GIS

The Geographic Approach for the Nation

ESRI Federal User Conference

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Geodatabase Essentials Part 1
An Introduction to the Geodatabase

Tosia Shall

Tim Clark

Session Path

The Geodatabase

- What is it?
- Why use it?
- What types are there?
- Geodatabase Demo

Inside the Geodatabase

Advanced Behavior

Editing Geodatabases

Geodatabase Potpourri

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
  - Base short transaction model
  - Relational integrity
  - Reliability, Flexibility, Scalability
  - Supports continuous, large datasets
- Built on the simple feature model
  - Open access (OGC, C, COM, SQL)

Geodatabase Data Management Approach …

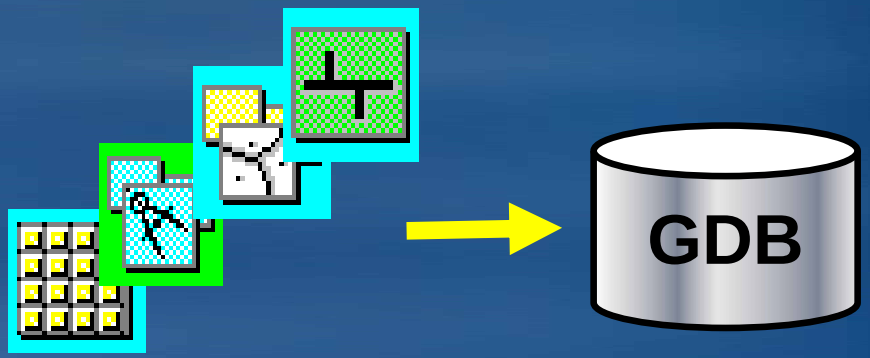
- Simple features + logic
  - All geographic data stored as tables in a DBMS
  - Extend functionality and data integrity
  - Functionality is consistent across DBMS’
- Application logic (software)
  - Works on standard DBMS tables
  - Implements GIS integrity and behavior
  - Business rules, topology, networks
    - Data Integrity

Geodatabase Data Management Approach …

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

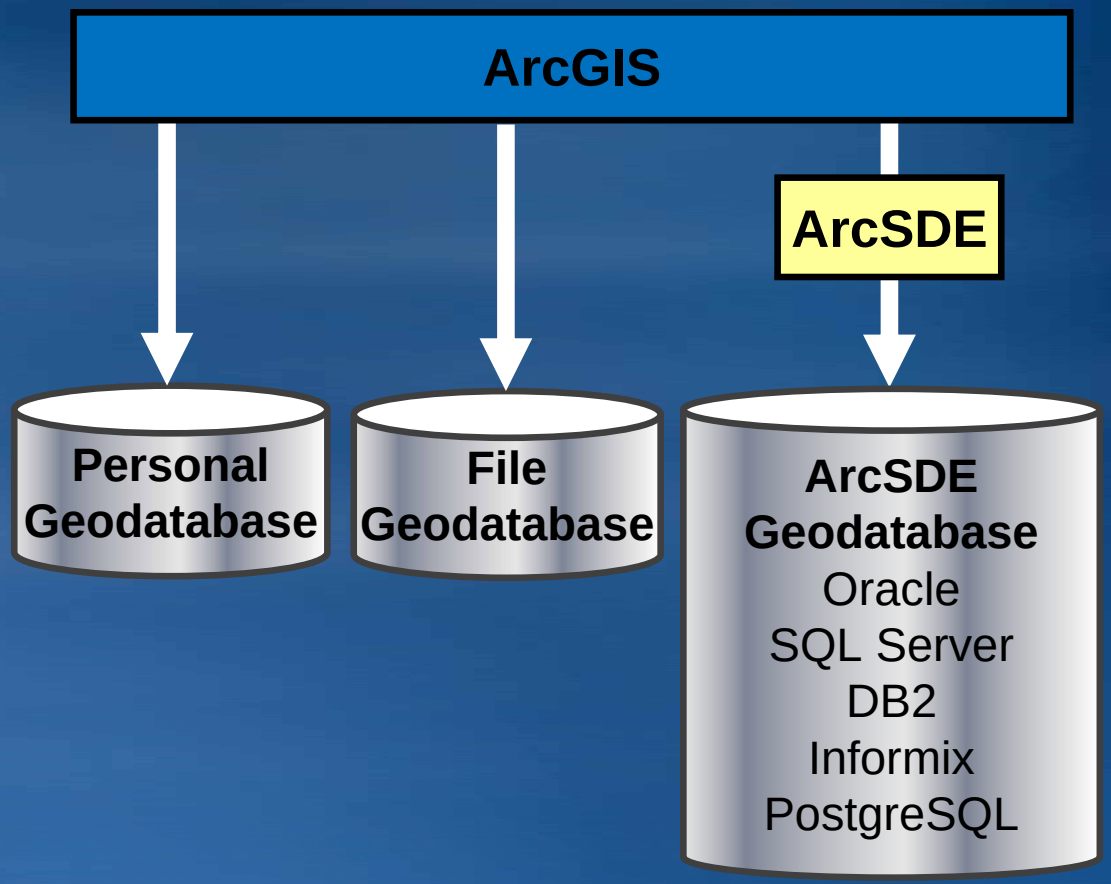
Geodatabase Data Management

- Schema is defined in ArcCatalog
  - Define feature classes, datasets, relationships, etc
- Import and convert data from other formats
  - Shapefile
  - Coverage
  - CAD
  - Raster
- Copy and Paste
- Geodatabase XML Export / Import
  - For transferring Schema or Features and Schema
- Use an ESRI Data Model
  - Industry specific data models available
  - Copy geodatabase template

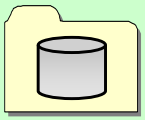
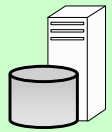


3 Types of Geodatabases

- **Personal Geodatabase**
  - Single user editing
  - Stored in MS Access
  - Size limit of 2 GB
- **File Geodatabase**
  - 1 TB per table
  - Reduced storage requirements
- **ArcSDE Geodatabase**
  - Stored in an enterprise DBMS
  - Supports multiuser editing via versioning
  - Requires ArcEditor or ArcInfo to edit



