888	27226	128630	155856
136737	0	n/a	1892	4506	4088	21236	20576	101392	26556	127134	153690
136737	0	n/a	1892	4506	3722	21236	20588	101896	26202	127638	153840
136737	0	n/a	1892	4506	3886	21270	20777	101893	26555	127669	154224

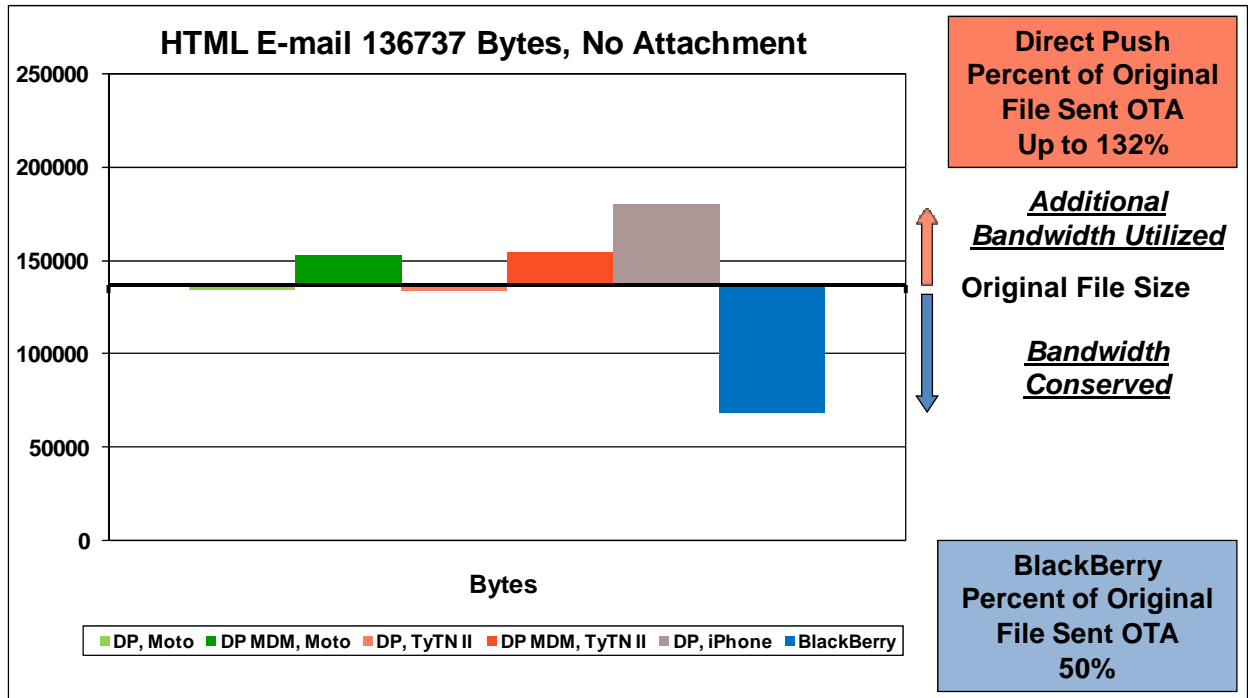
Microsoft Direct Push, iPhone

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
136737	0	n/a	6638	58344	16501	100289	0	0	23139	158633	181772
136737	0	n/a	7486	58383	13824	99937	0	0	21310	158320	179630
136737	0	n/a	6461	58252	15891	100699	0	0	22352	158951	181303
136737	0	n/a	6683	58249	14004	99655	0	0	20687	157904	178591
136737	0	n/a	7539	58382	13404	99599	0	0	20943	157981	178924
136737	0	n/a	6961	58322	14725	100036	0	0	21686	158358	180044

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Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
136737	0	n/a	120	2281	690	12697	7286	45705	8096	60683	68779
136737	0	n/a	120	2281	690	12697	7236	45681	8046	60659	68705
136737	0	n/a	120	2281	690	12697	7288	45705	8098	60683	68781
136737	0	n/a	120	2281	690	12697	7248	45705	8058	60683	68741
136737	0	n/a	120	2281	690	12697	7288	45705	8098	60683	68781
136737	0	n/a	120	2281	690	12697	7269	45700	8079	60678	68757



Rysavy Research Wireless E-Mail Efficiency Assessment

9.5 5 KB Text Message, 149 KB JPEG Attachment

Microsoft Direct Push, Motorola Q9h

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	152148	JPG	1307	4259	1361	5482	13705	241727	16373	251468	267841
5120	152148	JPG	1307	4257	1361	5484	13705	241727	16373	251468	267841
5120	152148	JPG	1307	4197	1361	5481	13705	241727	16373	251405	267778
5120	152148	JPG	1309	4265	1361	5484	13885	241727	16555	251476	268031
5120	152148	JPG	1309	4259	1361	5481	13705	241728	16375	251468	267843
5120	152148	JPG	1308	4247	1361	5482	13741	241727	16410	251457	267867

Microsoft Direct Push SCMDM, Motorola Q9h

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	152148	JPG	1892	4916	2136	6222	27428	256626	31456	267764	299220
5120	152148	JPG	1892	4932	2014	6222	27428	256626	31334	267780	299114
5120	152148	JPG	1892	4916	2014	6222	27428	256626	31334	267764	299098
5120	152148	JPG	1892	4932	2014	6222	27428	256626	31334	267780	299114
5120	152148	JPG	1892	4932	2014	6222	27428	256626	31334	267780	299114
5120	152148	JPG	1892	4926	2038	6222	27428	256626	31358	267774	299132

