

Ranging & Localization Development Kit Quick Start Guide

PulsON[®] 400 Series

TIME DOMAIN[®]

Cummings Research Park
4955 Corporate Drive Suite 101
Huntsville, AL 35805 USA
<http://www.timedomain.com>

Tel: +1 256.922.9229

+1 888.826.8378

Fax: +1.256.922.0387

320-0314E
October 2015



Copyright

All rights reserved. Time Domain® 2001-2015. All rights reserved.

Trademarks

Time Domain®, PulsON®, and “PulsON Triangle” logo are registered trademarks of Time Domain. Ethernet® is a registered trademark of Xerox Corporation. Microsoft®, Windows Vista®, Windows 7®, Windows 8® and Windows 10® are registered trademarks of Microsoft Corporation. MATLAB® is a registered trademark of MathWorks, Inc. Any trademarks, trade names, service marks or service names owned or registered by any other company and used in this manual are the property of its respective company.

Rights

Rights to use this documentation are set forth in the PulsON Products Terms and Conditions of Sale.

Introduction

Welcome to the world of Ultra Wideband (UWB) technology! Time Domain is pleased to introduce our latest addition to the PulsON® 400 product family, the PulsON 440 (P440). The P440 is the culmination of over a decade of UWB research and product development, including six generations of UWB-enabling silicon. This multi-purpose platform can be used for peer-to-peer distance measurement, data communications, and as part of a ranging network. It can also measure channel impulse response and serve as a monostatic, bistatic, or multistatic radar.

The PulsON Ranging and Localization Development Kit allows you to test and exercise the ability of P440s to accurately measure the distance between platforms, communicate data and operate as a network.

We designed the P440 to be easy to integrate, with a simple ranging protocol and support for interfacing to both PCs and embedded processors. Within the next 30 minutes, this *Quick Start Guide* will help you set up, configure, and test the P440s included in your Development Kit.

If you are already using other P400 series units from Time Domain, rest assured that all members of the P400 family (P400, P410, P412, and P440) will operate with RangeNet. To run RangeNet on your existing P4xx units, follow the instructions as shown and just mentally replace “P440” with whatever unit you own. Also, verify that your current units are at the latest revision. (The easiest way to check is to look in directory 1 – Embedded on the delivery disk. The most recent version number is contained in the name of the .zip file.) If you are not at the latest revision level, then all of your existing P4xx units need to be upgraded to this level.

This document assumes that you will be connecting to the unit with USB. This is the one communications interface that is common to all of our platforms. Well...you could also use serial, but that would be really slow. If you want to connect through Ethernet, then see the application note *Connecting to a P440 via Ethernet*. However, please try this after you have completed the *Quick Start Guide* process.

This guide is divided into the following sections:

- What’s in the box?
- What’s on the disk?
- What you will need to work with the P440
- Loading the PC Software
- Configuring the P440
- Initial System Power-Up
- Connecting to the P440
- Demo Ranging Between P440s
- Logging Ranging Data
- Configuring the RangeNet Network Parameters
- Using RangeNet as an ALOHA Network
- Using RangeNet as a TDMA Network
- Where do you go from here?

What's in the box?

Upon receipt of your Development Kit, inspect the shipping container and contents. If the contents of the Kit appear to be incomplete, or if there is mechanical damage, please notify Time Domain immediately.

Time Domain has supplied the following items with your kit:

Name	Part #	Qty.
P440 UWB Module	140RM01 or 02	5
Broadspec Antennas	100ANR3	5
P440 Enclosures	340EN01	5
Rechargeable UWB Batteries	340RB01	5
USB Wall Charger/Supply	N/A	5
USB Cable 6 ft. /1.8 m	N/A	5
USB Power Cable 6 in. / 15 cm	N/A	5
RangeNet Software & Documentation CD	140-0019	1

Table 1: Contents of the P440 Ranging and Localization Development Kit

Please note that a 440RL01Kit is intended for use in areas that conform with the US-FCC regulations for ultra wideband (UWB) transmissions while the 440RL02Kit is intended for use in areas that require conformance to the European or ETSI standard. In addition, if you are outside the US, you may also have been provided with an adapter to allow the Wall Charger/Supply to plug in your AC wall sockets.

What's on the disk?

The RangeNet Software and Documentation CD contains a directory entitled 140-0024C P4xx RangeNet Sftw & Lit CD. Within this directory are three sub-directories:

- **1-Embedded:** This directory contains all of the files necessary for updating the embedded code in any P4xx units you might have received prior to receiving this package. The units received in a kit are already at the latest revision level and do not require updating.
- **2-Host & Sample Code:** This directory has several sub-directories which contain Sample Applications and various demonstrations. It also contains the file **RangeNet RET Setup.msi**: This is the installer for the Windows-based Graphical User Interface (GUI) for the RangeNet Reconfiguration and Evaluation Tool (RangeNet RET). RangeNet RET allows the user to edit the configuration of the P440 module and to evaluate its ranging, communications and network capabilities.
- **3 - Documentation:** This directory contains the following documentation pertaining to RangeNet's functionality and operation:
 - **Quick Start Guide:** A soft copy of the manual you are currently reading
 - **RangeNet API Specification:** The Application Programming Interface (API) specification for the P4xx platforms.

- **RangeNet RET User Guide:** Document which explains in detail the user interface for RangeNet RET.
- **P440 Data Sheet:** Detailed specification for the P440 UWB platform.
- **Using the USB and Serial Interfaces:** Application note describing how to use the USB and 3.3V TTL UART microcontroller interfaces.
- **Updating PulsON Modules with New Embedded Code:** Instructions on how to any P4xx when new software releases are introduced.
- **White Paper:** *RangeNet -ALOHA Guide to Optimal Performance*
- **Application Note:** *Distributed Calibration of Time Domain UWB Ranging Radios*
- **Application Note:** *CAN Interface Application Note*
- **Application Note:** *Connecting to a P440 via Ethernet*
- **Sample Code:** Located in directory “2 – Host & Sample Code,” this sub-directory contains sample code intended to provide the user with additional help in starting their development and evaluation efforts, including:
 - **Sample C:** A directory containing sample C code. This may be useful to users in jumpstarting software development efforts.
 - **Sample MATLAB:** A directory containing sample MATLAB code. This may be useful to users in jumpstarting system analysis efforts.
 - **Two different Localization Demonstrations:** These demonstrations illustrate 3-D localization using the P440.

There are additional white papers and supporting documents available on the Time Domain website at www.timedomain.com.

What you will need to work with the P440

In order to connect to and control the P440s, the user will need the hardware and software as described below.

