

Agilent Testing Data Throughput of Wireless Devices

Setup and Procedure with the 8960 Series 10 Wireless Communications Test Set

Application Note

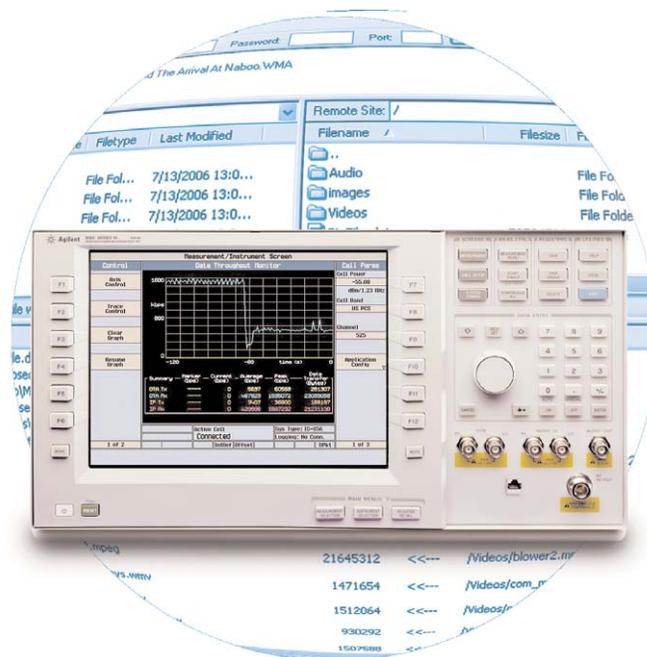
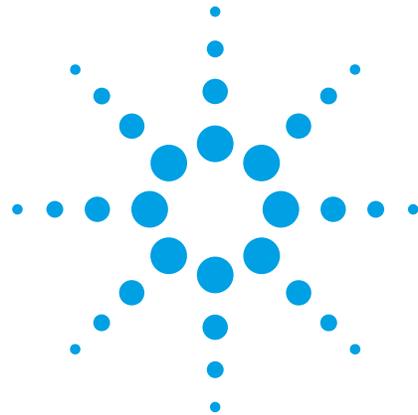


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1. Introduction

As cellular phones continue to evolve, so does their functionality. Modern cellular phones are no longer known for just voice communication, but also as hardware that delivers digital media to the user. As a result, today's mobile phones act as portable media devices such as MP3 players, internet browsers, streaming video players, and digital cameras. Perhaps one of the most important functions of phones today is data throughput. Whether a user is downloading a new ring tone, watching the latest news broadcast over streaming video, or checking their e-mail, the transmission of data is and will be an important feature for all current and next generation phones.

With the increase in demand for faster data transfers in wireless devices, research and development (R&D) teams are constantly finding ways to get more out of their cellular devices. As a result, these designers may find it advantageous to obtain a means of measuring the data transfer rates during the R&D process to ensure their phones can live up to the escalating standards of a competitive market.

The 8960 Wireless Communications Test Set from Agilent Technologies features a data throughput monitor to be used by designers during the R&D process. The data throughput monitoring provides both numerical and graphical measurements for the data rates (current, peak, and average) as well as the accumulations of IP packets and bytes both to and from the 8960 test set and the device under test (DUT).

The 8960 test set offers an advantage to designers by assisting them in optimizing data transfers. This useful data allows the designers to verify that their product meets set product specifications and provides useful information for differentiating their phones in the expanding and competitive marketplace.



Agilent 8960 Wireless Communications Test Set Series 10

2. Overview

This document will provide assistance in setting up and performing data throughput tests using the 8960 test set, as well as document a list of common problems one may run into while performing these tests. Most of the testing methods provided will show the capabilities of the DUT in an optimum environment; however, this article will also cover methods of generating real world factors such as noise and data corruption to allow the user to see the effects when such an issue is introduced into the system. It must be noted that the setup and procedure from the figures and diagrams shown may differ depending on the hardware currently being tested or the software used to perform the data transfer.

In order to run a successful data throughput test using the method described in this note, the following will be used:

- Server PC
- Client PC
- Device under test (DUT) (i.e. cellular phone, wireless card, etc.)
- Agilent 8960 Wireless Communications Test Set Series 10
- Appropriate cables and connectors (see *Section 3.3. Physical connection setup*)
- Appropriate software (see *Section 3.1. Server PC setup* and *Section 3.2. Client PC setup*)

More details regarding the software will be provided in *Section 3. Test Setup*. It should be noted that the settings noted in this article might differ depending on the data throughput format of the DUT you are currently testing. The software used to perform the data transfers in this document are recommended but not required (see *Section 3.1* and *3.2*). If desired, you may use similar file transfer software as long as the fundamental settings are changed to match the ones mentioned in this tutorial. To ensure that all the settings for the 8960 are correct, be sure to view Tables 2 through 4 in *Section 3.4* to get a list of all the settings used for each format when performing a data throughput test. If any problems occur, a troubleshooting section is provided at the end of the document that lists the solutions to common problems one may encounter when testing the wireless device.

3. Test Setup

Setting up a data throughput test runs along the same lines as setting up a standard FTP server/client connection. The following setup instructions will cover the settings used to obtain desirable test results on the 8960 test set. Setting up an FTP server and client will be covered first, followed by a physical connection diagram, and finally, the settings for the test set itself. If you already have an FTP server and client set up, skip to *Section 3.3. Physical connection setup*. However, keep in mind that the IP addresses you assign for the server, DUT, and the test set must all have the same subnet (the first three set of numbers in the IP address). Also, to ensure data rates that show the full potential of the device, be sure to set the internal transfer buffer size (also known as the file buffer size) to 56000.

3.1 Server PC setup

Before starting the server PC setup procedure, be sure to install the appropriate software to perform the data transfer. The tutorial will be describing a given set of downloadable applications, which are available at the provided links. It is recommend that you use the applications listed below, but you may use whatever programs you prefer as long as the same basic setup values apply (such as changing the transfer buffer size). Also, be sure to **turn off any firewalls that may interfere with the data transfer on both the server and client PC.**

- Apache HTTP server project: <http://httpd.apache.org/>
- Filezilla server application: <http://filezilla.sourceforge.net/>

Note: Filezilla is used for FTP file transfer tests while Apache is used for HTTP tests using Internet Explorer®.

Setting up an FTP server

Once all of the proper applications have been installed, we must first set the internal transfer buffer size to 56000. If this is not set to 56000, data transfer may be at less than optimal rates due to a lack of allocated resources. Increasing the internal transfer buffer size will ensure that the measurements will represent the full potential of the DUT. For this document, we will be using Filezilla as our FTP server application.

Note: When running Filezilla for the first time, a pop up screen will ask for the server address. These settings can be left as they are (the IP address mentioned in this window is referring to an internal IP address and should not be changed). Check the box to use this IP address always and this question will not re-appear each time the program is launched.

Setting the internal transfer buffer size can be done in Filezilla by clicking on the gear icon (see Figure 1) to bring up the server options, then go to **Miscellaneous** and set the **Internal transfer buffer** size to **56000** (see Figure 2).

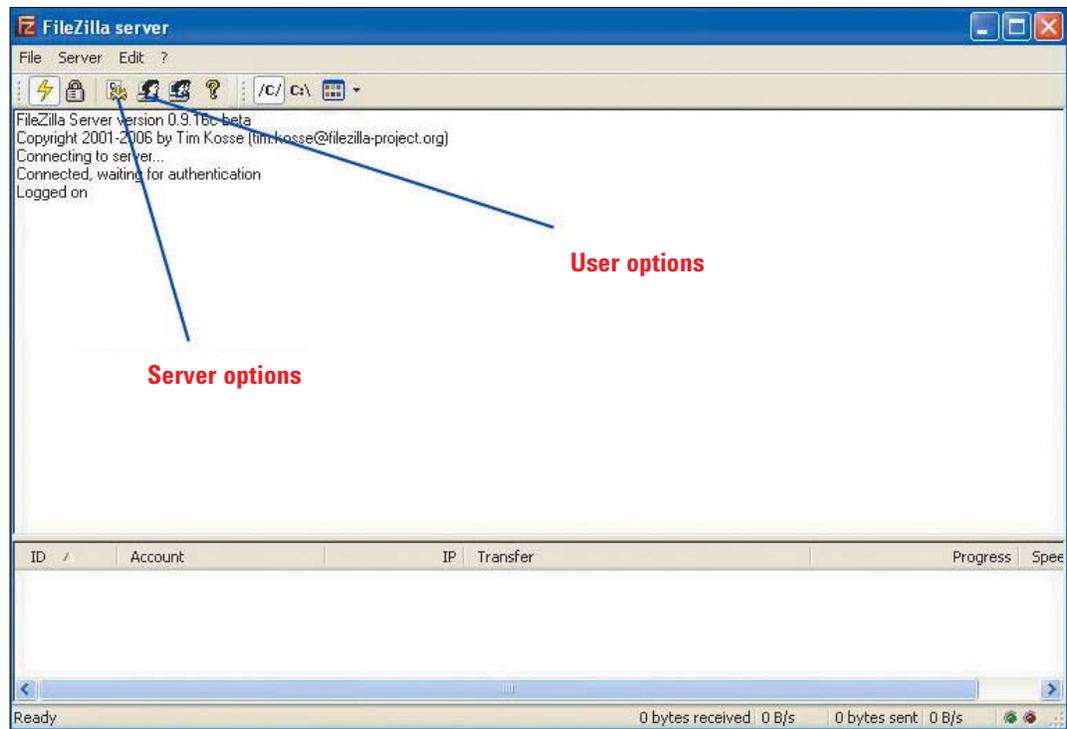


Figure 1. The Filezilla server application with the server and user options marked

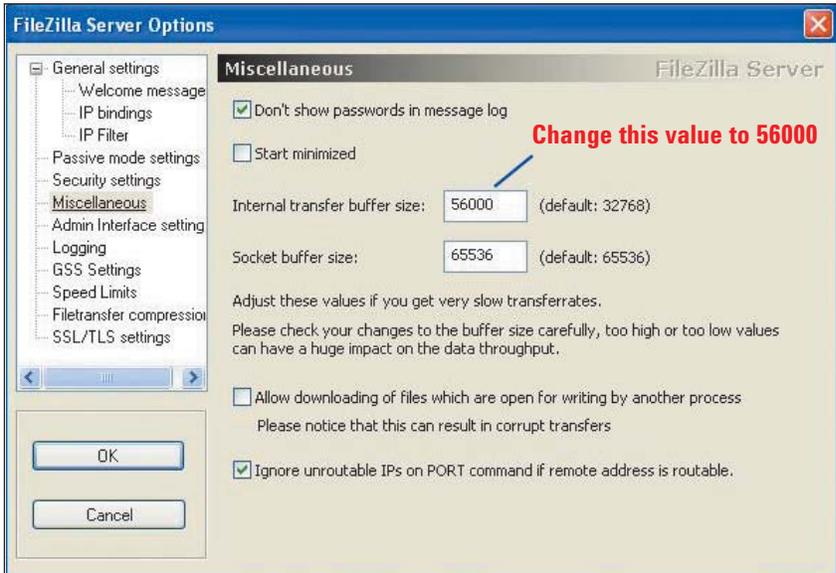


Figure 2. Miscellaneous Server options page. Set the internal transfer buffer size to 56000 (or any number less than the socket buffer size)

Next, click on the **User options** button (Figure 1) and then the **Add** button on the right hand side. Name this new user **Anonymous** and leave the group as **<none>**. Go into the **Shared folders** page, click the **Add** button, and then select the folder with the files you would like to transfer (see Figure 3). In this case, we will select the folder **C:/FTPRoot** that has already been setup on the server PC. The purpose for this step is to define which files on the server will be available for download to the client. Since we are dealing with a closed connection, no password is necessary. If a password is entered, ensure that the client PC has the password entered in order to log into the server. Once this step is complete, click **OK** and minimize the program. No further changes to Filezilla's options will be made at this point.

