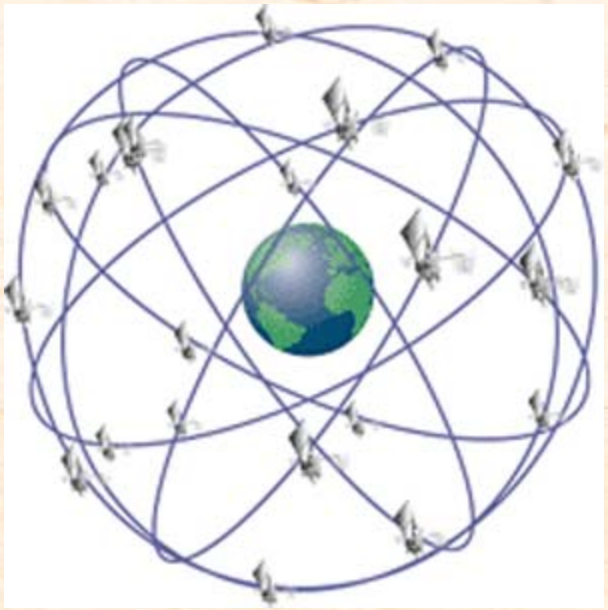
Introduction to Global Positioning System

GPS

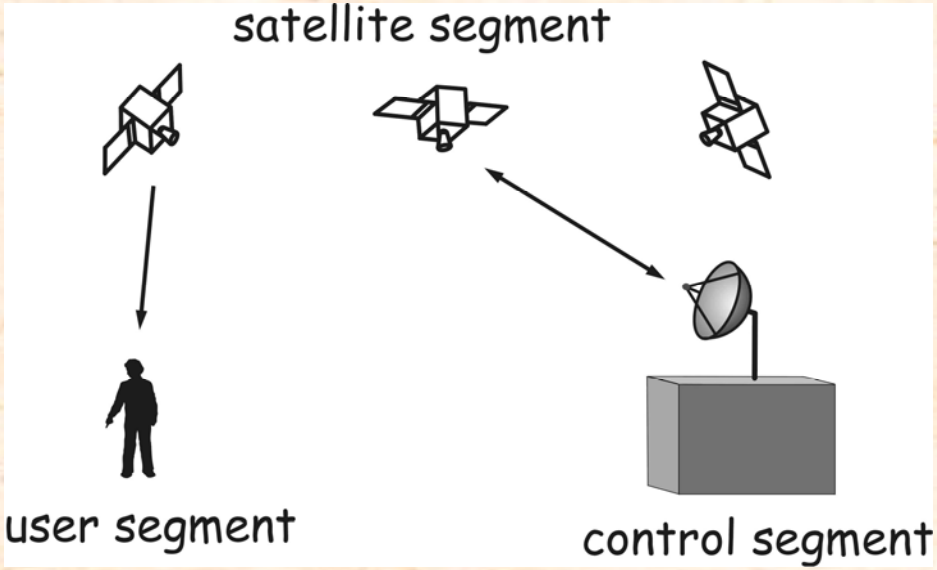
- The Global Positioning System (GPS) is a satellite-based positioning system



GPS Segments

The satellite segment consists of a nominal constellation of 24 operating satellites that transmit one-way signals that give the current GPS satellite position and time

The user segment consists of the GPS receiver equipment, which receives the signals from the GPS satellites and uses the transmitted information to calculate the user's three-dimensional position and time.

