

# **TREK**

## **METADATA**

## **TUTORIAL**



**November 2024**

Approved for Public Release; Distribution is Unlimited.

## TABLE OF CONTENTS

| <u>PARAGRAPH</u>                              | <u>PAGE</u> |
|-----------------------------------------------|-------------|
| <b>1 Welcome.....</b>                         | <b>1</b>    |
| <b>2 Technical Support.....</b>               | <b>1</b>    |
| <b>3 Introduction.....</b>                    | <b>1</b>    |
| <b>4 Overview of the User Interface .....</b> | <b>3</b>    |
| 4.1 Main Window.....                          | 3           |
| 4.2 Menus.....                                | 5           |
| <b>5 TReK Metadata Tour .....</b>             | <b>5</b>    |
| 5.1 Create a Parameter Collection .....       | 8           |
| 5.2 Create a Packet .....                     | 17          |
| 5.3 Packet Data Flow.....                     | 27          |

## FIGURES

| <u>FIGURE</u>                                                            | <u>PAGE</u> |
|--------------------------------------------------------------------------|-------------|
| Figure 1 Packets, Parameter Collections, and Parameters .....            | 2           |
| Figure 2 A Packet and Its Zones.....                                     | 2           |
| Figure 3 Main Window .....                                               | 4           |
| Figure 4 Tutorial Telemetry Packet.....                                  | 6           |
| Figure 5 Tutorial Telemetry Packet.....                                  | 8           |
| Figure 6 Metadata Main Window.....                                       | 9           |
| Figure 7 Parameter Collection Name - Science Data .....                  | 9           |
| Figure 8 Library Area Showing Integer Expanded.....                      | 10          |
| Figure 9 Drag and Drop Areas for 16-Bit Unsigned Integer Parameter ..... | 11          |
| Figure 10 16-Bit Unsigned Integer Parameter in List.....                 | 11          |
| Figure 11 UINT_16 Parameter Updated with Name .....                      | 12          |
| Figure 12 Start Bit of 0.....                                            | 12          |
| Figure 13 Sign and Magnitude Integer .....                               | 13          |
| Figure 14 Sign and Magnitude Parameter .....                             | 14          |
| Figure 15 IEEE Floating Point Parameter .....                            | 14          |
| Figure 16 Undefined String Parameter.....                                | 15          |
| Figure 17 Validate Collection Dialog.....                                | 15          |
| Figure 18 Export Telemetry Collection Dialog .....                       | 16          |
| Figure 19 Export Successful Message.....                                 | 16          |
| Figure 20 Main Window with Packet Selected .....                         | 18          |
| Figure 21 CCSDS Packet .....                                             | 18          |
| Figure 22 Packet Drop Zones .....                                        | 19          |
| Figure 23 Entire Packet Drop Zone Highlighted.....                       | 19          |
| Figure 24 Data Zone Drop Zone Highlighted.....                           | 19          |
| Figure 25 Packet Tab with Name Populated .....                           | 19          |
| Figure 26 Telemetry Predefined Packet Template List Expanded .....       | 20          |
| Figure 27 Entire Packet Drop Zone Highlighted.....                       | 21          |
| Figure 28 trek_ccsds_template Packet.....                                | 21          |
| Figure 29 Packet Properties Dialog.....                                  | 22          |
| Figure 30 Packet Properties Dialog (Identifiers Tab).....                | 22          |
| Figure 31 Telemetry Collection List Expanded.....                        | 23          |
| Figure 32 Science Data Collection in Data Zone .....                     | 23          |
| Figure 33 Packet with APID Value Set to 314.....                         | 24          |
| Figure 34 Packet Validate Dialog.....                                    | 24          |
| Figure 35 Export Telemetry Packet Dialog .....                           | 25          |
| Figure 36 TReK Data Main Window .....                                    | 27          |
| Figure 37 Add Service Dialog.....                                        | 28          |
| Figure 38 Service Name Populated .....                                   | 29          |
| Figure 39 Add Service Dialog Data Description Tab.....                   | 30          |
| Figure 40 Science Packet in Packet List.....                             | 31          |
| Figure 41 Process Tab .....                                              | 32          |
| Figure 42 Process Tab with Process set to Yes .....                      | 33          |
| Figure 43 Packet 314 in the Data Main Window.....                        | 34          |
| Figure 44 Packet 314 Activated.....                                      | 35          |
| Figure 45 Displays Dialog.....                                           | 35          |
| Figure 46 Science Packet Display .....                                   | 36          |
| Figure 47 Generator Main Window.....                                     | 37          |
| Figure 48 Generator Add Service Dialog .....                             | 38          |
| Figure 49 Add Service Dialog Generate Tab (Packet 314) .....             | 39          |
| Figure 50 Configure Generator Properties Dialog.....                     | 39          |
| Figure 51 Add Service Dialog Generate Tab .....                          | 40          |

Figure 52 Generator Add Service Dialog Forward Tab.....41

Figure 53 Generator Main Window with Packet 314 .....42

Figure 54 Generator Main Window Activated Service .....43

Figure 55 Generator Sending Packet 314 .....44

Figure 56 TReK Data Receiving Packet 314 Data .....45

Figure 57 TrekCcsds.314 Packet Data Values.....46

## 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 Metadata application provides the capability to create and manage telemetry and command metadata. This includes support for creating databases and metadata files and translating between different types of metadata formats.

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

The topics in this tutorial require an understanding of the topics covered in the TReK Concepts document. Please be sure you have read the TReK Concepts document before proceeding with this tutorial.

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:

E-Mail: [trek.help@nasa.gov](mailto:trek.help@nasa.gov)

Messages sent to this address are automatically forwarded to the TReK team.

The HOSC Help Desk (256-544-5066) can provide assistance as needed and is available 24x7.

## 3 Introduction

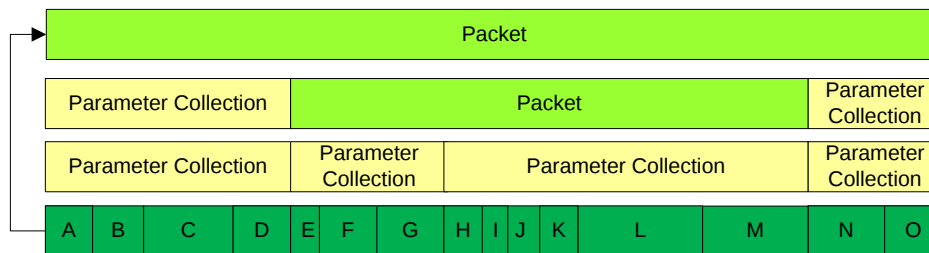
The TReK Metadata application provides the capability to create and manage telemetry and command metadata. This includes support for creating databases and metadata files and translating between different types of metadata formats. For a more detailed introduction to TReK metadata please reference the TReK Concepts document.

Packets are most often the data that are sent from one system to another system. Commands and telemetry are just packets. Command data is packets that tell another system to do something. Telemetry data is packets that supply information about the system sending the packet.

Parameters are the individual data values that contain information about the state of the sending system or actions to be taken by the receiving system. Parameters have a value and are either placed in the outgoing data or pulled from the incoming data. TReK uses

the terms “build” to describe placing parameters in a packet and “extract” to describe pulling parameters from a packet.

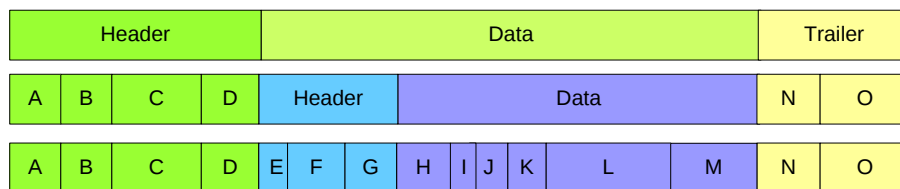
Parameters are grouped with related parameters into collections named parameter collections. Parameter collections are the basic building blocks of packets which are the data sent from one system to another. Figure 1 has four views of the same packet. The first row shows a packet as a single entity that could be sent between systems. The second row shows that the packet is composed of parameter collections and another packet. The third row shows that eventually a packet will break down into a series of parameter collections. The final row shows that all parameter collections are a series of parameters. Each row is a different view of the same data.



**Figure 1 Packets, Parameter Collections, and Parameters**

As mentioned earlier, Packets are the data that travel between systems. The packet is the largest aggregation of data in TReK.

Packets are divided into three zones: header, data, and trailer. One or more zones must be defined in a packet for it to be considered valid. Figure 2 shows each of the three zones and their relative locations. Each zone of a packet contains either another packet or a parameter collection.



**Figure 2 A Packet and Its Zones**

The first line in the figure above shows a packet that has all three zones defined. The second level shows that the header and trailer zone are composed of parameter collections which contain one or more parameters. The data zone is composed of another packet which only has the header and data zones defined. The third line shows that the packet in the data zone of the top-level packet is composed of two parameter collections and that all the data in a packet will eventually break down into a series of parameters.

The Metadata application provides the capability to create and modify a telemetry packet or a command packet. The application provides all the support needed to define the

details for a Packet, Parameter Collection, and Parameters like those shown in Figure 1 and Figure 2. Once defined these packet definitions can then be used with various TReK applications to monitor and control an asset in space or on the ground.

Since there are many ways to format metadata, TReK supports a variety of formats as described below.

#### C Programming Language Header File

Many software developers represent a packet definition using a C structure defined in a C header file. TReK can import the packet definition by reading the C structure defined in a C header file.

#### Gateway Extensible Markup Language (XML) Telemetric and Command Exchange (XTCE)

Gateway XTCE is Gateway program format that contains metadata described using XTCE. It is used to exchange telemetry and command information between data systems.

#### TReK Database

A TReK database is a SQLite database that can contain metadata information for one or more packets.

#### TReK Metadata File

This is a TReK generated file that contains metadata described using XML (e.g., a Packet definition, a Parameter Collection definition).

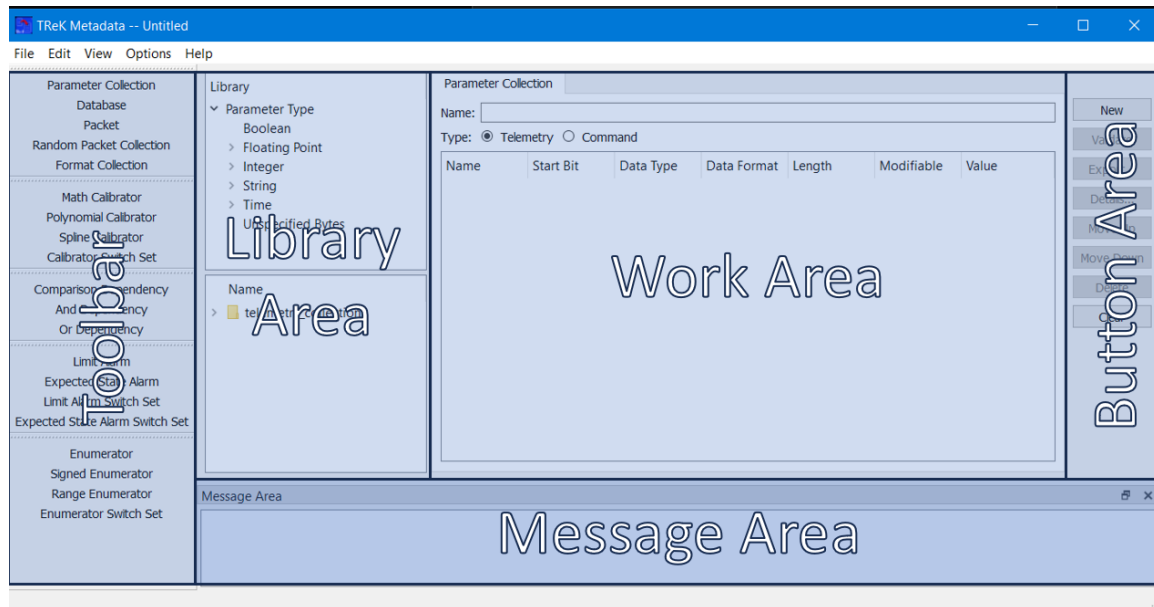
The Metadata application can read, write, and translate between these different types of formats.

The Metadata application also provides the capability to import metadata information obtained from the HOSC including metadata defined in Partial Database Download Files and Ground Support Equipment (GSE) packet definitions.

## **4 Overview of the User Interface**

### **4.1 Main Window**

The main window contains several areas as shown in Figure 3. The Toolbar contains multiple buttons that reconfigure the main window to focus on a specific metadata element such as a Parameter Collection, a Database, a Limit Alarm, a Packet, etc.



**Figure 3 Main Window**

### Toolbar

The toolbar at the top of the window provides quick access to configure the main window to work on a specific metadata element.

### Library Area

The Library Area is context sensitive and will be reconfigured to support the specific area you are working on. For example, if you are creating a Parameter Collection, the Library Area will be configured to show a list of all the types of parameters that you can add to a parameter collection. If you are working on a Database, the Library will be configured to show you a list of databases you can work with.

### Work Area

The Work Area is context sensitive and will be reconfigured to support the specific type of element you are working on. If you are working on a Parameter Collection, the Work Area will display the Parameter Collection content. If you are working on a Database, the Work Area will display the list of packets in the Database you have selected. If you are working on a Limit Alarm, the Work Area will display the content of the Limit Alarm. If you are working on a Packet, the Work Area will display the contents of the packet. The Work Area provides the capability to create or modify the contents of a specific element.

### Button Area

The Button Area is context sensitive and will be reconfigured to display functions available for the specific area you are working on. For example, for a Parameter Collection, you would have functions such as creating a New Parameter Collection, Validating a Parameter Collection, and Exporting the Parameter Collection (saving it in a file in a specified format). There are also functions available to modify the order of

parameters in the collection by moving them up and down in the list and deleting a parameter.

#### Message Area

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

### **4.2 Menus**

The Metadata application menus are File, Edit, View, Options, and Help. Each of these menus is described in more detail below.

#### File Menu

The File menu provides the capability to manage configurations and exit the application.

#### Edit Menu

Provides an alternative means to configure the main window to work on specific metadata elements. This is especially useful if you reconfigure the application to hide the Toolbar.

#### View Menu

The View menu provides the capability to clear the main window message area and show and hide different areas in the main window.

#### Options Menu

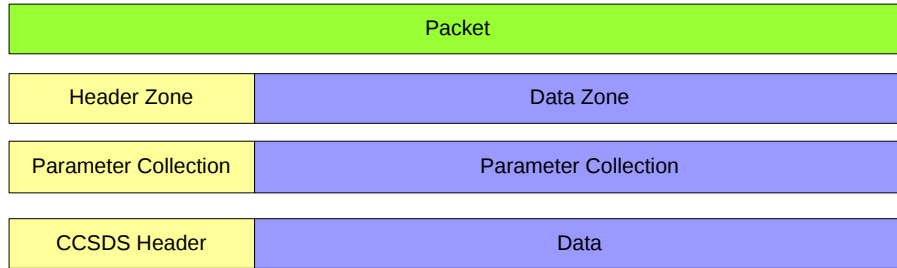
The Options menu provides access to the Messages dialog and other special functions such as working with HOSC Partial Database Download files, Common Data Exchange Format files, and Gateway XTCE files.

#### Help Menu

The Help menu provides access to on-line help and application version information.

## **5 TReK Metadata Tour**

Sometimes it's easier to learn how to use an application by example. This section describes how to use the Metadata application to create a Telemetry Packet definition and then use it with the TReK Data application to receive and process telemetry data that matches that packet definition. Figure 4 shows the structure of the Telemetry Packet to be defined.



**Figure 4 Tutorial Telemetry Packet**

This packet contains a Header Zone and a Data Zone. Each zone contains a parameter collection. The final product will be a packet with a CCSDS Header in the Header Zone and a Custom Parameter Collection in the Data Zone. Most programs select a standard header (e.g., CCSDS) or define a custom header that will be used on packets exchanged between their flight and ground systems. It is common to create multiple packets that all have the same header zone but contain different data zones.

Step-by-Step instructions are divided into the following sections:

- ❖ Create a Parameter Collection – this section shows how to create a custom parameter collection that will serve as the Data Zone of the Packet
- ❖ Create a Packet – this section shows how to use a packet template to create a telemetry packet and then add the custom Parameter Collection to the Data Zone.
- ❖ Packet Data Flow – this section shows how you can use the packet definition you created with the TReK Data application to receive and process packets that match the packet definition.

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

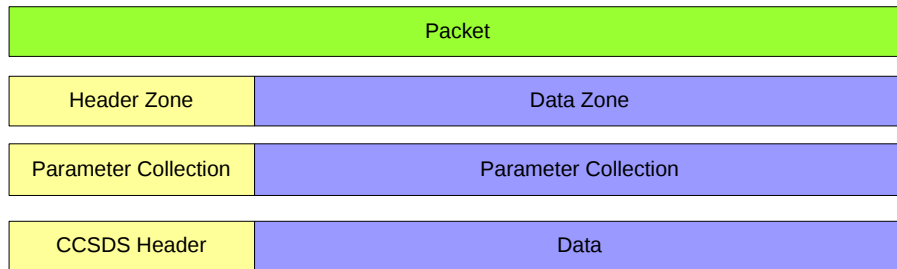
If at any time you need to exit the application so you can resume working through the Tutorial later, File Save will allow you to save all the data you entered.