Microsoft Direct Push, TyTN II

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	152148	JPG	1193	3349	1305	5429	13713	241726	16211	250504	266715
5120	152148	JPG	1193	3349	1365	5430	13713	241726	16271	250505	266776
5120	152148	JPG	1189	3344	1365	5426	13713	241726	16267	250496	266763
5120	152148	JPG	1189	3347	1365	5489	13999	241666	16553	250502	267055
5120	152148	JPG	1193	3352	1365	5429	13713	241726	16271	250507	266778
5120	152148	JPG	1191	3348	1353	5441	13770	241714	16315	250503	266817

Microsoft Direct Push SCMDM, TyTN II

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	152148	JPG	1738	3872	2014	6116	27428	256504	31180	266492	297672
5120	152148	JPG	1770	3872	2014	6100	27428	256504	31212	266476	297688
5120	152148	JPG	1770	3888	2014	6116	27550	256626	31334	266630	297964
5120	152148	JPG	1770	3888	2136	6238	27428	256504	31334	266630	297964
5120	152148	JPG	1722	3872	2014	6116	27306	256504	31042	266492	297534
5120	152148	JPG	1754	3878	2038	6137	27428	256528	31220	266544	297764

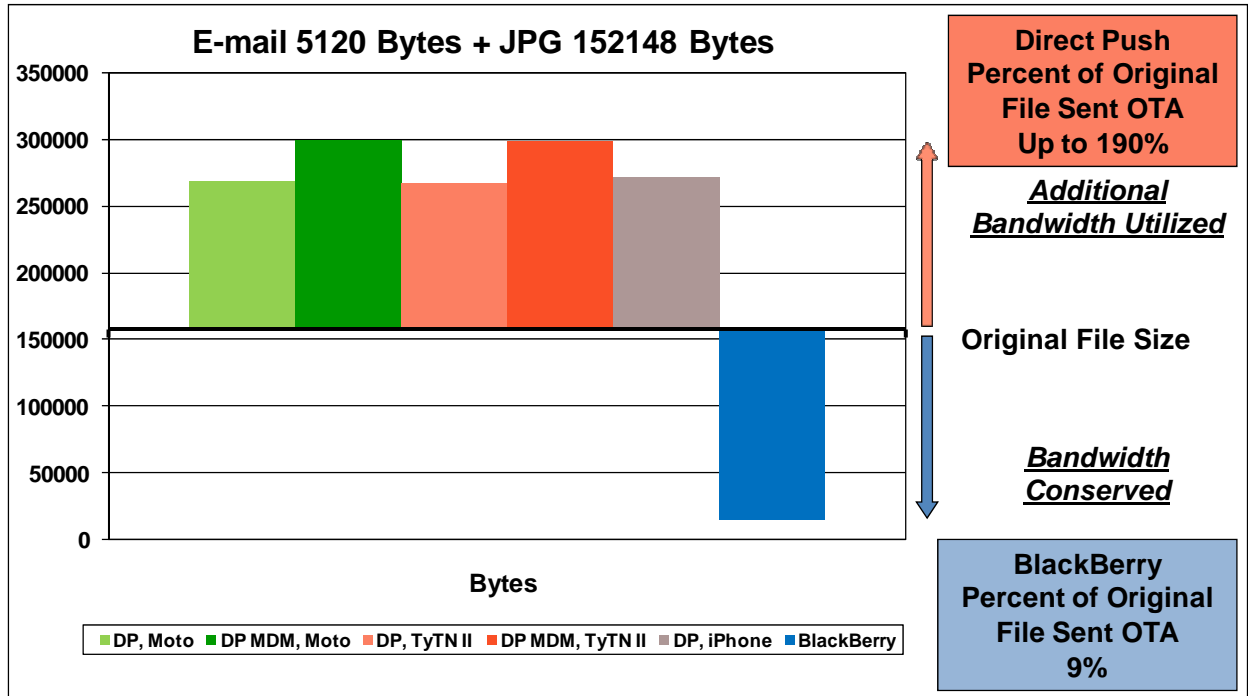
Microsoft Direct Push, iPhone

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	152148	JPG	1651	2521	4731	6002	13050	242198	19432	250721	270153
5120	152148	JPG	2444	2796	5630	6269	13644	242132	21718	251197	272915
5120	152148	JPG	2205	2593	4731	6005	13512	242132	20448	250730	271178
5120	152148	JPG	2444	2799	5524	6272	13446	242132	21414	251203	272617
5120	152148	JPG	2205	2587	4231	6004	13248	242132	19684	250723	270407
5120	152148	JPG	2190	2659	4969	6110	13380	242145	20539	250915	271454

Rysavy Research Wireless E-Mail Efficiency Assessment

RIM BlackBerry 9000

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	152148	JPG	60	1106	390	1945	465	10647	915	13698	14613
5120	152148	JPG	60	1106	390	1945	465	10647	915	13698	14613
5120	152148	JPG	60	1106	390	1945	465	10647	915	13698	14613
5120	152148	JPG	60	1106	390	1945	465	10647	915	13698	14613
5120	152148	JPG	60	1106	390	1945	465	10647	915	13698	14613
5120	152148	JPG	60	1106	390	1945	465	10647	915	13698	14613



9.6 5 KB Text Message, 355 KB PDF Attachment, Full View

Microsoft Direct Push, Motorola Q9h

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	363139	PDF-IMG	1311	4273	1361	5491	29245	522432	31917	532196	564113
5120	363139	PDF-IMG	1311	4269	1361	5432	29305	522433	31977	532134	564111
5120	363139	PDF-IMG	1311	4276	1361	5493	29365	522553	32037	532322	564359
5120	363139	PDF-IMG	1309	4275	1421	5495	29305	522433	32035	532203	564238
5120	363139	PDF-IMG	1309	4273	1361	5491	29245	522432	31915	532196	564111
5120	363139	PDF-IMG	1310	4273	1373	5480	29293	522457	31976	532210	564186

