

Moving On

Migrating ArcView 3.x and ArcInfo networks to ArcGIS network datasets

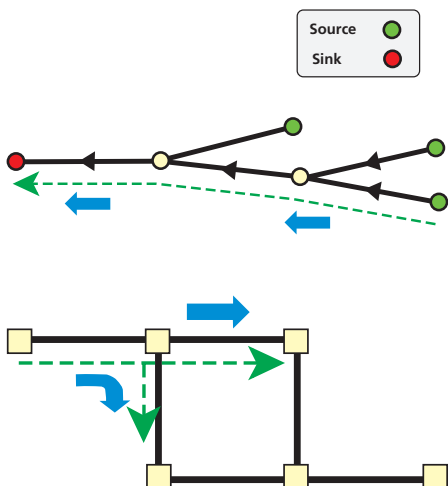
By Colin Childs, ESRI Educational Services

Networks are an integral part of our daily lives. We drive cars from home to work on a street network. We cook our dinner with natural gas or electricity that is delivered through networks of utility lines. We catch up on the news and send e-mail through the Internet, the largest wide area network.

In GIS, a network is defined as an interconnected set of lines and points representing geographic features through which resources can move. Three common types of networks are roads, streams, and utilities. Networks used for different applications have different types of network systems.

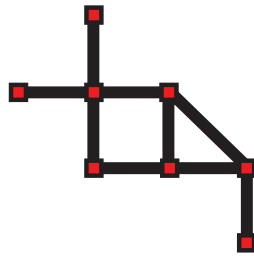
What Types of Networks Does ArcGIS 9 Support?

In ArcGIS, networks are typically either directed flow networks or undirected flow networks. In a directed flow network, the flow moves from a source toward a sink and the resource moving makes no travel decisions (e.g., river system). In an undirected flow system, flow is not entirely controlled by the system. The resource may make travel decisions that affect the result (e.g., traffic system).



ArcGIS uses two different data structures to support the different network types that represent directed flow networks and undirected flow networks. Directed flow networks are supported by geometric networks, while undirected flow networks are supported

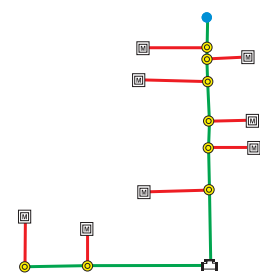
Roads



Streams



Utilities



by network datasets. This article focuses on creating a network dataset, the data structure crucial to the functionality of the ArcGIS Network Analyst extension.

What Components Make Up Networks?

Networks have two parts: the physical network and the logical network. The physical network consists of the data layers used to generate a network and provides the features to generate network elements. The logical network consists of a collection of tables that models network connectivity and references network element relationships.

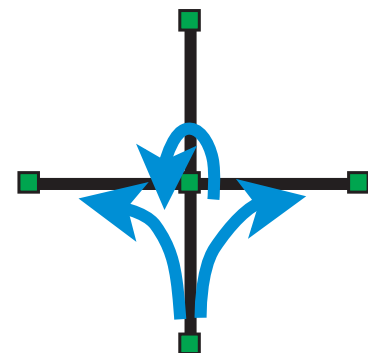
Defining a Network Dataset

The network dataset is a new data structure similar to a geometric network or a topology. It contains network elements (edges, junctions, and turns) that are generated from simple point and line features. Because it was designed to work with the ArcGIS Network Analyst extension, creating the structure requires an ArcGIS Network Analyst extension license. Network elements for a network dataset are derived from features when the network dataset is created.

- Edges are generated from linear features and are connected by junctions. Edges in the network dataset are bidirectional.
- Junctions are generated from point features. They connect edges and facilitate navigation. A junction may be connected to any number of edges.
- Turns are generated from line features or turn tables and describe transitions between edges.

The logical network consists of a set of element and index tables that link feature

classes and features to network elements and their connectivity. These tables are updated each time a network dataset is built. The purpose of the logical network is to provide the data structure necessary to enable network analysis such as route finding and service area location.