3 Types of Geodatabases…

	Personal GDB	File GDB	ArcSDE GDB (3 editions)
			
Storage format	Microsoft Access	Folder of binary files	DBMS
Storage capacity	2 GB	1 TB per table*	Depends on edition
Supported O/S platform	Windows	Any platform	Depends on edition
Number of users	Single editor Multiple readers	Single editor Multiple readers	Multiple editors & readers
Distributed GDB functionality	Check out/check in and One-way replication	Check out/check in and One-way replication	Replication (all types) & versioning

* By default; option to have 256 TB per table

3 Types of Geodatabases…

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		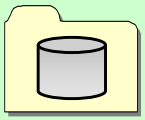	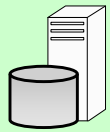
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		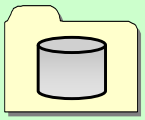	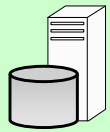
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Geodatabase Demo

Tosia Shall

Session Path

- The Geodatabase
- Inside the Geodatabase
  - Object class, Feature class, Raster dataset
  - Feature datasets
  - Validation rules
  - Domains, Subtypes, Relationship classes
  - Annotation, Dimensions
  - Exploring a Geodatabase DEMO
- Advanced Behavior
- Editing Geodatabases
- Geodatabase Potpourri

Inside the Geodatabase

- A geodatabase contains datasets
- Datasets represent collections of information with a real-world interpretation
- Types of geographic datasets:
  - Tables
  - Object classes, feature classes, relationship classes
  - Feature datasets
  - Networks, Topologies, Raster and cadastral datasets
- Datasets have associated information to help manage integrity, behavior, and interpretation
  - Domains, Relational integrity, Topology, Metadata

Inside the Geodatabase…

- Table
- Feature dataset
  - Feature class
    - Polygon
    - Line
    - Point
    - Annotation
    - Dimension
    - Route
  - Relationship class
  - Topology
  - Geometric network
  - Network dataset
  - Terrain
- Raster dataset
- Raster catalog
- Schematic dataset
- Survey dataset
- Project folder
- Project
- Toolbox
- Tool
- Model
- Script
- Behavior
  - Attribute domains
  - Attribute defaults
  - Split/merge policy
  - Relationship rules
  - Connectivity rules
  - Topology rules

Objects and Object Classes

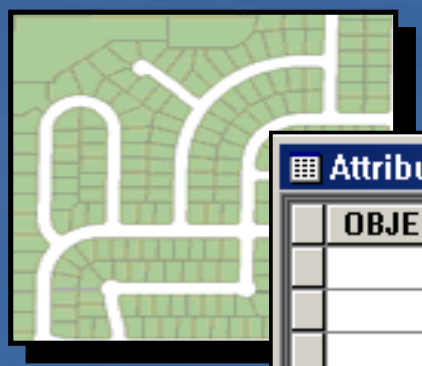
- Objects are entities with properties and behavior
- An object is an instance of an object class
- All objects in an object class have the same properties and behavior
- An object can be related to other objects via relationships

A row stores an Object

A table stores an ObjectClass

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 with
  - Geometry attribute types



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

Field data types

- The geodatabase supports eight field data types

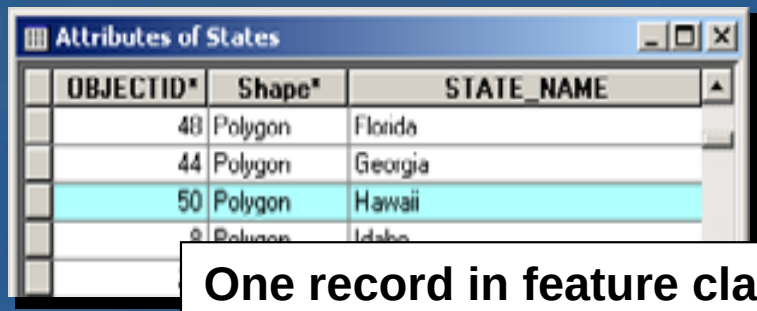
Data type	Bytes	Range / format / notes
Short Integer	2	-32,768 to +32,767
Long Integer	4	-2,147,483,648 to +2,147,483,647
Float	4	About –3.4e38 to +1.2e38 (~7 significant digits)
Double	8	About –2.2e308 to +1.8e308 (~14 significant digits)
Text	varies	Up to ~64,000 characters
Date	8	mm/dd/yyyy hh:mm:ss am/pm
BLOB	varies	Store large binary content or other multimedia
Raster	varies	Store images

- Supported field data types are generic
  - Data types specific to an RDBMS are not supported

