



## GST 102: Spatial Analysis Lab Series

### Lab 6: Vector Data Analysis – Network Analysis

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## Introduction

This lab is part of a series of lab exercises designed through a grant initiative by the National Information, Security & Geospatial Technologies Consortium (NISGTC), funded by the United States Department of Labor in partnership with the Department of Education under the Trade Adjustment Assistance Community College and Career Training Grant Program (TAACCCT).

In this lab, students will build a network dataset from existing roads data. Students will be creating service areas and operating a network with barriers and impedances. Network analysis allows for the streamlining of a flow through the network. Using the algorithms of the program, a network can be used to calculate the best routes from point to point. The closest facility from an event and service areas in which certain facilities operate can be determined.

Your instructor may require that you provide screen captures and/or exported files. Please check with your instructor for the requirements specific to your class.

This lab includes the following tasks:

1. Creating a Network Dataset
2. Performing analysis on a network

## Objective: Learn Basics of Network Analysis

The objective of this lab is to learn the basic operations of the network analysis extensions in ArcMap. We will use the Network Analyst to solve route selections, create a service area for facilities, and calculate the closest facility.

## Lab Settings

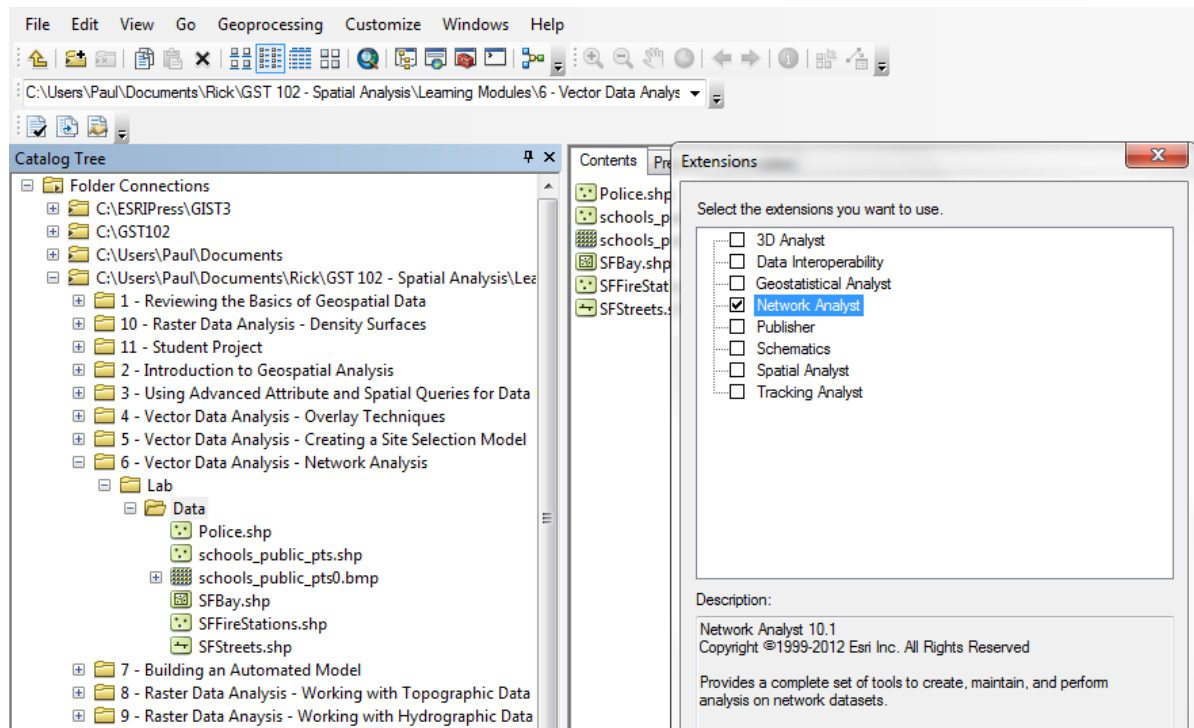
### Required Virtual Machines and Applications