Microsoft Direct Push SCMDM, Motorola Q9h

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	363139	PDF-IMG	1892	4932	2014	6222	58904	554972	62810	566126	628936
5120	363139	PDF-IMG	1892	4948	2258	6222	58904	554972	63054	566142	629196
5120	363139	PDF-IMG	1892	4948	2014	6222	58904	554972	62810	566142	628952
5120	363139	PDF-IMG	1892	4948	2136	6222	58904	554972	62932	566142	629074
5120	363139	PDF-IMG	1892	4948	2014	6222	58904	554972	62810	566142	628952
5120	363139	PDF-IMG	1892	4945	2087	6222	58904	554972	62883	566139	629022

Microsoft Direct Push, TyTN II

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	363139	PDF-IMG	1143	3364	1365	5500	29193	522439	31701	531303	563004
5120	363139	PDF-IMG	1191	3362	1365	5437	29253	522379	31809	531178	562987
5120	363139	PDF-IMG	1191	3359	1365	5500	29313	522439	31869	531298	563167
5120	363139	PDF-IMG	1193	3364	1365	5440	29479	522439	32037	531243	563280
5120	363139	PDF-IMG	1191	3366	1365	5500	29253	522439	31809	531305	563114
5120	363139	PDF-IMG	1182	3363	1365	5475	29298	522427	31845	531265	563110

Microsoft Direct Push SCMDM, TyTN II

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	363139	PDF-IMG	1770	3888	1014	6100	58904	554834	61688	564822	626510
5120	363139	PDF-IMG	1770	3888	1014	6116	58538	554956	61322	564960	626282
5120	363139	PDF-IMG	1770	3888	1014	6100	58782	554956	61566	564944	626510
5120	363139	PDF-IMG	1770	3888	1014	6100	58782	554956	61566	564944	626510
5120	363139	PDF-IMG	1770	3888	1014	6100	58904	554956	61688	564944	626632
5120	363139	PDF-IMG	1770	3888	1014	6103	58782	554932	61566	564923	626489

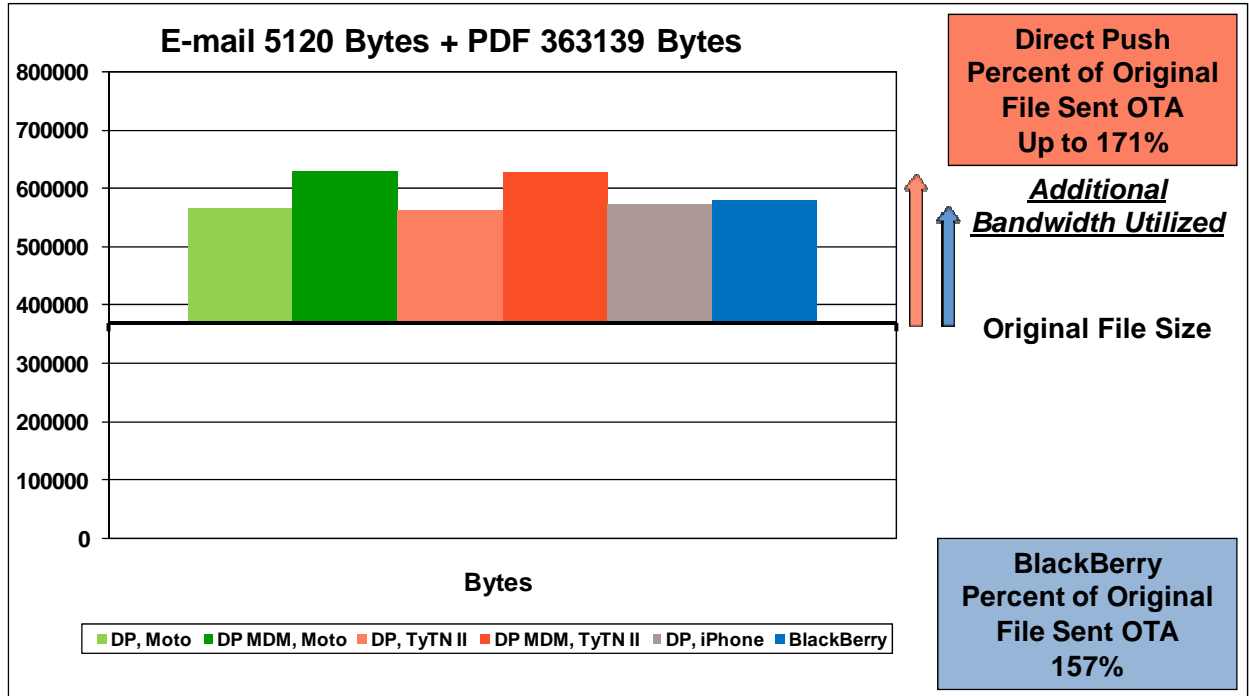
Microsoft Direct Push, iPhone

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	363139	PDF-IMG	2464	2194	5592	6288	27968	525682	36024	534164	570188
5120	363139	PDF-IMG	2444	2812	5526	6289	28166	525682	36136	534783	570919
5120	363139	PDF-IMG	2415	2803	5715	5888	27547	525814	35677	534505	570182
5120	363139	PDF-IMG	2444	2815	5592	6293	28392	525682	36428	534790	571218
5120	363139	PDF-IMG	2415	2807	5023	5750	28019	525880	35457	534437	569894
5120	363139	PDF-IMG	2436	2686	5490	6102	28018	525748	35944	534536	570480

Rysavy Research Wireless E-Mail Efficiency Assessment

RIM BlackBerry 9000

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	363139	PDF-IMG-TXT	60	1130	390	1953	13598	560469	14048	563552	577600
5120	363139	PDF-IMG-TXT	60	1130	390	1953	13598	560693	14048	563776	577824
5120	363139	PDF-IMG-TXT	60	1130	390	1953	13598	560469	14048	563552	577600
5120	363139	PDF-IMG-TXT	60	1130	390	1953	13598	560469	14048	563552	577600
5120	363139	PDF-IMG-TXT	60	1130	390	1953	13598	560514	14048	563597	577645



