



Theory of Operations and User Manual

SPF-005 GEAS WDNV-II

SDRL A036

Digi Part Number: 90001937

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1 Overview or Purpose

This document is the user manual for the Wireless Data Network Unit (WDNU-II). It assumes the reader has some general knowledge of the product, which can be gained from other documents. The goal of this document is to describe the various ways to interact with and use the WDNU-II.

2 Scope

This Subcontractor Data Requirements List (SDRL) document applies to the Wireless Data Network Unit-II for the Aircraft Health Management System as defined in the specification listed in the references.

The information within this document is intended to be informative and explanatory. It is based on the actual design artifacts and should not be considered authoritative.

3 Reference Material

3.1 Reference Documents

| Customer Document ID | Digi Part Number | Document | Filename | Revision | Date | Source |
|----------------------|------------------|---|---|----------|----------|-------------|
| SOW1281 | NA | Statement of Work for Wireless Data Network Unit (WDNU-II) | WDNU II Statement of Work_SOW1281_Revx2_20140527.pdf | X2 | 12/4/13 | GE Aviation |
| -- | NA | WDNU-II SOW1281 & TRS1255 Amendments | WDNU II Rev D SOW1281_TRS1255 Amendments_20140527.pdf | | | GE Aviation |
| TRS1255 | NA | Technical Requirements Specification for the Wireless Data Network Unit (WDNU-II) | TRS1255 22-JAN-2015.pdf | TBD | 01/22/15 | GE Aviation |
| YV2818 | NA | Interface Protocol Specification for the Command Handler Superset of the Wireless Data Network Unit | YV2818_Extended_Draft01-.doc | — | 01/27/15 | GE Aviation |
| SDRL A007 | 90001451-88 | Interface Control Doc | A007 - Interface Control Document.docx | — | 03/16/15 | EWDS |
| SDRL A008 | 50001885-01-PRT | WDNU-II Installation Drawing | 50001885-01-PRT, WDNU-II INSTALLATION DRAWING, REV 1P.PDF | 1P | 03/11/15 | EWDS |
| SDRL A018 | NA | WDNU-II BIT Description | A018 - BIT Description.docx | — | 03/16/15 | EWDS |
| SDD | NA | Software Design Document | WDNU-II Software Design Document.docx | — | 03/16/15 | EWDS |

3.2 Acronyms, Terms and Definitions

| Acronyms and Terms | Definition |
|--------------------|---|
| ACK | Acknowledge |
| AP | Access Point |
| ARP | Address Resolution Protocol |
| BIT | Built-In Test |
| CHIP | Command Handler Interface Protocol |
| CLI | command-line interface |
| DC | Direct Current |
| DHCP | Dynamic Host Configuration Protocol |
| EWDS | Etherios Wireless Design Services |
| GE | General Electric |
| GEAS | General Electric Aviation Systems |
| GSM | Global System for Mobile |
| HDD | Hardware Design Document |
| HTTPS | Hypertext Transfer Protocol Secure |
| ICCID | Integrated Circuit Card Identifier |
| ICMP | Internet Control Message Protocol |
| ID | Identifier or Identification |
| I/O | Input/Output |
| IEEE | Institute of Electrical and Electronics Engineers |
| IMSI | International Mobile Subscriber Identity |
| IP | Internet Protocol |
| LRU | Line Replaceable Unit |
| OTG | On-The-Go |
| NA | Not Applicable |
| PC | Personal Computer |

| Acronyms and Terms | Definition |
|--------------------|---|
| PSK | Pre-shared key |
| RF | Radio Frequency |
| SDRL | Subcontractor Data Requirements List |
| SDD | Software Design Document |
| SIM | Subscriber Identity Module |
| SMA | SubMiniature version A |
| SOW | Statement of Work |
| SSH | Secure Shell |
| SSID | Service set identification |
| STD | Standard |
| TBD | To Be Determined |
| TNC | Threaded Neill-Concelman |
| TRS | Technical Requirements Specification |
| UBIFS | Unsorted Block Image File System |
| UDP | User Datagram Protocol |
| UI | User Interface |
| USB | Universal Serial Bus |
| VBUS | Virtual Bus |
| VPN | Virtual Private Network |
| WDNU | Wireless Data Networking Unit |
| WDNU-II | Enhanced Wireless Data Networking Unit |
| Wi-Fi | Wireless Fidelity (IEEE 802.11) |
| WPA | Wireless Fidelity (Slang) Protected Access |
| WPA2 | Wireless Fidelity (Slang) Protected Access II |

4 WDN-U-II Overview

4.1 General Description

The WDN-U-II provides the wireless bridge between the host and access points while the aircraft is on the ground. Operation of the WDN-U-II occurs when the host provides power, enables the device and requests connection via either Wi-Fi or GSM.

Physically, the subsystem is comprised of a WDN-U-II Line Replaceable Unit (LRU) that connects to a Wi-Fi and GSM antenna providing optimized Wi-Fi and GSM connectivity and range. 28V DC power is supplied to the WDN-U-II by the aircraft power system. A control signal is provided by the host system for the WDN-U-II to enable itself.

The WDN-U-II will provide an Ethernet interface direct to the host. The host will transmit and receive data in standard Ethernet packets to and from the WDN-U-II. The WDN-U-II supports VPN connections over the Wi-Fi and GSM interfaces to provide data security. The WDN-U-II may also be configured as a Wi-Fi access point that will accept up to 4 simultaneously connected Wi-Fi clients.

4.2 Physical Description

The physical configuration of the WDN-U-II is shown in Figure 1. The information comes from SDRL A008, Digi Part Number 50001885-01-PRT.

