INTRODUCTION TO GIS

GIS-WHAT IS IT?

- Geographic/Geospatial Information
  - information about places on the earth's surface
  - knowledge about "what is where when"
    (Don't forget time!)
  - Geographic/geospatial: synonymous

- GIS--what's in the S?
  - Systems: the technology
  - Science: the concepts and theory
  - Studies: the societal context

GEOGRAPHIC INFORMATION *TECHNOLOGIES*

Global Positioning Systems (GPS)

- a system of earth-orbiting satellites which can provide precise (100 meter to sub-cm.) location on the earth's surface (in lat/long coordinates or equiv.)

Remote Sensing (RS)

- use of satellites or aircraft to capture information about the earth's surface
- Digital ortho images a key product (map accurate digital photos)

Geographic Information Systems (GIS)

- Software systems with capability for input, storage, manipulation/analysis and output/display of geographic (spatial) information

GPS and RS are sources of input data for a GIS.
A GIS provides for storing and manipulating GPS and RS data.

EXAMPLES OF APPLIED GIS

Urban Planning, Management & Policy
- Zoning, subdivision planning
- Land acquisition
- Economic development
- Code enforcement
- Housing renovation programs
- Emergency response
- Crime analysis
- Tax assessment

Environmental Sciences
- Monitoring environmental risk
- Modeling stormwater runoff
- Management of watersheds, floodplains, wetlands, forests, aquifers
- Environmental Impact Analysis
- Hazardous or toxic facility siting
- Groundwater modeling and contamination tracking

Political Science
- Redistricting
- Analysis of election results
- Predictive modeling

Civil Engineering/Utility
- Locating underground facilities
- Designing alignment for freeways, transit
- Coordination of infrastructure maintenance

Business
- Demographic Analysis
- Market Penetration/ Share Analysis
- Site Selection

Education Administration
- Attendance Area Maintenance
- Enrollment Projections
- School Bus Routing

Real Estate
- Neighborhood land prices
- Traffic Impact Analysis
- Determination of Highest and Best Use

Health Care
- Epidemiology
- Needs Analysis
- Service Inventory

What GIS Applications Do:

manage, analyze, communicate

make possible the automation of activities involving geographic data

- map production
- calculation of areas, distances, route lengths
- measurement of slope, aspect, viewshed
- logistics: route planning, vehicle tracking, traffic management

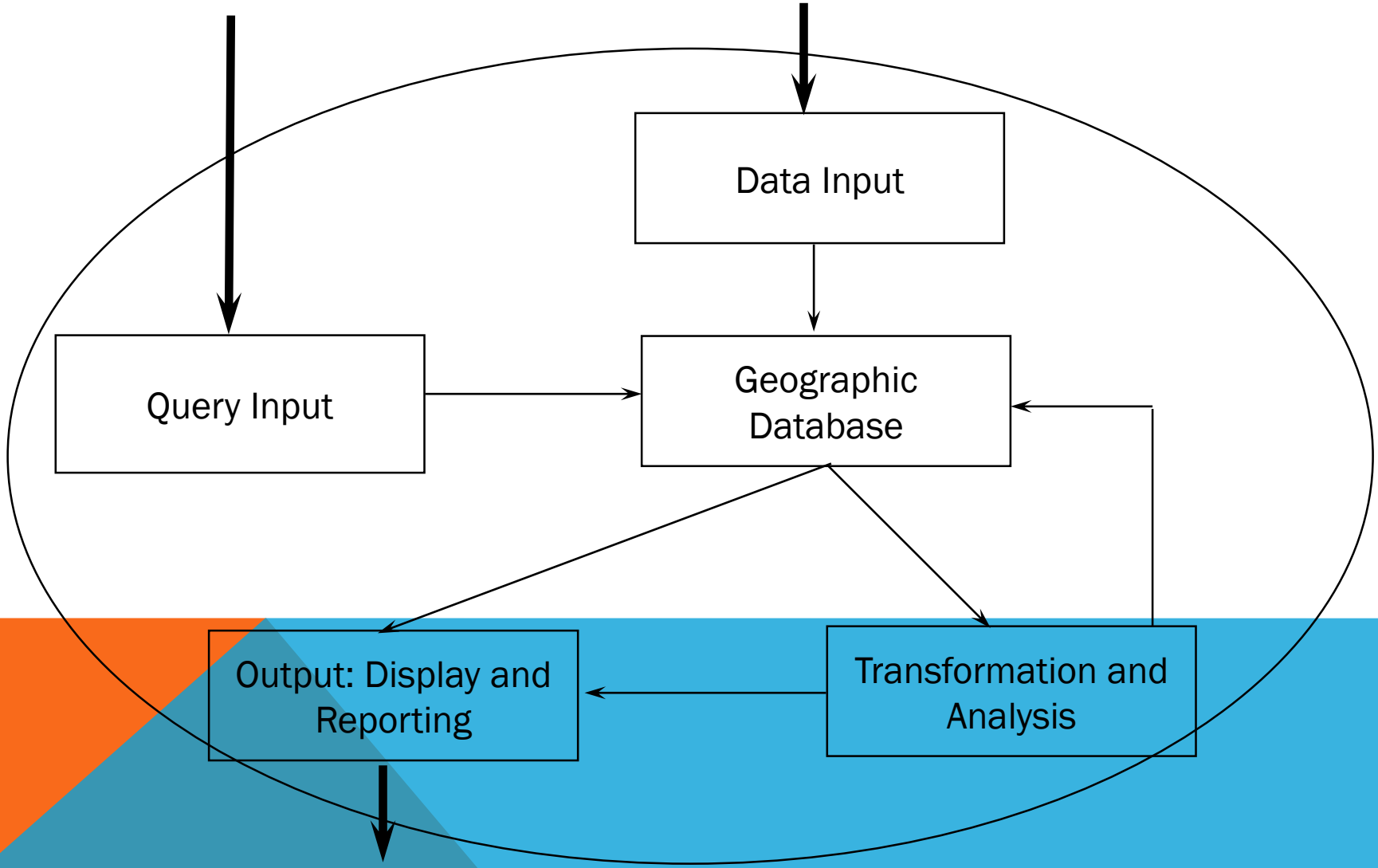
allow for the integration of data hitherto confined to independent domains (e.g property maps and air photos).

