GainSpan®

Serial to Wi-Fi Bridge

INTRODUCTION

THE GAINSPAN ULTRA-LOW-POWER WI-FI™ SYSTEM-ON-CHIP may be used as a transparent bridge to carry serial (UART) traffic over an 802.11 (802.11b - GS1011, 802.11b/g/n - GS1500M) wireless link. Serial commands are used to manage the wireless network configuration.

BEFORE YOU BEGIN

Ensure you have followed the steps in the Serial to Wi-Fi Evaluation Kit Startup Guide as installed the necessary software on the host PC before proceeding.

TEST SETUP AND STARTUP

1. Using the Network control panel, record the Wi-Fi host PC IP address for the network adapter that has been used to connect to the AP. If the wireless network adapter is used, then note its IP address, if the Ethernet port is used and connected to the AP via Ethernet cable, then note the IP address of the Ethernet network adapter. The example below shows PC connected to AP via Ethernet and the IP address used is 192.168.2.160.

Figure 1 Serial to Wi-Fi Bridge Test Setup

2. Using AT commands, you can configure the bridge so data can be sent.

3. In *Tera Term*, issue the command AT+NDHCP=1. This command allows the Evaluation Board to employ DHCP to obtain or renew its IP address.

The command AT+NSTAT=? will show us the current network configuration of the Evaluation Board, including the IP address (Screen 1). In this example, the IP address of the Evaluation Board is 192.168.2.53. Record the address you find; we will use this address to configure client and server functions in *Simple Terminal*.

> Note: if the NSTAT Output shows WSTATE = Not Connected, then issue the command AT+WA=GainSpanDemo (or whatever SSID value you configured in the AP), causing the Evaluation Board to associate to the AP. Then issue the command AT+NSTAT =? again to see the connected state and note the IP address assigned.

```
OK
at+nstat=?
MAC=00:1d:c9:01:99:99
WSTATE=CONNECTED      MODE=AP
BSSID=00:1d:7e:5e:5a:de    SSID: GainSpanDemo    CHANNEL=6    SECURITY=NONE
RSSI=-39
IP addr=192.168.2.53    SubNet=255.255.255.0  Gateway=192.168.2.1
DNS1=192.168.1.25        DNS2=192.168.1.26
Rx Count=12      Tx Count=4959
```

Screen 1: AT+NSTAT Output

Once you have the IP addresses of the Ethernet host PC and the Evaluation Board, you will be able to configure a serial-to-Wi-Fi bridge. The *Serial2WiFi* application allows the Evaluation Board to act as a UDP server or client, or a TCP server or client; some example configurations are illustrated in the remainder of this document.

A few things to be aware of as you proceed:

> ► If you change the MAC address of the Evaluation Board and then run DHCP, the DHCP server will give the board a new IP address. You'll need to issue AT+NSTAT=? again to discover the new address.

> ► The Tera Term VT terminal can have Local Echo enabled or disabled. For issuing AT commands, it is generally best to turn off Local Echo (disable), as otherwise every typed letter is echoed: AATT&&VV can become disconcerting. However, the letters following an <Esc> sequence are not echoed by default, causing you to type blind (at least until you make an error). Thus, when issuing <Esc> sequences, it may be useful to turn Local Echo back on.

> ► *Tera Term* also handles the <Esc> key differently depending on keyboard history; if you have typed enter (issuing a carriage return <CR> with optional linefeed <LF>), a press of the <Esc> key will **not** be echoed to the screen. Once an <Esc> sequence has begun, subsequent <Esc> key presses will issue a backward arrow, ←.

> ► Finally, the *Serial2WiFi* application is not sensitive to whether Tera Term is set to issue a <CR> or <CR><LF> when you type enter, so you can employ whichever configuration is more comfortable.

MANUAL OPERATION OF A UDP SERVER

In the first example, we'll set up the Evaluation Board as an UDP server, using no wireless security. To send a command, type the text in *Tera Term* and press the RETURN or ENTER key.

1. Issue the command sequence listed in Table 1.

Table 1: Set Up Wireless Server

Sequence	Command	Description
1	AT+ndhcp=1	The Evaluation Board is to use DHCP to obtain an IP address.
2	AT+wa=GainSpanDemo	Instruct the Evaluation Board to associate with the desired network SSID.
3	AT+nsudp=10	Open a UDP socket bound to port 10.

