Geodatabase – An Introduction

David Crawford and Jonathan Murphy
Session Path

• The Geodatabase
  • What is it?
  • Why use it?
  • What types are there?

• Inside the Geodatabase
• Advanced Behavior
• 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
Why use the Geodatabase?

- Simple!
- The model to best support the ArcGIS system within an organization
Why use the Geodatabase?

- Campus Place Finder
- Showing business logic
Session Path

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  • What is it?
  • Why use it?
  • What types are there?

• Inside the Geodatabase
• Advanced Behavior
• Geodatabase Potpourri
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

<table>
<thead>
<tr>
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<th>Enterprise gdb (3 Types)</th>
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<tbody>
<tr>
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<td>1 TB per table*</td>
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</tr>
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</tr>
<tr>
<td><strong>Number of users</strong></td>
<td>Single editor</td>
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<td>Multiple editors &amp; readers</td>
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* By default; option to have 256 TB per table
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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 Catalog
- 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 Potpourri
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

- Feature dataset
  - Spatial reference
- Feature classes
  - Polygon
  - Line
  - Point
  - Annotation
- Raster datasets
  - Parcel fabrics
  - Terrain datasets
  - Representations
  - Locators
- Additional geodatabase elements
- Relationship classes
- Geometric networks
- Topology
- Network datasets
- Toolboxes
  - Tool
  - Model
  - Script
- Behavior
  - Attribute defaults
  - Attribute domains
  - Split/merge policy
  - Connectivity rules
  - Relationship rules
  - 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
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
Geodatabase Supports Advanced Geometry

- Point, lines, polygons
  - Single and multipart features
- 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

Subdivision
- ParcelCorner
- Parcel
- ParcelAnno
- LotLines
- Parcel_Topo
- LotDimensions
- BoundryLines
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
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
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

<table>
<thead>
<tr>
<th>Parcels</th>
<th>Buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td>ParcelID</td>
<td>Parcel_ID</td>
</tr>
<tr>
<td>28</td>
<td>28</td>
</tr>
<tr>
<td>794</td>
<td>794</td>
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<tr>
<td>858</td>
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<td>Zone</td>
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<tr>
<td>28</td>
<td>Commercial</td>
</tr>
<tr>
<td>794</td>
<td>Residential</td>
</tr>
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<td>858</td>
<td>Residential</td>
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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

Feature Class | Composite Relationship class | Annotation Feature class
---|---|---
41  | 21 41 92 | 92 Placerville
43  | 23 43 94 | 94 Sacramento
47  | 27 47 95 | 95 Topanga Canyon
49  |  |  |
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 Potpourri
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
Network Datasets

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

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  - 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
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 Potpourri
  • Terrains, Representations, Parcel fabrics, Geocoding
Other Geodatabase Resources

• Geodatabase Island in the Showcase Area
  Meet the specialists!

• Geodatabase Resource Center
  http://resources.arcgis.com/en/communities/geodata

• Inside the Geodatabase Blog

• ArcGIS.com

• Check out the Demo Theatre schedules
Thanks for listening!

• Fill out surveys – Esri.com/ucsessionsurveys
• Offering ID:
  • Tuesday - #1198
  • Wednesday - #1306

• Questions?
Other Relevant Sessions

Technical Workshops

• **Automating Geodatabase Creation with Geoprocessing Tools**
  - Thursday 3:15pm – Room 07 A/B

• **Editing Versioned Geodatabases: An Introduction**
  - Thursday 1:30 – Ballroom 6F

• **Geometric Networks: An Introduction**
  - Thursday 8:30am – Ballroom 6D

• **Topology in the Geodatabase: An Introduction**
  - Wednesday 10:15am – Ballroom 6C

• **Using the ArcGIS System to Access your Geodata**
  - Wednesday 3:15pm – Ballroom 6D
  - Thursday 3:15pm – Ballroom 6F