by tieing data to maps, permits the succinct communication of complex spatial patterns (e.g environmental sensitivity).

provides answers to spatial queries (how many elderly in delhi live further than 10 minutes at rush hour from ambulance service?)

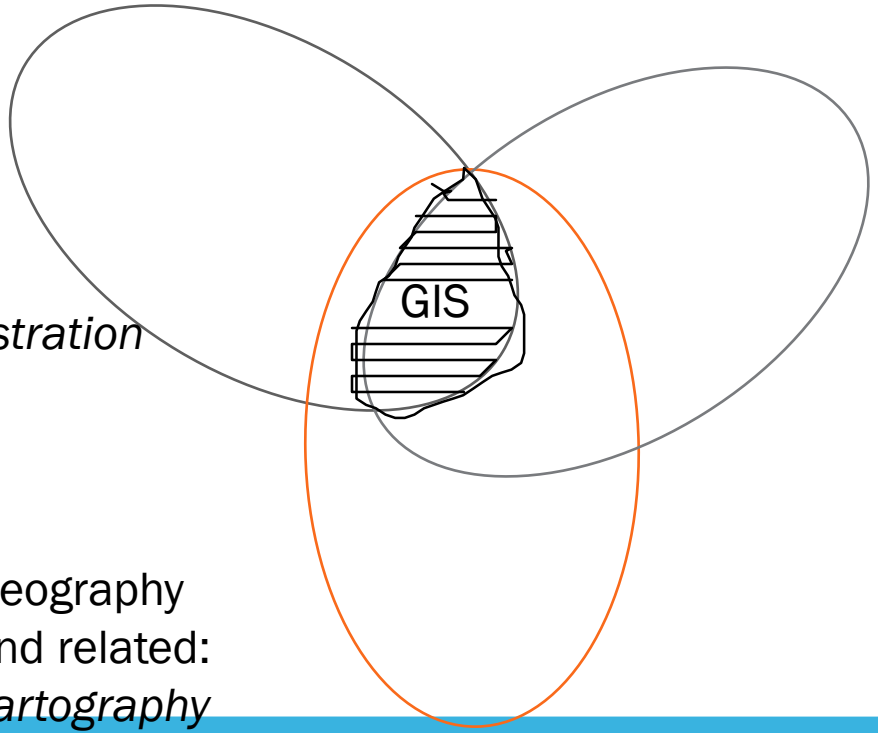
perform complex spatial modelling (*what if* scenarios for transportation planning, disaster planning, resource management, utility design)

GIS SYSTEM ARCHITECTURE AND COMPONENTS



KNOWLEDGE BASE FOR GIS

Computer Science/MIS
graphics
visualization
database
system administration
security



Application Area:
public admin.
planning
geology
mineral exploration
forestry
site selection
marketing
civil engineering
criminal justice
surveying

