GIS Data in ArcGIS

GIS Data Models

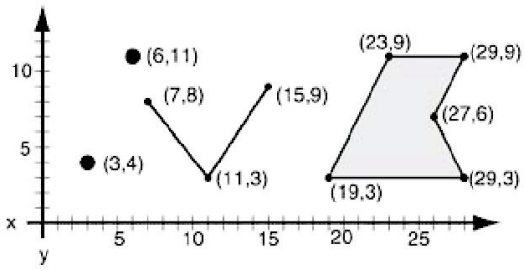
- Vector
  - Points, lines, polygons, multi-part, multi-patch
  - Composite & secondary features
    - Regions, dynamic segmentation (routes)
- Raster
  - Grids, images
  - Nominal, ordinal, interval, ratio measures
- Triangulated Irregular Network (TIN)
- Tabular
- Terrain dataset (ArcGIS 9.2 and later)
- Network dataset (ArcGIS 9.X)

GIS Data Structures

- Coverage
- File-based
  - Shapefiles (.shp, .dbf, …)
  - File-based Geodatabase (ArcGIS 9.2 and later)
- DBMS-based
  - Personal Geodatabase – MS Access
  - ArcSDE

Vector Data Model

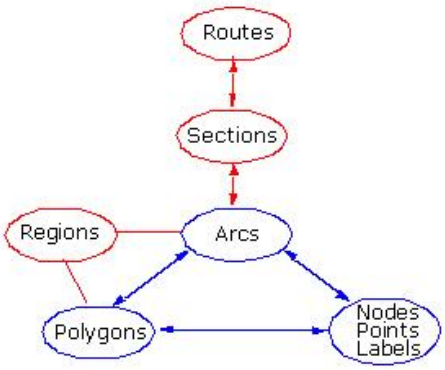
Geometry



Attributes
(PAT, AAT, PAT)

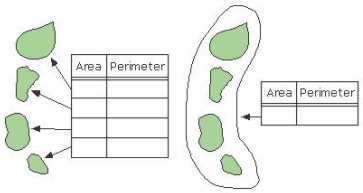
TRACT	POP1990	AREA	PERIMETER
0056	3433	5205890	9508.022
0057	1775	17330714	17017.602
001102	1331	13391034	15832.158
001202	3245	10129278	12933.502
001302	2839	8228478	11483.996

Composition Features (Coverage)

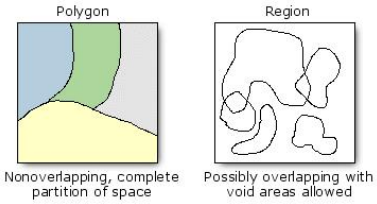


Regions (Coverage) / Multipart Features

- Disjoint polygons



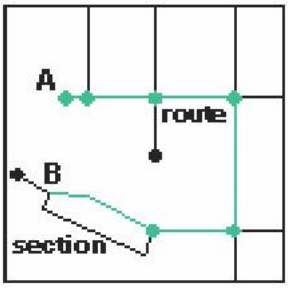
- Overlapped polygons



Multipatch

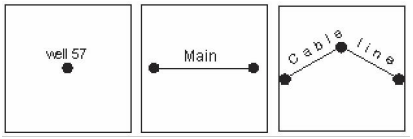
- Its geometry type can contain 3D models with vertical and overhanging faces.
- These faces may contain texture information.
- Multipatch data is stored in the same manner as point, line, and polygon data in GDB or shapefiles.
- It can have attributes and can be used with the standard tools, such as the Identify tool.
- Use 3D Analyst tools to manage multipatch features.

