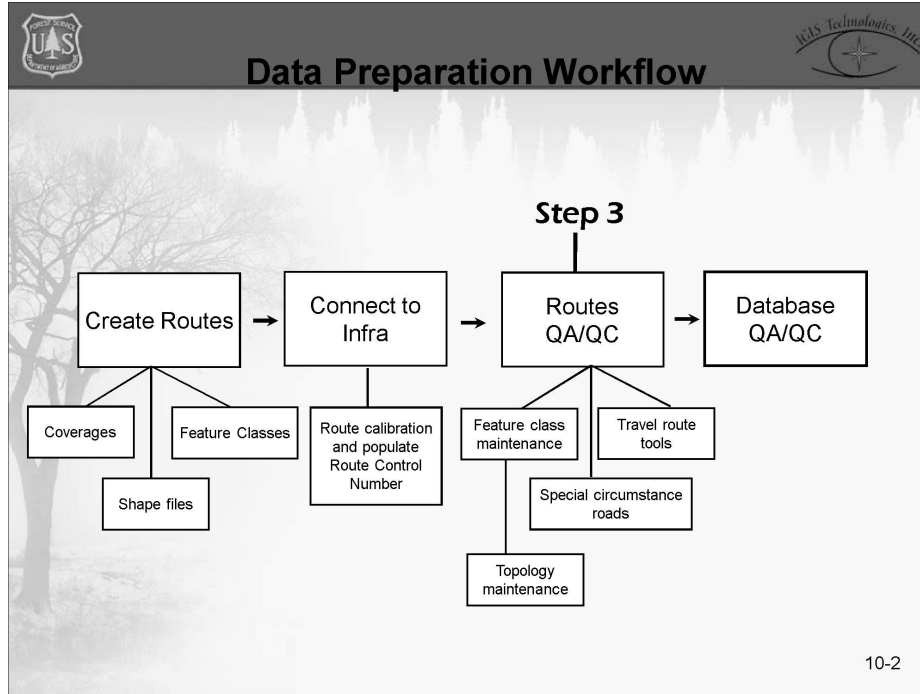






Geodatabase Topology

Objective: To learn how to create topology rules so that roads and trails can maintain their topological relationships.

10-1

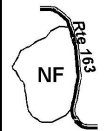




Topology maintenance is one of the steps that is part of feature class maintenance. Topology is the collection of rules and relationships that enables the geodatabase to more accurately model geometric relationships. It consists of ensuring that the roads and trails are connected to one another correctly, are validated, and do not contain any multi-part routes. In this lecture you will learn about topology rule files, which will store these spatial relationships between roads and trails and other feature classes. Topology rules will be the basis for validating data, searching for errors, and fixing errors. You will also learn how to find and fix multi-part routes, which can occur when you have roads with dual designations (which will be discussed in more detail in the next lecture).




Topologies Useful in the MVUM

- Adjacency – common boundaries
- Coincidence – features that lie on top of other features
- Connectivity – routing features


	Road is <i>adjacent</i> to forest boundary
	Trail A is partially <i>coincident</i> to Highway
	Road is <i>connected</i> to Highway

10-3

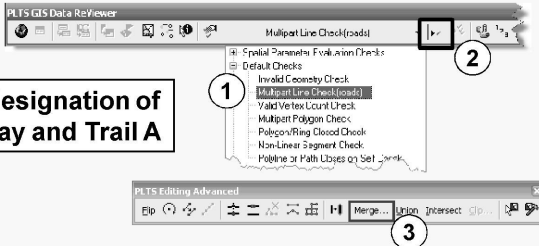
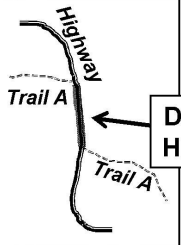
There are three types of topology. Adjacency allows the user to identify features with common boundaries. Coincidence allows the user to identify features that lie on top of other features. Connectivity allows the user to perform routing functions, which is especially important to the MVUM given the connected nature of the roads and trails. The graphics above show instances where MVUM roads can be checked according to topological rules to improve spatial accuracy.



Multi-Part Roads & Trails





- Roads must be single-part
- Coincidence of road and trail results in dual-designation of segment
- To fix: Use “Merge”




10-4

In order to correctly calibrate roads and trails with Infra data, they must be single-part features. This is sometimes not the case when a portion of a trail or road overlaps with another section of road, resulting in a dual-designation of that section. In other words, that segment has the attributes of both the road and trail. In some cases you will find that the road or trail has been broken into two segments, which will cause problems in reading the eventual MVUM. You can find these features using a PLTS topology quality control spatial data check called “Multipart Line Check.” In the previous chapter, you learned how to use some PLTS tools to streamline some basic editing functionality. In addition to editing, PLTS incorporates many useful data checks to employ quality control on your data. This particular check looks for multipart lines and allows you to go through each record that is found to see if it is in fact an error. You can check the current extent, selected features, or the entire feature class. In most cases, you will simply copy the coincident segment, if it is missing, and merge the separate pieces into one line, maintaining the attributes of the existing road.



