



White Paper

Testing Wireless PC Cards

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1: Testing Competitive Wireless PC Cards

- Introduction
- Performance
- Design
- Operation
- Technical support

Introduction

This document outlines a suggested procedure for testing the performance of competitive wireless PC cards. There are several factors to consider when testing wireless PC cards, these include:

- Performance
 - Throughput
 - Radio Frequency (RF) performance
- Design
 - Antenna design
 - Power drain
- Operation
 - Installation and configuration
 - User interface and software features
- Technical support

Each of these factors is discussed in this document. Also included is a detailed test procedure for accurately testing the throughput of a wireless device under varying signal strength conditions. After reading this document, you should be able to characterize the throughput of different PC Cards under different signal strength conditions and you should also be able to characterize wireless devices based on the features listed above.

2: Performance

- Throughput and RF performance

Introduction

It is important to test the PC Cards under different signal strength conditions, since the radio frequency (RF) characteristics or sensitivity to signal strength affects the throughput of the PC Card. The results of this testing also give an understanding of the RF performance of the PC Card.

The throughput of a wireless PC Card is directly influenced by the received signal strength, so the better the RF performance of the PC Card, the better the throughput of the wireless PC Card is (especially under weaker signal strength conditions). This is important, since PC Cards are rarely used under ideal signal strength conditions. Regular users of wireless devices find themselves in fringe signal areas, or weak signal areas, and it is important to determine how the device works under these conditions.

After following the tests outlined in this chapter, you should be able to characterize the throughput of competitive PC cards under different signal strength conditions.

FTP testing

File Transfer Protocol (FTP) allows for a more reliable measurement of actual throughput of a network card or modem, since FTP is a protocol optimized for file transfer. Other web-based throughput tests would not have the same degree of reliability since they use HTTP (Hypertext transfer protocol).

Using an FTP server

The first step in testing the throughput of a device would be to set up an FTP server to allow for upload and download of data. There are some public FTP servers available (such as ftp.microsoft.com and ftp.nai.com), however, these generally only allow for downloading data and not for uploading data to the server. This means you would be able to test the download speed of a PC card, but not the upload speed. It is therefore recommended that you use an existing FTP server within your

organization (your network administrator will be able to supply you with an FTP server address, user name, and password).

Performing an FTP throughput test

Once you have an FTP server set up, the first step is to connect to the server and log in. This can be done by running a command prompt (or DOS prompt) by clicking on **Start > Programs > Accessories > Command Prompt**.

Once you have a command prompt open, you can log into the FTP server by typing "ftp" followed by the server IP address or name. You are then prompted to enter a user name and password. An example of this is shown below (connecting to an FTP server at the IP address 64.114.87.227, with user name "speed" and a password):

```
C:\>ftp 64.114.87.227
Connected to 64.114.87.227.
220 parmftp1 Microsoft FTP Service (Version 5.0).
User (64.114.87.227:(none)): speed
331 Password required for speed.
Password:
230 User speed logged in.
ftp>_
```

Once logged into the FTP server, a file can be downloaded from the FTP server to your local computer (over the wireless modem) by typing in "get" followed by the filename and extension. An example of this command is shown below:

```
ftp> get sw.bin
200 PORT command successful.
150 Opening ASCII mode data connection for sw.bin
(131400 bytes).
226 Transfer complete.
ftp: 131400 bytes received in 4.00Seconds
32.85 Kbytes/sec.
```

Note: The throughput is given in Kilobytes per second. To convert to Kilobits per second, you should multiply this number by 8.

As can be seen from the last line, you are informed of the total bytes received, the time taken and the actual throughput. This last line is the most interesting, and the throughput should be recorded.

Now a file can be uploaded from your local computer to the FTP server (also over the wireless modem) by typing in "put" followed by the filename and extension. An example of this is shown on the following page.

```
ftp> put sw.bin
200 PORT command successful.
150 Opening ASCII mode data connection for sw.bin.
226 Transfer complete.
ftp: 131400 bytes sent in 9.00Seconds 14.60 Kbytes/
sec.
```

Recording the last line gives you the upload speed of the file transfer.