Windows Machine User Account	Train
Windows Machine User Password	Train1ng\$

## 1 Creating a Network Dataset

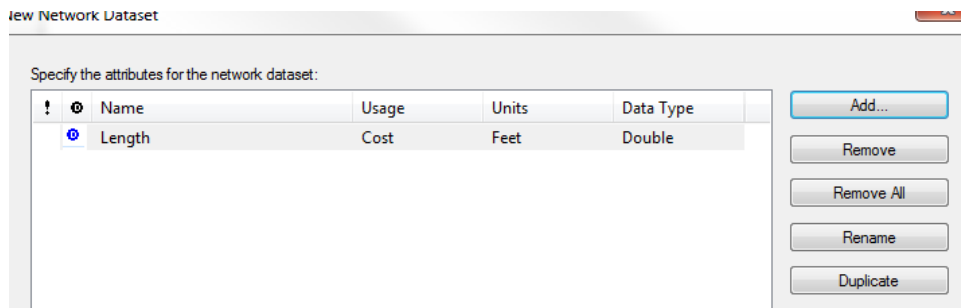
In order to use a network, a network dataset must be created to establish relationships between the roads and the intersections, also known as junctions. When we build a network dataset, the line dataset is analyzed and every intersection is turned into a junction. If we do not create the network dataset there will be no way of calculating when to turn or not to turn, or even to create the directions. None of the network analysis functions will be available without the creation of a network dataset.

1. Log into the computer, using the information provided in the Lab Settings section.
2. The data for this lab is located on the lab machine at: *Shared drive\GST 102\Lab 6*. Copy the Lab 6 folder into your C:\GST 102 folder.
3. Click **Start->All Programs->ArcGIS->ArcCatalog 10.1**. ArcCatalog will open.
4. Connect to your *GST102* folder you created on the C: drive.
5. In ArcCatalog, from the main menu click **Customize->Extensions** and check **Network Analyst**.



6. Navigate to the data you have been given for this lab.
7. **Right click->SanFranciscoStreets.shp** and **click New Network Dataset**. If it is grayed out, ensure the network analyst extension is turned on.
8. The first window will be the name of the network. **Click Next**.
9. The next window will ask if you want to model turns in this network. It is already set to Yes and should say <Global Turns>. This allows us to model the turns in the network. **Click Next**.
10. The next window deals with connectivity. Connectivity can be managed on either every vertex or just the endpoints of the network. Since all our streets are connected at the endpoints, it is set to endpoints by default. **Click Next**.

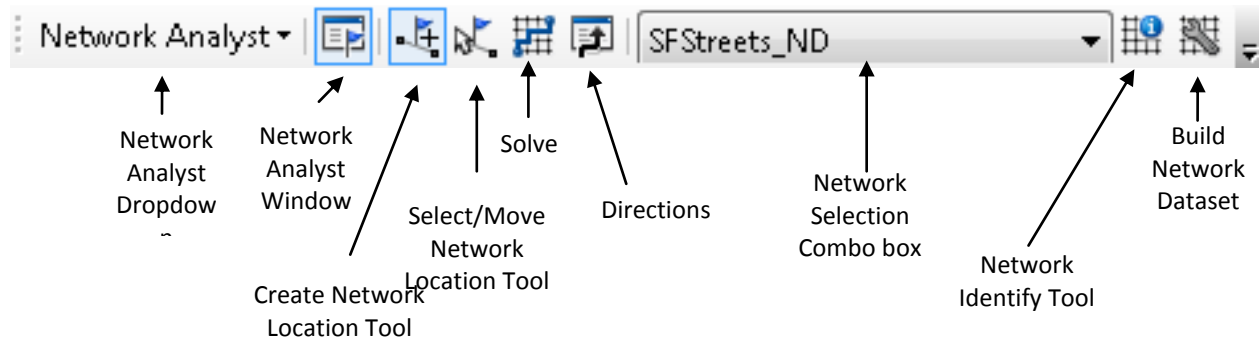
11. The next window deals with elevation. We will not be using the elevation fields so select the “None” radio button. Elevation makes a difference in the way the routes are calculated taking into account bridges and dips. **Click Next.**
12. This window specifies the attributes we will be dealing with. Multiple attributes such as travel times or one way streets can be modeled. We will be doing basic operations on the network so we will not be adding any attributes. **Click Next.**