9.7 5 KB Text Message, 355 KB PDF Attachment, Text View

Microsoft Direct Push, Motorola Q9h

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	363139	PDF-IMG	1311	4273	1361	5491	29245	522432	31917	532196	564113
5120	363139	PDF-IMG	1311	4269	1361	5432	29305	522433	31977	532134	564111
5120	363139	PDF-IMG	1311	4276	1361	5493	29365	522553	32037	532322	564359
5120	363139	PDF-IMG	1309	4275	1421	5495	29305	522433	32035	532203	564238
5120	363139	PDF-IMG	1309	4273	1361	5491	29245	522432	31915	532196	564111
5120	363139	PDF-IMG	1310	4273	1373	5480	29293	522457	31976	532210	564186

Microsoft Direct Push SCMDM, Motorola Q9h

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	363139	PDF-IMG	1892	4932	2014	6222	58904	554972	62810	566126	628936
5120	363139	PDF-IMG	1892	4948	2258	6222	58904	554972	63054	566142	629196
5120	363139	PDF-IMG	1892	4948	2014	6222	58904	554972	62810	566142	628952
5120	363139	PDF-IMG	1892	4948	2136	6222	58904	554972	62932	566142	629074
5120	363139	PDF-IMG	1892	4948	2014	6222	58904	554972	62810	566142	628952
5120	363139	PDF-IMG	1892	4945	2087	6222	58904	554972	62883	566139	629022

Microsoft Direct Push, TyTN II

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	363139	PDF-IMG	1143	3364	1365	5500	29193	522439	31701	531303	563004
5120	363139	PDF-IMG	1191	3362	1365	5437	29253	522379	31809	531178	562987
5120	363139	PDF-IMG	1191	3359	1365	5500	29313	522439	31869	531298	563167
5120	363139	PDF-IMG	1193	3364	1365	5440	29479	522439	32037	531243	563280
5120	363139	PDF-IMG	1191	3366	1365	5500	29253	522439	31809	531305	563114
5120	363139	PDF-IMG	1182	3363	1365	5475	29298	522427	31845	531265	563110

Microsoft Direct Push SCMDM, TyTN II

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	363139	PDF-IMG	1770	3888	1014	6100	58904	554834	61688	564822	626510
5120	363139	PDF-IMG	1770	3888	1014	6116	58538	554956	61322	564960	626282
5120	363139	PDF-IMG	1770	3888	1014	6100	58782	554956	61566	564944	626510
5120	363139	PDF-IMG	1770	3888	1014	6100	58782	554956	61566	564944	626510
5120	363139	PDF-IMG	1770	3888	1014	6100	58904	554956	61688	564944	626632
5120	363139	PDF-IMG	1770	3888	1014	6103	58782	554932	61566	564923	626489

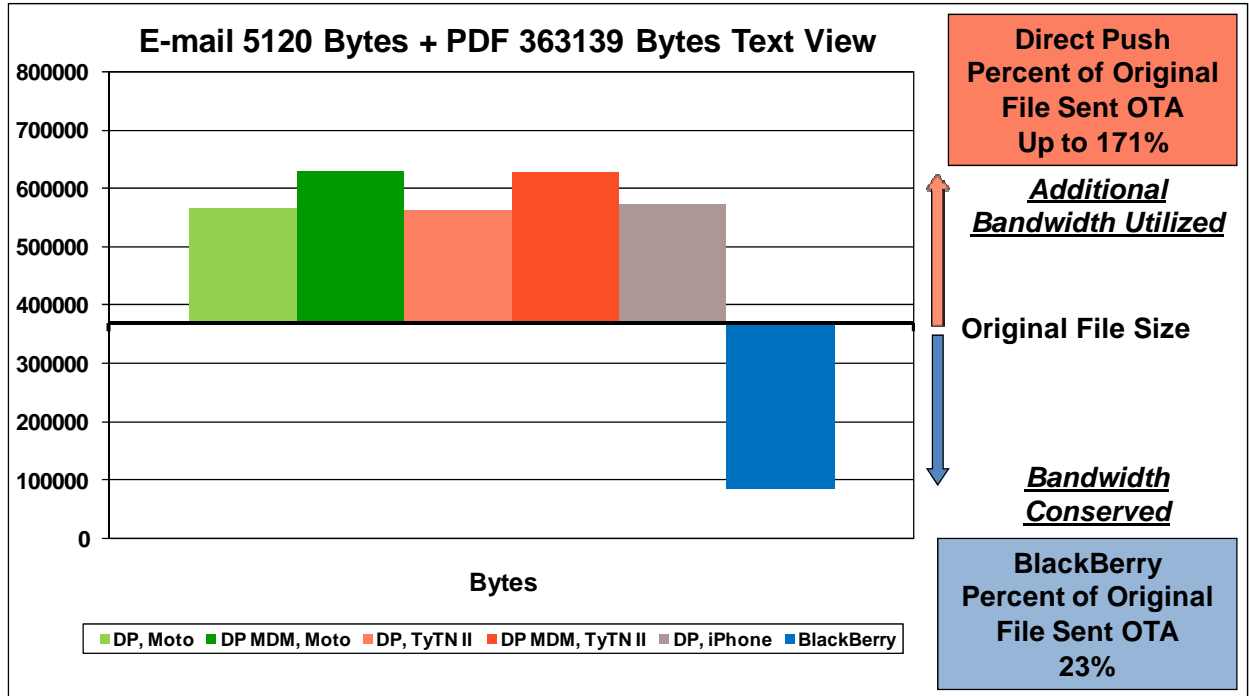
Microsoft Direct Push, iPhone

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	363139	PDF-IMG	2464	2194	5592	6288	27968	525682	36024	534164	570188
5120	363139	PDF-IMG	2444	2812	5526	6289	28166	525682	36136	534783	570919
5120	363139	PDF-IMG	2415	2803	5715	5888	27547	525814	35677	534505	570182
5120	363139	PDF-IMG	2444	2815	5592	6293	28392	525682	36428	534790	571218
5120	363139	PDF-IMG	2415	2807	5023	5750	28019	525880	35457	534437	569894
5120	363139	PDF-IMG	2436	2686	5490	6102	28018	525748	35944	534536	570480