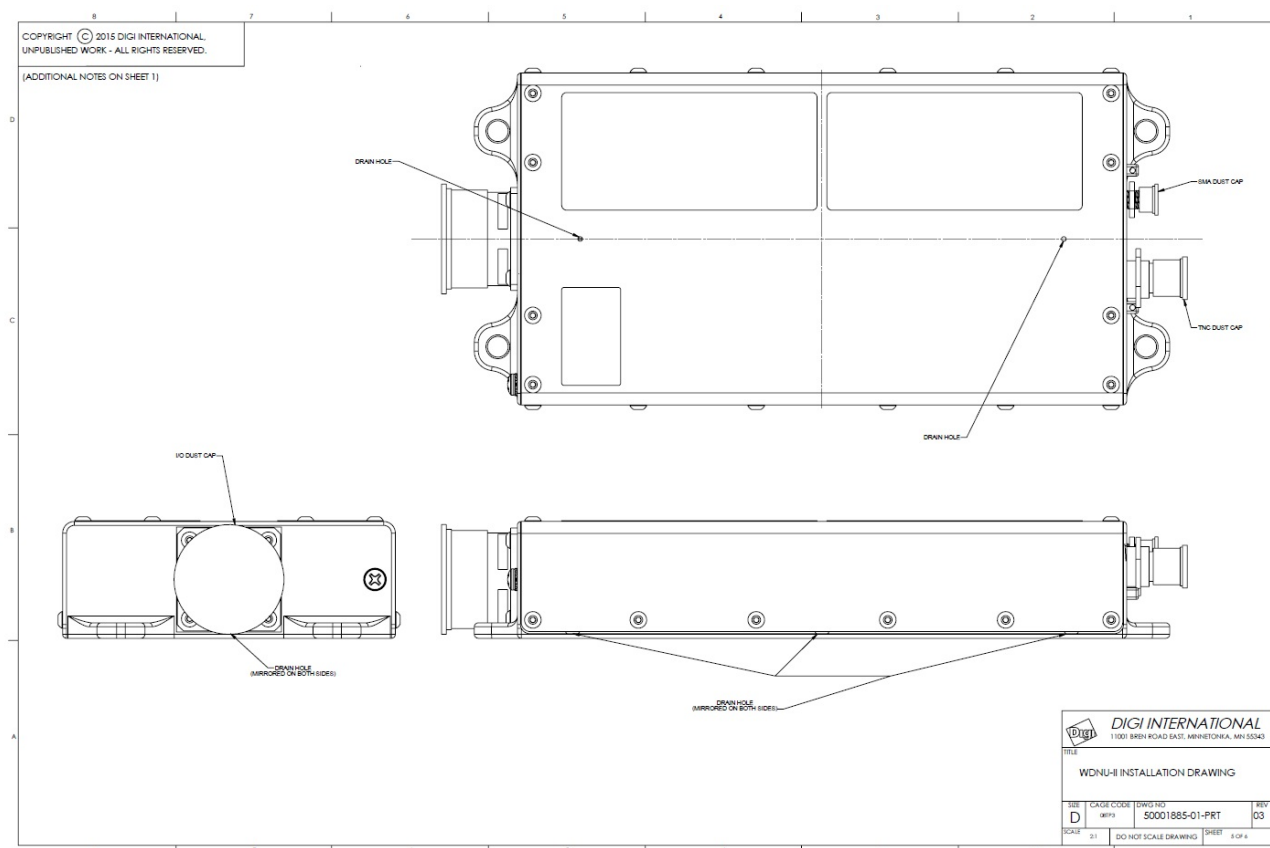


Figure 1: WDN-U-II Top and Side Views

4.3 WDN-U-II Interfaces

The following information comes from SDRL A007, Digi Part Number 90001451-88.

The electrical signal interface is provided by a set of contacts in a connector on the outer panel of the WDN-U and by a set of antenna connectors on the opposite panel as show in Figure 2 and Figure 3.

The connector on the outer panel of the WDN-U-II provides the following connection points:

- 38 Size 22 contacts and one Quadrax contact.
- LRU connector: Amphenol TVP-00-RQF-17-2-p (or equivalent)
 - Aircraft I/O mating connector: Amphenol TV06-RQF-17-2-S (or equivalent)

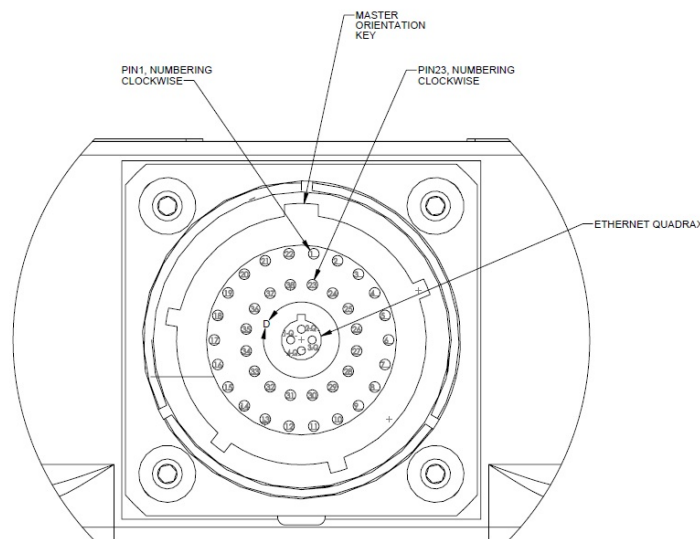


Figure 2: Amphenol TVP-00-RQF-17-2-P WDN-U-II Front Panel Connector

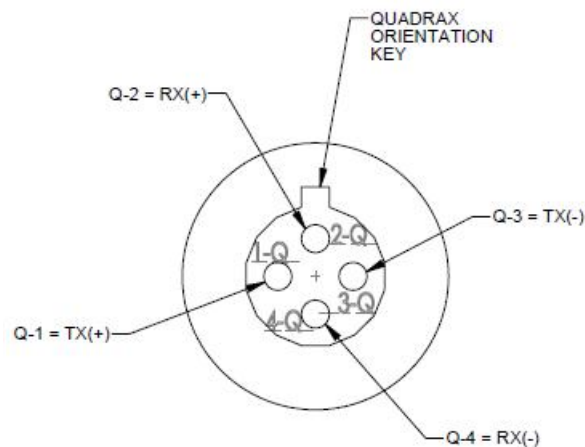


Figure 3: Ethernet Quadrax Contact Detail Showing Pin Orientation and Numbering

Table 1 presents an extract of the pin assignments for the main connector on the front panel.

Table 1: Assignments for the Main Connector on the Front Panel

| Pin ID | Pin Name |
|--------|--------------------------------|
| 1 | Chassis Ground |
| 2 | 28 VDC Power In 1 |
| 3 | 28 VDC Power In 2 |
| 4 | 28 VDC Power Return 1 |
| 5 | 28 VDC Power Return 2 |
| 6 - 15 | Not Connected |
| 16 | USB_OTG_VBUS_SOM |
| 17 | USB_N |
| 18 | USB_P |
| 19 | USB_OTG_ID |
| 20-21 | Not Connected |
| 22 | Power Off Discrete Out – O/G |
| 23 | Power On Discrete In |
| 24 | Power Off Discrete Out – 28V/O |
| 25 | Shield/Ground |
| 26-27 | Not Connected |
| 28 | RS-232 FORCEOFF |
| 29 | RS-232 In |
| 30 | RS-232 Out |
| 31 | RS-232 Common |
| 32 | Not Connected |
| 33-36 | Not Connected |
| 37 | USB Common |
| 38 | Not Connected |
| Q-1 | Ethernet RX-A (+) |
| Q-2 | Ethernet TX-A (+) |
| Q-3 | Ethernet RX-B (-) |
| Q-4 | Ethernet TX-B (-) |

The back panel of the WDNII provides the following connection points:

- WiFi Antenna Connector: TNC Amphenol 122192 (or equivalent)
 - WiFi Antenna mating connector: TNC Amphenol 122116, straight plug (or equivalent)
- GSM Antenna Connector: Subminiature version A (SMA) Amphenol 132176 (or equivalent)
- GSM Antenna mating connector: SMA Amphenol 132178 (or equivalent)

4.3.1 Radio Power On Discrete

The radio power on signal is an Open/Ground discrete output from the host used to turn the WDNII on or off. When asserted (grounded), power to the WDNII is applied and the system is on. When de-asserted (open), the WDNII is off.

4.3.2 Radio Power Off Discretes

The radio provides two discrete power off signals. These signals are described as:

- WDNU_OFF1 is a 28VDC/Open discrete output from the WDNU-II to indicate whether the WDNU-II is on or off. When the host turns the WDNU-II on with the radio power on discrete, the radio power off discrete will be open to signal that the WDNU-II is on. When the WDNU-II is off this signal will be pulled up to the aircraft supply voltage (28VDC nominal).
- WDNU_OFF2 is an Open/Ground discrete output from the WDN-II to indicate when the WDNU-II is on or off. When the host turns the WDNU-II on with the radio power on discrete, the radio power off discrete will be grounded (and able to sink up to 20ma) to signal that the WDNU-II is on. When the WDNU-II is off this signal will be open.

