TREK

CCSDS FILE DELIVERY PROTOCOL (CFDP)

TUTORIAL

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1 Welcome

The Telescience Resource Kit (TReK) is a suite of software applications and libraries that can be used to monitor and control assets in space or on the ground. The TReK CFDP application provides the capability to transfer files using the Consultative Committee for Space Data Systems (CCSDS) File Delivery Protocol (CFDP).

This tutorial provides step-by-step instructions describing how to perform common application functions.

This tutorial uses screen dumps taken on a Windows computer. However, the steps are the same regardless of whether you are running on Windows or Linux.

2 Technical Support

If you are having trouble installing the TReK software or using any of the TReK software, please contact us for technical assistance:

TReK Help Desk E-Mail, Phone & Fax:

E-Mail: trek.help@nasa.gov
Telephone: 256-544-3521 (8:00 a.m. - 4:00 p.m. Central Time)
Fax: 256-544-9353

If you call the TReK Help Desk and you get a recording please leave a message and someone will return your call. E-mail is the preferred contact method for help. The e-mail message is automatically forwarded to the TReK developers and helps cut the response time. The HOSC Help Desk (256-544-5066) can provide assistance as needed and is available 24x7.

3 Introduction

The TReK CFDP application provides the capability to transfer files using the Consultative Committee for Space Data Systems (CCSDS) File Delivery Protocol (CFDP).

The CCSDS File Delivery Protocol (CFDP) was developed by the Consultative Committee for Space Data Systems (CCSDS). Official specifications are contained in a CCSDS document called the CFDP Blue Book (available at www.ccsds.org). The CFDP protocol provides reliable transfer of files from one computer to another, and has been designed to work well over space links. It can be used to perform space to ground, ground to space, space to space, and ground to ground file transfers.

CFDP requires a sender and a receiver. The sender and receiver must be configured and running at the same time to perform a file transfer. Each party is referred to as an "Entity". The sender is an entity and the receiver is an entity. Each "Entity" must have a unique Entity ID. For example:

Figure 1 CFDP Sender and Receiver

To move a file from one computer to another, you will enter one or more CFDP Commands (primitives) to indicate the action to be taken. The syntax of a primitive is as follows:

[CFDP Directive] [Transmission] [source-path] [remote-EID] [destination-path]

The TReK CFDP application provides support for CFDP over User Datagram Protocol (UDP) and CFDP over Bundle Protocol (BP) using the Jet Propulsion Lab (JPL) Interplanetary Overlay Network (ION) Delay Tolerant Networking software. The CFDP over UDP configuration option is referred to as Native CFDP. The CFDP over BP configuration option is referred to as ION CFDP. In the Native CFDP configuration, the application uses UDP sockets and a Goddard Space Flight Center (GSFC) CFDP library that performs the CFDP work. In the ION CDFP configuration, the TReK CFDP application communicates with the ION software which performs the CFDP work.

There are differences in capabilities and syntax between the CFDP Native mode and the ION CFDP mode. These differences are summarized below.

<u>Native CFDP Configuration</u>
The syntax of a primitive is as follows:

[CFDP Directive] [Transmission] [source-path] [remote-EID] [destination-path]

Native CFDP Example: put class2 "D:\file1.txt" 2 "/home/kirk/file1.txt"

The TReK CFDP application currently supports multiple CFDP Directives for both Native and ION CFDP modes. These are defined in the CFDP Directives section below.

Valid Transmission values are class1 or class2. Class1 does not guarantee reliable delivery of the file to the destination. Class2 does ensure reliable delivery.

The file you want to transfer is considered the "Source" and the location it should be transferred to is considered the "Destination".

When entering a Source or Destination in a CFDP command line, it must be encapsulated in double quotes.

ION CFDP Configuration

The syntax of a primitive is as follows:

[CFDP Directive] [Transmission] [source-path] [remote-EID] [destination-path]

ION CFDP Example: put //// “D:\file1.txt” 2 “/home/kirk/file1.txt”

The TReK CFDP application currently supports multiple CFDP Directives for both Native and ION CFDP modes. These are defined in the CFDP Directives section below.

The Transmission entry for ION CFDP is composed of five properties. Once these properties are configured, a “////” string is used to indicate that the pre-configured values should be used. The “////” nomenclature is shorthand notation for the following combination of values:

Lifespan/Bundle Protocol Class of Service/Expedited Priority Ordinal/Transmission Mode/Criticality

When the values are empty it indicates that pre-configured values should be used for these properties.

The Transmission properties are described below:

Property	**Description**
Lifespan	The lifespan is the bundle's "time to live" (TTL) in seconds. The bundle is destroyed if its TTL has expired and it has not reached its destination.
Bundle Protocol Class of Service	The Bundle Protocol Class of Service defines the transmission priority of outbound bundles from three ION priority queues corresponding to bulk, standard, and expedited priorities. The expedited priority queue must be empty before bundles in the standard or bulk queues are serviced by ION. Therefore, bundles with expedited priority should only be sent in critical/emergency situations.
Expedited Priority Ordinal	The expedited priority ordinal is only associated with the expedited priority class of service.
Transmission Mode	The transmission mode defines the reliability of bundle delivery to a destination. The three transmission modes supported are best effort, assured, and assured with custody transfer.
Criticality	A critical bundle is one that has to reach its destination as soon as is physically possible. For this

	reason, bundles flagged as critical may not include custody transfer and require an ION configuration with contact graph routing. In some cases, a critical bundle may be sent over multiple routes to ensure delivery to its final destination. Critical bundles are placed in the expedited priority queue and should only be used in emergency situations.

CFDP Directives

The TReK CFDP application currently supports multiple CFDP Directives for both Native and ION CFDP modes. This includes get and put, multiple filestore directives, and the message directive. These are defined as follows:

Directive	Description
append_file	append a file at the remote entity to another file at the remote entity.
bit_rate	changes the aggregate file transfer bit rate, in real time, for local or remote entities hosting a TReK implementation of Native CFDP. The “affected EID” may be the local entity ID or a remote entity ID. The "bit_rate" primitive is delivered to a remote entity in the form of a TReK CFDP message.
close_rec_file	send a directive to a TReK Record library to close one or all open record files. If the record file name is not included in the primitive, all open record files associated with the TReK Record library are closed. The TReK Record library automatically opens a new record file after it closes a current record file. The “affected EID” may be the local entity ID or a remote entity ID. The "close_rec_file" directive is delivered to a remote entity in the form of a TReK CFDP message.
create_dir	create a directory at the remote entity.
create_file	create an empty file at the remote entity.
delete_file	delete a file at the remote entity.
deny_dir	delete a directory at the remote entity. (like remove_dir, but does not fail if the directory does not exist. Directory must be empty.)
deny_file	delete a file at the remote entity. (like delete_file, but does not fail if the file does not exist)
get	copy one file from the remote entity to the local entity. (File cannot be empty.)
message	send a text string to the remote entity.
put	copy one file from the local entity to the remote entity. (File cannot be empty.)
remove_dir	delete a directory at the remote entity (directory must be empty).
rename_file	rename a file at the remote entity.
replace_file	replace a file (contents) at the remote entity with another file (contents) at the remote entity.

Some directives only require a Source. The following table describes what is required for Source and Destination for each directive. Name of file, filename, and name of directory refer to an absolute path.

Directive	Source (first file)	Destination (second file)
append_file	name of file whose contents form first part of new file and name of the new file	name of file whose contents will form second part of new file
bit_rate	aggregate file transfer bit rate	
close_rec_file	name of the TReK record library device	name of the TReK record file to close (if not included all record files associated with the record device are closed)
create_dir	name of directory to be created	
create_file	filename to be created	
delete_file	filename to be deleted	
deny_dir	name of directory to be deleted	
deny_file	filename to be deleted	
get	file or directory name of file(s) to retrieve	file or directory name for file(s) retrieved
message	message	
put	file or directory name of file(s) to send	file or directory name for file(s) sent
remove_dir	Name of directory to be deleted	
rename_file	old filename	new filename
replace_file	filename whose contents are to be replaced	filename whose contents will replace the contents of the first filename

When entering a Source or Destination in a CFDP command line, it must be encapsulated in double quotes.

Note: The Get directive is not supported in all ISS CFDP Native and ION implementations. Filestore and message directives are not supported in all ISS CFDP Native implementations. They are supported by TReK when both the sender and receiver are TReK CFDP implementations (TReK CFDP application, TReK CFDP console application, or TReK CFDP Library). In addition, the bit rate directive is not part of the CFDP Blue Book and is only supported by the TReK CFDP implementation of Native CFDP.