Topology Requirements

- All feature classes must be in the same feature dataset
- A feature class can only participate in one topology
- Cannot delete, rename, or move a feature class participating in a topology without first deleting topology

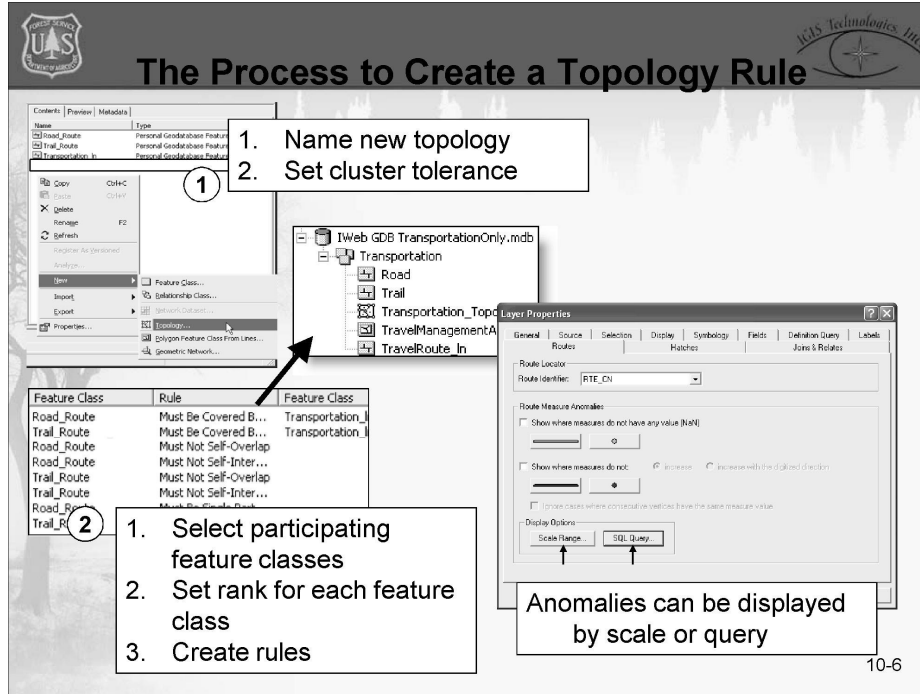


Container for topology rules

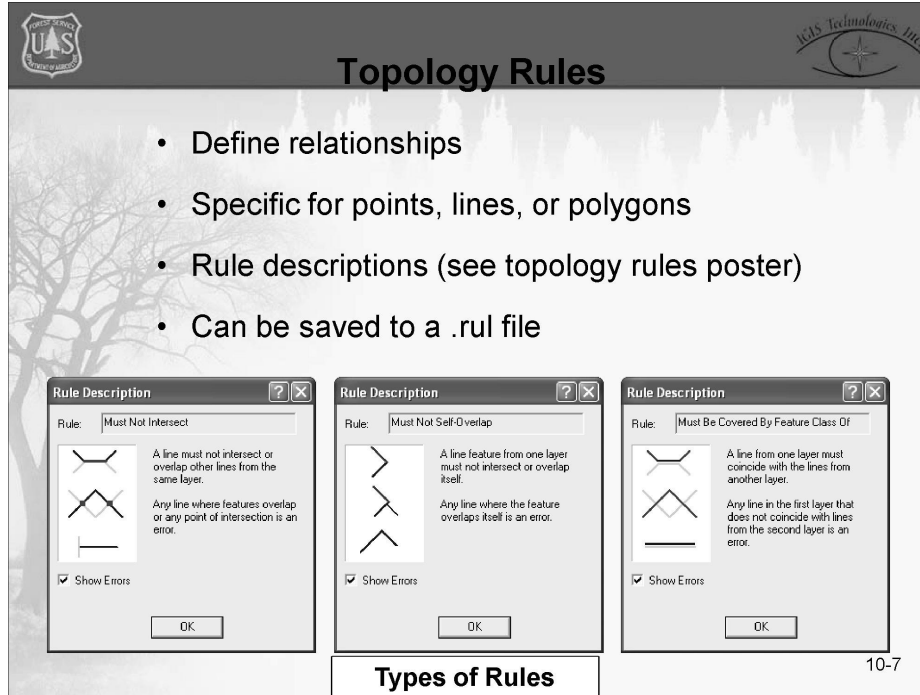
10-5

There are some important points to remember about geodatabase organization when creating geodatabase topology. First, all feature classes that participate in a topology must be in the same feature dataset. Second, a feature class can only participate in one topology at a time. However, there can be multiple topologies within a feature dataset. Third, once a feature class participates in a topology, it cannot be deleted, renamed, or moved without first deleting the topology that in which it participates.



As discussed earlier, the IWeb GDB TransportationOnly geodatabase is provided as a template to use for MVUM data preparation. This is the geodatabase that you will prepare all of your roads and trails data in. As part of that preparation, you will create a topology feature class within the Transportation feature dataset. We will talk about how to create the topology feature class in the following slide.



