

GIS Data in ArcGIS

Pay Attention to Data!!!



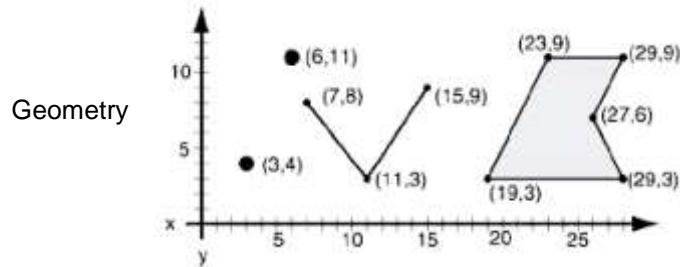
GIS Data Models

- 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

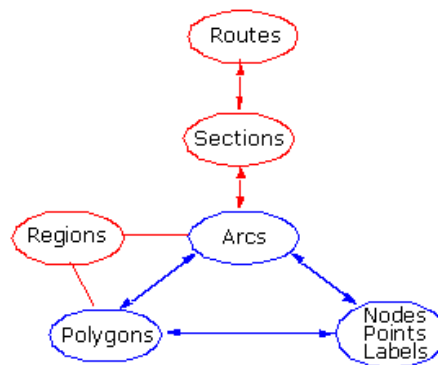
Vector Data Model



Attributes
(PAT, AAT, PAT)

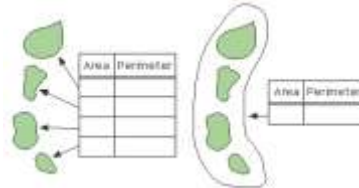
TRACT	POP1990	AREA	PERIMETER
0056	3433	5205890	9508.022
0057	1775	17330714	17017.602
001102	1331	13591034	15832.158
001202	3245	10129278	12933.502
001302	2839	8228478	11483.996

Composition Features (Coverage)

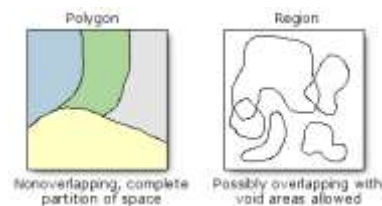


Regions (Coverage) / Multipart Features

- Disjoint polygons



- Overlapped polygons

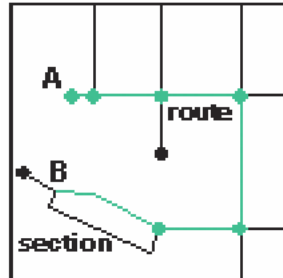


Multipatch

- 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.

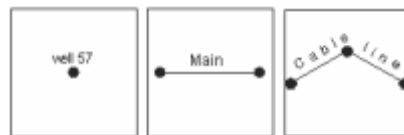


Routes

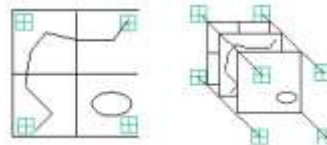


Secondary Features

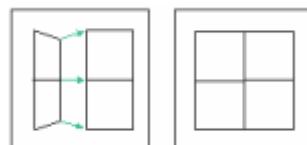
Annotations



Tics



Links

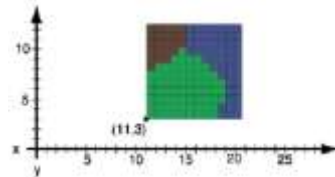


Raster Data Model

- Cells (Pixels)
- Cell value



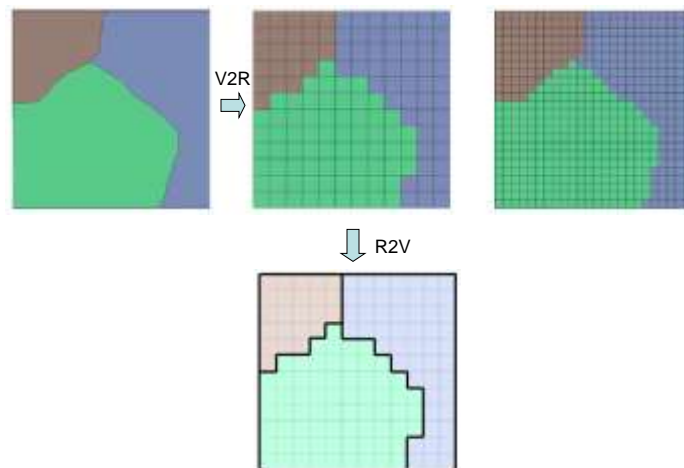
- x, y cell sizes
- Geographic coordinates