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

## Create a Parameter Collection

### 5.1 Create a Parameter Collection

The first step in creating the Telemetry Packet definition is to create a Parameter Collection to serve as the Data Zone. The following steps describe how to create a Parameter Collection. Let's look once again at the packet you are going to define. It is shown in Figure 5 below.



**Figure 5 Tutorial Telemetry Packet**

The Parameter Collection in the Data Zone will contain the following parameters as shown in Table 1 below.

| Parameter | Start Bit | Data Type                  | Total Length |
|-----------|-----------|----------------------------|--------------|
| UINT_16   | 0         | Unsigned Integer           | 16 (2)       |
| INT_32    | 16        | Sign and Magnitude Integer | 32 (4)       |
| FEEE_64   | 48        | Floating Point             | 64 (8)       |
| SUND_80   | 112       | Undefined String           | 80 (10)      |

**Table 1 Data Zone Parameters**

#### Step-By-Step

1. If you haven't started the Metadata Application, use the operating system's menu to start the application. You should see the Metadata main window shown in Figure 6.

The Main Window initializes with the Collection work area as the default. On the left-hand side of the Main Window you will see the Library Area. It is configured to provide access to items you can use to create a Parameter Collection. In the middle of the Main Window you will see the Work Area showing the Parameter Collection Tab. This is where you will define the details of your Parameter Collection. On the right-hand side of the Main Window you will see a list of buttons that provide various capabilities applicable to the Parameter Collection you are working on (e.g. Validating the Parameter Collection and Exporting the Parameter Collection).

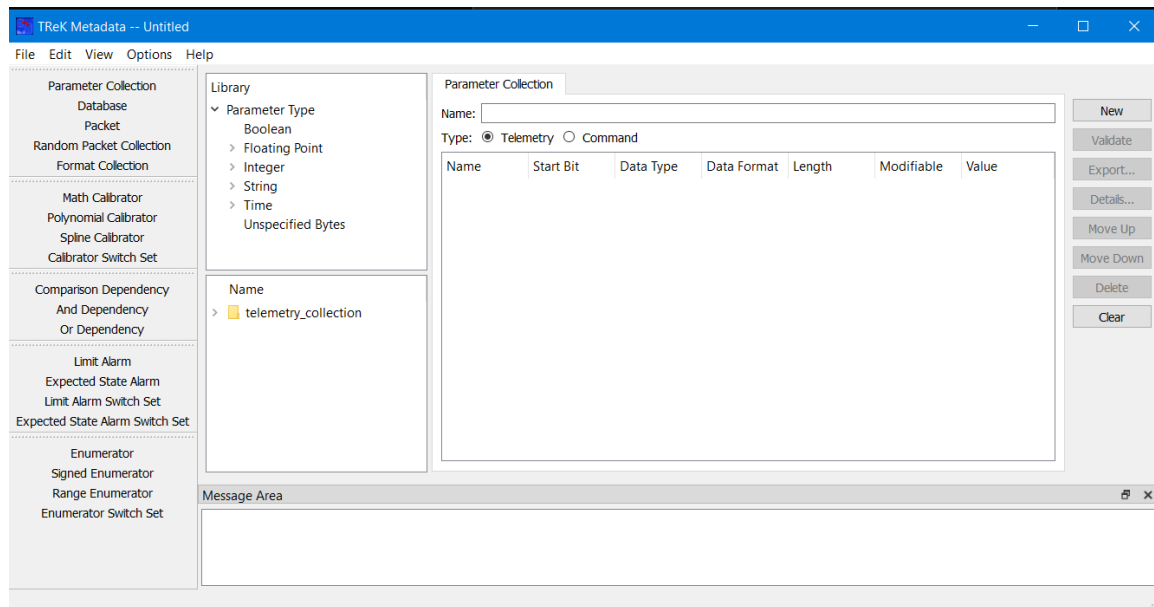


Figure 6 Metadata Main Window

2. Start by entering a name for the Parameter Collection. In the Name field enter **Science Data**. After completing this step, the Main Window should look like the one shown in Figure 7.

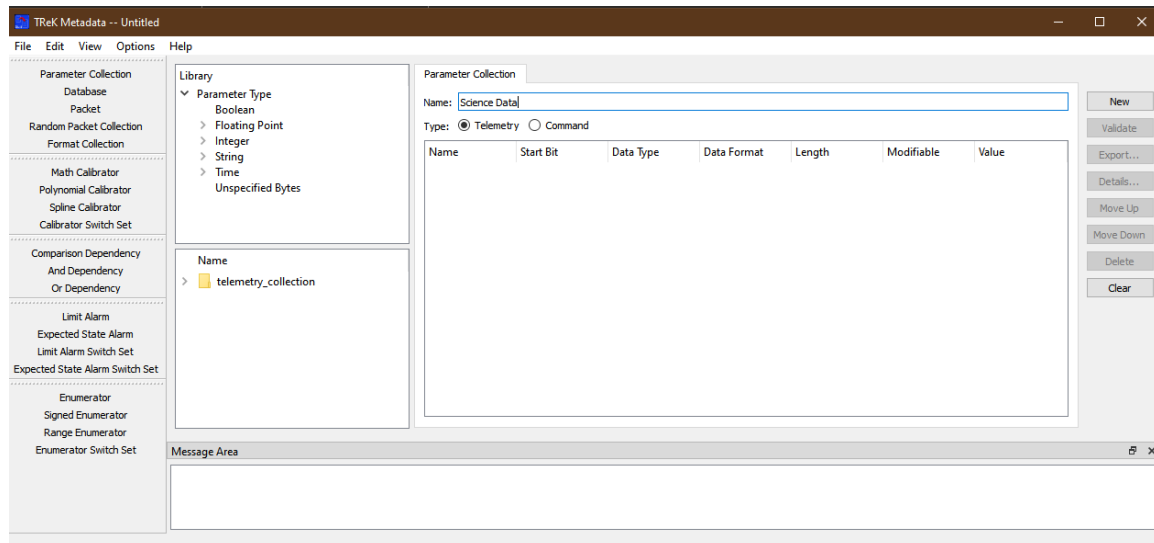
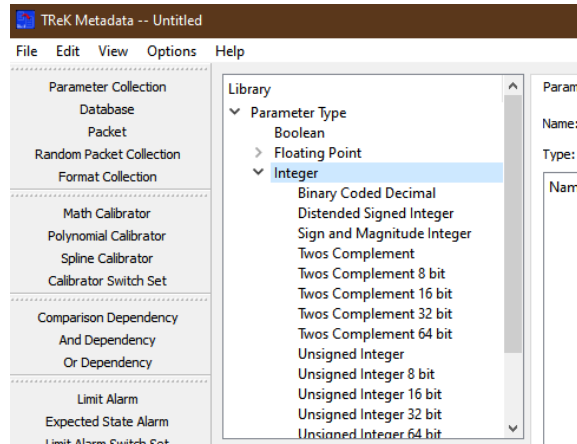


Figure 7 Parameter Collection Name - Science Data

3. Since you are creating a Telemetry Collection you need to ensure the Telemetry radio button is selected as shown in Figure 7.
4. The next step is to start adding parameters to the Parameter Collection. There are four parameters you need to add to the Parameter Collection. The Metadata application uses Drag and Drop to move items from the Library Area into the Work

Area. The first parameter you need to add to the Parameter Collection is a 16-bit unsigned integer. Go to the Library Area and click on the Integer item in the list so it expands as shown in Figure 8.

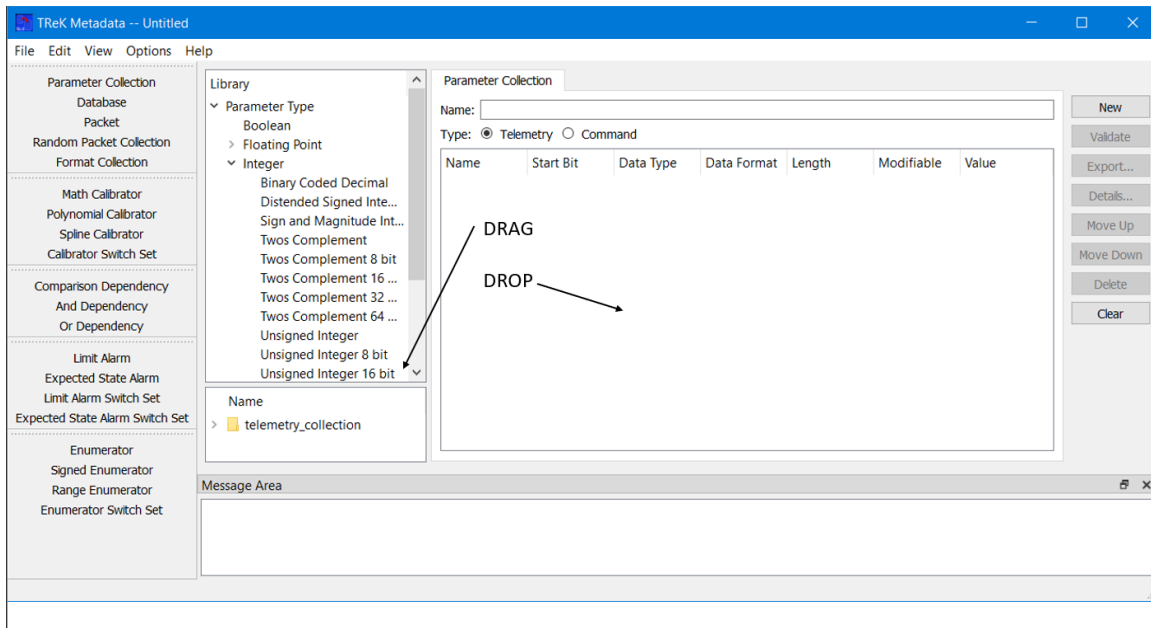


**Figure 8 Library Area Showing Integer Expanded**

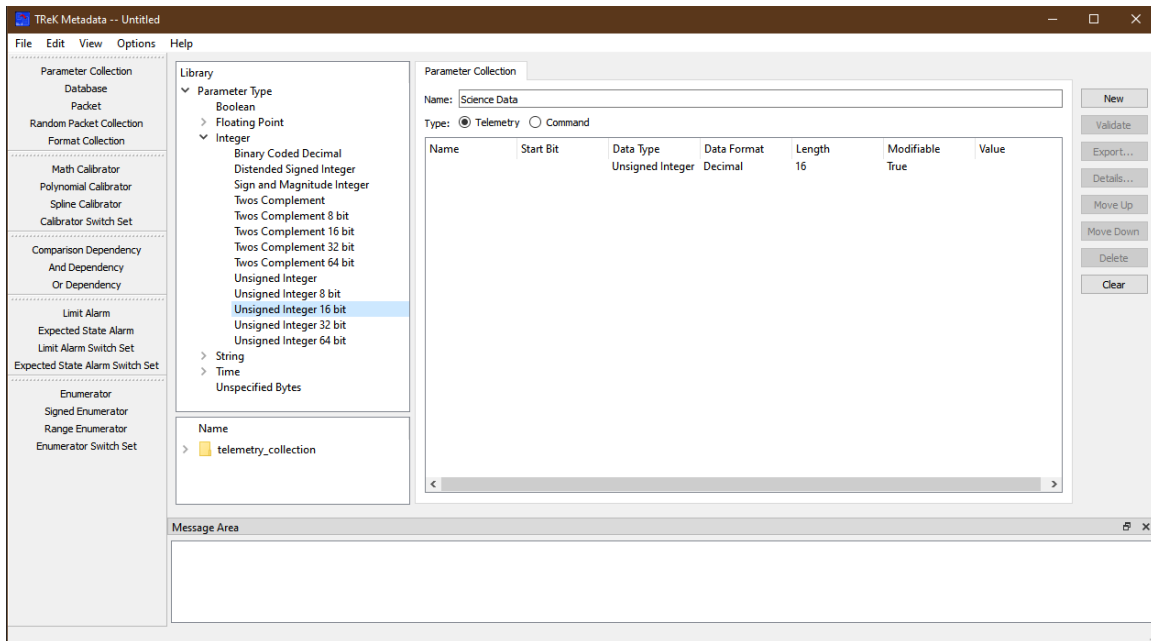
5. Use your left mouse button to select the Unsigned Integer 16-bit item in the list, and while holding the left mouse button down, drag the item to the Work Area and drop it as shown by the arrows in Figure 9. After dropping, you should see the parameter in the list as shown in Figure 10.

#### Collection Drag and Drop Tips and Tricks

- ❖ If you drop an item anywhere on the list, it will be placed at the end of the list.
- ❖ If you drop an item on top of another item, the item will be placed below that item in the list.

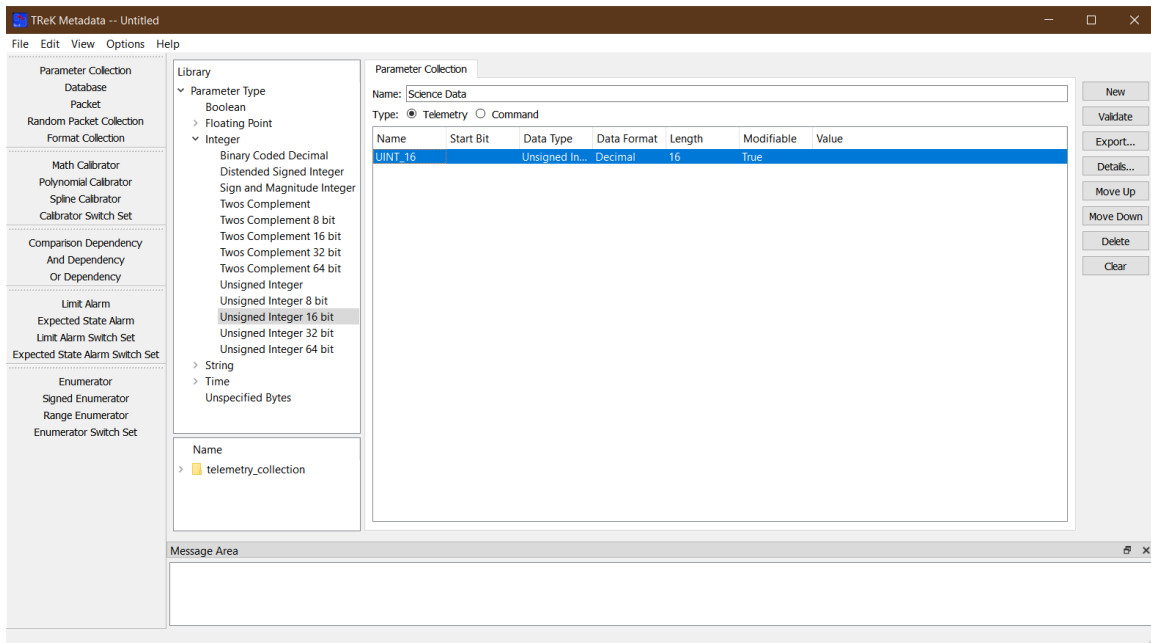


**Figure 9 Drag and Drop Areas for 16-Bit Unsigned Integer Parameter**



**Figure 10 16-Bit Unsigned Integer Parameter in List**

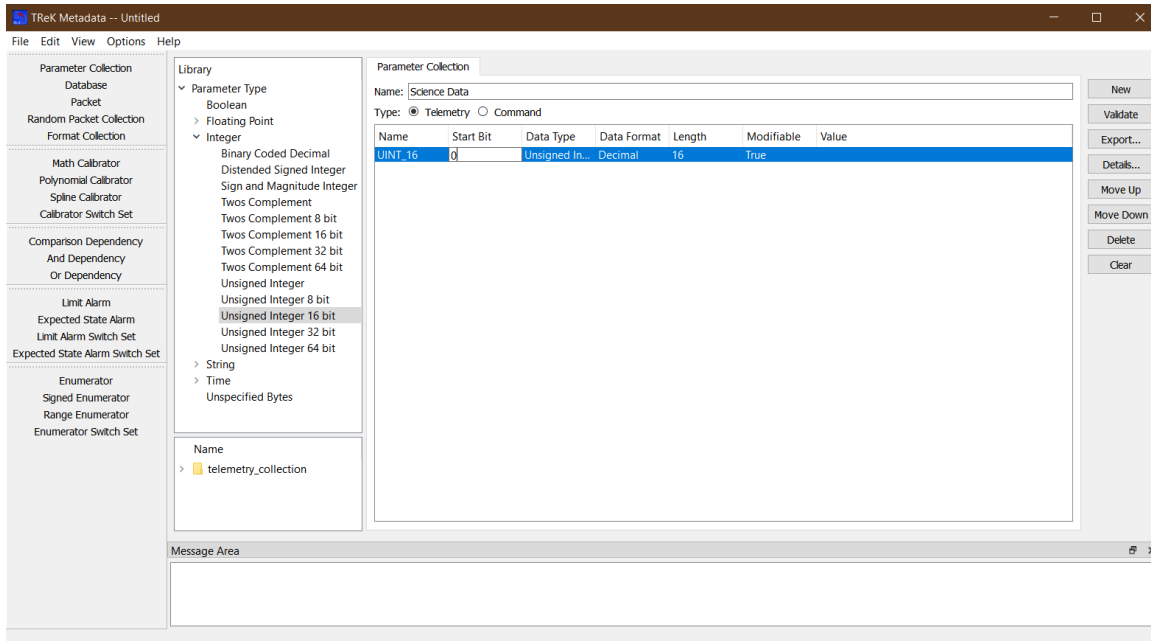
6. Now you need to fill in the information for the Parameter. Use your left mouse button to double click in the Name cell of the row in the list and then enter the name UINT\_16. When you are finished it should look like Figure 11.