To create a topology, you first right-click in the feature dataset and click New > Topology (1). You will need to define the name of the topology. A default name is usually given: <feature dataset>_Topology. (Note that spaces are not allowed in the topology name, including the path.) You also have the opportunity to assign a cluster tolerance, or accept the default tolerance. The cluster tolerance is the distance range in which all vertices and boundaries are considered coincident. To minimize errors this tolerance should be set as small as possible. In the next dialog window, you are prompted to check the boxes for the feature classes that will participate in the topology. Next, you assign the ranks for the individual feature classes that participate in the topology. You assign ranks according to the accuracy of the participating feature classes. For instance, if you know that Trail_Route feature class is not as accurate as Road_Route, then you would assign it a lower rank. This would result in the movement of Trail_Route features so that they snap to the Road_Route feature when the features are within the cluster tolerance. The final step is to assign rules to the topology (2). After the topology is created, you can view its properties at any time in ArcCatalog. Note that you can add additional rules at a later time. You can even add a feature class to participate in the topology at a later time, by clicking on the Feature Classes tab. You will only be given the option to choose from feature classes within the feature dataset that do not already participate in the topology.

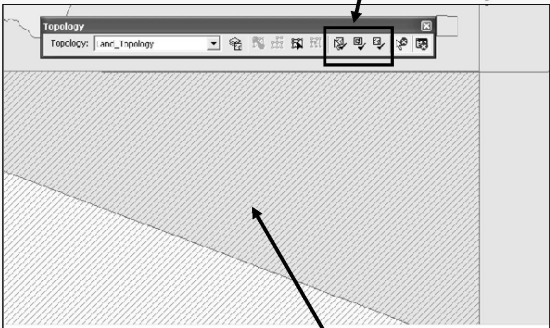


Topology rules define the relationships between features in one feature class or subtype or between two feature classes or subtypes. There are specific rules (which often sound very similar), depending on whether the relationship is between point, line or polygon feature classes. The easiest way to discern which rule to use is to use either the rule descriptions, which are accessible when you are creating the topology, or to consult the Topology Rules Poster. You can view it online: http://webhelp.esri.com/arcgisdesktop/9.2/pdf/Topology_rules_poster.pdf. A set of rules can be saved to a .rul file to be imported to other Feature Datasets.



Topology Validation

- Checks data against rules you created
- ArcCatalog
 - Entire topology
- ArcMap
 - Specific area
 - Current extent
 - Entire topology
- Dirty areas