Routes

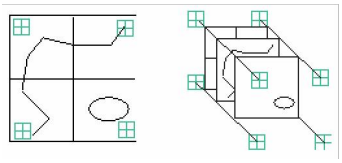


Secondary Features

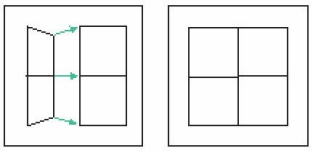
Annotations



Tics

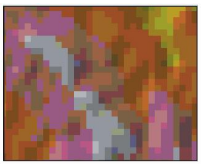


Links

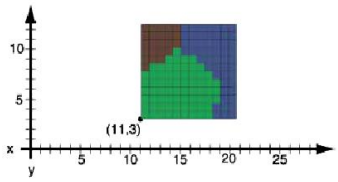


Raster Data Model

- Cells (Pixels)
- Cell value



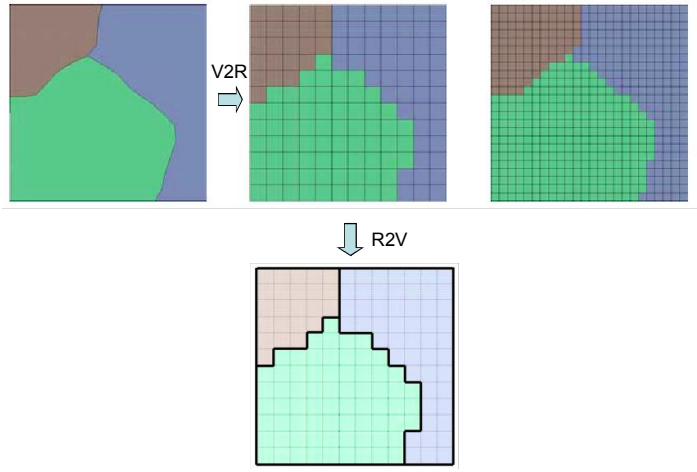
- x, y cell sizes
- Geographic coordinates



Attributes

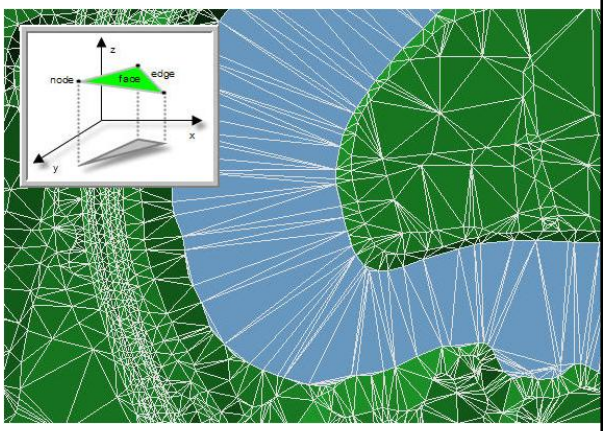
Value	Count	Name	Suitability	Type
2	30672	Cropland and pastureland	4	Agriculture
3	3339	Urban and industrial	5	Urban
10	212	Clearings and brushfields	5	Cleared
21	1383	Cottonwood	4	Riparian
463	142	Ash-Cottonwood	3	Woodland
476	7205	Oak	3	Woodland
505	1112	Douglas fir	2	Forest
510	6557	Mixed evergreen-broadleaf	3	Forest
512	7943	Douglas fir-Hemlock-Cedar	1	Forest

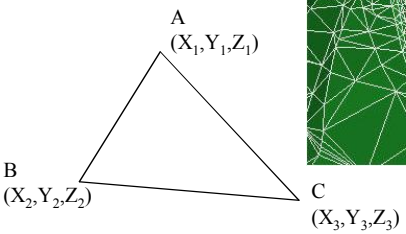
Raster to Vector / Vector to Raster



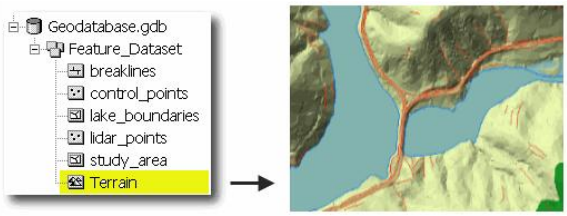
TIN

- Node (x, y, z)
- Edge
- Triangles

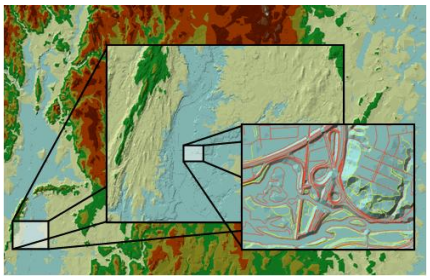




ArcGIS 9.2 Terrain Dataset



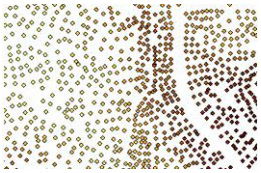
A terrain dataset is a multi-level (pyramid-level) TIN