Rysavy Research Wireless E-Mail Efficiency Assessment

RIM BlackBerry 9000

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	363139	PDF-IMG-TXT	60	1130	390	1953	3323	79006	3773	82089	85862
5120	363139	PDF-IMG-TXT	60	1130	390	1953	3263	78998	3713	82081	85794
5120	363139	PDF-IMG-TXT	60	1130	390	1953	3263	78998	3713	82081	85794
5120	363139	PDF-IMG-TXT	60	1130	390	1953	3263	79222	3713	82305	86018
5120	363139	PDF-IMG-TXT	60	1130	390	1953	3271	79006	3721	82089	85810
5120	363139	PDF-IMG-TXT	60	1130	390	1953	3277	79046	3727	82129	85856



9.8 5 KB Text Message, 500 KB Word Document Attachment

Microsoft Direct Push, Motorola Q9h

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	511488	DOC	1431	4313	1361	5477	31331	551204	34123	560994	595117
5120	511488	DOC	1307	4252	1361	5474	31405	551098	34073	560824	594897
5120	511488	DOC	1307	4254	1361	5476	31345	551098	34013	560828	594841
5120	511488	DOC	1309	4253	1361	5477	31465	551098	34135	560828	594963
5120	511488	DOC	1309	4254	1361	5479	31285	551098	33955	560831	594786
5120	511488	DOC	1333	4265	1361	5477	31366	551119	34060	560861	594921

Microsoft Direct Push SCMDM, Motorola Q9h

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	511488	DOC	1892	4916	2258	6206	63418	588260	67568	599382	666950
5120	511488	DOC	1892	4916	2258	6206	64272	588244	68422	599366	667788
5120	511488	DOC	1892	4916	2258	6206	64028	588260	68178	599382	667560
5120	511488	DOC	1892	4916	2258	6206	63906	588260	68056	599382	667438
5120	511488	DOC	1892	4916	2258	6206	64152	588260	68302	599382	667684
5120	511488	DOC	1892	4916	2258	6206	63955	588257	68105	599379	667484

Microsoft Direct Push, TyTN II

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	511488	DOC	1193	3342	1365	5474	31405	551033	33963	559849	593812
5120	511488	DOC	1193	3346	1365	5480	31353	551033	33911	559859	593770
5120	511488	DOC	1191	3344	1365	5479	31653	551033	34209	559856	594065
5120	511488	DOC	1193	3340	1365	5470	31773	551033	34331	559843	594174
5120	511488	DOC	1193	3346	1365	5477	31173	551033	33731	559856	593587
5120	511488	DOC	1193	3344	1365	5476	31471	551033	34029	559853	593882

Microsoft Direct Push SCMDM, TyTN II

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	511488	DOC	1738	3872	2014	6084	63662	588196	67414	598152	665566
5120	511488	DOC	1770	3888	2014	6084	64150	588074	67934	598046	665980
5120	511488	DOC	1770	3888	2014	6084	63348	587946	67132	597918	665050
5120	511488	DOC	1770	3888	2014	6084	63784	588090	67568	598062	665630
5120	511488	DOC	1770	3888	2014	6084	64638	588106	68422	598078	666500
5120	511488	DOC	1764	3885	2014	6084	63916	588082	67694	598051	665745

