CSS 4200

Geographic Information Systems

Lecture 5:

– Spatial Database Development

Database Issues in GIS

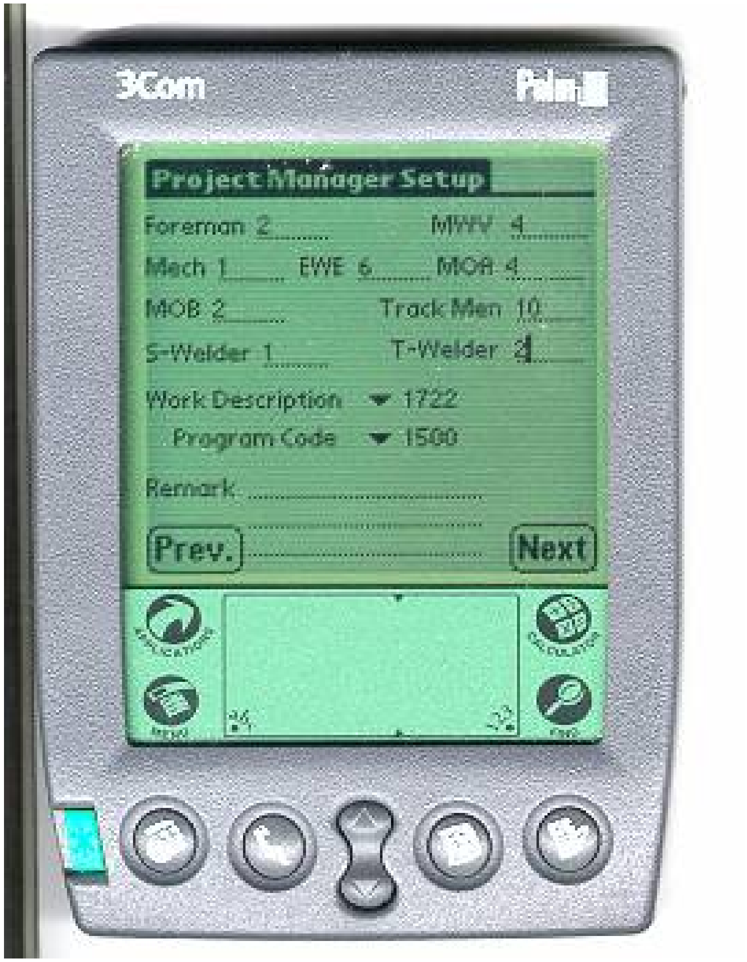
- GIS applications often require spatial queries and searching
  - Contiguity
  - Connectivity
  - Containment
  - Visualization
- Need to consider temporal issues
- Generally separate GIS data layers

Database Issues in GIS (cont.)

- Requires 'seamless' integration of spatial and attribute components
  - Extent, Location, Orientation
  - Attribute
- Need to maintain integrity of spatial relationships
- Need to provide capability for data capture, integration, and update.
- Storage issues
  - Need to consider raster and vector data
  - Increased file size compared to traditional databases
  - Issues with indexing compared to alphanumeric data

Primary Data Collection

- Other field surveys
  - many types of data collected using site visits, tallies, interviews, etc.
  - require careful attention to sampling design



Secondary Data Collection Methods

- Text Entry
- Coordinate Geometry (COGO)
- File conversion
- Manual digitizing
- Automated digitizing

Digitizing

- There are three primary methods for digitizing spatial information:
  - Manual Methods include:
    - Tablet Digitizing
    - Heads-up Digitizing
  - An Automated Method includes:
    - Scanning

Tablet Digitizing

- Tablet digitizing requires a person to enter coordinate information through the use of a *digitizing tablet* and *digitizing puck*

  - A **digitizing tablet** is a hard surface with a fine electrical wire grid under the surface.

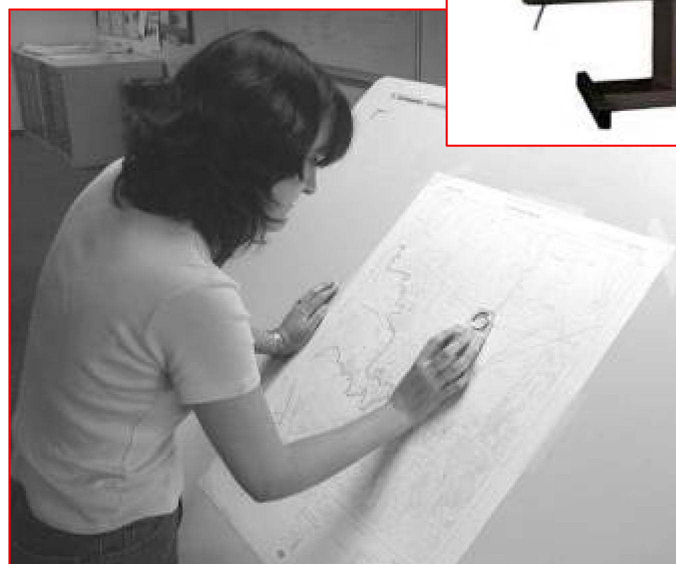
  - Digitizing tablets are either firm, more stationary tables or rollup boards designed for portability.