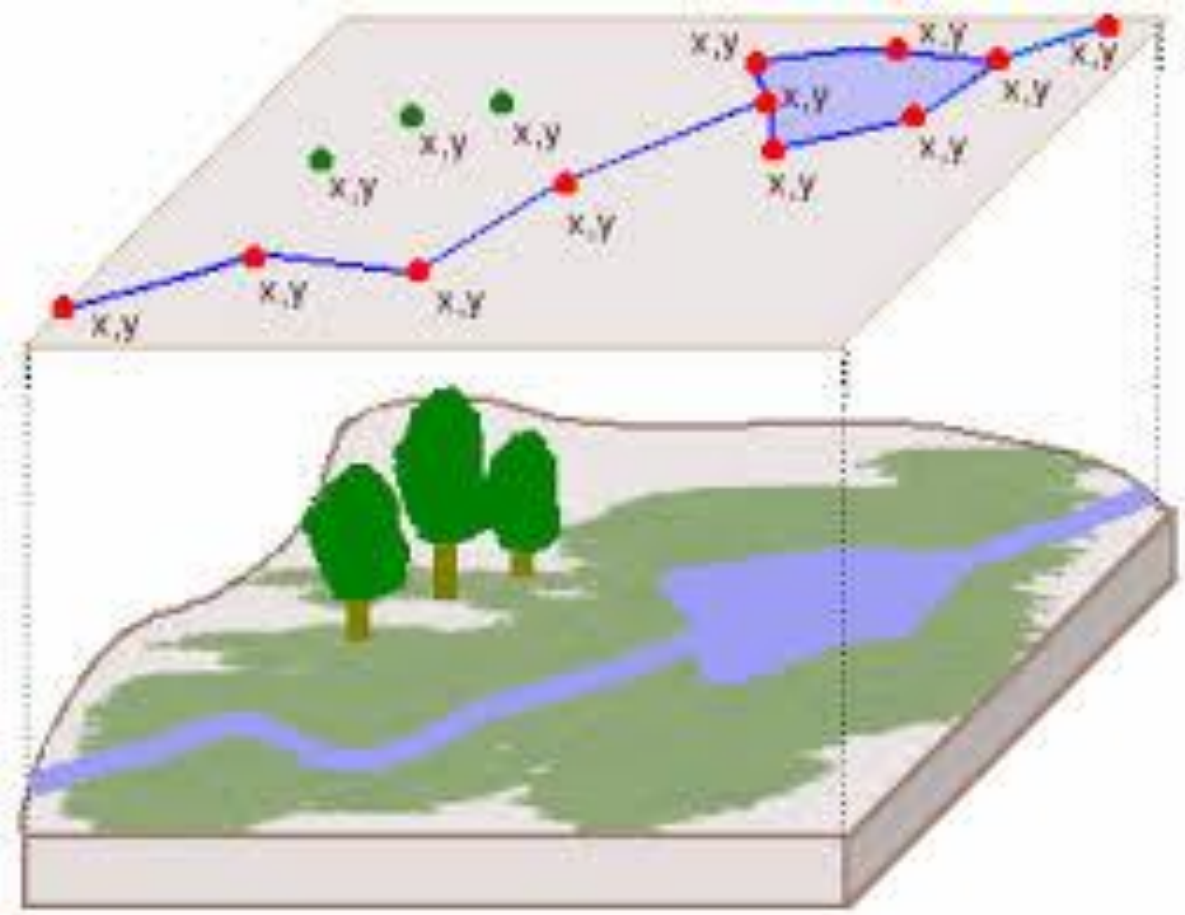
Geography and related:
cartography
geodesy
photogrammetry
landforms
spatial statistics.

The convergence of technological fields and traditional disciplines.

THE GIS DATA MODEL

THE GIS DATA MODEL: PURPOSE

allows the geographic features in real world locations to be digitally represented and stored in a database so that they can be abstractly presented in map (analog) form, and can also be worked with and manipulated to address some problem