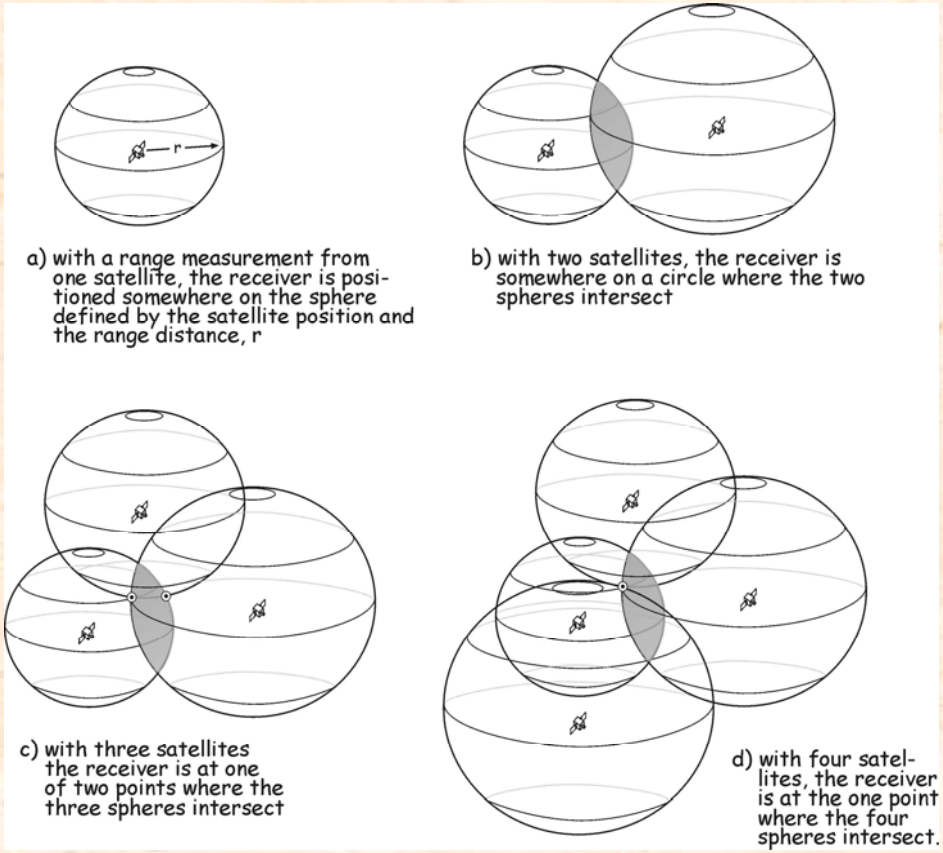


The control segment consists of worldwide monitor and control stations that maintain the satellites in their proper orbits through occasional command maneuvers, and adjust the satellite clocks.

Satellite Segment

- Satellite circle the earth twice daily
- Four to twelve satellites should be visible from any unobstructed location.
- Each satellite continuously broadcasts signals on two carrier frequencies, L1 and L2.
- Satellites also transmit coded signals, modulations of the carrier signals.

Measurements to multiple satellites determine position



Global Navigation Satellite System GNSS

- NAVSTAR GPS (USA) Since early 1980's
- Galileo – (European Union) by 2008
- GLONASS (Russian) 1993
  - *Global'naya Navigatsionnaya Sputnikovaya Sistema*
  - *Global Orbiting Navigation Satellite System*

Sources of Error

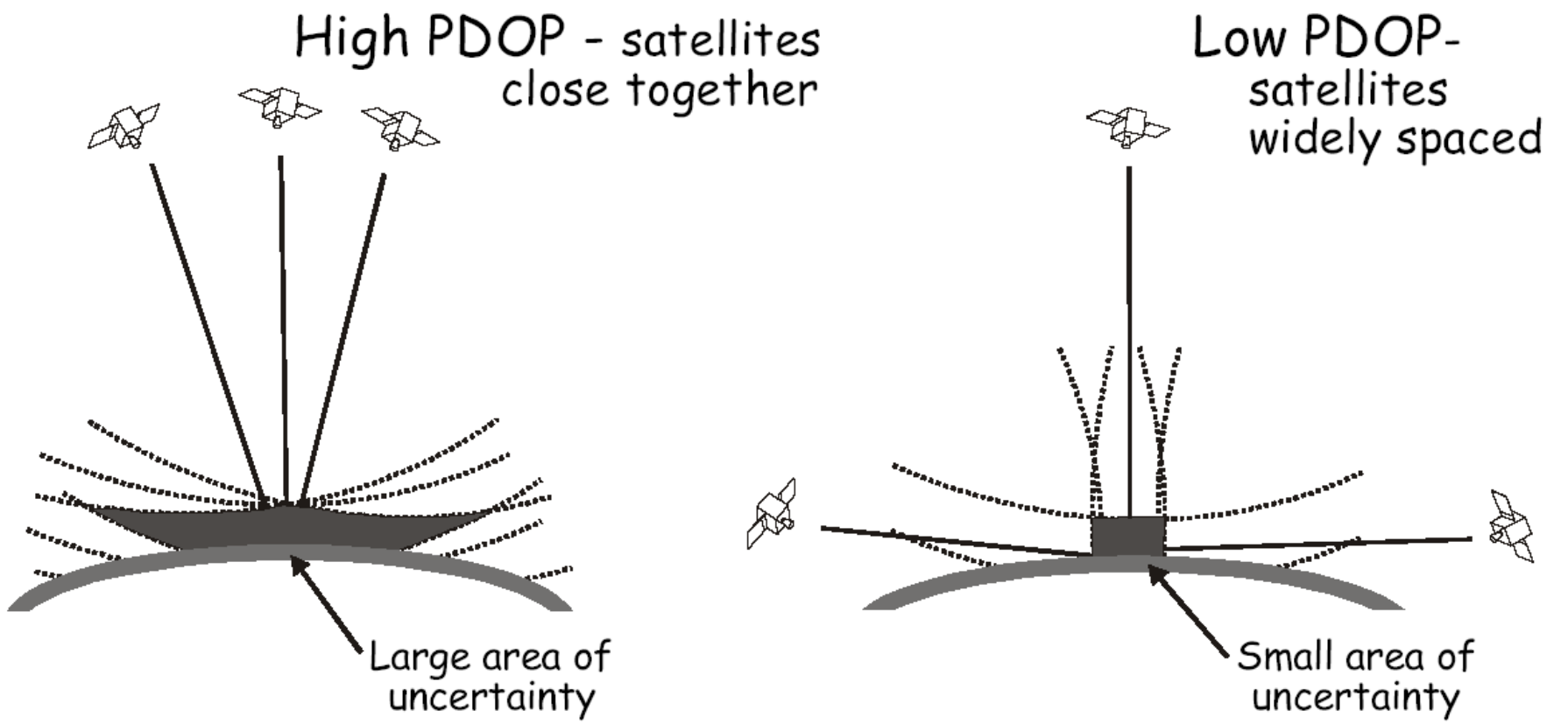
Several factors can result in erroneous location determination with GPS (besides blunders)

- Satellite clock error
- Satellite position error
- Receiver error
- Atmospheric/Ionospheric effects

Positional Dilution of Precision (PDOP)

- PDOP is a measure of satellite spacing – a wider-spaced constellation is better
- PDOPs typically range from 2 to 10, but can go as low as 1, or as high as 100's
- Lower PDOPs are better, because they represent signals from widely spaced satellites, and hence a smaller area of uncertainty.