  - A **digitizing puck** is an electrical device with cross hairs and multiple buttons to perform data entry operations.

  - An operator then enters the information using the puck.

Getting the Map in the Computer

1. Convert hardcopy map to electronic form through manual digitization
2. Convert hardcopy map electronic form using on-screen digitizing or digital orthophotograph
3. Condition of source document is very important



Manual Digitizing

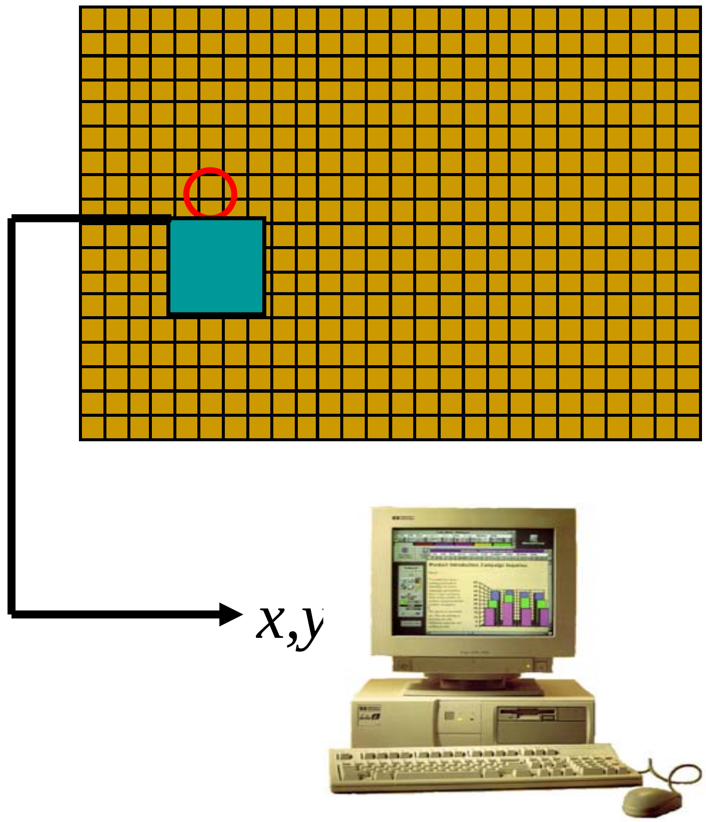
- Systematic approach is critical
- Set up source document
- Digitize control points and register source document
- Digitize features of interest
  - Point mode
  - Stream mode
- Assess quality (accuracy and completeness)