x,y
x,y
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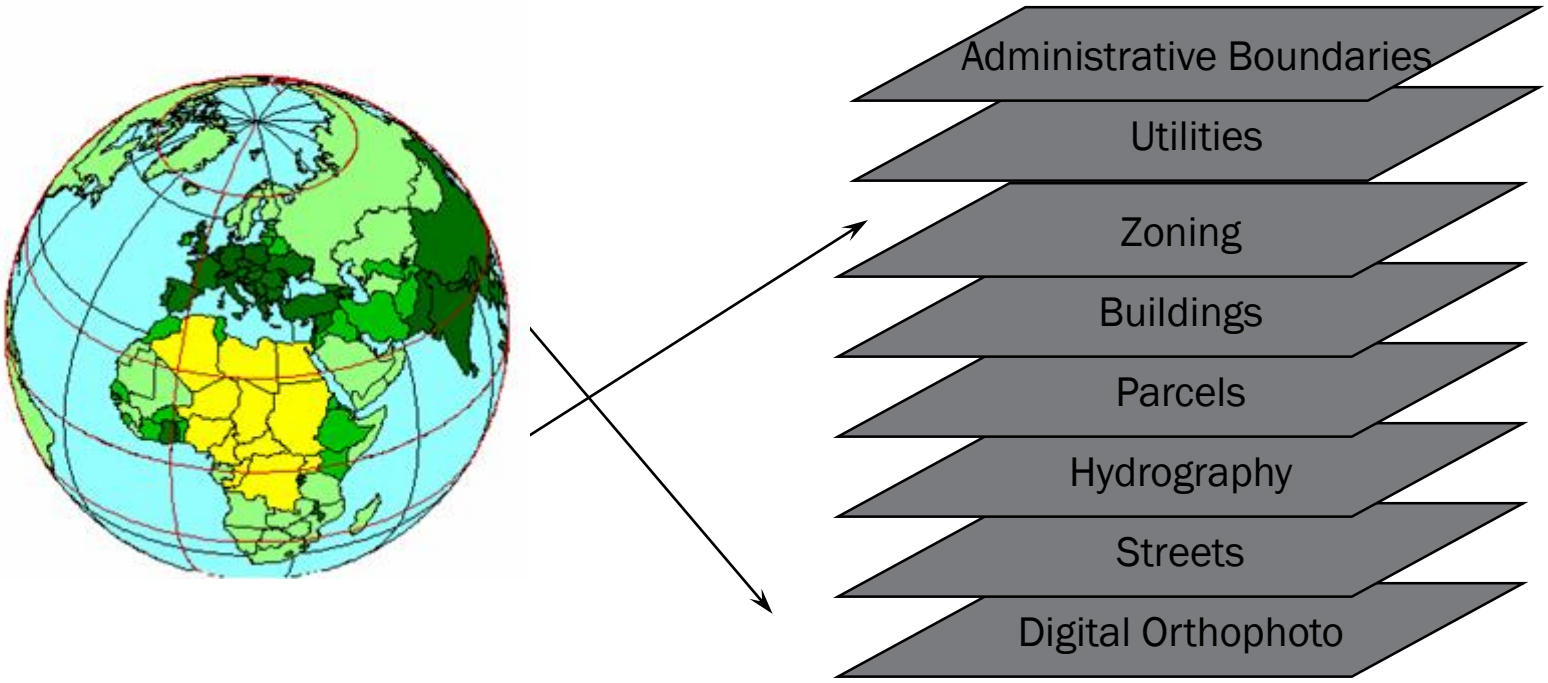
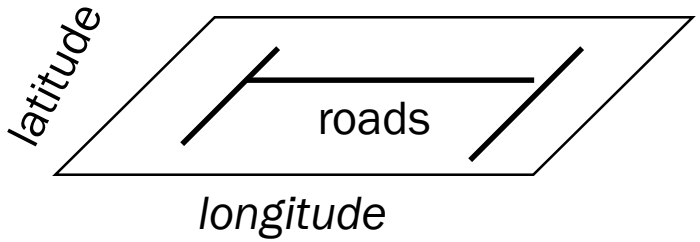
THE GIS DATA MODEL: IMPLEMENTATION

GEOGRAPHIC INTEGRATION OF INFORMATION



- Data is organized by layers, coverages or themes (synonomous concepts), *with each layer representing a common feature.*
- Layers are integrated using explicit location on the earth's surface, *thus geographic location is the organizing principal*.

THE GIS MODEL: EXAMPLE



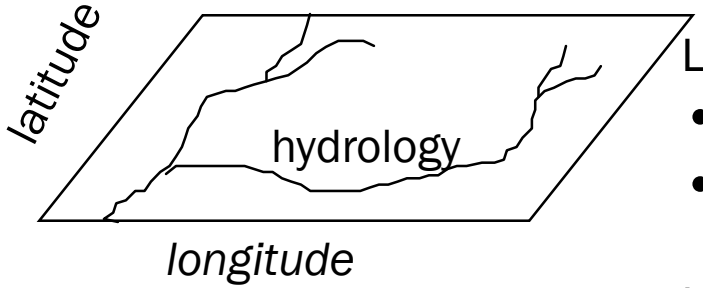
Here we have three layers or themes:

--roads,

--hydrology (water),

--topography (land elevation)

They can be related because precise geographic coordinates are recorded for each theme.

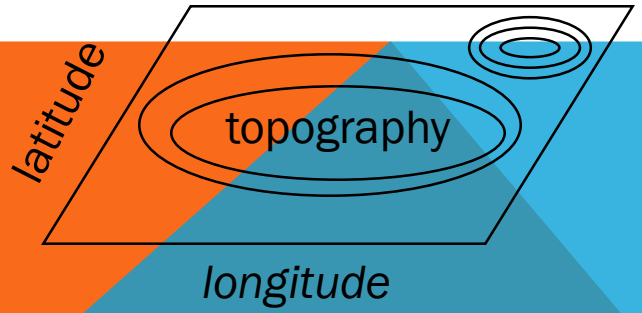


Layers are comprised of two data types

- *Spatial data* which describes location (where)
- *Attribute data* specifing what, how much,when

Layers may be represented in two ways:

- in *vector* format as points and lines
- in *raster(or image)* format as pixels



All geographic data has 4 properties:
projection, scale, accuracy and resolution

SPATIAL AND ATTRIBUTE DATA

Spatial data *(where)*

- specifies location
- stored in a *shape file, geodatabase* or similar geographic file

Attribute (descriptive) data *(what, how much, when)*

- specifies characteristics at that location, natural or human-created
- stored in a data base *table*

GIS systems traditionally maintain spatial and attribute data separately, then "join" them for display or analysis

- for example, in ArcView, the *Attributes of …* table is used to link a *shapefile* (spatial structure) with a *data base table* containing attribute information in order to display the attribute data spatially on a map

PROJECTION, SCALE, ACCURACY AND RESOLUTION

THE KEY PROPERTIES OF SPATIAL DATA

Projection: the method by which the curved 3-D surface of the earth is represented by X,Y coordinates on a 2-D flat map/screen

- distortion is inevitable

Scale: the ratio of distance on a map to the equivalent distance on the ground

- in theory GIS is scale independent but in practice there is an implicit range of scales for data output in any project

Accuracy: how well does the database info match the real world

- *Positional*: how close are features to their real world location?
- *Consistency*: do feature characteristics in database match those in real world
  - is a road in the database a road in the real world?

