



Technical Workshops |

# Geodatabase – An Introduction



# Session Path

- **The Geodatabase**
  - **What is it?**
  - **Why use it?**
  - **What types are there?**
- **Inside the Geodatabase**
- **Advanced Behavior**
- **Geodatabase Extension Datasets**

# What is the Geodatabase?

- **Core ArcGIS data model**
  - A comprehensive model for representing and managing GIS data
- **A physical store of geographic data**
  - Scalable storage model supported on different platforms
- **A transactional model for managing GIS workflows**
- **Set of COM components for accessing data**

# Geodatabase Data Management Approach

- **The geodatabase is built on an extended relational database**
  - Base relational model
  - Relational integrity
  - Base short transaction model
  - Supports continuous, large datasets
  - Reliability, Flexibility, Scalability
- **Built on the simple feature model**
  - Open access (OGC, C, COM, SQL)

# Geodatabase Data Management Approach...

- **Editing and data compilation**
  - Rich set of editing tools
  - Maintain spatial and attribute integrity
- **Versioning workflows**
  - Undo and redo edits
  - Multiple users editing the same data
  - Archiving
  - Distributed data management
- **Robust, customizable framework**
  - Build and manage your own specific GIS solution

# Why use the Geodatabase?

- **Simple!**
- **The model to best support the ArcGIS system within an organization**
- **<http://resources.arcgis.com/en/communities/geodata/>**

# Why use the Geodatabase?

- Campus Viewer
- Showing business logic



# Session Path

- **The Geodatabase**
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  - **What types are there?**
- Inside the Geodatabase
- Advanced Behavior
- Geodatabase Extension Datasets



# 3 Types of Geodatabases

- **Personal Geodatabase**

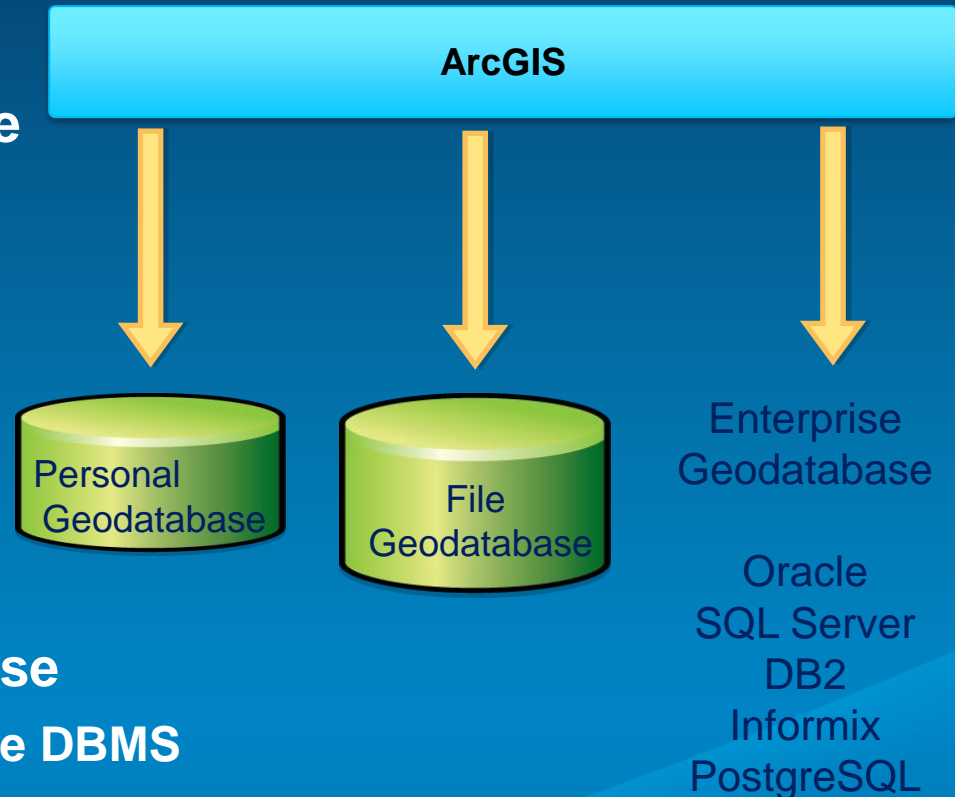
- Single user editing
- Stored in MS Access
- Size limit of 2 GB

- **File Geodatabase**




- 1 TB per table
- Cross platform

- **Enterprise Geodatabase**

- Stored in an enterprise DBMS
- Supports multi-user editing via versioning
- Extremely large datasets






# 3 Types of Geodatabases




	Personal GDB	File GDB	Enterprise gdb (3 Types)
<b>Cool Graphic</b>			
<b>Storage Format</b>	Microsoft Access	Folder of binary files	DBMS
<b>Storage capacity</b>	2 GB	1 TB per table*	Depends on edition
<b>Supported OS platform</b>	Windows	Any platform	Depends on edition
<b>Number of users</b>	Single editor Multiple readers	Single editor Multiple readers	Multiple editors & readers

\* By default; option to have 256 TB per table




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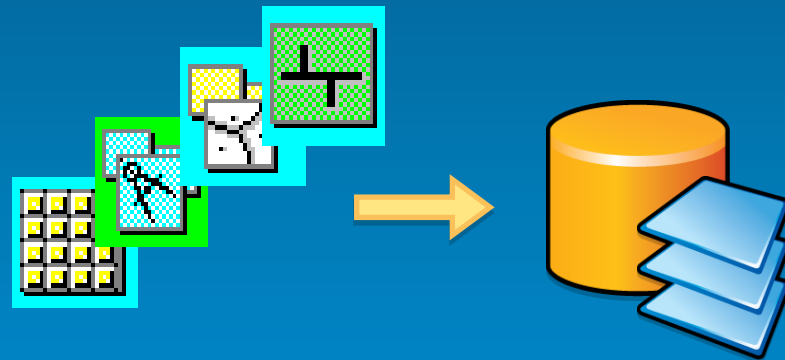
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# Geodatabase Data Management

- **Schema is defined in ArcCatalog**
  - Define feature classes, datasets, relationships, etc
  - Catalog window
  - Import and convert data from other formats
  - Shapefile
  - Coverage
  - CAD
  - Raster
- **Copy and Paste**
- **ArcGIS.com**
  - Import basemaps and layers from galleries, groups...
- **Use an esri Data Model or Downloadable Template**
  - Industry specific data models available
  - Download a geodatabase template from the resource centers