The resulting display should look like Screen 1A (where we have suppressed profile storage and verification for simplicity). Note the reply to the last command, CONNECT 0; this tells us the UDP server was established and assigned the connection ID (**CID**) value 0.


```
OK
AT+ndhcp=1
OK
AT+wa= GainSpanDemo
OK
AT+nsudp=10
CONNECT 0

OK
```

Screen 1A: Setting the UDP Connection as CID 0

2. To talk with the UDP server, you need to set up an UDP client. Launch the Simple Terminal Application that will be configured as the UDP client. If you have not copied the application from the USB key of the evaluation kit, then copy the application to the Eval Kit folder. Configure a UDP client in the Wi-Fi host by filling in the fields as shown in Screen 1 in the Simple Terminal Window. Select Connection Type = UDP. Enter the Remote Host IP address. (This is the IP address that the Evaluation Board received from the DHCP server in the Windows machine when it associated with the AP, intercepted by *Wireshark* in step 16 of the Setup procedure above.) Set the Remote Port to 10.
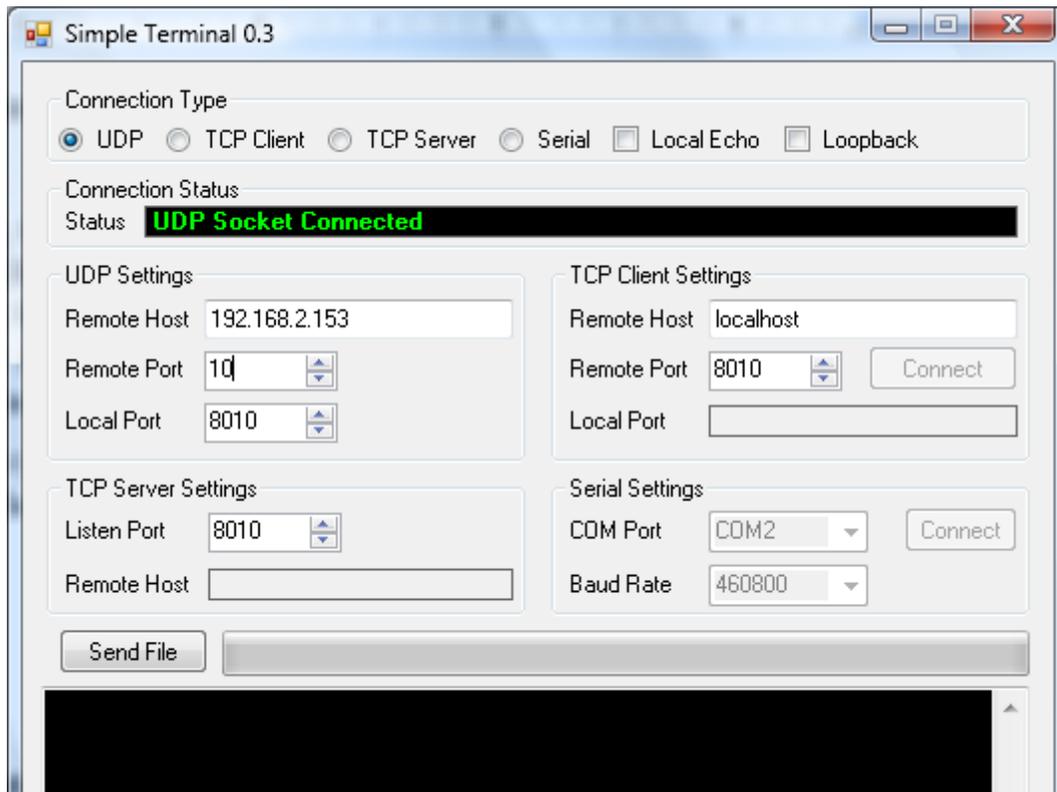
Screen 1: Configuring the UDP Client

Once the UDP client is running, you can send data to the Evaluation Board from *Simple Terminal*. The data will be forwarded over the serial connection to *Tera Term*. The data sent should appear in the *Tera Term* window. You can also send data in the other direction, using *Tera Term* to forward data over the serial connection to the Evaluation Board, which will then forward it via Wi-Fi to *Simple Terminal*.

For example, click in the data window in *Simple Terminal* and type Hello World. The characters you type are sent as packets, and will appear in the *Tera Term* window with their source IP address and port (Screen 2 next page).

Screen 2: Data Sent from *Simple Terminal* Received Over the Serial Connection by *Tera Term*

You can also send the contents of a text file (producing a more readable result), by using the Send File button in *Simple Terminal* to select the text file. An example result is shown in Screen 3.