TReK also provides the capability to create CFDP dropboxes to push files to a remote destination. The dropboxes are available in both Native and ION CFDP modes. Dropbox configuration parameters include where the dropbox is located and the destination of each file placed in the dropbox.

In addition to this application, TReK also includes a CFDP console application and a CFDP library. If you need CFDP functionality onboard a spacecraft consider the TReK CFDP console application. If you need to include CFDP functionality in your own application, consider the TReK CFDP library. The TReK CFDP library can be used to include CFDP functionality in a ground or flight application.

4 Overview of the User Interface

4.1 Main Window

The main window contains several areas as shown in Figure 2. Each area is a dock window that you can float or dock. To float a dock window, use your left mouse button to click and hold the title area while dragging the window to another area of the screen. To dock, use the title bar to drag the dock window over the main window and drop.

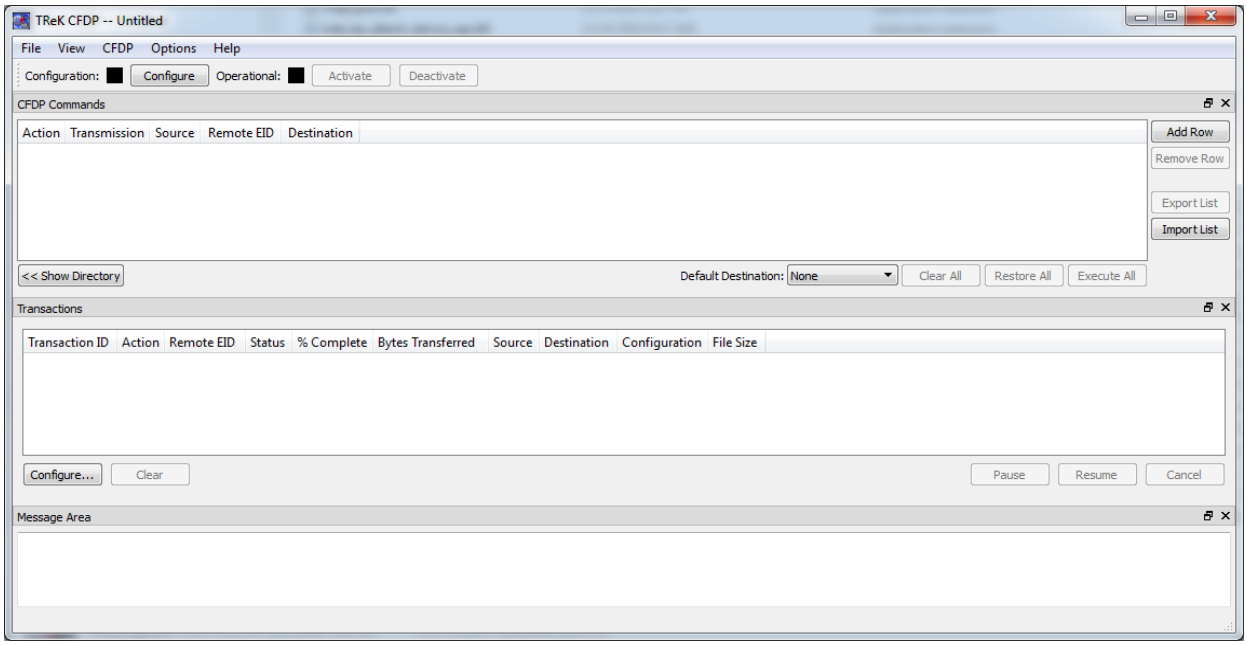

Figure 2 Main Window

Toolbar

The toolbar at the top of the window provides quick access to configure the application and start and stop the CFDP service.

CFDP Commands

The CFDP Commands area provides a way to add and execute one or more CFDP commands (primitives). For example, you can add a “put” command to send a file to a remote entity. The “Show Directory” button provides access to the local file system. Files can be dragged from this view of the local file system or from a file explorer window. Files can also be added by pushing the Add Row button and typing in the file transfer information. To delete a file from the list put your cursor in the row you would like to delete and push the Remove Row button. To delete all files in the list push the

Clear All button. The Export List button provides a way to save the list of CFDP Commands in a file. The Import List button provides a way to load a list of CFDP Commands from a file. Each CFDP command entered into the list must include a directive, transmission information, the absolute path of the source file, the Remote Entity ID (Remote EID), and the absolute path of the destination file. To execute all the CFDP commands in the list, push the Execute All button. After you push the Execute All button, the Restore All button can be used to restore the list of commands. The Restore All button will only restore the list of CFDP commands previously sent by pushing the Execute All button. The Default Destination menu can be used to identify a default destination. This can save typing when dragging and dropping files into the list. If the Default Destination is set, the destination selected will automatically be copied into the Destination field when a file is dropped into the list. The Default Destination menu can be populated using the Configure dialog.

Note: You can enter the absolute path for a directory in the Source and Destination fields. All the files in the first level of the directory will be transferred. Subdirectories will not be transferred. Each file in the directory will result in the execution of an individual CFDP Command (primitive). Therefore, the transactions area will contain transaction information for each file transferred.

Note 2: There are two types of configuration files for the CFDP application: the CFDP Application Configuration File and the CFDP Commands List file. File/Save/Save As can be used to save an Application Configuration File. The File/Open command provides a way to open an Application Configuration File. The Export List button provides a way to save a CFDP Commands List file. The Import List button provides a way to load a CFDP Commands List file.

Transactions

The Transactions area displays file transfer activity. The Configure button displays the Configure dialog which provides a way to show and hide columns and rearrange the order of the columns. To Clear, Pause, Resume, or Cancel one or more transactions, select the transactions in the list and push the desired button.

Message Area

The Message Area displays important status and error messages. The message area can be cleared using the View menu.

4.2 Toolbar

The toolbar provides visual information about the state of the application and provides access to common application functions.

Configuration Status

When the Configuration status is black, this indicates the application has not been configured. When the Configuration status is green, this indicates the application has been configured and the CFDP service can be activated.

Use the Configure button to access the Configure dialog to configure the application.

Operational Status

When the Operational status is black, this indicates the CFDP service is inactive. When the Operational status is green, this indicates the CFDP service is active and file transfer is supported. The application must be properly configured before the Activate button will be available. The CFDP service must be active before the Deactivate button will be available.

Use the Activate button to activate the CFDP service. This will initiate all internal activities needed to prepare the application to send and receive files. When you activate the CFDP service, you will see activation status messages in the main window message area. If you need to reconfigure the CFDP application, deactivate the CFDP service, and then push the Configure button to reconfigure.

5 TReK CFDP Tour

Sometimes it's easier to learn how to use an application by example. This section describes how to use the CFDP application to transfer a file using Native CFDP. To learn about transferring a file using ION CFDP, please reference the TReK DTN Tutorial.

This section was written assuming that you have read the Introduction section and the Main Window section. If you have not read these sections, please go back and read them. They contain important information that is not repeated in this section.

If you have a firewall enabled on your computer, you may need to turn it off or allow traffic through for the ports and protocols used in this example.

Please go through the tour in order. Some sections depend on data from previous sections.

How to Transfer a File

5.1 How to Transfer a File

The following steps describe the minimum necessary to transfer a file using Native CFDP. Typically CFDP involves transferring files from one computer to another computer. An instance of the CFDP application is run on each computer. The two CFDP applications communicate with each other using the CCSDS File Delivery Protocol (CFDP). While normally you run an instance of the CFDP application on each computer, it is possible to run two instances on the same computer (doesn't make a lot of sense but is possible). In this configuration, you can transfer a file from one directory to another directory on the same computer. To avoid the need for two computers, this is the approach taken in this tutorial. The steps below describe how to use two instances of the CFDP application running on the same computer to transfer a file from one directory to another directory on the same computer using Native CFDP. The configuration that will be used is shown in Figure 3.

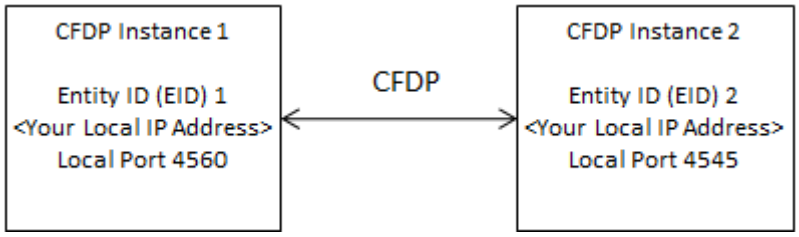

Figure 3 Tutorial Configuration

While you will be doing this on a single computer, the steps to configure and run will be the same steps when you do this with two computers.