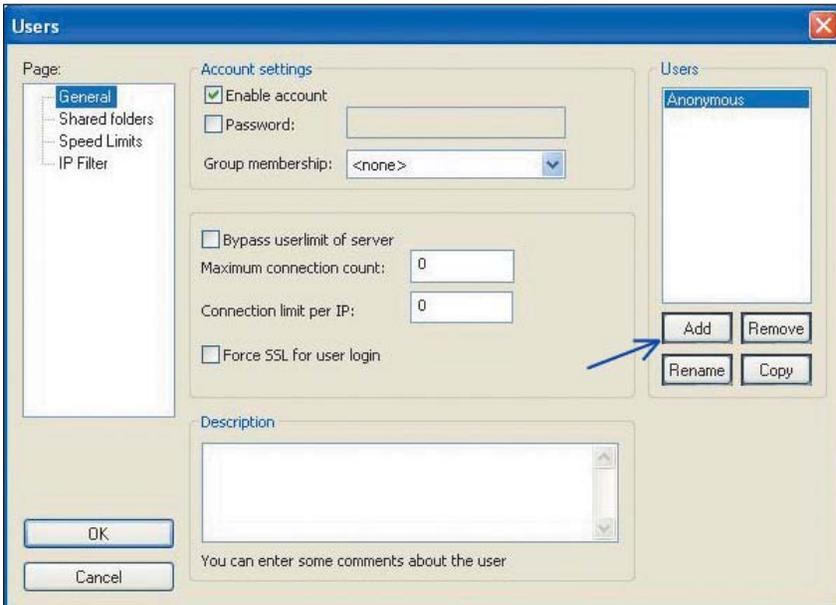


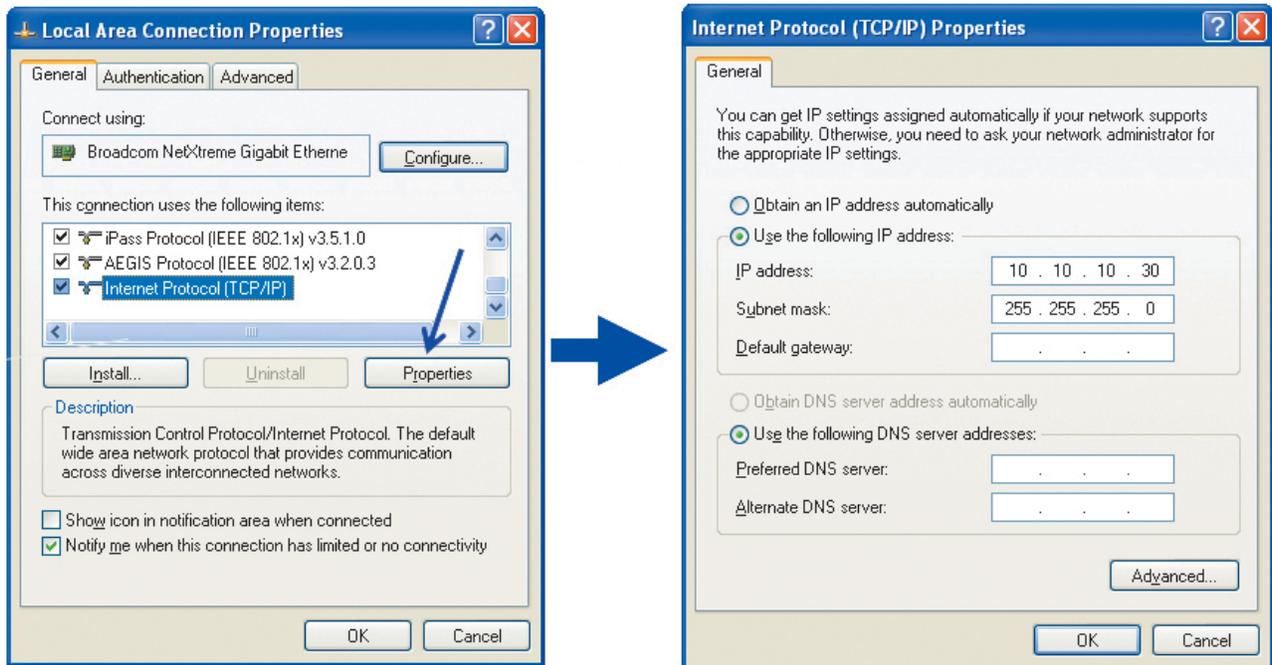
Figure 3. Filezilla User options. Click the Add button to create a new profile

Setting the server PC IP address

In order for the data connection to exist, the server, DUT, and test set must all have unique IP addresses assigned to them. This allows the receiver to know where to look for the files and the data packet to know its destination. To change the IP address for the server PC, click **Start > Control Panel > Network Connections** then right click **Local Area Connection > Properties**. Under the **General** tab, click **Internet Protocol (TCP/IP)** then the **Properties** button. This will bring up a new window where you can change the IP of the server PC. First check **“Use the following IP address”** then enter the following (see Figure 4):

IP address: 10.10.10.30
Subnet mask: 255.255.255.0

The server PC is now assigned the IP address of 10.10.10.30. Click **OK**, exit the local area connection properties, and proceed to the next section. (Note: Any IP address will do as long as the server PC, client PC, and the test set all have the same subnet.)



Figures 4. TCP/IP properties with the IP address and Subnet mask set to 10.10.10.30 and 255.255.255.0

Setting up Internet Explorer

The Agilent 8960 test set has a variety of features that can be accessed through a standard PC via a Web browser such as Internet Explorer. Features such as changing the HTTP SMS router settings and taking screenshots of the 8960 display can be accessed this way. In order to configure Internet Explorer to access the test set's settings, follow the steps below.

Note: In order to reach the Web page, you must also set up the IP address on the 8960. Please refer to *Section 3.4. Agilent 8960 test set setup – Assigning a LAN IP address to the 8960.*

Open up the Internet Explorer browser then click **Tools > Internet Options Connections > LAN Settings**. Make sure the following options are unchecked (see Figure 5):

- **Automatically detect settings**
- **Use automatic configuration script**
- **Use a proxy server for your LAN**

When you have finished changing the settings, press **OK** to exit the window.

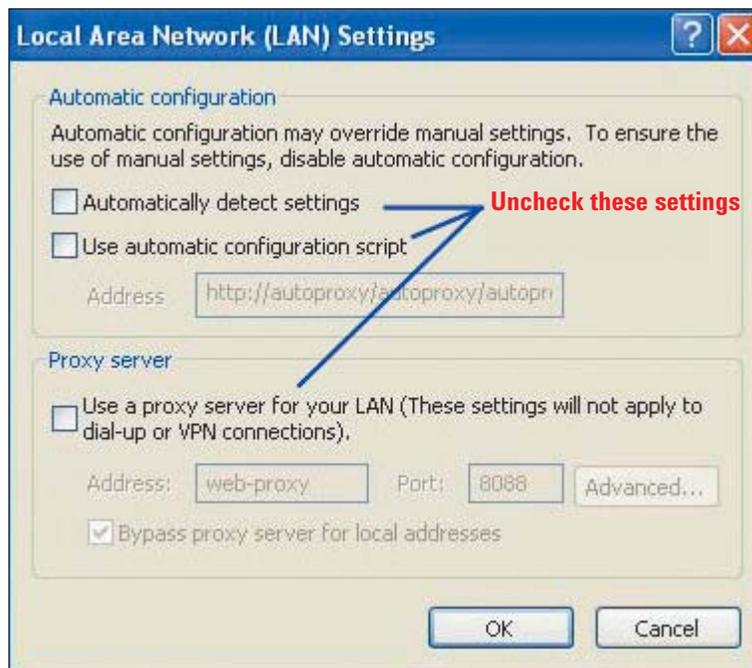


Figure 5. Internet Explorer LAN settings

Go to <http://10.10.10.10/> to reach the main page (Note: This address will depend on the current setting of the LAN IP address on the 8960 test set). See *Section 3.4. Agilent 8960 test set setup – Assigning a LAN IP address to the 8960* for more details.

Address

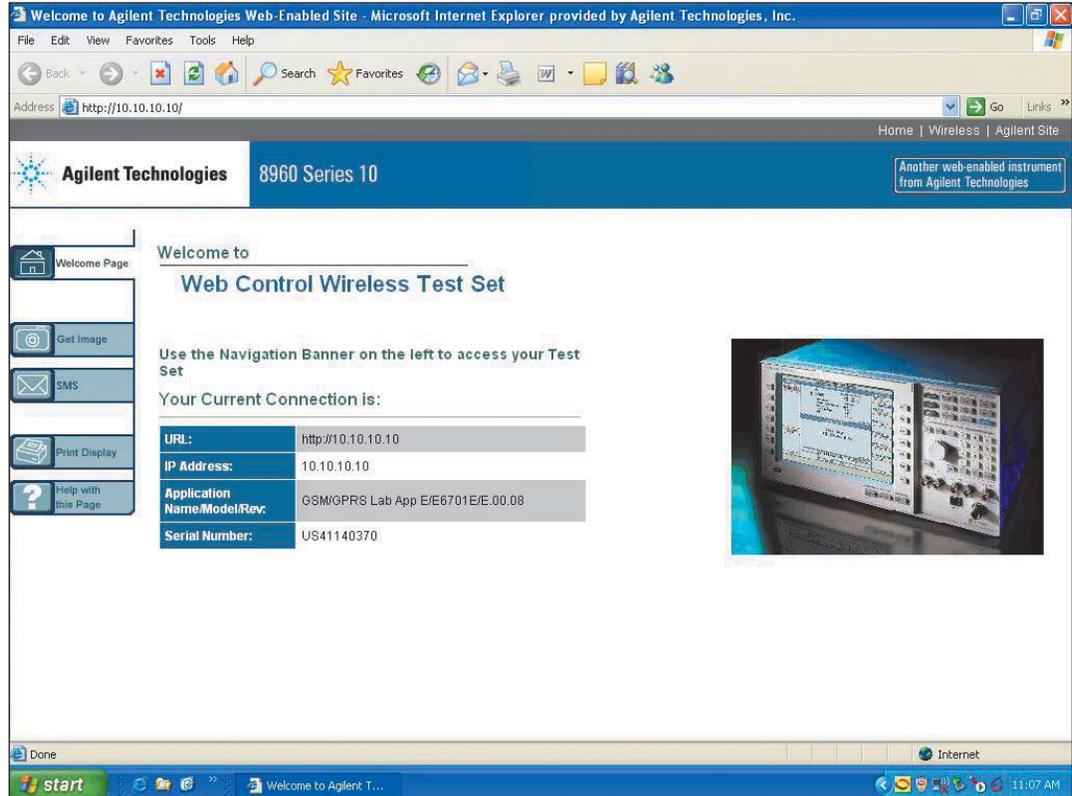


Figure 6. Internet Explorer's 8960 page

3.2 Client PC setup

The client PC setup only requires the installation of the DUT drivers and an FTP client application. For demonstration purposes, we will be using Filezilla's client program but remember that any FTP client application will work. Once again, be sure to **turn off any firewalls that may interfere with the data transfer**.

- Filezilla Client Application: <http://filezilla.sourceforge.net/>

Note: Filezilla is used in setting up data transfer data rate tests for FTP. When performing a HTTP test, Apache (see *Section. 3.1. Server PC setup*) and Internet Explorer are required.

DUT setup for cellular phones

The first step in setting up your client PC is to ensure that the DUT is properly configured and that the latest drivers are installed. If the DUT is a wireless card, ensure that auto connect is turned on and the device drivers are installed. If the DUT is a cellular phone, ensure that device drivers are installed and that it is properly connected.

On the client PC, go to **Start > Control Panel > Network Connections**. Click **Next**. Then **Connect to the Internet > Set up my connection manually > Connect using a dial up modem** on the screen, check only the **DUT**. Click **Next** (Figure 7). Leave the ISP name blank and for the phone number, use one of the following depending on the type of phone being tested:

Phone number	Type of data packet transfer
#777	1xEVDO / cdma2000
#99*	W-CDMA / GPRS

The user name and password can be left blank.