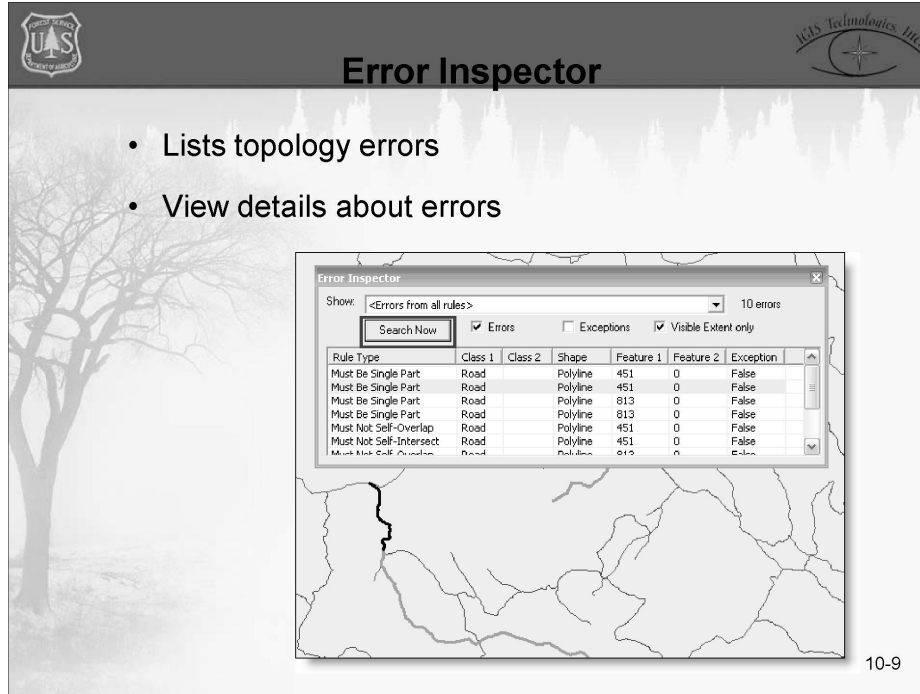


Validation options in ArcMap

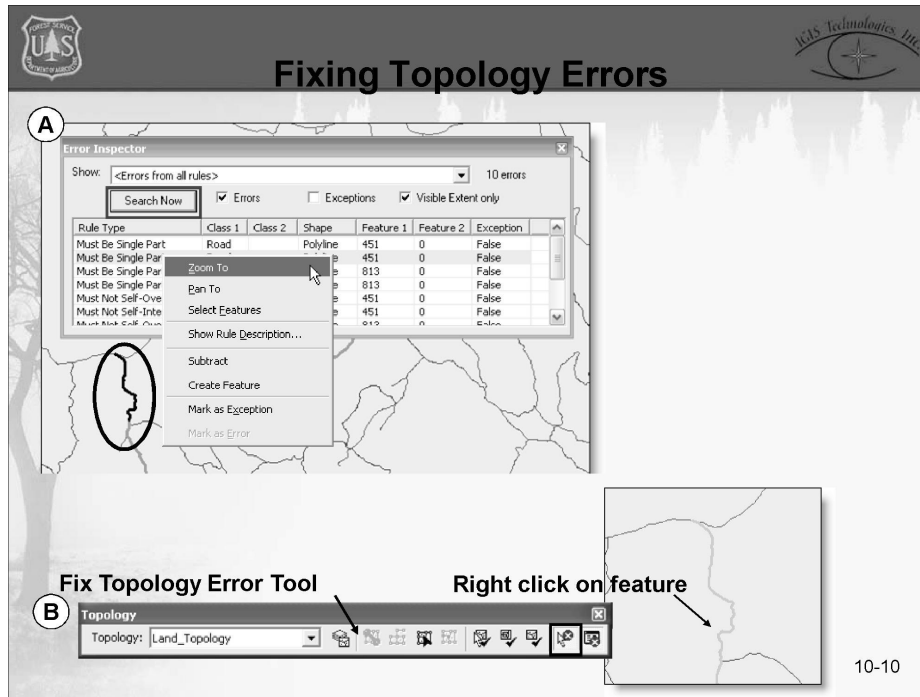
Dirty Area

10-8

The validation process involves ArcGIS checking whether the data meets the rules that you set up during the topology creation process. In ArcCatalog, once you have created a topology, you will be asked whether you want to validate the topology. This is not generally recommended, since you only have the option to validate the entire topology, and this could take a very long time. On the other hand, in ArcMap, you have more flexibility in the validation process. Using three of the tools on the Topology toolbar, you have the option to validate a specific area (you define the rectangle), validate the current extent, or validate the entire topology. (Note: you have to be in an edit session to validate in ArcMap.) So a more common process might be to validate local sections of your forest as you perform updates in those areas. Dirty areas are areas where no validation has occurred. Once you create a new topology, the extent of the topology feature class will be a dirty area, shown with blue cross hatching. Once you have validated an area, it will only become “dirty” again after edits are made, to reflect the fact that the area has not been validated since it was edited. This allows the user to quickly determine where the areas are that need to be validated.





Once you have validated an area's topology, and you can see that errors exist, you will want to address these in the Error Inspector. This dialog box lists the topology errors for the area that you validated and allows you to view the error details, zoom to the feature, and even perform a spatial edit. (Note: in order to see the errors, you must click on the Search Now button.) The default options are to show only errors in the visible extent and to show errors from all rules. However you can choose to show only those errors that refer to a specific rule. In the next slide we will discuss how to fix errors. Note that in this example, the rule that a road must be single part is being violated.



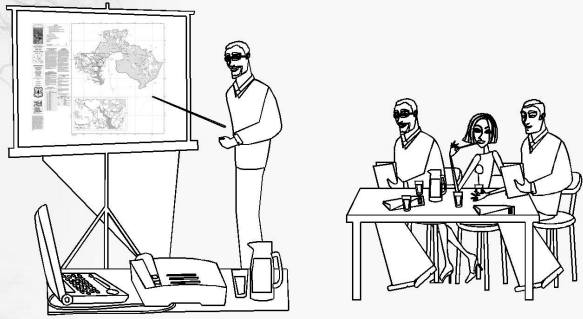
There are two ways of addressing topology errors. The first is by right-clicking on an error in the Error Inspector to see a number of options to address that error (1). You can zoom or pan to the error. You can select the features that participate in the error. You can also show the description for the rule that is being violated. Once you have reviewed the error, it might need to be marked as an exception, meaning that the rule should not be applied to this particular case. (Note: this will change the value in the “Exception” field from “False” to “True.”) This option gives the user some flexibility in within a geodatabase topology that never existed with coverage topology. In addition, depending on the type of rule that is being violated, you may also have the option to quickly fix the error by subtracting the feature or creating the feature. In the case noted in the ellipse, you notice that this is a multi-part road that needs to be merged with the road that continues to the south. Once you select and merge these two roads, the error would disappear (2).

The second method to address errors is to use the Fix Topology Error tool. After selecting the tool, and then clicking on the feature(s) in the display and right-clicking, you will have the same options as listed above. Once the errors have been addressed, they disappear from the Error Inspector and from the display area.





Demo

- Create a route topology rule




10-11



Exercise:



Use Topology to Find Errors with Roads and Trails

- Goal: Work with topology rules to find and fix road and trail errors.






1. Create topology
2. Apply existing topology rule file
3. Validate & fix errors
4. Find & fix multi-part roads

10-12



Summary

-  Topology creation is part of the feature class maintenance step and is stored within the temporary geodatabase.
-  Topology rules are useful for ensuring that data geometries are accurate.
-  The error inspector helps you quickly find and correct topology errors.

10-13

Exercise 10: Use topology to find errors with roads and trails



Exercise goal: Students will learn how to work with topology rules to find and fix road and trail errors.

There will be many edits required to keep a routes layer up to date. Topology rules are useful to uncover errors and systematically address them. Through multiple edit sessions you can track errors that have yet to be resolved. And you can migrate to various parts of the dataset to validate areas as you go. Without topology rules, the process of uncovering errors in the data is much more random.