Step-By-Step

1. If you haven't started the CFDP Application, use the operating system's menu to start the application. You should see the CFDP main window shown in Figure 4. We will refer to this instance as CFDP Instance 1.

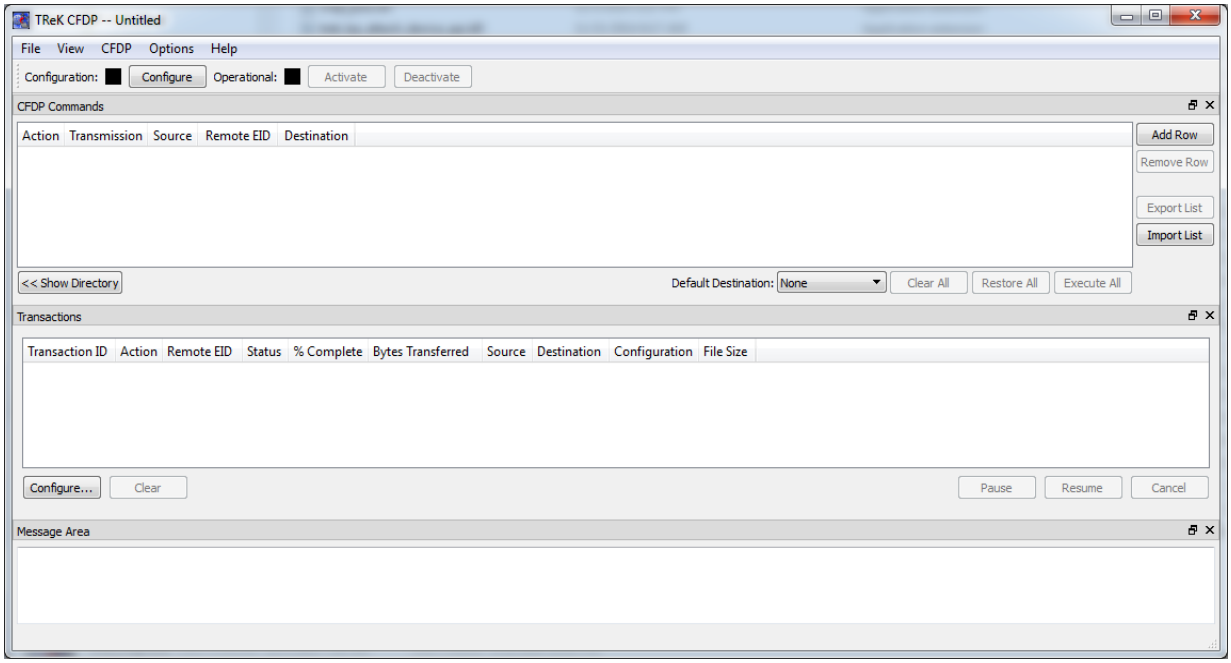

Figure 4 CFDP Main Window

2. The Configuration Toolbar at the top of the main window contains a Configure button. Push the Configure button to display the Configure dialog. You should see the dialog shown in Figure 5.

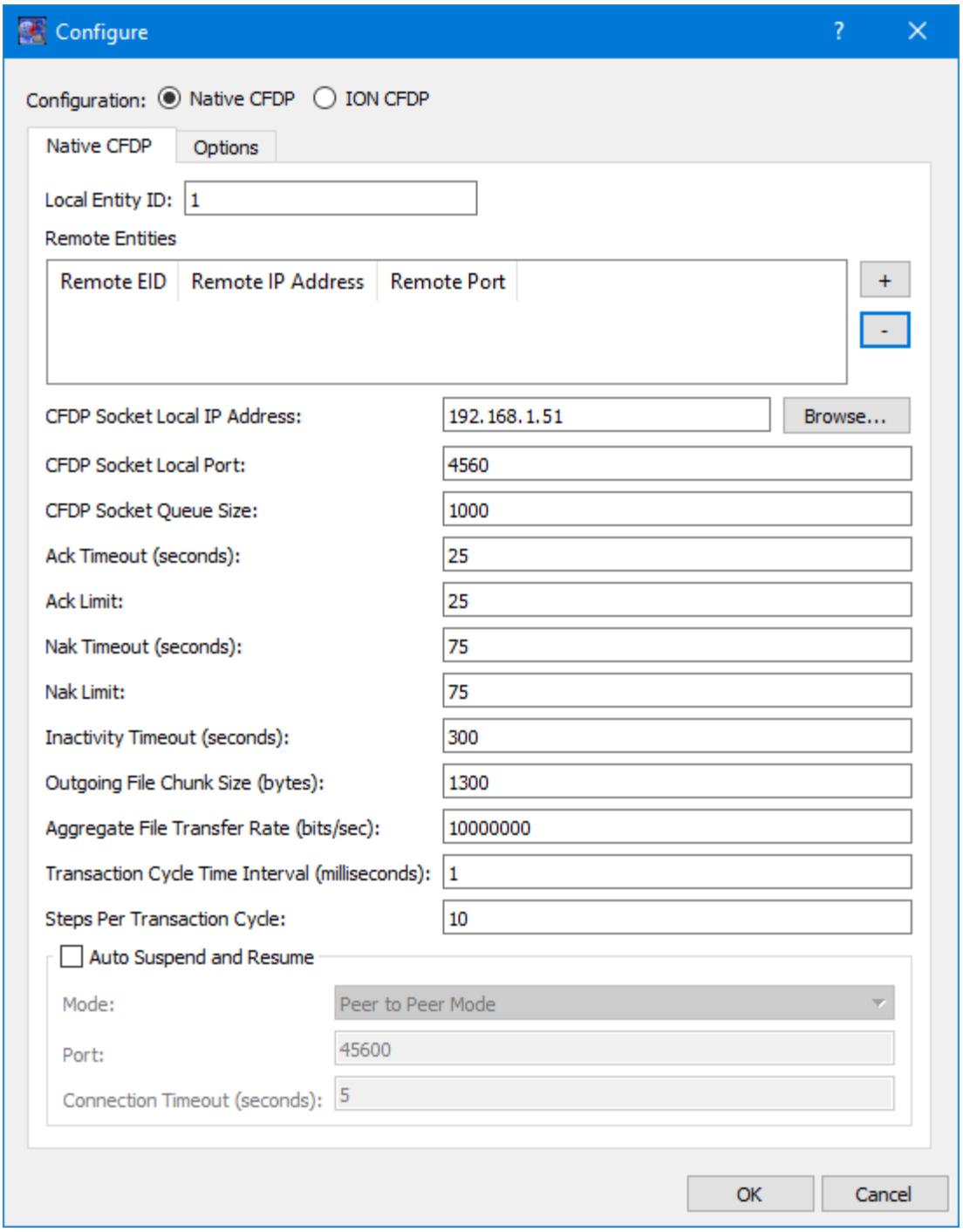

Figure 5 CFDP Configuration Dialog

3. Ensure Native CFDP is selected. The Local Entity ID is the Entity ID that will be used by this CFDP application when it performs a file transfer. It defaults to 1. This is the EID that should be used by CFDP Instance 1.

   Note: If you have identified you will be using the CFDP capability in your Payload Integration Agreement, you will be assigned a "Ground Node ID". The Ground Node ID is an Entity ID and should be entered into the Local Entity ID field. If there are multiple people on your team, your team may have more than one Ground Node ID. Each team member who needs to run the CFDP application will need a unique Entity ID.

4. The next step is to identify the remote entity that this CFDP application will communicate with. This will be CFDP Instance 2 (which we have not started yet). Push the + button to create a row to enter the Remote Entity information. Type in the following information:

   Remote Entity ID: 2
   Remote IP Address: <Your Local IP Address>
   Remote Port: 4545

   Note: The CFDP application can communicate with one or more remote entities.

Your dialog should now look similar to the dialog shown in Figure 6.

