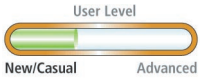

ArcGIS Topology for ArcView Users

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Editor's note: This article provides an introduction to the topology tools available at ArcGIS 8.3 and focuses on the map topology tools available to ArcView license users.

Topology is a special field within the mathematical sciences. However, in the context of maps and cartography, it is largely used to compare the positions of geographic features relative to one another, such as roads that are connected to highways, or a capital city that is contained within a state, or two land parcels that are adjacent to one another.

All map users intuitively work with topology as they read maps and attempt to discern the location or position of geographic features. For example, a truck driver needing to deliver a load may simply follow the highways and roads that connect the origin to the delivery destination on a map.

Examining the coordinates of spatial features relative to one another can assist us in deriving topological relationships between features. As GIS practitioners, we take advantage of the topological structure of digital map data in a variety of ways—for example, by selecting features by location relative to other features or tracing the flow of a contaminant in a river network.

The topological structure of data may also be used to ensure that features are spatially correct. This structure ensures that, for example, soil polygons do not overlap one another and bus routes follow roads.

ArcGIS 8.3 provides tools that maintain the topological integrity of features in one or more feature classes. Features that are supposed to be spatially coincident, such as the common edges between parcels of land, are snapped together so that they really are coincident.

You can control how far coordinates move when they are snapped. Setting the relative importance of feature classes allows you to specify how coordinates are snapped together. This prioritizing, for instance, would force less accurate digitized parcel boundaries to move to more accurate surveyed lot lines.

In a typical GIS database, many features may be wholly or partially coincident with one another. For example, parcel, census tract, and land use boundaries may be superimposed. Topology can integrate coincident features into a common editing environment, so changes to one shared feature such as a parcel boundary will automatically change all the coincident features.

ArcGIS 8.3 introduces a set of tools for spatial data validation that includes tools for creating and editing as well as validating topologically related features in a geodatabase. Although topology, or at least the maintenance of coincident geometry, has been available in the geodatabase since its inception, ArcGIS 8.3 introduces a more structured approach to managing and maintaining spatial relationships between features through a set of validation rules that define how features may share a geographic space.

Topology at ArcGIS 8.3 includes a set of editing tools designed to work in an integrated fashion with features that share geometry. Explicit topological relationships between features in the ArcInfo coverage model are stored arcs with from- and to-nodes and left and right polygons. In ArcGIS, feature topology is discovered on the fly by applications by ArcMap so that the data structure is stable. This means that mapping, analysis, and editing can be performed without applying CLEAN or BUILD.

You can manage the spatial integrity of data with tools for editing coincident geometry between feature classes. Multiple feature classes can be edited simultaneously if they contain coincident geometry. This means a parcel polygon that shares a common boundary with polygons from zoning, land use, and subdivision layers can be edited using the ArcMap topology editing tools, and all coincident features will be automatically updated or individual shared features can be selected for update.

Geodatabase topology stores the topology rules, ranks, and cluster tolerance instead of storing topological information for all features. When topology is validated, the rules, ranks, and cluster tolerance are used to discover where the topology may have been violated. To take advantage of geodatabase topology, you must have an ArcEditor or ArcInfo license.

Understanding Map Topology

ArcView 8.3 users can use map topology to perform many topological edits on shapefiles or simple feature classes (i.e., points, lines, polygons, or annotation with no topological associations among them) without setting ranks and rules or validating. Map topology, a basic form of topology, is used on simple features in a map during an edit session. These features may be stored as a shapefile or personal geodatabase feature class.

In a map topology, features that overlap or touch can be simultaneously edited using tools located on the Topology toolbar. These features may be in one or more feature classes and may have different geometries, but they must be stored in the same folder or geodatabase.

At the geometry level, topologies are about simple relationships, such as coincidence, covering, and crossing, between the geometric primitives that make up features. All simple feature class geometries (i.e., point, line, polygon) may participate in topologies. Internally edges, nodes, and pseudonodes are the types of geometry that are acted on when a topology is edited. An edge is a line segment that defines a line or polygon. A node is a point at the end of an edge. A pseudonode is a node that connects only two edges or a logical split defined in the topology cache while editing. After editing, pseudonodes created by a logical split become vertices.