Upon completion of the exercise, you will be able to...

- ✓ Create topology
- ✓ Use rule files
- ✓ Validate topologies
- ✓ Use the Error Inspector to manage edits

STEP	DESCRIPTION	PAGE
1	Create topology	10 – 15
2	Apply existing topology rule file	10 – 17
3	Validate and fix errors	10 – 18

Step 1: Create Topology

In this section, students create a topology class for the IWeb GDB TransportationOnly geodatabase and load a topology rule file, which will create all of the rules for the topology.

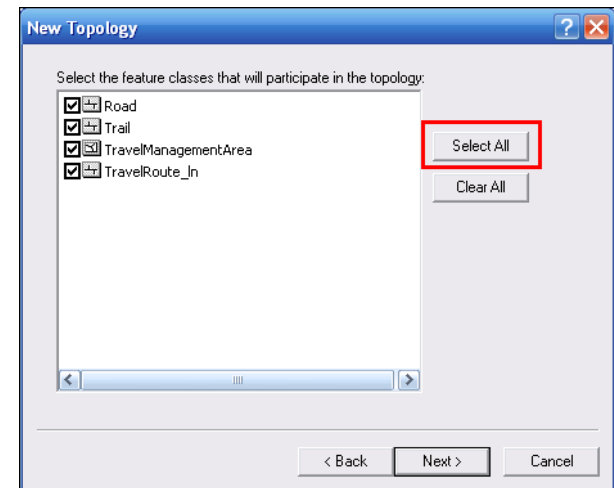
- Open **ArcCatalog**, and navigate to **C:/training/Ex10**. 
- Double-click on the **IWeb GDB TransportationOnly** geodatabase. Double-click on the **Transportation** feature dataset.
- In the white space, right-click, and choose **New → Topology**.
- In the New Topology window, read the dialog box, and click **Next**.
- Accept the default name for your topology, as well as the default cluster tolerance. Click **Next**.
- In the next dialog, click **Select All**, so that all of the feature classes within the feature dataset are available to create topology rules.

In this exercise, you will be applying a rule file, which we have pre-created with a number of topology rules. They include rules for all four of the feature classes, so that if you did not select all of the feature classes to participate in the topology, you would receive an error.

- Click **Next**.

In this next dialog box, you set the ranking for each feature class. Since each of these feature classes were created with roughly the same accuracy, you do not want to prioritize one feature class to move more other feature classes. Therefore they will all retain the rank of 1.

- Click **Next**.



Geodatabase Topology

This last dialog box is where you define the topology rules. In this case you will import the .rul file that has already been created.

- i. Click **Load Rules**.
- j. Navigate to **c:/training/Ex10**. Select the **topology.rul** file, and click **Open**.

Review the rules.

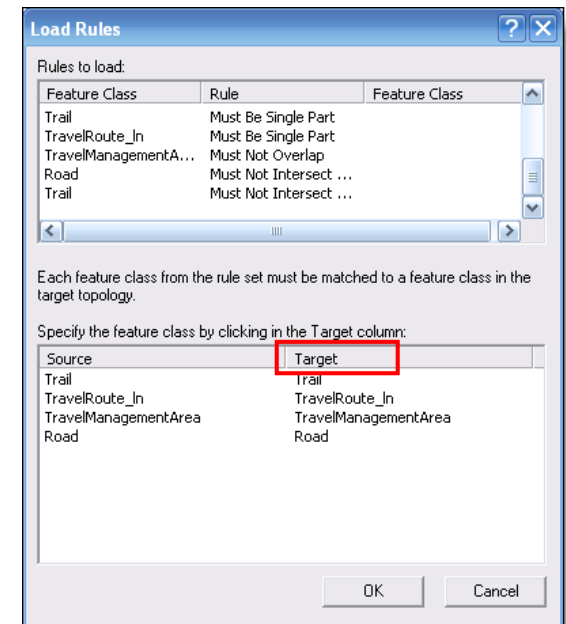
Question:

1. List the rules that the Road feature class participates?

Note that if your feature classes had been named differently, you could have picked them in the Target area.

- k. Click **OK** to close the Load Rules dialog box. Click **Next**.
- l. Review the Summary of the rules, and click **Finish**.
- m. When asked if you would like to validate the new topology, click **No**.


Your feature classes are now setup with topology rules that will allow systematic editing.



Step 2: Validate the topology

In this step you will validate the topology that you previously created. In order to save time, you will only validate a portion of the topology. When you first create a topology, you typically validate the entire topology. Then when you made edits, you would only validate the edited area.

- a. Open ArcMap. Choose to open **An existing map**. Click **OK**. Navigate to `c:/training/Ex10` and select **Ex10.mxd**. Click **Open**.