Using this method you should be able to determine both the upload and download speeds of the PC card.

Testing Prerequisites

The following prerequisites are required to ensure that the testing is fair on both wireless cards, and to eliminate differences in the physical location and network environment.

- The same computing device should be used for both PC cards to ensure the same test environment for both wireless cards.
- The tests should be carried out in the same physical location, to ensure the signal (RF) conditions are the same for both PC cards.
- The tests on both PC cards should be carried out at the same time, to ensure similar network conditions for both PC cards.
- The tests should be carried out on the same wireless carrier's network to eliminate the differences between cellular providers' networks.
- Create a file that you will transfer using FTP. A file size of 100–200 kilobytes is recommended. It does not take too long to transfer, but still gives accurate results.

Suggested test procedure

The test procedure involves repeating the FTP upload and download tests to get a good average for the overall performance of the wireless cards. The tests are also carried out under varying signal conditions to establish the performance of the wireless card under different signal strength conditions.

Setup the computer with the first wireless card installed. Find an area of good signal strength and record the signal strength. Then perform the following tests:

1. Insert the PC Card into the computer
2. Launch a wireless connection to the network
3. Ensure that there is no longer data traffic being passed
4. Open up a command prompt (or MS-DOS window)
5. Connect to the FTP server
6. Login using your user name and password
7. Type in: `get filename` where "*filename*" is the your test file (such as `test.bin`)
8. Repeat the "get" operation 5 times and record the throughput speed for each test
9. Type in: `put filename` where "*filename*" is the your test file
10. Repeat the "put" operation 5 times and record the throughput speed for each test
11. Eject the PC Card
12. Insert the competitive wireless card and repeat steps 1 through 11.

Repeat the procedure as many times as possible for more accurate results

Enough tests should be performed to obtain a good average throughput figure. The test computer should then be moved to an area of moderate signal strength and the above tests should then be repeated for both cards. Finally, the test computer should then be moved to an area of weak signal strength and the tests repeated.

Tabulating and charting the results

Once these tests have been performed in different signal (RF) strength conditions, it should be possible to tabulate the results. The results should be averaged to give an overall performance average. This is done to eliminate variations caused by network fluctuations and differences in packet routing across the Internet.

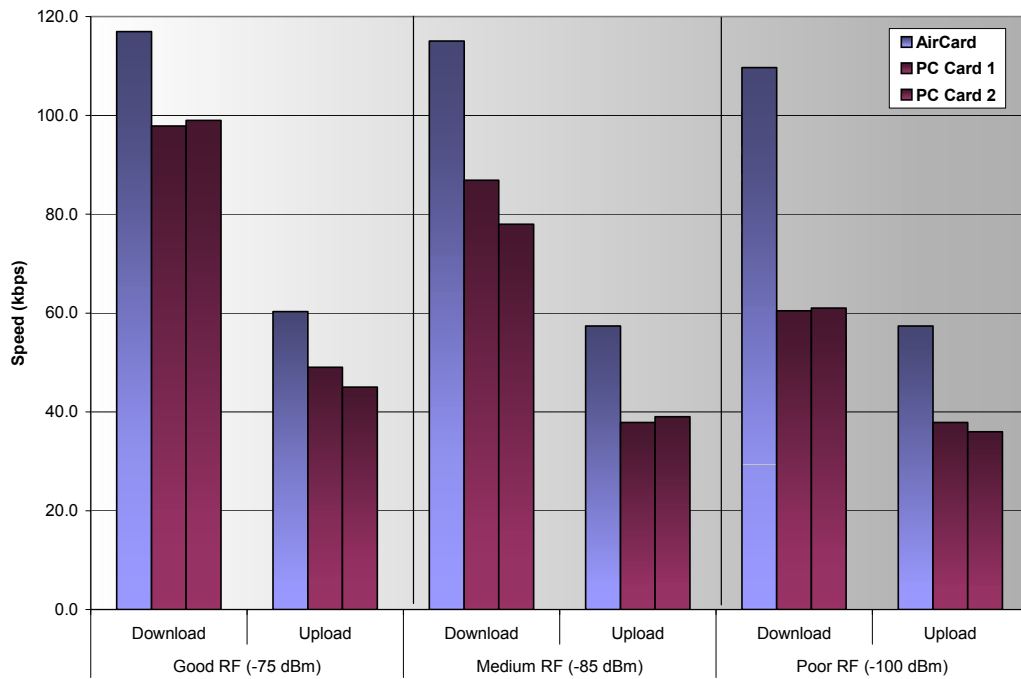
A sample tabulation is shown on the following page.