- **PC running Windows Vista, 7, 8, or 10** – The RangeNet RET software has been developed to work with Windows Vista (32 and 64 bit), Windows 7 (32 and 64 bit), Windows 8 (32 and 64 bit), and Windows 10 (32 and 64 bit).
- **A 1.6 m (6ft) USB 2.0 A to Micro-B cable** (Five cables are provided with each kit.)
- **A 15 cm (6 inch) USB Power cable** (Five cables are provided with each kit.)

Loading the PC Software

RangeNet RET software has been developed to work with Windows Vista (32 and 64 bit), Windows 7 (32 and 64 bit), Windows 8 (32 and 64 bit), and Windows 10 (32 and 64 bit).

However, operation of the RangeNet RET software on these operating systems requires that the Windows operating system on your Host computer has been provided with a reasonably current version of the Windows .NET Framework program. If your computer has a reasonably current version, then the RangeNet RET Setup software will load in about a minute and you will be done.

If your computer doesn't have a recent version loaded, then you will be prompted to go to the Microsoft website and download a newer version of code. Depending on the version of your operating system, this prompt might appear as you run the RangeNet setup or the first time you try to run RangeNet. Downloading the proper version is very easy. You click on a few buttons, wait 15 to 20 minutes for the code to load, and you are done. This process only needs to be performed once per computer. If a download is required, then please refer to **Appendix A** for a step-by-step walk-through of the download process.

The following steps are required to install the Host portion of RangeNet RET on your computer.

1. Log in as **Administrator** or with administrative privileges.

Insert the CD labeled *PulsON RangeNet Software and Documentation*, navigate to and then double-click on RangeNet RET Setup.msi. (The .msi can be found in the directory "140-0024C P4xx RangeNet Sftw & Lit CD/2 – Host & Sample Code").

If a screen similar to the one shown in **Figure 1A** appears, then you will need to download a newer version of .NET Framework from the Microsoft website. See **Appendix A** for details. If not, then you should see the box shown in **Figure 1B**.

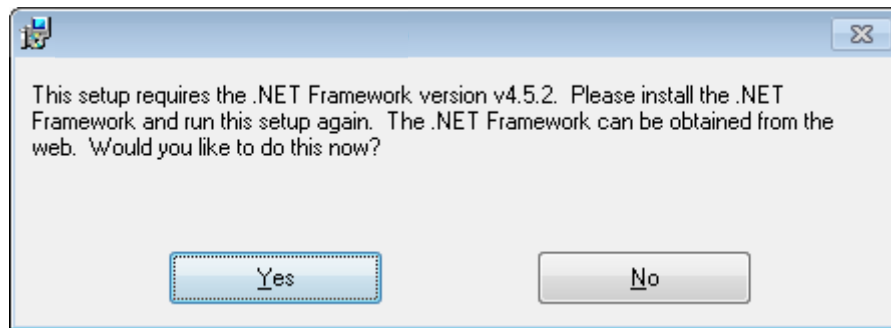


Fig. 1A: Message warning that you will need to download a newer version of .NET Framework

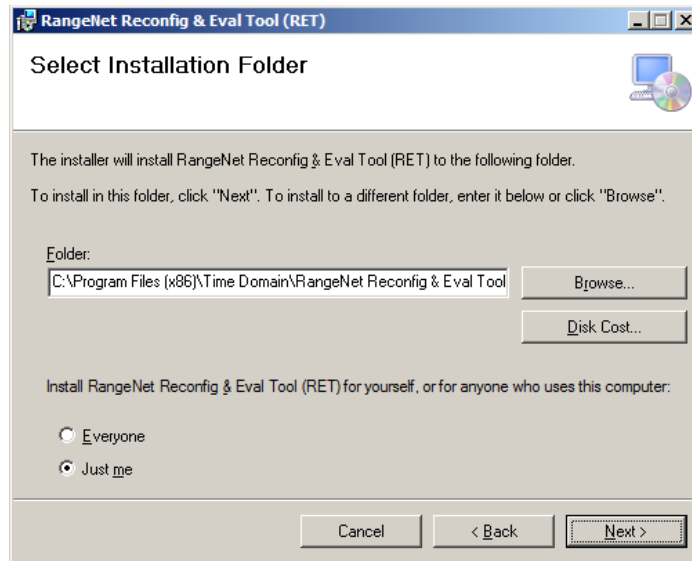


Fig. 1B: Initial installation screen for the RangeNet RET software

2. Click the Next > button.
3. When you reach the screen shown in **Figure 2**, you will be given a choice of directories into which the RangeNet RET software can be loaded. We recommend that you accept the default.

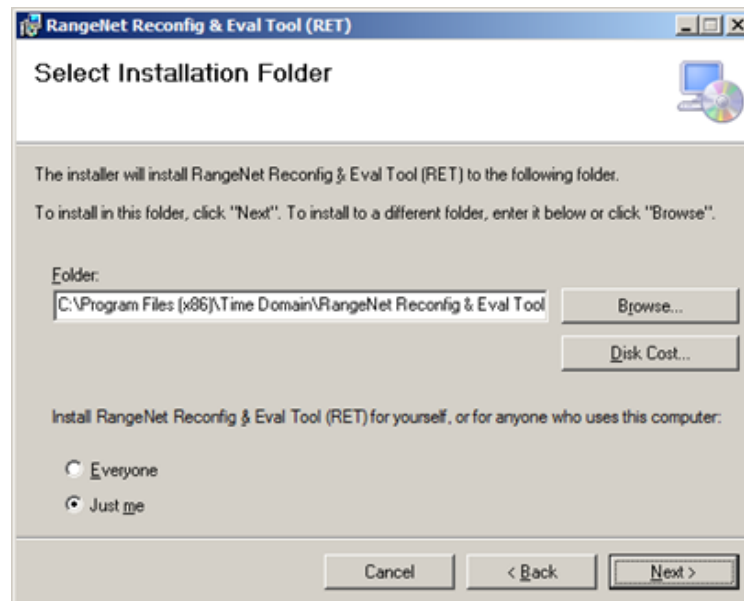


Fig. 2: Screen for designating Program Files location for RangeNet RET software

6. Follow the instructions onscreen for the remainder of the installation process.
7. Close the application. Program installation is complete. During this installation process, the icon shown in **Figure 3** will be installed on the Desktop.

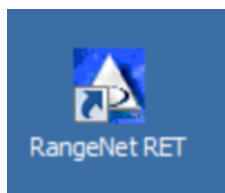


Fig. 3: RangeNet RET Icon installed on Desktop

8. During the RangeNet RET installation process, the USB drivers will be loaded. This process starts when the screen shown in **Figure 4** appears.