4.3.3 Ethernet Interface

The WDNU-II provides one Ethernet interface for communications with the host. The Ethernet channels will support the IEEE-STD-802.3 10/100 Ethernet protocol with auto-negotiation. The cable configuration specified is a crossover connection.

4.3.4 Universal Serial Bus (USB) Serial

The WDNU-II provides one USB Serial interface with Virtual Bus (VBUS) and identification (ID) control lines. The data bus communication protocol is defined in the USB standard.

4.3.5 RS-232 Interface

A RS-232 serial communication interface has been included through the main connector to the host. The settings for the RS-232 interface are shown in Table 2.

Table 2: RS-232 Port Settings

| RS-232-Port Settings | |
|-------------------------------|--------|
| Baud rate | 115200 |
| Number of data bits | 8 |
| Parity | None |
| Number of stop bits | 1 |
| Flow control | None |
| Automatic baud rate detection | No |

This RS-232 FORCEOFF pin controls the operation state of the RS-232 Data Bus. When pulled to ground, the RS-232 Data Bus is enabled. The RS-232 Data Bus is disabled when this pin is left floating.

4.4 WDNU-II RF Interfaces

The WDNU-II has two external coaxial connections for the GSM and Wi-Fi transceivers.

4.4.1 Wi-Fi Connection

- TNC Amphenol 122192 (or equivalent)
- Mating connector: TNC Amphenol 122116, straight plug (or equivalent)

4.4.2 GSM Connection

- Subminiature version A (SMA) Amphenol 132176 (or equivalent)
- Mating connector: SMA Amphenol 132178 (or equivalent)

5 WDNU-II Functional Description

The WDNU-II is a gateway product which runs a server that allows the host to connect to a remote server over a secure connection. This section describes some of the features of the WDNU-II, which are illustrated in Figure 4.

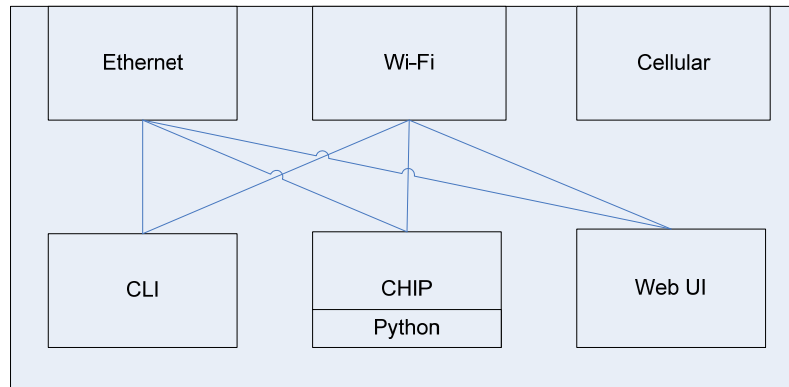


Figure 4: Major Functional Components

5.1 Network Interfaces

The WDNU-II has Ethernet, Wi-Fi (802.11 b/g/n, 2.4GHz only) and cellular (GSM 3G) network interfaces.

5.1.1 Ethernet

The Ethernet interface is factory configured with a static IP address of 192.168.114.1 and subnet mask of 255.255.0.0. ARP and ICMP are both enabled on the interface. Three main services are provided on the Ethernet interface. These services are the Command-Line Interface (CLI), the Command Handler Interface Protocol (CHIP), and the web user interface (web UI). The general use case for the Ethernet port is the host communicates with the WDNU-II using CHIP.

5.1.2 Wi-Fi

The Wi-Fi interface is not enabled by default, but can be configured with any of the available services on the Ethernet interface. It can be configured to operate in station mode, access point (AP) mode, or concurrent mode which is simultaneous client and AP mode. By default the CLI, CHIP and web interface are not supported on the Wi-Fi interface, but the CLI and web interface can be enabled on AP mode via a configuration update.

When configured in station mode, the WDNU-II can scan and connect to nearby access points and use DHCP to get an IP address. When in AP mode, it will broadcast an SSID for Wi-Fi stations to find and connect to. When in concurrent mode the device suffers a throughput penalty so the device should be configured in station mode or AP mode when concurrent operation is not necessary.

When configured as an AP in either AP mode or concurrent mode, the AP interface has an IP address of 192.168.3.1 and the DHCP server will hand out addresses in the 192.168.3.0/24 subnet in the range 192.168.3.10 – 192.168.3.85. This network configuration can be changed via a software update of the configuration partition. ARP and ICMP are both enabled on the AP interface.

To configure Wi-Fi via the web interface:

1. Login to the WDN-U-II web interface and select **Wi-Fi Configuration** in the navigation bar. The screen shown in Figure 5 will be displayed.
2. Select **STATION**, **ACCESS POINT** or **CONCURRENT** to enable the Wi-Fi interface in one of the desired operational modes. If station or concurrent mode was selected, the WDN-U-II can scan for Wi-Fi networks and add each one to the 'Available Networks' dropdown list.
3. To connect to a WPA-PSK or WPA2-PSK network; select the approach SSID from the list, enter the passphrase and press **Connect**.
4. To disable any of the interfaces select **DISABLED** from the dropdown.
5. To configure the AP for WPA2-PSK operation entered the desired SSID and passphrase and press **Configure**.