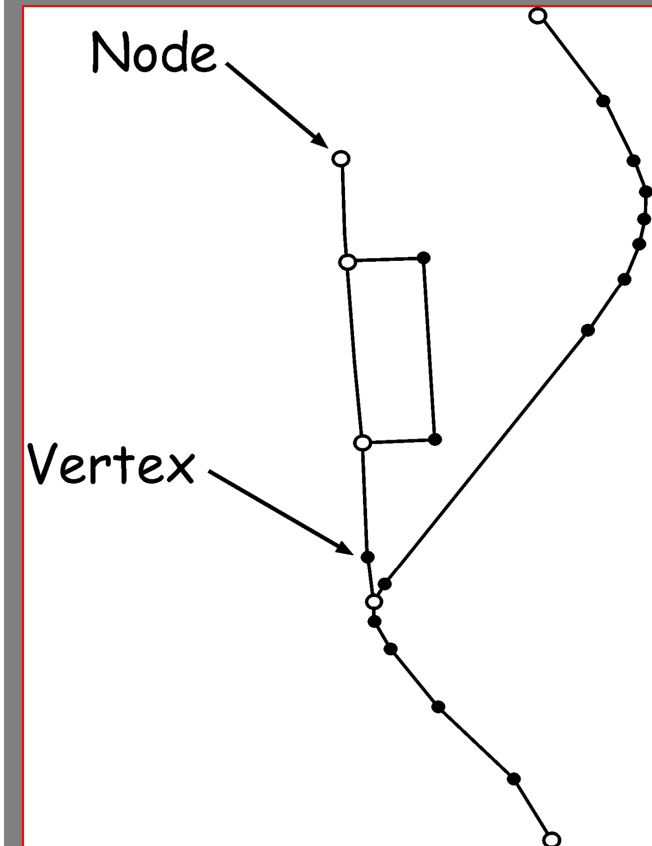
Tablet Digitizing – how it works

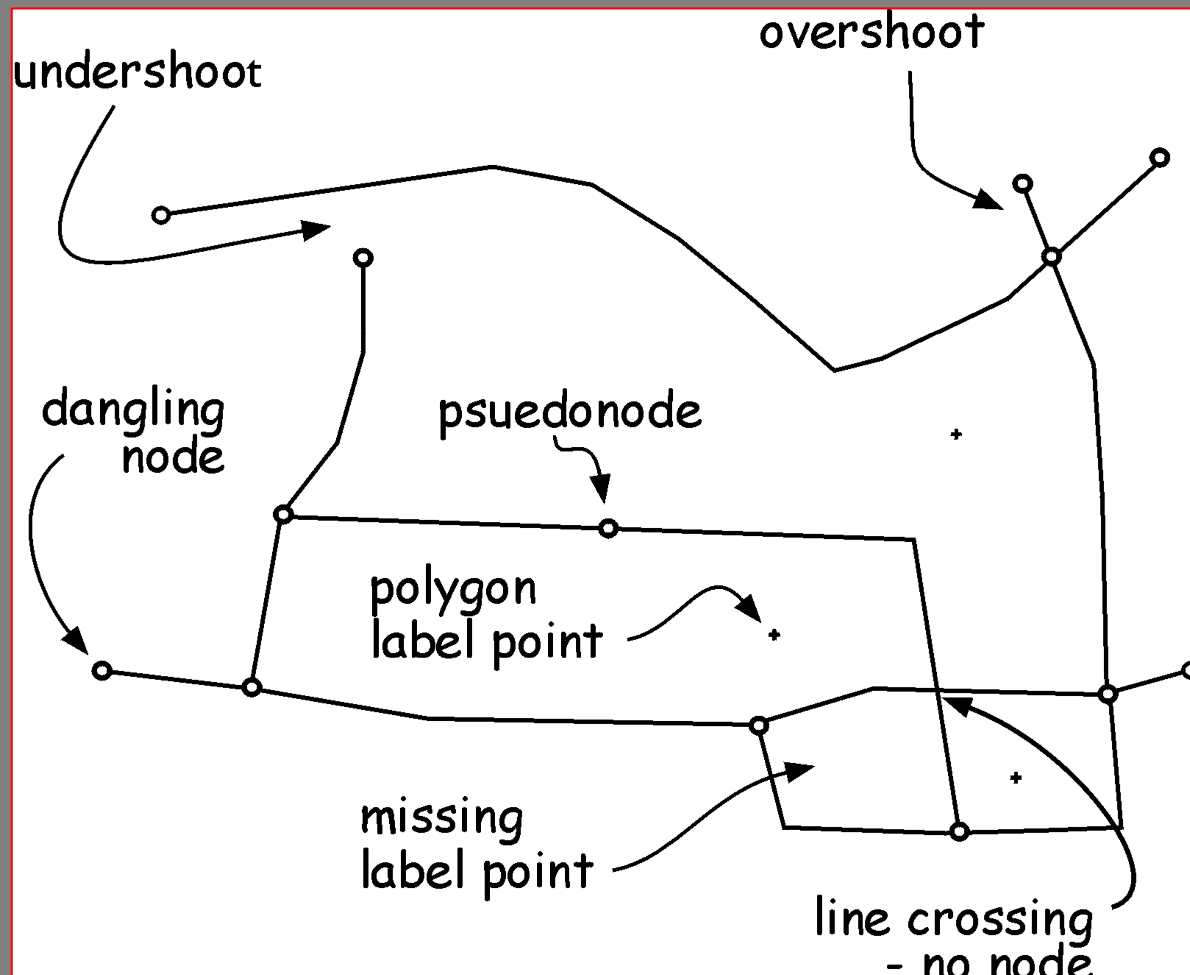
- When the user places the digitizing puck over a location on the tablet, and presses one of the buttons, the wire mesh beneath the tablet records the location of the puck.

