Vector Topology in ArcGIS

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• GIS data as representations of features and processes on and near the surface of the Earth, need to:
  
  o Reflect the existing spatial relationships between the features, processes (e.g. residential houses representations are positioned on the land, not in lakes; fish spawn in rivers and lakes, not on the land, etc.).

  o Form database architecture that allows for reliable and efficient use and management of data (e.g., the width of overlaps or gaps between forest polygons should not be even just a couple of mm)

Logical consistency!
Examples of GIS data spatial relationships:

**Within GIS datasets**
- Land classes (stands) must not overlap
- No gaps (holes) between adjacent lands classes (stands) or inside stands can exist
- Roads must not overlap
- Roads must not have gaps along the road line

**Between GIS datasets**
- Depletion polys must not overlap reserves
- Sample plots must contain sample points; or, sample points must be within sample plots.
- Vegetation polygons must be covered by soil polygons.

- Topological relationships are part of the GIS database’s **Data Dictionary**.

- Sources of spatial logical consistency errors in GIS data:
  - Errors or lack of rules in collecting data.
  - Errors or lack of rules in managing data.
  - Errors in actual actions on the ground.
GIS Topology

- In GIS, topological analysis is the most effective and sometimes the only way of evaluating, establishing and monitoring many components of spatial data quality.

- **Map topology**, or so called on-the-fly topology, is used in ArcMap on vector datasets, be it shapefiles or geodatabase feature classes, and is a lower level of dealing with some topological issues inherent to editing features in shapefiles and feature classes.

- **Geodatabase topology** in ArcGIS explicitly defines spatial relationships within and between GIS datasets.

Topology and other approaches to evaluating and enforcing GIS data quality should, however, be used only as a quality control of an already well thought out and robustly built database architecture where everyone involved in the entire process, from the building of schema and collecting data to data management, has been following well designed and clear rules.
Map Topology – Topology On-the-fly

- On-the-fly topology can be established for a shapefile or feature class and enable performing operations on shared feature.

1. Open Topology toolbar:
   1) Start Editing
   2) Editor toolbar dropdown menu > More Editing Tools > Topology

2. Create topology

- Map Topology is very handy in moving common borders between polygons and in constructing features, e.g., polygons from lines.
- Map Topology works on shapefiles as well; it can be used only during editing.
- It’s different from regular Topology – rules cannot be established and validated.
Map Topology can be used to move the mutual border between polygons, avoiding overlaps and gaps between the polygons.

1) In the editing mode, click on Topology Edit Tool.

2) Click on the border.

3) Use Modify Edge or Reshape Edge to add/move vertices or reshape the border by drawing a line, respectively.
Topology in Geodatabase

• Topology is created within a Feature Dataset, on Feature Classe(s) that it contains.

• Feature Datasets represent the spatial and map projection envelope within which Feature Classes are nested.

• Topology can be created for vector datasets but not for rasters.

• Topology is defined through topological rules
• Applicable to all feature types, polygons, lines, and points.

• Defined and validated in feature datasets within personal databases; validated, errors viewed and corrected through editing in ArcMap.

• Enforcement of topological rules can ensure spatial accuracy and integrity across the GIS database.

• Application of a specific rule depends on the desirable type of spatial relationships within and between feature classes.

• Topology rules can also be marked as exceptions.
How to Create Topology Rules

1) In ArcCatalog, select the feature dataset, right-click, select New, and select Topology. The Topology wizard opens. Click Next.
2) Enter a name and leave the default cluster tolerance unless otherwise desired. Click Next.
3) Select the feature classes that will participate in the topology. Click Next.
4) Leave the default number of ranks unless otherwise desired. Click Next.
5) Add desired rules for the feature classes involved in the topology. Click Next.
6) Finish.
7) Say yes if asked to validate the topology.

- When created, the topology shows up in the Feature Dataset content, in ArcCatalog, as a File (Personal) Geodatabase Topology. This new item can now be dragged into an open ArcMap project along with the feature classes involved in the topology.
- In Arc Catalog, a topology can be modified (right-click on the topology – Properties), deleted (right-click – Delete), etc.
- Violations of topological rules can be fixed in ArcMap through regular editing.
ArcMap Topology Editing

- Topology editing is located on the Topology toolbar: Editor → More Editing Tools → Topology
- Violations are fixed by first validating the involved layers and set rules, then fixing the violations, and lastly, validating again to make sure that the violations are fixed.

1) Bring (drag) in the project the topology and involved feature classes

2) Start Editing

3) Turn-on the Topology Toolbar.

4) Use Error Inspector or Fix Error tool to address violations one by one.

5) Use other editing tools if needed to fix violations.

6) Keep validating and saving edits as the violations are fixed.

7) When all violations are fixed/addressed (some can be left as exceptions – depends on the goals), save & stop editing.
The Error Inspector enables to list all rule violations, select individual ones, zoom-in, and solve them.

Only specific violations can be listed and displayed.

The specific violation can be zoomed-in to and resolved with the offered functions.

All violations listed and displayed.

Offered functions are only suggestions; the violations can be resolved with any suitable editing function.

After the violations have been edited and solved, the datasets need to be validated to determine if the violation has been properly addressed and removed.

Violations can be solved or set as exceptions.