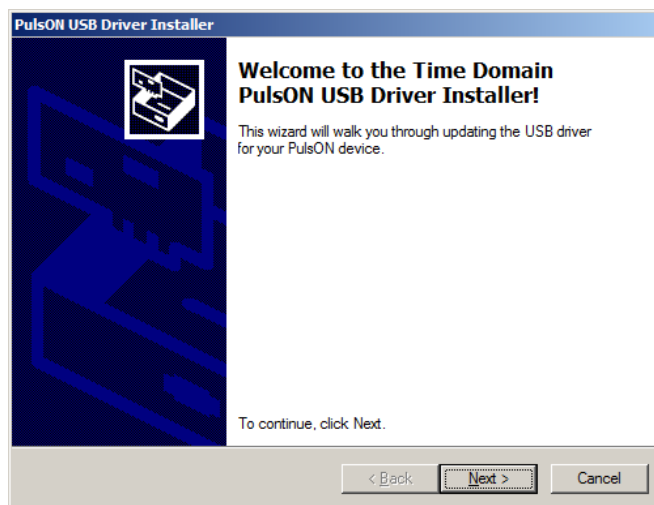


Fig. 4: USB driver installation screen

9. Follow the instructions onscreen for the remainder of the installation process.
10. When complete, close the application.

The RangeNet RET application should now be successfully installed on your PC. At this time, we recommend that you copy the remaining CD files onto your PC at a location of your choice.

Configuring the P440

Each of the five P440s in your kit will have a label on the RF shield below the PulsON logo bearing a three-digit number (100, 101, 102, 103, or 104). These numbers represent the P440's unique UWB IDs and are also the last three digits of the unit's Ethernet IP address. (The first digits are 192.168.1.xxx.) Remove the P440 bearing the ID # 101 from the box, along with one BroadSpec antenna, one Power Supply, a short USB power cable and long USB cable.

1. When handling the P440, please take care to prevent electrostatic discharge from damaging the unit. We recommend grounding yourself first by touching a piece of metal and then grasping the P440 by the SMA connector.

2. Attach the Broadspec antenna to the SMA port “A” (the connector in line with the Ethernet connector; see **Figure 5**). This is the default antenna connection. The Broadspec antenna is omni-directional.
3. The P440 is equipped with a second antenna SMA port (“B”). Both connections are active and support both transmit and receive functions.



Each P440 as supplied by Time Domain includes four rubber feet to provide a stable base for the module and to prevent slippage. Underneath these rubber feet are mounting holes for 4/40 screws. These may be used to mount the enclosure inside a different housing. Alternatively you can remove the P440 from the plastic enclosure and mount the board in a housing of your choice.



Ensure that the SMA connector on both the antenna and 90degree connector are firmly tightened over the connection to avoid accidental disconnection. Do NOT over-tighten. Use only your fingers or an approved 5/16" SMA torque wrench (Digi-Key, part number A99929-ND or equivalent) with the P440. The connector center pins on the SMA cables are fragile. If you meet resistance when connecting a cable to a port, either during insertion or when tightening the connector nut, do not force the connection. Abort this attempt and try again. Damage to the SMA connector caused by over-tightening is not covered by the warranty.

Initial System Power-Up

Use one of the short USB Power cables to connect either an Anker USB Power Supply (itself plugged into an AC socket) or a rechargeable battery to the P440 USB “PWR” connector. To disconnect the power supply from the power interface, pull the power connector from the power interface.



Fig. 5: Side view of the P440 module showing the various connections

The P440 powers up automatically when the power supply is connected and the P440 LEDs (see **Figure 6**) will activate in the following sequence:

1. As soon as the power supply is connected, the Blue LED in the lower left (Built-in-Test LED or BIT LED) will turn on and stay on for about 10 – 15 seconds. This indicates that the unit is going through a self-test procedure. At the same time, the Green LED on the right side

(FPGA LED) of the board will blink about 3 or 4 times per second. This indicates that the FPGA is loaded and ready. The Green LED on the left side of the board (UWB Activity LED) will be off.

2. Approximately 10-15 seconds later, the UWB Activity LED will turn on and the BIT LED will blink once every 2-3 seconds. This indicates that the P440 processor has successfully booted and it is ready to send and receive UWB packets. Each time a UWB activity occurs (see Section 4.9 of the *P440 Data Sheet* for details) the UWB activity will toggle (turn off if it is on or turn on if it is off).

If the LEDs do not behave in this fashion, then the board is not working properly and you should contact Time Domain. Examples of problems would include, but are not limited to, the following: the FPGA LED remaining on (or off) continuously, the BIT LED remaining on (or off) continuously, or the BIT LED blinking at a very fast rate.



When powered up, the P440 by default is in response mode. This means it is listening for range requests from other P440s and will respond automatically to any such requests.

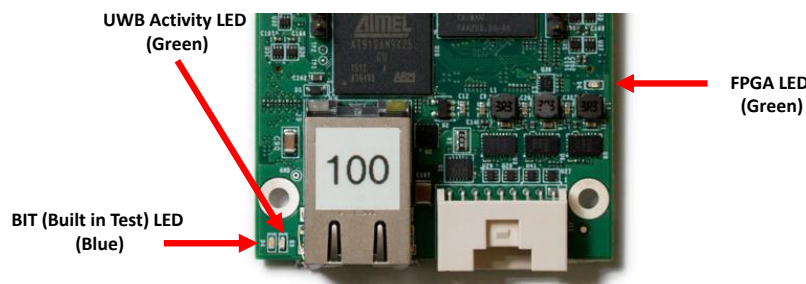


Fig. 6: Indicating LEDs

Connecting to the P440

Once you have loaded the PC software and set up the PC, you are ready to begin using the RangeNet RET to conduct a ranging conversation and to collect/log range data. A detailed description of the RangeNet RET application will not be provided here; for more detailed information on using RangeNet RET, please refer to the *RangeNet RET User Guide*.

The following procedure will launch the RangeNet RET application and connect to the P440.

1. Double-click on the RangeNet RET icon. The screen shown below in **Figure 7** will appear. Depending on the version of your Windows OS, the screen shown in **Figure 1A** may appear instead. If it does, please follow the instructions in **Appendix A**.

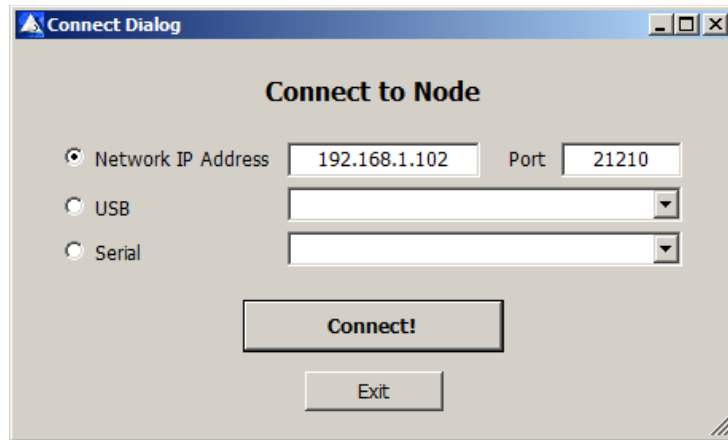


Fig. 7: RangeNet RET connect screen prior to USB hookup

2. Connect the USB cable from the P440 USB port to the host computer. A system message should appear indicating that the system has identified a new connection and the correct driver is being connected. This could take as long as two minutes. Once that process is complete, RangeNet RET will set the USB button and indicate which COM port is connected to the P440. This is illustrated below in **Figure 8**.