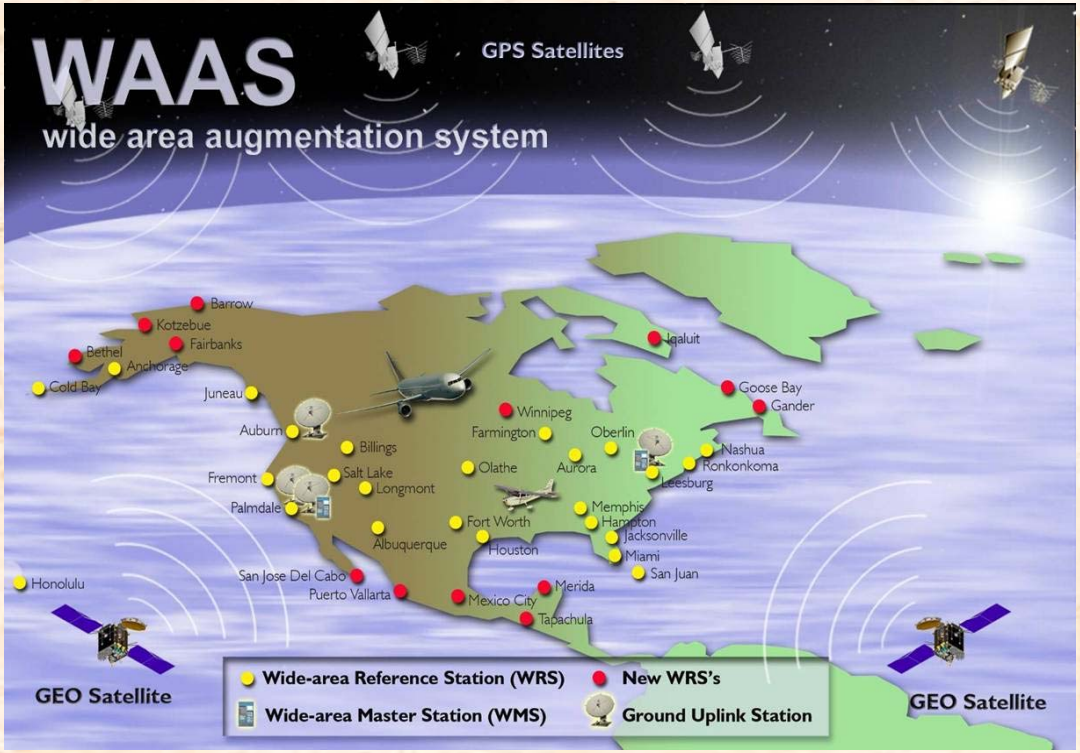
PDOPs – Position Dilution of Precision



GPS - WAAS

The **Wide Area Augmentation System (WAAS)**

- an air navigation aid developed by the Federal Aviation Administration to augment the GPS, with the goal of improving its accuracy, integrity, and availability.



Using GIS with GPS

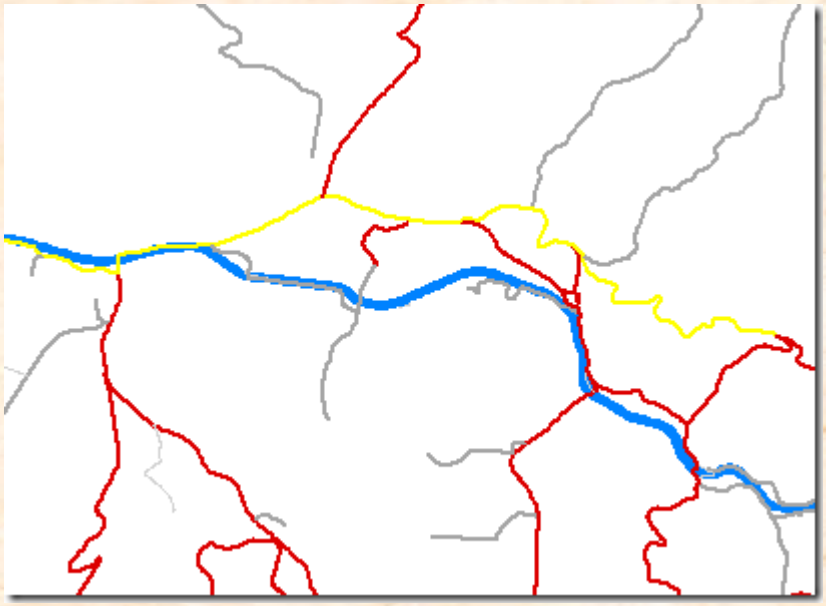
GPS is one of the great new technologies of our lifetime, and its integration with GIS delivers powerful applications to improve our daily lives.

