Topological Vector Model

• Topology: the “science and mathematics of relationships in a GIS” or “the study of geometric properties”
  – Topological vector models explicitly record topological relationships

• There are four kinds of topological relationships...
  – **Adjacency** – which polygons are next to which?
  – **Connectivity** – which lines connect to which?
  – **Containment** – which features are within another feature (e.g., “island polygons” -- an island within a lake)
  – **Coincidence** - which occupy the same space?

Example of Polygon Topology
(source: Longley et al 2001, p. 191)

Figure 9.9 The contiguity of a topologically structured polygon data layer. For each line the left and right polygon is stored with the geometry data (Source: after ESRI 1997)
Topological Vector Model Continued...

- Why is topology so important in GIS analysis?
  - Topology greatly enhances analysis
  - Topological relationships allow these to be explored (without it they couldn’t be)
    - Which parcels are adjacent to which?
      - Adjacency analysis are simply a database table lookup
      - Can you imagine the computing (or programming) required without topological data for a parcel GIS layer with 100,000’s of parcel polygons?
    - Which roads are connected to which?
    - Which counties are adjacent to each other?
    - Which streams are in a watershed?
    - Which polygons of one layer intersect with another layer (a type of overlay analysis)?
      - Involves line adjacency

Limitations of Topological Vector Model

- Computational costs (modest) in defining the topological structure (e.g., Build, Clean functions)

- Data (GIS layers) need to be clean to use topological functions.
  - All lines must begin and end with a node
  - All polygons must be closed
  - Substantial “editing” work to get a layer clean.
  - Errors occur in analysis if these are not done.

- Limitations far outweighed by the analytic benefits topologic vector models provide
Topological Vector Model Continued...

- Some GIS software and data structures allow for topological relationships and some do not

  - ArcGIS/ArcInfo – “coverages” (native vector data structure from the old software ArcInfo) are topological. ArcInfo commands “build” and “clean”

  - ArcView – “Shapefiles” are not topological

  - ArcGIS “Geodatabase” – increasing topologic functionality.