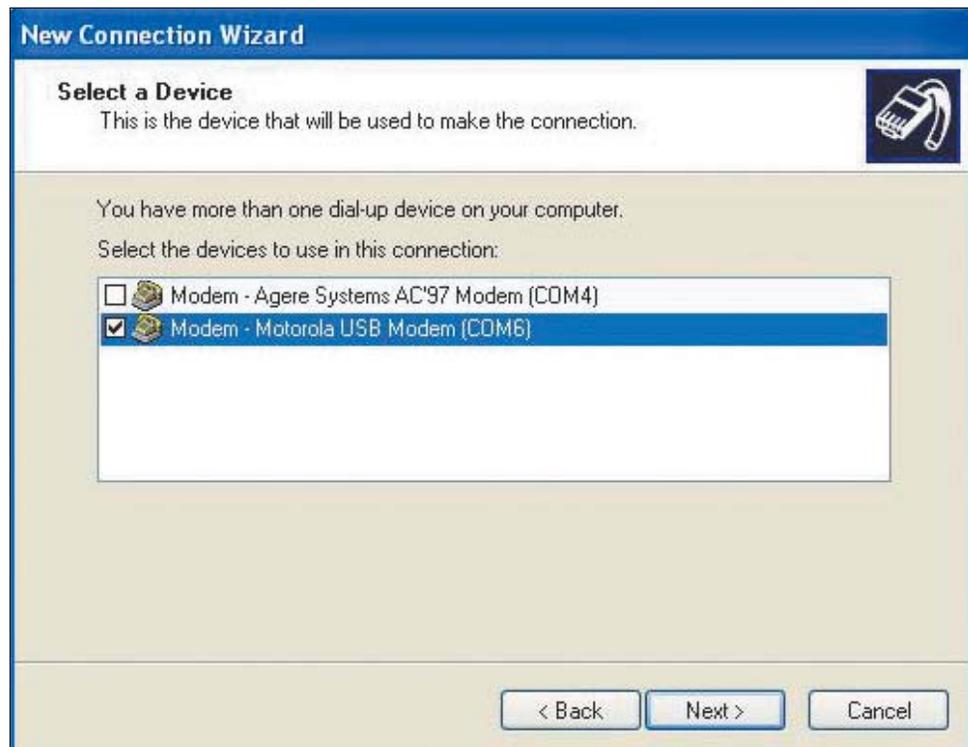


Figure 7. New Connection Wizard with the DUT selected as the only device for this connection

DUT setup for a wireless card

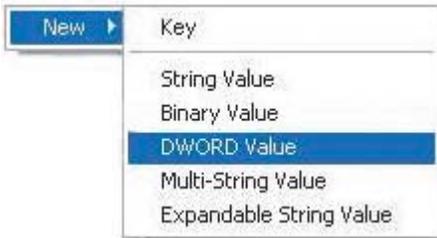
When testing a wireless card, be sure to have the appropriate drivers and software installed. Use the cards software application to establish a connection to the 8960. When a connection is established, the status on the test set will go from **Idle** to **PDP Active**.

Setting the internal transfer buffer size

In order to ensure that the maximum data rates are produced, we must set the transfer buffer size on the client PC as well. This allocates the proper resources needed to show the DUT's full potential when performing a data throughout test. Setting the transfer buffer size on the client PC can be done by adding a new DWORD value to the registry. To do this go to **Start > Run** then type in **regedit** and click **OK**.



Go to **HKEY_LOCAL_MACHINE > SYSTEM > CurrentControlSet > Services > Tcpip > Parameters**. Then right click > **New > DWORD Value**



Enter the following in the edit window:

Value name: TcpWindowSize
Value data: 13f60
Base: Hexadecimal
Value name: Tcp13230pts
Value data: 1

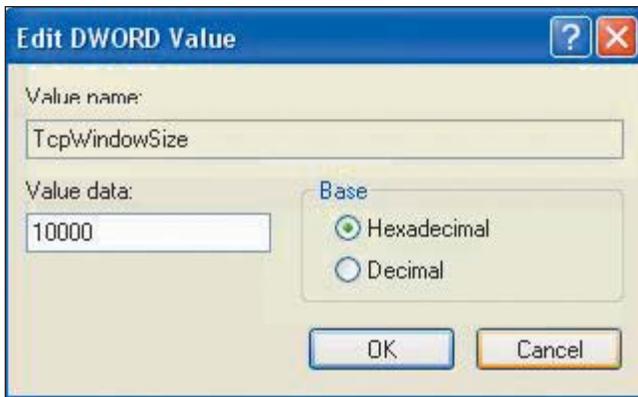


Figure 8. The values for the new DWORD entry

Once the new registry value is added, close the regedit screen and reboot the PC.

Setting up Internet Explorer

Additional tests can be done through Internet Explorer, which emulate Web surfing when connected through the DUT. From this Web page, all net activity, including HTTP downloads and page loading, will all be displayed on the data throughput monitor. The Internet Explorer setup procedure is the same as the steps outlined in *Section 3.1. Server PC setup*. For further information on the tests, see *Section 4. Testing Applications and Procedures*.

Setting up the FTP client application

Before running the FTP client software, be sure to configure correctly the program for successful file transfers. Enter the following settings:

IP address: 10.10.10.30 (if you chose to use a different IP for the server, enter it here)

Local path: C:/FTPDump (or wherever you would like to save the downloaded files)

Anonymous login
Include sub-folders

This will tell the client PC to connect to the server PC via the DUT and download the files to the C:/FTPDump folder.

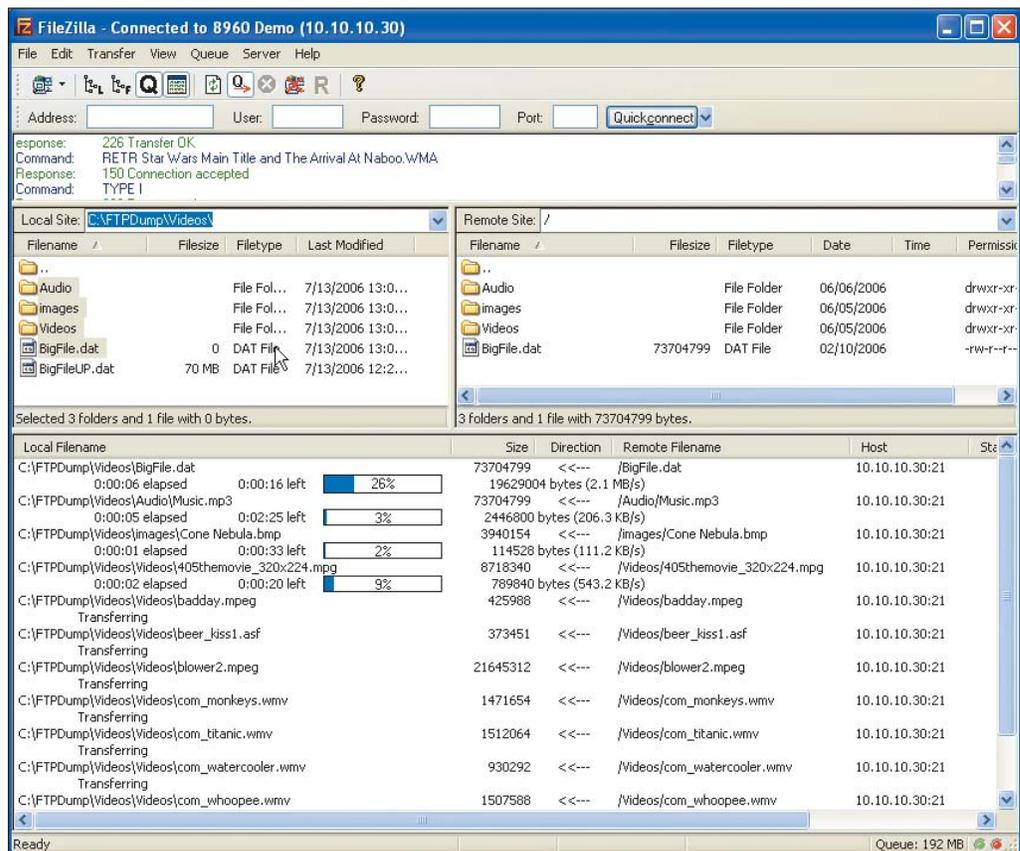


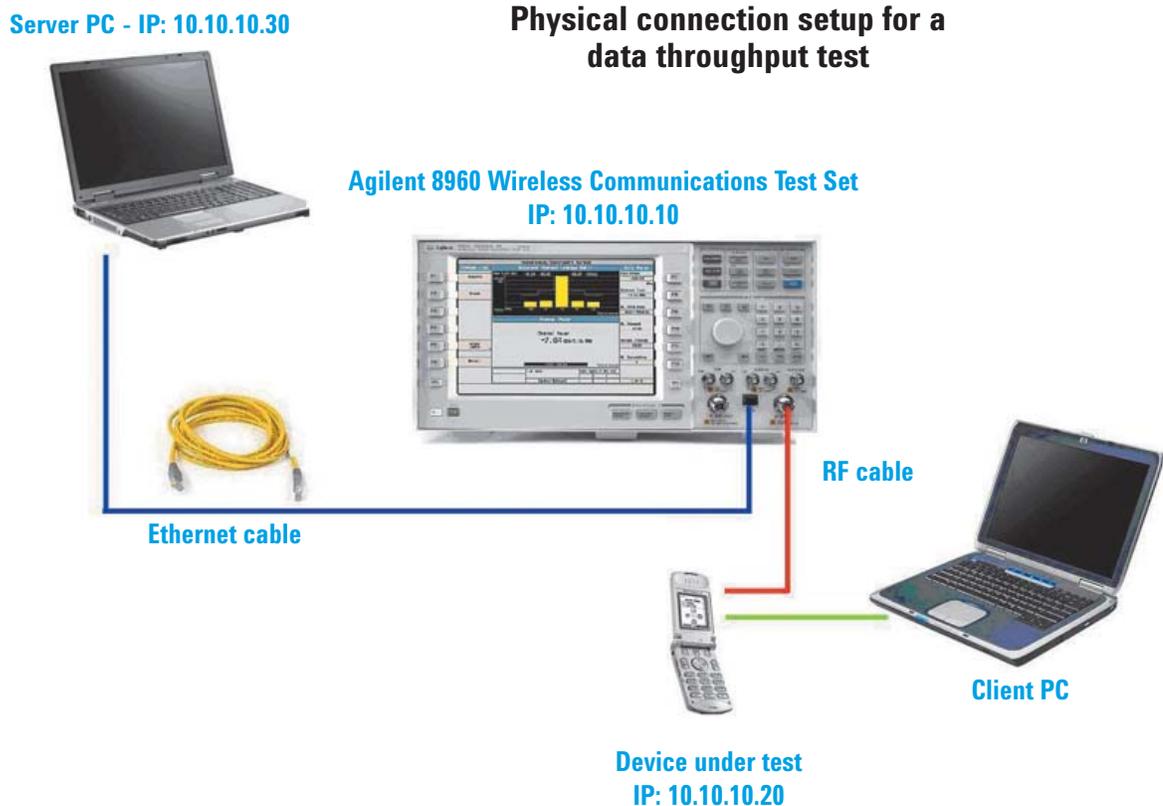
Figure 9. Filezilla Client user interface

The Filezilla client transfer program functions much in the same way as any other FTP software you may have used before. The program incorporates a drag and drop feature to transfer files. To transfer a file, drag any file from the right hand menu (**Local Site**) to the left menu (**Remote Site**). The transfer is now displayed on the bottom window.