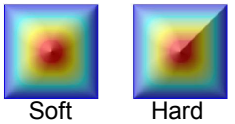
Surface Feature Types (SFTypes) of Terrain Dataset

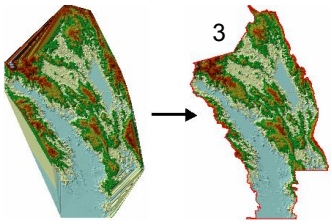
1. Mass points (x,y,z locations)
2. Breaklines (hard or soft)
3. Clipping polygons (hard or soft)
4. Erase polygons (hard or soft)
5. Replace polygons (hard or soft)

1



2





Network

- Geocoding
  - Address
  - Intersection
- Dynamic segmentation
  - Sections and routes (for linear referencing)
  - Events
- Network connective
  - Geometric network and transportation network
  - Edge + junctions (geodatabase)
  - Turn tables associated with junctions.

Network

- Topology-based features – connectivity
  - Intersections (junctions)
    - Junctions
    - Sources and sinks
    - Turns, Turn impedance
    - Overpasses and underpasses
  - Links (edges)
    - Directions
    - Impedance (length, travel time, flow volume)
    - Directional impedance

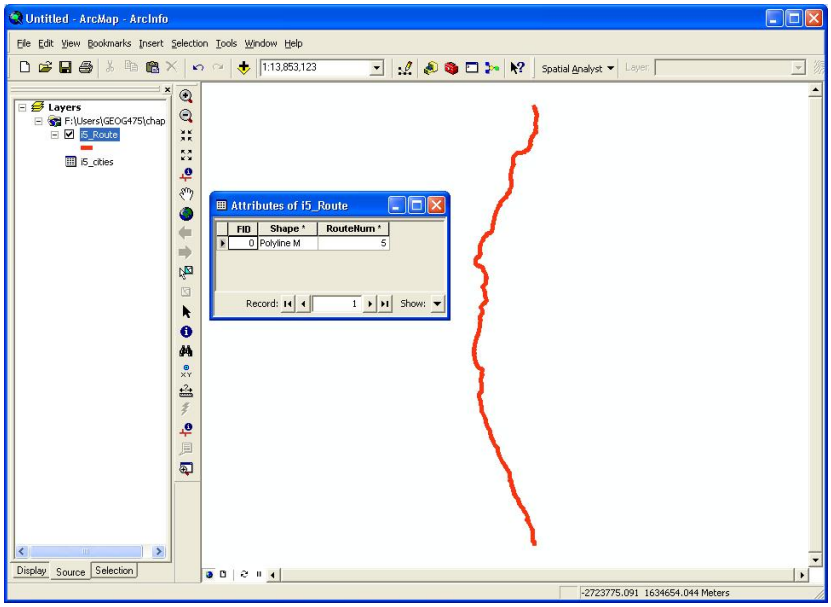
Street Layer for Geocoding

Attributes of streets

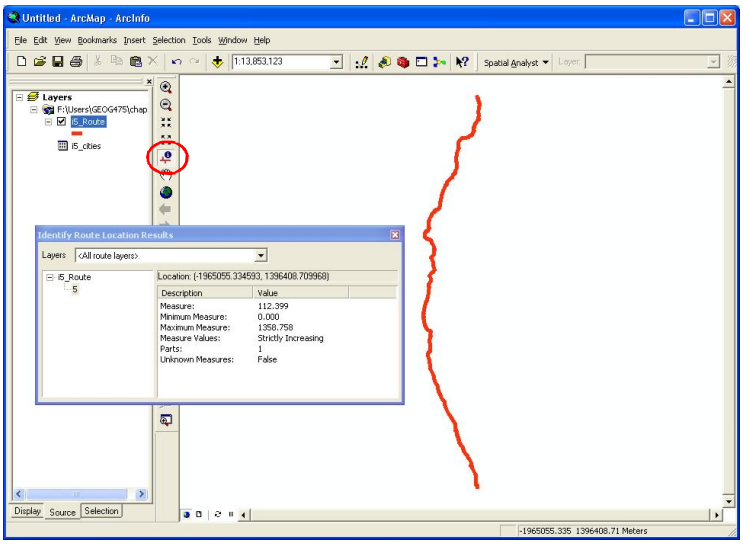
FID	Shape *	LENGTH	LOCALID	ZERO	PREFIX	STREETNAME	FTYPE	DIRECTION	LEFTADD1	LEFTADD2	RGTADD1	RGTADD2	LEFTZIP	RIGHT
105	Polyline	12875.442517	200011	0	NW	HWY 47	HWY		23301	27999	23300	27998	97109	
106	Polyline	9683.605408	219390	0	NW	POTTRATZ	RD		25601	26789	25600	26788	97133	
107	Polyline	1111.038289	219418	0					0	0	0	0	97106	
108	Polyline	292.653994	219423	0	NW	POND	AVE		23201	23299	23200	23298	97109	
109	Polyline	7502.219667	218347	0	NW	SKY RANCH	RD		24001	25499	24000	25498	97133	
110	Polyline	1041.723534	100090	0	NW	ST HELENS	RD		23511	23579	23510	23578	97231	
111	Polyline	2425.538532	100069	0	NW	REEDER	RD		24301	24509	24300	24508	97231	
112	Polyline	502.329093	219428	0					0	0	0	0	97109	
113	Polyline	5685.111874	219188	0	NW	SUNSET	HWY		51230	52998	51231	52999	97109	
