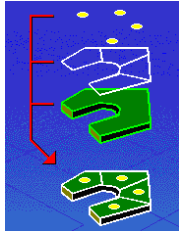


# Topology



Defined as the “the science and mathematics of relationships used to validate the geometry of vector entities, and for operations such as network tracing and tests of polygon adjacency”

Longley et al., p. 190.

## Shapefile versus Coverage Views

- There no topology defined in shapefiles.
- Features are disconnected.
- Boundaries between polygons are represented twice.

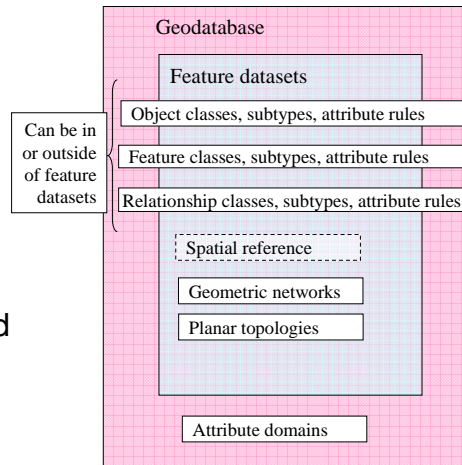


- Topological connections must be maintained in coverages.
- Boundaries are digitized only once.

# Contents of a Geodatabase

Generally,

- Characteristics of a geodatabase are defined within ArcCatalog.
- Data are entered, edited, and validated in ArcMap.



## Topology in Geodatabases

- A topology helps monitor and protect the spatial relationships in a feature dataset.
- A feature class can have no rules, a single rule, or several rules.
- A topology rule can monitor spatial relationships of features in a single feature class, or the relationships that exist between feature classes.
- Only simple feature classes in the same dataset can participate in a topology (Annotation, dimension, and geometric network features are not simple features).
- A topology must be in the same feature dataset as the feature classes it monitors. Feature classes outside of the topology's feature dataset cannot participate in the topology.
- A feature dataset can contain more than one topology, but feature classes cannot participate in more than one topology at a time.
- You can add and remove topologies and rules at any time.
- Rules are not applied until a topology is validated (discussed later).

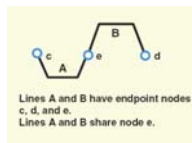
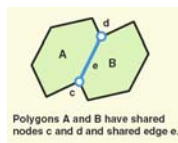
# How Topologies are Built?

## Geometries involved in a topology

- Edges
- Endpoints (nodes)
- Pseudonodes (vertices)

## Ways of sharing geometry

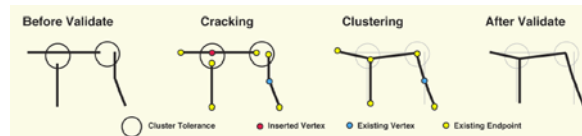
- Line features can share endpoints
- Area features can share edges
- Line features can share segments with other line features
- Area features can be coincident with other area features
- Line features can share endpoint vertices with other point features
- Point features can be coincident with line features



# How Topologies are Built? (cont.)

## Building a topology

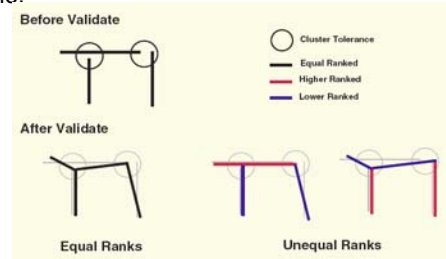
- Cracking
- Clustering



## Cluster tolerance

- should be as small as possible.  
The default is 0.