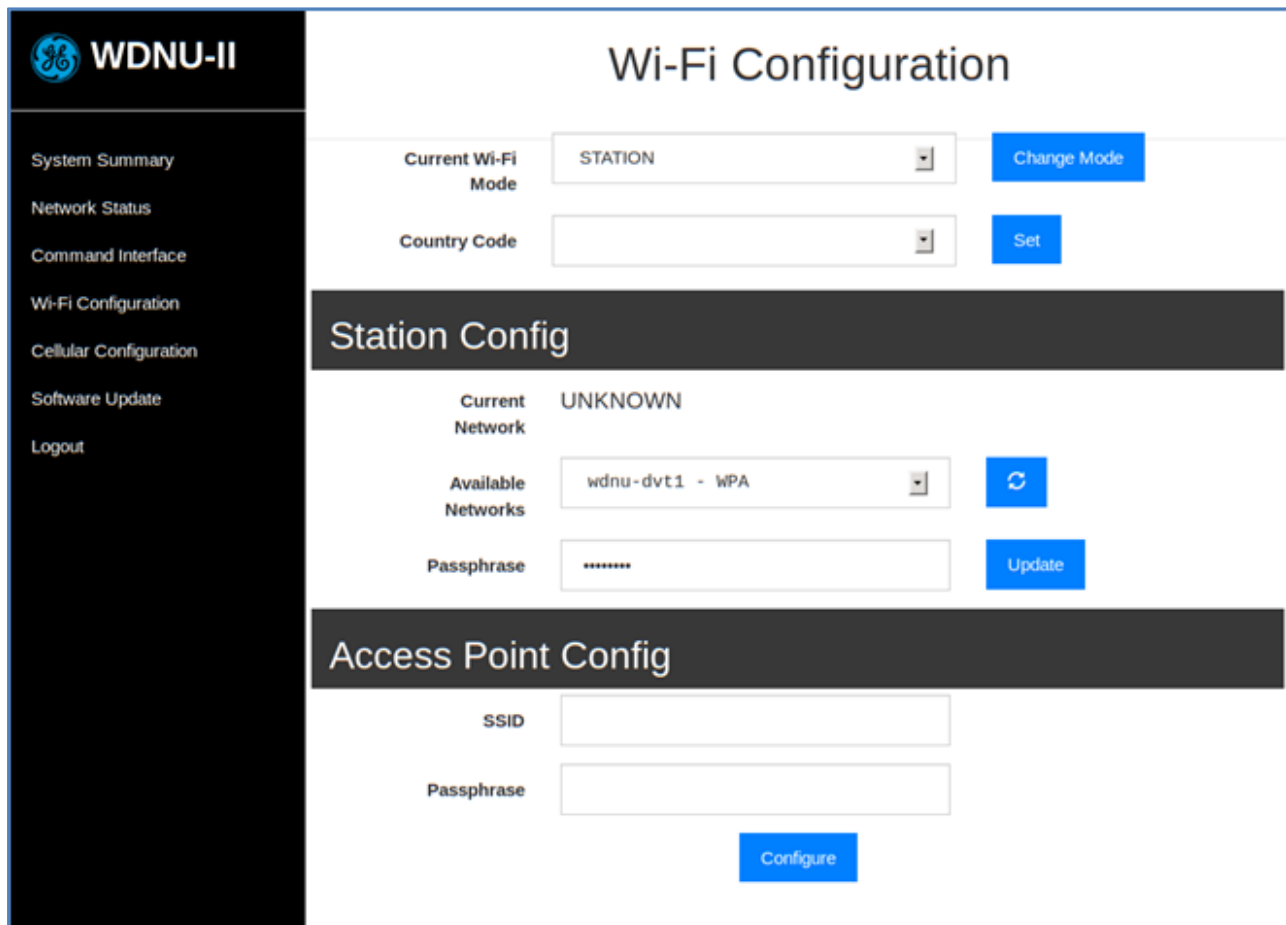


Figure 5: Wi-Fi Network Configuration using the Web User Interface

5.1.3 Cellular

The GSM cellular interface does not support the CLI, CHIP or web interfaces. It is used by the host to connect to a remote server when there are not any Wi-Fi access points available or when the operator defines it as the primary communication path. The WDN-U-II contains two SIM card slots which are populated with an AT&T SIM and a Vodafone SIM. The cellular interface can be configured via the CLI, CHIP or the web UI services using either the Ethernet or Wi-Fi interfaces (if enabled).

Figure 6 illustrates the configuration of the cellular connection using the web UI.

To configure cellular connection using the web UI: (See Figure 6)

1. Login to the WDNUII web interface, then select **Cellular Configuration** from the navigation bar and select **Enabled** to enable the cellular interface.
2. Enter **1** or **2** to select the SIM Card, and enter the APN, username and password (if required).
3. Click **Apply Updates** to configure the cellular interface and establish a data connection.
4. Select **Disabled** from the dropdown to disable the cellular interface completely.

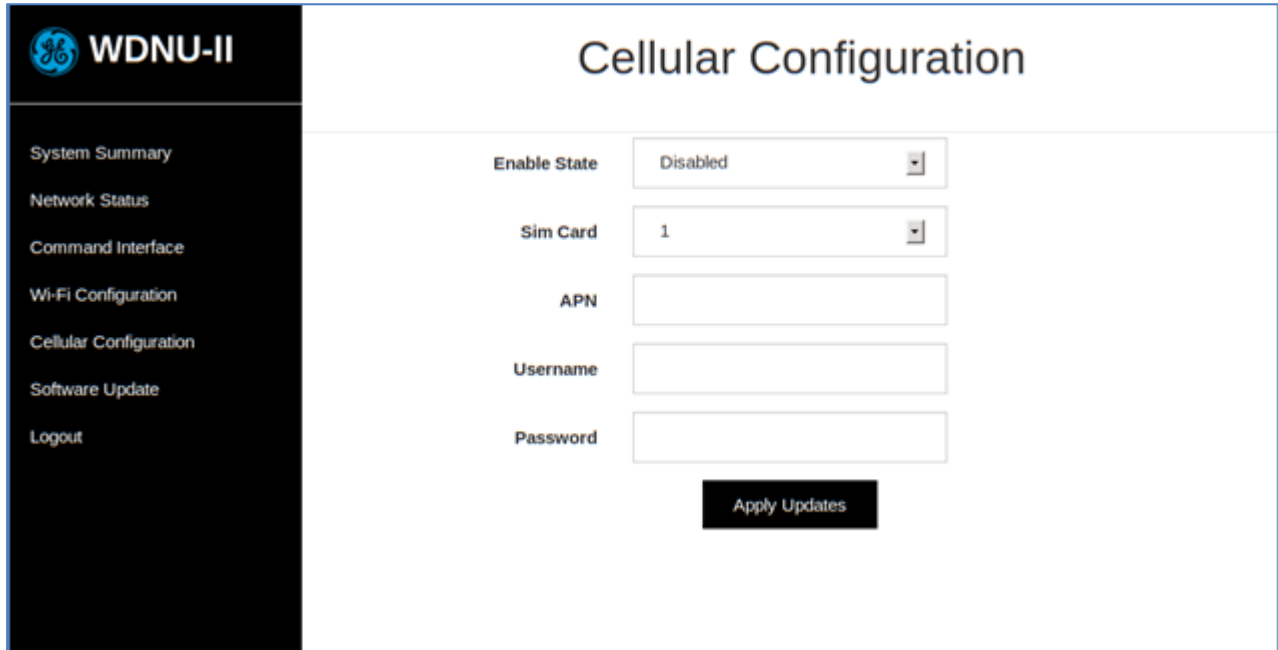


Figure 6: Mobile Configuration using the Web User Interface

5.2 Services

This section describes the services that are available on some of the network interfaces. To access these interfaces an example of a basic test configuration setup is detailed in Figure 7.

Equipment Needed:

1. WDNUII board loaded with pre-installed SIM cards
2. Off the shelf GSM antenna
3. Off the shelf Wi-Fi antenna
4. 2 DC power supplies
5. Digital Test cable for WDNUII
6. Windows PC with operating system of XP or higher