13. We can model the directions of the roads and the directions of traffic in the next window. **Select Yes** and **click Next.**
14. The last window is a summary of all the options and inputs. **Click Finish** and another window will pop up asking to build the network. **Click Yes.**

## 2 Network Analysis Types

Several analysis methods can be performed on networks. We will be looking at Route Analysis, Service Areas and Closest Facilities. To perform the network analysis operations you will need to be acquainted with the network analyst tool bar (see diagram below).

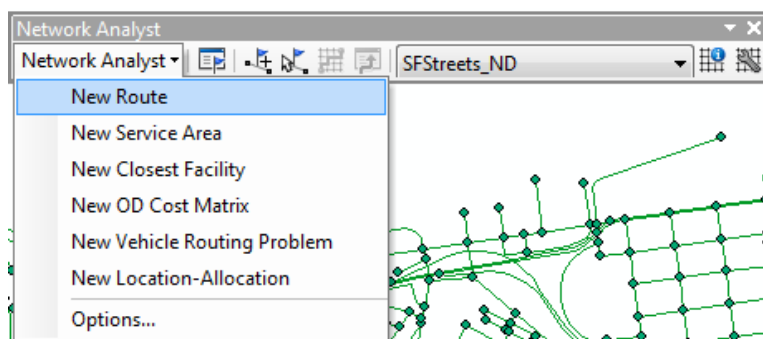



1. Open **ArcMap 10.1** to a blank map.
2. Turn your network analysis extension on in ArcMap By **clicking Customize->Extensions->check Network Analyst** and **click Close**.
3. Navigate to your GST102 folder and add the network dataset you created in Task 1, **SanFranciscoStreets\_ND.nd**, to the map. You will be asked about adding all feature layers that participate in the network dataset **click Yes**.
4. Turn the Network Analyst toolbar on. **Click Customize->Toolbars->Network Analyst**. This is the toolbar we will be using in the following tasks.

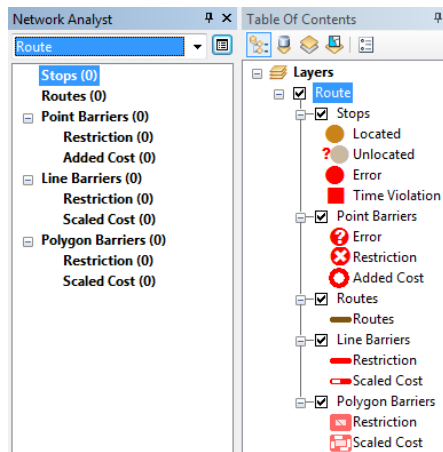
### 2.1 Route Selection

For this task, we will be looking at route selections. Route selection is performed using two or more points on the network. To identify a route from one point in the network to another, we must set the points on the network and click Solve. A route to the destination will be displayed. We can also add constraints such as barriers in the form of points, lines, and polygons.