3.3 Physical connection setup

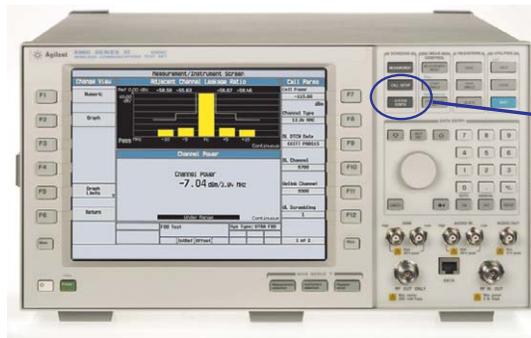
Now it is time to connect the server and client PC to the 8960 test set. The server PC and DUT will be connected directly to the 8960 while the client CP is connected to the DUT. A standard Ethernet cable will be used for the server/8960 connection and the DUT will be connected via a standard RF cable with adapter. The front data port on the test set is used for front panel access and acts as a connection that leads directly to the rear of the test set. Ensure that the jumper located on the back of the test set is connected to the correct port. Depending on the 8960 test set, there may be more than one LAN port. In this case, ensure that the jumper connection is going to the port marked **LAN 2 Port**. The LAN 2 Port is used for data-only connection which will be used for data throughout testing (LAN 1 Port is used for host connections – see *Section 5. Troubleshooting* for more details).

The diagram below is provided to assist in the connection setup. The IP addresses for the server, DUT, and test set are shown, as well as the type of cable used to make the connection. Note that the DUT may be either a mobile phone (shown below) or a wireless card, but the IP address remains unchanged.



3.4 Agilent 8960 test set setup

8960 user interface



CALL SETUP and SYSTEM CONFIG buttons

The two main windows used for setting up the 8960 are the Call Setup and System Config screens, which can be easily accessed by pressing the gray **CALL SETUP** and **SYSTEM CONFIG** buttons located on the upper right side of the display. Each screen has two menus located on the left and right side and each menu option can be selected by pressing the corresponding F1-F12 keys. Figures 10 and 11 show the Call Setup and System Config screens when running the 1xEV-DO lab application.

Call Control		Active Cell Operating Mode		Call Parms	
Operating Mode	Active Cell	Access Terminal Information (AT Reported)		Cell Power	-55.00
		Session Seed:			dBm/1.23 MHz
		Hardware ID Type (Hex):		Cell Band	US PCS
		Hardware ID (Hex):			
		Hardware ID (Decimal):		Channel	525
Start Data Connection		Access Terminal Information (AM Assigned)			
		UATI 024:		Application Config	▼
		UATI Color Code:		FTAP Rate	307.2 kbps
		MAC Index:			(2 Slot, QPSK)
Close Session		Access Terminal Information (User Entered)		RTAP Rate	9.6 kbps
		AT Max Power:			
Handoff Setup		Application Configuration			
		Session Application Type: Test Application			
AT Max Power	23 dBm/1.23 MHz	Test Application Protocol: FTAP			
		Limited TAP: Off			
		AT Directed Packets: 50 %			
		ACK Channel Bit Fixed Mode Attribute: On			
		Active Cell	Sys Type: IS-856		
		Idle	Logging: No Conn.		
Page number	1 of 3	IntRef	Offset	FTAP	1 of 3

Call status

Figure 10. The Call Setup screen for the 1xEVDO lab application

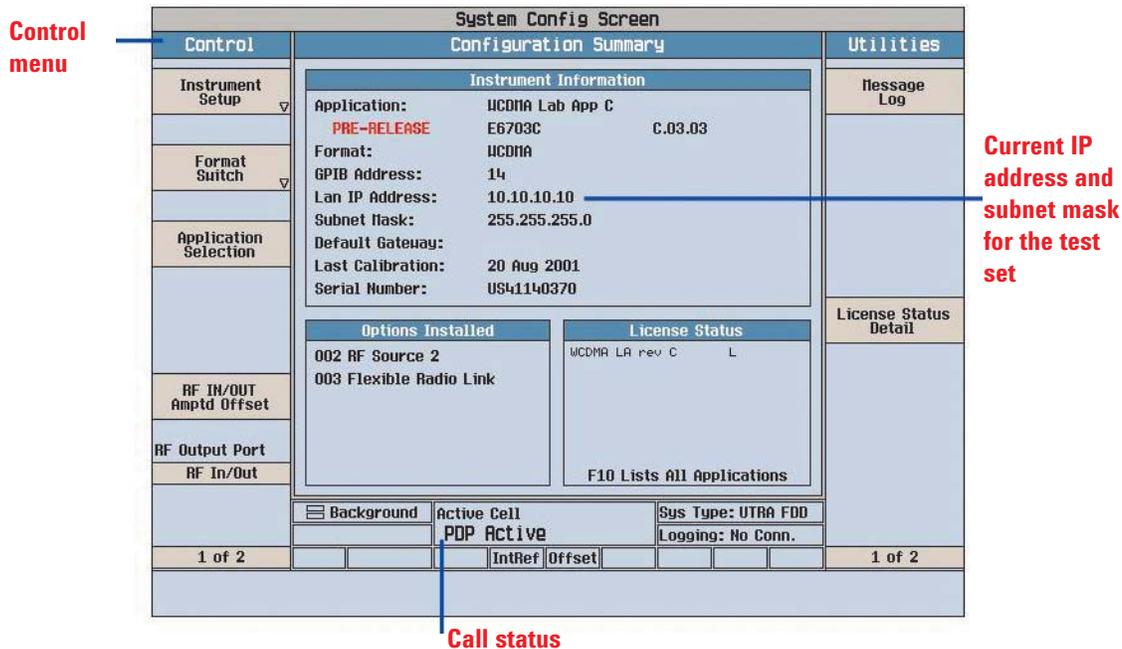


Figure 11. The System Configuration screen

Application selection

The final series of settings will be made on the Agilent 8960 test set. The first step should be to set the test set to the appropriate test application. This can be done by pressing the following buttons:

SYSTEM CONFIG > Application Selection (F3) > Application Switch (F1)

Then choose the appropriate data throughput application (i.e. 1xEV-DO lab application) as shown in Figure 12 below. Once you select the appropriate lab application, allow the system to reboot. Once the system has finished rebooting, you will now be running the proper lab application. (Note: The lab application can also be chosen during the system boot up by pressing the **SYSTEM CONFIG** button at the startup screen, then using the number pad to select the appropriate application.)

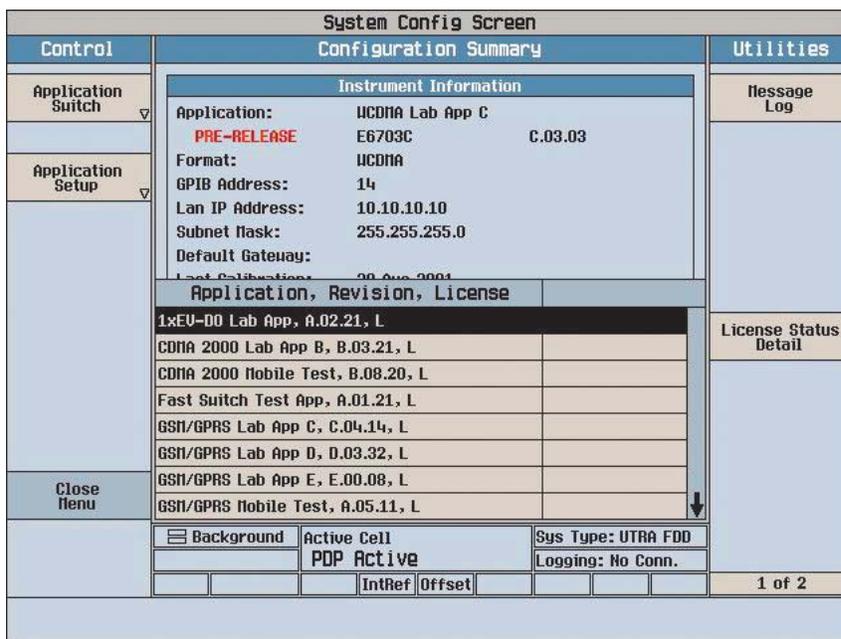


Figure 12. The Application Switch menu in the System Config menu

The following lists the appropriate lab application based on the format being tested:

Table 1. Application selection based on data transfer format

Format	Application
cdma2000	E6702B – cdma2000 lab app B; B.03.21 (or later rev.) or E6702T – CDMA lab app T; T.00.04 (or later rev.)
1xEV-DO	E6706A – 1xEV-DO lab app; A.02.21 (or later rev.) or E6706T – 1xEV-DO lab app T; T.00.04 (or later rev.)
For E6785C with GPRS, EGPRS, and W-CDMA	E6785C – GSM/GPRS_W-CDMA lab app C; C.03.12 (or later rev.)
For E6703D/T with W-CDMA and HSDPA	E6703D – W-CDMA lab app D; D.00.03 (or later rev.) or E6703T – W-CDMA lab app T; T.00.04 (or later rev.)

Assigning a LAN IP address to the 8960

To assign a LAN IP address to the 8960 press **SYSTEM CONFIG > Instrument Setup (F1)** then scroll to **LAN IP Address**, change it to **10.10.10.10**, and set **Subnet Mask** to **255.255.255.0** (see Figure 13).

Once again, the IP address and subnet used here are for demonstration. You may use the IP shown in this document or choose one of your own as long as the subnet is the same for all three devices and each IP is unique.

System Config Screen																																				
Control	Configuration Summary							Utilities																												
Instrument Setup ▾	<table border="1"> <thead> <tr> <th colspan="3">Instrument Information</th> </tr> </thead> <tbody> <tr> <td>Application:</td> <td>1xEV-DO Lab App</td> <td></td> </tr> <tr> <td></td> <td>E6706A</td> <td>A.02.21</td> </tr> <tr> <td>Format:</td> <td>IS-856</td> <td></td> </tr> <tr> <td>GPIB Address:</td> <td>14</td> <td></td> </tr> <tr> <td>Lan IP Address:</td> <td>10.10.10.10</td> <td></td> </tr> <tr> <td>Subnet Mask:</td> <td>255.255.255.0</td> <td></td> </tr> <tr> <td>Default Gateway:</td> <td></td> <td></td> </tr> <tr> <td>Last Calibration:</td> <td>20 Aug 2004</td> <td></td> </tr> </tbody> </table>							Instrument Information			Application:	1xEV-DO Lab App			E6706A	A.02.21	Format:	IS-856		GPIB Address:	14		Lan IP Address:	10.10.10.10		Subnet Mask:	255.255.255.0		Default Gateway:			Last Calibration:	20 Aug 2004		Message Log	
Instrument Information																																				
Application:	1xEV-DO Lab App																																			
	E6706A	A.02.21																																		
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	Subnet Mask					255.255.255.0																														
	Default Gateway																																			
RF IN/OUT Amptd Offset	Display Mode					Track																														
	Display Brightness					High																														
	Beeper State					On																														
Close Menu	Date (yyyy.mm.dd)					2006.06.26																														
	Active Cell Idle					Sys Type: IS-856																														
						Logging: No Conn.																														
				IntRef	Offset			DPkt	1 of 2																											

Figure 13. LAN IP setup menu

Assigning an IP address to the DUT

The IP address for the DUT can be changed in the 8960. While data channel settings for 1xEV-DO are shown here, other formats are similar. To do this, press **CALL SETUP** then go to the third page of **Call Control** by pressing the **More** button on the bottom left. Once this is done, press **Data Channel Info (F2) > Data Channel Parameters (F1)** then change **DUT IP Address** to **10.10.10.20** (see Figure 14).