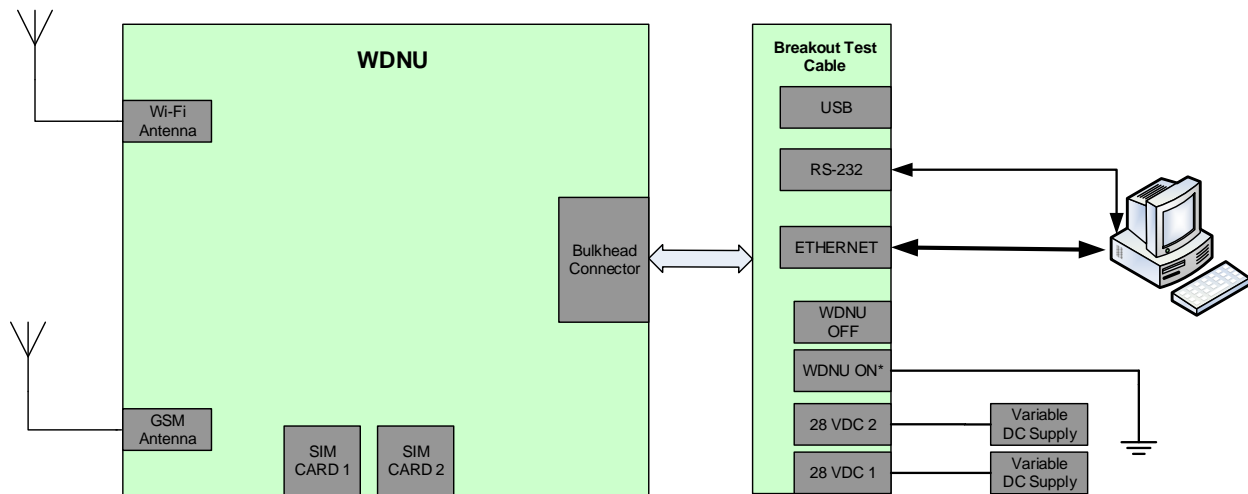


Figure 7: Example Test Configuration Setup

5.2.1 Command-Line Interface (CLI)

The command-line interface provides a means interacting with the WDNUnit-II. It is available via the RS232 and USB serial interfaces, or over Ethernet or Wi-Fi AP (when enabled) using SSH. The serial interfaces require username/password authenticated access but the communication is not encrypted. The CLI interface can be accessed from Windows machine using a terminal program called [PuTTY](#) using serial mode or SSH mode. On a Linux machine, PuTTY or another serial or SSH client can be used. This terminal provides unfettered access to the Linux operating system. It can be used to run custom python scripts or view system details not available via the CHIP CLI or web interface.

5.2.2 Command Handler Interface Protocol (CHIP)

CHIP provides many of the same configuration and status commands that are available through the command-line interface, but in a more defined and consistent format. The available commands in CHIP are defined in the *Command Handler Interface Protocol Specification for the Wireless Data Network Unit* (YV2818). The CHIP service is available on UDP port 49000.

5.2.3 Web User Interface

The WDNUnit-II provides a collection of web pages for interacting with the WDNUnit-II. Much of the information available on the web pages is also available through the CLI and CHIP services. The WDNUnit-II web UI is available via HTTPS on port 443 and can be accessed by a modern web browser like Internet Explorer, Firefox or Chrome. The web interface is described in more detail in Section 6.2.

5.3 Network Interface Configuration

The WDNUnit-II has a custom set of factory default configuration settings. The WDNUnit-II uses these configurations every time it boots up. Configuration changes are not persistent from one boot to the next. The custom defaults include setting the Ethernet IP address to 192.168.114.1, auto-running the WDNUnit-II Python application, etc... The Ethernet and Wi-Fi settings are described in more detail in Section 5.1. Default settings can be customized via a software update of the /opt/config UBIFS partition using the CLI.

5.4 Python

The WDN-U-II can be customized using the Python programming language. The Python interpreter can be invoked from the CLI with the python command. A Python application was developed for the WDN-U-II to support the CHIP service. The CHIP Python application can only be updated with a complete system update.

5.5 Startup Sequence

During boot the WDN-U-II tests RAM, flash, and the validity of the firmware image. It also runs BIT, where it tests the power subsystem and physical and logical connections to the Wi-Fi and cellular interfaces and both SIM cards. BIT is described further in SDRL A018. The results of the BIT test can be retrieved with the 'Transmit BIT Results CHIP' command. Once booted, the Wi-Fi transceiver is off, the cellular radio is off and the CHIP server application is running. The WDN-U-II uses the factory default settings on every boot, which is described in Section 5.3.

6 Detailed WDNU-II-Specific Description

6.1 CHIP

CHIP stands for the Command-Handler Interface Protocol. It was developed by GE for use on a communication network between a client and server. It defines the protocol used for communication between the host and the WDNU-II. It is defined in document YV2818.

6.1.1 CHIP Commands

CHIP contains a number of commands that can be used by the host to configure the WDNU-II, get BIT status, and setup a VPN.

6.1.1.1 Generic Command

One of the commands is the 'generic' command. This command can be used to execute a standard Linux CLI command over the CHIP protocol. The command can be up to 1020 characters long and the response is the same as if the command had been executed directly on the command line, including blank lines and newline characters. The maximum size of the response data is 1022 characters and the response will be truncated to 1022 characters if necessary.

6.1.1.2 Transmit BIT Status

This command reports on the BIT status of the power subsystem and Wi-Fi and cellular interfaces. Note that this command switches the active SIM card.

6.1.1.3 Configure Wi-Fi

The Wi-Fi radio can be configured by enabling the interface with the 'Wi-Fi Interface Control' command, and then configuring the interface with the 'Set Wi-Fi Mode' and 'Set Wi-Fi Tx Power' commands.

6.1.1.4 Configure GSM

The GSM radio can be configured by enabling the interface with the 'GSM Interface Control' command, and then configuring it with the 'Set Active SIM Card' command.

6.1.1.5 Configure VPN

The VPN can be set up by executing this CHIP command sequence:

1. Set Global VPN Mode.
2. Set VPN Tunnel Options.
3. Set VPN Phase 1 Proposal Options.
4. Set VPN Phase 2 Proposal Options.
5. Set VPN Interface ID.

6.1.2 Python and CHIP

The Python application implements the CHIP interface on the WDNU-II. This means the Python application is responsible for accepting CHIP command messages, translating the commands to the native format, executing the commands, and sending back the responses in CHIP ACK or data messages.

6.1.2.1 Python application

The Python application and supporting libraries are packaged into a single binary which is started automatically on system boot. The CHIP server listens for a CHIP client on UDP port 49000. When a UDP message is received, the server creates a thread to execute the CHIP request handler. The CHIP request handler does general validation of the request message, and then executes the appropriate CHIP command handler routine.

6.1.2.2 Logging

The Python application logs debugging information to `/var/data/logs/app.log[X]`. The files are limited in size to 100KB each, and to a total number of 5 files. The active log file is always `app.log`. When this file reaches 100KB, the oldest log file is removed, `app.log.3` is renamed to `app.log.4`, `app.log.2` is renamed to `app.log.3`, etc... and a new `app.log` file is created. The application logs information about both internal state as well as chip and web commands received. It will also log any errors encountered in the process of executing.

There are also a number of additional logs with more specific information that work in a similar manner. See Table 3 for a list of log file descriptions.

Table 3: Log File Descriptions

| Log Location | Description |
|---|---|
| <code>/var/data/logs/bit.log</code> | Information about the power-on and initiated BIT. |
| <code>/var/data/logs/shell.log</code> | Contains the output of any system commands called from the Python application (such as <code>'ifconfig wlan0 up'</code>). |
| <code>/var/data/logs/wpad.log</code> | Contains the output from the <code>wpa_supplicant</code> process as it is run and controlled by the Python app. |
| <code>/var/data/logs/mmd.log</code> | Contains information about the <code>modem_manager</code> process as it is run and controlled by the Python app. |
| <code>/var/data/logs/pppd.log</code> | Contains information about the <code>ppp</code> process as it is run and controlled by the Python app. |
| <code>/var/data/logs/access.log</code> | Contains information about users that log in via through any means (SSH, serial, web, etc.). |
| <code>/var/data/logs/startup.log</code> | Contains information about the application startup process including settings that are overridden from the <code>config-fs</code> . |