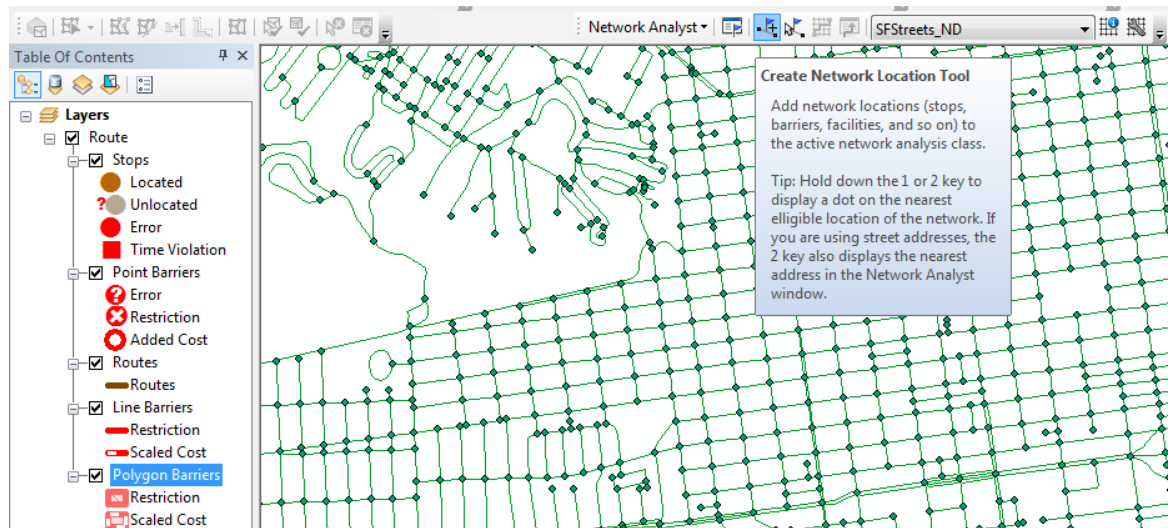
2. Click the Network Analyst dropdown on the Network Analyst toolbar and **click New Route**.



- Open the Network Analyst window by clicking the **Network Analyst** button  on the network analyst toolbar. The window that shows up on the left allows you to organize the Stops, Routes, Point Barriers, Line Barriers, and Polygon Barriers for routes that are created.



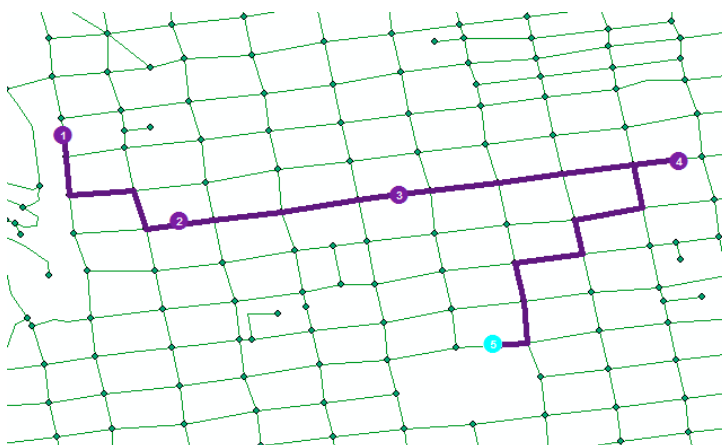
- A new layer has also been automatically added to the Table Of Contents called **Route**. It will contain various subtypes such as Stops, Point Barriers, Line Barriers, and Polygon Barriers. We will just be looking at the route solving. **Click the Create Network Location Tool.** This will allow you to plot points on the road network.



5. Create two locations on the network by **clicking any two different points on the network**. When you click, a number will be assigned to that point, this is the order in which they were added to the network. (If you haven't zoomed in already, this step is easier if you zoom in a little)