Screen 3: Data from a Text File Sent to *Tera Term* with *Simple Terminal*'s Send File Button

To send data in the other direction, from over the serial bridge to Wi-Fi, select the *Tera Term* window. Press the <Esc> key on your keyboard, and then type a message, e.g.

U0192.168.2.160:8010:Hello World

followed by the <Esc> key and E to complete the data transfer operation. You may wish to turn Local Echo on (in the Terminal menu) prior to issuing the <Esc> sequences to help you type correctly. Remember that commands are case sensitive: U and u, or E and e, are not the same!

The sequence <Esc>U indicates that data is to be sent; 0 is the connection ID provided in Screen . This is followed by the IP address and port of the UDP client to which the message is to be sent; this port was set in Screen 1. Note that the IP address is entered in dotted-decimal format, with a colon, ":", as the delimiter between address and port, as well as between port and the data to be sent. The sequence <Esc>E tells the *Serial2WiFi* application that the data is ready to be sent over the air.

The sent data should then appear in the *Simple Terminal* window (Screen 4).
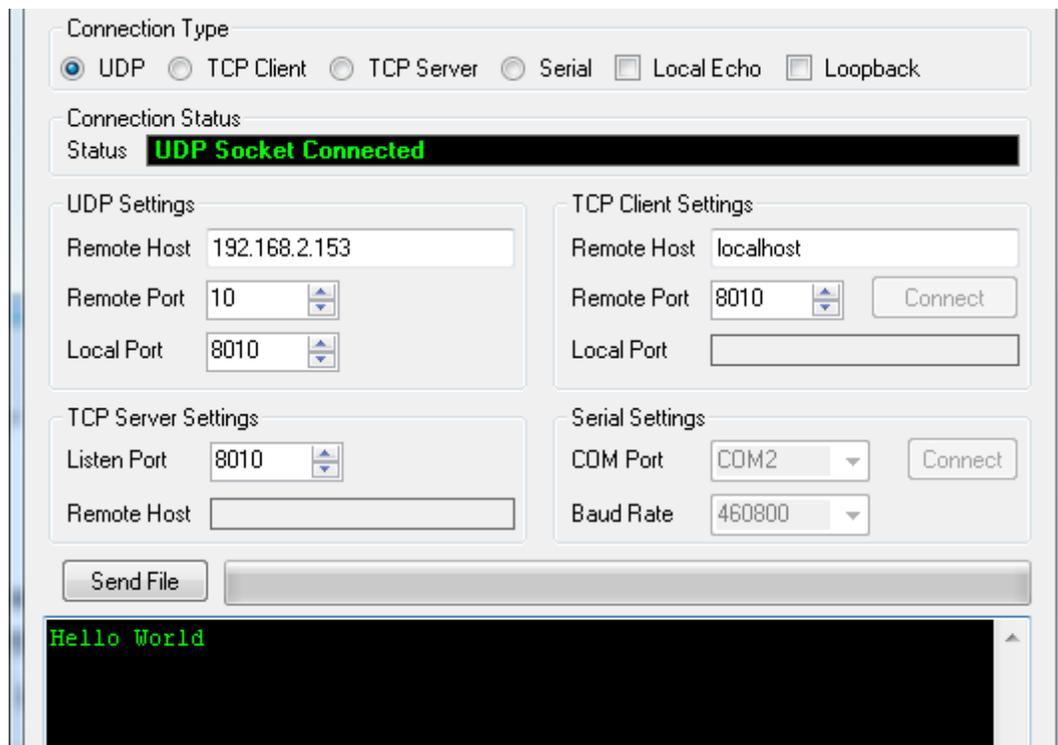
Screen 4: Data sent from *Tera Term* is received over Wi-Fi by *Simple Terminal*

You may also send the contents of a text file from *Tera Term*. There are two ways to do this. You can type the command and address information:

<Esc>U0192.168.2.160:8010:

and then select Send File from *Tera Term*'s File menu. The text file data will be placed after the delimiter. You still need to type <Esc>E to send the data. If you prefer, you can include the header text

U0192.168.2.160:8010:whatever_ascii_data_you_want...

in the file itself. You then simply type <Esc> and select Send File, followed by <Esc>E In either case, the file contents (absent the header if included) should appear in the *Simple Terminal* window.

TCP SERVER WITH WPA2 SECURITY

The second example is very similar to what has been described previously except using TCP rather than UDP, and WPA2 encryption/authentication.

1. Using the Access Point configuration utility, set the AP to use WPA2 security and enter the passphrase. *Make certain to note the passphrase.* We use the passphrase "GSDemo123" below, but any suitable passphrase may be employed.

