Parcel Management
Using Topology in ArcGIS 8.3

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With the advent of ArcGIS and the geodatabase, it is easy to model geographic features in a relational database. With the introduction of topology at version 8.3, it is now possible to build, maintain, and qualify the spatial integrity of those geographic features. With geodatabase topology, spatial integrity is managed by applying rules to features that belong to a topology. These rules can be applied to a single feature class or a subtype and can specify conditions such as "must not overlap" or "must be contained within."

Using ArcCatalog and ArcMap, the validation process checks for violations of these topology rules and stores them in the geodatabase. ArcMap has new tools to identify and fix validation errors. This article describes how topological relationships are defined and maintained in ArcGIS 8.3.

Prior to the geodatabase, the coverage model was the standard for GIS topology. Primitive topology elements—nodes, lines, and polygons—are depicted in a coverage. Subclasses are created from these primitive entities to form regions and routes that define real-world geographic features. Using the CLEAN command, spatial integrity can be enforced between these feature types. However, all errors must be fixed prior to creating a topology. Arc and ArcEdit provide a collection of commands for creating, maintaining, and analyzing the relationships between these geographic features.

When comparing coverage topology to topology in the geodatabase, the basic principles remain the same. Topology is the foundation of spatial integrity. However, there are differences in implementation and requirements. Unlike the coverage model, a geodatabase can model real-world behaviors in features without topology. While the coverage model requires a "clean" topology (i.e., free from dangles, overshoots, pseudo nodes, etc.) before topology is established, the geodatabase is more flexible. It allows errors and exceptions between geographic features while maintaining topology in the dataset. Rules are applied to a topology and enforced through the validation process so that spatial integrity errors between features are corrected and data quality maintained.

What Is a Topology?

Topology, whether in a coverage or a geodatabase, is defined by rules that manage the spatial relationships between different
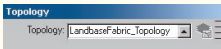
Icon	Tool	Function
Topology: LandbaseFabric_Topology	Topologies	Topologies present in ArcMap
	Map Topology	Creates temporary topology between features in the map
	Construct Features	Creates new features in target feature layer
	Planarize Lines	Creates points at intersections between features
	Topology Edit	Interactive shared edit tool
	Show Shared Features	Display spatial relationships between features
	Validation	Validates dirty areas
	Error Inspection	Interactive error inspecting tools for QA/QC

Figure 1: Topology tools

objects in a database. Before going any further, let's clarify what a topology is in the context of ArcGIS 8.3. A topology contains relationships between objects in different feature classes exposed as a layer in ArcCatalog. In addition, this layer tracks feature edits during an edit session to enforce the rules applied to the topology. Validation tools are then used to determine if topology rules have been broken during the edit session.

In ArcCatalog, a topology layer is created inside a feature dataset because all participating feature classes must have the same spatial reference. Feature datasets may contain multiple topologies with many different types of feature classes so that topologies based on real-world objects, such as towns, tracts, and parcels, can be created without limiting the user to the classic line-to-polygon spatial relationship. At ArcGIS 8.3, topologies can be chosen individually for maintenance or analysis in ArcMap using the new editing tools on the Topology toolbar.

Create a topology layer by right-clicking on the feature dataset and choosing New > Topology in the context menu. Use the Topology Layer Properties to set the cluster tolerance, feature class ranking, and topology rules. Click on the General tab to specify a cluster tolerance that fits the precision of the data. The cluster tolerance defines the spatial coincidence between features. If two parcel boundaries are two map units away from each other and the cluster tolerance is set to three map units, the validation will cause those boundaries to become coincident.

Click on the Feature Classes tab to assign ranks to feature classes and prioritize how features will be moved during the validation process. This process is similar to the use of CLEAN with a fuzzy tolerance in Workstation ArcInfo. However, far more control can be applied to each feature class using the new topology in ArcGIS 8.3.

On the Rules tab, click on Add Rule to include rules that will manage the topological relationships between features with a feature class or features between feature classes. Creating a rule, such as "must not overlap," does not guarantee it will never be broken but will ensure that violations will be marked as errors.

Areas that have been edited but not validated, and are therefore undefined, are
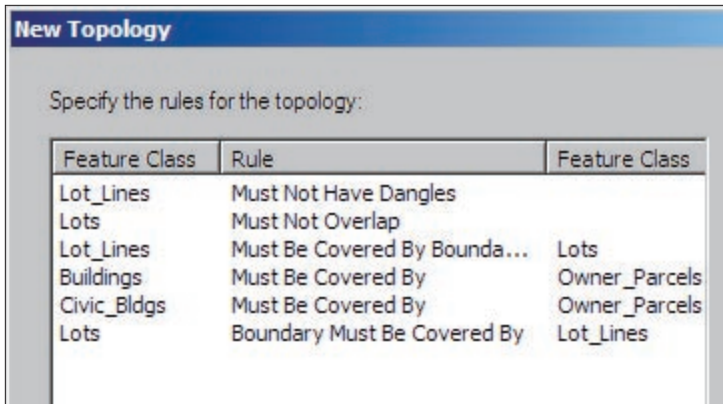
Setting rules manages the topological relationships between features with a feature class or features between feature classes.

referred to as dirty areas. Unlike Workstation ArcInfo, in ArcGIS, polygons are always present regardless of edits made to the data—CLEAN and BUILD do not have to be run to reestablish topology after editing. ArcGIS users are not required to run validate before saving changes and dirty areas are allowed to persist in the database. Validation can be limited to specific features or an extent of the data. This allow organizations to develop less restrictive work flows. During the validation process, the errors that are flagged may be left unresolved in the database, marked as exceptions, or fixed.