Figure 8 shows an example of the format for the logs from app.log:

```
[12/12 20:22:44] | INFO | chip_srv | Got Long Running Command: Set WiFi Mode (ID: 0x0106, Seqno: 152)
[12/12 20:22:44] | INFO | chip_srv | Completing long running transaction
[12/12 20:22:44] | INFO | chip_srv | Responding with: ACK - (Seqno: 152, Status: OK)
[12/12 20:22:44] | INFO | chip_srv | STATE_LONG_RUNNING_RESPONSE_READY -> STATE_IDLE
[12/12 20:22:53] | WARNING | chip_srv | Message 7: Unexpected seqno(88) expected(153)
[12/12 20:22:53] | INFO | chip_srv | Got Short Running Command: WiFi Network Connection Control (ID: 0x0104, Seqno: 88)
[12/12 20:22:53] | INFO | wlan0.sta | STATE_CONFIGURED -> STATE_CONNECTING
[12/12 20:22:53] | INFO | chip_srv | Responding with: ACK - (Seqno: 88, Status: OK)
[12/12 20:22:53] | INFO | wpad | wlan0: CTRL-EVENT-SCAN-STARTED
[12/12 20:22:53] | INFO | wlan0.sta | wpa_supplicant property changed 'State': 'scanning'
[12/12 20:22:55] | INFO | wpad | wlan0: Trying to associate with SSID 'wdnu-dvt1'
[12/12 20:22:55] | INFO | wlan0.sta | wpa_supplicant property changed 'State': 'associating'
[12/12 20:22:55] | INFO | wpad | wlan0: Associated with e8:de:27:fc:1d:59
[12/12 20:22:55] | INFO | wpad | wlan0: WPA: Key negotiation completed with e8:de:27:fc:1d:59 [PTK=TKIP GTK=TKIP]
[12/12 20:22:55] | INFO | wlan0.sta | wpa_supplicant property changed 'State': '4way_handshake'
[12/12 20:22:55] | INFO | wlan0.sta | wpa_supplicant property changed 'CurrentBSS': '/fi/w1/wpa_supplicant1/Interfaces/1/BSSs/0'
[12/12 20:22:55] | INFO | wpad | wlan0: CTRL-EVENT-CONNECTED - Connection to e8:de:27:fc:1d:59 completed [id=0 id_str=]
[12/12 20:22:55] | INFO | wlan0.sta | wpa_supplicant property changed 'State': 'completed'
[12/12 20:22:55] | INFO | wlan0.sta | wpa_supplicant property changed 'CurrentAuthMode': 'WPA2-PSK+WPA-PSK'
```

Figure 8: Sample app.log

6.2 Web Interface

The WDNUII has a web interface available via HTTPS on port 443. It can be accessed with a modern web browser like Chrome or Firefox by typing https://<ip_addr> into the address bar. The following sections are a break-down of the web interface functionality and how to effectively use the web interface. Table 4 shows valid username and passwords for accessing the web interface.

Table 4: Web Interface Access Levels

| Access Level | Username | Password | Available Pages |
|---------------|-----------|-----------|--|
| Read Only | wreadonly | wreadonly | <ul style="list-style-type: none"> ✓ System Summary ✓ Network Status |
| Operator | woperator | woperator | <ul style="list-style-type: none"> ✓ Command Interface ✓ Wi-Fi Configuration ✓ Cellular Configuration |
| Administrator | wadmin | wadmin | <ul style="list-style-type: none"> ✓ Software Updates |

6.2.1 Login

The WDN-U-II web interface is only accessible with a valid username and password (see Figure 9). There are three access levels when using the web interface, admin, operator and read-only. The following sections describe one of the pages featured in the web interface along with the required access-level to reach it. For a comprehensive look at the web pages access levels along with usernames and passwords see Table 4.



The login page features the GE Aviation logo in the background. The title "GE Aviation WDN-U-II" is prominently displayed. Below the title, there are two input fields: "Username" and "Passphrase". A blue "Connect" button is positioned below the "Passphrase" field.

Figure 9: Login Page

6.2.2 System Summary (read-only)

Figure 10 provides static information about the WDN-U-II system as a whole including system identification information and BIT status/results.

| WDNU-II | System Summary | |
|---|-----------------------|--------------------|
| <ul style="list-style-type: none"> System Summary Network Status Command Interface Wi-Fi Configuration Cellular Configuration Software Update Logout | Identification | |
| | Model | WDNU-II |
| | Device ID | W150903000009 |
| | Manufacturing Date | 2015-03-05 |
| | Hardware Version | 3 |
| | Firmware Version | wdnu2-linux-v0.8.2 |
| | Config FS Version | wdnu2-linux-v0.8.2 |
| | App Version | wdnu2-v0.14.2 |
| | BIT Status | |
| | Currently in Progress | NO |
| | Wi-Fi | PASS |
| | Compute | PASS |
| | Cell SIM 1 | PASS |
| | Cell SIM 2 | PASS |
| | Cellular | PASS |
| | Power | PASS |

Figure 10: System Summary Page

6.2.3 Network Status (read-only)

Figure 11 features a dynamic view into the systems network configuration and current status. The networking interfaces of interest here include Ethernet (host system digital interface), Wi-Fi client/station (external), cellular and Wi-Fi access point.

| WDNU-II | | Network Status | |
|---|--------------------------------------|-------------------|-------------------------------|
| <ul style="list-style-type: none"> System Summary Network Status Command Interface Wi-Fi Configuration Cellular Configuration Software Update Logout | Host System Digital Interface | | External Wi-Fi Network |
| | MAC Address | 00:40:9D:7F:83:07 | MAC Address No Data |
| | IP Address | 192.168.114.1 | SSID No Data |
| | Subnet Mask | 255.255.255.0 | IP Address No Data |
| | Link | CONNECTED | Subnet Mask No Data |
| | | | Security No Data |
| | | | Mode No Data |
| | | | Signal Strength No Data |
| | | | Speed No Data |
| | | | |
| | Cellular Network | | Wi-Fi Access Point |
| | Module Identification | No Data | MAC Address No Data |
| | IMEI | No Data | SSID No Data |
| | SIM 1 ICCID | No Data | IP Address No Data |
| | SIM 1 IMSI | No Data | Subnet Mask No Data |
| | SIM 2 ICCID | No Data | Security No Data |
| | SIM 2 IMSI | No Data | Access Point Status No Data |
| | Status | No Data | |
| | Signal Strength | No Data | |
| | | | |

Figure 11: Network Status Page

6.2.4 Command Interface (operator)

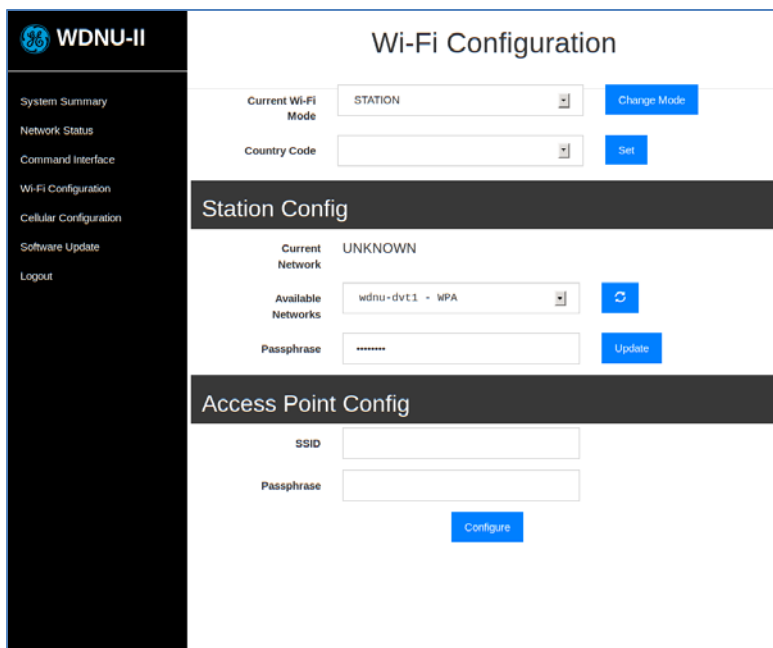
The Command Interface page (see Figure 12) is a fully interactive way to send raw CHIP commands and view their responses. Based on the selected CHIP command from the top drop-down menu, the arguments below will be generated per the CHIP spec (YV2818). Each line in “Responses” table can be clicked on to show a more detailed breakdown of the response.