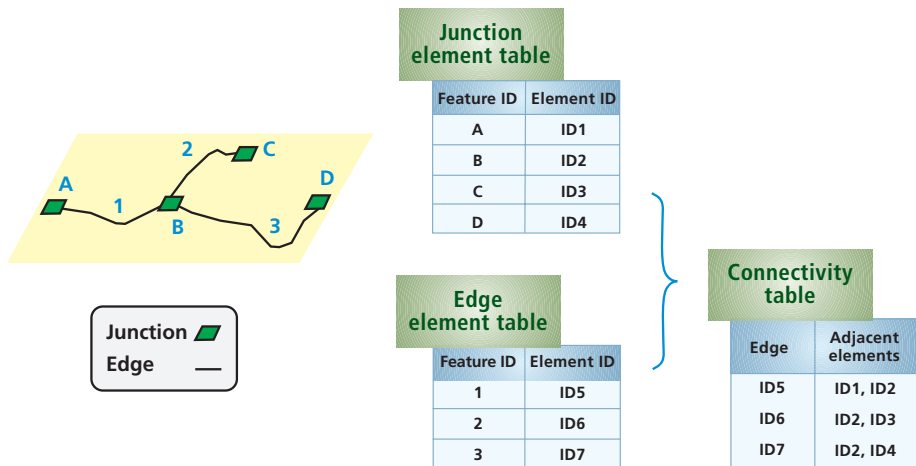
Turn Elements

In the network dataset, the connectivity of network elements is discovered by finding the geometric coincidences of points, polyline endpoints, and polyline vertices. Network element and connectivity information for the network dataset is stored in the logical network.

Data Sources for Network Datasets

There are three data sources for a network dataset:

- Personal geodatabases and multiuser geodatabases
- Shapefiles (the native data format for ArcView 3.x)
- StreetMap data (read only)



Network Dataset Properties

The network dataset has significant advantages over ArcView 3.x and ArcInfo network structures and offers enhanced modeling capabilities. Connectivity can be defined using a model that supports multimodal networks. Networks can model complex turns and maneuvers and apply network attributes through an advanced attribute model. Note that the simple features participating in the network dataset may also participate in a topology.

Creating a Network Dataset

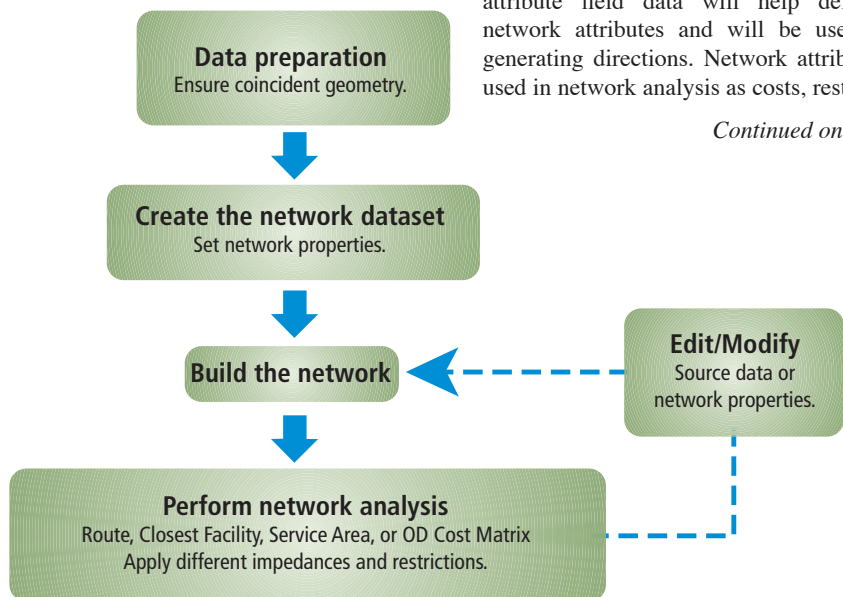
A wizard guides the user through the process of naming the network dataset and specifying the network element sources; defining connectivity policies and groups; incorporating turns and applying network attributes; and, lastly, specifying the properties for driving directions that can be created by some of the network solvers. Once the network dataset is generated, the logical network must be built.

Before creating the network dataset, decide whether it will be geodatabase based or shapefile based. A geodatabase-based network dataset can support multiple sources and can take advantage of other geodatabase components such as subtypes and topology. A multimodal network is best modeled using a geodatabase-based network dataset. A shapefile-based network dataset allows only one connectivity group and cannot use geodatabase functionality. Simple networks with only one source can be easily modeled with a shapefile-based network dataset.

When creating a network dataset, the source data used to derive network elements must be good quality. Good quality data has features that have coincident geometry and appropriate attributes. Conversely, poor quality data has features lacking coincident geometry and appropriate attributes and requires data preprocessing using geodatabase topology and/or the Integrate tool and the addition of suitable attribute fields.

The presence of suitable and appropriate attribute field data will help define the network attributes and will be used when generating directions. Network attributes are used in network analysis as costs, restrictions,

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What is a multimodal network?