Results (in kbps)

Test	Good RF -75 dBm				Medium -85 dBm				Poor RF -100 dBm			
	AirCard		PC Card 1		AirCard		PC Card 1		AirCard		PC Card 1	
	Down	Up	Down	Up	Down	Up	Down	Up	Down	Up	Down	Up
Ave	117.0	60.3	97.9	49.0	115.0	61.0	86.9	51.8	109.7	57.4	60.5	37.9
1	118.96	63.68	117.68	60.80	123.04	68.48	68.88	66.24	90.8	51.12	24.56	15.76
2	124.64	60.80	108.32	35.92	93.44	68.80	62.32	53.44	116.88	59.44	115.36	24.24
3	108.64	66.32	80.96	42.64	119.28	68.24	97.92	52.72	118.24	60.16	34.96	43.60
4	109.92	57.28	67.68	45.60	111.52	67.20	56.48	69.84	112.64	57.84	44.88	27.84
5	122.08	60.48	106.88	54.88	122.88	67.76	67.2	35.04	115.12	57.12	90.56	62.00
6	113.36	60.64	109.12	58.32	117.92	59.76	34.08	32.40	114.72	62.40	33.04	56.72
7	132.24	57.28	107.44	60.56	118.88	60.08	116.24	34.96	71.52	61.04	69.12	57.04
8	112.64	60.48	108.32	35.92	117.52	59.28	93.76	56.72	104.88	56.40	19.68	12.32
9	108.64	60.64	80.96	42.64	119.28	58.16	93.76	39.12	115.6	51.36	113.04	12.08
10	109.92	57.28	67.68	45.60	119.04	58.32	107.12	58.32	118.72	60.00	36.32	56.48
11	122.08	60.48	106.88	54.88	114.08	60.48	90.8	58.00	113.36	54.96	90.56	62.00
12	113.36	60.64	109.12	58.32	115.6	54.96	99.52	61.28	104.88	61.04	33.04	56.72
13	113.36	57.28	107.44	60.56	117.28	54.80	105.52	57.20	115.6	56.40	69.12	57.04
14	132.24	60.48	108.32	35.92	112.16	56.40	91.12	62.96	118.72	51.36	19.68	12.32
15	112.64	60.64	80.96	42.64	103.44	51.60	118.48	38.16	113.36	60.00	113.04	12.08

Using these results, it should then be possible to draw a chart similar to the one below (this chart now compares more than two wireless cards):

Throughput Speeds in Different Signal conditions



Charts like this allow a comparison of the performance of wireless PC Cards under different signal conditions. For example, in the sample Chart you can see that the AirCard has a higher throughput than the competitors' PC Cards, and that under poor signal conditions it is significantly better than the competitors based on its better RF performance in poor signal strength areas.

Other methods of testing throughput

There are quicker, although less accurate, methods of testing download speeds; most of these are web-based throughput tests. Two of the more popular are:

- www.bandwidthplace.com
- www.toast.net

3: Design

- Antenna design
- Power drain

Antenna design

The design of the antenna for a wireless PC Card is an important consideration when choosing between wireless devices. The antenna design can influence the connectivity of the wireless PC Card to the network. It can be a significant repair cost, and also be a factor in the convenience of the user experience.