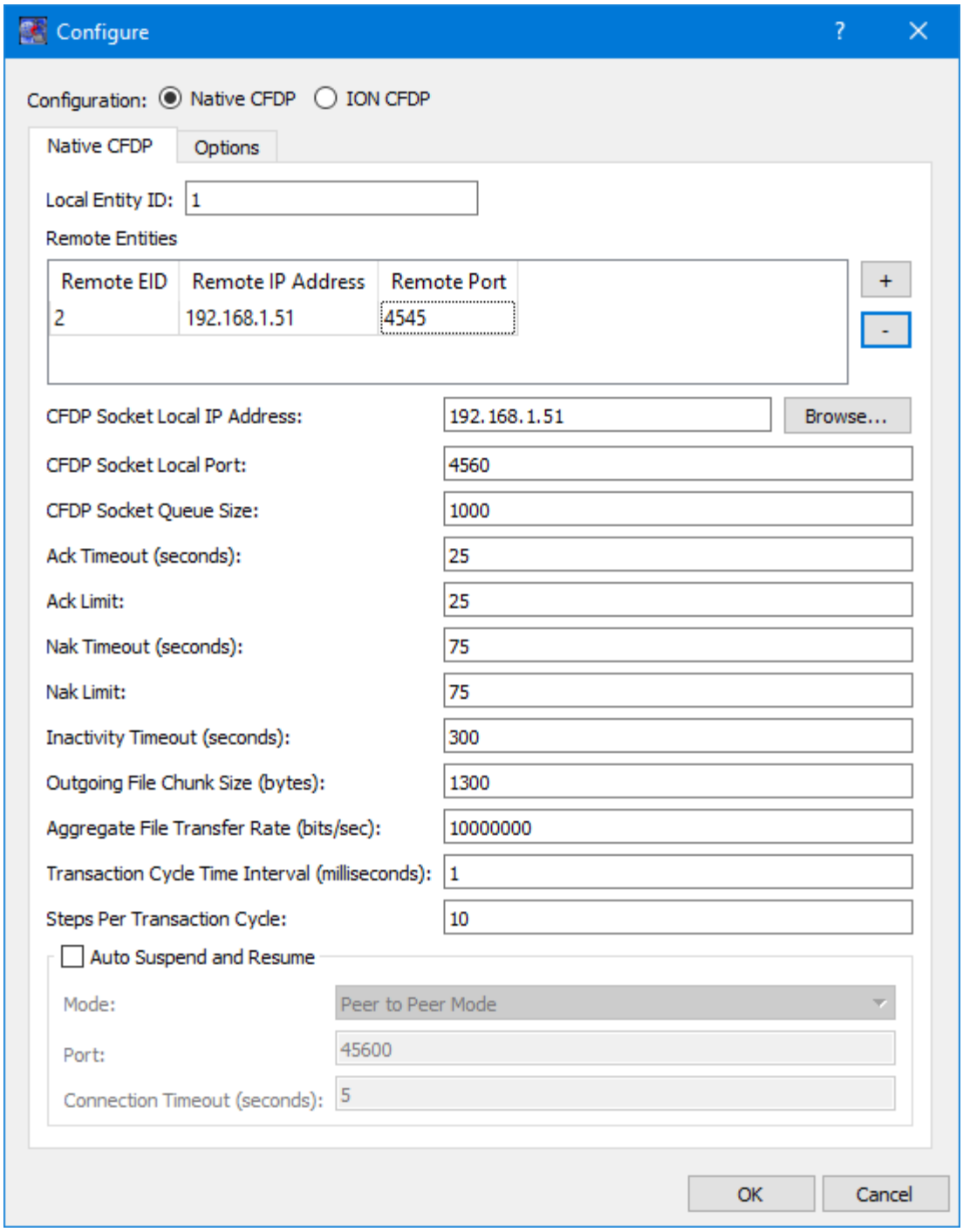

Figure 6 Configuration with Remote Entity

5. Ensure the CFDP Socket Local IP Address and the Remote IP Address contains your local IP address.

6. All the other defaults in the dialog are acceptable.

7. Push the OK button to save the configuration information and exit the dialog.

8. If the application is configured correctly, the Configuration status in the main window will be green as shown in Figure 7. If you do not see green, the most likely problem is the local IP address. Verify that you have entered a valid local IP address for your computer.

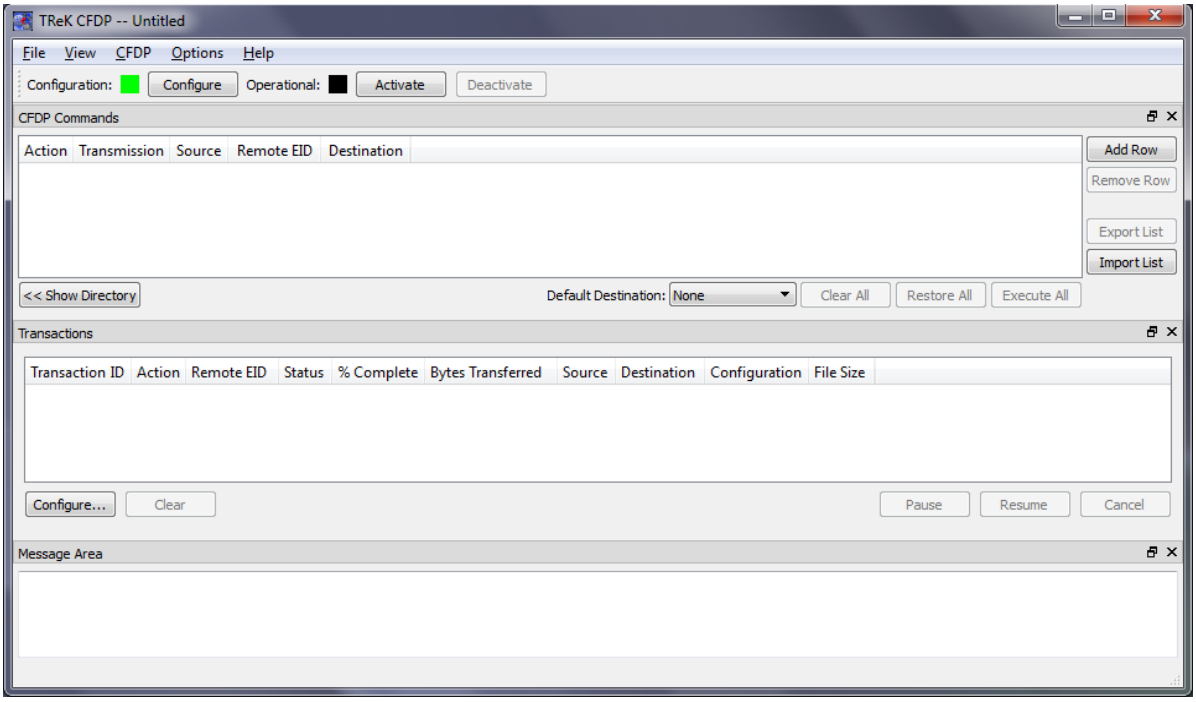

Figure 7 Configuration Status

9. Go to the File menu and save the configuration naming it CFDP_Instance_1. This will update the application title bar and make it easier to distinguish between the two instances once we have both instances running. This is shown in Figure 8.

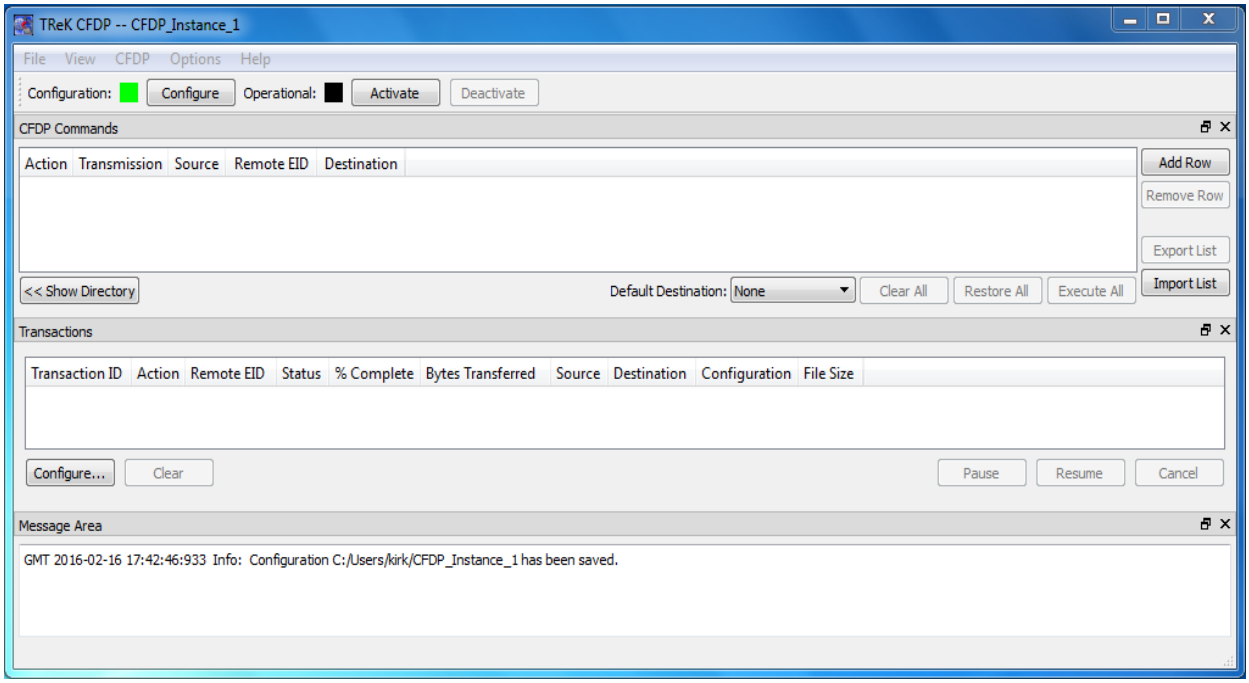

Figure 8 CFDP_Instance_1

10. Push the Activate button located in the Configuration Toolbar in the main window. This will activate all the underlying services needed to perform CFDP functions. If activation is successful, your main window should look like the one shown in Figure 9. The Operational Status will be green.