2. In *Tera Term*, issue the serial commands listed in Table 2. This creates a TCP server in the Evaluation Board.

Table 2: Setup TCP Server with WPA2 Security

Sequence	Command	Description
1	AT+WD	Instruct the Evaluation Board to disassociate from the AP.
2	AT+WWPA=GSDemo123	Set the WPA2 passphrase. (If you used a different passphrase in the AP, substitute that value in this command.)
3	AT+WA=GainSpanDemo	Instruct the Evaluation Board to associate with the desired network SSID. Note that the SOC needs to compute the PSK from the passphrase, which takes a while. Be patient!
4	AT+NSTCP=20	Start a TCP server on Port 20.

3. Create the corresponding TCP client in the Wi-Fi host. In *Simple Terminal*, set the Connection Type to TCP Client, the Remote Host IP address to the Evaluation Board value (from *Wireshark*), and the Remote Port to 20. Press Connect. See Screen 5.
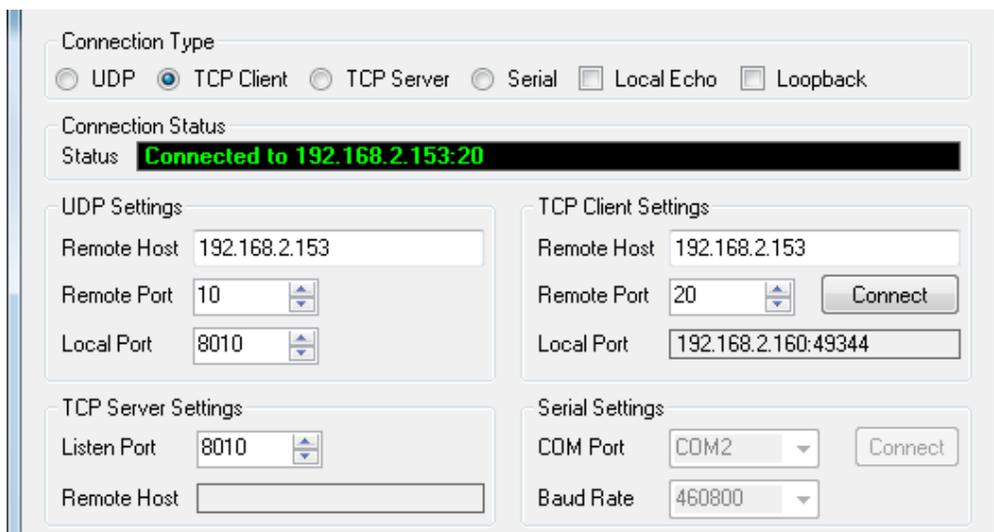
Screen 5: TCP Client Parameters

The client will create a TCP connection with the Evaluation Board server. When this connection is established, the Serial2WiFi application sends a corresponding message over the serial port. The message, here CONNECT 0 1 192.168.2.160 49344 (Screen 6), indicates that a connection with the TCP server arrived on CID 0, and has been assigned to CID 1. The remote IP address and port, 192.168.2.160 and 49344, respectively, are also shown.

Screen 6: Connect Notification from the Serial2WiFi Application

Now that the TCP connection is established, we can again send data in either direction. For example, if you type Hello World in the *Simple Terminal* window, Tera Term will display the message one character per line, with each character preceded by the CID (1 in this case), as shown in Screen 7.

Screen 7: Characters Sent from *Simple Terminal* Over TCP connection 1 displayed in *Tera Ter*m

We can also send data in the other direction. Press the <Esc> key on your keyboard and then type