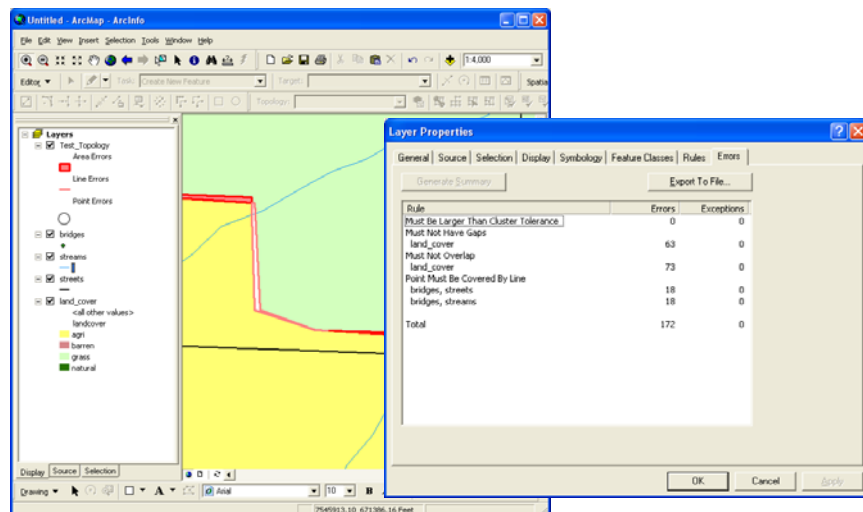
## Feature class ranks



# Validating Topology

- Once you've made edits to a feature that participates in a topology or created a new topology, the next step is to validate the topology.
- Validating the topology means checking the features to identify any violations of the rules that have been defined for the topology.
- You can validate the whole topology, validate the visible extent of your map, or drag a box around the area to validate. You can also validate the whole topology in ArcCatalog
- Validating the topology also starts the cracking and clustering process. ***The process is irreversible in ArcCatalog!***

## Validating Topology (cont.)



# Topology Editing

- When you move a node in a topology, all of the edges that connect to it are stretched to stay connected to the node. When you move an edge, edge segments stretch to maintain the connection of shared endpoint nodes to their previous location.
- Using Topology Edit Tools

## Geodatabase Topology Rules

... aren't automatically applied; need to be selected by database designer or user

### ***Line or Polygon***

- (Distance b/t vertices) Must be larger than cluster tolerance

### ***Point Rules***

- Point must be covered by line
- Must be properly inside (polygons)
- Must be covered by endpoint of
- Must be covered by boundary of

### ***Line Rules***

- Must not overlap
- Must be single part
- Must not self overlap
- Must not overlap with
- Must not have dangles
- Must not have pseudo-nodes (pseudos)
- Must not intersect
- Must not self intersect
- Endpoint must be covered by
- Must be covered by boundary of
- Must not intersect or touch interior
- Must be covered by feature class of

### ***Polygon Rules***

- Contains points
- Must not overlap
- Must not have gaps
- Must not overlap with
- Must be covered by
- Must cover each other
- Boundary must be covered by
- Must be covered by feature class of
- Area boundary must be covered by boundary of

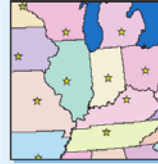
## Point

### Must be properly inside polygons

Points in one feature class or subtype must be inside polygons of another feature class or subtype.



Point errors are created where the points are outside or touch the boundary of the polygons.



State capitals must be inside each state.

Use this rule when you want points to be completely within the boundaries of polygons.

## Point

### Must be covered by boundary of

Points in one feature class or subtype must touch boundaries of polygons from another feature class or subtype.



Point errors are created where points do not touch the boundaries of polygons.



Utility service points might be required to be on the boundary of a parcel.

Use this rule when you want points to align with the boundaries of polygons.

## Point

### Must be covered by endpoint of

Points in one feature class or subtype must be covered by the ends of lines in another feature class or subtype.



Point errors are created on the points that are not covered by the ends of lines.



Street intersections must be covered by the endpoints of street centerlines.

Use this rule when you want to model points that are coincident with the ends of lines.

## Point

### Point must be covered by line

Points in one feature class or subtype must be covered by lines in another feature class or subtype.



Point errors are created on the points that are not covered by lines.



Monitoring stations must fall along streams.

Use this rule when you want to model points that are coincident with lines.

## Line or Polygon

### Must be larger than cluster tolerance

Cluster tolerance is the minimum distance between vertices of features.

Vertices that fall within the cluster tolerance are defined as coincident and are snapped together.



Cluster Tolerance

Cluster Tolerance

Any polygon or line feature that would collapse when validating the topology is an error.



Soil polygons must be larger than the cluster tolerance.

*This rule is applied to all line and polygon feature classes that participate in the topology.*

## Polygon

### Must not overlap

Polygons must not overlap within a feature class or subtype. Polygons can be disconnected or touch at a point or touch along an edge.



Polygon errors are created from areas where polygons overlap.



A voting district map cannot have any overlaps in its coverage.

*Use this rule to make sure that no polygon overlaps another polygon in the same feature class or subtype.*

## Polygon

### Contains point

Each polygon of the first feature class or subtype must contain within its boundaries at least one point of the second feature class or subtype.



Polygon errors are created from the polygons that do not contain at least one point. A point on the boundary of a polygon is not contained in that polygon.