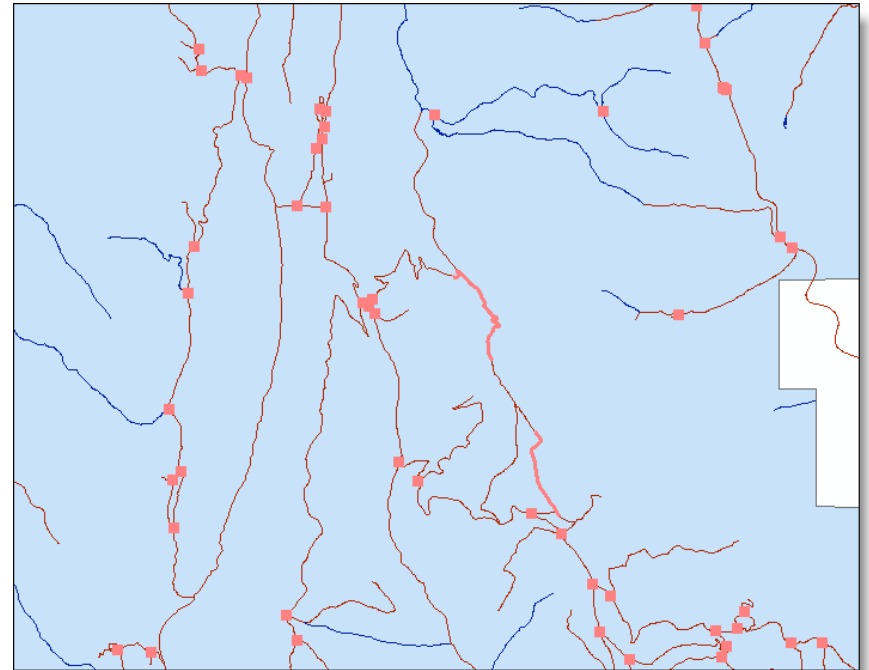
 **NOTE:** If you were starting a new ArcMap session, you could drag the topology feature class from ArcCatalog into your Table of Contents and quickly add all of the feature classes that participate in that topology.

You will validate this extent. In order to validate you *must* start an editing session. If you do not have your Editor toolbar open, click View → Toolbars → Editor.

- b. On the Editor toolbar, click **Editor → Start Editing**.
- c. From the main menu bar, click **View → Toolbars → Topology**.
- d. On the Topology toolbar, click the **Validate Topology in Current Extent** icon.




You will see a number of point and line errors that show up as pink point and line symbols. Now you will view those errors using the Error Inspector.



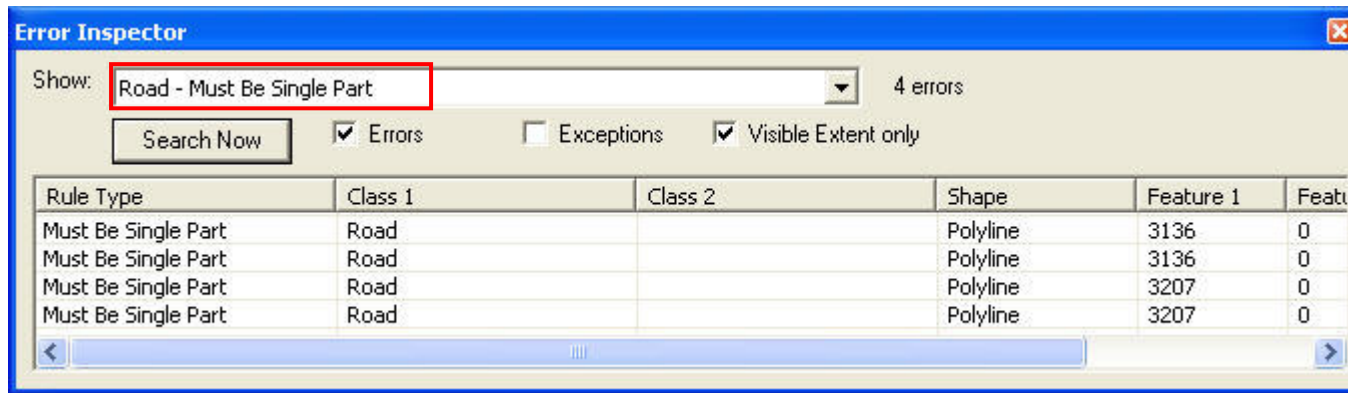
- e. On the Topology toolbar, click on the **Error Inspector** icon.



Geodatabase Topology

 **NOTE:** In the Error Inspector, you can search for the errors either in the full extent, or just the visible extent. If you only validated a certain extent, as in this exercise, the Error Inspector will only find the errors in this extent, even if you do not check Visible Extent Only (which normally would show all of the errors for the entire topology). You can also choose to show only errors of a particular rule. Since we are only interested in fixing multi-part features at this point, we will only show these types of errors.

- f. In the Error Inspector, for Show, click the **drop-down arrow** and choose **Road - Must Be Single Part**.



- g. Click the **Search Now** button.

Question:

2. How many errors to this rule are in the current extent? _____

The Error Inspector is a good place to manage your errors as you can continue to validate and see the error list. These errors can be addressed over multiple edit sessions. .

Step 3: Use the Error Inspector to fix multi-part features

In this step you will use the Error Inspector to zoom to and fix the multi-part features that you found in the previous step. It turns out that these multi-part errors result from splitting the roads when they intersect other roads. As a result a road that should be a single feature is broken up into multiple segments. This is incompatible with Infra and will result in problems when connecting to Infra.