# Editing Geodatabases...

- **ArcGIS datasets in the geodatabase are editable**
  - Modify building footprints in parcel management
  - Add water mains to a water network
  - Update land owners information stored in a table
  - Etc...
- **Transaction model for editing in ArcGIS**
  - Edits are performed in an edit session
    - Open session – edit – save edits / don't save edits
  - A series of edit operations constitutes a transaction
    - The transaction is either committed or rolled back

# Editing Geodatabases...

- **Personal Geodatabases**
  - Mainly single user editing on small datasets
  - Multiple readers
  - Editing locks at geodatabase level
    - Two editors cannot edit within the same geodatabase at the same time
  
- **File Geodatabase**
  - Mainly single user editing small to very large datasets
  - Multiple readers
  - Editing locks at the dataset level
    - Multiple editors cannot edit the same table or stand-alone feature class at the same time
    - Multiple editors cannot edit feature classes in the same feature dataset at the same time



# Editing Geodatabases...

- **Enterprise Geodatabases**
  - Extend the transaction model with Versions
  - Multiuser editing without locking
  - Unique isolated view of the geodatabase
- **Benefits of versioned editing**
  - Multiple editors, editing over long periods of time
  - Undo / Redo
  - Archiving
  - Replication

# Creating a Geodatabase

- Using ArcCatalog
- Creating a Geodatabase
- Loading existing data (shapefile)



# Session Path

- **The Geodatabase**
- **Inside the Geodatabase**
  - **Object Classes, Feature Classes, Rasters**
  - **Feature Datasets**
  - **Validation Rules**
  - **Domains, Subtypes, Relationship Classes**
  - **Annotation, Dimensions**
  - **Exploring a Geodatabase DEMO**
- **Advanced Behavior**
- **Geodatabase Extension Datasets**

# Inside the Geodatabase

- **A geodatabase contains datasets**
- **Datasets represent collections of information with a real-world interpretation**
- **Types of geographic datasets:**
  - Tables, feature classes, raster
  - Feature datasets
  - Networks, Topologies, Terrains
- **Datasets have associated information**
  - Manage integrity, behavior, and interpretation
  - Domains, Relational integrity, Topology, Metadata

# Geodatabase Elements

## Geodatabase

### Feature dataset

Spatial reference



Polygon



Route



Line



Dimension



Point



Annotation

### Relationship classes



### Geometric networks



### Topology



### Network datasets



## Tables



## Feature Classes



## Raster Datasets



## Additional geodatabase elements

Parcel fabrics

Terrain datasets

Representations

Locators

## Toolboxes



Tool



Model



Script

## Behavior

Attribute defaults

Connectivity rules

Attribute domains

Relationship rules

Split/merge policy

Topology rules

# Objects and Object Classes – Tables

- Objects are entities with properties and behavior
- An object is an instance of an object class
- All objects in an object class have the same properties and behavior

OBJECTID ^	NAME	ADDRESS	ZIP	TYPE	SALES
10	Central Petroleum	1100 CENTER ST NW	30318	Service Station	55130.41
11	Charlie Cota Inc.	400 EIGHTH ST NW	30318	Restaurant	45468.801
12	City Food Market	501 ETHEL ST NW	30318	Store	55686.898
13	Clamerty's	421 SPRING ST NW	30308	Store	55305.93
14	Crossroads Theater	120 MEMORIAL DR SE	30312	Movie Theater	30117.699
15	Damar Sales	388 7TH ST NE	30308	Service Station	55518.012
16	Dan's Taco Emporium	1032 CENTER ST NW	30318	Restaurant	55243.43
17	Darby's Market	1001 CENTER ST NW	30318	Store	55369.801
18	Dream Ice Cream	77 MILLS ST NW	30308	Restaurant	55260.5
19	Eastern Express	150 6TH ST NE	30308	Cafe	55574.148

# Features and Feature Classes

- Builds on the Relational Model
- A feature is a spatial object
- A feature is an instance of a feature class
- Extended the relational model
  - Geometry attribute type



A feature class is a table of rows, where each row has a geographic column

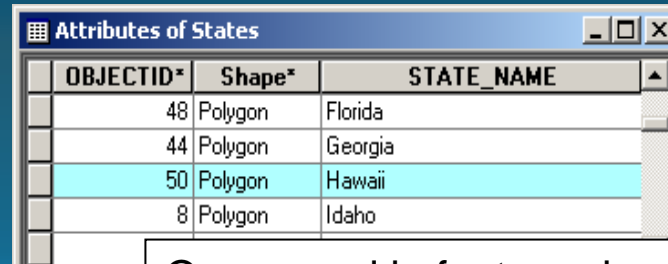
Attributes of Parcels						
	OBJECTID*	SHAPE*	PARCEL_ID*	ZONE_CODE*	SHAPE_Length	SHAPE_Area
	4513	Polygon	67970	W	544.053559	9259.209935
	4514	Polygon	67971	W	158.545394	774.602847
	4515	Polygon	67973	R60M	400.003008	7499.965473
	4516	Polygon	67974	B1	236.126101	2905.890606
	4517	Polygon	67982	B1	550.458538	17499.011493

# Geodatabase Supports Advanced Geometry

- Point, lines, polygons
  - Single and multipart features



Feature with many parts

A screenshot of a database table window titled "Attributes of States". The table has three columns: "OBJECTID\*", "Shape\*", and "STATE\_NAME". The data rows are:

OBJECTID*	Shape*	STATE_NAME
48	Polygon	Florida
44	Polygon	Georgia
50	Polygon	Hawaii
8	Polygon	Idaho