Some factors to consider in Antenna design are:

Radio frequency (RF) performance—This is the signal performance of the wireless PC Card. This can be significantly influenced by the design of the antenna. A test plan for characterizing the RF performance is included under the section on throughput and RF testing in the previous chapter.

Fixed extension from the computer—Does the antenna include a fixed extension from the computer so that the card is larger than a standard Type II PC Card? An antenna extended from the computer can be a disadvantage meaning that the PC Card must be removed every time the device is packed away into a laptop case. It also may prevent other PC Cards using the second slot on the computer. Extensions from a computer also present an increased risk of damage to the PC Card and could result in a permanently damaged card.

Omnidirectional antenna—Is the antenna able to move in multiple directions? Having the ability to move the antenna a few millimeters in more than one direction can often have a significant effect on signal strength in a particular location due to the short wavelength of wireless radio signals. A fixed antenna, or one that moves only along one plane, is not able to take advantage of small micro-variations in signal strength around a computer, which an omnidirectional antenna is able to.

Removable—is the antenna removable? If so, it means that the antenna can be removed when the PC Card is not being used. This allows the PC Card to be left inside the computer, minimizing the risk of losing the card. A removable antenna is also much easier to replace in case of loss or damage.

Extendable—Does the PC Card have the ability to extend the antenna to an external antenna? This is important if the device is used inside a vehicle, or in areas of marginal signal strength.

Having an external antenna, or the ability to locate the antenna away from the computer device can significantly improve signal reception.

Power drain testing

Another important feature of wireless PC Cards is the amount of power they draw from the host's battery. This is an important factor, since a mobile user often uses their laptop or PDA and wireless PC Card in an environment where there may be no power outlet. Thus, a device with lower power draw is important in increasing the amount of time the user is able to use the laptop or PDA.

Theory

It is easy to calculate the theoretical power draw from a device. The amount of power is merely the voltage (**V**) multiplied by the current draw (**i**), or:

$$\text{Power} = Vi$$

This means that power draw can be calculated from the specifications provided by the device manufacturer. It is important to note that manufacturers may give different voltage and current ranges, based on the operating environment of the device, so it may be difficult to accurately predict how a wireless PC Card will influence the battery life of the laptop or handheld device.

An example of this is a wireless PC Card that uses a network adapter interface and can go into standby mode when there is no data being transmitted. This means that when data is not being transmitted (when the PC Card is in standby mode), the power draw is much lower than when data is being transmitted.

Battery drain testing

It is important to perform a practical test of a wireless PC Card's actual current draw under a variety of conditions. There are two ways of doing this, and these are described below. For all battery testing, it is important to ensure that the competitive PC Cards are both tested on the same computer, with the battery fully charged at the start of all tests. This ensures that the test conditions are the same for both devices.

The first test option is to test the device under maximum power draw conditions (connected to the wireless network, with continuous data flow, such as streaming audio) and also

under minimum power draw (connected to the wireless network, but not passing any data traffic). This gives you both the longest and shortest life of the battery being tested.

The second option is to construct a typical usage profile. An example of this would include 10 minutes of heavy data traffic (simulating a user downloading their e-mail, or connecting to an application), followed by 30 minutes of no data traffic (simulating the user connected to the network, but reading and replying to e-mail, or using information from the application). Repeating this test profile until the battery dies, gives you the expected length of battery life for a typical user.

Once you have run one of the above tests on both wireless PC Cards, you are able to take the results and compare both the theoretical power draw to the battery life actually tested in a real life scenario. This allows you to compare the battery drain that both PC Cards have on the computer.