People are very good at navigating transportation systems to get to a destination in the shortest time. A person wanting to get from one neighborhood in a city to another will naturally walk on streets to the nearest subway entrance, catch a ride on the subway, transfer to another subway line, exit at a station, and walk to the final destination. Network datasets are designed to model this kind of navigation.

This simple example combines two modes of transportation: walking on streets and riding a subway. While streets and subways often cross each other, these two systems have separate connectivity, which joins only at subway entrances.

This is specified by setting subway entrances to be in both the street and subway connectivity groups; this is the transition point between the two network systems.

Methods for Ensuring Coincidence

Create a geodatabase topology to

- Enforce the spatial integrity of data.
- Model spatial relationships for features within a single feature class or between two feature classes.
- Discover and correct errors using topology tools.
- Improve poor quality data before creating a network dataset.
- ArcEditor and ArcInfo only

Use the Integrate tool to

- Compare features and make lines, points, or vertices within a certain distance identical or coincident.
- Insert vertices along lines when they intersect other lines.
- Modify the original input features without creating new data.
- All license levels

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descriptors, or hierarchies. Some typical attribute fields useful for network attributes and directions are shown in Table 1.

Turns in the Network Dataset

In a network, turns describe transitions between two or more edges. In a network dataset, turns are used to model cost and/or restrictions in the network. Incorporating turn elements in a network dataset yields more realistic network solver results.

In a network dataset, there are two options with regard to turns—incorporating turn features and applying global (default) turns. When incorporating turn features, the global turn properties are replaced by the turn feature properties for those locations where a turn feature is present. Where turn features are not present, the global turn policy is applied.

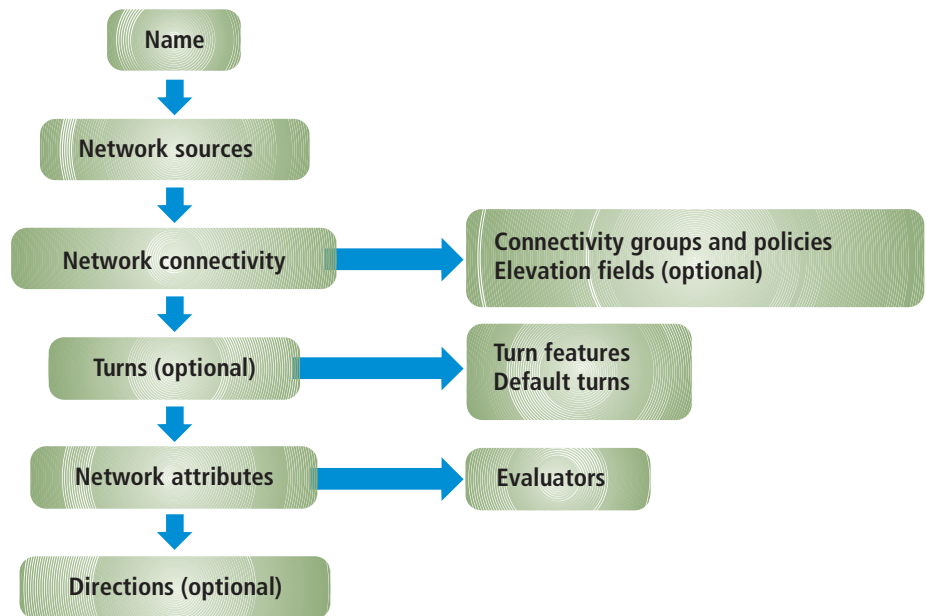
Migrating to the ArcGIS Network Dataset

The process for creating a network dataset is relatively simple but involves making decisions on connectivity policies and connectivity groups, the incorporation of turns and hierarchies, and the creation of network attributes. When migrating from an ArcInfo Workstation network or an ArcView 3.x network, first migrate the street geometry and attributes from these formats; then migrate the turns to a turn feature class, and, finally, create a network dataset with the migrated features. Note that it is not necessary to migrate the street data when creating a shapefile-based network from an existing ArcView 3.x network. Simply migrate the turn table to a turn feature class, then create the network dataset on top of the original street shapefile.

To migrate the street features stored in a coverage or shapefile to a geodatabase feature class, first create a new feature dataset in the geodatabase with the same spatial reference as the original coverage or shapefile data, then use the Feature Class To Feature Class geoprocessing tool and specify the feature dataset created as the Output Location.