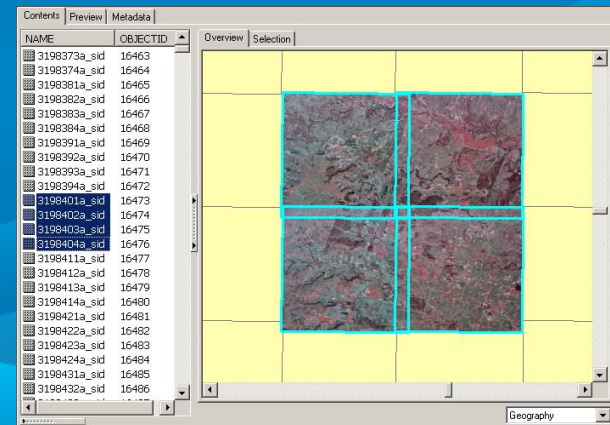
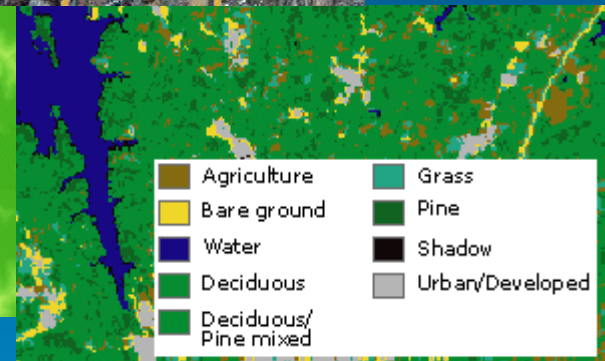
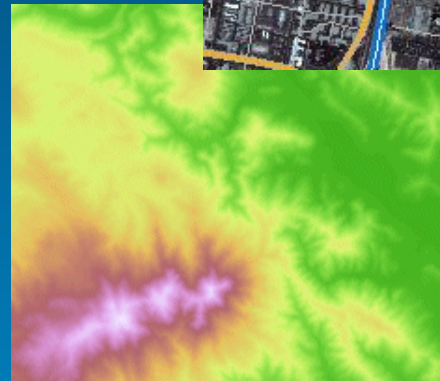
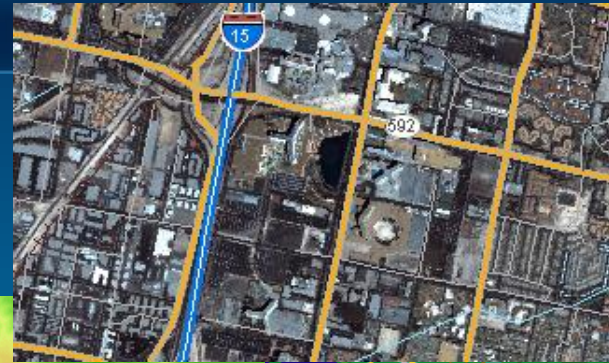
One record in feature class table

- Text and surfaces
- Flexible coordinates
  - XY, Z, M



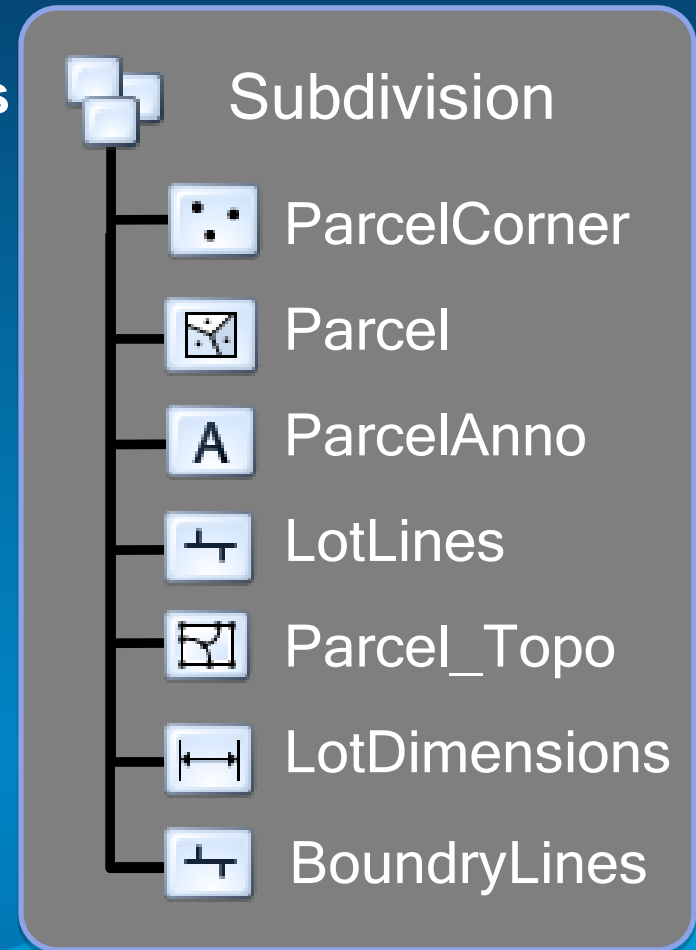
# Raster and Imagery

- Support for many formats
  - Tiff, bmp, GRID, among others
- Attribute field in a table
- Mosaic dataset
  - Data model for managing raster collections
  - Stored as a catalog, viewed as a mosaic
  - Advanced querying and processing



# Feature Datasets

- A container object for other datasets
  - Same spatial reference
- Analogous to a coverage
  - Less restrictive
- Contain geometric networks, topologies, terrains, etc...
  - Optionally relationship classes

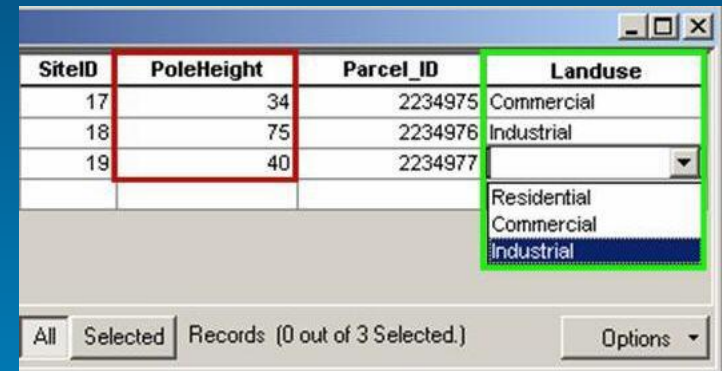


# Validation Rules

- **Attribute, connectivity, and relationship rules**
  - Stored on objects as part of the geodatabase
- **Predefined, parameter driven**
  - Attribute range rule
  - Attribute set rule
  - Connectivity rule
- **Perform custom validation by writing code**

# Domains

- Describe the legal values of a field type
  - Used to ensure attribute integrity
- Defined at the geodatabase level
- Types of domains:
  - Range
    - Valid values between a min / max range
    - A tree can have a height between 0 and 300 feet
    - A road can have between one and eight lanes
  - Coded Value
    - Valid values chosen from a set list
    - A tree can be of type oak, redwood, or plain
    - A road can be made of dirt, asphalt, or concrete



The screenshot shows a table with four columns: SiteID, PoleHeight, Parcel\_ID, and Landuse. The Landuse column has a dropdown menu open, showing a list of values: Residential, Commercial, and Industrial. The table contains three rows of data. The PoleHeight field is highlighted with a red border, and the Landuse field is highlighted with a green border.