**Figure 11 UINT\_16 Parameter Updated with Name**

Note: If the columns are not wide enough to display the text in the column, you can resize the columns by dragging the vertical bar next to the column name.

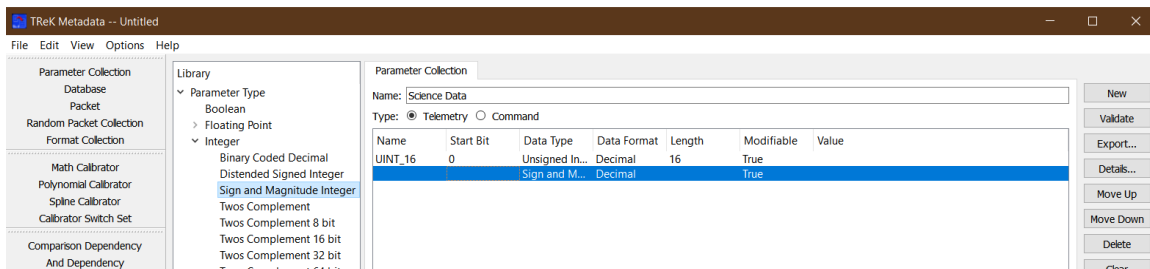
7. The next item to fill in is the Start Bit. Since this is the first parameter in the Parameter Collection, enter 0 for the Start Bit as shown in Figure 12.



**Figure 12 Start Bit of 0**

You have now completed entering the first parameter in the Parameter Collection. Now you need to perform the same steps for each of the remaining three parameters.

8. Notice that the Data Type, Data Format, and Length columns are already filled in for you. This is because you selected a specific parameter type from the Library that had a predefined length. A telemetry parameter is always considered modifiable. Since you are defining a telemetry packet, there is no need to specify a value. It will be extracted from the telemetry packet.
9. The second parameter in the list is a 32-bit Sign and Magnitude Integer. Find the Sign and Magnitude Integer in the Library and drag and drop it into the list. Depending on where you drop it in the list the item may end up as the first item in the list instead of the second item in the list. No worries. Just select the 32-bit Sign and Magnitude Integer in the list and push the Move Down button to move it to the second position in the list. The Main Window should look like the one in Figure 13.



**Figure 13 Sign and Magnitude Integer**

10. As before, edit the row to enter the name (INT\_32), the Start Bit (16), and the Length (32). Once you are done your list should look like the one in Figure 14.

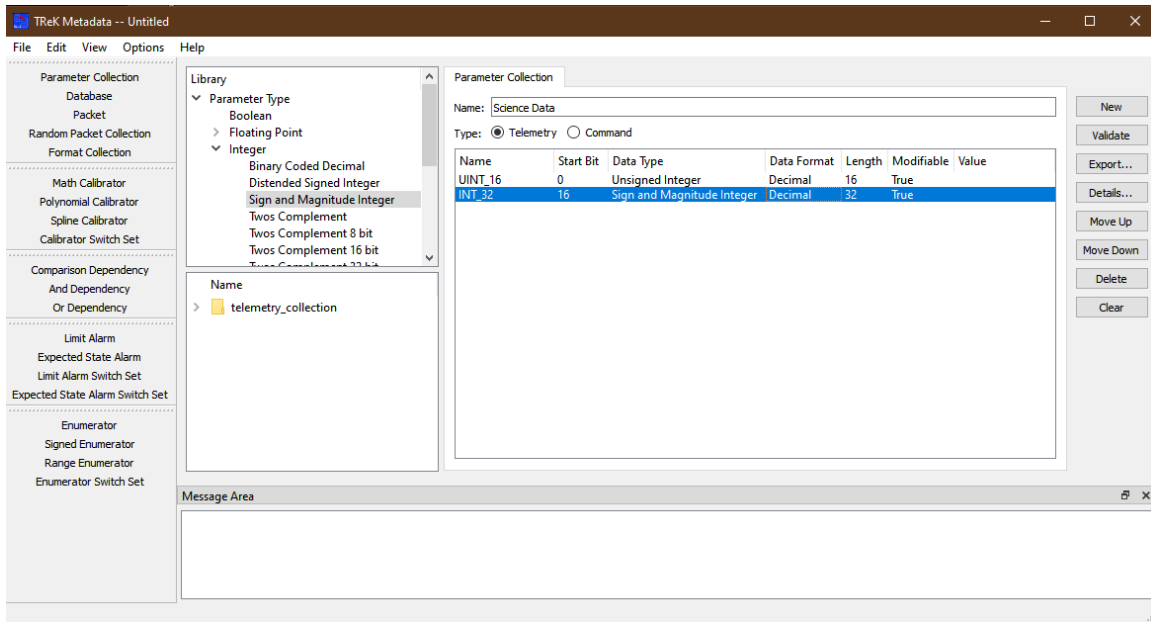


Figure 14 Sign and Magnitude Parameter

11. The third parameter in the list is a 64-bit Floating-Point parameter. Expand the Floating-Point item and look for 64-bit IEEE Floating Point item. Drag and drop the item in the list and edit the row to enter the name (FEEE\_64) and the start bit (48). The Main Window should look like the one in Figure 15.

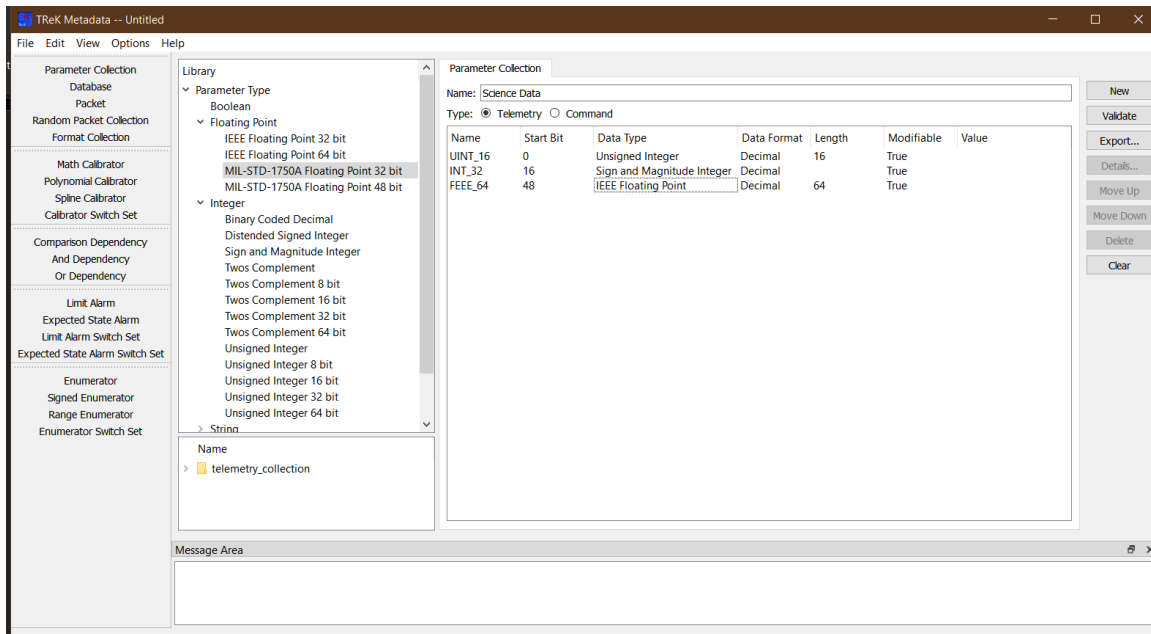
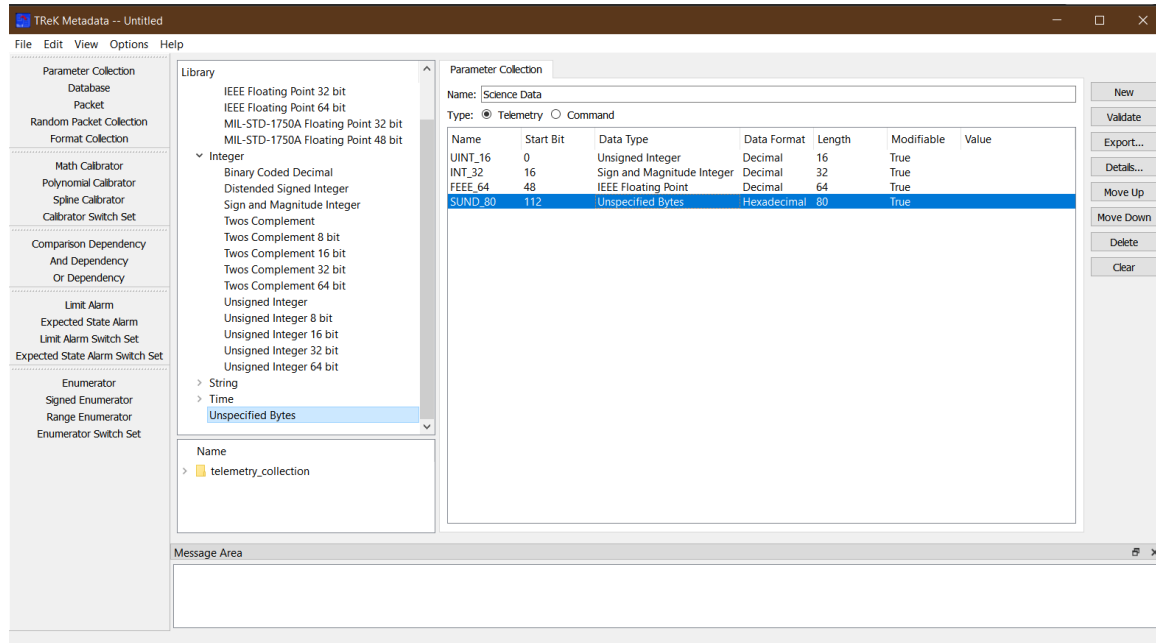


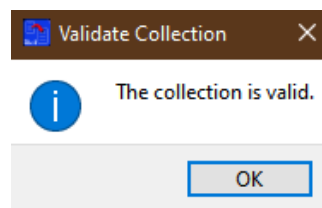
Figure 15 IEEE Floating Point Parameter

12. The fourth parameter in the list is an undefined string that is 80 bits (10 bytes) long. Find the Unspecified Bytes parameter and drag and drop it in the list. Edit the row to enter the name (SUND\_80), the start bit (112), and the length (80). The Main Window should look like the one in Figure 16.



**Figure 16 Undefined String Parameter**

13. In order to use the new Parameter Collection in a packet, you need to export the Parameter Collection so it is saved in a file. Before you export, it is always a good idea to validate to be sure everything is correct. Push the Validate button. You should see a dialog like the one shown in Figure 17.

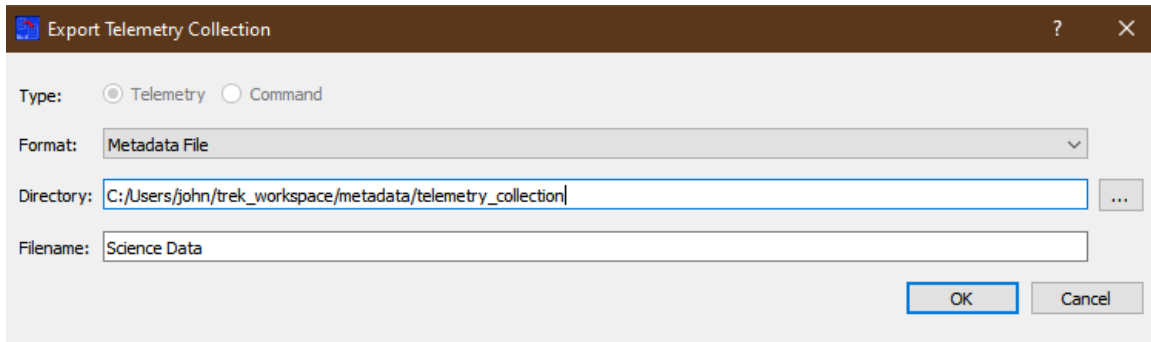


**Figure 17 Validate Collection Dialog**

Note: If there are errors, please check your entries to be sure they match the information in the tutorial.

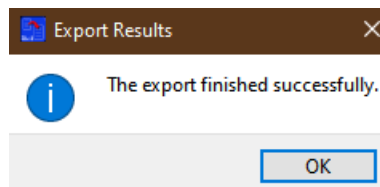
14. Now that you know the collection is valid, push the Export button to export the Parameter Collection. You should see the dialog shown in Figure 18. Notice that

the Filename defaults to the collection name and the default location is the telemetry\_collection directory in the trek\_workspace.



**Figure 18 Export Telemetry Collection Dialog**

15. In the Export Collection dialog, push the OK button to perform the Export. You should see the message in Figure 19. Push the OK button in the message dialog and both the message dialog and the Export dialog will close. Once the Export dialog closes a message will appear in the Main Window message area and the Science Data collection will be listed in the Telemetry Collection list in the Library Area.



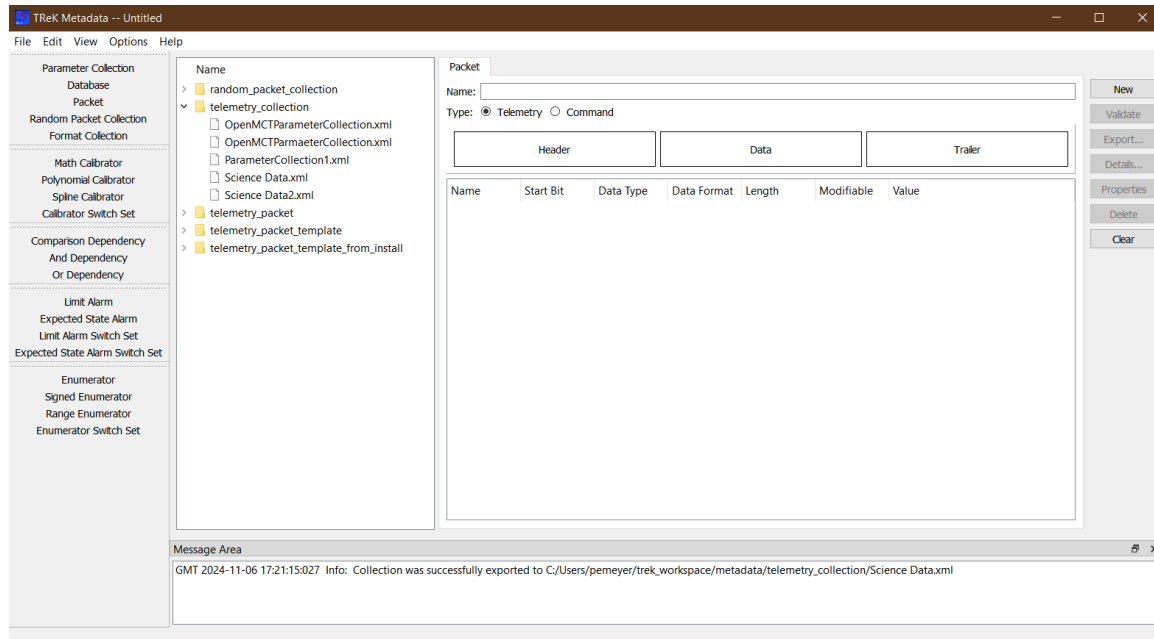
**Figure 19 Export Successful Message**

Congratulations – you have successfully created your first Parameter Collection.

# Create a Packet

## 5.2 Create a Packet

This section will cover how to create a packet. If you haven't moved to the Packet tab yet, please push the **Packet** button in the Main Window toolbar so your Main Window looks like the one in Figure 20.



**Figure 20 Main Window with Packet Selected**

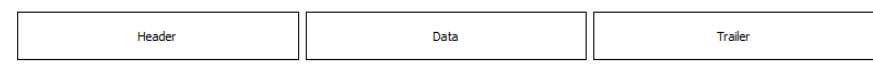
As shown in Figure 21, the goal of this tutorial is to create a CCSDS packet. A CCSDS Packet has a CCSDS Header and a specific set of Packet Attributes. You could create the packet from scratch. However, it is much easier to use a packet template and save yourself some work. TReK provides a set of predefined packet templates. These are listed under “telemetry\_packet\_template\_from\_install” and “command\_packet\_template\_from\_install”. A packet template is a packet that includes pre-populated zones and packet attributes corresponding to the specific type of packet. For example, a CCSDS packet template contains a CCSDS Header and the following packet attributes: a Counter parameter, an APID Identifier, a Length parameter, and a Timestamp Parameter. By using a template, you can start your packet definition with all that information already defined.



**Figure 21 CCSDS Packet**

The Main Window Library Area is configured to provide access to items you can use to create a packet. In the middle of the Main Window, the Packet tab provides a place to define the details of your packet. On the right-hand side of the Main Window the buttons provide various capabilities applicable to the Packet you are working on.

Notice the rectangle that contains three smaller rectangles with one for each zone of the Packet (Header, Data, and Trailer) as shown in Figure 22.