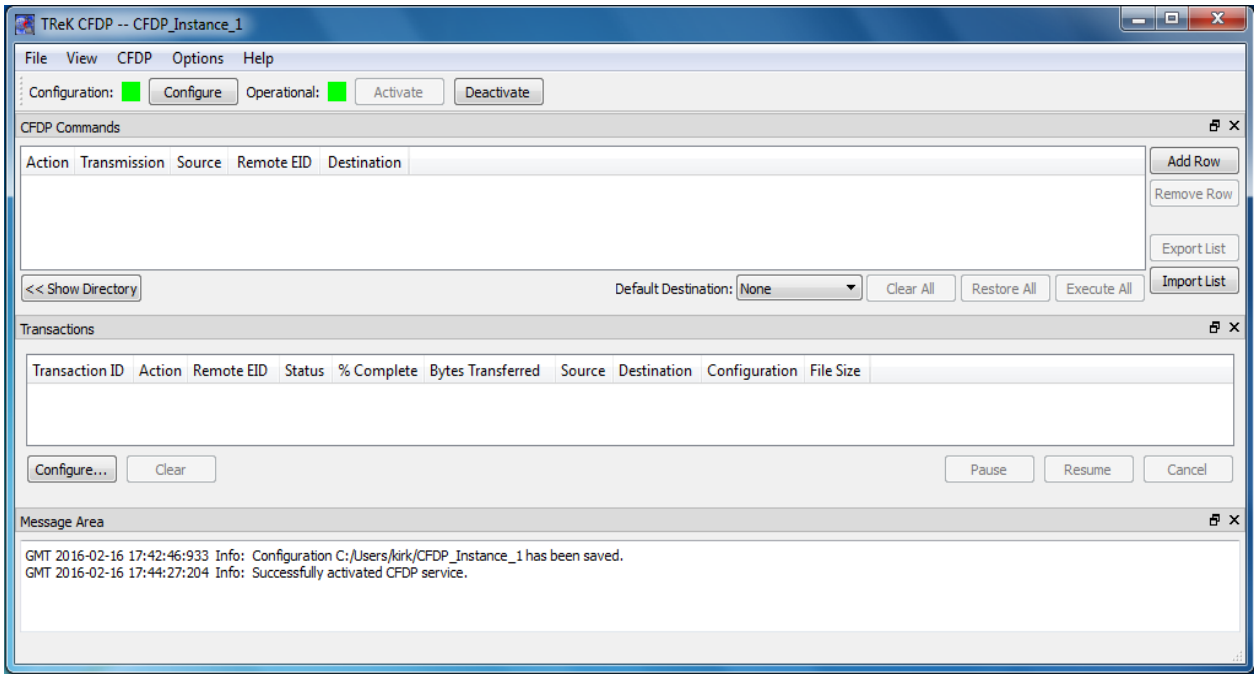

Figure 9 CFDP_Instance_1 Activated

11. Now that one instance is configured and running, launch a second instance of the CFDP application.

12. In the second instance of the CFDP application, push the Configure button and update the following:

Local Entity ID:	2
Remote Entity ID:	1
Remote IP Address:	<Your Local IP Address>
Remote Port:	4560
CFDP Socket Local Port:	4545

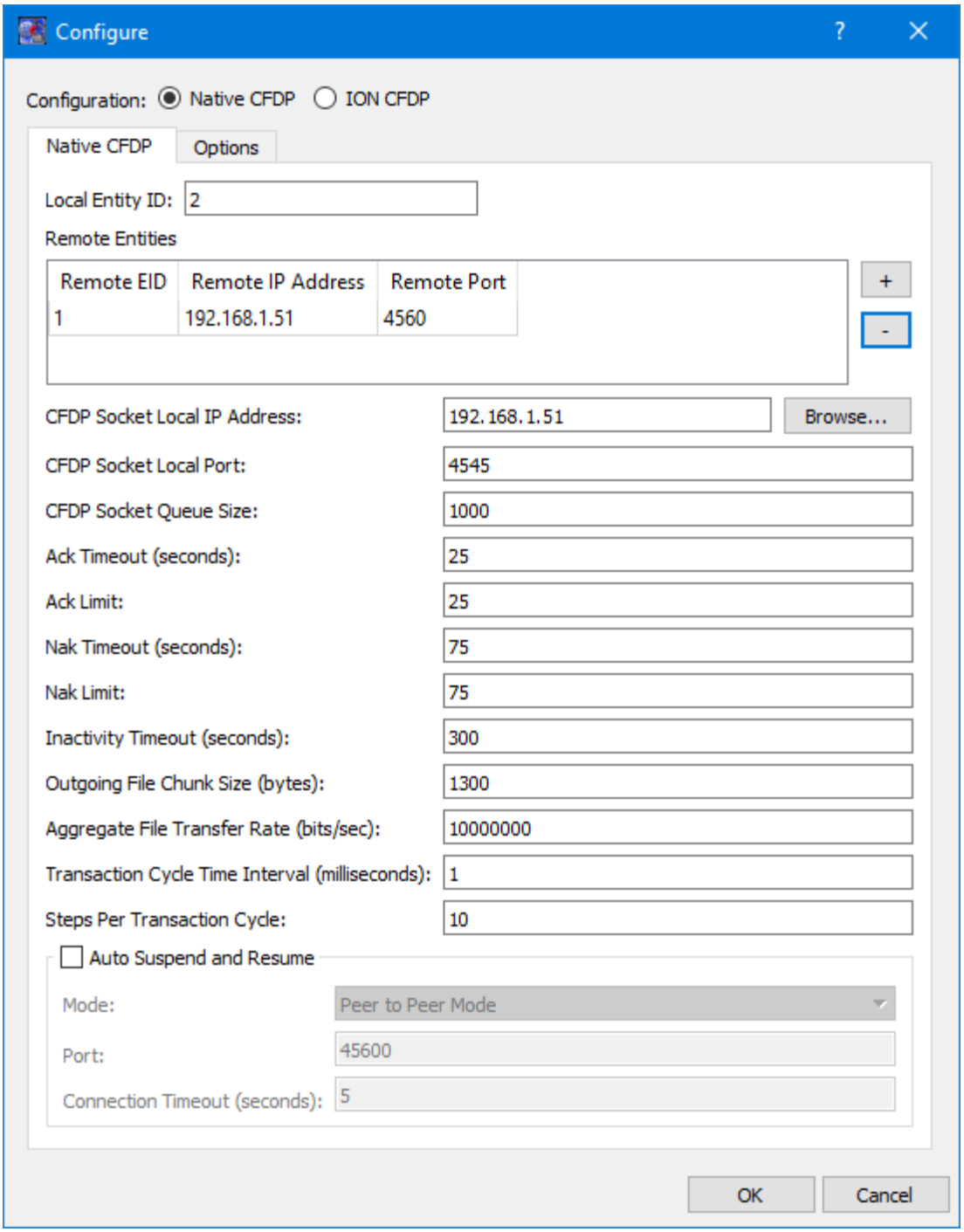

Figure 10 Configuration for CFDP_Instance_2

Note: Now that you have configured both instances you can compare the configuration information. You configured each instance with local entity information and remote entity information. Both instances have information needed to communicate with the other. As a reminder, the tutorial configuration is shown in Figure 11.