Attributes

Value	Color	Name	Substraw	Type
1	000	Water of bed (shallow)		Water
11	111	Water of bed (deep)		Water
12	122	Water of bed (shallow)		Water
13	133	Water of bed (shallow)		Water
14	144	Water of bed (shallow)		Water
15	155	Water of bed (shallow)		Water
16	166	Water of bed (shallow)		Water
17	177	Water of bed (shallow)		Water
18	188	Water of bed (shallow)		Water
19	199	Water of bed (shallow)		Water
20	200	Water of bed (shallow)		Water
21	211	Water of bed (shallow)		Water
22	222	Water of bed (shallow)		Water
23	233	Water of bed (shallow)		Water
24	244	Water of bed (shallow)		Water
25	255	Water of bed (shallow)		Water
26	266	Water of bed (shallow)		Water
27	277	Water of bed (shallow)		Water
28	288	Water of bed (shallow)		Water
29	299	Water of bed (shallow)		Water
30	300	Water of bed (shallow)		Water
31	311	Water of bed (shallow)		Water
32	322	Water of bed (shallow)		Water
33	333	Water of bed (shallow)		Water
34	344	Water of bed (shallow)		Water
35	355	Water of bed (shallow)		Water
36	366	Water of bed (shallow)		Water
37	377	Water of bed (shallow)		Water
38	388	Water of bed (shallow)		Water
39	399	Water of bed (shallow)		Water
40	400	Water of bed (shallow)		Water
41	411	Water of bed (shallow)		Water
42	422	Water of bed (shallow)		Water
43	433	Water of bed (shallow)		Water
44	444	Water of bed (shallow)		Water
45	455	Water of bed (shallow)		Water
46	466	Water of bed (shallow)		Water
47	477	Water of bed (shallow)		Water
48	488	Water of bed (shallow)		Water
49	499	Water of bed (shallow)		Water
50	500	Water of bed (shallow)		Water
51	511	Water of bed (shallow)		Water
52	522	Water of bed (shallow)		Water
53	533	Water of bed (shallow)		Water
54	544	Water of bed (shallow)		Water
55	555	Water of bed (shallow)		Water
56	566	Water of bed (shallow)		Water
57	577	Water of bed (shallow)		Water
58	588	Water of bed (shallow)		Water
59	599	Water of bed (shallow)		Water
60	600	Water of bed (shallow)		Water
61	611	Water of bed (shallow)		Water
62	622	Water of bed (shallow)		Water
63	633	Water of bed (shallow)		Water
64	644	Water of bed (shallow)		Water
65	655	Water of bed (shallow)		Water
66	666	Water of bed (shallow)		Water
67	677	Water of bed (shallow)		Water
68	688	Water of bed (shallow)		Water
69	699	Water of bed (shallow)		Water
70	700	Water of bed (shallow)		Water
71	711	Water of bed (shallow)		Water
72	722	Water of bed (shallow)		Water
73	733	Water of bed (shallow)		Water
74	744	Water of bed (shallow)		Water
75	755	Water of bed (shallow)		Water
76	766	Water of bed (shallow)		Water
77	777	Water of bed (shallow)		Water
78	788	Water of bed (shallow)		Water
79	799	Water of bed (shallow)		Water
80	800	Water of bed (shallow)		Water
81	811	Water of bed (shallow)		Water
82	822	Water of bed (shallow)		Water
83	833	Water of bed (shallow)		Water
84	844	Water of bed (shallow)		Water
85	855	Water of bed (shallow)		Water
86	866	Water of bed (shallow)		Water
87	877	Water of bed (shallow)		Water
88	888	Water of bed (shallow)		Water
89	899	Water of bed (shallow)		Water
90	900	Water of bed (shallow)		Water
91	911	Water of bed (shallow)		Water
92	922	Water of bed (shallow)		Water
93	933	Water of bed (shallow)		Water
94	944	Water of bed (shallow)		Water
95	955	Water of bed (shallow)		Water
96	966	Water of bed (shallow)		Water
97	977	Water of bed (shallow)		Water
98	988	Water of bed (shallow)		Water
99	999	Water of bed (shallow)		Water
100	1000	Water of bed (shallow)		Water