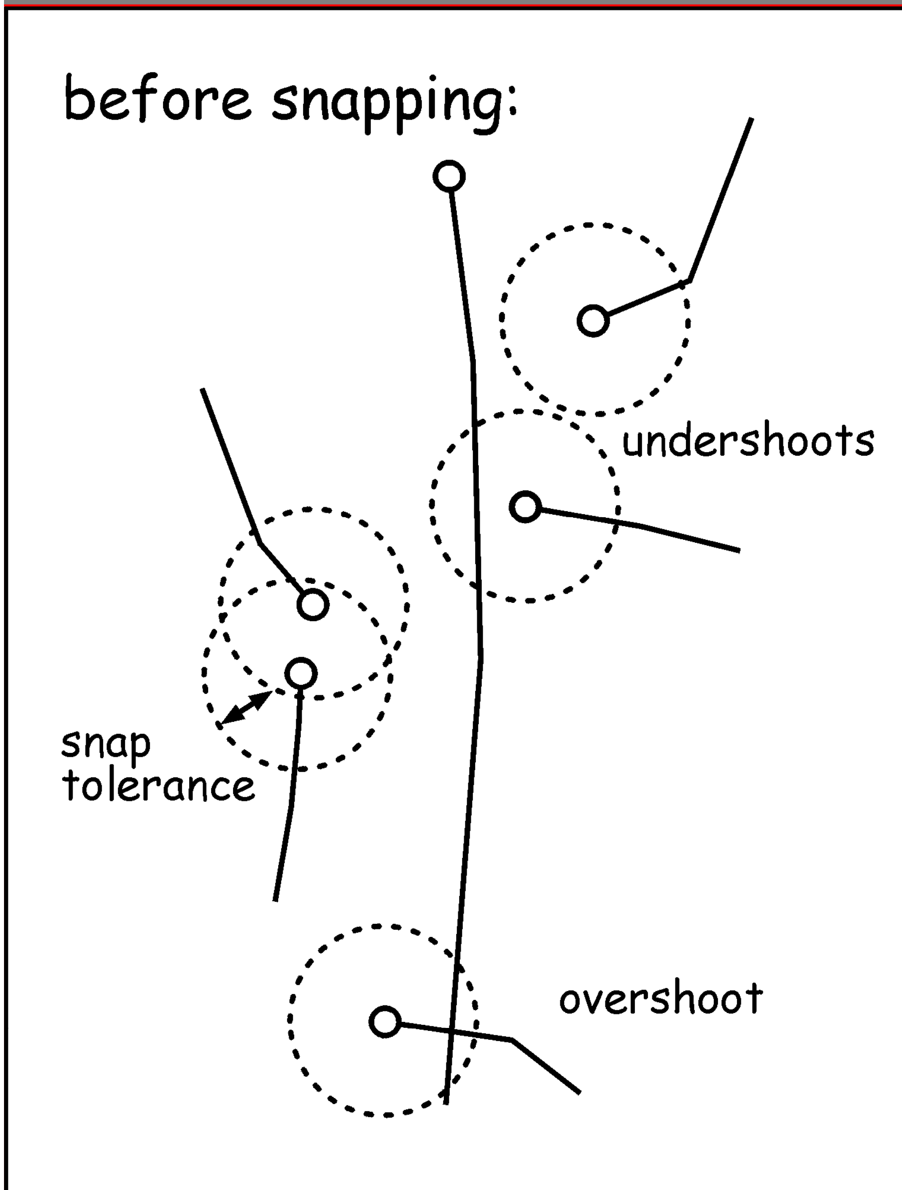
- Digitizing tablets are very accurate, with more expensive tablets able to measure objects to within 0.006 mm.