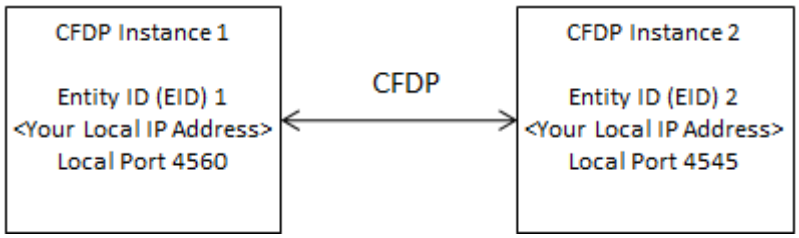

Figure 11 Tutorial Configuration Reminder

13. Push the OK button to save the configuration information and exit the dialog.

14. Verify the Configuration status is green.

15. Go to the File menu and save the configuration as CFDP_Instance_2.

16. Push the Activate button located in the Configuration Toolbar in the main window. This will activate all the underlying services needed to perform CFDP functions. If activation is successful, the main window for CFDP Instance 2 should look like the one shown in Figure 12. The Operational Status will be green.

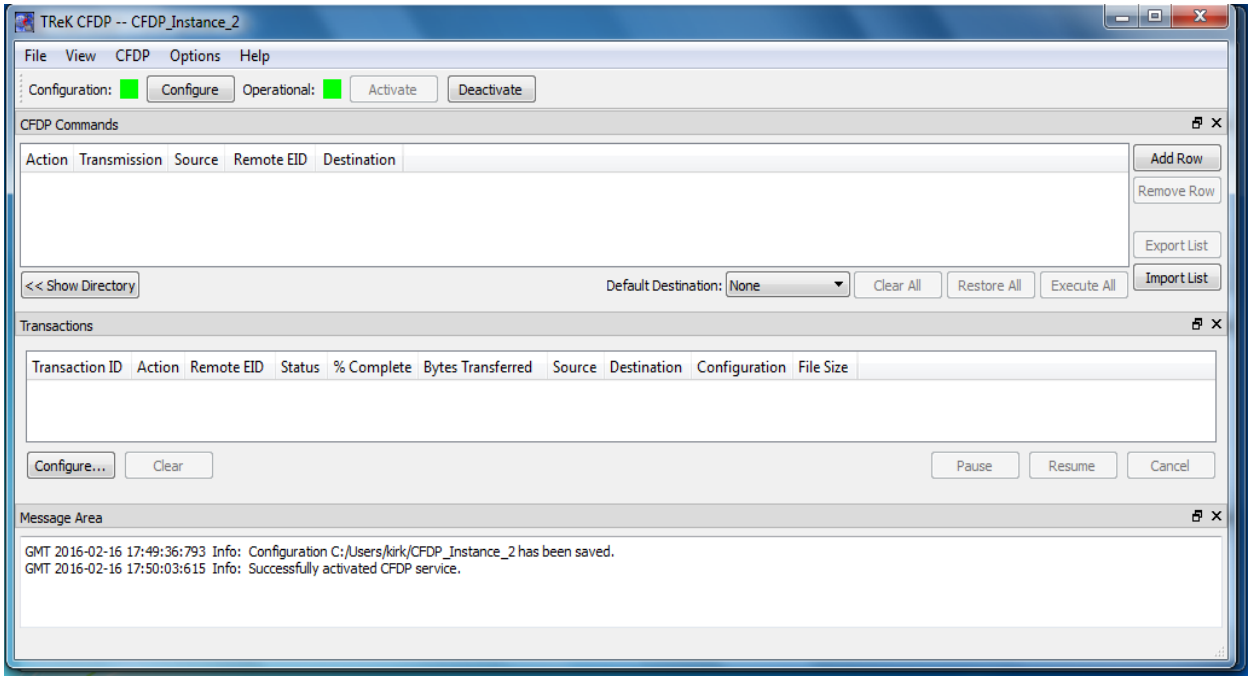

Figure 12 CFDP_Instance_2

17. You are now ready to transfer a file. The easiest way to identify the file(s) you want to transfer is to use drag and drop to drop the file(s) into the main window CFDP Commands list. To get some extra help from the application, you can set some application defaults that will fill in information in the CFDP Commands list when

you drop files into the list. So before transferring a file, let's set the defaults used by drag and drop. Push the Configure button in the main window configuration toolbar. Go to the Options tab. Set the Default Remote EID to 2 as shown in Figure 13.

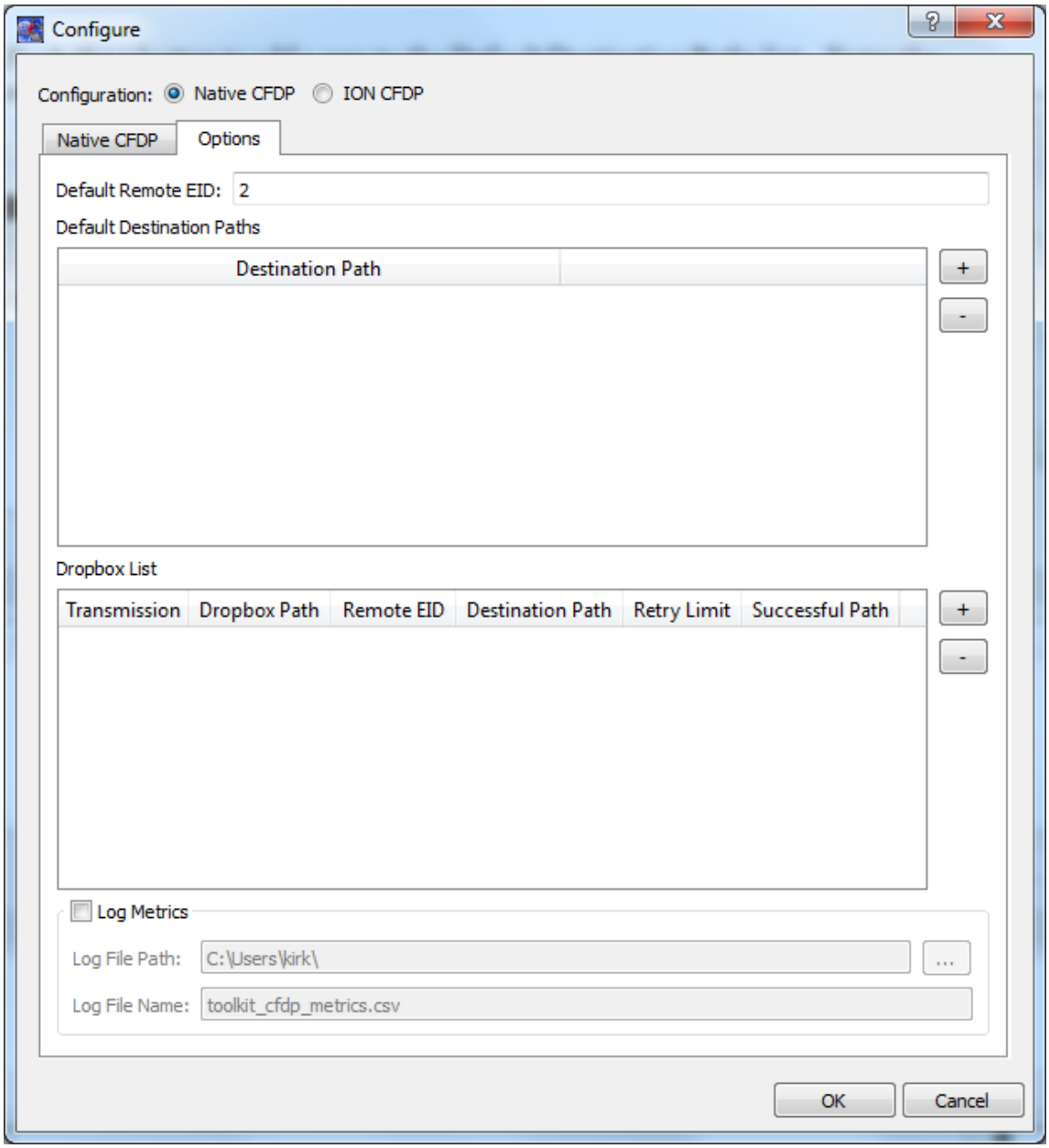

Figure 13 CFDP Configuration Options Tab

18. Push the + button to add a row to the Default Destination Paths list. Enter the absolute path for your home directory (<C:\Users\<your username> on Windows or /home/<username> on Linux) on your computer. Your dialog should be similar to the one shown in Figure 14.