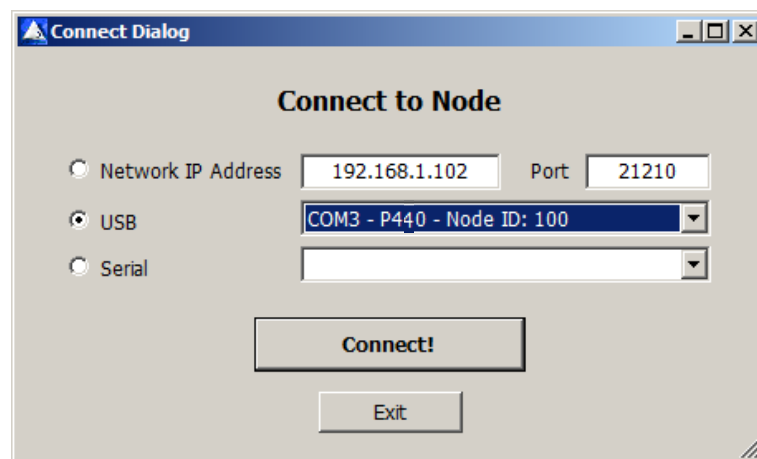


Fig. 8: RangeNet RET connect screen after USB connection

If the USB connection does not appear, then (a) check the P440 LEDs to confirm that the P440 has successfully powered up and booted, (b) confirm that the USB connector is properly connected to both the P440 and the host USB connector, and (c) confirm that the system recognizes that the USB port is active. This can be confirmed by clicking on the Windows Start Button > Device Manager and confirming that the port is connected. See **Figure 9** for examples of successful and unsuccessful connections.

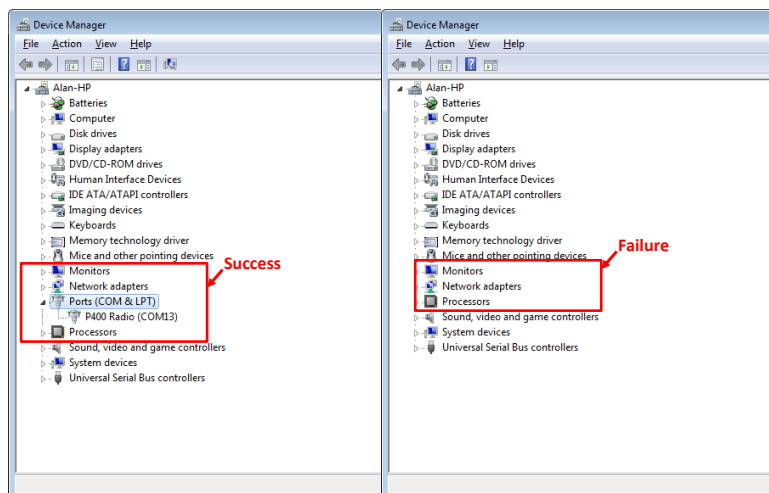


Fig. 9: Successful connection (left), unsuccessful connection (right)

If the P440 is functioning and the Device Manager shows a failure, then either the USB cable or the computer port is defective.

3. If the connection is successful, click the **Connect!** button. The main operating window will open (**Figure 10**). The status window at the bottom should confirm that “Get Config” was successful.

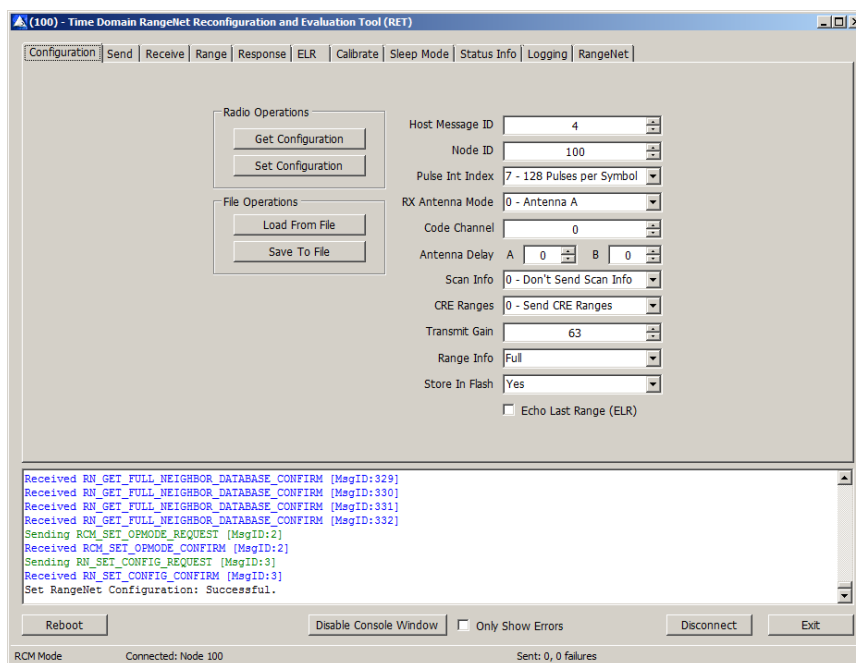


Fig. 10: RangeNet RET connected to the P440

At this point you have established that the PC and P440 are communicating and that the radio has powered up successfully. Note that RangeNet has two different modes: “RCM Mode” and “RangeNet Mode.” The operating mode is indicated in the lower left hand corner of the screen. When the P440 is in RCM mode, it operates as a point-to-point ranging system in which the operator

is responsible for initiating all conversations. (RCM stands for Ranging and Communications Mode.) When the unit is in RangeNet Mode, then the P440 will schedule and perform all range requests independent of the user and Host. The user can, of course, define whether the ranging will be done using either the ALOHA or TDMA protocols, provide guidance on other network behavior and monitor network operation, but the P440 will execute these instructions independently from the user. Also, units in RCM mode will not respond to units in RangeNet mode. Switching between RCM and RangeNet Mode will be illustrated shortly.