114	Polyline	97.661364	219186	0	NW	SUNSET	HWY		51220	51228	51221	51229	97106	
115	Polyline	497.806404	219434	0	NW	STRASSEL	RD		51250	51398	51251	51399	97106	
116	Polyline	678.736173	100071	0	NW	GILLIHAN	RD		23901	24099	23900	24098	97231	
117	Polyline	1938.780757	219438	0	NW	PONGRATZ	RD		49400	49998	49401	49999	97109	
118	Polyline	1945.934434	171627	0	NW	MORAN	RD		22901	23899	22900	23898	97056	
119	Polyline	8461.599045	100072	0	NW	SAUVIE ISLAND	RD		23001	26799	23000	26798	97231	
120	Polyline	2010.014284	200012	0	NW	HWY 47	HWY		22701	23299	22700	23298	97109	
121	Polyline	2230.025779	219187	0	NW	SUNSET	HWY	W	51000	51218	51001	51219	97106	
122	Polyline	1511.806464	218430	0	NW	LINKLATER	RD		42800	43198	42801	43199	97106	
123	Polyline	2150.031997	219439	0	NW	GREEN MOUNTAIN	RD		22501	22899	22500	22898	97106	
124	Polyline	5544.848132	222200	0	NW	ROUND TOP	RD		21001	23999	21000	23998	97144	
125	Polyline	1884.333814	221463	0	NW	MORAN	RD		22401	22899	22400	22898	97133	
126	Polyline	3137.010971	100075	0	NW	LUCY REEDER	RD		17400	18098	17401	18099	97231	
127	Polyline	1729.447703	219184	0	NW	SUNSET	HWY	W	50000	50998	50001	50999	97106	
128	Polyline	965.803867	100078	0	NW	LUCY REEDER	RD		17000	17398	17001	17399	97231	
129	Polyline	8285.617492	219452	0	NW	PUMPKIN RIDGE	RD		22001	24699	22000	24698	97133	
130	Polyline	1769.580067	100081	0	NW	LUCY REEDER	RD		16400	16998	16401	16999	97231	
131	Polyline	1156.062043	100084	0	NW	LUCY REEDER	RD		15700	16398	15701	16399	97231	
132	Polyline	8603.309992	100085	0	NW	REEDER	RD		22301	24299	22300	24298	97231	
133	Polyline	624.467784	100092	0					0	0	0	0	97231	

Record: 1 Show: All Selected Records (0 out of 100244 Selected) Options

Polylines for Dynamic Segmentation - Routes



Linear Referencing - Identify Route Locations Tool



- The tool needs to be added to ArcMap manually using the customize interface.