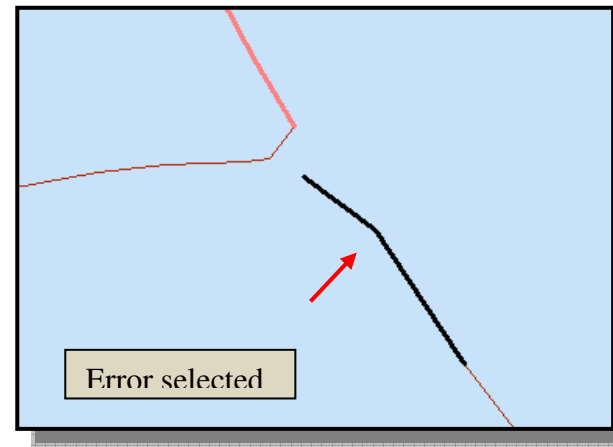
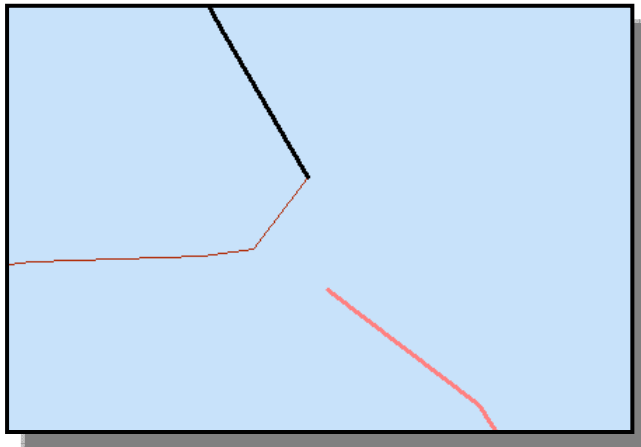
Geodatabase Topology

- a. Scroll down until the Rule Type is **"Must be Single Part"** and click on the first Feature 1 number **3207** to select it.

- b. Right-click on this selected error and click **Zoom To**. Next click on the Feature 1 value (shown by the arrow) of the selected error to highlight it.

Rule Type	Class	C...	Shape	Feature 1
Must Not Intersect Or Touch Interior	Road		Point	1216
Must Not Intersect Or Touch Interior	Road		Point	556
Must Not Intersect Or Touch Interior	Road		Point	1216
Must Not Intersect Or Touch Interior	Road		Point	575
Must Not Intersect Or Touch Interior	Road		Point	1421
Must Be Single Part	Road		Polyl...	3136
Must Be Single Part	Road		Polyl...	3136
Must Be Single Part	Road		Polyl...	3207
Must Be Single Part	Road		Polyl...	3207


Zoom To



- c. In the table of contents turn off all layers except Road.
- d. Uncheck **Transportation_Topology** in the table of contents.

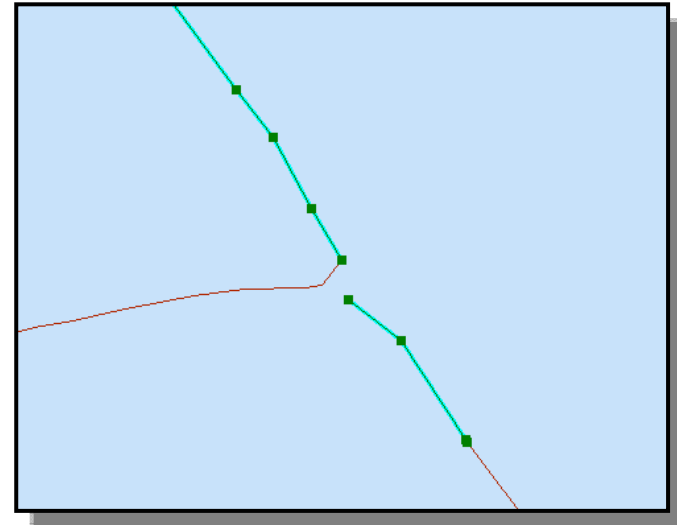
Geodatabase Topology


- e. In the Editor toolbar set the task to **Modify**

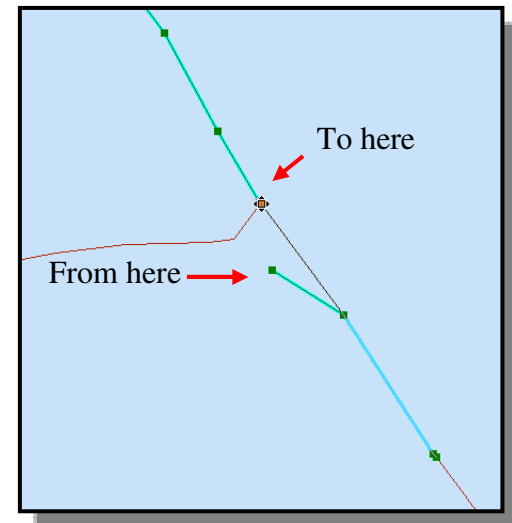
Feature, click the **Edit Tool**  and select the lower arc. Both arcs are now selected because they are connected as a multipart feature.