The Topology Toolbar

In ArcMap, the Topology toolbar provides a set of robust tools for maintaining and querying features in a database that participate in a topology. The toolbar is accessed by choosing Select Editor > More Editing Tools > Topology. A list of the tools provided is shown in Figure 1.

### The Topology Layer in ArcMap

The topology layer not only contains special features that represent the errors, exceptions, and dirty areas present in the data but can also be used to refine selection criteria for the Fix Topology Error tool. Just like other data layers in a map document, the topology layer has a properties page that displays the individual components of the topology layer. The symbology used for representing individual errors and exceptions can be modified. Several renderers are used to display different types of topology errors. Reports listing the errors for the current edit session can be generated and rules and feature class ranks can also be added or modified for a particular editing session using the Topology Layer Properties page.

More Powerful Spatial Editing

ArcGIS allows multiple feature classes to be edited at the same time, helps ensure topological integrity through the validation process, and provides new tools not only for editing but also for correcting errors. The new capabilities allow editing of features in two feature classes at once. Features can easily be merged and split. Tools such as Construct Features can create features in
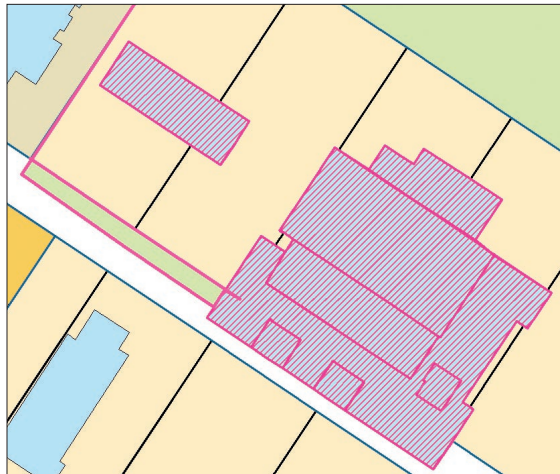
In this example, topological rules specified that buildings (blue) not overlap parcels (tan) and that lot lines share coincident geometry with lot polygons. Running Validate identifies violations of these rules and highlights these errors in magenta.
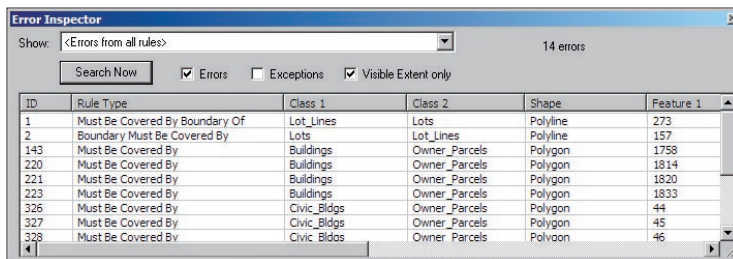
The Error Inspector displays both errors and exceptions in the topology.

one feature class based on the geometry of selected features in another feature class. The Advanced Editing toolbar adds editing tools not available on the standard Editor toolbar such as fillet, extend, trim, explode multipart objects, traverse, generalize, smooth, and a new annotation editing tool.

The Error Inspector manages errors found during the validation process. As previously mentioned, errors can be left as unresolved in the database, marked as exceptions, or corrected using the Fix Topology Error tool or some other method. The Fix Topology Error tool provides a list of possible corrections that include merge, subtract, dissolve, and trim. The user can search for all errors or only errors caused by specific rule violations. An error report can be generated and exported to file in the Topology Layer Properties page on the Errors tab. This feature gives administrators the total number of errors and exceptions in the data and helps estimate how long it will take to clean the data.

Conclusion

ArcGIS 8.3 provides users with advanced topological editing tools that enforce spatial integrity constraints between features. Topology is now more independent of the data, which enables users to develop work flows based on organization-specific data requirements rather than a software data model. With the new tools in ArcGIS 8.3, users can effectively maintain spatial integrity across multiple feature classes in a geodatabase. Additional information on topology is available from the ArcGIS online help.

About the Author

Ty Fitzpatrick received a bachelor's degree in geography from the University of Delaware. While attending college, he worked for the Water Resources Agency of New Castle County, Delaware. He began working for ESRI seven years ago and currently works in Technical Marketing on the ESRI Redlands campus.