- Integration of higher real-time accuracies
- Better data display
- Easier integration

GPS Summary

- Space-based positioning system with satellite, control, and user segments
- Range measurements from 4 or more satellites to estimate position
- Range errors from ionosphere, atmosphere, system, and receivers
- Satellite geometry affects position accuracy – low PDOPs are better

Topology



Topology:

Definition - the spatial relationships among features.

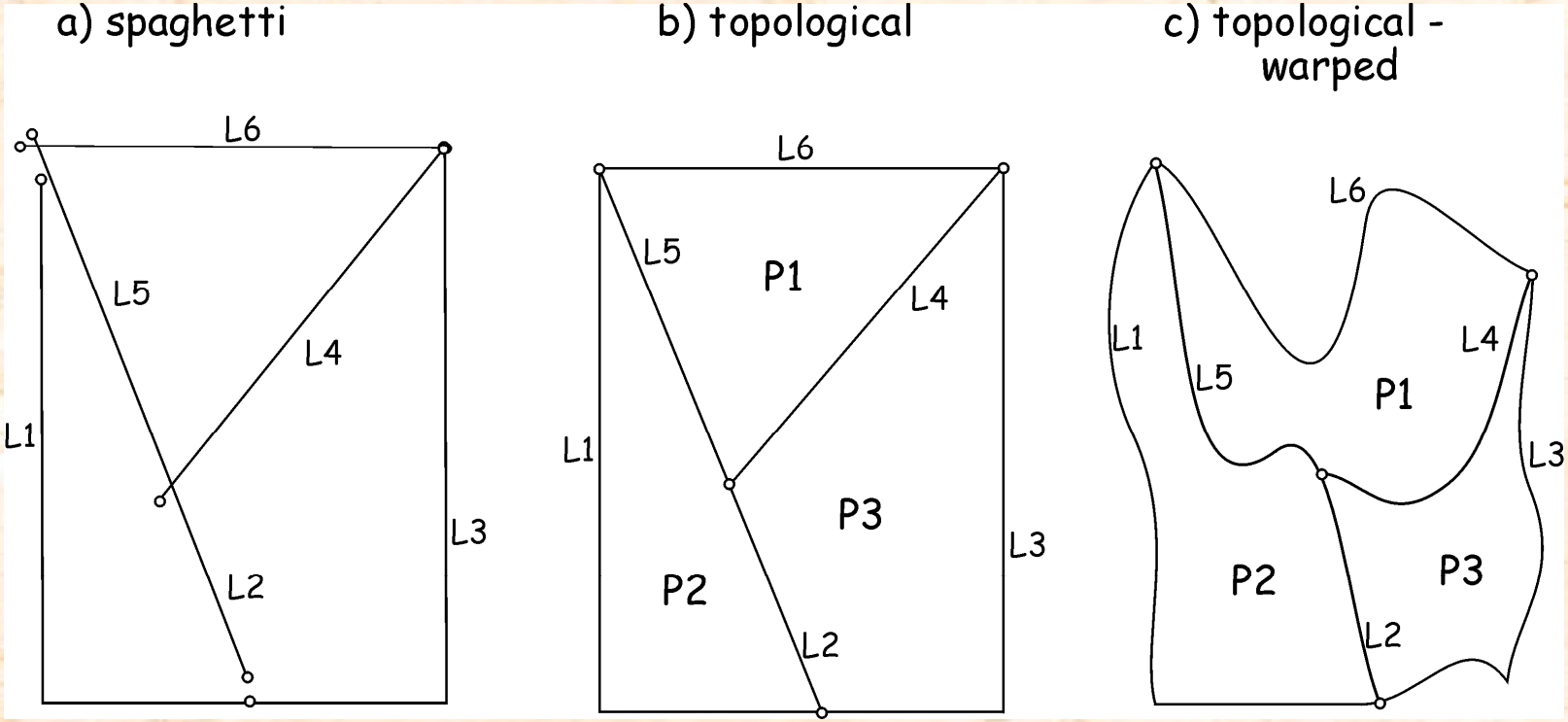
- Main components:
  - Adjacency
    - polygons are adjacent
  - Connectivity
    - lines connect
  - Containment
    - one polygon contains another
    - a set of arcs contain a polygon
  - Direction
    - an arc has a direction, with a left and right side defined by the direction that it was created