Geodatabase Supports Advanced Geometry

- Points, lines, polygons
  - Single and multipart features

Feature with many parts



One record in feature class table

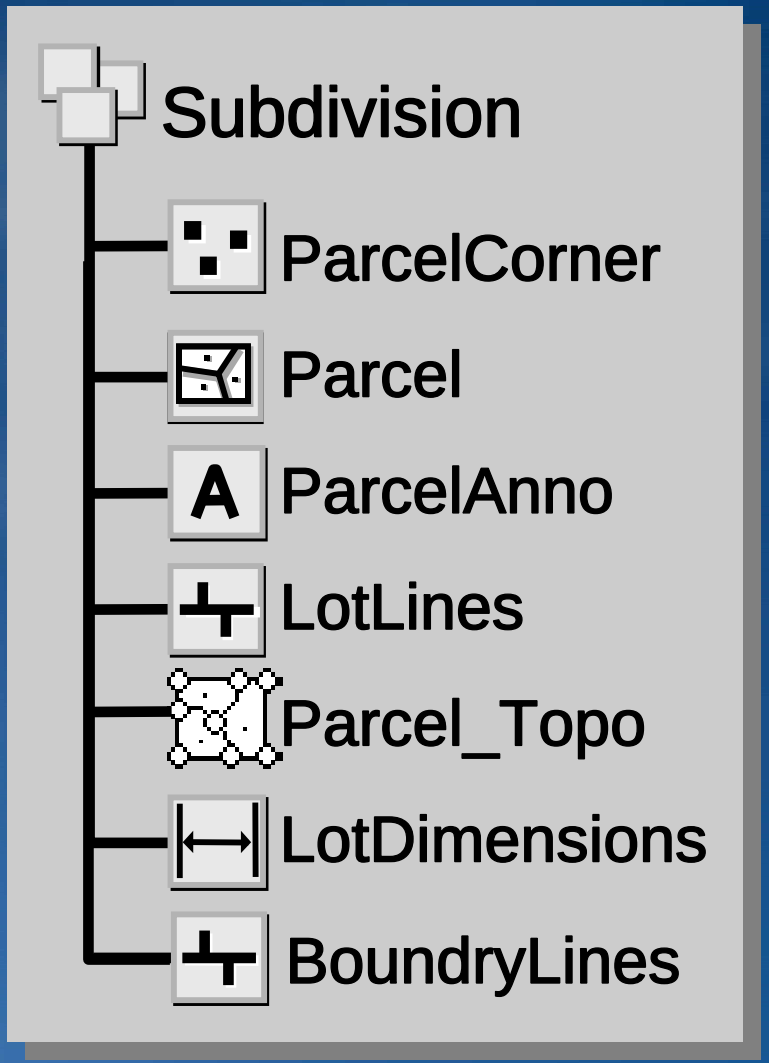
- Text and surfaces
- Flexible coordinates
  - XY, Z, M

Geodatabase Raster Data

- Support for many formats
  - tiff, bmp, GRID
- Raster dataset
  - Separate rasters
  - Mosaicking
- Raster catalog
  - A collection of raster datasets
  - Accessed as one entity
  - Each member can be accessed as a raster dataset
  - Each member can have its own storage properties
  - Managed/Unmanaged

Feature Datasets

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

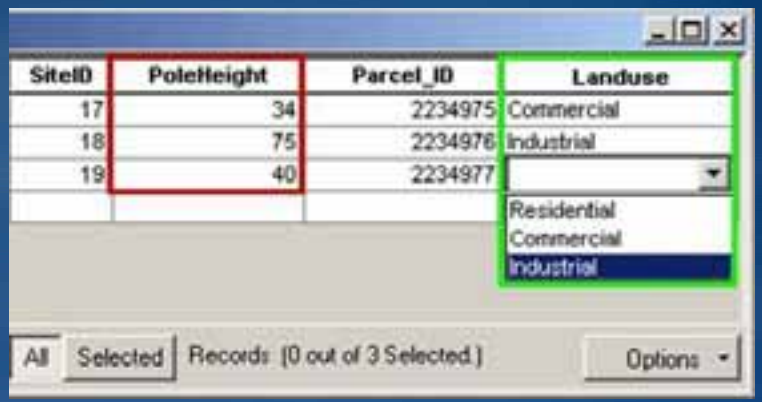


Validation Rules

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

Domains

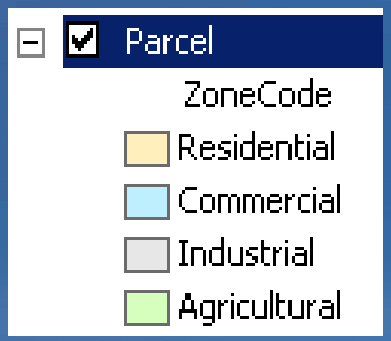
- Describe the legal values of a field type
  - Used to ensure attribute integrity
- Defined at the geodatabase level
- Types of domains:
  - Range
    - A tree can have a height between 0 and 300 feet
    - A road can have between one and eight lanes
  - Coded Value
    - A tree can be of type oak,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



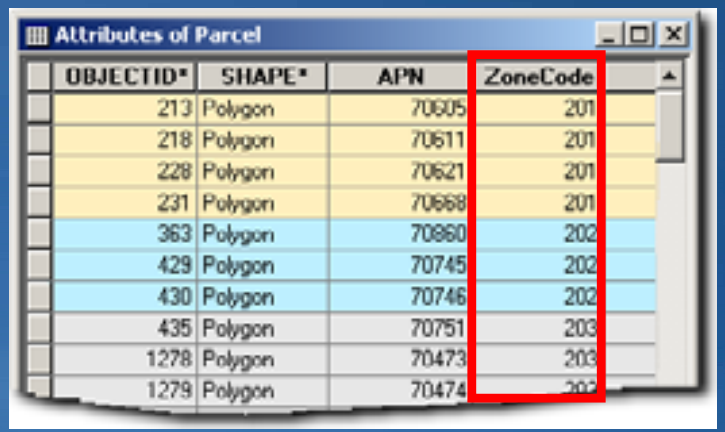
Subtypes

- Partition the objects in a class into like groups
- Defined at the class level
- Defined by the value of a subtype field
  - Have the same attribute\behavior schema
  - Can have different default values and domains for each field
  - Can define topology rules between subtypes