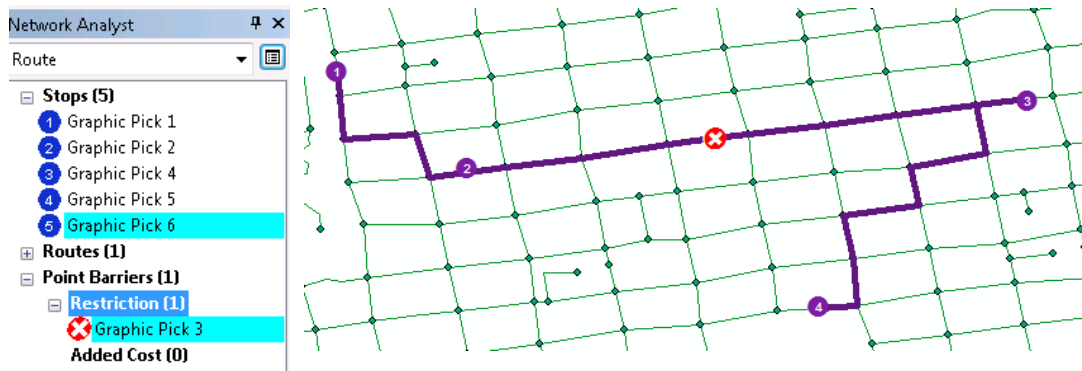


6. Click the **Solve** button on the Network Analyst toolbar to get the route from Point 1 to Point 2 from the network.
7. The route should be selected in the Table of Contents. Leave the route selected and **Export Map**, from the File tab in the main menu, of the route you just created so the network is visible.
8. Now, we will make use of barriers. Add some more locations and make sure there are at least 3 in a line on one road.

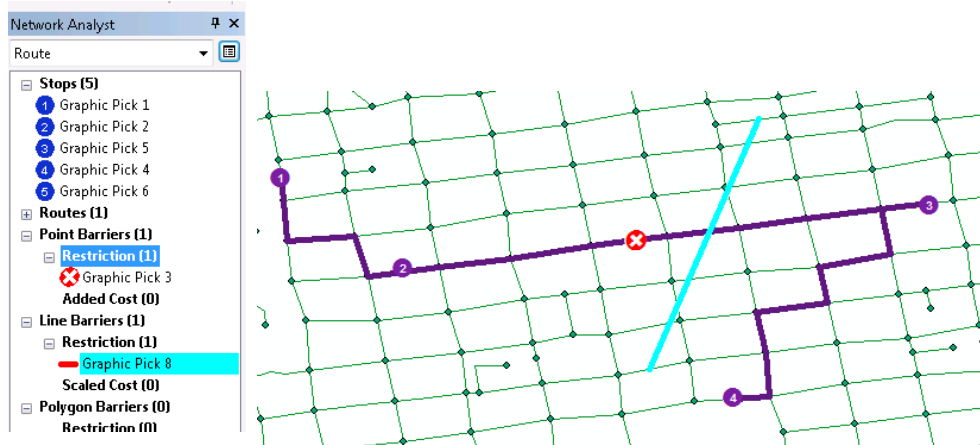




- The point in the middle will be turned into a barrier. In the network window, move your midpoint (in our case, Graphic Pick 3) by dragging and dropping into the Point Barriers category and the symbol will change from a number to a red cross. Click Solve and see how this point barrier changes the route between locations.



- In order to create a line barrier, **click** on the **Line Barriers** category in the Network Analyst window and you will be able to draw a line. **Click** one point anywhere on the map, draw a line across your route and over 3 or 4 streets, and **Double Click** to end the line. **Click Solve**. This should detour the route around your line barrier.



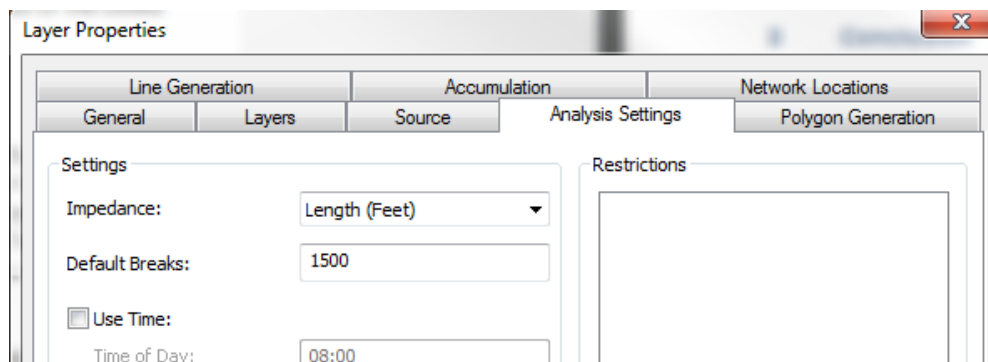
- Now create a polygon barrier on your route by **clicking** on the **Polygon Barriers** category and creating a polygon on the route.
- Solve the network again and observe the results.