  Completeness: are all real world instances of features present in the database?
  - Are all roads included.

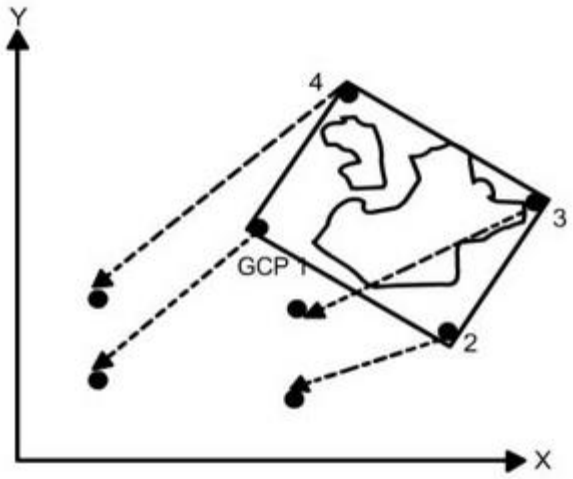
Resolution: the size of the smallest feature able to be recognized

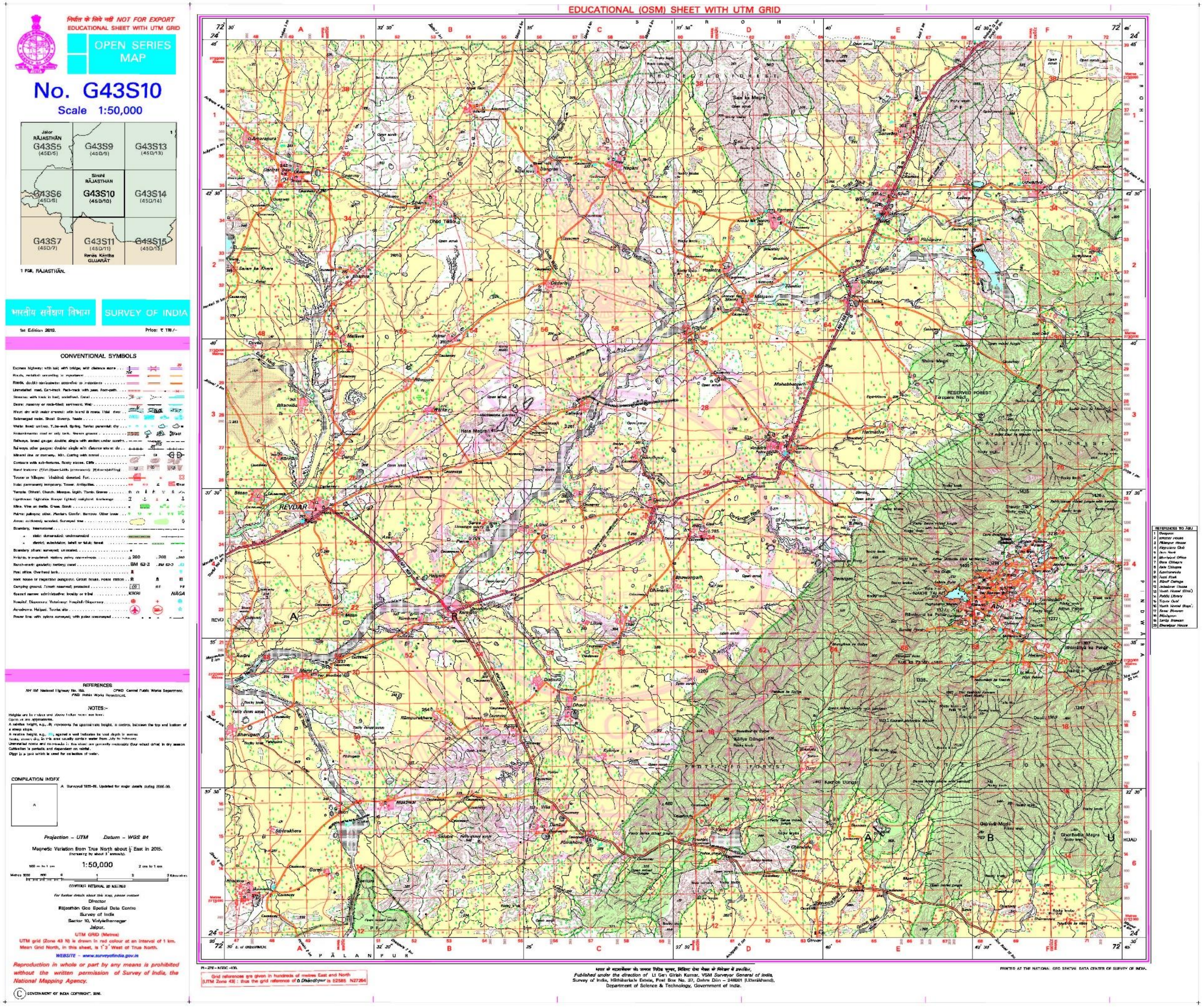
- for raster data, it is the *pixel* size

GEOREFERENCING

It is a process of locating an entity in real world coordinates. It aligns geographic data to a known coordinate system representing earth defined through projection systems so it can be viewed, queried, and analyzed with other geographic data.