Demo Ranging Between P440s

You are now ready to explore UWB in greater detail. The next logical step is to establish a link between two P440 units and begin collecting range measurements. For the purposes of this demonstration, we will use a P440 with UWB ID # 100 as the range requester and a P440 with UWB ID # 103 as the range responder.

1. Ensure that the P440 with UWB ID # 100 is connected to RangeNet RET as described in the previous section. Since the P440 with UWB ID # 103 will be used as the responder and since response is its default mode, there is no need to connect it to a PC. Just connect an antenna to Port A and power it up.
2. Separate the P440s by some distance, a meter or more is fine.
3. In the RangeNet RET software application, select the Send Tab (**Figure 11**).

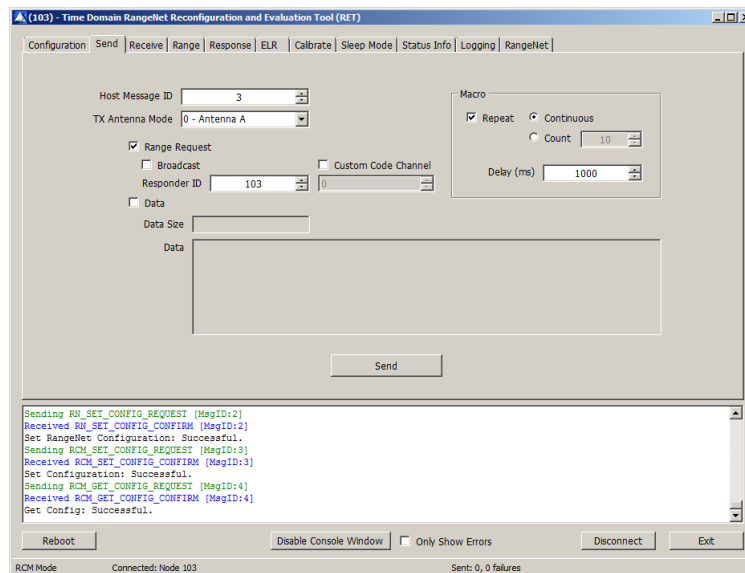


Fig. 11: RangeNet RET Send Tab

4. Check the box marked Range Request, enter the responder P440's UWB ID number (in this case 103), click the Repeat button, and set Delay to 1000 ms. This sets up the system to measure the range between unit 100 and unit 103 at a rate of once per second.

- Click **Send**. If the range measurement was successful, you will see a confirmation message in the status window (“Range Status: Successful”). The range measurement will update every second. If, for some reason, the range measurement is consistently unsuccessful (“Range Status: Timeout Error”), then make sure that there is nothing blocking either of the antennas and that the antennas are really both on Port A. Select the Range Tab (**Figure 12**) to view your range measurement. (By default, the measurement is displayed in millimeters. Double-clicking the measurement window will display the measurement in meters, and double-clicking a second time will display it in feet.)

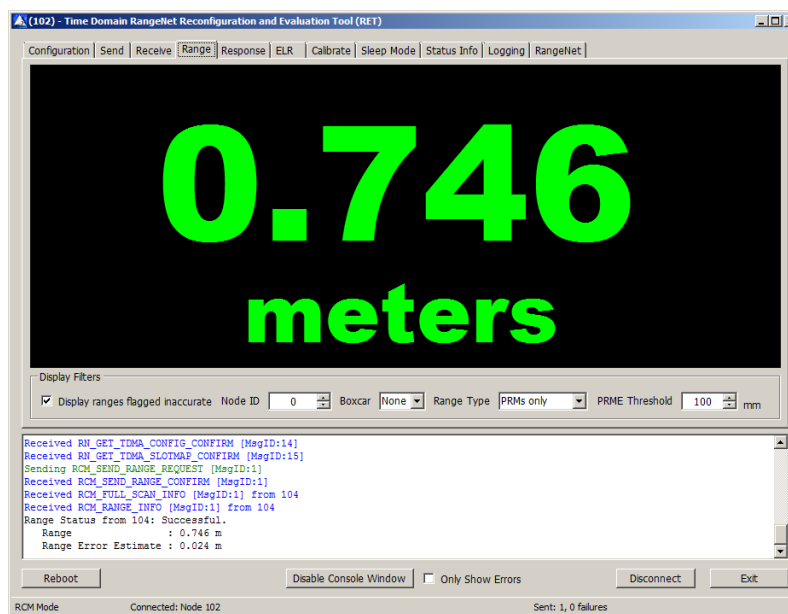


Fig. 12: RangeNet RET Range Tab

- Move one unit relative to the other and observe the change in range. When satisfied with these experiments, return to the Send screen and click **Stop**.

Logging Ranging Data

The process to collect ranging data using the RangeNet RET is simple.

- In the RangeNet RET software application, select the Logging Tab.
- You will need to specify a location where the collected ranging data logfile can be stored. We recommend that you create a desktop folder titled RET_DATA and then navigate to that directory using the Change button on the Logging Tab.
- You will need to specify a file name for the logfile. If it isn't already there, we recommend you enter "RetLog_" in the Logfile Prefix field. Click **Start Logging**. The message "Logging to File: RetLog_000.csv" will appear.
- Select the Send Tab. In the Macro section, check the box marked "Repeat" and select "Count." Enter a value for the count (e.g., 100).

5. Click **Send**. The status will scroll while the ranges are being measured.
6. Open your ranging data destination folder. You should see a text document titled “RetLog_000.csv.” This is your logfile. (Each successive logfile will be numbered sequentially.)
7. Click **Stop Logging** and open the logfile. You will see several columns of data (see **Figure 13**). (For details on the exact format, review the *RangeNet API Specification* and *RangeNet RET User Guide*). The second column from the right is the range measurement value in millimeters. Periodically you may notice an outlier value. You will also notice a column of mostly zeros near the middle. This is the Range Status value. Zero indicates that the calculated range value is considered to be good; a non-zero number (e.g., 4) indicates a range error.

Timestamp	RcmConfig	NodeId	PulseInte	AntennaMode	AntennaT	CodeChar	AntennaDelay	ScanInfo	DisableCf	Transmitt	ELR
1.44E+09	RcmConfig	100	7	0	False	0	0	0	False	63	False
1.44E+09	RcmSendRangeRequ	19	103	0	0	0	0	0	0	0	0
1.44E+09	RcmSendRangeConf	19	0	0	0	0	0	0	0	0	0
1.44E+09	RcmRangeInfo	19	103	0	0	0	0	20	725	725	725
1.44E+09	RcmSendRangeRequ	20	103	0	0	0	0	21	725	725	725
1.44E+09	RcmSendRangeConf	20	0	0	0	0	0	21	725	725	725
1.44E+09	RcmRangeInfo	20	103	0	0	0	0	20	840	840	840
1.44E+09	RcmSendRangeRequ	21	103	0	0	0	0	20	840	840	840
1.44E+09	RcmSendRangeConf	21	0	0	0	0	0	20	840	840	840
1.44E+09	RcmRangeInfo	21	103	0	0	0	0	20	840	840	840
1.44E+09	RcmSendRangeRequ	22	103	0	0	0	0	20	840	840	840
1.44E+09	RcmSendRangeConf	22	0	0	0	0	0	20	840	840	840

Fig. 13: Text logfile containing RangeNet RET range data

You have now completed the installation and demonstration of standalone ranging.