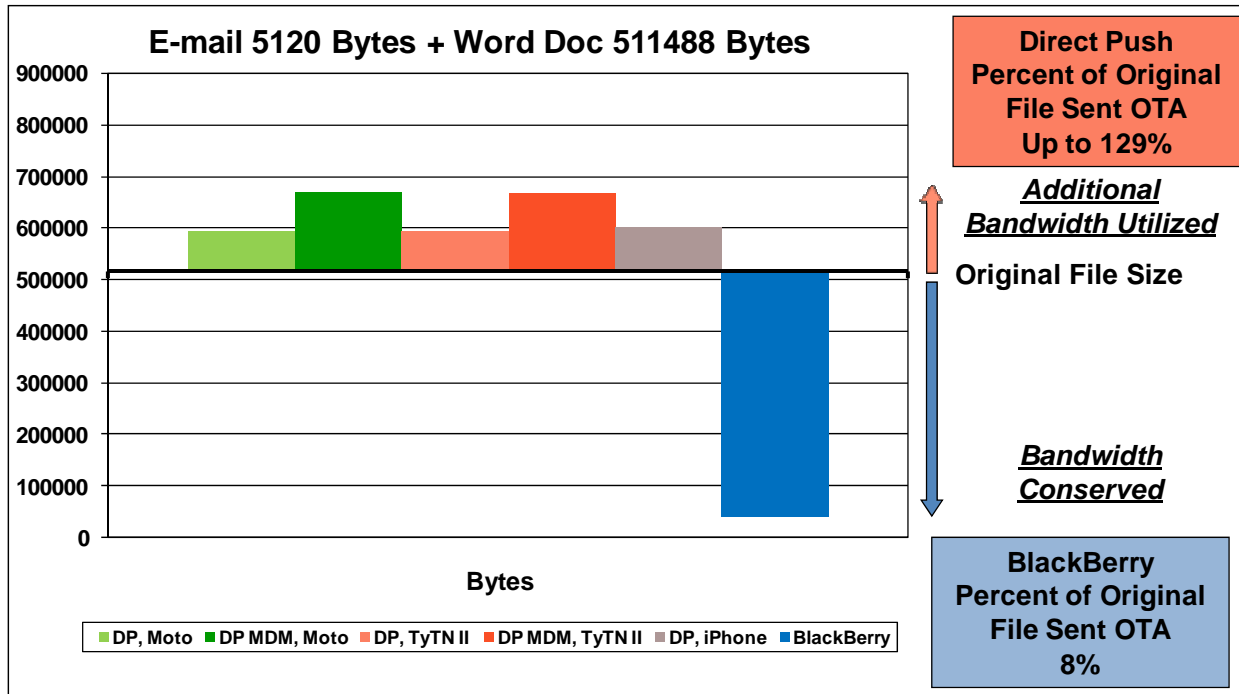
Microsoft Direct Push, iPhone

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	511488	DOC	2444	2793	5524	6273	29814	554902	37782	563968	601750
5120	511488	DOC	2205	2589	4731	6001	29722	554968	36658	563558	600216
5120	511488	DOC	2205	2590	4797	5998	32520	554902	39522	563490	603012
5120	511488	DOC	2205	2584	4731	5998	32784	554902	39720	563484	603204
5120	511488	DOC	2251	2524	4797	6001	30936	554902	37984	563427	601411
5120	511488	DOC	2262	2616	4916	6054	31155	554915	38333	563585	601919

Rysavy Research Wireless E-Mail Efficiency Assessment

RIM BlackBerry 9000

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	511488	DOC	60	1106	390	1953	2049	36366	2499	39425	41924
5120	511488	DOC	60	1106	390	1953	2049	36366	2499	39425	41924
5120	511488	DOC	60	1106	390	1945	2049	36366	2499	39417	41916
5120	511488	DOC	60	1106	390	1953	2049	36366	2499	39425	41924
5120	511488	DOC	60	1106	390	1953	2049	36366	2499	39425	41924
5120	511488	DOC	60	1106	390	1951	2049	36366	2499	39423	41922



9.9 5 KB Text Message, 944 KB PowerPoint Attachment

Microsoft Direct Push, Motorola Q9h

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	966144	PPT	1261	4266	1361	5474	72851	1351380	75473	1361120	1436593
5120	966144	PPT	1307	4264	1361	5484	73525	1357550	76193	1367298	1443491
5120	966144	PPT	1309	4266	1467	5487	72745	1351380	75521	1361133	1436654
5120	966144	PPT	1309	4263	1361	5423	73271	1351380	75941	1361066	1437007
5120	966144	PPT	1307	4264	1361	5484	72865	1351380	75533	1361128	1436661
5120	966144	PPT	1299	4265	1382	5470	73051	1352614	75732	1362349	1438081

Microsoft Direct Push SCMDM, Motorola Q9h

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	966144	PPT	1892	4948	2258	6238	148330	1435716	152480	1446902	1599382
5120	966144	PPT	1892	4932	2258	6222	148818	1435764	152968	1446918	1599886
5120	966144	PPT	1892	4948	2214	6360	148574	1435732	152680	1447040	1599720
5120	966144	PPT	1892	4932	2258	6222	148208	1435732	152358	1446886	1599244
5120	966144	PPT	1892	4932	2258	6222	148574	1435732	152724	1446886	1599610
5120	966144	PPT	1892	4938	2249	6253	148501	1435735	152642	1446926	1599568

Microsoft Direct Push, TyTN II

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	966144	PPT	1145	3346	1365	5487	72753	1351385	75263	1360218	1435481
5120	966144	PPT	1147	3350	1365	5428	72739	1351385	75251	1360163	1435414
5120	966144	PPT	1147	3351	1365	5486	72873	1351385	75385	1360222	1435607
5120	966144	PPT	1147	3349	1365	5426	72293	1351386	74805	1360161	1434966
5120	966144	PPT	1147	3354	1365	5489	73339	1357556	75851	1366399	1442250
5120	966144	PPT	1147	3350	1365	5463	72799	1352619	75311	1361433	1436744

Microsoft Direct Push SCMDM, TyTN II

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	966144	PPT	1770	3872	2136	6238	147720	1435732	151626	1445842	1597468
5120	966144	PPT	1738	3872	2136	6116	149306	1435796	153180	1445784	1598964
5120	966144	PPT	1770	3872	2014	6116	148696	1435716	152480	1445704	1598184
5120	966144	PPT	1738	3872	2136	6116	149306	1435716	153180	1445704	1598884
5120	966144	PPT	1738	3872	2014	6116	148208	1435732	151960	1445720	1597680
5120	966144	PPT	1751	3872	2087	6140	148647	1435738	152485	1445751	1598236