Call Setup Screen																																
Data Channel	Data Channels Info						Call Parms																									
Data Channel Parameters ▾	<table border="1"> <thead> <tr> <th colspan="4">Data Counters</th> </tr> <tr> <th>Class</th> <th>Type</th> <th>Forward</th> <th>Reverse</th> </tr> </thead> <tbody> <tr> <td rowspan="3">RLP Control</td> <td>Reset Messages</td> <td>0</td> <td>0</td> </tr> <tr> <td>NAK Messages</td> <td>0</td> <td>0</td> </tr> <tr> <td>NAKked Octets</td> <td>0</td> <td>0</td> </tr> <tr> <td rowspan="2">RLP Data</td> <td>New Octets</td> <td>0</td> <td>0</td> </tr> <tr> <td>Retransmitted Octets</td> <td>0</td> <td>0</td> </tr> </tbody> </table>						Data Counters				Class	Type	Forward	Reverse	RLP Control	Reset Messages	0	0	NAK Messages	0	0	NAKked Octets	0	0	RLP Data	New Octets	0	0	Retransmitted Octets	0	0	Cell Power
Data Counters																																
Class	Type	Forward	Reverse																													
RLP Control	Reset Messages	0	0																													
	NAK Messages	0	0																													
	NAKked Octets	0	0																													
RLP Data	New Octets	0	0																													
	Retransmitted Octets	0	0																													
Traffic Channel Packet Info							-55.00																									
Clear IP Counters							dBm/1.23 MHz																									
Clear RLP Counters							Cell Band																									
Close Menu							US PCS																									
	Data Channel Parameters			Values			Channel																									
	DUT IP Address			10.10.10.20			525																									
	External PDSN State			Off			Application Config ▾																									
	External PDSN IP Address																															
	External PDSN TCP Port			53613																												
	External PDSN Connect Timeout			2																												
	Active Cell			Sys Type: IS-856																												
	Idle			Logging: No Conn.																												
			IntRef	Offset		DPkt	1 of 3																									

Figure 14. DUT IP setup menu

Settings based on DUT format

The following lists the settings one would use depending on the type of DUT being tested. Each table describes how to reach each setting and the value it should be set to. "Column title and side" refers to the menus located on the left and right side of the display while "Menu level" refers the page it is on. The soft key sequence is shown with the corresponding F-keys and the value to be changed is in **bold**. Be sure to have the correct application loaded on the 8960 before proceeding.

Table 2. 1xEV-DO settings for maximum data throughput (downlink)

Column title and side (left/right)	Menu level	1xEV-DO soft key sequence and data entry
Call control (left)	More (2 of 3)	F2: Access network info F1: Configurable attribute ctrl Preferred control channel cycle control = AT specified
Call control (left)	More (2 of 3)	F2: Access network info F2: Cell parameters Subnet mask = [increment or decrement number already in the field so it is different than the last value seen by the DUT] Example: if value is currently 104, change it to 103 or 105; any legal value (0 – 128) is OK except the previous value
Call control (left)	More (3 of 3)	F2: Data channel info F1: Data channel parameters DUT IP address = 10.10.10.20
Call control (left)	More (3 of 3)	F3: Ping F1: Ping setup Device to ping = Alternate Alternate ping address (server PC) = 10.10.10.30 Press F3: Start ping to check your setup
Call parms (right)	More (1 of 3)	F8: Cell band = US PCS
Call parms (right)	More (1 of 3)	F9: Channel = 500
Call parms (right)	More (1 of 3)	F10: Application config Session application type = Default packet application AT directed packets = 100%

Table 3. cdma2000 settings for maximum data throughput (downlink)

Column title and side (left/right)	Menu level	cdma2000 soft key sequence and data entry
Call control (left)	More (2 of 5)	F2: Cell info F2: Cell parameters System ID (SID) = 2
Call control (left)	More (4 of 5)	F2: Data channel info F1: Data channel parameters F-SCH data rate = 153.6 kbps DUT IP address = 10.10.10.20
Call control (left)	More (4 of 5)	F3: Ping F1: Ping setup Device to ping = Alternate Alternate ping address (server PC) = 10.10.10.30 Press F3: Start ping to check your setup
Call parms (right)	More (1 of 4)	F8: Cell band = US PCS
Call parms (right)	More (1 of 4)	F9: Channel = 1125
Call parms (right)	More (1 of 4)	F12: FCH service option setup Service option for Fwd3, Rvs3 = S033 (+ F-SCH)

Table 4. GPRS and EGPRS settings for maximum data throughput (downlink)

Column title and side (left/right)	Menu level	GPRS soft key sequence and data entry	EGPRS soft key sequence and data entry
Call control (left)	More (1 of 3)	F1: Active cell = Active cell (GPRS)	F1: Active cell = Active cell (EGPRS)
Call control (left)	More (2 of 3)	F2: DUT PDP setup DUT IP address = 10.10.10.20	Same
Call control (left)	More (2 of 3)	F3: Ping F1: Ping setup Device to ping = Alternate Alternate ping address for server PC = 10.10.10.30 Press F3: Start ping to check your setup	Same
Call control (left)	More (2 of 3)	F5: Short message service F3: HTTP setup HTTP SMS input state = On HTTP SMS output state = On	Same
Call parms (right)	More (1 of 2)	F7: BCH parameters F7: Cell power = -50 dBm/3.84 MHz	Same
Call parms (right)	More (1 of 2)	F9: PDTCH parameters	F9: PDTCH parameters
PDTCH parms (right)	More (1 of 2)	F11: Coding scheme = CS4	F11: Modulation coding scheme Uplink modulation coding scheme = MCS-9 (8PSK)
PDTCH parms (right)	More (2 of 2)	F7: Multislot config = 4 Down, 1 Up	Same

Table 5. W-CDMA settings for maximum data throughput (downlink)

Column title and side (left/right)	Menu level	W-CDMA soft key sequence and data entry
Call control (left)	More (2 of 4)	F4: Uplink parameters Maximum uplink transmit power level = 24 dBm
Call control (left)	More (3 of 4)	F2: DUT IP setup DUT IP address = 10.10.10.20 DUT primary DNS server IP address = (blank) DUT secondary DNS server IP address = (blank)
Call control (left)	More (3 of 4)	F3: Ping F1: Ping setup Device to ping = Alternate Alternate ping address (server PC) = 10.10.10.30 Press F3: Start ping to check your setup
Call control (left)	More (3 of 4)	F4: Data channels F1: Packet data setup GPRS radio access bearer = 64k UL / 384k DL PS
Call control (left)	More (4 of 4)	F6: Short message service F3: HTTP setup HTTP SMS input state = On HTTP SMS output state = On
Call parms (right)	More (1 of 3)	F7: Cell power = -50 dBm / 3.84 MHz

Table 6. HSDPA and W-CDMA settings for max data throughput (downlink)

Column title and side (left/right)	Menu level	W-CDMA soft key sequence and data entry	HSDPA soft key sequence and data entry
Call control (left)	More (2 of 4)	F4: Uplink parameters Maximum uplink transmit power level = 24 dBm	Same
Call control (left)	More (3 of 4)	F2: DUT IP setup DUT IP address = 10.10.10.20 DUT primary DNS server IP address = (blank) DUT secondary DNS server IP address = (blank)	Same
Call control (left)	More (3 of 4)	F3: Ping F1: Ping setup Device to ping = Alternate Alternate ping address (server PC) = 10.10.10.30 Press F3: Start ping to check your setup	Same
Call control (left)	More (3 of 4)	F4: Data channels F1: Packet data setup GPRS radio access bearer = 64k UL/384k DL PS	F4: Data channels F1: Packet data setup GPRS radio access bearer = 64k UL/HSDPA DL PS For E6703T: 384k UL/HSDPA DL PS
Call control (left)	More (4 of 4)	F6: Short message service F3: HTTP setup HTTP SMS input state = On HTTP SMS output state = On	Same
Call parms (right)	More (1 of 3)	F7: Cell power = -50 dBm / 3.84 MHz	Same
Call parms (right)	More (1 of 3)	[none]	F10: HSDPA parameters
HSDPA parms (right)	More (1 of 2)	[none]	F7: HSDPA PS data setup CQI value = 15 (max) For E6703T: CQI value = 22 (max)

4. Testing Applications and Procedures

Once everything is set up, it is now time to begin the data throughput tests. The Agilent 8960 is able to perform various data transfer tests which will not all be covered in this section. The measurements and graphs can be accessed through the Measurement selection and Instrument selection buttons located to the bottom right of the display. The following lists just a few of the measurements you can perform (in 1xEVDO, tests will vary depending on the format) with the Agilent 8960 test set.

- Data throughput monitor
- Spectrum monitor
- Traffic channel packet info
- Channel power
- Packet error rate
- Digital average power

Handoff tests can also be performed with the use of an additional 8960 test set. With this feature, R&D designers are able to view in real time how the handoff between cells affects the data transfer. This is just one of many features Agilent brings to its customers worldwide.

Data throughput test using an FTP file transfer

FTP or file transfer protocol is a commonly used protocol for exchanging files over any network that supports the TCP/IP protocol. To begin the measurements, merely connect the client PC using the DUT. For cellular phones, this can be done on the PC by going to **Start > Control Panel > Network Connections** then right clicking on the dial up connection you previously made then **Connect** (see Figure 15). For connections using wireless cards, use the appropriate software for that card to establish a connection to the 8960 test set.

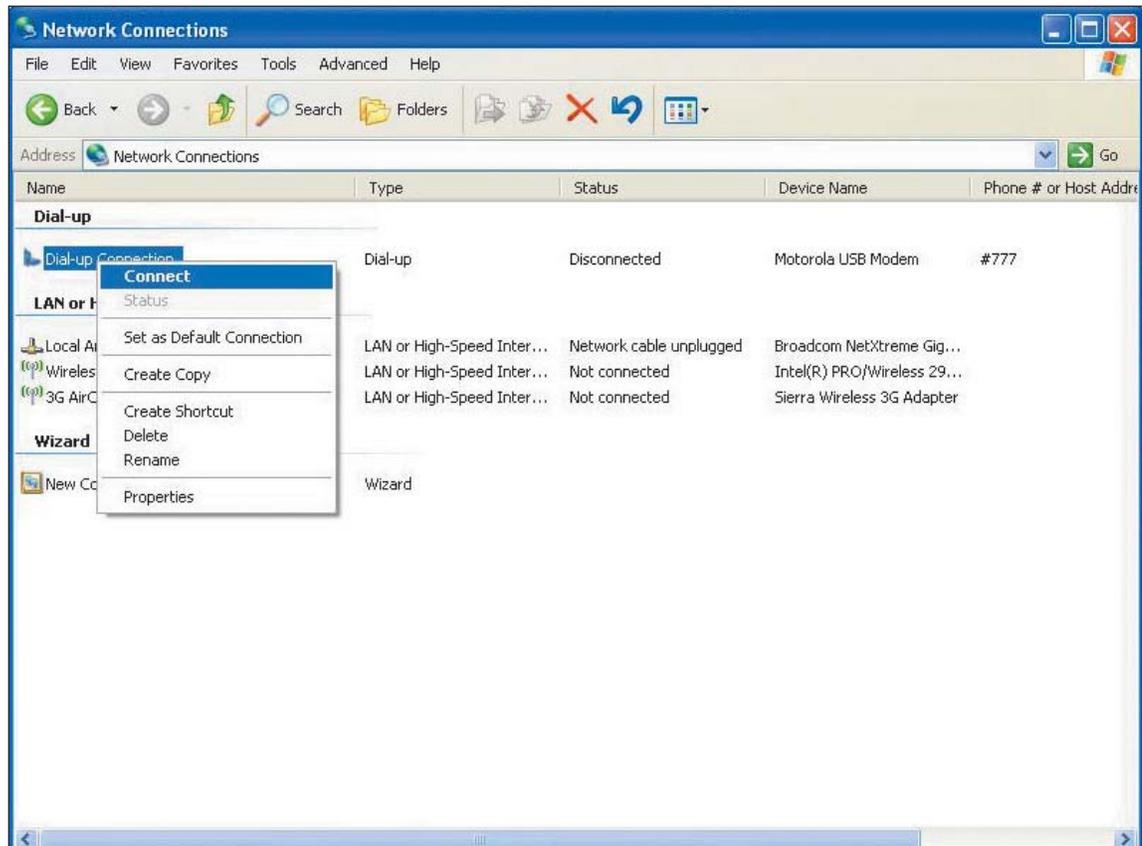


Figure 15. Connecting to the 8960 through the DUT

The status window on the bottom will change from **Session Open** to **Connected** (for 1xEVDO and cdma2000).