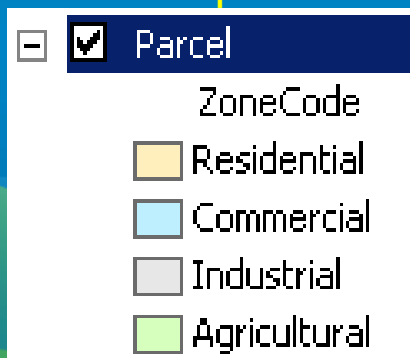
SiteID	PoleHeight	Parcel_ID	Landuse
17	34	2234975	Commercial
18	75	2234976	Industrial
19	40	2234977	<input type="text"/>

At the bottom of the window, there are buttons for 'All', 'Selected', and 'Records (0 out of 3 Selected.)', along with an 'Options' dropdown menu.

# Subtypes

- **Categorize objects or features into groups**
  - Share the same attributes
- **Defined at the class level**
- **Select a field to base the subtype on**
  - Short or long integer field
  - Can have different default values and domains for each field
  - Can define behavior rules between subtypes

## Descriptions

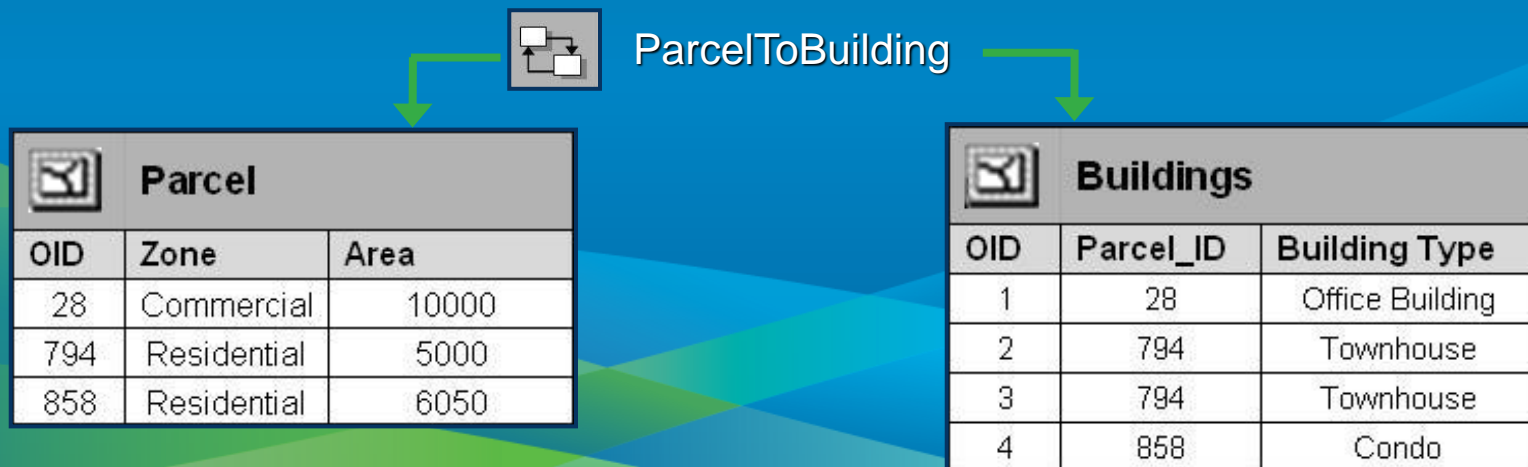


## Codes

OBJECTID*	SHAPE*	APN	ZoneCode
213	Polygon	70605	201
218	Polygon	70611	201
228	Polygon	70621	201
231	Polygon	70668	201
363	Polygon	70860	202
429	Polygon	70745	202
430	Polygon	70746	202
435	Polygon	70751	203
1278	Polygon	70473	203
1279	Polygon	70474	203

# Relationship Classes

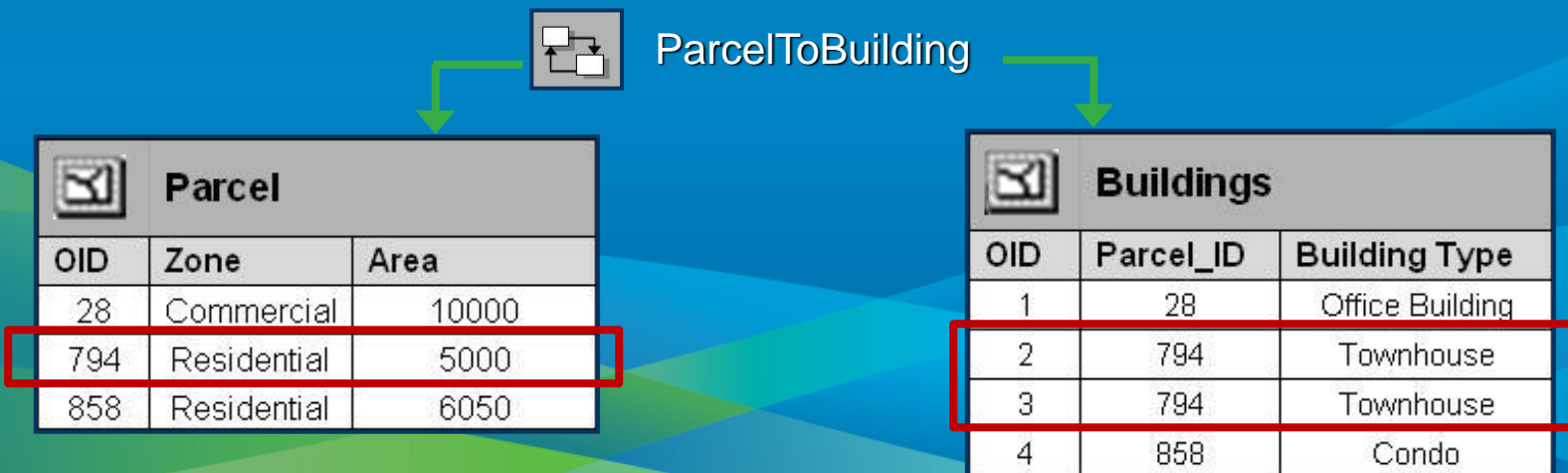
- Association between objects in one class and another
  - A class may participate in multiple relationship classes
- Simple relationships
- Composite relationships
  - Related objects can message each other
  - Can trigger behavior (cascade delete, move to follow, custom, etc.)
- Associate rules with relationship classes
  - Each Parcel can have between 1 to 3 Buildings