Raster to Vector / Vector to Raster

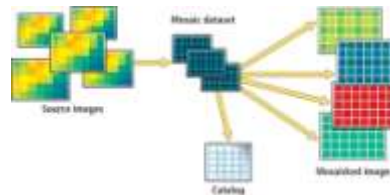


ArcGIS Mosaic Dataset (first released in ArcGIS 10)

- A Mosaic Dataset is an ESRI geodatabase model that is used to store and manage collections of raster datasets.
- Created to help streamline raster data management over varying spatial, spectral, temporal and radiometric resolutions between raster datasets.



A mosaic dataset in ArcMap



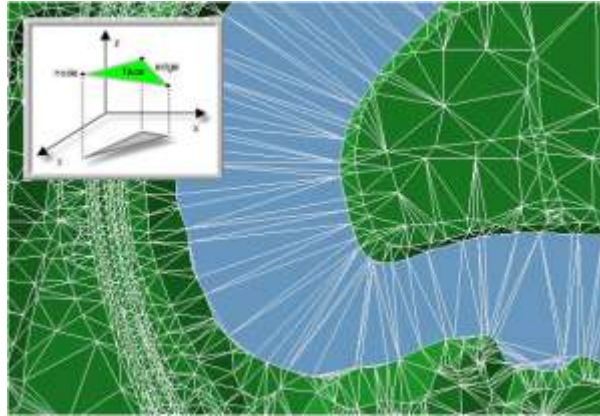
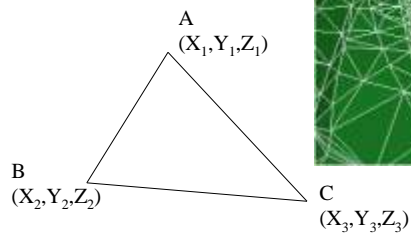
The mosaic dataset structure

Viewing and Querying Capabilities of Mosaic Dataset

- Dynamic mosaicking
- On-the-fly processing (slope, aspect, hillshade, orthorectification)
- Temporal querying
- Catalog view of footprints with associated attributes and metadata

TIN

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



ArcGIS Terrain Dataset (first released in ArcGIS 9.2)

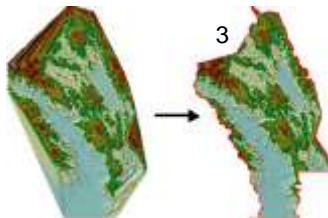
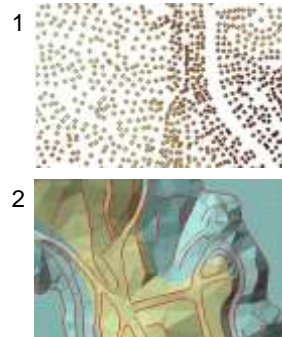
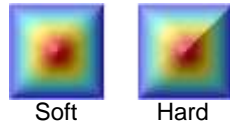


A terrain dataset is a multi-level (pyramid-level) TIN



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)



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.