        S1Hello World

followed by typing in the <Esc>E to complete the data transfer operation. The sequence <Esc>S sends data over the CID provided, here = 1. The sent data should then appear in the *Simple Terminal* window.
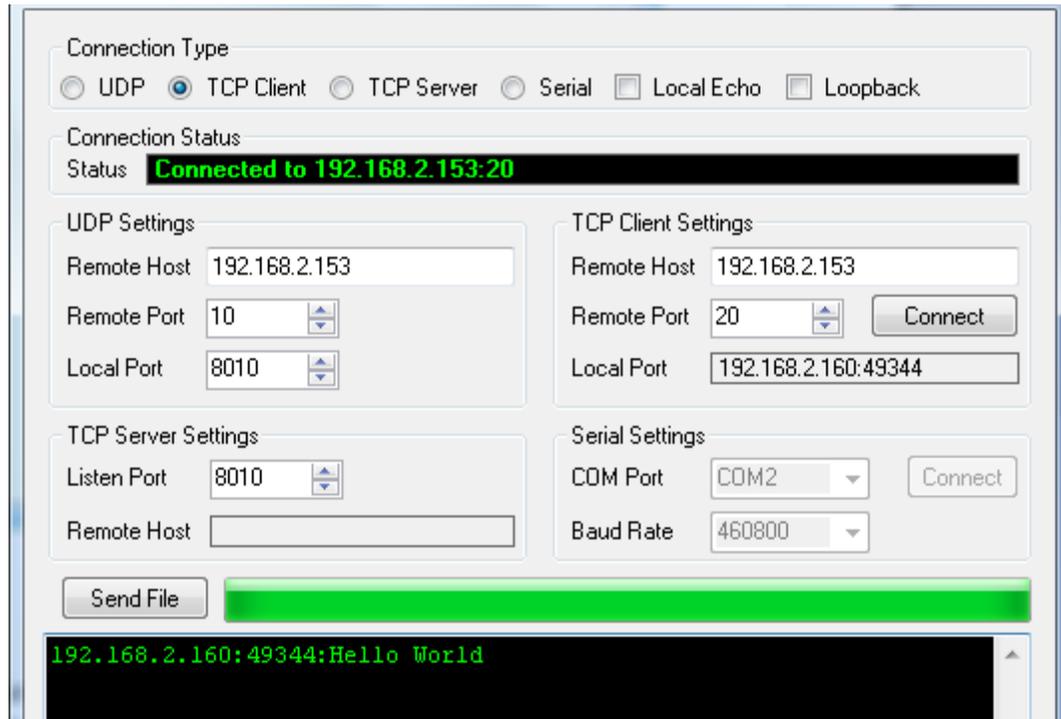
Screen 8: Data Sent from *Tera Term* Over a TCP Connection Appears in *Simple Terminal*

As with the UDP client/server, text data files can also be sent in either direction. Note that in this case, the header used in a file sent from *Tera Term* is just S1, and can readily be eliminated altogether; just type <Esc> S1 first, and then select Send File and browse to the desired text file.

TCP CLIENT WITH WEP ENCRYPTION

The final example is very similar to those described previously. This one, however, uses a TCP client on the Evaluation Board and WEP encryption for the Wi-Fi connection.

1. Using the Access Point configuration utility, set the AP to use WEP security, enter and note the key value for KEY1. We use the value "01234567890" below, but any suitable value may be employed. (Note that static WEP security is readily penetrated and use of WEP is not recommended where secure data transfer is required; this example is provided to demonstrate the compatibility only.)

2. Create a TCP server on the Wi-Fi host listening to port 8020, as shown in Screen 9.

Screen 9: Create a TCP Server in *Simple Terminal*

3. In *Tera Term*, issue the serial commands listed in Table 3.

Table 3: Setup TCP Client with WEP Security

Sequence	Command	Description
1	AT+WD	Instruct the Evaluation Board to disassociate from the AP.
2	AT+WWEP1=1234567890	Set WEP Key 1
3	AT+WA=GainSpanDemo	Instruct the Evaluation Board to associate with the desired network SSID. (Repeat if needed; see Screen 10.)
4	AT+NCTCP=192.168.2.160,8020	Attempt TCP connection to Destination. Note parameters are comma-delimited.