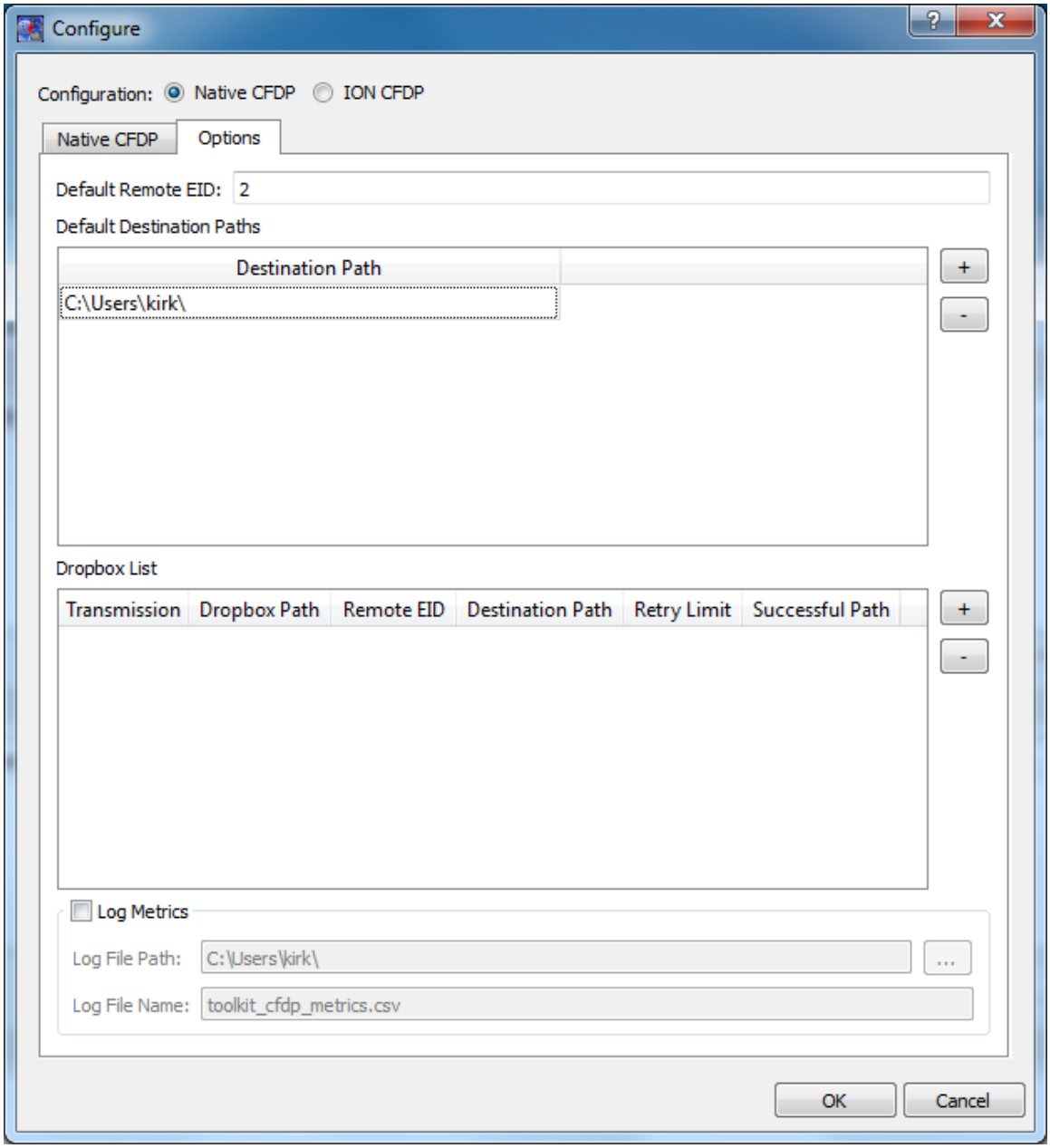

Figure 14 Default Destination Path

When you drag and drop a file the Remote EID will automatically be populated for you with the Default Remote EID. The Default Destination Paths will appear on the Default Destinations menu in the application (more on this below).

19. Push the OK button to save the configuration information and exit the dialog.

20. In the main window under the CFDP Commands list, there is an option menu called Default Destinations. Select the path you entered in the Default Destinations list in the Configuration dialog (<C:\Users\<your username> on Windows or

/home/<username> on Linux). Your CFDP_Instance_1 main window should look like the one shown in Figure 15.

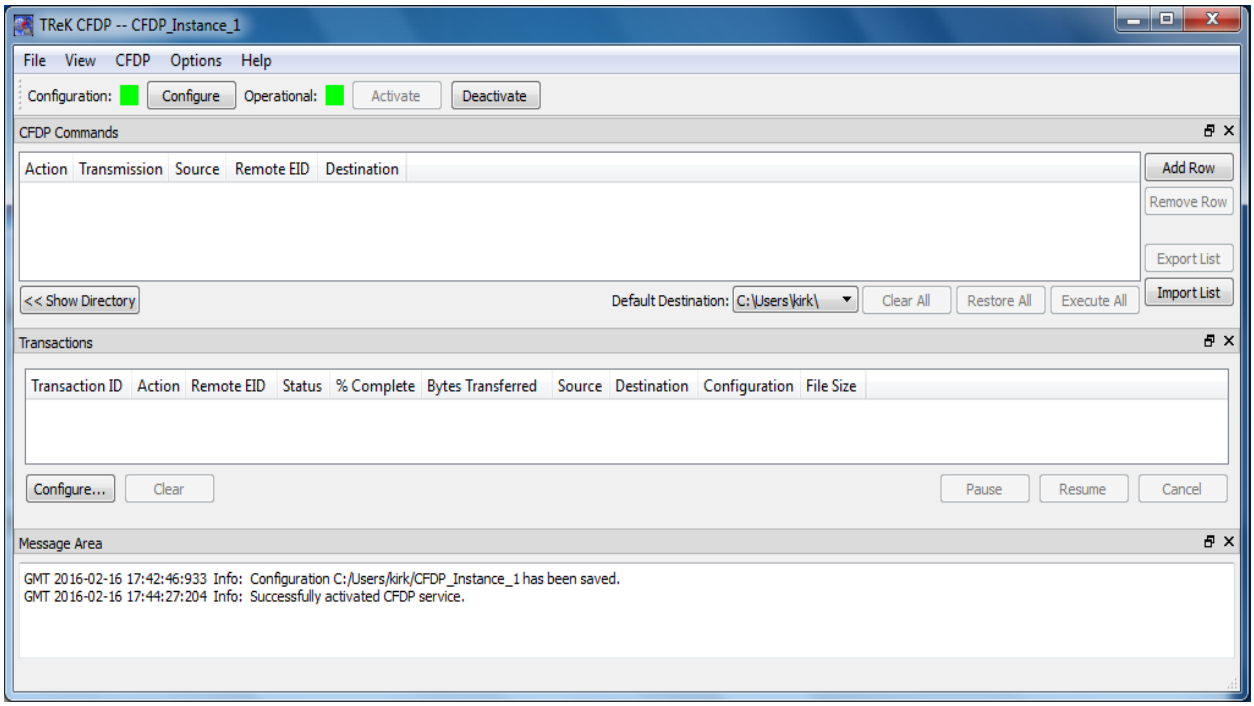

Figure 15 Main Window with Default Destination Selected

21. Let's transfer a file. Open a file explorer window and select a file to transfer. Make sure it is not a file in your home directory since that is the destination of the file. Drag the file from the file explorer window and drop it into the CFDP_Instance_1 CFDP Commands List. If all the information about the file is valid, your main window should look similar to the one shown in Figure 16.