Parcels must contain at least one address point.

*Use this rule to make sure that all polygons have at least one point within their boundaries. Overlapping polygons can share a point in that overlapping area.*

## Polygon

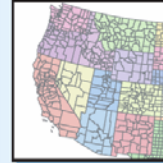
### Must be covered by feature class of



The polygons in the first feature class or subtype must be covered by the polygons of the second feature class or subtype.



Polygon errors are created from the uncovered areas of the polygons in the first feature class or subtype.



States are covered by counties.

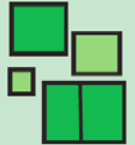
Use this rule when each polygon in one feature class or subtype should be covered by all the polygons of another feature class or subtype.

## Polygon

### Must not overlap with



Polygons of the first feature class or subtype must not overlap polygons of the second feature class or subtype.



Polygon errors are created where polygons from the two feature classes or subtypes overlap.



Lakes and land parcels from two different feature classes must not overlap.

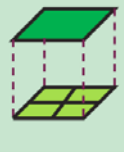
Use this rule when polygons from one feature class or subtype should not overlap polygons of another feature class or subtype.

## Polygon

### Area boundary must be covered by boundary of



The boundaries of polygons in one feature class or subtype must be covered by the boundaries of polygons in another feature class or subtype.



Line errors are created where polygon boundaries in the first feature class or subtype are not covered by the boundaries of polygons in another feature class or subtype.



Subdivision boundaries are coincident with parcel boundaries, but do not cover all parcels.

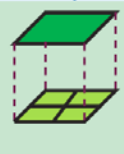
Use this rule when the boundaries of polygons in one feature class or subtype should align with the boundaries of polygons in another feature class or subtype.

## Polygon

### Area boundary must be covered by boundary of



The boundaries of polygons in one feature class or subtype must be covered by the boundaries of polygons in another feature class or subtype.



Line errors are created where polygon boundaries in the first feature class or subtype are not covered by the boundaries of polygons in another feature class or subtype.



Subdivision boundaries are coincident with parcel boundaries, but do not cover all parcels.

Use this rule when the boundaries of polygons in one feature class or subtype should align with the boundaries of polygons in another feature class or subtype.



## Polygon

### Must not have gaps

Polygons must not have a void between them within a feature class or subtype.



Line errors are created from the outlines of void areas in a single polygon or between polygons. Polygon boundaries that are not coincident with other polygon boundaries are errors.



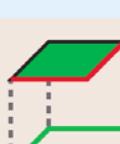
**Use this rule when all of your polygons should form a continuous surface with no voids or gaps.**

Soil polygons cannot include gaps or form voids—they must form a continuous fabric.

## Polygon

### Boundary must be covered by

Polygon boundaries in one feature class or subtype must be covered by the lines of another feature class or subtype.



Line errors are created where polygon boundaries are not covered by a line of another feature class or subtype.



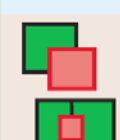
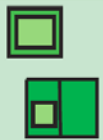
**Use this rule when polygon boundaries should be coincident with another line feature class or subtype.**

Major road lines form part of outlines for census blocks.

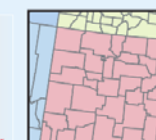
## Polygon

### Must be covered by

Polygons in one feature class or subtype must be covered by a single polygon from another feature class or subtype.



Polygon errors are created from polygons from the first feature class or subtype that are not covered by a single polygon from the second feature class or subtype.



**Use this rule when you want one set of polygons to be covered by some part of another single polygon in another feature class or subtype.**

Counties must be covered by states.

## Polygon

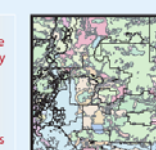
### Must cover each other

All polygons in the first feature class and all polygons in the second feature class must cover each other.

- FC1 Must be covered by feature class of FC2.
- FC2 Must be covered by feature class of FC1.



Polygon errors are created where any part of a polygon is not covered by one or more polygons in the other feature class or subtype.



**Use this rule when you want the polygons from two feature classes or subtypes to cover the same area.**

Vegetation and soils must cover each other.

## Line

### Must not have dangles

The end of a line must touch any part of one other line or any part of itself within a feature class or subtype.



Point errors are created at the end of a line that does not touch at least one other line or itself.



Use this rule when you want lines in a feature class or subtype to connect to one another.

A street network has line segments that connect. If segments end for dead-end roads or cul-de-sacs, you could choose to set as exceptions during an edit session.