Event Table – Point & Line Events

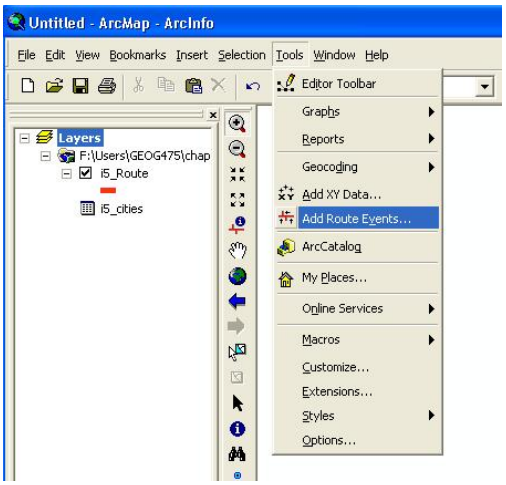
Attributes of i5_cities

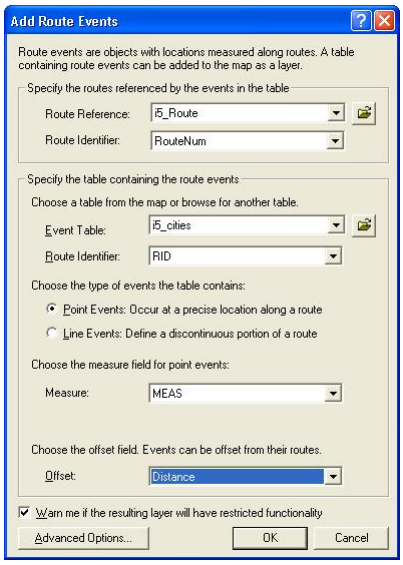
OID	RID	MEAS	Distance	CITY_FIPS	CITY_NAME	STATE_FIPS	STATE_NAME	STATE_CITY	NDistance
0	5	23.396613	444.287262	05280	Bellingham	53	Washington	5305280	-444.287262
1	5	48.442991	-1439.397149	47560	Mount Vernon	53	Washington	5347560	1439.397149
2	5	71.721368	-3780.440602	49992	North Marysville	53	Washington	5349992	3780.440602
3	5	76.05396	-2854.762079	43955	Marysville	53	Washington	5343955	2854.762079
4	5	79.154825	-5581.984603	77542	West Lake Stevens	53	Washington	5377542	5581.984603
5	5	82.220723	-442.665484	22640	Everett	53	Washington	5322640	442.665484
6	5	88.31138	2227.181163	52765	Paine Field-Lake Stickney	53	Washington	5352765	-2227.181163
7	5	87.404949	-4757.788616	64452	Silver Lake-Fircrest	53	Washington	5364452	4757.788616
8	5	90.837257	2185.154758	37705	Lake Serene-North Lynnwood	53	Washington	5337705	-2185.154758
9	5	90.065851	-1085.58979	43815	Martha Lake	53	Washington	5343815	1085.58979
10	5	93.113678	1818.075979	40840	Lynnwood	53	Washington	5340840	-1818.075979
11	5	94.941517	5224.655605	20750	Edmonds	53	Washington	5320750	-5224.655605
12	5	91.365016	-6628.376516	49670	North Creek-Canyon Park	53	Washington	5349670	6628.376516
13	5	92.980897	-3776.716929	01178	Alderwood Manor-Bothell North	53	Washington	5301178	3776.716929
14	5	95.254614	-210.832347	47490	Mountlake Terrace	53	Washington	5347490	210.832347
15	5	95.994023	3196.09603	22255	Esperance	53	Washington	5322255	-3196.09603
16	5	93.972105	-9084.148291	07380	Bothell	53	Washington	5307380	9084.148291
17	5	97.572945	1712.638391	58340	Richmond Highlands	53	Washington	5358340	-1712.638391
18	5	98.118295	-557.873428	49642	North City-Ridgecrest	53	Washington	5349642	557.873428
19	5	92.44348	-15208.975801	79590	Woodinville	53	Washington	5379590	15208.975801
20	5	99.411855	-11619.602434	35835	Kingsgate	53	Washington	5335835	11619.602434
21	5	99.774335	-6496.780574	33380	Inglewood-Finn Hill	53	Washington	5333380	6496.780574
22	5	102.58559	-9670.250453	35940	Kirkland	53	Washington	5335940	9670.250453
23	5	103.24225	-15668.847464	57535	Redmond	53	Washington	5357535	15668.847464
24	5	106.962049	2070.250146	63000	Seattle	53	Washington	5363000	-2070.250146
25	5	109.484063	-12745.704785	05210	Bellevue	53	Washington	5305210	12745.704785
26	5	113.121048	-6224.982736	45005	Mercer Island	53	Washington	5345005	6224.982736
27	5	115.89153	-8339.060539	48855	Newport Hills	53	Washington	5348855	8339.060539
28	5	113.62014	5427.103839	78242	White Center-Shorewood	53	Washington	5378242	-5427.103839