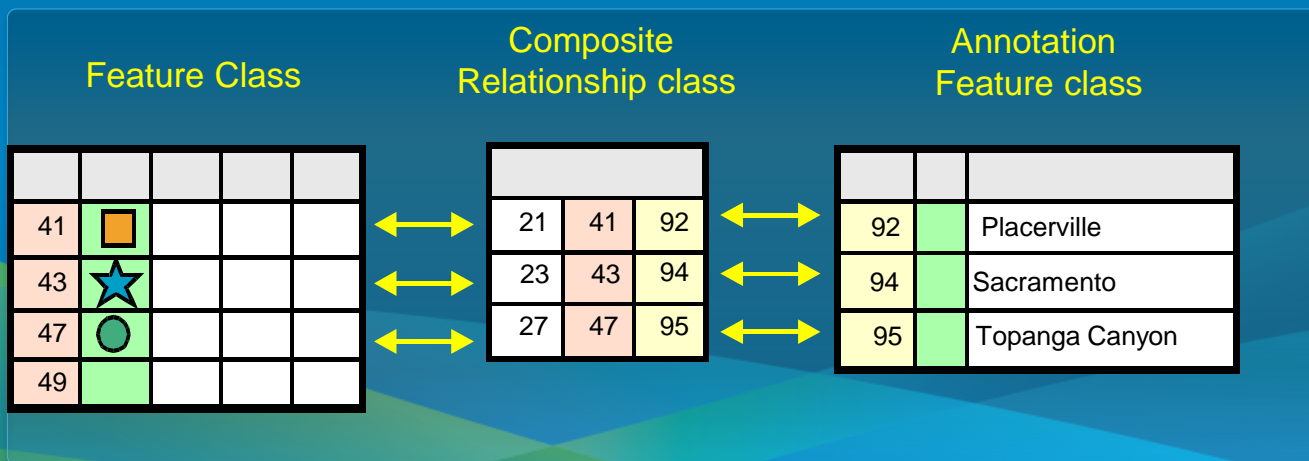
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# Annotation

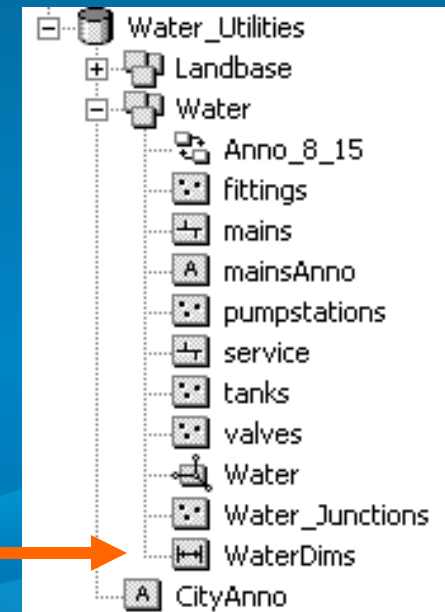
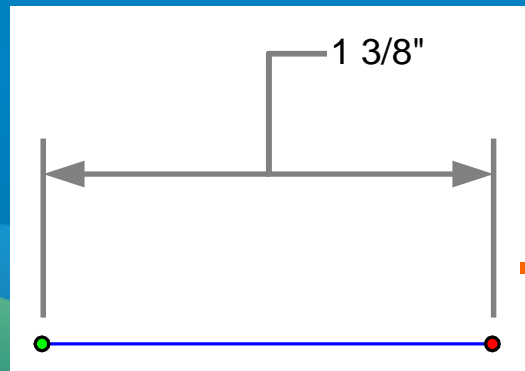
- **Annotation feature classes**
  - Placing text and graphics on the map
  - Feature linked or Non-feature linked
- **Composite relationship manages link**
- **Can store text as well as other graphics**
  - Lines, arrows, boxes, etc...
  - Visible scale range





# Dimension Features

- Type of annotation that displays specific distances on a map
- Graphic features stored in a dimension feature class
  - Can be created automatically from features
  - Set of editing tools
  - Define a style, description of symbology



# Object Behavior

- You can:
  - Control the default value and acceptable values for any attribute. (Domains)
  - Partition the objects into like groups. (Subtypes)
  - Instantiate classes with predefined behavior. (Dimensions and Annotation)
  - Control the general relationships in which an object can participate. (Relationship Classes)
- Out of the Box in ArcGIS!
  - Configurable, no programming required

# Exploring a Geodatabase

- Tables / Feature Classes
- Subtypes
- Domains
- Relationship Classes

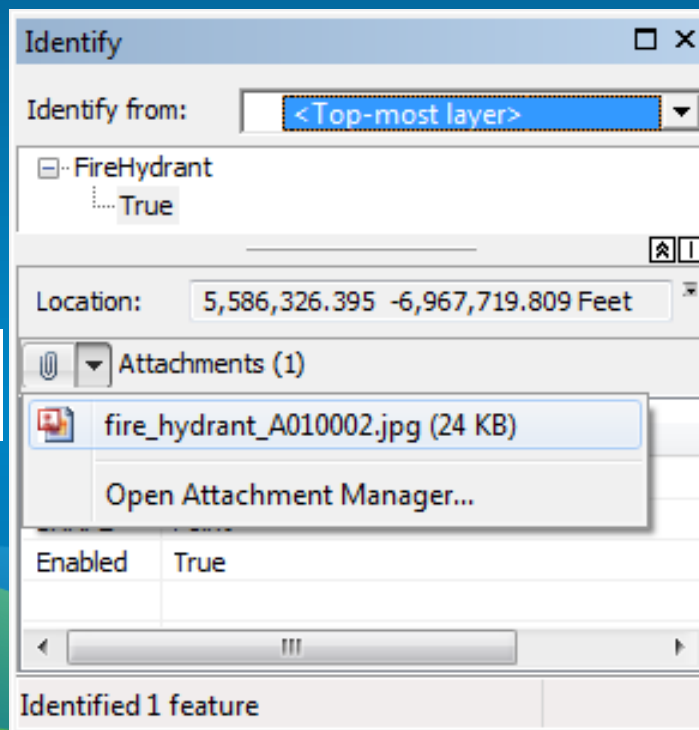


# Session Path

- The Geodatabase
- Inside the Geodatabase
- **Advanced Behavior**
  - **Attachments**
  - **Geometric Networks**
  - **Network Datasets**
  - **Geodatabase Topology**
  - **Advanced Behavior DEMO**
- **Geodatabase Extension Datasets**