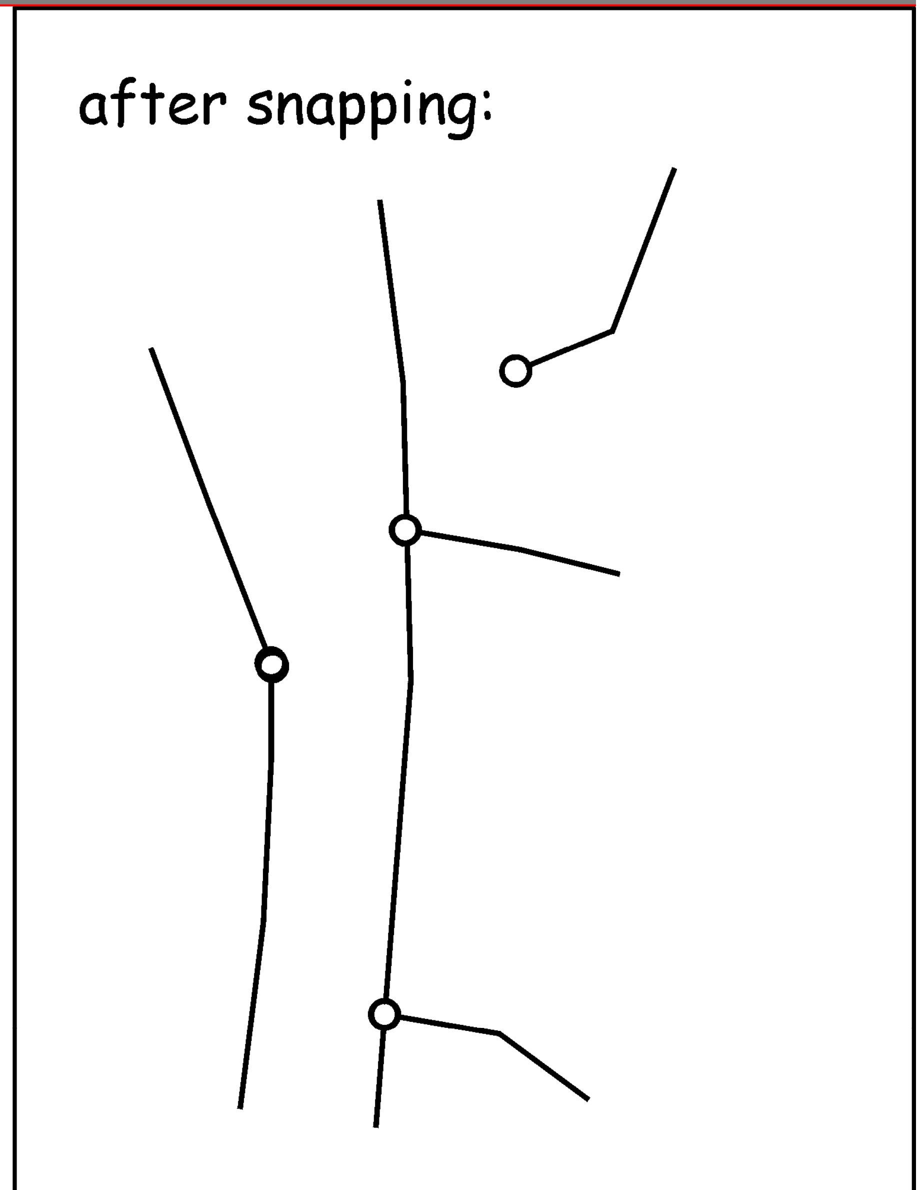
- The coordinate, as referenced by the tablet is then stored in the computer.