Configuring the RangeNet Network Parameters

This section will (1) demonstrate how to configure RangeNet, and then (2) operate your P440s as a 4-node network.

To configure the P440s, perform the following steps:

1. Connect your PC to the P440 and establish connection with the P440.
2. On the Configuration Tab, click the RangeNet Tab.
3. Click the “Download to Radio Upon Load” button.
4. Click the “Load From File” button (Windows should navigate to the directory C:/Program Files (x86)/Time Domain/RangeNet Reconfig & Eval Tool (RET)), select RangeNet Factory Defaults.rn, and click open.
5. If the connected P440 has an optional transmit power amplifier, then go to the RCM Configuration Tab (Config Tab on the top line), set the Transmit Gain to 0 and then click the “Set Configuration” button. This will set the transmit power to the minimum possible. This transmit power is approximately equal to the regulatory limit. When finished, click the RangeNet Tab.
6. Open a new instance of RangeNet RET.

- Repeat steps 1-6 for three other P4xx units (101-103).

Using RangeNet as an ALOHA Network

At this point your computer will be attached to four different P4xx units and all four instances of RangeNet RET are active and are on the RangeNet Tab. In this example, we will connect 100, 102, and 103 to the network. Please follow these steps:

- Open the instance of RangeNet RET connected to unit # 100.
- Click on the “Enter RangeNet Mode” button and “Set Configuration.” The unit will now start searching for neighboring P4xx units.
- Click on the Neighbor Database (DB) Tab. See **Figure 14**. This screen shows the status of the network. Since this is the first unit on the network, there are no other units in the system.

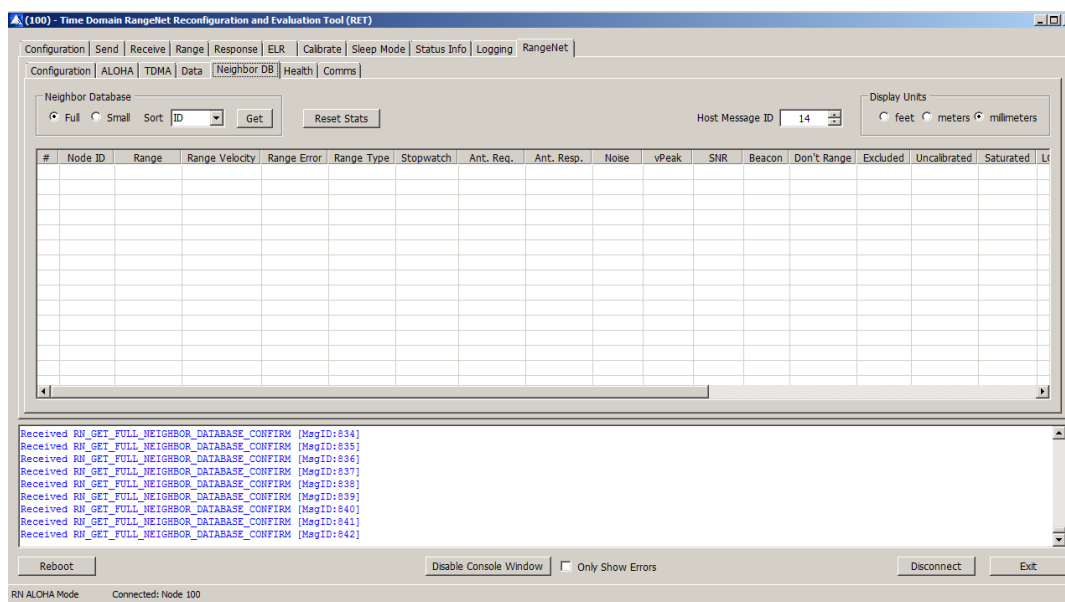


Fig. 14: Unit 100 RangeNet Neighbor Database showing the 16 left-most database values

- Open the instance of RangeNet and connect to unit # 102. Do not shut down the connection to unit # 100.
- Go to the RangeNet Configuration Tab associated with unit # 102. Minimize the screen and maneuver the screens such that you can also see the top few entries of unit # 100's Neighbor DB Tab.
- Click unit # 102's “Enter RangeNet Mode” button and “Set Configuration.” Within a few moments, unit # 100's Neighbor DB Tab will show that it is ranging to unit # 102.
- Click unit # 102's Neighbor DB Tab. It will show that it is ranging to unit # 100. At this point you should be seeing something that looks similar to **Figure 15**.

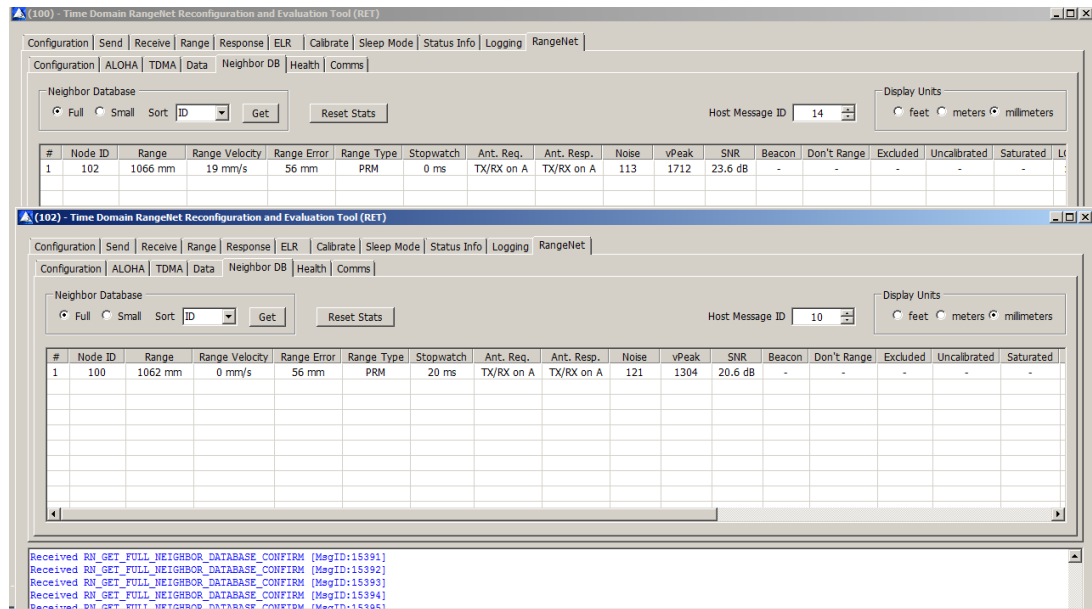


Fig. 15: Example ALOHA Network with two members

- Repeat this process for unit # 103 and you will see that each unit now sees two other units. An example is shown in **Figure 16**.