Topology

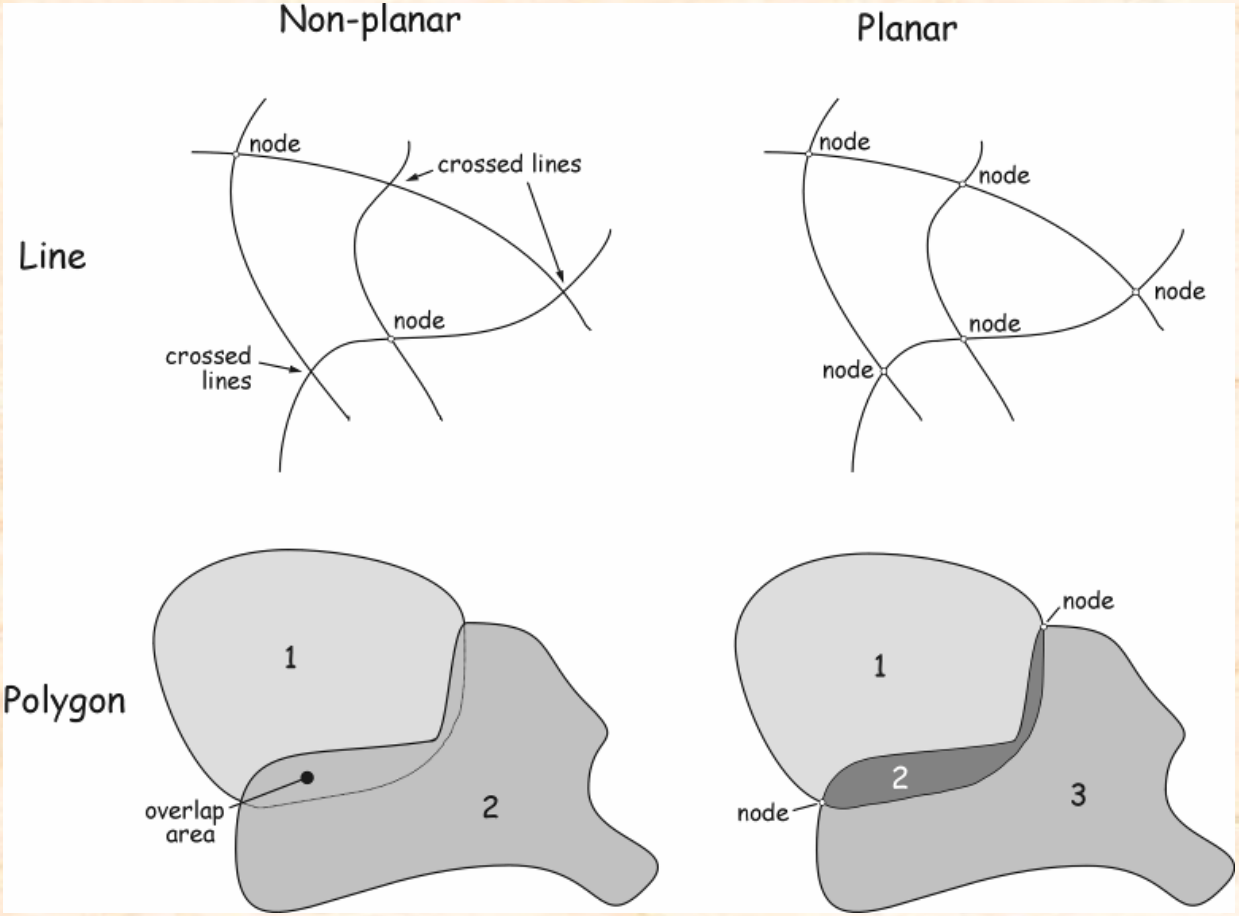
- The **topology toolbar** provides additional editing tools.
- These include
  - shared editing
  - validating topology
  - fixing topological errors

Note that the first step is using the Topology tools is to set up map topology using the Map Topology button. 

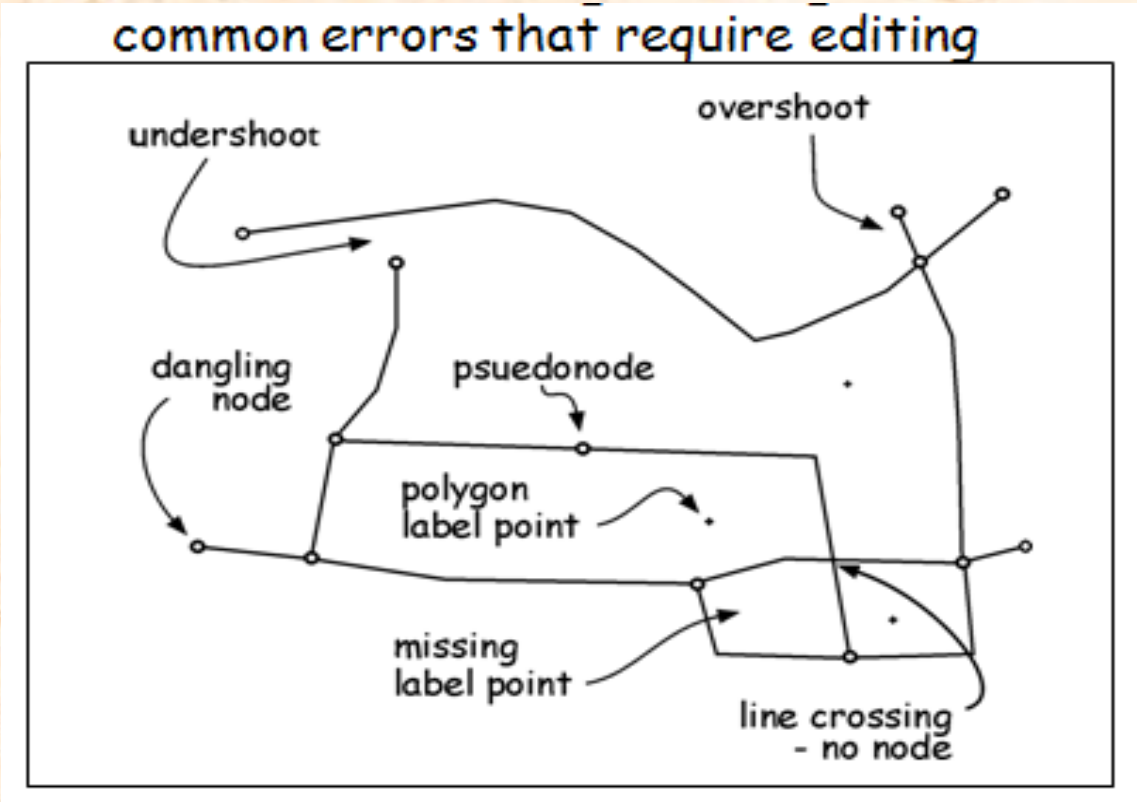
Vector Topology – geometric properties that do not change with shape: Adjacency, connectivity, containment