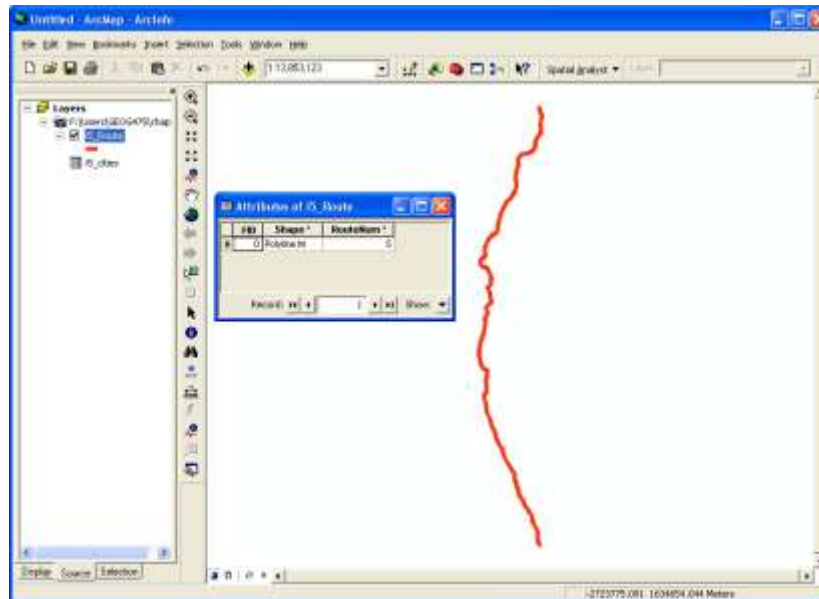
Network

- 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

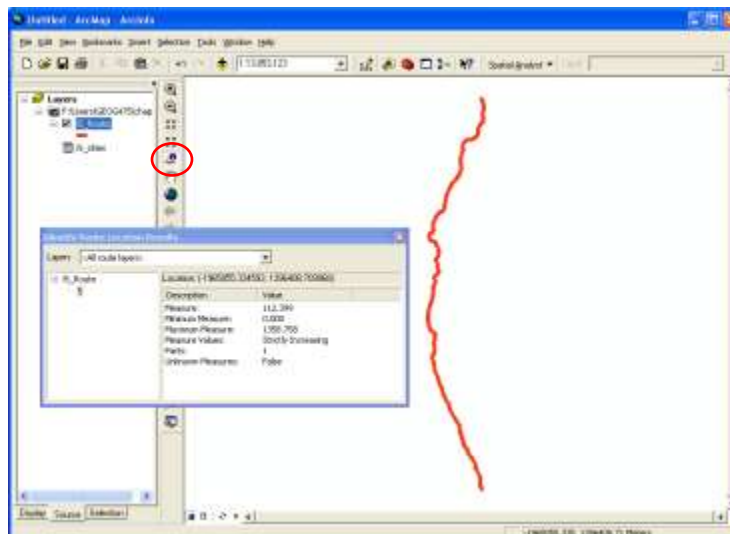
Street Layer for Geocoding

ID	Shape *	LENGTH	LOCALID	ZERO	PREID	STREETNAME	FTYPE	DIRECTION	LEFTAB01	LEFTAB02	RGTAB01	RGTAB02	LEFT2IP	RIGHT
105	Polyline	12675.442517	200071	0	NAV	HVY 47	HVY		23301	27995	23300	27999	97109	9
106	Polyline	9680.605408	219390	0	NAV	POTTRATZ	RD		25801	26789	25800	26788	97133	9
107	Polyline	1111.038289	219418	0					0	0	0	0	97106	9
108	Polyline	252.653994	219420	0	NAV	POND	AVE		23201	23299	23200	23299	97109	9
109	Polyline	7502.219667	219347	0	NAV	SKY RANCH	RD		24301	25499	24300	25499	97133	9
110	Polyline	1041.723534	100096	0	NAV	ST HELENS	RD		23511	23579	23510	23579	97231	9
111	Polyline	2425.539532	100068	0	NAV	REEDER	RD		24301	24599	24300	24599	97231	9
112	Polyline	502.329093	219426	0					0	0	0	0	97109	9
113	Polyline	5695.111074	219186	0	NAV	SUNSET	HVY		51230	52999	51231	52999	97109	9
114	Polyline	97.661364	219186	0	NAV	SUNSET	HVY		51230	51231	51221	51229	97106	9
115	Polyline	487.005404	219434	0	NAV	STRASSEL	RD		51250	51399	51251	51399	97106	9
116	Polyline	678.736173	100071	0	NAV	GILLMAN	RD		23901	24099	23900	24099	97231	9
117	Polyline	1936.700757	219436	0	NAV	PONGRATZ	RD		49400	49999	49401	49999	97109	9
118	Polyline	1945.934434	171627	0	NAV	MORAN	RD		22901	23899	22900	23899	97006	9
119	Polyline	8461.999045	100072	0	NAV	SALVIE ISLAND	RD		23001	26799	23000	26799	97231	9
120	Polyline	2010.014294	200072	0	NAV	HVY 47	HVY		23701	23299	23700	23299	97109	9
121	Polyline	2230.025779	219187	0	NAV	SUNSET	HVY	W	51300	51218	51001	51219	97106	9
122	Polyline	1511.005484	219430	0	NAV	LINGLATER	RD		42900	43199	42901	43199	97106	9
123	Polyline	2150.031997	219438	0	NAV	GREEN MOUNTAIN	RD		22501	22899	22500	22899	97106	9
124	Polyline	5544.948132	222200	0	NAV	ROUND TOP	RD		21001	23999	21000	23999	97144	9
125	Polyline	1084.333914	221463	0	NAV	MORAN	RD		23401	23999	23400	23999	97133	9
126	Polyline	3137.010971	100075	0	NAV	LUCY REEDER	RD		17400	18099	17401	18099	97231	9
127	Polyline	1728.447703	219184	0	NAV	SUNSET	HVY	W	50000	50999	50001	50999	97106	9
128	Polyline	965.003057	100078	0	NAV	LUCY REEDER	RD		17000	17399	17001	17399	97231	9
129	Polyline	8022.617492	219452	0	NAV	PUMPKIN RIDGE	RD		22001	24699	22000	24699	97133	9
130	Polyline	1759.500057	100081	0	NAV	LUCY REEDER	RD		16400	16999	16401	16999	97231	9
131	Polyline	1156.052043	100094	0	NAV	LUCY REEDER	RD		15700	16399	15701	16399	97231	9
132	Polyline	8603.309992	100095	0	NAV	REEDER	RD		22301	24299	22300	24299	97231	9
133	Polyline	624.467794	100092	0					0	0	0	0	97231	9