Descriptions

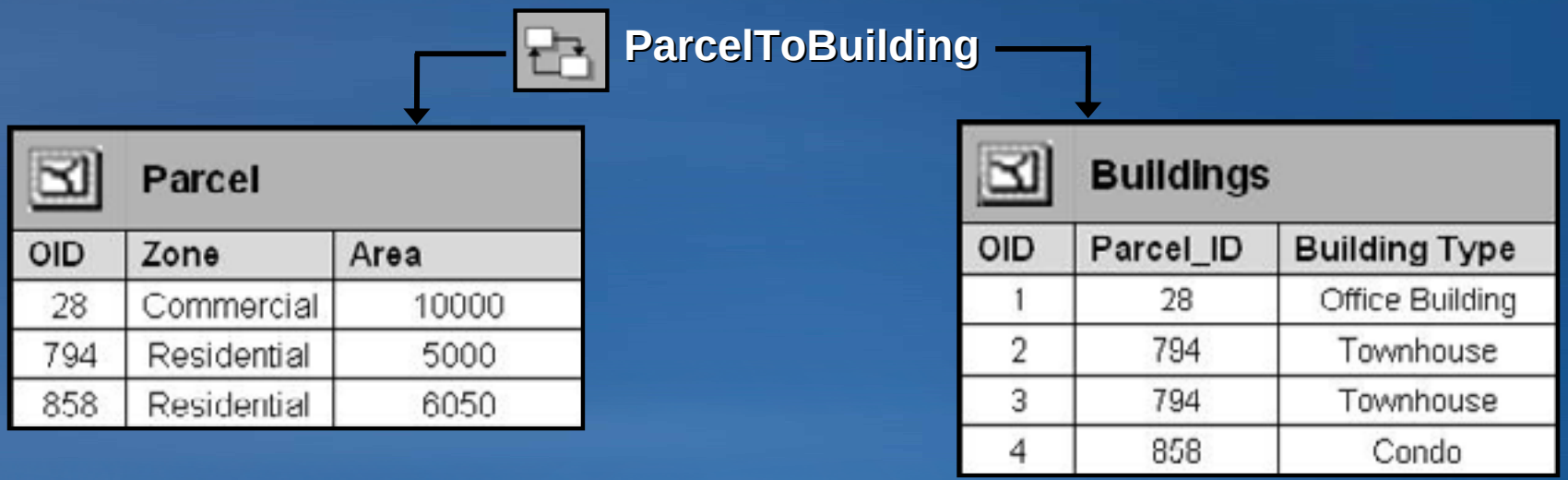


Codes



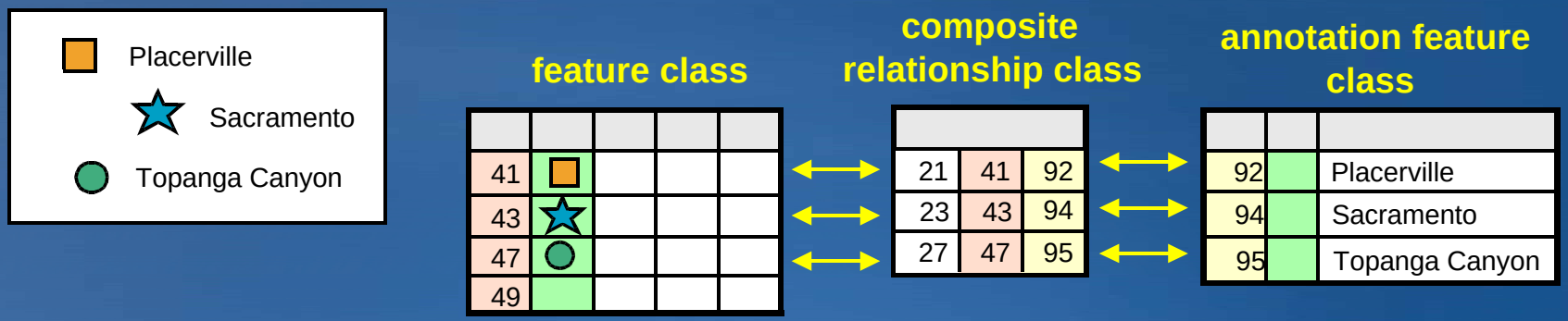
Relationship Classes

- An association between two object classes
  - 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



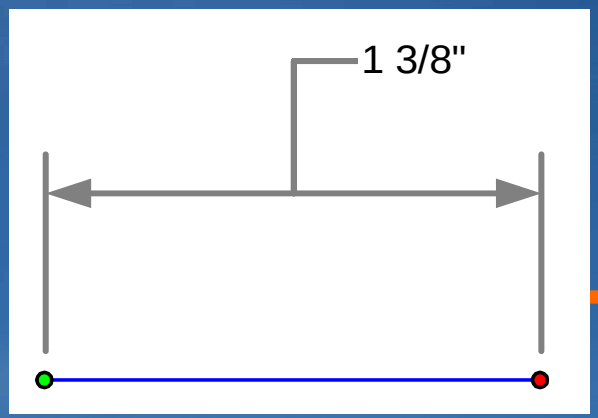
Annotation

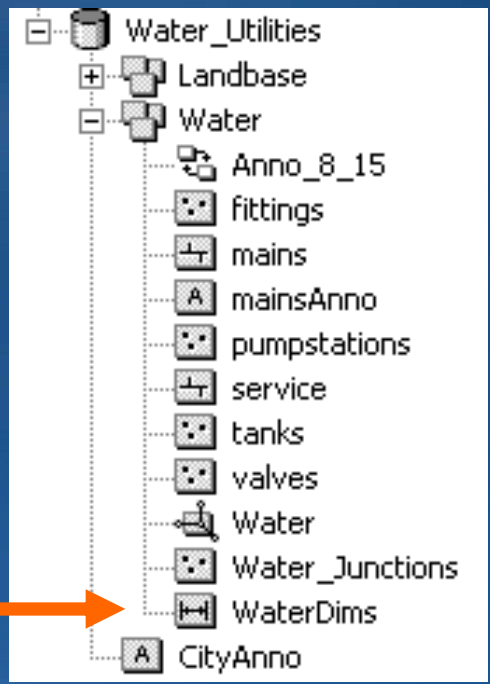
- Annotation feature classes may be
  - Feature linked or Non-feature linked
- Composite relationship manages link
- Can store text as well as other graphics
  - Lines, arrows, boxes, etc…



Dimension Features

- Type of annotation that displays specific distances on a map
- Graphic features stored in a dimension feature class
- "Smart" feature
  - Special drawing
  - Special editing





Object Behavior

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

Exploring a Geodatabase Demo

- Explore a Geodatabase
  - Tables
  - Feature Classes
  - Subtypes
  - Domains
  - Relationship Classes