Screen 10: Serial2WiFi Messages during TCP Client Setup

When the Evaluation Board has successfully connected to the TCP server, the *Serial2WiFi* application sends the message CONNECT 0 (indicating the new connection has been assigned CID 0), as shown in Screen 10. *Simple Terminal* will also display a notification (Screen 11).
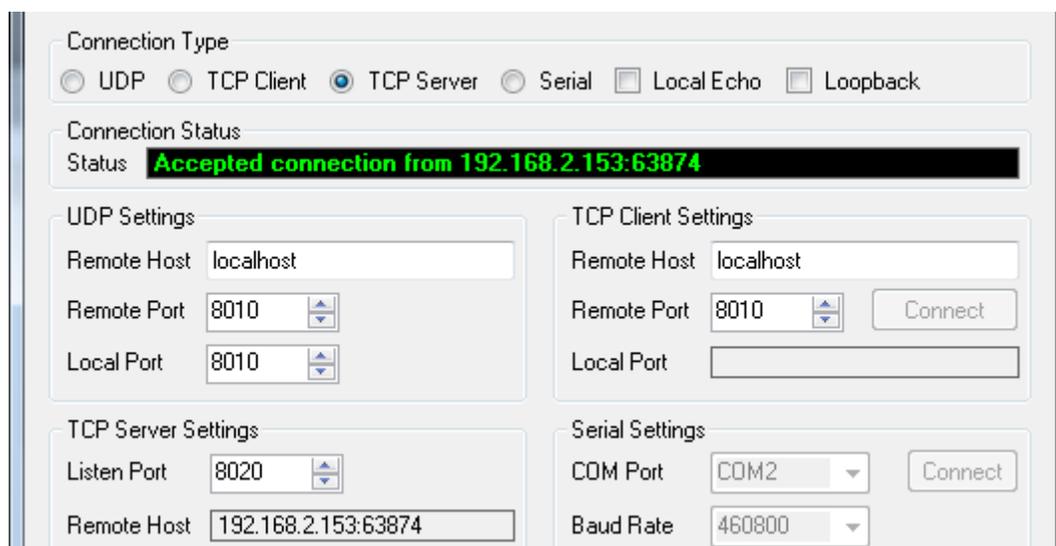
Screen 11: *Simple Terminal* Displays a Connection Message for the Evaluation Client

Now the connection can be used to send data in either direction. You can type a message in *Simple Terminal*'s data pane; the received characters will be displayed in *Tera Term*, as depicted in Screen 14.

```
at+nctcp=192.168.2.160,8020
CONNECT 0
0H
0e
01
01
0o
0
0W
0o
0r
01
0d
```

Screen 12: Data Sent from the TCP Server is Displayed by Tera Term

To send data from the serial side (in this case a TCP client), press the <Esc> key on your keyboard first and then type in

        S0Hello World

followed by typing in <Esc>E. <Esc>S sends data over the provided CID (0 here).   The sent data should then appear in the *Simple Terminal* window.   The contents of data files can also be transferred using the same procedures employed in the previous section.

UDP SERVER OVER AD HOC NETWORK

The IEEE 802.11 standard describes two different types of networks: an *Infrastructure* network, where Stations connect to an Access Point that provides network access, and an *Ad Hoc* network, where Stations connect directly to each other. A Station can send beacons and act as an *Independent Basic Service Set* (IBSS); another station can then associate with it and exchange packets. Ad hoc networks can be convenient in many circumstances where quick temporary connections are desired. For GEPS versions 1.3.2 and above, SOC operations with ad hoc networks are supported. In this section we show how to set up an ad hoc serial bridge. For this example, you don't need an Access Point, but you do need a Wi-Fi client either built into or connected to the *Simple Terminal* laptop, and a client application capable of setting up an IBSS.

1. Issue the command AT+NDHCP=0 to the Evaluation Board. This command disables DHCP, allowing you to set the IP address of the board.

2. Issue the command AT+NSET=192.168.2.50,255.255.255.0,192.168.2.1. This command sets the IP address of the Evaluation Board to 192.168.2.50, the subnet mask to 255.255.255.0, and the gateway IP address to 192.168.2.1.

3. Using the Network Connections control panel, set the IP address of the wireless connection on the *Simple Terminal* laptop computer to an address in the same subnet as the Evaluation Board; we'll use the example value 192.168.2.51 here.