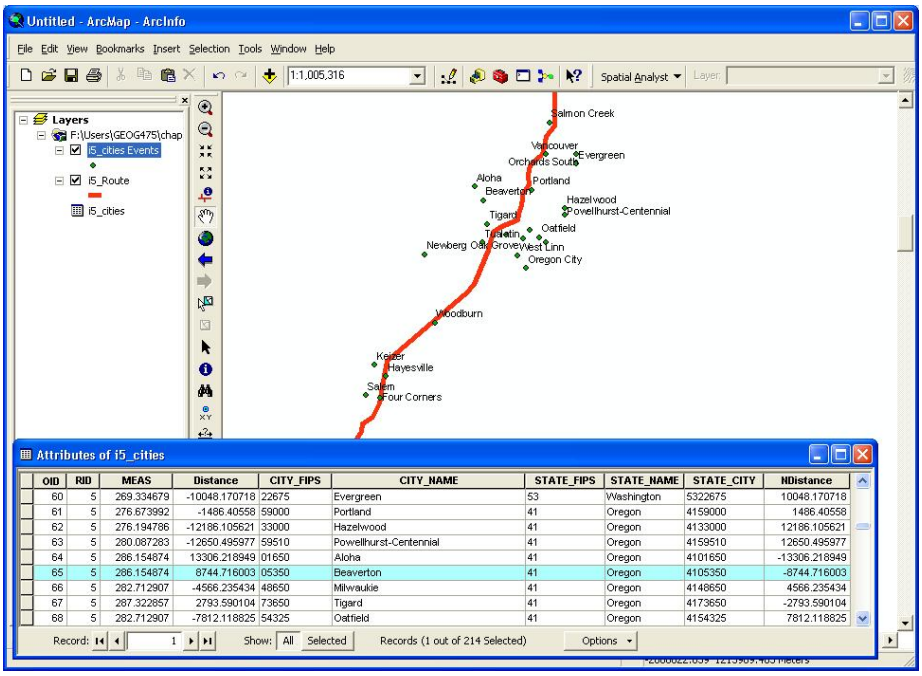
Record: 1 Show: All Selected Records (0 out of 214 Selected) Options

- Offset: A value indicating how far the events are from the route – the sign of the value indicates the direction of the offset – right or left.

Add Route Events



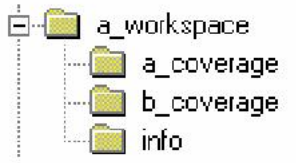




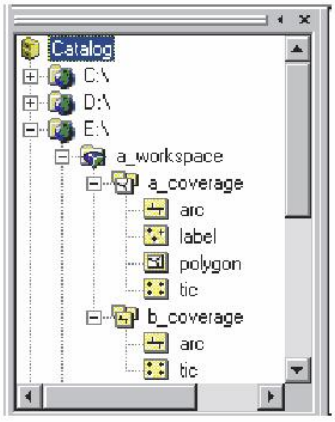
GIS Data Structures

- Geometry & attributes
- File-based
  - ArcInfo: Coverages + Info tables
  - ArcView: Shapefiles + dbf tables
  - ArcGIS: File geodatabase (since 9.2)
- DBMS-based
  - ArcGIS: Personal Geodatabase (mdb) & Geodatabase (SDE)

ArcInfo Coverage Data Structure



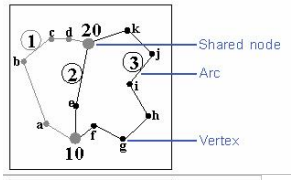
Workspace in the file system



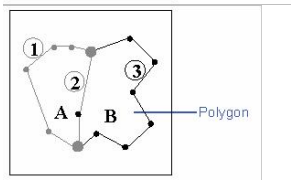
Workspace in ArcCatalog

Coverage Topology

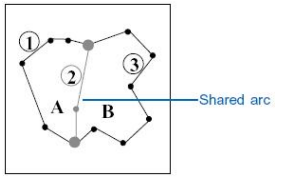
Connectivity: Arcs that share a node are Connected (arc-node topology)



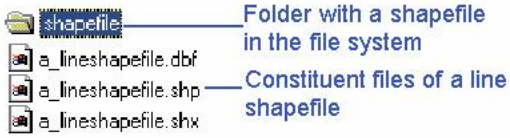
Area definition: An area is defined by a series of connected arcs (polygon-arc topology)



Contiguity: Arcs have directions and left and right polygons (left-right topology)

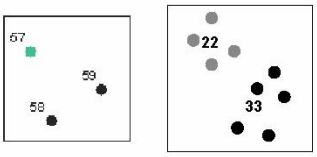


ArcView Shapefile Data Structure

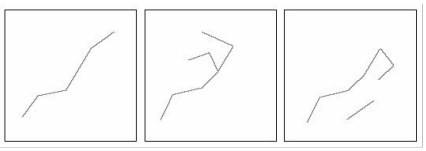


Shapefile (No Topology!)