| WDNU-II | | Command Interface | | | |
|---|---------------------|-------------------|---------------------------------|--|--|
| <ul style="list-style-type: none"> System Summary Network Status Command Interface Wi-Fi Configuration Cellular Configuration Software Update Logout | Set Active SIM Card | | | | |
| | Sim Card Number | SIM Card 1 | | | |
| | APN | | | | |
| | Username | | | | |
| | Password | | | | |
| | Execute | | | | |
| | Responses | | | | |
| | Seqno | Command | Response Type Ack Message | | |
| | 41 | Get Information | Data | | |
| | 40 | Get Information | Ack Long Duration Command Start | | |

Figure 12: Command Interface Page

6.2.5 Wi-Fi Configuration (operator)

Although the main interface into the WDN-U-II for configuring the system is through CHIP, the Wi-Fi Configuration page (see Figure 13) provides a simplified mechanism for quickly configuring both Wi-Fi station and access-point.

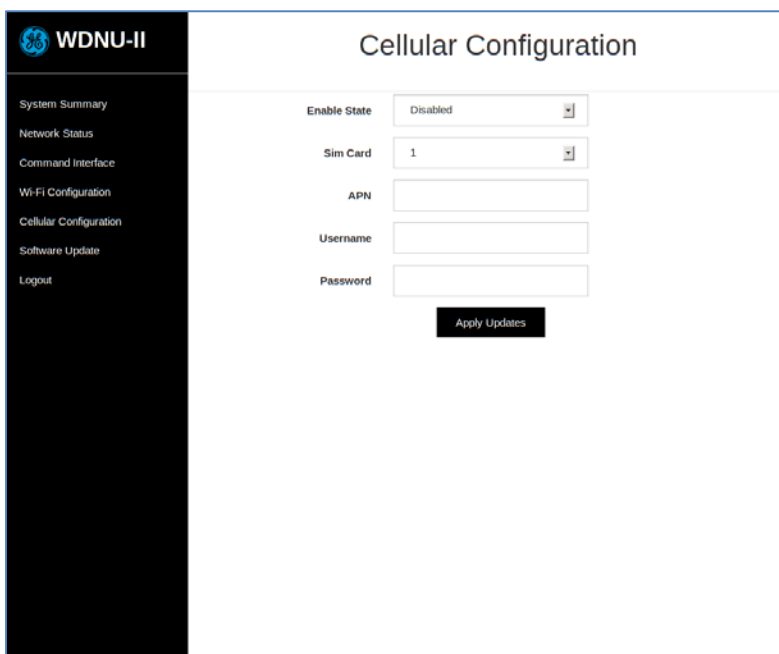


The screenshot shows the 'Wi-Fi Configuration' page for the WDN-U-II. On the left is a dark sidebar with a menu: System Summary, Network Status, Command Interface, Wi-Fi Configuration (highlighted), Cellular Configuration, Software Update, and Logout. The main content area has a title 'Wi-Fi Configuration'. Below the title are two sections: 'Station Config' and 'Access Point Config'. The 'Station Config' section includes a 'Current Wi-Fi Mode' dropdown set to 'STATION' with a 'Change Mode' button, a 'Country Code' dropdown with a 'Set' button, a 'Current Network' dropdown set to 'UNKNOWN', an 'Available Networks' dropdown showing 'wdnu-dvt1 - WPA' with a refresh button, and a 'Passphrase' field with an 'Update' button. The 'Access Point Config' section includes an 'SSID' field, a 'Passphrase' field, and a 'Configure' button.

Figure 13: Wi-Fi Configuration Page

6.2.6 Cellular Configuration (operator)

Similar to the Wi-Fi Configuration page, the Cellular Configuration page (see Figure 14) provides an alternative mechanism for quickly configuring the WDN-U-II for connecting to a cell tower. This page also allows the operator to change the currently active SIM card.



The screenshot shows the 'Cellular Configuration' page for the WDN-U-II. It features the same left sidebar as Figure 13, with 'Cellular Configuration' highlighted. The main content area has a title 'Cellular Configuration'. Below the title are five configuration fields: 'Enable State' (dropdown set to 'Disabled'), 'Sim Card' (dropdown set to '1'), 'APN' (text field), 'Username' (text field), and 'Password' (text field). At the bottom of these fields is a black button labeled 'Apply Updates'.

Figure 14: Cellular Configuration Page

6.2.7 Software Updates (admin)

The Software Update page (see Figure 15) will allow any administrator to overwrite one or many of the flash partitions running on the WDN-U-II. These updates should be built using instructions provided by Etherios. Regardless of what is in the update package it must be GPG signed in order to work. The most common uses of this page will be updating the entire WDN-U-II software or only the “config-image” to change WDN-U-II configuration and behavior.

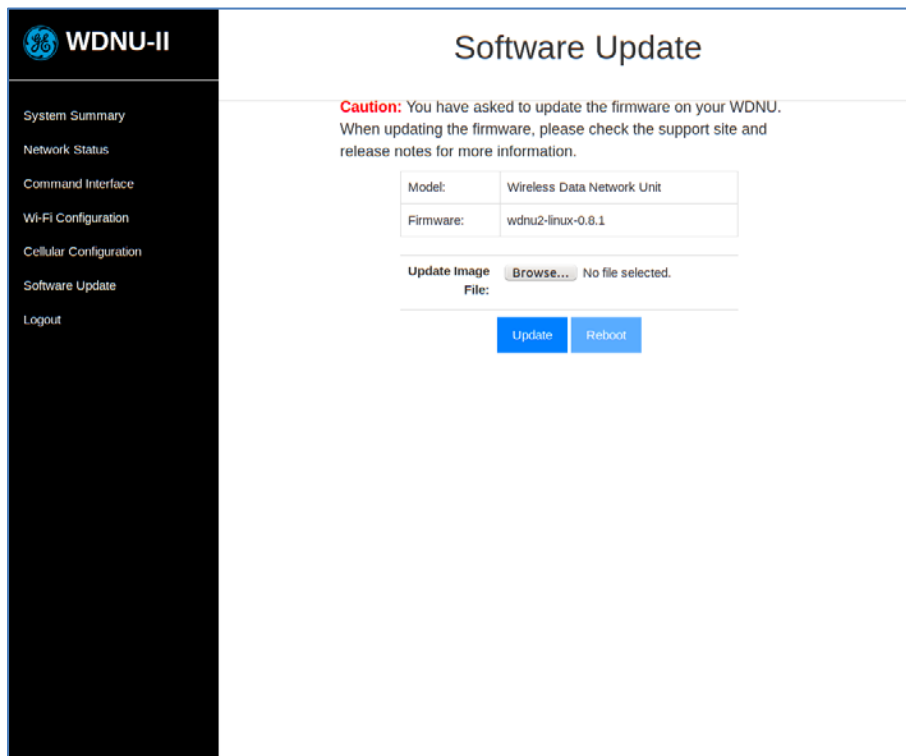


Figure 15: Software Update Page

6.3 LRU Update Procedure via Web Interface

The WDN-U-II root file system (rootfs), config file system, u-boot, kernel, updaterd, and the bootscript can all be updated using the CLI, Chip command, or the web UI.