4: Operation

- Installation and configuration
- User interface and software features

Installation and configuration

The overall ease of installation of a device onto a computer can be a significant factor in the overall satisfaction of the user. To determine how easy it is to install a PC Card onto a device, a good test is to find a user unfamiliar with both devices, and record how long it takes him or her to get from sitting down in front of a computer with the device to being connected to the network. It is a good test to install competitive PC Cards onto a computer and compare the times, to determine which PC Card was easier to install and configure.

Several factors can influence the time taken to install and configure a PC Card quickly and easily. Some of these are listed below.

Clear installation instructions— Easily understood software installation instructions, mean that users follow the installation in the correct order and it is clear at all stages of the installation what the next step should be.

Drivers loaded automatically— Correct driver files automatically copied onto the computer during the installation means that the user does not have to manually copy the files. This means that the user will not select the incorrect driver files during the installation.

Connections created automatically— The software should create the default connections to the wireless network automatically. This means that the user does not have to create Dial-Up Networking connections and have to know the dial-up numbers required by the network to connect.

WHQL certification— Microsoft Windows now has a database of drivers that are tested and certified by the Windows Hardware Quality Labs for Windows 2000 and Windows XP. Having WHQL certification allows for an easier installation on these operating systems, since the drivers are automatically recognized and loaded.

User interface and software features

The software user interface that the wireless PC Card loads onto the computer can influence the user's ability to connect to the network and understand the operation of the PC Card and its connection to the network. Some of the factors that can be important in the software user interface are:

Hardware interface—Does the device have a modem (COM) interface or a network adapter (NIC) interface? There are distinct advantages to having a network adapter interface, including: convenience, power management, faster registration, suspend and resume, intelligent switching, simultaneous communication. These features are discussed in more detail in a Sierra Wireless white paper entitled "*Advantages of a Network Interface*", available at www.sierrawireless.com

Single application—If the user interface is loaded in a single application, it can be a lot clearer to the end user which application to run for accessing the Internet wirelessly. Having more than one application to access the wireless network, and information about the PC Card, can often be confusing and frustrating to the user.

Signal strength—It is essential to have a clear indication of the current signal strength in a location, as this can influence the connectivity of the PC Card to the network. A wireless PC Card with a network interface can give a real-time reading of the signal strength conditions while simultaneously passing data. Devices with a modem interface often require separate applications to monitor signal strength, and connection to the network. This means that you may not be able to monitor the signal strength while connected to the Internet.

Integration with other applications—This is an important convenience factor for the end user. For example, integrating the contacts in your e-mail application (such as Microsoft Outlook), with the software controlling the PC Card, is much more convenient for the user that wants to dial contacts directly from the PC Card.

PC Card and network information—It is sometimes necessary to access important information about the PC Card or the network. Ensure that the Software application is able to access details of the card that is being used.

»» 5: Support

- Technical support
- Conclusions

Technical support

Another important factor to consider when choosing between competitive PC Cards is the after sales technical support. Wireless data modems can sometimes present challenges when installing, configuring, and in daily use. It is important to determine the level of technical support that you will receive if you experience difficulties with your PC Card.

Visit each of the competitors' web sites and determine the level of technical support that is available from each one. Features that are important are:

- Clear layout, so that you are able to find information quickly
- Latest software and user guides available for download
- Technical resolutions outlining known issues and providing resolutions
- Troubleshooting guides for troubleshooting your PC Card
- Documentation on wireless data topics in general
- A Frequently Asked Questions (FAQ) section, answering common questions

It may also be worthwhile speaking to other customers to determine the level of technical support that they have received in the past.

Conclusion

When purchasing wireless PC Cards it is important to understand the differences between the wireless products on the market. It is important to understand how fast the actual throughput of the PC Card is, both for uploading and downloading data, and to understand how the wireless card performs under different signal conditions. Since signal strength can affect the throughput of the PC Card, it is important to test under a variety of signal strength conditions.

It is also important to compare the wireless PC Cards considering factors such as: power drain, antenna design, installation and configuration, user interface and software features, and technical support.

When comparing wireless PC Cards, it is important to consider all of these features before choosing a product.