Exploring a Geodatabase Demo

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Session Path

The Geodatabase

Inside the Geodatabase

Advanced Behavior

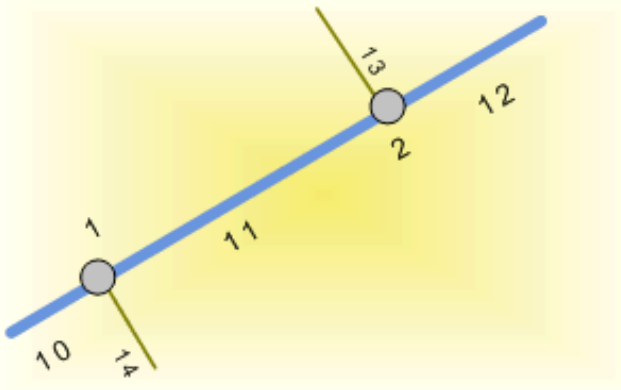
- Geometric Networks
- Network Datasets
- Geodatabase Topology
- Advanced behavior DEMO

Editing Geodatabases

Geodatabase Potpourri

Geometric Networks

- Used to model network systems
- Connectivity relationships between feature classes
  - Can associate connectivity rules with the network
  - Connectivity is based on geometric coincidence, always live
- Each feature class has a role in the network
  - A network may have multiple feature classes in the same role



Water junction fittings (Points)

OID	Shape	Equip ID	Valve Type
1		816-32	T203
2		816-45	Y53

Water mains (Lines)

OID	Shape	Diameter	Material
10		8	Concrete
11		10	PVC
12		8	Concrete

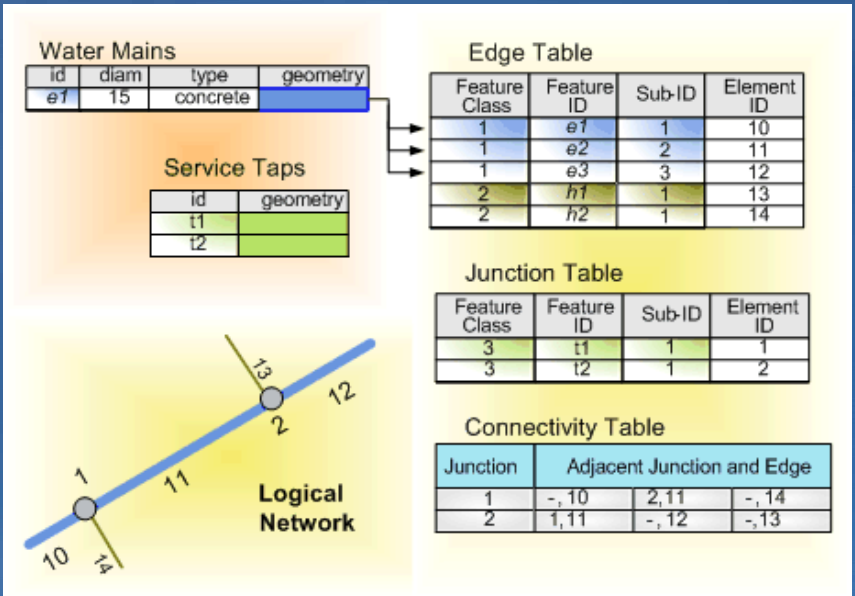
Water services (Lines)

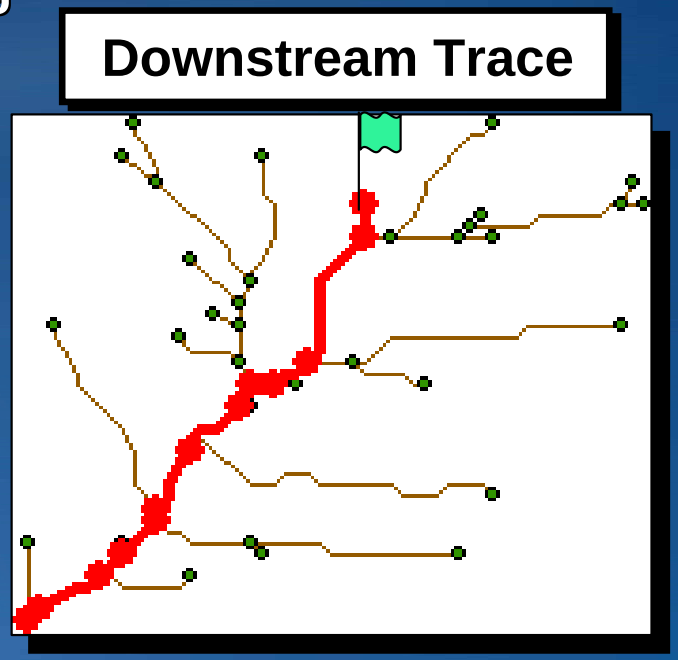
OID	Shape	Service ID	Material
13		1001	Cast iron
14		1002	Copper