**Figure 22 Packet Drop Zones**

These rectangles are “Drop” zones. The large rectangle is a drop zone for the Entire Packet. If you drop a Packet Template or a Packet on the large rectangle, this will populate the entire Packet. If you drop a Packet or a Parameter Collection on one of the individual packet zones, that zone of the Packet will be updated. The drop zones will highlight so you can verify you are dropping the item in the correct location. Figure 23 shows what the “Entire Packet” drop zone looks like when it is highlighted. Figure 24 shows what the “Data Zone” drop zone looks like when it is highlighted.

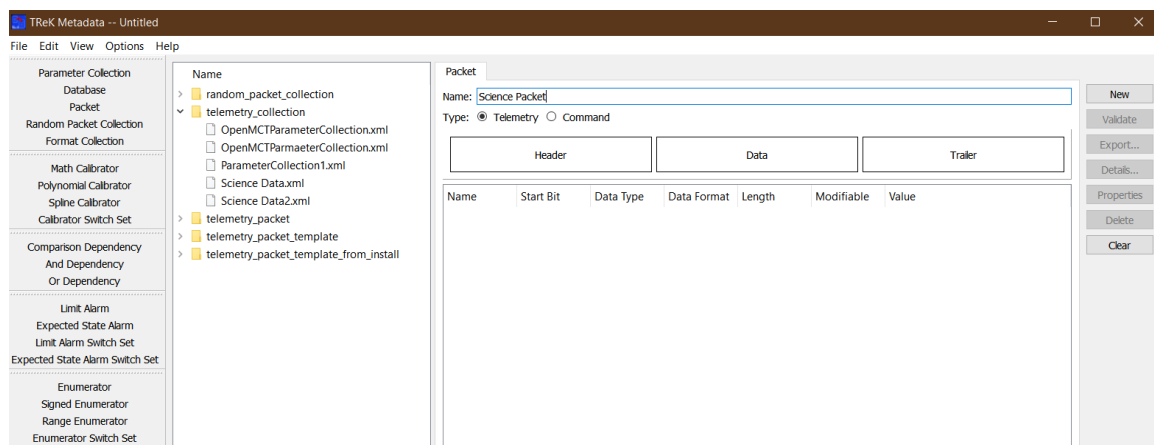


**Figure 23 Entire Packet Drop Zone Highlighted**



**Figure 24 Data Zone Drop Zone Highlighted**

16. To get started, first enter **Science Packet** in the **Name** field as shown in Figure 25.



**Figure 25 Packet Tab with Name Populated**

17. Since the packet is a Telemetry Packet, ensure the Type is set to Telemetry as shown in Figure 25.

18. In the Library Area, ensure the “telemetry\_packet\_template\_from\_install” item is expanded to show the list of templates as shown Figure 26. Your list may vary based on the release version of TReK.

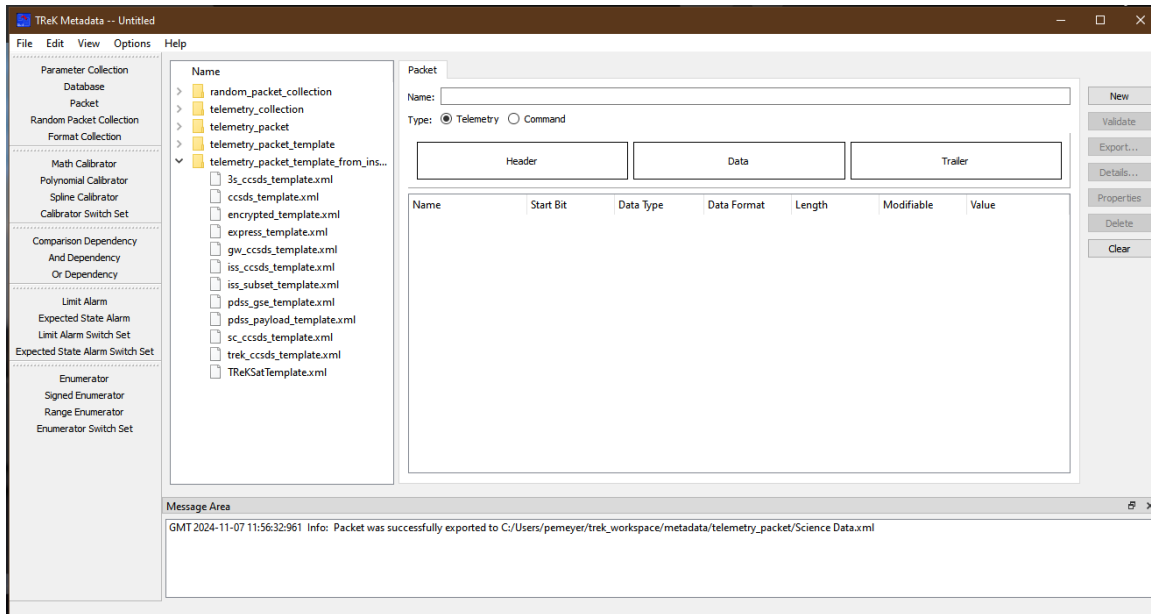


Figure 26 Telemetry Predefined Packet Template List Expanded

19. In the Library Area, you may see several “CCSDS” related packet templates. Some projects use a standard header. For this tutorial, we will use a sample CCSDS Header. Select the `trek_ccsds_template` item under the “telemetry\_packet\_template\_from\_install” list using your left mouse button. Hold the left mouse button down and drag the item into the large rectangle – you should see it highlight the entire packet drop zone as shown in Figure 27. You must avoid dropping on the specific zone names. Once you see the highlight release the mouse button to drop the item. Once you drop the item your Main Window should look like the one in Figure 28. You can now see you have a packet with a CCSDS Header. Dropping in this specific area sets the template of the packet and auto-configures the properties of the packet.

Note: If by chance it did not drop into the location you intended, you can push the **New** or **Clear** button to clear the packet and start over.

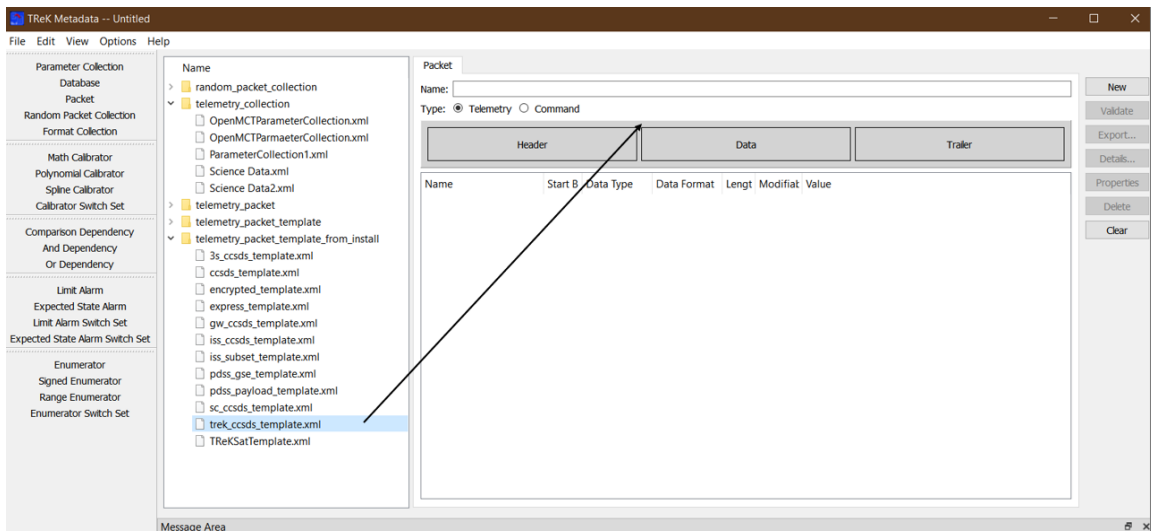
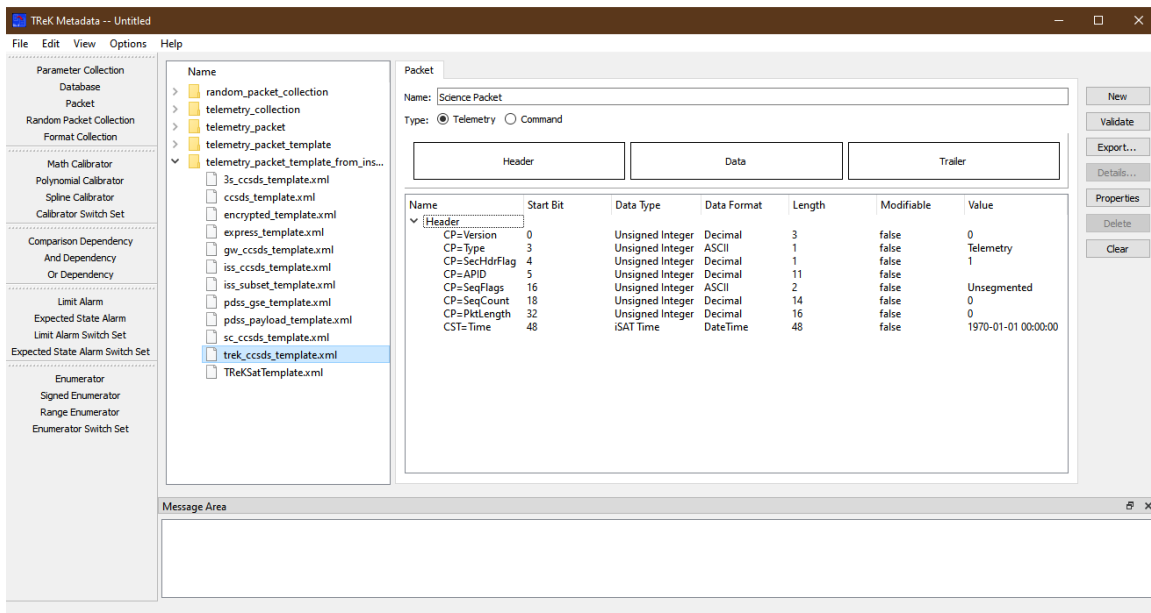
Figure 27 Entire Packet Drop Zone Highlighted

Figure 28 trek\_ccsds\_template Packet

20. To see that the Packet Attributes are already defined by the Packet template, push the **Properties** button to display the **Packet Properties dialog** as shown in Figure 29. If you look through the tabs in the dialog, you will see it has a Counter parameter, an APID identifier, a Length parameter, and a Timestamp parameter. Go to the Identifiers tab and set **Has Expected Value** to **true** and **Expected Value** to **314** as shown in Figure 30. Identifiers are used to identify incoming

data so the expected value of 314 must be entered for the APID. Push the OK button to close the Packet Properties dialog and save this change.

Packet Properties

☒ Counter

Parameter: CP=SeqCount Browse...

Zone: Header

Start Count: 0

Forward Count: True

Minimum Count: 0

Maximum Count: 16383

Reset Value: 0

Attributes | Checksum | Counter | Description | Identifiers | Length | Time Stamp

OK Cancel

**Figure 29 Packet Properties Dialog**

Packet Properties

☒ Identifiers

| Name    | Zone   | Type    | Has Default Value | Default Value | Has Expected Value | Expected Value | Parent Start Bit |        |
|---------|--------|---------|-------------------|---------------|--------------------|----------------|------------------|--------|
| CP=APID | Header | Content | false             |               | true               | 314            | 0                | +<br>- |

Attributes | Checksum | Counter | Description | Identifiers | Length | Time Stamp

OK Cancel

**Figure 30 Packet Properties Dialog (Identifiers Tab)**

20. Now it's time to add the Science Data collection you created in the Data Zone of the packet. In the Library Area, be sure the Telemetry Collection item is expanded so you can see the list as shown in Figure 31.

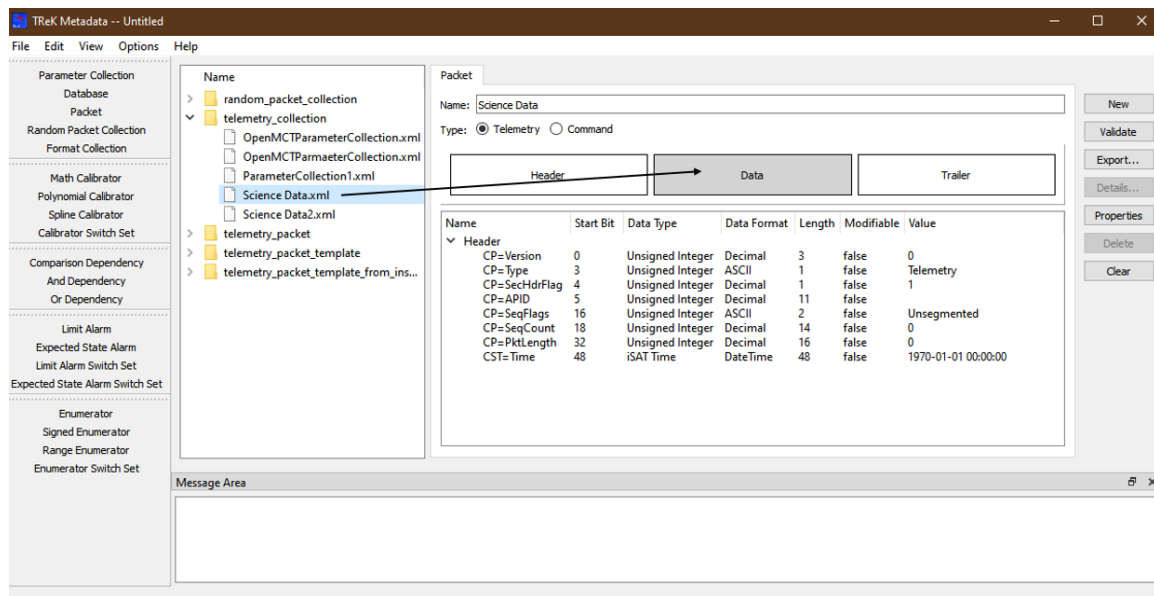


Figure 31 Telemetry Collection List Expanded

21. In the Library Area, select the Science Data item and drag and drop it over the “Data” Drop Zone. Remember to look for the Data rectangle to highlight so you know that you are dropping it in the right location. Your Main Window should look like the one in Figure 32.

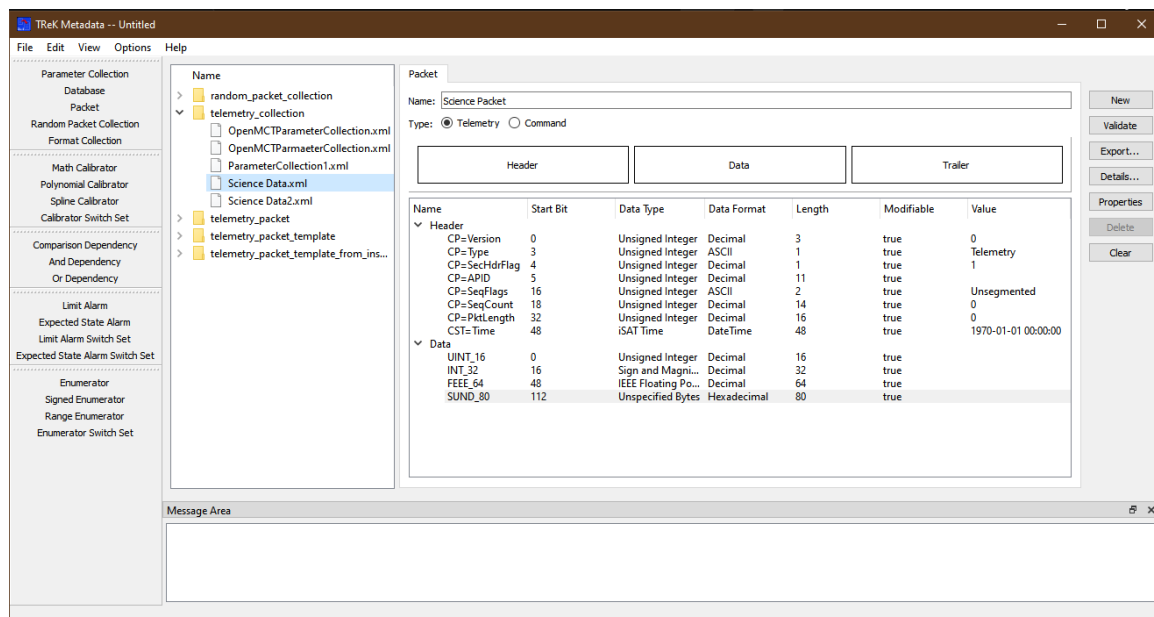


Figure 32 Science Data Collection in Data Zone

22. There is one more step to finish the packet definition. Since this is a unique packet definition, you will set the CCSDS Application Identifier (APID) to give

the packet a unique number. The **APID** parameter is the fourth parameter in the list of parameters in the Header. Double click in the **Value** cell of the **APID** row and enter the number **314**. Your Main Window should look like the one shown in Figure 33.