Polylines for Dynamic Segmentation - Routes



Linear Referencing - Identify Route Locations Tool



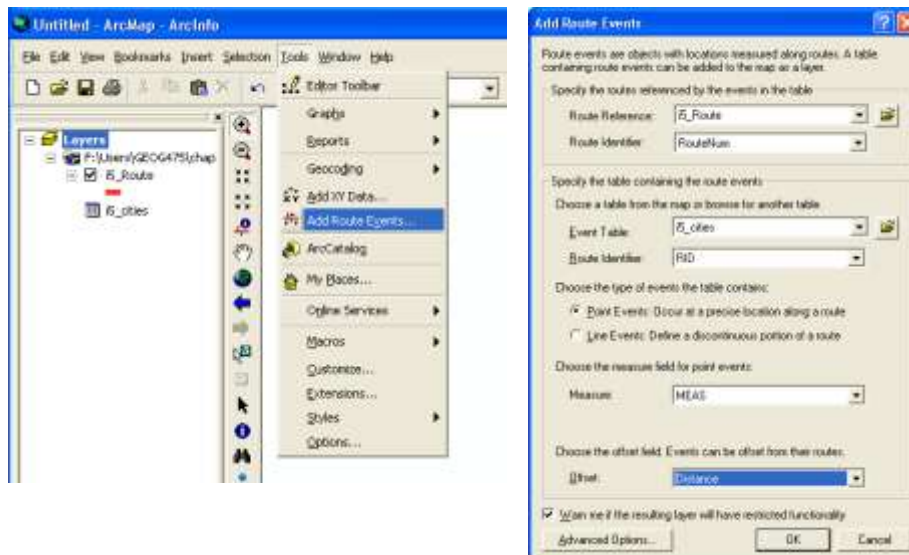
- The tool needs to be added to ArcMap manually using the customize interface.