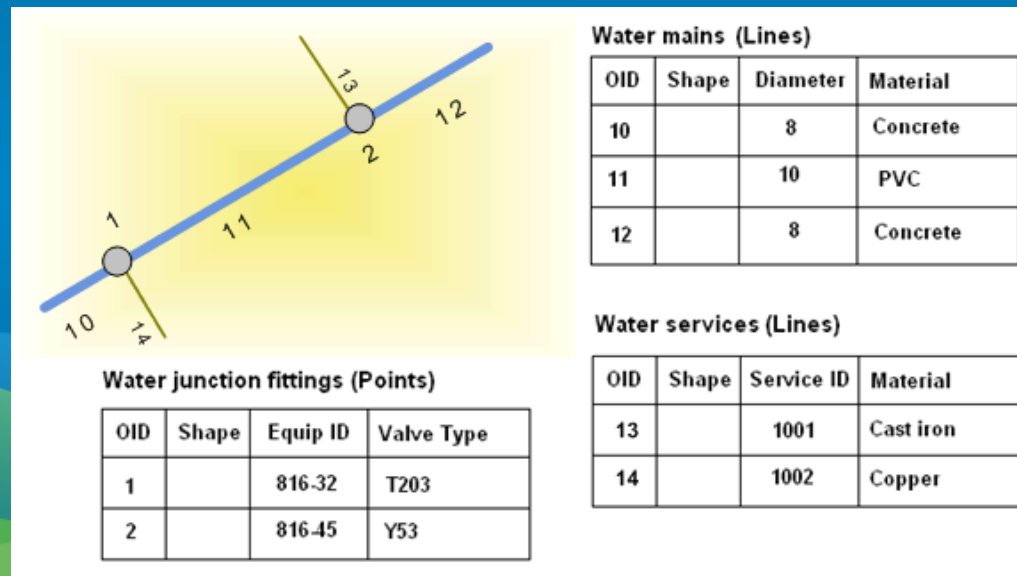
# Attachments

- Associate any type of file with a feature
- Available on a Feature Identify
- In ArcMap if the file type is known by Windows it can be directly accessed.



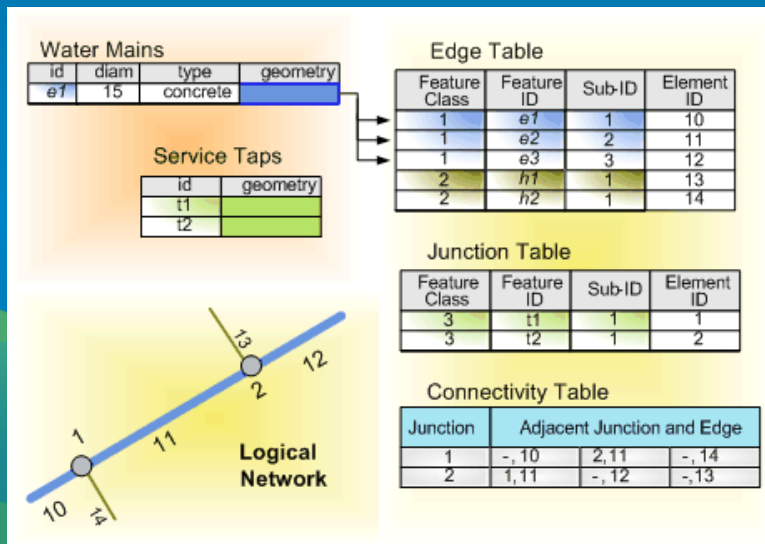
# Geometric Networks

- Uses edges and junctions to model network systems
- Built in a feature dataset
  - Each feature class has a role in the network
- Connectivity relationships between feature classes
  - Based on geometric coincidence
  - Can associate connectivity rules with the network
  - Connectivity is maintained on the fly

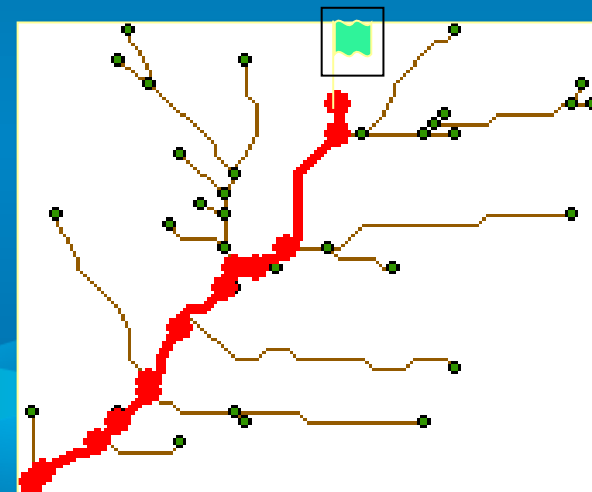


# Geometric Networks

- A geometric network is associated with a logical network
  - Each network feature is associated with one or more elements in the logical network
- Trace solvers on the logical network provide
  - Connectivity tracing, cycle detection, flow directions
  - Upstream / downstream tracing, isolation tracing



## Downstream Trace





# Network Datasets

- Network designed for the transportation industry
- Multimodal scenarios
- Edges & Junctions
- Attributes
  - Properties to control traversability
  - Travel time, restrictions, speeds
  - On-the-fly calculation of costs
  - Improves analysis