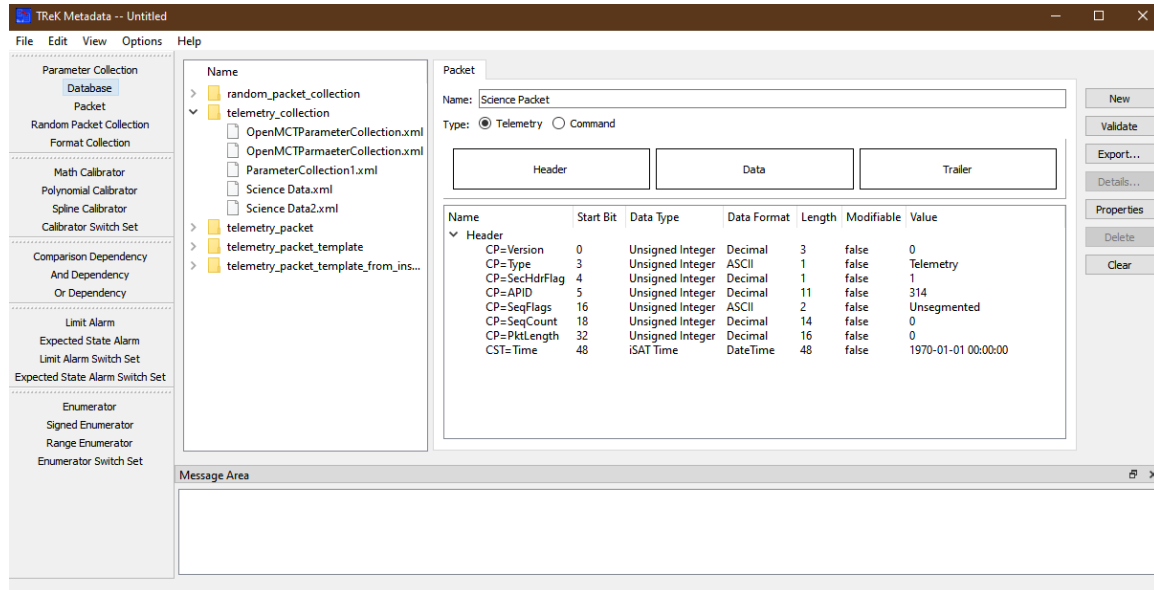


Figure 33 Packet with APID Value Set to 314

23. As before, it is always a good idea to Validate your packet definition. Push the **Validate** button and you should see the Validate dialog as shown in Figure 34.

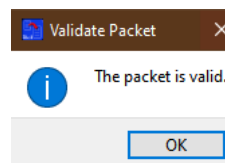
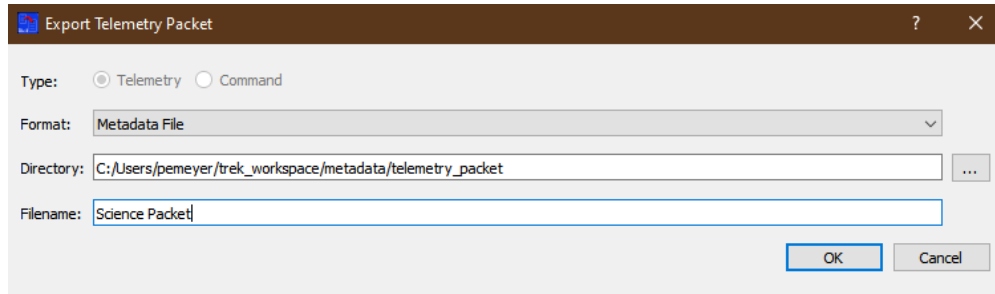


Figure 34 Packet Validate Dialog

24. Now that you know the packet is valid, push the Export button to export the Packet. You should see the dialog shown in shown in Figure 35. Notice that the filename defaults to the packet name and the directory defaults to the telemetry\_packet directory in the trek\_workspace.



**Figure 35 Export Telemetry Packet Dialog**

25. In the Export Packet dialog, push the OK button to perform the Export. You should see the Export Results message dialog showing the export was successful. Push the OK button to close the Export Results message and the Export dialog. Once the Export dialog closes you should see a message in the Main Window indicating the export was successful and the Science Packet will be listed in the Telemetry Packet list in the Library Area.

Congratulations – you have successfully created your first Packet!

You have completed all the tasks you need to perform with the Metadata Application so you can exit the application. You don't need to save the configuration since you have exported all changes to the disk.

## Packet Data Flow

### 5.3 Packet Data Flow

This section will show you how you can use the packet definition you created with the TReK Data application to receive and process Packet 314 data.

26. Go to the operating system's menu to start the **TReK Data** application. You should see the **TReK Data** main window shown in Figure 36.

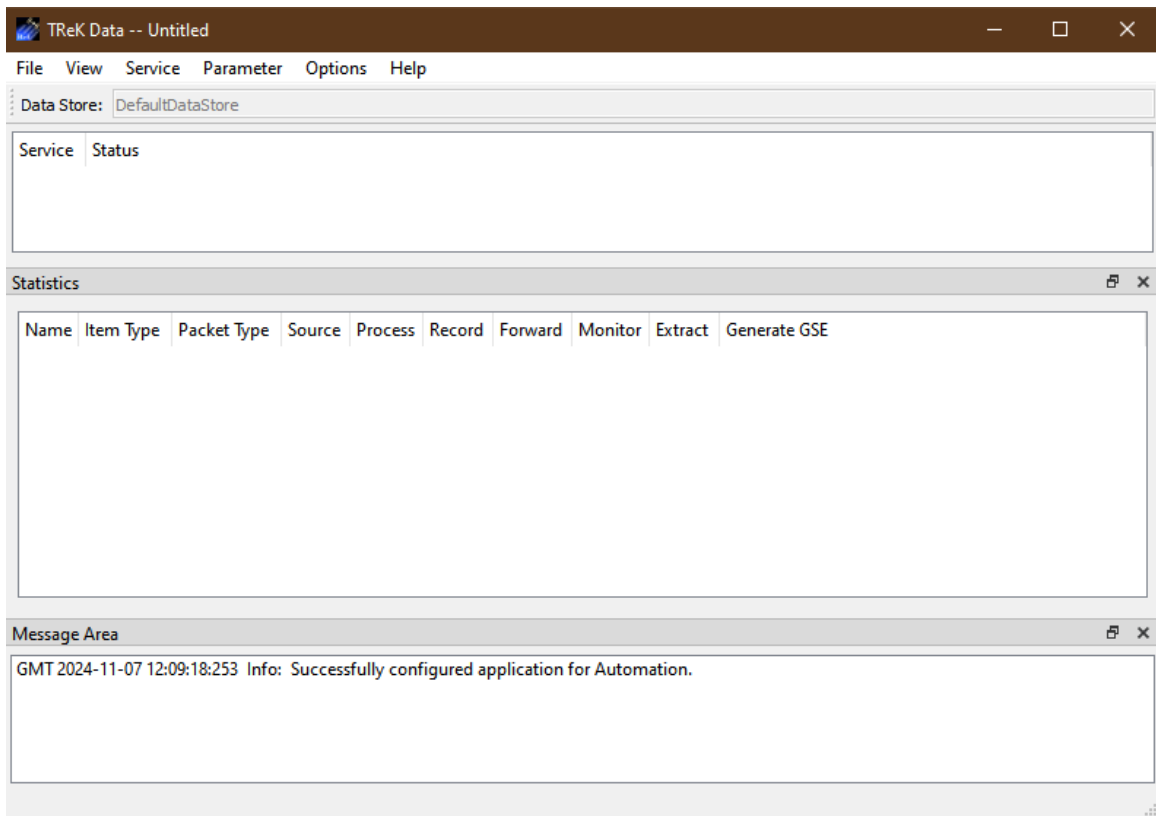


Figure 36 TReK Data Main Window

27. Go to the **Service** menu and select **Add Service**. You should see the dialog shown in Figure 37.

The image shows a software window titled "Add Service". At the top, there is a "Service Name:" label followed by an empty text input field. Below this is a tabbed interface with tabs labeled "Data Source", "Data Description", "Process", "Record", "Forward", "Monitor", "Extract", and "Generate". The "Data Source" tab is currently selected. Under this tab, there is a "Communication Type:" label with a dropdown menu showing "UDP". Below the dropdown are three sub-tabs: "General", "Queues", and "Decrypt". The "General" sub-tab is selected. Within the "General" sub-tab, there is a "Local Information" section containing two text input fields: "Local IP Address:" with the value "127.0.0.1" and "Local Port:" with the value "6100". To the right of the "Local IP Address:" field is a "Browse..." button. At the bottom right of the dialog are "OK" and "Cancel" buttons.

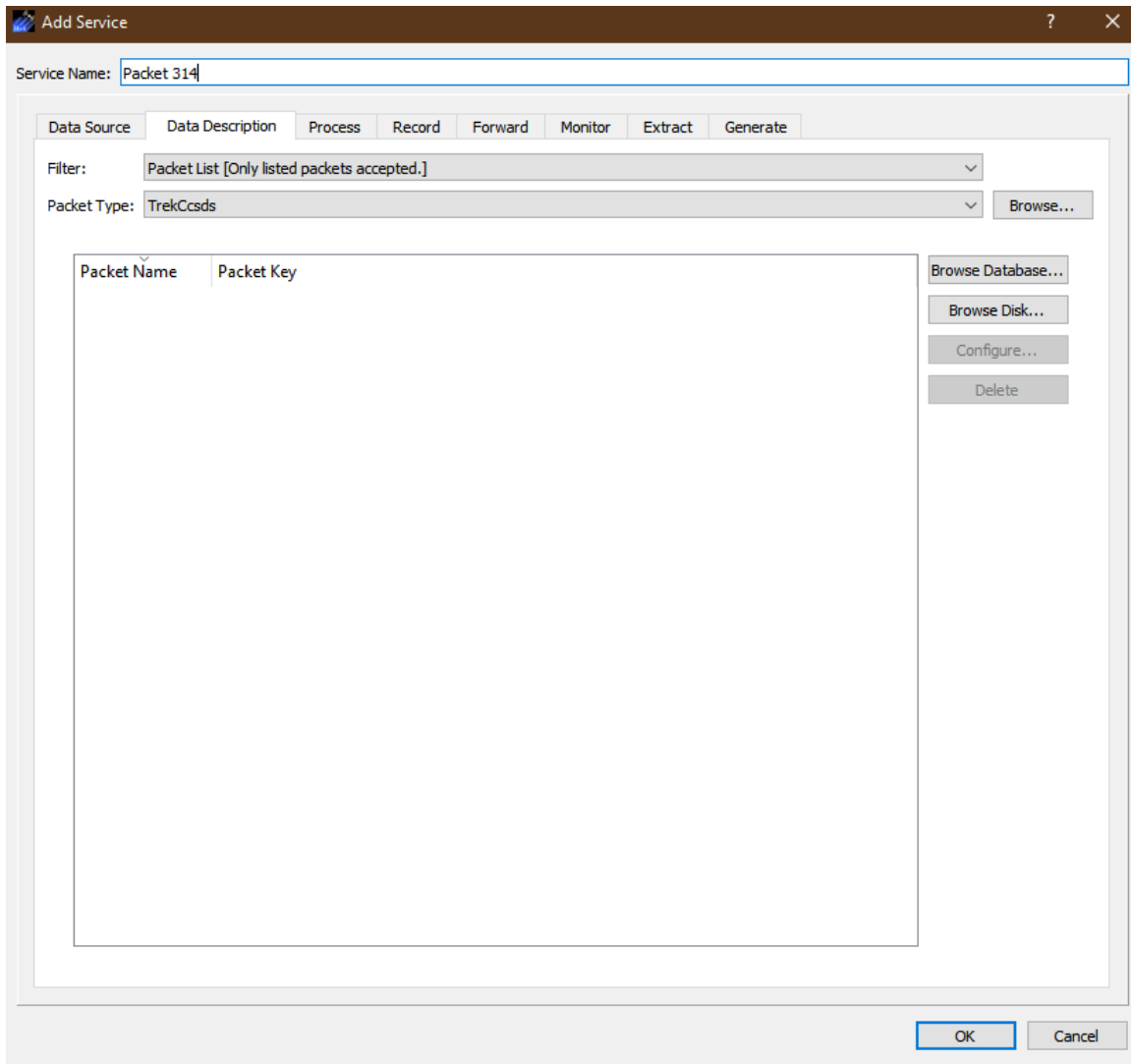
Figure 37 Add Service Dialog

28. In the **Add Service** dialog enter **Packet 314** in the **Service Name** field as shown in Figure 38. Enter the loopback address (127.0.0.1) in the **Local IP Address** field. All the other settings on this tab are set correctly.

The screenshot shows a window titled "Add Service". At the top, there is a "Service Name:" label followed by a text box containing "Packet 314". Below this is a tabbed interface with tabs labeled "Data Source", "Data Description", "Process", "Record", "Forward", "Monitor", "Extract", and "Generate". The "Data Source" tab is currently selected. Under the "Data Source" tab, there is a "Communication Type:" label with a dropdown menu showing "UDP". Below this is another set of tabs labeled "General", "Queues", and "Decrypt". The "General" tab is selected. In the "General" tab, there is a "Local Information" section. It contains two text boxes: "Local IP Address:" with the value "127.0.0.1" and a "Browse..." button to its right, and "Local Port:" with the value "6100". At the bottom right of the window are "OK" and "Cancel" buttons. The "OK" button is highlighted with a blue border.

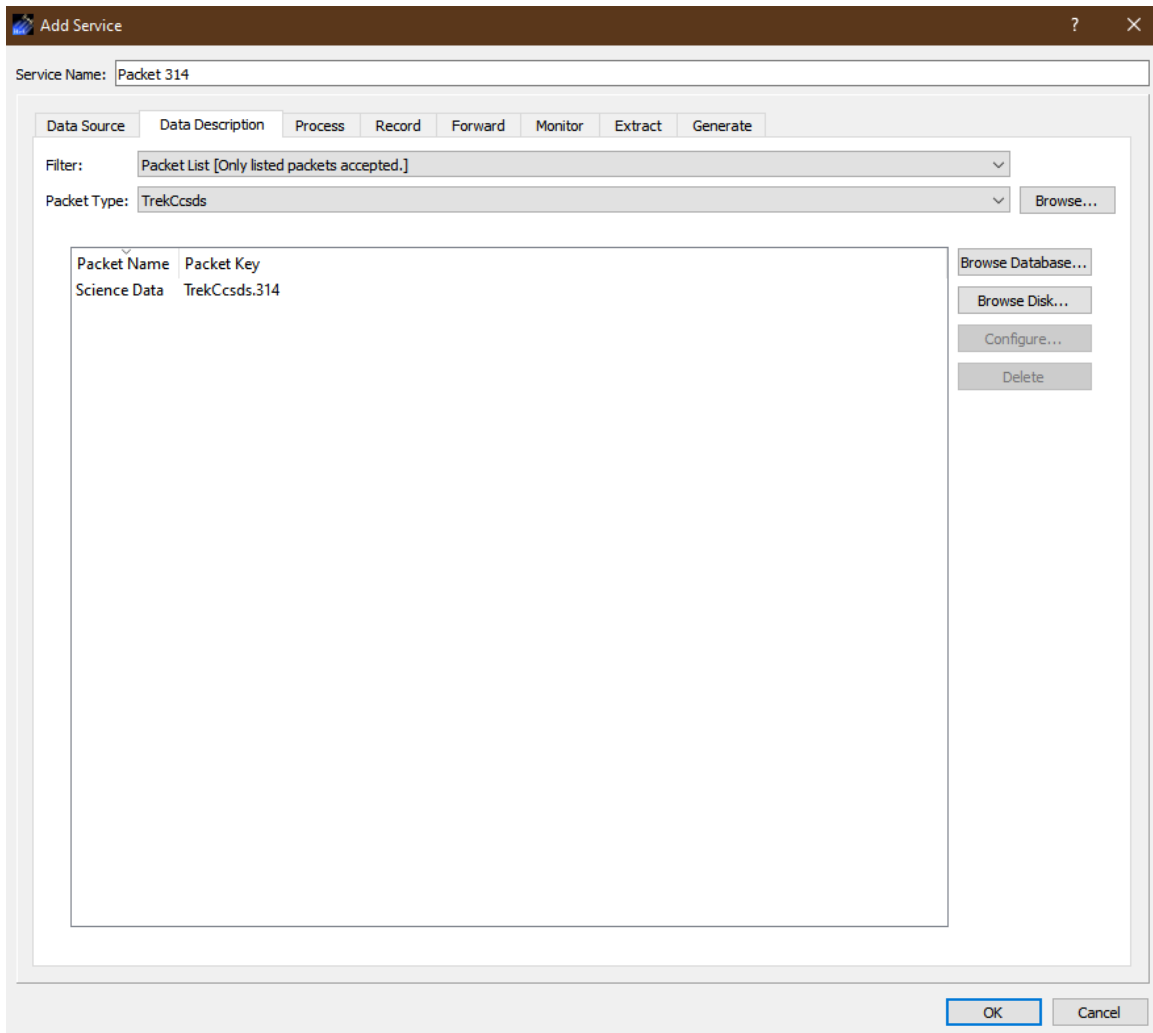
**Figure 38 Service Name Populated**

29. Go to the Data Description tab as shown in Figure 39. The Filter should be set to Packet List. Use the **Packet Type** menu to select **TrekCcsds**.