Migrating coverage or shapefile turn data in a turn table to a turn feature class requires the Turn Table To Turn Feature Class geoprocessing tool and two inputs: the Turn table in dBASE or INFO format and a reference street dataset. The reference street dataset is the migrated street feature class. The tool will create a turn shapefile or a geodatabase turn feature class as output.

Once all the data has been migrated, create and build the network dataset using the New Network Dataset wizard.



Field name	Data type	Attribute type	Application
One way	Text	Restriction	Helps determine one-way streets
Length	Double	Cost	Calculates shortest route
Travel time	Double	Cost	Calculates fastest route
Speed	Integer	Descriptor	May be used to calculate travel time
Street name or address data	Text	NA	Helps generate network locations and directions

Table 1: Attribute fields useful for network analysis

Network element type	Coverage data source
Network links	Arc features in a line coverage (.AAT file)
Network nodes	Node features in a line coverage (.NAT file)
Turns	Turn table or coverage TRN file (INFO table)

Solver inputs	Coverage data source
Stops	Stops file (INFO table)
Centers	Centers file (INFO table)

Network element type	ArcView 3.x data source
Edges	Line theme from coverage, shapefile, or third-party vendor data. Attribute table must contain road "behavior" information.
Junctions	Stored in network index directory file (nodes.dbf). Implicitly generated based on edge features.
Turns	Turn table (dBASE table)

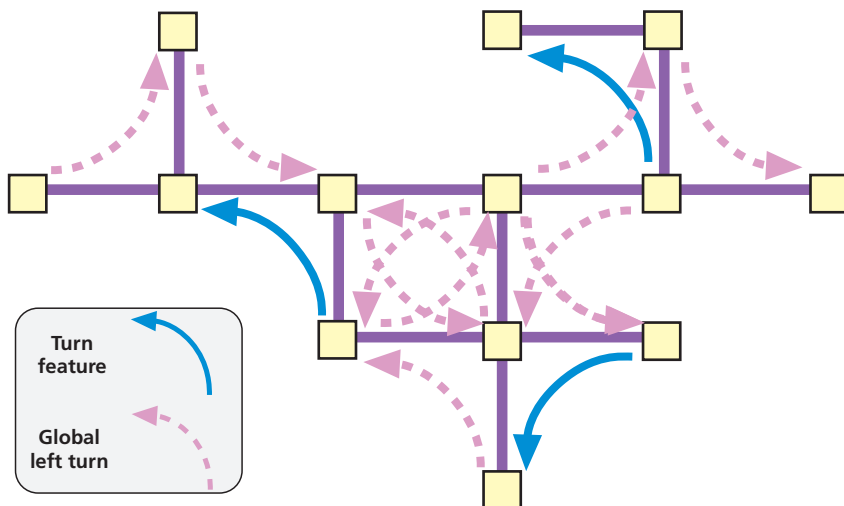
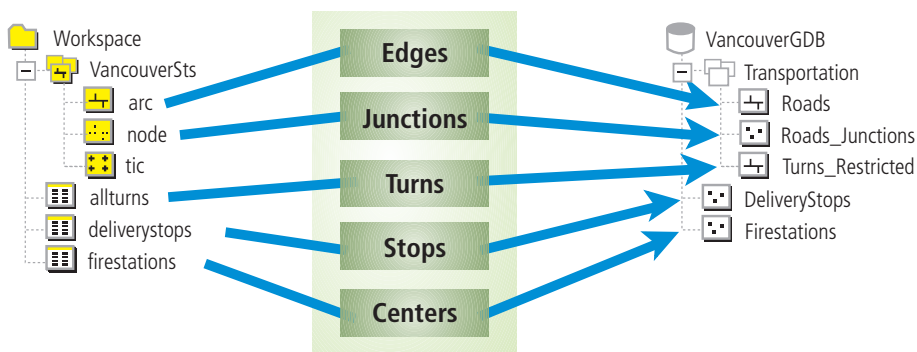
Solver inputs	ArcView 3.x data source
Stops	Point theme
Facilities	Point theme
Incidents	Point theme

Conclusion

Network datasets can be created from geodatabase feature classes and shapefiles. It is important to check the quality of source data and ensure that network element source features have coincident geometry and appropriate attributes. Existing ESRI networks from ArcInfo Workstation and ArcView 3.x can be migrated to the geodatabase and used to create network datasets for use with the ArcGIS Network Analyst extension.

About the Author

Colin Childs is an ESRI software instructor in Redlands, California. He has a degree in geography from the Rand Afrikaans University in Johannesburg, South Africa. He was a software instructor for GIMS, ESRI's South African distributor, before joining ESRI in Redlands five years ago.



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