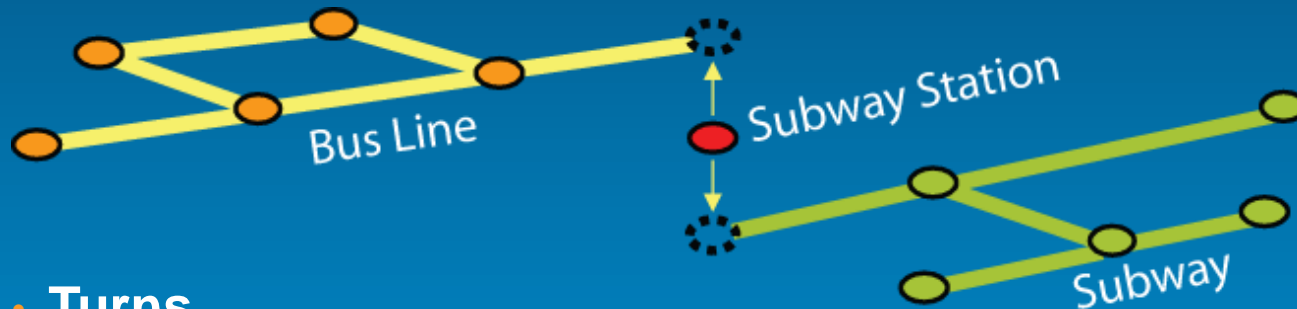




# Network Dataset Functionality

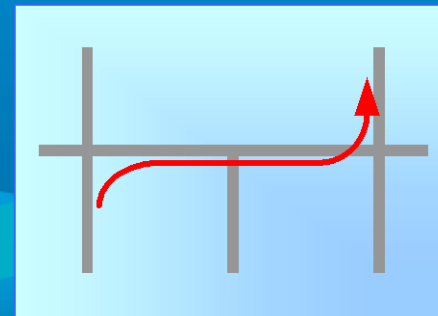
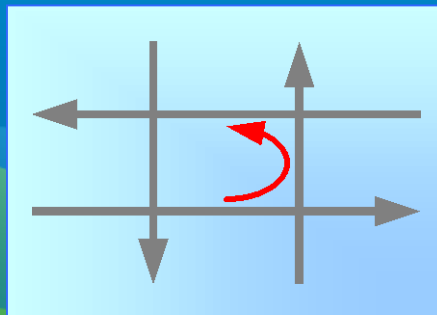
- **Multimodal**

- Points span multiple connectivity groups
- Used to create connectivity between lines in different groups



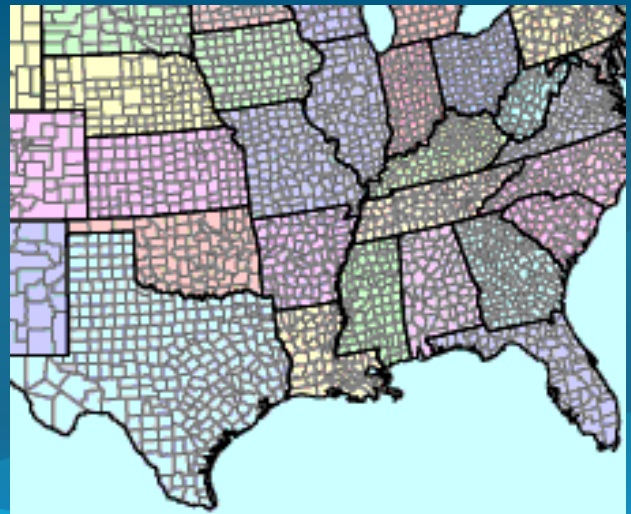
- **Turns**

- Turns do not alter connectivity, but traversability (e.g. U-Turn restriction)



# Geodatabase Topology

- A topology manages a set of simple feature classes that share geometry
- Topology is used to:
  - Constrain how features share geometry
  - Define data integrity rules
  - Control editing tools
  - Validate features
  - Ensure the quality of your data



# Topological Integrity

- **Create topologies in a feature dataset**
  - Participating feature classes / subtypes
  - Cluster tolerance, ranks and rules
    - Cluster Tolerance for XY and Z
- **Define rules when creating the Topology**
  - Rules are evaluated during validation
- **Violations are expressed as error features**
  - Managed in the database as a part of the topology
  - Error and Exceptions
  - Examine and Fix errors in ArcMap

# Topology Error Examples

- Rules enforced to maintain topological integrity
  - 25+ topology rules in ArcGIS

## Must not overlap

Polygons must not overlap within a feature class or subtype. Polygons can be disconnected or touch at a point or touch along an edge.



Polygon errors are created from areas where polygons overlap.

## Must be properly inside polygons

Points in one feature class or subtype must be inside polygons of another feature class or subtype.



Point errors are created where the points are outside or touch the boundary of the polygons.

## Must not have dangles

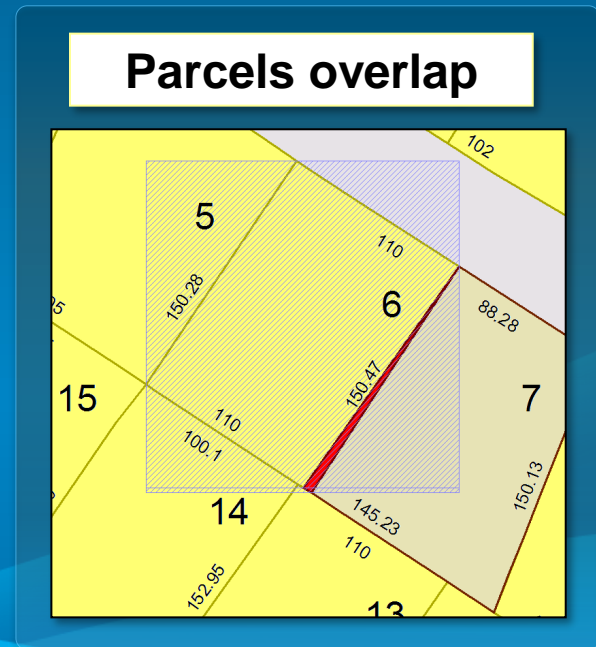
The end of a line must touch any part of one other line or any part of itself within a feature class or subtype.



Point errors are created at the end of a line that does not touch at least one other line or itself.

# Editing with a Topology

- **Editing creates a dirty area**
  - Area has been edited and may contain errors
  - Can be symbolized
- **Errors are found during validation**
  - Errors have properties
    - What rule was violated
    - Which feature(s) created the error
- **Your options:**
  - Ignore the error
  - Mark as exception
  - Fix the error



# Exploring a Geodatabase

- Topology
- Geometric Network
- Attachments



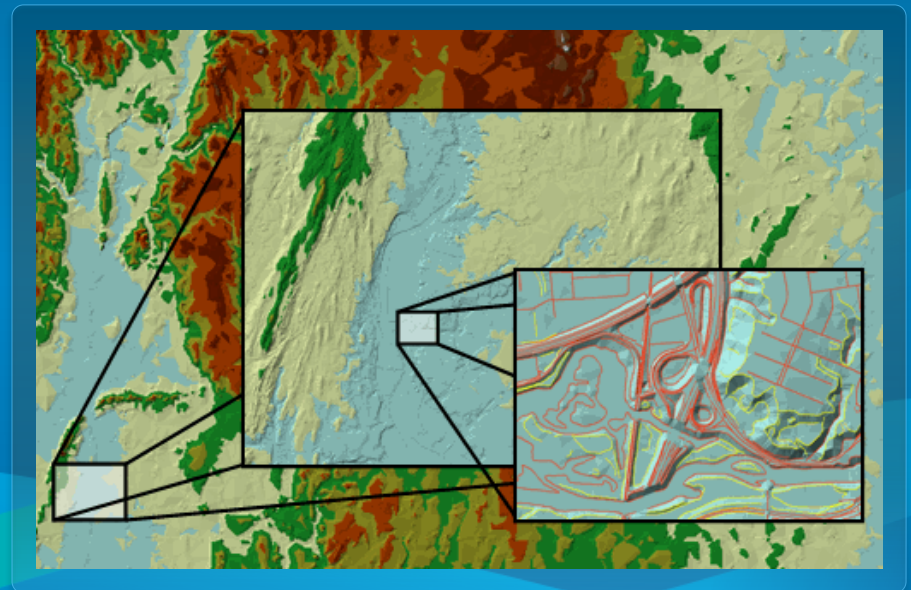
# Session Path

- **The Geodatabase**
- **Inside the Geodatabase**
- **Advanced Behavior**
- **Geodatabase Extension Datasets**
  - **Terrains**
  - **Cartographic representations**
  - **Parcel fabrics**
  - **Geocoding**