Note: For W-CDMA and HSDPA, the status should be **PDP active and Transferring**.

Transfer any file from the server PC using the FTP application on the client PC and proceed with the measurements on the 8960 test set.

Local Filename	Size	Direction	Remote Filename	Host	Sta
C:\FTPDump\Videos\BigFile.dat 0:00:06 elapsed 0:00:16 left	73704799	<<---	/BigFile.dat	10.10.10.30:21	
	19629004 bytes (2.1 MB/s)				
C:\FTPDump\Videos\Audio\Music.mp3 0:00:05 elapsed 0:02:25 left	73704799	<<---	/Audio/Music.mp3	10.10.10.30:21	
	2446800 bytes (206.3 KB/s)				
C:\FTPDump\Videos\images\Cone Nebula.bmp 0:00:01 elapsed 0:00:33 left	3940154	<<---	/images/Cone Nebula.bmp	10.10.10.30:21	
	114528 bytes (111.2 KB/s)				
C:\FTPDump\Videos\Videos\405themovie_320x224.mpg 0:00:02 elapsed 0:00:20 left	8718340	<<---	/Videos/405themovie_320x224.mpg	10.10.10.30:21	
	789840 bytes (543.2 KB/s)				
C:\FTPDump\Videos\Videos\badday.mpeg Transferring	425988	<<---	/Videos/badday.mpeg	10.10.10.30:21	
C:\FTPDump\Videos\Videos\beer_kiss1.asf Transferring	373451	<<---	/Videos/beer_kiss1.asf	10.10.10.30:21	
C:\FTPDump\Videos\Videos\blower2.mpeg Transferring	21645312	<<---	/Videos/blower2.mpeg	10.10.10.30:21	
C:\FTPDump\Videos\Videos\com_monkeys.wmv Transferring	1471654	<<---	/Videos/com_monkeys.wmv	10.10.10.30:21	
C:\FTPDump\Videos\Videos\com_titanic.wmv Transferring	1512064	<<---	/Videos/com_titanic.wmv	10.10.10.30:21	
C:\FTPDump\Videos\Videos\com_watercooler.wmv Transferring	930292	<<---	/Videos/com_watercooler.wmv	10.10.10.30:21	
C:\FTPDump\Videos\Videos\com_whoopee.wmv Transferring	1507588	<<---	/Videos/com_whoopee.wmv	10.10.10.30:21	

Figure 16. The data transfer window on the client PC using Filezilla

Data throughput test using Internet Explorer (HTTP test)

Files can also be transferred through Internet Explorer instead of the FTP application. This test is used to imitate the device's performance when a user Web surfs while connected through the DUT. Since HTTP is the main interface used for Web browsing, customers may want to determine how their device operates under such an interface. It should be noted that data transfer will be slower compared to FTP. As a rule of thumb, data transfers using HTTP are generally about half that of an FTP transfer.

To perform the test open Internet Explorer on the client PC and go to <http://10.10.10.30/index.htm> (or whatever IP you have assigned the server PC). From here, you can download image, video, and audio files from the server PC and view the data throughput using the 8960's data throughput monitor (see *Section 4.1. Data throughput monitor*). Before running this test, ensure that the phone is properly configured and connected to the network. (Active cell display says **PDP active** or **Connected**.)

Note: For this test, we used the Apache HTTP program. In order to view a Web page, you must first set one up with Apache. See the program's documentation regarding how to do this.

Data throughput test using UDP Blast (UDP test for 8960 demo kits)

UDP Blast is a simple program that allows a user to see the absolute full potential of the DUT. While a UDP test does not accurately represent normal Web interactions in any way, it provides a quick measurement of the potential for high rate testing (for tests that are more realistic, see the FTP and HTTP testing procedures). It is essentially a very fast interface over the Web that has no acknowledgement from the receiver of the data and no repeats for an error. The program was written by Agilent Wireless Division's lab but is available to our customers (contact your Agilent Representative if interested). It should be noted that this program should not be run on a live network as it will use all of the networks resources and thus incapacitate the network. To perform a UDP test, simply run the UDP Blast program on the server PC and view the data transfer rate on the data throughput monitor. To terminate UDP Blast, press **Ctrl-C** twice in the DOS window.

Note: Do not run UDP when FTP is active since it will stall the phone. If this happens, reset the phone by disconnecting the network connection on the server PC, physically unplug it from the server PC's USB port, and cycle the power.

4.1 Data throughput monitor

To demonstrate one of the tests you can perform, this section will cover the details of the data throughput monitor. To bring up the data throughput monitor, press the **Instrument selection** button and choose **Data Throughput Monitor**. This will bring up the data transfer graph. Time is displayed on one axis and the data transfer rate in kbps on the other as shown in Figure 17 below. Axis control can be changed by pressing the **Axis Control (F1)** button and **Trace Control (F2)** allows for precise measurements at specific locations on the graph. The display shows a plot of the data transfer rate over the time span. The current, average, and peak transfer rates (in bps) and the total number of bytes transferred are shown directly below to the graph (see Figure 17).

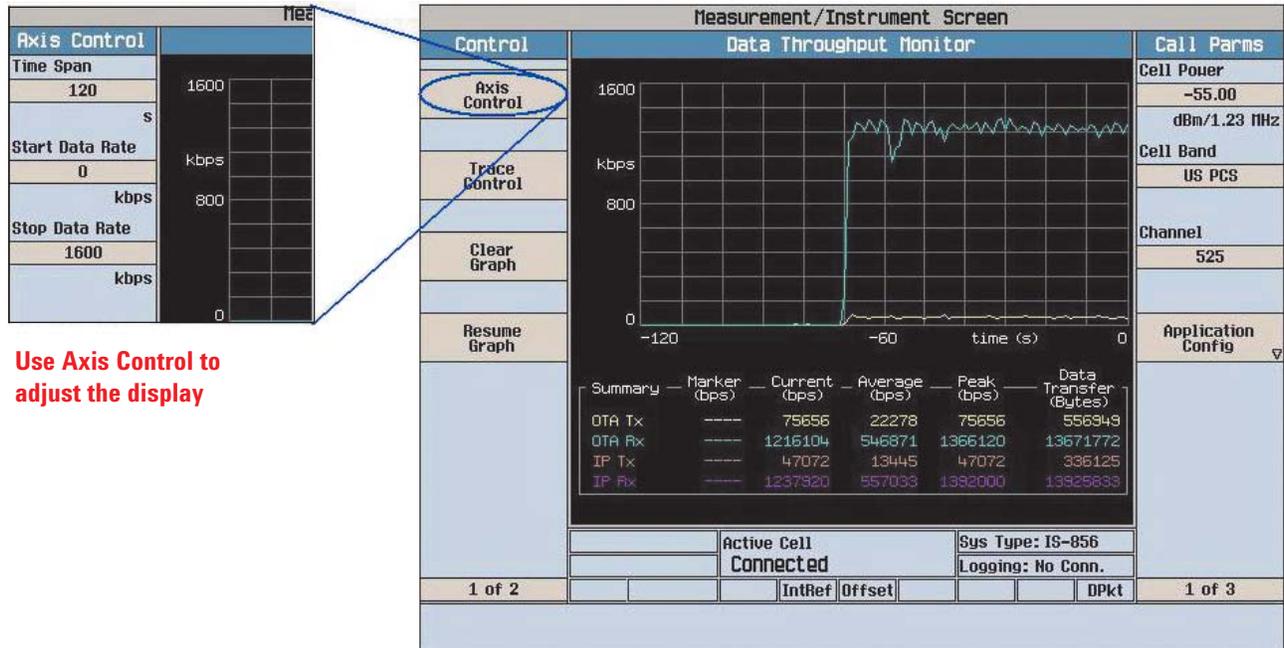


Figure 17. The Data Throughput Monitor screen

4.2 Travel channel packet info (for the 1xEV-DO lab application)

The Traffic Channel Packet Info screen monitors the forward and reverse packets delivered to the DUT. To access this monitor, press **CALL SETUP** and go to page 3 of the **Call Control** menu on the left hand side. Then press **Data Channel Info > Traffic Channel Packet Info**. The screen you see is the **Traffic Counters** of the data transfer. When a data transfer is occurring from the server to the client PC, the number of packets transferred will be displayed at the rate in which it was transferred. The counters can be easily cleared by pressing the **Clear Traffic Counters** button in the **Data Channel** menu located on the left hand side.

Call Setup Screen						
Data Channel	Traffic Channel Packet Info				Call Parm	
ALIGN Power Off Clear Traffic Counters Return	Forward Packets per DRC		Reverse Packets Per Data Rate		Cell Power	
	38.4kbps(16 Slot)	0	9.6kbps	690	-55.00	
	76.8kbps(8 Slot)	17	19.2kbps	447	dBm/1.23 MHz	
	153.6kbps(4 Slot)	0	38.4kbps	1692	Cell Band	
	307.2kbps(2 Slot)	0	76.8kbps	3853	US PCS	
	307.2kbps(4 Slot)	0	153.6kbps	1502	Channel	
	614.4kbps(1 Slot)	0	Null Packets	0	525	
	614.4kbps(2 Slot)	0			Application Config	
	921.6kbps(2 Slot)	0				
	1.228Mbps(1 Slot)	0				
	1.228Mbps(2 Slot)	4				
	1.843Mbps(1 Slot)	25				
2.457Mbps(1 Slot)	81287					
Total Directed	81333					
Not Directed	1834481					
	Background	Active Cell Connected		Sys Type: IS-856		
				Logging: No Conn.		
		IntRef	Offset		DPkt	
					1 of 3	

Figure 18. The Travel Channel Packet Info screen displays the forward and reverse packets per data rate

4.3 Downlink corruption / Adding noise in a 1xEV-DO system

For testing purposes, you may want to add noise to the system to get an idea of how real world factors affect the data rate. The 8960 test set has a built-in noise generator to mimic such a scenario. To access this feature, press **CALL SETUP > Page 2 in Call Control (more) > Generator Info (F3) > AWGN Power (F2)** then enter the power of noise you wish to add (in dBm). The affects of noise on the system can now be clearly seen using the data throughput monitor (see Figure 19). As expected, as noise increases, the data throughput speed will decrease depending on the cell power. When dealing with noise, keep in mind that increasing the noise power at a value much higher than the cell power may cause the phone to disconnect, and that the effects of noise is directly related to the cell power. Figure 19 shows the affects on a 1xEVDO data transfer with a cell power of -55 dBm and a noise power of -57 dBm.