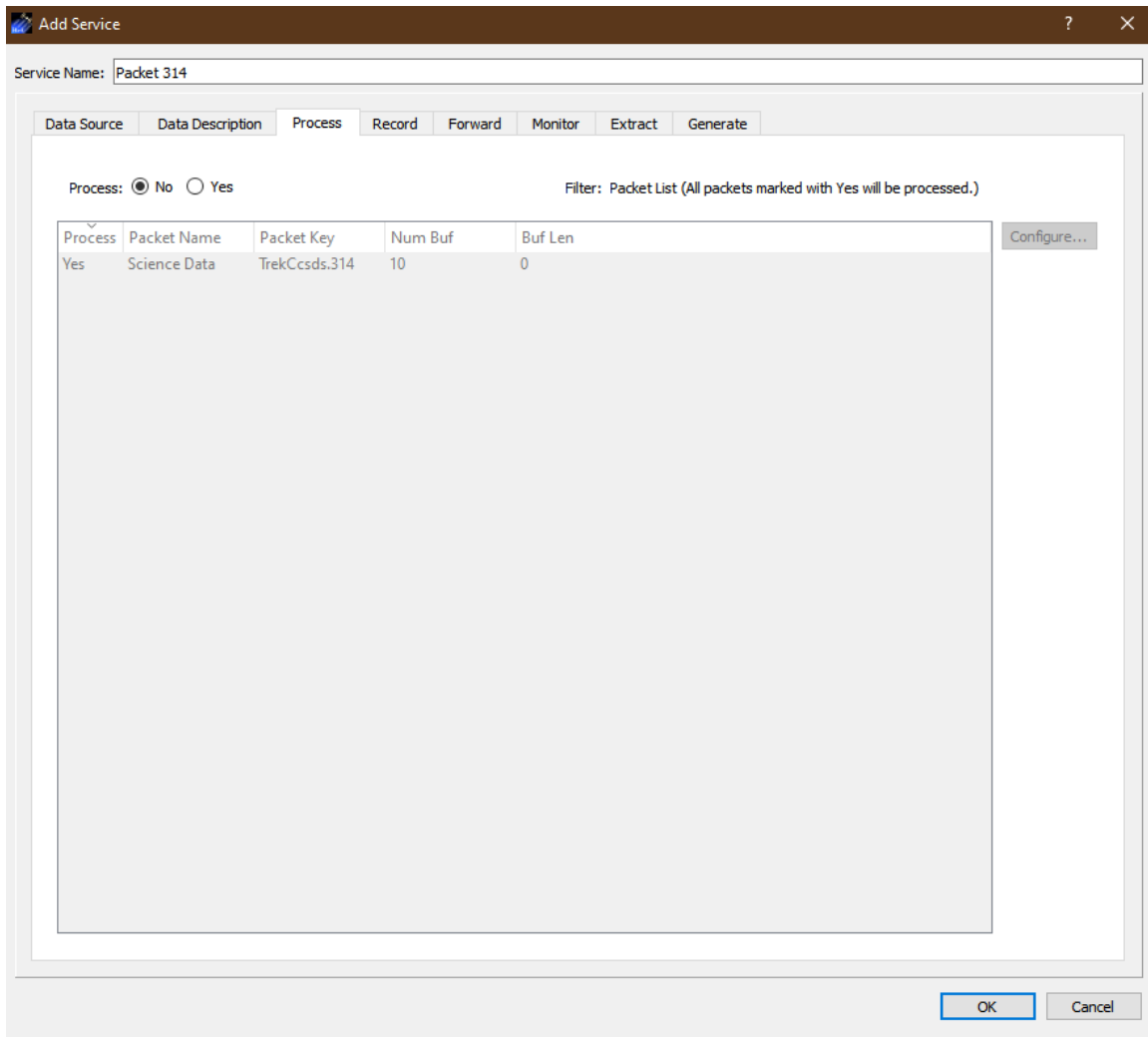
**Figure 39 Add Service Dialog Data Description Tab**

30. On the Data Description tab push the Browse Disk button. In the Open dialog that is displayed select the Science Packet.xml file and push Open. This will add the packet to the packet list and your dialog should look like the one in Figure 40.



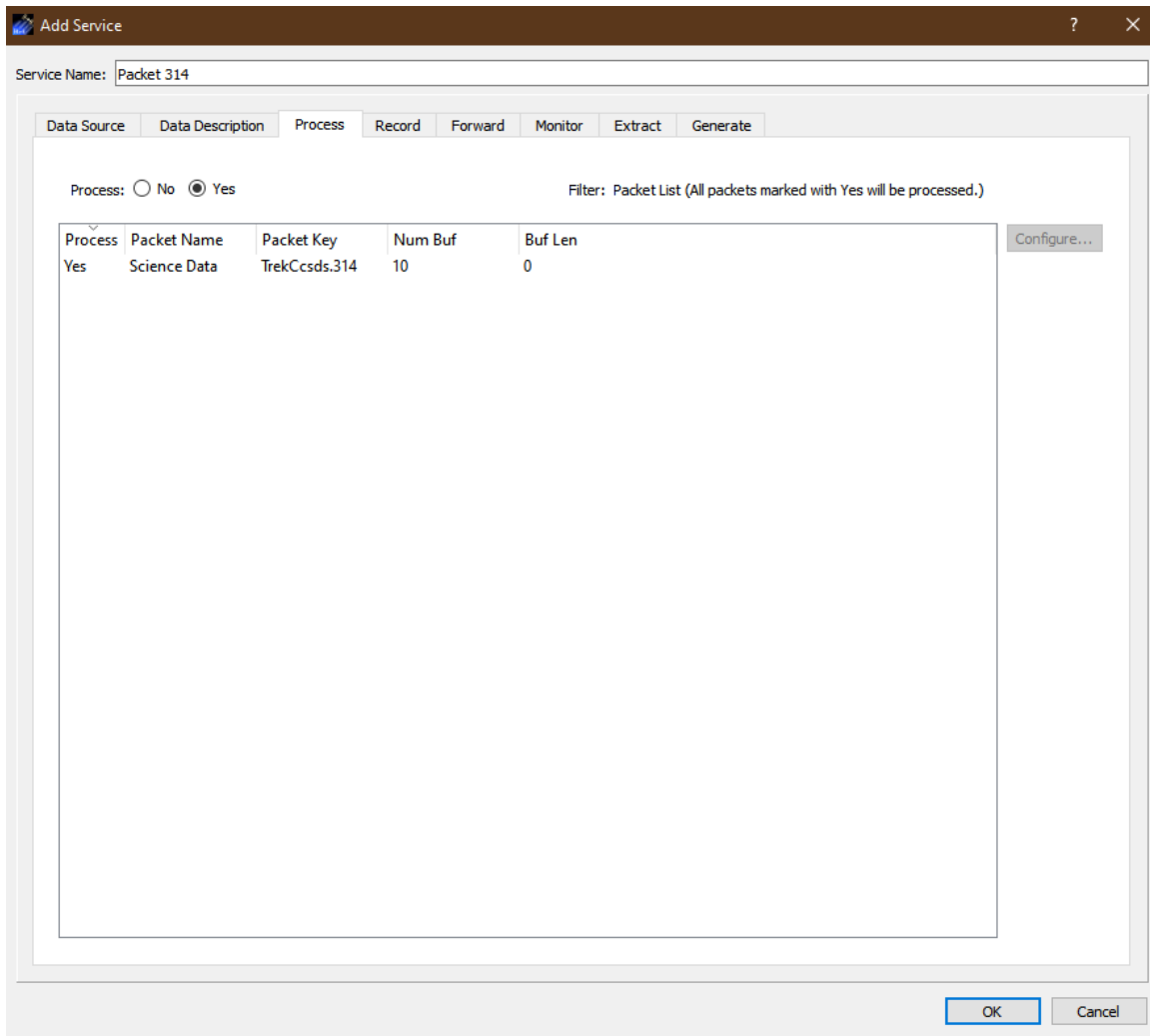
**Figure 40 Science Packet in Packet List**

31. Select the Process tab as shown in Figure 41.



**Figure 41 Process Tab**

32. In the Process tab, select the Yes radio button to indicate you want to process data when it arrives as shown in Figure 42.



**Figure 42 Process Tab with Process set to Yes**

33. Push the OK button in the **Add Service** dialog to close the dialog.
34. Select Packet 314 in the Main Window as shown in Figure 43.

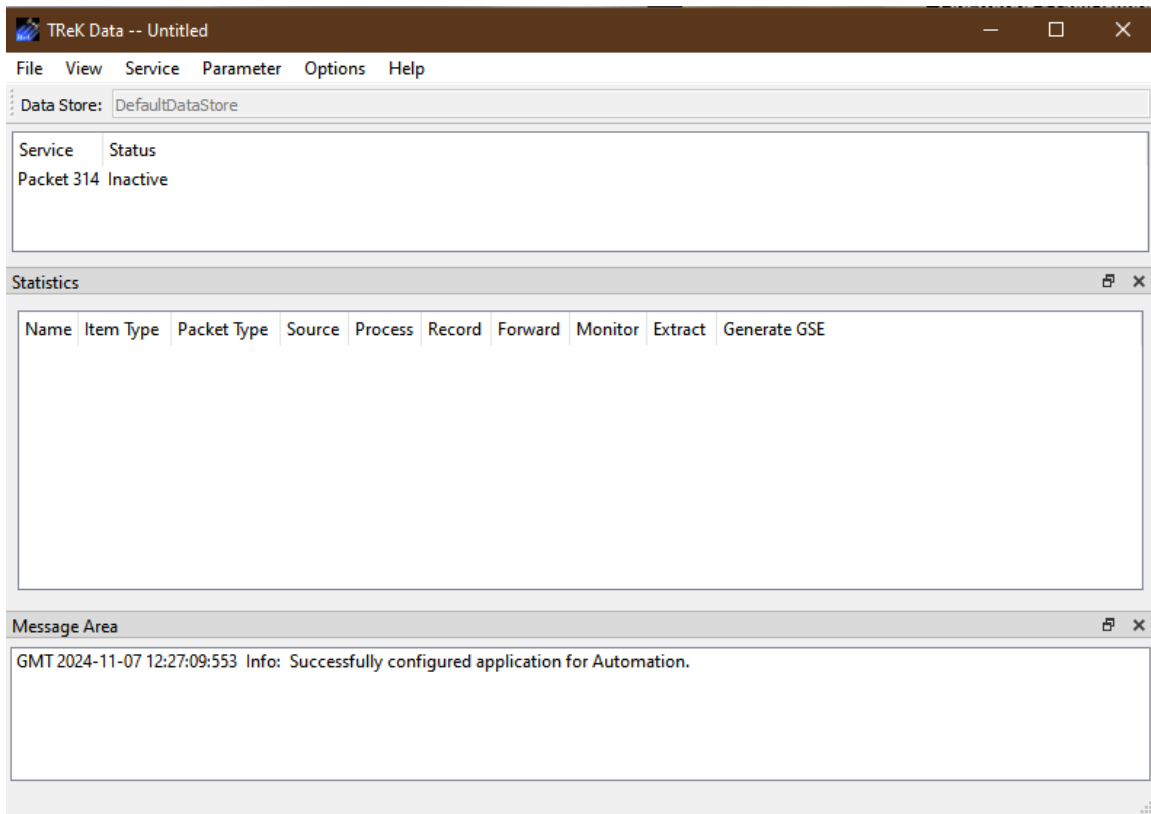


Figure 43 Packet 314 in the Data Main Window

35. With **Packet 314** selected, go to the **Service** menu and select **Activate Service**. Your Main Window should look like the one shown in Figure 44. Now you have everything configured to receive and process your packet.

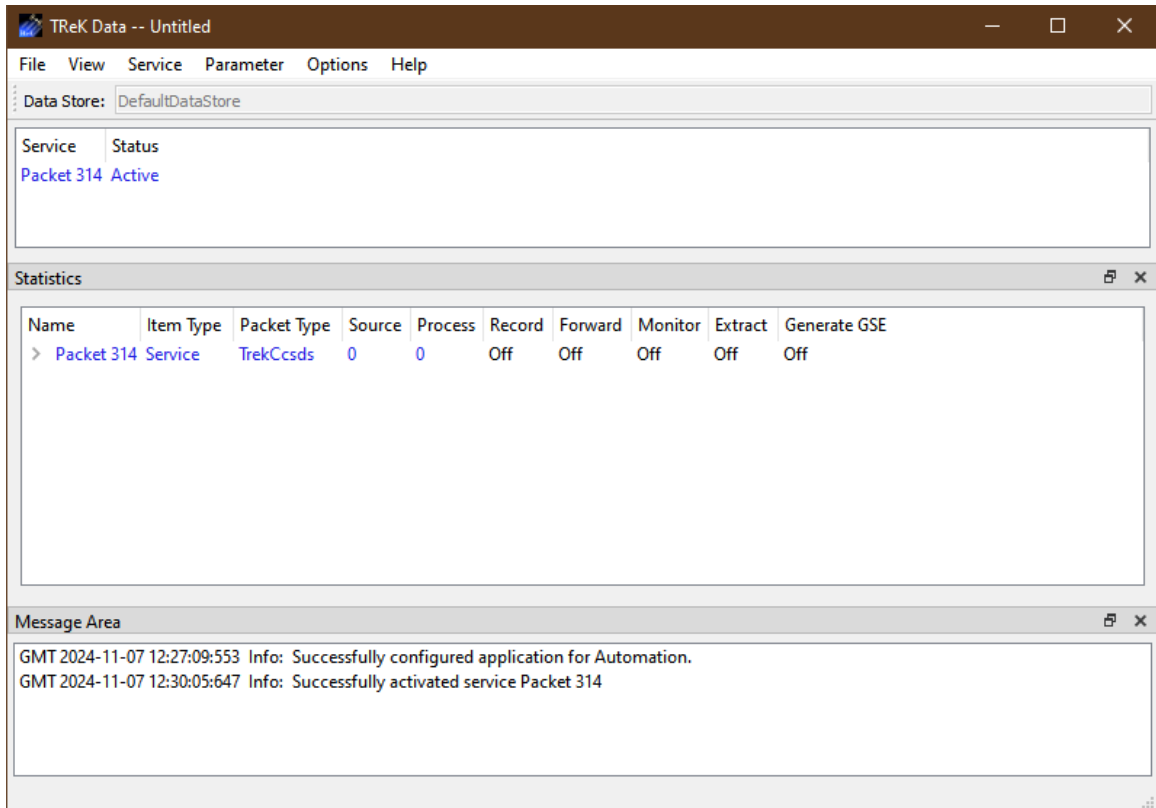


Figure 44 Packet 314 Activated

36. In the **Parameter** menu, select **Manage Displays**. You should see the dialog shown in Figure 45.

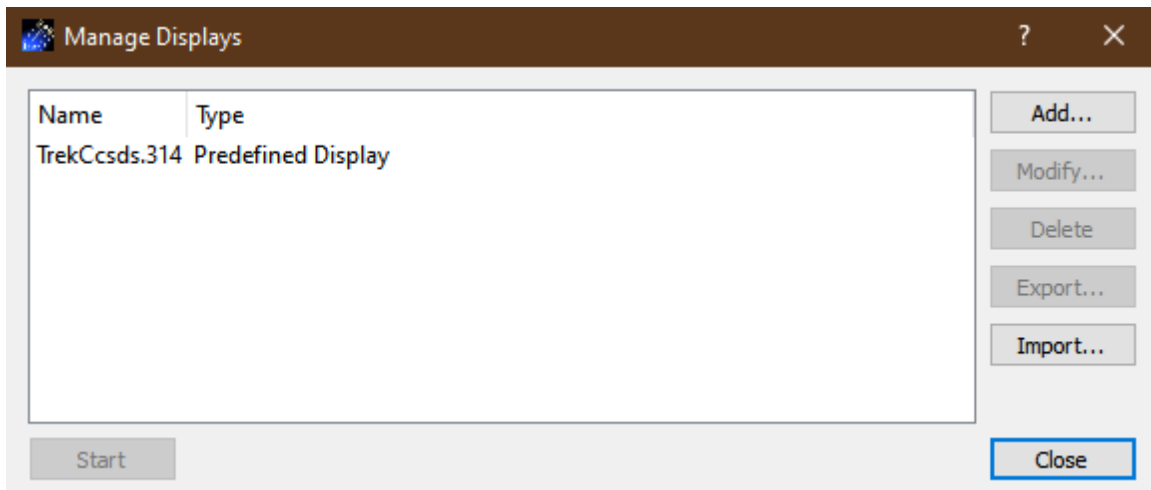


Figure 45 Displays Dialog

37. In the **Displays** dialog, select the **TrekCcsds.314** display and push the **Start** button. You should see the dialog shown in Figure 46. Now you have a display to see the processed data each time a packet is received. The Value and Status columns are empty because you have not received any data.