## 2.2 Creating a Service Area

Service areas are created so that we can set a threshold for where a facility operates in the network. Fire stations service a certain area around their firehouse. These service areas show where the areas are that are serviced within a certain distance. This will calculate the area using the accessible roads. It can also model toward and away from the facility.

Add the **SFFirestations** shapefile to your map in ArcMap:

1. Click the Network Analyst dropdown and click **New Service Area**. A service area layer will be added to your Table Of Contents.
2. Right-click on the **Facilities** and click **Load Locations**. The Load Locations window will pop up. Choose the **SFFirestations** layer and click **OK**. Facilities will now have 62 items.
3. Right-click on the **Service Area** in the TOC, and click **Properties**, go to the **Analysis Settings** tab. We will be using length in feet as that is the only impedance we have. Type 1500 for Default Breaks.

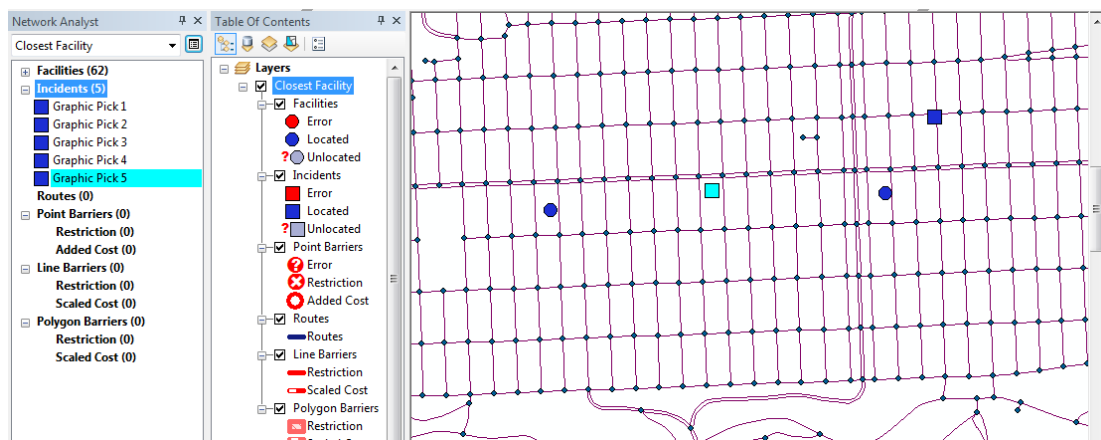


4. Click **OK** and **click Solve**. This should create polygons 1500 ft around each station.

## 2.3 Closest Facility Analysis

The Closest Facility Analysis calculates the closest facility to an event. Think of a police car: if an accident occurred, the police car that is the nearest should be the responder. So, the police car would be the facility and the accident is the event. We can also use restrictions, as this is an enhanced route selection query.

1. Click the Network Analyst dropdown and click **New Closest Facility**. A Closest Facility layer will be added to your Table Of Contents.
2. Load the facilities again in the new layer box, using the SFFirestations layer as we did in the previous task.
3. **Click on Incidents** below Facilities and then **click on the Create Network Location** tool on the Network Analyst toolbar and add some locations to the network.



4. **Click Solve** and lines will be drawn from the closest facility to the incidents.

## Conclusion

In this lab, we can see the use of the network analysis extension in ArcGIS. There are several applications for this analysis, emergency management being a huge contender. Network analysis allows for a great amount of data to be considered when calculating the best routes and service areas.

## Discussion Questions

1. What is a real world application of network analysis?
2. How can network analysis benefit the logistics industry?
3. What other networks can this apply to besides roads?