- f. In the Editor toolbar click **Editor** → **Snapping**. Set the snapping for the vertex of the Road layer.


Layer	Vertex	Edge	End
TravelRoute_In	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Trail	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Road	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
TravelManagementA	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



- g. Use the Edit Tool and click on the top vertex of the selected lower arc and drag it until it snaps to the first vertex of the arc above it.
- h. Click **Clear Selected Features**  in the Tools toolbar.
- i. **Turn on** the Transportation_Topology layer in the table of contents.




Now let's validate the topology again to see if other errors exist.

- j. From the Topology toolbar click **Validate Topology in Current Extent** icon  and click on **Error Inspector**. In the Error Inspector,

Geodatabase Topology

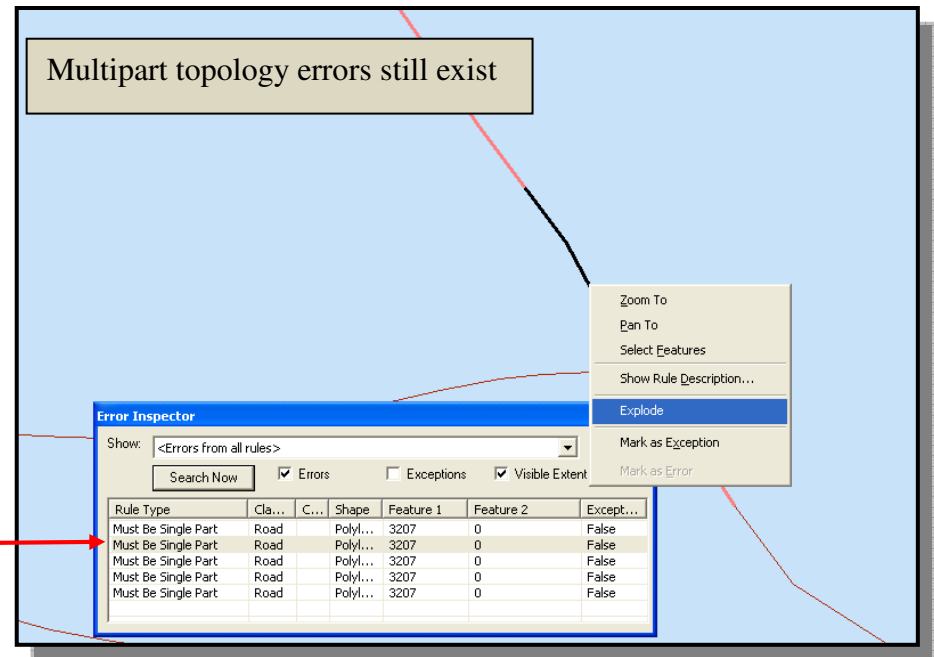
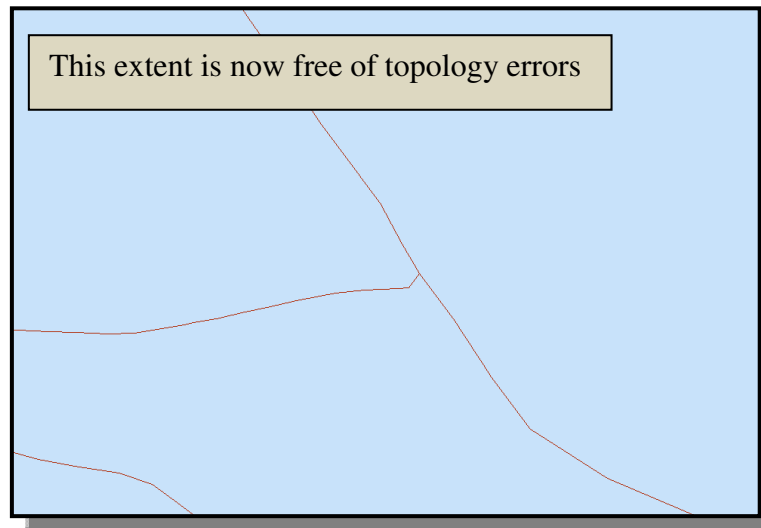
check **Errors** and **Visible Extent only** then click **Search Now**.

k. Select the second error in the table, right-click and choose **Select Features**.

- l. In the Topology toolbar select the **Fix Topology Tool**  right-click on the selected arc and click **Explode**.

With the addition of our recent vertex edit, this arc was digitized at different times. It consists of multiple parts even though it shows up as a single feature in the attribute table. Single parts are required for correct calibration. The Explode function removes all feature parts so that an ordered set of M values can occur.

- m. Repeat step l to validate the topology in this extent again.



The feature we just edited is now a single part feature, but if you did some querying, you would still see that this route number consists of multiple features. This would still be a source for an error and as we covered earlier, you would want to perform feature merging to maintain a unique route number for a single feature.

n. Save edits and stop editing.

In this exercise you were exposed to the advantages of using topology rules. You learned how to create a topology, apply a topology rule file, validate errors, and fix errors including multi-part road features. It is encouraged to use topology rules when possible to QA GIS data. After becoming comfortable with using topology and the topology toolbar you may find it useful to create and apply your own rules for specific errors that need to be located.

End Exercise.