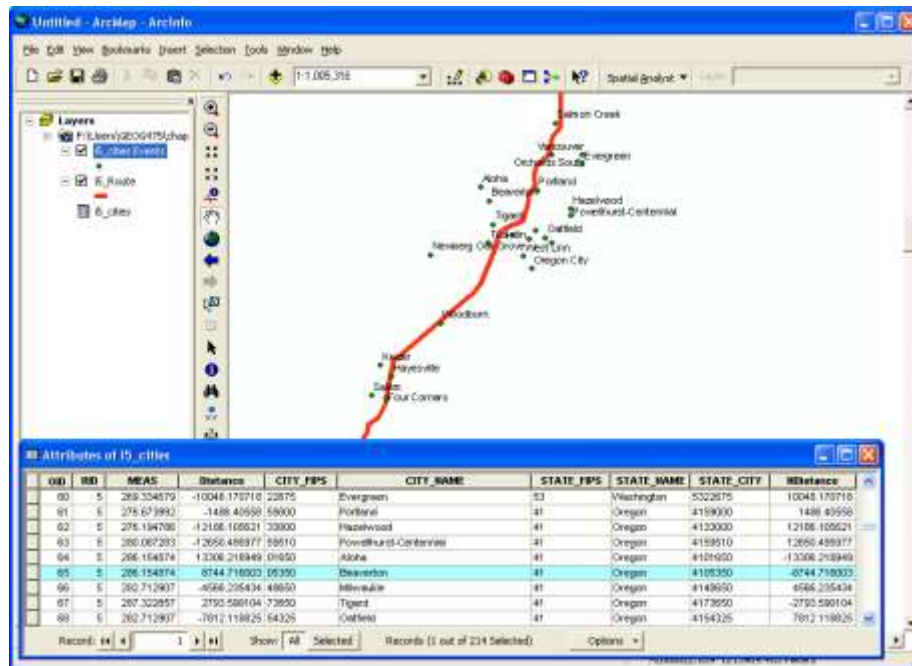
Event Table – Point & Line Events

ID	FID	MEAS	Distance	CITY_FIPS	CITY_NAME	STATE_FIPS	STATE_NAME	STATE_CITY	Mileage
0	5	23.386013	-444.267262	35200	Belington	53	West Virginia	5306260	-444.267262
1	5	48.442991	-1438.381148	41760	Mount Vernon	53	West Virginia	5347960	1438.381148
2	5	71.721368	-3700.448002	46662	North Marysville	53	West Virginia	5349992	3700.448002
3	5	76.66306	-2064.762079	43664	Marysville	53	West Virginia	5343466	2064.762079
4	5	75.154825	-5501.864803	77542	West Lake Stevens	53	West Virginia	5377542	5501.864803
5	5	82.220729	-442.665404	32640	Dover	53	West Virginia	5322640	-442.665404
6	5	88.31138	2227.181163	52768	Pine Fork-Lake Skinsney	53	West Virginia	5362768	-2227.181163
7	5	87.404940	-4757.708016	54452	Silver Lake-Pined	53	West Virginia	5344452	4757.708016
8	5	98.607262	2195.154750	37704	Lake Seneca-North Lynwood	53	West Virginia	5323706	-2195.154750
9	5	98.085051	-1089.589719	43010	Mertha Lake	53	West Virginia	5343010	1089.589719
10	5	90.113678	1810.075879	40040	Lynwood	53	West Virginia	5340040	-1810.075879
11	5	94.987617	8224.856805	20760	Edinboro	53	West Virginia	5320760	-8224.856805
12	5	91.585016	-4826.375516	48670	North Creek-Canyon Park	53	West Virginia	5348670	4826.375516
13	5	82.988897	-3776.714826	31178	Alderwood Manor-Bethel North	53	West Virginia	5301178	3776.714826
14	5	88.254614	-210.832347	47400	Mountain Terrace	53	West Virginia	5347400	210.832347
15	5	86.964023	3196.086023	22260	Expansive	53	West Virginia	5322260	-3196.086023
16	5	93.972105	-8084.148291	97380	Wythe	53	West Virginia	5307380	8084.148291
17	5	87.572945	1712.638391	50340	Richmond Highlands	53	West Virginia	5326340	-1712.638391
18	5	86.118296	-557.873426	48642	North City-Ridgcrest	53	West Virginia	5348642	557.873426
19	5	82.44248	-15208.575801	79500	Woodville	53	West Virginia	5379500	15208.575801
20	5	86.411055	-11619.604304	35026	Hingst	53	West Virginia	5336026	11619.604304
21	5	86.774305	-8486.780574	33380	Hagerwood-Pine Hill	53	West Virginia	5333380	8486.780574
22	5	102.58559	-9870.255453	35940	Harford	53	West Virginia	5335940	9870.255453
23	5	101.24235	-19668.847484	57638	Reinwood	53	West Virginia	5367638	19668.847484
24	5	106.962049	2070.250146	63000	Seaside	53	West Virginia	5363000	-2070.250146
25	5	109.484003	-12745.704795	95210	Salisbury	53	West Virginia	5360210	12745.704795
26	5	113.121048	-8224.982736	48005	Moscow Island	53	West Virginia	5349005	8224.982736
27	5	112.89153	-8330.060539	40055	Newport Hills	53	West Virginia	5348055	8330.060539
28	5	113.63014	-4427.103836	76042	White Center-Shorewood	53	West Virginia	5376042	4427.103836