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



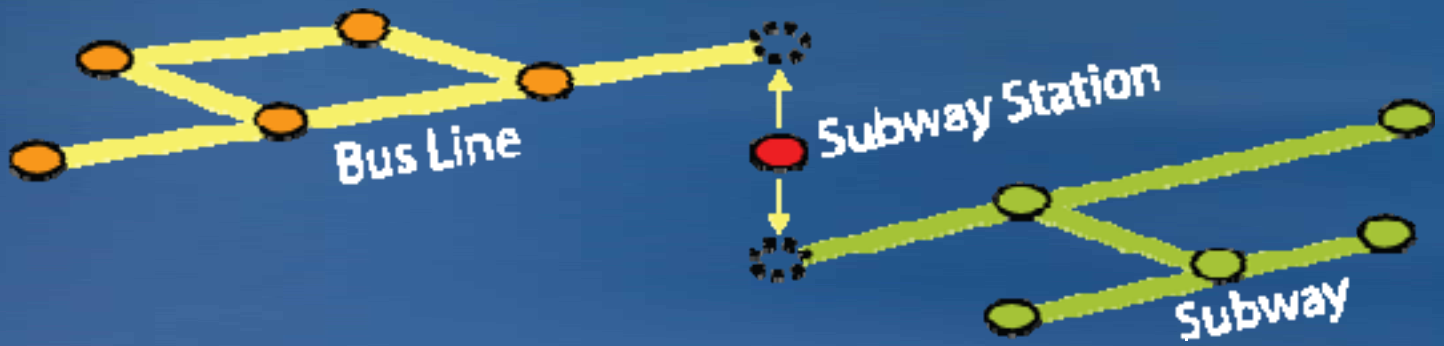


Network Datasets

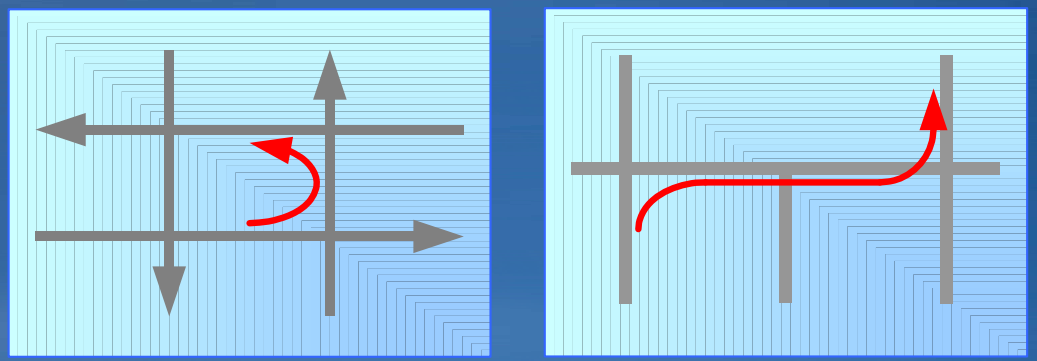
- Network designed for the transportation industry
- Does not replace the Geometric Network
- Multimodal
- Edges, Junctions & Turns
- Attributes
  - On-the-fly calculation of costs
  - Improves analysis
    - Cost, restriction, descriptor

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

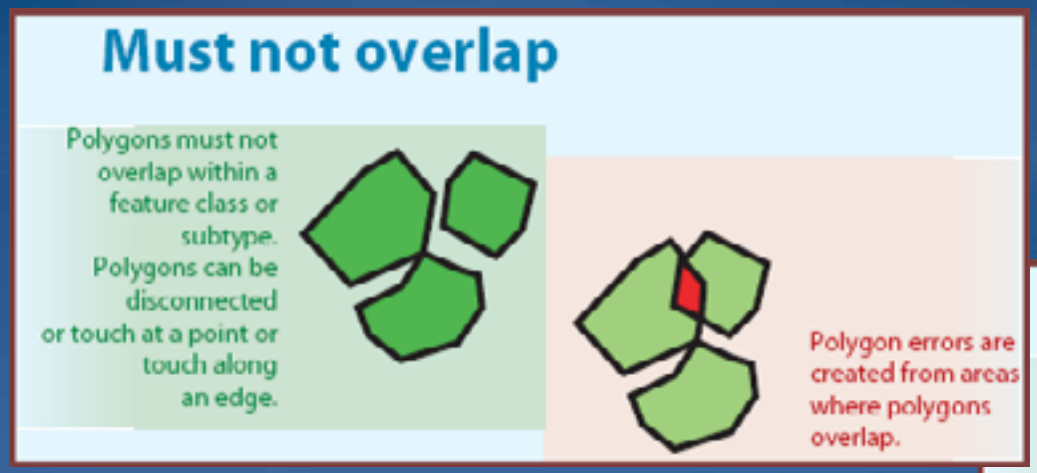
- A topology manages a set of simple feature classes that share geometry
- Topology is used to
  - Integrate feature geometry
  - Validate features
  - Control editing tools
  - Define relationships between features
  - Ensure the quality of your data