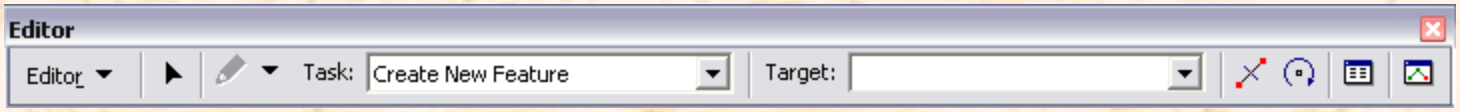
Planar Topology – no overlaps



Editing Spatial Information



Starting an Edit Session

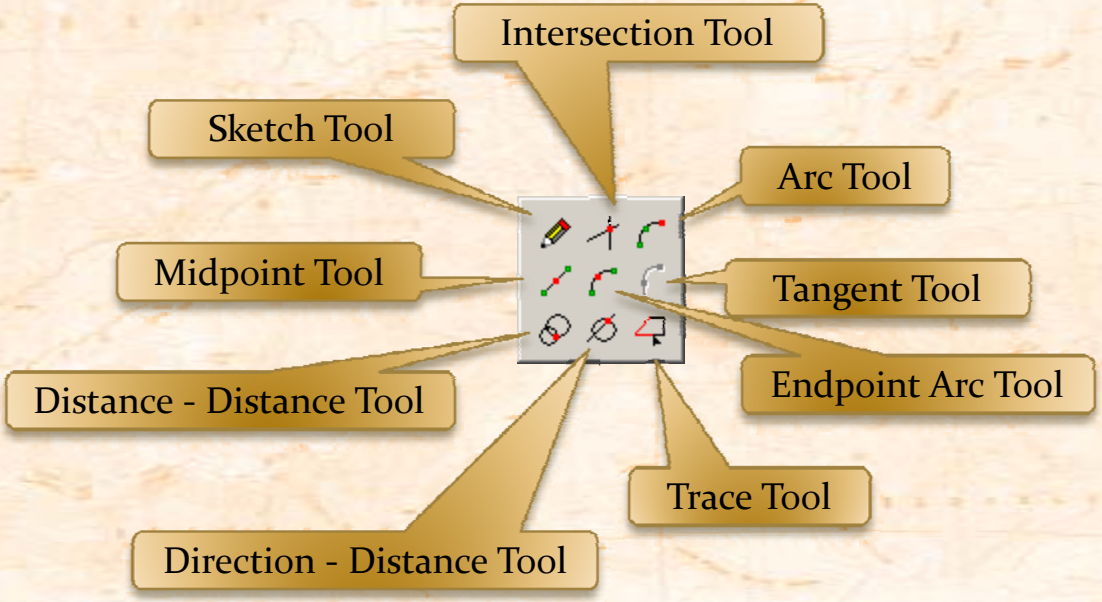


- **Current Task list**
  - You can use a sketch to complete various tasks; these are listed in the Current Task drop-down list shown below.
- **Target layer list**
  - The type of feature you create is determined by the setting of the Target layer drop-down list. This list contains the names of all the layers in the workspace with which you're working, as well as any subtypes.
- **Sketch construction tools**
  - The Sketch tool is the main tool you use to create a sketch. To create point features, click once on the map. To create line or polygon features, use the Sketch tool to digitize the vertices that make up that feature. To create the last vertex and finish the sketch, double-click the mouse. After you finish the sketch, ArcMap adds the final segment of the sketch, and the sketch turns into a feature. There are several other tools you can use to create a sketch. The Sketch tool and the other tools are found on the Editor toolbar tool palette.

Creating Features

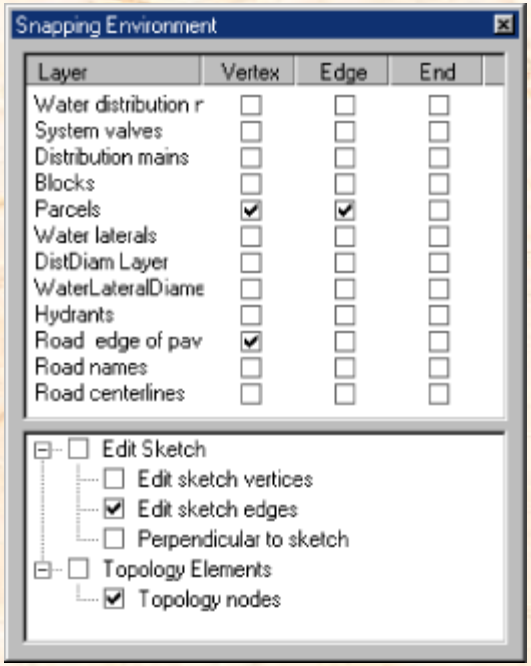
Methods for creating points, vertices, and segments of features