# Terrains

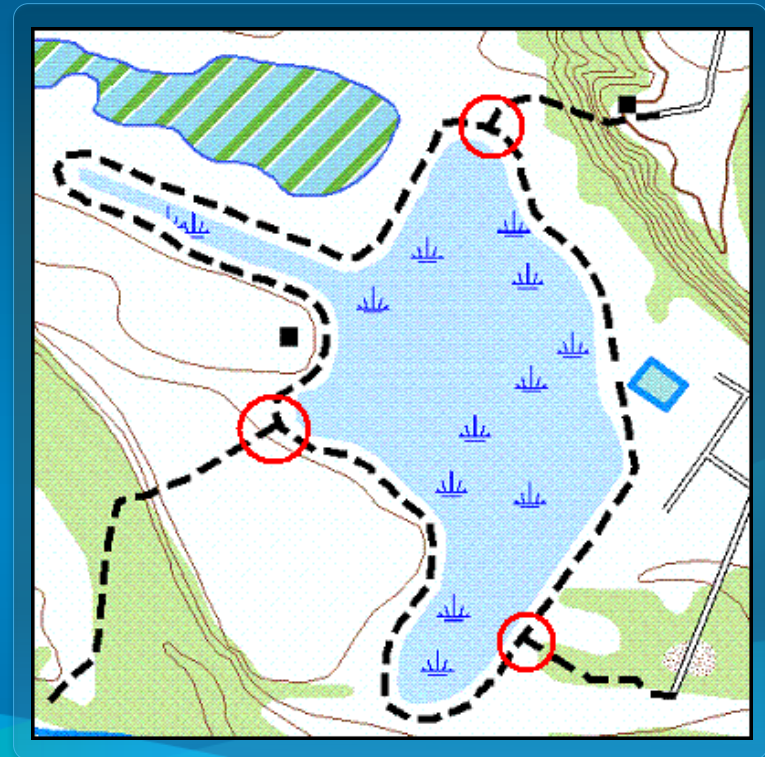
- **Massive point datasets, multi-resolution, on-the-fly TIN**
  - Dataset for modeling 3D surfaces
  - Modeled within a feature dataset
  - User defined terrain (pyramid) levels
    - Different resolutions & vertical tolerances
- **Requires 3D Analyst**
  - Extension to define & edit
  - No license needed to view





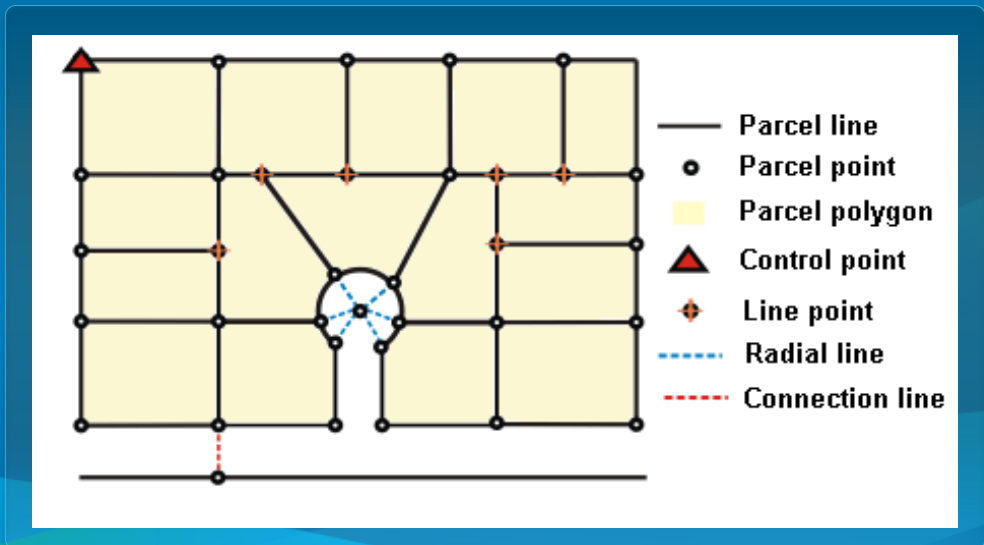
# Cartographic Representations

- **Property of a feature class**
  - Stores info about feature symbology
- **One feature class – multiple representations**
- **Rules and overrides**
- **Representation Management Toolset**



# Parcel Fabric

- **Solution for parcel data management**
  - Pre-10.0 requires the Survey Analyst extension
  - As of 10.0 no longer requires the extension
- **Storage, maintenance and editing of parcels**
- **Create in a feature dataset**
- **Parcel editor toolbar**
  - Streamline workflows
  - Increase spatial accuracy



# Geocoding

- **Address matching and location services**
  - Use a locations description to find a location
    - Coordinates, street name, place name
    - Points of Interest, addresses
- **Address locators**
  - Rules for interpreting addresses
  - Parsing and matching address elements
  - Standard street components
  - Reference map data

100 South King Street, Suite 500, Seattle, WA 98104							
House number	Direction prefix	Street name	Street type	Sub-address	City	State	Postal code



# Summary

- **The Geodatabase**
  - Data model, Storage, Transaction model, COM components
- **Inside the Geodatabase**
  - Datasets, Validation rules, data behavior and integrity
- **Advanced Behavior**
  - Geometric Networks, Network Datasets, and Topology
- **Geodatabase Extension Datasets**
  - Terrains, Representations, Parcel fabrics, Geocoding

## Other Geodatabase Resources

- **Geodatabase Island in the Showcase Area**  
**Meet the specialists!**
- **Geodatabase Resource Center**
- **Inside the Geodatabase Blog**
- **ArcGIS.com**
  
- **Check out the Demo Theatre schedules at the Islands in the Showcase Area**