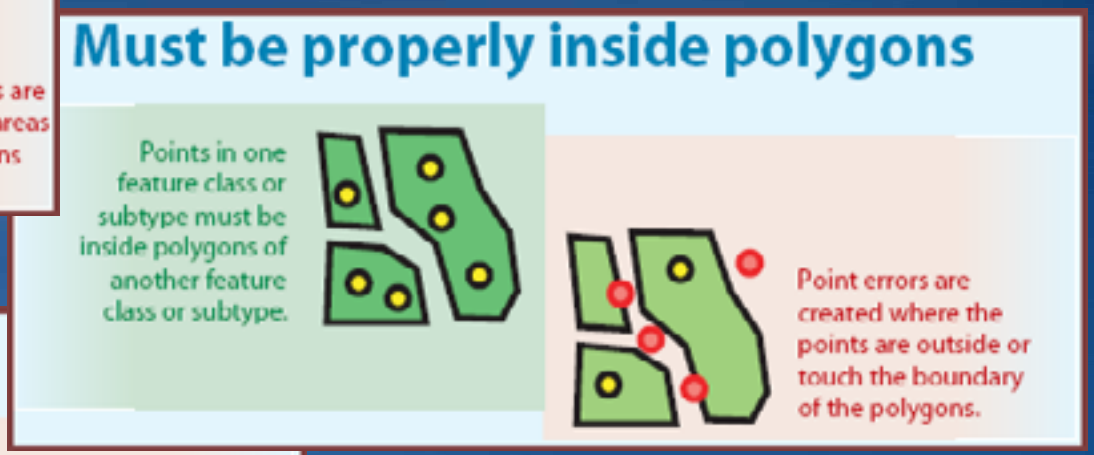
Topological Integrity

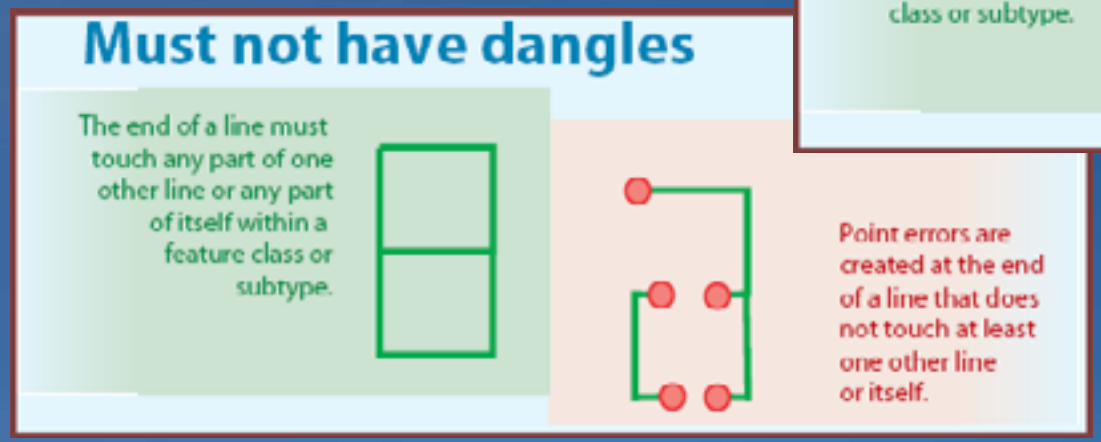
- Topology defines integrity rules for associated feature classes
  - Participating feature classes / subtypes
  - Cluster tolerance, ranks and rules
    - Cluster Tolerance for XY and Z
- Rules are evaluated during Validation
  - Define rules when creating the Topology
- Violations of these rules are 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**

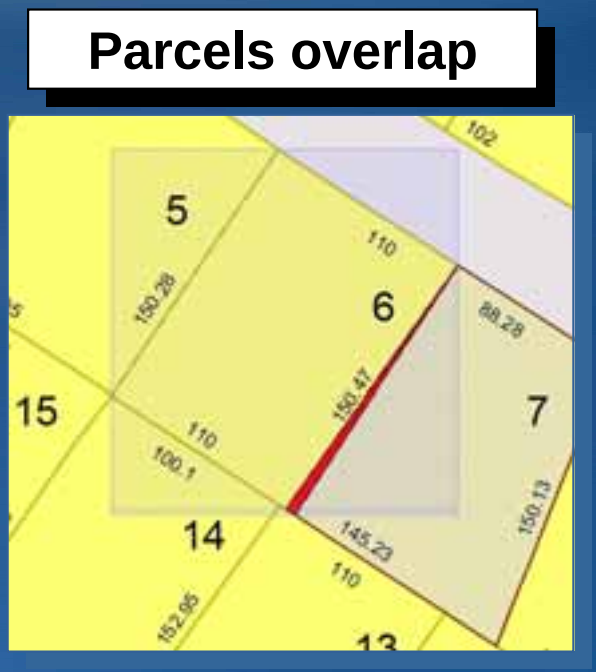






Editing with a Topology

- 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



Geodatabase Behavior Demo

- Explore a Geodatabase
  - Topology
  - Geometric Network

Advanced Behavior Demo

Tosia Shall

Session Path

The Geodatabase

Inside the Geodatabase

Advanced Behavior

Editing Geodatabases

- Transaction model
- Geodatabase editing solutions
- Versioning

Geodatabase Potpourri

Editing Geodatabases

- ArcGIS datasets stored in the geodatabase are editable
  - Merge adjacent parcels in a topology
  - Add water mains to a network
  - Update land owners in a relationship class
  - Etc…
- There is a rich 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
    - Unit of work performed against the database
    - The transaction is either committed or rolled back

Editing Geodatabases…

- **Personal Geodatabases**
  - Single user, cubicle editing on small datasets
  - Multiple readers
  - Editing locks at geodatabase level
    - Two editors cannot edit within the same geodatabase at same time

- **File Geodatabase**
  - Single user , Workgroup editing on small to very large datasets
  - Multiple readers
  - Editing locks at the feature level
    - Two editors cannot edit the same object/feature class at same time

Editing Geodatabases…

- ArcSDE Geodatabases
  - Extend the transaction model with Versions
  - Enterprise level editing
  - Multiuser editing without locking
    - Unique isolated view of the geodatabase
- Benefits of versioned editing
  - Long Transactions
  - Undo / Redo
  - Archiving
  - Replication / mobile GIS