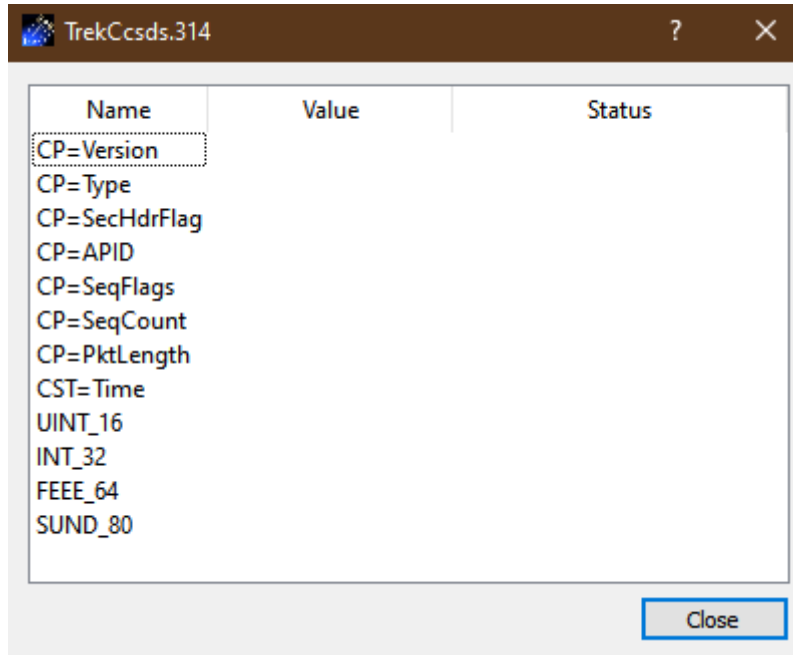
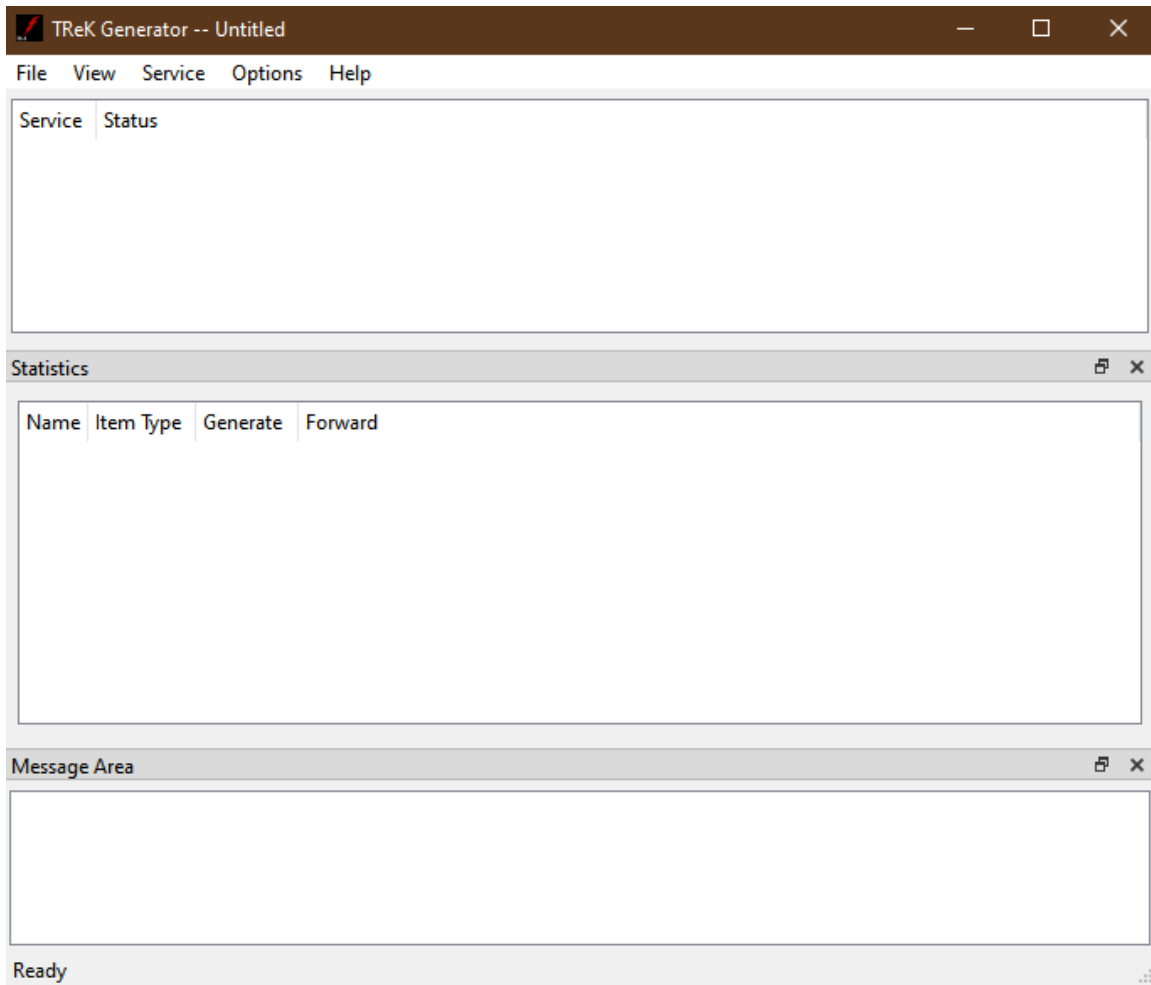


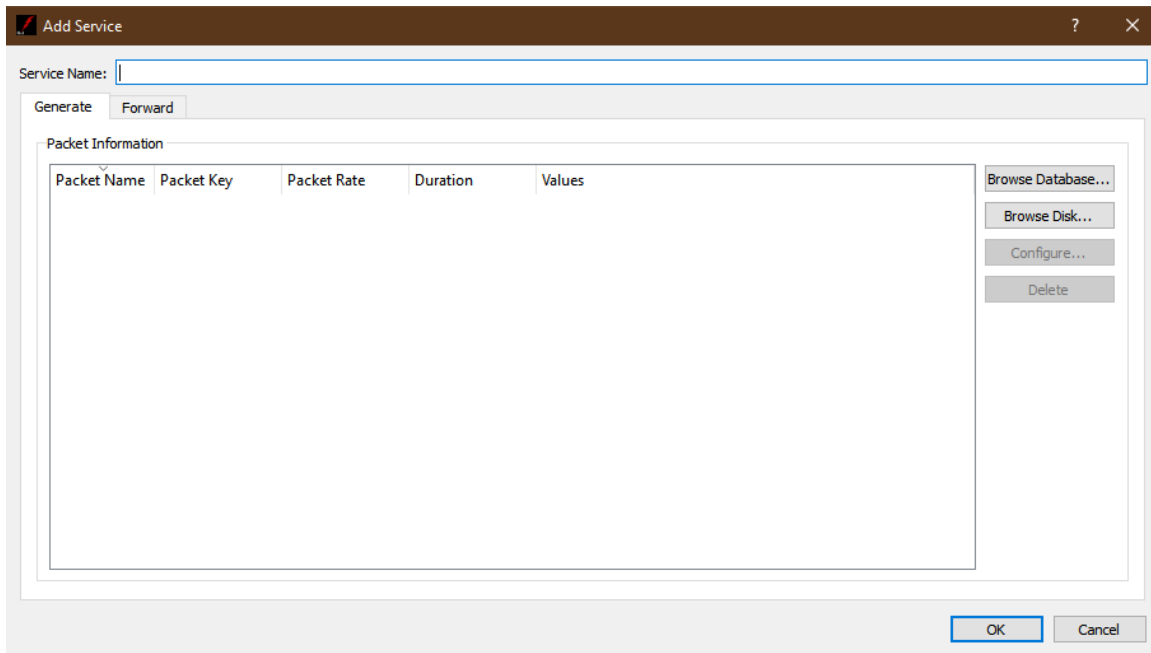
Figure 46 Science Packet Display

38. Now we need to flow some data. Go to the operating system's menu to start the **TReK Generator** application. You should see the Generator Main Window shown in Figure 47.



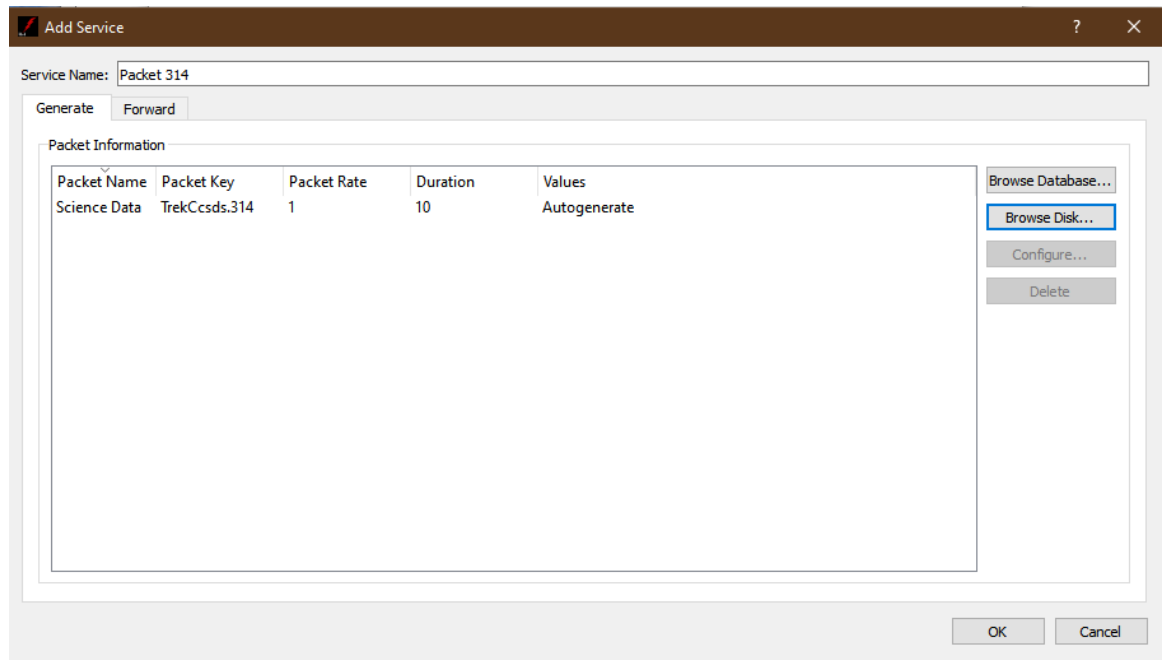
**Figure 47 Generator Main Window**

39. In the **Generator** application, go to the **Service** menu and select **Add Service**. You should see the dialog shown in Figure 48.



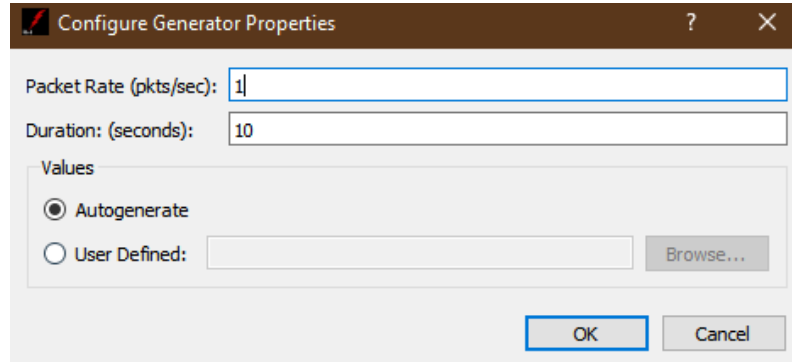
**Figure 48 Generator Add Service Dialog**

40. In the **Add Service** dialog enter **Packet 314** in the **Service Name** field.
41. On the **Generate** Tab select the **Browse Disk** button. In the Open dialog that is displayed choose the **Science Packet.xml** metadata file and push the OK button to add it to the list. The Generator application will use information in the metadata file to automatically generate data values for the packet contents. Your dialog should look similar to the one shown in Figure 49.



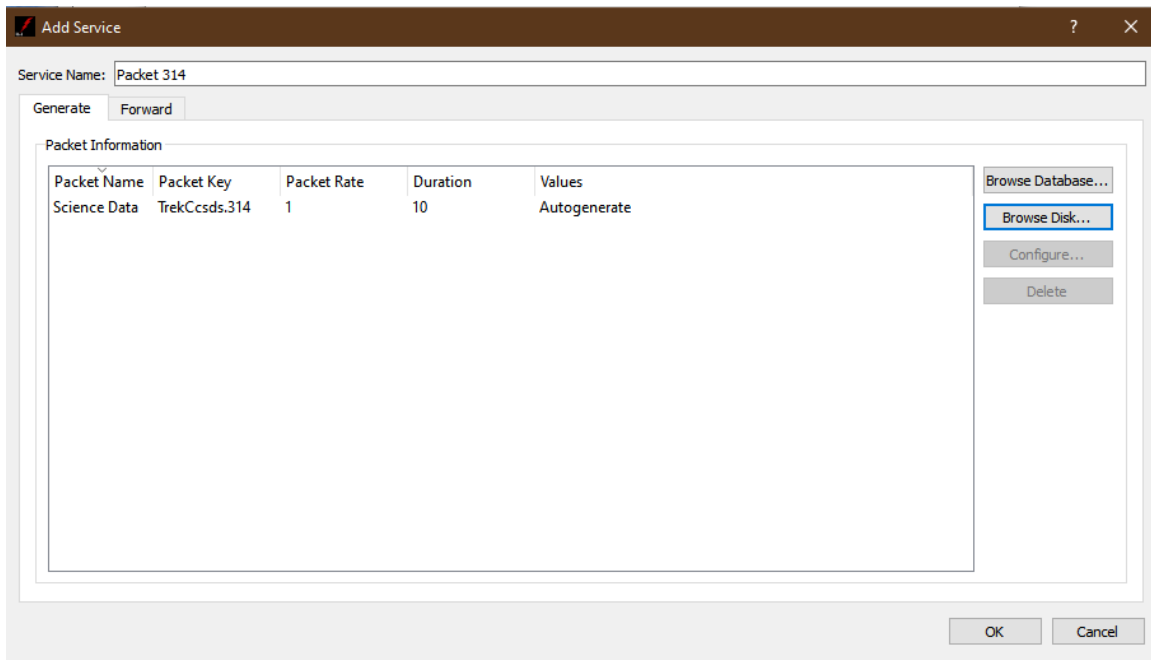
**Figure 49 Add Service Dialog Generate Tab (Packet 314)**

42. Select the packet in the list and push the Configure button. You should see the dialog in Figure 50.



**Figure 50 Configure Generator Properties Dialog**

43. In the Configure Generator Properties dialog change the duration to 100 and then push the OK button. You should see the duration has been set to 100 in the Add Service dialog as shown in Figure 51.

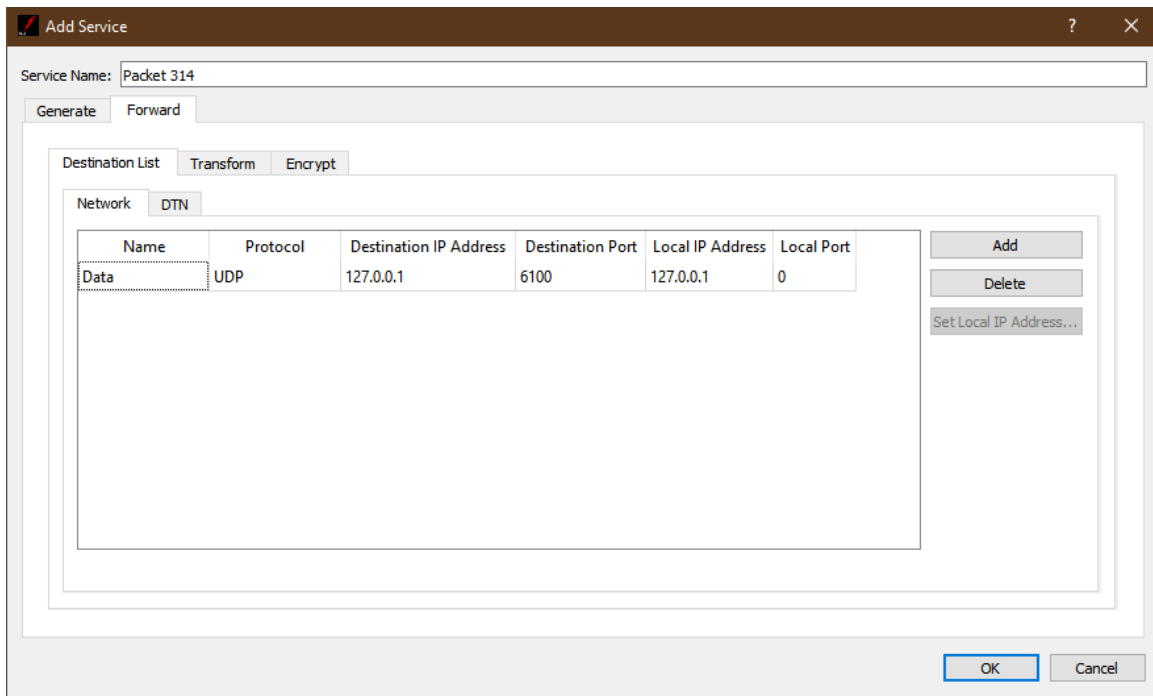


**Figure 51 Add Service Dialog Generate Tab**

44. Go to the **Forward** Tab. In the **Destination List Network Tab** push the **Add** button to add a row to the table. Enter the following information in the row to define a destination with details on where and how to forward the generated data:

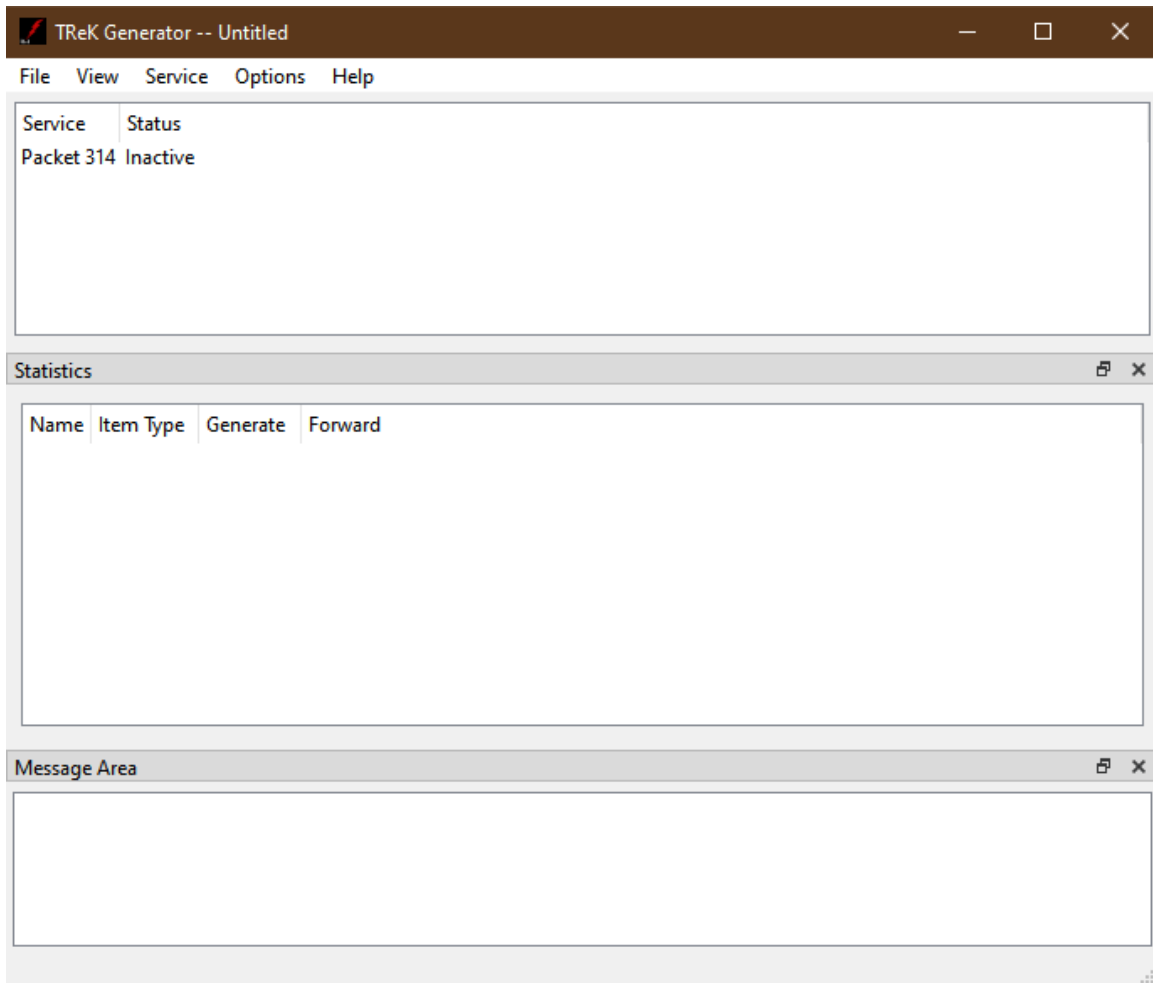
|                         |           |
|-------------------------|-----------|
| Name                    | Data      |
| Protocol                | UDP       |
| Destination IP Address  | 127.0.0.1 |
| Destination Port Number | 6100      |
| Local IP Address        | 127.0.0.1 |
| Local Port              | 0         |

45. Your dialog should look similar to the one shown in Figure 52. Push the OK button to add the service.



**Figure 52 Generator Add Service Dialog Forward Tab**

46. Your Main Window should look like the one shown in Figure 53.



**Figure 53 Generator Main Window with Packet 314**

47. Now that you have identified the telemetry packet to send, you can activate the service. In the Generator main window select the Packet 314 service, go to the **Service** menu and select **Activate Service**. The service in the Generator will turn blue to indicate it is active and ready to generate data as shown in Figure 54.

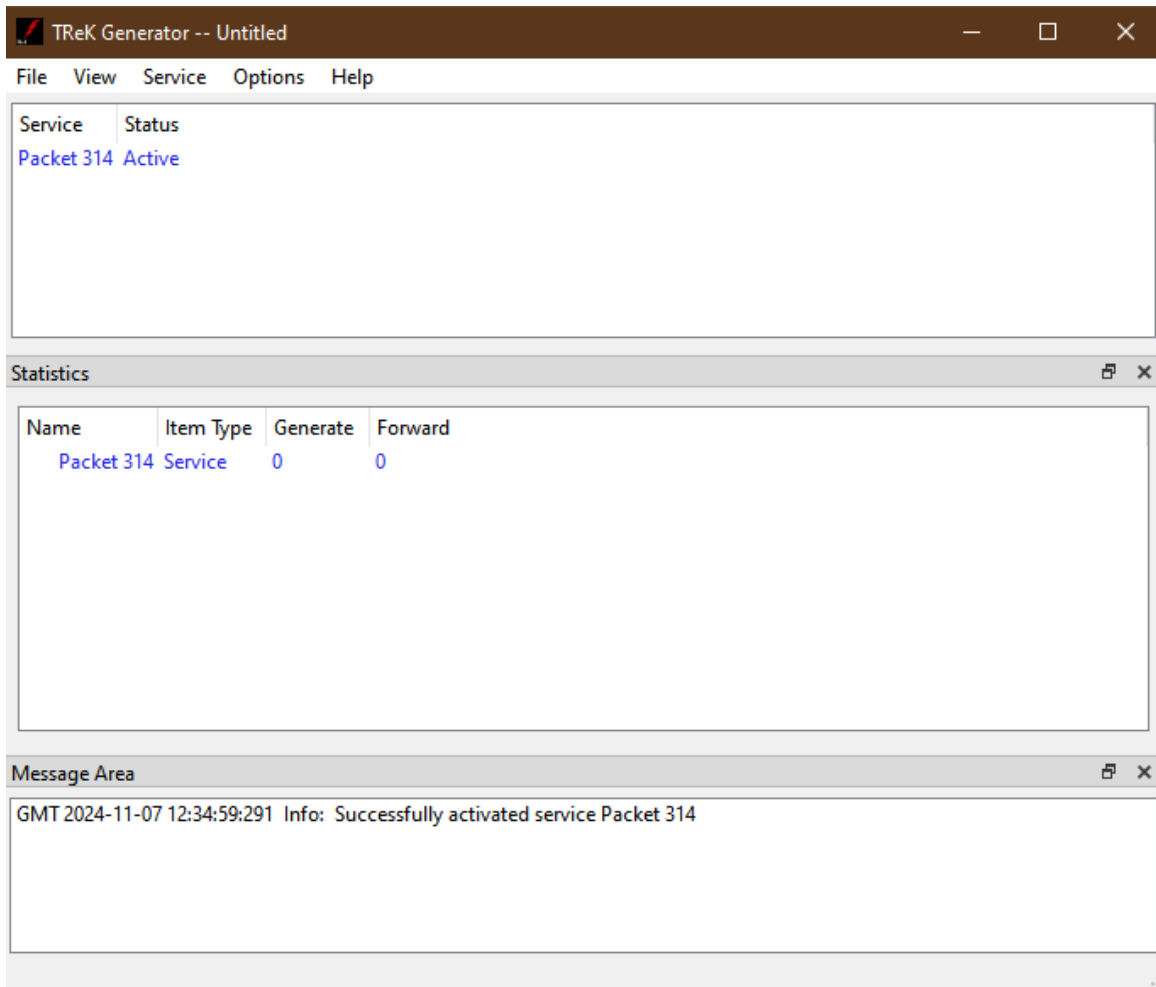


Figure 54 Generator Main Window Activated Service

48. Now that you have activated the service you can start the data flow. In the Generator main window select the Packet 314 service, go to the **Service** menu and select **Start Packets**. The service in the Generator will turn green to indicate it is generating Packet 314 as shown in Figure 55.

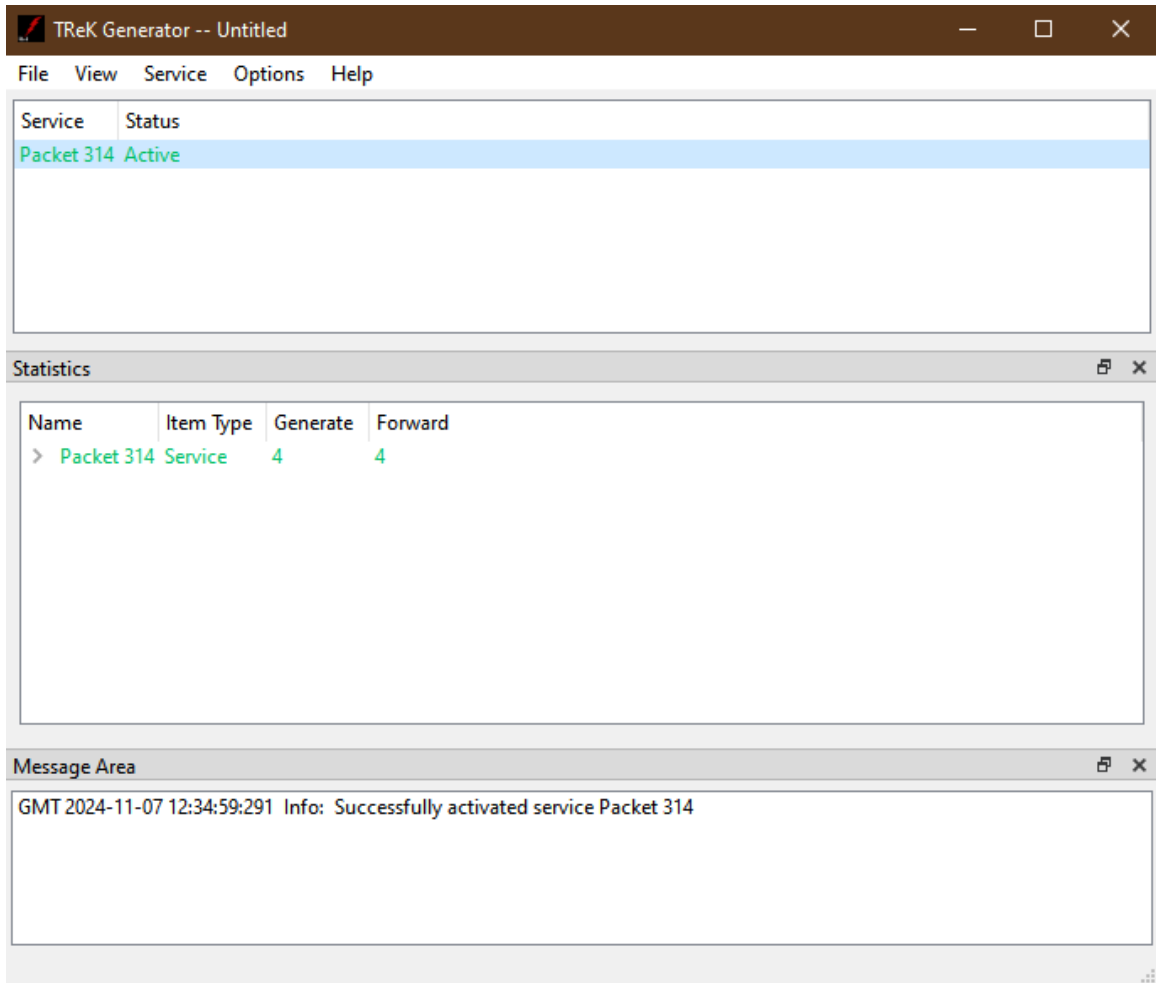
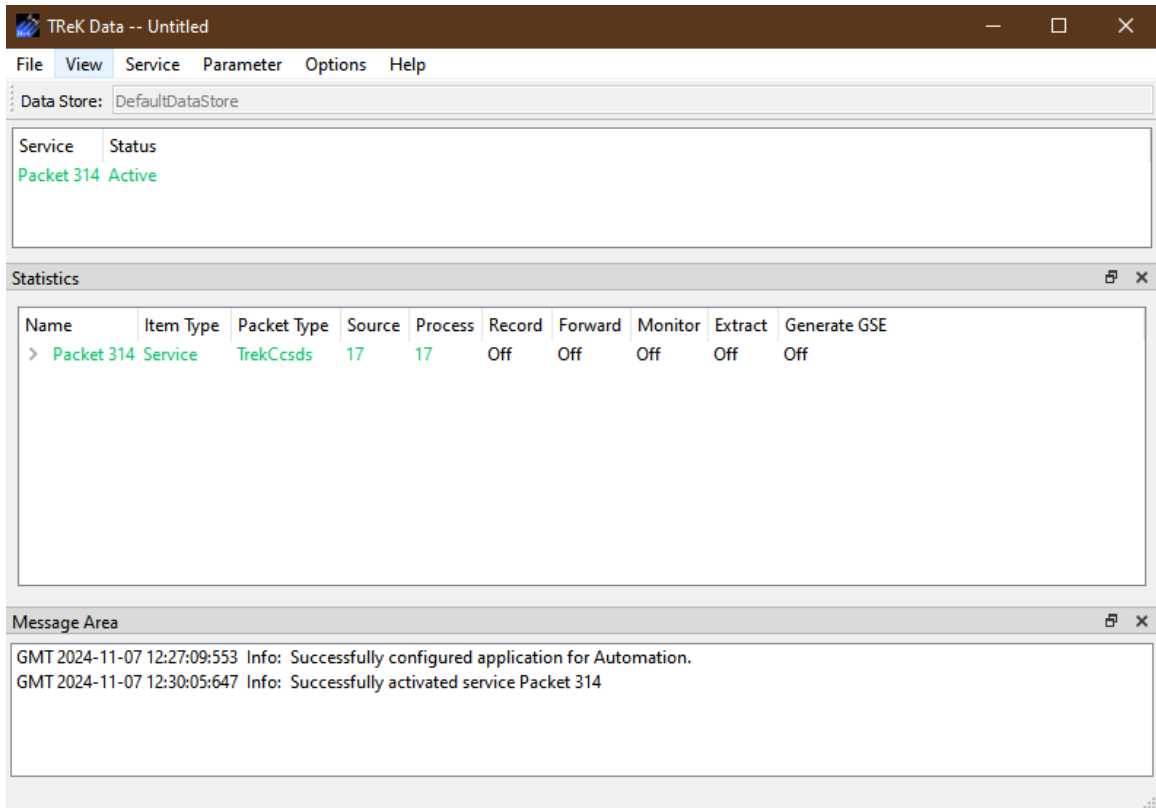


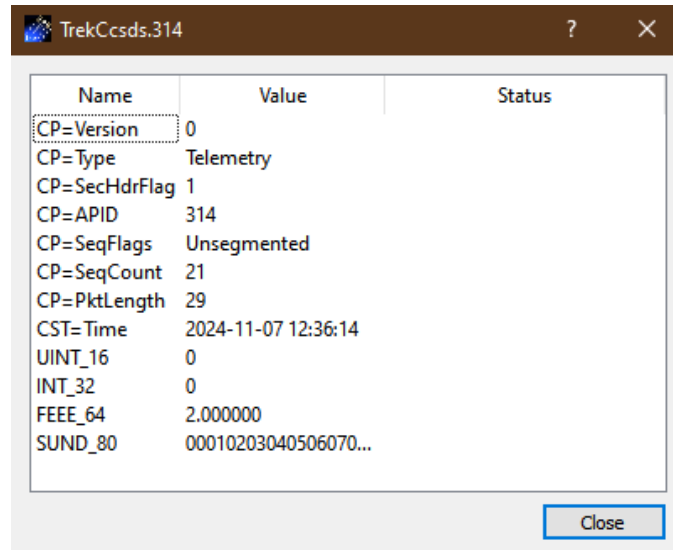
Figure 55 Generator Sending Packet 314

49. Look at the **TReK Data** Main Window. The service named **Packet 314** is green indicating it is receiving data as shown in Figure 56.



**Figure 56 TReK Data Receiving Packet 314 Data**

50. Look at the **TrekCcsds.314** display. The **Value** column should contain data values as shown in Figure 57. The data value of each parameter in the packet is displayed on the **TrekCcsds.314** display each time a new packet of data arrives and is processed by the TReK Data application. The Status column will be empty until there is status information to display.



The screenshot shows a window titled "TrekCcsds.314" with a table of packet data values. The table has three columns: Name, Value, and Status. The data is as follows:

| Name          | Value                | Status |
|---------------|----------------------|--------|
| CP=Version    | 0                    |        |
| CP=Type       | Telemetry            |        |
| CP=SecHdrFlag | 1                    |        |
| CP=APID       | 314                  |        |
| CP=SeqFlags   | Unsegmented          |        |
| CP=SeqCount   | 21                   |        |
| CP=PktLength  | 29                   |        |
| CST=Time      | 2024-11-07 12:36:14  |        |
| UINT_16       | 0                    |        |
| INT_32        | 0                    |        |
| FEEE_64       | 2.000000             |        |
| SUND_80       | 00010203040506070... |        |

A "Close" button is located at the bottom right of the window.

Figure 57 TrekCcsds.314 Packet Data Values

Congratulations – you have successfully completed the Tutorial!