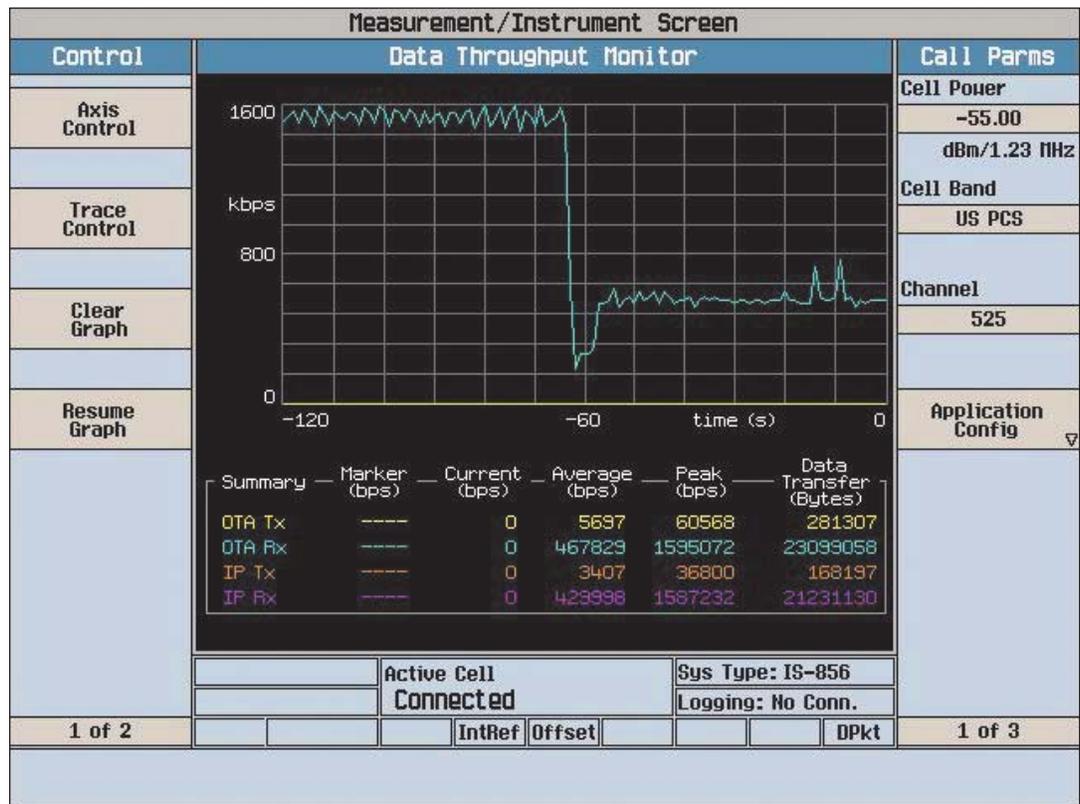


Figure 19. The transfer rates with and without noise

For GPRS, downlink corruption can be implemented by going to **CALL SETUP > Page 2 in Call Control (more) > Protocol Control (F4) > Layer 1 (F1) > PDTCH Downlink Corruption** and turning **Downlink Corruption On** (you can further change the corruption settings from this menu).

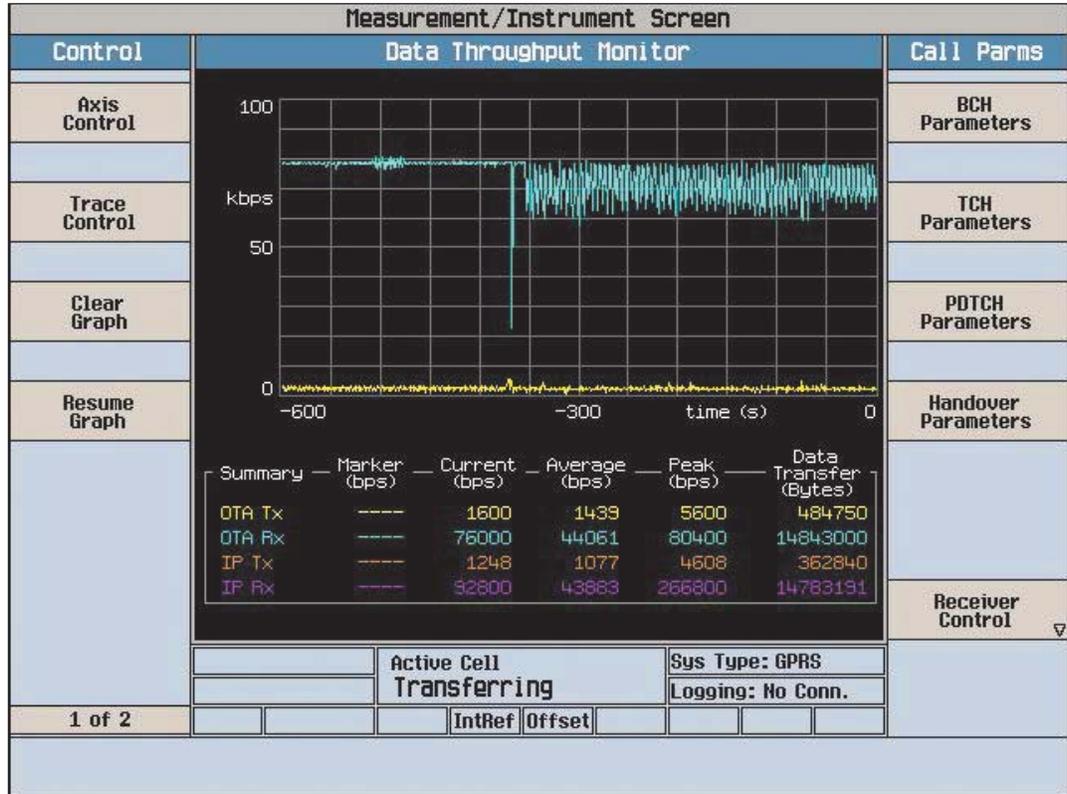


Figure 20. The transfer rate before and after downlink corruption is turned on

5. Troubleshooting

The following section will assist in possible problems or discrepancies one may encounter during the data throughput test. Before proceeding, ensure that the DUT is properly configured and that the Agilent 8960's settings are set according to Tables 2 through 4.

- **Slower than expected data rates for the DUT**

Internal transfer buffer size too low

Make sure that the transfer buffer size is set correctly for both the server PC and the client PC. This can be done on the server PC by setting the **Internal transfer buffer size** to **56000** (or higher as long as it is below the socket buffer size value) and for the client PC by using regedit as described in *Section 3.2. Client PC setup – Setting transfer buffer size*.

MS Config and MCS / CS changes on the mobile device

Depending on the MS class support of the DUT you are currently testing, a possible cause of slow data transfers is due to the uplink/downlink setting. You can try setting up more uplinks or downlinks on the phone to improve data transfer rates.

Presence of noise in the system

A possible reason for slow rates is due to the noise generator. Remember that the 8960 not only tests data throughput in an ideal environment, but also can mimic real world factors such as noise (see *Section 4.3. Downlink corruption/ Adding noise in a 1xEV-DO system*). If the noise generator is on and at a significant level, it will directly affect the maximum speed in which data can be traveled. Ensure that the noise generator is off by going to **CALL SETUP > Call Control Page 2 (more) > Generator Info (F3) > AWGN Power (F2)** and making sure this setting is **Off**.

AT directed packets incorrectly set (for 1xEVDO)

If you are testing a 1xEVDO DUT, then make sure that the session application type is set to default packet and the AT directed packets is changed to 100 percent. Failure to do so may result in slower transfer rates or possible failure to connect at all (see Figure 21). This setting can be changed in **CALL SETUP > Application Config (F10)**.

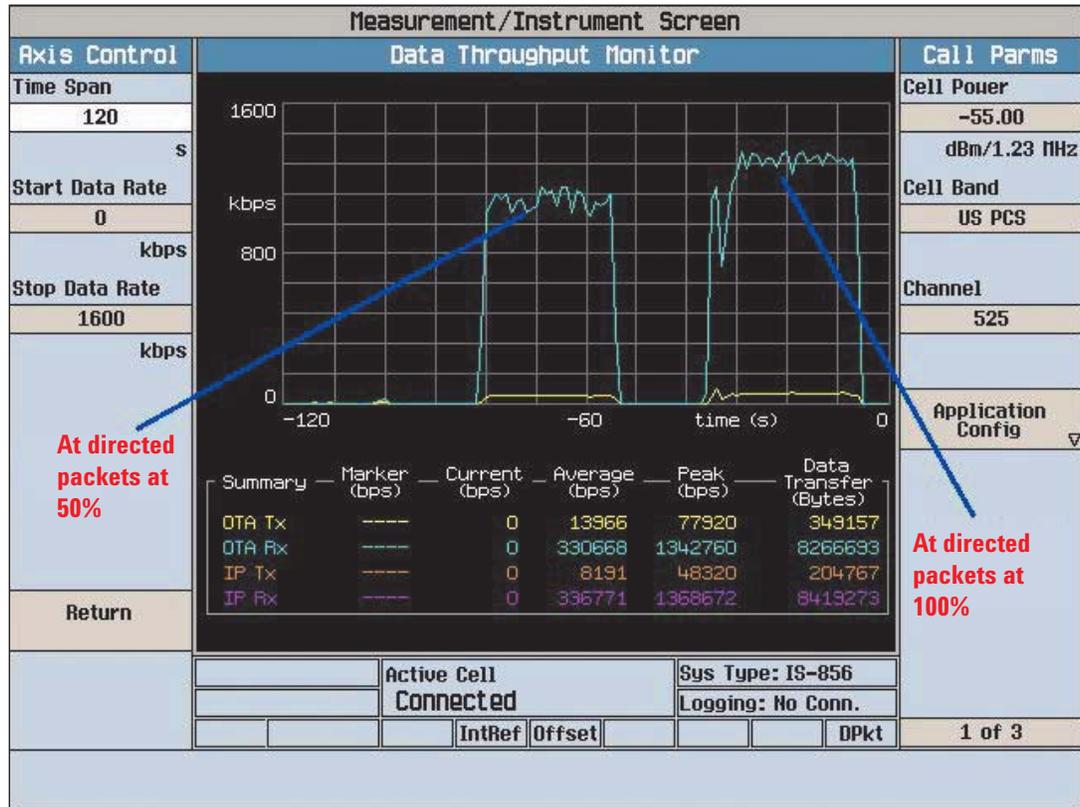


Figure 21. The data transfer rate when AT directed packets is changed to 50 percent and 100 percent

CQI set too low (for HSDPA)

For HSDPA, the CQI value can be changed. If the CQI is accidentally changed to a lower value, there is a possibility that it will affect the data transfer rate because the DUT believes the quality of the channel is less than optimal and thus sends the data at slower rates. Usually a CQI of **22** will be sufficient in data tests up to 3.6 Mbps. The CQI value can be changed by going to **HSDPA Parameters (F10) > HSPDA PS Setup > CQI Value**. The default CQI value is set to five.

Internal transfer buffer size set greater than the socket buffer size

When changing the internal buffer size (also known as the file buffer size), ensure that the value is **less than** the socket buffer size (i.e. internal buffer size: 56000 and socket buffer size: 65536). If the value is greater, the data throughput you will get will be less than what the DUT is capable of (approximately a 33 percent drop in data rate).

Cell power too low

Ensure that the cell power in the **Call Params** menu of the **Call Setup** screen is set to a reasonable value (by default the value is -55 dBm). A very small cell power could lead to slower data transfer rates especially when dealing with moderate amounts of noise in the system.

MCS rate too low (for EGPRS)

If you believe the DUT is capable of higher data transfer rates than those being produced, changing the MCS to a higher rate (such as 9) will allow more data to be transferred with less protection, thus potentially improving data transfer speeds. To change the MCS setting, go to **PDTCH Params** (menu on the right) then go to **Modulation Coding Scheme (F11)** then change the value to **MCS-9 (8PSK)**.

RLC window size (for EGPRS)

The window size parameter sets the RLC window size on the downlink. Setting this to the maximum value of download slots or the minimum window size for all timeslots might improve transfer speeds.

Settings in the 8960 not set correctly

One of the more common reason for a slower than expected transmission rate is due to the fact that the settings on the Agilent 8960 test set are incorrectly set. Make sure that the settings are the same as described in Tables 2 through 4 depending on the format the DUT currently uses.

Older 8960 hardware

The data transfer rates could be much slower depending on the 8960 hardware you are using. The older the hardware is, the less the maximum data throughput will be. As a result, you may see slower data speeds regardless of the settings due to the hardware itself. While this will generally not pose a problem for slower data transfer formats, it could affect tests where the goal is to see the maximum transfer rate for a DUT capable of high data rates.

- **Data rate occasionally “dips”**

TCP/IP settings not optimized

When performing a 1xEVDO or HSDPA test (or any high-speed data transfer test), the data transfer rate may drop to a slow speed then immediately return to full speed (see Figure 22). This “dip” usually occurs whenever the TCP/IP settings are not set correctly. In order to ensure that the dips in the transfer rate are caused by this, check the RLP counters in the 8960. This can be done by going to **CALL SETUP > Call Control Page 3 (more) > Data Channel Info (F2)**.