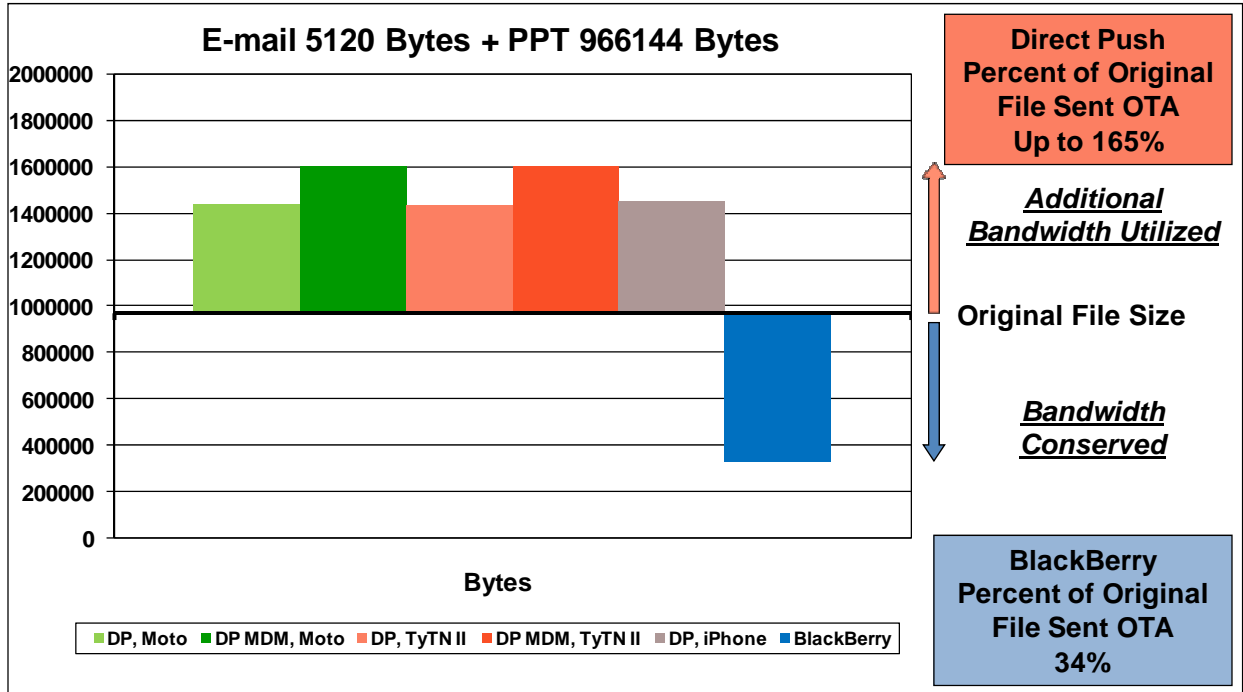
Microsoft Direct Push, iPhone

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	966144	PPT	2682	2989	6580	6141	72757	1363881	82019	1373011	1455030
5120	966144	PPT	2708	3065	5964	6076	71239	1363815	79911	1372956	1452867
5120	966144	PPT	2708	3062	5913	6082	72149	1363947	80770	1373091	1453861
5120	966144	PPT	2814	3058	6508	6144	70315	1363815	79637	1373017	1452654
5120	966144	PPT	2705	2992	5992	6076	72553	1363870	81250	1372938	1454188
5120	966144	PPT	2723	3033	6191	6104	71803	1363866	80717	1373003	1453720

Rysavy Research Wireless E-Mail Efficiency Assessment

RIM BlackBerry 9000

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	966144	PPT	60	1106	390	1945	7170	318432	7620	321483	329103
5120	966144	PPT	60	1106	390	1945	7170	318432	7620	321483	329103
5120	966144	PPT	60	1106	390	1945	7170	318432	7620	321483	329103
5120	966144	PPT	60	1106	390	1945	7170	318432	7620	321483	329103
5120	966144	PPT	60	1106	390	1945	7170	318432	7620	321483	329103



Rysavy Research Wireless E-Mail Efficiency Assessment

9.105 KB Text Message, 50 KB Excel Attachment

Microsoft Direct Push, Motorola Q9h

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	51200	EXCEL	1259	4252	1361	5473	2425	19712	5045	29437	34482
5120	51200	EXCEL	1309	4255	1361	5412	2305	19658	4975	29325	34300
5120	51200	EXCEL	1307	4255	1361	5477	2185	19598	4853	29330	34183
5120	51200	EXCEL	1309	4255	1361	5474	2425	19712	5095	29441	34536
5120	51200	EXCEL	1309	4255	1361	5475	2425	19651	5095	29381	34476
5120	51200	EXCEL	1299	4254	1361	5462	2353	19666	5013	29383	34395

Microsoft Direct Push SCMDM, Motorola Q9h

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	51200	EXCEL	1892	4916	2014	6222	4126	21846	8032	32984	41016
5120	51200	EXCEL	1892	4932	2258	6222	4014	21846	8164	33000	41164
5120	51200	EXCEL	1860	4916	2014	6222	4126	21846	8000	32984	40984
5120	51200	EXCEL	1892	4916	2014	6222	4126	21846	8032	32984	41016
5120	51200	EXCEL	1892	4916	2014	6222	4126	21846	8032	32984	41016
5120	51200	EXCEL	1886	4919	2063	6222	4104	21846	8052	32987	41039

Microsoft Direct Push, TyTN II

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	51200	EXCEL	1195	3342	1365	5421	2253	19653	4813	28416	33229
5120	51200	EXCEL	1193	3342	1365	5421	2253	19714	4811	28477	33288
5120	51200	EXCEL	1191	3340	1365	5481	2253	19653	4809	28474	33283
5120	51200	EXCEL	1193	3339	1431	5480	2373	19653	4997	28472	33469
5120	51200	EXCEL	1191	3340	1365	5477	2253	19653	4809	28470	33279
5120	51200	EXCEL	1193	3341	1378	5456	2277	19665	4848	28462	33310

Microsoft Direct Push SCMDM, TyTN II

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	51200	EXCEL	1770	3872	2014	6222	4236	21724	8020	31818	39838
5120	51200	EXCEL	1770	3872	2014	6100	4248	21724	8032	31696	39728
5120	51200	EXCEL	1770	3872	2014	6100	4192	21846	7976	31818	39794
5120	51200	EXCEL	1770	3872	2014	6100	4126	21724	7910	31696	39606
5120	51200	EXCEL	1770	3872	2014	6100	4126	21724	7910	31696	39606
5120	51200	EXCEL	1770	3872	2014	6124	4186	21748	7970	31745	39714