4. Set up an IBSS from the laptop's wireless adapter, and note the SSID used. We'll use S2WF_IBSS here, but any suitable name can be substituted. The setup for an Intel PROSet client is summarized in Screen 13 and Screen 14; other wireless clients may differ slightly.
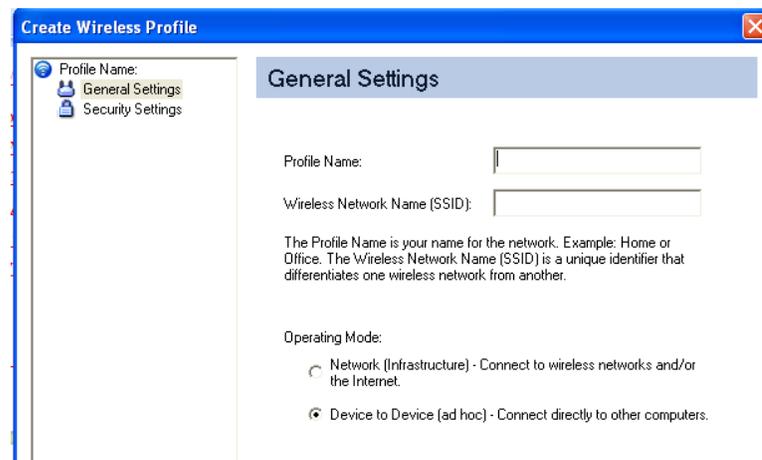
Screen 13: AD HOC Setting
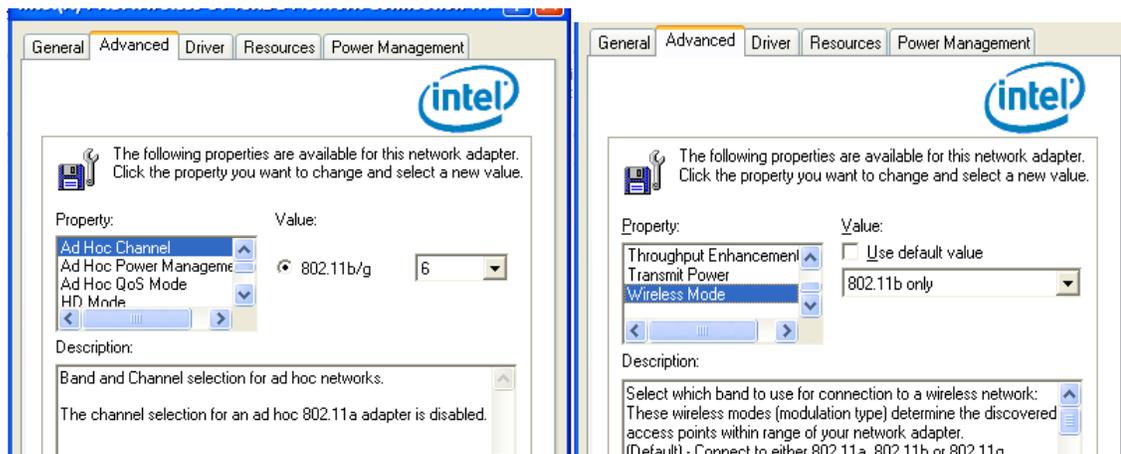
Screen 14: Channel and Operating Mode for AD HOC IBSS

5. Issue the command AT+WA=S2WF_IBSS to the Evaluation Board; this will cause it to associate with the IBSS created by the laptop computer wireless interface.

6. Issue the command AT+NSUDP=10, creating a UDP server on port 10. You can then configure *Simple Terminal* to connect to the server and send a message over the ad hoc wireless network (), which will be displayed on *Tera Term* ().
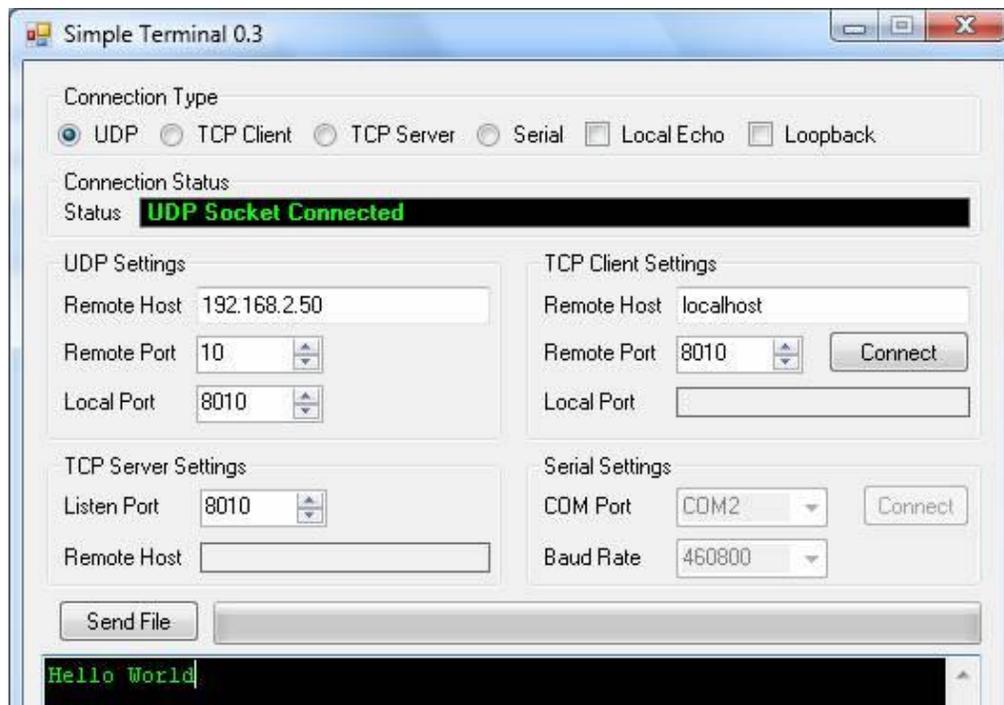
Screen 15: Connecting to the UDP Server at 192.168.2.50,10 Over an AD HOC Network

```
OK
0192.168.2.51 8010       H
0192.168.2.51 8010       e
0192.168.2.51 8010       l
0192.168.2.51 8010       l
0192.168.2.51 8010       o
0192.168.2.51 8010
0192.168.2.51 8010       W
0192.168.2.51 8010       o
0192.168.2.51 8010       r
0192.168.2.51 8010       l
0192.168.2.51 8010       d
```