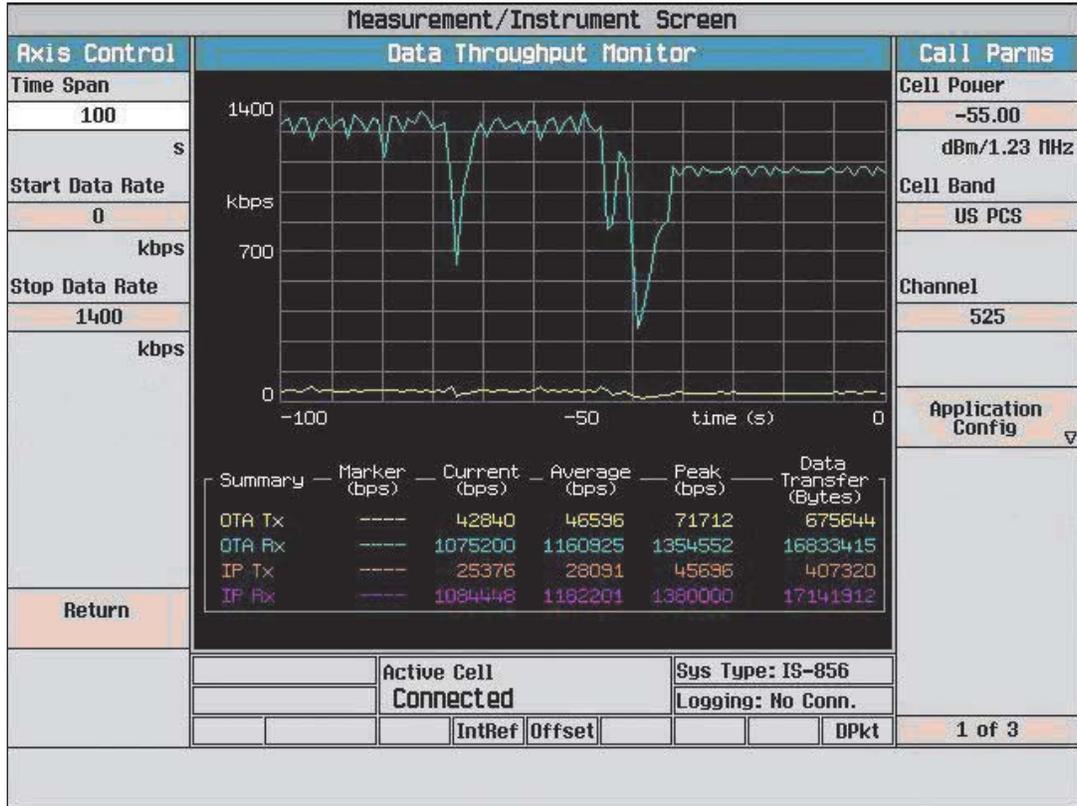


Figure 22. The data transfer rate when AT directed packets is set to 50 percent and 100 percent

At the RLP counters screen, if the retransmitted octets (the RLP data class) for forward transmission is greater than the reverse NAK messages (RLP control class), then the problem lies at the TCP/IP layer. The solution to this problem is to ensure that the proper TCP/IP settings are correct (refer to the TCP/IP settings in Sections 3.1 and 3.2 on how to change these settings). You can always clear the RLP counters by pressing the **Clear RLP Counters (F4)** button.

- **Severe fluctuations in data transfer rate**

Downlink corruption active (for GPRS)

Downlink corruption is one of the options that can be turned on in order to mimic less than optimal scenarios when testing data transfer rates. Ensure that this is turned off to get steady data throughput results (see Section 4.3).

- **Data transfer starts but randomly drops during the test**

Physical connection problems

Sometimes, the physical connections (especially the RF cable connected to the phone) are sensitive. Moving the DUT during the data transfer may loosen the connection causing the connection to drop. If the DUT is no longer able to connect to the server PC or the 8960 after the signal is dropped, remove then reattach the connection. This usually will solve this problem.

Also see *TCP/IP settings not optimized and Presence of noise in the system.*

- **Unable to access 8960 features through Internet Explorer**

Internet Explorer not configured properly

Make sure that the settings in internet options are correctly set and that any firewalls that may obstruct the connecting are turned off. Also, be sure that the following are unchecked in the internet options:

- **Automatically detect settings**
- **Use automatic configuration script**
- **Use a proxy server for your LAN**

- **The server PC cannot be detected on the 8960**

Possible interference from the PC firewall

If you have a firewall running, it may cause issues regarding connectivity. Turn off all firewalls to ensure that the PC can be detected by the 8960. Also, remember that Windows XP® has a built in firewall. To turn off XP's firewall, go to **Start > Control Panel > Windows Firewall** and deactivate this service.

Incorrect LAN port on the 8960

Depending on the 8960 hardware you are using, you may have more than one LAN port. It should be noted that the Ethernet port located on the front panel of the 8960 is merely for easier access to the rear ports. Look at the rear of the 8960 test set and double check that the cable leading from the ETHERNET TO FRONT PANEL port is connected to the correct LAN port. If you are currently testing with the High Data Rate Special Hardware Configuration (E5515C-H08 or E5515CU-589 upgrade), refer to the following:

LAN 1 port: Host connection – used for protocol logging, firmware downloads, screen captures, etc

LAN 2 port: Data-only connection – transfers data to the test set (used for data throughput testing)

Problem with the cable connection

An often-overlooked problem is the cable connecting the server PC to the 8960. Ensure that the cable being used is an Ethernet cable and double-check all connections. A loose connection may be the problem.

Note: When connecting two 8960's for a handoff test, a crossover Ethernet cable is used instead of a standard one.

Also see *Miscellaneous issues.*

- **The client PC cannot connect to the 8960**

Cell band/Channel incorrectly set (for 1xEV-DO and cdma2000)

If the client PC is unable to connect at all, check that the cell band and channel are correctly set depending on the type of DUT being tested (i.e. 1xEVDO, W-CDMA, etc.) These settings can be changed by going to **CALL SETUP > Cell Band (F8) or CALL SETUP > Channel (F9)**. For the correct values, refer to Tables 2 through 4.

Ensure the IP address was correctly assigned to the server PC

In order to check if the IP addresses for the server PC, go to **Start > Run** and type in **cmd**. In the command prompt, type **ipconfig** and ensure that the IP address has been correctly changed (see Section 3.1 for further details on setting the IP address.)

Also see *FTP client PC software cannot connect to the server but can connect to the 8960*.

- **FTP client PC software cannot connect to the server**

AT directed packets not set in the application config window (for 1xEVDO DUTs)

If you are testing a 1xEVDO DUT, then make sure that the session application type is set to default packet and AT specified is set in the configurable attribute control. Failure to do so will result in failure to connect to the server PC.

- The session application type can be configured by pressing **CALL SETUP > Application Config (F10)**.
- The configurable attribute control can be reached by pressing **CALL SETUP > Call Control page 2 (more) > Access Network Info (F2) > Configurable Attribute Ctrl (F1)** and setting this to **AT Specified** (for 1xEVDO).

FTP server software not set to internal IP

When running the FTP server software for the first time, a pop up screen may appear and ask which IP the server should use to establish a connection. This should be changed to the internal IP address of the PC, which is displayed automatically (127.0.0.1). Remember that the internal IP address is not the same as the 10.10.10.30 IP address we assigned earlier (see *Section 3.1: Server PC setup*). The program essentially used the internal IP to point to the server PC and the server PC is configured to an IP of 10.10.10.30 for testing purposes. Ensure that the FTP server software is appropriately configured to ensure proper connectivity during the tests.

- **The DUT is not being detected by the 8960**

Cell band not set correctly

Be sure that you are using the correct cell band for the DUT you are testing. This value can be changed by going to **CALL SETUP > Cell Band (F8)** on the 8960 test set.

Device not properly configured

A possible reason to why a device cannot be detected by the 8960 is due to the DUT not being properly configured. Please ensure that the device you are testing is appropriately set up in order to perform the data throughput tests.

RLC re-establish

Depending on the chipset of the phone, the DUT may not connect if RLC re-establish is on. If other phones can connect properly but the DUT you are currently testing is not, try to turn off RLC re-establish. To do this, go to **Call Parms** column (2 of 3), and change **RLC Re-Establish** to **Off**.

Also see *The client PC cannot connect to the 8960*.

- **Miscellaneous issues**

Wrong application software running

Be sure that the application the 8960 is currently running matches that of the DUT you are testing. To check which application is currently running, press **SYSTEM CONFIG** and looking under **Instrument information** on the screen. The current application the system is running will be displayed on the first line. You can change the application from this menu by pressing **Application Selection (F3) > Application Switch (F1)** and choosing the appropriate lab application (see Table 1). Changing the lab application will require the test set to reboot. Refer to *Section 3.4. Agilent 8960 test set setup* for more details.

IP addresses assigned do not have the same subnet

If you assigned your own IP addresses for the DUT, server, or client PC, make sure that the subnet for all three IP addresses are the same. If this problem continues, use the IP addresses and subnet mask values used in this document before making any further changes. The server PC IP can be viewed by going to **Start > Run** and typing in **cmd**. In the command window, type in **ipconfig** and the IP address will be listed. The IP addresses for both the DUT and the test set can be changed in the test set's options. Please refer to *Section 3.4. Agilent 8960 test set setup* for more details.

- **If problem is not resolved...**

Restore all settings to default

If certain settings were changed prior to setting up the Agilent 8960 test set for a data throughput test, return the values to their default value. If unsure which settings were changed, hold down the blue **SHIFT** key in the upper right side of the test set and press the **Preset** button (green) located next to the power button to return all settings to its default values. When this is done, change only the settings mentioned in this document (*Section 3.4. Agilent 8960 test set setup*).

Full system reboot

In some rare circumstances, the Agilent 8960 test set may need to be rebooted in order to fix the problem. Usually this happens when the DUT cannot be detected by the Agilent 8960 device. If such problems occur, reboot the system by hitting the **Power** button on the lower left side of the test set. You may also consider rebooting the DUT or the server/client PCs as well.

Contact your Agilent Representative

The following troubleshooting covers most of the common problems one will face when performing a data throughput test. If this section does not cover your particular problem or is unable to solve the problem, contact your Agilent representative for further assistance in resolving the issue. We will be glad to provide assistance to any issue you may have.

6. Summary

We have seen that data throughput testing plays an important and useful role in the development of all current and future wireless mobile devices. With Agilent's 8960 Wireless Communications Test Set, any researcher can effectively test their device in both optimal and real world scenarios. This provides them with data regarding the device's full potential, as well as an insight on how the device may react to real world affects such as noise and data corruption. Such data is essential as it provides valuable information about the capabilities of the wireless device.

The sections in this article have covered the initial setup and operating procedures for performing a data throughput test, as well as provided solutions to common problems one may run into while performing these tests. Every aspect of the testing procedure from the server and client setup to the settings on the Agilent 8960 has been covered in detail. By following the instructions provided, you will be able to setup your own data throughput test successfully for any device using the common data transfer formats.

As mobile devices continue to evolve and the demand from the customers continues to grow, the need for a reliable testing device for researchers will become increasingly critical. Data throughput testing is just one of the many advantages the Agilent 8960 test set can provide. Agilent's 8960 Wireless Communications Test Set is a beneficial testing device that will give your wireless device an edge over the competitor and distinguish itself among others in the vast market.

7. Glossary of Terms

1xEV-DO	cdma2000-based high speed wireless data standard
ACK	Acknowledge character
AN	Access network
AT	Access terminal
AWGN	Additive white Gaussian noise
CDMA	Code division multiple access
cdma2000	CDMA-based 3G wireless standard
CQI	Channel quality indicator
DUT	Device under test
EGPRS	Enhanced general packet radio service
FTP	File transfer protocol
GPRS	General packet radio service
GSM	Global system for mobile communication
HSDPA	High speed downlink packet access
IP	Internet protocol
LAN	Local area network
NACK	Negative-Acknowledge character
RLP	Radio link protocol
SMS	Short message service
TCP	Transmission control protocol
W-CDMA	Wideband code division multiple access

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