- To georeference a geographic data, the positions of known points, called control points, are determined.
- The Ground Control Points (GCPs) are defined as the points with known geographical location, whose positions on map correspond to their positions on earth.
- GCPs are collected from fixed objects and are marked on the data to be georeferenced that define where the data is on earth. The whole data adjusts itself according to these GCPs.
- At least three control points are required for georeferencing a data.
- Additional control points help increasing the accuracy. Once the data is georeferenced, each point has a coordinate associated to it which means the location of any object in the data (map) can now be determined





EDUCATIONAL (OSM) SHEET WITH UTM GRID
NOT FOR EXPORT
EDUCATIONAL SHEET WITH UTM GRID
OPEN SERIES MAP
No. G43S10
Scale 1:50,000
G43S5
G43S9
G43S13
G43S6
G43S10
G43S14
G43S7
G43S11
G43S15
SURVEY OF INDIA
CONVENTIONAL SYMBOLS
REFERENCES
NOTES:-
COMPILATION INDEX
1:50,000
REVDAR
Abu

GIS DATA MODELS

Data models are conceptual models of the real world. These describe us the representation and storage of the geographic data. The data models used in GIS are described below:

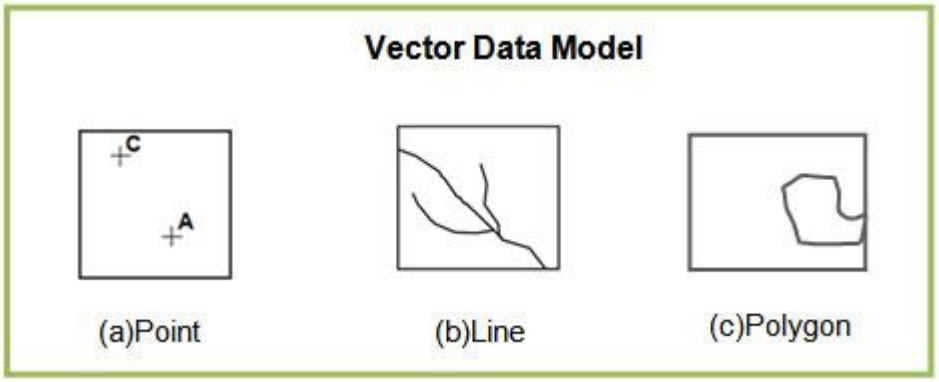
Vector Data Model

The vector data model is closely linked with the discrete object view. In vector data model, geographical phenomena are represented in three different forms;-point, line and polygon. The shape of a spatial entity is stored using two-dimensional (x, y) coordinate system.

Point : A location depicted by a single set of (x, y) coordinates at the scale of abstraction.

The wells in a village, electricity poles in a town and cities in the world map are the examples of spatial features described by points.

Note: A city can be marked as a single point on a world map but would be marked as a polygon on a state map. The scale plays an important role in deciding the geometry of a geographical feature.



Line/Arc : Ordered sets of (x, y) coordinate pairs arranged to form a linear feature. The curves in a linear feature are generated by increasing the density of points/vertices.

The roads, rails and telephone cables are the examples of the spatial features described by lines.

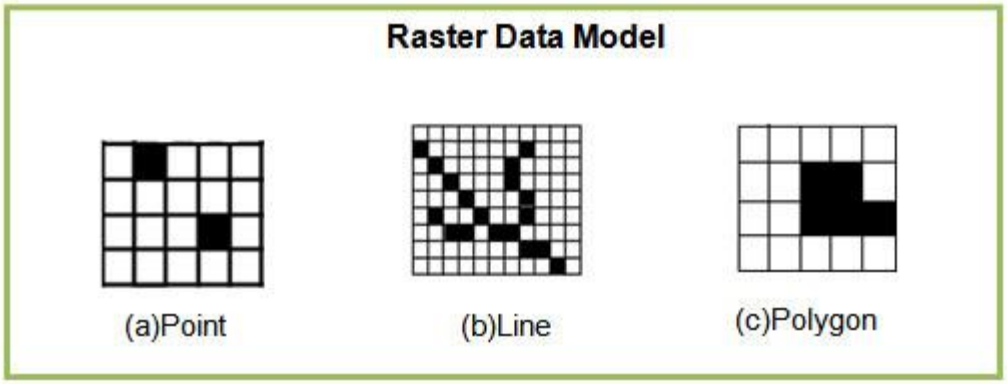
Polygon : The set of (x, y) coordinate pairs enclosing a homogeneous area.