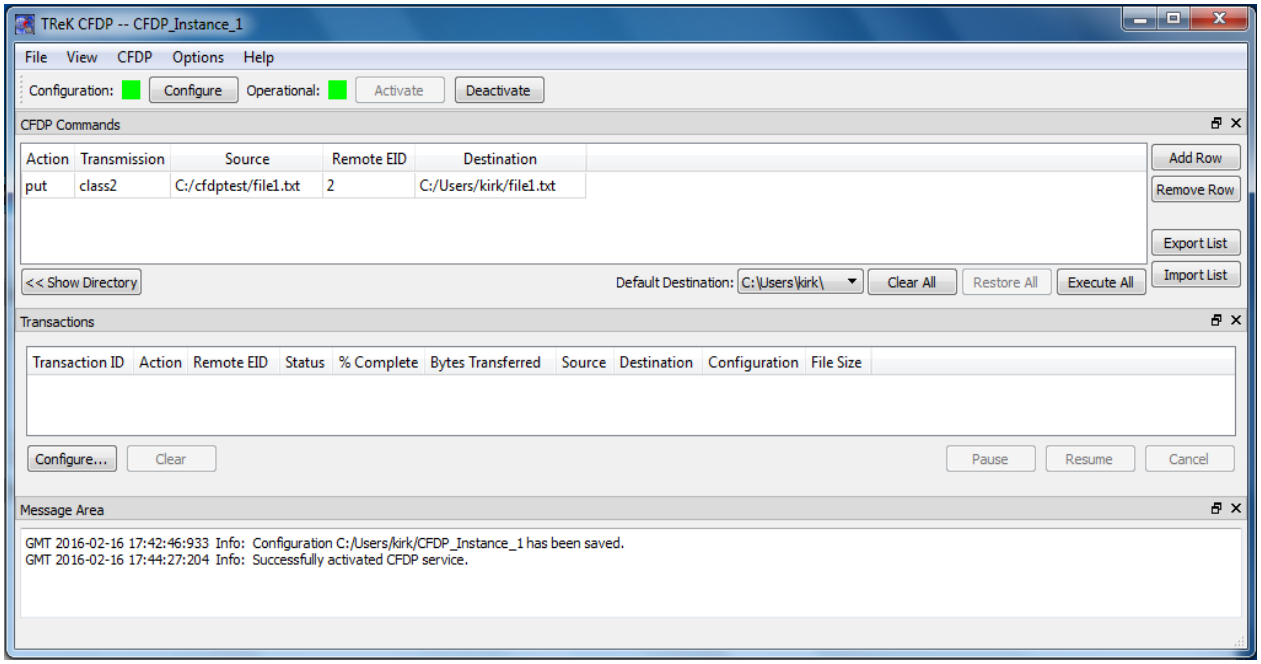

Figure 16 CFDP Commands List

Let's take a look at what we have in the list.

CFDP Command Syntax	[CFDP Directive] [Transmission] [source-path] [remote-EID] [destination-path]
CFDP Command	put class2 c:/cfdptest/file1.txt 2 C:/Users/kirk/file1.txt

Command Field	Value	Description
Put/Get	put	Indicates the file will be 'put' (copied) from the local entity (CFDP_Instance_1) to the remote entity (CFDP_Instance_2)
Transmission	class2	Class 2 ensures reliable file delivery; any required retransmissions are requested and performed by CFDP.
Source	C:/cfdptest/file1.txt	Identifies the 'source' file you wish to transfer to the destination (CFDP_Instance_2). (Note: Double quotes are not required when entering data in the CFDP Commands List.)
Remote EID	2	Identifies the remote entity ID is 2.
Destination	C:/Users/kirk/file1.txt	Identifies the 'destination' file by providing the absolute path and filename that should be used when the file is placed at the destination. (Note: Double quotes are not required when entering data in the CFDP Commands List.)

22. Everything is ready to go. Push the Execute All button in the CFDP_Instance_1 main window.

23. You should see the Transactions area populated with transaction information in both the CFDP_Instance_1 main window and the CFDP_Instance_2 main window as shown below in Figure 17 and Figure 18. Use the file explorer window to look at your home directory and you should see the file you transferred.

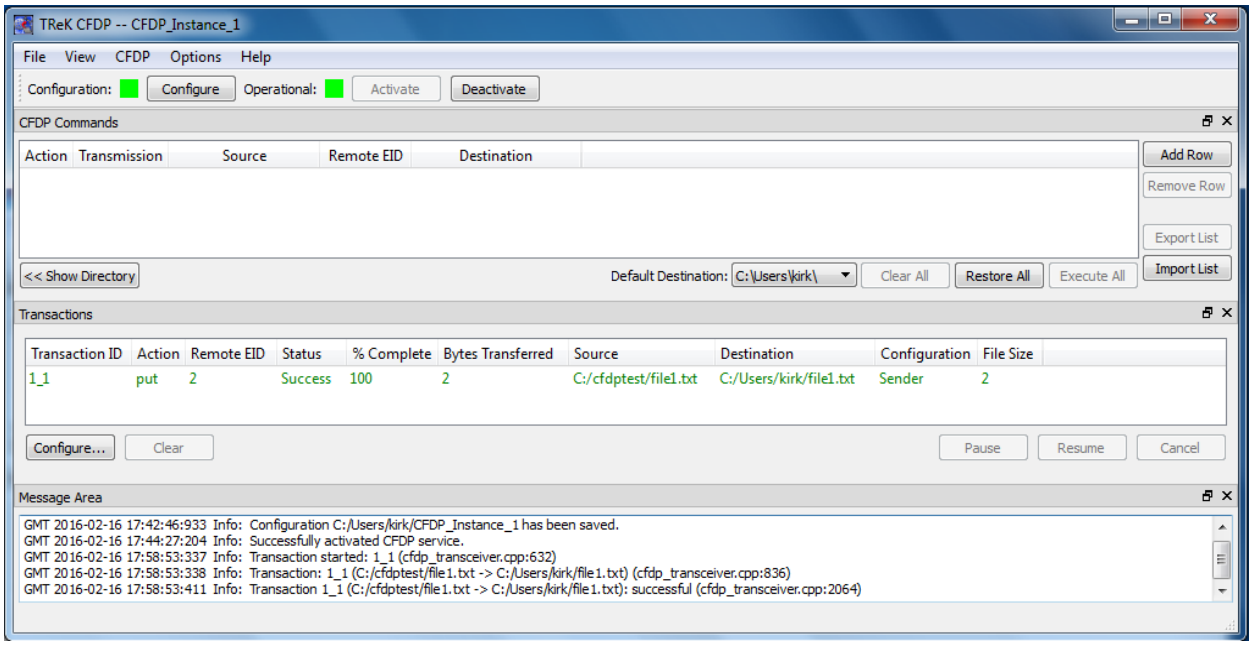

Figure 17 CFDP_Instance_1 Transaction Information

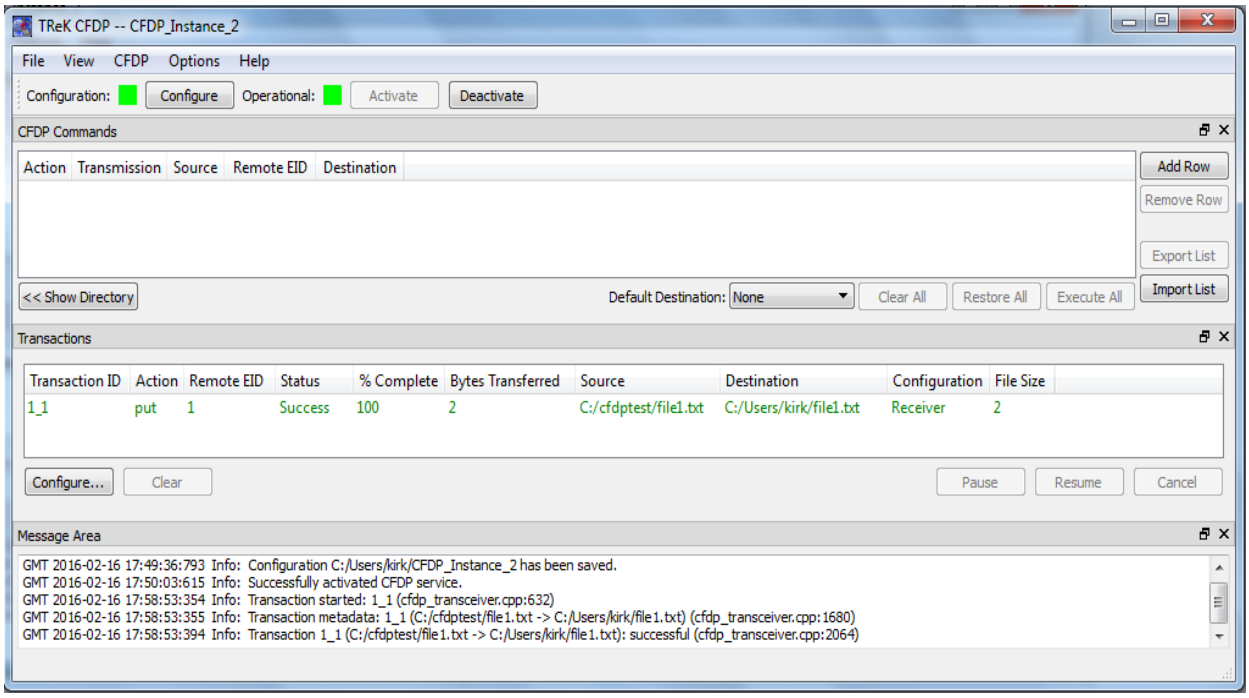

Figure 18 CFDP_Instance_2 Transaction Information

That's it! You have successfully transferred a file using CFDP. For more information please see the TReK CFDP User Guide.

Happy Transferring!!!