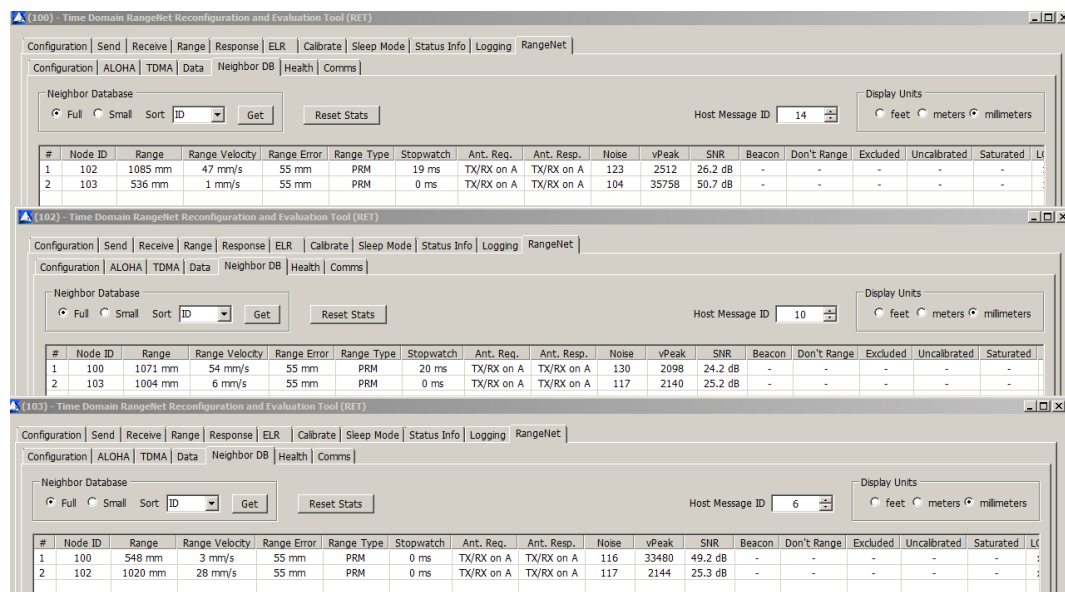


Fig. 16: Example ALOHA Network with three members

- Now experiment with the units in the network. Move them apart and observe how the range information changes as the units move. If you have more units and a USB Hub, connect more units and build a bigger network. Connect and disconnect units from the network and observe how long it takes units to drop out of and rejoin the system. (With the default settings it should take about 10 seconds to drop out and 1 second to rejoin.) There are several ways to connect and disconnect:

- a. You can return to the RangeNet Configuration Tab and click on “Return to RCM Mode.”
- b. You can go to the Configuration Tab and change the Code Channel.
- c. You can do a software reboot.
- d. You can remove the power from one unit.

Note: If you are testing with the standard (~1.8 m cables), then the units will be rather close to each other. So close, in fact, that they will actually be saturating each other’s receivers. While this will not damage the radios in any way, operating the radios in saturation may slightly degrade the ranging performance. Either turn down the transmit power, add some attenuation between the P4xx and the antenna, or move them farther apart. This degradation will decrease once the units are separated by more than about 6 feet (2 m) degradation decreases. Past 15 feet (5 m) the degradation is entirely gone.

Using RangeNet as a TDMA Network

We will now reconfigure the units to operate as a TDMA network. Please perform the following steps.

1. Click on the instance of RangeNet connected to unit 100.
2. Click the RangeNet Configuration Tab (the lower Configuration Tab).
3. Click “Return to RCM Mode” and then click “Set Configuration.”
4. Go to the Network Mode drop-down, select “TDMA” and click “Set Configuration.”
5. Click the TDMA Tab.
6. Click “Load from CSV.” Windows will then send you the default program file. Select the file “RangeNet Default TDMA Slot Map.csv” and click Open.
7. Click the lighted Set button and when it turns green, click the Get button as well.
8. Click the RangeNet Configuration Tab.
9. Repeat this process for each of the four units.

At this point all the units are in RCM mode.

10. Click on the instance of RangeNet RET connected to unit 100.
11. Click the “Enter RangeNet Mode” button and “Set Configuration.”
12. Click on the Neighbor DB Tab.

Unit 100 is in RangeNet mode and is waiting for units to join.

13. Repeat steps 10-12 for units 101, 102, and 103.
14. Then align the database screens such that you can observe all 4 data bases. It will likely look similar to **Figure 17**.

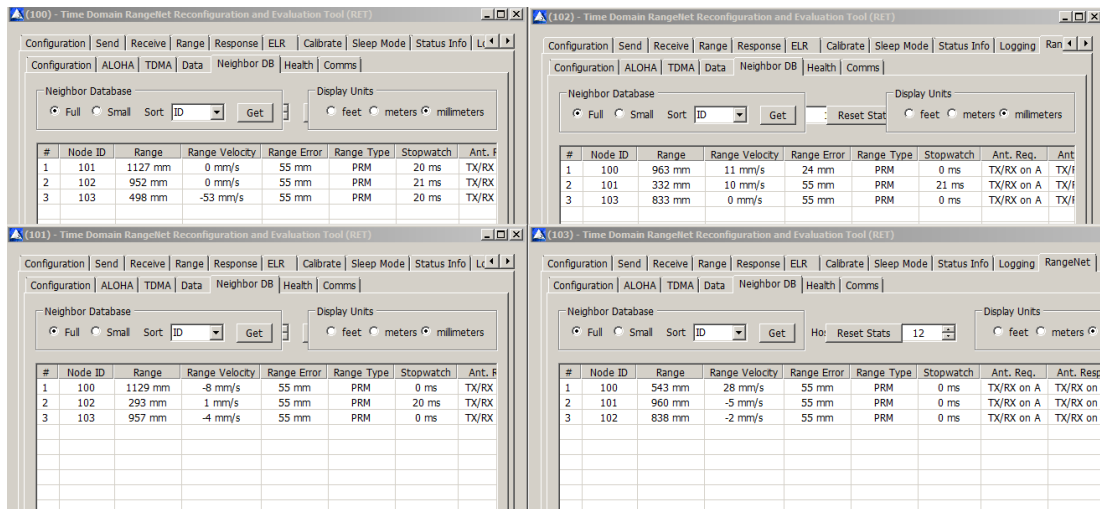


Fig. 17: Example TDMA Network with four members

This concludes the demonstration. At this point you should familiarize yourself with all of the commands and parameters as well as operation of the units both in standalone and network modes. It is not the intent of this guide to cover the RangeNet RET application in detail; for information on how to configure the various parameters, please refer to the *RCM RET / RangeNet RET User Guide* and the *RangeNet API Specification*.