The land parcels, agricultural farms and water bodies are the examples of the spatial features described by polygons.

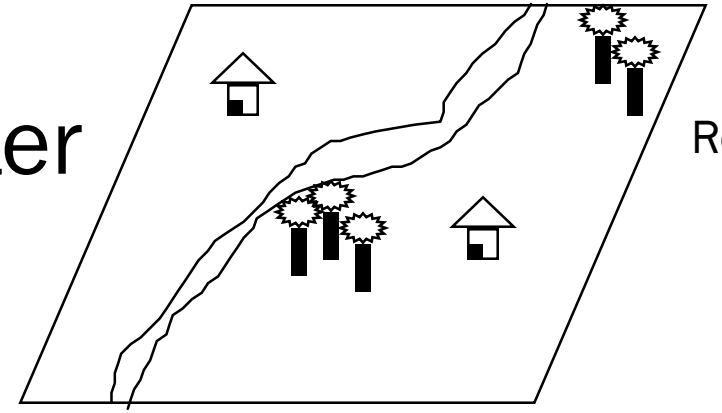
Raster Data Model

The raster data model is commonly associated with the field conceptual model. Here, geographic space is represented by array of cells or pixels (aka picture elements) which are arranged in rows and columns. Each pixel has a value that represents information. The value can be in the form of integer, floating points or alphanumeric.

A point can be represented by a single pixel in raster model.
A line is a chain of spatially connected cells with the same value. Similarly, a water body in raster data is represented as a set of contiguous pixels having same value that represents a homogeneous area.



Concept of Vector and Raster

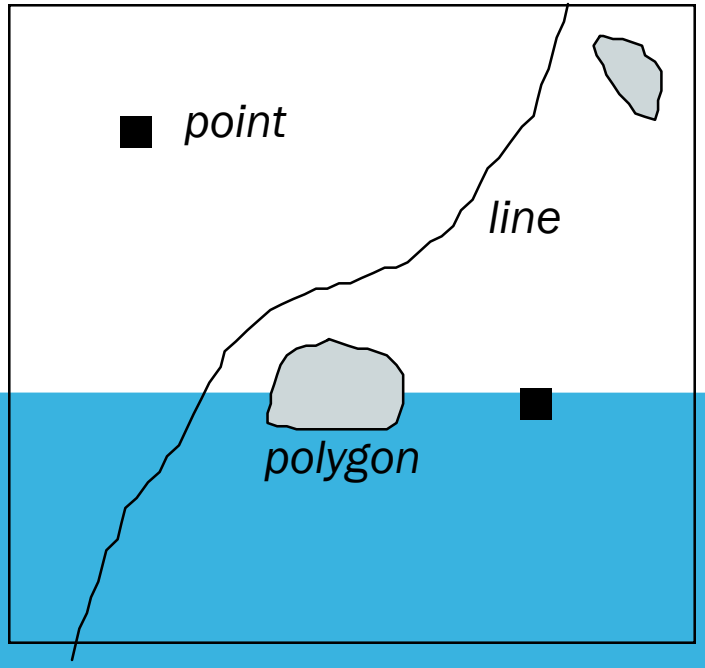


Real World

Raster Representation

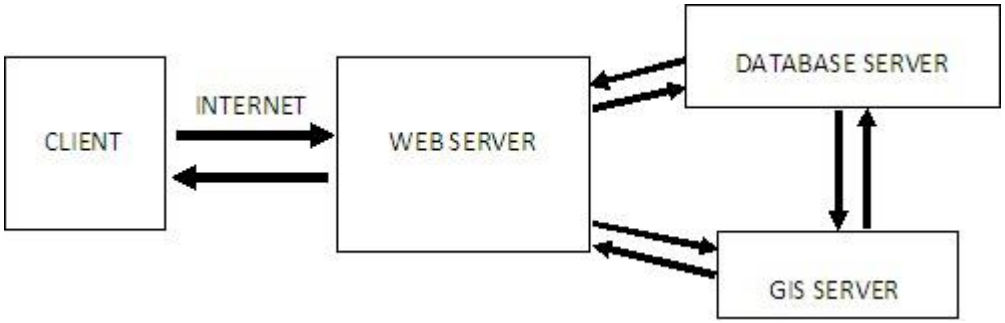
	0	1	2	3	4	5	6	7	8	9
0								R	T	
1							R			T
2		H					R			
3							R			
4					R	R				
5				R						
6			R		T	T		H		
7			R		T	T				
8		R								
9		R								