Node
Vertex

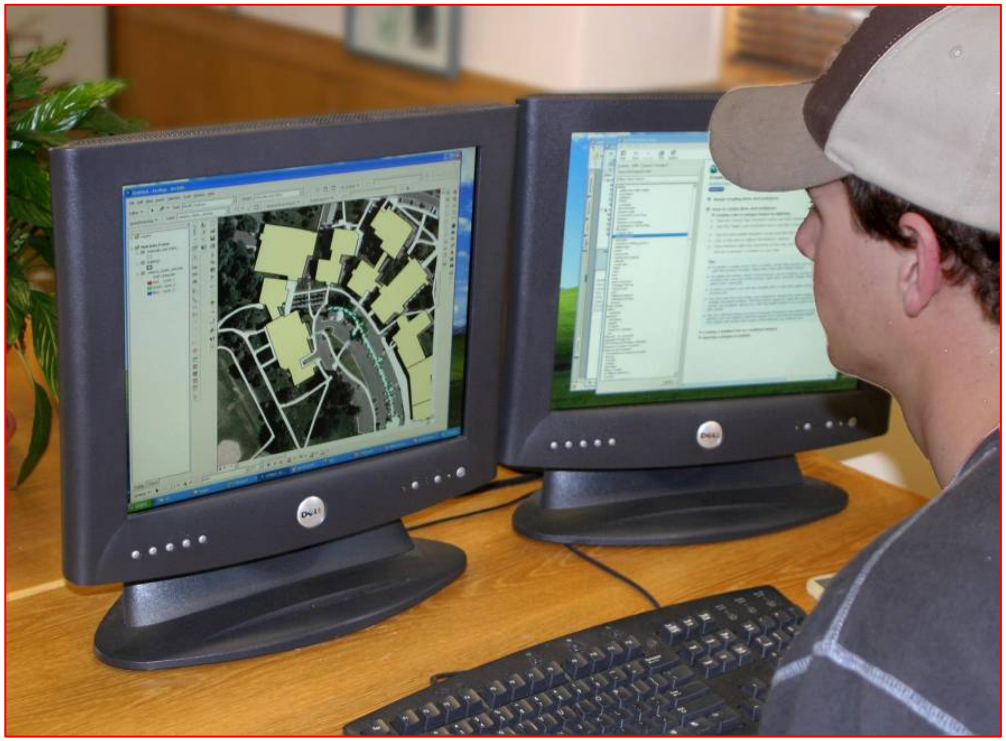

undershoot
overshoot
dangling
node
psuedonode
polygon
label point
missing
label point
line crossing
- no node


before snapping:
undershoots
snap tolerance
overshoot


after snapping:

Heads-up Digitizing

- Similar to regular manual digitizing
- Done with a mouse on-screen
  - Generally with an image in the background
- Usually less precise
- Usually faster



Digitizing – heads up digitizing

- Heads up digitizing is a combination of scanning and manual digitizing.

- The main steps in heads up digitizing typically include:

  - **Scanning the map** – a user can scan the map at a high resolution.

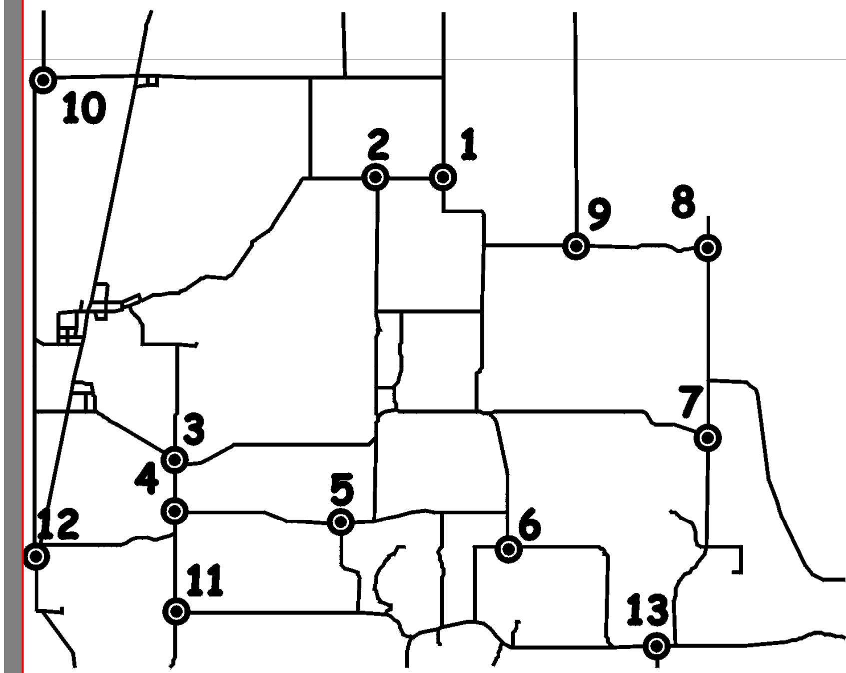
  - **Geo-referencing the map** – using mathematical transformation methods, the user can enter control points on screen and transform the scanned image to real world coordinates.

  - **Digitizing the map** – the user can zoom to specific areas on screen and trace points, lines, or polygons on the map. Because the maps are already in the correct geographic coordinate system anything digitized on top of the map will also be in the correct coordinate system.

Automated Digitizing

- Conversion principles based on “scanning”
  - Concept
  - Approaches
  - Resolution
  - Convert scan values to meaningful values
- Assessment of quality important
- Condition of source document is very important to scanning success
- Vectorization