Screen 16: Message from Simple Terminal Received over AD HOC/Serial Bridge

AUTO CONNECT WITH TCP CLIENT MODE

The Auto Connect mode will automatically associate a specified Access Point with a construct a TCP connection when the Adapter is powered on. In this section, we provide an example in which the Adapter connects as a TCP Client.

It is first necessary to configure the Adapter for Auto Connect operation. Start with the Adapter in Command mode, and issue the following commands from *TeraTerm* (Screen 17):

1. AT+NDHCP=1 to enable DHCP.

2. AT+NAUTO=0,1,192.168.2.160,8888 to configure the Adapter as a TCP client, with port 8888. The IP address of the TCP server is not required with Serial-to-WiFi versions 1.0.8 and above.

3. AT+WAUTO=0,GainSpanDemo,,6 configure the SSID ("GainSpanDemo") and channel number of the AP with which the unit will associate. You may need to substitute the SSID of your Access Point, and check that the AP is configured to operate on the channel given in this command.

4. ATC1 to enable Auto Connect mode.

5. AT&W0 to save the new configuration in Profile 0.

6. AT&Y0 to set Profile 0 as the profile to be loaded on the next cold boot (power-up).

Screen 17: Auto Connect Setup

Turn off the power to the Adapter. In *Simple Terminal*, select the TCP Server button, and set Listen Port to 8888 (Screen 18).

Screen 18: *Simple Terminal* TCP Server Setup

Power up the Adapter and the Adapter will automatically associate with the requested AP (if it is accessible); when the connection is made, the Adapter will send the message CONNECT 0 over the serial port, from whence it will be displayed by *Tera Term*.   The Status panel in *Simple Terminal* will report that it has accepted a connection from the IP address of the Adapter (here 192.168.2.52), with a random source port, as shown in Screen 18. Data can now be sent between the two machines; for example, typing Hello World in *Tera Term* will produce the corresponding text in *Simple Terminal*, as shown in Screen 18.

To escape from Auto Connect Mode to AT Command mode, use *Tera Term* to enter the special escape sequence "+++" and wait for at least one second delay after typing the last character before entering any other data or commands. The Adapter will enter Command mode, and is ready to receive additional AT commands.   To disable Auto Connect mode, issue the command ATC0.

ADDITIONAL REFERENCES

1. Serial to Wi-Fi Evaluation Kit Startup Guide.pdf
2. Serial to WiFi_Adapter_Guide.pdf
3. Serial to WiFi_Command_Reference.pdf
4. Serial to Provisioning Methods with S2W App Note AN039.pdf
   The Serial to Wi-Fi application supports multiple methods of provisioning the device to connect to the infrastructure (i.e. Access Point) including Web Based Provisioning and Wi-Fi Protected Setup (WPS).
5. S2W HTTP TCP UDP Protocol Examples AN045.pdf
   This document details sequences for using AT commands for setting up HTTP/TCP/UDP connections
6. Firmware Update over Wi-Fi Interface using S2W App Note AN038.pdf
   This document details the necessary steps and processes required for performing a firmware update over the Wi-Fi interface with the Serial2Wi-Fi Application.

ADDITIONAL RESOURCES

1. `http://www.ayera.com/teraterm/` or
   `http://hp.vector.co.jp/authors/VA002416/teraterm.html`

2. *Simple Terminal* requires the .NET framework, available for Windows computers from Microsoft Corporation; search for ".NET framework" at
   `http://www.microsoft.com/downloads/en/default.aspx`
   We recommend version 2.0 or above.

3. `http://www.wireshark.org/`

Version	Date	Remarks
3.2	14 September 2010	Initial Release with MEE-DB
3.3	16 Dec 2010	Changed images for boards
3.4	9 June 2011	Updated for GS1500
3.5	10 Oct 2011	New Artwork

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