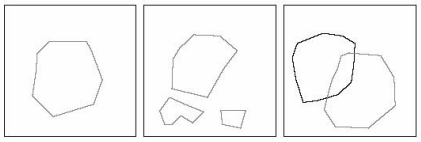
Point, multipoint



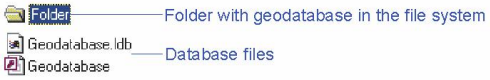
Line

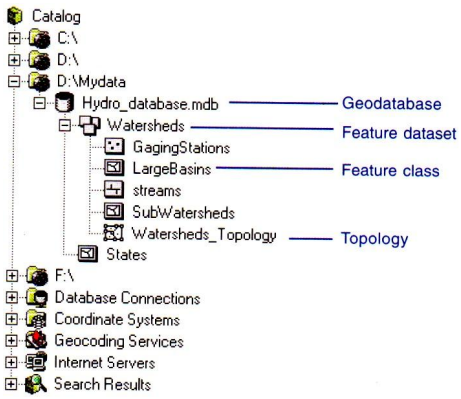


Polygon



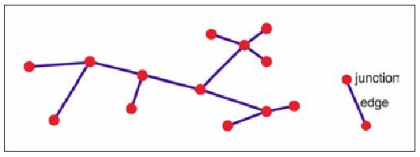
ArcGIS Geodatabase Data Structure





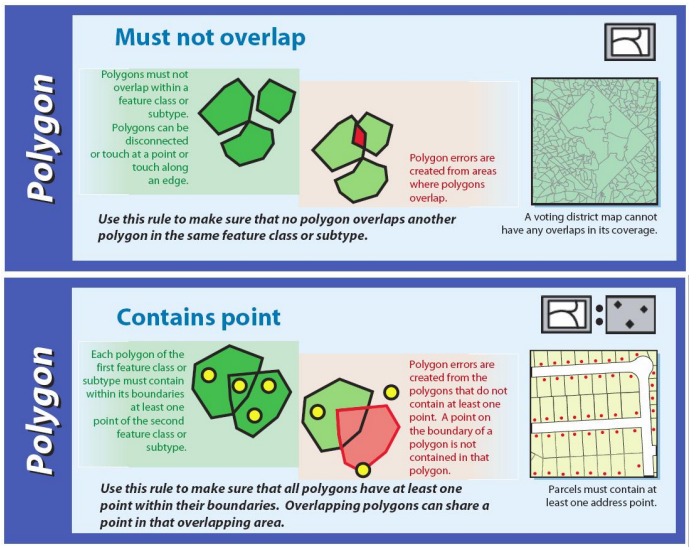
Features / Feature Classes

- All point, line, and polygon features can:
  - Be multipart
  - Have x,y; x,y,z; or x,y,z,m coordinates
    - (m-coordinates store distance measurement values, a line with m-coordinates becomes a route)
  - Be stored as continuous layers instead of tiled
  - Lines are built from line segments, circular arcs, and splines.
- Network dataset
  - Junctions, edges
- Terrain dataset



Geodatabase Topology (Optional)

ArcGIS topology defines the spatial relationships between geometries



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 then 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

Why do we need topology in GIS?

- Enforce geometric rules for spatial representation and maintain data integrity
- Reduce data redundancy
- Improve data access/update efficiency

Summary

Data Structure	*Type*	*Topology*	*Portability*	*Spatial Integrity*
Coverage	File-based	Required	Low	High
Shapefile	File-based	None	High	None
Geodatabase	DBMS	Optional	High	High (if topology rules are defined)
8.X & 9.1 Personal Geodatabase	DBMS (MS Access)	Optional	High	High (if topology rules are defined)
9.2 File-based Geodatabase	File-based	Optional	High	High (if topology rules are defined)