- You can use any combination of the following methods for creating points, vertices, or segments to create a new line or polygon feature:

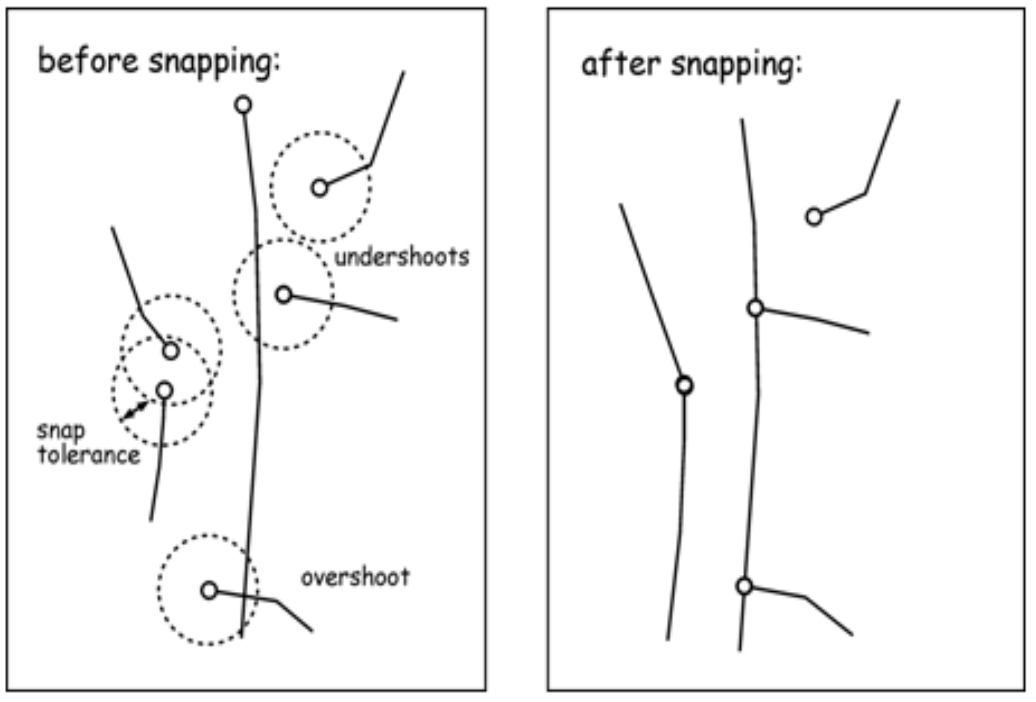


Setting the Snapping Environment

- Helps establish exact locations in relation to other features
- Used to move a feature to a precise location in relation to another feature
- Involves:
  - setting a snapping tolerance
  - snapping properties
  - snapping priority



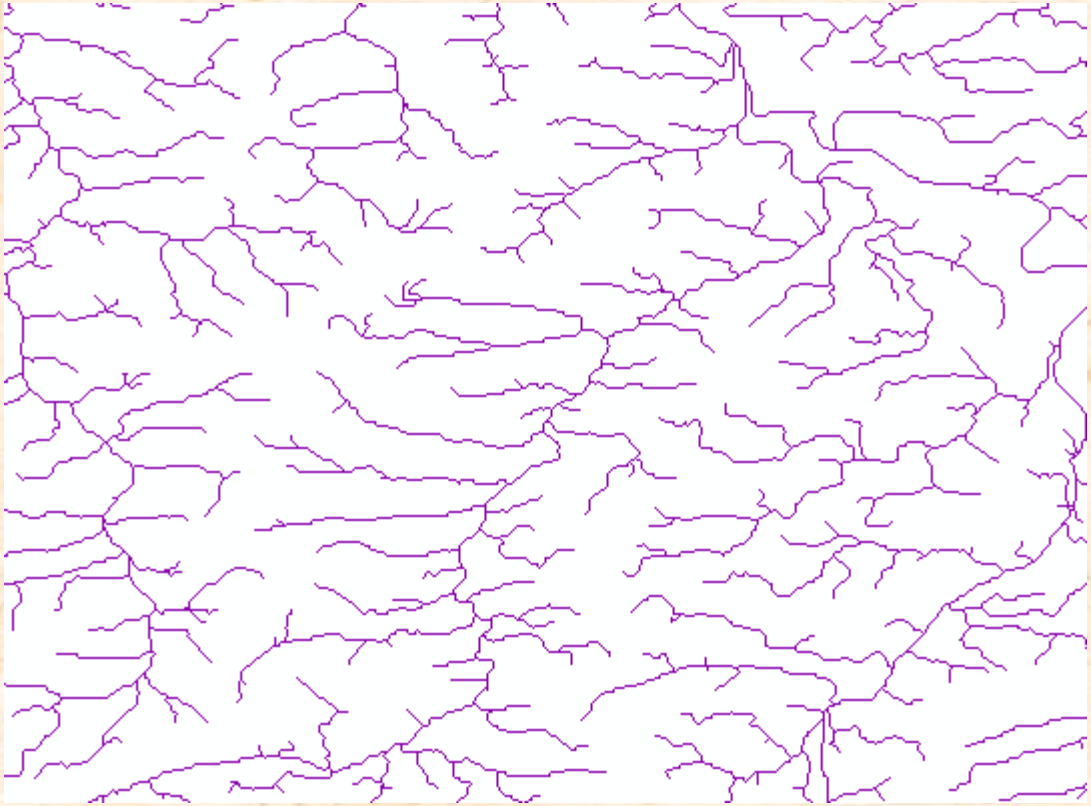
Importance of Setting Snapping Environment