Where do you go from here?

Once you are comfortable with operating the equipment, you should experiment with the following activities. Use the standalone mode to get a feel for how ranging works in your target environment. Check to see if/how mounting configurations may degrade your performance. Learn what each of the parameters on the Receive and Neighbor DB tabs means. See how the waveforms and reported statistics vary as you move nodes closer and farther away. If you are working outside at ranges greater than 250 feet (76 m), learn about Fresnel effects. Understand the trade between pulse integration index (PII) settings and system performance. (As PII is increased, it will take longer to take measurements but the system will operate over longer ranges.) Try sending some data. Log some waveform scans.

Once you have a feel for ranging, experiment with network operation. Try different settings. Send data. Log and examine network messages. Experiment with Echo Last Range (ELR). In ALOHA try the Automatic Congestion Control (it will make your life easier). In TDMA, try alternate Slot Maps. Experiment with defining units as beacons.

We hope that this document, along with the *RCM RET / RangeNet RET User Guide* and *RangeNet API Specification* provide the information you need to begin using the P440s for network operation. If you have any problems, please use the Time Domain website (www.timedomain.com) as your first point of contact. We offer multiple levels of support depending on your needs. To discuss how we can help you, please feel free to contact us:

E-Mail: info@timedomain.com
 Telephone: +1 256.922.9229
 Fax: +1 256.922.0387

Appendix A – Updating Microsoft .NET Framework

Operating any of Time Domain's Host-based software (RangeNet, MRM, CAT) requires that your computer have a reasonably recent version of Microsoft .NET Framework software. Most computers have a reasonably recent version but that is not guaranteed. When you try to load or operate CAT, MRM RET or RangeNet RET software, you may receive the popup message shown in **Figure A-1**. If this happens, then you will need to follow the instructions and upgrade your system. The operation only needs to be done once per computer and is both safe and easy.

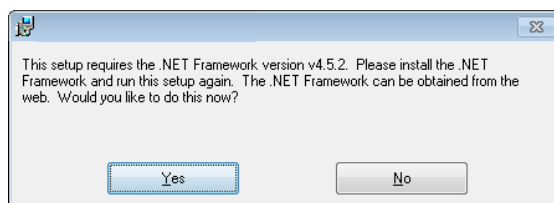


Fig. A-1: Message warning that you will need to update your version of .NET Framework

If you receive this message then click YES. You will then be directed to a website that looks like the one shown in **Figure A-2**. (The website you are directed to changes depending on your version of operating system.) Click the Download button. This will then download a copy of the .NET Framework installer. This is an executable file.

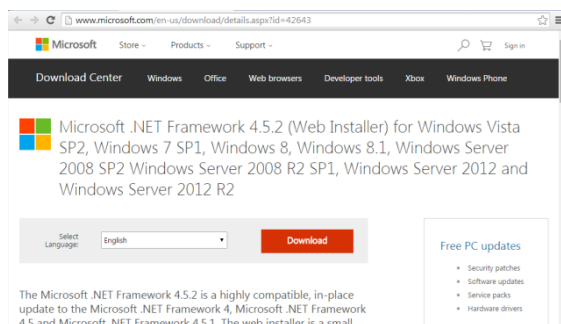


Fig. A-2: Website where you can download a current version of .NET Framework

Copy the installer to your desktop and double-click on the .exe. On some machines this may begin automatically. After a few moments, the display shown in **Figure A-3** will appear.

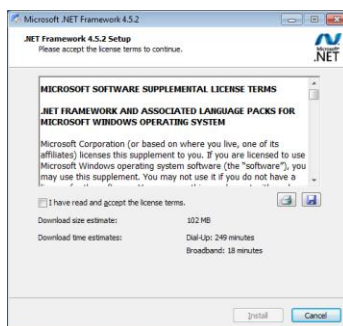


Fig. A-3: License agreement for .NET Framework

Click “I have read and accept the license terms” and then click the Install button. You will be advised that the program will take 15-20 minutes to download via broadband and will show the progress bar shown in **Fig. A4**. This would be a good time to get a cup of coffee.

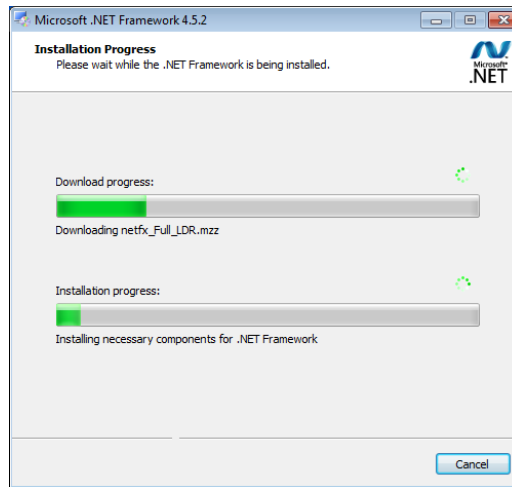


Fig. A-4: Progress bar shown while .NET Framework installs

On completion, you will see a screen that looks similar to the one in **Figure A-5**. Unless you need to run this program on another computer you will probably never need to run this program again. You are done and can return to the point in the *Quick Start Guide* that brought you here.

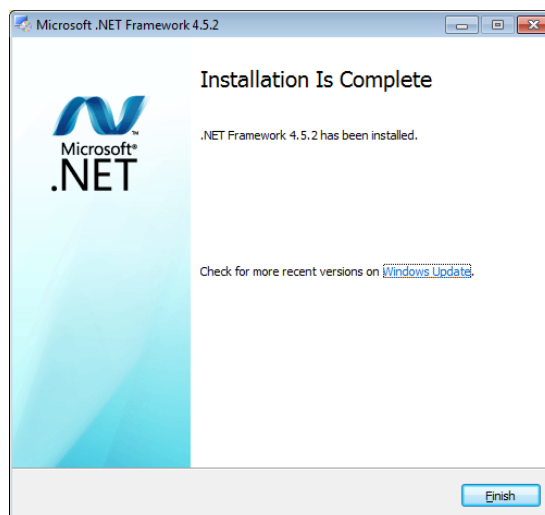


Fig. A-5: License agreement for .NET Framework