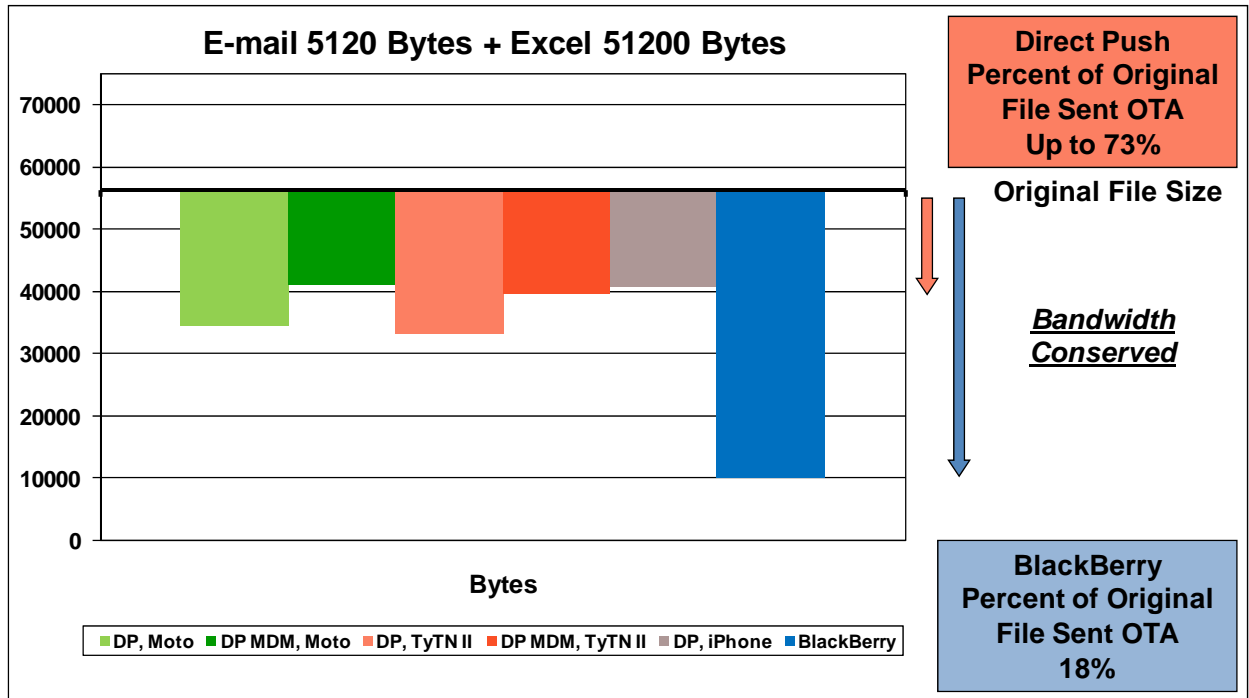
Microsoft Direct Push, iPhone

Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	51200	EXCEL	5634	28458	3520	2374	0	0	9154	30832	39986
5120	51200	EXCEL	5638	28464	4858	2712	0	0	10496	31176	41672
5120	51200	EXCEL	5528	28468	3520	2308	0	0	9048	30776	39824
5120	51200	EXCEL	6180	28655	3792	2580	0	0	9972	31235	41207
5120	51200	EXCEL	5660	28521	4065	2440	0	0	9725	30961	40686
5120	51200	EXCEL	5728	28513	3951	2483	0	0	9679	30996	40675

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Body size	Attach size	Attach type	Upload - init msg	Download - init msg	Upload - full msg	Download - full msg	Upload - attach	Download - attach	Total upload	Total download	Total bytes
5120	51200	EXCEL	60	1098	390	1953	987	5648	1437	8699	10136
5120	51200	EXCEL	60	1098	390	1945	987	5640	1437	8683	10120
5120	51200	EXCEL	60	1098	390	1945	987	5640	1437	8683	10120
5120	51200	EXCEL	60	1098	390	1953	987	5640	1437	8691	10128
5120	51200	EXCEL	60	1098	390	1953	987	5640	1437	8691	10128
5120	51200	EXCEL	60	1098	390	1950	987	5642	1437	8689	10126



10 Appendix D: Exchange Server 2007 and Windows Mobile 6.0

This appendix provides a summary of the test results from the report that Rysavy Research published April of 2008.

Table 3: Exchange Server 2007 SP1 and Windows Mobile 6 vs. BlackBerry 4.1

Message Size	Attachment Type	Attachment Size	Message Plus Attachment	Direct Push		BlackBerry	
				Sent Over The Air	% Sent	Sent Over The Air	% Sent
5120	None	0	5120	14715	287%	3466	68%
10240	None	0	10240	17378	170%	6094	60%
20480	None	0	20480	23149	113%	11475	56%
5120	JPEG	152148	157268	272321	173%	11285	7%
5120	PDF full	363139	368259	566340	154%	266935	72%
5120	PDF text view	363139	368259	566340	154%	160516	44%
5120	Word Doc	511488	516608	597438	116%	41473	8%
5120	PPT file	966144	971264	1439055	148%	496991	51%
5120	Excel	51200	56320	36665	65%	10062	18%

11 Appendix E: Exchange Server 2003 and Windows Mobile 5

This appendix provides a summary of the test results from the initial report that Rysavy Research published in 2006.

Table 4: Exchange Server 2003 SP2 and Windows Mobile 5 vs. BlackBerry 4.1

Message Size	Attachment Type	Attachment Size	Message Plus Attachment	Direct Push		BlackBerry	
				Sent Over The Air	% Sent	Sent Over The Air	% Sent
5120	None	0	5120	12489	244%	3244	63%
10240	None	0	10240	16154	158%	6012	59%
20480	None	0	20480	20994	103%	11518	56%
5120	JPEG	152576	157696	270385	171%	11170	7%
5120	PDF text	165888	171008	251416	147%	187641	110%
5120	PDF image	108052	113172	183658	162%	26896	24%
5120	Word Doc	512000	517120	602027	116%	58209	11%
5120	PPT file	966656	971776	1450367	149%	266949	27%
5120	Excel	76800	81920	29055	35%	7581	9%