- 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

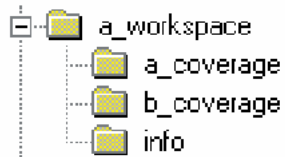




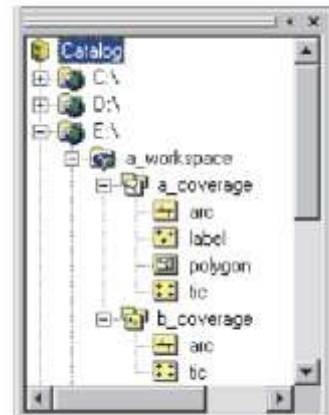
GIS Data Structures

- 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



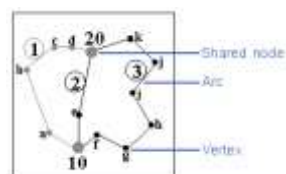
Workspace in the file system



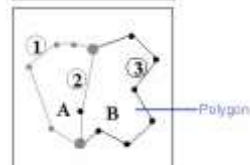
Workspace in ArcCatalog

Coverage Topology

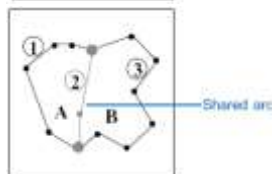
Connectivity: Arcs that share a node are Connected (arc-node topology)



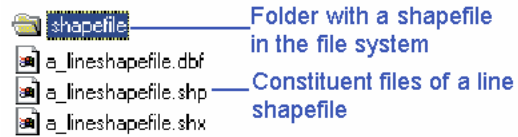
Area definition: An area is defined by a series of connected arcs (polygon-arc topology)



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

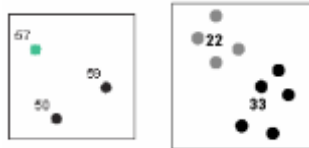


ArcView Shapefile Data Structure



Shapefile (No Topology!)

Point, multipoint



Line



Polygon

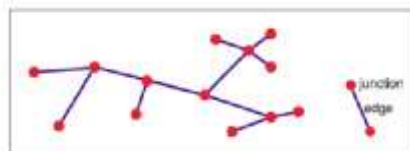


ArcGIS Geodatabase Data Structure



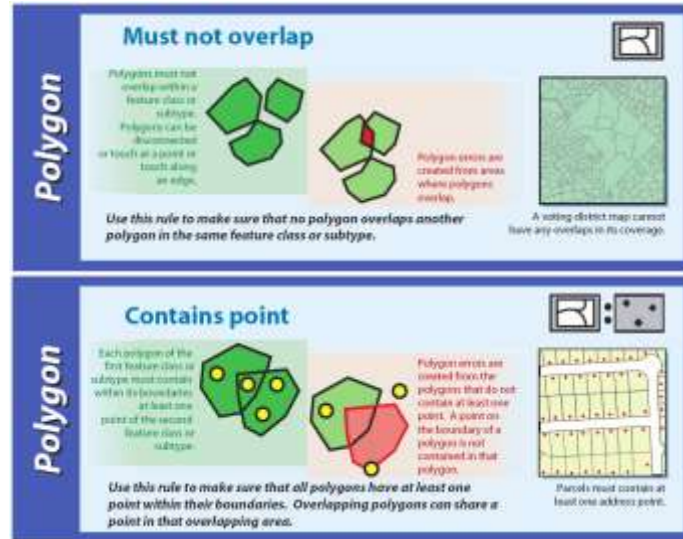
Features / Feature Classes

- 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



25 Geodatabase Topology Rules (in 9.x)

... aren't automatically applied; need to be selected by database designer or user

Line or Polygon

- (Distance b/t vertices) Must be larger than 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

Six New Rules in ArcGIS 10

- Polygon: Contains One Point
- Line: Must Not Intersect With
- Line: Must Not Intersect or Touch Interior With
- Line: Must Be Inside
- Point: Must Be Coincident With
- Point: Must Be Disjoint

<http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/001t000000sp000000.htm>

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

<i>Data Structure</i>	<i>Type</i>	<i>Topology</i>	<i>Portability</i>	<i>Spatial Integrity</i>
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)

ESRI keeps adding new features to its geodatabase DBMS. Most of the GDB are backward-compatible. Make sure you have the latest service pack or patches to ensure trouble-free access to GDB created in different versions of ArcGIS.