## Line

### Must not overlap

Lines must not overlap any part of another line within a feature class or subtype. Lines can touch, intersect, and overlap themselves.



Line errors are created where lines overlap.



Use this rule with lines that should never occupy the same space with other lines.

Lot lines cannot overlap one another.

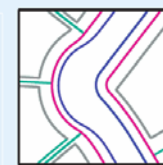
## Line

### Must not intersect

Lines must not cross or overlap any part of another line within the same feature class or subtype.



Line errors are created where lines overlap, and point errors are created where lines cross.



Use this rule with lines whose segments should never cross or occupy the same space with other lines.

Lot lines cannot intersect or overlap, but the endpoint of one feature can touch the interior of another feature.

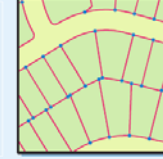
## Line

### Must not intersect or touch interior

Lines can only touch at their ends and must not overlap each other within a feature class or subtype. Lines can touch, intersect, and overlap themselves.



Line errors are created where lines overlap, and point errors are created where lines cross or touch.



Use this rule when you only want lines to touch at their ends and not intersect or overlap.

Lot lines cannot intersect or overlap and must connect to one another only at the endpoint of each line feature.

## Line

### Must not overlap with

Lines in one feature class or subtype must not overlap any part of another line in another feature class or subtype.



Line errors are created where lines from two feature classes or subtypes overlap.



**Use this rule for lines that should never occupy the same space with lines in another feature class or subtype.**

Highways can cross and come close to rivers, but road segments cannot overlap river segments.

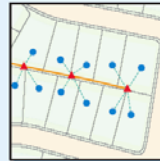
## Line

### Endpoint must be covered by

The ends of lines in one feature class or subtype must be covered by points in another feature class or subtype.



Point errors are created at the ends of lines that are not covered by a point.



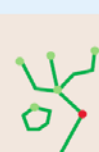
**Use this rule when you want to model the ends of lines in one feature class or subtype that are coincident with point features in another feature class.**

Endpoints of secondary electric lines must be capped by either a transformer or meter.

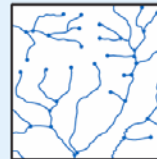
## Line

### Must not have pseudonodes

The end of a line cannot touch the end of only one other line within a feature class or subtype. The end of a line can touch any part of itself.



Point errors are created where the end of a line touches the end of only one other line.



**Use this rule to clean up data with inappropriately subdivided lines.**

For hydrologic analysis, segments of a river system might be constrained to only have nodes at endpoints or junctions.

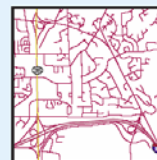
## Line

### Must not self overlap

Lines must not overlap themselves within a feature class or subtype. Lines can touch, intersect, and overlap lines in another feature class or subtype.



Line errors are created where lines overlap themselves.



**Use this rule with lines whose segments should never occupy the same space as another segment on the same line.**

For transportation analysis, street and highway segments of the same feature should not overlap themselves.

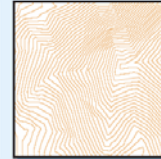
## Line

### Must not self intersect

Lines must not cross or overlap themselves within a feature class or subtype. Lines can touch themselves and touch, intersect, and overlap other lines.



Line errors are created where lines overlap themselves, and point errors are created where lines cross themselves.



Contour lines cannot intersect themselves.

Use this rule when you only want lines to touch at their ends without intersecting or overlapping themselves.

## Line

### Must be single part

Lines within a feature class or subtype must only have one part.



Multipart line errors are created where lines have more than one part.



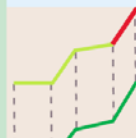
A highway system is made up of individual features where any one feature is not made up of more than one part.

Use this rule when you want lines to be composed of a single series of connected segments.

## Line

### Must be covered by feature class of

Lines in one feature class or subtype must be covered by lines in another feature class or subtype.



Line errors are created on the lines in the first feature class that are not covered by lines in the second feature class.



Lines that make up bus routes must be on top of lines in a road network.

Use this rule when you have multiple groups of lines describing the same geography.

## Line

### Must be covered by boundary of

Lines in one feature class or subtype must be covered by the boundaries of polygons in another feature class or subtype.



Line errors are created on lines that are not covered by the boundaries of polygons.



Polygons used for displaying block and lot boundaries must be covered by parcel boundaries.

Use this rule when you want to model lines that are coincident with the boundaries of polygons.