A map topology is created while editing features. To use the Map Topology tool, the participating feature classes and the cluster tolerance must be specified. Once a map topology is created, the Topology Edit tool can be used to edit the coincident edges and

Simple feature	Topology elements
Polygon	Edges define a polygon boundary. Nodes are located at edge intersections. Vertices define the shape of edges.
Line	An edge is defined by a line. Two nodes define the endpoints of an edge. Vertices define the shape of the edge.
Point	Points have node behavior when coincident with other features in a topology.

Topology Tool Availability

	Geodatabase Topology	Map Topology (ArcEditor)	Map Topology (ArcView)
Topology Edit Tool	✓	✓	✓
Show Shared Features	✓	✓	✓
Planarize Lines	✓	✓	
Construct Features	✓	✓	
Validate	✓		
Error Management	✓		

Geodatabase topology stores the topology rules, ranks, and cluster tolerance instead of storing topological information for all features.

nodes shared by the features.

Editing an edge or node shared by two or more different features will modify each participating feature so that moving a parcel's corner vertex will update the related parcel polygons and lot boundaries at the same time.

When creating a map topology, setting an appropriate cluster tolerance is critical. The cluster tolerance represents a distance in which all geometry is considered identical or coincident. The cluster tolerance specified determines which parts of features are coincident and which edges and nodes in the topology are shared. Typically, a cluster tolerance is actually a very small ground distance and should be about one-tenth the positional accuracy of the coordinates. Setting large cluster tolerances can cause features to collapse or become distorted when vertices within a feature snap together.

Creating and Using Map Topology

The Topology toolbar contains tools for creating a map topology and for working with map and geodatabase topologies. Topology tools are only available within an edit session. Once the data to be edited is displayed, start an editing session by choosing Editor > Start Editing from the Editor toolbar. Click the map topology icon on the Topology toolbar, select the participating feature classes, and set the cluster tolerance.

Next, select the topology element to be edited using the Topology Edit tool. ArcMap creates a topology cache. The topology cache stores the topological relationships between edges and nodes of the features that fall within the current display extent. If you are editing with the map zoomed in to a very small area and return to a previous extent, some of the features in the new extent may not be in the topology cache. However, you can rebuild the topology cache to include these features as well as to remove temporary topology nodes created for snapping and editing.

Map Topology Tasks

Although you can use regular editing tools to edit the individual features that participate in a topology, this means that you are editing only one feature at a time. The map topology tools offer additional functionality designed to maintain the coincidence between features and edit shared geometry. Map topology creates a topological relationship between the parts of features that are coincident.

Moving coincident geometry, a common topology task, is accomplished using the Topology Edit tool to select and edit coincident edges and nodes. To edit common features, hold down the E or N key while selecting an edge or node with the Topology Edit tool. A topology cache is created, and the topology edge or node can be moved to a new location. Rubber banding (the automatic adjustment of connected features in all participating feature classes) ensures feature integrity. Participating features and feature classes can be managed by using the Show Shared Features tool.

Two new edit tasks, Reshape Edge and Modify Edge, have been added to the Task list under the Topology Tasks category. The Reshape Edge task, which is similar to Reshape Feature but acts only on shared edges, lets you reshape a shared edge with a sketch. The Modify Edge task allows you to edit the vertices of an edge in the edit sketch and have these modifications cascade to all participating feature classes.

Split/Move Node is a new technique that can be used to move an edge and a node without moving the edges and nodes connected to those features (i.e., you can move an edge without rubber banding connected features). Split/Move Node temporarily removes an edge and a node from the topology while you move a feature and then puts it back without rubber banding the connected features. This is accomplished by selecting one edge and one node, then holding down the S key and left mouse button over the node to move. Release the left mouse button to return the node back to the topology.

Conclusion

ArcGIS 8.3 provides ArcView users with powerful topological editing capabilities through the use of map topology. This functionality enforces spatial integrity between features and between multiple feature classes and shapefiles and can complement the rich set of data validation tools available to ArcEditor and ArcInfo users.

For additional information on map topology, see the ArcGIS online help. A companion tutorial for this article, complete with a sample dataset, can be downloaded from the *ArcUser Online* Web site at www.esri.com/arcuser.