Vector Representation

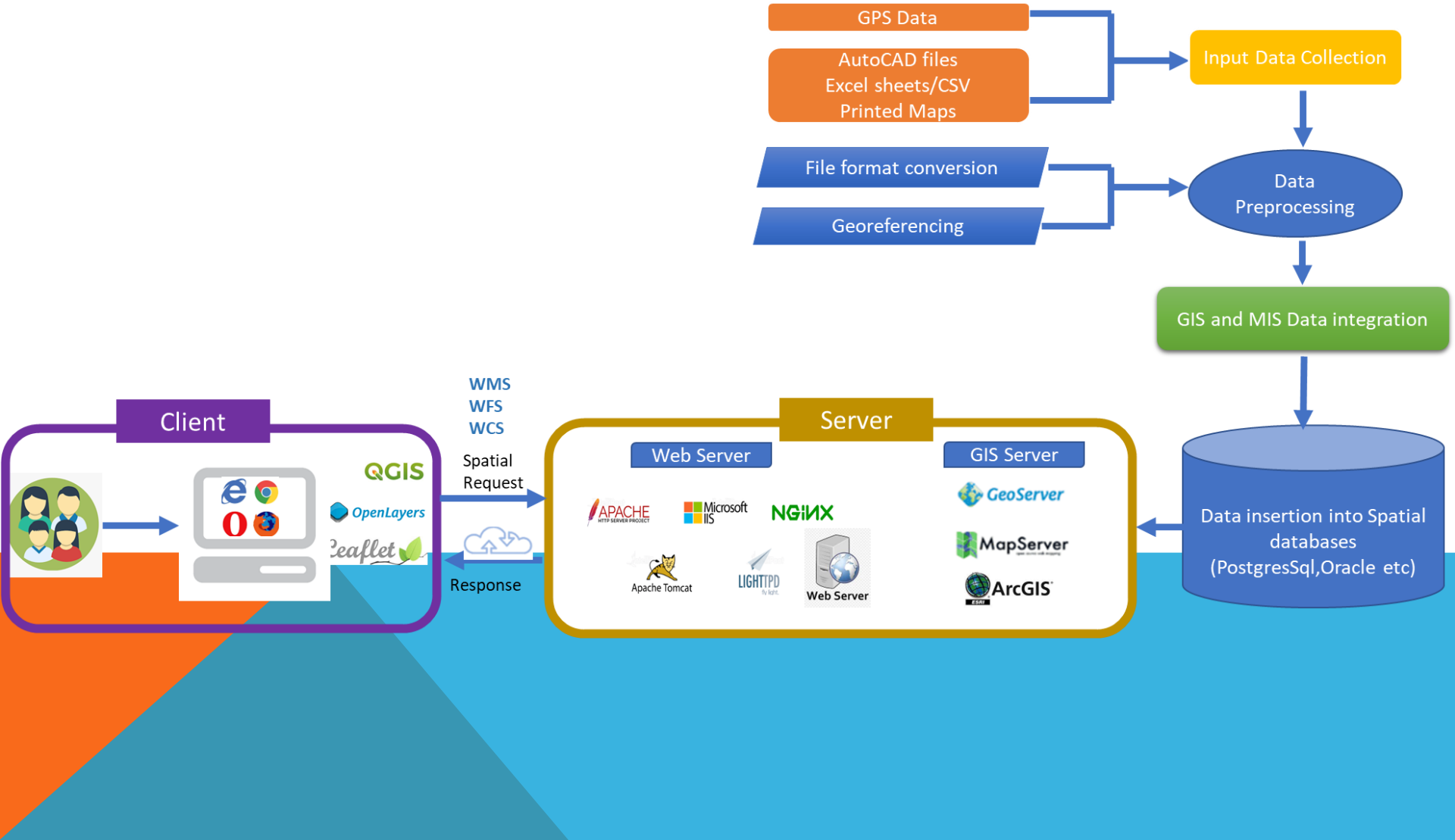


WEBGIS

The WebGIS is an integrated client-server network system similar to the client-server architecture of the web, where web browser application provides Internet users to access and send requests to the GIS applications residing at server end. The server processes the requests and returns the results to the client, the client then manipulates the data and/or results and presents to the user.



WEBGIS APPLICATION FLOW DIAGRAM



GIS SOFTWARES FREE

GIS category	Major software	Online resource
Desktop GIS	Quantum GIS	www.qgis.org
	Open Jump	www.openjump.org
	GRASS	http://grass.osgeo.org
GIS database management	Postgre SQL and	www.postgresql.org
	POST GIS	http://postgis.refractions.net
GIS development libraries	FDO	http://fdo.osgeo.org
	GDAL/OGR	www.gdal.org
	GeoTools	www.geotools.org
Web GIS	Open Layer API	www.openlayers.org
	GeoEXT, etc.	www.geoext.org
Geo-web Services	GeoServer	www.geoserver.org
	OSGEO-Map Server	www.osgeo.org/mapserver
	Degree	www.deegree.org
Catalogue/metadata	Geonetwork	http://geonetwork-opensource.org/

GIS SOFTWARES COMMERCIAL

ArcGIS ESRI, Inc., Redlands, CA

MapInfo, Troy N.Y.

Intergraph (Huntsville, AL)

Bentley Systems (Exton, PA)

Autodesk (San Rafael, CA)

lat	long