Session Path

The Geodatabase

Inside the Geodatabase

Editing Geodatabases

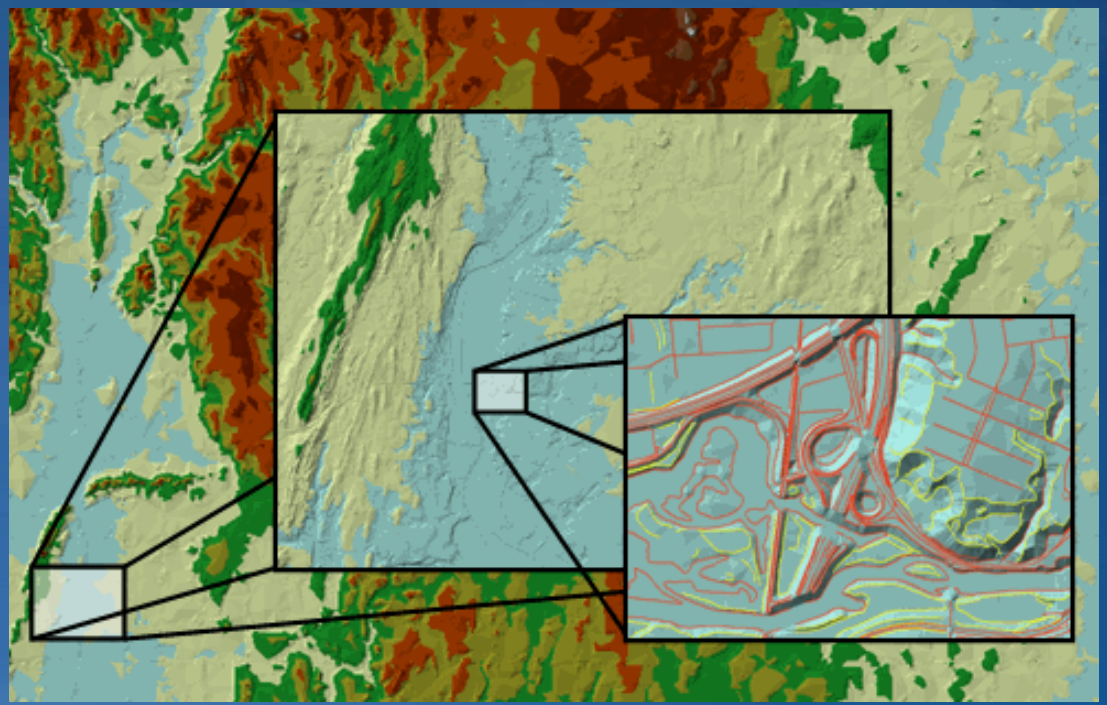
Advanced Behavior

Geodatabase Potpourri

- Terrains
- Cartographic representations
- Cadastral
- Demo

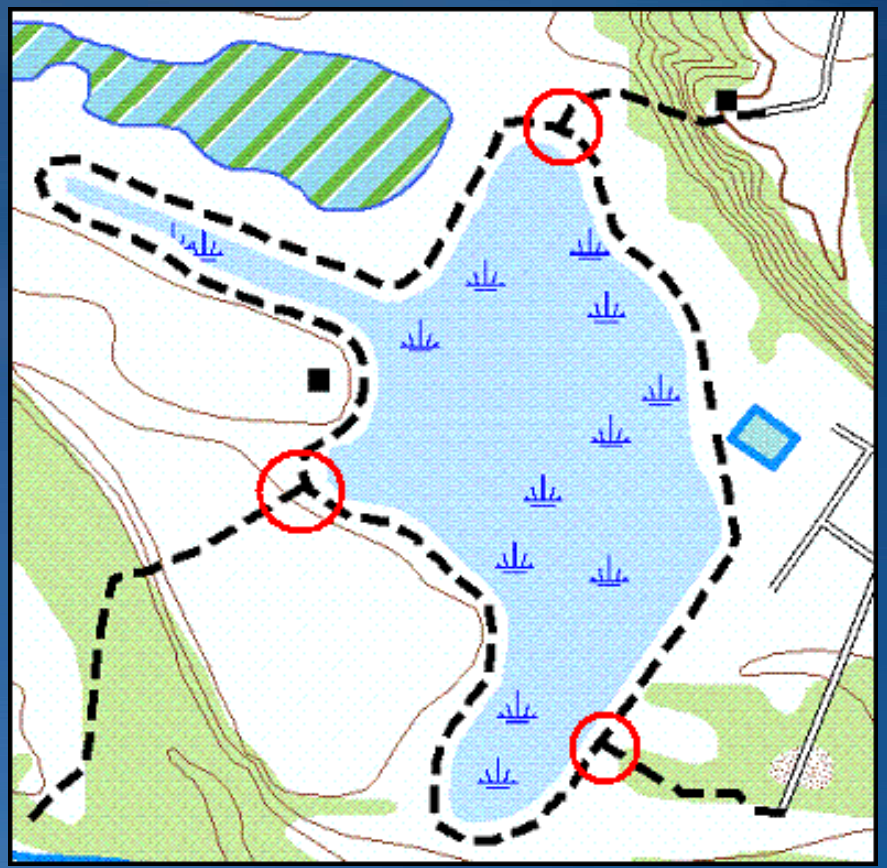
Terrains

- Massive point datasets in a multi-resolution, on-the-fly generated 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



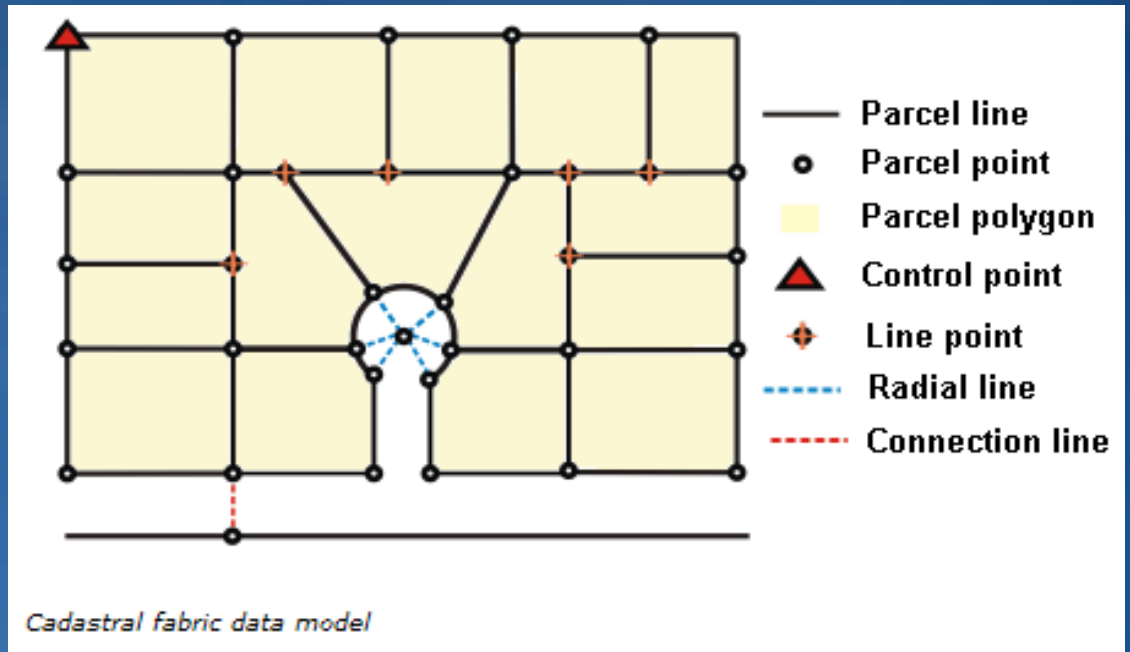
Representations

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



Cadastral Editor

- Solution for parcel data management
  - Survey Analyst extension
    - Uses COGO attributes and survey control to improve spatial accuracy
- Cadastral editing
  - Cadastral editor toolbar
  - Cadastral fabrics
    - Group layer with sublayers
    - Jobs



Cadastral fabric data model

Geodatabase potpourri Demo

Tosia Shall

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
- Editing Geodatabases
  - Transaction model, Editing solutions, Versions
- Geodatabase Potpourri
  - Terrains, Representations, Cadastral

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