Control Points

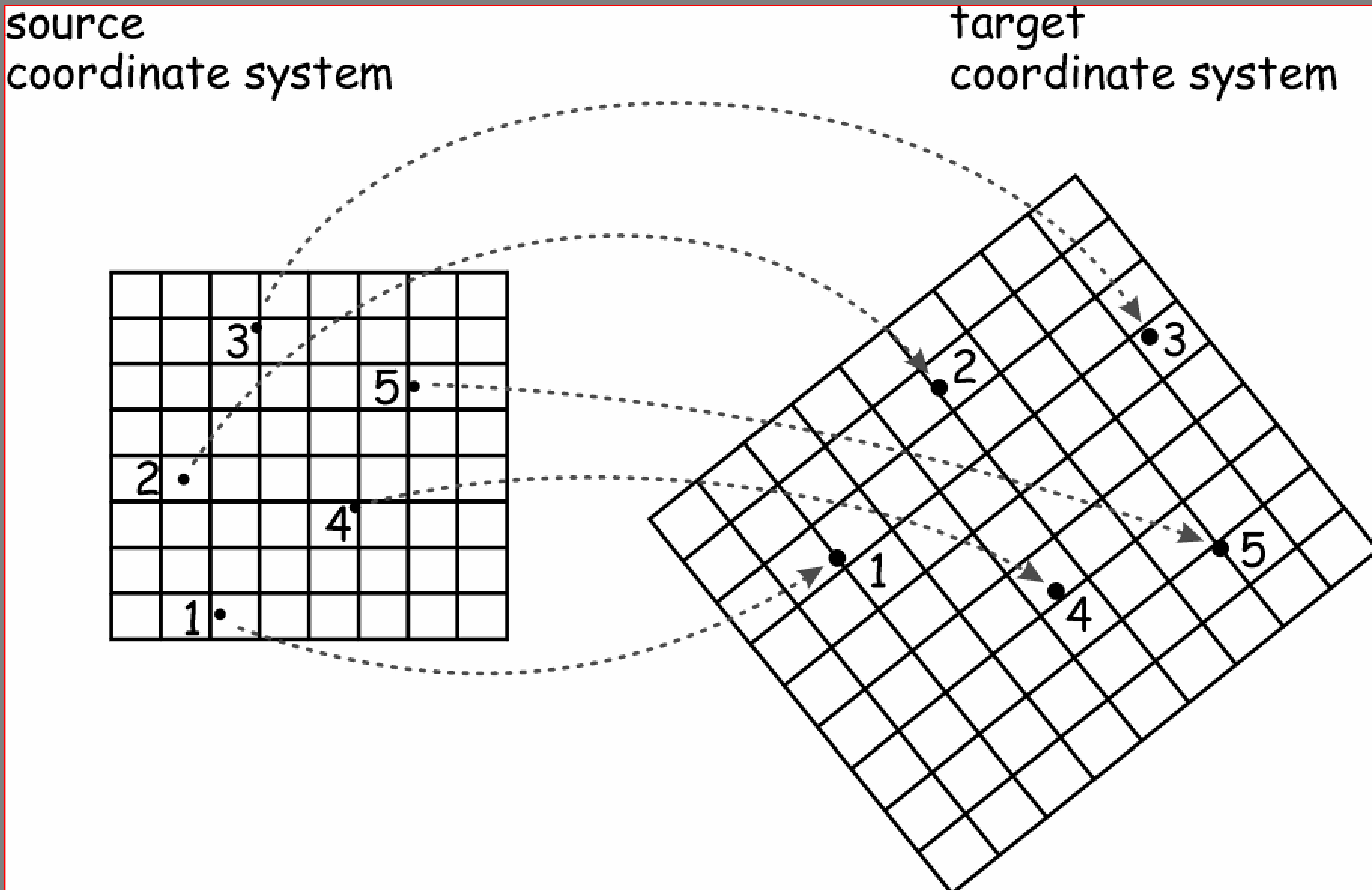


Digitizer Coordinates

ID	x	y
1.0	103.0	-100.1
2.0	0.8	-69.1
3.0	-20.0	-69.0
4.0	-60.0	-47.0
5.0	-102.0	-47.2
6.0	-101.7	10.8
7.0	-86.0	75.8
8.0	-40.0	45.7
9.0	11.0	36.8
10.0	63.0	34.0
11.0	63.0	17.7
12.0	63.0	64.3
13.0	106.0	47.7