The first step is to build the new software images. The build process is described in the Software Design Document (SDD). Once the new image is built the WDN-U-II can be updated via the web interface using the following steps:

1. Navigate to the WDN-U-II web interface, login to the device as the admin level user (wadmin currently) and use the navigation bar on the left to visit the Software Update page. A screen similar to that shown in Figure 16 will appear:

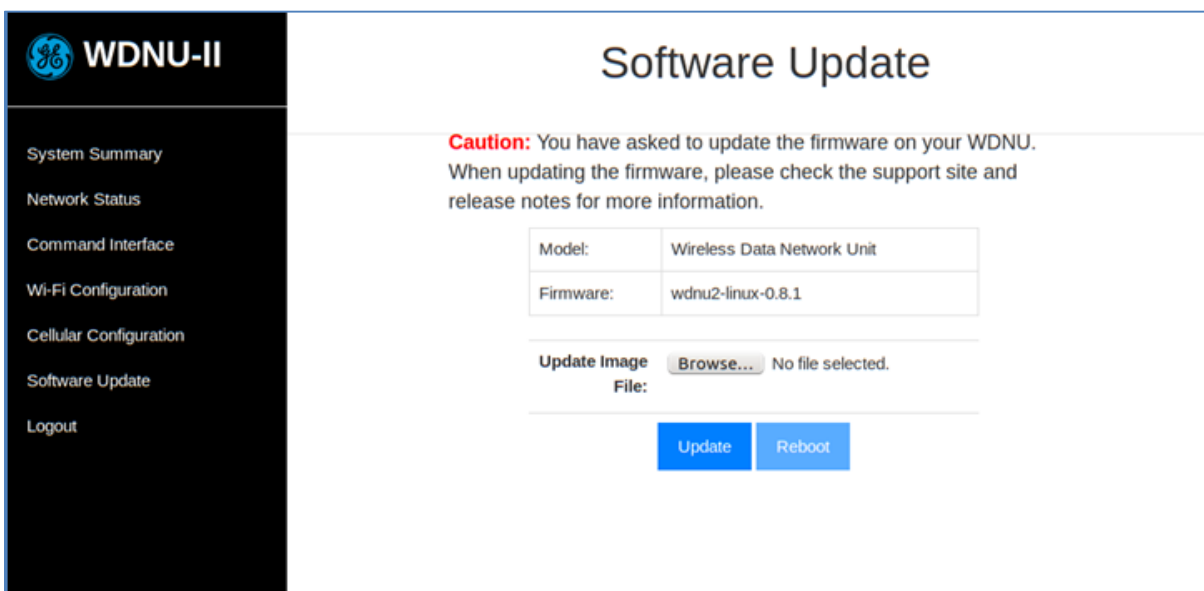


Figure 16: Software Update Screen

This will provide current version of the firmware that is loaded on the image, as well as give the option to choose and update image file.

2. Click **Choose File** and select the update image. This should populate the file name into the page (see Figure 17).
3. Click **Update** to begin the process. A green notification at the top of the screen will appear when the upload has completed. After the upload is completed a reboot must be triggered manually using the reboot button shown in the screen capture.

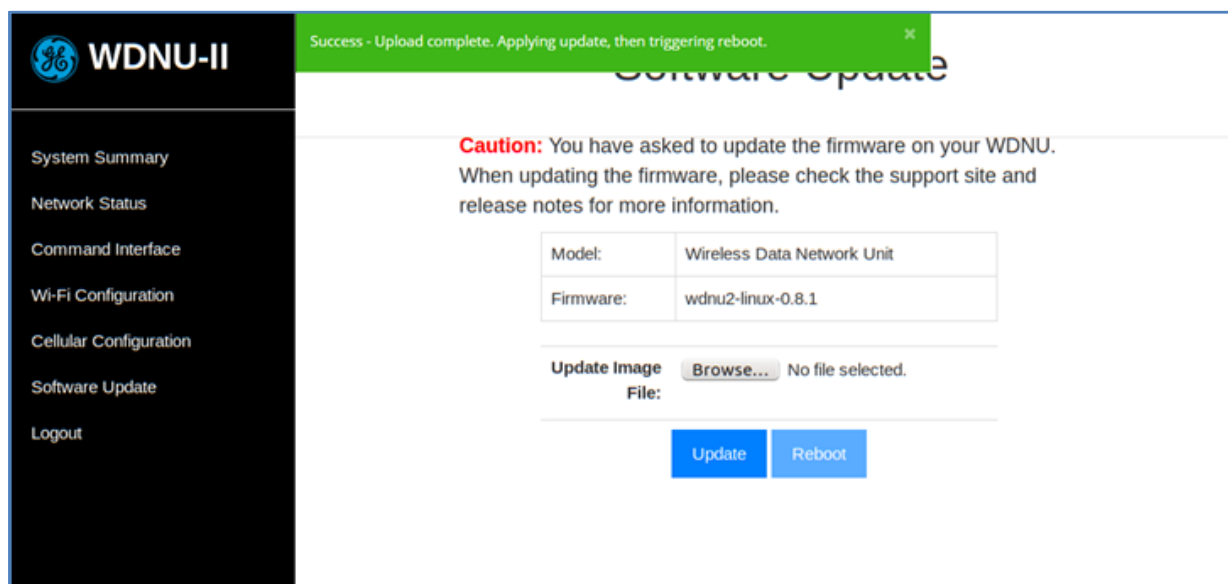


Figure 17: Update Success

6.4 SIM Activation

GE will handle the activation of the SIM cards for the WDNU-II. The SIM activation process will require the ICCID and/or the IMSI from each SIM card. This information can be retrieved from the following places:

- Electronic file from Digi manufacturing
- Label affixed to the WDNU-II
- Web interface

7 Certifications

7.1 FCC

Per FCC 15.19(a)(3) and (a)(4) This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment

7.1.1 FCC-Approved Antennas

The WDNUII can be installed utilizing the following antenna and system gain. The EUT may only operate using and antenna of the same type and lesser net system gain then approved.

| Description | Part Number | Type | Peak Gain | Peak System Gain |
|--|------------------------|-----------|-----------|------------------|
| 3dbi DAS antenna; Radiation pattern – Omni | HG72703MGURB-NM | Mono-pole | 3 dBi | 0 dBi |

7.2 Canada (IC)

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

7.2.1 IC Approved Antennas

This radio transmitter (IC: 1846A-WDNUII) has been approved by Industry Canada to operate with the antenna types listed in the table above with the maximum permissible system gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a system gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Le présent émetteur radio (IC: 1846A-WDNUII) a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.