Point snapping:
Points which fall within a specified distance of each other are snapped

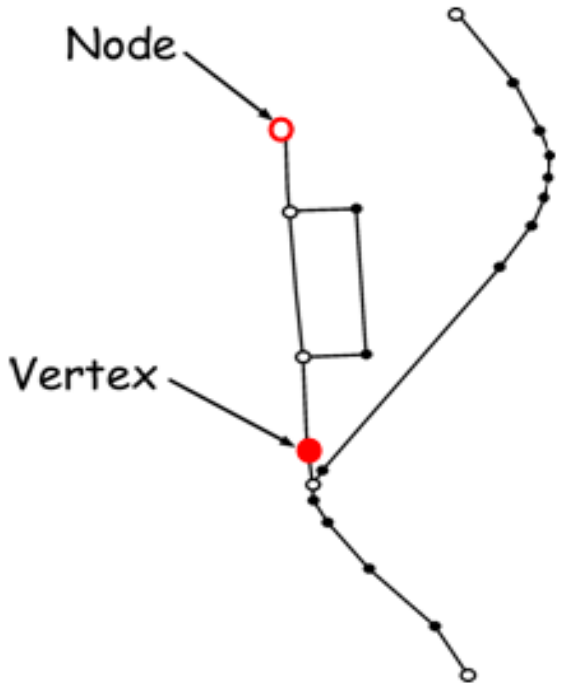
Line snapping:
When a vertex or node is "close" to a line or end point, the lines are "snapped" together

Digitizing



Digitizing Spatial Information

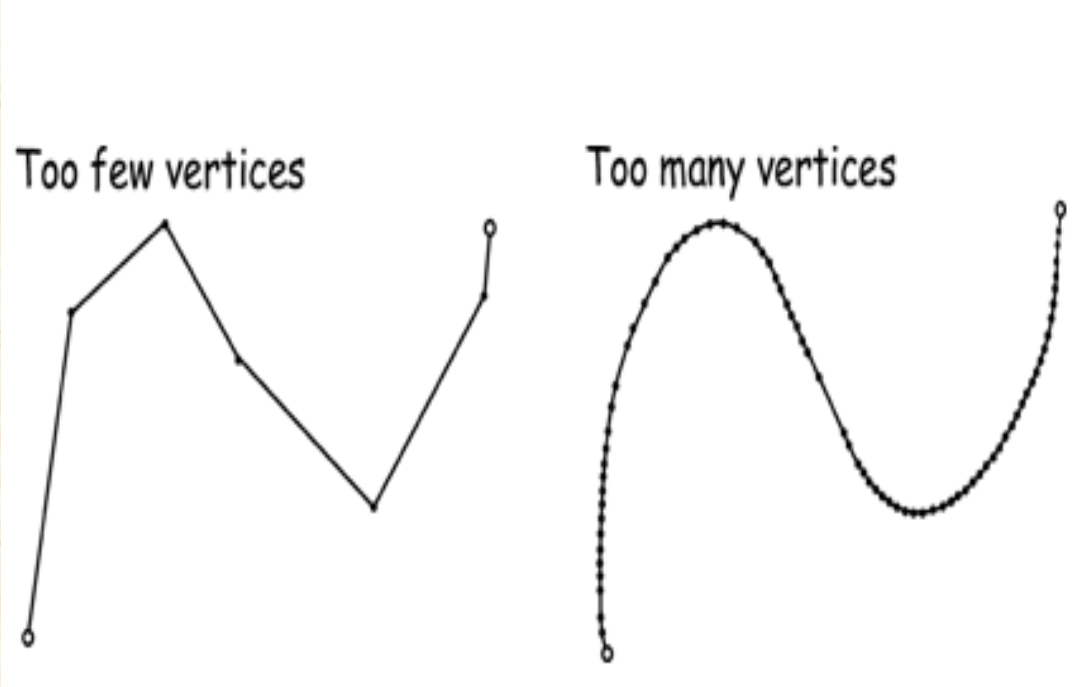
- nodes at line endpoints
- vertices define line shape



Digitizing - Adding New Features

- Typically, new features are digitized in relation to existing features. Heads-up digitizing is a method that is commonly used, which describes digitizing when looking at the monitor and occurs when other spatial data, usually an image, is used as a base map.

Digitizing – Importance of Vertices



Digitizing – Spline Interpolation

To Few Vertices –

Spline Interpolation

Create smooth, curving lines by fitting piecewise polynomial functions