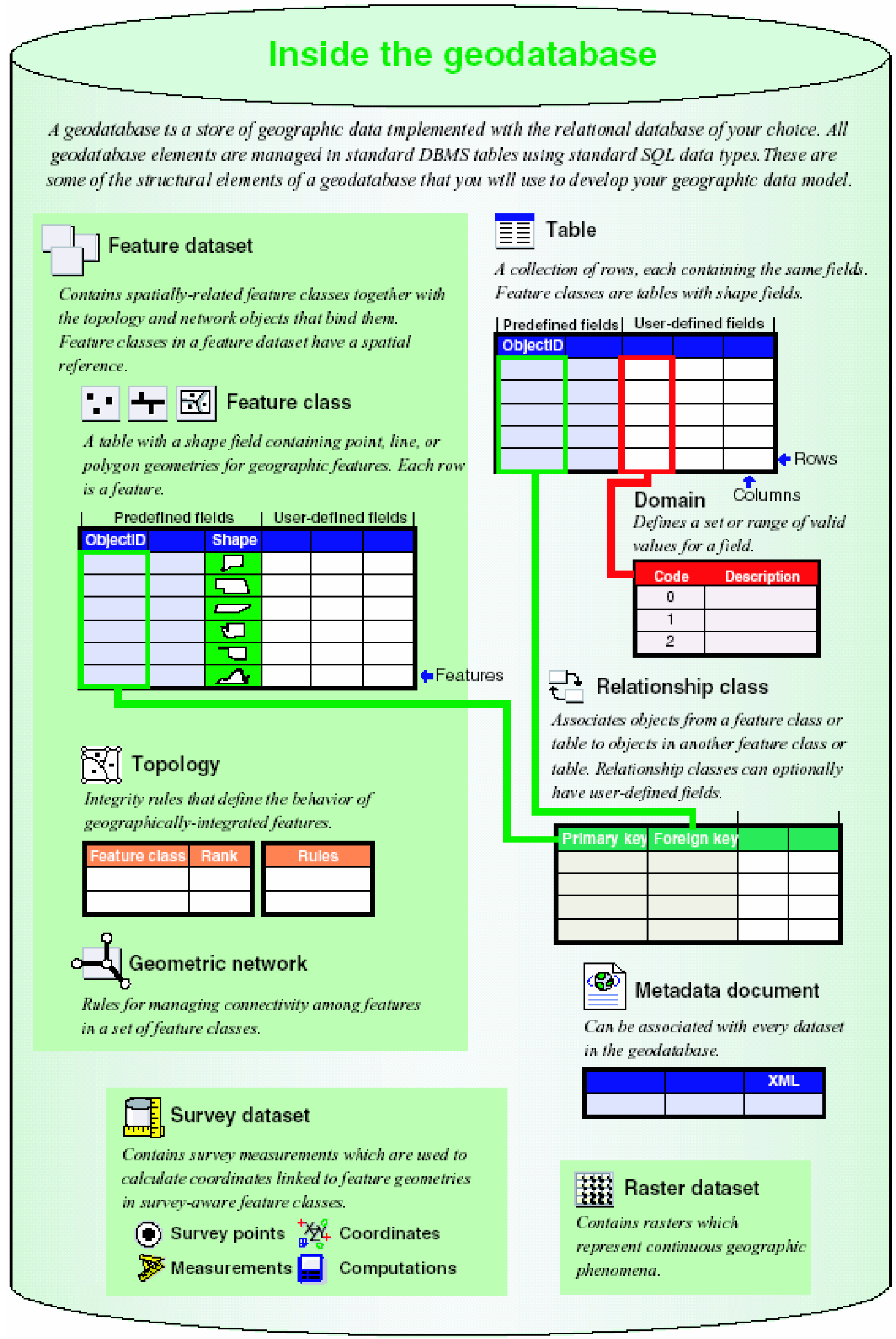
Projection Coordinates (UTM)

E	N
500,083.4	5,003,683.5
504,092.3	5,002,499.5
504,907.5	5,002,499.5
506,493.3	5,001,673.5
508,101.3	5,001,651.0
508,090.1	4,999,384.0
507,475.9	4,996,849.0
505,689.2	4,998,022.0
503,679.2	4,998,368.0
501,657.9	4,998,479.5
501,669.1	4,999,116.0
501,680.3	4,997,296.0
500,005.3	4,997,943.5


source
coordinate system
target
coordinate system
1
2
3
4
5
1
2
3
4
5

Geodatabase Model

- Represents geographic information using standard relational databases with extensions.
- Data are managed through relational tables, and geographic objects can have *integrity rules* and *behavior*
- Example from *unique natural areas (UNAs)*
  - *Feature datasets*
  - *Feature classes*
  - *Topology rules*
  - *Relationships*



Advantages of 'Geodatabases'

- **Faster performance**, at times by a factor of 100 or more in interactive GIS operations as compared to older architectures.
- **Reliable**, conflict-free editing of complex data in a multi-user environment.
- **Freedom** to choose almost any DBMS vendor (as long as they can support the spatial data types).
- **Heterogeneous**, free form utilization of Enterprise servers.
- **DBMS safety**. If the DBMS crashes while working on an Enterprise project the project is still safe and can be saved with no loss of data.
- **Network fault tolerance**. If the network crashes while working on an Enterprise project the project is still safe.
- **Ability to use Internet.** The high bandwidth requirements of older architectures mean that connecting over Internet to a remote DBMS is not usually realistic.